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TASK FINAL REPORT

on

PLANNING FOR A DATA BASE SYSTEM
TO SUPPORT SATELLITE CONCEPTUAL DESIGN
(Report No. BCL-OA-TFR-76-11)

by

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FOREWORD

The study reported herein was carried out by Battelle's Columbus Laboratories for the NASA Office of Applications, as a task under Contract Number NASw-2800. The study task leader was Dr. Charles R. Claydon, and the work was done under the general supervision of Dr. A. C. Robinson, Battelle's manager for the contract. Task monitor in the Office of Applications was Mr. Walt McCandless, Code ESE. In addition, a number of discussions were held with Mr. Bob Nagler of JPL during the course of the study, and his assistance is gratefully acknowledged.

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PLANNING FOR A
DATA BASE SYSTEM TO SUPPORT
SATELLITE CONCEPTUAL DESIGN

by

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I. INTRODUCTION

A. Background

     This report summarizes the plans for a data base system to support
satellite conceptual design. The planning study was proposed March 22, 1976,
in response to a February 26, 1976, directive to Battelle's Columbus Laboratories
(BCL) from NASA's Mr. Forrest Waller. A copy of the task statement of work is
attached to this report as Appendix A.

     Based upon the statement of work and conversations with Mr. Robert
Nagler of the Jet Propulsion Laboratory (JPL), Battelle personnel developed a
conceptual design of an automated data base system. The data base consists of
the satellite catalog prepared by JPL personnel. The preparation of a sensor
catalog and a science and applications opportunities catalog is planned by
JPL staff. Upon completion of these catalogs, they will become part of the
data base. To support usage of the data base for satellite conceptual design,
the conceptual system design utilized capabilities of the BASIS storage,
retrieval, and analysis system. The satellite catalog and the BASIS system
are described briefly below.

B. The Satellite Catalog

During fiscal year 1975 the preparation of a satellite catalog was initiated by JPL staff. Data were cataloged and synthesized for all Earth orbital satellites funded to the hardware stage for launch between 1970 and 1980. Assistance with data collection was provided by personnel of satellite prime contractors.

The objective of the satellite catalog effort is the concise compilation of satellite capabilities and design parameters. The categories of data collected are

- Project and contractor identification
- Trajectory parameters
- Satellite design parameters
- Payload design parameters
- Launch date, site, vehicle identification
- Stabilization method
- Attitude control design parameters
- Attitude reference sensor design parameters
- Power source
- In-orbit propulsion functions
- Telemetry parameters
- Command parameters
- Tracking parameters
- Clock parameters.

The detailed list of data elements is discussed in Section III.C. It should be noted that at present only a few key sensor payload parameters have been included in the satellite catalog. As a part of future JPL data collection, the satellite catalog will be updated with data on the cost of satellite subsystems and components.

In concert with the satellite catalog preparation, the cataloging of design parameters of sensors was initiated. When it is completed, this sensor catalog will include sensors flown on satellites that are contained in the satellite catalog or that are under funded development for future programs.

A future phase of the JPL data cataloging effort will be the preparation of a science and application opportunities catalog. This effort will emphasize opportunities that have recognized economic, social, or scientific return. These opportunities include the exploration for, utilization of, and protection of Earth resources.

C. The BASIS Storage, Retrieval, and Analysis System

Battelle personnel developed a conceptual design of a computerized data base system to support satellite conceptual design during early option studies. This data base system design utilizes the capabilities of BASIS, a Battelle designed and developed information storage, retrieval, and analysis system. BASIS has been used in several hundred data base applications for dozens of governmental and private business organizations.

The BASIS system allows users to search large files of textual or numeric information by key words and phrases and by numeric value and range. The user does not need a knowledge of computers to successfully search the data base, retrieve selected information, and apply analysis procedures. Advantages of the utilization of BASIS to support the satellite catalog are the ability of the user to

- Create and maintain large and small data bases
- Combine textual and numeric information in the same data base
- Index the information by key words, key word phrases, numeric value, and numeric range
- Use a thesaurus to control vocabulary in the index
- Compute arithmetic expressions
- Analyze data statistically
- Plot data in a variety of user-specified formats
- Tabulate data in a variety of user-specified formats
- Specify tailored report formats

- Sort records by one or more data elements
- Provide customized user-computer dialog
- Monitor complete user-computer interaction for later analysis.

A more complete discussion of BASIS capabilities is provided in Section III.D.

II. OBJECTIVES

The objectives of this data base system planning task are:

- The conceptual design of an automated system to
  support the use of

  - the satellite catalog
  - the sensor catalog when it is completed
  - the science and application opportunities
    catalog when it is completed

- The recommendation of a plan for implementation of
  of the data base system

- The estimation of costs for development and operation
  of the system.

The automated data base system is to be used in conjunction with studies to
evaluate the cost effectiveness of future NASA missions. To support this goal,
the data base must be organized so that candidate satellite systems can be
selected based upon

- Demonstrated existing capabilities

- Flexibilities inherent in each satellite design
  that would allow additional capabilities without
  major redesign and/or requalification.

III. CONCEPTUAL SYSTEM DESIGN

As a prelude to the discussion of the results of the conceptual design of an automated data base system, the methodology used by Battelle personnel for system design will be addressed. Over the last 7 years, Battelle staff have acquired extensive experience in the analysis, evaluation, conceptualization, design, development, implementation, and operation of data base systems. The entire system development process is approached in a logical progression. This permits examination of necessary decisions and available alternatives and permits making each decision in full awareness of its interaction with, or effect upon, other elements of the system. Experience has indicated that a step-by-step approach is most likely to produce a coordinated, effective system that is responsive to user needs.

In designing a computerized data base system, Battelle personnel follow the general steps illustrated in the following discussion. Specific work elements are modified wherever necessary to meet the requirements of the project and to incorporate lessons learned. Some elements may be eliminated on the basis of knowledge already available to the sponsor or because certain sponsor requirements are already clearly identified. However, each element is commented upon to indicate Battelle's approach to that particular portion of the system design. The general system design steps are:

- Analysis of System Requirements

    - Definition of the User Group. The value of an automated
      data base system must be measured in terms of its ability
      to satisfy the needs of those who use it. Thus, first
      attention must be to the user group. Who are they and
      what information do they need? The answer to the first
      question is the definition of the user group. The primary
      user group is usually the sponsor staff which use the system
      to respond to inquiries, and most attention is devoted to
      its needs. However, the influences of the audiences and
      recipients of service should not be neglected. A review
      of the project sponsor organizational structure, objectives,
      and functions is also vital to definition of the system
      user group.

- Determination of User Needs. Once the identity of the user group is established, Battelle staff conduct a survey to determine the information needs of the user group. The most direct approach is to ask some or all of the users, by personal interview or questionnaire, what types of information they have needed in the past and anticipate needing in the future.

- Establishment of System Requirements. Battelle staff evaluate and analyze the results of the user-needs study to establish system requirements. These requirements are discussed with sponsor personnel to be certain that they are in keeping with present and anticipated policies and objectives of the sponsor. Particular note is taken of policies and objectives that may be subject to considerable change.

● Development of a System Design

- Definition of Required Coverage (Data Elements). The information needs of the user group provides the basis for determining the coverage of the system. Coverage is defined by a number of parameters, including (1) which specific scientific and technical subject areas will be included, (2) whether information (ideas) or data (unit facts) or both will be included, and (3) the level of work to be included (on-going and/or completed work). The aim is to select limits within which the system can provide broad coverage with maximum benefit to the greatest number of users.

- Identification and Examination of Appropriate Sources. Once the limits of coverage are defined, Battelle staff generate a list of specific sources from which the information could be acquired most efficiently. In most cases this would involve examination and evaluation of sources such as journals, books, patents, technical reports, correspondence, and design drawings.

- Definition of Types and Forms of Input Documents. This step in system design is aimed at summarizing the two previous steps to gain a clear picture of the variety of form and content of input documents required by the system.

- Establishment of Level and Types of Services Required. The services to be provided are established after user needs have been analyzed, and information coverage and sources are determined. Two distinct decisions are involved: selection of the types of services and the levels of service to be offered.

The user-needs study indicates the types of services required. That is, users would need either a current-awareness service or a retrospective-searching service or both. A current-awareness service keeps users abreast of current information. A retrospective-searching service stores information and allows retrieval of it in response to specific requests. The user-needs study also indicates the level of service users need. The levels of service provided by systems vary from simple document referral services to complex analysis. It is necessary to select a range of services that provides users with the information in the most usable form. If the level of service is subject to change, the widest anticipated range should be selected.

- Definition of System Functions. Once the level and types of services are specified, the necessary types and forms of system output are clear. Thus, it is possible to specify the functions involved in converting the input information into the output information and services. Some examples of typical functions performed by data base systems are acquisition, screening, abstracting, indexing, storage and retrieval, and analysis and synthesis of information and data.

- Specification of System Operations. This work element goes beyond the naming of functions to be performed to describe how the named functions should be performed. A major decision at this point is the selection of an appropriate indexing or classification system by which important ideas in the input documents are identified and reduced to index data. Document acquisition and input screening are other operations whose procedures must be specified at this stage of system design. In all cases, alternative methods available are weighted in terms of their compatibility with other elements of the system and their ability to meet the needs of the users.

- Selection of Storage Media. In general, the selection of storage media follows, and is dependent upon, the specification of system operations. In most operations, two things are stored: documents and index data. They may be stored together or separately, depending upon system requirements as well as the types of documents and index data involved. The typical media considered are: hardcopy, microfilm, and computer readable magnetic storage (tape and or disk).

- Provision for Monitoring and Accounting. Before a data
  base system can be considered complete, provision must
  be made for monitoring the system to maintain economic
  control and quality control. Monitoring also is essential
  to provide for evolutionary improvement of the system.
  The level of mechanization of the monitoring and accounting
  system should be determined by the level of mechanization
  of the storage systems. For a fully automated system,
  statistics such as indexing cost per document and number
  of searches per month can be registered and accumulated
  so that the sponsor is in a position to evaluate costs of
  installation and operation and the efficiency of the
  resulting services.

For the specific system design which is the subject of this planning
task, many of the above-mentioned design steps were not performed because early
design perogatives were exercised by JPL personnel. In these cases, a review of
such decisions was made by Battelle staff to assess the remaining design alter-
natives. Design steps for which prior decisions were made are

- Definition of the User Group - in setting of the objectives
  of the system, the JPL staff have indicated that the user
  group consists of satellite conceptual designers and
  mission planners.

- Definition of Required Coverage (Data Elements) - the
  contents of the data catalogs were determined by JPL staff
  before Battelle personnel started the planning task.

- Identification and Examination of Appropriate Sources - the
  source of data, the satellite prime contractors, was deter-
  mined by JPL staff when the satellite cataloging effort was
  initiated.

- Determination of Types and Forms of Input Documents - the
  initial data collection form was designed by JPL staff; a
  revised form was submitted by a satellite prime contractor.

- Establishment of Level and Types of Services Required - in
  setting of the objectives of the system, the JPL staff
  determined that retrospective searching is the type of
  service required and that the level of service required
  ranges from catalog referral to complex mathematical analysis.

- Selection of Storage Media – by limiting the
  conceptual design alternatives to an automated data
  base that can be utilized in interactive mode, the
  scope of this planning task has essentially pre-
  determined magnetic disk storage as the only viable
  medium for storage of the catalog and index data.

A summarization of the results of the design steps is provided in Figure 1. For the above-mentioned predetermined steps, little additional discussion is provided in this report. The rest of this section summarizes the results of the performance of the remaining design steps:

- Determination of user needs
- Establishment of system requirements
- Design of data base structure
- Assessment of the BASIS system capabilities for support requirements
- Discussion of system requirements not supported by BASIS
- Design of special output displays (tables and graphs).

FIGURE 1. SUMMARY OF THE CONCEPTUAL SYSTEM DESIGN RESULTS

System Design Step	Report Reference	Summary of Results
Analysis of System Requirements		
Definition of the User Group	Section III.A.	The data base system users are the personnel of NASA Headquarters and Research Centers who are: • Performing satellite conceptual design • Evaluating the cost effectiveness of future NASA missions.

Determination of User Needs	Section III.A.	The study has determined that:
		
		• Data base information display is needed in a variety of formats
		• Data base searching is needed for
		  – Satellite capability search mode
		  – Satellite design search mode
		  – Satellite subsystem supplier search mode
		• User oriented dialog for interaction with the data base system is needed.

Establishment of System Requirements	Section III.B.	The data base system requirements are the capabilities for • Data base creation and maintenance • Selective (tabular and graphical) display of satellite catalog information • Search by gross (Level 1) capability categories (capability search) • Search by gross (Level 1) design parameters (design search) • Search by detailed (Level 2) capability categories • Search for subsystem suppliers by detailed (Level 2 and 3) capabilities • Tabular display of requested capability or design parameter information • Graphical display (on both teletype compatible and graphic terminals) of design parameter data • Utilization of cost estimating relationships in simple computational statements and in complex mathematical or statistical methodologies.

FIGURE 1. SUMMARY OF THE CONCEPTUAL SYSTEM DESIGN RESULTS (CONTINUED)

System Design Step	Report Reference	Summary of Results
Development of a System Design		
Definition of Required Coverage (Data Elements)	Appendix F	A satellite catalog, prepared by JPL staff, covered all Earth orbital satellites funded to the hardware stage for launch between 1970 and 1980. Assistance with data collection was provided by personnel of satellite prime contractors. The categories of data collected are: ● Project and contractor identification ● Trajectory parameters ● Satellite design parameters ● Payload design parameters ● Launch date, site, vehicle identification ● Stabilization method ● Attitude control design parameters ● Attitude reference sensor design parameters ● Power Source ● In-orbit propulsion functions ● Telemetry parameters ● Command parameters ● Tracking parameters ● Clock parameters.
Identification and Examination of Appropriate Sources	Section I.B.	The satellite catalog is being compiled by JPL staff with the assistance of satellite prime contractor personnel. The data source is thus satellite prime contractor design documents.
Definition of Types and Forms of Input Documents	Appendix C Appendix D	Two formats of data collection forms were identified: ● The JPL designed form ● The revised form submitted by a satellite prime contractor.

FIGURE 1. SUMMARY OF THE CONCEPTUAL SYSTEM DESIGN RESULTS (CONTINUED)

System Design Step	Report Reference	Summary of Results
Establishment of Level and Type of Services	Section III.B.	The type of service required is a retrospective-searching capability. The level of service required ranges from simple catalog referral to complex mathematical analysis.
Definition of System Functions	Section III.B.	The system functions are to provide information storage, retrieval, analysis, and output display in specially designed formats such as data tables and plots.
Specification of System Operation	Section III.B., C., D.	Information storage and retrieval functions are to be performed by the BASIS system utilizing the inverted file indexing technique. Specialized output displays are to be provided by the tabular formatting and plotting capabilities of the BASIS system.
Selection of Storage Media	Section III	Magnetic disk storage is required for delivery of services in an interactive mode.
Provision for Monitoring and Accounting	Section III.D.3	Monitoring and accounting of system usage is required to maintain economic control and quality control of the system and to provide guidance for evolutionary improvement of the system.

A. Determination of User Needs

The determination of data base system user needs was not made in the customary manner of interviewing the user group. The user group was defined via task objectives in only a general sense. The data base system users are the personnel of NASA Headquarters and Research Centers who are

- Performing satellite conceptual design
- Evaluating the cost effectiveness of future NASA missions.

With such a general user group definition, no attempt to interview prospective users was made. Rather, an initial determination of user needs was based upon conversations with Mr. Robert Nagler of JPL. As a result of these conversations, Mr. Nagler outlined his perception of searching, display, and analysis functions needed by the data base system user. This detailed list of functions is attached to this report as Appendix B. After additional analysis of the objectives of the data base system and of the services it should deliver, the user needs were categorized as:

- Data base creation and updating capabilities are needed to maintain the currency and accuracy of the data catalogs.

- Interactive time-shared access to the data base is needed to perform the functions of satellite conceptual design and cost effectiveness analysis.

- Catalog information needs to be selectively displayed; options to be selected by the user are the level of detail and the categories of data desired.

- Data base searching modes are needed for
    - Satellite capability
    - Satellite design parameters
    - Satellite subsystem supplier.

- Catalog information needs to be appropriately indexed to support the searching modes; indexing is needed by
    - Key words
    - Key word phrases
    - Data values
    - Data value ranges.

- Tabulation of data is needed in a variety of user-specified formats.

- Plotting of data is needed in a variety of user-specified formats.

- Analytical capabilities are needed to specify arithmetic expressions and to statistically analyze data.

- Customized, user-oriented dialog is needed for the user-system interface.

- Monitoring of system usage is needed to provide evolutionary improvement of the system.

The data base system requirements to support these categories of user needs will be discussed in the next part of this section.

B. Establishment of System Requirements

In order to establish requirements for a data base system, the following system design criteria were utilized:

- The system development and operating cost should be minimized.

- The system implementation time should be minimized.

- The system should be implementable on a wide variety of computer vendor hardware systems.

- Full support of user needs should not be sacrificed to achieved the other design criteria.

One of the initial design decisions was to utilize a commercially available data base storage and retrieval system. The advantages of utilization of an existing system over the design and development of a new system are

- The investment of time and money is minimized.

- A state-of-the-art system is obtained.

- Continuing support and enhancement of the system is available from the vendor.

- From the large number of commercially available systems, one can usually be chosen that satisfies the system design criteria.

A brief survey of commercially available storage and retrieval systems indicated several candidates. Of these candidate systems, the BASIS system offers the widest range of needed capabilities in addition to information storage and retrieval. Some of these capabilities are:

- Versatile data tabulation
- User-formatted data plotting
- Arithmetic expression evaluation
- Statistical analysis procedures
- Record sorting by data elements

- Customized user-computer dialog
- Tutorial procedures
- Complete user-computer interaction monitoring
  for later analysis.

A more complete description of the BASIS system capabilities is provided in Section III.D.

The data base system requirements to be established were categorized according to

- Hardware requirements
- Software requirements
- Personnel requirements.

Since this planning task is to provide a conceptual system design, the system requirements have not been determined to the detail of hardware model numbers or personnel job descirptions.

To support an interactive, time-shared data base system, the following basic hardware elements are required:

- A time-sharing computer central processor

- Input-output devices such as
  - Card readers/punches
  - Magnetic tape readers
  - Terminals (teleprinters or graphic displays)
  - Auxilliary devices (optical character recognition,
    OCR, and computer output microfilm, COM, equipment)

- Storage media such as
  - Disk packs
  - Mass storage.

The data base of satellite information will be accessed by users at many geographical locations such as NASA Headquarters and Research Centers. Thus, the following additional hardware is required:

- Telecommunications service (either analog or digital)
- Modems or multiplexors.

The specific determination of hardware requirements should be made at the time that the conceptual design is implemented. Factors which will influence hardware specifications are

- The number of simultaneous users to be serviced
- The response time desired by users
- The amount of information to be stored
- The geographic distribution of the users.

A discussion of the optimal choice of hardware for any specific set of factors is beyond the scope of this report.

The prime software requirement is the BASIS system. To support implementation of the BASIS system, a FORTRAN compiler and a time-sharing operating system are required. BASIS can be implemented using a wide variety of compilers and operating systems supplied by the computer vendor. For example, BASIS is currently operational on Control Data, Univac, Digital Equipment Corporation, Xerox, and International Business Machine products.

Personnel requirements are minimal for the data base system since it will utilize BASIS. Software maintenance is provided by Battelle. Only the data management team need be at the computer site. The data management team usually consists of the project supervisor, a computer systems analyst, and a keypunch operator. It is anticipated that for support of the catalog of satellite data, the updating activity will be slight. Thus, only part time involvement by the team is required to operate the data base system.

In addition to the above-mentioned hardware, software, and personnel requirements, the data base system must provide specific capabilities to support the needs of the system users. These capabilities include (a) data base creation and maintenance, (b) selective (tabular and graphical) display of satellite catalog information, (c) search by gross (Level 1) capability categories (capability search), (d) search by gross (Level 1) design parameters (design search), (e) search by detailed (Level 2) capability categories, (f) search for subsystem suppliers by detailed (Level 2 and 3) capabilities, (g) tabular display of requested capability or design parameter information, (h) graphical display (on both teletype compatible and graphic terminals) of design parameter data, and

(i) utilization of cost estimating relationships in simple computational state-
ments and in complex mathematical or statistical methodologies. A detailed
list of Level 1 and Level 2 capability and design parameter information to be
used for search criteria for items (c) through (g) is provided in Appendix B.

