NASA Technical Memorandum 4213

Data Base Architecture for Instrument Characteristics Critical to Spacecraft Conceptual Design

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Data Base Architecture for Instrument Characteristics Critical to Spacecraft Conceptual Design

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Contents

Acronyms

CADE	computer-aided design and engineering
DBMS	data base management system
EASIE	Environment for Application Software Integration and Execution
EMI	electromagnetic interference
GEO	geostationary orbit
LaRC	Langley Research Center
MKS	meter-kilogram-second
MORIS	Moderate Resolution Imaging Spectrometer
MSFC	Marshall Space Flight Center
NASA	National Aeronautics and Space Administration
RIM	Relational Information Management
SAB	Spacecraft Analysis Branch

Summary

Spacecraft designs are driven by the payloads and mission requirements that they support. Many of the payload characteristics, such as mass, power requirements, communication requirements, moving parts, and so forth, directly affect the choices for the spacecraft structural configuration and its subsystem design and component selection. The conceptual design process, which translates mission requirements into early spacecraft concepts, must be tolerant of frequent changes in the payload complement and resource requirements.

A computer data base has been designed and implemented for the purposes of (1) containing the payload characteristics pertinent for spacecraft conceptual design, (2) tracking the evolution of these payloads over time, and (3) enabling the integration of the payload data with engineering analysis programs for improving the efficiency in producing spacecraft designs. In-house computer tools have been used to integrate the subject data base with an existing analysis program that optimizes selected payload mass locations on any specified spacecraft geometry.

Introduction

The National Aeronautics and Space Administration (NASA) is developing plans and conducting design studies for a complement of new spacecraft, both near term (to the year 2000) and far term (post 2000), that will carry numerous multidisciplinary science instruments. The focus of the NASA program in remote sensing is primarily Earth system science and the monitoring of Earth global changes (ref. 1). Currently, there are insufficient measurement techniques and operational systems to collect the diverse, high-resolution data needed to understand the complex interactions among the surface, oceanic, atmospheric, and biological elements of the planet. These data, once obtainable, will be used to model and forecast the courses of such major trends as global warming, ozone depletion, and acid rain.

In order to identify the advanced technology needs of one class of new Earth sciences spacecraft, the Spacecraft Analysis Branch (SAB) of the NASA Langley Research Center (LaRC) is conducting system studies of second-generation platform concepts for geostationary orbit (GEO). Such large spacecraft would serve as stable platforms for large optical and antenna systems as well as numerous other complementary scientific instruments. The platform structural configuration and support subsystem designs are highly dependent on the set of instruments selected and the characteristics of each individual instrument such as the requirements for field of view, pointing accuracy and stability, power, and data communications. In addition, the mass, volume, and potential interference of the instrument with other sensors will affect both launch packaging and the layout of the platform when once in operation. However, since the instruments to be flown in most cases do not yet exist (it is expected that several will be derivatives of existing lower Earth orbit versions), the early spacecraft design process must tolerate the evolution of these instruments and the associated ill-defined requirements placed on the spacecraft.

As a direct result of the need for managing the descriptions of developing instrument technology, a computer data base was designed and implemented for the purposes of (1) providing a flexible means of storing instrument attribute information, (2) providing a change history for these attributes as they are updated over time, and (3) allowing traceability between the engineering analysis results and the associated instrument complement upon which they were based. In addition to tracing requirements, the data base can be used to automate the communication of instrument attributes to several computer-aided design and engineering (CADE) programs used by SAB. Thus, an electronic form of the data exists that reduces the errors common with repeated human handling when information is exchanged in hardcopy form only.

During the geostationary platform study (ref. 2), a "straw-man" instrument list was selected and data were stored in the data base for user access. The intent of this report is to provide the background and motivation for the data base development and to describe the data base architecture and its initial set of values. For completeness, additional sections also provide a brief overview of the interactive data base software used and describe an example of the integration of the data base with an analysis code.

Instrument Attribute Definitions

The set of instrument attributes selected for this data base were those characteristics having a major impact on the design of the spacecraft subsystems and configuration. Although other attributes could be included, this set is adequate to describe typical instrumentation proposed for spacecraft operating at arbitrary Earth orbits.

The information contained in the data base (the schema) for each instrument is described pictorially in figure 1. The data base is broken down into a set of nine tables (relations). Eight of the relations contain data specific to the instrument, and one table contains information that relates specific groups of instruments to particular spacecraft concepts. Relation GEN_INFO contains the objective, contact person, and reference information of the instrument. DIMEN, THERMAL, E_POWER, DATA_COM, MV_PARTS, and POINTING contain attributes that define the physical properties and performance requirements of the instrument. Relation SPEC_CON is set aside for comments or considerations not contained elsewhere in the data base. Finally, the relation SPACECFT contains the names of spacecraft concepts being analyzed and the spacecraft specific locations and orientations of the particular instrument set selected for that concept. Guidelines used during the development of the data base are presented in the following sections.

Instrument Description Guidelines

Units are in the MKS (meter-kilogram-second) system, but angles and angular rates are given in the units common to the discipline (radians, degrees, arcseconds, etc.).

Reference will be made to a sketch (or computer solid model) of each instrument that defines a right-hand coordinate system attached to and fixed in the instrument. This coordinate system, assigned by the instrument designer, fixes the origin for defining the instrument center of mass, inertias, and orientation. These values will be used to allow calculation of overall mass properties for any particular spacecraft to which the instrument is attached. The axis convention suggested is to align the $+z$-axis along the primary viewing axis of the instrument. Figure 2 shows a Moderate Resolution Imaging Spectrometer (MORIS) with the suggested coordinate system attached.

For each instrument, overall envelope dimensions of length, width, and height (ℓ, w, and h) will be given as increments along the instrument x-, y-, and z-axes, respectively. These overall measurements identify the volume of space needed by the instrument itself including any additional clearances for installation and/or maintenance. The value provided for the attribute VOLUME in the relation DIMEN should be the actual volume of the instrument although the product of $\ell \times w \times h$ will be used if no more definitive information is available.

