INTEGRATED OPERATIONAL REQUIREMENTS DOCUMENT (IORD) I

NATIONAL POLAR-ORBITING OPERATIONAL ENVIRONMENTAL SATELLITE SYSTEM (NPOESS)

ACAT LEVEL I

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NPOESS Integrated Operational Requirements Document

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FOR THE

NATIONAL POLAR-ORBITING OPERATIONAL ENVIRONMENTAL SATELLITE SYSTEM (NPOESS)

1. General Description of Operational Capability.

1.1 Mission Area.

The National Polar-orbiting Operational Environmental Satellite System (NPOESS) supports the operational needs of the civilian meteorological, oceanographic, environmental, climatic, and space environmental remote sensing programs, and Global Military Environmental Support, for Geophysical and Space Support. In addition, NPOESS supports the National Space Act of 1958 and the Presidential Decision Directive (PDD)/NSTC-2, dated May 5, 1994 and promotes a positive international image for the United States Government.

1.2 Mission Needs Summary.

The U.S. Government (USG), specifically the Department of Commerce's (DOC) National Oceanic and Atmospheric Administration's (NOAA) and Department of Defense's (DoD) environmental missions, requires an enduring capability to acquire and receive in real time at field terminals, and to acquire, store and disseminate to processing centers, global and regional meteorological, environmental, and associated data at varying refresh rates. These data must include, but are not limited to: information on imagery, atmospheric profiles of temperature and moisture, and other specialized meteorological, terrestrial, climatic, oceanographic, and solar-geophysical data, as well as a search and rescue capability to support world-wide USG (Military and Civil) operations and high-priority programs.

The USG requires regular and reliable global imagery and quantitative atmospheric, oceanic, land, solar, and space environmental measurements in support of (not in priority order): 1) aviation forecasts (domestic, military, and international); 2) medium range forecast outlook (out to ten days); 3) tropical cyclone (e.g., hurricane) warnings; 4) severe storm and flood warnings; 5) forecasts of ice conditions; 6) solar and space environmental forecasts; 7) hydrologic forecasts; 8) forecasts of the ocean surface and internal structures; 9) seasonal and interannual climate forecasts; 10) decadal-scale monitoring of climate variability; 11) assessment of long-term global environmental change; 12) environmental air quality monitoring and emergency response; 13) tactical decision aids; and, 14) weapon systems utilization.

The NOAA Polar-orbiting Operational Environmental Satellite (POES) and the Defense Meteorological Satellite Program (DMSP) meet most U.S. needs for remote environmental sensing. The NPOESS will be a replacement program for the POES and DMSP Follow-On systems. During the NPOESS era, Europe plans to fly operational polar-orbiting satellites under their Meteorological Operational (METOP) program. The role of METOP in NPOESS is TBD pending an international agreement between the USG and the European Space Agency (ESA)/European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT). To minimize cost to the USG, the NPOESS Integrated Program Office (IPO) will determine the optimum level of utilization of METOP in meeting some USG requirements, such as refresh rate.

1.2.1 Requirements and Mission Needs Document Summary. Numerous requirements and mission needs documents exist which contain specific requirements for both POES and DMSP. Those documents pertaining to NPOESS are listed below.

Environmental Sensing. DOC and DoD require global and regional environmental data which includes cloud imagery, atmospheric profiles, and other specialized meteorological, oceanographic, climatic, and solar-geophysical data to provide forecasts, advisories, and warnings to support civilian and military operations as well as national programs. DoD's need for this information is documented in the Air Force Space Command (AFSPC) Mission Need Statement (MNS) 035-92 for Environmental Sensing, validated 6 January 1993. DOC's need for this information is documented in the Department of Commerce, National Oceanic and Atmospheric Administration 1995-2005 Strategic Plan, dated 15 July 1993, and Public Law 15 USC 313 "Organic Act".

Other specific DoD mission needs documents are:

Remote Atmospheric Soundings (REAMOS). United States Air Force (USAF) Statement of Need (SON) 505-79 (S), validated 30 September 1979.

Space Environmental Monitoring (SEM). USAF SON 001-83 (S), validated 24 August 1987.

Environmental Requirements (Draft). United States Marine Corps.

Operational Requirements Document for Oceanographic/Meteorological/Acoustic Mini-Drifting Data Buoy, number 276-096-91, promulgated by CNO (OP-91) , 11 January 1991.

Shallow Water/Littoral Warfare Oceanography Requirement. CINCLANT letter 3140 Ser N37003801 dated 13 August 1993.

Critical Meteorological and Oceanographic Thresholds for SOF Operations. United States Special Operations Command Manual dated 27 October 1993.

Report on Environmental Requirements for the Battle Force Information Management System. Space and Naval Warfare Systems Command dated March 1987.

Promulgation of Environmental Requirements to Support the Tomahawk Weapon. Program Executive Officer, Cruise Missiles Project and Unmanned Aerial Vehicles Joint Project letter 3090 Ser PMA-281/C147 dated 31 August 1993.

Satellite Measurement of Oceanographic Parameters (SMOP). The Operational Requirement (OR) for SMOP is OR-W0527-05 (U), validated 10 February 1977.

The OR for Oceanographic Sensors for the Defense Meteorological Satellite Program was approved 12 April 1990 and specifically addresses Navy unique options for the DMSP Follow-on System.

Improved Weather Analysis and Prediction System (IWAPS). USAF SON 006-86, validated 16 September 1988.

Pre-Strike Surveillance and Reconnaissance System (PRESSURS). General Operational Requirement (GOR) 508-78, validated 28 December 1978.

Ionospheric Sensing (IONS). USAF SON 002-80, validated 21 March 1980.

Space Environmental Technology Transition (SETT). USAF SON 005-86, dated 28 March 1986, validated 15 June 1988.

Survivable Weather and Fallout Assessment System (SWFAS). SAC-004-87 (S), validated 26 October 1987.

Electro-Optical Tactical Decision Aids (EOTDA). USAF SON 509-87, dated 9 December 1987, validated 20 December 1988.

Global and Theater Weather Analysis and Prediction System (GTWAPS). USAF MNS 014-92 (draft), validated 22 Dec 1993.

Integrated Meteorological System (IMETS). The Operational and Organizational (O&O) Plan for IMETS (AN/TMQ-40) was validated 22 December 1986, and the Required Operational Capability (ROC) for IMETS was validated 12 March 1991.

Target Area Meteorological Sensors System (TAMSS). The MNS for TAMSS was validated 14 September 1992.

Cloud Depiction and Forecast System II. HQ USAF MNS 005-92, dated 3 Sep 92.

1.3 Proposed System Requirements.

The NPOESS Program is required to provide, for a period of at least 10 years, a remote sensing capability to acquire and receive in real time at field terminals, and to acquire, store and disseminate to processing centers, global and regional environmental imagery and specialized meteorological, climatic, terrestrial, oceanographic, solar-geophysical, and other data in support of DOC mission requirements, and DoD peacetime and wartime missions. The NPOESS Program has four segments: 1) Space; 2) Launch Support; 3) Command, Control, and Communications (C^3); and, 4) Interface Data Processor (IDP) (Figure 1.0). Standardization (which includes compatibility, interoperability, interchangeability, and commonality) of DoD, DOC, and NASA systems, components and interfaces, will be a primary goal of NPOESS.

1.3.1 Space Segment. The Space Segment will include platforms for sensors which will collect and transmit environmental and other data directly to IDPSs collocated with Field Terminals (receivers used by deployed/remote units to obtain environmental data) and will collect and store environmental data and other data until it can be downlinked directly to the C^3 Segment. The Space Segment will consist of meteorological, oceanographic, terrestrial, space environmental monitoring, and climatic sensors, in addition to other systems for surface data collection/location, and search and rescue.

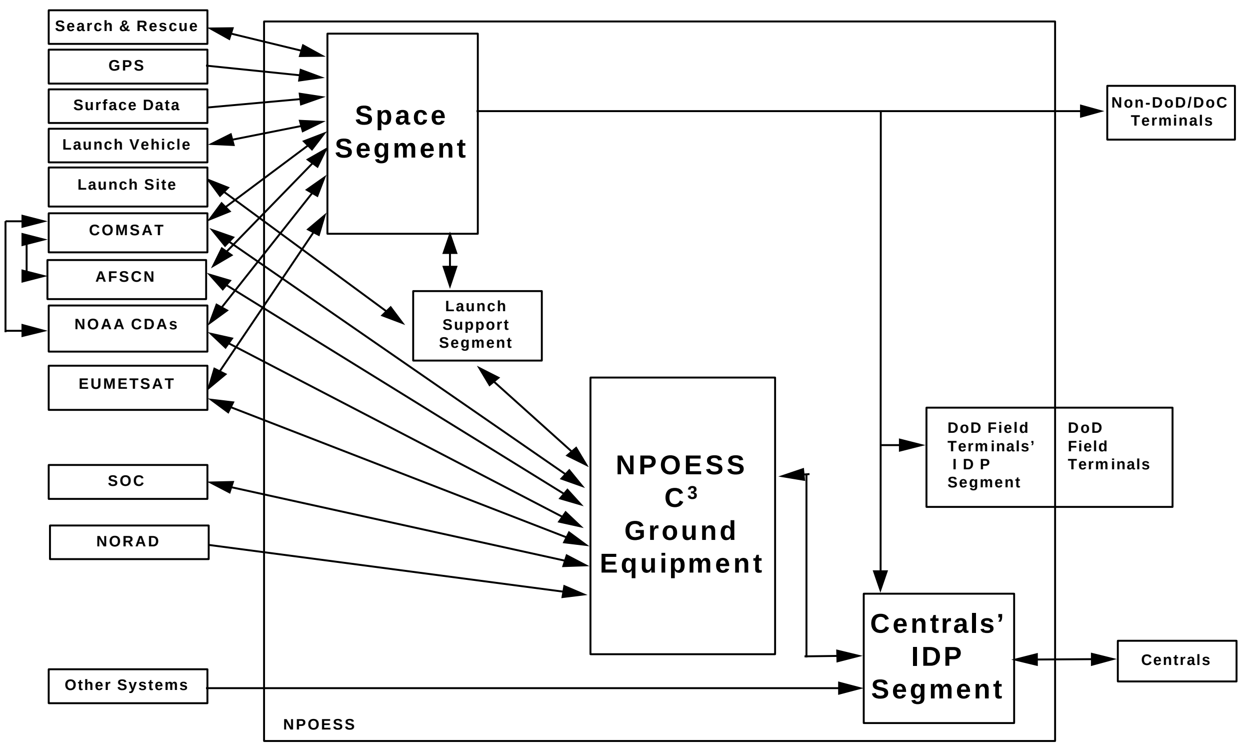

Figure 1.0 - NPOESS Functional Diagram

To meet the requirements from DoD, DOC, and national and international agreements, the NPOESS Program must have the capability to simultaneously broadcast two types of "real-time data" to suitably equipped ground stations. The first is high (full) resolution imagery and other associated environmental data (similar to the current DMSP fine mode and NOAA High Resolution Picture Transmission (HRPT) data). The second is a subset of the imagery data (i.e., fewer channels at full resolution, or all channels at reduced resolution) and other associated environmental data (similar to the current NOAA Automatic Picture Transmission (APT) or future Low Resolution Picture Transmission (LRPT) or DMSP's real time data smooth mode). Future communications capabilities may allow other-than-direct data transmission to follow-on Field Terminal systems, provided the requirements of timeliness and guaranteed reception are met.

1.3.2 Launch Support Segment. The Launch Support Segment includes all launch support equipment including Aerospace Ground Equipment (AGE) and Real Property Installed Equipment (RPIE), and launch facilities. AGE consists of test equipment, computer check-out systems, etc. RPIE includes items such as power equipment, air conditioning equipment, and non-flight fuel stores. The launch facilities include payload test facilities, and other required equipment and facilities to place the spacecraft into operational orbit.

1.3.3 Command, Control, and Communications (C^3) Segment. The NPOESS C^3 Segment consists of shared and dedicated C^3 resources such as antennas, communication links, and ground equipment, needed to fulfill the NPOESS mission. NOAA and AFSPC will provide the C^3 Segment support for NPOESS operations. The NPOESS C^3 Segment will consist of a rational and cost effective mix of NOAA and Air Force Satellite Control Network (AFSCN) C^3 assets. These assets consist of NOAA's Command and Data Acquisition (CDA) ground stations at Fairbanks, Alaska, and Wallops Island, Virginia, and a Satellite Operations Center (SOC) at Suitland, Maryland, as well as the AFSCN's sixteen common-user ground stations located at nine geographical sites and Satellite Operations Center (SOC) at Falcon AFB, Colorado. The high latitude European CDA station at Kiruna, Sweden, or Tromso, Norway, will be used by NPOESS if and when necessary according to international agreements, but the remainder of the C^3 segment for NPOESS control must be able to meet 100 percent of NPOESS C^3 requirements without the European station's support. This segment will also include all spacecraft simulators.

The AFSCN/CDA network will be the DoD and DOC source of command, control, and data routing to the data processing centers (Centrals) for NPOESS. The NPOESS C^3 Segment must include all functions required for day-to-day state-of-health monitoring of all operating spacecraft and must support the delivery of data to the designated Centrals. One hundred percent of the mission data must be provided to the Centrals. Real-time data must be provided to users via a direct communications link between the spacecraft and user terminals.

The NPOESS C^3 Ground Equipment will consist of the resources to conduct commanding, mission planning, launch and early orbit operations, command and telemetry database management, code configuration management, telemetry evaluation, spacecraft analysis, telemetry storage, ground system management, data distribution, encryption/decryption capabilities and resources to use spacecraft simulators. The ground-space system interface will use the most current technology available, within fiscal constraints, to reduce the time required to process data. It will employ such concepts as work-station based, color monitors, and icon and graphical interfaces. The planning function will be designed to enable real-time adjustments for satellite usage schedule changes.

1.3.4 Interface Data Processor Segment (IDPS). The IDPS consists of two components: data processing functions which meet the requirements of Centrals and Field Terminals. All IDPSs must consist of at least, but must not be limited to, the hardware and software necessary to receive and process Raw Data Records (RDRs) into Environmental Data Records (EDRs). Processing RDRs into EDRs will require production of intermediate-level satellite instrument data files, commonly known as Sensor Data Records (SDRs) and Temperature Data Records (TDRs). The requirement for the SDRs/TDRs is for retrospective processing, leading to improved methods, or for archival, for long-term sensor evaluation or troubleshooting. Typically the RDRs are very large data files that are difficult to archive, and require an IDPS to process. The TDRs, which contain the counts and calibration data at geolocated points, allow any necessary retrospective analyses without requiring archival of the packed raw data file. The calibration data and counts in the TDRs provide reversible data, to recreate RDRs from EDRs for validation purposes. This intermediate-level needs to be available as separate and selectable data records. This data is vital when validating the data, determining data quality, and in data quality resolution.

Data must be delivered to the Centrals' and Field Terminals' IDPSs as RDRs. Furthermore, the DoD's IDPSs must convert RDRs to appropriate SDRs/TDRs and EDRs for model/forecaster use, for the DoD unique and joint DoD/DOC parameters. Throughout this document, production of EDRs will necessarily also mean production of SDRs/TDRs, as needed. This especially includes the EDR/RDR matrix (Table 1.0), which lists delivery destinations of RDRs/EDRs.

In addition, the spacecraft must provide real-time data to Field Terminal components (land and ship-based, fixed and mobile environmental data receivers operated by USAF, United States Navy (USN), United States Marine Corps (USMC), United States Coast Guard (USCG), and United States Army (USA), and surface receivers operated by world wide weather services and other agencies).

Other federal, state, and local agencies, universities/academia, and industry, on a world-wide basis, must also be able to access NPOESS data. NPOESS must be designed to meet user needs with minimum impact to existing receiver terminals and procedures.

1.4 Operational and Support Concepts.

1.4.1 Operational Concept. The NPOESS satellite system must be controlled by the C^3 Segment. The C^3 Segment may also support TBD portions of METOP and incorporate TBD portions of EUMETSAT CDA stations. The operational concept for the NPOESS Program is for the space segment to collect space, climatic, meteorological, terrestrial, solar geophysical, oceanographic and other environmental data and transmit the data as RDRs to IDPSs collocated with field terminals and centralized processing centers. These IDPSs must convert RDRs to EDRs before hand-off to the respective Field Terminals and Centrals, which then integrate them into weather and other environmental products for transmission to end users.

The NPOESS responsibilities for data handling/manipulation/distribution end with the passing of data from the IDPSs to the Centrals and Field Terminals.

The primary SOC, as part of the C^3 segment, will be operated by the NPOESS IPO at Suitland, MD. This SOC will be responsible for performing the operational functions of satellite command and control, mission planning, antenna resource scheduling, launch and early orbit, anomaly resolution, data access, and the relay of data to Centrals, through the AFSCN/CDA network. DoD and DOC, not the NPOESS program, will have primary responsibility for data processing and distribution to their respective user agencies below Central level.

A minimally manned backup SOC will be operated by the USAF at Falcon AFB, CO. This backup SOC will be capable of performing the same operational functions as the primary SOC with the exception of launch and early orbit operations. The backup SOC will routinely exercise its capability to perform backup functions to maintain proficiency.

In the event of a catastrophic failure at the Suitland SOC, or during any other scenario when directed by the IPO (e.g., preventive maintenance activities, wartime contingencies), the backup SOC will assume primary operational responsibility for NPOESS.

The responsibility for satellite control resides with the IPO. Satellite Control Authority (SCA) is the authority to direct, approve, or delegate satellite command and control operations to maintain a specific satellite in a safe operating configuration, take actions necessary to "safe" the satellite, and to implement approved satellite hardware and software reconfigurations. This authority resides within the SOCs. Procedures must be developed to enable the transfer of SCA between SOCs, as necessary, in the event of conflicts (war) and contingency situations.

1.4.1.1 Space Segment. The Space Segment must continuously observe, store and transmit required environmental data to the Centrals' IDPS. Real-time data are also continuously broadcast to users within the satellite field of view. Launch and early orbit command and control of NPOESS will be the joint responsibility of the IPO's acquisition and operations directorates.

1.4.1.2 Launch Support Segment. The Launch Support Segment will be provided jointly by DoD/DOC, as appropriate.

1.4.1.3 C^3 Segment. Data will be distributed through the C^3 Segment to Centrals which are: Air Force Global Weather Central (AFGWC), Fleet Numerical Meteorological and Oceanographic Center (FNMOC), the 50th Weather Squadron (50 WS) (AF Space Command), Naval Oceanographic Office (NAVOCEANO), and National Environmental Satellite, Data, and Information Service (NESDIS). DoD and DOC will have primary responsibility for data processing and distribution to their respective user agencies below Central level, for processing within required timelines for priority and routine data. EUMETSAT requirements are TBD.

1.4.1.4 IDP Segment. This segment must have the capability to receive and store RDRs, process EDRs as necessary, send EDRs to user's processors, and allow data retrieval by users.

1.4.1.4.1 Centrals IDPS. The Centrals' IDPS must store the RDRs, process them into EDRs (for DoD), using ancillary data as necessary, and store the data IAW TBD procedures. Centrals and EUMETSAT (TBD) may provide the data to local systems and other users, as required. Other users may also have an independent reception capability. The processing, archiving, and dissemination of these data is their responsibility.

1.4.1.4.2 Field Terminal IDPS**.** DOC and DoD will, as required, operate field terminals which will receive NPOESS data. This document will only discuss the acquisition and maintenance of the IDPS equipment for DoD field terminals, and request provision of interface control documentation, not discuss the field terminals themselves.

2. Threat.

The threats to NPOESS are discussed in the following classified references: Space Systems Threat Environment Description (TED), S/NF/FRD, DOC NAIC-1571-727-95, 11 Sep 95, and the Defense Meteorological Satellite Program (DMSP)/National Polar-Orbiting Operational Satellite System (NPOESS) System Threat Assessment Report (STAR), SECRET, NAIC-1571-0110-96, Mar 96.

2.1 Operational Threat Environment.

See DMSP/NPOESS STAR for details on countries that have the capability, or potential capability to threaten NPOESS, and how NPOESS would be threatened under the Major Regional Contingency (MRC)-East (Middle East) and MRC-West (Korean peninsula) scenarios.

2.2 System Specific Threats at Initial Operational Capability (IOC) (2005) and IOC+10 years (2015).

The most likely threats against NPOESS fall into four main categories. The first is Information Warfare (IW), which encompasses network vulnerabilities, Electronic Warfare (EW), and exoatmospheric nuclear bursts. The second is the threat from anti-satellite (ASAT) directed energy weapons (DEWs), to include lasers, radio frequency weapons, and neutral particle beam weapons. The third is the threat from ASAT kinetic energy weapons (KEWs). The fourth is the threat to NPOESS terminal control segments from conventional, unconventional, and non-military forces. See DMSP/NPOESS STAR for details.

2.3 Reactive Threat.

The reactive threat is an assessment of changes to the threat environment that could reasonably be expected to occur as a direct result of the development and deployment of NPOESS. No reactive threats are anticipated. See DMSP/NPOESS STAR for an explanation.

3. Shortcomings of the Existing Systems.

The existing DOC capability to satisfy the requirements specified in paragraph 1.2 is primarily through NOAA's POES plus leveraging of other satellite programs such as DMSP, and research satellites like the NASA-French Topex/Poseidon (T/P) and European Space Agency's (ESA) ERS-1. DoD utilizes the same data sources, but DMSP is DoD's primary source of satellite data. The following are some shortcomings associated with these systems: 1) Many current requirements, such as ocean color data, sea surface topography, and wind direction are not being met; 2) Some T/P data are received too late in time to be operationally useful; 3) T/P will be operational only through 1996 and no follow-on system is currently programmed; 4) ERS - 1 data are received in a pre-processed product format, possibly limiting some usefulness at central processing sites; 5) Neither of these systems (T/P, ERS-1) can be received in real-time at deployed/field sites; 6) NOAA’s current polar-orbiting satellites will only be operational through approximately 2007; and, 7) Lifetime probability predictions of the current space segment of DMSP (5D2/5D3 series satellites) indicate that this series of satellites will be capable of supporting the DoD mission requirements only through 2008.

The current system capability is achieved through the coordinated efforts of four Segments: the Space Segment; the Launch Support Segment; the C^3 Segment; and the IDP Segment.

3.1 Space Segment.

The current POES and DMSP systems maintain no growth capability for areas such as power, payload capacity, data throughput, weight, or autonomy. Planned sensor manifests for DMSP 5D-3 and NOAA K,L,M series of satellites make maximum use of available power, weight, and data processing, leaving no possibility for growth. The current DMSP system has the capability to collect day and nighttime fine resolution data. However, the capacity of on-orbit data storage and data transmission rates limit the quantity of fine resolution data from DMSP and high resolution data from POES which can be stored for subsequent transmission to the ground. The current mapping accuracies do not meet requirements, posing a limitation to the application of infrared (IR) and visible resolution capability. Mapping error is incurred by uncertainties in spacecraft internal alignment, attitude control, ephemeris prediction, and ground data processing.

Current DMSP and POES mission sensors do not meet all resolution and accuracy requirements stated in this IORD, nor do they provide the swath width (sensor’s viewing footprint) required to provide contiguous global data for certain parameters. These shortcomings result in a lack of contiguous data near the equator which limits its usefulness in tropical storm and small-scale forecasting, and increases the period of time it takes for the satellite to provide global refresh of data. The orbital precession of POES satellites compromises data continuity. Finally, the current systems downlink stored data to ground stations with an average delay of over 50 minutes (oldest data delayed more than 102 minutes). This increases the delay in providing forecasts to customers.

Given the perishability of environmental data, the refresh inadequacies present a severe limitation to improving forecast accuracy and timeliness. With the current DMSP and POES systems, the data refresh rate ranges from 15 to 415 minutes, due to unequally spaced orbits. This results in DoD theater components providing customer support based upon data that are hours old. Local phenomena may develop and dissipate prior to receipt of the sensed data at the Centrals and Field Terminals.

3.2 C^3 Segment.

The current approach to DMSP C^3 Segment software support is limited and not responsive to support requirements, leading to a disjointed process. Limited access to a training system due to sharing with operational resources reduces the time available for operator training resulting in a lower level of system experience. In addition, the current DMSP system maintains only one communication path for the recovery of mission data. The current Space-Ground Link System (SGLS) and Data Retrieval and Routing (DRR) System does not provide sufficient bandwidth to support the high data rate downlink requirements of the current system. Any improvements in data delivery, such as the ability to downlink mission data more than once per revolution as well as multiple mission data routing paths, would result in direct improvements in forecasts and weapons deployments. Finally, the current system is at or near capacity and currently programmed modifications to AFSCN site availability further exacerbate this shortfall (i.e., the dedicated SOCs and RTS will close by 1998).

NOAA's current C^3 Segment, using a single control center and two CDAs, does not permit continuous or near continuous Telemetry, Tracking and Control (TT&C) and mission data recovery, resulting in uncommanded orbits and potentially lost or untimely data.

3.3 IDP Segment.

NOAA's current capacity to ingest data into its central computer processing system, convert these data to products to satisfy user demands, and deliver them to the users, is approaching maximum limits. Upgrades are anticipated to expand this capability in the NOAA K, L, M-era. However, further upgrades are needed to both DOC and DoD Centrals in the NPOESS era due to any NPOESS-induced changes.

4. Capabilities Required.

NPOESS must collect and disseminate timely environmental data to all Centrals and Field Terminals. Specific system capabilities are stated in the following paragraphs.

4.1 System Performance.

NPOESS must sense, collect, and disseminate full-earth-coverage environmental information once per given time period (consistent with observational requirements). All segments must adhere to a common system architecture to the maximum extent possible, and, as an objective, segments should employ common system software and hardware, particularly between the C^3 and IDP segments. System performance parameters such as measurement ranges, accuracy, and timeliness, and mission reliability, maintainability, and availability (RMA) requirements, as well as other required capabilities are broken out by segment below. NPOESS, when in an autonomous mode (i.e., satellite operating without updated command/control instructions), must continue to provide data to the Field Terminals.

4.1.1 Space Segment. The Space Segment will provide platforms for sensors which will collect and store environmental and other data (except search and rescue) until they can be downlinked directly to Field Terminals and to the C^3 Segment. Future communications capabilities may allow other-than-direct data transmission to follow-on Field Terminal systems, provided the requirements of timeliness and guaranteed reception are met.

4.1.1.1 Mission Payload Characteristics. Mission sensor data will be collected by multiple technologies to satisfy system requirements. These sensors will be located on one or multiple spacecraft. Data collection requirements may be met by either direct sensing of required parameters or derivation from sensed information. Imagery and vertical profiler sensors will be a combination of optical and microwave multi-spectral imagers/sensors. Each channel, as appropriate, must be independently commandable in “RDR”, or “no data” downlink modes, where the satellite provides either RDRs or no data. Other sensors must monitor Earth Radiation Budget, Space Environmental, Ocean/water, and Land parameters, described in Section 4.1.6.

4.1.1.2 Other Payloads. NPOESS must also provide sensors enabling surface data collection and location services (i.e., ARGOS or its follow-on) plus the capability to provide search and rescue functions (i.e., Search and Rescue Satellite Aided Tracking - SARSAT).

4.1.2 Launch Support Segment. The Launch Support Segment will provide resources, as appropriate, to accomplish launch operations, and putting each satellite into the correct orbit.

4.1.3 C^3 Segment. The NPOESS C^3 segment must be designed to take into maximum consideration the experience the NOAA and DoD operators have with the current POES and DMSP satellite control systems. Under the NPOESS program, the hardware and software located at the IPO SOC in Suitland, Maryland, and at the DoD SOC at Falcon AFB, Colorado, must be compatible with existing military standards and civil protocols to ensure seamless transition during backup operations, continuity of data flow and processing, and ease of maintenance; it must be interoperable. Interoperable means functionally identical computer system architectures and specific programs which are operated and maintained using the same commands and procedures. The system must ingest and process EUMETSAT data as required. The C^3 equipment will be in place and operational at the IPO and DoD SOCs prior to launch of the first NPOESS satellite. This segment will include all spacecraft simulators.

If data compression techniques are used in stored data retrieval, the compression must be lossless. Phase 1 studies may investigate if low rate, direct data broadcasts (APT) serving low resolution Field Terminals must accept lossy compression. Commencing with the launch of the first NPOESS satellite, the C^3 Segment may use the existing AFSCN/NOAA CDA sites to the maximum extent, augmented by the EUMETSAT northern European Station (at Tromso or Kiruna). The EUMETSAT station will be used to augment capabilities, but all NPOESS requirements must be met without that augmentation. The Tracking and Data Relay Satellite Systems (TDRSS) may be used for data routing and retrieval. Though TDRSS is not yet a requirement, nor is it yet a validated option, it may be studied as part of Phase 1, with a final report to users as a Phase 1 deliverable.

The NPOESS C^3 segment software (including ground equipment and/or data processing routines) will be written in a computer language which is compatible with the future equipment selected for the DOC and DoD sites. The software must be interoperable between agencies systems.

4.1.4 IDP Segment. The IDPS must have the ability to receive RDRs from the C^3 or Space Segments (as appropriate for Centrals or Field Terminals), process the RDRs into EDRs, and store RDRs, EDRs, and surface data collection/location data in a data base management system until delivered to, or retrieved by, the users' computer processor for access as needed by users. The design of the IDPS will not preclude, but will minimize, the use of other external data sources in generating EDRs. The IDPS must have adequate temporary storage capacity to allow the Centrals to access the RDRs (DOC) or RDRs/EDRs (DoD) for 24 hours worth of passes per satellite, for potentially TBD simultaneous NPOESS spacecraft contacts (data downloads). The IDPS must provide for 100% growth in storage and processing capacity. The IDPS must not overwrite the RDR/EDR field until the Centrals or Field Terminals receive the data. If there are three simultaneous contacts, the IDPS needs to store three passes. For the Field Terminal IDPS, the design must consider, to the maximum extent possible, the Field Terminals' operations and maintenance concepts, which call for operator maintenance.

4.1.5 System Characteristics. The agency shown in the headings of the following paragraphs is the primary user of that parameter. Where more than one agency name is listed, the agency name which appears first generally has the more stringent requirement. The parameters and sub-parameters noted with an asterisk **(*)** and **bold** type are those to be included in the Acquisition Program Baseline as key performance parameters (KPPs). KPPs are those parameters so significant that failure to meet the threshold is cause for the system to be reevaluated or the program to be reassessed or terminated.

