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DATABASE DEVELOPMENT FOR THE DMSP SSIES EXPERIMENT

Dennis E. Delorey
Paul N. Pruneau
Carolyn M. Parsons

SPACE DATA ANALYSIS LABORATORY
BOSTON COLLEGE
Chestnut Hill, Massachusetts 02167

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INTRODUCTION

This document describes data processing efforts required to generate data bases for researchers analyzing the DMSP SSIES experiment's results for the Air Force.

Chapter 1 provides information on the DMSP project, in general, and is prepared primarily to provide a brief background for analysts new to the effort.

Chapter 2 describes in more detail the SSIES experiments and support electronics on-board the DMSP vehicles.

Chapter 3 provides an overview of the data processing procedures associated with the SSIES experiment.

Chapter 4 describes, in detail, the data reduction procedures used to generate SSIES data bases in geophysical and engineering units.

The Appendices contain detailed information on the data base formats relevant to the SSIES processing effort.

CHAPTER 1. DMSP OVERVIEW

1.1 HISTORICAL PERSPECTIVE

The Defense Meteorological Satellite Program (DMSP) has been in existence since the early 1960's. It has resulted in the successful launch and operation of several polar orbiting satellites designed primarily to provide tropospheric weather data through the use of the Operational Line Scan (OLS) system which images the earth in both the visible light and infra-red bands.

The DMSP vehicles have typically carried secondary sensors designed for the study of the ionosphere, stratosphere, troposphere and ocean surfaces. As the DMSP program has matured and the technology base has increased, the secondary sensors have become correspondingly more sophisticated. The early DMSP vehicles carried only one ionospheric secondary experiment consisting of a simply designed sensor for the measurement of the electrons which cause the aurora. The most recent vehicles have carried a particle spectrometer for the measurement of electron and ion fluxes; a triaxial fluxgate magnetometer; a radiation dosimeter; a thermal plasma monitor; and a scanning X-ray imager.

1.2 PURPOSE OF MISSION

The (OLS) system has been used to produce images of the earth's clouds and aurora. While the cloud images provide the necessary tropospheric data, the auroral images are an invaluable source of information on the auroral regions where increases in activity can cause serious disruptions in communications systems.

This instrumentation provides an excellent means of studying the high-latitude ionosphere which is connected to the magnetosphere. Thus, the study of magnetospheric processes can be accomplished by means of the secondary sensors flown on the DMSP vehicles. The AFGL particle spectrometer, thermal plasma monitor and fluxgate magnetometer provide an excellent combination of experiments to monitor the polar regions. Since the DMSP vehicles pass through the low altitude region of the Van Allen radiation belts, the dosimeter can be used to monitor these regions

in addition to studying the polar cap regions during solar flares.

The purpose of the SSIES experiment is to monitor the ionospheric thermal plasma, which affects communications and operations. The total ionospheric electron content (TEC) determines the phase delay of radio signals. The plasma density and scale height measured by the SSIES instrument, together with other data sources which describe the lower ionosphere, are used to determine TEC on an operational basis. Finally, the SSIES and SSJ/4 measurements can be combined to calculate the rate of joule heating of the lower ionosphere by currents driven by forces from the magnetosphere.

1.3 DESCRIPTION OF VEHICLES

Normally there are two DMSP vehicles in operation at any given time, each with a planned lifetime in orbit of three years. They are both in sun-synchronous orbits with one operating in the dawn-dusk meridian plane (0600: to 1800:) and the other in the meridian plane covering approximately 1030: to 2230:. The altitude of these vehicles is 835-840 kilometers (circular) which results in an orbital period of approximately 101 minutes. The vehicles are non-spinning with the vehicle +X axis pointing vertically to earth throughout the orbit. Momentum wheels located within the spacecraft are used to maintain the desired attitude.

1.4 DESCRIPTION OF EXPERIMENTS

The instruments on board the vehicles are the particle spectrometer (SSJ/4), the triaxial fluxgate magnetometer (SSM), the radiation dosimeter (SSJ-Star), and the thermal plasma monitors (SSIES). A brief description of each of these instruments is included in the succeeding sections of this chapter.

1.4.1 SSJ/4 PARTICLE SPECTROMETER

The SSJ/4 electron and ion spectrometer is the latest version of an instrument which has undergone a series of improvements over the detectors flown on previous DMSP

missions. The energy range from 30 eV to 30 keV is covered in 20 logarithmically spaced channels by the use of four cylindrical electrostatic analyzers (two for electrons and two for ions). Instrument apertures are mounted to look to local zenith. Electron and ion spectra are obtained approximately every second. The telemetry reads out compressed counts which when decompressed are convertible to differential number flux (and hence distribution function).

1.4.2 SSM TRIAXIAL FLUXGATE MAGNETOMETER

The SSM triaxial fluxgate magnetometer is mounted on the body of the DMSP vehicles and has succesfully produced science quality magnetic field measurements. The sensor consists of three separate single axis fluxgate magnetometers which are mounted orthogonally on the spacecraft. Instrument design is the same as the triaxial system flown on the HILAT spacecraft. The instrument obtains 20 magnetic field vector measurements per second. These vector measurements are sent to the telemetry system as compressed counts which are convertable to total magnetic field intensity. Each axis of the triaxial system has a resolution of 12 nT.

1.4.3 SSJ-STAR RADIATION DOSIMETER

The instrument consists of four solid state detectors each of which is mounted behind aluminum shielding of different thicknesses. These shieldings result in thresholds of 1, 2.5, 5, and 10 mev for electrons and 20, 35, 51 and 75 MeV for protons. Telemetry counts readout by each detector are proportional to energy deposition. By summing the energy depositions between fixed energy bands, the total dose for both low and high energy particles can be determined. Pulses per unit time are also recorded and are used to obtain measurements of integral electron and proton flux. Energy depositions above 40MeV are counted as nuclear star events.

1.4.4 SSIES THERMAL PLASMA MONITORS

The SSIES version of the thermal plasma monitors is an enhanced version of the SSIE instrument which was flown on

previous DMSP missions. The SSIES thermal plasma experiment consists of four instruments along with associated electronics. The four instruments are the planar ion driftmeter (IDM), a planar retarding potential analyzer (RPA), a spherical electron langmuir probe (LP) and a planar total ion density trap or scintillation meter (SM). The associated electronics includes a microprocessor used to control the instrument. The SSIES instrument measures ion and electron temperatures or scale heights, the bulk flow velocity of the thermal plasma, the plasma density and its fluctuations, the ratio of light ions (H+ and He+) to 0+ and the differences between the drift velocities of the light ions and drift velocity of 0+.

A more detailed description of the individual SSIES instruments and associated electronics can be found in the succeeding chapter.