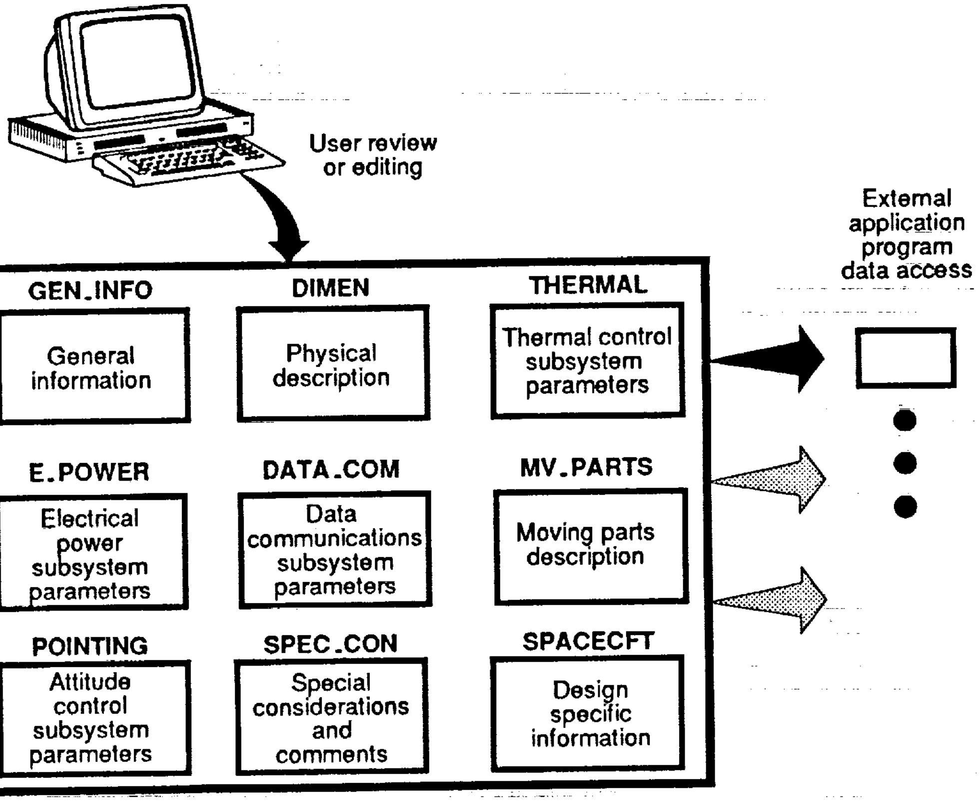

Figure 1. Block diagram of instrument data base.

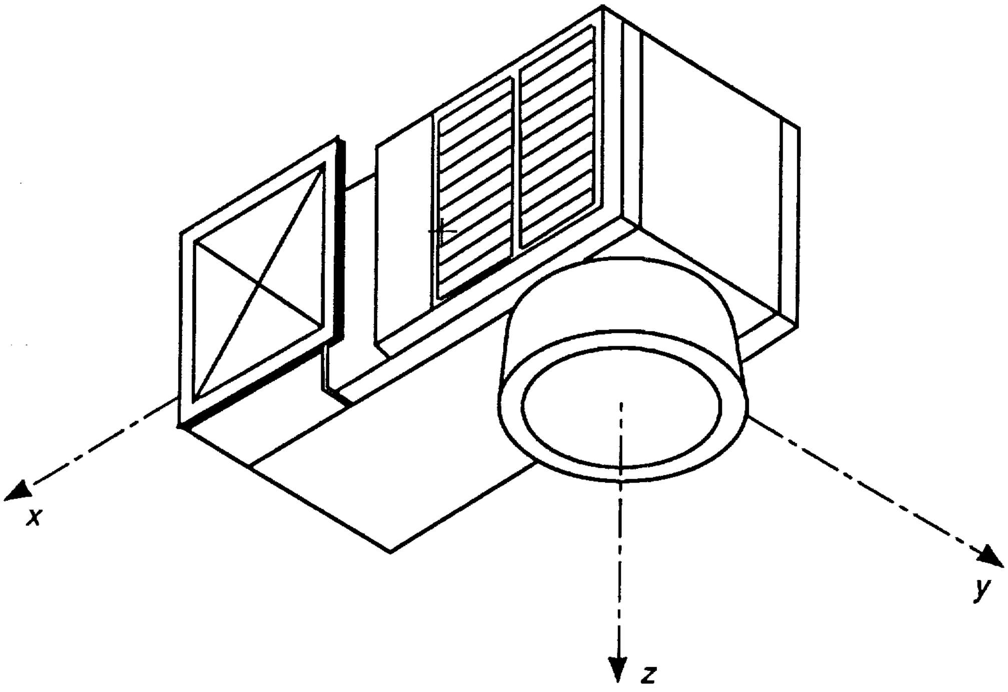

Figure 2. Example of instrument coordinate system.

An integer value between 1 and 8 will be used to signify the development status of a given instrument in accordance with table 1. (See ref. 3.)

Thermal considerations can be described over three operational modes: nominal, peak, and standby. The heat dissipation for the instrument is accommodated in the data base for all three modes, as are the temperature ranges for the electronics module and one antenna (if one exists). Also, any assumptions made about the radiator field of view (FOV) of the instrument (i.e., full hemisphere clear view, radians clear view with no reflectance, etc.) can be stated. This information is used to size passive (radiators) or active thermal control options and to determine their impact on the spacecraft configuration.

Electrical power requirements of the instrument are likewise given for these three operational modes. This information, together with duty cycle, voltage type, and range, will be used when determining the spacecraft power source, storage, and distribution methods.

Data for a maximum of two moving parts per instrument can be entered. If more than two moving parts exist, the two with the largest impact on instrument performance should be selected. This information will be used primarily to define dynamic disturbance functions for testing the spacecraft structural response.