C. Design of Data Base Structure

The initial data collection form, excerpts of which are illustrated in Figure 2, shows the data elements sought by JPL staff in their initial efforts to have satellite prime contractors provide satellite design parameter characteristics. In response to the request for data, one satellite prime contractor redesigned the data collection form to include more detailed data on telemetry, tracking, and command. Excerpts of the revised data collection form are illustrated in Figure 3. The entire data collection forms from which Figures 2 and 3 were excerpted are attached as Appendixes C and D.

After studying the initial and revised data collection forms (Appendices C and D), the individual data elements to be stored in the satellite catalog data base were defined and a new revision of the data collection was proposed. This proposed composite data collection form, excerpts of which are shown in Figure 4, is actually a merger of data elements from the earlier versions of the data collection form. However, it differs greatly in appearance because some composite data elements were separated into several individual data elements. For example, "Design Trajectory" was separated into "Trajectory Altitude", "Trajectory Inclination", "Trajectory Eccentricity", and "Trajectory Period". The entire proposed composite data collection form is attached as Appendix E.

The results of the detailed specification of the individual data elements are illustrated in Figure 5. The full list of data base field specifications are attached as Appendix F. This detailed specification constitutes the major portion of the data base file design. The remaining specifications of the file structure are the default settings for options available to the user of the data base during record retrieval and information display operations. These remaining specifications are not shown in this report.

The detailed data element specifications were designed so that they could be easily modified should testing of the prototype data base indicate a need for refinement of specifications. Thus, the fields, or data elements, were numbered with vacancies left for future use. The meaning of the number and letter codes in the columns in Figure 5 have the following meaning:

FIGURE 2. EXCERPTS·FROM THE INITIAL JPL DESIGNED
DATA COLLECTION FORM*

SATELLITE INFORMATION FILE

Data Element:	Sample Data:
Program Name	Civilian Meteorology/Defense Meteorology(DMSP)
Program Sponsor·	NOAA-NASA/DoD
Project Name	TIROS, ITOS, SMS/Block 5D-1
Project Manager	NESS-GSFC/Air Force
Prime Contractor	RCA, RCA, Philco-Ford/RCA
Sensor Type	Passive V&IR/Passive $\mu\omega$/F&P/X-ray
Sensor Acronyms	
Launch Date(s)	
In-Flight Experience (Yrs.)	
Design Life (Goal, Expendables Sized) (Yrs.)	
Trajectory Class	Polar/Sun Sync/Geostationary/Geosync/Elliptical
Design Trajectory (Periapsis Altitude, Inclination, Eccentricity, Period) (km, Deg., Min.)	

Data elements omitted

Payload Data Production Rate(s) (b/s)	
Telemetry Data Rate(s) (b/s)	
Telemetry Link Characteristics (Frequency, Bandwidth, RF Power, Coding, Modulation) (GHz, MHz, W)	VHF: .139, .01, 6, Convolution, RZ PCM PSK/S-Band: 2.300, .1, 20, Block, PCM FSK
Telemetry Transmitter Technology	TWT/Solid State
Telemetry Transmitter Manufacturer	

Data elements omitted

Data Storage (Type, Number, Capacity, Record Rates, Playback Rates) (b, b/s)	Tape/Solid State/Bubble/Film, #, $10^6/10^8/10^9/10^{10}$, 25k/500k
Data Storage Manufacturer	

Data elements omitted

*The complete data collection form is attached as Appendix C.

FIGURE 3. EXCERPTS FROM THE REVISED DATA COLLECTION FORM
SUBMITTED BY A SATELLITE PRIME CONTRACTOR*

SATELLITE INFORMATION FILE

Data Element: Sample Data:

Program Name   OSO

Program Sponsor

Project Name   OSO - I

Project Manager

Prime Contractor   Hughes Aircraft Co.

   Sensor Experience   Multichan. UV/Vis Spec., Cosmic X-Ray Spec., Soft
                             X-Ray, Crystal Spec. Polarimeter, High Energy
                             Celestral X-Ray, Mapping X-Ray Heliometer

   Sensor Acronyms

   Launch Date(s)   1975

   In-Flight Experience (Yrs.)

   Design Life (Goal,
     Expendable Sized) (Yrs.)   1 Yr.

Trajectory Class   160 km. 30°, 0, 100 min

Design Trajectory (Periapsis
  Altitude, Inclination,
  Eccentricity, Period)
  (km, Deg., Min.)

Data elements omitted

Telemetry

   Ground system compatibility   NASA/GSFC
     (NASA/GSFC, Aerospace
     Standards, SGLS, etc.)

   Channel capacity (No. of
     Channels)

   Channel type (analog,
     digital, bi-level)

   Data rate or baseband (Hz)   6.4 kbps RT, 128 kbps stored data

   Data source encoding type   8 bit PCM, Manchester coded
     (PCM, ΔMOD)

   Channel encoding type
     (convolutional, etc.)

   Subcarrier frequency, if
     used (Hz)

   Subcarrier modulation,
     technique (FSK, PSK, etc.)

*The complete data collection form is attached as Appendix D.

FIGURE 3. EXCERPTS FROM THE REVISED DATA COLLECTION FORM
SUBMITTED BY A SATELLITE PRIME CONTRACTOR (CONTINUED)

Data Element:

Sample Data:

Data/subcarrier modulation
index (radians, etc.)

Carrier frequency (MHz)   136.92 MHz-real time; 2212.5 MHz-stored data

Carrier stability (± Hz)

Carrier modulation   PM
technique (PM, FM, etc.)

Subcarrier/carrier   S-Band: 1 radian; VHF: 1.44 radian
modulation index
(radians, etc.)

Transmitter RF level, tol.   1 W VHF, 1 W S-Band
(watts, ± watts)

Transmitted EIRP, tol.
(dBm, ± dB)

Occupied RF bandwidth (MHz)

Telemetry subsystem concept
(centralized, data bus,
etc.)

Storage capabilities   Not reprogrammable, tape recorder (1), 8.6×10^{7}
(medium, data bits,   bits. PB @ 128 kbps
programmable, etc.)

Telemetry subsystem   Hughes/EMM/Opetics
manufacturers

Data elements omitted

FIGURE 4.   EXCERPTS FROM THE PROPOSED COMPOSITE DATA COLLECTION FORM*

FIELD TITLE	FIELD
Ident	
Accession Number	2
File Name	3
Subfile Name	4
Program	5
Program Name	7
Program Sponsor	8
Project	9
Project Name	10
Project Manager	11
Prime Contractor(s)	12
Prime Contractor	14
Prime Contractor	15
Prime Contractor	16
Trajectory	17
Trajectory Class	20
Trajectory Altitude	21
Trajectory Inclination	22
Trajectory Eccentricity	23
Trajectory Period	24
	25

Fields omitted

FIELD TITLE	FIELD
Data Rate, Payload Prod.	230
Data Rate, Payload	231
Telemetry	240
Telemetry Identification	241
Tele Ground Sys Compatbility	242
Tele Sys Concept	243
Tele Sys Mfgr	244
Tele Sys Storage	246
Tele Sys Storage Type	247
Tele Sys Storage Quantity	248
Tele Sys Storage Capacity	249
Tele Sys Storage Record Rate	250
Tele Sys Storage Playback Rate	251
Tele Sys Storage Programblty	252
Tele Sys Storage Mfgr	253
Tele Data Rate	255
Tele Digital Data Rate	256
Tele Analog Baseband	257

FIELD TITLE	FIELD
Tele Carrier	260
Tele Carrier Frequency	261
Tele Carrier Freq Range Min	262
Tele Carrier Freq Range Max	263
Tele Carrier Stability	264
Tele Carrier Bandwidth	265
Tele Carrier Modulation Tech	266
Tele Data Coding Tech	267
Tele Data Coding Tech (1)	268
Tele Data Coding Tech (2)	269
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Tele Subcarrier Modul (1)	295
Tele Subcarrier Modul (2)	296
Tele Subcarrier Modul (3)	297
Tele Subcarrier Modul (4)	298
Tele Sub/Carrier Index	299
Tele Channel	300
Tele Channel Type (1)	301
Tele Channel Type (2)	302
Tele Channel Type (3)	303
Tele Channel Type (4)	304
Tele Channel Capacity (1)	305
Tele Channel Capacity (2)	306
Tele Channel Capacity (3)	307
Tele Channel Capacity (4)	308
Tele Channel Coding Tech	309

Fields omitted

*The complete data collection form is attached as Appendix E.

FIGURE 5. EXCERPTS FROM THE SATELLITE CATALOG DATA ELEMENT SPECIFICATIONS*

Level	Category Code	Class	Index	Search Level	Design Level	Field	Field Mnemonic	Field Title
0	00.	M				2	IDENT	Ident
1	00.1	I	I			3	ACC	Accession Number
1	00.2	S	I			4	FILE	File Name
1	00.3	S	I			5	SUBFILE	Subfile Name
0	01.	M				7	PROGRAM	Program
1	01.1	S	I	C1		8	PROG	Program Name
1	01.2	S	I	C1		9	SPONSOR	Program Sponsor
0	02.	M				10	PROJECT	Project
1	02.1	S	I	C1		11	PROJ	Project Name
1	02.2	S	I	C1		12	MANAGER	Project Manager
0	03.	M				14	PRIME	Prime Contractor(s)
3	03.1.1.1	S	I	C1		15	PRIME1	Prime Contractor
3	03.1.1.2	S	I	C1		16	PRIME2	Prime Contractor
3	03.1.1.3	S	I	C1		17	PRIME3	Prime Contractor
0	04.	M				20	TRAJECTORY	Trajectory
1	04.1	S	I	C1	D1	21	TRAJC	Trajectory Class
2	04.1.1	R	N			22	TRAJA	Trajectory Altitude
2	04.1.2	R	N			23	TRAJI	Trajectory Inclination
2	04.1.3	R	N			24	TRAJE	Trajectory Eccentricity
2	04.1.4	R	N			25	TRAJP	Trajectory Period

Fields omitted

Level	Category Code	Class	Index	Search Level	Design Level	Field	Field Mnemonic	Field Title
0	13.	M				230	DATARATE	Data Rate, Payload Prod.
1	13.1	R	R	C1	D1	231	DRP	Data Rate, Payload
0	14.	M				240	TELEMETRY	Telemetry
1	14.1	M				241	TIDENT	Telemetry Identification
2	14.1.1	S	N			242	TGSC	Tele Ground Sys Compatibility
2	14.1.2	S	N			243	TSC	Tele Sys Concept
3	14.1.2.1	S	N			244	TSM	Tele Sys Mfgr
1	14.2	M				246	TSSTORAGE	Tele Sys Storage
2	14.2.1	S	N			247	TSST	Tele Sys Storage Type
2	14.2.2	I	N			248	TSSQ	Tele Sys Storage Quantity
2	14.2.3	R	N			249	TSSC	Tele Sys Storage Capacity
2	14.2.4	R	N			250	TSSRR	Tele Sys Storage Record Rate
2	14.2.5	R	N			251	TSSPR	Tele Sys Storage Playback Rate
2	14.2.6	S	N			252	TSSP	Tele Sys Storage Programblty
3	14.2.6.1	S	N			253	TSSM	Tele Sys Storage Mfgr
1	14.3	M				255	TDATARATE	Tele Data Rate
2	14.3.1	R	R	C1		256	TDDR	Tele Digital Data Rate
2	14.3.2	R	R	C1		257	TABB	Tele Analog Baseband
1	14.4	M				260	TCARRIER	Tele Carrier
2	14.4.1	R	R	C2		261	TCF	Tele Carrier Frequency
2	14.4.2	R	R	C2		262	TCFMIN	Tele Carrier Freq Range Min
2	14.4.3	R	R	C2		263	TCFMAX	Tele Carrier Freq Range Max
2	14.4.4	R	N			264	TCS	Tele Carrier Stability
2	14.4.5	R	N			265	TCB	Tele Carrier Bandwidth
2	14.4.6	S	N			266	TCMT	Tele Carrier Modulation Tech
1	14.5	M				267	TCODING	Tele Data Coding Tech
2	14.5.1	S	I	C2		268	TDCT1	Tele Data Coding Tech (1)
2	14.5.2	S	I	C2		269	TDCT2	Tele Data Coding Tech (2)
2	14.5.3	S	I	C2		270	TDCT3	Tele Data Coding Tech (3)
2	14.5.4	S	I	C2		271	TDCT4	Tele Data Coding Tech (4)
1	14.6	M				275	TPOWER	Tele Transmitter RF Power
2	14.6.1	R	R	C2		276	TTRFL	Tele Transmitter RF Level
2	14.6.2	R	R	C2		277	TTRFLT	Tele Transmitter RF Tolerance
2	14.6.3	R	R	C2		278	TTEIRP	Tele Transmitted EIRP
2	14.6.4	R	R	C2		279	TTEIRPT	Tele Transmitted EIRP Tol.
1	14.7	M				290	TSCARRIER	Tele Subcarrier
2	14.7.1	R	N			291	TSCF1	Tele Subcarrier Freq (1)
2	14.7.2	R	N			292	TSCF2	Tele Subcarrier Freq (2)
2	14.7.3	R	N			293	TSCF3	Tele Subcarrier Freq (3)
2	14.7.4	R	N			294	TSCF4	Tele Subcarrier Freq (4)
2	14.7.5	S	N			295	TSCM1	Tele Subcarrier Modul (1)
2	14.7.6	S	N			296	TSCM2	Tele Subcarrier Modul (2)
2	14.7.7	S	N			297	TSCM3	Tele Subcarrier Modul (3)
2	14.7.8	S	N			298	TSCM4	Tele Subcarrier Modul (4)
2	14.7.9	R	N			299	TSCMI	Tele Sub/Carrier Index

*The complete data element specifications form is attached as Appendix F.

FIGURE 5. EXCERPTS FROM THE SATELLITE CATALOG DATA ELEMENT SPECIFICATIONS (CONTINUED)

Level	Category Code	Class	Index	Search Level	Design Level	Field	Field Mnemonic	Field Title
1	14.8	M				300	TCHANNEL	Tele Channel
2	14.8.1	S	N			301	TCT1	Tele Channel Type (1)
2	14.8.2	S	N			302	TCT2	Tele Channel Type (2)
2	14.8.3	S	N			303	TCT3	Tele Channel Type (3)
2	14.8.4	S	N			304	TCT4	Tele Channel Type (4)
2	14.8.5	R	N			305	TCC1	Tele Channel Capacity (1)
2	14.8.6	R	N			306	TCC2	Tele Channel Capacity (2)
2	14.8.7	R	N			307	TCC3	Tele Channel Capacity (3)
2	14.8.8	R	N			308	TCC4	Tele Channel Capacity (4)
2	14.8.9	R	N			309	TCCT	Tele Channel Coding Tech

Fields omitted

- Level: The initial JPL designed data collection form was organized as a hierarchy of data elements; the level indicated in Figure 5 is the level of that data element hierarchy with level 0 serving as group identifier.

- Category Code: The category code is an indenture level coding of the 17 groups of data element hierarchies. The numbering of the indenture level is in correspondence with the level code.

- Class: The data element class indicates the manner in which the data element will be used in the data base and displayed during output requests. The class codes are:

  - M: A map field which points to a group 'of fields to be displayed by an output request.

  - S: A string or textual field which will be displayed left justified and broken at whole words for multiple lines of output.

  - I: An integer field that can be used in integer or floating point arithmetic expressions by the BASIS computational package and the statistical and modeling programs.

  - R: A real or floating point field that can be used in arithmetic expressions by the BASIS computational package and the statistical and modeling programs.

- Index: Each data element has been analyzed for the necessity of indexing to be used for record retrieval. The index codes are:

  - N: Not indexed

  - I: Indexed as a term that will be included in the inverted index file

  - R: Range indexed; numeric data elements can be searched by a retrieval request for all records containing a data element in a specified range.

- Search Level: The search level code indicates by a C1 or C2 the data elements that are designed to be used for satellite capability searching at level 1 or level 2.

- Design Level: The design level code indicates by a D1 or D2 the data elements that are designed to be used for satellite design searching at level 1 or level 2.

- Field: The field number is a numeric tag to identify each of the individual data elements that make up a data base record.

- Field Mnemonic: The field mnemonic is a textual tag to be used in BASIS computational expressions or in requests for display of data elements.

- Field Title: The field title is the identifier that will be printed by the BASIS output programs when the display of a field is requested.

The modes of searching the satellite catalog data base and the modes of use of data elements in computational expressions or in display requests is described in the next part of this section, BASIS System Capabilities.

D. BASIS System Capabilities

As discussed in Section III.B., the conceptual design of the data base system is founded on the utilization of the BASIS system. The BASIS system is an interactive, conversational system to be used on a time-sharing computer; it can also be used in batch mode.

The storage and retrieval capability of BASIS allows users who are not necessarily knowledgeable in computer programming to search large files. BASIS is a modular system that also allows the user to perform data analysis and data base management tasks. The BASIS system and data base files are operated and maintained on a 19 hour day on Battelle's CDC 6400 computer. Users may be located throughout the United States. Access to Battelle's computer is via standard telephone dial-up service or via a communication network for long distance economy.

In addition to Battelle's installation, BASIS has been installed at many sponsor organizations within the U.S. and several foreign countries. BASIS is operational on five different vendor computers: CDC 6000 series, UNIVAC 1108, SIGMA 9, DEC 10, and IBM 360, 370 series computers.

The BASIS system is similar in many respects to other on-line storage and retrieval systems. However, it provides a wide range of additional capabilities:

- Combined textual and numeric data retrieval and analysis
- On-line mathematical expression evaluation and statistical analysis
- Ability to execute external programs (OWNCODE) from BASIS
- Saved user procedures - PROFILE
- On-line sort
- On-line report generator
- On-line graphics (including storage tube and bidirectional terminals)
- On-line modeling
- Complete system interaction monitoring
- User aids and tutorial procedures
- On-line thesaurus
- Extremely fast retrieval for small and large files
- Sophisticated file creation and maintenance packages (including the ability to easily update very large files).

As indicated, an organization may choose to implement their data base files on Battelle's computer or acquire BASIS to operate on their own computer. Organizations selecting BASIS for implementation on their computer are always given close personal assistance by qualified individuals. This assistance includes:

- A determination of the organization's overall information needs
- Assistance in creating files
- Training of users
- Development of user guides
- Training of the data manager
- Training of systems programmers in the use of BASIS software
- Provision of documentation that includes source code listings of all BASIS modules.

An organization can choose to maintain BASIS with internal staff or have Battelle provide this support.

Careful design attention has been paid to insuring both the portability and modifiability of all BASIS software. Battelle is committed to an ongoing development of system capabilities. Users can be assured that BASIS will remain a state-of-the-art system and that its continued evolution will not render existing applications obsolete. Users who have chosen to install BASIS on their own computer do so with the knowledge that a change of computers, even to that of another vendor, will not require the complete redesign of the data base.

1. The BASIS Storage and Retrieval Module

The core system utilized by BASIS is the Storage and Retrieval Module, a highly sophisticated user oriented system widely known for its speed, flexibility, and ease of operation. The BASIS document file consists of unit records composed of data elements (or fields) of variable length and may have repeated occurrences. The specification of the data fields for the satellite catalog was described in Section III.C. A unique accession number is assigned as the

logical address of each record. BASIS index and range files use the accession number to reference the occurrence of key words, key word phrases, data values, and data value ranges.

BASIS is an interactive, conversational system which continually prompts the user and provides diagnostic messages. Requests to the storage and retrieval module fall into classes:

- Retrieval requests
- System commands.

Retrieval requests may utilize either the inverted index or the sequential search capability.

The Storage and Retrieval Module permits a random nonhierarchical search strategy. This offers a high degree of freedom in pursuing a complex, changing search strategy. An alternate hierarchical mode can be set on or off by the user at any time during the search session. Each retrieval request is entered one search key at a time. A retrieval request is one of two types:

- Index Term: A search key or term is a string of characters entered from the terminal requesting the set of records that contain that specific value. Index terms or keys are items of data, either text words or numeric data points or ranges. An index is constructed for these terms in a prespecified manner. Index terms and their corresponding accession numbers are compiled at file creation or update into an inverted index. This permits extremely fast retrieval of records having a single index term or Boolean combinations of terms, which may include general numeric data ranges. Access to the index is through a term entered by the user. In addition, records may be searched sequentially.

- Boolean Logic: BASIS assigns ascending line numbers as reference tags for retrieved record sets. Boolean logic statements may be utilized to combine these sets in a complex manner. Boolean operators used in this process include:
  - AND (abbreviated as A)
  - OR (abbreviated as O)
  - AND NOT (abbreviated as A N).

A list of index terms for the prototype satellite catalog data base is attached as Appendix G.