CHAPTER 2. OVERVIEW OF SSIES EXPERIMENT

2.1 DRIFTMETER

The driftmeter is similar to one flown on HILAT. In its 'normal' mode, every other measurement represents the ratio of ion current flowing to the left and right halves of the sensor. The alternating measurements represent the ratio of ion current flowing to the top and bottom halves of the sensor. Unlike the HILAT driftmeter, this sensor has only one range. Thus, the ratio is converted into a flow speed of the ions in the horizontal (left to right) and vertical (top to bottom) direction by a simple trigonometric formula. This instrument has two operating modes, normal mode and H+ mode. Normal mode is intended to measure the average drift velocity of all ion species. The H+ mode, experimental in nature and ,therefore, not used often, is intended to separate the measurement of the drift velocities of lighter ions, H+ and He+, from the total ion drift velocity which is dominated by O+.

The instrument makes measurements of the plasma's bulk velocity and, hence, the convection electric field. The sensor measures the two components of the plasma drift velocity along two axes perpendicular to the spacecraft's velocity vector.

2.2 SCINTILLATION METER

The scintillation meter or duct meter is similar to an RPA sensor that never retards ions. In earlier versions of this DMSP sensor, the RPA would dwell at zero voltage for 52 seconds and sweep its voltage for 12 seconds. These two modes have been made into two separate sensors. The scintillation meter now has five ranges and can change ranges at any time.

The scintillation meter measures total ion density and variations in the plasma density over scale lengths from 1 METER to 100 km. This sensor is a simple ion trap (Faraday cup) with no retarding voltage.

2.3 ION RETARDING POTENTIAL ANALYZER

The ion retarding potential analyzer data is processed

to determine the temperatures, masses and densities of the different ion species present, their velocities parallel to the spacecraft's direction of motion and the spacecraft potential. The RPA measures the total flux of ions as a function of a voltage placed upon a screen within the sensor. The 'normal' mode for the RPA sensor is for that voltage to vary from a zero level to a level that repels all thermal ions in four seconds. When all ions are repelled, no current will be measured. The current collected vs voltage level data is fitted to a theoretical curve.

2.4 ELECTRON SENSOR (LANGMUIR PROBE)

The electron sensor is a conducting sphere surrounded by a spherical grid. As the voltage applied to the grid changes, the sphere collects the resulting current. Data from the sensor is used to determine the electron temperature and density and the spacecraft potential.

The sensor measures the total flux of electrons as a function of a voltage placed upon the sensor. The 'normal' mode for the sensor is for that voltage to vary from a level that accelerates thermal electrons to a voltage that repels all thermal electrons in four seconds. At some level, all thermal electrons will be be repelled and a background current of photoelectrons and other electrons will be measured. The processing consists of finding the accelerating and repelling portions of current collected vs. voltage levels data and fitting the two regions to straight lines.

2.5 MICROPROCESSOR

Although not an SSIES sensor, per se, the microprocessor is used to control the SSIES instrument. The microprocessor performs on-board data reduction including calculation of the plasma potential. The instrument does on-board analysis of RPA and electron sensor data.

The sensor is also used to collect data similar to that going into the data stream and to calculate answers similar to the calculations to be done on the ground. Thus, the sensor calculates ion densities and temperatures and, if two ion species are present, downrange drift velocity and spacecraft potential. The processed answers in the data stream are multiplied by constants and saved for future comparisons with the answers from the ground processed answers.

CHAPTER 3. OVERVIEW OF SSIES PROCESSING

3.1 PHASE I (ARCHIVE OF RAW DATA)

Data from each DMSP satellite is stored first in an onboard tape recorder. Approximately once per orbit, the data are transferred to ground stations and relayed to the Air Force Global Weather Central, Offutt AFB, Nebraska. Data from the various sensors are analyzed for various operational needs. Once each day, the raw data from the ionospheric sensors are transferred to tape. The tapes are sent to AFGL for archiving of the data.

The SSIES Phase I database package has several major programs and an interactive program. Since these programs must be run in batch mode, the interactive program provides an interface between the user and the program. The interactive program has four options, which are the four steps towards creating the SSIES database.

The first option concatenates several raw data tapes, that are received from Air Force Global Weather Central (AFGWC), onto a single tape. The SSIES raw data files (IESPREPFILE) are found on each raw data tape and copied to an output tape. The header records and end of files are deleted.

The second option makes a copy of a concatenated tape. This is done so that the database tapes have a secure backup should a tape become unreadable.

The third option edits data from concatenated tapes. It checks for the correct satellite, valid data, and valid times. The data must fall in the user-specified day range (1-5,6-10,11-15,etc.) for a specific year and month. A five day (six days when processing at the end of a 31 day month) range was chosen because the amount of temporary disk storage used to sort the data into the correct time order was becoming excessive. A data base tape is created for the first ten, middle ten, and last ten or eleven days for each month of data.

The fourth option creates a batch file that allows the user to make a copy of a data base tape onto a multifile tape. This option is not used.

3.2 PHASE II (PROCESSING OF RAW DATA INTO GEOPHYSICAL PARAMETERS)

The SSIES Phase II database package accesses the Phase I

SSIES database in order to unpack a specified interval of data. Then, it either runs the data processing routines to produce a scientific database of ionospheric plasma parameters or simply dumps the data to a file for future raw data plotting or printing for debugging.

Packed binary files with ephemeris are generated separately for the driftmeter, scintillation meter, retarding potential analyzer, langmuir probe, and microprocessor.

There is an option to process or to not process the RPA data. A particular RPA subroutine package must be chosen to process the RPA data.

Data is processed in one minute intervals with a variable number of minutes per output record depending upon the experiment. All variables are converted to positive integers and are stored in 8, 16, 24, or 32 bits. If variables are not within an expected range, the associated bits are one filled. Data is separated by day; multiple days may be executed.

3.3 PHASE III (PLOTTING PROCESSED DATA)

Programs have been developed which access the Phase II database to plot the processed data on microfiche. The programs generate routine survey plots of the following quantities as functions of time. From the driftmeter, the program plots the components of the drift velocity perpendicular to the satellite's velocity, from the scintillation meter, total ion density and power from the various filters, and from the langmuir probe, electron temperature and density and spacecraft potential. Also plotted are the measured aperture potential with respect to spacecraft ground and the results of the on-board microprocessor's data analysis.

The plotting program can be run in an interactive mode. The program is menu driven and can display data in more detail for short time periods. Although RPA analysis is not run on a routine basis because of the cpu time required, the RPA data is processed for case studies. The plotting program includes an option to plot total ion density, density of the different ion species, ion temperature aperture potential, spacecraft potential and downrange drift velocity.

Additional computer programs to calculate electric fields from the driftmeter and RPA data, and integrated potential along the satellite track from driftmeter data are in the development stage.

CHAPTER 4. SSIES PROCESSING SYSTEMS

4.1 PHASE I (ACCESS AND UNPACK DATA FROM AGENCY TAPES)

The SSIES Phase I data base package begins by concatenating SSIES raw data from several tapes, that contain data from various DMSP experiments. The header records and end of files that separate one experiment from another on the agency tapes are deleted.

The concatenated tapes contain records consisting of a bit stream of Univac 36 bit words that must be appropiately unpacked according to data type and stored into 60 bit words on the Central Data Corporation Cyber 180 using the NOS operating system. These records contain data from multiple time intervals, referred to as playbacks, comprised of information records followed by data records.