4.1.5.1 Data Availability (DoD/DOC). Ninety-seven point five percent (97.5%) (on an annualized basis) of the observable data collected must be provided to the Centrals as a DOC threshold. As a DoD threshold, ninety-five percent (95%) of the time these data must be provided to the Centrals within 1.25 times the orbital period, plus 30 minutes, from the time of observation. Time for data processing (RDR to EDR) by IDPS before passing to DoD Centrals and Field Terminals must not exceed 20 minutes. This 20 minute period must be part of the 30 minute period mentioned in this paragraph. If a satellite contact is missed, data must be recovered on the next available contact. Data must be provided directly to Field Terminals as collected. Mission data processing (RDR to EDR) time by IDPS at DoD Field Terminals must not exceed 20 minutes from the time data are received. However, capability to display imagery data in near-real-time as it is received is still required. Imagery must be processed/displayed first for these DoD terminals, with other data allowed to take up to 20 minutes to be processed into EDRs. DOC has the requirement to receive all stored (global) RDRs from any NPOESS satellite within 15 minutes of its loss of signal (LOS) at any NPOESS C^3 station. DOC has the requirement that a global RDR data set be defined as beginning at LOS to the next LOS of any given C^3 station. (The RDR data set will then include, as the end of the orbit, observations being acquired by the NPOESS satellite during acquisition at any C^3 station).

DOC requires NPOESS satellites to continuously transmit data per Table 1.0 (page 44) in real time (i.e. as acquired by the NPOESS satellite) for acquisition by any remote ground station/Field Terminal. DOC requires these data be available to any remote ground station/Field Terminal at full resolution with the exception of such services as the existing reduced-resolution terminals. Table 1.0 lists the RDRs/EDRs needed at any DoD or DOC site, but does not indicate whether the receiving agency has a threshold for that data. Section 4.1.6 lists threshold information.

4.1.5.2. Autonomous Operations (DoD). The spacecraft will have an autonomous operations capability which maintains the ability to provide real-time mission data without C^3 contact for a period of at least 21 days (60 days objective) with a mapping accuracy threshold of at least 45 km ($\leq$ 1 km objective), to DoD Field Terminals. All storing of mission sensor data and transfer of stored data to ground receivers may be affected, but real-time transmissions must not be affected by autonomous operation. Each satellite must be capable of being commanded, or must automatically transition into autonomous operation after a period of 24 hours has passed from the time of transmission of the last command from the C^3 Segment. Each satellite must be capable of performing housekeeping tasks without ground contact. When transition to autonomous operation occurs, satellites will automatically begin transmission of data using TBD methods to accomplish data denial. Each satellite must also maintain a historical record of autonomous events to the extent necessary to enable reconstruction of the decisions made and methods used by the satellite while in the autonomous mode. Each satellite must be commandable from the ground to toggle between normal non-autonomous and autonomous operation. In addition, ground override of any autonomous function must be provided.

4.1.5.3 Stored High Resolution Data (DoD/DOC). An operator must be able to command selection of up to one-half of each orbit to be stored at regional resolution for those parameters with a regional resolution specified. This is in addition to the other half of each orbit being stored at global resolution. Specific commanded areas for each orbit might or might not be contiguous.

4.1.5.4 Surface Data Collection/Location (DOC/DoD). As a threshold NPOESS will geolocate data sources and/or collect data from globally deployed environmental sensor platforms, such as drifting buoys, for real-time transmissions to Field Terminals, and must be stored for relay to central and field locations. This will be done by the French-supplied System ARGOS (or its follow-on system) as on the current NOAA POES.

4.1.5.5 Orbital Characteristics (DoD/DOC). NPOESS must be designed, as a threshold, so the same latitude is imaged/measured at approximately the same local solar time (LST) each day. NPOESS must be capable of flying at any equatorial node crossing times, with an objective of user selectable crossing times. DoD requires a satellite to be flown at a nodal crossing time of approximately 0530 LST (daylight descending) and DOC requires a satellite to be flown at a nodal crossing time of approximately 1330 LST. The orbit will be a "precise" orbit (i.e., altitude maintained to ± TBD km, nodal crossing times maintained to ± 10 minutes throughout the mission lifetime) to minimize orbital drift (precession). The satellite orbits must be equally spaced, to the maximum extent possible. The capability must also exist to maintain an exact ground track repeat of ± TBD km and TBD days.

4.1.5.6 System Survivability (DoD). See DMSP/NPOESS STAR.

4.1.5.7 Search and Rescue (DOC). Threshold and objective requirements are TBD, however, DOC requires the NPOESS Program to be operationally compatible with and carry specific receivers, transmitters, etc., to fulfill DOC's international agreements (Russia, Canada, U.S., France, COSPAS (Russian search and rescue satellite system)/SARSAT agreement, 1 Jul 1988) for search and rescue (i.e., emergency transmitter locations).

4.1.5.8 Compatibility (DOC). Other federal, state, and local agencies, universities/academia, and industry, on a world-wide basis, must also be able to access NPOESS data pending Tri-Agency agreements. NPOESS development will consider these users in addition to DOC users and will be designed to be compatible, where practical and economical, to meet user needs with minimum impact to existing receiver terminals and procedures, as a threshold.

4.1.5.9 Space Debris Minimization (DoD/DOC). The NPOESS satellite must be designed so that measures will be taken to minimize space debris to the maximum extent possible (IAW National Space Policy Directive 1, dated 2 Nov 89, and USSPACECOM Reg 57-2), as a threshold.

4.1.5.10 *Data Access (*DoD). The NPOESS must be **capable of selectively denying all U.S. environmental sensor data (excepting ARGOS and SARSAT)** as a threshold, during contingencies or conflicts.

4.1.5.11 Geolocation of Data (DOC/DoD). NPOESS satellite orbit and attitude information must be provided with environmental data, as a threshold, to accurately locate the data source.

4.1.5.12 Space Environmental Constellation Characteristics (DoD/DOC). As a threshold, all space environmental parameters must be measured in each orbital plane continuously at required resolution along the entire orbital track. In addition, equal spacing, and adequate coverage of the dawn/dusk transitions and the approximate noon/midnight fluctuations of the ionosphere and magnetosphere are necessary. One exception to these requirements is the solar Extreme Ultraviolet (EUV) flux, which is obtained by viewing the sun directly, and must be measured at least once every five hours.

4.1.6 Performance Characteristics. For both DoD and DOC, the final output products of their Centrals are accurate forecasts and analyses of environmental conditions to enhance various military and civilian operations. These forecasts are prepared using data from multiple systems, including NPOESS. DOC and DoD operational requirements are data values to be used as inputs to computer algorithms in order to create final forecast products for customers. The following environmental data record (EDR) requirements define the environmental data to be derived from the NPOESS data stream and delivered to DoD users to meet mission needs. DOC requirements of the NPOESS data do not exclusively equate to environmental data records. DOC does not require generation and delivery of EDRs by NPOESS, but will process RDRs acquired by its IDPS Central into products for its uses and distribution.

EDR parameters listed in 4.1.6.1 unique to DOC, or jointly defined with DoD, include DOC-submitted attribute thresholds (and their justifications in RCM-II) which characterize DOC's satellite sensor data requirements. DOC's mission requirements include derivative products not listed as EDRs, but which are derivable from data that must be provided in order to generate EDRs as defined here.

Parameter thresholds are cited first and objectives are cited second in the following paragraphs. Note that thresholds and objectives listed refer to the minimum requirement at any point where measurements are sensed, (e.g., a requirement for horizontal resolution of 25 km indicates a need for data at that resolution or better across the entire area where data are being measured, unless indicated with a nadir (direct overhead view) and worst case (at the edge of satellite field of view) resolution separately). Any requirement giving “nadir resolution” as an attribute presumes the expansion of the resolution at oblique viewing angles is a natural outcome of observing a sphere from space, and does not presume a specific scanning methodology. In these instances technology will be driven by the nadir, or highest quality, field of view.

Parameter attributes may be referred to as global and/or regional. Global coverage denotes the observation of all points on the Earth or its atmosphere at least once per given time period (consistent with observational requirements), and may imply use of lower resolution recorded data. Regional coverage denotes observations of a smaller geographic area which may be stored as higher resolution data.

Data are required during any weather conditions. Thresholds given for attributes broken into "cloudy" (greater than or equal to five-tenths cloud cover) and "clear" (less than five-tenths cloud cover) cases indicate the government's recognition that different technologies must be employed to provide accurate measurements under these two different atmospheric conditions. Threshold value differences between cloudy and clear cases demonstrate how the more stringent of the two is required when obtainable, and will add important information in the ultimate operational application of the data.

All data are required at the accuracy/refresh/resolution stated, for any Earth location/profile. The performance characteristics for the EDR attributes of Sensing Depth, Measurement Range, Vertical Sampling Interval and/or Vertical Resolution, and Measurement Precision must be within the normal/expected sensing range unless specifically indicated otherwise for each EDR.

DOC requires NPOESS instrument performance data be delivered with the data streams so changes in responsivity, noise, and other parameters requiring ground processing corrections can be characterized. Furthermore, sensor data must be calibrated to ensure measurement repeatability, and the calibration statistics must be capable of being monitored over the instrument lifetime. Instrument stability characterization is required by DOC, in order to ensure that changes (stepwise or trends) over time in products or EDRs can be quantified with respect to any possible instrument performance changes. "Long term stability," (also known as "long term calibration") is defined as the maximum excursion of the short-term average measured value of a parameter under identical conditions over the mission duration. The short-term average is the average of a sufficient number of successive measurements of the parameter under identical conditions such that the random error is negligible relative to the systematic error. DOC's climate monitoring mission depends on the ability to quantify long-term stability to remove temporal variations in instrument bias. This does not necessitate checking the data for ground truth, but perhaps for reasonable data value bounds.

EDRs are organized into Key, Atmospheric, Cloud, Earth Radiation Budget, Land, Ocean/water, and Space Environmental parameters. Potential pre-planned product improvement EDRs are also listed. Attachment 3 contains the definitions for parameter characteristics.

4.1.6.1 Key Environmental Performance Parameters. (Listed alphabetically).

4.1.6.1.1 *Atmospheric Vertical Moisture Profile (*DOC/*DoD): Water vapor mixing ratio profile throughout the troposphere where moisture is normally measured via radiosonde. (Units: g/kg). Measurement accuracy is relative to ground truth, not absolute, accuracy.

Systems Capabilities	Thresholds	Objectives
a. Horizontal Resolution	15 km at nadir	2 km
b. Vertical Sampling Interval		
1. Surface to 850 mb	20 mb	5 mb
2. 850 to 100 mb	50 mb	15 mb
c. Mapping Accuracy	5 km	1 km
d. Measurement Accuracy (expressed		±10 %

as percent error of average mixing ratio in 2 km layers)		
Clear:		
1. Surface to 600 mb*	**±20 % (DoD: ±25%)**	
2. 600 mb to 400 mb	±35 %	
3. 400 mb to 100 mb	±35 %	
Cloudy:		
4. Surface to 600 mb*	**±20 % (DoD: ±25%)**	
5. 600 mb to 400 mb	±40 %	
6. 400 mb to 100 mb	±40 %	
e. Refresh	6 hours	3 hours

4.1.6.1.2 *<u>Atmospheric Vertical Temperature Profile</u> (<u>*DOC/*DoD</u>). Sampling of temperature at stated intervals throughout the atmosphere.

Systems Capabilities	Thresholds	Objectives
a. Horizontal Resolution		
1. Clear, nadir	18.5 km	5 km
2. Clear, worst case	100 km	
3. Cloudy, nadir	40 km	5 km
4. Cloudy, worst case	50 km	
b. Vertical Sampling Interval		
1. Surface to 850 mb	20 mb	15 mb
2. 850 to 300 mb	50 mb	15 mb
3. 300 to 100 mb	25 mb	15 mb
4. 100 to 10 mb	20 mb	10 mb
5. 10 to 1 mb	2 mb	1 mb
6. 1 to 0.1 mb	0.2 mb	0.1 mb
7. 0.1 to 0.01 mb	0.02 mb	.01 mb
c. Mapping Accuracy	5 km	1 km
d. Measurement Accuracy (expressed as error in layer average temperature)		±0.5 K
Clear:		
1. Surface to 300 mb*	**±1.6 K per 1 km layer**	
2. 300 mb to 30 mb	±1.5 K per 3 km layer	
3. 30 mb to 1 mb	±1.5 K per 5 km layer	
4. 1 mb to 0.01 mb	±3.5 K per 5 km layer	
Cloudy:		
5. Surface to 700 mb*	**±2.5 K per 1 km layer**	
6. 700 mb to 300 mb	±1.5 K per 1 km layer	
7. 300 mb to 30 mb	±1.5 K per 3 km layer	
8. 30 mb to 1 mb	±1.5 K per 5 km layer	
9. 1 mb to 0.01 mb	±3.5 K per 5 km layer	

e. Refresh	6 hours	3 hours

4.1.6.1.3 *<u>Imagery (*DoD/*DOC)</u>. Specialized cloud and ice imagery at sufficient resolution to enable analyst discernment of atmospheric phenomena - from cloud types and elements (as defined in AFI 15-111, Vol. I) to planetary scale (10^7 m) weather patterns. DoD needs the ability for visual (including visual night imagery), IR, microwave and stratus/fog/snow discrimination in regional resolution. Microwave imagery is also required. However, thresholds for microwave imagery need only match the level of performance required for other EDRs requiring microwave data. Imagery must also provide digital input to remote sensing algorithms which produce other EDRs, and to characterize sea and freshwater ice properties, including location of the ice edge, concentration, thickness and size of leads and polynyas. With this resolution, ice edge detection and ice concentration analyzed to the nearest 1/10 will be produced interactively by ice analysts using computer workstation.

Systems Capabilities	Thresholds	Objectives
a. Horizontal Resolution		
1. Global (DOC*)		
(a) **At nadir***	**1.0 km**	
(b) Worst case	2.4 km	0.65 km
2. Regional **(DoD*)** (all vis and IR bands)		
(a) **At nadir***	**0.4 km**	
(b) Worst case	0.8 km	0.1 km
3. Night-time visual	2.6 km	0.65 km
b. Mapping Accuracy		
1. At nadir	3 km	
2. Worst case	4 km	0.5 km
c. Refresh* (DoD*) (for visible and IR bands)	**At any location: a) the average revisit time will be 4 hours or less and the maximum revisit time will be 6 hours or less; b) at least 75% of the revisit times will be 4 hours or less.**	1 hour

4.1.6.1.4 *<u>Sea Surface Temperature (SST) (*DOC/*DoD</u>). Sea surface temperature (SST) is defined as the temperature of the surface layer of ocean water. It has two major applications: 1) sea surface phenomenology, and 2) use in infrared cloud/no cloud decision for processed cloud data.

Systems Capabilities	Thresholds	Objectives
a. Horizontal Resolution		
1. Global, nadir	3 km	1 km
2. Global, worst case	4 km	
3. Regional, nadir*	**1 km**	0.25 km
4. Regional, worst case	1.3 km	
b. Mapping Accuracy		
1. Global, nadir	1 km	0.5 km
2. Global, worst case	3 km	

3. Regional, nadir	1 km	0.1 km
4. Regional, worst case	3 km	
c. Measurement Range	-2° to 40° C	-2° to 40° C
d. Measurement Precision	0.2° C	0.1° C
e. Measurement Accuracy*	**±0.5° C**	±0.1° C
f. Refresh	6 hours	3 hours

4.1.6.1.5 *Sea Surface Winds (Speed and Direction) (*DoD/*DOC). Measure of atmospheric wind speed/direction at the sea/atmosphere interface.

Systems Capabilities	Thresholds	Objectives
a. Horizontal Resolution	20 km	1 km
b. Mapping Accuracy	5 km	1 km
c. Measurement Range	3 to 25 m/s, 0 to 360°	1 to 50 m/s, 0 to 360°
d. Measurement Precision		
1. Speed	1 m/s	1 m/s
2. Direction	10°	10°
e. Measurement Accuracy		
1. Speed*	**greater of ±2 m/s or ±20 %, whichever is greater;**	greater of ±1 m/s or ±10 %, whichever is greater;
2. Direction	±20 °	±10 °
f. Refresh	6 hours	1 hour

4.1.6.1.6 *Soil Moisture (Surface) (*DoD/DOC). Moisture in the soil within the zone of aeration, including water vapor present in soil pores.

Systems Capabilities	Thresholds	Objectives
a. Sensing Depth*	**Surface (skin layer: -0.1 cm)**	Surface to -80 cm
b. Horizontal Resolution (HR)		
1. Clear, nadir	1 km	
2. Clear, worst case	4 km	2 km
3. Cloudy, nadir	40 km	2 km
4. Cloudy, worst case	50 km	
c. Vertical Sampling Interval	Not Required	5 cm
d. Mapping Accuracy	3 km	1 km
e. Measurement Accuracy	Bare soil, in regions with known soil types: ±10 cm/m (low HR) ±20 cm/m (high HR - clear skies)	Surface: ±1 cm/m 80 cm column: ±5 % or ±130 g/m^3
f. Refresh	8 hours	3 hours

4.1.6.2 Atmospheric Parameters.

4.1.6.2.1 Aerosol Optical Thickness (DOC/DoD). Vertical visibility estimated at 1.0 μm wavelength. (# - applies to total column optical depth).

Systems Capabilities	Thresholds	Objectives
a. Sensing Depth	Surface to 30 km	Surface to 50 km
b. Horizontal Resolution	10 km	1 km

c. Vertical Sampling Interval	Total column	
1. from 0 to 2 km		0.25 km
2. from 2 to 5 km		0.5 km
3. >5 km		1 km
d. Mapping Accuracy #	4 km	1 km
e. Measurement Range #	0 to 2	0 to 10
f. Measurement Precision #	0.03	0.01
g. Measurement Accuracy	±0.03 over ocean	±0.01
h. Refresh	6 hours	4 hours, 2 hours during daylight
i. Long Term Stability	0.01	0.003

4.1.6.2.2 Aerosol Particle Size (DOC/DoD). Measurement of sizes of aerosols comprising aerosol concentration (Angstrom wavelength exponent). (# - applies to total column particle size).

Systems Capabilities	Thresholds	Objectives
a. Sensing Depth	Surface to 30 km	Surface to 50 km
b. Horizontal Resolution	10 km	1 km
c. Vertical Resolution	Total column	
1. from 0 to 2 km		0.25 km
2. from 2 to 5 km		0.5 km
3. > 5 km		1 km
d. Mapping Accuracy	4 km	1 km
e. Measurement Range #	-1 to +3	-2 to +4
f. Measurement Precision #	0.3	0.1
g. Measurement Accuracy #	±0.3 over ocean	±0.1
h. Refresh	6 hours	4 hours, 2 hours during daylight
i. Long Term Stability	0.1	0.03

4.1.6.2.3 Ozone Total Column/(Profile, Objective) (DOC). Measurement of ozone concentration within a specified volume.

Systems Capabilities	Thresholds	Objectives
a. Horizontal Resolution		
1. Total Column	50 km at nadir	50 km worst case
2. Profile	250 km	250 km
b. Vertical Resolution		
1. 0 to 10 km	N/A	3 km
2. 10 to 25 km	5 km	1 km
3. 25 to 60 km	5 km	3 km
c. Mapping Accuracy		
1. Total Column, at nadir	5 km	5 km
2. Profile	25 km	25 km
d. Measurement Range		
1. Total Column	0.05 to 0.65 atm-cm	0.05 to 0.65 atm-cm
2. Profile		
a. 0 to 10 km	N/A	0.01 to 3 ppmv

b. 10 to 60 km	0.1 to 15 ppmv	0.1 to 15 ppmv
e. Measurement Precision		
1. Total Column	0.001 atm-cm	0.001 atm-cm
2. Profile		
a. 0 to 10 km	N/A	10 %
b. 10 to 15 km	10 %	3 %
c. 15 to 50 km	3 %	1 %
d. 50 to 60 km	10 %	3 %
f. Measurement Accuracy		
1. Total Column	±0.015 atm-cm	±0.005 atm-cm
2. Profile		
a. 0 to 10 km	N/A	±10 %
b. 10 to 15 km	±20 %	±10 %
c. 15 to 60 km	±10 %	±5 %
g. Refresh		
1. Total Column	24 hours	24 hours
2. Profile	7 days	24 hours
h. Long Term Stability		
1. Total Column	1 %	0.5 %
2. Profile	2 %	1 %

4.1.6.2.4 Precipitable Water (DOC). Total atmospheric water vapor contained in a vertical column of unit cross-sectional area between any two specified levels. Units are millimeters of condensed vapor.

Systems Capabilities	Thresholds	Objectives
a. Sensing Depth	Surface to Top of Atmosphere (TOA)	
b. Horizontal Resolution	25 km	1 km
c. Mapping Accuracy	3 km	0.1 km
d. Measurement Range	0 to 75 mm	0 to 100 mm
e. Measurement Precision	1 mm	1 mm
f. Measurement Accuracy	greater of 2 mm or ±10 %	±1 mm
g. Refresh	6 hours	3 hours

4.1.6.2.5 Precipitation Type/Rate (DoD/DOC). Precipitation rate and identification by type as rain, cloud water, or ice.

Systems Capabilities	Thresholds	Objectives
a. Horizontal Resolution	15 km	0.1 km
b. Mapping Accuracy	3 km	0.1 km
c. Measurement Range	0 to 250 mm/hr	
d. Measurement Precision	1 mm/hr	1 mm/hr
e. Measurement Accuracy	±2 mm/hr	±2 mm/hr
f. Refresh	8 hours	3 hours

4.1.6.2.6 Pressure (Surface/Profile) (DoD). Measurement of pressure at surface and profile.

Systems Capabilities	Thresholds	Objectives

a. Sensing Depth	Surface to 30 km	Surface to 30 km
b. Horizontal Resolution	25 km	5 km
c. Vertical Resolution		
1. 0 to 2 km	1 km	0.25 km
2. 2 to 5 km	1 km	0.5 km
3. > 5 km	1 km	1 km
d. Mapping Accuracy	7 km	1 km
e. Measurement Range	10 to 1050 mb	10 to 1050 mb
f. Measurement Precision	4 mb	2 mb
g. Measurement Accuracy		
1. 0 to 10 km	±5 %	±3 %
2. 10 to 30 km	±10 %	±5 %
h. Refresh	12 hours	1 hour

4.1.6.2.7 Suspended Matter (DoD/DOC). Detection of suspended dust, sand, volcanic ash as thresholds, and these plus sea salt detection as an objective.

Systems Capabilities	Thresholds	Objectives
a. Horizontal Resolution	3 km	1 km
b. Vertical Sampling Interval	Not required	0.2 km
c. Mapping Accuracy	3 km	0.1 km
d. Measurement Range		
1. Detect aerosols	dust, sand, ash	dust, sand, ash, sea salt
2. Radioactive/smoke plumes	TBD	0 to 100 $\mu g/m^3$ (smoke)
e. Refresh	12 hours	3 hours

4.1.6.2.8 Total Water Content (DoD). Measure of moisture in a given volume of the atmosphere.

Systems Capabilities	Thresholds	Objectives
a. Horizontal Resolution	20 km	10 km
b. Vertical Resolution	3 km	1 km
c. Mapping Accuracy	7 km	7 km
d. Measurement Accuracy		
1. Total Integrated Water Vapor	±2 kg/m^2, 1 kg/m^2 global average	
2. Cloud Liquid Water Content	±0.2 kg/m^2, over ocean only	
e. Refresh	8 hours	3 hours

4.1.6.3 Cloud Parameters (DoD/DOC). Cloud data are required by both DoD and DOC. The specific types of cloud data required are broken out in the following subparagraphs.

4.1.6.3.1 Cloud Base Height (DOC/DoD). Height above ground level where cloud bases occur, from surface to 30 km.

Systems Capabilities	Thresholds	Objectives
a. Horizontal Resolution	25 km	10 km
b. Vertical Sampling Interval	TBD	0.25 km

c. Mapping Accuracy	4 km	1 km
d. Measurement Accuracy	±2 km	±0.25 km
e. Refresh	6 hours	4 hours

4.1.6.3.2 Cloud Cover/Layers (DoD/DOC). Cloud cover is the fraction of a given area that is overlaid in the local normal direction by clouds; it is the portion of the earth's horizontal surface that is masked by the vertical projection of clouds. It needs to be known at separate, distinct levels.

Systems Capabilities	Thresholds	Objectives
a. Horizontal Resolution	25 km	2 km
b. Vertical Sampling Interval	4 layers	0.1 km
c. Mapping Accuracy	4 km	1 km
d. Measurement Range	0 to 100%	0 to 100%
f. Measurement Precision	15 % (layers)	2.5 %
e. Measurement Accuracy	±10 % (cover)	±5 %
g. Refresh	6 hours	4 hours

4.1.6.3.3 Cloud Effective Particle Size (DOC/DoD). Area-averaged measure of cloud particle size, derived from imagery. The effective radius is the ratio of the third moment of the drop size distribution to the second moment.

Systems Capabilities	Thresholds	Objectives
a. Horizontal Resolution	50 km	10 km
b. Vertical Sampling Interval	1 km	0.3 km
c. Mapping Accuracy	4 km	1 km
d. Measurement Range	0 to 50 µm	
e. Measurement Precision	greater of 5 % or 2 µm	2 %
f. Measurement Accuracy	greater of ±10 % or ±4 µm	greater of ±5 % or ±2 µm
g. Refresh	8 hours	3 hours
h. Long Term Stability	2 %	1 %

4.1.6.3.4 Cloud Ice Water Path (DOC). A measure of the equivalent water mass of the ice particles in a unit vertical column through the cloud. Measured information is dependent on the number of particles, their sizes, and their densities.

Systems Capabilities	Thresholds	Objectives
a. Sensing Depth	Surface to 15 km	Surface to 20 km
b. Horizontal Resolution	50 km	10 km
c. Vertical Sampling Interval	Total column	0.3 km
d. Mapping Accuracy	4 km	1 km
e. Measurement Range	0 to 1 mm	0 to 1 mm
f. Measurement Precision	5 %	2 %
g. Measurement Accuracy	±10 %	±5 %

h. Refresh	6 hours	3 hours
i. Long Term Stability	2 %	1 %

4.1.6.3.5 Cloud Liquid Water (DOC/DoD). Measurement of water equivalent within clouds.

Systems Capabilities	Thresholds	Objectives
a. Horizontal Resolution	20 km	5 km
b. Vertical Sampling Interval	Total Column	0.3 km
c. Mapping Accuracy	7 km	1 km
d. Measurement Accuracy	±0.5 mm over ocean, ±0.25 mm over land	±0.01 mm
e. Refresh	8 hours	4 hours

4.1.6.3.6 Cloud Optical Depth/Transmissivity (DOC). Measurement of cloud optical thickness and emissivity in the visible and IR portions of the spectrum.

Systems Capabilities	Thresholds	Objectives
a. Horizontal Resolution	50 km	10 km
b. Mapping Accuracy	4 km	10 km
c. Measurement Precision	5 %	2 %
d. Measurement Accuracy	±10 %	±5 %
e. Refresh	8 hours	3 hours
f. Long Term Stability	2 %	1 %

4.1.6.3.7 Cloud Top Height (DOC/DoD). Measurement of cloud top height.

Systems Capabilities	Thresholds	Objectives
a. Horizontal Resolution	25 km	10 km
b. Vertical Sampling Interval	four layers	0.25 km
c. Mapping Accuracy	4 km	1 km
d. Measurement Precision	0.3 km	0.15 km
e. Measurement Accuracy		
1. Optically thick	±0.5 km	±0.3 km
2. Optically thin	±2 km	±0.3 km
f. Refresh	8 hours	6 hours
g. Long Term Stability	0.2 km	0.1 km

4.1.6.3.8 Cloud Top Pressure (DOC). Derived atmospheric pressure at cloud tops for optically thick clouds.

Systems Capabilities	Thresholds	Objectives
a. Horizontal Resolution	15 km	10 km
b. Mapping Accuracy	4 km	1 km
c. Measurement Precision		
1. Surface to 3 km	50 mb	10 mb
2. 3 to 7 km	38 mb	7 mb
3. > 7 km	25 mb	5 mb

d. Measurement Accuracy		
1. Surface to 3 km	±100 mb	±30 mb
2. 3 to 7 km:	±75 mb	±22 mb
3. > 7 km	±50 mb	±15 mb
e. Refresh	8 hours	3 hours
f. Long Term Stability		
1. Surface to 3 km	10 mb	3 mb
2. 3 to 7 km	7 mb	2 mb
3. > 7 km	5 mb	1 mb

4.1.6.3.9 Cloud Top Temperature (DOC/DoD). Measurement of temperature at cloud tops.

Systems Capabilities	Thresholds	Objectives
a. Horizontal Resolution	25 km	10 km
b. Mapping Accuracy	4 km	1 km
c. Measurement Precision	1.5 K	0.5 K
d. Measurement Accuracy	±3 K	±1.5 K
e. Refresh	6 hours	6 hours
f. Long Term Stability	1 K	0.1 K

4.1.6.4 Earth Radiation Budget Parameters.

4.1.6.4.1 Albedo (Surface) (DOC/DoD) Measurement of the ratio of the amount of visible spectrum electromagnetic radiation reflected by the Earth to the amount incident upon it.

Systems Capabilities	Thresholds	Objectives
a. Horizontal Resolution	4 km	0.5 km
b. Mapping Accuracy	4 km	1 km
c. Measurement Range	0 to 100%	0 to 100 %
d. Measurement Precision	2 % (albedo units)	1 %
e. Measurement Accuracy	±5 % (albedo units)	±1.25 %
f. Refresh	24 hours	4 hours
g. Long Term Stability	2 % (albedo units)	1 %

4.1.6.4.2 Downward Longwave Radiation (DLR) (Surface) (DOC). DLR at the surface.

Systems Capabilities	Thresholds	Objectives
a. Horizontal Resolution	40 km at nadir	10 km
b. Mapping Accuracy	10 km	
c. Measurement Range	0 to 500 W/m^2	0 to 500 W/m^2
d. Measurement Precision	0.1 W/m^2	0.1 W/m^2
e. Measurement Accuracy	±5 W/m^2	±1 W/m^2
f. Refresh	14 hours	6 hours

4.1.6.4.3 Insolation (DOC). Incident Solar Radiation--amount of solar energy incident at the Earth's surface (hourly estimate).

