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USER'S GUIDE FOR THE TOPSIDE IONOSPHERIC PLASMA MONITOR (SSIES, SSIES-2 AND SSIES-3) ON THE SPACECRAFT OF THE DEFENSE METEOROLOGICAL SATELLITE PROGRAM (DMSP) VOLUME II: PROGRAMMER'S GUIDE FOR SOFTWARE AT AFSFC

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The objective of the Programmer's Guide for the DMSP SSIES flight data processing software is to provide AFSFC personnel with the information necessary to understand and use the various components of the system. This software has been specifically developed to process the SSIES-2 and SSIES-2A data formats, with provisions for retroactive adaptation to the original SSIES format and future adaptation to the SSIES-3 format.

This Programmer's Guide describes the three programs which constitute the AFSFC SSIES processing system: BNBA, LDCON02 and APGA. The BNBA program performs data format conversions for the various SSIES telemetry data formats to generate a common file format for subsequent processing by the APGA program. The LDCON02 program generates the reference parameter file of satellite and instrument conversion constants and processing options for use by the APGA program. The APGA program performs quality evaluations and analyses of the SSIES telemetry data to create database files and reports of quantities which characterize the ionosphere.

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1.0 Scope.

The objective of the Programmer's Guide for the DMSP SSIES flight data processing software is to provide AFSFC personnel with the information necessary to understand and use the various components of the system. This software has been specifically developed to process the SSIES-2 and SSIES-2A data formats, with provisions for retroactive adaptation to the original SSIES format and future adaptation to the SSIES-3 format.

2.0 System Configuration.

The raw DMSP sensor data stream is received at DMSP site III from a satellite ground station. It is subsequently separated into files by satellite and orbit number and transmitted to AFSFC. At AFSFC, the SSIES raw data are unpacked and preprocessed into a common data format for processing by the APGA program.

The AFSFC DMSP Mission Sensor processing system consists of the following components:

a. BNBA - A program which unpacks and pre-processes raw DMSP flight sensor data from IES, IES2, IES2A, or IES3 satellite configurations into the common format IESPREPFILE for input to the APGA program.

b. LDCON02 - A program which writes the various sensor constants and program control parameters required by the APGA program into the IESCNTRLFILE.

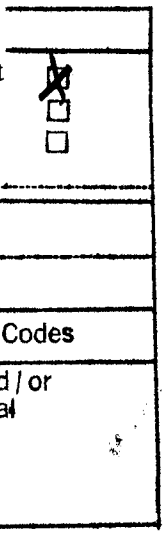
c. APGA - A program which processes raw common format flight data from DMSP Mission Sensors for Ions, Electrons, and Scintillation (SSIES), in conjunction with sensor constants and control parameters, to provide geophysical parameters describing the earth's ionosphere.

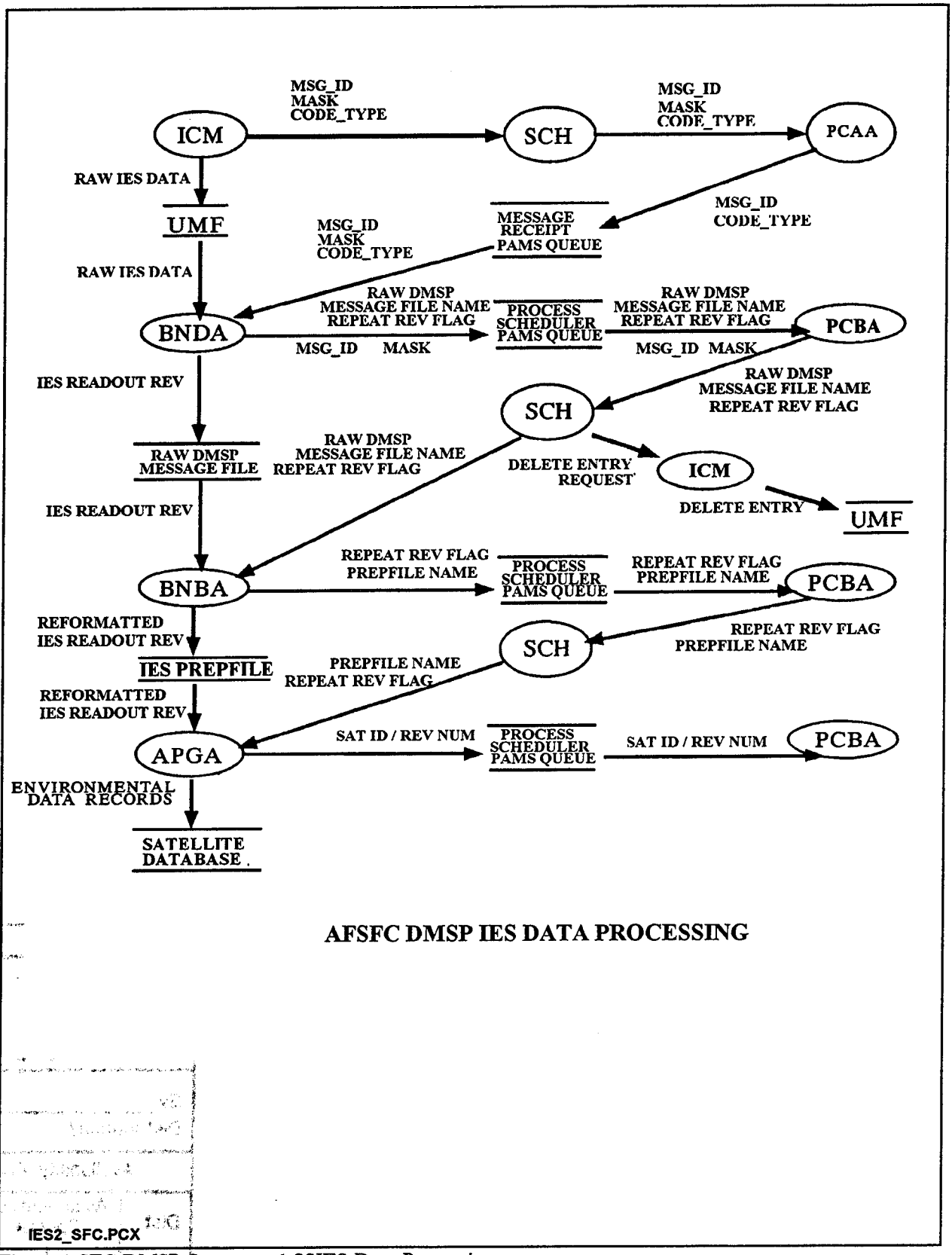
2.1 Classification.

The BNBA, LDCON02, and APGA programs are unclassified.

2.2 System Configuration.

Figure 1 illustrates the data flow and processing control for the DMSP SSIES data processing at Space Forecast Center. Of the items shown in the figure, only the BNBA and APGA programs and the IESPREPFILE and IESEDRFILE data files are described in this document.





IES2_SFC.PCX

Figure 1 SFC DMSP System and SSIES Data Processing.

3.0 Data Re-Formatter Program for the Topside Thermal Plasma Monitor (BNBA).

BNBA reads, unpacks, verifies, and reformats raw SSIES data for processing by APGA, the IES processing program. The input data file, transcribed at SFC on a VAX/VMS processing system, consists of binary data records with the following peculiarities:

1. The data are received from AFGWC, and transcribed at SFC, in the Sperry/UNIVAC 36 bit word, 9-bit byte format.
2. The one minute Ephemeris and Telemetry data records are in time reversed (time descending) order.
3. The 60 seconds of data within each Telemetry record are also in time reversed order.
4. The size and format of the Telemetry data records are not consistent among the existing and proposed instrument configurations, e.g.: SSIES, SSIES-2, SSIES-2A, and SSIES-3.

An ambiguity is presented by the lack of a distinction between the SSIES-2 and SSIES-2A identifiers in the Readout Information Record (RIR). This is currently circumvented by implementing distinct versions of BNBA which associate this common RIR identifier with different data record formats. Use of the incorrect BNBA version will produce a READ error associated with an invalid record length during the telemetry data acquisition process.

3.1 Sub-Program Structure.

This section describes the modular hierarchy for the BNBA program, with a brief description of each routine. For a normal error-free run the routines are invoked in the order presented.

BNBA	Main Program
. USERIN:	Request run parameter inputs Subroutine
. . CHEK_IN:	Verify run parameter inputs Subroutine
. RIREXT:	Read, unpack, and reformat RIR data Subroutine
. . IBITS:	VAX Fortran bit manipulation Function
. . MVBITS:	VAX Fortran bit manipulation Subroutine
. . ERRLOG:	I/O Error reporting Subroutine
. EPHEXT:	Read and unpack Ephemeris data Subroutine
. . IBITS:	VAX Fortran bit manipulation Function
. . ERRLOG:	I/O Error reporting Subroutine
. TMEXT:	Read and unpack Telemetry data Subroutine
. . IBITS:	VAX Fortran bit manipulation Function
. . MVBITS:	VAX Fortran bit manipulation Subroutine
. . ERRLOG:	I/O Error reporting Subroutine
. WORKOUT:	Write unpacked Ephemeris/Telemetry data to intermediate work file Subroutine
. . ERRLOG:	I/O Error reporting Subroutine
. WORKIN:	Read unpacked Ephemeris/Telemetry data in time ascending order Subroutine
. . ERRLOG:	I/O Error reporting Subroutine
. PRINTIT:	Print unpacked data Subroutine

. GET_XCEPTS:	Reformat Telemetry data Subroutine
.. IES_XCEPT:	Process exceptions for IES data Subroutine
... VALCHEK:	Verify Telemetry data Subroutine
... CYCNT1:	Cycle 1 specific processing Subroutine
.... VALCHEK:	Verify Telemetry data Subroutine
.... CYCNT2:	Cycle 2 specific processing Subroutine
... CYCNT2:	Cycle 2 specific processing Subroutine
.... VALCHEK:	Verify Telemetry data Subroutine
.... CYCNT1:	Cycle 1 specific processing Subroutine
.. IES2_XCEPT:	Process exceptions for IES2 data Subroutine
... VALCHEK:	Verify Telemetry data Subroutine
... CYCNT1:	Cycle 1 specific processing Subroutine
.... VALCHEK:	Verify Telemetry data Subroutine
.... CYCNT2:	Cycle 2 specific processing Subroutine
... CYCNT2:	Cycle 2 specific processing Subroutine
.... VALCHEK:	Verify Telemetry data Subroutine
.... CYCNT1:	Cycle 1 specific processing Subroutine
.. IES2A_XCEPT:	Process exceptions for IES2A data Subroutine
... VALCHEK:	Verify Telemetry data Subroutine
... CYCNT1:	Cycle 1 specific processing Subroutine
.... VALCHEK:	Verify Telemetry data Subroutine
.... CYCNT2:	Cycle 2 specific processing Subroutine
... CYCNT2:	Cycle 2 specific processing Subroutine
.... VALCHEK:	Verify Telemetry data Subroutine
.... CYCNT1:	Cycle 1 specific processing Subroutine
.. IES3_XCEPT:	Process exceptions for IES3 data Subroutine (This is currently not implemented.)
. STOREM:	Store reformatted Telemetry block Subroutine
. OUTPUT:	Write reformatted RIR/Ephemeris/Telemetry data blocks Subroutine

3.2 Inputs.

The BNBA program requires one input data file and a series of user supplied interactive inputs.

3.2.1 Input Data File.

The data reformatter program (BNBA) uses a single input file. This unformatted binary input file is created in a keyed indexed form by the BNDA program. The contents and formats of the file are described in Sections 3.3.2.2.4 - 3.3.2.2.6 of the Air Force Global Weather Central (AFGWC) and Space Forecast Center (SFC) Interface Specification. The file consists of the following 3 distinct types of data records:

1. The Readout Information Record (RIR) is the first physical record in the file, and appears once per file. The RIR contains packed satellite, orbit, and IES instrument/telemetry identification, date, and time information.

2. Ephemeris data records occur once for each minute of the orbit, and the data contained in each Ephemeris record are valid for the specified minute of orbit.

3. SSIES (Telemetry) data records occur once for each minute of the orbit. The Telemetry record for a given minute of orbit follows the Ephemeris record for the same time period. Each Telemetry record consists of 60 sets of packed Telemetry data, each set representing one second of time within the minute.

3.2.2 User Inputs.

User inputs are supplied either interactively, in response to prompts, at the user console, or in a run file for a batch process. The required inputs are as follows:

1. The INPUT file name with full directory path.
2. The OUTPUT file name with full directory path.
3. The internal WORK (SCRATCH) file name with full directory path.
4. The code for the instrument type being processed, i.e.: 1 for SSIES; 2 for SSIES-2; 3 for SSIES-2A; 4 for SSIES-3.
5. The 4 digit Mission (Satellite) Identifier.
6. The data Start time of interest as YY DDD HH MM SS
7. The data End time of interest as YY DDD HH MM SS

   Where: YY is the 2 digit Year, i.e.: 93 for 1993,
   DDD is the Julian Day of the Year,
   HH is the Hour of the day,
   MM is the Minute of the Hour,
   SS is the Second of the Minute.

   Note: The start time must always be greater than the end time because the input file data are in time descending order.
8. The option for generating a diagnostic listing of the data (NO or YES).

   The input values are checked, and if found to be out of range the erroneous value is displayed, and the user is prompted to enter correct values.

9. The program will echo the inputs selected and request the user to input YES to proceed or NO to modify the input values.

3.3 BNBA Sub-program Processing and Logic.

The main program BNBA consists of a user input section, an unpacking loop and a reformatting loop.

3.3.1 Subroutine USERIN.

Subroutine USERIN, called from the user input section of BNBA, prompts the user for each of the required user-supplied run parameters, reads the response, and when appropriate, validity checks the response. If the response is incorrect, the user is informed and prompted to enter a correct value. When a correct value is obtained, the user is prompted for the next parameter needed, until all of the necessary parameters have been correctly supplied.

3.3.1.1 Subroutine CHEK_IN.

Subroutine CHEK_IN, called from USERIN, validity checks the user entered time parameters (YY, DDD, HH, MM, SS). When the parameters are proper, CHEK_IN calculates the packed date (YYDDD) and time in total seconds for use elsewhere in the program.

3.3.2 Subroutine RIREXT.

Subroutine RIREXT, called from BNBA, opens the input data file and reads the Readout Information Record (RIR) into a VAX BYTE array. This BYTE array is EQUIVALENCEd to an INTEGER * 4 (Word) array. The order of the input Word array is then reversed to align the bits within the record into the exact order of the original UNIVAC data bit sequence. The 40 distinct data quantities are then unpacked within a DO LOOP. The unpacking is controlled by tables which contain the number of bits for each data value, and the number of bits to be skipped between adjacent data values. Unpacking begins at the last bit in the array and decrements forward until all data values have been unpacked and stored into VAX words. The 4 characters of the Mission ID and the 12 characters of the Prepfile name are concatenated into VAX Character arrays. The Mission ID is converted to an Integer value, the Prepfile name is used to determine the IES instrument type which produced the data, necessary calculations are made, and the data are stored in the proper format for output.

3.3.3 Subroutine EPHEXT.

Subroutine EPHEXT, called from the unpacking loop of BNBA, reads an Ephemeris data record into a VAX BYTE array. The BYTE array is EQUIVALENCEd to a Word array. The order of the word array is then reversed to align the bits into the exact order of the original UNIVAC data bit sequence. Unpacking, performed in a DO LOOP, begins at the end of the bit stream and is controlled by tables which specify the size and type of each particular data quantity, and the number of bits to be skipped between data values. When the data type is REAL, an inner loop controls the unpacking of the sign, mantissa, and characteristic parts of the value. These parts are then used to create a VAX REAL value. When the data type is INTEGER, the least significant 32 bits of the UNIVAC value are unpacked into a VAX INTEGER.