Table 1. Definitions of Technology Readiness Levels

Readiness level	Definition
1	Basic principles observed and reported
2	Conceptual design formulated
3	Conceptual design tested analytically or experimentally
4	Critical function/characteristics demonstrated
5	Component/breadboard tested in relevant environment
6	Prototype engineering model tested in relevant environment
7	Engineering model tested in space
8	Full operational capability (incorporated in production design)

Pointing control requirements will be given in terms of short- and long-term pointing angles and short- and long-term angular rates. Three fields of view (instantaneous, maximum, and protected) are specified.

The downlink requirements for data communications are also given over the same three operational modes as thermal and electrical power: nominal, peak, and standby. Data rates and duty cycles are given for both the science and housekeeping data communications.

The electromagnetic interference (EMI) between elements is assumed to be within the military standards of reference 4 (MIL-STD-461C). If this assumption is false, a notation should be made in the SPEC_CON relation.

The information just described has been grouped into the set of relations shown in figure 1. The attributes for each relation (including the variable name, a brief definition, unit of measure, and the FORTRAN data type) are given below, and example values are given in the appendix. These descriptions should be sufficient for a user of the data base to understand the intent of the data and to calculate or estimate needed information.

Listing of Attributes by Relation

GEN_INFO:

INSTR_NO: Instrument identification number; integer
TITLE: Instrument name and abbreviation (if applicable); text
UPDATE: Date of latest update; text
CONTACT: Name, address, and phone number of the contact person for the instrument; text
M_OBJ: Measurement objective; text
DESCRIPT: Brief description of sensing method; text
DEV_STAT: Development status between 1 and 8; integer
SKETCH: Reference to sketch of instrument; text
REFER: Reference information available on instrument (latest data); text

DIMEN:

INSTR_NO: See above.
TITLE: See above.
LENGTH: Overall instrument length, plus clearances, measured in instrument x-axis (typically along flight path), m; real
WIDTH: Overall instrument width, plus clearances, measured in instrument y-axis (typically perpendicular to orbit plane), m; real
HEIGHT: Overall instrument height, plus clearances, measured in instrument z-axis (typically along nadir), m; real
VOLUME: Instrument volume; default to LENGTH × WIDTH × HEIGHT, m^3; real
MASS: Instrument total mass, kg; real
LOCAL_CM: x, y, z location of instrument center of mass relative to instrument origin (if $0, 0, 0$, then center of mass is equal to the coordinate system origin), m; real (3)
INERTIA: XX, YY, ZZ, XY, XZ, YZ local moments of inertia relative to instrument axes, kg-m^2; real (6)
CENTER: x, y, z displacement from instrument origin to center of operational volume defined by LENGTH, WIDTH, and HEIGHT (if $0, 0, 0$, then center of volume is equal to the coordinate system origin), m; real (3)

THERMAL:

INSTR_NO: See above.
TITLE: See above.
RAD_ASMP: Radiator viewing design assumptions for this instrument; text
DIS_NOM: Nominal heat dissipation (rejection), min and max, W; real (2)
DIS_PEK: Peak heat dissipation, min and max, W; real (2)

DIS_STB: Standby heat dissipation, min and max, W; real (2)
ETMP_NOM: Electronics nominal-operation temperature ranges, min and max, °C; real (2)
ETMP_PEK: Electronics peak-operation temperature ranges, min and max, °C; real (2)
ETMP_STB: Electronics standby-operation temperature ranges, min and max, °C; real (2)
ATMP_NOM: Antenna (if applicable) nominal-operation temperature ranges, min and max, °C; real (2)
ATMP_PEK: Antenna (if applicable) peak-operation temperature ranges, min and max, °C; real (2)
ATMP_STB: Antenna (if applicable) standby-operation temperature ranges, min and max, °C; real (2)

E_POWER:
INSTR_NO: See above.
TITLE: See above.
PWR_NOM: Instrument nominal-operation power, W; real
PWR_PEK: Instrument peak-operation power, W; real
PWR_STB: Instrument standby power, W; real
INP_VOLT: Instrument input voltage, V; real
VOLT_TYP: Input-voltage type (i.e., AC or DC); text (10)
REG: Power regulation, min and max, V; real (2)
DUTY_CYC : Instrument duty cycle, percent; real

DATA_COM:
INSTR_NO: See above.
TITLE: See above.
SDATA_R: Data rate necessary for science applications, kbps; real
HDATA_R: Data rate necessary for housekeeping operations, kbps; real
SDUTY_C: Duty cycle for science applications, percent; real
HDUTY_C: Duty cycle for housekeeping operations, percent; real
UREQ_RAT: Uplink data requirement rate for nominal operation, kbps; real
UREQ_VOL: Uplink data requirement volume (number of commands) for nominal operation, bits; real
DREQ_NOM: Downlink data requirements for nominal operation, analog and digital, kbps; real (2)
DREQ_PEK: Downlink data requirements for peak operation, analog and digital, kbps; real (2)
DREQ_STB: Downlink data requirements for standby operation, analog and digital, kbps; real (2)

MV_PARTS:
(NOTE: A maximum of two moving parts can be recorded. If more then two moving parts exist, choose the two with the presumed largest effects on spacecraft performance.)
INSTR_NO: See above.
TITLE: See above.
MP1_COMP: Name or type of first moving component (i.e., antenna, mirror); text
MP1_MASS: Mass of first moving component, kg; real
MP1_MARM: Moment arm to center of mass of first moving component, m; real
MP1_MOI: Moments of inertia of first moving component: XX, YY, ZZ, XY, XZ, YZ, respectively, kg-m^2; real (6)
MP1_LACC: Linear acceleration of first moving part in x, y, z, respectively, m/sec; real (3)
MP1_AACC: Angular acceleration of first moving part about x, y, z, respectively, deg/sec; real (3)

MP2_COMP: Name or type of second moving part; text
MP2_MASS: Mass of second moving part, kg; real
MP2_MARM: Moment arm to center of mass of second moving part, m; real
MP2_MOI: Moments of inertia of second moving part: XX, YY, ZZ, XY, XZ, YZ, respectively, kg-m^2; real (6)
MP2_LACC: Linear acceleration of second moving part in x, y, z, respectively, m/sec; real (3)
MP2_AACC: Angular acceleration of second moving part about x, y, z, respectively, deg/sec; real (3)