Systems Capabilities	Thresholds	Objectives
a. Horizontal Resolution	50 km	100 km

b. Mapping Accuracy	5 km	1 km
c. Measurement Range	0 to 1400 W/m^2	0 to 1400 W/m^2
d. Measurement Precision	5 W/m^2	0.1 W/m^2
e. Measurement Accuracy	±20 W/m^2	±1.0 W/m^2
f. Refresh	24 hours	24 hours

4.1.6.4.4 Net Shortwave Radiation (TOA) (DOC). In-coming short wave radiation.

Systems Capabilities	Thresholds	Objectives
a. Horizontal Resolution	100 km	20 km
b. Mapping Accuracy	10 km	5 km
c. Measurement Range	0 to 900 W/m2	0 to 900 W/m^2
d. Measurement Precision	3 W/m^2	1.5 W/m^2
e. Measurement Accuracy	±5 W/m^2	±2.5 W/m^2
f. Refresh	12 hours	8 hours

4.1.6.4.5 Solar Irradiance (DOC). Incident radiation measurements (total and 2 narrow bands).

Systems Capabilities	Thresholds	Objectives
a. Measurement Range		
1. Total	1320 to 1420 W/m^2	1320 to 1420W/m^2
2. 200 to 300 nm band	0 to 10 W/m^2	0 to 10 W/m^2
3. 1500 nm band	0 to 10 W/m^2	0 to 10 W/m^2
b. Measurement Precision		
1. Total	0.002 %/year	0.0005 %/year
2. 200 to 300 nm band	0.02 %/year	0.01 %/year
3. 1500 nm band	0.01 %/year	0.005 %/year
c. Measurement Accuracy		
1. Total	±1.5 W/m^2	±0.5 W/m^2
2. 200 to 300 nm band	±2.0 %	±0.5 %
3. 1500 nm band	±2.0 %	±0.5 %
d. Refresh	20 minutes of viewing sun each orbit, 1 satellite	20 minutes of viewing sun each orbit, 3 satellites

4.1.6.4.6 Total Longwave Radiation (TOA) (DOC). Outgoing longwave radiation.

Systems Capabilities	Thresholds	Objectives
a. Horizontal Resolution	100 km	20 km
b. Mapping Accuracy	10 km	5 km
c. Measurement Range	0 to 500 W/m^2	0 to 500 W/m^2
d. Measurement Precision	3.0 W/m^2	1.5 W/m^2
e. Measurement Accuracy	±5 W/m^2	±2.5 W/m^2
f. Refresh	24 hours (once/daytime & once/nighttime)	4 hours

4.1.6.5 Land Parameters.

4.1.6.5.1 Land Surface Temperature (DoD/DOC). Land surface temperature is defined as the skin temperature of the uppermost layer of the land surface. It has two major applications: 1) characterization of backgrounds for electro-optical systems; and 2) use in infrared cloud/no cloud decision for processed cloud data.

Systems Capabilities	Thresholds	Objectives
a. Horizontal Resolution	4 km	1 km
b. Mapping Accuracy	4 km	1 km
c. Measurement Range	- 60 to 70 ° C	- 60 to 70 ° C
d. Measurement Precision	0.5^{o} C	0.025^{o} C
e. Measurement Accuracy	Clear: $\pm 2.5^{o}$ C	$\pm 1^{o}$ C
f. Refresh	Clear: 6 hours	3 hours

4.1.6.5.2 Normalized Difference Vegetation Index (DOC). Measure of biomass greenness in NDVI units.

Systems Capabilities	Thresholds	Objectives
a. Horizontal Resolution	4 km	1 km
b. Mapping Accuracy	4 km	1 km
c. Measurement Range	-1 to +1	-1 to +1
d. Measurement Precision	0.04 NDVI units	0.02 NDVI units
e. Measurement Accuracy	±0.05 NDVI units	±0.03 NDVI units
f. Refresh	24 hours	24 hours
g. Long Term Precision	0.04 NDVI units	0.04 NDVI units

4.1.6.5.3 Snow Cover/Depth (DoD/DOC). Horizontal and vertical extent of snow cover.

Systems Capabilities	Thresholds	Objectives
a. Sensing Depth	0 to 40 cm	1 m
b. Horizontal Resolution		
1. Clear	1.3 km	1 km
2. Cloudy	12.5 km	1 km
c. Vertical Sampling Interval	12.5 cm	> 8 cm > 15 cm > 30 cm > 51 cm > 76 cm
d. Mapping Accuracy		
1. Clear	2 km	1 km
2. Cloudy	7 km	1 km
e. Measurement Accuracy		
1. Clear	±10 % (snow/no snow)	±10 % for snow depth
2. Cloudy	±20 % (snow/no snow)	
f. Refresh	12 hours	3 hours

4.1.6.5.4 Vegetation Index/Surface Type (DoD). Predominant vegetation type in a given area, coupled with type of soil. The 21 types to be measured are: crop land, brush/scrub, coniferous forest, deciduous forest, tropical forest, grass land, swamp, marsh/bog, flooded land, loam, sandy soil, clay, peat, gravel, desert, water, snow/ice, urban/developed, rocky fields, tundra, and Savannah.

Systems Capabilities	Thresholds	Objectives
a. Horizontal Resolution		
1. Global	20 km	1.0 km
2. Regional	20 km	0.25 km
b. Mapping Accuracy	5 km	1 km
c. Measurement Range	Identification of 21 types	0 to 100 % vegetation and identification of 21 surface types
d. Measurement Precision	10 %	0.1 %
e. Measurement Accuracy	70 % correct for 21 types	±2 %
f. Refresh	24 hours	3 hours

4.1.6.6 Ocean/water Parameters.

4.1.6.6.1 Currents (DoD- near shore; DOC- surface). Large-scale movements of the surface waters of the ocean driven by wind, and the distribution of water density. Currents are a vector quantity with both speed and direction.

Systems Capabilities	Thresholds	Objectives
a. Sensing Depth	0 to 10 m	0 to 30 m
b. Horizontal Resolution		
1. Global, worst case	4 km	1 km
2. Regional, worst case	1.3 km	0.25 km
c. Vertical Resolution	Average vector for 5 m layers	Average vector for 1 m layers
d. Mapping Accuracy	3 km	1 km
e. Measurement Range	0 to 5 m/s, 0 to 360^o	0 to 5 m/s, 0 to 360^o
f. Measurement Precision	0.25 m/s, 15^o	0.1 m/s, 5^o
g. Measurement Accuracy	±0.25 m/s, ±15^o	±0.1 m/s, ±5^o
h. Refresh	TBD	12 hours

4.1.6.6.2 Fresh Water Ice (DOC/DoD). Ice property derived from imagery EDRs.

Systems Capabilities	Thresholds	Objectives
a. Sensing Depth	Ice Surface	1 m
b. Horizontal Resolution		
1. Regional, nadir	0.4 km	
2. Regional, worst case	0.8 km	0.65 km
c. Mapping Accuracy	3 km	1 km
d. Measurement Range	1/10 to 10/10 concentration	0/10 to 10/10 concentration
e. Measurement Accuracy		
1. Ice Edge Boundary	±10° latitude/longitude	±5° latitude/longitude
2. Ice Edge Concentration	±20%	±10%
f. Refresh	12 hours	6 hours

4.1.6.6.3 Ice Surface Temperature (DOC/DoD). Temperature at the ice surface.

Systems Capabilities	Thresholds	Objectives
a. Sensing Depth	Ice Surface	2 meters above ice surface
b. Mapping Accuracy	3 km	1 km
c. Measurement Range	-60 to +20^{o} C	
d. Measurement Accuracy	±1^{o} C	
e. Refresh	24 hours	12 hours

4.1.6.6.4 Littoral Sediment Transport (DoD). The transport of sediment by river systems and along shore currents. Measurement units are m^3/day.

Systems Capabilities	Thresholds	Objectives
a. Horizontal Resolution, worst case	1.3 km	0.1 km
b. Mapping Accuracy, worst case	3 km	0.1 km
c. Measurement Precision	40 %	15 %
d. Measurement Accuracy	±30 %	±15 %
e. Refresh	48 hours	12 hours

4.1.6.6.5 Net Heat Flux (DoD). Difference between incoming and outgoing radiation at air/sea interface.

Systems Capabilities	Thresholds	Objectives
a. Sensing Depth	Air/Sea interface	Air/Land/Sea interface
b. Horizontal Resolution	20 km	5 km
c. Mapping Accuracy	7 km	
d. Measurement Range	0 to 2000 W/m^2	0 to 1000 W/m^2
e. Measurement Precision	5 W/m^2	1 W/m^2
f. Measurement Accuracy	±10 W/m^2	±1 W/m^2
g. Refresh	6 hours	3 hours

4.1.6.6.6 Ocean Color/Chlorophyll (DoD/DOC). Color of the ocean as seen from a distance of at least 1 meter or chlorophyll content of water.

Systems Capabilities	Thresholds	Objectives
a. Horizontal Resolution		
1. Global, worst case	2.6 km	1 km
2. Regional, worst case	1.3 km	0.1 km
b. Mapping Accuracy		
1. Global, worst case	3 km	0.5 km
2. Regional, worst case	3 km	0.1 km
c. Measurement Range	0.05 to 50 mg/m^3	0 to 100 mg/m^3
d. Measurement Precision	20 %	10%
e. Measurement Accuracy	±30 %	±30 %
f. Refresh	48 hours	12 hours

4.1.6.6.7 Ocean Wave Characteristics (DoD/DOC). The height and period/frequency of ocean waves. (DoD requires period and frequency as an objective only.)

Systems Capabilities	Thresholds	Objectives
a. Horizontal Resolution		
1. Global, nadir, along track	20 km	5 km
2. Regional, nadir, along track	10 km	0.25 km
b. Mapping Accuracy		
1. Global, worst case	10 km	2 km
2. Regional, worst case	4 km	0.25 km
c. Measurement Range		
1. Height	0.5 to 30 m	0.5 to 30 m
2. Direction	0 to 360^o	0 to 360^o
d. Measurement Precision		
1. Height	0.2 m	0.1 m
2. Direction	10^o	5^o
e. Measurement Accuracy		
1. Height	±0.2 m	±0.2 m
2. Direction	±10^o	±5^o
f. Refresh	72 hours	6 hours

4.1.6.6.8 Sea Ice Age/Sea Ice Edge Motion (DOC/DoD). Ice properties derived from imagery EDRs.

Systems Capabilities	Thresholds	Objectives
a. Sensing Depth	Ice Surface	1 m
b. Horizontal Resolution		
1. Ice Age	3 km	0.1 km
c. Mapping Accuracy	3 km	1 km
d. Measurement Range		
1. Ice Age	1 to 36+ months	
2. Ice Edge Motion	TBD	0 to 50 km/day
e. Measurement Accuracy		
1. Ice Age	Separation of 1 year old and 2 + year old ice with 70% of area defined correctly	Separation of <1 year old ice (new ice), 1 year old (1st year), & 2+ year old (multi-year) ice; with 90% of area defined correctly
2. Ice Edge Motion	±1 km/day	±0.1 km/day
f. Refresh	24 hours	12 hours

4.1.6.6.9 Sea Surface Height (DOC)/Topography (DoD). Sea surface height (topography) is the longwave horizontal variations in the height of the sea surface with respect to the geoid.

Systems Capabilities	Thresholds	Objectives
a. Horizontal Resolution	4 km	0.5 km
b. Mapping Accuracy	2 km	1 km
c. Measurement Range	±50 m	±50 m
d. Measurement Precision	3 cm	2 cm
e. Measurement Accuracy	±5 cm	±3 cm
f. Refresh	72 hours	3 hours

4.1.6.6.10 Surface Wind Stress (DOC/DoD). The frictional stress of the wind acting on the sea surface, causing it to move as a wind-drift current, and causing the formation of waves.

Systems Capabilities	Thresholds	Objectives
a. Horizontal Resolution	50 km	20 km
b. Mapping Accuracy	7 km	10 km
c. Measurement Range	0 to 50 N/m^2	0 to 50 N/m^2
d. Measurement Precision	2 N/m^2	1 N/m^2
e. Measurement Accuracy	±2 N/m^2	±1 N/m^2
f. Refresh	12 hours	12 hours

4.1.6.6.11 Turbidity (DoD/DOC). A measure of suspended matter in the ocean. Turbidity may also be derived from ocean color data.

Systems Capabilities	Thresholds	Objectives
a. Sensing Depth	Surface	
b. Horizontal Resolution	1.3 km	0.25 km
c. Mapping Accuracy	TBD	0.5 km
d. Measurement Range	TBD	0 to 100 mg/l
e. Measurement Precision	TBD	0.1 mg/l
f. Measurement Accuracy	±30 %	±0.1 mg/l
g. Refresh	48 hours	24 hours

4.1.6.7 Space Environmental Parameters.

4.1.6.7.1 Auroral Boundary (DoD/DOC). Locate the boundary of the auroral zone.

Systems Capabilities	Thresholds	Objectives
a. Measurement Accuracy	±50 km	±10 km

4.1.6.7.2 Auroral Energy Deposition, Total (DoD/DOC). Physical heat input parameter required for models of atmospheric densities.

Systems Capabilities	Thresholds	Objectives
a. Measurement Range		
1. electrons	10^{-4} to 1 W/m^2	$5x10^{-5}$ to 1 W/m^2
2. ions	10^{-4} to 10^{-1} W/m^2	$5x10^{-5}$ to 10^{-1} W/m^2
b. Measurement Accuracy	greater of $\pm 10^{-4}$ W/ m^2 or ±20 %	greater of $5x10^{-5}$ W/m^2 or ±10 %

4.1.6.7.3 Auroral Imagery (DoD/DOC). Specialized imagery in the proper wavelengths to allow visual interpretation of auroral characteristics.

Systems Capabilities	Thresholds	Objectives
a. Measurement Range	120 to 180 nm	80 to 250 nm
b. Measurement Accuracy	±10 %	±5 %
c. Horizontal Resolution	20 km	10 km

4.1.6.7.4 Electric Field (DoD/DOC). A vector field at a location in the immediate external environment of the satellite wherein any charged particle would experience an electrical force.

Electric field data in the auroral and polar cap regions are needed as input to operational space environmental models of the magnetosphere and ionosphere.

Systems Capabilities	Thresholds	Objectives
a. Measurement Range	0 to 150 mV/m	0 to 250 mV/m
b. Measurement Precision	2 mV/m	0.1 mV/m
c. Measurement Accuracy	±3 mV/m	±0.1 mV/m

4.1.6.7.5 Electron Density Profiles/Ionospheric Specification (DoD/DOC). Specifies the ionosphere by measuring Electron Density Profiles (EDPs), Total Electron Content (TEC), and identifying characteristics of the layer of maximum electron density (F2) by height in meters (HmF2), electron density (NmF2) and critical frequency (foF2).

Systems Capabilities	Thresholds	Objectives
a. Horizontal Resolution		
1. 0 to 30^o Lat	200 km	100 km
2. 30 to 50^o Lat	500 km	250 km
3. 50 to 90^o Lat	100 km	50 km
b. Vertical Resolution		
1. Within 100 km of either the E layer or F layer peaks	10 km	5 km
2. Elsewhere	20 km	5 km
c. Measurement Range		
1. Local density	$3x10^5$ to 10^7 cm^{-3}	10^4 to 10^7 cm^{-3}
2. TEC	$3x10^{16}$ to $2x10^{18}$ m^{-2}	10^{16} to $2x10^{18}$ m^{-2}
3. foF2	5 to 30 MHz	1 to 30 MHz
d. Measurement Accuracy		
1. Local density	$\pm 3x10^5$ cm^{-3}	$\pm 10^4$ cm^{-3}
2. NmF2	±20 %	±5 %
3. HmF2	±20 km	±5 km
4. TEC	greater of ±20% or $3x10^{16}$ m^{-2}	$\pm 10^{16}$ m^{-2}

4.1.6.7.6 Geomagnetic Field (DoD). Measurements of the Earth's vector magnetic field at spacecraft location.

Systems Capabilities	Thresholds	Objectives
a. In-Track Resolution	10 km	0.5 km
b. Mapping Accuracy	100 m	
c. Measurement Range	3D mag vector at s/c alt 20,000 to 60,000 nT	3D mag vector at s/c alt 10,000 to 60,000 nT
d. Measurement Precision	2 nT	0.5 nT
e. Measurement Accuracy		
1. Magnitude	±6 nT (rms)	±2 nT
2. Vector direction	1 arc min	0.6 arc min

4.1.6.7.7 In-situ Ion Drift Velocity (DoD/DOC). Measurements of in-situ plasma drift velocities; also used to infer electric field strengths and patterns in the auroral and polar cap regions.

Systems Capabilities	Thresholds	Objectives
a. Measurement Range	0 to 3 km/sec	0 to 5 km/sec
b. Measurement Precision	50 m/s	25 m/s
c. Measurement Accuracy	±75 m/s	±50 m/s

4.1.6.7.8 In-situ Plasma Density (DoD). Ion composition information required to determine the altitude of transition between oxygen and lighter ion species, as input to high altitude ionospheric models.

Systems Capabilities	Thresholds	Objectives
a. In Track Resolution	50 km	10 km
b. Measurement Range	$5x10^3$ to $5x10^6$ cm^{-3}	10^2 to 10^7 cm^{-3}
c. Measurement Accuracy	±20 %	±5 %

4.1.6.7.9 In-situ Plasma Fluctuations (DoD). Measurement of ionospheric structures responsible for scintillation occurring primarily at altitudes near the peak of the F2 region (250 to 400 km).

Systems Capabilities	Thresholds	Objectives
a. In-Track Resolution	100 km	5 m
b. Measurement Range		
1. Spectral Index	2 to 5	1 to 10
2. $\Delta n/n$	10^{-2} to 1.0	10^{-4} to 1.0

4.1.6.7.10 In-situ Plasma Temperature (DoD). Plasma temperatures measured in the mid-latitude region.

Systems Capabilities	Thresholds	Objectives
a. In-Track Resolution	100 km	10 km
b. Measurement Range	500 to 10,000 K	500 to 10,000 K
c. Measurement Accuracy	±10 %	±5 %

4.1.6.7.11 Ionospheric Scintillation (DoD). The fluctuation of both amplitude and phase of an electromagnetic frequency signal caused by variations in electron density along the transmission path.

Systems Capabilities	Thresholds	Objectives
a. Horizontal Resolution	100 km	50 km
b. Measurement Range		
1. Amplitude Index (S4)	0.1 to 1.5	
2. Phase Index (σ_ϕ)	0.1 to 20 radians	
c. Measurement Precision		
1. Amplitude Index (S4)	0.1	
2. Phase Index (σ_ϕ)	0.1 radians	
d. Measurement Accuracy	factor of ±2	

4.1.6.7.12 Neutral Density Profiles/Neutral Atmospheric Specification (DoD/DOC). Measurements of upper atmospheric densities.

Systems Capabilities	Thresholds	Objectives
a. Sensing Depth	100 to 750 km	90 to 1600 km
b. In Track Resolution	500 km	50 km

c. Vertical Resolution		
1. Up to 120 km	10 km	0.5 km
2. Above 120 km	10 km	3 km
d. Measurement Range		
1. Density	$3x10^{-9}$ to $2x10^{-19}$ g/cm^{-3}	
2. Number density	$6x10^{13}$ to $9x10^{4}$ cm^{-3}	
e. Measurement Accuracy		
1. 100 to 500 km	±15 %	
2. > 500 km	±20 %	
3. 90 to 500 km		±5 %
4. 500 to 700 km		±10 %
5. 700 to 1600 km		±15 %

4.1.6.7.13 Radiation Belt and Low Energy Solar Particles (DoD/DOC). Measurements of particles through this energy range.

Systems Capabilities	Thresholds	Objectives
a. Measurement Range		
1. Energy: ions	30 keV to 10 MeV in 8 bands	
electrons	30 keV to 10 MeV in 8 bands	
2. Flux: ions	10^{5} to 10^{11} $m^{-2}sec^{-1}ster^{-1}$	
electrons	10^{5} to 10^{11} $m^{-2}sec^{-1}ster^{-1}$	
b. Measurement Precision	5 %	1 %
c. Measurement Accuracy	±20 %	±10 %

4.1.6.7.14 Solar and Galactic Cosmic Ray Particles (DoD/DOC). Measurements of particles through this energy range.

Systems Capabilities	Thresholds	Objectives
a. Measurement Range		
1. Energy		
(a) protons	>10 MeV to 1000 MeV/nucleon in 6 bands	>10 MeV to >1000 MeV/nucleon in 8 bands
(b) alphas	>10 MeV to 1000 MeV/nucleon in 6 bands	>10 MeV to >1000 MeV/nucleon in 8 bands
(c) heavy ions (CNO)	>10 to 100 MeV/nucleon in 4 bands	
(d) heavy ions (Fe):	>10 to 100 MeV/nucleon in 4 bands	
2. Flux		
(a) protons	10^{3} to 10^{10} $m^{-2}sec^{-1}ster^{-1}$	10^{2} to 10^{10} $m^{-2}sec^{-1}ster^{-1}$
(b) alphas:	10^{2} to 10^{8} $m^{-2}sec^{-1}ster^{-1}$	10^{2} to 10^{8} $m^{-2}sec^{-1}ster^{-1}$
(c) heavy ions (CNO)	10^{0} to 10^{7} $m^{-2}sec^{-1}ster^{-1}$	10^{-2} to 10^{7} $m^{-2}sec^{-1}ster^{-1}$
(d) heavy ions (Fe):	10^{-1} to 10^{6} $m^{-2}sec^{-1}ster^{-1}$	10^{-3} to 10^{6} $m^{-2}sec^{-1}ster^{-1}$
b. Measurement Precision	5 %	1 %
c. Measurement Accuracy	±20 %	±10 %

4.1.6.7.15 Solar Extreme Ultra Violet (EUV) Flux (DOC). A measurement of that portion of the solar spectrum which is responsible for creation of the Earth's ionosphere as well as much of the heating of the upper atmosphere.

Systems Capabilities	Thresholds	Objectives
a. Measurement Range	5 to 130 nm in 4 channels	1 to 175 nm in 10 channels
b. Measurement Accuracy	greater of $\pm 10^{-4}$ W/m^2 or ±20 %	greater of $\pm 5 \times 10^{-5}$ W/m^2 or ±10 %

4.1.6.7.16 Supra-thermal through Auroral Energy Particles (DoD/DOC). Measurements of particles through this energy range.

Systems Capabilities	Thresholds	Objectives
a. Measurement Range		
1. Energy	30 eV to 30 keV	
2. Flux	10^8 to 10^{15} m^{-2}sec^{-1}ster^{-1}keV^{-1}	
b. Measurement Precision		
1. Energy, $\Delta E/E$	0.2	0.1
2. Flux	5 %	1 %
c. Measurement Accuracy	±20 %	±10 %

4.1.6.7.17 Upper Atmospheric Airglow (DoD). Measurements of airglow in the extreme and far ultraviolet portions of the spectrum used to infer the density of upper atmospheric neutral and ionized constituents; measurements of the magnitude (intensity) of particular frequencies of particle emissions. Units of R (Rayleighs) and kR (kiloRayleighs) are units of photon brightness.

Systems Capabilities	Thresholds	Objectives
a. In Track Resolution (Limb)	750 km	100 km
b. Horizontal Resolution (Disk)		
1. 0 to 30^o Lat	200 km	100 km
2. 30 to 50^o Lat	500 km	250 km
3. 50 to 90^o Lat	100 km	10 km
c. Vertical Resolution (Limb)	20 km	5 km
d. Measurement Range		
1. Limb, at 83.4 nm	20 to 1000 R	10 to 1000 R
2. Limb, at 135.6 nm	0.2 to 10 kR	0.1 to 10 kR
3. Limb, at 140 to 180 nm	0.2 to 30 kR	0.1 to 30 kR
4. Disk, at 121.6 nm	1 to 30 kR	0.5 to 30 kR
5. Disk, at 135.6 nm	4 to 4000 R	1.0 to 4000 R
6. Disk, at 140 to 180 nm	4 to 5000 R	1 to 5000 R
e. Measurement Accuracy	±10 %	±5 %

4.1.6.8 Potential Pre-planned Product/Process Improvements. This paragraph describes elements of the NPOESS mission needs having potentially restrictive technical or programmatic uncertainties identified as a result of Phase 0 Concept studies. DOC and DoD maintain a need for these observations, and prioritize them in terms of mission criticality below. The NPOESS Demonstration/Validation (Phase 1) allows for continued examination of possible solutions to these needs, including new or modified instrumentation in future space segments beyond NPOESS IOC. Candidate technologies for meeting these needs should be examined in NPOESS Phase 1 for possible inclusion at a later time. No thresholds are stated.

4.1.6.8.1 Tropospheric Winds (DOC/DoD). Wind measured throughout the troposphere. Wind profile required for cloud returns and planetary boundary layer aerosol returns.

Systems Capabilities	Thresholds	Objectives
a. Sensing Depth		Surface to 20 km
b. Horizontal Resolution		50 km
c. Vertical Sampling Interval		0.1 km
d. Mapping Accuracy		10 km
e. Measurement Range		0 to 100 m/s
f. Measurement Precision		0.5 m/s, vector winds
g. Measurement Accuracy		±1 m/s, horiz. components
h. Refresh		1 hour

4.1.6.8.2 Ozone Profile - High-Resolution (DOC). Measurement of ozone concentration within a specified volume.

Systems Capabilities	Thresholds	Objectives
a. Sensing Depth		TBD
b. Horizontal Resolution (Profile)		250 km
c. Vertical Resolution (Profile)		
1. 0 to 10 km		3 km
2. 10 to 25 km		1 km
3. 25 to 60 km		3 km
d. Mapping Accuracy (Profile)		25 km
e. Measurement Range (Profile)		
1. 0 to 10 km		0.01 to 3 ppmv
2. 10 to 60 km		0.1 to 15 ppmv
f. Measurement Precision (Profile)		
1. 0 to 10 km		10 %
2. 10 to 15 km		3 %
3. 15 to 50 km		1 %
4. 50 to 60 km		3 %
g. Measurement Accuracy (Profile)		
1. 0 to 10 km: N/A		10 %
2. 10 to 15 km: 20 %		10 %
3. 15 to 60 km: 10 %		5 %
h. Refresh (Profile)		24 hours
i. Long Term Calibration (Profile)		1 %

4.1.6.8.3 CH_4 (Methane) Column (DOC). Measure of amount of methane contained in a specified volume of air.

Systems Capabilities	Thresholds	Objectives
a. Sensing Depth		Total column

b. Horizontal Resolution		100 km
c. Mapping Accuracy		25 km
d. Measurement Range		40 to 80 μmoles/cm^2
e. Measurement Precision		1 %
f. Measurement Accuracy		± 5%
g. Refresh		24 hours

4.1.6.8.4 CO (Carbon Monoxide) Column (DOC). Measure of carbon monoxide in a specified volume of air.

Systems Capabilities	Thresholds	Objectives
a. Sensing Depth		Total column
b. Horizontal Resolution		100 km
c. Mapping Accuracy		25 km
d. Measurement Range		0 to 7 μmoles/cm^2
e. Measurement Precision		3 %
f. Measurement Accuracy		±5 %
g. Refresh		24 hours

4.1.6.8.5 CO_2 (Carbon Dioxide) Column (DOC). Retrievals of column and total carbon dioxide, calibrated by the users with ground-based measurements, of stated precision needed to afford deduction of long-term variations and trends.

Systems Capabilities	Thresholds	Objectives
a. Sensing Depth		Total column
b. Horizontal Resolution		100 km
c. Mapping Accuracy		25 km
d. Measurement Range		11,000 to 15,000 μmoles/cm^2
e. Measurement Precision		15 to 20 μmoles/cm^2
f. Measurement Accuracy		TBD
g. Refresh		24 hours

NOTE: Carbon dioxide, carbon monoxide, and methane column data are required by NOAA to accomplish its climate mission. In order to predict the concentrations of trace gases in the troposphere, the spatial distributions of the sources and sinks of these gases must be known. For species with long atmospheric lifetimes, this requires very precise total column data. Values of the absolute accuracies of these gases needed for adequate predictions would not be as strict as the precision requirements due to the availability of supporting ground-based measurements. Long-term trends/variations in the amounts of these gases in the atmosphere are almost certainly addressed best by carefully calibrated ground-based measurements. However, the satellite retrievals would allow for important assessments of the geographical distribution of patterns or gradients in the trace gas concentrations that are not feasible otherwise.

4.1.6.8.6 Optical Backgrounds (DoD). Emissions are the result of interactions between precipitating energetic particles and solar ultraviolet radiation with neutral atmospheric constituents.

Systems Capabilities	Thresholds	Objectives
a. Coverage		Global
b. Horizontal Resolution		10 km
c. Mapping Accuracy		50 km
d. Measurement Range		
1. Wavelength		1 to 29 microns, 0.4 to 0.7 microns, 0.04 to 0.2 microns
2. Brightness		TBD
e. Measurement Precision		TBD
f. Measurement Accuracy		TBD
g. Refresh		each orbit

4.1.6.8.7 Bathymetry (Deep Ocean and Near Shore) (DoD). Vertical depth of water.

Systems Capabilities	Thresholds	Objectives
a. Sensing Depth		
1. Deep Ocean		0 to 300 m
2. Near shore		0 to 200 m
b. Horizontal Resolution		
1. Deep Ocean		300 m
2. Near shore		TBD
c. Vertical Resolution		1 m
d. Mapping Accuracy		10 m
e. Measurement Accuracy		±0.3 m
f. Refresh		TBD

4.1.6.8.8 Bioluminescence (DoD). A measurement of the number of bioluminescent organisms present in sea water within a region.

Systems Capabilities	Thresholds	Objectives
a. Horizontal Resolution		TBD
b. Mapping Accuracy		TBD
c. Measurement Accuracy		TBD
d. Refresh		TBD

4.1.6.8.9 Salinity (DoD/DOC). A measure of the quantity of dissolved materials in sea water. A formal definition is “the total amount of solid materials, in grams, contained in one kilogram of sea water, when all the carbonate has been converted to oxide, the bromine and iodine converted to chlorine, and all organic matter is completely oxidized. Units of measurement are parts per thousand, by weight.”

Systems Capabilities	Thresholds	Objectives
a. Sensing Depth		0 to 300 m
b. Horizontal Resolution		
1. Global		20 km
2. Regional		0.25 km
c. Vertical Resolution		
1. Global		±10 m

2. Regional	±2 m
d. Mapping Accuracy	
1. Global	5 km
2. Regional	0.25 km
e. Measurement Range	0 to 40 ppt
f. Measurement Precision	0.1 ppt
g. Measurement Accuracy	
1. Global	TBD
2. Regional	0.5 ppt
h. Refresh	72 hours

4.1.7 External Interfaces.

Interface is defined as the ability for two entities to physically or electronically interact and/or communicate with each other.

4.1.7.1 Space Segment Interfaces.

4.1.7.1.1 Space Segment to Launch Site Interfaces. The satellite should be designed to require minimal preparation at the launch site. When a launch is required, existing U.S. launch site facilities will be used to the maximum extent possible.