3.3.4 Subroutine TMEXT.

Subroutine TMEXT, called from the unpacking loop of BNBA, reads a packed Telemetry data record into a VAX BYTE array. The BYTE array is EQUIVALENCEd to a Word array. The order of the word array is then reversed to align the bits into the exact order of the original UNIVAC data bit sequence. Each Telemetry data quantity is an unsigned, 9 bit UNIVAC byte. Unpacking begins at the end of the data stream and is controlled by nested DO LOOPs. The outer loop points to the second of data, within the minute, being unpacked. The next loop points to the UNIVAC 36-bit word, within the second, being unpacked. The innermost loop points to the data quantity (UNIVAC byte), within the word, being unpacked. The first 4 bytes of each second comprise the "Synch Word", the next 4 bytes of each second comprise the time word, and the remaining bytes are Telemetry data values. As the data for each second are being unpacked, the 36 bits of the synch word are discarded, the least significant 27 bits of the time word are stored in a VAX INTEGER and converted to seconds, and the remaining data bytes are unpacked and stored in VAX INTEGER * 2 words. The indexing of the innermost loop compensates for the UNIVAC convention of byte reversal within a word. The indexing of the outermost loop reorders the unpacked data seconds into time ascending order within the minute.

3.3.5 Subroutine WORKOUT.

Subroutine WORKOUT, called from the unpacking loop of BNBA, writes the unpacked Ephemeris, Telemetry time, and Telemetry data to the intermediate work file. Each minute of data is written, in the time descending order of input, as a single record to this keyed, indexed file. The primary key used to write the file is the integer record count.

3.3.6 Subroutine PRINTIT.

Subroutine PRINTIT, called from the reformatting loop of BNBA, optionally generates text listings of the Readout Information Record, Ephemeris, Telemetry time, and Telemetry data. This is intended for diagnostic purposes, rather than routine processing.

3.3.7 Subroutine WORKIN.

Subroutine WORKIN, called from the reformatting loop of BNBA, reads an unpacked Ephemeris, Telemetry time, and Telemetry data record from the intermediate work file. The alternate key used to read the file is the Ephemeris time word of the data. This key accesses the data in time ascending order. The data must be in time ascending order for the reformatting processing.

3.3.8 Subroutine GET_XCEPTS.

Subroutine GET_XCEPTS, called from the reformatting loop of BNBA, controls the processing of variations between the standard APGA processing program Telemetry data format and the Telemetry data formats downlinked by the instrument configurations. The exceptions primarily consist of data values which appear in different cycles, at non-standard intervals, or in packed form. The exceptions storage block for the current minute is initialized, exceptions which carry forward from the previous minute of data are stored into the current minute block, and the proper routine to process exceptions for the IES data source is called.

3.3.8.1 Subroutines IES_XCEPT, IES2_XCEPT, IES2A_XCEPT, and IES3_XCEPT.

Subroutines IES_XCEPT, IES2_XCEPT, IES2A_XCEPT, and IES3_XCEPT, called from GET_XCEPTS, process the exceptions for the downlinked Telemetry format of the instrument indicated by the subroutine name. The processing concept for each of these routines is identical. Each second of telemetry data is processed in a loop. The data are checked and flagged for validity, the data cycle is determined, and the data exceptions for this data cycle are extracted and stored into the exceptions array. The list of exceptions for each cycle of each Telemetry format appears in the comment header block of the pertinent routine. (The IES3_XCEPT routine is currently not implemented.)

3.3.8.1.1 Subroutine VALCHK.

Subroutine VALCHK, called from the exceptions processing routines, tests certain values within the unpacked data array to determine the validity of that second of data. When the data are not valid, the cycle indicator for the second of data is set to -1, otherwise the cycle indicator is set to 0.

3.3.8.1.2 Subroutines CYCNT1 and CYCNT2.

Subroutines CYCNT1 and CYCNT2, called from the exceptions processing routines, extract and process the data from the first two unpacked data words of each cycle, the Cycle ID and

Configuration ID. CYCNT1 processes Cycle 1 data and CYCNT2 processes Cycle 2 data. These routines extract and store necessary information and flags from bit settings in these words, calculate the cycle counter, and store this information for inclusion in the exceptions data block.

3.3.9 Subroutine STOREM.

Subroutine STOREM, called from the reformatting loop of BNBA, stores a one minute Ephemeris data block and one minute of Telemetry data in the standard IES processing format. The form (Real or Integer) of each Ephemeris value is determined by a table, which controls the storage into the output array. The reformatting of the Telemetry data is also table driven. A unique storage mapping table for each IES type and data cycle combination specifies the source of each data word to be stored in the standard format as an unpacked data array location, an exceptions data array location, a null value, or a constant.

3.3.10 Subroutine OUTPUT.

Subroutine OUTPUT, called from the reformatting loop of BNBA, writes the reformatted data to the output file. On the initial call, the designated output file is opened, the RIR record is written, and the first one minute Ephemeris/Telemetry record is written. On subsequent calls, only the current Ephemeris/Telemetry record is written.

3.4 Outputs.

This section describes the files and informative messages generated during the execution of the BNBA program.

3.4.1 Output Data Files.

The IESPREPFILE, the primary output of the BNBA program, is a sequential, unformatted binary file with a fixed record size of 4888 words. The first record contains the 10 word RIR data record. The second and successive records contain a 20 word Ephemeris data block, a 60 word data frame time block, and a 4800 word Telemetry data frame block. The data frame block consists of 60 data frames, each containing 160 VAX 16 bit half words. The IESPREPFILE is subsequently used as the primary input to the SSIES processing program (APGA). The exact format of the records contained in this file appears in Appendix 8.3 of this document.

An optional output print file (FOR088.DAT) may be obtained by activating the Subroutine PRINTIT. This ASCII file contains the unpacked and reformatted RIR data, the unpacked Ephemeris data, and the unpacked raw Telemetry data before reformatting. This print option should be used over short time spans of data for debug or verification purposes only.

An additional keyed, indexed, WORK or SCRATCH file is created by the BNBA program for internal use and is of no further use once the run has completed. The unpacked Ephemeris/Telemetry data records are written to this file, using a sequential primary key, in the time reversed order received on the input file. When all of the input data have been unpacked, the data records are retrieved from the work file in time ascending order using the secondary (Ephemeris time) key, reformatted, and written to the output file.

3.4.2 Messages.

Several self-explanatory prompts which appear during user input processing are described in

Section 3.2.2. In addition to these user prompts, BNBA generates the following informative message after the RIR record has been processed:

PROCESSING AN aaaaaaa DATASET FOR MISSION nnnn.

aaaaaaa	is the IES instrument type which produced the data, i.e.: SSIES, SSIES-2, SSIES-2A, SSIES-3.
nnnn	is the Mission (Satellite) ID.

3.5 Error recovery and handling.

Informative error messages are printed to alert the user of problems encountered in processing the raw data stream. These messages are generally followed by program termination. The messages contain enough information for the user to determine the cause of the error and correct it before attempting another run.

REQUESTED INPUT FILE "input file path and name"
CONTAINS DATA FOR "IES instrument type a" SATELLITE xxxx
YOU REQUESTED DATA FOR "IES instrument type r" SATELLITE yyyy
JOB TERMINATED.

The specified input file contains data which does not correspond to the requested IES instrument type (SSIES, SSIES-2, SSIES-2A, or SSIES-3), or for the requested Satellite.

The run will be terminated; no output file will be written.

SATELLITE REV. CHANGED FROM xxxx TO yyyy AT TIME = nnnnnn SEC.
where: xxxx is the original rev (orbit) number,
yyyy is the latest rev (orbit) number,
nnnn is the time of the latest Ephemeris record,

indicates one of the following problems with the input file:
1. There are data for more than one orbit on the input file.
2. The data on the input file are corrupted in format or content.

The data already unpacked up to this point will be reformatted and written to the specified output file before the run is terminated.

NOT ENOUGH DATA TO PROCESS - TERMINATING RUN.

Less than 2 minutes of Ephemeris/Telemetry data were found between the specified Start and End times. The run will be terminated; no output file will be written.

I/O STATUS OF xxxx WAS RETURNED WHEN aaaaaING THE bbbbb cccccc AT RECORD KEY NUMBER nnnn.

An I/O error has occurred, where:

xxxx is the VAX IOStatus code.
aaaaa is the operation, i.e.: OPEN, READ, WRITE.
bbbbb is the data type indicator, i.e.: RIR, EPHEM, TELEM, WORK.
ccccc is either FILE or RECORD.
nnnn is the record number (for the keyed access files).

The run will be terminated. An output file may or may not have been written.

UNKNOWN SENSOR TYPE xxxxxxxxxxx
DEFINED TYPES ARE:
IESP
IL2P
IL2P (or IX2P)
IL3P
where: xxxxxxxxxxx is the PREPFILE name acquired from the Readout Information Record. Its first four characters must match the four characters of one of the defined types for processing to proceed.

The third item for defined types will be "IL2P" if BNBA is configured at compilation for normal processing of SSIES-2A records, but will be "IX2P" if BNBA is configured for normal processing of SSIES-2 records.

TM RECORD nnnnn READ STATUS = ssssssss
where: nnnnn is the index key value for the record being acquired.
ssssssss is the system error number reported for the data acquisition error.

This message is reported only if an error condition is encountered. Processing will attempt to continue.

UNMATCHED DATA TYPE nn IN GET_XCEPTS. NO EXCEPTION PROCESSING PERFORMED.
NOTIFY PROGRAMMER.
where: nn is an index value previously assigned for one of the IES instrument types (SSIES, SSIES-2, SSIES-2A, or SSIES-3), but it does not match any of the options for exception handling. The program will continue, but data items will be missing from the output file.

MODE SWITCH FROM IES TYPE nn AT TIME ttttt
where: nn is an index value previously assigned for one of the IES instrument types (SSIES, SSIES-2, SSIES-2A, or SSIES-3).
ttttt is the telemetry time in seconds at which the change was detected.

A mode switch occurs if the SSIES-2 telemetry data record has been generated by the RAM microprocessor program, rather than the standard PROM microprocessor program, or if the SSIES-2A telemetry data record has been generated by the PROM program instead of the RAM program. For either change, the telemetry record length has been defined to remain unchanged, but the data storage locations for quantities do change. The current BNBA exception handling routines do not accommodate these storage location changes within a record type, so that erroneous data are stored in the IESPREPFILE when a mode switch is reported.

3.6 Processing Time.

The time required for BNBA to process one orbit (~101 minutes) of data is about 20 seconds on a VAX 7000.

4.0 Data Processing Program for the Topside Thermal Plasma Monitor (APGA).

The APGA program processes data from various SSIES instruments to produce environmental and geophysical parameters.

4.1 APGA Sub-Program Structure.

This section describes the modular hierarchy for the APGA program, with a brief description of each routine. The routines normally will be invoked in the order listed, but the selection of various processing options may alter the order of invocation.

SSIES:	top-level program, calling other main modules
. DSSIES:	block data
. TIMES:	report clock and CPU time
. . ADATE:	report date and time from system
. INIT:	initialize reference variables and data files
. . CDATE:	reformat date and time for program use
. . . ADATE:	report date and time from system
. . . TIMCON:	convert between UT and IES reference minutes
. . VSWEEP:	initialize reference EP and RPA sweep voltages
. . OPNPRP:	open IESPREPFILE and read RIR record
. . . FILERR:	determine and report file error status
. . VEHPAR:	acquire processing parameter values for current satellite
. . . COPY:	initialize array or transfer values between arrays
. . OPNEDR:	initialize IESEDRFILE
. . . PRNTON:	set PRINTAWAY status for conclusion of processing
. . . FILERR:	determine and report file error status
. . OPNAPX:	acquire APEX conversion table from IESAPEXTABLE
. . . FILERR:	determine and report file error status
. . OPNXFR:	initialize IESAGDBXFR1 or IESAGDBXFR2
. . . PRNTON:	set PRINTAWAY status for conclusion of processing
. . . FILERR:	determine and report file error status
. . OPNSTF:	initialize IESSTATFILE
. . . PRNTON:	set PRINTAWAY status for conclusion of processing
. . . FILERR:	determine and report file error status
. . FILERR:	determine and report file error status
. INPUT:	acquire and distribute SSIES-2 data
. . RDPREP:	acquire a one minute data record from IESPREPFILE
. . EPHEM:	prepare ephemeris information for processing
. . . TIMCON:	convert between UT and IES reference minutes
. . . LATLON:	calculate latitude and longitude from orbit parameters

. . . APXTAB:	convert to APEX latitude and longitude
. . . . OFFSET:	convert between geographic and magnetic dipole coordinates
. . . . INTERP:	interpolate from a list of values
. . . PRNTON:	set PRINTAWAY status for conclusion of processing
. . CHEKIT:	assess validity of one-second data frame
. . DECODE:	distribute data frame values for processing, in proper units
. . . DSMSTT:	determine instrument status from DSM subcom
. . . DECDMP:	print data frame information, for diagnostics
. . HSKPNG:	acquire and assess sensor housekeeping data
. **PROCES**:	control processing of one data frame
. . **SMPRC**:	process scintillation meter (SM) data
. . . RANGE:	interpret electrometer/SM-wideband range setting value
. . . . SMCMD:	interpret SM command value
. . . PRNTON:	set PRINTAWAY status for conclusion of processing
. . . ELAMP:	convert electrometer/SM-wideband values to ion density
. . . . COPY:	initialize array or transfer values between arrays
. . . . FND511:	search for range change flag in SM data sequence
. . . . PRMRNG:	check environment parameters against allowed ranges
. . . COPY:	initialize array or transfer values between arrays
. . . FILTER:	convert SM filter band values to power spectral density values
. . . SMDIAG:	report SM processing diagnostics
. . . . OPNDOF:	initialize diagnostic output file
. . . . . BITON:	test for bit setting
. . . . . FILERR:	determine and report file error status
. . . . . PRNTON:	set PRINTAWAY status for conclusion of processing
. . . . FILERR:	determine and report file error status
. . **EPPRC**:	process electron probe (EP) data
. . . SWPCOL:	accumulate data for a complete sweep analysis
. . . . COPY:	initialize array or transfer values between arrays
. . . EPSWP:	process EP sweep data for density, temperature, and potential
. . . . COPY:	initialize array or transfer values between arrays
. . . . EPDIAG:	report EP processing diagnostics
. . . . . OPNDOF:	initialize diagnostic output file
. . . . . BITON:	test for bit setting
. . . . . FILERR:	determine and report file error status
. . . . . PRNTON:	set PRINTAWAY status for conclusion of processing
. . . . . LOGLIN:	transform tabulated values between standard and log10 form
. . . . . FILERR:	determine and report file error status
. . . . FITLIN:	perform linear least-squares fit for tabulated values
. . . . NTRP:	perform two-point interpolation
. . . . PRMRNG:	check environment parameters against allowed ranges
. . . SELNRM:	select normalization density or temperature for EP DC analysis
. . . EPDC:	process EP DC (dwell) data for electron density
. . . . PRMRNG:	check environment parameters against allowed ranges
. . **RPAPRC**:	process retarding potential analyzer (RPA) data
. . . SWPCOL:	accumulate data for a complete sweep analysis
. . . RPAALG:	process RPA sweep data for density, temperature, and potential
. . . . COPY:	initialize array or transfer values between arrays