A sample BASIS search and retrieval is shown in Figure 6. This sample search illustrates

- Index term entry (e.g., TRAJC:LOW EARTH ORBIT as shown for line 11 of the sample search)

- Stem search entry: a stem request can be used without the index term limit parameter (e.g., PROJ:* as shown for line 1 of the sample search) or with an index term limit (e.g., PIF:*6 as shown for line 5 of the sample search)

- Stem selection options (e.g., ALL as shown for line 1; a group such as A TO D and G TO I as shown for lines 2 and 3 respectively; or enumeration of selected terms such as E,F as shown for line 2)

- Range term entry (e.g., PSPEOL:LT 200 as shown for line 8); ranges may be specified using:
  - LT for less than
  - LE for less than or equal
  - GT for greater than
  - GE for greater than or equal
  - EQ for equal
  - NE for not equal
  - TO for an inclusive range

- Boolean logic entry (e.g., (2 OR 3) as shown for line 4 or (10 AND 11) as shown for line 12).

To supplement the highly interactive inverted file search capability, BASIS provides a sequential file searching capability. There are three major benefits in the use of sequential searching:

- The ability to search record entries not specifically indexed

- The reduction in amount of disk storage needed for index files (since the sequential search need not rely on the BASIS index file for all search information)

- The ability to perform complex searches requiring more sophisticated character masking than possible with inverted file searching.

The component phrases of the sequential search request have the following syntax:

[field specification][relational operator][search term]...[search term].

FIGURE 6.   SAMPLE BASIS SEARCH AND RETRIEVAL

```
BATTELLE INTERCOM 4.5
DATE  11/29/76
TIME  22.07.59.

PLEASE LOGIN
LOGIN,SEASAT,TEST,SUP,X

COMMAND- BASIS,RUN,BASIS3,CLAYDON,SEASAT
              B A S I S

ENTER YOUR REQUESTS ONE AT A TIME

....................SAMPLE SEARCH..........
........................STEM SEARCH.......
   1/ PROJ:*


   .ITEMS.     TERM
A       2   PROJ:ANIK 2
B       1   PROJ:COMSAT
C       1   PROJ:GMS
D       1   PROJ:INTELSAT IV
E       1   PROJ:JAPANESE GEOSTATIONARY METEOROLOGICAL SATEL
F       1   PROJ:MARISAT
G       1   PROJ:ORBITING SOLAR OBSERVATORY
H       1   PROJ:OSO 1
I       2   PROJ:WESTAR
END OF TERMS WITH YOUR STEM
ENTER LETTERS TO BE COMBINED,
SEPARATED BY COMMAS, OR ALL
.........................SAMPLE ENTRIES...
   1/ ALL
        6 ITEMS
SELECT TERMS, OR ENTER YOUR REQUEST
   2/ A TO D,E,F
        5 ITEMS
SELECT TERMS, OR ENTER YOUR REQUEST
   3/ G TO I
        3 ITEMS
SELECT TERMS, OR ENTER YOUR REQUEST
.........................BOOLEAN LOGIC TERMS..
   4/ ( 2 OR 3 )
        6 ITEMS
.........................STEM WITH LIMIT..
   5/ PIF:*6


   .ITEMS.     TERM
A       5   PIF:APOGEE BOOST
B       2   PIF:ATTITUDE ADJUST
C       2   PIF:ATTITUDE ADJUSTMENT
D       1   PIF:ATTITUDE CONTROL
```

FIGURE 6.   SAMPLE BASIS SEARCH AND RETRIEVAL
(CONTINUED)

E   1 PIF:INITIAL SPIN-UP ADJUSTMENT
F   1 PIF:INITIAL SUN ACQUITION
ENTER MORE TO CONTINUE TERM LIST
ENTER LETTERS TO BE COMBINED,
SEPARATED BY COMMAS, OR ALL
   5/ ALL
          6 ITEMS
SELECT TERMS, OR ENTER YOUR REQUEST
   6/ MORE

   .ITEMS.   TERM
A   1 PIF:ORBIT ADJUST
B   2 PIF:ORBIT ADJUSTMENT
C   1 PIF:ORBIT CONTROL
D   1 PIF:SPIN AXIS ORIENTATION
E   1 PIF:SPIN SPEED CONTROL
END OF TERMS WITH YOUR STEM
ENTER LETTERS TO BE COMBINED,
SEPARATED BY COMMAS, OR ALL
   6/ ALL
          5 ITEMS
SELECT TERMS, OR ENTER YOUR REQUEST
   7/ (2 OR 3)
          6 ITEMS
   8/ RESET
DO YOU WANT TO RESET SOME LINES?
   / NO
WHAT DO YOU WANT TO SET THE LINE NUMBER TO?
   / 7
   7/ END*RESET
ENTER YOUR REQUEST
   7/ (5 OR 6)
          6 ITEMS
.....................RANGE TERMS..........
   8/ PSPEOL:LT 200
          0 ITEMS
   9/ PSPEOL:200 TO 400
          4 ITEMS
  10/ PSPEOL:GT 400
          2 ITEMS
.....................INDEX TERM..........
  11/ TRAJC:LOW EARTH ORBIT
          1 ITEM
  12/ (10 AND 11)
          1 ITEM

Search terms may be literals containing actual values to be used in the search, data elements or portions of data elements, or literals in which some characters are not to be matched. This variety of search term forms gives the user an extremely flexible tool with which he may compare fields within documents, compare fields with actual data values, or compare fields with string patterns in which selected characters are to be matched. He may also specify where patterns must occur in the data element in order for the document to be selected. The relational operators available for use in sequential searching are:

EQ, IS, comma(,), or blank	— equal (universal match of characters may be specified by $ or ?; i.e., PIF EQ "ADJ"??? will match the appearance of "ADJUST" in field PIF)
NE, NOT	— not equal
GT	— greater than
LT	— less than
GE	— greater than or equal
LE	— less than or equal
BT	— between, endpoints included
BX	— between, endpoints excluded
AB	— data element absent
PR	— data element present
SCAN	— looks for one or more search terms anywhere in the data element
PREFIX, STEM	— tests the first characters of a data element and ignores the remainder
SAME SENTENCE	— same as SCAN except search terms must appear in the same sentence
$\begin{cases} W = n \\ \quad < n \\ \quad > n \end{cases}$	— tests the number of words separating two search terms where n is an integer (when n is zero, the search terms must be adjacent).

A sample sequential file search is shown in Figure 7. This sample illustrates

- Sequential search specifications: the specifications are initiated by the system command SEARCH SEQUENTIAL and are terminated by a BASIS command (e.g., ABORT is shown in the sample as the specification terminator); each specification is provided a unique tag by BASIS

FIGURE 7.   SAMPLE BASIS SEQUENTIAL SEARCH AND RETRIEVAL

.....................SAMPLE SEQUENTIAL SEARCH.....
.........................SEARCH SPECIFICATIONS...
 13/ SEARCH SEQUENTIAL
ENTER SEQUENTIAL SEARCH SPECIFICATION
 A1 /ACJG IS "NITROGEN"
 A2 /ABORT
ENTER YOUR REQUEST
 13/ SEARCH SEQUENTIAL
ENTER SEQUENTIAL SEARCH SPECIFICATION
 B1 /PROPULSION SCAN "ATTITUDE"
 B2 /PROPULSION SCAN "SPIN"
 B3 /PROPULSION SCAN "ADJUST"????
 B4 /PROPULSION W<2 "APOGEE", "BOOST"
 B5 /ABORT
ENTER YOUR REQUEST
 13/ SEARCH ON 1 USING A,B1,B3,B4   ....SEARCH REQUEST....
THE SEARCH CAN BE COMPLETED IN A SINGLE PASS OVER THE DOCUMENT
SET UNDER LINE 1   WHICH CONTAINS 6   DOCUMENTS, THE
FOLLOWING SEARCH LINES WILL BE RETRIEVED

TAG   TEXT

A1   ACJG IS "NITROGEN"
B1   PROPULSION SCAN "ATTITUDE"
B3   PROPULSION SCAN "ADJUST"$$$$
B4   PROPULSION W<2 "APOGEE", "BOOST"

SHALL I PROCEED WITH PASS 1 . ENTER YES OR NO.
   / YES   ....SEARCH EXECUTION....

PASS 1 COMPLETED, THE FOLLOWING RESULTS HAVE BEEN SAVED FROM
THE SEARCH ON LINE 1

 TAG LINE   REQUEST

 A1   13/ ACJG IS "NITROGEN"
                 1 ITEM
 B1   14/ PROPULSION SCAN "ATTITUDE"
                 5 ITEMS
 B3   15/ PROPULSION SCAN "ADJUST"$$$$
                 5 ITEMS
 B4   16/ PROPULSION W<2 "APOGEE", "BOOST"
                 5 ITEMS
END OF SEQUENTIAL SEARCH
.............................DISPLAY OF RETRIEVED RECORDS.....
ENTER YOUR REQUEST
 17/ DISPLAY 13

WHAT FIELDS DO YOU WANT TO SEE?
.ENTER FIELD NUMBERS SEPARATED BY COMMAS OR ALL
     / MECHANISM

FIGURE 7.   SAMPLE BASIS SEQUENTIAL SEARCH AND RETRIEVAL
(CONTINUED)

ITEM 1

CONTROL MECHANISM : GAS JET
CONTROL MECH, JET GAS : NITROGEN
CONTROL MECH, JET SIZE : 0.4 LB

DO YOU WANT TO ENTER ANOTHER EXPRESSION?
    / NO

FINISHED WITH PRINT OUT
ENTER YOUR REQUEST
 17/ DISPLAY

WHAT FIELDS DO YOU WANT TO SEE?
    / PROPULSION
THIS PRINTOUT MAY BE LENGTHY
        5 ITEMS
HOW MANY ITEMS DO YOU WANT FIRST?
    / 1

ITEM 1

PROP, IN-ORBIT FUNCTIONS : ORBIT ADJUSTMENT
PROP, IN-ORBIT CAP, FUEL : HYDRAZINE
PROP, IN-ORBIT CAP, DELTA V : 426 M/S
PROP, IN-ORBIT, MFGR : HUGHES AIRCRAFT CO.
PROP, IN-ORBIT FUNCTIONS : ATTITUDE ADJUSTMENT
PROP, IN-ORBIT CAP, FUEL : HYDRAZINE
PROP, IN-ORBIT CAP, DELTA V : 426 M/S
PROP, IN-ORBIT, MFGR : HUGHES AIRCRAFT CO.
PROP, IN-ORBIT FUNCTIONS : APOGEE BOOST
PROP, IN-ORBIT CAP, FUEL : SOLID
PROP, IN-ORBIT CAP, DELTA V : 1850 M/S
PROP, IN-ORBIT, MFGR : UTC (FW-5)
DO YOU WANT TO SEE MORE?
    / NO

DO YOU WANT TO ENTER ANOTHER EXPRESSION?
    / NO

FINISHED WITH PRINT OUT
ENTER YOUR REQUEST
 17/

● Sequential search request: the search request is initiated
by the BASIS command SEARCH ON < line number > USING
< sequential search tag(s) > where

   - < line number > is the BASIS line number of the set of
     records to be searched sequentially
   - < sequential search tag(s) > is a list of tags indicating
     which sequential search specifications are to be utilized

● Sequential search execution: for each pass of the set of
records to be sequentially searched, the user must answer
"YES" or "NO" (e.g., lines 13 through 16 of the sample
illustrate retrievals performed by BASIS sequential
searching).

It should be noted that a mapped field (a collection of fields) can be sequentially
searched (e.g., in the sample the mapped field PROPULSION, a collection of fields for
in-orbit propulsion capability, is searched using the operators SCAN and W).

2. BASIS System Commands

In addition to the above-mentioned retreival requests, the user may
select from a full range of system commands. System commands allow the user to
request tutorial assistance, interrogate and dynamically modify system parameters,
perform utility functions, control the execution of modules outside of the storage
and retrieval module (including OWNCODE), and save complex dialogs to be run later.

a. TEACH. TEACH provides for an interactive user-system dialog which
explains (with appropriate examples) the various features available. When the
user enters TEACH, the system will list available features and ask the user to
select one for detailed explanation. The description provided includes instructions
and examples to clarify the BASIS capability. The dialog may be addressed to
specific data base applications since the TEACH command is data base dependent.

b. DISPLAY, DEFINE, PRINT. A retrieved set of records may be selectively
displayed or may be utilized in computational expressions; the results can be (1)
displayed using the DISPLAY command, (2) saved internal to the system through a
defined variable using the DEFINE command, or (3) printed off-line using the
PRINT command. The computational language (COMP) allows the use of the operators
and functions shown in Figure 8. The syntax of the DISPLAY command is "DISPLAY

FIGURE 8.   THE COMPUTATIONAL OPERATORS AND FUNCTIONS

Boolean Operators

.NOT.   .AND.   .OR.

Relational Operators

.GT.   (greater than)   .LT. (less than)   .EQ.   (equal to)

.GE.   (greater than   .LE. (less than or   .NE.   (not equal to)
       or equal to)   equal to)

Arithmetic Operators

+ (add)   * (multiply)   ** (exponentiation)

- (subtract)   / (divide)

Common Functions

LOG   ($\log_e$)   MIN   (minimum)   SUM   (sum)

LOG10   ($\log_{10}$)   MAX   (maximum)   CUM   (cumulate)

EXP   (base e)   AVG   (average)   DECUM   (decumulate)

ABS   (absolute)   STD   (standard   LREG   (linear regression)
VAL (value of defined variable   deviation)
    from next or previous
    records)

n" or "DISPLAY" where n is the record set line number. It defaults to the last line number retrieved. The syntax for the DEFINE and PRINT commands is the same as for DISPLAY. In response to the DEFINE command the BASIS system issues the message "WHAT FIELDS DO YOU WANT TO SEE?" followed by a "/" to solicit user response. An expression may be a simple request to display the contents of a record entry (field) or a complex computational relationship utilizing the full scope of computational operators and functions. Sample usage of the computational language with the DEFINE command is shown in Figure 9. The displayed results are printed in a general format which may be modified using the SET command (e.g., set heading off to eliminate annotative headings).

The syntax of the COMP language is similar to standard FORTRAN, but knowledge of computer programming is not required. Computational expressions are separated by commas. Expressions are comprised of entry (field) mnemonics or numbers, defined variables, and literals (constant values) in conjunction with COMP operators and functions. Entry (field) mnemonics or numbers reference the contents of a record entry (field). Defined variables are expressions that have been evaluated and assigned names (the syntax is: name = expression). The syntax for literals is: "constant". When an expression is evaluated, the BASIS system accesses each record of the retrieved set, obtains from each record the values of required record entries and defined variables, performs the requested operations and functions, and disposes of the results (by displaying, printing, or saving).

The class of expressions accommodated by the COMP module are:

● Integer (maximum magnitude determined by hardware)
● Floating point (maximum magnitude determined by hardware)
● Logical (true and false values)
● String (full range of character set).

Defined variable names may be assigned to any class of expression.

FIGURE 9. SAMPLE USAGE OF DEFINE AND DISPLAY

```
1/ TRAJC*ALL
        6 ITEMS
      2 TERMS WITH YOUR STEM WERE COMBINED
2/ DEFINE

WHAT FIELDS DO YOU WANT TO SEE?
ENTER FIELD NUMBERS SEPARATED BY COMMAS OR ALL
    / XM=MAX(PAP)

DO YOU WANT TO ENTER ANOTHER EXPRESSION?
    / XCOUNT=SUM("1")

DO YOU WANT TO ENTER ANOTHER EXPRESSION?
    / X=CUM("1.")*XM/XCOUNT,Y1="275."+"1.1"*X,Y2="1.1"*X

DO YOU WANT TO ENTER ANOTHER EXPRESSION?
    / NO

FINISHED WITH PRINT OUT
ENTER YOUR REQUEST
    2/ RUN SAR(EDIT)
ENTER EDIT COMMAND
    / ITEMIZE,ALL
```

LINE	VARIABLE	TYPE	VALUES	NULLS	CHAR(MAX)
1	XM	REAL	1	0	---
1	XCOUNT	INTEGER	1	0	---
1	X	REAL	6	0	---
1	Y1	REAL	6	0	---
1	Y2	REAL	6	0	---

```
ENTER EDIT COMMAND
    / STOP
ENTER YOUR REQUEST
    2/ LIST VARIABLES
```

SEQ.	LINE	VARIABLE AND DEFINITION
1	1	XM=MAX(PAP)
2	1	XCOUNT=SUM("1")
3	1	X=CUM("1.")*XM/XCOUNT,
4	1	Y1="275."+"1.1"*X,
5	1	Y2="1.1"*X

```
ENTER YOUR REQUEST
    2/ DISPLAY

WHAT FIELDS DO YOU WANT TO SEE?
    / XM, XCOUNT
XM, =                                                    415.000
 XCOUNT =                                                      6

DO YOU WANT TO ENTER ANOTHER EXPRESSION?

    / NO

FINISHED WITH PRINT OUT
ENTER YOUR REQUEST
```

The evaluation of expressions may be qualified by use of the computational IF statement. Using e_i to symbolize the i_{th} expression (including defined variable expressions), the syntax of the IF statement is:

IF logical expression THEN e_1, e_2,...,e_i ELSE e_{i+1}, e_{i+2},...;

Note that the expression immediately following IF must be a logical class expression; any other expression, e_i, may be of any class.

COMP Operators. The three categories of operators available for use in the COMP language are:

- Boolean
- Relational
- Arithmetic.

The operators are shown in Figure 8. The periods on each end of the alphabetic symbol are required for Boolean and relational operators. The arithmetic operators can be used only in conjunction with numeric (integer and floating point) operands. The relational operators can be used in conjunction with any class of expression, but the present implementation of COMP recognizes only .EQ. or .NE. for comparisons of string or logical expressions. String expressions may utilize only the relational operators (bit manipulation using .AND. and .OR. is not implemented). For the Boolean operators the operands must be logical expressions. Any expression utilizing Boolean or relational operators is of logical class. Mixed numeric class expressions are allowed by the COMP language, but the resultant expression will be of floating point class. An expression involving only integers and arithmetic operators will be classed as integer. The user should be aware of the consequences of integer arithmetic; for example, the integer expression "7"/"8" has the integer value "0".

COMP Functions. Except for the VAL function, all of the functions of the COMP language are of numeric class. Most of the numeric functions shown in Figure 8 are familiar to potential system users, with the exception of two unusual numeric functions CUM and DECUM. CUM is used to cumulate the values of an expression (e.g., cumulative dosage of toxic drug); DECUM is the inverse of CUM and could be used to calculate difference for a cumulated expression. Except

for the function LREG, numeric functions use a single parameter. The parameter can be any numeric expression (i.e., a defined variable, entry mnemonic or number, or any complex expression utilizing operators and functions). The functions LOG, LOG10, EXP, ABS, CUM, and DECUM produce a value for every record processed. The functions MIN, MAX, AVG, SUM, and STD are standard descriptive statistical functions and produce one value for the entire set of records. The LREG function for simple linear regression utilizes two parameters:

- Parameter 1: the independent variable
- Parameter 2: the dependent variable.

Each of these parameters may be any numeric expression.

c. PROFILE (Saved Procedure). Because of the recurring nature of many functions performed within some BASIS modules, the system provides a capability called PROFILE that allows a user to save search statements, display requests, computational expressions, logic statements, and all other repetitive user text. The user may delete or modify profiles in batch or interactive mode using the PROFILE editor. The saved profile can contain variable expressions to be entered by the user at search time. Any BASIS dialog can be saved in a profile and profiles can be linked to permit one to execute others (profile nesting). Sample profile usage is shown in Figure 10 and Appendices H and I.

Profile Creation. A user may create a profile in capture mode by entering "PROFILE CREATE ON" or "SET PROFILE ON", or in editor mode. The created profile is terminated and named by entry of the command "PROFILE SAVE name", where name is a user supplied name of 30 characters or less which may contain any characters but "["and"]"; the first word of the name may not be a BASIS system command.

Profile Execution. Once saved, a profile may be executed by the "PROFILE EXECUTE name" command where name is spelled and punctuated exactly as when saved.