4.1.7.1.2 Space Segment to C^3 Segment Interfaces. The Space Segment will interface with a number of C^3 elements including NOAA CDAs, EUMETSAT CDA, and AFSCN RTSs. All communication links to and from the Space Segment (with exception of search and rescue, and surface data collection transmissions) must provide the capability to preclude interference or unauthorized contact.

4.1.7.1.3 Space Segment to IDPS Interfaces. The interface from the Space Segment to the IDPS at Field Terminals must be designed to be compatible with minimal impact on planned to be in existence Field Terminals such as the AN/UMQ-13 Mark IVB, AN/TMQ-43 (Small Tactical Terminal), SMQ-11 and AN/UMK-3 Tactical Environmental Support System (TESS), AN/TMQ-44 Meteorological Mobile Facility, and civilian HRPT/LRPT/APT. The NPOESS program must modify the DoD Field Terminals, as necessary, to allow for ingest and processing into EDRs of NPOESS data with no degradation in existing capabilities. The resulting system must not exceed current Field Terminal requirements of maximum size, weight, power, nor environmental constraints.

4.1.7.1.4 Surface Data Transmissions to Space Segment Interfaces. This interface allows the transmission from ARGOS (or its follow-on) transmitters to NPOESS satellites.

4.1.7.2 Launch Support Segment Interfaces. The Launch Support Segment must have interfaces with the launch site, Space Segment, and C^3 Segment to conduct launch of all NPOESS satellites.

4.1.7.3 C^3 Segment Interfaces.

4.1.7.3.1 C^3 to AFSCN Range Scheduling Interfaces. Depending on the utilization of AFSCN sites, the C^3 Segment will require an interface with AFSCN Range Scheduling (22 SOPS, Falcon AFB, CO and 21 SOPS (backup to 22 SOPS), Onizuka AFB, CA.)

4.1.7.3.2 NORAD to C^3 Interfaces. NPOESS requires appropriate interfaces with NORAD to ensure proper accomplishment of the C^3 function.

4.1.7.3.3 C^3 to Centrals' IDPS Interfaces. The interface from the C^3 segment to the IDPS must be designed to be compatible with minimal impact on existing Centrals.

4.1.8 Equipment Requirements.

4.1.8.1 Centrals. IDPSs are required at five major Centrals: NOAA/NESDIS, AFGWC, FNMOC, NAVOCEANO, and the 50th Weather Squadron (formerly the Air Force Space Forecast Center). Direct downlink of data is not required at all Centrals, however a minimum of two Centrals must receive downlink via communications satellites from the space segment in order to provide for backup and contingencies.

4.1.9 Transportability. The satellite(s) and all other transportable elements must be designed for ground and air transportation in accordance with best commercial practices, to minimize irreparable damage to equipment during shipment (all segments) and launch.

4.1.10 Flexibility and Expansion. All systems must, where practical, incorporate designs which allow for variations in operation without system redesign. For example, the system may allow the flexibility to establish signal routing to equipment items via either computer or manual operation. Segment expansion within the major facilities must only be limited by applicable floor space, power, air conditioning, and weight constraints.

4.1.11 Portability. The equipment must provide for portability of hardware and software.

4.1.11.1 Hardware. Individual equipment/subsystems and components must be designed to be portable, as necessary.

4.1.11.2 Software. Software portability means using the software on systems with the same or compatible model computers, with compatible peripheral devices. Source code portability requires only changes to accommodate changes in hardware or operating system environments limited to using the software on systems using the same or compatible model of a computer, as long as the computer is equipped with compatible peripheral devices. Source code must be portable so the only changes required are those changes necessary to accommodate changes in hardware or operating system environments.

4.1.12 IDPS Computer Capacity. Reserve capacity for IDPS computers at Centrals must be 100 percent of the worst case loading scenario to include processing and memory.

4.2 Logistics and Readiness.

The NPOESS reliability, maintainability, availability (RMA), and readiness requirements will be further defined, via studies and analysis, in the next phase (Phase 1) of the NPOESS acquisition.

4.2.1 System Operational Availability. System Operational Availability (A_O) is defined as the probability that a system is operable and ready to perform its mission at any given time. A_O is a function of mean time between critical failure (MTBCF) and mean time to restore functions (MTTRF) and will be calculated as:

$$Ao = \frac{\text{MTBCF}}{\text{MTBCF} + \text{MTTRF}}$$

where:

$$\text{MTBCF} = \frac{\text{operating time}}{\text{number of critical failures}}$$

and:

$$\text{MTTRF} = \frac{\text{total time down from critical failures}}{\text{number of critical failures}}$$

The space segment must be operational 24 hours per day with no on-orbit repair capability. The NPOESS space segment must meet an A_O of not less than 95.00 %. MTBCF for the space segment must be no less than TBD hours and MTTRF for the space segment must not exceed TBD hours.

4.2.2 Space Segment.

4.2.2.1 Minimum Useful Satellite Lifetime (MUSL). The NPOESS space segment must support a total mission design life of at least 10 years after IOC.

4.2.2.2 Maintainability. The spacecraft design must include maintainability features to ensure timely replacement or test of spacecraft subsystems or sensors prior to launch.

4.2.2.3 Design for Maintainability. Only remove and replace maintenance actions will be performed on the satellite after acceptance for shipment or storage by the procuring agency. Space-based elements of the system must not require maintenance or repair during on-orbit service life (i.e., no on-orbit maintenance is planned for the system).

4.2.3 NPOESS C^3 Segment Ground Equipment and IDPS Equipment.

4.2.3.1 Fault Detection. Built-In-Test (BIT)/Built-In-Test-Equipment (BITE) fault detection must automatically or manually detect not less than 98%, with an objective of 99%, of any single failure down to the line replaceable unit (LRU) without any support equipment.

4.2.3.2 Fault Isolation. Built-In-Test (BIT)/Built-In-Test-Equipment (BITE) fault isolation must automatically or manually identify not less than 98%, with an objective of 99%, of any single failure down to the line replaceable unit (LRU) without any support equipment. The fault isolation must also be operator-initiation capable.

4.3 Critical System Characteristics.

4.3.1 Mandatory Characteristics.

4.3.1.1 Environmental Survivability.

4.3.1.1 Nuclear, Biological, and Chemical (NBC) Survivability. The NPOESS design must include NBC survivability requirements per the DMSP/NPOESS STAR, as applicable.

4.3.1.2 Environmental Survivability.

4.3.1.2.1 Space Segment. The NPOESS spacecraft must operate reliably in the specific space environment for which it is designed (i.e., no major degradation caused by its environment over its design life).

4.3.1.2.2 C^3 Segment. Sources of information on C^3 segment survivability requirements are contained in the AFSCN ORD and the DMSP/NPOESS STAR.

4.3.1.2.3 Interface Data Processor Segment. Impact to the Centrals IDPS, from the operational environment must also be minimal. All centralized processing facility equipment must be located in environmentally controlled facilities with backup power sources able to provide power for 2 hours and constructed to withstand local weather conditions.

4.3.1.2.4 Interoperability. The NPOESS must be designed to be interoperable and compatible, to the furthest extent possible, with existing systems listed previously. Interoperability means functionally identical computer system architectures and specific programs which are operated and maintained using the same commands and procedures. NPOESS must have standardized communications protocols to the maximum extent possible to ensure interoperability between the military Services, DoD and civil communities, and allied systems.

4.3.2 Security. Security requirements must be responsive to the identified threat as defined in Section 2 of this document. System security must be engineered into the design and manufacturing of all parts in this system in accordance with DoDI 5000.2 (and other documents TBD), to protect critical components from compromise.

4.3.2.1 Information Security. Information security is a combination of administrative policies and procedures for identifying, controlling, and protecting information from unauthorized disclosure. NPOESS information security must comply with applicable DoD and DOC directives, as well as yet to be developed IPO security regulations.

4.3.2.2 Personnel Security. The NPOESS personnel security program must be managed IAW DoD, DOC and NASA directives, as applicable.

4.3.2.3 Physical Security. Physical security and resource protection for the NPOESS must be provided and managed IAW DoD, DOC and NASA directives, as applicable.

4.3.2.4 Industrial Security. NPOESS procedures and methods for protecting classified information in the possession of NOAA, NASA and DoD personnel and government contractors must be developed and managed following applicable directives.

4.3.2.5 COMSEC, OPSEC, TEMPEST, COMPUSEC Thresholds.

4.3.2.5.1 COMSEC. Communications security (COMSEC) measures provide protection for the transmission of sensitive information. All uplink and downlink signals to the satellites, with the exception of surface data collection/location and search and rescue data, must be capable of being denied to selected users. All commands uplinked to the satellite must pass through an authentication procedure on the spacecraft. A failure to be authenticated must cause a command not to be executed. The results of the attempt to authenticate uplinked commands by the satellite must be transmitted over a telemetry link to the C^3 Segment.

4.3.2.5.2 Operations Security (OPSEC). The NPOESS design must protect information which could reveal system plans, procedures, or missions. NPOESS OPSEC procedures must be developed IAW DoD, DOC and NASA directives, as applicable. Protection of critical information requires that NOAA, DoD, and contractor personnel practice COMSEC and OPSEC to preclude compromise. Usually, the data collected are unclassified; however, planned acquisition or application of data to a specific military operation could reveal U.S. intentions.

4.3.2.5.3 Compromising Emanations (TEMPEST). The appropriate TEMPEST protection must be applied to facilities, systems, or equipment which electrically process classified (national security) information. The protection should be proportional to the threat of exploitation and the potential damage to National Security.

4.3.2.5.4 Computer Security (COMPUSEC). Any computer or communications system used in software development or maintenance interfacing with or part of the NPOESS computer system must comply with the appropriate security class, operating mode, and trusted systems criteria requirements IAW DoD, DOC, and NASA documents as applicable.

4.3.3 Electronic Counter Countermeasures (ECCM). To determine ECCM requirements, Centrals and field components must use the susceptibility and vulnerability data compiled for existing systems.

4.4 Safety.

4.4.1 Range Safety Compliance. Spacecraft developed for this program will comply with applicable Eastern/Western Test Range requirements.

4.4.2 End-of-Life Safety. NPOESS spacecraft must be designed, as a threshold, to comply with the space debris minimization policies outlined in section 4.1.5.9. As an objective, the NPOESS spacecraft must be designed so non-mission capable spacecraft or spacecraft nearing their end of life can be removed from operational orbits.

5. Integrated Logistics Support (ILS).

5.1 Space Segment. N/A

5.2 Launch Support Segment. TBD

5.3 C^3 Segment.

The NPOESS C^3 Segment will provide redundant C^3 capability to meet the data acquisition and constellation management requirements. The C^3 Segment consists of antennas, communication relays, and NPOESS C^3 Ground Equipment.

The NPOESS C^3 Ground Equipment consists of the resources to conduct commanding, mission planning, launch and early orbit operations, command and telemetry database management, code configuration management, telemetry evaluation, spacecraft analysis, telemetry storage, ground system management, data distribution, training (e.g. spacecraft simulators), and encryption/decryption capabilities. The majority of this equipment will be located at the SOCs in Suitland, MD and Falcon AFB, CO. Depending on the final architecture of the Space and C^3 Segments, some unique NPOESS C^3 Ground Equipment may be located at NOAA CDA and AFSCN RTS sites. The integrated NPOESS SOCs are responsible for maintaining the health of the NPOESS spacecraft in orbit. Additionally, the Suitland SOC will provide the capability for monitoring and commanding the spacecraft during launch, orbit attainment, and flight checkout.

5.3.1 Maintenance Planning.

5.3.1.1 Maintenance Concepts. The NPOESS C^3 Ground Equipment will be operated by a mix of USG civilian and military personnel, and contractors. Remedial and preventive maintenance of the C^3 Ground Equipment is an NPOESS Integrated Program Office (IPO) function and must be consistent with stated requirements for overall NPOESS system availability and reliability. The USG requires maintenance of the NPOESS C^3 Ground Equipment including equipment installed at the SOCs and any NPOESS unique equipment installed at the CDAs/RTSs. This maintenance is required during development, installation, Initial Operational Test and Evaluation (IOT&E), Initial Operations, and for 12 months after full operational capability (FOC) is certified (hereinafter referred to as the extended maintenance period). In addition, the NPOESS system delivered must include options for additional one-year periods of C^3 Ground Equipment hardware and software maintenance and upgrades, which can be exercised at the discretion of the USG throughout the program life cycle.

The C^3 Ground Equipment is required to have sufficient diagnostic and failure detection capabilities (hardware and software) to allow USG operations staff to be alerted immediately to system failures. The USG requires that the C^3 Ground Equipment be configured to allow hardware or software components to be repaired or replaced without the loss of data or spacecraft mission to a level meeting specified NPOESS system availability requirements.

Hardware may either be repaired or replaced, but approved procedures will predetermine these actions.

Sufficient redundancy must exist that hardware and software upgrades can be installed and tested on non-critical portions of the system without affecting the ongoing operations. When specifically approved by the USG, some minimal loss of redundancy may be acceptable for such upgrades. Proposals for such operations shall take into account the duration of the procedure to be followed and the potential effect on operations if random failures occur on the remaining operational system before upgrade activities are complete.

5.3.1.2 Maintenance Tasks.

5.3.1.2.1 Hardware. USG requires failed C^3 Ground Equipment to be immediately identifiable by USG operations staff. Procedures are required to allow USG operators to determine the consequences (i.e. the effect on NPOESS space segment or IDPS operations) of the failure and take appropriate actions to continue C^3 operations without loss of mission or data. USG requires immediate availability of the NPOESS logistical support contractors for notification of any failure. The C^3 Ground Equipment with the failed component(s) must be returned to operations within 4 hours.

Hardware upgrades, including those of non-developmental or commercial off-the-shelf components, needed to ensure continued serviceability and performance reliability of systems during the NPOESS life cycle, are required to be provided on a timely and non-interference basis.

The USG requires remedial and preventive maintenance on TBD government furnished equipment (GFE) NPOESS C^3 Ground Equipment hardware during the interval beginning with delivery of the GFE to the NPOESS C^3 Ground Equipment contractor and ending with acceptance of NPOESS C^3 Ground Equipment, and, for TBD equipment, during the first year of FOC. Maintenance provisions shall be in addition to those provided by manufacturer's warranties, but do not exclude the use of warranties. USG further requires that records be kept and reports made to the USG on all maintenance performed and on engineering changes installed on the GFE prior to acceptance of the NPOESS C^3 Ground Equipment.

For the extended maintenance period, the USG requires both preventive and remedial maintenance on all contractor supplied and government furnished NPOESS C^3 Ground Equipment hardware at both the primary and backup SOCs. Maintenance capability is required at both SOCs on a 24 hours per day, 7 days per week basis. Remedial maintenance activities are required on-site at the location of the failure within 4 hours of the USG’s notice requesting maintenance service by the contractor.

CDA Stations and AFSCN RTS maintenance of all NPOESS C^3 Ground Equipment is the responsibility of Station personnel. Telephone support is required for all CDA and RTS sites, on a 24 hour per day, 7 day per week basis, to assist USG personnel in preventive and remedial maintenance. A response time of 30 minutes or less is required for this support. If the problem can not be resolved by telephone, on-site maintenance service to the CDA or RTS will be required.

5.3.1.2.2 Software. All software maintenance procedures will be approved by the USG. The C^3 Ground Equipment is required to have sufficient diagnostic and failure detection to allow USG operations staff to immediately be informed of a system or applications software failure (logic failure). The USG requires the ability to complete fault isolation within 30 minutes. The USG requires parallel, off-line software testing and integration paths that allow software debugging and modifications to be pursued without impacting operations of the NPOESS C^3 Ground Equipment.

Software maintenance is expected to be performed by contractor personnel.

The NPOESS systems requires maintenance of COTS or contractor-modified COTS software selected for use in NPOESS C^3 Ground Equipment. Maintenance includes automatic and timely licensing and software version upgrades, as well as modification to COTS software required to ensure compatibility with USG-requested hardware upgrades.

5.3.2 Support Systems.

5.3.2.1 Non-Developmental Items. Maximum utilization shall be made of non-developmental items (NDI) or commercial off-the-shelf (COTS) items, including Original Equipment Manufacturer (OEM) data processing equipment and standard software systems. NDI or COTS hardware, including computers, communications equipment, and monitoring and testing hardware, should be furnished whenever practical. Maintenance of COTS hardware must be guided by maintenance concepts given in 5.3.1. Applicable warranties to COTS hardware must be maintained.

5.3.2.2 Fault Isolation Equipment. USG requires that all NPOESS C^3 Ground Equipment be supplied with diagnostics capability for fault isolation and remediation. This shall include not only OEM diagnostics, but also similar capability for all special or unique subsystems which make up part of the NPOESS C^3 Ground Equipment. Fault isolation equipment may be independent systems or subsystems (hardware or software) within the NPOESS C^3 Ground Equipment operational configuration. The basic requirement is to be alerted to any system fault immediately, and complete fault isolation within 30 minutes of occurrence.

5.3.3 Human Systems Integration.

5.3.3.1 Training Concept and Goals. The objective for NPOESS C^3 Segment training is for USG operations and maintenance personnel to be certified as qualified to operate the hardware and software of the NPOESS C^3 Ground Equipment. Qualification will be certified by the contractor training instructors following execution of a training plan subject to USG approval. The training plan to meet this goal is required to cover all aspects of hardware and software needed to insure operational continuity of the NPOESS C^3 Segment.

5.3.3.2 Training Plan. The USG requires that a training plan be developed not later than six months prior to the scheduled delivery of the NPOESS C^3 Ground Equipment. This training plan shall be consistent with the provisions of NOAA Standard No. S24.804. This plan shall define courses of study recommended to qualify USG operations and maintenance personnel on the new system. Software maintenance and usage training will be provided in accordance with NOAA Standard S24.806. These Standards essentially provide for maintenance training to be provided by the contractor in accordance with a USG-approved training plan in USG-provided facilities beginning during the IOT&E period and continuing up until IOC. The plan shall identify course locations, schedules, duration, and recommended training aids.

The USG will provide all training facilities which will consist of classroom facilities in close proximity to the facilities for NPOESS C^3 Ground Equipment. These will include overhead projector(s), white boards with copy capability, and secure storage for training materials/aids. Specialized training aids shall be provided by the contractor. It is acceptable to the USG for the training to be conducted on the NPOESS C^3 Ground Equipment on a non-interference basis with the on-going preparation of the system for operations.

The training plan will include contractor-developed courses of instruction covering each of the contractor-developed functions. Training to be provided by the NPOESS C^3 Ground Equipment contractor is discussed below. The USG shall have the right to videotape all or any portions of the training provided. Training shall include the following: 1) NPOESS C^3 Segment Overview; 2) Computer Systems Training; 3) Spacecraft Operations Training; 4) Software Maintenance Training; 4) Analytical Capabilities Training; 5) Computer Maintenance Training; and 6) Scheduling/Plans. Upon completion of each contractor-developed course, copies of training materials (instructor lesson plans, student study guides, overheads, etc.) shall be provided to the appropriate government agency for use in developing follow-on sustainment training.

The training plan shall include training on the operation and maintenance of other vendor supplied OEM items. OEM training shall include one course at each of the NPOESS C^3 Segment sites. Training at each site shall accommodate TBD persons. Length of training shall be consistent with complexity of equipment and material covered. Proposed courses may be conducted by the equipment manufacturer. Administration and content of these courses shall be the responsibility of the NPOESS C^3 Ground Equipment contractor. OEM items in this category include but are not limited to: 1) Communications equipment; 2) Configuration switching equipment; 3) Digital signal processing equipment; 4) System monitoring hardware, including operational work stations or terminals.

5.3.3.3 Manpower. The user will determine operations and logistics support manning required for the NPOESS with the objective of no increase in manpower requirements for the Air Force.

5.3.4 Computer Resources.

5.3.4.1 Computer resource constraints. In general, any logistical support requirements for which independent or specialized computer resources are needed (e.g., automated test equipment) must be interoperable with operational NPOESS C^3 Ground Equipment computer systems in terms of architecture, language support, and communications and connectivity.

5.3.4.2 Unique interface requirements. Logistical support to the NPOESS C^3 Ground Equipment includes the requirement to maintain appropriate operational interfaces with the IDPS, including any required GFE equipment and software.

5.3.4.3 Documentation. All C^3 Ground Equipment hardware and software must be described in appropriate engineering documentation that will be maintained in USG NPOESS C^3 Segment libraries. USG requires that all documentation be prepared according to NOAA Standards S24.801 through S24.810. The documentation should be developed to a level to allow sustainment, upgrade, modification, and reprocurement of all equipment. Operations and Maintenance manuals for all hardware provided with the C^3 Ground Equipment are required 12 weeks in advance of delivery of the associated system. One of the O & M manuals shall provide an overview of the entire NPOESS C^3 Segment including a functional description of each major element. Manuals shall be provided as defined in the following subsections and shall be written in accordance with NOAA Standard No. S24.801, FIPS Publication 38 and other TBD specifications. All NPOESS C^3 Ground Equipment software, other than commercially available computer manuals, shall be covered in this documentation.

An Interface Control Document describing all electrical and data transfer media interfaces with the NPOESS C^3 Segment, including links to domestic, civilian, or military communications networks, and existing facilities at the SOC and CDAs will be required. Further documentation describing the data structure and signal characteristics of all NPOESS telemetry and command data is required one-year prior to IOT&E.

5.3.5 Other Logistics Considerations.

5.3.5.1 Provisioning Strategy/Spares Concept. The NPOESS C^3 Ground Equipment requires spare parts to ensure overall NPOESS system reliability and availability. Initial supplies, to the quantities specified, shall be provided by the contractor at IOT&E. The USG, together with the contractor during IOT&E, will analyze parts usage and correct these specifications, as dictated by experience. Following FOC, the USG will stock necessary spare parts. The requirement for stocked spares is such that stocks at the CDA/RTS sites and SOCs will normally be ordered on a "just-in-time plus one" basis. This means that orders will be placed to arrive when the parts are anticipated to be needed; however, one extra part will be advance-stocked to guard against the probability of delays in shipping. In time of international crisis or heightened tensions, the number of parts advance-stocked will be increased to the number expected to be required during a one year period.

5.3.5.2 Support Systems/Site Preparation. Site preparation at CDA/RTS sites and SOCs will be the responsibility of the USG and will provide for building modifications, uninterruptible power system, heating, ventilation, and air conditioning (HVAC), and other attributes of the physical plant. The contractor shall provide a preliminary estimate of requirements for space (both square footage of floor space and volumetric - especially required are volume and dimensions below floor and head room above raised floor), and power requirements (power factor, peak load, etc.) Human factors engineering will comply with all requirements of the Occupational Safety and Health Administration (OSHA) and other Federal laws. Constraints peculiar to the NPOESS C^3 Ground Equipment are TBD.

5.3.5.3 Special Equipment Supplied to the USG. The Space System Contractor will be required to provide a high-fidelity spacecraft emulator containing, if applicable, a computer identical in performance to the spacecraft on-board computer. In addition the emulator will simulate with the highest practical fidelity, all instruments and subsystems and will faithfully reproduce the spacecraft reaction to any commands or sequence of commands. The spacecraft emulator will not be required to provide high-fidelity emulation of scientific data, but it will be required to provide data at the instrument output ports which resembles true scientific data from a spacecraft housekeeping analysis perspective

5.3.5.4 Systems Integration and Acceptance Tests. On-site tests of the NPOESS C^3 Ground Equipment shall be required for system acceptance. Integration and Acceptance tests of NPOESS C^3 Ground Equipment hardware and software shall be conducted after installation of equipment at the SOCs and, if applicable, CDA and AFSCN stations. These tests will be conducted in accordance with contractor provided/USG approved test plans and procedures, using USG provided personnel in operational capacities. Tests will parallel live operations and may use live, recorded, or simulated telemetry inputs, as appropriate. Tests shall be designed to ensure no loss of operational data and shall result in no impact to ongoing operations. Test plans will incorporate procedures to disengage the test system in order to reestablish operational integrity.

5.4 IDP Segment.

The Interface Data Processor segment of NPOESS provides for the acquisition of raw data records (RDR) at Centrals and field sites, and the processing of the RDRs into environmental data records (EDR) for distribution or local use. Logistical support to this segment includes maintenance of the systems implemented to acquire the NPOESS sensor data streams and the systems deployed to produce the EDRs.

5.4.1 Maintenance Planning.

5.4.1.1 Maintenance Concepts.

5.4.1.1.1 Centrals. IDPS hardware and software will require operational maintenance at all Central sites. DoD Centrals IDPSs will be configured to produce the operational EDRs specified in Section 4.1.6 using NPOESS-delivered software. The NOAA Central IDPS will be configured to acquire RDRs for use in the NOAA Central's own product processing hardware-software systems. Therefore, the maintenance tasks associated with the IDPS at

DoD and NOAA will be different. Any requirements defined in this section relating to the production and delivery of EDRs refer exclusively to the DoD IDPS.

For both NOAA and DoD, remedial and preventive maintenance of interface hardware delivered to acquire NPOESS data streams at Centrals is expected to be an NPOESS contractor function and must be consistent with stated requirements for overall NPOESS system availability, reliability, and product delivery timeliness. The USG requires maintenance of the entire IDPS, including processing equipment and software needed to generate EDRs at DoD Centrals, during development, installation, Initial Operational Test and Evaluation (IOT&E), Initial Operations, and for 12 months after full operational capability (FOC) is certified (hereinafter referred to as the extended maintenance period). In addition, the NPOESS system delivered must include options for additional one-year periods of IDP system hardware and software maintenance and upgrades, which can be exercised at the discretion of the USG throughout the program life cycle.

The IDPS Centrals are required to have sufficient diagnostic and failure detection capabilities (hardware and software) to allow USG operations staff to be alerted immediately to system failures. The USG requires that the IDP Centrals segment be configured to allow hardware or software components to be repaired or replaced without the loss of data to a level meeting specified NPOESS system availability requirements. Hardware may either be repaired or replaced, but approved procedures will predetermine these actions.
Sufficient redundancy must exist that hardware and software upgrades can be installed and tested on non-critical portions of the system without affecting the ongoing operations. When specifically approved by the USG, some minimal loss of redundancy may be acceptable for such upgrades. Proposals for such operations shall take into account the duration of the procedure to be followed and the potential effect on operations if random failures occur on the remaining operational system before upgrade activities are complete.

5.4.1.1.2 <u>Field Terminals</u>. DoD requires delivery of IDPS equipment at TBD field sites to acquire specified NPOESS RDRs via direct broadcast from the space segment, and generate specified EDRs for local field site use. Field level maintenance of the hardware and software at the field terminals is required and will be performed by DoD personnel following appropriate IDPS hardware and software maintenance training, and consistent with the field terminal operations and maintenance concepts. Depot level hardware and software maintenance of the IDPS is expected to be an NPOESS contractor function.

5.4.1.2 <u>Maintenance Tasks.</u>

5.4.1.2.1 <u>Hardware</u>. USG requires failed IDPS equipment to be immediately identifiable by USG operations staff. Procedures are required to allow USG operators to determine the consequences of the failure and take appropriate actions to continue acquisition and product processing of NPOESS data operations without loss of mission. USG requires immediate availability of the NPOESS logistical support contractors for notification of any failure. The IDPS with the failed component(s) must be returned to operations within 4 hours.

USG requires routine preventive maintenance (including upgrades authorized by USG personnel) be performed by the contractor at all times. This maintenance will follow approved procedures and not impact any operational data handling or processing.

The USG requires remedial and preventive maintenance on GFE IDP hardware during the interval beginning with delivery of the GFE to the NPOESS contractor and continuing through FOC. USG further requires that records be kept and reports made to the USG on all maintenance performed and on engineering changes installed on the GFE prior to acceptance of the IDPS system..

5.4.1.2.2 Software. The IDPS is required to have sufficient diagnostic and failure detection to allow USG operations staff to immediately be informed of a system or applications software failure (logic failure). The USG requires the ability to complete fault isolation within 30 minutes. The USG requires parallel, off-line software testing and integration paths that allow software debugging and modifications to be pursued without impacting operations of the IDPS.

USG requires the contractor accept notification of the failure/error and determine the required corrective action as follows;

> Immediate - system cannot operate without correction, or data are degraded/unusable
>
> Delayed (no more than 12 hours) - System can continue (restart/reboot or on backup) while corrective actions are determined

Software maintenance (e.g., compilation of a succeeding revisions of the system software) is expected to be performed by contractor personnel.

Additional software maintenance tasks include developing and implementing software modifications needed to ensure compatibility with IDPS hardware upgrades; revision of product validation software; and upgrades to data base and product distribution software. USG requires that the contractor will develop and deliver software configuration control mechanisms and procedures (with USG approval) as part of the NPOESS IDPS. USG staff will oversee and manage NPOESS software configuration control as of IOC.

USG requires that all warranties for all COTS be transferred to the USG, yet administered by the contractor for the USG following approved procedures for tracking COTS upgrades and the discontinuing of any COTS software/support. The NPOESS system further requires maintenance of COTS or contractor-modified COTS software selected for use in the IDPS. Maintenance includes automatic and timely licensing and software version upgrades, as well as modification to COTS software required to ensure compatibility with USG-requested hardware upgrades.

5.4.2 Support Systems.

5.4.2.1 Non-Developmental Items. Maximum utilization shall be made of non-developmental items (NDI) or commercial off-the-shelf (COTS) items, including original equipment manufacturer (OEM) data processing equipment and standard software systems. NDI or COTS hardware, including computers, communications equipment, and monitoring and testing hardware, should be furnished whenever practical. Maintenance of COTS hardware must be guided by maintenance concepts given in 5.4.1. Applicable warranties to COTS hardware and software must be maintained.

5.4.2.2 Fault Isolation Equipment. USG requires that all IDPS equipment be supplied with diagnostics capability for fault isolation and remediation. This shall include not only Original Equipment Manufacturer (OEM) diagnostics, but also similar capability for all special or unique subsystems which make up part of the IDPS. Fault isolation equipment may be independent systems or subsystems (hardware or software) within the IDP operational configuration. The basic requirement is to be alerted to any system fault immediately, and complete fault isolation within 30 minutes of occurrence.

5.4.3 Human Systems Integration.

5.4.3.1 Training Concepts and Goals. The goal of IDPS training is for USG operations and maintenance personnel to be certified as qualified to operate and maintain the hardware and software of the IDPS. Qualification will be certified by the contractor training instructors following execution of a training plan subject to USG approval. The training plan to meet this goal is required to cover all aspects of hardware and software needed to insure operational continuity of NPOESS data acquisition, data quality control, and EDR processing and distribution.