.... LOGLIN: transform tabulated values between standard and log10 form
.... CHKSWP: pre-process and validate RPA sweep data
..... RPDIAG: report RPA processing diagnostics
...... OPNDOF: initialize diagnostic output file
.... BITON: test for bit setting
.... FILERR: determine and report file error status
.... PRNTON: set PRINTAWAY status for conclusion of processing
...... FILERR: determine and report file error status
..... MEANSD: calculate mean and standard deviation for list of values
.... XPOS: determine voltages for specified sweep currents
..... COPY: initialize array or transfer values between arrays
.... RPDIAG: report RPA processing diagnostics
.... SSLOPE: find local minimum in slope of sweep profile
..... COPY: initialize array or transfer values between arrays
..... FITLIN: perform linear least-squares fit for tabulated values
.... PLASMA: determine environmental parameters from engineering data
..... ERF: error function for normal (Gaussian) distribution
.... PRMRNG: check environment parameters against allowed ranges
.... RPASWP: calculate instrument response to specified plasma environment
..... ERF: error function for normal (Gaussian) distribution
.... COMPAR: determine variance between measured and theoretical sweeps
.... ANLSAV: store RPA sweep solution
.... FITLIN: perform linear least-squares fit for tabulated values

.. **DMPRC**: process driftmeter (DM) data
... DMINFO: determine current state of DM sensor
.... DMCMD: interpret DM command value
..... DMSWCH: set processing status for DM mode change
..... PRNTON: set PRINTAWAY status for conclusion of processing
.... PRNTON: set PRINTAWAY status for conclusion of processing
... PRNTON: set PRINTAWAY status for conclusion of processing
... DMVEL: convert DM voltages to ion drift velocity and angle of arrival
... PRMRNG: check environment parameters against allowed ranges
... DMDEN: calculate ion density for DM log level data
... DMFIBA: convert DM filter band values to power spectral density values
.... OPNDOF: initialize diagnostic output file
..... BITON: test for bit setting
..... FILERR: determine and report file error status
..... PRNTON: set PRINTAWAY status for conclusion of processing
... HPMODE: report DM H+ mode data
.... OPNDOF: initialize diagnostic output file
..... BITON: test for bit setting
..... FILERR: determine and report file error status
..... PRNTON: set PRINTAWAY status for conclusion of processing
... DMDIAG: report DM processing diagnostics
.... OPNDOF: initialize diagnostic output file
..... BITON: test for bit setting
..... FILERR: determine and report file error status
..... PRNTON: set PRINTAWAY status for conclusion of processing
.... FILERR: determine and report file error status

.. **MPPRC**: process microprocessor (MP) data

. . . BITON:	test for bit setting
. . . MPEP:	process MP data for EP
. . . . COPY:	initialize array or transfer values between arrays
. . . . UPBITS:	unpack bits from a word into an array
. . . . PRMRNG:	check environment parameters against allowed ranges
. . . MPRPA:	process MP data for RPA
. . . . COPY:	initialize array or transfer values between arrays
. . . . UPBITS:	unpack bits from a word into an array
. . . . PRMRNG:	check environment parameters against allowed ranges
. . . MPDIAG:	report MP diagnostics, and EPPRC/RPAPRC comparison
. . . . BITON:	test for bit setting
. . . . OPNDOF:	initialize diagnostic output file
. . . . . BITON:	test for bit setting
. . . . . FILERR:	determine and report file error status
. . . . . PRNTON:	set PRINTAWAY status for conclusion of processing
. . . . LATLON:	calculate latitude and longitude from orbit parameters
. . **CKLPRC:**	perform calculations for CKL analysis
. . . BITON:	test for bit setting
. . . CKLSAV:	collect density and SM filter data
. . . . COPY:	initialize array or transfer values between arrays
. . . PRNTON:	set PRINTAWAY status for conclusion of processing
. . . COPY:	initialize array or transfer values between arrays
. . . CKLPRP:	prepare plasma density data for CKL calculation
. . . . DENFIX:	interpolate for missing density data values
. . . . DETRND:	detrend data and compute absolute and relative RMS
. . . . . COPY:	initialize array or transfer values between arrays
. . . ENVMOD:	calculate ionospheric model irregularity parameters
. . . . ERF:	error function for normal (Gaussian) distribution
. . . BLDPDS:	calculate power spectrum from density and filter values
. . . . DENPDS:	compute FFT of detrended density data
. . . . . WINDOW:	calculate FFT windowing weight factors
. . . . . . COPY:	initialize array or transfer values between arrays
. . . . . FFT:	interface to IEEE FFT routines
. . . . . . FR2TR:	IEEE radix 2 iteration routine
. . . . . . FR4TR:	IEEE radix 4 iteration routine
. . . . . . FORD1:	IEEE in-place reordering routine
. . . . . . FORD2:	IEEE in-place reordering routine
. . . . . BSMOO:	perform binomial weight smoothing for data
. . . . . COPY:	initialize array or transfer values between arrays
. . . . FILPDS:	compute power spectrum from SM filter data
. . . TANDP:	calculate T1 and P1 parameters from power spectrum
. . . . LSF:	perform linear least-squares fit for data
. . . PRMRNG:	check environment parameters against allowed ranges
. . . DVAVE:	compute average values of ion drift velocity
. . . CVEFF:	calculate effective spacecraft velocity relative to irregularities
. . . . CTRANS:	transform between spacecraft and geographic coordinates
. . . . MAGFLD:	calculate magnetic field from model
. . . . . IGRF80:	initialize coefficients for IGRF-80 model
. . . . CMAT:	construct transformation matrix for irregularity coordinates
. . . CK:	compute the CK irregularity parameter estimate
. . . CKDIAG:	report CKL processing diagnostics

.... OPNDOF:	initialize diagnostic output file
..... BITON:	test for bit setting
..... FILERR:	determine and report file error status
..... PRNTON:	set PRINTAWAY status for conclusion of processing
.... FILERR:	determine and report file error status
.. **QCPRC:**	perform and report intercomparisons of processor results
... SCDIAG:	report spacecraft and processing diagnostics
.... BITON:	test for bit setting
... IAVRGE:	compute an integer average for specified sum
... AVRAGE:	compute a floating point average for specified sum
... LDSTF:	prepare IESSTATFILE for new status report
.... TIMCON:	convert between UT and IES reference minutes
.... PRNTON:	set PRINTAWAY status for conclusion of processing
.... COPY:	initialize array or transfer values between arrays
.... SFSUM:	report summary records
.... FILERR:	determine and report file error status
... COPY:	initialize array or transfer values between arrays
... QCRPA:	obtain ion data from RPAPRC or MPPRC results
... QCEP:	obtain electron data from EPPRC or MPPRC results
. **OUTPUT:**	generate IESEDRFILE and IESAGDBXFR records
.. WRTEDR:	process the Environmental Data Records (EDRs) for output
... TIMCON:	convert between UT and IES reference minutes
... PRNTON:	set PRINTAWAY status for conclusion of processing
... COPY:	initialize array or transfer values between arrays
... EDRPRT:	generate an EDR summary text report
.... OPNDOF:	initialize diagnostic output file
..... BITON:	test for bit setting
..... FILERR:	determine and report file error status
..... PRNTON:	set PRINTAWAY status for conclusion of processing
... FILERR:	determine and report file error status
.. WRTXFR:	process AGDB summary records
... LDXFR:	generate AGDB record from EDR
... XFRPRT:	generate an AGDB record text report
.... OPNDOF:	initialize diagnostic output file
..... BITON:	test for bit setting
..... FILERR:	determine and report file error status
..... PRNTON:	set PRINTAWAY status for conclusion of processing
... COPY:	initialize array or transfer values between arrays
... PRNTON:	set PRINTAWAY status for conclusion of processing
... FILERR:	determine and report file error status
.. SETEDR:	initialize EDR segments for IESEDRFILE
... PRNTON:	set PRINTAWAY status for conclusion of processing
... TIMCON:	convert between UT and IES reference minutes
... COPY:	initialize array or transfer values between arrays
... FILERR:	determine and report file error status
.. LDEDR:	store processed data into EDR output arrays
... COPY:	initialize array or transfer values between arrays
... LDSWPS:	acquire EP or RPA results for EDR
. **SUMOUT:**	generate summaries at end of processing

. . PRNTON:	set PRINTAWAY status for conclusion of processing
. . SFSUM:	report summary records
. . IESPRT:	transfer information from diagnostic file to summary file
. . FILERR:	determine and report file error status
. QUIT:	prepare printing status and data file transfer

4.2 Inputs.

The inputs required for operation of the APGA program are explained in the following paragraphs.

4.2.1 Input Data Files.

The APGA program acquires input data from three data files. There is an additional optional data file which may be used to limit the time span of data processed by the APGA program. The formats and contents of these files are given in Sections 8.3, 8.4, and 8.5. Sample input values are given in Section 6.

4.2.1.1 IESPREPFILE.

The IESPREPFILE, which is the principal input data file for the APGA program, is created by the BNBA reformatting program. The file contains spacecraft and orbit information and the time ordered Ephemeris and raw Instrument data for the specified orbit of the specified spacecraft. The IESPREPFILE is a sequential binary file with a fixed record size of 4888 VAX 32 bit Longwords. The first record of the file is the 10 word RIR data record. Each successive record consists of a 28 word Ephemeris data block, a 60 word data frame time block, and a 4800 word raw instrument data frame block. The data frame block is comprised of 9600 VAX 16 bit half words representing 160 data quantities for each of the 60 seconds of the minute. The format and content of the data blocks are shown in Section 8.3.

4.2.1.2 IESCNTRLFILE.

The IESCNTRLFILE is a binary file consisting of a single 1095 word record containing the following types of information required by the APGA program:

a. Sensor constants. These parameters define the physical and electronic attributes of the various SSIES sensors required for the conversion of the telemetry data frame words into environmental parameters. These include such items as sensor aperture areas, telemetry conversion factors, and amplifier gains/offsets. These parameters may change with each vehicle, and some may need periodic adjustment to compensate for instrument aging.

b. Processing control switches. These parameters inform the APGA program how the data are to be processed. Included are switches which control the amount of data processed for each sensor, processing control parameters such as solution test criteria and iteration control parameters, and switches which control diagnostic output. These switches allow the user to control the functioning of the APGA program and, to some degree, the processing time required and the accuracy of the results obtained.

c. Irregularity model parameters. These parameters are used to define the structure of ionospheric irregularities for use in the calculation of the irregularity/scintillation parameters T_1, p_1, and C_kL.

The IESCNTRLFILE is built and updated via the LDCON02 program and accommodates data for a maximum of 3 DMSP satellites.

4.2.1.3 IESAPEXTABLE.

The IESAPEXTABLE is a binary file with a single 8203 word record containing geomagnetic coordinate transformation information. This input contains the information required to transform from geographic latitude and longitude to modified Apex latitude and longitude defined at an altitude of 840 km. The inputs also contain the information required to transform from geographic coordinates to an offset-dipole coordinate system, and a large look-up table to convert from the offset-dipole system to modified Apex coordinates. Since the contents of this file should not require updating, no program has been supplied for this purpose. A description of modified Apex coordinates can be found in reference 7.1m.

4.2.1.4 IESPROLIMITS.

The IESPROLIMITS is an optional ASCII input data file consisting of a single 3 word record. This file, if used, will limit APGA processing to the time span specified by its parameters. If this file is not found, the APGA program will ignore the fact that it is missing, and process the entire time span of the IESPREPFILE. Normally this file is used only for testing or diagnostic purposes.

4.2.2 User inputs.

The APGA program does not require user inputs *per se*. However it is the user's responsibility to supply, via an ASSIGN or DEFINE VAX DCL statement, the directory path and file name of the IESPREPFILE to be processed.

4.3 Sub-Program Calculations.

The APGA program reads SSIES Ephemeris data and raw telemetry data frames from the IESPREPFILE and converts the raw data into environmental and geophysical parameters. The APGA program flow and calculations are described in the following paragraphs.

4.3.1 Subroutine INIT.

Open and initialize the various input and output files used by the program and read processing control information from these files.

4.3.2 Subroutine INPUT.

Read SSIES raw data records from the IESPREPFILE, convert the 9 bit data words to raw engineering data (i.e., voltages, currents, status flags, etc.), and calculate ephemeris information.

4.3.3 Subroutine PROCES.

Control the conversion of engineering data into geophysical parameters for a one-second data frame and perform a limited quality control on the geophysical parameters to include construction of a summary record of REV-averaged parameters for file IESSTATFILE.

4.3.3.1 Subroutine SMPRC.

The Ion Scintillation Meter (SM) measures the *in situ* total ion density, and RMS ΔN_i, which is a measure of the strength of ion density irregularities. The sampling frequencies cover a range of irregularity scale sizes from roughly 1 to 400 meters.

Subroutine SMPRC performs the following types of SM data processing:

a. The 24 voltages from the electrometer and differencing amplifier (EL/AMP data) are converted to ion density.
b. The voltages from the filters in the filter comb are converted to measures of the power spectral density at different scale sizes (frequencies). There are nine (9) filter voltages in IES Telemetry and six (6) filter voltages in IES2 and IES3 Telemetry.
c. The amplifier range setting data from the range data word in the data frame and embedded in the EL/AMP data stream are converted from voltages to range settings for the electrometer (affects EL/AMP and filter data) and the wideband ranging amplifier (affects only filter data).

Outputs from this processor are 24 ion density observations, 6 or 9 power spectral density measurements, and the average ion density for the entire second of data.

4.3.3.2 Subroutine EPPRC.

The Electron Probe (EP) measures the *in situ* electron density, electron temperature, and the spacecraft potential with respect to the local plasma.

Subroutine EPPRC operation is EP sensor mode dependent. When the sensor is in a sweep mode (or is running a sweep during a DC mode), the module collects 24 log currents from each second of data until an entire sweep is collected (4 seconds for a normal sweep in modes A and D, 3 seconds for calibration sweeps in all modes, and 2 seconds for normal sweeps in mode E). When data for an entire sweep have been collected, the sweep is analyzed to provide estimates of the electron density, electron temperature, and the potential of the spacecraft with respect to the ionospheric plasma.

When the sensor is in a DC mode (modes C and D) between sweeps, the module converts the 24 currents reported in each data second to 24 electron density measurements. Outputs are also sensor mode dependent. For sweep modes, the outputs are one electron density, electron temperature, and spacecraft potential measurement every 4/3/2 seconds (depending on the sweep duration described above). For non-sweep modes, the outputs are 24 electron density measurements every second and the average electron density for the entire second of data.

4.3.3.3 Subroutine RPAPRC.

The Retarding Potential Analyzer (RPA) measures the *in situ* O+ and H+ (or He+) ion densities, the ion temperature, and the ion drift velocity component along the orbit track.

Subroutine RPAPRC operation is similar to the EPPRC module sweep mode processing. Log currents are collected from each second of data (24 values/second for IES, IES2, and IES2A; 36 values/second for IES3) for the 4 second duration of each RPA sweep. The sweep is analyzed to provide estimates of the density of O+ ions, the density of the primary light ion present (H+ or He+), the temperature of the O+ ions, the drift velocity of the O+ ions with respect to the spacecraft in the ram (along-orbit) direction, and the potential of the spacecraft with respect to the ionospheric plasma. The sweep analysis results are written to output every 4 seconds.

Note: Only one light ion density is analyzed for in the algorithm currently implemented, and the ion temperature and ram ion drift velocity measurements are for the O+ ions only.