4.2 PHASE I (EDIT DATA ACCORDING TO TIME CONSTRAINTS)

Because the time order from one playback to another is random and the order within a playback is usually in reverse chronological order, the times are quality checked. If the time interval or the satellite identification on the information record is not what the user wants,the data for this playback is excluded.

The ephemeris times, associated with each data record, are also quality checked. If the year or day is not within the requested range or the time is less than zero or greater than 86400 seconds, the data for this record is eliminated.

If the sync value for a particular second of telemetry data is incorrect, the time for this second is set to 99999999 and the data is subsequently eliminated. An attempt is made to assign the proper day number with total seconds. Each data record is divided and stored into a file of ephemeris data and a file of telemetry data channels. A system sort routine is then used to put the file of ephemeris data into chronological order.

As the data on the concatenated tapes is quality checked, selected ephemeris parameters for the first, last, and every thirtieth record within an accepted playback interval are printed. For each concatenated tape processed, a printout of which playbacks have been rejected and which have been accepted is generated.

4.3 PHASE I (EDIT FILE OF TELEMETRY DATA)

The file of telemetry data must be further edited. Due to digitization problems, times associated with a telemetry stream may be duplicated, missing, or incorrect.
Time values greater than or equal to 86400 may mean that the satellite clock has not been properly reset. If, after subtracting 86400 from these times, the time for a second still exceeds 86400, the data associated with this second is eliminated. If a time value is encountered that is not near its neighbors, this second of data is eliminated. If three time values that are the same are encountered, an attempt is made to shift a value into a vacant slot. If an appropriate vacant slot cannot be found, this second of data is eliminated.

This editing procedure only uses eleven consecutive values. Because there may be an overlap of several minutes of data between playbacks, these duplicated times have not been eliminated.

A disk file consisting of day, time, and 120, nine bit words of telemetry data is created. Every hundredth set of sixty consecutive day and time values is printed as this file is generated. A system sort routine is used to put this telemetry file into chronological order. Duplicate times between playbacks remain.

4.4 PHASE I (INTERPOLATE EPHEMERIS AT EVEN MINUTE)

Ephemerides values are interpolated at each even minute contained within the time interval covered by the ephemeris data. The time at the even minute must be bound by unequal times.

A linear interpolation is performed on the ephemeris parameters: geodetic latitude and longitude. The interpolation is accomplished by constructing two successive unit position vectors surrounding the time, in question, and linearly interpolating between each of the three respective components of these two vectors. The new latitude and longitude values are then derived from the components of the normalized resultant position vector.

Linear interpolation is performed on the altitude at the beginning and end of the interval in question, each of the components of the position vector in the earth centered inertial system of base vectors, and the angle on the

orbital plane between the ascending node and satellite
location.

4.5 PHASE I (MERGE AND PACK OUTPUT)

The file of ephemeris data that has been interpolated at
each even minute is merged with the file of telemetry
channel data that has been edited. If there is no channel
data for a particular minute, the ephemeris for this minute
is deleted. A time bit map word is constructed so that, when
a bit is set, data exists for a particular second following
the even minute.
    Examples:
        7777777777777777777B (All seconds exist)
          0077777777777777777B (First six seconds missing)

If data for a particular second is missing, the
telemetry stream is packed continuously with zero fill at
the end of existing data to ensure that the same number of
words will be used for each minute. Duplicate telemetry
seconds of data are eliminated. The number of seconds that
are rejected is listed on the output.
    At each even minute corrected geomagnetic latitude and
longitude at the sub-satellite point are calculated using
subroutine CGLALO. Using subroutines MGFLD2, LINTRA, and
CONVERT geographic latitude (CLAT) and longitude (CLON) at
110km, invariant latitude, Bx, By and Bz are calculated.
Using CLAT and CLON the geomagnetic latitude and longitude
at 110km is calculated using subroutine CGLALO. The magnetic
local time at 110km and the geographic latitude and
longitude at the subsolar point are calculated using
subroutine MAGTIM.
    The ephemeris values and telemetry data are packed into
sixty bit words according to the format described in
Appendix B. Thus, at the end of the Phase I level of
processing a database has been created which contains the
data in chronological order to be used as input in the Phase
II processing.

4.6 PHASE II (COMPUTE GEOPHYSICAL QUANTITIES)

Program Phase II reads in time ordered, raw SSIES data
from Phase I. The user requests a time interval beginning at

a particular day and time and ending at a particular day and time. Within this time interval data is unpacked.

If meaningful physical quantities are to be produced, the user specifies whether or not to process the RPA experiment and to turn on the RPA debugging prints. If an RPA database is to be created, the user specifies the name of the RPA subroutine package to be loaded with the program as each package takes up a considerable amount of space. These RPA options are included because the data is questionable, at times, and relatively time consuming to process on the computer.

Each physical record of data contains three logical records that represent one minute of data each. Each minute of data contains seven header words and eighteen words per second of data. Each minute is unpacked separately. The telemetry stream of 120, nine bit words is unpacked and stored into arrays as exhibited in Table 1 for each second of existing data. The variable, N, in Table 1 refers to the particular second within a minute of data. Using the time bit map word, if a second is missing the arrays are padded with a garbage value. If the first bit of the first housekeeping word, cycle value, is the same for two successive seconds, the arrays associated with the latter second are filled with a garbage value.

If the data is not to be processed into physical quantities, the unpacked data stream is dumped to a file for future raw data plotting or printing. Six records of ephemeris values and unpacked instrument readings are generated for each minute.

If a database is to be created for each experiment, the next minute is read in to determine the cycle value, if the data starts at second zero, and if the data for the first second exists. If time and the cycle count are increasing sequentially and the housekeeping flags indicate the satellite is in the proper mode, the data for this second is processed. If there is a time gap the data for the following second is eliminated.

4.7 PHASE II (PACK ACCORDING TO EXPERIMENT)

The data is processed in intervals of one minute and stored separately according to experiment on different disk files. The physical record size and the number of minutes of data within a record for each experiment are fixed. If there

is no data for an entire minute subsequent data is packed
continuously without filling for the missing minute.

For each experiment, each set of data for each minute
begins at specified word and bit locations to ensure that
each minute of data has the same length of bytes. Zero fill
is used to maintain the proper length. (See Appendix C)

Each minute of data contains the satellite and data file
identification, ephemeris parameters, and data values
associated with the experiment. Since the data is packed
within sixty bit words, all values are stored as positive
integers. If the value of a data word could be negative, a
bias is added to the value to ensure that it is always
stored as a positive. This bias value is noted in
parentheses in the description of each variable in Appendix
C. If a value exceeds its range the bytes associated with
the value are one filled.

When the end of the time range or an end of file is
reached the remaining minutes, if any, stored in core are
written to the appropriate disk file. The disk files are
rewound and copied to tape in the order described in
Appendix C. A message is written to indicate disk files have
been successfully copied to tape. If more days are to be
processed, the program reads the next record of data. If a
double end of file has been reached a message is printed
indicating that Phase II has finished executing.