All USG operations staff are required to be fully trained before IOC. This should include extensive simulations. USG requires operational training material and instruction, and will approve all training material and course formats proposed by the NPOESS contractor. Critical items to be covered are:

Operations:

- Routine operations and monitoring
- Quality Control
- Data flow and associated communications
- System reconfiguration and fail overs
- Failure/error indications and resulting actions
- Calibration, Navigation, Earth location
- S/C Data base management and user communications
- Spacecraft emergencies
- Emergency operational procedures for IDP systems
- Quality assurance and problem tracking

USG requires an operational database be implemented for operations staff to maintain, track and report system status.

Hardware: USG requires that a limited number (TBD) of USG hardware technicians/engineers receive training on the IDPS hardware. USG does not expect these staff to effect repairs but expects them to monitor and evaluate the contractor's performance on all aspects of the IDPS hardware maintenance. USG staff will be provided training on:

- System configuration
- All major hardware components specifications and the type of maintenance being provided by the contractor (i.e. repairs, replacements, third party OEM) for each
- All standard operational procedures for hardware diagnostics and repairs.
- Quality Control and Quality assurance.

Software: USG requires that a limited number (TBD) of USG software staff be trained on various aspects of the IDPS. In general 2 levels of training are expected:

- Systems level covering: Operating System(s); Data base management systems; hardware diagnostics and failure detection; Configuration Control; Quality Control; Quality assurance & accounting

- Applications level covering: Data processing, including ingest and EDR generation and distribution; RGPs; communications

5.4.3.2 Training Plan. The USG requires that a training plan be developed not later than six months prior to the scheduled delivery of the IDP system. This training plan shall be consistent with the provisions of NOAA Standard No. S24.804. This plan shall define courses of study recommended to qualify USG operations and maintenance personnel on the new system. Software maintenance and usage training will be provided in accordance with NOAA Standard S24.806. These Standards essentially provide for maintenance training to be provided by the contractor in accordance with a USG-approved training plan in USG-provided facilities beginning during the IOT&E period and continuing up until IOC. The plan shall identify course locations, schedules, duration, and recommended training aids.

The training plan shall include training on the operation and maintenance of other vendor supplied OEM items. OEM training shall include one course at each of the IDP Central sites. Training at each site shall accommodate TBD persons. Length of training shall be consistent with complexity of equipment and material covered. Proposed courses may be conducted by the equipment manufacturer. Administration and content of these courses shall be the responsibility of the NPOESS contractor.

Upon completion of any contractor-developed course, copies of training materials (instructor lesson plans, student study guides, overheads, etc.) shall be provided to the appropriate government agency for use in developing follow-on sustainment training.

5.4.3.3 Manpower. The user will determine operations and logistics support manning required for the NPOESS with the objective of no increase in manpower requirements for the Air Force.

5.4.4 Computer Resources.

5.4.4.1 Computer resource constraints. In general, any logistical support requirements for which independent or specialized computer resources are needed (e.g., automated test equipment) must be interoperable with operational IDP computer systems in terms of architecture, language support, and communications and connectivity.

5.4.4.2 Unique interface requirements. Logistical support to the NPOESS IDPS includes the requirement to maintain appropriate operational interfaces with the C^3 segment, including any required GFE equipment and software.

Any NPOESS IDP equipment must be deployed and integrated into the existing satellite data processing and distribution facilities. The NPOESS IDPS must be maintained in a way that will not interfere with the ongoing operations.

5.4.4.3 Documentation. All IDPS hardware and software must be described in appropriate engineering documentation that will be maintained in USG NPOESS ground segment libraries. USG requires that all documentation be prepared according to NOAA Standards S24.801 through S24.810.

Operations and Maintenance manuals for all hardware provided with the IDPS are required 8 weeks in advance of delivery of the associated system. One of the O & M manuals shall provide an overview of the entire IDPS including a functional description of each major element. Manuals shall be provided as defined in the following subsections and shall be written in accordance with NOAA Standard No. S24.801, FIPS Publication 38 and other TBD specifications. All IDP software, other than commercially available computer manuals, shall be covered in this documentation.

An Interface Control Document (ICD) describing all electrical and data transfer media interfaces with the IDPS, including links to domestic, civilian, or military communications networks, will be required. This ICD must include descriptions of interfaces to operational NPOESS field terminals. Further documentation describing the data structure and signal characteristics of all direct broadcast NPOESS data is required one-year prior to IOT&E.

5.4.5 Other Logistics Considerations.

5.4.5.1 Provisioning Strategy/Spares Concept. The IDPS subsystems require spare parts to ensure overall NPOESS system reliability and availability. Initial supplies, to the quantities specified, shall be provided by the contractor at IOT&E. The USG, together with the contractor during IOT&E, will analyze parts usage and correct these specifications, as dictated by experience. Following FOC, the USG will stock necessary spare parts. The requirement for stocked spares is such that stocks at the Centrals and appropriate field sites will normally be ordered on a "just-in-time plus one" basis. This means that orders will be placed to arrive when the parts are anticipated to be needed; however, one extra part will be advance-stocked to guard against the probability of delays in shipping. In time of international crisis or heightened tensions, the number of parts advance-stocked will be increased to the number expected to be required during a one year period.

5.4.5.2 <u>Support Systems/Centrals Site Preparation.</u> Site preparation at IDP Centrals will be the responsibility of the USG and will provide for building modifications, uninterruptible power system, HVAC, and other attributes of the physical plant. The contractor shall provide a preliminary estimate of requirements for space (both square footage of floor space and volumetric - especially required are volume and dimensions below floor and head room above raised floor), and power requirements (power factor, peak load, etc.) Human factors engineering will comply with all requirements of the Occupational Safety and Health Administration (OSHA) and other Federal laws. Constraints peculiar to the IDPS are TBD.

5.4.5.2 <u>Systems Integration and Acceptance Tests</u>. On-site tests of the IDPS system is required at Centrals and at selected field terminals for system acceptance. Integration and Acceptance tests of all IDP hardware and software shall be conducted after installation of equipment at the Centrals and, if applicable, at selected field terminals. These tests will be conducted in accordance with contractor provided/USG approved test plans and procedures, using USG provided personnel in operational capacities. Tests will parallel live operations and may use live, recorded, or simulated input, as appropriate. Tests shall be designed to ensure no loss of operational data and shall result in no impact to ongoing operations. Test plans will incorporate procedures to disengage the test system in order to reestablish operational integrity.

6. Infrastructure Support and Interoperability.

The NPOESS design must address how the system will be integrated into interfacing systems, including those related to command, control, communications, and intelligence (C^3I); transportation and basing; standardization, interoperability, and commonality; mapping, charting, and geodesy support; and environmental support. Each of these areas is addressed below. The DoD Joint Potential Designator is recommended to be "joint", due to the joint management involved (Senior User's Advisory Group, Joint Agency Requirements Council) and probable joint funding.

6.1 Command, Control, Communications, and Intelligence (C^3I).

The NPOESS design must address how the system will be integrated into the C^3I architecture forecast to exist at the time the system will be fielded. The design must include data requirements (data, voice, video), computer network support, and anti-jam requirements, as required.

6.1.1 Electromagnetic Spectrum Design and Frequency Allocations.

6.1.1.1 Space Segment to C^3 Segment Interface. This interface includes the up and downlink Radio Frequency (RF) and data interfaces required for the C^3 Segment. The interface between the Space and C^3 Segments consists of the uplink for command and control, as well as the downlinks for telemetry. This interface must be compatible with the AFSCN/CDA Elements. The probability of undetected bit errors must be equal to or less than 1.0×10^{-6}. All command and control data must be encrypted/decrypted using National Security Agency (NSA) approved devices. Interface requirements include the following:

	Uplink	Downlink
Operational Frequency Band	TBD	TBD

6.1.1.2 Space Segment to Interface Data Processor Segment (Field Terminal component) Interfaces. This interface includes downlink RF and data interfaces required for the Interface Data Processor Segment Field Terminals and the first-in systems. The interface consists of data records and ephemeris data downlinks to tactical terminals. The interface must provide automatic tracking from horizon to horizon with sufficient link margin to satisfy user requirements. The probability of undetected bit errors must be equal to or less than 1.0×10^{-6}. Interface requirements include the following:

	Uplink	Downlink
Operational Frequency Band	TBD	TBD

6.1.1.3 C^3 Segment to Centrals IDPS Interface. This includes the communications required to transfer data from the C^3 Segment to the Centrals. In addition, the C^3 Segment provides ephemeris data to the Centrals in support of data processing activities. Interface requirements include the following:

	Uplink	Downlink
Operational Frequency Band	TBD	TBD

6.1.2 Electromagnetic Compatibility**.** The NPOESS must be designed to be electromagnetically compatible with itself, with its known equipment, with test equipment, ground support equipment, and with Government furnished equipment (GFE). The Electromagnetic Compatibility (EMC) requirements must be IAW existing DoD, DOC ,and NASA documentation. All support facilities, including test facilities and launch base facilities, must comply with the ground requirements.

6.2 Transportation and Basing.

Centrals and the SOCs consist of fixed installations and are not subject to movement.

6.3 Standardization, Interoperability, and Commonality.

The NPOESS acquisition and design must comply with existing DoD, DOC and NASA Compatibility, Interoperability, and Integration of Command, Control, Communications, Computers, and Intelligence (C^4I) standards, if applicable. The design must conform to existing DoD, DOC, and NASA common operating environment models, technical reference models, and established programmatic and technical standards. The design must address open systems environment goals and interoperability with supported C^4I systems. The NPOESS must comply with appropriate information technology standards (DoD/DOC) applicable at the time of IOC.

The NPOESS design must address considerations for joint use (DoD/Civil), NATO cross-servicing, etc. The design must incorporate procedural and technical interfaces, and communications protocols and standards required to ensure interoperability with other service, joint service and allied systems. There is a requirement for adopting/developing standard data formats, interfaces, and methods to ensure interoperability and cost effectiveness. At a minimum, the standards and systems identified in this IORD must be addressed as part of the interoperability certification. The design must address energy standardization and efficiency needs for both fuels and electrical power, as applicable.

6.4 Mapping, Charting, and Geodesy Support.

C^3 Segment requirements for site surveys and antenna alignment surveys are TBD.

6.5 Environmental Support.

The NPOESS requires normal weather support during launch activities. While on orbit, NPOESS requires normal space environmental support to aid in analyzing communication and satellite anomalies.

7. Force Structure.

7.1 Space Segment. The number of satellites procured must be sufficient to meet all system requirements for a ten year period following IOC.

7.2 Launch Support Segment. All specific equipment required to support NPOESS launches will be located at the NPOESS launch site.

7.3 C3 Segment. C^3 ground equipment must be located at the SOCs in Suitland, MD and Falcon AFB, CO. Additional equipment must be located at each of the Centrals to provide data to the IDPS. Futhermore, additional equipment may be located, if necessary, at antenna sites utilized by NPOESS.

7.4 Interface Data Processor Segment. IDPS equipment will be located at each of the Centrals and at each DoD tactical terminal.

8. Schedule Considerations**.**

The NPOESS must follow an incremental acquisition, development, and deployment strategy. Key milestones and schedule issues are discussed below.

8.1 Initial Operational Capability (IOC) Criteria.

The NPOESS program director will declare IOC has been met when: two satellites are operational; sufficient C^3 and mission data recovery resources are available to allow all mission data to be processed at all Centrals and 50 percent of field terminals; sufficient crews are trained to allow 24 hours/day, 365 days/year operations at the primary SOC, and to allow backup operations as needed; sufficient sustaining engineering resources are in place to allow for anomaly resolution, for example; sufficient logistics resources are in place to support C^3, data recovery, and the IDP segment; and approval to operate at Falcon AFB is received.

8.2 IOC Schedule**.**

8.2.1 IOC. Anticipated first launch in 2007, anticipated second launch (IOC) 2009.

8.3 Final Operational Capability (FOC) Criteria.

The NPOESS program director will declare that FOC has been met when: a full NPOESS satellite constellation is operational (currently anticipated to be two US and one EUMETSAT); sufficient C^3 and mission data recovery resources are available; sufficient crews are trained; sufficient logistics resources are in place to support C^3, data recovery, and the IDP segment; and approval to operate at Falcon AFB is received.

8.4 FOC Schedule.

8.4.1 FOC. Anticipated METOP 3 launch in 2009.

Sect 4	PARAMETER	DoD (NAVY)				DOC
Para #		FNMOC	NAVO	HRD Field	LRD Field	NESDIS
4.1.6.1.x	**KEY ENVIRONMENTAL PARAMETERS**					
1	Atmospheric Vertical Moisture Profile	R/E		R/E		R
2	Atmospheric Vertical Temperature Profile	R/E		R/E		R
3	Imagery	R/E		R/E	R/E	R
4	Sea Surface Temperature	R/E	R/E	R/E		R
5	Sea Surface Winds	R/E	R/E	R/E	R/E	R
6	Soil Moisture	R/E		R/E		R
4.1.6.2.x	**ATMOSPHERIC PARAMETERS**					
1	Aerosol Optical Thickness	R/E		R/E	R/E	R
2	Aerosol Particle Size	R/E		R/E	R/E	R
3	Ozone Total Column/Profile					R
4	Precipitable Water	R/E		R/E		R
5	Precipitation Type/Rate	R/E		R/E	R/E	R
6	Pressure (surface/profile)	R/E		R/E	R/E	R
7	Suspended Matter	R/E		R/E	R/E	R
8	Total Water Content	R/E		R/E		R
4.1.6.3.x	**CLOUD PARAMETERS**					
1	Cloud Base Height	R/E		R/E	R/E	R
2	Cloud Cover/Layers	R/E		R/E	R/E	R
3	Cloud Effective Particle Size	R/E		R/E		R
4	Cloud Ice Water Path					R
5	Cloud Liquid Water	R/E		R/E		R
6	Cloud Optical Depth/Transmittance	R/E		R/E		R
7	Cloud Top Height	R/E		R/E	R/E	R
8	Cloud Top Pressure					R
9	Cloud Top Temperature	R/E		R/E	R/E	R
4.1.6.4.x	**EARTH RADIATION BUDGET PARAMETERS**					
1	Albedo (Surface)	R/E		R/E	R/E	R
2	Downward Longwave Radiation (Surface)	R/E		R/E		R
3	Insolation	R/E		R/E		R
4	Net Shortwave Radiation (TOA)	R/E				R
5	Solar Irradiance	R/E				R
6	Total Longwave Radiation (TOA)	R/E				R
4.1.6.5.x	**LAND PARAMETERS**					
1	Land Surface Temperature	R/E		R/E		R
2	Normalized Differential Vegetation Index (NDVI)					R
3	Snow Cover/Depth	R/E		R/E	R/E	R
4	Vegetation/Surface Type	R/E		R/E	R/E	R
4.1.6.6.x	**OCEAN/WATER PARAMETERS**					
1	Currents	R/E	R/E	R/E	R/E	R
2	Fresh Water Ice	R/E	R/E	R/E		R

3	Ice Surface Temperature	R/E	R/E	R/E		R
4	Littoral Sediment Transport	R/E	R/E	R/E		R
5	Net Heat Flux	R/E		R/E		R
6	Ocean Color/Chlorophyll	R/E	R/E	R/E		R
7	Ocean Wave Characteristics	R/E	R/E	R/E		R
8	Sea Ice Age and Sea Ice Motion	R/E	R/E	R/E	R/E	R
9	Sea Surface Height/Topography	R/E	R/E	R/E	R/E	R
10	Surface Wind Stress	R/E		R/E		R
11	Turbidity	R/E	R/E	R/E	R/E	R
4.1.6.7.x	**SPACE ENVIRONMENTAL PARAMETERS**					
1	Auroral Boundary					R
2	Auroral Energy Deposition (Total)					R
3	Auroral Imagery					R
4	Electric Field					R
5	Electron Density Profile/Ionospheric specification					R
6	Geomagnetic Field	R/E		R/E	R/E	R
7	In-Situ Ion Drift Velocity					R
8	In-Situ Plasma Density					R
9	In-Situ Plasma Fluctuations					R
10	In-Situ Plasma Temperature					R
11	Ionospheric Scintillation					R
12	Neutral Density Profiles/Neutral Atmospheric Spec					R
13	Radiation Belt and Low Energy Solar Particles	R/E				R
14	Solar and Galactic Cosmic Ray Particles	R/E				R
15	Solar EUV Flux					R
16	Supra Thermal through Auroral Energy Particles					R
17	Upper Atmospheric Airglow					R

ATTACHMENT 1
Requirements Correlation Matrix

Part I

The system capabilities and characteristics are listed in two main categories, General and Environmental Data Records, which are further divided into key system parameters and other parameters. The ***** and **bold** type denotes items to be included in the Acquisition Program Baseline (APB) as key parameters.

Requirements presented here may be unique to DOC or DOD or common to both agencies. The source of each requirement is designated in parenthesis following the stated parameter or value. For shared or common requirements, both agencies will be shown, but the value corresponding to the highest performance will be shown in Section 4 and the RCM, Part I. Agency designation indicates the primary user of the end product. When more than one agency's name is listed, the agency listed first generally has the more stringent requirement. The other agency's requirement can be found in RCM, Part II, under the appropriate parameter.

The performance characteristics for the parameter elements of Sensing Depth, Measurement Range, Vertical Resolution, and Measurement Precision shall be within the normal/expected sensing environment unless specifically indicated otherwise for each parameter. They shall also pertain to sensitivity across the entire scan, not just at nadir.

Attachment 3 contains definitions.

Requirements Correlation Matrix
(General)
PART 1

SYSTEM CAPABILITIES AND CHARACTERISTICS	IORD I Thresholds	IORD I Objectives	IORD II Thresholds	IORD II Objectives
Para 4.1.x				
5.1. Data Availability (DoD/DOC)				
a. To Centrals	97.50%	TBD		
b. Timeliness to Centrals within 1.25 times the orbital period plus 30 minutes (DoD)	95%	TBD		
b. To Field Terminals	Field of View	TBD		
5.2. Autonomous Operations (DoD)				
a. Duration	21 days	60 days		
b. Mapping Accuracy	45 km	1 km		
5.3. Stored High Resolution Data (DoD/DOC)	1/2 Orbit			
5.4. Surface Data Collection/Location (DOC/DoD)	ARGOS	TBD		
5.5. Orbital Characteristics (DoD/DOC)	Same lat imaged at same LST: 0530 daylight descending 1330 Evenly spaced orbits . Precise orbit. Exact ground track repeat.	User selectable times.		
5.6. System Survivability (DoD)	See DMSP/NPOESS STAR.	See DMSP/NPOESS STAR.		
5.7. Search and Rescue (DOC)	Equipment IAW International agreements.			
5.8. Compatibility(DOC)	Minimize impact to existing user terminals.			
5.9. Space Debris Minimization (DoD/DOC)	IAW Nat'l Space Policy Directive, 2 Nov 89 and USSPACECOM REG 57-2.			
5.10. *Data Access (*DoD)	**Selectively deny all U.S. environmental sensor data**			
5.11. Geolocation of Data (DoD)	Ability to precisely locate data & provide location data with RDRs			
5.12. Space Environmental Constellation Characteristics (DoD/DOC)	SESS data from all orbital planes. Continuous data according to specified RES.			

SYSTEM CAPABILITIES AND CHARACTERISTICS	IORD I Thresholds	IORD I Objectives	IORD II Thresholds	IORD II Objectives
Para 4.1.x				
7. External Interfaces				
7.1.1. Space Segment to Launch Site	Minimal preparation; U.S. launch sites.			

7.1.2. Space Segment to C3 Segment	Interface with NOAA CDAs, EUMETSAT CDA, & AFSCN RTSs. Comm links must preclude interference or unauthorized contact.			
7.1.3. Space Segment to IDPS	Compatible with minimal impact on Centrals and DoD field terminals. Modify DoD field terminals as needed to receive and process NPOESS data, without exceeding current field terminal size, weight, power, and environment constraints.			
7.1.4. Surface Data Transmissions to Space Segment	Allow transmissions from ARGOS or its follow-on.			
7.2. Launch Support Segment	Interface with launch site, space segment, and C3 segment for launches.			
7.3 C3 Segment 7.3.1. C3 to AFSCN Range Scheduling	Interface between C3 and range scheduling at Falcon AFB CO and Onizuka AFB CA.			
7.3.2. NORAD to C3	Interface with NORAD.			
SYSTEM CAPABILITIES	**IORD I**		**IORD II**	
AND CHARACTERISTICS	**Thresholds**	**Objectives**	**Thresholds**	**Objectives**
Para 4.1.x 8. Equipment Requirements	IDPS at 4 Centrals at least; downlink to at least 2.	TBD		
9. Transportability	Ground and air transportable IAW best commercial practices.			
10. Flexibility and Expansion	Allow for variations in operation without system redesign.			
11. Portability	Portability of hardware and software.			
12. IDP Reserve Capacity a. Centrals component	100% of worst case scenario, to include processing and memory.			
b. Field terminal component	TBD	TBD		
Para 4.2.x 1. Logistics and Readiness for System				
a. Ao	95%	TBD		
b. MTBCF	TBD	TBD		

c. MTTRF	TBD	TBD		
2.1. Minimum Useful Satellite Lifetime	10 years (system)	TBD		
2.2. Maintainability		TBD		
2.3. Design for Maintainability	No on-orbit repair.			
3.1. Fault Detection	Automatically or manually detect 98% of faults.	Automatically or manually detect 99% of faults.		

SYSTEM CAPABILITIES AND CHARACTERISTICS	IORD I		IORD II	
	Thresholds	**Objectives**	**Thresholds**	**Objectives**
Para 4.2.x 3.2. Fault Isolation	Automatically or manually isolate 98% of faults.	Automatically or manually isolate 99% of faults.		
Para 4.3.x 1.1 NBC Survivability	See DMSP/NPOESS STAR.			
1.2 Environmental Survivability 1.2.1 Space Segment 1.2.2 C^3 Segment 1.2.3 IDP Segment 1.2.4 Interoperability	Operate reliably in space environment for which it is designed. See DMSP/NPOESS STAR. Environmentally controlled facilities, with backup power sources able to withstand local weather conditions. Functionally identical computer system architectures and specific programs which are operated and maintained using the same commands and procedures. Standardized communications protocol between Services, DoD and civil communities, and allied systems.			
2 Security 2.1 Information Security	IAW applicable DoD, DOC and IPO directives.			
2.2 Personnel Security	IAW DoD, DOC and NASA directives.			
2.3 Physical Security	IAW DoD, DOC and NASA directives.			
2.4 Industrial Security	IAW DoD, DOC and NASA directives.			

2.5.1 COMSEC	Uplink and downlink signals capable of being encrypted; Uplinked commands shall pass through an authentication procedure on the spacecraft; results of authentication attempts will be telemetry linked to the C3 segment.			
SYSTEM CAPABILITIES AND CHARACTERISTICS	**IORD I**		**IORD II**	
	Thresholds	**Objectives**	**Thresholds**	**Objectives**
Para 4.3.x				
2.5.2 OPSEC	Developed IAW DoD, DOC and NASA directives.			
2.5.3 TEMPEST	Proportional to threat of exploitation and the potential damage to National Security.			
2.5.4 COMPUSEC	IAW DoD, DOC and NASA directives.			
3. Electronic Counter Countermeasures	TBD	TBD		
Para 4.4.x				
1. Range Safety Compliance	IAW applicable Eastern/Western Test Range requirements.			
2. End-of-Life Safety	IAW space debris minimization policies.	Designed so that non-mission capable s/c or s/c nearing end of life can be removed from operational orbits.		

Requirements Correlation Matrix
(Key Environmental Data Records)
Part 1

SYSTEM CAPABILITIES AND CHARACTERISTICS	IORD I Thresholds	IORD I Objectives	IORD II Thresholds	IORD II Objectives
Key (Para 4.1.6.1.x)				
1. Atmospheric Vertical Moisture Profile (*DOC/*DoD)				
a. Horizontal Resolution	15 km at nadir	2 km		
b. Vertical Sampling Interval	Surface to 850 at 20mb	5 mb		
	850 to100 at 50mb	15 mb		
c. Mapping Accuracy	5 km	1 km		
d. Measurement Accuracy (g/kg)		± 10%		
Clear:				
1. Surface to 600 mb*	**± 20% (DoD: ±25%)**			
2. 600 to 400 mb	± 35%			
3. 400 to 100 mb	± 35%			
Cloudy:				
4. Surface to 600 mb*	**± 20% (DoD: ±25%)**			
5. 600 to 400 mb	± 40%			
6. 400 to 100 mb	± 40%			
e. Refresh	6 hrs	3 hrs		
2. Atmospheric Vertical Temperature Profile (*DOC/*DoD)				
a. Horizontal Resolution				
1. Clear, nadir	18.5 km	5 km		
2. Clear, worst case	100 km			
3. Cloudy, nadir	40 km	5 km		
4. Cloudy, worst case	50 km			
b. Vertical Sampling Interval				
1. Surface to 850 mb	20 mb	15 mb		
2. 850 to 300 mb	50 mb	15 mb		
3. 300 to 100 mb	25 mb	15 mb		
4. 100 to 10 mb	20 mb	10 mb		
5. 10 to 1 mb	2 mb	1 mb		
6. 1 to 0.1 mb	0.2 mb	0.1 mb		
7. 0.1 to 0.01 mb	0.02 mb	0.01 mb		

SYSTEM CAPABILITIES AND CHARACTERISTICS	IORD I Thresholds	IORD I Objectives	IORD II Thresholds	IORD II Objectives
Key Para 4.1.6.1.x				
2. Atmospheric Vertical Temperature Profile (*DOC/*DoD)				
c. Mapping Accuracy	5 km	1 km		
d. Measurement Accuracy		± 0.5 K		
Clear:				
1. Surface to 300 mb*	**±1.6 K per 1 km layer**			
2. 300 to 30 mb	±1.5 K per 3 km layer			
3. 30 to 1 mb	±1.5 K per 5 km layer			
4. 1 to 0.01 mb	±3.5 K per 5 km layer			
Cloudy:				

5. Surface to 700 mb*	**±2.5 K per 1 km layer**			
6. 700 to 300 mb	±1.5 K per 1 km layer			
7. 300 to 30 mb	±1.5 K per 3 km layer			
8. 30 to 1 mb	±1.5 K per 5 km layer			
9. 1 to 0.01 mb	±3.5 K per 5 km layer			
e. Refresh	6 hrs	3 hrs		
3. Imagery (*DoD/*DOC)				
a. Horizontal Resolution				
DoD-Vis, IR, and stratus/fog discrimination in regional resolution				
1. Global (*DOC)	**1.0 km at nadir**	0.65 km		
	2.4 km worst case			
2. Regional (all vis & IR bands) (*DoD)	**0.4 km at nadir**			
	0.8 km worst case	0.1 km		
3. Night-time visual	2.6 km worst case	0.65 km		
b. Mapping Accuracy	3 km at nadir			
	4 km worst case	0.5 km		
c. Refresh (*DoD)	**(For visible and IR) At any location: a) the average revisit time will be 4 hours or less and the maximum revisit time will be 6 hours or less; b) at least 75% of the revisit times will be 4 hours or less**	1 hour		

SYSTEM CAPABILITIES AND CHARACTERISTICS	IORD I		IORD II	
	Thresholds	**Objectives**	**Thresholds**	**Objectives**
Key Para 4.1.6.1.x				
4. Sea Surface Temperature (*DOC/*DoD)				
a. Horizontal Resolution				
1. Global, nadir	1 km	1 km		
2. Global, worst case	4 km			
3. Regional, nadir*	**1 km**	0.25 km		
4. Regional, worst case	3 km			
b. Mapping Accuracy				
1. Global, nadir	1 km	0.5 km		
2. Global, worst case	3 km			
3. Regional, nadir	1 km	0.1 km		
4. Regional, worst case	3 km			
c. Measurement Range	-2 deg C to 40 deg C	-2 deg C to 40 deg C		
d. Measurement Precision	0.2 deg C	0.1 deg C		
e. Measurement Accuracy*	**±0.5 deg C**	±0.1 deg C		
f. Refresh	6 hours	3 hours		
5. Sea Surface Winds (*DoD/*DOC)				
a. Horizontal Resolution	20 km	1 km		
b. Mapping Accuracy	5 km	1 km		
c. Measurement Range	3 to 25 m/s, 0-360 deg	1 to 50 m/s, 0-360 deg		
d. Measurement Precision	1 m/s; 10 deg dir	1 m/s; 10 deg dir		
e. Measurement Accuracy				

1. Speed*	**±2 m/s or ±20% speed, whichever is greater;**	±1 m/s or ±10% speed, whichever is greater;		
2. Direction	±20 deg	±10 deg		
f. Refresh	6 hours	1 hour		

SYSTEM CAPABILITIES AND CHARACTERISTICS	**IORD I**		**IORD II**	
	Thresholds	**Objectives**	**Thresholds**	**Objectives**
Key Para 4.1.6.1.x				
6. Soil Moisture (*DoD/DOC)				
a. Sensing Depth*	**surface (skin layer: to -0.1 cm)**	surface to -80 cm		
b. Horizontal Resolution (HR)				
1. Clear, nadir	1 km			
2. Clear, worst case	4 km	2 km		
3. Cloudy, nadir	40 km	2 km		
4. Cloudy, worst case	50 km			
c. Vertical Sampling Interval	Not required	5 cm		
d. Mapping Accuracy	3 km	1 km		
e. Measurement Accuracy	Bare soil, in regions with known soil types: ±10 cm/m (low HR) ±20 cm/m (high HR - clear skies)	sfc: ± 1 cm/m 80 cm column: ±5% or 130 g/m^3		
f. Refresh	8 hrs	3 hrs		

Requirements Correlation Matrix
(Other Environmental Data Records)
Part 1

SYSTEM CAPABILITIES AND CHARACTERISTICS	IORD I		IORD II	
	Thresholds	**Objectives**	**Thresholds**	**Objectiv**
Para 4.1.6.2.x - Atmospheric Parameters				
1. Aerosol Optical Thickness (DOC)/(DoD)				
a. Sensing Depth	Surface to 30 km	Surface to 50 km		
b. Horizontal Resolution	10 km	1 km		
c. Vertical Sampling Interval	Total Column			
1. From 0 to 2 km		0.25 km		
2. From 2 to 5 km		0.5 km		
3. > 5 km		1 km		
d. Mapping Accuracy	4 km	1 km		
e. Measurement Range	0 to 2	0 to 10		
f. Measurement Precision	0.03	0.01		
g. Measurement Accuracy	±0.03 over ocean	±0.01		
h. Refresh	6 hrs	4 hrs; 2 hrs during daylight		
i. Long Term Stability	0.01	0.003		
2. Aerosol Particle Size (DOC/DoD)				
a. Sensing Depth	Surface to 30 km	Surface to 50 km		
b. Horizontal Resolution	10 km	1 km		
c. Vertical Resolution	Total Column			
1. From 0 to 2 km		0.25 km		
2. From 2 to 5 km		0.5 km		
3. > 5 km		1 km		
d. Mapping Accuracy	4 km	1 km		
e. Measurement Range	-1 to +3	-2 to +4		
f. Measurement Precision	0.3	0.1		
g. Measurement Accuracy	±0.03 over ocean	±0.01		
h. Refresh	6 hours	4 hours; 2 hrs during daylight		
i. Long Term Stability	0.1	0.03		