Profile Parameters. Some of the text of a profile may be left unspecified until execution time. During profile creation, all text parameters are indicated by "[message]" where message can be any string of ten or less characters

FIGURE 10.   SAMPLE USAGE OF PROFILE

```
.............................SAMPLE OF SAVING A PROFILE...........
ENTER YOUR REQUEST
 18/ SET PROFILE ON
ENTER YOUR REQUEST
 18/ TELL(.......SAMPLE OF A SEARCH TERM PROFILE USING PARAMETERS...)
.......SAMPLE OF A SEARCH TERM PROFILE USING PARAMETERS...
ENTER YOUR REQUEST
 18/ [FIELD]:[DATA VALUE]*ALL
              FIELD ? PIF
          DATA VALUE ? ATTITUDE
          5 ITEMS
        3 TERMS WITH YOUR STEM WERE COMBINED
 19/ PROFILE SAVE SAMPLE SEARCH TERM PROFILE
.............................SAMPLE OF PROFILE EXECUTION
ENTER YOUR REQUEST
 19/ PROFILE EXECUTE SAMPLE SEARCH TERM PROFILE


THE FOLLOWING ARE PARAMETERS TO BE SATISFIED
              FIELD ? PIF
          DATA VALUE ? ORBIT
.......SAMPLE OF A SEARCH TERM PROFILE USING PARAMETERS...
 19/ PIF:ORBIT*ALL
          4 ITEMS
        3 TERMS WITH YOUR STEM WERE COMBINED
 20/  PROFILE SHOW SAMPLE SEARCH TERM PROFILE
DATE CREATED ON :  11/01/76
      AUTHOR    : SEASAT
FILE LOCATED IN : SAVE FILE
    5 = TELL(.......SAMPLE OF A SEARCH TERM PROFILE USING PARAMETERS...)
   10 = [FIELD]:[DATA VALUE]*ALL
CONTINUE
```

(except "[" and "]"). Multiple parameters per line of entry text are allowed. Parameters having the same name are assumed identical and the system will request entry only once.

Profile Showing. To view the profile table of contents, the user enters the command "PROFILE SHOW". To view the text of a particular profile the command "PROFILE SHOW name" is entered, where name is spelled and punctuated exactly as when saved.

Profile Commands. Commands that have special importance within profiles are:

- TELL (message)
- ASK (message)
- WAIT.

Message is a line of text of 60 characters or less that is issued by the system when one of the above commands is encountered. The TELL command is used to provide information only, the ASK command is used to solicit user response, and the WAIT command is used to allow the system to pause until user reponse (any entry) is received by the system.

d. SET. The SET command provides the user with optional control over BASIS functions. A figure in Section III.D.2.e. shows the parameters that may be SET. Use of the LIST STATUS command will display the current status (values) of the SET parameters. The SET command may be followed by a series of parameter key words and parameter values delimited by a blank or equal sign. Keyword/value pairs are delimited by a blank or comma. If an incorrect response is entered, BASIS issues the seris of messages "EXAMPLE OF CORRECT FORM FOR SET", "LINE=40, PRLINE=100,PAGE=ON", "ENTER PARAMETERS AND VALUES" followed by a "/".

Most of the SET parameters control output format for the DISPLAY or PRINT commands. TRLINE and PRLINE set the maximum line length for printing on an interactive terminal and batch printer respectively. SEQ and FIELD, are used to set usage of sequence or field (entry) headings on or off. ITEM is used to turn on or off the printing of the record count within DISPLAYed or PRINTed output. UNIT and THES are used for printing the unit of measure for entry (field) values

and for thesaurus usage respectively. ADJAC is used for setting the number of index terms to be printed for terms adjacent to a search entry for which no index term exists. PAUSE is used to set the number of records to DISPLAY, DEFINE, or PRINT before pausing to ask if the user wishes to continue with the output. PAGE is used to set on or off the message that a requested output may be lengthy. PROFILE is used to set profile capture mode on or off for creating a profile. UNIVERSE is used to limit searching to the set of records indicated by the line number parameter. HIERARCHY is used for a hierarchical search (i.e., for each search the universe is the last retrieved set of records). A sample of a hierarchical search is shown in Figure 11.

e. LIST. The LIST command allows the user to list:

- Line numbers and corresponding search terms for retrieved record sets

- BASIS commands and a brief description of their function

- Parameters that may be utilized with a SET command

- The status (values) of the SET parameters

- Defined variable names, line numbers, and definitions.

Sample usage of the LIST command is shown in Figure 12.

f. XEQ,RUN. To facilitate the highly modular design of BASIS, a special loading program swaps systems modules. The RUN command is used to swap independent BASIS modules into computer memory. The XEQ command is used to call other software from the system library or user supplied OWNCODE. Sample usage of the XEQ and RUN commands is shown in Figure 13.

g. ABORT. One of the central design concepts of the BASIS system is to allow the user complete freedom to choose and modify his strategy. The ABORT command allows the user to immediately stop the execution of a BASIS command or supporting system module like the SAR Module. Upon entry of ABORT whenever input

FIGURE 11.   SAMPLE USAGE OF SET


```
    1/ SET HIERARCHY ON
ENTER YOUR REQUEST
    1/ TRAJC*ALL
            6 ITEMS
        2 TERMS WITH YOUR STEM WERE COMBINED
.......................HIERARCHICAL SEARCH.....
    2/ PIF:APOGEE BOOST
            5 ITEMS
 IN YOUR DATA SUBSET
    3/ PSPEOL:250 TO 450
            3 ITEMS
 IN YOUR DATA SUBSET
    4/ ST:*


    .ITEMS.    TERM
 IN YOUR DATA SUBSET
A        1  ST:NO SCIENCE PAYLOAD
B        1  ST:UHF, C-BAND, L-BAND TRANSPONDERS
END OF TERMS WITH YOUR STEM
ENTER LETTERS TO BE COMBINED,
SEPARATED BY COMMAS, OR ALL
    4/ B
            1 ITEM
 IN YOUR DATA SUBSET
SELECT TERMS, OR ENTER YOUR REQUEST
    5/ DISPLAY

WHAT FIELDS DO YOU WANT TO SEE?
    / PROJ

ITEM 1

PROJECT NAME : MARISAT

DO YOU WANT TO ENTER ANOTHER EXPRESSION?
    / PAYLOAD

ITEM 1

PAYLOAD CLASS : COMMUNICATIONS
WT., SENSOR PAYLOAD : 68 KG
SENSOR TYPE (EXPERIENCE) : NO SCIENCE PAYLOAD; UHF, C-BAND, L-BAND
        TRANSPONDERS
STOWED DIMEN., DIAMETER : 216 CM
STOWED DIMEN., LENGTH : 381 CM

DO YOU WANT TO ENTER ANOTHER EXPRESSION?
    / NO

FINISHED WITH PRINT OUT
ENTER YOUR REQUEST
    5/ SET HIERARCHY OFF
ENTER YOUR REQUEST
```

FIGURE 12. SAMPLE USAGE OF LIST

ENTER YOUR REQUEST
 18/ LIST

```
   .ITEMS. LINE        REQUEST
 *       6   1/  PROJ:(STEM) ALL   `
 *       5   2/  PROJ:(STEM) A TO F
 *       3   3/  PROJ:(STEM) G,H,I
 *       6   4/  ( 2 OR 3 )
 *       6   5/  PIF:(STEM) ALL
 *       5   6/  PIF:(STEM)[ 2] ALL
 *       6   7/  ( 5 OR 6 )
 *       0   8/  PSPEOL:LT 200
 *       4   9/  PSPEOL:200 TO 400
 *       2  10/  PSPEOL:GT 400
 *       1  11/  TRAJC:LOW EARTH ORBIT
 *       1  12/  ( 10 AND 11 )
 *       1  13/   A1   ACJG IS "NITROGEN"
 *       5  14/   B1   PROPULSION SCAN "ATTITUDE"
 *       5  15/   B3   PROPULSION SCAN "ADJUST"$$$$
 *       5  16/   B4   PROPULSION W<2 "APOGEE", "BOOST"
 *       6  17/  TRAJC*ALL
```
ENTER YOUR REQUEST
 18/ LIST COMMANDS
BASIS COMMANDS USED IN SEASAT

DISPLAY SHOW SOURCE FILE DATA ONLINE
PRINT   SHOW SOURCE FILE DATA OFFLINE
LIST   SHOW LINES USED IN SEARCH OR
        COMMANDS,PARAMETERS,STATUS
        VARIABLES,DESCRIBE
SET   CHANGE VARIOUS PARAMETERS
        FOR MORE INFORMATION ENTER: LIST PARAMETERS
QUIT,END TERMINATE THE USAGE OF BASIS
LOGOUT TERMINATE USAGE OF BASIS
        AND THE COMPUTER SYSTEM
RESTART START THE USE OF BASIS FROM
        THE BEGINNING AGAIN
PROFILE INITIATE THE USE OF THE PROFILE SUB-SYSTEM
RUN   EXECUTE USER OWNCODE PROGRAMS
XEQ   EXECUTE INTERCOM COMMANDS AND RETURN TO BASIS
DEFINE DEFINE VARIABLES FOR FUTURE USE
ABORT   ABORT PRESENT FUNCTION AND RETURN TO SEARCHING
CLOCK   SHOW TIME USED SO FAR
EXPLAIN EXPLAIN THE LAST MESSAGE
ALSO: RESET,SEARCH
        ASK,TELL,WAIT,.OUTPUT.,SEE,ENT
ENTER YOUR REQUEST

FIGURE 12. SAMPLE USAGE OF LIST
(CONTINUED)

ENTER YOUR REQUEST
 18/ LIST VARIABLES

SEO. LINE   VARIABLE AND DEFINITION
  1   1   XM=MAX(PAP)
  2   1   XCOUNT=SUM("1")
  3   1   X=CUM("1.")*XM/XCOUNT,
  4 . 1   Y1="275."+"1.1"*X,
  5   1   Y2="1.1"*X
  6   17   XM=MAX(PAP)
  7   17   XCOUNT=SUM("1")
  8   17   X=CUM("1.")*XM/XCOUNT,
  9   17   Y1="275."+"1.1"*X,
 10   17   Y2="1.1"*X
ENTER YOUR REQUEST
 18/ LIST PARAMETERS

PARAMETERS THAT CAN BE SET :

PROFILE SET PROFILE CREATE ON/OFF
ADJAC   NUMBER OF ADJACENT TERMS TO SHOW
UNIV   SET SEARCHING TO A SUBSET OF THE DATA BASE
        UNIV=1 , MEANS USE THE SUBSET DEFINED BY LINE 1 FOR
        SEARCHING
DISPOSE FOR ROUTING OF OFF-LINE PRINT FILE TO REMOTE PRINTERS
        DISPOSE=XX DISPOSE TO REMOTE PRINTER WITH ID XX
                    (EACH REMOTE PRINTER HAS A TWO CHARACTER ID)
        DISPOSE=ON FOR USERS AT A 200 UT, DISPOSE TO THEIR
                    PRINTER
        DISPOSE=OFF DO NOT DISPOSE THE PRINT FILE
        DISPOSE=C   DISPOSE TO PRINTER AT BATTELLE (DEFAULT)
TRLINE ON-LINE TERMINAL LINE LENGTH
PRLINE OFF-LINE PRINTER LINE LENGTH
INDENT INDENTATION OF ADDITIONAL LINES FOR FIELDS
        WITH SEVERAL LINES OF OUTPUT
FIELD   SET FIELD NUMBERS ON/OFF
SEQ   SET SEQUENCE NUMBERS ON/OFF
HEAD   SET HEADINGS ON/OFF
UNIT   SET UNITS ON/OFF
PAGE   SET PAGING ON/OFF
ITEM   SET RECORD COUNT ON/OFF
SUP   SUPPRESS SHOWING UNIV ITEM COUNT IN TERM LISTS ON/OFF
LINKS   USE OF LINKS ON/OFF
HIER   HIERARCHICAL SEARCHING MODE ON/OFF
WARN   SEQ. SEARCH WARNING MESSAGE ON/OFF
PAUSE   PAUSE IN DISPLAY OF DATA COUNT
VALUES SET USE OF DEFINED VARIABLE VALUES ON/OFF
        OFF MEANS RECALCULATE DEFINED VARIABLES
ALSO : DEBUG AND ATTACH
ENTER YOUR REQUEST

FIGURE 13.   SAMPLE OF XEQ AND RUN

17/ (13 OR 14)
          6 ITEMS
18/ RUN SORT(PSPEOL)

BEGIN BASIS SORT
 18/ (13 OR 14) **SORTED**
          6 ITEMS
ENTER YOUR REQUEST
 19/ SET ITEM OFF
ENTER YOUR REQUEST
 19/ DISPLAY

WHAT FIELDS DO YOU WANT TO SEE?
    / PSPEOL
PSP, END OF LIFE : 212 W (SUMMER SOLSTICE)
PSP, END OF LIFE : 250 W (SUMMER SOLSTICE)
PSP, END OF LIFE : 250 W (SUMMER SOLSTICE)
PSP, END OF LIFE : 305 W (AFTER 5 YRS)
PSP, END OF LIFE : 402 W
PSP, END OF LIFE : 600 W

DO YOU WANT TO ENTER ANOTHER EXPRESSION?
    / NO

FINISHED WITH PRINT OUT
ENTER YOUR REQUEST
 19/ RUN SAR(EDIT)
ENTER EDIT COMMAND
    / ITEMIZE ALL

LINE VARIABLE   TYPE   VALUES NULLS CHAR(MAX)

ENTER EDIT COMMAND
    / STOP
ENTER YOUR REQUEST
 19/ XEQ,FILES
--LOCAL FILES--
 *SAVEPFL *BASIS3 $INPUT $OUTPUT   PRINT
 *PROFILE   BACK   *SAR3   *SORT3
ENTER YOUR REQUEST .

is solicited, system control will be transferred to the BASIS Storage and
Retrieval Module and a prompting message "ENTER YOUR REQUEST" will be issued
followed by line number and a "/" for input solicitation. Sample usage of the
ABORT command is shown in Figure 14.

     h. RESET. The RESET command is used to reset line numbers associated
with retrieved record sets. For example, one could discard lines 1 through 4;
reset lines 5 and 6 as new line numbers 1 and 2; set the line number for the
next retrieved record set to 3. Note that when the LIST command is used to
list retrieval terms, the annotation "*RESET*" is appended to the line to remind
the user of the reset.

     The RESET command can be used to:

- Discard erroneously retrieved sets of records
- Discard preliminary component record sets while
  keeping the final record set
- Change the line number order of sets of
  retrieved records.

These uses are "house cleaning" operations since the occurrence of unwanted
record sets or the order of occurrence is of little importance, except that the
limit of 99 sets of retrieved records may be avoided by discarding unused line
numbers. Sample usage of the RESET command is shown in Figure 15.

     i. RESTART, QUIT, LOGOUT. The RESTART command facilitates the change
of one data base to another. The BASIS system will issue the messages "READY
TO START AGAIN", "PLEASE ENTER THE NAME OF THE DATA BASE YOU WANT" and will
solicit a response with a "/". After selection of the data base, the BASIS
system will request the user to "PLEASE ENTER YOUR DATA BASE PASSWORD" if a
security password is required for the data base. The QUIT and LOGOUT commands
enable the user to terminate his usage of the BASIS system. When using QUIT,
system control is returned to the host operating system and the user is
responsible for ending the terminal session. The use of BASIS command LOGOUT
will both exit BASIS and end the terminal session. LOGOUT provides only connect
time, while QUIT allows the user to obtain whatever statistics are provided by
the host system. Sample usage of the RESTART, QUIT, and LOGOUT commands is
shown in Figure 16.

FIGURE 14.   SAMPLE USAGE OF ABORT

```
 17/ RUN SAR(EDIT)
ENTER EDIT COMMAND
    / ABORT
 17/ ABORT
ENTER YOUR REQUEST
 17/ SEARCH SEQUENTIAL
ENTER SEQUENTIAL SEARCH SPECIFICATION
 C1 /ABORT
ENTER YOUR REQUEST
 17/ RUN SORT
ENTER SORT SPECIFICATION
    / ABORT
 17/ ABORT
ENTER YOUR REQUEST
 17/ SET
ENTER PARAMETERS AND VALUES
    / ABORT
ENTER YOUR REQUEST
 17/ RESET
DO YOU WANT TO RESET SOME LINES?
    / ABORT
 17/
```

FIGURE 15.   SAMPLE USAGE OF RESET

ENTER YOUR REQUEST
 17/ LIST   ....LIST OF RETRIEVALS......

     .ITEMS. LINE   REQUEST
 *   6   1/ PROJ:(STEM) ALL
 *   5   2/ PROJ:(STEM) A TO F
 *   3   3/ PROJ:(STEM) G,H,I
 *   6   4/ (2 OR 3)
 *   6   5/ PIF:(STEM) ALL
 *   5   6/ PIF:(STEM)[2] ALL
 *   6   7/ (5 OR 6)
 *   0   8/ PSPEOL:LT 200
 *   4   9/ PSPEOL:200 TO 400
 *   2   10/ PSPEOL:GT 400
 *   1   11/ TRAJC:LOW EARTH ORBIT
 *   1   12/ (10 AND 11)
 *   1   13/   A1   ACJG IS "NITROGEN"
 *   5   14/   B1   PROPULSION SCAN "ATTITUDE"
 *   5   15/   B3   PROPULSION SCAN "ADJUST"$$$$
 *   5   16/   B4   PROPULSION W<2 "APOGEE", "BOOST"
ENTER YOUR REQUEST
 17/ RESET   ....SAMPLE OF RESET..........
DO YOU WANT TO RESET SOME LINES?
    / 1=9,2=10,3=11,4=12,5=16,6=7

LINE 1   RESET AS LINE 9   WAS DEFINED
LINE 2   RESET AS LINE 10 WAS DEFINED
LINE 3   RESET AS LINE 11 WAS DEFINED
LINE 4   RESET AS LINE 12 WAS DEFINED
LINE 5   RESET AS LINE 16 WAS DEFINED
LINE 6   RESET AS LINE 7   WAS DEFINED
DO YOU WANT TO RESET MORE LINES?
    / NO
WHAT DO YOU WANT TO SET THE LINE NUMBER TO?
    / 7
ENTER YOUR REQUEST
  7/ LIST   ....LIST OF RESET LINES.......

     .ITEMS. LINE   REQUEST
 *   4   1/ PSPEOL:200 TO 400 *RESET*
 *   2   2/ PSPEOL:GT 400 *RESET*
 *   1   3/ TRAJC:LOW EARTH ORBIT *RESET*
 *   1   4/ (10 AND 11) *RESET*
 *   5   5/   B4   PROPULSION W<2 "APOGEE", "BOOST" *RESET*
 *   6   6/ (5 OR 6) *RESET*
ENTER YOUR REQUEST

FIGURE 16. SAMPLE USAGE OF RESTART, QUIT, LOGOUT

ENTER YOUR REQUEST
  5/ RESTART   ....SAMPLE OF RESTART........

READY TO START AGAIN
PLEASE ENTER THE NAME OF THE DATA BASE YOU WANT   .
   / SEASAT

ENTER YOUR REQUESTS ONE AT A TIME
   1/ TRAJC*ALL
         6 ITEMS
      2 TERMS WITH YOUR STEM WERE COMBINED
   2/ QUIT   ....SAMPLE OF QUIT...........

GOODBYE
COMMAND- BASIS,RUN,BASIS3,CLAYDON,SEASAT

            B A S I S

ENTER YOUR REQUESTS ONE AT A TIME
   1/ LOGOUT   ....SAMPLE OF LOGOUT.........

CONNECT TIME 0 HRS. ** MIN.

GOODBYE

3. Monitoring and Accounting

To provide detailed information on the usage of the BASIS System, Battelle supports an elaborate monitor module. This module is designed to supply information about capabilities used by an individual and the time at which each was used. The Monitor module generates a record for a particular session including:

(a) Name of user and data base(s) accessed

(b) Elapsed time of total search

(c) BASIS capability used with indication of the nature of the system response (wall clock time is given for all occurrences)

(d) Other information about internal "states" of the BASIS system for each user action.

a. The Set of User/System States Monitored. One of the greatest problems in describing the person-computer interaction is in the careful choice of states that each participant of the interaction can be in. In other person-machine studies the states for the person and machine are presumed to be necessarily identical. Such descriptive states are often more oriented to the computer than to the human and obscure much of the psychology of person-computer interaction. The states should not only be exhaustive, mutually exclusive, and ambiguous but interesting. The states currently controlled by the Monitor module may be changed to fit the particular needs of the data base.

The eleven states selected for analysis of the person-computer interaction are defined as:

(1) Begin Session - user initiates a session with the BASIS interactive retrieval system

(2) Request Data Base - user selectes a file to search via the BASIS system

(3) Search Index - user enters an index term, a word
     stem, an author's name, or any other characteristic
     in order to determine if such a term is in the
     index and, if so, the amount of information
     available related to that term. This function is
     an analog to establishing a common vocabulary
     between conversants and is a form of browsing or
     associative conversation.

(4) Logic Formulation - user couples search terms in a
     logical combination (and,or,not) to build up sets
     of potentially relevant documents. This process
     is analogous to formulating a problem statement
     or a hypothesis.

(5) Off-Line Print - user requests documents printed
     out off-line for later review. Such a function
     would be performed generally when the problem
     statement has been tested and shown to be accurate
     or when the number of potentially relevant docu-
     ments is quite large.