TABLE 1: PHASE II PROGRAM VARIABLE NAMES

Each word = 9 bits
120 words = 1 second of raw data

word 1	2	3	4	5	6	7	8	9	10
HKP 1,N	SCIN 1,N	RPA 1,N	ELEC 1,N	SWPMON 1,N	DRIFT 1,N	SCIN 2,N	RPA 2,N	ELEC 2,N	SMFILT 1,N
11	12	13	14	15	16	17	18	19	20
SMFILT 2,N	SCIN 3,N	RPA 3,N	ELEC 3,N	SWPMON 2,N	DRIFT 2,N	SCIN 4,N	RPA 4,N	ELEC 4,N	SMFILT 3,N
21	22	23	24	25	26	27	28	29	30
SMFILT 4,N	SCIN 5,N	RPA 5,N	ELEC 5,N	SWPMON 3,N	DRIFT 3,N	SCIN 6,N	RPA 6,N	ELEC 6,N	SMFILT 5,N
31	32	33	34	35	36	37	38	39	40
SMFILT 6,N	SCIN 7,N	RPA 7,N	ELEC 7,N	SWPMON 4,N	DRIFT 4,N	SCIN 8,N	RPA 8,N	ELEC 8,N	SMFILT 7,N
41	42	43	44	45	46	47	48	49	50
SMFILT 8,N	SCIN 9,N	RPA 9,N	ELEC 9,N	SWPMON 5,N	DRIFT 5,N	SCIN 10,N	RPA 10,N	ELEC 10,N	SMFILT 9,N
51	52	53	54	55	56	57	58	59	60
SMFILT 10,N	SCIN 11,N	RPA 11,N	ELEC 11,N	SWPMON 6,N	DRIFT 6,N	SCIN 12,N	RPA 12,N	ELEC 12,N	HKP 2,N DM LLB

WD 61	62	63	64	65	66	67	68	69	70
HKP 3,N	SCIN 13,N	RPA 13,N	ELEC 13,N	SWPMON 7,N	DRIFT 7,N	SCIN 14,N	RPA 14,N	ELEC 14,N	HKP 4,N
71	72	73	74	75	76	77	78	79	80
HKP 5,N	SCIN 15,N	RPA 15,N	ELEC 15,N	SWPMON 8,N	DRIFT 8,N	SCIN 16,N	RPA 16,N	ELEC 16,N	HKP 6,N
81	82	83	84	85	86	87	88	89	90
HKP 7,N	SCIN 17,N	RPA 17,N	ELEC 17,N	SWPMON 9,N	DRIFT 9,N	SCIN 18,N	RPA 18,N	ELEC 18,N	HKP 8,N
91	92	93	94	95	96	97	98	99	100
HKP 9,N	SCIN 19,N	RPA 19,N	ELEC 19,N	SWPMON 10,N	DRIFT 10,N	SCIN 20,N	RPA 20,N	ELEC 20,N	HKP 10,N
101	102	103	104	105	106	107	108	109	110
HKP 11,N	SCIN 21,N	RPA 21,N	ELEC 21,N	SWPMON 11,N	DRIFT 11,N	SCIN 22,N	RPA 22,N	ELEC 22,N	HKP 12,N
111	112	113	114	115	116	117	118	119	120
HKP 13,N	SCIN 23,N	RPA 23,N	ELEC 23,N	SWPMON 12,N	DRIFT 12,N	SCIN 24,N	RPA 24,N	ELEC 24,N	HKP 14,N

HKP = Housekeeping and microprocessor data
SCIN = Scintillation meter data
RPA = Retarding Potential Analyzer data
ELEC = Electron Sensor data
SWPMON = Applied voltages on swept grids of RPA and ELEC
DRIFT = Ion Driftmeter data

APPENDIX A - AGENCY TAPE FORMAT

        Data tapes are produced at AFGWC, Omaha, Nebraska.
    Each tape contains a series of files with each file
having the data from a particular experiment (data from
multiple spacecraft for the same experiment may be on the
same file). Each file consists of a header record followed
by multiple playbacks. Each playback contains an information
record and multiple data records. The formats for these
record types follow. All words are Univac 36 bit words; all
physical records are 672, CDC 60 bit words in length.
        In general, data for a particular day will overlap files
and probably overlap tapes. The time order from one playback
to another is random, and the order within a playback is
probably in reverse chronological order. Data may simply be
missing or repeated a number of times.

    Header Record:

    The header record contains 20 Univac 36 bit words of
information for the first playback followed by eight zero
filled words. The succeeding 28 words contain information
for the second playback, etc.. These words are followed by
zero filled words to bring the record to the specified
length. The word definitions are as follows:

Word No. Bits Description
   ------- ---- -----------
     1   1-36 Processing batch number (I)
     2   1-36 Satellite ID (eg. WX9543) (A)
     3   1-36 Playback rev number (I)
     4   1-36 Nodal longitude x 10 (I)
     5   1-36 Nodal Julian hour (I)
     6   1-6   Nodal day (I)
           7-12 Nodal month (I)
           13-24 Nodal year (I)
           25-36 Nodal time - HHMM (eg. 2359) (I)
     7   1-36 Beginning address (I)
     8   1-36 Ending address + 1 (I)
     9   1-36 Number of logical data records in playback (I)
    10   1-12 Julian day of first record in playback (I)
           13-18 Filler
           19-24 Hour of first playback (I)
           25-30 Minute of first playback (I)
           31-36 Second of first playback (I)

        A-1

```
   11      1-12  Julian day of last playback (I)
           13-18 Filler
           19-24 Hour of last playback (I)
           25-30 Minute of last playback (I)
           31-36 Second of last playback (I)
   12      1-36  Number of physical records in playback (I)
   13      1-36  Number of playbacks (I)
   14      1-36  Namel                          (A)
   15      1-36  Namem   Identifying            (A)
   16      1-36  Namer       Experiment         (A)
   17      1-36  Playback rev number (I)
   18      1-36  Frame count (I)
   19      1-36  Number of time code discontinuities (I)
   20      1-36  Tape physical record size (e.g.1120 words)(I)
21-28            Zero filled

29-56            Words 1-28 repeated for the next playback
57-84            "    "     "     "    "   "     "
```

Information for each playback within this file is stored in this header record. After the last word of information the remaining words are zero filled to bring the record to the specified length of 1120, 36 bit words.

Information Record:

The information record for each playback contains the same twenty-eight words as in the header record for that playback. The remaining words are zero filled to bring the record to the specified length.

Data Records:

Folowing the information record are the data records for this playback. Each data record has the ephemeris data for a one minute period followed by the telemetry data in 60 one second intervals, consisting of a sync word, time word, and telemetry data.

Ephemeris Data: All words are 36 bit Univac words.