SYSTEM CAPABILITIES AND CHARACTERISTICS	IORD I		IORD II	
	Thresholds	**Objectives**	**Thresholds**	**Objectiv**
Para 4.1.6.2.x - Atmospheric Parameters				
3. Ozone Total Column/Profile (DOC)				
a. Horizontal Resolution				
1. Total Column	50 km at nadir	50 km worst case		
2. Profile	250 km	250 km		
b. Vertical Resolution				
1. 0-10 km	N/A	3 km		
2. 10-25 km	5 km	1 km		

3. 25-60 km	5 km	3 km		
c. Mapping Accuracy				
1. Total Column, at nadir	5 km	5 km		
2. Profile	25 km	25 km		
d. Measurement Range				
1. Total Column	0.05 to 0.65 atm-cm	0.05 to 0.65 atm-cm		
2. Profile				
a. 0-10 km	N/A	0.01 to 3 ppmv		
b. 10-60 km	0.1 to 15 ppmv	0.1 to 15 ppmv		
e. Measurement Precision				
1. Total Column	0.001 atm-cm	0.001 atm-cm		
2. Profile				
a. 0-10 km	N/A	10%		
b. 10-15 km	10%	3%		
c. 15-50 km	3%	1%		
d. 50-60 km	10%	3%		
f. Measurement Accuracy				
1. Total Column	±0.015 atm-cm	±0.005 atm-cm		
2. Profile				
a. 0-10 km	N/A	10%		
b. 10-15 km	20%	10%		
c. 15-60 km	10%	5%		
g. Refresh				
1. Total Column	24 hrs	24 hrs		
2. Profile	7 days	24 hrs		
h. Long Term Stability				
1. Total Column	1%	0.50%		
2. Profile	2%	1%		

SYSTEM CAPABILITIES AND CHARACTERISTICS	**IORD I**		**IORD II**	
	Thresholds	**Objectives**	**Thresholds**	**Objectiv**
Para 4.1.6.2.x - Atmospheric Parameters				
4. Precipitable Water (DOC)				
a. Sensing Depth	Surface to TOA			
b. Horizontal Resolution	25 km	1 km		
c. Mapping Accuracy	3 km	TBD		
d. Measurement Range	0 to 75 mm	0 to 100 mm		
e. Measurement Precision	1 mm	1 mm		
f. Measurement Accuracy	greater of 2mm or ±10%	± 1 mm		
g. Refresh	6 hrs	3 hours		
5. Precipitation Type/Rate (DoD/DOC)				
a. Horizontal Resolution	15 km	0.1 km		
b. Mapping Accuracy	3 km	0.1 km		
c. Measurement Range	0 to 250 mm/hr			
d. Measurement Precision	1 mm/hr	1 mm/hr		

e. Measurement Accuracy	± 2 mm/hr	± 2 mm/hr		
f. Refresh	8 hrs	3 hrs		
6. Pressure (Surface/Profile) (DoD)				
a. Sensing Depth	Surface to 30 km	Surface to 30 km		
b. Horizontal Resolution	25 km	5 km		
c. Vertical Resolution				
1. 0-2 km	1 km	0.25 km		
2. 2-5 km	1 km	0.5 km		
3. >5 km	1 km	1 km		
d. Mapping Accuracy	7 km	1 km		
e. Measurement Range	10 to 1050 mb	10 to 1050 mb		
f. Measurement Precision	4 mb	2 mb		
g. Measurement Accuracy	0 to 10 km: ± 5 % 10 to 30 km: ±10%	0 to 10 km: ±3% 10 to 30 km: ±5%		
h. Refresh	12 hrs	1 hr		
SYSTEM CAPABILITIES AND CHARACTERISTICS	**IORD I**		**IORD II**	
	Thresholds	**Objectives**	**Thresholds**	**Objectiv**
Para 4.1.6.2.x - Atmospheric Parameters				
7. Suspended Matter (DoD/DOC)				
a. Horizontal Resolution	3 km	1 km		
b. Vertical Sampling Interval	Not required	0.2 km		
c. Mapping Accuracy	3 km	0.1 km		
d. Measurement Range				
(1) Detect Aerosols	Dust, sand, and ash	dust, sand, ash & sea salt		
(2) Radioactive/Smoke Plumes	TBD	0 to 100 $\mu g/m^3$ (smoke)		
e. Refresh	12 hrs	3 hrs		
8. Total Water Content (DoD)				
a. Horizontal Resolution	20 km	10 km		
b. Vertical Resolution	3 km	1 km		
c. Mapping Accuracy	7 km	7 km		
d. Measurement Accuracy				
1. Total Integrated Water Vapor (TIWV)	±2 kg/m2, 1 kg/m3 global avg			
2. Cloud Liquid Water Content (CLWC)	±0.2 kg/m2, over ocean only			
d. Refresh	8 hrs	3 hrs		
Para 4.1.6.3.x - Cloud Parameters				
1. Cloud Base Height (DOC/DoD)				
a. Horizontal Resolution	25 km	10 km		
b. Vertical Sampling Interval	TBD	0.25 km		
c. Mapping Accuracy	4 km	1 km		

d. Measurement Accuracy	±2 km	±0.25 km		
e. Refresh	6 hrs	4 hrs		
SYSTEM CAPABILITIES AND CHARACTERISTICS	**IORD I**		**IORD II**	
	Thresholds	**Objectives**	**Thresholds**	**Objectiv**
Para 4.1.6.3.x - Cloud Parameters				
2. Cloud Cover/Layers (DoD/DOC)				
a. Horizontal Resolution	25 km	2 km		
b. Vertical Sampling Interval	4 layers	0.1 km		
c. Mapping Accuracy	4 km	1 km		
d. Measurement Range	0 to 100 %	0 to 100 %		
e. Measurement Precision	15% (layers)	2.50%		
f. Measurement Accuracy	±10% (cover)	±5%		
g. Refresh	6 hrs	4 hrs		
3. Cloud-Effective Particle Size (DOC/DoD)				
a. Horizontal Resolution	50 km	10 km		
b. Vertical Sampling Interval	1 km	0.3 km		
c. Mapping Accuracy	4 km	1 km		
d. Measurement Range	0-50 µm			
e. Measurement Precision	greater of 5% or 2 µm	2%		
f. Measurement Accuracy	greater of ±10% or ±4 µm	greater of ±5% or ±2 µm		
g. Refresh	8 hrs	3 hrs		
h. Long Term Stability	2%	1%		
SYSTEM CAPABILITIES AND CHARACTERISTICS	**IORD I**		**IORD II**	
	Thresholds	**Objectives**	**Thresholds**	**Objectiv**
Para 4.1.6.3.x - Cloud Parameters				
4. Cloud Ice Water Path (DOC)				
a. Sensing Depth	Surface to 15 km	Surface to 20 km		
b. Horizontal Resolution	50 km	10 km		
c. Vertical Sampling Interval	Total Column	0.3 km		
d. Mapping Accuracy	4 km	1 km		
e. Measurement Range	0 to 1 mm	0 to 1 mm		
f. Measurement Precision	5%	2%		
g. Measurement Accuracy	±10%	±5%		
h. Refresh	6 hrs	3 hrs		
i. Long Term Stability	2%	1%		
5. Cloud Liq. Water (DOC/DoD)				
a. Horizontal Resolution	20 km	5 km		
b. Vertical Sampling Interval	Total Column	0.3 km		
c. Mapping Accuracy	7 km	1 km		
d. Measurement Accuracy	± 0.5 mm over ocean ± 0.25 mm over land	± 0.01 mm		
e. Refresh	8 hrs	4 hours		

SYSTEM CAPABILITIES AND CHARACTERISTICS	IORD I Thresholds	IORD I Objectives	IORD II Thresholds	IORD II Objectiv
6. Cloud Optical Depth/Transmissivity(DOC)				
a. Horizontal Resolution	50 km	10 km		
b. Mapping Accuracy	4 km	10 km		
c. Measurement Precision	5%	2%		
d. Measurement Accuracy	±10%	±5%		
e. Refresh	8 hrs	3 hrs		
f. Long Term Stability	2%	1%		
7. Cloud Top Height (DOC/DoD)				
a. Horizontal Resolution	25 km	10 km		
b. Vertical Sampling Interval	Four layers	0.25 km		
c. Mapping Accuracy	4 km	1 km		
d. Measurement Precision	0.3 km	0.15 km		
e. Measurement Accuracy	optically thick: ± 0.5 km	±0.3 km		
	optically thin: ± 2 km	±0.3 km		
f. Refresh	8 hrs	6 hrs		
g. Long Term Stability	0.2 km	0.1 km		

SYSTEM CAPABILITIES AND CHARACTERISTICS	IORD I		IORD II	
	Thresholds	Objectives	Thresholds	Objectiv
Para 4.1.6.3.x - Cloud Parameters				
8. Cloud Top Pressure (DOC)				
a. Horizontal Resolution	15 km	10 km		
b. Mapping Accuracy	4 km	1 km		
c. Measurement Precision				
1. sfc to 3 km	50 mb	10 mb		
2. 3 to 7 km	38 mb	7 mb		
3. > 7 km	25 mb	5 mb		
d. Measurement Accuracy				
1. sfc to 3 km	±100 mb	±30 mb		
2. 3 to 7 km	±75 mb	±22 mb		
3. > 7 km	±50 mb	±15 mb		
e. Refresh	8 hrs	3 hrs		
f. Long Term Stability				
1. sfc to 3 km	10 mb	3 mb		
2. 3 to 7 km	7 mb	2 mb		
3. > 7 km	5 mb	1 mb		
9. Cloud Top Temperature (DOC/DoD)				
a. Horizontal Resolution	25 km	10 km		
b. Mapping Accuracy	4 km	1 km		
c. Measurement Precision	1.5 K	0.5 K		
d. Measurement Accuracy	±3 K	±1.5 K		
e. Refresh	6 hrs	6 hrs		
f. Long Term Stability	1 K	0.1 K		

SYSTEM CAPABILITIES	IORD I		IORD II	

AND CHARACTERISTICS	Thresholds	Objectives	Thresholds	Objectiv
Para 4.1.6.4.x - Earth Radiation Budget Parameters				
1. Albedo (Surface) (DOC/DoD)				
a. Horizontal Resolution	4 km	0.5 km		
b. Mapping Accuracy	4 km	1 km		
c. Measurement Range	0 to 100%	0 to 100 %		
d. Measurement Precision	2 % (albedo units)	1%		
e. Measurement Accuracy	±5 % (albedo units)	± 1.25%		
f. Refresh	24 hrs	4 hrs		
g. Long Term Stability	2 % (albedo units)	1%		
2. Downward Longwave Radiation (Surface) (DOC)				
a. Horizontal Resolution	40 km at nadir	10 km		
b. Mapping Accuracy	10 km			
c. Measurement Range	0 to 500 W/m^2	0 to 500 W/m^2		
d. Measurement Precision	0.1 W/m^2	0.1 W/m^2		
e. Measurement Accuracy	± 5 W/m^2	±1 W/m^2		
f. Refresh	14 hrs	6 hrs		
3. Insolation (DOC)				
a. Horizontal Resolution	50 km	100 km		
b. Mapping Accuracy	5 km	10 km		
c. Measurement Range	0 to 1400 W/m^2	0 to 1400 W/m^2		
d. Measurement Precision	5 W/m^2	0.1 W/m^2		
e. Measurement Accuracy	±20 W/m^2	±1.0 W/m^2		
f. Refresh	24 hrs	24 hrs		
SYSTEM CAPABILITIES	**IORD I**		**IORD**	**II**
AND CHARACTERISTICS	**Thresholds**	**Objectives**	**Thresholds**	**Objectiv**
Para 4.1.6.4.x - Earth Radiation Budget Parameters				
4. Net Shortwave Radiation (TOA) (DOC)				
a. Horizontal Resolution	100 km	20 km		
b. Mapping Accuracy	10 km	5 km		
c. Measurement Range	0 to 900 W/m^2	0 to 900 W/m^2		
d. Measurement Precision	3 W/m^2	1.5 W/m^2		
e. Measurement Accuracy	± 5 W/m^2	± 2.5 W/m^2		
f. Refresh	12 hrs	8 hrs		
5. Solar Irradiance-Total & 2 Narrow Bands(DOC)				
a. Measurement Range				
1. Total	1320 to 1420 W/m^2	1320 to 1420 W/m^2		
2. 200-300 nm band	0 to 10 W/m^2	0 to 10 W/m^2		
3. 1500 nm band	0 to 10 W/m^2	0 to 10 W/m^2		

b. Measurement Precision				
1. Total	0.002 % per year	0.0005% per year		
2. 200-300 nm band	0.02% per year	0.01 % per year		
3. 1500 nm band	0.01% per year	0.005% per year		
c. Measurement Accuracy				
1. Total	± 1.5 W/m^2	± 0.5 W/m^2		
2. 200-300 nm band	±2%	±0.5%		
3. 1500 nm band	±2%	±0.5%		
d. Refresh	20 minute viewing sun each orbit, 1 satellite	20 minute viewing sun each orbit, 3 satellite		
6. Total Longwave Radiation (TOA) (DOC)				
a. Horizontal Resolution	100 km	20 km		
b. Mapping Accuracy	10 km	5 km		
c. Measurement Range	0 to 500 W/m^2	0 to 500 W/m^2		
d. Measurement Precision	3 W/m^2	1.5 W/m^2		
e. Measurement Accuracy	± 5 W/m^2	± 2.5 W/m^2		
f. Refresh	24 hrs (once/daytime, once/nighttime)	4 hrs		

SYSTEM CAPABILITIES AND CHARACTERISTICS	**IORD I**		**IORD II**	
	Thresholds	**Objectives**	**Thresholds**	**Objectiv**
Para 4.1.6.5.x - Land Parameters				
1. Land Surface Temperature (DoD/DOC)				
a. Horizontal Resolution	4 km	1 km		
b. Mapping Accuracy	4 km	1 km		
c. Measurement Range	-60 to 70 deg C	-60 to 70 deg C		
d. Measurement Precision	0.5 deg C	0.025 deg C		
e. Measurement Accuracy	Clear: ±2.5 deg C	± 1 deg C		
f. Refresh	Clear: 6 hrs	3 hrs		
2. Normalized Difference Vegetation Index (DOC)				
a. Horizontal Resolution	4 km	1km		
b. Mapping Accuracy	4 km	1 km		
c. Measurement Range	-1 to +1	-1 to +1		
d. Measurement Precision	0.04 NDVI units	0.02 NDVI units		
e. Measurement Accuracy	±0.05 NDVI units	±0.03 NDVI units		
f. Refresh	24 hrs	24 hrs		
g. Long Term Precision	0.04 NDVI units	0.04 NDVI units		
3. Snow Cover/Depth (DoD/DOC)				
a. Sensing Depth	0-40 cm	1 m		
b. Horizontal Resolution	Clear: 1.3 km	1 km		
	Cloudy: 12.5 km	1 km		
c. Vertical Sampling Interval	12.5 cm	> 8 cm		
		> 15 cm		

		> 30 cm		
		> 51 cm		
		> 76 cm		
d. Mapping Accuracy	Clear: 2 km	1 km		
	Cloudy: 7 km	1 km		
e. Measurement Accuracy	± 10%(snow/no snow)	± 10% for snow depth		
	± 10%(snow/no snow			
f. Refresh	12 hrs	3 hrs		

SYSTEM CAPABILITIES AND CHARACTERISTICS	**IORD I**		**IORD II**	
	Thresholds	**Objectives**	**Thresholds**	**Objectiv**
Para 4.1.6.5.x - Land Parameters				
4. Vegetation Index/Surface Type (DoD)				
a. Horizontal Resolution				
1. Global	20 km	1 km		
2. Regional	20 km	0.25 km		
b. Mapping Accuracy	5 km	1 km		
c. Measurement Range	Identification of 21 surface types	0 to 100% vegetation, identification of 21 surface types		
d. Measurement Precision	10%	0.10%		
e. Measurement Accuracy	70% correct for 21 types	± 2%		
f. Refresh	24 hrs	3 hrs		
Para 4.1.6.6.x - Ocean/Water Parameters				
1. Currents (DoD - near shore; DOC - surface)				
a. Sensing Depth	0 to 10 m	0 to 30 m		
b. Horizontal Resolution				
1. Global	4 km	1 km		
2. Regional	1.3 km	0.25 km		
c. Vertical Resolution	Avg Vector for 5 m layer	Avg vector for 1 m layers		
d. Mapping Accuracy	3 km	1 km		
e. Measurement Range	0 to 5 m/s, 0 to 360 deg	0 to 5 m/s, 0 to 360 deg		
f. Measurement Precision	0.25 m/s, 15 deg	0.1 m/s, 5 deg		
g. Measurement Accuracy	±0.25 m/s, ±15 deg	±0.1 m/s, ±5 deg		
h. Refresh	TBD	12 hrs		
2. Fresh Water Ice (DOC/DoD)				
a. Sensing Depth	Ice surface	1 m		
b. Horizontal Resolution				
1. Regional, nadir	0.4 km			
2. Regional, worst case	0.8 km	0.65 km		
c. Mapping Accuracy	3 km	1 km		
d. Measurement Range	1/10 to 10/10 concentration	0/10 to 10/10 concentration		
e. Measurement Accuracy				
1. Ice Edge Boundary	±10 deg latitude/longitude	±5 deg latitude/longitude		

SYSTEM CAPABILITIES AND CHARACTERISTICS	IORD I Thresholds	IORD I Objectives	IORD II Thresholds	IORD II Objectiv
2. Ice Edge Concentration	±20%	±10%		
f. Refresh	12 hrs	6 hrs		
SYSTEM CAPABILITIES	**IORD I**		**IORD II**	
AND CHARACTERISTICS	**Thresholds**	**Objectives**	**Thresholds**	**Objectiv**
AND CHARACTERISTICS	**Thresholds**	**Objectives**	**Thresholds**	**Objectiv**
Para 4.1.6.6.x - Ocean/Water Parameters				
3. Ice Surface Temperature (DOC/DoD)				
a. Sensing Depth	Ice Surface	2 m above ice surface		
b. Mapping Accuracy	3 km	1 km		
c. Measurement Range	-60 to +20 deg C			
d. Measurement Accuracy	± 1 deg C			
e. Refresh	24 hrs	12 hours		
4. Littoral Sediment Transport (DoD)				
a. Horizontal Resolution, worst case	1.3 km	0.1 km		
b. Mapping Accuracy, worst case	3 km	0.1 km		
c. Measurement Precision	40%	15%		
d. Measurement Accuracy	± 30%	± 15%		
e. Refresh	48 hrs	12 hrs		
5. Net Heat Flux (DoD/DOC)				
a. Sensing Depth	Air/Sea interface	Air/Land/Sea Interface		
b. Horizontal Resolution	20 km	5 km		
c. Mapping Accuracy	7 km			
d. Measurement Range	0 to 2000 W/m2	0 to 1000 W/m^2		
e. Measurement Precision	5 W/m^2	1 W/m^2		
f. Measurement Accuracy	± 10 W/m^2	± 1 W/m^2		
g. Refresh	6 hrs	3 hrs		
6. *Ocean Color/Chlorophyll (DoD/DOC)*				
a. Horizontal Resolution				
1. Global, worst case	2.6 km	1 km		
2. Regional, worst case	1.3 km	0.1 km		
b. Mapping Accuracy				
1. Global, worst case	3 km	0.5 km		
2. Regional, worst case	3 km	0.1 km		
c. Measurement Range	0.05 to 50 mg/m^3	0 to 100 mg/m^3		
d. Measurement Precision	20%	10%		
e. Measurement Accuracy	± 30%	± 30%		
f. Refresh	48 hours	12 hrs		
SYSTEM CAPABILITIES	**IORD I**		**IORD II**	
AND CHARACTERISTICS	**Thresholds**	**Objectives**	**Thresholds**	**Objectiv**
Para 4.1.6.6.x - Ocean/Water Parameters				
7. Ocean Wave Characteristics (DoD/DOC)				
a. Horizontal Resolution				

1. Global, nadir along track	20 km	5 km		
2. Regional nadir along track	10 km	0.25 km		
b. Mapping Accuracy				
1. Global, worst case	10 km	2 km		
2. Regional, worst case	4 km	0.25 km		
c. Measurement Range	height: 0.5 to 30 m	0.5 to 30 m		
	direction: 0 to 360 deg	0 to 360 deg		
d. Measurement Precision	height: 0.2 m	0.1 m		
	direction: 10 deg	5 deg		
e. Measurement Accuracy	height: ± 0.2 m	± 0.2 m		
	direction: ± 10 deg	± 5 deg		
f. Refresh	72 hrs	6 hrs		
f. Refresh	72 hours	6 hours		
8. Sea Ice Age and Motion (DOC/DoD)				
a. Sensing Depth	Ice Surface	1 m		
b. Horizontal Resolution (Ice Age)	3 km	0.1 km		
c. Mapping Accuracy	3 km	1 km		
d. Measurement Range				
1. Ice Age	1 to 36+ months			
2. Ice Motion	TBD	0 to 50 km/day		
e. Measurement Accuracy				
1. Ice Age				
2. Ice Edge Motion	±1 km/day	±0.1 km/day		
f. Refresh	24 hrs	12 hrs		

SYSTEM CAPABILITIES AND CHARACTERISTICS	IORD I		IORD II	
	Thresholds	**Objectives**	**Thresholds**	**Objectiv**
Para 4.1.6.6.x - Ocean/Water Parameters				
9. Sea Surface Height (DOC)/Topography (DoD)				
a. Horizontal Resolution	4 km	0.5 km		
b. Mapping Accuracy	2 km	1 km		
c. Measurement Range	± 50 m	± 50 m		
d. Measurement Precision	3 cm	2 cm		
e. Measurement Accuracy	± 5 cm	± 3 cm		
f. Refresh	72 hrs	3 hrs		
10. Surface Wind Stress (DOC/DoD)				
a. Horizontal Resolution	50 km	20 km		

b. Mapping Accuracy	7 km	10 km		
c. Measurement Range	0 to 50 N/m^2	0 to 50 N/m^2		
d. Measurement Precision	± 2 N/m^2	1 N/m^2		
e. Measurement Accuracy	± 2 N/m^2	± 1 N/m^2		
f. Refresh	12 hrs	12 hrs		
11. Turbidity (DoD/DOC)				
a. Sensing Depth	Surface	TBD		
b. Horizontal Resolution	1.3 km	0.25 km		
c. Mapping Accuracy	TBD	0.5 km		
d. Measurement Range	TBD	0 to 100 mg/l		
e. Measurement Precision	TBD	0.1 mg/l		
f. Measurement Accuracy	± 30%	±0.1 mg/l		
g. Refresh	48 hrs	24 hrs		
Para 4.1.6.7.x - Space Environmental Parameters				
1. Auroral Boundary (DoD/DOC)				
a. Measurement Accuracy	50 km	10 km		
2. Auroral Energy Deposition (Total) (DoD/DOC)				
a. Measurement Range	electrons:10^{-4} to 1.0 W/m^2 ions: 10^{-4} to 10^{-1} W/m^2	electrons:$5x10^{-5}$ to 1.0 W/m^2 ions: $5x10^{-5}$ to 10^{-1} W/m^2		
b. Measurement Accuracy	greater of ±20% or ±10^{-4} W/m^2	greater of ±10% or ±$5x10^{-5}$ W/m^2		

SYSTEM CAPABILITIES AND CHARACTERISTICS	**IORD I**		**IORD II**	
	Thresholds	**Objectives**	**Thresholds**	**Objectiv**
Para 4.1.6.7.x - Space Environmental Parameters				
3. Auroral Imagery (DoD/DOC)				
a. Measurement Range	120 to 180 nm	80 to 250 nm		
b. Measurement Accuracy	± 10%	± 5%		
c. Horizontal Resolution	20 km	10 km		
4. Electric Field (DoD/DOC)				
a. Measurement Range	0 to 150 mV/m	0 to 250 mV/m		
b. Measurement Precision	2.0 mV/m	0.1 mV/m		
c. Measurement Accuracy	±3.0 mV/m	±0.1 mV/m		
5. Electron Density Profile/Ionospheric Specification (DoD/DOC)				
a. Horizontal Resolution				
1. 0-30 deg lat	200 km	100 km		
2. 30-50 deg lat	500 km	250 km		

3. 50-90 deg lat	100 km	50 km		
b. Vertical Resolution				
1. W/in 100km of either the E layer or F layer peaks	10 km	5 km		
2. Elsewhere, away from E-, F-layer peaks	20 km	5 km		
c. Measurement Range				
1. local density	$3x10^5$ to 10^7 cm^{-3}	10^4 to 10^7 cm^{-3}		
2. TEC:	$3x10^{16}$ to $2x10^{18}$ m^{-2}	10^{16} to $2x10^{18}$ m^{-2}		
3. foF2:	5 to 30 MHz	1 to 30 MHz		
d. Measurement Accuracy				
1. local density	$\pm 3x10^5$ cm^{-3}	$\pm 10^4$ cm^{-3}		
2. NmF2:	±20%	±5%		
3. HmF2:	±20 km	±5 km		
4. TEC:	greater of ±20% or $3x10^{16}m^{-2}$	$\pm 10^{16}$ m^{-2}		

SYSTEM CAPABILITIES AND CHARACTERISTICS	IORD I		IORD II	
	Thresholds	Objectives	Thresholds	Objectiv
Para 4.1.6.7.x - Space Environmental Parameters				
6. Geomagnetic Field (DoD)				
a. In-Track Resolution	10 km	0.5 km		
b. Mapping Accuracy	100 m			
c. Measurement Range	3D mag vector at s/c alt 20,000 to 60,000 nT	3D mag vector at s/c alt 10,000 to 60,000 nT		
d. Measurement Precision	2 nT	0.5 nT		
e. Measurement Accuracy				
1. Magnitude	± 6 nT(rms)	2 nT		
2. Vector direction	1.0 arc min	0.6 arc min		
7. In-situ Ion Drift Velocity (DoD/DOC)				
a. Measurement Range	0 to 3 km/sec	0 to 5 km/sec		
b. Measurement Precision	50 m/s	25 m/s		
c. Measurement Accuracy	± 75 m/s	± 50 m/s		
8. In-Situ Plasma Density (DoD)				
a. In-Track Resolution	50 km	10 km		
b. Measurement Range	$5x10^3$ to $5x10^6$ cm^{-3}	10^2 to 10^7 cm^{-3}		
c. Measurement Accuracy	± 20%	± 5%		
9. In-Situ Plasma Fluctuations (DoD)				
a. In-Track Resolution	100 km	5 m		
b. Measurement Range	Spectral Index: 2 to 5 $\Delta n/n$: 10^{-2} to 1.0	Spectral Index: 1 to 10 $\Delta n/n$: 10^{-4} to 1.0		
10. In-Situ Plasma Temperature (DoD)				
a. In-Track Resolution	100 km	10 km		

b. Measurement Range	500 to 10,000 K	500 to 10,000 K		
c. Measurement Accuracy	± 10%	± 5%		
SYSTEM CAPABILITIES AND CHARACTERISTICS	**IORD I**		**IORD II**	
	Thresholds	**Objectives**	**Thresholds**	**Objectiv**
Para 4.1.6.7.x - Space Environmental Parameters				
11. Ionospheric Scintillation (DoD)				
a. Horizontal Resolution	100 km	50 km		
b. Measurement Range				
1. Amplitude Index (S4)	0.1 to 1.5			
2. Phase Index (σ_ϕ)	0.1 to 20 radians			
c. Measurement Precision				
1. Amplitude Index (S4)	0.1			
2. Phase Index (σ_ϕ)	0.1 radians			
d. Measurement Accuracy	Factor of ±2			
12. Neutral Density Profile/Neutral Atmospheric Specification (DoD/DOC)				
a. Sensing Depth	100 to750 km	90 to 1600 km		
b. In-Track Resolution	500 km	50 km		
c. Vertical Resolution	10 km	up to 120 km: 0.5 km >120 km: 3 km		
d. Measurement Range	$3x10^{-9}$ to $2x10^{-19}$ g/cm^{-3} $6x10^{13}$ to $9x10^{4}$ cm^{-3}			
e. Measurement Accuracy	± 15% at 100 to 500 km ± 20% at > 500 km	± 5% at 90 to 500 km ± 10% at 500 to 700 km ± 15% at 700 to 1600 km		
SYSTEM CAPABILITIES AND CHARACTERISTICS	**IORD I**		**IORD II**	
	Thresholds	**Objectives**	**Thresholds**	**Objectiv**
Para 4.1.6.7.x - Space Environmental Parameters				
13. Radiation Belt and Low Energy Solar Particles (DoD/DOC)				
a. Measurement Range				
1. Energy	ions: 30 keV to 10 MeV in 8 bands electrons: 30keV to 10 MeV in 8 bands			
2. Flux	ions: 10^{5} to 10^{11} $m^{-2}sec^{-1}ster^{-1}$ electrons: 10^{5} to 10^{11} $m^{-2}sec^{-1}ster^{-1}$			
b. Measurement Precision (energy)	5%	1%		
c. Measurement Accuracy	±20%	±10%		

14. Solar & Galactic Cosmic Ray Particles(DoD/DOC)				
a. Measurement Range				
1. Energy	protons: >10 MeV to >1000 MeV/nucleon in 6 bands; alphas: >10 MeV to >1000 MeV/nucleon in 6 bands; heavy ions (CNO): >10 to >100 MeV/nucleon in 4 bands; heavy ions (Fe): >10 to >100 MeV/nucleon in 4 bands	protons: >10 MeV to >1000 MeV/nucleon in 8 bands; alphas: >10 MeV to >1000 MeV/nucleon in 8 bands; heavy ions (CNO): >10 to >100 MeV/nucleon in 4 bands; heavy ions (Fe): >10 to >100 MeV/nucleon in 4 bands		
2. Flux	protons: 10^{3} to 10^{10} $m^{-2}sec^{-1}ster^{-1}$ alphas: 10^{2} to 10^{8} $m^{-2}sec^{-1}ster^{-1}$ heavy ions (CNO): 10^{0} to 10^{7} $m^{-2}sec^{-1}ster^{-1}$ heavy ions (Fe): 10^{-1} to 10^{6} $m^{-2}sec^{-1}ster^{-1}$	protons: 10^{2} to 10^{10} $m^{-2}sec^{-1}ster^{-1}$ alphas: 10^{2} to 10^{8} $m^{-2}sec^{-1}ster^{-1}$ heavy ions (CNO): 10^{-2} to 10^{7} $m^{-2}sec^{-1}ster^{-2}$ heavy ions (Fe): 10^{-3} to 10^{6} $m^{-2}sec^{-1}ster^{-2}$		
b. Measurement Precision	5%	1%		
c. Measurement Accuracy	±20%	±10%		

SYSTEM CAPABILITIES AND CHARACTERISTICS	**IORD I**		**IORD II**	
	Thresholds	**Objectives**	**Thresholds**	**Objectiv**
Para 4.1.6.7.x - Space Environmental Parameters				
15. Solar EUV Flux (DOC)				
a. Measurement Range	5 to 130 nm in 4 channels	1 to 175 nm in 10 channels		
b. Measurement Accuracy	greater of ±20 % or $\pm10^{-4}$ W/m^{2}	greater of ±10 % or $\pm5x10^{-5}$ W/m^{2}		
16. Supra-thermal through Auroral Energy Particles (DoD/DOC)				
a. Measurement Range				
1. Energy	30 eV to 30 keV			
2. Flux	10^{8} to $10^{15}m^{-2}sec^{-1}ster^{-1}keV^{-1}$			
b. Measurement Precision				
1. Energy	ΔE/E = 0.2	ΔE/E = 0.1		
2. Flux	5%	1%		
c. Measurement Accuracy	±20%	±10%		
17. Upper Atmospheric Airglow (DoD)				
a. In track resolution (Limb)	750 km	100 km		
b. Horizontal Resolution				
1. Limb (measurement interval)	750 km	100 km		
2. Disk 0-30 deg lat	200 km	100 km		

30-50 deg lat	500 km	250 km		
50-90 deg lat	100 km	10 km		
c. Vertical Resolution (limb only)	20 km	5 km		
d. Measurement Range				
1. Limb	20-1000 R at 83.4 nm	10-1000R at 83.4 nm		
	0.2-10 kR at 135.6 nm	0.1-10kR at 135.6 nm		
	0.2-30 kR at 140-180 nm	0.1-30kR at 140-180 nm		
2. Disk	1-30 kR at 121.6 nm	0.5-30kR at 121.6 nm		
	4-4000 R at 135.6 nm	1-4000R at 135.6 nm		
	4-5000 R at 140-180 nm	1-5000R at 140-180 nm		
e. Measurement Accuracy	±10%	±5%		

Requirements Correlation Matrix
Part II

NOTE: The agency listed first (DOC or DoD) has the more stringent requirements. "AWS Report" refers to the AWS report Use of Polar-orbiting Meteorological Satellite Data by Air Force Weather. "Navy Study" refers to the Navy study Meteorology and Oceanography Satellite Remote Sensing Requirements of the United States Navy and Marine Corps.