POINTING:
INSTR_NO: See above.
TITLE: See above.
PT_REQ_A: Instrument pointing control requirement angles, about x, y, z short term and x, y, z long term, respectively, deg; real (6)
PT_REQ_R: Instrument pointing control requirement rates, about x, y, z short term and x, y, z long term, respectively, deg/sec; real (6)
FOV_INST: Instrument instantaneous field of view about x- and y-axes, respectively, deg; real (2)
FOV_MAX: Instrument maximum scanning field of view about x- and y-axes, respectively, deg; real (2)
FOV_PROT: Instrument field-of-view restriction to protect it from damaging radiation about x- and y-axes, respectively, deg; real (2)

SPEC_CON:
INSTR_NO: See above.
TITLE: See above.
SP1: First row of special considerations; text
SP2: Second row of special considerations; text
.
.
.
SP10: Tenth row of special considerations; text

The information contained in the special considerations relation of SPEC_CON will vary greatly from instrument to instrument. Suggestions for the kinds of data represented here are as follows: scan patterns used, reasons for field-of-view restrictions, sensor duty-cycle time and constraints, calibration requirements and frequency, ancillary information needs (data needs from the spacecraft or other instruments), complementary instruments required with this instrument, location or mounting constraints, contamination/environmental constraints (radiation, magnetic, chemical, optical, etc.), flexible appendage constraints (allowable linear and angular motions), and EMI in violation of MIL-STD-461C (source and receiver). (See ref. 4.)

SPACECFT:
SCNAME: Name of spacecraft concept analysis model; text
INSTR_NO: Instrument identification number; integer
LOCATE: x, y, z location of instrument origin from the spacecraft origin, m; real (3)
ORIENT: x, y, z rotation angles needed to align the instrument correctly on the spacecraft configuration, deg; real (3)

Although this last relation of information will not be provided by the instrument specialist, it is used in the computer-aided design environment of the SAB as the mechanism by which specific instruments are related to specific spacecraft designs for follow-on engineering studies.

Data Base Application

The instrument data base just described has been created to support and expedite spacecraft design studies being conducted within the Spacecraft Analysis Branch at LaRC and provides both management of the data and certain analysis advantages. The baseline data base is protected from unauthorized modifications by read-only permission, but any user may make personal copies to modify any or all of the data to create an instrument set reflective of his study requirements. A typical user scenario would see an engineer create and access a copy of the data base, select the instruments of interest, query or alter the attributes of interest, and print the data needed for his study. This hardcopy would serve as his input data listing. In fact, for studies requiring frequent use of computer codes that use the data base information as input, subroutines can be automatically generated to read from (or write to) the data base directly. This allows rapid execution of analysis codes and avoids the human interaction and potential error associated with manual input of data. This section will provide an example of the integration of an analysis program to the data base and briefly discuss the tools themselves.

Program Integration

The instrument data base has been implemented on the same computer that hosts SAB's major CADE tools so that information can be drawn easily from the data base as needed by various analyses. To provide an example of such data base/analysis integration, a program that optimizes the placement of instruments on a platform (ref. 5) will be cited. This program alters the platform inertias by moving the instrument masses within the configuration constraints and, by optimizing mass placement, can estimate the potential savings achieved in the amount of platform control propellant expended over a mission lifetime. The optimization program reads the instrument names, dimensions, masses, centers of gravity (c.g.), and locations from the data base. These data, along with a platform layout description that is input by the analyst, are used by the optimization program to assess possible alternative payload arrangements for improving platform performance. Thus, as individual instrument characteristics evolve or as new groupings of instruments are proposed, the mass optimization program can be quickly reinitialized because of its direct link to the data base. Analysis results can be placed back into suitably defined locations in the data base for use by other programs. This method of data access reduces the chance for human error and improves traceability between analysis results and instrument definition. (In a similar fashion, a large group of programs has been integrated to provide an entire spacecraft conceptual design capability (ref. 6) implemented around a central data base for information exchange.)

Data Base Management System

The integration of the optimization program with the data base was facilitated by LaRC-developed software utilities that support several necessary functions. First, tools to actually create the data base are needed. Second, tools that automatically generate code to read from or write to the data base are needed. Third, a standard editor for data review and modification is needed. The instrument data base application described in the last section was constructed using a set of utilities developed at LaRC specifically for program integration. These tools, known as the Environment for Application Software Integration and Execution (EASIE) (refs. 7–11) provide an upper-level command language for constructing data base schema, interfacing stand-alone programs, and developing menus and execution procedures. EASIE also provides a generic editor that can be used to review and/or modify data in any of the relations, regardless of their construction. These tools, written in FORTRAN-77, currently support two data base management systems (DBMS's), but the specific version used in this application is based upon the Relational Information Management (RIM[1]) version 7 (ref. 12) from Boeing Computer Services. EASIE itself, and thus the instrument data base, have been implemented on a VAX[2] 11/785 under the VMS[3] 5.0 operating system; however, EASIE provides a portability to other operating systems and other DBMS's. Currently, a version of EASIE is being implemented in the UNIX operating system so that today's workstation environment can be supported. In this way, the integrated engineering environment can be ported, thus retaining the commands familiar to the user and, therefore, reducing the start-up time normally associated with learning a new operating system or DBMS.

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[1] RIM: Trademark of Boeing Computer Services.

[2] VAX: Trademark of the Digital Equipment Corporation.

[3] VMS: Trademark of the Digital Equipment Corporation.

Concluding Remarks

The primary motivation for the development of this instrument data base was for management of evolving instrument definitions needed during spacecraft conceptual design. The approach provides an architecture that allows versions of instrument descriptions to be dated and then used in spacecraft analysis as the project team dictates. Any user of the computer data base can make his own uncontrolled copy and modify it to test the impact of instrument requirement changes in his specific engineering area. In this manner, the instrument data base will allow traceability between analysis results and the specific instruments used in that study. The data base approach also has been found to yield significant analysis execution efficiencies by providing a basis for communications between the instrument data base and other analysis programs. Using integration utilities developed at NASA, a payload mass optimization program has been integrated with the data base to enhance iterative studies assessing the potential impact of changes in the location of instruments on the spacecraft.