4.3.3.4 Subroutine DMPRC.

The Ion Drift Meter (DM) measures the vertical and horizontal components of the *in situ* ion drift velocity perpendicular to the orbit track and the *in situ* total ion density. Subroutine DMPRC processes the DM data as follows:

a. When the DM sensor is in normal operating mode, the voltages from the offset amplifier are converted into six pairs (horizontal and vertical) of cross-orbit-track components of the ion drift velocity, and 1 second average horizontal and vertical drift velocities are computed.
b. The voltages from the log-level (LL) amplifiers are converted into ion density.
c. When the DM sensor is in H+ operating mode, the offset amplifier voltages are converted into a single pair of ion drift velocities, and the offset amplifier voltages are written to a diagnostic output file for post-run analysis.
d. When the sensor is in DMFIBA mode of operation, the voltages from the 6 DM filters are converted to measures of the power spectral density (PSD). The PSD results, the filter voltages, and the offset amplifier voltages are written to a diagnostic output file for post run analysis.

4.3.3.5 Subroutine MPPRC.

The Microprocessor results analysis module, MPPRC, uses the voltages produced by the SSIES onboard microprocessor EP sweep analysis to calculate electron density, electron temperature, spacecraft potential, and analysis flags. The voltages produced from RPA sweep analysis are used to calculate O+ density, H+ (or He+) density, O+ temperature, H+ (or He+) temperature, ion ram drift velocity, spacecraft potential, and analysis flags. MP data are output at the same frequency as the EP and RPA modules. The MP module also compares these results to the results from the EP and RPA processing modules. These comparisons are written to two diagnostic print files. The user can select whether to use the EP/RPA analyses from the MP data or from the EP and RPA modules for output to the various data bases.

4.3.3.6 Subroutine CKLPRC.

The C_kL module, CKLPRC, performs a second-stage processing of data from all other modules. High time-resolution (24 samples/ second) plasma density measurements from either the SM or EP (when in a DC mode) sensors and the power spectral density estimates from the SM sensor are the primary input. These data are collected in a 22-second data buffer in the module. Every 10 seconds, the latest 22 seconds of density data and the 10 seconds of SM filter data centered in the 22-second period are used to construct an estimate of the power density spectrum (PDS) of irregularities in the ionospheric plasma (see Figure 2). The upper section (in terms of amplitude) of the PDS (from roughly 0.02 Hz to 19 Hz) is constructed from a fast Fourier transform (FFT) of the 22 seconds of density data, and the lower section (from roughly 19 Hz to 8800 Hz) is constructed from the 10 seconds of SM filter data samples. Two parameters are derived from a log-linear fit to the PDS: p_1, the (negative) slope of the log-linear fit, and T_1, the value of the log-linear fit at a frequency of 1 Hz (which corresponds to the zero intercept in a log-linear fit). These two parameters, with the estimates of the ion drift velocities from the DM and RPA sensors, are used to calculate an estimate of the parameter C_k, the irregularity strength at a scale size of one kilometer. A simple model is then used to convert this to an estimate of the C_kL

parameter, the integrated irregularity strength. (Note: This last step is comparable to calculating an estimate of the Total Electron Content (TEC) from one of the plasma density measurements.) The outputs from this module, one set every 10 seconds, are the percent variance of the center ten seconds of the data sample used in the analysis ((RMS ΔN)/N), the p_1 and T_1 parameters, the C_kL parameter, and a 15-point power density spectrum constructed by interpolating in the FFT section of the PDS for the first 6 points and by averaging the 10 SM filter data samples for the last 9 points. If the (RMS ΔN)/N is below a user-defined level, only the (RMS ΔN)/N is calculated and provided. Also, if too many points are missing from the 22-second density data sample (more than 3 sequential missing points or more than 24 total missing data points), the module will attempt to calculate the parameters from an 11-second data set in the center of the 22-second data sample. If too many points are missing in this set also, no calculations are attempted on that data set.

4.3.3.7 Subroutine QCPRC.

The Quality Control module, QCPRC, as currently implemented, performs a quality monitor function. This module keeps track of running averages of densities, temperatures, velocities, and other parameters which go into the processing summary records stored in file IESSTATFILE.

4.3.4 Subroutine OUTPUT.

The output module, OUTPUT, stores the environmental parameters from the various sensors in Environmental Data Records (EDRs) as the results become available. When a one-minute EDR is filled, it is written to file IESEDRFILE, and a summary record for the AGDB is constructed and written to the transfer file used by the current run (file IESAGDBXFRI). When the QC module detects an end-of-data or new satellite condition, the REV-average summary record for the file IESSTATFILE is completed and written to that file, and a written summary is produced for that readout REV.

4.3.5 Subroutine SUMOUT.

Generate all Hour's Summary Print (HSP) necessary as follows:

a. Generate a summary print of all REV-average records in file IESSTATFILE if the time since the last generation of this summary print is greater than the interval called for by the user-supplied parameter in file IESCNTRLFILE.
b. If data have been written to files IESMPEPPRT, IESMPRPAPRT, or IESDMHPMODE, write them out to the normal print file if this option has been selected in file IESCNTRLFILE.

4.3.6 Subroutine QUIT.

When all data have been processed, the following actions are taken:

a. Send applicable error/warning messages to the system operator.
b. Set the system condition word to control the PRINTAWAY post-processor for routing the ASCII print files (Sections 4.4.1 and 4.4.1.1) to a printer. The PRINTAWAY post-processor is disabled if:
   1) an error was encountered,
   2) a summary print from file IESSTATFILE has been generated,
   3) print from files IESMPEPPRT, IESMPRPAPRT, or IESDMHPMODE have been generated,
   4) the user has indicated that the processor should be disabled via the control parameter

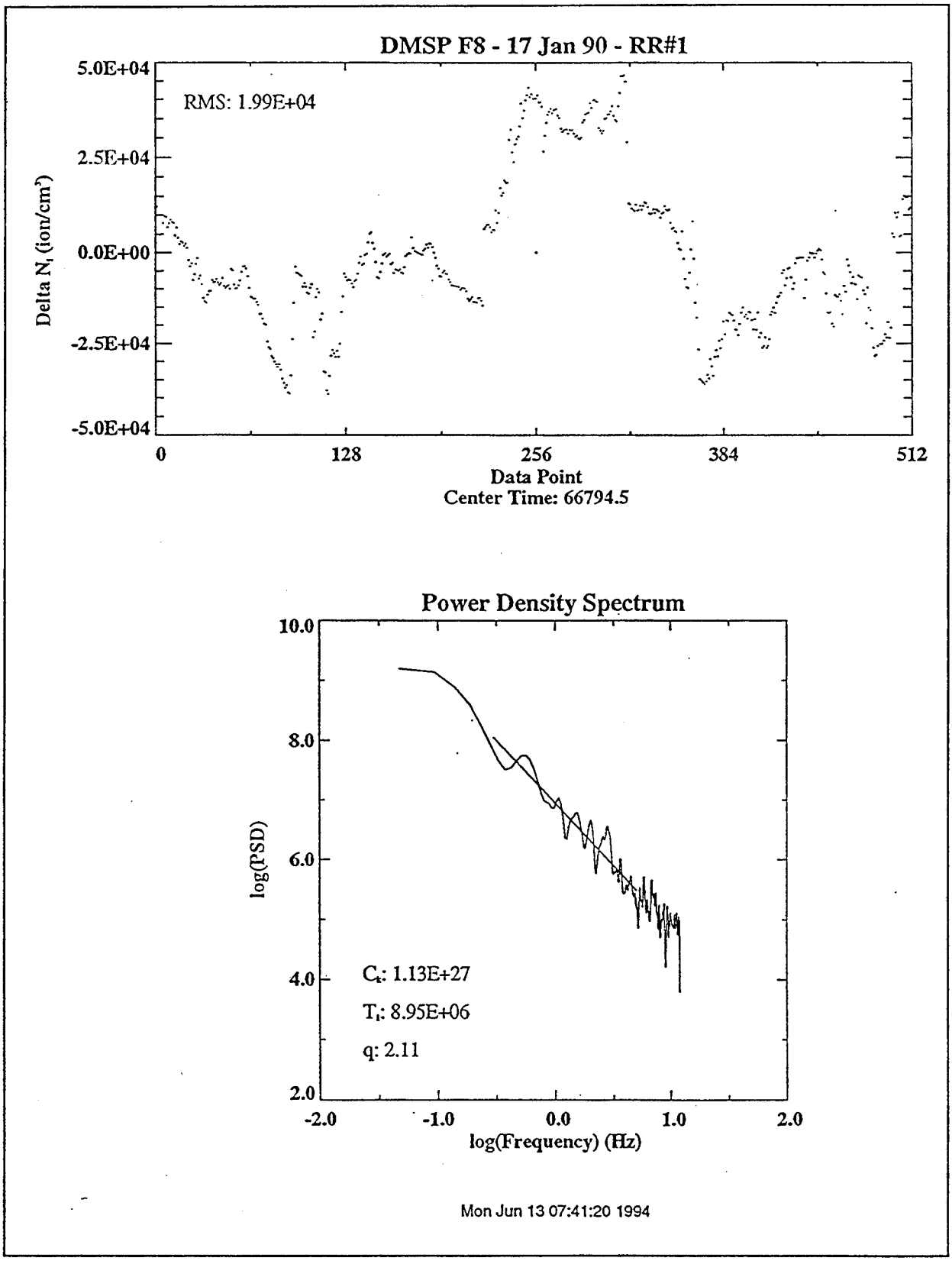


Figure 2 Time-sequence and Power Spectrum Analysis Results

in file IESCNTRLFILE.

c. Close all files used by the APGA program.

Currently, neither the system interface to control the PRINTAWAY post-processor nor the PRINTAWAY post-processor itself have been implemented at SFC, but the PRINTAWAY control provisions have been retained in APGA from their use at AFGWC.

4.4 Outputs.

The APGA program produces a number of binary files and ASCII print files containing analysis results during normal operation. The program also is equipped to generate various optional files which contain analysis results from specific instrument processing. Generation of these optional files is controlled via user-specified flags in the IESCNTRLFILE.

4.4.1 Output Data Files.

IESEDRFILE - A direct access binary file with a fixed record size of 1791 words, containing the Environmental Data Records (EDRs) which are the results of the APGA analysis.

IESSTATFILE - A direct access binary file with a fixed record size of 833 words, containing average values of analysis results, processing statistics, and sensor status summaries.

IESAGDBXFR1/IESAGDBXFR2 - Direct access binary files with a fixed record size of 1791 words. These files were used at AFGWC for the transfer of subsets of the 1 minute EDR records to the Astro-Geophysical Data Base, but will probably not be used at SFC. (IESAGDBXFR2 is no longer utilized by APGA.)

IESMPEPPRT - A formatted ASCII print file containing comparisons of the ground-based APGA EP analysis to the results of the EP processing performed by the on-board microprocessor.

IESMPRPAPRT - A formatted ASCII print file containing comparisons of the ground-based APGA RPA analysis to the results of the RPA processing performed by the on-board microprocessor.

IESDMHPMODE - A formatted ASCII print file containing data reports from the driftmeter during DM H^+mode operation.

IESFIBAMODEA - A formatted ASCII print file containing data reports from the driftmeter during DM FIBA mode operation.

4.4.1.1 Optional Output Data Files.

Generation of each of these optional files is controlled via a switch in the IESCNTRLFILE, and they are not intended for use as part of APGA normal production operations. These files are useful for analysis and resolution of processing anomalies and should be used only for that purpose.

IESCKLDIAG - A binary file of CKL processing diagnostic data.

IESCKLPRT - An ASCII file of CKL processing results.

IESDMDIAG - A binary file of DM processing diagnostic data.

IESDMPRT - An ASCII file of DM processing results.

IESEDRPRT - An ASCII file of EDR information.

IESEPDIAG - A binary file of EP processing diagnostic data.

IESEPPRT - An ASCII file of EP processing diagnostic messages.

IESRPADIAG - A binary file of RPA processing diagnostic data.

IESRPAPRT - An ASCII file of RPA processing diagnostic messages.

IESSMDIAG - A binary file of SM processing diagnostic data.

IESSMPRT - An ASCII file of SM processing results.

IESXFERPRT - An ASCII file of transfer file records.

4.4.2 Messages.

The APGA program generates various informative and warning messages during a typical processing run. This section describes these messages.

4.4.2.1 Status Messages.

The APGA program generates occasional routine status messages to alert the user of events the processor has encountered. None of these require further actions.

STATUS(DMCMD) A NEW COMMAND HAS BEEN RECEIVED BY THE DRIFT METER
LAST COMMAND: xxx NEW COMMAND: yyy

The Drift Meter processing routine has encountered a new command in the command monitor word for the Drift Meter. The information provided is the previous command (xxx) and the new command (yyy).

---

*STATUS: WILL USE TRANSFER FILE IESAGDBXFR1

*STATUS: WILL USE TRANSFER FILE IESAGDBXFR2

This message from OPNXFR will be printed out at the start of each APGA program run to indicate which of the two transfer files is to be used in the current run.

OPNDOF DIAGNOSTIC FILE OPENED (LU: nn, NAME: xxxx)

This message from OPNDOF is printed for each of the diagnostic output files opened during the current run. The information provided is the unit number (nn), and the file name (xxxx).

*** NO DATA IN FILE xxxx (LU = nn)

This message from SUMOUT is printed if one of the three files which can be listed at the end of a program run (IESMPEPPRT, IESMPRPAPRT, or IESDMHPMODE) is empty. The information provided is the file name (xxxx) and unit number (nn).

---

*QUIT ** EXAMINE SSIES PRINT FOR WARNING **

This message is printed at the conclusion of the run if any warning messages were generated during the run.

4.4.2.2 Diagnostic messages.

Optional diagnostic status messages can be generated by the APGA program when the user sets the IDPQC (IQCDGP) flag in IESCNTRLFILE.

SCDIAG NEW SATELLITE: FLIGHT ID = xx, REV # yyyy AT sssss

The latest data frame processed indicated the start of the processing for a new satellite. The information provided is the satellite flight ID (xx), the readout REV number (yyyy), and the time of the current data frame (sssss, seconds since midnight).

SCDIAG NEW REV NUMBER: REV # = yyyy AT sssss

The latest data frame processed indicated the start of processing for a new readout REV. The information provided is the new readout REV number (yyyy) and the time of the current data frame (sssss, seconds since midnight).

SCDIAG GENERAL RESET ** AT sssss

The input section of the APGA program has encountered timing problems with the current readout REV and has issued a general reset flag to all processing modules. The information provided is the time of the current data frame (sssss, seconds since midnight).

SCDIAG END OF DATA ** AT sssss

The APGA program has determined that there are no more data to process in file IESPREPFILE. The information provided is the time of the last data frame (sssss, seconds since midnight).

SCDIAG DUPLICATE FRAME, IDTIME = sssss

The current one-second data frame received from file IESPREPFILE was a duplicate of the preceding one. The information provided is the time of the current data frame (sssss, seconds since midnight).

SCDIAG BAD FRAME, IDTIME = sssss

The current one-second data frame received from file IESPREPFILE contained an error and was not processed. The information provided is the time of the current data frame (sssss, seconds since midnight).

SCDIAG TIME JUMP FROM xxxxx TO yyyyy

The time of the current data frame is more than one second beyond the time in the last data frame. The information provided is the time of the last data frame and the time of the current data frame (xxxxx and yyyyy respectively, seconds since midnight).

SCDIAG SWEEP CLOCK JUMP FROM xxxx TO yyyy AT sssss

The sweep clock program counter in the current data frame is more than one count beyond the time in the last data frame. The information provided is the sweep counter value from the last frame and that from the current frame (xxxx and yyyy respectively), and the time of the current data frame (sssss, seconds since midnight).