System Characteristics (Para 4.1.5.x.)

Parameter 1--Data Availability (DoD/DOC). (USAF) Data availability values are based on perishability of weather data as documented in HQ USAF/XOWX memo, 3 Mar 95, National Agenda for Meteorological Services and Supporting Research which states how meteorological data value, for predictive purposes, diminishes exponentially with time. Failure to meet threshold values would result in degraded support to National Program customers whose requirements for polar-orbiting satellite derived products are documented in National Program Requests for Environmental Support (RES) and Interface Control Documents (ICDs) on file at Air Weather Service's Special Projects Division (HQ AWS/XOS).

(DOC) DOC requires time-continuous measurements of atmospheric, oceanic, and land-surface parameters to ensure successful analyses for environmental prediction missions. Coverage gaps critically degrade utility of high-resolution measurements for real time prediction and climatological missions.

Parameter 2--Autonomous Operations (DoD). (USAF) DoD requires continuing data transmissions during contingencies or conflicts, even when the C^3 segment is down. The threshold values were established as a result of AFSPC evaluations in determining the amount of time required to reconstitute the C^3 segment using redundant assets.

Parameter 3--Stored High Resolution Data (DoD/DOC). (USAF) USAF requires the ability to have commandable portions of each orbit sensed in high resolution, data stored, then down-linked at the end of each orbit to the C^3 segment. Justification for DoD is on file at HQ AWS/XOS.

Parameter 4--Surface Data Collection (DOC/DoD). (DOC) DOC requirement for ARGOS system payload covered by Memorandum of Understanding between National Oceanic and Atmospheric Administration and the Centre National D'Etudes Spatiales for the ARGOS Data Collection and Platform Location System; effective beginning 26 March 1986. US Navy also will require ARGOS capability.

Parameter 5--Orbital Characteristics (DoD/DOC). (USAF) Requirements specified in classified documents maintained at HQ AWS/XOS identify the need for required orbital characteristics.

(DOC) DOC requires observations from NPOESS in sun-synchronous, early afternoon (around 1330L equatorial crossing time) orbit to maximize availability of meteorological, oceanic, and surface measurements over the areas of the globe most critical to numerical weather prediction model initialization for the United States. (Scientific assessment -- National Centers for Environmental Prediction.)

Parameter 6--System Survivability (DoD). See DMSP/NPOESS STAR.

Parameter 7--Search and Rescue (DOC). (DOC) DOC operates this system under guidelines of a memoranda of agreement with the governments of France, Russia, and Canada: (1) International COSPAS-SARSAT Program Agreement (1 July 1988), Russia, Canada, France, and U.S. (2) International SARSAT Memorandum of Agreement (5 September 1995), Canada, France, and U.S. (3) Memorandum of Understanding among the National Oceanic and Atmospheric Administration, U.S. Coast Guard, U.S. Air Force, and NASA Regarding the United States Responsibilities Relating to the U.S. COSPAS-SARSAT System (23 September 1991).

Parameter 8--Compatibility (DOC). DOC depends on remote-sensing expertise exchange through cooperative institutes with several universities and other civilian agencies who gather POES data directly. Further, DOC has fostered private-sector markets for polar-orbiting satellite image receiving and processing systems. Evolution to next-generation ground processing systems for NPOESS must be manageable and non-disruptive to these efforts where economical and practical.

Parameter 9--Space Debris Minimization (DoD/DOC). These requirements are IAW National Space Policy Directive 1, dated 2 Nov 1989 and USSPACECOM Regulation 57-2.

Parameter 10--*Data Access (*DoD). (USAF) DoD operational security (OPSEC) regulations direct the control of data generated by DoD systems that could be used against our operational forces. Presidential Decision Directive/NSTC-2, 5 May 94, requires data denial capability on NPOESS.

(USA) CJCSI 3810.01, “Meteorological and Oceanographic Operations”, Jan 95, establishes need to selectively deny data to potential adversaries while retaining access for U.S. forces.

Parameter 11--Geolocation of Data (DOC/DoD). (DOC) NPOESS satellite orbit and attitude information must be provided with the sensor data so the USG or other users can assign a specific Earth location to any measurement or observation. Such Earth location information is required in order to be able to correctly process quantitative data into mapped values, and to co-locate measurements with measurements from other space-based or in situ sensors.

(USAF) This is a requirement of Air Combat Command (ACC) and Central Command (CENTCOM) which will allow their Small Tactical Terminal (STT) users to use a GPS reference grid to determine location of cloud features and other data received from NPOESS. Documentation of this requirement may be found in the STT Concept of Operations (CONOPS).

Parameter 12--Space Environmental Constellation Characteristics (DoD/DOC). These parameters must be measured continuously in each orbital plane, at specified resolutions, to get a representative sampling of the ionosphere, which is itself semi-sun-synchronous. In addition, equal spacing, and adequate coverage of the dawn/dusk transitions and the approximate noon/midnight fluctuations are necessary.

<u>Key Environmental Data Records (Para 4.1.6.1.x.)</u>

Parameter 1--*Atmospheric Vertical Moisture Profile (***DOC/*DoD**). (USAF) Atmospheric profiles of moisture from space-based platforms are required at the specified threshold values as documented in AWS Report.

(USN) Navy Study concluded atmospheric profiles of moisture from polar-orbiting satellites are required at the specified threshold values to initialize the Navy's emerging high-resolution global air/ocean models. These models provide the global meteorological and oceanographic predictions to the Fleet and other military services and provide the boundary conditions for both the regional and tactical models which support specific warfare areas and weapons systems tactical decision aids. Much of the atmospheric moisture is concentrated close to the Earth's surface, in the lowest 1 to 2 km of the atmosphere. Comparisons of Navy model simulations indicate if the measurement accuracies of the profiles are less than the threshold values, the profile data corrupts the model rather than increasing its capability to forecast. Observational errors, usually on the smaller scales, amplify and through nonlinear interactions gradually spread to the longer scales, eventually destroying forecast skill. In previous studies, numerical models using data with a standard deviation of 0.5◦C at all levels had an exponential error growth with a doubling time of about 2.5 days. Similar results were found for other data types (i.e., winds, moisture, etc.), with forecast errors as high as 20 to 30%. Navy model simulations show a one to three day improvement in forecast ability in the data sparse Southern hemisphere.

(DOC) The National Centers for Environmental Prediction (NCEP) scientific assessment and "NOAA Requirements for Support from Polar-Orbiting Spacecraft," identifies model initialization and data assimilation requirements which drive vertical sampling interval, mapping accuracy and refresh rate values consistent with specified threshold requirements. Results from the AGU Chapman Conference on Water Vapor in the Climate System, 25-28 October 1994 indicate DOC requires measurement accuracies better than specified threshold requirements in order to achieve any improvements in NOAA's regional model three hour forecast.

Parameter 2--*Atmospheric Vertical Temperature Profile (***DOC/ *DoD**). (USAF) Atmospheric profiles of temperature from space-based platforms are required at the specified threshold values as documented in AWS Report.

(USN) Navy Study concluded atmospheric profiles of temperature from polar-orbiting satellites are required at the specified threshold values to initialize the Navy's emerging high-resolution global air/ocean models. These models provide the global meteorological and oceanographic predictions to the Fleet and other military services and provide the boundary conditions for both the regional and tactical models which support specific warfare areas and weapons systems tactical decision aids. Comparisons of Navy model simulations indicate if the measurement accuracies of the profiles are less than the threshold values, the profile data corrupts the model rather than increasing its capability to forecast. Observational errors, usually on the smaller scales, amplify and through nonlinear interactions gradually spread to the longer scales, eventually destroying forecast skill. In previous studies, numerical models using data with a standard deviation of 0.5◦C at all levels had an exponential error growth with a doubling time of about 2.5 days. Similar results were found for other data types (i.e., winds, moisture, etc.), with forecast errors as high as 20 to 30%. Navy model simulations show a one to three day improvement in forecast ability in the data sparse Southern hemisphere.

(DOC) The National Centers for Environmental Prediction (NCEP) scientific assessment and "NOAA Requirements for Support from Polar-Orbiting Spacecraft," identifies model initialization and data assimilation requirements which drive vertical sampling interval, mapping accuracy and refresh rate values consistent with specified threshold requirements. The National Weather Service Technical Procedures Bulletin No. 422 describes the 6 hr forecast error at 500 mb from 1979 to 1991 as decreasing from 1.8 K to about 1.4 K over this period. Extrapolating to the 2005-2010 time frame yields an expected 6 hour forecast error of 1.0 K. The satellite retrieval must be better than the 6 hr forecast error to be useful, therefore DOC desires measurement accuracies exceeding specified threshold requirements.

Parameter 3--*Imagery (***DoD/*DOC**). (USAF) Threshold values are those required for weather model inputs and to provide field forecasters with clarity required for adequate forecast accuracy as documented in AWS Report. A global refresh threshold of 2 hours (1 hour objective) is essential to support the above requirements. This 2-hour refresh requirement is driven by the need to provide data with sufficient timeliness to be used as input into Tactical Decision Aid software models. Those models ultimately provide Precision Guided Munitions employment forecast products with the accuracy required by ACC/PACAF/USAFE (ACC/DR letter to AF/XOW, Dec 1991). This imagery data is also used as input into the future Cloud Depiction and Forecast System-2 (CDFS-2) operated by the AFGWC. This two-hour requirement is based on hourly global analyses and forecasts to provide customer support. Geostationary satellite data provide adequate imagery, albeit degraded compared to polar satellite resolution, for areas equatorward of 45 degrees at refresh rates varying between 5 minutes and one hour. Data from these satellites are limited poleward of 45 degrees due to degradation in resolution, radiometric accuracy (caused by increased atmospheric slant path), geolocation of cloud features, and cloud identification. These limitations make it necessary to use polar-orbiting satellite data poleward of 45 degrees and to supplement the global database equatorward of 45 degrees. This latitude was selected based on the extent of coverage yielded by the location and spacing of the five geostationary satellites described by the World Meteorological Organization agreement of 1967. This geostationary constellation results in gaps in quantitatively useful data poleward of 45 degrees. The "Defense Meteorological Satellite Program (DMSP) Tactical Enhancement Analysis/Navy Final Report" (14 May 1993) illustrates significant cost savings based on a regional-scale conflict of a duration similar to Desert Storm, if 6 hour refresh is used with emphasis on E-O weapons. Thunderstorms have lifetimes of approximately one hour or less, thus the objective, allowing the capability to forecast development, growth, speed, and decay of thunderstorms. A cost-performance trade forces a refresh rate longer than one hour.

(USN) Navy Study concluded a 4 hour refresh is required to adequately represent the time scale of the weather having the most significant impact on Carrier strike, amphibious and special warfare operations. It also concluded operations during the Persian Gulf and Bosnia conflicts demonstrated weather can change hourly. Imagery provides the qualitative means of analyzing weather on the horizontal (1 km/global, 0.4/regional) and temporal scales (4 hours) having significant impact on mission planning, aircraft operation, weapon delivery/loadout and Battle Damage Assessment.

(DOC) Imagery thresholds are based on values required to support cloud properties, aerosol, and sea surface temperature products as validated in Aug, Sep, and Oct 1995, by NOAA Product Oversight Panels on Calibration, Oceans, Land, and Image-Cloud-Aerosol.

Parameter 4--***Sea Surface Temperature** (***DOC**/***DoD**). (USAF) The requirements for the stated thresholds are documented in AWS Report.

(USN) Navy Study concluded sea surface temperature details (i.e., frontal analysis) can be taken into proper consideration only by emerging high-resolution models using a polar-orbiting weather satellite. Horizontal resolutions of 4 km (global) and 1 km (regional) and a measurement accuracy of 0.5^{o} C specify the resolution and accuracy needed. In addition, these resolution and accuracy requirements are needed to bound detection and accuracy parameters for emerging shallow water antisubmarine warfare systems.

(DOC) A regional resolution of at least 3 km at nadir (global resolution) and 1 km (0.25 km Objective) (regional resolution) is required to support coastal management missions within DOC, as described by *NOAA Requirements for Support from Polar Orbiting Satellites, NOAA, DOC*, June 1990, and in *NOAA-DOD-NASA Triagency Polar Requirements Summary, NOAA*, 1993. In order to be able to discern thermal details in bays and estuaries for analyses of coastal dynamics, human health, ecosystem sustainability, and resource management, this high-resolution capability is key.

Parameter 5--*Sea Surface Winds (Speed and Direction) (*DoD/*DOC). (USAF) As stated in AWS Report, wind speed data at the specified values are needed as inputs to prepare tropical cyclone warnings, to derive sea state, and for use in ship and aircraft routing, flight safety, and other operations, such as NBC dispersions.

(USN) Navy Study concluded skill in sea surface wave forecasting depends heavily on the skill of predicting sea surface winds. At 20 km horizontal increments and 6 hours refresh, sea surface winds from a polar-orbiting weather satellite with a measurement accuracy of +-2 m/s or +- 10% (whichever is higher) will yield open ocean wave heights within an error of 10-20% and wave energy within 20-50%. This provides wind and wave data within the critical/narrow values for Precision Guided Munitions (i.e., Tomahawk), amphibious landing craft operations, naval facilities located in low lying coastal areas (i.e., hurricane/flooding) and aircraft safety and recovery during aircraft carrier flight operations.

(DOC) DOC requires a horizontal resolution of 25 km, based on operational experience and our projected requirements for future numerical weather prediction models. (See citation summary, below.) DOC requires sufficient accuracy and sensitivity to allow retrieval of the ocean surface wind speed to +/- 2 m/s or 10%, whichever is greater, and carries a wind direction attribute objective of +/-20 degrees, to meet the modeling requirements of the National Meteorological Center. These values are based on conclusions from the following citations: O'Brien, James J. et al., "Scientific Opportunities Using Satellite Wind Stress Measurements over the Ocean, Report of the Satellite Surface Stress Working Group," NASA Technical Report, 1982; Burpee, Richard A., *Memorandum: Military requirements for Defense Environmental Satellites*, MJCS 154-86, 1986; Hooper, Nancy and John W. Sherman III, *1986, Temporal and Spatial Analysis of Civil Marine Satellite Requirements, NOAA Technical Report NESDIS 16,* U.S. Department of Commerce; Jet Propulsion Laboratory, *Ocean Services User Needs Assessment*, Tech. Report, NOAA, 1984; Sullivan, Kathryn (chairperson), 1993, *NOAA-DOD-NASA Tri-Agency Polar Requirements Summary, NOAA.*)

Parameter 6--*Soil Moisture (***DoD**/DOC). (USAF) Data at the specified threshold values are required to derive optical and infrared characteristics of the earth's surface for E-O weapon systems support, determining state of ground for trafficability forecasts and mine placement and detection, and as input to stream flow analysis (used for river crossing, dam volume capacity and Agriculture Meteorological (AGROMET) models) as stated in AWS Report. The objective values are established by Army Field Manual 34-81-1, by FM 100-27/FM 4-61/AFM 2-50, and by the Concept Paper for US Army Tactical Weather and Environmental Data Requirements (Oct 91).

(USA) IAW Army FM 34-81-1, 23 Dec 92, Army FM 100-27, and the Concept Paper for US Army Tactical Weather and Environmental Data Requirements, Oct 91, measurements of soil moisture are required to assess the ability for movement of tanks, self-propelled artillery, and other tactical vehicles. The skin layer of soil is determined to be 0.1 cm. Moisture in the surface to 5 cm depth is important to determine surface traction. Moisture at 5 to 10 cm depth impacts cross country vehicle speed. Moisture in the 10 to 30 cm depth can impact trafficability when more than one tank is crossing the same terrain. Trafficability of large scale operations is impacted with moisture in the 30 to 80 cm depth range. Refresh rate must be sufficient to detect microscale to mesoscale weather features.

(DOC) A National Centers for Environmental Prediction Scientific Assessment by K. Mitchell has determined the NCEP Eta model requires soil moisture to properly calculate the energy fluxes at the surface. To support this model DOC requires measurements at the surface with a horizontal resolution of 50 km, mapping accuracy of 3 km and measurement accuracy of $\pm$10 cm of water per one meter column of soil. Short-term rainfall variability demands a refresh of 8 hours to avoid false characterization of surface moisture in model initialization, according to the NCEP Scientific Assessment.

Atmospheric Parameters (Para 4.1.6.2.x.)

Parameter 1--Aerosol Optical Thickness (DOC/DoD). (USAF) AWS Report establishes aerosol optical thickness threshold values required to provide useful measurements to support PGM employment.

(DOC) This EDR is derived from imagery and threshold values are consistent with values specified in the imagery parameter.

Parameter 2--Aerosol Particle Size (DOC/DoD). (USAF) AWS Report establishes aerosol particle size information at the specified values crucial to precision guided munitions (PGM) support.

(DOC) This EDR is derived from imagery and threshold values are consistent with values specified in the Imagery parameter.

Parameter 3--Ozone Total Column/Profile (DOC). (DOC) All threshold values for ozone total column/profile are based on national climate requirements as detailed in Summary Report - Workshop on NPOESS Ozone Measurements Requirements, August 30-31, 1993.0

Parameter 4--Precipitable Water (DOC/DoD). (DOC) This EDR is derived from imagery, atmospheric sounding data, and microwave observations. DOC threshold requirements are consistent with values specified under parameters of Atmospheric Vertical Moisture Profile, Atmospheric Vertical Temperature Profile, Imagery, Sea Surface Winds, and Soil Moisture, respectively.

Parameter 5--Precipitation (Type, Rate) (DoD/DOC). (USAF) Precipitation information at specified values is required to determine the effects on communications, air operations, reconnaissance systems, weapons delivery, field engineering activities and surveillance systems. Threshold values are established in AWS Report.

(DOC) This EDR is derived from imagery, atmospheric sounding data, and microwave observations. DOC threshold requirements are consistent with values specified in parameters for Atmospheric Vertical Moisture Profile, Atmospheric Vertical Temperature Profile, Imagery, Sea Surface Winds, and Soil Moisture.

Parameter 6--Pressure (Surface/Profile) (DoD). (USAF) Pressure profiles are required for high-precision targeting of naval and Army artillery gunfire and ballistic missiles at specified threshold values as documented in AWS Report.

Parameter 7--Suspended Matter (DoD/DOC). (USAF) AWS Report establishes the system capabilities values required to determine the effects of suspended matter on military operations.

(DOC) Volcanic ash plumes are a threat to civil aviation. DOC participates in a civil aviation warning system for volcanic ash hazards by monitoring these plumes in satellite imagery. DOC also monitors smoke from large scale fire events to provide information to the relevant agencies and the public.

Parameter 8--Total Water Content (DoD). (USAF) Liquid water information is required at the given values to identify, analyze, and forecast conditions favorable for air frame icing and contrail formation, forecast precipitation amounts, and as input to Tactical Decision Aids. Threshold values are documented in AWS Report.

Cloud Parameters (Para 4.1.6.3.x.)

Parameter 1--Cloud Base Height (DOC/DoD). (USAF) Ceiling height data at the specified threshold values are vital to determining areas of potential icing and determining the most effective weapon delivery altitudes. Threshold values are established in AWS Report.

(DOC) This EDR is derived from imagery and atmospheric sounding data. DOC threshold requirements are consistent with values specified in parameters for Atmospheric Vertical Moisture Profile, Atmospheric Vertical Temperature Profile, and Imagery.

Parameter 2--Cloud Cover/Layers (DoD/DOC). (USAF) Cloud cover data at the specified values is a critical input to general forecasting, albedo measurements, E-O weapons utility forecasting, and other meteorological applications. Threshold requirements are established in AWS Report.

(DOC) This EDR is derived from imagery and/or atmospheric sounding data. DOC threshold requirements are consistent with values specified in parameters Atmospheric Vertical Moisture Profile, Atmospheric Vertical Temperature Profile, and Imagery.

Parameter 3--Cloud Effective Particle Size (DOC/DoD). (USAF) These data are required in global numerical weather prediction (NWP) models and in hurricane forecasting at threshold values established in AWS Report.

(USN) Navy Study concluded skill in forecasting aircraft icing depends, in part, on predicting cloud effective particle size. At a horizontal resolution of 50 km, vertical sampling interval of 1 km, measurement range of 0-50 μm, and refresh of 6 hours, this parameter, in conjunction with other cloud data parameters, will aid the forecaster in judging the collection efficiency of the aircraft surfaces to supercooled water droplets in both stratiform and cumuliform clouds. It will also aid in the forecast of rime versus clear icing. It is an important element of the enroute data segment of the flight weather briefing package as outlined in NAVOCEANCOMINST 3140.14C.

(DOC) This EDR is derived from imagery, atmospheric sounding data, and/or microwave observations. NOAA threshold requirements are consistent with and justified by values specified under the Atmospheric Vertical Moisture Profile, Atmospheric Vertical Temperature Profile, Imagery, Sea Surface Winds, and Soil Moisture parameters.

Parameter 4--Cloud Ice Water Path (DOC). (DOC) This EDR is derived from imagery, atmospheric sounding data, and microwave observations. DOC threshold requirements are consistent with values specified in parameters for Atmospheric Vertical Moisture Profile, Atmospheric Vertical Temperature Profile, Imagery, Sea Surface Winds, and Soil Moisture.

Parameter 5--Cloud Liquid Water (DOC/DoD). (USAF) With appropriate assumptions, this parameter may be related to cloud optical thickness which is key to determining EO weapon effectiveness. Threshold values are established in AWS Report.

(DOC) This EDR is derived from imagery, atmospheric sounding data, and microwave observations. DOC threshold requirements are consistent with values specified in parameters for Atmospheric Vertical Moisture Profile, Atmospheric Vertical Temperature Profile, Imagery, Sea Surface Winds, and Soil Moisture.

Parameter 6--Cloud Optical Depth/Transmittance(DOC). (DOC) This EDR is derived from imagery, atmospheric sounding data, and microwave observations. DOC threshold requirements are consistent with values specified in parameters for Atmospheric Vertical

Moisture Profile, Atmospheric Vertical Temperature Profile, Imagery, Sea Surface Winds, and Soil Moisture.

Parameter 7--Cloud Top Height (DOC/DoD). (USAF) Used in severe weather forecasting and aircraft routing. Threshold values are established in AWS Report.

(USN) Navy Study concluded skill in forecasting aircraft icing depends, in part, on predicting the thickness of the layer in which icing conditions occur. The cloud top height parameter gives an upper bound for the layer in which icing can occur. At a horizontal resolution of 25 km, a measurement accuracy from 0.5 km to 2 km, and a refresh of 6 hours, this parameter, in conjunction with the other cloud data parameters, will help the forecaster predict rime and mixed icing in stratiform clouds from 3000-6000 feet; and clear or mixed icing in cumuliform clouds from 3000-20000 feet. It is an important element of the enroute data segment of the flight weather briefing package as outlined in NAVOCEANCOMINST 3140.14C.

(DOC) This EDR is derived from imagery, atmospheric sounding data, and/or microwave observations. NOAA threshold requirements are consistent with and justified by values specified under parameters for Atmospheric Vertical Moisture Profile, Atmospheric Vertical Temperature Profile, Imagery, Sea Surface Winds, and Soil Moisture.

Parameter 8--Cloud Top Pressure (DOC). (DOC) This EDR is derived from imagery and/or atmospheric sounding data. DOC threshold requirements are consistent with values specified in parameters for Atmospheric Vertical Moisture Profile, Atmospheric Vertical Temperature Profile, and Imagery.

Parameter 9--Cloud Top Temperature (DOC/DoD). (USAF) This data is used in operational forecasting. Threshold values are established in AWS Report.

(DOC) This EDR is derived from imagery and/or atmospheric sounding data. DOC threshold requirements are consistent with values specified in parameters for Atmospheric Vertical Moisture Profile, Atmospheric Vertical Temperature Profile, and Imagery.

<u>Earth Radiation Budget Parameters (Para 4.1.6.4.x.)</u>

Parameter 1--Albedo (Surface) (DOC/DoD). (USAF) Albedo is applied to cloud analyses and used in calculations of inherent contrast between targets and background by E-O weapons systems with values as stated in AWS Report.

(DOC) This EDR is derived from imagery and threshold values are consistent with values specified in the parameter for Imagery.

Parameter 2--Downward Longwave Radiation at the Surface (DOC). (DOC) Stowe, 1988 (Report of the Earth Radiation Budge Requirements Review ~1987, NOAA Technical Report NESDIS 41, U.S. Dept. of Commerce, Wash., DC) states a 40 km horizontal spatial resolution is required for input to NWP models, and precision of 0.1 W/m^2 is required to monitor regional anomalies. Threshold values for measurement accuracy and refresh are the minimums acceptable to demonstrate impact in monitoring studies as cited in Suttles, J. T. and

G. Ohring, 1986: Report of the Workshop on Surface Radiation Budget for Climate Applications, Columbia, MD,
WCP-115, 144 pp.

Parameter 3--Insolation (DOC). (DOC) Insolation is the primary source of energy to the surface and drives the surface fluxes of water vapor and sensible heat. It is used in soil moisture, snowmelt and crop models. According to the Scientific assessment - National Centers for Environmental Prediction, DOC requires a horizontal spatial resolution of 50 km, a mapping accuracy of 5 km, measurement accuracy of 20 W/m^2, and a daily refresh to run an off-line global soil moisture model that approximates a current state-of-the-art regional model (NCEP Eta model).

Parameter 4--Net Shortwave Radiation (Top of Atmosphere) (DOC). (DOC) Stowe, 1988: Report of the Earth Radiation Budget Requirements Review - 1987, (NOAA Technical Report NESDIS 41, U.S. Dept. of Commerce, Wash., DC) identifies values consistent with longwave components and specified threshold requirements as key components for monitoring the current state and variability of the climate system.

Parameter 5--Solar Irradiance (DOC). (DOC) The threshold value for measurement range was calculated based on values for spectral irradiance variation cited in White, O., 1977: The Solar Output and its Variation, Table 2, pp. 185-186. Precision, measurement accuracy and refresh threshold requirements are based on variations of solar irradiance over the solar cycle and its impact on global climate change as documented by National Research Council, 1994: Solar Influences on Global Change.

Parameter 6--Total Longwave Radiation (Top of Atmosphere) (DOC). (DOC) Stowe, 1988: Report of the Earth Radiation Budget Requirements Review - 1987, (NOAA Technical Report NESDIS 41, U.S. Dept. of Commerce, Wash., DC) identifies values consistent with specified threshold requirements as key components for monitoring the current state and variability of the climate system.

<u>Land Parameters (Para 4.1.6.5.x.)</u>

Parameter 1--Land Surface Temperature (DoD/DOC). (USAF) The requirement for land surface temperature at specified threshold values is established in the Concept Paper for US Army Tactical Weather and Environmental Data Requirements (Oct 91) and AWS Report.

(DOC) This EDR is derived from imagery and/or atmospheric sounding data. DOC threshold requirements are consistent with values specified in parameters Atmospheric Vertical Moisture Profile, Atmospheric Vertical Temperature Profile, and Imagery.

Parameter 2--Normalized Difference Vegetation Index (NDVI) (DOC). (DOC) This EDR is derived from imagery and threshold values are consistent with values specified in the parameter for Imagery.

Parameter 3--Snow Cover/Depth (DoD/DOC). (USAF) Snow cover data at specified values are required to determine background conditions for electro-optical weapons systems and forecasts of trafficability. Threshold values are established in AWS Report.

(USA) IAW Army FM 34-81-1, snow cover data are required to determine background conditions for E-O weapons systems. Forecasts of soil trafficability, river stage, flood, air rescue conditions, and other phenomena also depend on this information, especially for data-sparse and data-denied areas.

(DOC) This EDR is derived from imagery, atmospheric sounding data, and microwave observations. DOC threshold requirements are consistent with values specified in parameters for Atmospheric Vertical Moisture Profile, Atmospheric Vertical Temperature Profile, Imagery, Sea Surface Winds, and Soil Moisture.