Word No Description
   ------- -----------
    1   Lat1 geodetic - radians (R)
    2   Long1 - radians (R)

                A-2

```
 3      Alt1 - NM (I)
 4      Julian day1 (I)
 5      Time1 - Time of first readout on record-seconds (I)
 6      Lat2 - As above for 60 seconds earlier (R)
 7      Long2 - As above for 60 seconds earlier (R)
 8      Alt2 - As above for 60 seconds earlier (R)
 9      Julian day2 - As above for 60 seconds earlier (R)
10      Time2 - As above for 60 seconds earlier (R)
11      X1 Position (R)
12      Y1 Position (R)
13      Z1 Position (R)
14      X2 Position for 60 seconds earlier (R)
15      Y2 Position for 60 seconds earlier (R)
16      Z2 Position for 60 seconds earlier (R)
17      Lat1A x 10000 - Geodetic - radians (I)
18      Long1A x 10000 - radians (I)
19      Alt1A - NM (R)
20      Lat2A - As above for 60 seconds earlier (I)
21      Long2A - As above for 60 seconds earlier (I)
22      Alt2A - As above for 60 seconds earlier (R)
23      Sath angle 1 (R)
24      Sath angle 2 (R)
25      Dummy (I)
26      Dummy (I)
27      Dummy (I)
28      Dummy (I)
29-1120 Sixty sets of sync, time, and telemetry follow. (I)
        The time is in bits 10-36 of the second word.
        (Seconds is obtained by dividing the integer
        value by 1024.) For the SSIES experiment, there
        are 120, 9 bit words per second. Thus, data records
        require 28 + 60(30 + 2) = 1948 Univac words per
        minute. With a block size of 1120 words, GWC will
        require one physical record plus a portion of
        another record to store one minute of data. The
        first record will have a full 1120 word record of
        flight data; the second record will have 828 data
        words followed by 68 zero filled words. The second
        logical record begins at word 897 of the second
        physical record. Refer to Figure 1.
```

```
R.N. 1      2     3     4     5     6     7     8     9    10
     ------ ----- ----- ----- ----- ----- ----- ----- ----- -----
     |    | |   | |   | |   | |   | |   | |   | | 156 | |   | |   |
     |    | |   | |   | |   | |   | | 380| |   | |  +  | |   | |   |
     |    | |   | |   | | 604| |   | |  + | |   | | 68  | |   | |   |
     |    | | 828| |   | |  + | |   | | 68 | |   | |words| |   | |   |
     |1120| |  + | |1120| | 68 | |1120|words| |1120|-----| |1052| |1120|
     |36-bit| | 68 |words|words|words|-----|words|     | |  + |words|
     |words| |words| |   | -----| |   | |   | |   | | 896 | | 68 | |   |
     |    | |   | |   | |   | |   | | 672|     |words|words| |   |
     |    | |-----| |   | | 448| |words|     | |   | |   | |   |
     |    | | 224| |   | |words| |   |     |   | |   | |   | |   |
     |    | |words| |   | |   |     |   |     | |   | |   | |   |
     ------ ----- ----- ----- ----- ----- ----- ----- ----- -----
```

R.N. = Physical record number.

Logical record no. 1 consists of 1120 words plus 828 words
plus 68 zero filled words.

Logical record no. 2 consists of 224 words plus 1120 words
plus 604 words plus 68 words. (etc.)

Logical record no. 5 ends evenly on the ninth record.

The sequence is repeated beginning at physical record no. 10.

Figure 1

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APPENDIX B - PHASE I DATABASE FORMAT

                  SSIES FORMAT - DMSP/F8/F9/F10

     There are 3264 words per physical record. Each record
contains 3 minutes of data. For each minute there is
ephemeris data and exactly 60 frames of telemetry data (one
frame per second). Each minute of data requires 1087 (60
bit) CDC words. The three minutes of data are stored in
words 1-3261. Word 3262 contains a code word to identify the
spacecraft. The remaining two words are vacant (zero fill).
The last record of data for a day is followed by an End of
File. If the last record for a day does not contain three
minutes of SSIES data, the day number following the last
good set of data is set to 999 and the remainder of the
record is zero filled.
     Should data be missing due to telemetry dropout or other
reasons, zero fill is used at the end of the good data. The
use of zero fill guarantees that all one minute groups are
the same size. A 60 bit mapping word is used to indicate
whether or not data exists for a particular second for the
associated minute of data. If bit 60 is set to 1, the data
for the zero second exists; if bit 59 is set to 1, the data
for the next second exists, etc..
     All angles are in degrees and the altitude is in
nautical miles. In the bit numbering sequence below, bit 60
is the most significant bit of a CDC word and bit 1 is the
least significant bit.

     CDC
     Word Bits Description
     ---- ----- -----------
      1   60-49 Geographic longitude(GLON)[X10]
          48-37 Geographic latitude(GLAT)[X10]
          36-31 Second(IS)
          30-25 Minute(IM)
          24-19 Hour(IH)
          18- 7 Day of year (JDAY)
           6- 1 Year (IYR) [Year=Year-50]
      2   60-49 Geomagnetic latitude at 110 km (RMLAT)[X10]
          48-37 Geomagnetic longitude at satellite(GMLONST)[X10]
          36-25 Geomagnetic latitude at satellite(GMLATST)[X10]
          24-13 Geographic longitude at subsolar point(ALON)[X10]
          12- 1 Geographic latitude at subsolar point(DEC)[X10]

```
3    60-49 Alt. at beginning of ephem. minute(ALTBEG)-NMI
     48-37 Invariant latitude (RNVARLT)[X10]
     36-25 Geographic longitude at 110 km  (CLON)[X10]
     24-13 Geographic latitude at 110 km (CLAT)[X10]
     12- 1 Geomagnetic longitude at 110 km (RMLON)[X10]
4    60-41 X coordinate of satellite in ECI (XECOS)[X10**5]
     40-23 Magnetic local time at 110 km (RMLT)-SEC
     22-11 Alt. at end of ephemeris minute (ALTEND) - NMI
     10- 1 Filler
5    60-41 BX in 10ths of gamma
     40-21 Z coordinate of satellite in ECI (ZECOS)[X10**5]
     20- 1 Y coordinate of satellite in ECI (YECOS)[X10**5]
6    60-41 BZ in 10ths of gamma
     40-21 BY in 10ths of gamma
     20- 1 Filler
7    60- 1 Mapping word(IMAP)
  8-1087       60 groups of 18 words (one group per sec.)
1088-2174      Repeat order of words 1-1087 for next minute
2175-3261      Repeat order of words 1-1087 for next minute
   3262  60- 1 Satellite id (integer; 8 for satellite F8,
                                    9 for satellite f9)
3263-3264      Vacant (zero fill)
```

    NOTES:
1.The 18 CDC words containing the telemetry data actually
consist of 120 9 bit words (since the SSIES telemetry rate
is 1080 bps).

2.For XECOS, YECOS and ZECOS, if the MSB of the 20 bit word
is set to 1, the value is negative. To obtain the proper
negative number subtract 1048575 from the value stored in
the 20 bits.