SCDIAG CALIBRATION SWEEP, IDTIME = sssss

The EP calibration sweep flag was set in the current data frame. The information provided is the time of the current data frame (sssss, seconds since midnight).

SCDIAG EP MODE CHANGE FROM x TO y AT sssss

The EP sensor mode has changed in the current data frame. The information provided is the previous EP mode and the new EP mode (x and y respectively, 0-6 corresponding to modes A, B, BS, C, D, DS, E).

SCDIAG OLS COMMAND CHANGE FROM xxx TO yyy AT sssss

SCDIAG DSM COMMAND CHANGE FROM xxx TO yyy AT sssss

The OLS or DSM (DM and SM) sensor command reported in the current data frame is changed from the last reported command. Information provided is the previous command (xxx), the new command (yyy), and the time of the current data frame (sssss, seconds since midnight).

4.4.2.3 Warning Messages.

Warning messages are generated to notify the user of possible problems or unusual conditions. The message format usually contains *WARNING* followed by the name of the subroutine in parentheses and a brief description the situation. In some cases, specific data information is included. None of these conditions will cause the APGA program to terminate execution, but a few of them indicate possible errors or problems which require corrective action.

WARNING(DMCMD) THE RETARDING POTENTIAL ON THE DRIFT METER HAS CHANGED
OLD READING: xxx VOLTS NEW READING: yyy VOLTS

A command for the Drift Meter sensor has been processed which directs the sensor to place a repelling voltage on its outer grid. This will cause the ion densities calculated for the DM LLA and LLB data to be too low. If this command was actually sent to the spacecraft, nothing further can be done. If such a command was not sent, alert personnel responsible for DMSP operations that the SSIES DM sensor may be in an erroneous mode of operation. Information provided is the old (xxx) and new (yyy) settings of the repeller voltage.

WARNING(DMCMD) THE DRIFT METER HAS CHANGED INTO H+ MODE
COMMAND RECEIVED: xxx OLD MODE: y NEW MODE: z

A command for the Drift Meter sensor has been processed which directs the sensor to enter H+ mode. This will limit the sensor to one horizontal and vertical drift velocity measurement per second (instead of the normal six each per second) and will disable the calculation of ion density from the DM LLA/LLB data. If this command was actually sent to the spacecraft, nothing further can be done. If such a command was not sent, alert personnel responsible for DMSP operations that the SSIES DM sensor may be in an erroneous mode of operation. Information provided is the command received to place the sensor in H+ mode (xxx: DM command = 152 - 158), the last mode the DM sensor was in and the new mode (y and z respectively).

WARNING(DMCMD) DM FIBA COMMAND RECEIVED
COMMAND RECEIVED: (xxx)
DM FIBA PROCESSING IS NOT FULLY DEFINED

A command for the Drift Meter sensor has been processed which directs the sensor to enter FIBA mode. This will limit the sensor to two horizontal and vertical drift velocity measurements every four seconds (instead of the normal six each per second) and will disable the calculation of ion density from the DM LLA/LLB data. If this command was actually sent to the spacecraft, nothing further can be done. If such a command was not sent, alert personnel responsible for DMSP operations that the SSIES DM sensor may be in an erroneous mode of operation. Information provided is the command received to place the sensor in FIBA mode (xxx).

WARNING(DMCMD) H+ REPELLER VOLTAGE CMD WHILE IN FIBA MODE
COMMAND RECEIVED: xxx MODE: y

A repeller voltage command for the Drift Meter has been processed while the sensor is in FIBA mode. This is a test mode only, and would not be processed in the same manner as the standard FIBA mode. If this command was actually sent to the spacecraft, nothing further can be done. If such a command was not sent, alert personnel responsible for DMSP operations that the SSIES DM sensor may be in an erroneous mode of operation. Information provided is the command received for the H+ repeller setting (xxx: DM command = 144, 146 - 150) and the current DM sensor mode (y).

WARNING(DMCMD) COMMAND/SUBCOM DM MODE DISCREPANCY
SUBCOM MODE: xxx
CURRENT COMMAND MODE: yyy
NEXT COMMAND MODE: zzz

The status of the Drift Meter sensor as derived from the DSM subcom is different from the status as derived from the command monitor. Possible causes for this circumstance are:

a. A DM command has been missed, due to a lost second of data or by reporting of an immediately succeeding SM command in the same command monitor word.
b. A DM command has been received within the last 16 seconds, and the status derived from the subcom has not yet been updated to report the new command. The status change for the Drift Meter will occur after the next cycle count evenly divisible by 16.

In either case, the message should not recur unless further commands are actually sent to the Drift Meter. If the problem recurs, alert the responsible programmer.

WARNING(DMCMD) DM COMMAND ERROR
COMMAND RECEIVED: (xxx)
THIS IS A "SPARES" COMMAND

The last command reported from the DM sensor is identified as a "spare" command in the DM command table. Information provided is the DM command in the last data frame (xxx).

WARNING(DMFIBA) NO FIBA MODE FILE BUILT

The APGA program encountered problems in attempting to output DM FIBA mode data to file IESFIBAMODEA. This file is not critical to APGA operations. Notify the responsible programmer.

WARNING(DMINFO) DM SENSOR PROCESSING HAS BEEN WAITING FOR xxxxx SECONDS
TIME OF CURRENT DATA BLOCK = sssss SECONDS

Processing of data from the DM sensor has been placed in a wait status due to problems interpreting whether the sensor is in H+ mode, normal mode, or FIBA mode. This message will be generated every 10 minutes of data that the processor is in a wait status. If this occurs for the majority of a readout REV, there may be a problem with the data from the DM sensor, the command monitor, or the subcom readouts. Information provided is the length of time the processor has been in a wait status (xxxxx seconds) and the time of the latest data frame (sssss, seconds since midnight).

WARNING(DMPRC) OFFSET VOLTAGE ON DM SENSOR MAY BE DRIFTING
NOMINAL VALUE: xx.xx LATEST VALUE: yy.yy

The offset voltage (yy.yy) of the DM offset amplifier reported in the current data frame is more than 0.3 volts from the nominal value for this offset (xx.xx) stored in file IESCNTRLFILE. If this message shows up more than once in a given readout-REV, alert personnel responsible for DMSP operations that the SSIES DM sensor may be having problems with the offset amplifier zero voltage.

WARNING(ELAMP) RANGE FLAGS DISAGREE
IRDELR: xx, LSTELR: yy

There has been an EL range setting change. SM processing will be suspended until the range change is verified by a matching range flag imbedded in the data stream. Information provided is the new range flag setting (xx), and the previous range flag setting (yy). If this message appears frequently within a run, the SM range constants in the IESCNTRLFILE may need adjustment, or the SM electronics package which calculates the range data may be drifting. Notify the responsible programmer.

WARNING(HPMODE) NO DRIFT METER H+ MODE FILE BUILT

The APGA program encountered problems in attempting to output raw DM H+ mode data to file IESDMHPMODE. This file is not critical to APGA operation. Notify the responsible programmer.

WARNING(LDSTF) A NEW ENTRY HAS BEEN MADE TO FILE IESSTATFILE
SATELLITE: Fxx MISSION ID: WXyyyy

The APGA program has determined that a new vehicle needs to be added to file IESSTATFILE and has done so. The information provided is the flight ID (xx) and mission ID (yyyy) of the new satellite.

WARNING NO MP/EP DIAGNOSTIC FILE BUILT
WARNING NO MP/RPA DIAGNOSTIC FILE BUILT

These messages are from MPDIAG. The APGA program encountered problems in attempting to output comparisons of EP or RPA analyses from the on-board microprocessor to the ground processing results to either file IESMPEPPRT or IESMPRPAPRT. These files are not critical to APGA operation. Notify the responsible programmer.

WARNING(OPNEDR) FILE IESEDRFILE IS BEING REINITIALIZED

The APGA program has determined that file IESEDRFILE needed to be reinitialized and has done so. No further action is required.

WARNING(OPNSTF) FILE IESSTATFILE HAS BEEN INITIALIZED

The APGA program has determined that file IESSTATFILE needed to be reinitialized and has done so. No further action is required.

WARNING(RANGE) SCINTILLATION METER RANGE DATA TOO FAR FROM NOMINAL
LATEST RANGE DATA rrrr
RANGE TABLE IS:

zzzz	zzzz	zzzz	zzzz	zzzz
zzzz	zzzz	zzzz	zzzz	zzzz
zzzz	zzzz	zzzz	zzzz	zzzz
zzzz	zzzz	zzzz	zzzz	zzzz
zzzz	zzzz	zzzz	zzzz	zzzz

The range data value which indicates the range settings for the SM electrometer and wideband ranging amplifier appears to be drifting from the nominal values in the range table read in from file IESCNTRLFILE. The SM processor was able to select a range setting by expanding the fit criteria. This message will be generated the first time the condition is encountered and every 100 times thereafter in a given readout-REV. The information provided is the range data value (rrrr) and the range table values (zzzz). If the range table values are correct, the SM electronics which calculate the range data may be drifting and the range data table may require updating. Alert programmer personnel.

WARNING(WRTEDR) EDR TOO OLD FOR CURRENT IESEDRFILE
EDR NOT WRITTEN TO FILE IESEDRFILE
SATELLITE: xx DATE/TIME: date/time

This message is a relic of AFGWC UNIVAC processing and should not occur on the AFSFC VAX system. If this message does occur, notify the responsible programmer. The information provided is the satellite ID (xx) and the date/time of the data (date (YYMMDD) and time (HHMM)).

WARNING(WRTEDR) EDR FROM THE FUTURE
EDR NOT WRITTEN TO FILE IESEDRFILE
SATELLITE: xx DATE/TIME: date/time
CALCULATED RECORD: yyyy MAX ALLOWED: zzzz

This message is a relic of AFGWC UNIVAC processing and should not occur on the AFSFC VAX system. If this message does occur, notify the responsible programmer. The information provided is the satellite ID (xx), the date/time of the data (date (YYMMDD) and time (HHMM)), the file record number calculated for the date/time (yyyy), and the maximum record number allowed (zzzz).

WARNING(WRTXFR) TRANSFER FILE IESAGDBXFRn OVERFLOWED
A TOTAL OF nnn RECORDS WERE LOST

This message indicates that more than 424 minutes of data have been processed during the current program run (which should rarely, if ever, happen) and that there was no room in the transfer file for the entire set of data processed. The information provided is the number of records which were not written to the transfer file. When the overflow occurs, the program will automatically begin printing out the data which would have been stored in the transfer file.

4.5 Error Recovery Procedures.

Error messages are generated to alert the user of serious problems encountered during processing of SSIES data. These messages usually indicate program termination. The responsible programmer should be notified to analyze and correct the problem. The generic error message format is as follows:

ERROR(name) message
additional information (optional)

where "name" is the name of the program routine in which the error was encountered, "message" is a brief description of the problem, and "additional information (optional)" is additional information which may be of interest to the programmer responsible for the program.

ERROR(name) COULD NOT OPEN FILE xxxxx
STATUS: yyyy
*** REFER TO OPERATOR REFERENCE GUIDE FOR REQUIRED ACTIONS **

ERROR(name) COULD NOT READ FROM FILE xxxxx
STATUS: yyyy RECORD: zzzz
*** REFER TO OPERATOR REFERENCE GUIDE FOR REQUIRED ACTIONS **

ERROR(name) COULD NOT WRITE TO FILE xxxxx
STATUS: yyyy RECORD: zzzz
*** REFER TO OPERATOR REFERENCE GUIDE FOR REQUIRED ACTIONS **

An error was encountered attempting to:
1) open a file for use by the APGA program,
2) read from a file, or
3) write to a file.

The information provided is the name of the routine in which the error was encountered (name), the name of the file (xxxxx), the error status received from the system (yyyy), and the record number the program was trying to read from or write to (zzzz).

ERROR(CKLPRC) SM DATA WERE NOT AVAILABLE FOR CKL CALCULATION
NUMBER OF MISSING DATA-SECONDS: xxxx

ERROR(CKLPRC) EP DATA WERE NOT AVAILABLE FOR CKL CALCULATION
NUMBER OF MISSING DATA-SECONDS: xxxx

These messages indicate that density data from the sensor designated for use by the CKL processor has not been available. The message will appear after 100 seconds of data have been missing and every 100 seconds thereafter. The information provided is the total number of data-seconds which have been missing in the current readout-REV.

ERROR(CKLPRC) THE EP SENSOR IS NOT IN DC MODE
(MODE = x, SHOULD BE 3, 4, OR 5)

The CKL processor has been directed to use density data from the EP sensor in its calculation, but the EP sensor is not in one of the DC modes (mode C, D, or DS) which is required for this calculation. If the EP data must be used for this calculation (i.e., the SM sensor is unusable), then the EP sensor should be commanded into one of the DC modes. If the SM data are usable, the software switch in file IESCNTRLFILE should be set to direct the CKL processor to use the SM density data. If the SM data are unusable and the EP sensor cannot be run in one of the DC modes, the CKL processor should be turned off via the control switch in IESCNTRLFILE for this processor. The information provided is the current mode of the EP sensor (x = 0 to 6 for modes A, B, BS, C, D, DS, and E).

ERROR(DMPRC) DM WB2 RANGE DATA ERROR
TIME(SEC): sssss RANGE DATA: rrrr.rrrr
RANGE TABLE: xxxx.xx xxxx.xx xxxx.xx xxxx.xx xxxx.xx
DMFIBA VOLTAGES: vvv.vv vvv.vv vvv.vv vvv.vv vvv.vv vvv.vv

The range data value which indicates the range settings for the DM wideband ranging amplifier does not correlate with a value in the range table read in from file IESCNTRLFILE. This message will be generated every five (5) minutes that the DM data processing module cannot interpret the range data. The information provided is the time (sssss, seconds since midnight), the range data value (rrrr.rrrr), the values in the range table (xxxx.xx), and the DMFIBA voltages from the DM wideband amplifier for the current second (vvv.vv). Check the range table values to insure that they are correct by comparing them to the values in the LDCON02 specifications for the satellite being processed. If the table is incorrect, run LDCON02 to reload the table and reprocess the readout-REV. If the table is correct and this error message occurs only once in a readout-REV, do nothing further. If the message occurs frequently, there may be a problem with the DM electronics which calculate the range data, and the values in the range table may require updating. Notify programmer personnel.

ERROR(EPHEM) BAD DATE IN EPHEMERIS RECORD
READOUT DATE: yymmdd DOY: xxx
EPHEMERIS DOY: yyy
** EPHEMERIS DATA **
TIME1,LAT1,LON1,ALT1,PHI1: time1 lat1 lon1 alt1 phi1
TIME2,LAT2,LON2,ALT2,PHI2: time2 lat2 lon2 alt2 phi2

The day-of-year in an ephemeris record is incompatible with the readout date. The APGA program will skip the one-minute data block associated with this ephemeris record and try the next. If 10 bad ephemeris records are found in a single readout-REV, processing of that REV will be abandoned. The information provided is the date of the ascending node of the readout-REV (yymmdd); the day-of-year corresponding to yymmdd (xxx), the day-of-year for the current ephemeris record (yyy), the time (seconds since midnight), latitude (radians), longitude (radians), altitude (km), and angular distance along the orbit from the last ascending node (radians) for the first (time1, lat1, etc.) and last (time2, lat2, etc.) points in the ephemeris record.