(6) On-Line Print - user browses documents while at the
     terminal to determine if the problem statement
     accurately reflects his real informaiton needs when
     translated into system content. This function is
     a form of hypothesis testing.

(7) Review Search - user refers back to his previous
     actions involving index searching and logic infor-
     mation.

(8) Review Commands - user requests information on the
     command language of the BASIS system. This can be
     viewed as meta communication in that the user is
     asking the system about its communication capa-
     bilities and may be requesting a tutorial.

(9) Set Parameters - user modifies the various output
     features of the system including line length, page
     size, window around subject terms in adjacent term
     options, or length of term list in stem searching.

(10) Exit Data Base - user completes search in a file.
     He may request another file (i.e., converse with
     another source of information) or terminate the
     session.

(11) End Session - user terminates BASIS session. This
     may involve actually disconnecting from the computer
     or merely switching to some other computer program
     available on the system.

An alternative four-state model may also be used. This model consists
of three major states: (1) index search, (2) logic formation, and (3) on-line
print or document display plus a fourth category including all other states.
This condensed model emphasizes the three major components of information
processing.

b. Analysis of Monitor Data. The Monitor data can be used to study
data base usage, command usage, and to determine the criteria for changing
(adding or deleting) elements of the data base. The user and/or application's
programmer can use Monitor module data to optimize file access structures. For
example, it may be observed that users never or very infrequently utilize index
or range terms for some categories of data base entries. Such terms may be
eliminated from the index, and if needed, retrieved sequentially. The infor-
mation generated by the Monitor module can be accessed by (1) a user supplied
program, (2) Battelle supplied programs via the BASIS RUN command, or (3) by
BASIS if the Monitor file is loaded for BASIS using the Data Definition Language
(DDL) of the File Maintenance Module.

Given the basic eleven states as defined for person-computer inter-
action, Battelle has developed a series of computer programs for reduction and
analysis of the large quantity of data. The basic summary data used in the
analysis consist of state strings and associated timing data. The state strings
provide the basic frequency data on state and state transition occurrences. The
timing data provide the basic information on elapsed time within a particular
state or between states.

In addition, the source Monitor data are available for additional
specific analyses such as average sessions per user or distribution analysis of
number of uses per day by individual users. For the eleven-state model, programs
of zero-order and first-order analysis are available to the BASIS user.

Zero-Order Analysis. This analysis is concerned with independent
frequencies and results in data such as:

- Number of index terms per search
- Number of logic statements per search
- Number of off-line or on-line displays per search
- Average search time
- Average state transition time across all states.

In addition, simple proportions representing the ratio of specific
state or function time to overall search time can be computed. These same
proportions can be computed for discrete portions of the search sessions as
well. For example, all sessions can be divided into thirds and the change in
these zero-order statistics over time can be analyzed.

First-Order Analysis. The same state strings used in the zero-order
analysis are used in the first-order analysis. The basic products of the first-
order analysis are the probability transition matrix and the time transition
matrix. The typical products of this analytical technique are:

- Frequency of state-to-state transitions
- Probability of state-to-state transitions
- Elapsed time for each state-to-state transition
- Transition graph of search pattern
- Relative entropy of user/system states.

The frequency and probability transition matrices provide a ready means for
statistically comparing portions of the overall sample.

E. System Requirements for Software Development

In the course of establishing system requirements, only one searching capability was identified that could not easily be provided by BASIS retrieval methods. Since the objective of this planning task is limited to conceptual level system design, the additional searching capability was not developed and implemented as a part of the BASIS system. Rather, this capability requirement is discussed in this part of the report so that alternative software development solutions can be discussed. The recommended solution also will be discussed in Section IV, Recommended Implementation Plan.

In the course of satellite conceptual design, the system user needs to determine for a particular launch vehicle the deliverable weight. For this purpose, graphs of deliverable weight as a function of orbital parameters (inclination and altitude) are available. The problem is to design a method for the data base system to "read" values from the graphs. Several alternative methods are to:

- Store digitized curves in the data base and use interpolation methods to determine the appropriate deliverable weight.

- Approximate the curves by nonlinear regression analysis techniques so that a deliverable weight can be computed.

- Devise an interface to a separate orbital simulation computer program that is being used for another task of this contract.

For the purposes of this planning study, it is sufficient that implementation of any one of these methods will satisfy the user requirement of determining the weight deliverable by a launch vehicle.

IV RECOMMENDED IMPLEMENTATION PLAN

It is recommended that the Spacecraft Data Base be implemented
in prototype form for testing by the user community. This test phase period
should be about three months in duration. After this test period, a final
implementation phase should be scheduled for implementation of enhancements
recommended by the user group. This final implementation phase should re-
quire only about two months for completion.

During the prototype test phase the data base development cost
would be about $1,000 (for coding and keying and data base creation of the
Satellite Information File). Operational costs would be data storage:
$100 per month; computer usage: about $600 per month per user (assuming an
average usage of 2u hours of connect time per user per month); data base
maintenance: nominal (no updates anticipated); operational support staff:
$600 per month; staff for training users: about $500 per user group (a group
of one to six persons at one site); travel for training: about $300 per train-
ing visit; development of a method for retrieving launch vehicle delivery
weight: about $1,000 for staff.

Final implementation phase costs are estimated to be about $4,000
for staff and about $600 for computer cost.

For the operational cost of the final data base system, the costs
are estimated to be as for prototype operation; additional data base mainten-
ance costs of no more than $100 per month are estimated (the actual cost would
depend upon the update activity).

If it is deemed desirable to operate the data base system at a
NASA computer site, the following costs would apply: $75,000 for purchase
of the BASIS system (this includes installation on the NASA computer, building
the data base on that computer, and software maintenance for one year).

APPENDIX A

TASK STATEMENT OF WORK

APPENDIX A

TASK STATEMENT OF WORK

Background

JPL has assembled a catalog of spacecraft support systems and sub-systems covering some 40 separate designs. They are currently developing a catalog of sensors and they plan to develop a Science and Applications require-ments catalog in the future. The long range goal is to utilize the data in all of the catalogs to carry out quick systhesis of spacecraft designs to satisfy specific Science and Applications requirements.

Purpose

In this task the spacecraft support systems catalog will be reviewed by Battelle information systems specialists to develop a conceptual design of a retrieval system. Battelle's strong capabilities in the design and implementation of large data base systems together with their space systems knowledge provides a unique capability for transforming the spacecraft support systems catalog into a convenient, computer-based data file for use by system engineers and spacecraft planners.

Scope

This task should review the spacecraft support systems catalog and develop a design for a retrieval and search system for use with the catalog. The study output will be a detailed description of the system, a recommended implementation plan, and cost estimates for implementation and operation.

Time and Costs

It is estimated that this task can be completed in three months from initiation, at a cost of $10,000.

APPENDIX B

SATELLITE INFORMATION FILE CALLUP

SATTELITE INFORMATION FILE CALLUP

A. Tabulated inputs

   Call Program Name or Project Name

   Output - level one detail - all data at first margin

           - level two detail - first margin plus first indentation

           - level three detail - all data

B. Capability Search at level one - ask for this and printout below -

   - type for each below needed in search

   Call - 1. Investigation Class/Program

         2. Sponsor/Manager

         3. Project

         4. Contractor

         5. Trajectory Class

         6. Launch Data

         7. Range of Satellite Wieghts

         8. Range of Payload Weights

         9. Launch Vehicles

        10. Stabilization Category

        11. Pointing Reference Center

        12. Range of Attitude Control Accuracy

        13. Range of Attitude Control Knowledge

        14. Primary Power Source

        15. Range of Maximum Array Power

        16. Range of Maximum Battery Power

        17. Range of Average Total Power

        18. Range of Average Payload Power

        19. Range Payload Data Production Rates

        20. Range of Telemetry Data Rates

C. Design Search at level one

        1. Payload weight

        2. Payload power

        3. Pointing accuracy

        4. Trajectory class

     5. Stabilization class

     6. Payload Data Production rate

     7. Payload Type Class

C. Design Search continued

     1. Search for Trajectory Class and Stabilization Class Specified (Do not search further through non-applicable cases.)

     2. Payload Weight Search for Payload Class

     3. Payload Power Search

     4. Altitude Control Search

     Altitude control requirement read in and selects an appropriate decade of capability.

        If .2 control accuracy read in then all S/C with performance between .10001 and 1 are applicable.

        If .007, then between .0010001 and .01.

     5. Telemetry Rate Search

     Sensor Data Production Rates read in. This defines the appropriate decade of capability.

     < 30 kb/s
     30.01 kb/s to 300 Mb/s
     300.1 kb/s to 3 Mb/s
     3.001 Mb/s to 30 Mb/s
     30.01 Mb/s to 300 Mb/s
     > 300.1 Mb/s

     All satellites with telemetry reates in that decade or in greater decades are applicable.

D. Capability Search at level two

     1. Sensor Type

     2. Design Life

     3. Stowed Dimensions

     4. Launch Range

     5. Attitude Angular Rate Control

     6. Control Mechanization

     7. Battery Capacity

8. Array Articulations
9. Voltage Range
10. In Orbit Propulsion
11. Telemetry Link Frequency(s)
12. RF Power
13. Coding
14. Modulation
15. Command Data Rate
16. Command Link Frequency(s)
17. Tracking Mechanization
18. Tracking Link Frequency(s)
19. Clock Frequency
20. Clock Stability
21. Data Formatting
22. Data Processing Programmability
23. Data Processing Memory
24. Data Storage Capacity
25. Data Storage Playback Rate(s)

E. Design Display

   1. List of Satellites by:

Organization	Satellite Name	Satellite Function	Agency	Launch Date(D)

   2. Gross Satellite Capability Categories
   3. Launch Vehicle Curves

       Scout B&D

       Minuteman III

       Delta/Atlas F/bulks

       Atlas SLV/bulk, Atlas/Agena or Atlas Center

       Litan

       Shuttle

       Geosyncronous

   4. Attitude Control

       Pointing accuracy vs Pointing knowledge for spin
       stabilized and 3 axis stabilized S/C

5. Power - Satellite Average vs Payload Average

6. Array Power Satellite Average vs Max Array Power

7. VHF Downlinks

8. S band Downlinks

9. Data Storage Capability

F. Subsystem Supplier Search - Printout Suppliers with capability in Range Specified

1. Attitude Thruster Jet Size Range

2. Momentum Wheel Size Range

3. Control Logic Programmability

4. Attitude Reference Sensor Accuracy Range

5. Primary Power Range

6. Secondary Power Range

7. In Orbit Propulsion Delta V

8. Telemetry Transmitter Power

9. Telemetry Rate Range

10. Command Rate Range

11. Tracking Frequency Range

12. Clock Stability Range

13. Data Format Type

14. Data Processor Memory Capacity Range

15. Data Storage Capacity

APPENDIX C

INITIAL JPL-DESIGNED DATA COLLECTION FORM

SATELLITE INFORMATION FILE

Program Name	Civilian Meteorology/Defense Meteorology (DMSP)/
Program Sponsor	NOAA-NASA/DoD/
Project Name	TIROS, ITOS, SMS/Block 5D-1/
Project Manager	NESS-GSFC/Air Force ?/
Prime Contractor	RCA, RCA, Philco-Ford/RCA/
Sensor Type	Passive V&IR/Passive µω/Active µω/F&P/X-ray
Sensor Acronyms	
Launch Date[s]	
In-Flight Experience (Yrs.)	
Design Life [Goal, Expendables Sized] (Yrs.)	
Trajectory Class	Polar/Sun Sync/Geostationary/Geosync/Elliptical/
Design Trajectory [Periapsis Altitude, Inclination, Eccentricity, Period] (km, Deg., , Min.)	

Total Satellite Weight at Launch (kg)	
Sensor Payload Weight (kg)	
Weight of Spacecraft Electronics (kg)	TT&C + DH + A/C&PWR Electronics (no payload electronics)
Stowed Dimensions (M Diam. x M Long)	
Launch Vehicle Designation	Delta 2914/Atlas-F/Titan IIID-Agena/Scout D/
First Stage Designation	
First Stage Manufacturer	
Second Stage Designation	
Second Stage Manufacturer	
Third Stage Designation	
Third Stage Manufacturer	
Fourth Stage Designation	
Fourth Stage Manufacturer	
Launch Range	ETR/WTR/San Marcos/
Launch Pad	SLC-3/SLC-5/

Stabilization Category	3-Axis/Spin/Zero Momentum:Yaw Spinner/
Pointing Reference Center	Earth/Sun/Inertial/
Spin Axis Pointing	Along Track/Earth Centered/
Attitude Control Accuracy [All or Pitch, Roll, Yaw] (Deg.)	$\leq$ p0.5, r0.5, y0.7
Attitude Angular Rate Control Accuracy [All or p, r, y] (Deg./Sec.)	$\leq$ p , r , y
Control Mechanization	Gravity/Cold Gas Jets/Hot Gas Jets/Magnetic Torquer/
Jet Gas, Jet Size	Nitrogen/Freon/Hydrazine, .1θ/.25θ/.5θ
Jet Manufacturer	
Wheel Numbers:Locations, Size	3:All Axes, ?
Wheel Manufacturer	
Control Logic Technology [Programmability, Electronics]	Fixed/Multiple Fixed/Programmable/ , IC/LSI/CMOS/
Control Logic Manufacturer	
Attitude Knowledge Accuracy [All or Pitch, Roll, Yaw] (Deg.)	$\leq$ p0.1, r0.1, y0.2
Attitude Reference Sensor[s]	Earth Horizon/Sun/Star Piper/Starmapper/
Attitude Reference Sensor[s] Manufacturer	

SATELLITE INFORMATION FILE (Cont'd)

Primary Power Source	Solar Arrays/RTG:Snap 19/
Primary Power Source Manufacturer	
Secondary Power Source [Number, Capacity, Amp Hrs., Type]	10, 100 ah, $N_1C_1/3$, 2 ah, AgZn/
Secondary Power Source Manufacturer	
Maximum Primary Power Source Output [Design, EOL] (W)	500, 403
Design β Angle Excursions (Deg.)	60 to 90
Array Articulation [Mounting, Rotations]	Body Mounted/Extendable Panels/Body Fixed/1 Axis/2 Axis
Average Total Power to Satellite (W)	
Average Total Power to Sensor Payload (W)	
Voltage Range (V)	28 ± 4/24 to 36/

In-Orbit Propulsion Functions	Orbit Transfer/Orbit Adjust in Plane/
In-Orbit Propulsion Capability [Fuel, Δv] (f/s)	
In-Orbit Propulsion Manufacturer	

Payload Data Production Rate[s] (b/s)	
Telemetry Data Rate[s] (b/s)	
Telemetry Link Characteristics [Frequency, Bandwidth, RF Power, Coding, Modulation] (GHz, MHz, W)	VHF:.139, .01, 6, Convolution, RZ PCM PSK/S-Band:2.300, .1, 20, Block, PCM FSK/
Telemetry Transmitter Technology	TWT/Solid State/
Telemetry Transmitter Manufacturer	

Command Data Rate[s] (b/s)	
Command Link Characteristics [Frequency, Bandwidth, Coding, Modulation] (GHz, MHz)	
Telemetry & Command Technology	IC/LSI/
Telemetry Manufacturer	
Command Manufacturer	

Tracking Mechanization	Range:Range Rate/Doppler/Laser Retroreflectors
Tracking Manufacturer	
Tracking Link Characteristics [Frequencies, Bandwidth, RF Power] (GHz, MHz, W)	C-Band:4.6, ? , 8/S-Band:2.3, , 20/
Special Telemetry	TDRS/Satellite-to-Satellite
Clock [Frequency, Short Stability, Long Stability] (MHz)	5 MHz, $1_{in}10^{12}$, $1_{in}10^{10}$/
Clock Manufacturer	
Data Formatting [Programmability, Coding]	Hard Wired/Multiple Fixed/Programmable/ , Block/Convolutional/
Data Formatting Manufacturer	
Data Processing [Reprogrammability, Memory Capacity, Discrete Commands, Coded Commands] (b)	Programmable, 10^6, 256, 3/
Data Processing Manufacturer	
Data Storage [Type, Number, Capacity, Record Rates, Playback Rates] (b, b/s, b/s)	Tape/Solid State/Bubble/Film, θ, $10^6/10^8/10^9/10^{10}$, 25k/ , 500k/
Data Storage Manufacturer	

APPENDIX D

REVISED DATA COLLECTION FORM SUBMITTED
BY A SATELLITE PRIME CONTRACTOR

SATELLITE INFORMATION FILE

Program Name   OSO

Program Sponsor

Project Name   OSO - 1

Project Manager

Prime Contractor   Hughes Aircraft Co.

     Sensor Experience   Multichan. UV/Vis Spec., Cosmic X-Ray Spec., Soft X-Ray, Crystal Spec. Polarimeter,

     Sensor Acronyms   High Energy Celestral X-Ray, Mapping X-Ray Heliometer

     Launch Date[s]   1975

     In-Flight Experience (Yrs.)

     Design Life [Goal, Expendables Sized]   1 yr. 1 yr.
     (Yrs.)

Trajectory Class   160 km, 30°, 0, 100 min.

Design Trajectory [Periapsis Altitude,
Inclination, Eccentricity, Period]
(km, Deg., , Min.)

Total Satellite Weight at Launch (kg)   1020 kg

Sensor Payload Weight (kg)   383 kg (130 kg pointed, 252 kg spinning)

     Weight of Spacecraft Electronics (kg)

     Stowed Dimensions (M Diam. x M Long)   1.52 m dia. x 2.34 m long

Launch Vehicle Designation   Delta 2914

     First Stage Designation

       First Stage Manufacturer

     Second Stage Designation

       Second Stage Manufacturer

     Third Stage Designation

       Third Stage Manufacturer

     Fourth Stage Designation

       Fourth Stage Manufacturer

     Launch Range   ETR

     Launch Pad

Stabilization Category   Spin Stabilized

Pointing Reference Center

     Spin Axis Pointing   Normal to Sun Line

Attitude Control Accuracy [All or Pitch,   ± 3 SEC over 1 Orbit Day
Roll, Yaw] (Deg.)

     Attitude Angular Rate Control Accuracy
     [All or p, r, y] (Deg./Sec.)   1 sec jitter

     Control Mechanization

       Jet Gas, Jet Size   N2 Jets   0.4 lb.

         Jet Manufacturer

       Wheel Numbers:Locations, Size   None

         Wheel Manufacturer   -

     Control Logic Technology [Programmability,   { 3 modes: sun center pointing, offset pointing, raster
     Electronics]   { - digital closed loop

       Control Logic Manufacturer   Hughes

Attitude Knowledge Accuracy [All or Pitch,   ± 1 SEC over 1 Orbit Day
Roll, Yaw] (Deg.)

     Attitude Reference Sensor[s]   Sun, Star Sensors

       Attitude Reference Sensor[s]   Hughes Aircraft
       Manufacturer

OSO-1 SATELLITE INFORMATION FILE (Cont'd)

Primary Power Source   Solar Array

    Primary Power Source Manufacturer   Heliotech and Hughes

    Secondary Power Source [Number, Amp Hrs., Type]   (2) 12 AH Nicd Batteries

        Secondary Power Source Manufacturer   Battery Cells - G.E.

Maximum Primary Power Source Output [Design, EOL] (W)   464 W BOL, 402 W EOL

    Design β Angle Excursions (Deg.)   0

    Array Articulation [Mounting, Rotations]   Despin

Average Total Power to Satellite (W)   400W available (EOL)

Average Total Power to Sensor Payload (W)   119 W

    Voltage Range (V)   32 ± 1 V

In-Orbit Propulsion Functions   Initial Spin-Up Adjust, Initial Sun Acq., Spin Axis Orientation, Spin Speed Control

In-Orbit Propulsion Capability [Fuel, Δv] (m/s)   N2, 6.4 m/s

    In-Orbit Propulsion Manufacturer   Hughes Aircraft

Telemetry

    *Ground system compatibility (NASA/GSFC, Aerospace Standards, SGLS, etc.)   NASA/GSFC

    *Channel capacity (No. of Channels)

    Channel type (analog, digital, bi-level)

    *Data rate or baseband (Hz)   6.4 kbps RT, 128 kbps stored data

    Data source encoding type (PCM, ΔMOD)   8 bit PCM, Manchester coded

    Channel encoding type (convolutional, etc.)

    Subcarrier frequency, if used (Hz)

    Subcarrier modulation, technique (FSK, PSK, etc.)

    Data/subcarrier modulation index (radians, etc.)