3.For BX, BY and BZ, if the MSB of the 20 bit word is set
to 1, the value is negative. Use the same procedure
described in 2. above to get the proper value.

4.For all latitude values, if the MSB of the 12 bit word is
set to 1, the number is negative. To obtain the proper
negative number, subtract 4095 from the value stored in the
12 bit word.

APPENDIX C - PHASE II DATABASE FORMAT

The files of processed values for one day of SSIES data have
the following organization :

```
     FILE                      RECORD                      BITS
---------------   ------------------------------------   ------
Driftmeter (DM)   <packed data w/ephemeris - 10 mins> (3056
 data file        <packed data w/ephemeris - 10 mins>  60-bit
                      .                                    words)
                      .
                      .
last rec. of day  <packed data w/ephemeris - 10 mins or less>
                  <EOF>
Scintillation     <packed data w/ephemeris - 10 mins> (2656
meter (SM) data   <packed data w/ephemeris - 10 mins>  60-bit
 file                 .                                    words)
                      .
                      .
last rec. of day  <packed data w/ephemeris - 10 mins or less>
                  <EOF>
Ion Retarding     <packed data w/ephemeris - 20 mins> (1312
Potential Analy-  <packed data w/ephemeris - 20 mins>  60-bit
zer (RPATEX,          .                                    words)
RPAEWA, etc.)        .
data file *          .
last rec. of day  <packed data w/ephemeris - 20 mins or less>
                  <EOF>
Electron Langmuir <packed data w/ephemeris - 20 mins> (992
Probe (ELEC) data <packed data w/ephemeris - 20 mins>  60-bit
file                  .                                    words)
                      .
                      .
last rec. of day  <packed data w/ephemeris - 20 mins or less>
                  <EOF>
Microprocessor    <packed data w/ephemeris - 20 mins> (1312
(MICRO) data file <packed data w/ephemeris - 20 mins>  60-bit
                      .                                    words)
                      .
                      .
last rec. of day  <packed data w/ephemeris - 20 mins or less>
                  <EOF>
DM data file for    ..
next day            ..
                  <EOF>
```


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```
SM data file for      ..
next day              ..
                      <EOF>
RPA data file for     ..
next day *            ..
                      <EOF>
ELEC data file        ..
for next day          ..
                      <EOF>
Microprocessor        ..
file for next day     ..
                      <EOF>
(Repeated for as      ..
many days of data     ..
as the tape will      ..
hold)                 ..
                      ..
                      <EOI>
```

   * NOTE:

   Since the RPA processing is very time consuming, it is
anticipated that the RPA data files will be missing for most
(and perhaps all) days of routine processing. In such a
case, the output tape has 4 files per day instead of 5 files
per day.

   ****

PHASE II OUTPUT RECORD FORMAT

    Each record consists of a series of ephemeris words packed into bytes followed by a series of data words for 1 minute of data packed into bytes. The packed ephemeris and data words for the 2nd, 3rd, ... , Nth minute follow. Bytes from the end of the Nth minute of data to the end of the physical record are dummy filled.

    Packing consists of converting all variables into integers and placing 8-bit (1 byte) or 16-bits (2 bytes) or 24-bits (3 bytes) or 32-bits (4 bytes) into an output array. The tables below show: 1) the names of the variables output, 2) the definition of the variables output, 3) the internal type of the variable, 4) the expected range of the variable, and 5) the number of bytes used to store the

    variable in the output array. The expected range also indicates the number of significant numbers being packed. For example, an expected range of '0.0 - 180.0' indicates that one significant digit passed the decimal point is packed; and an expected range of '0.-18D.' indicates that one significant digit before the decimal point is dropped before packing.

    Variables not within the expected range are set to FF (Hex) or FFFF (Hex) or FFFFFF (Hex) or FFFFFFFF (Hex). Variables which are internally represented as a character string are converted into a set of 8-bit bytes; each byte represents one character. 41 (Hex) to 5A (Hex) will represent the characters A to Z; 30 (Hex) to 39 (Hex) represent the character 0, 1, ..., 9; 20 (Hex) represents the blank or space character.

    ****

INTERNAL NAME OF VARIABLE	DESCRIPTION (BIAS)	INTERNAL TYPE	EXPECTED RANGE	NO OF BYTES
-----	Spacecraft ID	CHAR	F8 - F20	5
-----	Data File ID (Driftmeter= 'DM ' Scintilation Meter = 'SM ' Ion RPA = 'RPATEX' [Univ of Texas, Dallas version] or 'RPAEWA' [Ewa Lewin's version] or 'RPADWF' [Dan Weimer's fast version] or 'RPADWS' [Dan Weimer's slow (SIMPLEX) version])	CHAR	----	6
year	year [Year -1950]	I	37 - 99	2
jday	julian date	I	1 - 366	2
hour	hour of day - hr	I	0 - 24	1
min	minute of hour - min	I	0 - 59	1
geolat	geographic latitude - deg (+90.)	F	0. - 180.0	2
geolong	geographic longitude - deg	F	0. - 360.0	2
maglat	geomagnetic latitude at sub-satellite pt. - deg (+90.)	F	0. - 180.0	2
mlt	magnetic local time at 110km field line intercept - hr	F	0. - 24.0	2
maglong	geomagnetic longitude at sub-satellite pt. - deg	F	0. - 360.0	2
glatsol	geographic latitude of sub-solar pt - deg (+90.)	F	0. - 180.0	2
glonsol	geographic longitude of sub-solar pt - deg	F	0. - 360.0	2
glat110	geographic latitude at 110 km - deg (+90.)	F	0. - 180.0	2
glon110	geographic longitude at 110 km - deg	F	0. - 360.0	2
mlat110	geomagnetic latitude at 110 km - deg (+90.)	F	0. - 180.0	2
mlon110	geomagnetic longitude at 110 km - deg	F	0. - 360.0	2
invlat	invariant latitude - deg	F	0. - 90.0	2
alt1	altitude at the start of minute - n.mi.	I	400 - 500	2
alt2	altitude at the end of minute - n.mi.	I	400 - 500	2
bx	x-component of model mag. field at satellite, local verticle coord - nT (+70,000.)	F	0.- 140000.0	4

by	y- comp of model field at sat. - nT (+70,000.)	F 0.- 140000.0	4
bz	z- comp of model field at sat. - nT (+70,000.)	F 0.- 140000.0	4
ex	x-component of satellite position unit vector in earth-centered inertial coordinates (+1.)	F 0. - 2.00000	3
ey	y-component of satellite position inertial unit vector (+1.)	F 0. - 2.00000	3
ez	z-component of satellite position inertial unit vector (+1.)	F 0. - 2.00000	3
ssenpot	potential control mode flag vbias (0) or senpot (1)	I 0 - 1	1
svbias	potential difference between s/c and electron probe ground - volts (+10.)	I 7 - 38	1
svip	potential difference between ion array and electron probe ground - volts (+3)	I 0 - 3	1
srepel	drift meter repeller grid functions (dm status)	I 0 - 16	1
sifree	scintillation meter filter range commands	I 0 - 16	1

TOTAL FOR GROUP =   71

DRIFTMETER GROUP OF DATA

INTERNAL NAME OF VARIABLE	DESCRIPTION (BIAS)	INTERNAL TYPE	EXPECTED RANGE	NO OF BYTES
ndm	no. of sets of dm outputs for this minute	I	1 - 60	1
	SUB-TOTAL FOR HEADER GROUP =			1
sec	sec of min for 1st dm set - sec	I	0 - 59	1
vx	vertical vel., 1st sample of sec - m/sec (3000.)	F	0 - 600D.	2
vx	vertical vel. - 2nd sample (normal mode); 1st of raw data (H+ mode)	F	"	2
vx	vertical vel. - 3rd sample (normal mode); 2nd of raw data (H+ mode)	F	"	2
vx	vertical vel. - 4th sample (normal mode); 3rd of raw data (H+ mode)	F	"	2
vx	vertical vel. - 5th sample (normal mode); 4th of raw data (H+ mode)	F	"	2
vx	vertical vel. - 6th sample (normal mode); 5th of raw data (H+ mode)	F	"	2
vz	horizontal vel., 1st sample of sec - m/sec (3000.)	F	0 - 600D.	2
vz	horizontal vel. - 2nd sample (normal mode); 7th of raw data (H+ mode)	F	"	2
vz	horizontal vel. - 3rd sample (normal mode); 8th of raw data (H+ mode)	F	"	2
vz	horizontal vel. - 4th sample (normal mode); 9th of raw data (H+ mode)	F	"	2
vz	horizontal vel. - 5th sample (normal mode); 10th of raw data (H+ mode)	F	"	2
vz	horizontal vel. - 6th sample (normal mode); 10th of raw data (H+ mode)	F	"	2
shkp2	housekeeping value - TM word 60 (If shkp2 .LT. 511, then = raw LLA/LLB output. If skhp2 .EQ. 511, then DM is in H+ mode for next 4 sec; use only first horz. & vert. as drifts.) - no units	I	0 - 511	2

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```
svap      measured aperature potential - V   F 0 - 60.00    2
            (19.)
---       zero fill                           --    --       8

                           SUB-TOTAL FOR 1st SEC  =     37

Repeat 37 bytes for 2nd second of minute.

Repeat 37 bytes for 3rd second of minute.
   ..
   ..
   ..
Repeat 37 bytes for ndm-th second of minute.

Zero Fill 37*(60-ndm) bytes.
                          TOTAL FOR DM GROUP   =     2221


    *****************************************************

              FORMAT FOR DRIFTMETER RECORD


DESCRIPTION                             NO. OF BYTES
Ephemeris for 1st minute of record           71
Driftmeter data for 1st minute of          2221
   record
Ephemeris for 2nd minute of record           71
Driftmeter data for 2nd minute of          2221
   record
Ephemeris for 3rd minute of record           71
Driftmeter data for 3rd minute of          2221
   record
   ..                                        ..
   ..                                        ..
   ..                                        ..
Ephemeris for 10th minute of record          71
Driftmeter data for 10th minute of         2221
   record

             TOTAL FOR DM RECORD       22920
```