ERROR(EPHEM) BAD ORBITAL INCLINATION ANGLE
NOMINAL VALUE: xxx DEG
CALCULATED VALUE: yyy DEG
** EPHEMERIS DATA **
TIME1,LAT1,LON1,ALT1,PHI1: time1 lat1 lon1 alt1 phil
TIME2,LAT2,LON2,ALT2,PHI2: time2 lat2 lon2 alt2 phi2

There was a discrepancy of greater than 5 degrees between the orbital inclination angle calculated from the satellite locations in the ephemeris record and that calculated from the altitude of the satellite based on a sun-synchronous orbit. The information provided is the angle calculated from the altitude (xxx), the angle calculated from the locations (yyy), and the ephemeris data described above.

ERROR(EPHEM) BAD TIMES IN EPHEMERIS RECORD
** EPHEMERIS DATA **
TIME1,LAT1,LON1,ALT1,PHI1: time1 lat1 lon1 alt1 phi1
TIME2,LAT2,LON2,ALT2,PHI2: time2 lat2 lon2 alt2 phi2

The times in the current ephemeris record were more than 60 seconds apart. The information provided is the ephemeris data described above.

ERROR(EPHEM) BAD ALTITUDES IN EPHEMERIS RECORD
** EPHEMERIS DATA **
TIME1,LAT1,LON1,ALT1,PHI1: time1 lat1 lon1 alt1 phi1
TIME2,LAT2,LON2,ALT2,PHI2: time2 lat2 lon2 alt2 phi2

The average of the two altitudes in the ephemeris record was outside the range 795 to 875 km. The information provided is the ephemeris data described above.

ERROR(EPHEM) TOO MANY BAD EPHEMERIS RECORDS FOR THIS REV
WILL ABANDON THIS REV

Ten bad ephemeris records have been found in the current readout-REV. Processing of this REV will be ended.

ERROR(LDSTF) FILE IESSTATFILE HAS NO ROOM FOR ANOTHER SATELLITE
NEW SATELLITE FLIGHT ID: Fxx
CURRENTLY IN IESSTATFILE:

ID:	Fy1	LAST	UPDATE:	date1/time1
ID:	Fy2	LAST	UPDATE:	date2/time2
ID:	Fy3	LAST	UPDATE:	date3/time3

There appear to be three active satellite sections in file IESSTATFILE, and data from a fourth satellite has been received. The APGA program will overwrite a satellite section with data from a new satellite if the time that the section overwritten was last updated is more than 10 days in the past. If there is indeed a fourth active satellite, this is a major problem, as the APGA program can handle only three active satellites. If there are three or fewer active satellites and this message appears frequently, alert programmer personnel. The information provided is the flight ID of the current satellite (xx) and the flight IDs (y1, y2, y3) and date (YYMMDD) and time (HHMM) last updated for each satellite in file IESSTATFILE.

ERROR(OPNXFR) COULD NOT USE EITHER AGDB TRANSFER FILE

The APGA program was unable to select one of the two transfer files (IESAGDBXFR1 and IESAGDBXFR2) for use. This message is a relic of the AFGWC UNIVAC system and should not occur when running on the AFSFC VAX. If this message occurs, notify the responsible programmer.

ERROR(SETEDR) SATELLITE FLIGHT ID NOT FOUND IN IESEDRFILE
FLIGHT ID: xx NUMBER OF SATELLITES IN FILE: yy
REFER TO ORG FOR REQUIRED ACTIONS

The DMSP satellite flight ID (i.e., 8 for satellite F-8, etc.) for the current raw DMSP SSIES data from file IESPREPFILE is for a satellite with no entry in file IESCNTRLFILE. Actions are as follows:

a. If the ID was valid, verify the parameters in file IESCNTRLFILE. If the parameters are correct, rerun the APGA program. If not, rebuild file IESCNTRLFILE containing the production inputs for file IESCNTRLFILE. If the APGA program continues to stop with this error message, contact the responsible programmer.
b. If the ID was invalid, the readout-REV containing the erroneous ID cannot be processed. Notify the responsible programmer.
c. If the ID is for a new satellite which has not yet been entered in file IESCNTRLFILE, update this file and rerun the APGA program.

ERROR(SETEDR) DATA TIME OLDER THAN FILE RANGE
DATA DATE: date DATA TIME: time
OLDEST DATE: date1 TIME: time1
LATEST DATE: date2 TIME: time2

The date/time of the first data record in the current readout-REV is older than the oldest valid time in file IESEDRFILE. The information provided is the date and time of the data (date (YYMMDD), and time (HHMM)), the date and time of the oldest record in the file (date1 and time1), and the date and time of the latest record in the file (date2 and time2). If the dates and times for the file are correct, then the data are just too old to be stored in the file, i.e., nothing can be done. If the dates and times for the file appear to be incorrect, reinitialize file IESEDRFILE and reprocess the readout-REV.

ERROR(SMPRC) SM RANGE DATA ERROR
TIME(SEC): xxxxx, RANGE DATA: rrr
RANGE TABLE: zzzz zzzz zzzz zzzz zzzz
zzzz zzzz zzzz zzzz zzzz
zzzz zzzz zzzz zzzz zzzz
zzzz zzzz zzzz zzzz zzzz
zzzz zzzz zzzz zzzz zzzz
SM EL/AMP VOLTAGES
vvv vvv vvv vvv vvv ...
vvv vvv vvv vvv vvv ...
SM FILTER VOLTAGES fff fff ...

The range data value which indicates the range settings for the SM electrometer and wideband ranging amplifier does not correlate with a value in the range table read in from file IESCNTRLFILE. This message will be generated every five (5) minutes that the SM data processing module cannot interpret the range data. The information provided is the time (xxxxx, seconds since midnight), the range data value (rrrr), the values in the range table (zzzz), and the EL/AMP (vvv) and filter band voltages (fff) from the SM sensor for the current second. Check the range table to insure that they are correct by comparing them to the values in the LDCON02 specifications for the satellite being processed. If the table is incorrect, run LDCON02 to reload the table and reprocess the readout-REV. If the table is correct and this error message occurs only once in a readout-REV, do nothing further. If the message occurs frequently, there may be a problem with the SM electronics which calculate the range data, and the values in the range table may require updating. Notify programmer personnel.

ERROR(VEHPAR) VEHICLE NOT DEFINED IN FILE IESCNTRLFILE
MISSION ID = mmmm

The DMSP satellite Mission ID for the current raw DMSP SSIES data from the file IESPREPFILE is for a satellite with no entry in file IESCNTRLFILE. Actions are as follows:

a. If the ID was valid, verify the parameters in file IESCNTRLFILE. If the parameters are correct, rerun the APGA program. If not, rebuild IESCNTRLFILE with the correct parameter set for the vehicle. If the APGA program continues to stop with this error message, notify the responsible programmer.

b. If the ID was invalid, the readout-REV containing the erroneous ID cannot be processed. Notify the responsible programmer.

c. If the ID is for a new satellite which has not yet been entered in the IESCNTRLFILE, update this file and rerun the APGA program.

4.6 Processing Time.

The APGA program requires approximately 1 minute of CPU time to process an orbit (~101 minutes) of SSIES telemetry data on a VAX 9000.

5.0 Restrictions and Limitations.

The APGA program has the following limitations:

a. The files used by the system are configured to allow data from no more than three active DMSP satellites.

b. While there is no upper limit to the number of data frames which can be processed in a single run of the APGA program, the data transfer files have room for only 424 minutes of data.

c. The Environmental Data Records have room for 15 EP sweep analyses per minute. When the EP sensor is in the high data-rate mode (Mode E), every other EP sweep analysis is retained.

d. When the EP sensor is in a DC mode (Mode C, or Mode D, or Mode DS), there is room in the EDRs for only three sweeps in addition to the DC mode density data. This will cause occasional loss of an EP sweep analysis in these modes.

e. Drift Meter H+ mode and FIBA data are not processed beyond writing the data to an ASCII-format diagnostic output file.

f. RPA sweep data taken during times when calibration sweeps are run on the EP sensor are not processed.

g. PRINTAWAY post-processing control through a system interface routine has not been implemented.

6.0 Sample Inputs and Outputs.

a. A sample script of user prompts and replies for BNBA (user responses are in italics, with explanatory comments following the "/").

```
$ R BNBA
Enter the INPUT File Name (with path if necessary)
RAW_IL2X_2546_013043.DAT                    /input file name: TmFileNam
Enter the OUTPUT File Name (with path if necessary)
IESCOM_013043.DAT                           /output file name: IESPrepFil
Enter the WORK File Name (with path if necessary)
IESWRK_013043.DAT                           /work file name: IESWorkFil
Enter Instrument Type: 1 for SSIES,   2 for SSIES-2
                       3 for SSIES-2A, 4 for SSIES-3
3                           /instrument type (SSIES-2A): IESReq
Enter Mission Id as a 4 digit INTEGER.
2546                        /Mission ID: MissID
Enter Start Time as YY DDD HH MM SS
99 365 23 59 59             /Start time: InYr InDay InHr InMin InSec
Enter End Time as YY DDD HH MM SS
90 001 00 00 00             /Start time: NdYr NdDay NdHr NdMin NdSec
Enter YES for diagnostic listing, or NO for no listing
YES                 /Diagnostic listing
We will process file RAW_IL2X_2546_013043.DAT
for SSIES-2A Mission Id 2546
from   99 365  23  59  59 86399
 to    90   1   0   0   0     0
and write the results to IESCOM_013043.DAT
with diagnostic listing.

Type YES to proceed.
Type NO  to change specifications.
YES                         /Confirmation for specifications

RIR Record  1001 Read Status =       0
Mission ID: 2546
PrepFile Name: IL2PREPFILE
Processing an SSIES-2A Dataset for Mission  2546
I/O Status of    -1 was returned when READ ing the EPHEM RECORD at record key number   8011

OPERATION TERMINATED !


Mode switch from IES Type  3 at time  74940
Mode switch from IES Type  3 at time  74942
Mode switch from IES Type  3 at time  74944
Mode switch from IES Type  3 at time  74946
Mode switch from IES Type  3 at time  74948
Mode switch from IES Type  3 at time  74950
Mode switch from IES Type  3 at time  74952
Mode switch from IES Type  3 at time  74954
```

```
Mode switch from IES Type  3 at time  74956
Mode switch from IES Type  3 at time  74958
Mode switch from IES Type  3 at time  74960
Mode switch from IES Type  3 at time  74962
Mode switch from IES Type  3 at time  74964
Mode switch from IES Type  3 at time  74966
Mode switch from IES Type  3 at time  74968
Mode switch from IES Type  3 at time  74970
Mode switch from IES Type  3 at time  74972
Mode switch from IES Type  3 at time  74974
Mode switch from IES Type  3 at time  74976
Mode switch from IES Type  3 at time  75257
Mode switch from IES Type  3 at time  75259
Mode switch from IES Type  3 at time  75261
Mode switch from IES Type  3 at time  75263
Mode switch from IES Type  3 at time  75265
Mode switch from IES Type  3 at time  75267
Mode switch from IES Type  3 at time  75269
Mode switch from IES Type  3 at time  75271
Mode switch from IES Type  3 at time  75273
Mode switch from IES Type  3 at time  75275
Mode switch from IES Type  3 at time  75287
FORTRAN STOP
```

b. A sample of the optional BNBA printed output.

```
Readout Information Record

IESTyp =  3
Mission Id =  2546
Rev Number = 13043
Total Minutes =    96
Total Seconds =   5744
Nodal YMD =  940608
Day / Time at End =    159 /  74939
Day / Time at Start =  159 /  80681


        EPHEMERIS DATA FOR MINUTE BEGINNING AT  74922 SEC

 -1.156892E+00      5.884959E+00             474             159
         74982     -1.212606E+00      5.956508E+00             474
           159             74922      3.705666E-01    -1.558989E-01
 -9.151898E-01      3.319059E-01     -1.124553E-01    -9.361568E-01
        -11569             58850      4.740258E+02           -12126
         59565      4.742587E+02      5.099575E+00     5.038152E+00
         13043                11                4            48953

                          (intervening records containing no data)


             TELEMETRY DATA FOR TIME =      0 SEC

000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000
000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000
000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000
000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000
-001-001-001-001-001-001-001-001-001-001-001-001-001-001-001-001-001-001-001-001
-001-001-001-001-001-001-001-001-001-001-001-001-001-001-001-001-001-001-001-001
```

TELEMETRY DATA FOR TIME = 74939 SEC

018 001 136 285 334 024 064 170 333 237 000 000 311 314 324 314 317 315 314 315
312 312 314 313 314 310 313 310 310 307 307 301 300 298 296 297 250 250 252 251
252 253 255 255 256 256 256 259 253 231 253 231 252 231 253 231 253 231 252 231
000 000 264 253 381 000 323 131 084 277 090 111 259 259 261 261 263 261 264 264
-001-001-001-001-001-001-001-001-001-001-001-001-001-001-001-001-001-001-001-001
-001-001-001-001-001-001-001-001-001-001-001-001-001-001-001-001-001-001-001-001

TELEMETRY DATA FOR TIME = 74940 SEC

069 005 136 145 227 373 000 000 067 332 000 000 290 284 284 285 276 268 268 263
257 249 244 239 234 227 221 211 205 196 190 182 169 160 153 143 008 008 335 335
511 274 273 275 274 273 276 275 253 231 252 231 253 231 253 231 253 231 253 231
349 373 308 326 369 359 331 142 099 285 090 139 275 274 273 275 274 273 270 272
-001-001-001-001-001-001-001-001-001-001-001-001-001-001-001-001-001-001-001-001
-001-001-001-001-001-001-001-001-001-001-001-001-001-001-001-001-001-001-001-001

7.0 References.

a.	Sponsor:	Air Force Space and Missile Command (USAF Materiel Command) Space Division, DMSP Program Office (SMC/CIE)
b.	Developer:	RDP Inc., based upon a system originally developed by Northwest Research Associates, Inc. (NWRA) for Air Force Global Weather Central (AFGWC)
c.	User:	Air Force Space Forecast Center (AFSFC)

7.1 Project Documents.

a. (Project Request) USAF Space Division contract no. F04701-84-C0038, Task 17-09.
b. AFGL-TR-78-0071, The Topside Ionosphere Plasma Monitor (SSIE) for the Block 5D/Flight 2 DMSP Satellite, March 1978, ADA058503.
c. Analytyx Report A30803R, SSIES Plasma Monitor System Main Electronics Package - R&D Equipment Information Report, prepared for AFGL contract no. F19628-80-C-0162, August 1983.
d. AFGL-TR-84-0103, Drift Scintillation Meter, March 1984, ADA142523.
e. DOD Standard 7935, Automated Data Systems Documentation, 15 February 1983.
f. AFGWC/SDMS, DMSP Block 5D2 Special Sensor Data Processing System Functional Description, revision 2, 10 December 1984.
g. AFGWC/SDMS, DMSP Block 5D2 Special Sensor Data Processing System Data Base Specification, May 1985.
h. AFGWC and SFC Interface Specification, 1 February 1991.
i. AFGL-TR-80-0152, In-Flight Characteristics of the Topside Ionosphere Monitor (SSIE) on the DMSP Satellite Flight 2 and Flight 4, April 1980, ADA088879.
j. Development of Software for the Analysis of Plasma Measurements Using the Retarding Potential Analyzer, Unpublished, undated document provided by AFGL/PHG, June 1985.
k. Users Guide for the Topside Ionospheric Plasma Monitor (SSIES, SSIES-2, and SSIES-3) on Spacecraft of the Defense Meteorological Satellite Program (DMSP): Volume 1, Technical Description, 1994, PL-TR-94-2187.
l. Livingston, R.C., C.L. Rino, J.P. McClure, and W.B. Hanson, "Spectral Characteristics of Medium-Scale Equatorial F Region Irregularities," J. Geophys. Res., **86**, 2421, April 1981.
m. PD-NW-83-292R, Definitions of Procedures for Gridding the WBMOD Ionosphere Scintillation Model, April 1983.
n. PD-NW-82-273R/R-2, WBMOD Scintillation Model System Documentation, May 1985.