    *Carrier frequency (MHz)   136.92 MHz-real time; 2212.5 MHz-stored data

    Carrier stability (± Hz)

    Carrier modulation technique (PM, FM, etc.)   PM

    Subcarrier/carrier modulation index (radians, etc.)   S-Band: 1 radian; VHF: 1.44 radian

    Transmitter RF level, tol. (watts, ± watts)   1 W VHF, 1 W S-Band

    *Transmitted EIRP, tol. (dBm, ± dB)

    Occupied RF bandwidth (MHz)

    Telemetry subsystem concept (centralized, data bus, etc.)

    Storage capabilities (medium, data bits, programmable, etc.)   Not reprogrammable, tape recorder (1), 8.6×10^7 bits. PB @ 128 kbps

    Telemetry subsystem manufacturers   Hughes/EMM/Opetics

Tracking

    * Tracking concept for range & range rate (GRARR, DSN/PRN, etc.)   STDN 149.5 MHz up; 136.9 MHz down

    Sidetone frequencies, if used (kHz)

    PRN code rate, if used (Cps)

    Uplink carrier modulation (FM, PM, radians, etc.)

    Downlink carrier modulation (PM, radians, etc.)

    * Transponder type (frequency conversion, phase-coherent, demodulate/remodulate)

    Command/telemetry compatibility (timeshared, continuous, etc.)

OSO-I SATELLITE INFORMATION FILE (Cont'd)

Command

*Command concept
(real-time, stored command, etc.)   Stored command, plus real time

*Channel capacity
(number of unique addresses)   1365 stored cmds, 128 pulse cmds, 8 serial mag. commands

*Command data rate, format   {800 bps; 19 RT commands/sec.; 25 ST cmds/sec
(PCM, etc.)   {"one" 11.5 kHz tone; "zero" 9.1 kHz tone

Command ground encoder compatibility
(NASA/GSFC Aerospace Stds, etc.)

Command word structure (format)   42 bit cmd word,

Subcarrier frequency (Hz)

Data/subcarrier modulation technique   FSK
(FSK, PSK)

Bit sync modulation   AM
(AM, integral with data)

Subcarrier/carrier modulation technique   AM
(PM, etc.)

Subcarrier/carrier modulation index   80 percent
(radians; etc.)

*Carrier frequency, tol.   149.5 MHz
(MHz, + KHz)

Occupied RF bandwidth (KHz)

Receiver Sensitivity (dBm)   - 60 to - 115 dBm (5 dB NF)

Command group manufacturer   Hughes

Design bit error probability $\leq 10^{-6}$

APPENDIX E

PROPOSED COMPOSITE DATA COLLECTION FORM

FIELD TITLE	FIELD
IDENT	2
ACCESSION NUMBER	3
FILE NAME	4
SUBFILE NAME	5
PROGRAM	7
PROGRAM NAME	8
PROGRAM SPONSOR	9
PROJECT	10
PROJECT NAME	11
PROJECT MANAGER	12
PRIME CONTRACTOR(S)	14
PRIME CONTRACTOR	15
PRIME CONTRACTOR	16
PRIME CONTRACTOR	17
TRAJECTORY	20
TRAJECTORY CLASS	21
TRAJECTORY ALTITUDE	22
TRAJECTORY INCLINATION	23
TRAJECTORY ECCENTRICITY	24
TRAJECTORY PERIOD	25
SATELLITE	30
WT., SAT. AT LAUNCH	31
IN-FLIGHT EXPERIENCE	32
DESIGN LIFE, GOAL	33
DESIGN LIFE, EXPEND. SIZED	34
WT., SAT. BEGIN OF LIFE	35
WT., SAT. END OF LIFE	36
PAYLOAD	40
PAYLOAD CLASS	41
WT., SENSOR PAYLOAD	42
SENSOR TYPE (EXPERIENCE)	43
SENSOR ACRONYM	44
WT., SENSOR ELECTRONICS	45
STOWED DIMEN., DIAMETER	46
STOWED DIMEN., LENGTH	47
STOWED DIMEN., WIDTH	48
STOWED DIMEN., HEIGHT	49

APPENDIX F

SATELLITE CATALOG DATA ELEMENT SPECIFICATIONS

LEVEL	CATEGORY CODE	CLASS	INDEX	SEARCH LEVEL	DISPLAY LEVEL	FIELD	FIELD MNEMONIC	FIELD TITLE
0	00.	M				2	IDENT	IDENT
1	00.1	I	I			3	ACC	ACCESSION NUMBER
1	00.2	S	I			4	FILE	FILE NAME
1	00.3	S	I			5	SUBFILE	SUBFILE NAME
0	01.	M				7	PROGRAM	PROGRAM
1	01.1	S	I	C1		8	PROG	PROGRAM NAME
1	01.2	S	I	C1		9	SPONSOR	PROGRAM SPONSOR
0	02.	M				10	PROJECT	PROJECT
1	02.1	S	I	C1		11	PROJ	PROJECT NAME
1	02.2	S	I	C1		12	MANAGER	PROJECT MANAGER
0	03.	M				14	PRIME	PRIME CONTRACTOR(S)
3	03.1.1.1	S	I	C1		15	PRIME1	PRIME CONTRACTOR
3	03.1.1.2	S	I	C1		16	PRIME2	PRIME CONTRACTOR
3	03.1.1.3	S	I	C1		17	PRIME3	PRIME CONTRACTOR
0	04.	M				20	TRAJECTORY	TRAJECTORY
1	04.1	S	I	C1	D1	21	TRAJC	TRAJECTORY CLASS
2	04.1.1	R	N			22	TRAJA	TRAJECTORY ALTITUDE
2	04.1.2	R	N			23	TRAJI	TRAJECTORY INCLINATION
2	04.1.3	R	N			24	TRAJE	TRAJECTORY ECCENTRICITY
2	04.1.4	R	N			25	TRAJP	TRAJECTORY PERIOD
0	05.	M				30	SATELLITE	SATELLITE
1	05.1	R	R	C1		31	WSAL	WT., SAT. AT LAUNCH
2	05.1.1	R	N			32	IFE	IN-FLIGHT EXPERIENCE
2	05.1.2	R	R	C2		33	DLG	DESIGN LIFE, GOAL
2	05.1.3	R	N			34	DLES	DESIGN LIFE, EXPEND. SIZED
1	05.2	R	N			35	WSBOL	WT., SAT. BEGIN OF LIFE
1	05.3	R	N			36	WSEOL	WT., SAT. END OF LIFE
0	06.	M				40	PAYLOAD	PAYLOAD
1	06.1	S	I		D1	41	PC	PAYLOAD CLASS
1	06.2	R	R	C1	D1	42	WSP	WT., SENSOR PAYLOAD
2	06.2.1	S	I	C2		43	ST	SENSOR TYPE (EXPERIENCE)
2	06.2.2	S	N			44	SA	SENSOR ACRONYM MULTIPLE SENSORS POSSIBLE
2	06.2.3	R	N			45	WSE	WT., SENSOR ELECTRONICS
2	06.2.4	R	R	C2		46	SDD	STOWED DIMEN., DIAMETER
2	06.2.5	R	R	C2		47	SDL	STOWED DIMEN., LENGTH
0	07.	M				60	LAUNCH	LAUNCH
1	07.1	S	I	C1		61	LVC	LAUNCH VEHICLE CLASS
2	07.1.1	I	R	C1		62	LD1	LAUNCH DATE
2	07.1.2	I	R	C1		63	LD2	LAUNCH DATE
2	07.1.3	I	R	C1		64	LD3	LAUNCH DATE
2	07.2	S	I	C1		70	LV	LAUNCH VEHICLE DESIGNATION
2	07.2.1	S	N			71	S1D	STAGE 1 DESIGNATION
3	07.2.1.1	S	N			72	S1M	STAGE 1 MANUFACTURER
2	07.2.2	S	N			73	S2D	STAGE 2 DESIGNATION
3	07.2.2.1	S	N			74	S2M	STAGE 2 MANUFACTURER
2	07.2.3	S	N			75	S3D	STAGE 3 DESIGNATION
3	07.2.3.1	S	N			76	S3M	STAGE 3 MANUFACTURER
2	07.2.4	S	N			77	S4D	STAGE 4 DESIGNATION
3	07.2.4.1	S	N			78	S4M	STAGE 4 MANUFACTURER
2	07.3	S	I	C2		79	LR	LAUNCH RANGE
2	07.3.1	S	N			80	LP	LAUNCH PAD

```
0 08.        M            90 STABILIZE  STABILIZATION
1 08.1       S I C1 D1    91 SC          STABILIZATION CATEGORY
1 08.2       S I C1       92 SPRC        POINTING REF. CENTER
2 08.2.1     S N          93 SADP         SPIN AXIS POINTING DIR.
0 09.        M           100 ATTITUDE   ATTITUDE CONTROL
1 09.0       M           101 CONTROL    ATTITUDE CONTROL
1 09.1       S N         102 ACAM       ATT. CONTROL ACC'Y, REMARKS
1 09.2       R R C1 D1   103 ACAA       ATT. CONTROL ACC'Y, ALL
1 09.3       R R C1 D1   104 ACAP       ATT. CONTROL ACC'Y, PITCH
1 09.4       R R C1 D1   105 ACAR       ATT. CONTROL ACC'Y, ROLL
1 09.5       R R C1 D1   106 ACAY       ATT. CONTROL ACC'Y, YAW
1 09.6       M           110 ANGRATE    ANG RATE CONTROL ACC'Y
2 09.6.1     S N         111 ARCAM       ANG RATE CONT'L ACC, REMARKS
2 09.6.2     R R C2      112 ARCAA       ANG RATE CONTROL ACC, ALL
2 09.6.3     R R C2      113 ARCAP       ANG RATE CONTROL ACC, PITCH
2 09.6.4     R R C2      114 ARCAR       ANG RATE CONTROL ACC, ROLL
2 09.6.5     R R C2      115 ARCAY       ANG RATE CONTROL ACC, YAW
1 09.7       M           120 MECHANISM  CONTROL MECHANISM
2 09.7.1     S I C2      121 ACM         CONTROL MECHANISM
2 09.7.2     S N         122 ACJG        CONTROL MECH, JET GAS
2 09.7.3     R N         123 ACJS        CONTROL MECH, JET SIZE
3 09.7.3.1   S N         124 ACJM         CONTROL MECH, JET MFGR
2 09.7.4     I N         125 ACWN        CONTROL MECH, WHEEL NUMBERS
2 09.7.5     S N         126 ACWL        CONTROL MECH, WHEEL LOCATION
2 09.7.6     R N         127 ACWS        CONTROL MECH, WHEEL SIZE
3 09.7.6.1   S N         128 ACWM         CONTROL MECH, WHEEL MFGR
1 09.8       M           130 LOGIC      ATT. CONTROL LOGIC
2 09.8.1     S N         131 ACLT        ATT. CONT'L LOGIC TECHNOLOGY
3 09.8.1.1   S N         132 ACLM         ATT. CONTROL LOGIC, MFGR
0 10.        M           140 KNOWLEDGE  ATTITUDE KNOWLEDGE
1 10.1       S N         141 AKAM       ATT. KNOW ACC'Y, REMARKS
1 10.2       R R C1      142 AKAA       ATT. KNOW ACC'Y, ALL
1 10.3       R R C1      143 AKAP       ATT. KNOW ACC'Y, PITCH
1 10.4       R R C1      144 AKAR       ATT. KNOW ACC'Y, ROLL
1 10.5       R R C1      145 AKAY       ATT. KNOW ACC'Y, YAW
1 10.6       M           150 ARSENSOR   ATT. REFERENCE SENSOR
2 10.6.1     S N         151 ARSE        ATT. REF SENS, EARTH
3 10.6.1.1   S N         152 ARSEM        ATT. REF SENS, EARTH, MFGR
2 10.6.2     S N         154 ARSUN       ATT. REF SENS, SUN
3 10.6.2.1   S N         155 ARSUNM       ATT. REF SENS, SUN, MFGR
2 10.6.3     S N         157 ARSTAR      ATT. REF SENS, STAR
3 10.6.3.1   S N         158 ARSTARM      ATT. REF SENS, STAR, MFGR
2 10.6.4     S N         160 ARSMAG      ATT. REF SENS, MAGNETOMETER
3 10.6.4.1   S N         161 ARSMAGM      ATT. REF SENS, MAG, MFGR
2 10.6.5     S N         163 ARSEMAG     ATT. REF SENS, ELECTROMAG
3 10.6.5.1   S N         164 ARSEMAGM     ATT. REF SENS, E MAG., MFGR
2 10.6.6     S N         166 ARSACCL     ATT. REF SENS, ACCELEROMETER
3 10.6.6.1   S N         167 ARSACCLM     ATT. REF SENS, ACCEL, MFGR
2 10.6.7     S N         169 ARSMB       ATT. REF SENS, BEACON
3 10.6.7.1   S N         170 ARSMBM       ATT. REF SENS, BEACON, MFGR
2 10.6.8     S N         172 ARSOTHR     ATT. REF SENS, OTHER TYPES
3 10.6.8.1   S N         173 ARSOTHRM     ATT. REF SENS, OTHER, MFGR
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0 11.         M        180 POWER      POWER SOURCE
1 11.1        S I C1   181 PSPC       POWER, PRIMARY, CLASS
2 11.1.1      S N      182 PSPD        POWER, PRIMARY, DESIGNATION
3 11.1.1.1 S N         183 PSPM         POWER, PRIMARY, MFGR
1 11.2        S N      185 PSSC       POWER, SECONDARY, CLASS
2 11.2.1      I N      186 PSSN        POWER, SECONDARY, NUMBER
2 11.2.2      R R C1   187 PSSMP       POWER, SECONDARY, MAX POWER
2 11.2.3      R R C2   188 PSSCAP      POWER, SECONDARY, CAPACITY
2 11.2.4      S N      189 PSST        POWER, SECONDARY, TYPE
3 11.2.4.1 S N         190 PSSM         POWER, SECONDARY, MFGR
1 11.3        R R C1   192 PSPMOD     PSP, MAX OUTPUT DESIGN
1 11.4        R R C1   193 PSPBOL     PSP, BEGIN OF LIFE
1 11.5        R R C1   194 PSPEOL     PSP, END OF LIFE
1 11.6        R R C1   195 PSPMAP     PSP, MAX ARRAY POWER
2 11.6.1      R N      196 PSPBAE      PSP, BETA ANG EXCURSIONS
2 11.6.2      S I C2   197 PSPAAM      PSP, ARRAY ATRICUL, MOUNTING
2 11.6.3      S I C2   198 PSPAAR      PSP, ARRAY ARTICUL, ROTATION
1 11.7        R R C1   199 PAS        POWER, AVG TO SATELLITE
1 11.8        R R C1 D1 201 PAP       POWER, AVG TO PAYLOAD SENSOR
1 11.9        M        202 VOLTAGE    VOLTAGE
2 11.9.1      R R C2   203 VA          VOLTAGE, AVERAGE
2 11.9.2      R R C2   204 VMIN        VOLTAGE, MINIMUM
2 11.9.3      R R C2   205 VMAX        VOLTAGE, MAXIMUM
2 11.9.4      S N      206 VR          VOLTAGE, RANGE
0 12.         M        210 PROPULSION PROPULSION, IN-ORBIT FUNCTIONS
1 12.1        S I      211 PIF1       PROP, IN-ORBIT FUNCTIONS
2 12.1.1      S N      212 PICF1       PROP, IN-ORBIT CAP, FUEL
2 12.1.2      R R C2   213 PICV1       PROP, IN-ORBIT CAP, DELTA V
3 12.1.2.1 S N         214 PIM1         PROP, IN-ORBIT, MFGR
1 12.2        S I      216 PIF2       PROP, IN-ORBIT FUNCTIONS
2 12.2.1      S N      217 PICF2       PROP, IN-ORBIT CAP, FUEL
2 12.2.2      R R C2   218 PICV2       PROP, IN-ORBIT CAP, DELTA V
3 12.2.2.1 S N         219 PIM2         PROP, IN-ORBIT, MFGR
1 12.3        S I      221 PIF3       PROP, IN-ORBIT FUNCTIONS
2 12.3.1      S N      222 PICF3       PROP, IN-ORBIT CAP, FUEL
2 12.3.2      R R C2   223 PICV3       PROP, IN-ORBIT CAP, DELTA V
3 12.3.2.1 S N         224 PIM3         PROP, IN-ORBIT, MFGR
0 13.         M        230 DATARATE   DATA RATE, PAYLOAD PROD.
1 13.1        R R C1 D1 231 DRP       DATA RATE, PAYLOAD
0 14.         M        240 TELEMETRY  TELEMETRY
1 14.1        M        241 TIDENT     TELEMETRY IDENTIFICATION
2 14.1.1      S N      242 TGSC        TELE GROUND SYS COMPATABILITY
2 14.1.2      S N      243 TSC         TELE SYS CONCEPT
3 14.1.2.1 S N         244 TSM          TELE SYS MFGR
1 14.2        M        246 TSSTORAGE  TELE SYS STORAGE
2 14.2.1      S N      247 TSST        TELE SYS STORAGE TYPE
2 14.2.2      I N      248 TSSQ        TELE SYS STORAGE QUANTITY
2 14.2.3      R N      249 TSSC        TELE SYS STORAGE CAPACITY
2 14.2.4      R N      250 TSSRR       TELE SYS STORAGE RECORD RATE
2 14.2.5      R N      251 TSSPR       TELE SYS STORAGE PLAYBACK RATE
2 14.2.6      S N      252 TSSP        TELE SYS STORAGE PROGRAMBLTY
3 14.2.6.1 S N         253 TSSM         TELE SYS STORAGE MFGR
1 14.3        M        255 TDATARATE  TELE DATA RATE
```

2	14.3.1	R	R	C1	256 TDDR	TELE DIGITAL DATA RATE
2	14.3.2	R	R	C1	257 TABB	TELE ANALOG BASEBAND
1	14.4	M			260 TCARRIER	TELE CARRIER
2	14.4.1	R	R	C2	261 TCF	TELE CARRIER FREQUENCY
2	14.4.2	R	R	C2	262 TCFMIN	TELE CARRIER FREQ RANGE MIN
2	14.4.3	R	R	C2	263 TCFMAX	TELE CARRIER FREQ RANGE MAX
2	14.4.4	R	N		264 TCS	TELE CARRIER STABILITY
2	14.4.5	R	N		265 TCB	TELE CARRIER BANDWIDTH
2	14.4.6	S	N		266 TCMT	TELE CARRIER MODULATION TECH
1	14.5	M			267 TCODING	TELE DATA CODING TECH
2	14.5.1	S	I	C2	268 TDCT1	TELE DATA CODING TECH (1)
2	14.5.2	S	I	C2	269 TDCT2	TELE DATA CODING TECH (2)
2	14.5.3	S	I	C2	270 TDCT3	TELE DATA CODING TECH (3)
2	14.5.4	S	I	C2	271 TDCT4	TELE DATA CODING TECH (4)
1	14.6	M			275 TPOWER	TELE TRANSMITTER RF POWER
2	14.6.1	R	R	C2	276 TTRFL	TELE TRANSMITTER RF LEVEL
2	14.6.2	R	R	C2	277 TTRFLT	TELE TRANSMITTER RF TOLERANCE
2	14.6.3	R	R	C2	278 TTEIRP	TELE TRANSMITTED EIRP
2	14.6.4	R	R	C2	279 TTEIRPT	TELE TRANSMITTED EIRP TOL.
1	14.7	M			290 TSCARRIER	TELE SUBCARRIER
2	14.7.1	R	N		291 TSCF1	TELE SUBCARRIER FREQ (1)
2	14.7.2	R	N		292 TSCF2	TELE SUBCARRIER FREQ (2)
2	14.7.3	R	N		293 TSCF3	TELE SUBCARRIER FREQ (3)
2	14.7.4	R	N		294 TSCF4	TELE SUBCARRIER FREQ (4)
2	14.7.5	S	N		295 TSCM1	TELE SUBCARRIER MODUL (1)
2	14.7.6	S	N		296 TSCM2	TELE SUBCARRIER MODUL (2)
2	14.7.7	S	N		297 TSCM3	TELE SUBCARRIER MODUL (3)
2	14.7.8	S	N		298 TSCM4	TELE SUBCARRIER MODUL (4)
2	14.7.9	R	N		299 TSCMI	TELE SUB/CARRIER INDEX
1	14.8	M			300 TCHANNEL	TELE CHANNEL
2	14.8.1	S	N		301 TCT1	TELE CHANNEL TYPE (1)
2	14.8.2	S	N		302 TCT2	TELE CHANNEL TYPE (2)
2	14.8.3	S	N		303 TCT3	TELE CHANNEL TYPE (3)
2	14.8.4	S	N		304 TCT4	TELE CHANNEL TYPE (4)
2	14.8.5	R	N		305 TCC1	TELE CHANNEL CAPACITY (1)
2	14.8.6	R	N		306 TCC2	TELE CHANNEL CAPACITY (2)
2	14.8.7	R	N		307 TCC3	TELE CHANNEL CAPACITY (3)
2	14.8.8	R	N		308 TCC4	TELE CHANNEL CAPACITY (4)
2	14.8.9	R	N		309 TCCT	TELE CHANNEL CODING TECH
0	15.	M			310 COMMAND	COMMAND
1	15.1	M			311 CIDENT	COMMAND IDENTIFICATION
2	15.1.1	S	N		312 CGEC	COMMAND GROUND ENCODER COMPAT
2	15.1.2	S	N		313 CSC	COMMAND SYS CONCEPT
3	15.1.2.1	S	N		314 CSM	COMMAND SYS MFGR
1	15.3	M			317 CDATARATE	COMMAND DATA RATE
2	15.3.1	R	R	C2	318 CDDR	COMMAND DIGITAL DATA RATE
2	15.3.2	R	R	C2	319 CABB	COMMAND ANALOG BASEBAND
1	15.4	M			320 CCARRIER	COMMAND CARRIER
2	15.4.1	R	R	C2	321 CCF	COMMAND CARRIER FREQ
2	15.4.2	R	R	C2	322 CCFMIN	COMMAND CARRIER FREQ RNG MIN
2	15.4.3	R	R	C2	323 CCFMAX	COMMAND CARRIER FREQ RNG MAX
2	15.4.4	R	N		324 CCT	COMMAND CARRIER TOLERANCE
2	15.4.5	R	N		325 CCB	COMMAND CARRIER BANDWIDTH
2	15.4.6	S	N		326 CCBSM	COMMAND CARRIER BIT SYNC MOD.
1	15.5	M			327 CCODING	COMMAND CODING
2	15.5.1	S	N		328 CCDF	COMMAND DATA FORMAT
2	15.5.2	S	N		329 CCWS	COMMAND WORD STRUCTURE
2	15.5.3	S	N		330 CDSM	COMMAND DATA/SUBCARRIER MOD.
1	15.7	M			340 CSCARRIER	COMMAND SUBCARRIER
2	15.7.1	R	N		341 CSCF	COMMAND SUBCARRIER FREQ
2	15.7.5	S	N		345 CSCM	COMMAND SUBCARRIER MOD.
2	15.7.9	R	N		349 CSCMI	COMMAND SUB/CARRIER MOD INDEX