Parameter 4--Vegetation/Surface Type (DoD). (USAF) The parameter is required as input to the agricultural analysis model supporting various U.S. Government customers and to EOTDA forecast models used by all services at threshold values documented in AWS Report.

Ocean/Water Parameters (Para 4.1.6.6.x.)

Parameter 1--Currents (DoD/DOC). (USN) Navy Study concluded the foremost limiting factor for detailed analysis of current structures, especially at high latitudes is horizontal resolution. Littoral current details (i.e., eddies) can be taken into proper consideration only by a high-resolution model using a polar-orbiting weather satellite. Horizontal resolutions of 4 km (global) and 0.5 km (regional) at 72 hours refresh, specify the resolution needed for global and regional ocean models to resolve structures on the scale of 8 km and 1 km, respectively. A sensing depth of 30 m, measurement precision/accuracy of +-.25 m/s, +-15 degrees and mapping accuracy of 2 km specify the range and accuracy requirements needed for global and regional ocean forecast model input to yield values needed for littoral sediment transport and turbidity analysis for special warfare and mine warfare operations. In addition, these resolution and accuracy requirements are needed to bound detection and accuracy parameters for emerging shallow water antisubmarine warfare systems.

(DOC) Threshold values are consistent with DOC's mission to monitor open ocean and near-shore marine environments as they effect marine weather forecasting, coastal ecosystem management, fisheries management, and climatological prediction missions.(NOAA Polar-Orbiting Satellite Requirements Study, DOC, 1990)

Parameter 2--Fresh Water Ice (DOC/DoD). (DOC) This EDR is derived from imagery and threshold values are consistent with values specified in the Imagery EDR.

(USN) The Naval Ice Center has an informal data exchange agreement with Canada's Ice Services Environment Canada, involving exchange of Great Lakes ice analyses and forecasts and Canadian Archipelago, Baffin Bay and Labrador Sea ice analyses. The National/Naval Ice Center produces thrice weekly Great Lakes analyses and expects to receive analyses for Canadian areas of interest. Hence polar orbiting visual and infrared satellite data is needed to remotely sense and analyze fresh water ice in all five Great Lakes. This data is critical for the National Ice Center's support of U.S. Coast Guard, commercial industry, National Weather Service, and the Canadian Government. A spatial resolution of 400 meters (or better) is critical to safe navigation, icebreaking operations, and weather forecasting model initialization.

Parameter 3--Ice Surface Temperature (DOC/DoD).

(DOC/USN) Currently, sea ice (and freshwater ice) thickness-and hence, tensile strength, is estimated using frost degree data compilations from shore station temperature reports in middle and high latitudes. Surface temperatures are not available in data sparse regions throughout the Arctic and Antarctic, making ice thickness estimations difficult and, potentially, inaccurate. Remotely-sensed ice surface temperatures would be an invaluable daily, large scale, and reliable data set used to estimate sea ice growth and decay. The temperature sensor must be accurate to within 1 degree Celsius to ensure an accurate calculation of frost degree day information.

Parameter 4--Littoral Sediment Transport (DoD). (USN) Navy Study concluded littoral sediment transport from a polar orbiting weather satellite is needed to analyze rates of sediment deposition in littoral areas to bound detection and accuracy parameters for emerging mine warfare systems. Littoral sediment transport forecasting depends heavily on the skill of predicting coastal ocean currents. A regional ocean current model with a horizontal resolution of 0.5 km and mapping accuracy of 0.5 km will yield values of littoral sediment transport on a scale of 1 km (i.e., horizontal resolution). The Navy Study concluded a +-30% measurement accuracy will still yield significant sediment observations for mine detection operations.

Parameter 5--Net Heat Flux (DoD). (USN) Navy Study concluded knowledge of net heat flux is essential to the correct physical modeling of natural phenomena occurring at the air/sea interface for both numerical meteorological and oceanographic prediction models. Horizontal resolutions of 20 km with a measurement range of 0-2000 W/m^2, measurement accuracy of 10 W/m^2 and a refresh of 6 hours specify the requirements needed for direct assimilation into global models to yield prognostic charts used to forecast mesoscale features in support of naval operations worldwide.

Parameter 6--Ocean Color/Chlorophyll (DoD/DOC). (USN) Navy Study concluded ocean color from a polar orbiting weather satellite is needed to identify bioluminescence potential and locate such water-mass features as fronts and eddies for antisubmarine warfare operations, and observe changing optical conditions (turbidity) in coastal regions to predict electro-optical system performance. Ocean color will be used to complement sea surface temperature analysis where a horizontal resolution/mapping accuracy of 2 km (global) and 0.25 km (regional) is needed to resolve ocean temperature structures (i.e., eddies and ocean fronts) on the scale of 4 km or less. The optical property most frequently associated with ocean color data is K(490), the diffuse attenuation coefficient at a wavelength of 490 nm (nanometers). Absorption by chlorophyll and other plant pigments is a major component of K(490), and variability in pigment concentration dominates variability in K(490) horizontally, vertically, and over time. Navy Study concluded a measurement range of chlorophyll concentration of 0.5-50 g/m3 (cubic meter) is required to calculated the extinction of solar radiation with depth as a function of chlorophyll concentration. This allows water-mass differentiation as an operational tool. The measurement accuracy of +-

30% is based on the analysis of historical ocean color data bases using the Coastal Zone Color Scanner (CZCS).

(DOC) This EDR is derived from imagery and thresholds for horizontal resolution and mapping accuracy are consistent with those specified under EDR #3, Imagery. DOC requires observations to allow quantification of chlorophyll concentrations within a measurement range of 0.05 to 50 mg/m^3 and a measurement accuracy of 30% to support coastal and fisheries management missions, as noted in the following documentation: Hooper, N., and J. Sherman, III, 1986. Temporal and Spatial Analyses of Civil Marine Satellite Requirements, *NOAA Technical Report NESDIS 16,* NOAA/NESDIS; Montgomery, D., R. Patton, S. McCandless, 1984. *Ocean Services User Needs Assessment, Volume 1: Survey Results, Conclusions & Recommendations,* Jet Propulsion Laboratory, Pasadena; and, *NOAA Requirements for Support from Polar-Orbiting Satellites,* NOAA, 1990. The DOC minimum refresh requirement of 24 hours is based upon rate of change in measured phenomena and is minimally acceptable values for oceanic monitoring missions as cited in McClain, E., W. Pichel, A. Strong, and M. Weaks, 1992. *NOAA CoastWatch Ocean Color Prospectus: A Cooperative Approach for Acquisition, Processing, Archiving, and Exchange of U.S. Coastal Ocean Color Data and Data Products,* NOAA/NESDIS.

Parameter 7--Ocean Wave Characteristics (DoD/DOC). (USAF) Sea state condition data at the required values are required by Army Engineers as it affects site selection and the operations of port and beach facilities. Threshold values are established in AWS Report.

(USN) Navy Study concluded the parameters of Sea Surface Winds, Sea Height/Topography and Ocean Currents have a direct effect on ocean wave characteristics. This is reflected in the global (20 km) and regional horizontal resolution (0.5 km), and global (5 km) and regional mapping accuracy (0.5 km). The measurement accuracy (height +- 0.3 m, direction: +- 10%) is attributed to sea surface wind errors (+-10%) that induce similar ocean wave height errors. Thus, a +- 10% error in ocean wave height with a measurement range of 0.5-30 m will roughly yield a measurement accuracy of +-0.3 m.

(USA) IAW FM 34-81-1, sea state condition knowledge is required by Army engineers as it affects site selection and the operations of port and beach facilities.

(DOC) Thresholds are consistent with DOC requirements for future forecast model improvements resulting from direct assimilation of wave measurements, described in NOAA Polar-Orbiting Satellite Requirements Study, DOC, 1990; and in Ocean-Atmosphere Observations Supporting Short-Term Climate Predictions, National Academy Press, 1994.

Parameter 8--Sea Ice Age and Sea Ice Motion (DOC/DoD). (DOC) Justification for thresholds presume this parameter is derived from the Imagery key parameter. Requirements are based on: a) mission; b) current state and expected evolution of relevant science disciplines and remote sensing technologies; c) planned or expected changes in organizations, mission emphasis or resources; and d) needs of non-NOAA clientele. These requirements are documented in "NOAA Requirements for Support from Polar-Orbiting Satellites," 1990, and previously in "Envirosat 2000 Report, NOAA Satellite Requirements Forecast", May 1985. This document shows a requirement for at least 0.4 km horizontal resolution for ice coverage at nadir.

(USN). Arctic and Antarctic operations and research are extremely dependent on sea ice age and ice motion. When sea ice obtains a specific age/thickness, icebreaking support is mandatory to prevent vessel damage. "Old" ice achieves significant tensile strength as it becomes compacted over time and salinity is lowered. Similarly, submarine surfacing operations are highly dependent on sea ice concentration and ice cover thickness. Further, ridging of "old" ice can result in ice keels penetrating to tens of meters below the sea surface, and pose a significant hazard to submarine navigation. The marginal ice zone (zone of sea ice between open sea and inner ice pack) is subject to significant variability in response to oceanographic and atmospheric forcing. Non-ice strengthened vessels risk damage if sea ice is advected into their operating area due to this forcing. Further, there is significant National and international interest in the advection of radionuclides from Arctic waters into densely populated coastal regions. Remotely sensed visual and infrared data is critical in assessing this threat. A spatial resolution of at least 400 meters is required to extract sea ice features of sufficient detail to aid in ice analyses and drift estimates.

Parameter 9--Sea Surface Height (DOC)/Topography (DoD). (USAF) Tide and current data are required by Army Special Operations Forces at the specified threshold values as documented in AWS Report.

(USN) Navy Study concluded sea surface height/topography from a polar orbiting weather satellite provides the only means of acquiring the high quality global data needed to analyze transient ocean current features (i.e., eddies) to the resolution and accuracy requirements needed for emerging coupled ocean-atmospheric models, and mine warfare and antisubmarine warfare systems. A horizontal resolution of 4 km and mapping accuracy of 2 km will yield values of sea surface height and topography on a scale of 8 km (i.e., eddies 5-10 km). The Navy Study concluded a +-5 cm measurement accuracy and +- 30 m measurement range will yield high quality observations of mean sea surface height, ocean wave height, wind speed and geostrophic ocean currents within the full range of typical sea-level variations.

(DOC) Threshold values are indicative of the measurement accuracy needed in measuring sea height rate-of-change and other parameters crucial to accurate modeling of mid- to long-term climate fluctuation. This requirement, derived from NOAA's climate monitoring and assessment mission, is described in NOAA Polar-Orbiting Satellite Requirements Study, DOC, 1990; and in Ocean-Atmosphere Observations Supporting Short-Term Climate Predictions, National Academy Press, 1994.

Parameter 10--Surface Wind Stress (DOC/DoD). (USN) Navy Study concluded surface wind stress from a polar-orbiting satellite is needed to construct quality analyses of ocean currents. Skill in surface sea surface wind stress analysis depends heavily on the skill of predicting sea surface winds. Navy Study concluded the finer the resolution, or cell size, the closer one can come to the littoral region for special studies of upwelling and other near-shore ocean events and the less data are lost. For this reason, the horizontal resolution is 20 km and mapping accuracy 7 km which falls within the grid resolution for planned global and regional meteorological/oceanographic models (i.e., 50 km).

(DOC) DOC regards this EDR as a derived parameter, resulting from sea surface wind measurements of the relative thresholds detailed in the Sea Surface Wind Speed EDR.

Parameter 11--Turbidity (DoD/DOC). (USN) Navy Study concluded turbidity from a polar orbiting weather satellite is needed to analyze rates of sediment deposition and optical clarity in littoral areas to bound detection and accuracy parameters for emerging mine warfare systems and special warfare operations. Turbidity forecasting depends heavily on the skill of predicting coastal ocean currents and wave characteristics. Regional ocean current/wave models with a horizontal resolution of 0.5 km and mapping accuracy of 0.5 km will yield values of littoral turbidity on a scale of 1 km (i.e., horizontal resolution). The Navy Study concluded a +-30% measurement accuracy will still yield significant turbidity observations for mine and special warfare operations. A sensing depth of 50 m is needed to analyze of the majority of enclosed ocean basins and coastal areas where mine and special warfare operations will occur.

(DOC) This EDR is derived from imagery and threshold values are consistent with values specified in the Imagery and Ocean Color/Chlorophyll parameters.

Space Environmental Parameters (Para 4.1.6.7.x.)

Parameter 1--Auroral Boundary (DoD/DOC), Parameter 2--Auroral Energy Deposition (Total) (DoD/DOC), Parameter 3--Auroral Imagery (DoD/DOC), Parameter 4--Electric Field (DoD/DOC), Parameter 5--Electron Density Profile/Ionospheric Specification (DoD/DOC), Parameter 6--Geomagnetic Field (DoD), Parameter 7--In-situ Ion Drift Velocity (DoD/DOC), Parameter 8--In-situ Plasma Density (DoD), Parameter 9--In-situ Plasma Fluctuations (DoD), Parameter 10--In-situ Plasma Temperature (DoD), Parameter 11--Ionospheric Scintillation (DoD), Parameter 12--Neutral Density Profile/Neutral Atmospheric Specification (DoD/DOC), Parameter 13--Radiation Belt and Low Energy Solar Particles (DoD/DOC), Parameter 14--Solar and Galactic Cosmic Ray Particles (DoD/DOC), Parameter 15--Solar Extreme Ultra Violet EUV Flux (DOC), Parameter 16--Supra-thermal through auroral energy particles (DoD/DOC), Parameter 17--Upper Atmospheric Airglow (DoD). The Space Environmental Parameters have threshold values established in a joint DOC/DoD study, "Space Environmental Monitoring Requirements For Polar Orbiting Spacecraft." These parameters must be measured continuously in each orbital plane, at specified resolutions, to get a representative sampling of the ionosphere, which is itself semi-sun-synchronous. In addition, equal spacing, and adequate coverage of the dawn/dusk transitions and the approximate noon/midnight fluctuations are necessary. One exception to these requirements is the solar EUV flux, which is obtained by viewing the sun directly.

ATTACHMENT 2
ACRONYMS AND ABBREVIATIONS

A

AF	Air Force
AFGWC	Air Force Global Weather Central
AFI	Air Force Instruction
AFM	Army Field Manual
AFSCN	Air Force Satellite Control Network
AFSPC	Air Force Space Command
AGE	Aerospace Ground Equipment
AN/UMQ-13	Mark IVB Tactical Terminal
APT	Automatic Picture Transmission
atm-cm	Atmosphere-centimeter

B

BIT	Built-In-Test
BITE	Built-In-Test-Equipment

C

CDA	Command and Data Acquisition
Centrals	Central Weather Data Processing Facilities
cm	Centimeters
cm/m^2	Centimeters Per Meter Squared
CH_4	Methane
CO	Colorado or Carbon Monoxide
CO_2	Carbon Dioxide
COMPUSEC	Computer Security
COMSEC	Communications Security
COTS	Commercial-Off-The-Shelf
C^3	Command, Control, and Communications
C^3I	Command, Control, Communications, and Intelligence
C^4I	Command, Control, Communications, Computers, and Intelligence

D

DMSP	Defense Meteorological Satellite Program
DOC	Department of Commerce
DoD	Department of Defense

E

E	Ionosphere Region Designator
ECCM	Electronic Counter-Counter Measures
EDR	Environmental Data Record
EO	Electro-Optical
ESA	European Space Agency
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
EUV	Extreme Ultra Violet
eV	Electron-Volt

F

FM	Field Manual
FMH	Federal Meteorological Handbook
FNMOC	Fleet Numerical Meteorology and Oceanography Center
FOC	Final Operating Capability

G

GeV	Giga-electron Volts
GFE	Government Furnished Equipment
GHz	Giga-Hertz
g/m^3	Grams Per Meter Cubed
GPS	Global Positioning System

H

HQ	Headquarters
HRPT	High Resolution Picture Transmission
HSI	Human Systems Integration

I

IAW	In Accordance With
ILS	Integrated Logistics Support
INFOSEC	Information Security
IOC	Initial Operating Capability
IORD	Integrated Operational Requirements Document
IOT&E	Initial Operational Test and Evaluation
IPO	Integrated Program Office
IR	Infrared

K

K	Kelvin
kbps	Kilobits per second
keV	Kilo electron Volts
kg/m^2	Kilogram Per Meter Squared
km	Kilometer

L

LRPT	Low Resolution Picture Transmission
LRU	Line Replaceable Unit
LST	Local Solar Time

M

m	Meters
m^2	Meters Squared
Mark III	Model AN/TMQ-37 TACTERM
Mark IV	Model AN/TMQ-35 TACTERM
Mark IVB	Model AN/UMQ-13 TACTERM
MB	Megabytes
Mb	Megabits
mb	Millibar
Mbps	Megabits-per-second
MD	Maryland
MeV	Mega-electron Volts
mg/m^3	Milligrams Per Cubic Meter
mg/l	Milligrams Per Liter

MHz	Mega-hertz
MLV	Medium Launch Vehicle
mm	Millimeter
mm/hr	Millimeters Per Hour
mm/m	Millimeters Per Meter
mm/m^2	Millimeters Per Meter Squared
MNS	Mission Need Statement
MTBCF	Mean Time Between Critical Failure
MTBDE	Mean Time Between Downing Events
MTTR	Mean Time To Repair
MTTRF	Mean Time To Restore Function
m/s	meters per second

N

NASA	National Aeronautics and Space Administration
NATO	North Atlantic Treaty Organization
NAVOCEANO	Naval Oceanographic Office
NBC	Nuclear, Biological, and Chemical
NDI	Non-Developmental Item
NESDIS	National Environmental Satellite, Data, and Information Service
NF	NOFORN (Not Releasable to Foreign Nationals)
nm	Nautical mile
NOAA	National Oceanic and Atmospheric Administration
NORAD	North American Aerospace Defense Command
NPOESS	National Polar-orbiting Operational Environmental Satellite System
NSA	National Security Agency
nT	Nanotesla
NWS	National Weather Service

O

OPSEC	Operations Security
OR	Operational Requirement
ORD	Operational Requirements Document
OT&E	Operational Test and Evaluation

P

PGM	Precision Guided Munitions
POES	Polar-orbiting Operational Environmental Satellite
ppmv	Parts per million by volume
PSE	Peculiar Support Equipment
PTF	Payload Test Facility

R

RCM	Requirements Correlation Matrix
RDR	Raw Data Record
RF	Radio Frequency
RH	Relative Humidity
RMA	Reliability, Maintainability, and Availability
RTS	Remote Tracking Station

S

S	Secret
S/NF/WN	Secret/No Foreign/Wnintel
S/C	Spacecraft
SCA	Satellite Control Authority
SDR	Sensor Data Record
sfc	Surface
SMC	Space and Missile Systems Center
SMOP	Satellite Measurement of Oceanographic Parameters
SMQ-11	USN Tactical Terminal
SOC	Satellite Operations Center
SON	Statement of Need
SOPS	Space Operations Squadron
SST	Sea Surface Temperature
STAR	System's Threat Assessment Report
STRATCOM	Strategic Command
STT	Small Tactical Terminal

T

T/P	Topex/Poseidon
TACTERM	Tactical Terminal

TBD	To Be Described/To Be Determined
TEC	Total Electron Content
TESS	Tactical Environmental Satellite System
TO	Technical Order
TOA	Top Of Atmosphere

U

U	Unclassified
UHF	Ultra High Frequency
US	United States
USA	United States Army
USAF	United States Air Force
USCG	United States Coast Guard
USMC	United States Marine Corps
USN	United States Navy
USSPACECOM	United States Space Command
UV	Ultraviolet

V

V	Vertical

W

W	Watts
W/m^2	Watts per meter squared
WN	WNINTEL "Warning Notice - Intelligence Sources or Methods Involved"
WX	Weather

ATTACHMENT 3

DEFINITIONS

Absolute humidity

The mass of water vapor per unit volume of moist air expressed in grams per cubic centimeter.

Airglow

Airglow is natural radiation arising from chemical reactions of upper atmospheric constituents. Airglow occurs as emission continua, atomic lines and molecular bands, with the brightest contributions arising from atomic oxygen and OH. Airglow lies predominantly in the visible through the SWIR spectrum, occurs in layers between 70 - 300 km altitude, and is both temporally and spatially variable.

Atmosphere-centimeter (atm-cm)
Read as atmosphere-centimeter, atm-cm denotes the amount of a gas in a vertical column from the earth’s' surface to space. It is the thickness of the slab of gas, in centimeters, if all the gas were concentrated in a layer at a pressure of atmosphere.

C^3 Segment

The system segment responsible for Command, Control, and Communications.

Centrals

Primary processing centers that use NPOESS RDRs and/or EDRs, and other data to produce environmental products for their customers. The processing, archiving, and dissemination of these data is their responsibility. For NPOESS, the following are Centrals: Air Force Global Weather Central (AFGWC), Fleet Numerical Meteorology and Oceanography Center (FNMOC), the 50th Weather Squadron (50 WS) (AF Space Command), the Naval Oceanographic Office (NAVOCEANO), and National Environmental Satellite, Data, and Information Service (NESDIS).

Cloud

An aggregate of minute non-precipitating water and/or ice particles in the atmosphere above the earth's surface.

Cloud Cover

The fraction of a given area overlaid in the local normal direction by clouds. It is the portion of the earth's horizontal surface masked by the vertical projection of clouds.

Cloud Type
The classification of clouds into the 18 types given in Tables 3-19 and 3-20 of the Federal Meteorological Handbook 1B.

Common Support Equipment (CSE)

Support equipment capable of common use by various systems throughout DoD, NOAA, and NASA, as applicable.

Communications Security (COMSEC)

Measures and controls taken to deny unauthorized persons information derived from telecommunications and ensure the authenticity of such telecommunications. NOTE: Communications security includes cryptosecurity, transmission security, emission security, and physical security of COMSEC material.

Computer Security (COMPUSEC)

Measures and controls that ensure confidentiality, integrity, and availability of the information processes and stored by a computer.

Critical Failure

Any fault, failure or malfunction which results in the loss of the system's ability to provide any key parameter.

Electronic Counter-Countermeasures (ECCM)

Measures taken to counter electronic warfare susceptibility and vulnerability of a specific system.

Environmental Data

"Environmental data" as used in this IORD is also termed "mission data" and refers to all data: atmospheric, oceanographic, terrestrial, space environmental and climatic, being sensed and collected by the spacecraft.

Environmental Data Record (EDR)

Data record produced when an algorithm is used to convert Raw Data Records (RDRs) to geophysical parameters (including ancillary parameters, e.g., cloud clear radiation, etc.).

Field Terminals

Field Terminals include the various receivers used by deployed/remote units to obtain environmental data in real time.

Horizontal Resolution

Imagery EDR: For a scanning imager on a space-based platform, a specified band, and a specified nadir angle, one half of the wavelength corresponding to the earth surface spatial frequency at which the end-to-end system modulation transfer function (MTF) equals 0.5 in the in-scan or cross-scan direction.

Other EDRs: For a parameter which is an estimate of the uniform spatial average of an environmental parameter over a square region of the earth s surface or within a square layer of the atmosphere, the side length of this square region or layer. (For a parameter which is an estimate of an environmental parameter at a point, the horizontal cell size is defined to be zero.) For a reported parameter not of this type but which is defined for a square region of the earth s surface or a square layer of the atmosphere (e.g., cloud cover, ice concentration, etc.), the side length of this square region.

Horizontal Wind Vector Accuracy

The wind speed error is $[[W_m]-[W_t]]$ where W_m is the measured velocity and W_t is the true velocity. The wind direction error is the angular difference between the directions of each component.

Imagery

Two dimensional array of numbers, in digital format, each representing the brightness of a small elemental area.

Information Systems Security (INFOSEC)

The protection of information systems against unauthorized access to or modification of information, whether in storage, processing or transit, and against the denial of service to authorized users or the provision of service to unauthorized users, including those measures necessary to detect, document, and counter such threats.

Interface Data Processor Segment (IDPS)

The NPOESS ground processing capability located at the user components. The IDPS receives RDRs from the Space or C^3 segment, temporarily stores RDRs, converts RDRs into EDRs (at DoD sites) then pushes all required data into the Central’s computers. An IDPS at field terminals performs similar functions.

In-Track Resolution

Resolution of in-situ measurements along the orbital path, determined by sampling frequency.

Key Parameter

A parameter so significant that failure to meet the threshold is cause for the system to be reevaluated or the program to be reassessed or terminated. These parameters are to be included in the Acquisition Program Baseline.

Leads

Any fracture or passageway through sea ice which is navigable by surface vessels.

Line Replaceable Unit

The smallest unit that can be removed and replaced without cutting or desoldering connections.

Long term stability (also "long term calibration")

The maximum excursion of the short-term average measured value of a parameter under identical conditions over the mission duration. The short-term average is the average of a sufficient number of successive measurements of the parameter under identical conditions such that the random error is negligible relative to the systematic error.

Mapping Accuracy

The maximum permissible error in geographic location of the measured data.

Mean Mission Duration

The integral of the reliability distribution R(t) evaluated from time (t) equals zero until 84 months. R(t) must include the effect of all wearout items on the spacecraft.

Mean Time Between Critical Failures

The total amount of mission time divided by the total number of critical failures during a stated series of missions.

Mean Time To Repair

The sum of corrective maintenance items at any specific level of repair divided by the total number of failures which an item repaired at that level during a particular interval under stated conditions.

Measurement Accuracy

The systematic error, as specified by the difference between a measured or derived parameter and its true value, in the absence of random errors.

Measurement Precision

The uncertainty in a measured or derived parameter due only to random errors, specified as the standard deviation of a parameter.

Measurement Range

Parameter range over which measurement accuracy and precision must be maintained.

Mission Sensors

Any sensor on the spacecraft directly used to satisfy any of the EDR requirements.

Moisture Profiles

Relative and absolute humidity - the mass of water vapor per unit volume of moist air.

Nephanalysis

Analysis of cloud cover in terms of type and amount.

Objective

An operationally significant increment above the threshold.

Operations Security (OPSEC)

Actions taken or plans developed to protect information, classified or unclassified, which could reveal system plans, procedures, or missions.

Parts per million by volume (ppmv)
Read as parts per million by volume, ppmv denotes volume mixing ratio, specifically the amount of gas in a sample of "air" under standard temperature and pressure. This is the volume of gas in a volume of air.

Payload

Mission sensors and on-board processor.

Peculiar Support Equipment (PSE)

Also called "unique". Support equipment especially designed for use with a specific system and usable only on that system.

Personnel Security

Procedures established to ensure that all personnel who have access to sensitive information have the required authority, as well as appropriate clearances, and the need-to-know for the information.

Precipitable Content

The total amount of water and ice contained in a vertical column of the atmosphere.

Raw Data Record (RDR)

Full resolution digital sensor data, time referenced and earth located, with absolute radiometric and geometric calibration coefficients appended, but not applied, to the data. Aggregates (sums or weighted averages) of detector samples are considered to be full resolution data if the aggregation is normally performed to meet resolution and other requirements. Sensor data must be unprocessed with the following exceptions: time delay and integration (TDI), detector array non-uniformity correction (i.e., offset and responsivity equalization), and data compression are allowed. Lossy data compression is allowed only if the total measurement error is dominated by error sources other than the data compression algorithm. All calibration data will be retained and communicated to the ground without lossy compression.

Refresh

The specified refresh thresholds represent the maximum value of the local average revisit time over the set of all locations on the Earth’s surface; where the local average revisit time represents the average time interval between consecutive measurements of a parameter at a given location on the Earth’s surface over a time period required for the ground trace to repeat.

Revisit Time

The time interval between consecutive measurements of a parameter at the same location.

Satellite Nadir Resolution

Resolution along satellite's nadir path.

Scene Albedo

The ratio of the amount of visible spectrum electromagnetic radiation returned to space by scattering and reflection from a given aerial region of the Earth's surface, atmosphere, and clouds, to the amount of visible spectrum electromagnetic energy incident upon that region.

Sea Surface Topography

The height of the sea surface relative to the center of mass of the Earth.

Sensing Depth

The specified vertical region of interest where data are to be collected or information is to be provided.

Sensor Data Record (SDR)

Data record produced when an algorithm is used to convert Raw Data Records (RDRs) to geolocated, calibrated brightness temperatures with associated ephemeris data. Temperature Data Records (TDRs) are geolocated, antenna temperatures with all relevant calibration data counts and ephemeris data to revert from T-sub-a into counts. The existence of the SDRs provides reversible data tracking back from the EDRs to the Raw data.

Significant Wave Height

The height of a theoretical wave whose height and period are equal to the average height and period of the largest one-third of the actual waves that pass a fixed point in some time period.

Space Segment

The spacecraft including its associated sensors, subsystems, equipment, and processors.

Specific Humidity

The mass of water vapor contained in a unit mass of air (dry air plus water vapor) expressed in grams per kilogram.

Surface Albedo

The fraction of solar radiation incident at the Earth's surface that is returned to space by reflection from the Earth's surface. In-band surface albedo refers to the surface albedo within a visible/NIR bandpass of an imager. Broad-band surface albedo refers to the surface albedo within the 0.4 - 2.0 mm bandpass, which may be inferred from the in-band albedos. The solar insolation at the surface must be estimated to calculate these quantities. The major applications are twofold: 1) characterization of backgrounds by electro-optical systems, and 2) use in the visible cloud/no cloud decision for processed cloud data.

<u>TACTERMs</u>

Tactical field component terminals such as the AN/SMQ-11 and TESS used by the USN and USMC; and the Mark IV and the Mark IVB used by the AF.

<u>TEMPEST</u>

Short name referring to the investigation, study, and control of compromising emanations from telecommunications and automated information systems equipment.

<u>Temperature Data Record (TDR)</u>

Temperature Data Records are geolocated, antenna temperatures with all relevant calibration data counts and ephemeris data to revert from T-sub-a into counts.

<u>Threshold</u>

The minimum requirement below which utility of the system becomes questionable.

<u>Tides</u>

The periodic component of the sea surface topography induced by the gravitational interaction between the Earth and the Moon.

<u>Timeliness</u>

Elapsed time between initiation of measurement of the environmental data parameter and delivery of the EDR to the user site.

<u>Users</u>

The people such as weather forecasters who employ the obtained environmental data.

<u>Vertical Resolution</u>

The thickness of an atmospheric layer for which average parameters should be specified.

<u>Vertical Sampling Interval</u>

The vertical increments at which the values of a parameter that varies with height, are reported. For soundings, it represents the pressure levels at which the profile is to be specified.

Visibility

The ability to detect objects through a layer of the atmosphere.