8.0 Appendices.

8.1 Terms and Abbreviations.

AFGL	-	Air Force Geophysics Laboratory (former name of PL/GP)
PHG	-	Space Physics Division (former name of PL/GPSG)
AFGWC	-	Air Force Global Weather Central
AFSFC	-	Air Force Space Forecast Center
AGDB	-	Astro-Geophysical Data Base
Apex Coordinates	-	(See Modified Apex Coordinates)
AWS	-	Air Weather Service
C_k	-	Irregularity strength parameter (defined at 1 km scale size)
C_kL	-	Height-integrated irregularity strength parameter (defined at 1 km scale size)
Data Frame	-	1 second SSIES telemetry data record from the DMSP data stream
DM	-	SSIES ion Drift Meter sensor
DMSP	-	Defense Meteorological Satellite Program
EDR	-	Environmental Data Record
EDR File	-	IESEDRFILE (APGA program output)
EP	-	SSIES Electron Probe
FDP	-	Flight Data Processing
Fortran 77	-	ANSI Standard X3.9-1978 Fortran
F8	-	DMSP Flight 8, Block 5D/2
Modified Apex Coordinates	-	Geomagnetic latitude, longitude, and local time coordinate system (see reference 7.1m)
MP	-	SSIES on-board microprocessor
N_e	-	Electron density (el/cm^3)
N_i	-	Total ion density (ion/cm^3)
N[H+]	-	Density of H+ ions (ion/cm^3)
N[He+]	-	Density of He+ ions (ion/cm^3)
N[O+]	-	Density of O+ ions (ion/cm^3)
NWRA	-	Northwest Research Associates, Inc.
PL/GP	-	Phillips Laboratory/Geophysics Directorate
PL/GPSG	-	Phillips Laboratory/Geophysics Directorate Space Plasma and Fields Branch
p1	-	Slope of the irregularity power spectrum (one dimensional)
PSD	-	Power spectral density $((el/cm^3)^2/Hz)$
PREP File	-	Preprocessed data file containing data frames and satellite ephemeris data (IESPREPFILE)
REV	-	One readout of DMSP flight data (nominally 101 minutes)
RMS_j	-	Output from j^{th}filter (1-9) of the SM sensor
RPA	-	SSIES ion Retarding Potential Analyzer
SDF	-	Spectral Density Function
SENPOT	-	SSIES Potential Sensor
SM	-	SSIES ion Scintillation Meter
SMC	-	Air Force Space and Missile Command (USAF Materiel Command)
CIE	-	DMSP Program Office, Engineering Division
SSIE	-	Mission Sensor for Ions and Electrons (DMSP F2 - F7)
SSIES	-	DMSP Mission Sensor for Ions, Electrons, and Scintillation (DMSP spacecraft F8 - F10)
SSIES2	-	DMSP Mission Sensor for Ions, Electrons, and Scintillation (DMSP spacecraft F11 - F15)

SSIES2A	-	SSIES2 with uplinked program to output 80 telemetry data words instead of 84
SSIES3	-	DMSP Mission Sensor for Ions, Electrons, and Scintillation (DMSP spacecraft F16 - F20)
T_e	-	Electron temperature (°K)
T_i	-	Ion temperature (°K)
T_1	-	Irregularity power spectral density at a fluctuating frequency of 1 Hz
TEC	-	Total Electron Content
Transfer File	-	One of two files used to transfer processed SSIES data for storage into the AGDB (files IESAGDBXFR1 and IESAGDBXFR2)
u_h	-	Ion drift velocity, horizontal cross-track component (m/s)
u_r	-	Ion drift velocity, horizontal along-track (ram) component (m/s)
u_v	-	Ion drift velocity, vertical cross-track component (m/s)
V_s	-	Spacecraft potential (volts)
$\Phi_{\Delta}N(f)$	-	Plasma irregularity spectral density function

Note: The tacit assumption that the ionospheric plasma is neutral, i.e. $N_e=N_i$,is made throughout this document.

8.2 Data File Format for Input to BNBA at AFSFC.

The input data file for BNBA is an unformatted binary file with an indexed file structure. The variable length records of the file are accessed via a monotonically increasing primary key. The size of these records is not necessarily an integral number of VAX 32-bit words, because the data contained in these records are received in the 9-bit byte, 36-bit word, UNIVAC convention and transcribed as VAX 8-bit bytes with no conversion or translation.

There are 3 types of data records represented in the file.

a. The RIR data record is the first record in the file, and occurs only once. This record is 504 VAX bytes in length.

b. The second, fourth, etc. records each contain a 1 minute Ephemeris data block. The Ephemeris records are 126 VAX bytes in length.

c. The third, fifth, etc. record each contain a 1 minute block of 60 telemetry data frames. Each telemetry data frame contains 1 second of data. The data frame times correspond to the time span of the preceding Ephemeris data record. The telemetry data record length is dependent upon the SSIES instrument configuration which produced it, i.e.: SSIES, SSIES-2, SSIES-2A, or SSIES-3.

The exact content and format of each of these records is described in the AFGWC and SFC Interface Specification, Sections 3.3.2.2.4 - 3.3.2.2.6, and in Appendices A, B, and C of Volume 1, Technical Description.

8.3 Data File Format Output by BNBA for APGA.

The IESPREPFILE is the principal output of the BNBA program and the principal input file of the APGA program. The IESPREPFILE is an unformatted binary file with fixed length 4888 word records. The first record contains the 10 word Readout Information Record (RIR). The second and successive records contain a 28 word Ephemeris data block, a 60 word data frame time block, and a 4800 instrument data frame block. The data frame block is comprised of 60 data frames, each frame consisting of 160 16-bit half words of instrument data. The format and content of each of these data blocks are listed below.

RIR DATA BLOCK

Item #	Name (Type)	Units	Definition
1	IESTyp (INT)	N/A	SSIES instrument type code. 1: SSIES, 2: SSIES-2, 3: SSIES-2A, 4: SSIES-3.
2	MissId (INT)	N/A	4 digit Mission identifier. i.e.: 2546 is satellite F11.
3	RevNum (INT)	N/A	Revolution (orbit) number.
4	NumMin (INT)	N/A	Number of minutes of data in readout.
5	Nframe (INT)	N/A	1 second telemetry data frame count in readout.
6	NodYMD (INT)	N/A	Packed Nodal Year, Month, and Day. i.e.: YYMMDD.
7	Jday1 (INT)	N/A	Julian day at end of readout data.
8	Time1 (INT)	Seconds	Time of last readout data record.
9	Jday2 (INT)	N/A	Julian day at first readout data record.
10	Time2 (INT)	Seconds	Time of first readout data record.

EPHEMERIS DATA BLOCK

Item #	Name (Type)	Units	Definition
1	Lat1 (REAL)	Radians	Geodetic Latitude of Satellite subpoint at end of data minute.
2	Long1 (REAL)	Radians	Geodetic Longitude of Satellite subpoint at end of data minute.
3	Alt1 (INT)	Nmi	Satellite Altitude at end of data minute.
4	Jday1 (INT)	N/A	Julian Day at end of data minute.
5	Time1 (INT)	Seconds	Time of day at end of data minute.
6	Lat2 (REAL)	Radians	Geodetic Latitude of Satellite subpoint at start of data minute.
7	Long2 (REAL)	Radians	Geodetic Longitude of Satellite subpoint at start of data minute.
8	Alt2 (INT)	Nmi	Satellite Altitude at start of data minute.
9	Jday2 (INT)	N/A	Julian Day at start of data minute.
10	Time2 (INT)	Seconds	Time of day at start of data minute.
11	Xpos1 (REAL)	N/A	X unit orientation vector at end of data minute.
12	Ypos1 (REAL)	N/A	Y unit orientation vector at end of data minute.
13	Zpos1 (REAL)	N/A	Z unit orientation vector at end of data minute.
14	Xpos2 (REAL)	N/A	X unit orientation vector at start of data minute.
15	Ypos2 (REAL)	N/A	Y unit orientation vector at start of data minute.
16	Zpos2 (REAL)	N/A	Z unit orientation vector at start of data minute.
17	Lat1 (INT)	Radians x 10000	Geodetic Latitude of Satellite subpoint at end of data minute.
18	Long1 (INT)	Radians x 10000	Geodetic Longitude of Satellite subpoint at end of data minute.
19	Alt1 (REAL)	Nmi	Satellite Altitude at end of data minute.
20	Lat2 (INT)	Radians x 10000	Geodetic Latitude of Satellite subpoint at start of data minute.
21	Long2 (INT)	Radians x 10000	Geodetic Longitude of Satellite subpoint at start of data minute.
22	Alt2 (REAL)	Nmi	Satellite Altitude at start of data minute.

23	Phi1 (REAL)	Radians	Angle on the orbital plane between the ascending node and the satellite location at end of data minute.
24	Phi2 (REAL)	Radians	Angle on the orbital plane between the ascending node and the satellite location at start of data minute.
25	Nrev (INT)	N/A	Revolution (Orbit) Number.
26	R^{+}Number (INT)	N/A	Readout Rev number relative to start of satellite day.
27	Filler	N/A	Unused data location.
28	Filler	N/A	Unused data location. Note that the APGA program stores the packed Nodal Year, Month, Day value from the RIR record into this word of the Ephemeris block.

DATA FRAME TIME BLOCK

Item #	Name (Type)	Units	Definition
1 - 60	Ifrmtim (INT)	Seconds	Data frame validity time in seconds since midnight.

INSTRUMENT DATA FRAME BLOCK

Cycle 1

Item #	Name (Type)	Units	Definition
1	Cycle1ID (INT)	N/A	Cycle counter
2	Config1ID (INT)	N/A	Configuration ID
3	OLSCmdMon (INT)	N/A	OLS command monitor
4	MPTemp:H+ (INT)	N/A	Microprocessor H+ temperature
5	MPTemp:O+ (INT)	N/A	Microprocessor O+ temperature
6	MPTemp:e (INT)	N/A	Microprocessor electron temperature
7	CurrentMon (INT)	N/A	Current monitor

8	ElmeterTemp (INT)	N/A	Electrometer temperature
9	VAperMon (INT)	N/A	Aperture voltage monitor
10	BiasMon (INT)	N/A	Bias voltage monitor
11	ElectronMon (INT)	N/A	Microprocessor EP flags
12	DMLLA (INT)	N/A	Driftmeter LLA
13	MPEPVehPot (INT)	N/A	Microprocessor EP vehicle potential
14	MPRamVel (INT)	N/A	Microprocessor ion velocity
15	DMSigLev (INT)	N/A	DM signal level
16	SMWIBAN1 (INT)	N/A	SM WIBAN1 range
17	DMWIBAN2 (INT)	N/A	DM WIBAN2 range
18	Spare		Unused
19	Spare		Unused
20	Spare		Unused
21	RPATherm (INT)	N/A	RPA thermistor
22-45	DSM:EL/AMP (INT)	N/A	DSM ELE/AMP (24 values)
46-57	DSM:Drift (INT)	N/A	DSM drift (12 values)
58-93	RPACurrent (INT)	N/A	RPA current (36 values)
94-117	EPCurrent (INT)	N/A	EP current (24 values)
118-126	SMFIBA (INT)	N/A	SM filter (9 values)
127-132	DMFIBA (INT)	N/A	DM FIBA (6 values)
133-138	EPSweepMon (INT)	N/A	EP sweep monitor (6 values)
139-144	RPASweepMon (INT)	N/A	RPA sweep monitor (6 values)
145	Cycle1MSB (INT)	N/A	Cycle 1 MSB
146	EPMode (INT)	N/A	EP mode flag (3 bits)
147	EP/RPAFlag (INT)	N/A	EP/RPA telemetry flag bit
148	TestMode (INT)	N/A	Test mode flag bit
149	BiasMode (INT)	N/A	Bias mode flag bit

150	SweepClock (INT)	N/A	Sweep clock flag bit
151	PRFReset (INT)	N/A	Program Reset Flag bit
152	RAM/PROM (INT)	N/A	Program upload flag
153	Test/Flt (INT)	N/A	Test/flight flag
154	ProgVer (INT)	N/A	Program version (7 bits)
155	VIPSet (INT)	N/A	VIP setting flag (2 bits)
156	VBIAS (INT)	N/A	VBIAS voltage (5 bits)
157	InstCode (INT)	N/A	Instrument code
158	CycleCount (INT)	N/A	Calculated cycle count
159-160	Spare		Unused (2 values)

Cycle 2

Item #	Name (Type)	Units	Definition
1	Cycle2ID (INT)	N/A	Cycle counter
2	Config2ID (INT)	N/A	Configuration ID
3	DSMCmdMon (INT)	N/A	DSM command monitor
4	MPDens:H+ (INT)	N/A	Microprocessor H+ density
5	MPDens:O+ (INT)	N/A	Microprocessor O+ density
6	MPDens:e (INT)	N/A	Microprocessor electron density
7	ADCTempMon (INT)	N/A	ADC temperature
8	DMTempElec (INT)	N/A	DM electron temperature
9	VAperMon (INT)	N/A	Aperture voltage monitor
10	BiasMon (INT)	N/A	Bias voltage monitor
11	RPAIonMon (INT)	N/A	Microprocessor RPA flags
12	DMLLB (INT)	N/A	Driftmeter LLB
13	MPRPAVehPot (INT)	N/A	Microprocessor RPA vehicle potential

14	MPRamVel (INT)	N/A	Microprocessor ion velocity
15	DMSigLev (INT)	N/A	DM signal level
16	SMWIBAN1 (INT)	N/A	SM WIBAN1 range
17	DMWIBAN2 (INT)	N/A	DM WIBAN2 range
18	Subcom1 (INT)	N/A	Subcom 1
19	Subcom2 (INT)	N/A	Subcom 2
20	DSMSensTemp (INT)	N/A	DM sensor temperature
21	EPTherm (INT)	N/A	EP thermistor
22-45	DSM:EL/AMP (INT)	N/A	DSM ELE/AMP (24 values)
46-57	DSM:Drift (INT)	N/A	DSM drift (12 values)
58-93	RPACurrent (INT)	N/A	RPA current (36 values)
94-117	EPCurrent (INT)	N/A	EP current (24 values)
118-126	SMFIBA (INT)	N/A	SM filter (9 values)
127-132	Spare		Unused (6 values)
133-138	EPSweepMon (INT)	N/A	EP sweep monitor (6 values)
139-144	RPASweepMon (INT)	N/A	RPA sweep monitor (6 values)
145	Cyc1MSB (INT)	N/A	Cycle 1 MSB
146	EPMode (INT)	N/A	EP mode flag (3 bits)
147	EP/RPAFlag (INT)	N/A	EP/RPA telemetry flag bit
148	Checksum (INT)	N/A	Checksum error flag bit
149	UplinkFlag (INT)	N/A	Uplink flag bit
150	Spare		Unused
151	VBiasMon (INT)	N/A	VBIAS monitor flag bit
152	RAMError (INT)	N/A	RAM error flag bit
153	DumpFlag (INT)	N/A	Dump flag
154	SerialNum (INT)	N/A	Serial number (3 bits)
155	VIPSet (INT)	N/A	VIP setting flag (2 bits)

156	VBIAS (INT)	N/A	VBIAS voltage (5 bits)
157	InstCode (INT)	N/A	Instrument code
158	CycleCount (INT)	N/A	Calculated cycle count
159-160	Spare		Unused (2 values)

Subcom Definitions

See Tables 2 and 3.