NASA Langley Research Center
Hampton, VA 23665-5225
August 10, 1990

Appendix

Example of Data Base Values

This appendix presents values contained in the data base for each of the eight tables that are descriptive of instrument properties. The ninth table (relation SPACECFT) is not included since it pertains to specific spacecraft models being studied by the Langley Spacecraft Analysis Branch and is not of general interest.

The initial set of values presented here were drawn from early instrument definition studies conducted by the Lockheed Missiles and Space Company, Inc., for the NASA Marshall Space Flight Center (MSFC).

Although many of the data values in this appendix are zero, ongoing instrument definition activities at MSFC are providing updated values as well as additional candidate instruments for science applications at geostationary orbit. Information regarding the Marshall effort can be obtained via electronic mail (NASAmail). Contact Dr. Vernon Keller, NASA Marshall Space Flight Center, Mail Stop PS-02, Huntsville, AL 35812 (phone (205) 544-2470).

INSTR_NO	TITLE
1	GEOSTATIONARY MILLIMETER IMAGER/SOUNDER (GEMIS)
2	MODERATE RES. IMAGING SPECTROMETER (MORIS)
3	INFRARED VERTICAL SOUNDER (IRVS)
4	MICHELSON SOUNDER (MIS)
5	FABRY-PEROT SOUNDER
6	LIGHTNING MAPPER (LIM)
7	OZONE MAPPER (OZM)
8	ACTIVE CAVITY RADIOMETER (ACR)
9	EARTH RADIATION RADIOMETER (ERRB)
10	SOLAR DISK SEXTANT
11	X-RAY IMAGER (XRI)
12	HIGH RES. IMAGING SPECTROMETER (HIRIS)
13	LASER RANGER (LRS)
14	COHERENT RADAR
15	SOLAR SPECTROMETER (SOS)
16	LOW-FREQUENCY MICROWAVE RADIOMETER (LFMR)
17	SPACE ENVIRONMENT MONITOR (SEM)
18	DATA COLLECTION PLATFORM (DCP)

INSTR_NO	UPDATE	CONTACT
1	MAY 1989	TOM FRASCHETTI, JPL, M/S 168-327
2	JUNE 20, 1989	RON KOCZOR, MSFC/ES41, MSFC, AL, 35812
3	NOV. 1988	P. MENZEL - NESDIS
4	NOV. 1988	
5	JUNE 1988	
6	NOV. 1988	P. KRIDER - U. OF AZ
7	NOV. 1988	
8	NOV. 1988	D. WILLSON - JPL
9	NOV. 1988	E. HARRISON - LaRC
10	JUNE 1988	
11	NOV. 1988	
12	SEPT. 1989	J. M. VOSS, JPL, M/S 11-116
13	NOV. 1988	P. BINDER - NBS
14	JUNE 1988	C. SWIFT - U. OF MASS
15	NOV. 1988	D. WILLSON - JPL
16	NOV. 1988	R. SPENCER - MSFC
17	NOV. 1988	
18	NOV. 1988	

INSTR_NO	M_OBJ
1	MEASUREMENTS OF PRECIPITATION, WATER VAPOR, TEMP. PROFILES, & STORM STRUCTURES
2	PROVIDE MOD. SPATIAL RES. (.5 TO 2 KM) IMAGERY TO MONITOR ATMOS., LAND, OCEAN
3	SHORT-TERM DETERMINATION OF TEMPORAL, HORIZONTAL, VERTICAL STRUCTURE OF ATMOS.
4	HIGH-RES. TRACE GAS DETECTION AND TEMP./HUMIDITY PROFILE DETERMINATION
5	HIGH-RESOLUTION TEMPERATURE AND HUMIDITY SOUNDING
6	MONITOR LIGHTNING EVENTS; PROVIDE SEVERE STORM DETECTION, ASSESS., AND TRACKING
7	DETERMINE TOTAL OZONE; VERTICAL DISTRIB. OF TEMP., OZONE, TRACE GASES
8	CONTINUOUS PRECISION MEASUREMENT OF SOLAR ENERGY OUTPUT
9	ACCURATE MEASUREMENTS OF EARTH'S RADIATION BUDGET
10	SOLAR DIAMETER
11	MONITOR SOLAR FLARE EVENTS AND ASSOC. IMPACTS ON NEAR-EARTH ENVIRONMENT
12	STUDIES ON TIME-VARYING SPECTRA FOR GEOLOGICAL, VEGETATION, AND HYDROLOGICAL ANALYSES
13	MONITOR FAULT DEVELOPMENT AND TECTONIC PROCESSES, PROVIDE EARTHQUAKE WARNINGS
14	MEASURES OCEAN CURRENTS ON A DAILY BASIS
15	CONTINUOUS SOLAR SPECTRAL RADIANCE MONITORING
16	PRECIPITATION, SURFACE TEMP., AND OCEAN WIND MEASUREMENTS
17	CONTINUOUS MONITORING OF THE SPACE ENVIRONMENT
18	COLLECT ENVIRO. DATA, RELAY TO GROUND STATION, PROVIDE LOCATION/MOVEMENT DATA