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1 15.8         M       350 CCHANNEL     COMMAND CHANNEL
2 15.8.1     S N       351 CCT          COMMAND CHANNEL TYPE
2 15.8.5     R N       355 CCC          COMMAND CHANNEL CAPACITY
2 15.8.9     S N       359 CCCT         COMMAND CHANNEL CODING TECH
1 15.9         M       360 CRECEIVER    COMMAND RECEIVER
2 15.9.1     S N       361 CRS          COMMAND RECEIVER SENSITIVITY
2 15.9.2     R N       362 CRSMIN       COMMAND RECEIVER SENS MIN
2 15.9.3     R N       363 CRSMAX       COMMAND RECEIVER SENS MAX
2 15.9.6     R N       366 CDBEP        COMMAND DESIGN BIT ERROR PROB
0 16.          M       370 TRACKING   TRACKING
1 16.1         M       371 TRIDENT      TRACKING IDENTIFICATION
2 16.1.1     S I C2    372 TRGSC        TRACKING GROUND SYS COMPAT
2 16.1.2     S I C2    373 TRC          TRACKING CONCEPT
2 16.1.3     S I C2    374 TRCTC        TRACKING COMMAND/TELE COMPAT
3 16.1.3.1   S N       375 TRM          TRACKING MFGR
1 16.2         M       376 TRUL       TRACKING UPLINK
2 16.2.1     S N       377 TRULR        TRACKING UPLINK, REMARKS
2 16.2.2     R R C2    378 TRULF        TRACKING UPLINK FREQUENCY
2 16.2.3     S N       379 TRULMT       TRACKING UPLINK MOD TECH
2 16.2.4     R N       380 TRULMI       TRACKING UPLINK MOD INDEX
2 16.2.5     R N       381 TRULBW       TRACKING UPLINK BANDWIDTH
2 16.2.6     R N       382 TRULRFL      TRACKING UPLINK RF LEVEL
1 16.3         M       383 TRDL       TRACKING DOWNLINK
2 16.3.1     S N       384 TRDLR        TRACKING DOWNLINK, REMARKS
2 16.3.2     R R C2    385 TRDLF        TRACKING DOWNLINK FREQUENCY
2 16.3.3     S N       386 TRDLMT       TRACKING DOWNLINK MOD TECH
2 16.3.4     R N       387 TRDLMI       TRACKING DOWNLINK MOD INDEX
2 16.3.5     R N       388 TRDLBW       TRACKING DOWNLINK BANDWIDTH
2 16.3.6     R N       389 TRDLRFL      TRACKING DOWNLINK RF LEVEL
1 16.4         M       390 TRST       TRACKING SIDETONE
2 16.4.1     S N       391 TRSTR        TRACKING SIDETONE, REMARKS
2 16.4.2     S N       392 TRSTFR       TRACKING SIDETONE FREQ RANGE
2 16.4.3     R N       393 TRSTF        TRACKING SIDETONE FREQUENCY
1 16.5         M       394 TRT        TRACKING TRANSPONDER
2 16.5.1     S N       395 TRTT         TRACKING TRANSPONDER TYPE
1 16.6         M       397 TRPRN      TRACKING PRN
2 16.6.1     R N       398 TRPRNCR      TRACKING PRN CODE RATE
0 17.          M       400 CLOCK      CLOCK
1 17.1       S N       401 CR         CLOCK, REMARKS
2 17.1.1     R R C2    402 CF           CLOCK FREQUENCY
2 17.1.7     R R C2    408 CSS          CLOCK SHORT STABILITY
2 17.1.8     R R C2    409 CLS          CLOCK LONG STABILITY
3 17.1.8.1   S N       410 CM           CLOCK MFGR
```

APPENDIX G

<u>INDEX TERMS FOR THE PROTOTYPE</u>
<u>SATELLITE CATALOG DATA BASE</u>

```
1    ACAA:0.0002/0.0090
5    ACAA:0.010/1.000
1    ACA:0.0002/0.0090
5    ACA:0.010/1.000
2    ACC:101
1    ACC:103
1    ACC:104
1    ACC:105
1    ACC:106
5    ACM:GAS JET
1    AKAA:0.0002/0.0090
3    AKAA:0.010/1.000
2    AKAP:0.010/1.000
2    AKAY:0.010/1.000
1    AKA:0.0002/0.0090
5    AKA:0.010/1.000
2    ARCAY:0.000000000/0.000019999
2    ARCA:0.000000000/0.000019999
1    CCFMAX:100.0/999999.0
1    CCFMIN:100.0/999999.0
2    CCF:1.010/99.999
2    CCF:100.0/999999.0
5    CDDR:1.010/99.999
2    CDDR:100.0/999999.0
6    DLG:1/1000
6    FILE:SATELLITE CATALOG
5    LD1:1001/10000
5    LD:1001/10000
6    LR:ETR
1    LV:ATLAS CENTAUR
5    LV:DELTA 2914
6    PAP:1/1000
6    PAS:1/1000
1    PC:ASTRONOMY
5    PC:COMMUNICATIONS
1    PC:INSTRUMENTATION
6    PICV1:1/1000
5    PICV2:1/1000
1    PICV2:1001/10000
1    PICV3:1/1000
4    PICV3:1001/10000
6    PICV:1/1000
5    PICV:1001/10000
1    PIF1:ATTITUDE ADJUST
1    PIF1:ATTITUDE CONTROL
1    PIF1:INITIAL SPIN-UP ADJUSTMENT
1    PIF1:INITIAL SUN ACQUITION
1    PIF1:ORBIT ADJUST
2    PIF1:ORBIT ADJUSTMENT
1    PIF2:APOGEE BOOST
1    PIF2:ATTITUDE ADJUST
2    PIF2:ATTITUDE ADJUSTMENT
1    PIF2:ORBIT CONTROL
```

```
1   PIF2:SPIN AXIS ORIENTATION
4   PIF3:APOGEE BOOST
1   PIF3:SPIN SPEED CONTROL
5   PIF:APOGEE BOOST
2   PIF:ATTITUDE ADJUST
2   PIF:ATTITUDE ADJUSTMENT
1   PIF:ATTITUDE CONTROL
1   PIF:INITIAL SPIN-UP ADJUSTMENT
1   PIF:INITIAL SUN ACQUITION
1   PIF:ORBIT ADJUST
2   PIF:ORBIT ADJUSTMENT
1   PIF:ORBIT CONTROL
1   PIF:SPIN AXIS ORIENTATION
1   PIF:SPIN SPEED CONTROL
4   PRIME1:HUGHES AIRCRAFT CO.
2   PRIME1:HUGHES AIRCRAFT CO,
4   PRIME:HUGHES AIRCRAFT CO.
2   PRIME:HUGHES AIRCRAFT CO,
1   PROG:OSO (ORBITING SOLAR OBSERVATORY)
2   PROJ:ANIK 2
1   PROJ:COMSAT
1   PROJ:GMS
1   PROJ:INTELSAT IV
1   PROJ:JAPANESE GEOSTATIONARY METEOROLOGICAL SATEL
1   PROJ:MARISAT
2   PROJ:WESTAR
1   PSPAAM:DESPIN
4   PSPAAM:SPINNING CYLINDER
1   PSPAAM:SPUN
5   PSPBOL:1/1000
6   PSPC:SOLAR ARRAY
6   PSPEOL:1/1000
1   PSPMAP:1/1000
5   PSSCAP:1/1000
5   SC:SPIN
1   SC:SPIN (AT 100 OV RPM)
6   SDD:1/1000
6   SDL:1/1000
1   SPONSOR:MARITIME
1   SPONSOR:U.S. NAVY
1   SPRC:SUN
1   ST:EARTH
1   ST:HELMTER
1   ST:HIGH ENERGY CELESTIAL X-RAY
1   ST:MAPPING X-RAY
1   ST:NO SCIENCE PAYLOAD
1   ST:SOLAR ACTIVITY MEASUREMENT
1   ST:SPEC. POLARIMETER
1   ST:SUN
1   ST:UHF, C-BAND, L-BAND TRANSPONDERS
1   ST:VIS/IR SPIN SCAN RADIOMETER
6   SUBFIL:SATELLITE
2   TCFMAX:100.0/999999.0
```

2	TCFMIN:100.0/999999.0
2	TCF:1.010/99.999
4	TCF:100.0/999999.0
2	TDCT1:PAM
1	TDCT1:PCM (MANCHESTER, 8 BIT)
1	TDCT1:PCM NRZ-M
1	TDCT1:PCM, 8 BIT
1	TDCT1:PCM, 8 BIT (MANCHESTER CODED)
1	TDCT1:8 BIT
1	TDCT2:RT - SUN EARTH MASTER INDEX
2	TDCT2:SUBCARRIER MODULATED BY BI-LEVEL DATA
1	TDCT3:RT - SUN EARTH
2	TDCT:PAM
1	TDCT:PCM (MANCHESTER, 8 BIT)
1	TDCT:PCM NRZ-M
1	TDCT:PCM, 8 BIT
1	TDCT:PCM, 8 BIT (MANCHESTER CODED)
1	TDCT:RT - SUN EARTH
1	TDCT:RT - SUN EARTH MASTER INDEX
2	TDCT:SUBCARRIER MODULATED BY BI-LEVEL DATA
1	TDCT:8 BIT
2	TDDR:1/1000
1	TDDR:1001/10000
5	TRAJC:GEOSYNCHRONOUS ORBIT
1	TRAJC:LOW EARTH ORBIT
1	TTEIRP:0.000000000/0.00001999
3	TTEIRP:1.010/99.999
4	TTRFL:1/1000
6	VA:1/1000
6	VMAX:1/1000
6	VMIN:1/1000
4	WSAL:1/1000
2	WSAL:1001/10000
6	WSP:1/1000

APPENDIX H

PROFILES FOR TABULAR DISPLAY OF
SATELLITE CATALOG INFORMATION

PROFILE SHOW

**** AVAILABLE PROFILES ****

****** USERS ******
ID .NAME.
A1 TEST

****** DATA BASE ******
ID .NAME.
B1 PROGRAM AND PROJECT
B2 TRAJECTORY PARAMETERS
B3 SATELLITE LIFE AND WEIGHT
B4 PAYLOAD
B5 LAUNCH
B6 LAUNCH VEHICLE DESIGNATION
B7 LAUNCH VEHICLE MANUFACTURER
B8 STABILIZATION
B9 ATTITUDE CONTROL
B10 CONTROL MECHANISM JETS
B11 ATTITUDE CONTROL LOGIC
B12 ATTITUDE KNOWLEDGE
B13 ATTITUDE REFERENCE SENSOR
B14 ATTITUDE REFERENCE SENSOR MFGR
B15 PRIMARY POWER SOURCE
B16 PRIMARY POWER
B17 SECONDARY POWER
B18 ALL TABLES
DO YOU WISH TO EXECUTE ANY OF THE PROFILES?
/ NO
ENTER YOUR REQUEST

PROFILE EXECUTE PROGRAM AND PROJECT

PROGRAM AND PROJECT   PAGE 1

PROGRAM NAME	PROGRAM SPONSOR	PROJECT NAME	PROJECT MANAGER	PRIME CONTRACTOR
- - - - - - - - - - - - - - -		ANIK 2 WESTAR	- - - - - -	HUGHES AIRCRAFT CO.
- - - - - - - - - - - - - -		WESTAR ANIK 2	- - - - -	HUGHES AIRCRAFT CO.
- - - - - -	U.S. NAVY MARITIME	MARISAT	- - - - -	HUGHES AIRCRAFT CO.
- - - - - - - - - - - - -		GMS JAPANESE GEOSTATIONARY METEOROLOGICAL SATELLITE	- - - - -	HUGHES AIRCRAFT CO,
- - - - - - - - - - - - -		OSO 1 ORBITING SOLAR OBSERVATORY	- - - - -	HUGHES AIRCRAFT CO.
- - - - - - - - - - - - -		INTELSAT IV COMSAT	- - - - -	HUGHES AIRCRAFT CO,

PROFILE EXECUTE TRAJECTORY PARAMETERS

TRAJECTORY PARAMETERS PAGE 1

TRAJECTORY CLASS	TRAJECTORY ALTITUDE	TRAJECTORY INCLINATION	TRAJECTORY ECCENTRICITY	TRAJECTORY PERIOD
GEOSYNCHRONOUS ORBIT	35,789.00	0	0	24
GEOSYNCHRONOUS ORBIT	35,789.00	0	0	24
GEOSYNCHRONOUS ORBIT	35,000.00	0	0	24
GEOSYNCHRONOUS ORBIT	35,000.00	0	0	24
LOW EARTH ORBIT	130.00	30	0	1
GEOSYNCHRONOUS ORBIT	35,000.00	0	0	24

PROFILE EXECUTE SATELLITE LIFE AND WEIGHT

SATELLITE LIFE AND WEIGHT   PAGE 1

DESIGN LIFE GOAL	DESIGN LIFE EXPEND. SIZED	IN-FLIGHT EXPERIENCE	SATELLITE WEIGHT AT LAUNCH	SATELLITE WEIGHT BEGIN OF LIFE	SATELLITE WEIGHT END OF LIFE
7 YR	7 YR	5 YEARS (AGGRAGATE, ALL SATS)	562 KG (EXCLUDING LV ADAPTER)	296 KG	240 KG
7 YR	7 YR	5 YEARS (AGGRAGATE, ALL SATS)	562 KG (EXCLUDING LV ADAPTER)	296 KG	240 KG
5 YR	5 YR	- - - - - - -	318 KG	- - - - - - - - - - -	
5 YR	3 YR	NONE	670 KG (EXCLUDING ADAPTER)	- - - - -	288 KG
1 YR	1 YR	- - - - - - -	1020 KG	- - - - - - - - - -	
7 YR	- - - - - -	0.25 YR	1480 KG	790 KG	667 KG

PROFILE EXECUTE PAYLOAD

PAYLOAD CLASS	WEIGHT OF SENSOR PAYLOAD	SENSOR TYPE EXPERIENCE	SENSOR ACRONYM	STOWED DIMEN. DIA.	STOWED DIMEN. LENGTH	STOWED DIMEN. WIDTH	STOWED DIMEN. HEIGHT
COMMUNICAT IONS	55 KG (TRANSP ONDER AND ANTENNA)	- - - -	- - - - -	185 CM	336 CM	- - -	- - -
COMMUNICAT IONS	55 KG (TRANSP ONDER AND ANTENNA)	- - - -	- - - - -	185 CM	336 CM	- - -	- - -
COMMUNICAT IONS	68 KG	NO SCIENCE PAYLOAD UHF, C-BAND, L-BAND TRANSPON DERS	- - - -	216 CM	381 CM	- - -	- - -
COMMUNICAT IONS INSTRUMENT ATION	109 KG	VIS/IR SPIN SCAN RADIOMET ER SOLAR ACTIVITY MEASUREM ENT	VISSR SEM	216 CM	363 CM	- - -	- - -
ASTRONOMY	383 KG 130 KG (POINTE D) 252 KG (SPINNI NG)	SPEC. POLARIME TER HIGH ENERGY CELESTIA L X-RAY MAPPING X-RAY HELIMETER	- - - -	152 CM	234 CM	- - -	- - -
COMMUNICAT IONS	167 KG	EARTH SUN	- - - -	240 CM	717 CM	- - -	- - -

PROFILE EXECUTE LAUNCH

| | | LAUNCH | | PAGE 1 |
LAUNCH VEHICLE CLASS	LAUNCH DATE	LAUNCH RANGE	LAUNCH PAD
DELTA 2914	1972 1974	ETR	17B
DELTA 2914	1972 1974	ETR	17B
DELTA 2914	1975	ETR	------
DELTA 2914	------	ETR	------
DELTA 2914	1975	ETR	------
ATLAS CENTAUR	1975 1976	ETR	------

PROFILE EXECUTE LAUNCH VEHICLE DESIGNATION

LAUNCH VEHICLE DESIGNATION   PAGE 1

LAUNCH VEHICLE DESIGNATION	STAGE 1 DESIGNATION	STAGE 2 DESIGNATION	STAGE 3 DESIGNATION	STAGE 4 DESIGNATION
DELTA 2914	- - - - - -	- - - - - -	- - - - - -	- - - - - -
DELTA 2914	- - - - - -	- - - - - -	- - - - - -	- - - - - -
DELTA 2914	- - - - - -	- - - - - -	- - - - - -	- - - - - -
DELTA 2914	- - - - - -	- - - - - -	- - - - - -	- - - - - -
DELTA 2914	- - - - - -	- - - - - -	- - - - - -	- - - - - -
ATLAS CENTAUR	- - - - - -	- - - - - -	- - - - - -	- - - - - -

PROFILE EXECUTE LAUNCH VEHICLE MANUFACTURER

LAUNCH VEHICLE MANUFACTURER   PAGE 1

LAUNCH VEHICLE DESIGNATION	STAGE 1 MANUFACTURER	STAGE 2 MANUFACTURE	STAGE 3 MANUFACTURER	STAGE 4 MANUFACUTER
DELTA 2914	- - - - - -	- - - - - -	- - - - - -	- - - - - -
DELTA 2914	- - - - - -	- - - - - -	- - - - - -	- - - - - -
DELTA 2914	- - - - - -	- - - - - -	- - - - - -	- - - - - -
DELTA 2914	- - - - - -	- - - - - -	- - - - - -	- - - - - -
DELTA 2914	- - - - - -	- - - - - -	- - - - - -	- - - - - -
ATLAS CENTAUR	- - - - - -	- - - - - -	- - - - - -	- - - - - -

PROFILE EXECUTE STABILIZATION

| STABILIZATION | STABILIZATION | PAGE 1 |
STABILIZATION CATEGORY	POINTING REFERENCE CENTER	SPIN AXIS POINTING CENTER
SPIN	— — — — — — — — —	ALONG ORBIT NORMAL
SPIN	— — — — — — — — —	ALONG ORBIT NORMAL
SPIN	— — — — — — — — —	ALONG ORBIT NORMAL
SPIN (AT 100 OV RPM)	— — — — — — — — —	ALONG ORBIT NORMAL
SPIN	SUN	NORMAL TO SUN LINE
SPIN	— — — — — — — — —	ALONG ORBIT NORMAL

PROFILE EXECUTE ATTITUDE CONTROL

	ATTITUDE CONTROL			PAGE 1
ATTITUDE CONTROL ACCURACY, REMARKS	ATTITUDE CONTROL ACCURACY, ALL	ATTITUDE CONTROL ACCURACY, PITCH	ATTITUDE CONTROL ACCURACY, ROLL	ATTITUDE CONTROL ACCURACY, YAW
0.17 DEG (N-S) 0.	0.17 DEG 0.09 DEG	- - - - - -	- - - - - -	- - - - - -
0.17 DEG (N-S) 0.	0.17 DEG 0.09 DEG	- - - - - -	- - - - - -	- - - - - -
- - - - - - -	0.65 DEG	- - - - - -	- - - - - -	- - - - - -
- - - - - - -	0.1 DEG	- - - - - -	- - - - - -	- - - - - -
3 SEC ARC OVER 1 ORBIT DAY	0.001 DEG	- - - - - -	- - - - - -	- - - - - -
- - - - - - -	0.2 DEG	- - - - - -	- - - - - -	- - - - - -

PROFILE EXECUTE CONTROL MECHANISM JETS

CONTROL MECHANISM   PAGE 1

CONTROL MECHANISM	CONTROL MECHANISM JET GAS	CONTROL MECHANISM JET SIZE	CONTROL MECHANISM JET MANUFACTURER
GAS JET	HYDRAZINE	1 LBF	HUGHES AIRCRAFT CO.
GAS JET	HYDRAZINE	1 LBF	HUGHES AIRCRAFT CO.
- - - - -	- - - - -	- - - - -	- - - - - - -
GAS JET	HYDRAZINE	- - - - -	HUGHES AIRCRAFT CO.
GAS JET	NITROGEN	0.4 LB	- - - - - - -
GAS JET	- - - - -	5 LB	HUGHES AIRCRAFT CO.

PROFILE EXECUTE ATTITUDE CONTROL LOGIC

ATTITUDE CONTROL LOGIC   PAGE 1

ATTITUDE CONTROL LOGIC,TECHNOLOGY	ATTITUDE CONTROL LOGIC,MANUFACTURER
CLOSED LOOP DESPIN ANALOG SERVO	HUGHES AIRCRAFT CO.
CLOSED LOOP DESPIN ANALOG SERVO	HUGHES AIRCRAFT CO.
DIGITAL CLOSED-LOOP FEEDBACK - NO PROGRAMABILITY	HUGHES AIRCRAFT CO.
ANALOG NULL DESPIN	HUGHES AIRCRAFT CO.
SUN CE	HUGHES AIRCRAFT CO.
- - - - - - - - -	HUGHES AIRCRAFT CO.

PROFILE EXECUTE ATTITUDE KNOWLEDGE

ATTITUDE KNOWLEDGE   PAGE 1

ATTITUDE KNOWLEDGE, REMARKS	ATTITUDE KNOWLEDGE, ALL	ATTITUDE KNOWLEDGE, PITCH	ATTITUDE KNOWLEDGE, ROLL	ATTITUDE KNOWLEDGE, YAW
0.004 DEG RESOLUTION	- - - - -	0.02 DEG	- - - - -	0.02 DEG
0.004 DEG RESOLUTION	- - - - -	0.02 DEG	- - - - -	0.02 DEG
ALLOWED TO DRIFT EACH ORBIT DAY - THEN RESTORED W/I 0.05 DEG	0.05 DEG	- - - - -	- - - - -	- - - - -
- - - - - -	0.1 DEG	- - - - -	- - - - -	- - - - -
1 SEC ARC OVER 1 ORBIT DAY	0.0003 DEG	- - - - -	- - - - -	- - - - -
ALLOWED TO DRIFT EACH DAY, RESTORED TO WITHIN 0.05 DEG OF SPECIFIED SPIN AXIS ATTITUDE	0.05 DEG	- - - - -	- - - - -	- - - - -

PROFILE EXECUTE ATTITUDE REFERENCE SENSOR

ATTITUDE REFERENCE SENSOR   PAGE 1

EARTH	SUN	STAR	MAGNET-OMETER	ELECTRO-MAGNET-OMETER	ACCELER-OMETER	BEACON	OTHER
EARTH	SUN	- - - -	- - - -	- - - -	- - - -	MONOPULSE BEACON	- - - -
EARTH	SUN	- - - -	- - - -	- - - -	- - - -	MONOPULSE BEACON	- - - -
SPINNING EARTH	SUN	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -
EARTH	SUN	- - - -	- - - -	- - - -	ACCELETOME TER (FOR ACTIVE NUTATION CONTROL IN TRANSFER ORBIT)	- - - -	- - - -
- - - -	SUN	STAR	- - - -	- - - -	- - - -	- - - -	- - - -
EARTH	SUN	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -

PROFILE EXECUTE ATTITUDE REFERENCE SENSOR MFGR

ATTITUDE REFERENCE SENSOR MANUFACTURER   PAGE 1

EARTH	SUN	STAR	MAGNET-OMETER	ELECTRO-MAGNET-OMETER	ACCELER-OMETER	BEACON	OTHER
BARNES ENG.	HUGHES AIRCRAFT CO.	- - -	- - - -	- - - -	- - - -	HUGHES AIRCRAFT CO.	- - - -
SERVO CORP.	HUGHES AIRCRAFT CO.	- - -	- - - -	- - - -	- - - -	HUGHES AIRCRAFT CO.	- - - -
HUGHES AIRCRAFT CO.	HUGHES AIRCRAFT CO.	- - -	- - - -	- - - -	- - - -	- - - -	- - - -
HUGHES AIRCRAFT CO.	HUGHES AIRCRAFT CO.	- - -	- - - -	- - - -	SUNSTRAND	- - - -	- - - -
- - - -	HUGHES AIRCRAFT CO.	HUGHES AIRCRAFT CO.	- - -	- - - -	- - - -	- - - -	- - - -
HUGHES AIRCRAFT CO.	HUGHES AIRCRAFT CO.	- - -	- - - -	- - - -	- - - -	- - - -	- - - -

PROFILE EXECUTE PRIMARY POWER SOURCE

PRIMARY POWER SOURCE   PAGE 1

CLASS	DESIGNATION	MANUFACTURER
SOLAR ARRAY	- - - - - - -	HUGHES AIRCRAFT CO.
SOLAR ARRAY	- - - - - - -	HUGHES AIRCRAFT CO.
SOLAR ARRAY	- - - - - - - - - - - - -	
SOLAR ARRAY	- - - - - - -	HUGHES AIRCRAFT CO.
SOLAR ARRAY	- - - - - - -	HUGHES AIRC
SOLAR ARRAY	- - - - - - -	HUGHES AIRCRAFT CO.

PROFILE EXECUTE PRIMARY POWER

PRIMARY POWER SOURCE   PAGE 1

MAXIMUM OUTPUT DESIGN	BEGIN OF LIFE	END OF LIFE	MAXIMUM ARRAY POWER	BETA ANGLE EXCURS- IONS	ARRAY ARTICULA- TION MOUNTING	ARRAY ARTICULA- TION ROTATION
- - - - -	320 W (EQUINOX)	250 W (SUMMER SOLSTICE)	- - - -	23 DEG	SPINNING CYLINDER	- - - - -
- - - - -	320 W (EQUINOX)	250 W (SUMMER SOLSTICE)	- - - -	23 DEG	SPINNING CYLINDER	- - - - -
- - - - -	390 W	305 W (AFTER 5 YRS)	- - - -	23 DEG	SPINNING CYLINDER	- - - - -
- - - - - - - - - -		212 W (SUMMER SOLSTICE)	- - - -	23 DEG	SPUN	- - - - -
- - - - -	464 W	402 W	- - - -	0 DEG	DESPIN	- - - - -
- - - - -	708 W	600 W	23 DEG	- - - -	SPINNING CYLINDER	- - - - -

PROFILE EXECUTE SECONDARY POWER

SECONDARY POWER SOURCE   PAGE 1

CLASS	NUMBER	MAXIMUM POWER	CAPACITY	TYPE	MANUFACTURER
BATTERIES	- - -	- - - -	16 AMP-HR	NICD BATTERY CELLS	GENERAL ELECTRIC
BATTERIES	- - -	- - - -	16 AMP-HR	NICD BATTERY CELLS	GENERAL ELECTRIC
BATTERIES	2	- - - -	10 AMP-HR	NICD BATTERY CELLS	- - - - - - -
BATTERIES	2	- - - -	3 AMP-HRS	NICD BATTERY CELLS	HUGHES EAGLE-PITC
BATTERIES	2	- - - -	12 AMP-HRS	NICD BATTERY CELLS	GENERAL ELECTRIC
- - - - -	- - -	0 FOR ECLIPSE OPERATION	- - - - - -	NICD BATTERY CELLS	GENERAL ELECTRIC

APPENDIX I

EXAMPLES OF PROFILES FOR DATA PLOTS
OF SATELLITE DESIGN PARAMETERS

ENTER YOUR REQUEST
  2/ PROFILE EXECUTE DATA PLOTS

THE FOLLOWING ARE PARAMETERS TO BE SATISFIED
                X VAR ? WSAL
       NUM POINTS ? 18
          SLOPE 1 ? ".42"
          SLOPE 2 ? ".105"
            Y VAR ? WSP
        X TITLE ? SATELLITE WEIGHT
        Y TITLE ? PAYLOAD WEIGHT

ENTER YOUR REQUEST
  2/ DEFINE

WHAT FIELDS DO YOU WANT TO SEE?
ENTER FIELD NUMBERS SEPARATED BY COMMAS OR ALL
   / XM=MAX(WSAL)

DO YOU WANT TO ENTER ANOTHER EXPRESSION?
   / XN=SUM("1.")

HOW MANY ITEMS DO YOU WANT FIRST?
   / 18

DO YOU WANT TO ENTER ANOTHER EXPRESSION?
   / X=CUM("1.")*XM/XN,Y1=".42"*X,Y2=".105"*X

DO YOU WANT TO ENTER ANOTHER EXPRESSION?
   / X3=WSAL,Y3=WSP

DO YOU WANT TO ENTER ANOTHER EXPRESSION?
   / NO

FINISHED WITH PRINT OUT
ENTER YOUR REQUEST
  2/ SAR(LPLOT)

THE FOLLOWING REQUIRED PARAMETERS(S) NEED TO BE ENTERED
Y   X
   / FRAME=3,CHAR(+,-,#),X1=X,Y1=Y1,X2=X,Y2=Y2,X3=X3,Y3=Y3,XLABEL(SATE
   / LLITE WEIGHT),YLABEL(PAYLOAD WEIGHT)