SCINTILLATION METER GROUP OF DATA

INTERNAL NAME OF VARIABLE	DESCRIPTION (BIAS)	INTERNAL TYPE	EXPECTED RANGE	NO OF BYTES
nsm	no. of sets of sm outputs for this minute	I	1 - 60	1
	SUB-TOTAL FOR HEADER GROUP =			1
sec	sec of min for 1st sm set - sec	I	0 - 59	1
power	ALOG10(rms of delta-N) from 1st filter for 1st data set-ALOG10(#/cm**3) (3.)	F	0 - 8.500	2
power	ALOG10(rms of delta-N) from 2nd filter for 1st data set-ALOG10(#/cm**3) (3.)	F	0 - 8.500	2
..	..	..	..	..
..	..	..	..	..
..	..	..	..	..
power	ALOG10(rms of delta-N) from 9th filter for 1st data set-ALOG10(#/cm**3) (3.)	F	0 - 8.500	2
density	one sec avg of ALOG10(density) for 1st data set - ALOG10(#/cm**3)	F	0 - 6.0000	2
rms	variance of one sec avg of ALOG10(density) for 1st data set - ALOG10(#/cm**3)	F	0 - 6.0000	2
---	zero fill	--	--	9
	SUB-TOTAL FOR 1st SEC =			32

Repeat 32 bytes for 2nd second of minute.

Repeat 32 bytes for 3rd second of minute.
  ..
  ..
  ..
Repeat 32 bytes for nsm-th second of minute.

Zero Fill 32*(60-nsm) bytes

TOTAL FOR SM GROUP =	1921	

```
*****************************************************
```

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```
                FORMAT FOR SCINTILLATION METER RECORD

DESCRIPTION                                    NO. OF BYTES
Ephemeris for 1st minute of record                  71
Scintillation meter data for 1st minute of        1921
  record
Ephemeris for 2nd minute of record                  71
Scintillation meter data for 2nd minute of        1921
  record
Ephemeris for 3rd minute of record                  71
Scintillation meter data for 3rd minute of        1921
  record
  ..                                              ..
  ..                                              ..
  ..                                              ..
Ephemeris for 10th minute of record                 71
Scintillation meter data for 10th minute of       1921
  record

                  TOTAL FOR SM RECORD       19920
```

ELECTRON LANGMUIR PROBE GROUP OF DATA

INTERNAL NAME OF VARIABLE	DESCRIPTION (BIAS)	INTERNAL TYPE	EXPECTED RANGE	NO OF BYTES
nlang	no. of sets of electron outputs for this minute	I	1 - 30	1
stype	flag to indicate type of output created for 1st elec set - 'S' = sweep, 'B' = bias, and 'D' = dwell type	CHAR	83, 66, or 68	1
stype	flag to indicate type of output created for 2nd elec set	CHAR	83, 66, or 68	1
..	..	..	..	..
..	..	..	..	..
..	..	..	..	..
stype	flag to indicate type of output created for 30th elec set	CHAR	83, 66, or 68	1

SUB-TOTAL FOR HEADER GROUP = 31

IF stype = 'S' OR 'B' FOR 1ST SET,
THEN THE NEXT GROUP OF BYTES FOLLOWS:

sec	sec of min for 1st elec set - sec	I	0 - 59	1
smode	langmuir probe mode for 1st elec set - 'A'...'E'	CHAR	65 - 69	1
edens	electron density - #/cm**3 (ALOG10)	F	0. - 6.50	2
phis	spacecraft potential calc. from analysis of elec.current vs. applied voltage - volts (+35.)	F	0. - 45.0	2
ste	electron temperature - deg. K (ALOG10)	F	2.00 - 4.50	2
---	zero fill	--	---	1

SUB-TOTAL FOR ONE SET OF DATA   = 9

```
IF stype = 'D' FOR 1ST SET,
THEN THE NEXT GROUP OF BYTES FOLLOWS:


sec       sec of min for 1st elec set - sec  I 0 - 59        1
smode     langmuir probe mode for 1st      CHAR 65 - 69      1
             elec set - 'A'...'E'
mean      mean of electron densities for     F 0. - 6.50     2
             1st 4 sec of dwell - #/cm**3
             (ALOG10)
sdev      standard deviation of electron     F 0. - 6.00     2
             densities) for 1st 4 sec of
             dwell   - ALOG10(#/cm**3)
---       fill                               -    ---        3


                     SUB-TOTAL FOR ONE SET OF DATA   =  9


Repeat 9 bytes for 2nd elec set of minute.