INSTR_NO	DESCRIPT
1	4.4 M SOLID DISH, 15 KM RES. AT 32–220 GHZ, FULL DISK - 30 MIN, REGIONAL - 15 MIN
2	TWO-AXIS SCANNING RADIOMETER W/TELESCOPE FORE-OPTIC AND SPECTRAL AFT-OPTIC
3	SPATIAL RES=5–10 KM, VERTICAL RES.=.2–1 KM, TEMP. RES.=1.0 DEG., FULL DISK - 60 MIN
4	TEMP. RES.=1 DEG., SPATIAL RES.=5–10 KM, VERT. RES.=1 KM, 2 COVERAGE MODES
5	
6	MULTICHANNEL NEAR INFRARED IMAGING, SAMPLING 1000 TIMES/SEC, SPATIAL RES.=5–10 KM
7	2 SEP. INSTRUMENTS: NADIR SOUNDER (GNS) AND LIMB SOUNDER (GLS)
8	SUN POINTING, FAIL SAFE SHUTTERS
9	2 MEASUREMENT SYSTEMS: SCANNING (3 TELESCOPES) & NONSCANNING (2 EARTH DETECTORS)
10	
11	
12	1 M OPTICAL TELESCOPE, SPATIAL RES.=100 M, APPROX. 100 CHANNELS (.3–12 MICRONS)
13	SENSES EARTH DEFORMATION, USES GROUND REFLECTORS (400–500 RETROS DEPLOYED)
14	10 GHZ, 400 WATTS EVERY 3 HRS., 30 KM RES., 5 CM/SEC ACCURACY
15	SUN POINTING, COMPLEMENTS ACR
16	15 M ANTENNA, SPATIAL RES.=10 KM (5–50 GHZ), FULL DISK - 30 MIN
17	5 SENSORS: MEPED, TED, LEFI, TAM, RAB.
18	AVG. CAPACITY 720 DCPS, SINGLE SCAN 1.2 KM

INSTR_NO	DEV_STAT	SKETCH	REFER
1	3	GEO. PLAT. STUDY FINAL REPORT, p93	NASAMAIL ON GEOPLAT (G. S. WILSON), AUG. 1989
2	3	GEO. PLAT. STUDY FINAL REPORT, p95	NASAMAIL UPDATE POSTED JULY 12, 1989 (DUPTON)
3	5	GEO. PLAT. REPORT, p97	GEOSTATIONARY PLATFORM STUDY (LOCKHEED)
4	5	GEO. PLAT. STUDY FINAL REPORT, p99	GEOSTATIONARY PLATFORM STUDY FINAL REPORT, NOV. 1988 (LOCKHEED)

INSTR_NO	DEV_STAT	SKETCH	REFER
5	2	GEO. ES PLAT. INSTRUMENT AND PLAT. CONCEPTS, p26	GEOSTATIONARY EARTH SCIENCE PLATFORM INSTR AND PLATFORM CONCEPTS, JUNE 1988 (FORD AERO/ LOCKHEED)
6	3	GEO. PLAT. STUDY FINAL REPORT, p101	GEOSTATIONARY PLATFORM STUDY FINAL REPORT, NOV. 1988 (LOCKHEED)
7	2	GEO. PLAT. STUDY FINAL REPORT, p103	GEOSTATIONARY PLATFORM STUDY FINAL REPORT; NOV. 1988 (LOCKHEED)
8	2	GEO. PLAT. STUDY FINAL REPORT, p105	GEOSTATIONARY PLATFORM STUDY FINAL REPORT, NOV. 1988 (LOCKHEED)
9	3	GEO. PLAT. STUDY FINAL REPORT, p107	GEOSTATIONARY PLATFORM STUDY FINAL REPORT, NOV. 1988 (LOCKHEED)
10	2	GEO. ES PLAT INSTRUMENT AND PLAT., CONCEPTS, p42	GEOSTATIONARY EARTH SCIENCE PLATFORM INSTR. & PLAT. CONCEPTS, JUNE 1988 (FORD AEROSPACE/LOCKHEED)
11	2	GEO. PLAT. STUDY FINAL REPORT, p109	GEOSTATIONARY PLATFORM STUDY FINAL REPORT, NOV. 1988 (LOCKHEED)
12	2	GEO. PLAT. STUDY FINAL REPORT, p111	GEOSTATIONARY PLATFORM STUDY FINAL REPORT, NOV. 1988 (LOCKHEED)
13	2	GEO. PLAT. STUDY FINAL REPORT, p113	GEOSTATIONARY PLATFORM STUDY FINAL REPORT, NOV. 1988 (LOCKHEED)
14	2	GEO. ES PLAT INSTRUMENT AND PLAT. CONCEPTS, p57	GEOSTATIONARY EARTH SCIENCE PLATFORM INSTRUMENT AND PLAT. CONCEPTS, JUNE 1988 (FORD AEROSPACE/LOCKHEED)
15	2	GEO. PLAT. STUDY FINAL REPORT, p115	GEOSTATIONARY PLATFORM STUDY FINAL REPORT, NOV. 1988 (LOCKHEED)
16	2	GEO. PLAT. STUDY FINAL REPORT, p117	GEOSTATIONARY PLATFORM STUDY FINAL REPORT, NOV. 1988 (LOCKHEED)
17	6	GEO. PLAT. STUDY FINAL REPORT, p119	GEOSTATIONARY PLATFORM STUDY FINAL REPORT, NOV. 1988 (LOCKHEED)
18	6	GEO. PLAT. STUDY FINAL REPORT, p121	GEOSTATIONARY PLATFORM STUDY FINAL REPORT, NOV. 1988 (LOCKHEED)

INSTR_NO	LENGTH	HEIGHT	WIDTH	VOLUME	MASS
1	4.4	6.6	4.4	30.4	250.
2	2.1	1.2	.9	2.268	230.
3	1.4	6.88	.95	1.22	146.
4	1.93	1.17	1.26	2.85	165.
5	2.	1.	.9	1.8	800.
6	.2	.2	.2	.008	30.
7	1.67	1.	1.	1.67	30.
8	.3	.4	.25	.03	50.
9	.9	.45	.7	.284	50.
10	.4	.3	.3	.036	100.
11	.73	.44	.47	.15	19.
12	2.43	1.47	1.57	5.6	400.
13	1.5	1.	1.5	2.25	100.
14	1.8	.4	1.2	.864	200.
15	.3	1.	.25	.075	60.
16	15.	5.	15.	78.5	200.
17	2.	.2	.2	.08	38.
18	.2	.2	.2	.008	23.