```
  750.+-----------------------------------------------------------         I
      I                                                                     I  I
      I                                                                     I  I
      I                                                              +      I
      I                                                                     I
  600.+                                                        +            I
  P   I                                                                     I
  A   I                                                    +                I
  Y   I                                                +                    I
  L   I                                            +                        I
  O 450.+                                      +                            I
  A   I                                  +                                  I
  D   I                            +      #                                 I
      I                        +                                            I
  W   I                                                                     I
  E 300.+                  +                                                I
  I   I                +                                                    I
  G   I            +                                                        I
  H   I          +                                                          I
  T   I        +                                            #              I
  150.+      +                                                              I
      I                                        #          - -  -           I
      I      +                            - -  -                            I
      I    +      #          - -  -                                         I
      I  +  -  -  -  -                                                      I
   0.+--------------+-------------+-------------+-------------+-------------+
      0.           360.          720.         1080.         1440.        1800.
                            SATELLITE WEIGHT
```

ENTER LPLOT COMMAND

   / STOP

ENTER YOUR REQUEST

  2/

    ABORT

ENTER YOUR REQUEST

  2/ PROFILE EXECUTE DATA PLOTS

THE FOLLOWING ARE PARAMETERS TO BE SATISFIED

          X VAR ? PAP

       NUM POINTS ? 18

         SLOPE 1 ? "275."+"1."

         SLOPE 2 ? "1."

          Y VAR ? PAS

        X TITLE ? SATELLITE AVERAGE POWER

        Y TITLE ? PAYLOAD AVERAGE POWER

ENTER YOUR REQUEST

  2/ DEFINE

WHAT FIELDS DO YOU WANT TO SEE?

   / XM=MAX(PAP)

DO YOU WANT TO ENTER ANOTHER EXPRESSION?
    / XN=SUM("1.")

DO YOU WANT TO ENTER ANOTHER EXPRESSION?
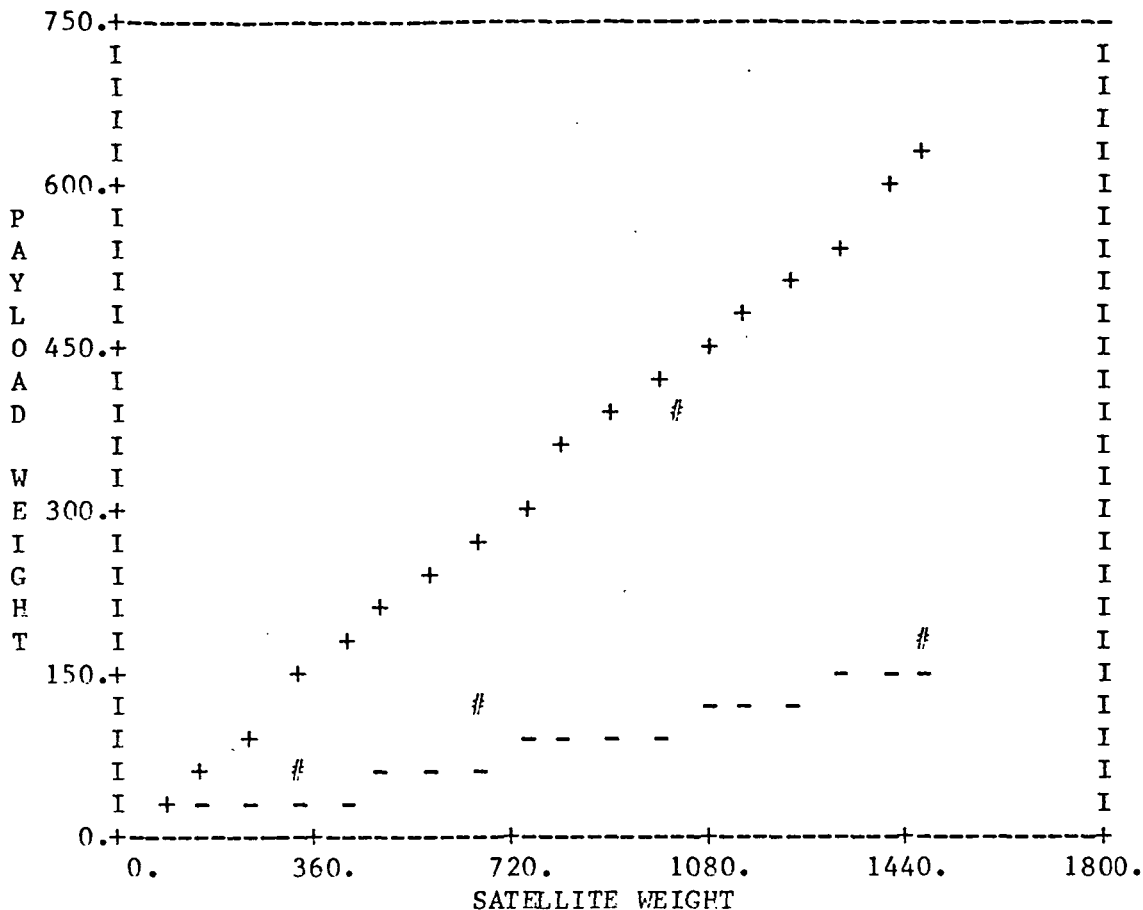   / X=CUM("1.")*XM/XN,Y1="275."+"1."*X,Y2="1."*X

DO YOU WANT TO ENTER ANOTHER EXPRESSION?
    / Y3=PAP,Y3=PAS

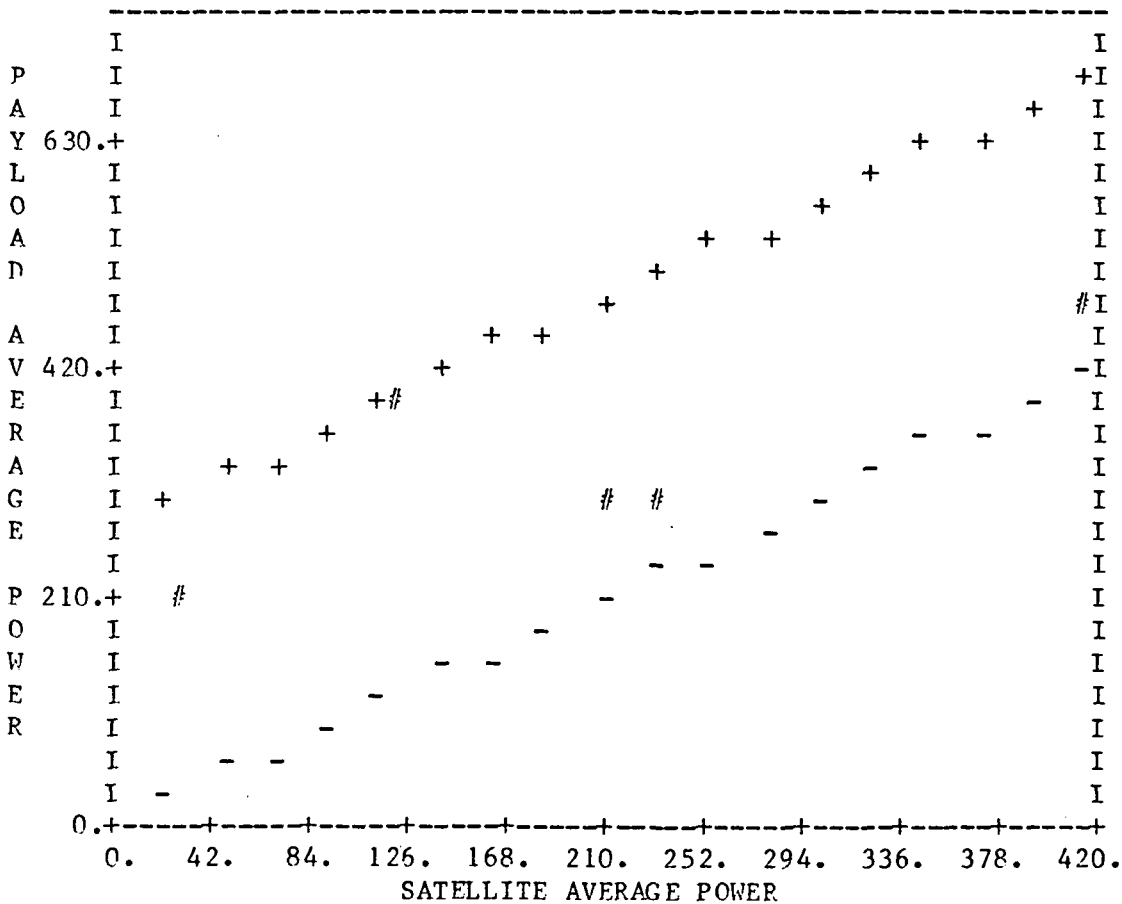DO YOU WANT TO ENTER ANOTHER EXPRESSION?
    / NO

FINISHED WITH PRINT OUT
ENTER YOUR REQUEST
   2/ SAR(LPLOT)

THE FOLLOWING REQUIRED PARAMETERS(S) NEED TO BE ENTERED
Y   X
    / FRAME=3,CHAR(+,-,#),X1=X,Y1=Y1,X2=X,Y2=Y2,X3=X3,Y3=Y3,XLABEL(SATE
    / LLITE AVERAGE POWER),YLABEL(PAYLOAD AVERAGE POWER)

```
       ---------------------------------------------------------------
          I                                                         I
   P      I                                                      +I
   A      I                                                +    I
   Y 630.+                                          +    +    I
   L      I                                    +            I
   O      I                               +                I
   A      I                     +    +                     I
   D      I                +                               I
          I            +                              #I
   A      I       +    +                                   I
   V 420.+              +                            -I
   E      I           +#                          -   I
   R      I         +                        -    -      I
   A      I    +    +                      -           I
   G      I +            #    #        -              I
   E      I                          -               I
          I                       -    -             I
   P 210.+    #                  -                  I
   O      I                  -                       I
   W      I        -    -                            I
   E      I       -                                  I
   R      I     -                                    I
          I  -    -                                  I
          I -                                        I
     0.+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
        0.   42.   84.  126.  168.  210.  252.  294.  336.  378.  420.
                          SATELLITE AVERAGE POWER
```

ENTER LPLOT COMMAND

    / STOP
ENTER YOUR REQUEST
   2/