Repeat 9 bytes for 3rd elec set of minute.
  ..
  ..
  ..
Repeat 9 bytes for nlang-th elec set of minute.

Zero fill 9* (30-nlang) bytes.

                     TOTAL FOR ONE MIN OF ELEC GROUP  =    301


   ********************************************************



       FORMAT FOR ELECTRON LANGMUIR PROBE RECORD


DESCRIPTION                          NO. OF BYTES
Ephemeris for 1st minute of record        71
Electron langmuir probe data for 1st     301
  minute of record
Ephemeris for 2nd minute of record        71
Electron langmuir probe data for 3rd     301
  minute of record
Ephemeris for 3rd minute of record        71
```

```
Electron langmuir probe data for 3rd          301
  minute of record
  ..                                           ..
  ..                                           ..
  ..                                           ..
Ephemeris for 20th minute of record            71
Electron langmuir probe data for 20th         301
  minute of record

             TOTAL FOR ELEC RECORD           7440
```

ION RETARDING POTENTIAL ANALYZER (RPA) GROUP OF DATA

INTERNAL NAME OF VARIABLE	DESCRIPTION (BIAS)	INTERNAL TYPE	EXPECTED RANGE	NO OF BYTES
nrpa	no. of sets of rpa outputs for this minute	I	1 - 15	1

SUB-TOTAL FOR HEADER GROUP = 1

sec	sec of min. for 1st rpa set - sec	I	0 - 59	1
iontemp	ion temperature for 1st rpa set - deg. K (ALOG10)	F	2.00 - 4.50	2
iondrif	downrange component of Ion drift velocity - m/sec (3000.)	F	0 - 600D.	2
scpot	spacecraft potential w.r.t. plasma calc. from 1st rpa set - Volts (35.)	F	0. - 45.0	2
nm	number of ion species used by 1st rpa sweep analysis	I	0 - 4	1
ionmass	mass of 1st ion species for 1st rpa sweep - amu	I	1,4,16,99	1
iondens	density of 1st ion species for 1st rpa sweep - #/cm**3 (ALOG10)	F	0. - 6.50	2
..	..	..	..	..
..	..	..	..	..
..	..	..	..	..
ionmass	mass of 4st ion species for 1st rpa sweep - amu	I	1,4,16,99 (0=not used)	1
iondens	density of 4th ion species for 1st rpa sweep - #/cm**3 (ALOG10)	F	0. - 6.50	2
err	error estimate for 1st rpa sweep - #/cm**3 (ALOG10)	F	0. - 6.00	2
densrpa	total ion density based on 18 pts of saturation current - #/cm**3 (ALOG10)	F	0. - 6.50	2
drpasdv	standard deviation 18pts of total ion densities - #/cm**3 (ALOG10)	F	0. - 6.00	2
---	zero fill	--	---	2

SUB-TOTAL FOR ONE SET OF DATA   = 28

Repeat 28 bytes for 2nd rpa set of minute.

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Repeat 28 bytes for 3rd rpa of minute.
```
     ..
     ..
     ..
```
Repeat 28 bytes for nrpa-th rpa set of minute.

Zero fill 28*(15-nrpa) bytes.

                              TOTAL FOR RPA GROUP   =   421

          ****

                      FORMAT FOR ION RPA RECORD

DESCRIPTION   NO. OF BYTES
Ephemeris for 1st minute of record   71
Ion rpa data for 1st minute of record   421
Ephemeris for 2nd minute of record   71
Ion rpa data for 2nd minute of record   421
Ephemeris for 2nd minute of record   71
Ion rpa data for 3rd minute of record   421
   ..   ..
   ..   ..
   ..   ..
Ephemeris for 20th minute of record   71
Ion rpa data for 20th minute of record   421

          TOTAL FOR RPA RECORD   9840

```
INTERNAL
NAME OF                                    INTERNAL EXPECTED NO OF
VARIABLE DESCRIPTION    (BIAS)             TYPE RANGE     BYTES
nmicro   no. of sets of micro outputs     I 1 - 15         1
           for this minute


                              SUB-TOTAL FOR HEADER GROUP =  1


sec      sec of min. for 1st micro set    I 0 - 59         1
           - sec
mcplvel  downrange plasma velocity - m/sec I 0 - 600D      2
           (3000.)
mcote    0+ temperature - deg K           I 50D - 2500D  2
mchte    H+ temperature - deg K           I 50D - 2500D  2
mcode    ALOG10(O+ density) - #/cm**3     F 0. - 6.50    2
mchde    ALOG10(H+ density) - #/cm**3     F 0. - 6.50    2
mcspoti  potential of plasma w.r.t. RPA   F 0. - 10.30   2
                 ground - Volts (6.)
mcete    1st electron temp - deg K        I 50D - 2500D  2
mcede    1st ALOG10(electron density)     F 0. - 6.50    2
           - #/cm**3
mcspote  1st potential of plasma w.r.t.   F 0. - 51.1    2
           s/c ground - Volts (10.)
mcete    2nd (Mode E) electron temp       I 50D - 2500D  2
           - deg K
mcede    2nd ALOG10(electron density)     F 0. - 6.50    2
           - #/cm**3
mcspote  2nd potential of plasma w.r.t.   F 0. - 51.1    2
           s/c ground - Volts (10.)
---      zero fill                        --        --- 3
                    SUB-TOTAL FOR ONE SET OF DATA   = 28
```

Repeat 28 bytes for 2nd microprocessor set of minute.

Repeat 28 bytes for 3rd microprocessor of minute.
```
  ..
  ..
  ..
```
Repeat 28 bytes for nmicro-th microprocessor set of minute.

Zero fill 28*(15-nmicro) bytes.

```
             TOTAL FOR MICROPROCESSOR GROUP   =    421
  ********************************************************
```

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```
                FORMAT FOR MICROPROCESSOR RECORD


DESCRIPTION                              NO. OF BYTES
Ephemeris for 1st minute of record            71
Microprocessor data for 1st min of record    421
Ephemeris for 2nd minute of record            71
Microprocessor data for 2nd min of record    421
Ephemeris for 3rd minute of record            71
Microprocessor data for 3rd min of record    421
   ..                                         ..
   ..                                         ..
   ..                                         ..
Ephemeris for 20th minute of record           71
Microprocessor data for 20th min of record   421


     TOTAL FOR MICROPROCESSOR RECORD        9840
```