INSTR_NO	LOCAL_CM			INERTIA					
	X	Y	Z	XX	YY	ZZ	XY	XZ	YZ
1	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.	0.
8	0.	0.	0.	0.	0.	0.	0.	0.	0.
9	0.	0.	0.	0.	0.	0.	0.	0.	0.
10	0.	0.	0.	0.	0.	0.	0.	0.	0.
11	0.	0.	0.	0.	0.	0.	0.	0.	0.
12	0.	0.	0.	0.	0.	0.	0.	0.	0.
13	0.	0.	0.	0.	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.	0.	0.	0.	0.
17	0.	0.	0.	0.	0.	0.	0.	0.	0.
18	0.	0.	0.	0.	0.	0.	0.	0.	0.

INSTR_NO	CENTER X	 Y	 Z
1	0.	0.	0.
2	0.	0.	0.
3	0.	0.	0.
4	0.	0.	0.
5	0.	0.	0.
6	0.	0.	0.
7	0.	0.	0.
8	0.	0.	0.
9	0.	0.	0.
10	0.	0.	0.
11	0.	0.	0.
12	0.	0.	0.
13	0.	0.	0.
14	0.	0.	0.
15	0.	0.	0.
16	0.	0.	0.
17	0.	0.	0.
18	0.	0.	0.

INSTR_NO	RAD_ASMP
1	90 DEGREES IN COLD SPACE UNOBSTRUCTED FOV
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	

INSTR_NO	DIS_NOM		DIS_PEK		DIS_STB	
	MIN	MAX	MIN	MAX	MIN	MAX
1	0.	100.	0.	100.	0.	50.
2	0.	100.	0.	100.	0.	0.
3	0.	110.	0.	110.	0.	0.
4	0.	128.	0.	128.	0.	0.
5	0.	138.	0.	138.	0.	0.
6	0.	100.	0.	100.	0.	0.
7	0.	30.	0.	30.	0.	0.
8	0.	20.	0.	20.	0.	0.
9	0.	30.	0.	30.	0.	0.
10	0.	150.	0.	150.	0.	0.
11	0.	10.	0.	10.	0.	0.
12	0.	100.	0.	100.	0.	0.
13	0.	300.	0.	300.	0.	0.
14	0.	400.	0.	400.	0.	0.
15	0.	40.	0.	40.	0.	0.
16	0.	50.	0.	50.	0.	0.
17	0.	25.	0.	25.	0.	0.
18	0.	32.	0.	32.	0.	0.

INSTR_NO	ETMP_NOM		ETMP_PEK		ETMP_STB	
	MIN	MAX	MIN	MAX	MIN	MAX
1	10.	35.	10.	35.	−10.	35.
2	−10.	40.	−10.	40.	0.	0.
3	−10.	40.	−10.	40.	0.	0.
4	−10.	40.	−10.	40.	0.	0.
5	−10.	40.	−10.	40.	0.	0.
6	−10.	40.	−10.	40.	0.	0.
7	−10.	40.	−10.	40.	0.	0.
8	−10.	40.	−10.	40.	0.	0.
9	−10.	40.	−10.	40.	0.	0.
10	−10.	40.	−10.	40.	0.	0.
11	−10.	40.	−10.	40.	0.	0.
12	−10.	40.	−10.	40.	0.	0.
13	−10.	40.	−10.	40.	0.	0.
14	−10.	40.	−10.	40.	0.	0.
15	−10.	40.	−10.	40.	0.	0.
16	−10.	40.	−10.	40.	0.	0.
17	−10.	40.	−10.	40.	0.	0.
18	−10.	40.	−10.	40.	0.	0.

INSTR_NO	ATMP_NOM		ATMP_PEK		ATMP_STB	
	MIN	MAX	MIN	MAX	MIN	MAX
1	−40.	40.	−40.	40.	−50.	80.
2	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.
8	0.	0.	0.	0.	0.	0.
9	0.	0.	0.	0.	0.	0.
10	0.	0.	0.	0.	0.	0.
11	0.	0.	0.	0.	0.	0.
12	0.	0.	0.	0.	0.	0.
13	0.	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.	0.
16	−10.	40.	−10.	40.	0.	0.
17	0.	0.	0.	0.	0.	0.
18	0.	0.	0.	0.	0.	0.

INSTR_NO	PWR_NOM	PWR_PEK	PWR_STB
1	300.	330.	50.
2	250.	250.	0.
3	110.	110.	0.
4	128.	128.	0.
5	138.	138.	0.
6	100.	100.	0.
7	30.	30.	0.
8	20.	20.	0.
9	30.	30.	0.
10	150.	150.	0.
11	10.	10.	0.
12	100.	100.	0.
13	300.	300.	0.
14	400.	400.	0.
15	40.	40.	0.
16	50.	50.	0.
17	25.	25.	0.
18	32.	32.	0.

			REG		
INSTR_NO	INP_VOLT	VOLT_TYPE	MIN	MAX	DUTY_CYC
1	28.	DC	0.	0.	100.
2	28.	DC	22.	38.	100.
3	0.		0.	0.	100.
4	0.		0.	0.	100.
5	0.		0.	0.	100.
6	0.		0.	0.	100.
7	0.		0.	0.	50.
8	0.		0.	0.	50.
9	28.	DC	0.	0.	100.
10	0.		0.	0.	100.
11	0.		0.	0.	50.
12	0.		0.	0.	100.
13	0.		0.	0.	100.
14	0.		0.	0.	100.
15	0.		0.	0.	50.
16	0.		0.	0.	100.
17	0.		0.	0.	100.
18	0.		0.	0.	100.

INSTR_NO	SDATA_R	HDATA_R	SDUTY_C	HDUTY_C	UREQ_RAT	UREQ_VOL
1	16.	4.	100.	100.	0.	0.
2	117000.	1.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.
8	0.	0.	0.	0.	0.	0.
9	100.	0.	0.	0.	0.	0.
10	0.	0.	0.	0.	0.	0.
11	0.	0.	0.	0.	0.	0.
12	0.	0.	0.	0.	0.	0.
13	0.	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.	0.
17	0.	0.	0.	0.	0.	0.
18	0.	0.	0.	0.	0.	0.

INSTR_NO	DREQ_NOM		DREQ_PEK		DREQ_STB	
	ANAL	DGL	ANAL	DGL	ANAL	DGL
1	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.
8	0.	0.	0.	0.	0.	0.
9	0.	0.	0.	0.	0.	0.
10	0.	0.	0.	0.	0.	0.
11	0.	0.	0.	0.	0.	0.
12	0.	0.	0.	0.	0.	0.
13	0.	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.	0.
17	0.	0.	0.	0.	0.	0.
18	0.	0.	0.	0.	0.	0.

INSTR_NO	MP1_COMP
1	MECHANICALLY SCANNED ANTENNA (+/– 10 DEG)
2	SCANNING MIRROR
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	

INSTR_NO	MP1_MASS	MP1_MARM	MP1_MOI					
			XX	YY	ZZ	XY	XZ	YZ
1	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.
8	0.	0.	0.	0.	0.	0.	0.	0.
9	0.	0.	0.	0.	0.	0.	0.	0.
10	0.	0.	0.	0.	0.	0.	0.	0.
11	0.	0.	0.	0.	0.	0.	0.	0.
12	0.	0.	0.	0.	0.	0.	0.	0.
13	0.	0.	0.	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.	0.	0.	0.
17	0.	0.	0.	0.	0.	0.	0.	0.
18	0.	0.	0.	0.	0.	0.	0.	0.

INSTR_NO	MP1_LACC			MP1_AACC		
	X	Y	Z	X	Y	Z
1	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.
8	0.	0.	0.	0.	0.	0.
9	0.	0.	0.	0.	0.	0.
10	0.	0.	0.	0.	0.	0.
11	0.	0.	0.	0.	0.	0.
12	0.	0.	0.	0.	0.	0.
13	0.	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.	0.
17	0.	0.	0.	0.	0.	0.
18	0.	0.	0.	0.	0.	0.

INSTR_NO	MP2_COMP
1	DEPLOYABLE SUNSHADE
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	

INSTR_NO	MP2_MASS	MP2_MARM	MP2_MOI					
			XX	YY	ZZ	XY	XZ	YZ
1	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.
8	0.	0.	0.	0.	0.	0.	0.	0.
9	0.	0.	0.	0.	0.	0.	0.	0.
10	0.	0.	0.	0.	0.	0.	0.	0.
11	0.	0.	0.	0.	0.	0.	0.	0.
12	0.	0.	0.	0.	0.	0.	0.	0.
13	0.	0.	0.	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.	0.	0.	0.
17	0.	0.	0.	0.	0.	0.	0.	0.
18	0.	0.	0.	0.	0.	0.	0.	0.

INSTR_NO	MP2_LACC X	Y	Z	MP2_AACC X	Y	Z
1	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.
8	0.	0.	0.	0.	0.	0.
9	0.	0.	0.	0.	0.	0.
10	0.	0.	0.	0.	0.	0.
11	0.	0.	0.	0.	0.	0.
12	0.	0.	0.	0.	0.	0.
13	0.	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.	0.
17	0.	0.	0.	0.	0.	0.
18	0.	0.	0.	0.	0.	0.

INSTR_NO	PT_REQ_A X (SHORT-TERM)	Y	Z	X (LONG-TERM)	Y	Z	PT_REQ_R X (SHORT-TERM)	Y	Z	X (LONG-TERM)	Y	Z
1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
8	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
9	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
11	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
12	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
13	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
17	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
18	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

INSTR_NO	FOV_INST		FOV_MAX		FOV_PROT	
	X	Y	X	Y	X	Y
1	15.	18.	0.	0.	0.	0.
2	.5	2.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.
8	0.	0.	0.	0.	0.	0.
9	0.	0.	0.	0.	0.	0.
10	0.	0.	0.	0.	0.	0.
11	0.	0.	0.	0.	0.	0.
12	0.	0.	0.	0.	0.	0.
13	0.	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.	0.
17	0.	0.	0.	0.	0.	0.
18	0.	0.	0.	0.	0.	0.

INSTR_NO	SP1 SP2
1	NADIR OVER FULL EARTH DISK (+/- 10 DEGREES) RASTER SCAN OVER 4000 KM × 4000 KM AREA IN 30 MINUTES
2	NADIR TO OFF-LIMB FULL DISK COVERAGE EVERY 30 MINUTES CALIBRATION - COLD SPACE WILL BE USED AS A ZERO REF. FOR ALL CHANNELS
3	EARTH POINTING
4	EARTH POINTING
5	EARTH POINTING
6	EARTH POINTING
7	EARTH POINTING
8	SOLAR POINTING
9	EARTH POINTING
10	SOLAR POINTING
11	EARTH POINTING
12	EARTH POINTING
13	EARTH POINTING
14	EARTH POINTING
15	EARTH POINTING
16	EARTH POINTING
17	SOLAR POINTING
18	EARTH POINTING

INSTR_NO	SP3 SP4
1	
2	CLEAR FIELDS OF VIEW
3	INTERNAL BLACKBODY TARGET TO CALIBRATE
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	

INSTR_NO	SP5 SP6
1	
2	HIGH DUTY CYCLE WITH NEAR-CONTINUOUS OPERATION EAST/WEST SCAN PATTERN W/ORTHOGONAL STEP FOR RASTER SCAN
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	

INSTR_NO	SP7 SP8
1	
2	WITHSTAND THE NATURAL RADIATION ENVIRONMENT
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	

INSTR_NO	SP9 SP10
1	
2	
3	
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16. Abstract

Spacecraft designs are driven by the payloads and mission requirements that they support. Many of the payload characteristics, such as mass, power requirements, communication requirements, moving parts, and so forth, directly affect the choices for the spacecraft structural configuration and its subsystem design and component selection. The conceptual design process, which translates mission requirements into early spacecraft concepts, must be tolerant of frequent changes in the payload complement and resource requirements. A computer data base has been designed and implemented for the purposes of (1) containing the payload characteristics pertinent for spacecraft conceptual design, (2) tracking the evolution of these payloads over time, and (3) enabling the integration of the payload data with engineering analysis programs for improving the efficiency in producing spacecraft designs. In-house computer tools have been used to integrate the subject data base with an existing analysis program that optimizes selected payload mass locations on any specified spacecraft geometry.

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