Word Number	Word Identification											
1 - 12	Cycle 1 ID	Config 1 ID	OLS Cmd Mon	MP Temp:H+	MP Temp:O+	MP Temp:e	Current Monitor	Elmeter Temp	Vaper Monitor	Bias Monitor	Electron Monitor	DM LLA
	Cycle 2 ID	Config 2 ID	DSM Cmd Mon	MP Dens:H+	MP Dens:O+	MP Dens:e	ADC Temp Monitor	DM Temp Electron			RPA Ion Monitor	DM LLB
13 - 24	MP EP Veh Pot	MP Ram Velocity	DM Signal Level	SM WIBAN1 Range	DM WIBAN2 Range	Not Used	Not Used	Not Used	RPA Therm	DSM: EL/AMP	-->	-->
	MP RPA Veh Pot					Subcom 1	Subcom 2	DSM Sens Temp	EP Therm			
25 - 36	DSM: EL/AMP	-->	-->	-->	-->	-->	-->	-->	-->	-->	-->	-->
37 - 48	DSM: ELE/AMP	-->	-->	-->	-->	-->	-->	-->	-->	DSM: DRIFT	-->	-->
49 - 60	DSM: DRIFT	-->	-->	-->	-->	-->	-->	-->	-->	RPA Current	-->	-->
61 - 72	RPA Current	-->	-->	-->	-->	-->	-->	-->	-->	-->	-->	-->
73 - 84	RPA Current	-->	-->	-->	-->	-->	-->	-->	-->	-->	-->	-->

Table 1A IESPREPFILE Common Format and Identification (part 1)

Word Number	Word Identification											
85 - 96	RPA Current	-->	-->	-->	-->	-->	-->	-->	-->	EP Current	-->	-->
97 - 108	EP Current	-->	-->	-->	-->	-->	-->	-->	-->	-->	-->	-->
109 - 120	EP Current	-->	-->	-->	-->	-->	-->	-->	-->	SMFIBA1	SMFIBA2	SMFIBA3
121 - 132	SMFIBA4	SMFIBA5	SMFIBA6	SMFIBA7	SMFIBA8	SMFIBA9	DMFIBA1 / Not Used	DMIFBA2 / Not Used	DMFIBA3 / Not Used	DMFIBA4 / Not Used	DMFIBA5 / Not Used	DMFIBA6 / Not Used
133 - 144	EP Sweep Monitor	-->	-->	-->	-->	-->	RPA Sweep Monitor	-->	-->	-->	-->	-->
145 - 156	Cycle 1 MSB	EP Mode	EP/RPA Flag	Test Mode / Checksum	Bias Mode / Uplink Flag	Sweep Clock / Not Used	PRF Reset / VBias Monitor	RAM/PROM Op. / RAM Error	Test/Flt Flag / Dump Flag	Prog. Version / Serial Number	VIP Setting	VBias Volts
157 - 160	Inst. Code	Cycle Count	Not Used	Not Used								

All cycles	Identification of telemetry item appearing in both even and odd cycles
Odd Cycles	Identification of telemetry item appearing in odd cycles
Even Cycles	Identification of telemetry item appearing in even cycles
Not Used	Spare word. Contains -1.

Table 1B IESPREPFILE Common Format and Identification (part 2)

Notes:

1. When a particular SSIES telemetry variant does not contain data for a common format word allocation, the preprocessor program fills that word with a (-1), i.e.: only SSIES-3 has 36 words of RPA current data, so, for SSIES, SSIES-2, and SSIES-2A, words 82 - 93 will contain (-1).

2. The sequence of values appearing in the two subcommutator words of the SSIES-2 and SSIES-2A telemetry are identified in the following table.

Cycle Second	Subcom 1	Subcom 2
2,18,34,50,66,...	REG3A	REG3B
4,20,36,52,68,...	REG3C	REG3D
6,22,38,54,70,...	REG2A	REG2B
8,24,40,56,72,...	REG2C	REG2D
10,26,42,58,74,...	REG1A	REG1B
12,28,44,60,76,...	REG1C	REG1D
14,30,46,62,78,...	SENSTEMP	ELECTEMP
16,32,48,64,80,...	COMDATD	RELAYFLG

Table 2 Subcommutator Format

The following table displays the values of the SSIES-2 and SSIES-2A subcom command registers, and the associated commands which set the registers. For each register, a reported zero value is derived from a nine-bit telemetry zero value, while a reported one value is derived from a nine-bit telemetry 511 value. The threshold between reported zero or one values is considered to be a nine-bit telemetry 256 value. The registers are latching registers, so that the instrument status can be determined from the subcom even after the associated commands have been superseded in the telemetry DSM command monitor. However, acquiring the appropriate values for one register set (REG1, REG2, or REG3) from the subcom requires at least three seconds (two successive even cycles), and acquiring the entire subcom set requires sixteen seconds.

Command	REG1D	REG1C	REG1B	REG1A	Mnemonic	Command	REG2D	REG2C	REG2B	REG2A	Mnemonic	Command	REG3D	REG3C	REG3B	REG3A	Mnemonic
82	0	0	0	0	WB2AUTO	88	0	0	0	0	WB1AUTO	90	0	0	0	0	DREP00
	0	0	0	1	spare		0	0	0	1	spare		0	0	0	1	spare
	0	0	1	0	spare		0	0	1	0	spare	92	0	0	1	0	DREP10
	0	0	1	1	spare		0	0	1	1	spare	93	0	0	1	1	DREP15
	0	1	0	0	spare		0	1	0	0	spare	94	0	1	0	0	DREP20
	0	1	0	1	spare		0	1	0	1	spare	95	0	1	0	1	DREP25
	0	1	1	0	spare		0	1	1	0	spare	96	0	1	1	0	DREP30
	0	1	1	1	spare		0	1	1	1	spare		0	1	1	1	spare
83	1	0	0	0	WB2RNG1	89	1	0	0	0	WB1RNG1	98	1	0	0	0	0WIGLO
84	1	0	0	1	WB2RNG2	8A	1	0	0	1	WB1RNG2	99	1	0	0	1	0WIGHI
85	1	0	1	0	WB2RNG3	8B	1	0	1	0	WB1RNG3	9A	1	0	1	0	1WIGLO
86	1	0	1	1	WB2RNG4	8C	1	0	1	1	WB1RNG4	9B	1	0	1	1	1WIGHI
87	1	1	0	0	WB2RNG5	8D	1	1	0	0	WB1RNG5	9C	1	1	0	0	2WIGLO
	1	1	0	1	spare	16,19	1	1	0	1	SENPOT	9D	1	1	0	1	2WIGHI
	1	1	1	0	spare	30-4C	1	1	1	0	VBIAS	9E	1	1	1	0	3WIGLO
	1	1	1	1	spare		1	1	1	1	spare	9F	1	1	1	1	3WIGHI

Table 3 Subcom Register Definitions

8.4 Data File Format for IESCNTRLFILE for APGA.

The IESCNTRLFILE, which is created by the LDCON02 program, is an APGA input file consisting of a single 1095 word binary record. This section describes the operating parameters supplied in the IESCNTRLFILE for input to APGA. The associated APGA program variable names for these parameters are identified, as are the mnemonics used in the LDCON02 program, which converts the user input specifications into the binary format for the IESCNTRLFILE.

The IESCNTRLFILE is structured to contain a single set of satellite-independent Program Information, Ionospheric Irregularity, Processing Control, and Diagnostic Control Parameters. The structure also accommodates a maximum of 3 sets of satellite-dependent Data Frame Conversion and Instrument Processing Parameters.

The LDCON02 program utilized for this conversion was developed for APGA usage based on an operational emulation of the original AFGWC LDCON program for SSIES.

The particular values listed are appropriate to the input data for the APGA program for the DMSP F11 satellite. These values are also the default values supplied within LDCON02.

The default values for IPCBEP, IPCBRP, and IDEFRE are set for the normal SSIES-2 telemetry mode in which the RPA currents are present in the telemetry and the EP currents are not present. If this condition is changed, then the values of all three parameters should be changed in the IESCNTRLFILE.

The spacecraft coordinate system referenced for the assignments of the HVSIGN and VVSIGN values is described in Section 3.2.3 of Volume 1, Technical Description.

SATELLITE IDENTIFIERS

LDCON02	Value	APGA	Description
NUMVEH	1	NUMSAT	Number of DMSP satellites in data set
MID01	2546	MISSN(1)	Mission ID for satellite 1
MID02	0	MISSN(2)	Mission ID for satellite 2
MID03	0	MISSN(3)	Mission ID for satellite 3
FID01	11	IDFLT(1)	Flight ID for satellite 1
FID02	0	IDFLT(2)	Flight ID for satellite 2
FID03	0	IDFLT(3)	Flight ID for satellite 3

PROGRAM INFORMATION PARAMETERS

LDCON02	Value	APGA	Description
IPAWAY	0	IPAWAY	PRINTAWAY processor control: IPAWAY = 0 for internal determination; IPAWAY = 1 for no PRINTAWAY execution
INTSUM	12	INTSUM	Statistics file summary print interval, in hours (PRINTAWAY disabled for non-zero INTSUM)
ICNWRT	0	ICNWRT	Console message control: ICNWRT = 0 in operational mode; ICNWRT = 1 for messages in listing
ISSDGP	0	ISSDGP	Diagnostic print control: ISSDGP = 0 in operational mode; ISSDGP = {1,2,3,4} for increasing amounts of diagnostic reporting

IONOSPHERIC IRREGULARITY MODEL PARAMETERS

LDCON02	Value	APGA	Description
AEQLAT	50.0	SCNPAR(1): AE	Equatorial value for "a"
AMALAT	8.0	SCNPAR(2): AA	Mid/Auroral latitude value for "a"
BALAT	0.75	SCNPAR(3): BH	Auroral latitude value for "b"
EQBLAT	20.0	SCNPAR(4): GMLA	Equatorial latitude boundary location
EQBWDT	3.0	SCNPAR(5): GMLAW	Width of transition across equatorial boundary
AUBLAT	71.8	SCNPAR(6): GML1	Latitude of auroral boundary for $K_p = 0$
AUBKPV	1.5	SCNPAR(7): CK	Variation of auroral boundary with K_p
AUBTMV	5.5	SCNPAR(8): CBT	Variation of auroral boundary with time
AUBTMO	2.0	SCNPAR(9): DBT	Local time offset of the auroral boundary
AUBWDT	0.15	SCNPAR(10): CHB	Width of transition across auroral boundary
DELTA	0.0	SCNPAR(11): DELTA0	Angle between irregularity sheets and L-shell
EFFLEQ	1.5E6	SCNPAR(12): LE	Equatorial value for effective layer thickness
EFFLML	4.5E6	SCNPAR(13): LM	Mid-latitude value for effective layer thickness
EFFLAU	3.5E7	SCNPAR(14): LA	Auroral value for effective layer thickness
P1MOD	1.5	SCNPAR(15): Q	Value for "p_1"

PROCESSING CONTROL PARAMETERS

LDCON02	Value	APGA	Description
IPCRPA	1	INFOPR(1): IDORP	RPA process control (0 = off; 1 = on)
IPCEP	1	INFOPR(2): IDOEP	EP process control (0 = off; 1 = on)
IPCDM	7	INFOPR(3): IDODM	Driftmeter process control: Bit 1 (LSB) controls Normal processing (0 = off; 1 = on); bit 2 controls H+ processing; bit 3 controls FIBA processing
IPCSM	3	INFOPR(4): IDOSM	Scintillation Meter process control: Bit 1 (LSB) controls EL/AMP data (0 = off; 1 = on); bit 2 controls filter data
IPCMP	3	INFOPR(5): IDOMP	Microprocessor process control: Bit 1 (LSB) controls EP report (0 = off; 1 = on); bit 2 controls RPA report
IPCCKL	1	INFOPR(6): IDOCK	CKL process control (0 = off; 1 = on; N > 1 = process every N'th CKL period)
IPCQC	1	INFOPR(7): IDOQC	Quality Control report control (0 = off, with no summary status records; 1 = on)
IPCBEP	2	INFOPR(8): IDBEP	EP sweep analysis source designation (1 = EP; 2 = microprocessor)
IPCBRP	1	INFOPR(9): IDBRP	RPA sweep analysis source designation (1 = RPA; 2 = microprocessor)
IPCDEN	1	INFOPR(10): ISWNE	Plasma density source designation (1 = SM [EL/AMP]; 2 = DM [LLA/LLB]; 3 = EP [modes C, D, DS]
IPCXXX	1	INFOPR(11): ISWVP	Spare
IPCDCK	2	INFOPR(12): ISWCKL	Plasma density source designation for CKL (1 = SM [EL/AMP]; 2 = SM [EL/AMP and filters]; 3 = EP [modes C, D, DS]
IDEFRE	0	INFOPR(13): IDEFRE	Default setting for RPA or EP currents in telemetry (0 = RPA; 1 = EP)

DIAGNOSTIC CONTROL PARAMETERS

LDCON02	Value	APGA	Description
IDPRPA	0	INFODG(1): IRPDGP	RPA diagnostic report control: (0 = no diagnostic output; 1 = binary diagnostic output; 2 = text diagnostic output; 3 = both binary and text diagnostic output; {-2,-3} = text diagnostic output in standard print file)
IDPEP	0	INFODG(2): IEPDGP	EP diagnostic report control: (0 = no diagnostic output; 1 = binary diagnostic output; 2 = text diagnostic output; 3 = both binary and text diagnostic output; {-2,-3} = text diagnostic output in standard print file)
IDPDM	0	INFODG(3): IDMDGP	DM diagnostic report control: (0 = no diagnostic output; 1 = binary diagnostic output; 2 = text diagnostic output; 3 = both binary and text diagnostic output; {-2,-3} = text diagnostic output in standard print file)
IDPSM	0	INFODG(4): ISMDGP	SM diagnostic report control: (0 = no diagnostic output; 1 = binary diagnostic output; 2 = text diagnostic output; 3 = both binary and text diagnostic output; {-2,-3} = text diagnostic output in standard print file)
IDPMP	3	INFODG(5): IMPDGP	MP diagnostic report control: (0 = no diagnostic output; 1 = EP analysis text output; 2 = RPA analysis text output; 3 = both EP and RPA analysis text output; {-1,-2,-3} = text analysis output in standard print file, with PRINTAWAY disabled)
IDPCKL	0	INFODG(6): ICKDGP	CKL diagnostic report control: (0 = no diagnostic output; 1 = binary diagnostic output; 2 = text diagnostic output; 3 = both binary and text diagnostic output; {-2,-3} = text diagnostic output in standard print file)
IDPQC	0	INFODG(7): IQCDGP	QC diagnostic report control: (0 = no diagnostic output; 1 = text diagnostic output in standard print file)
IDPEDR	1	INFODG(8): IEDDGP	EDR diagnostic report control: (0 = no diagnostic output; 1 = text diagnostic output; N > 1 = text diagnostic output every N'th Environmental Data Record)
IDPXFR	0	INFODG(9): IAGDGP	AGDB diagnostic report control: (0 = no diagnostic output; 1 = text diagnostic output; -1 = text diagnostic output in standard print file)
IDPXXX	0	INFODG(10): IXXDGP	Spare

DATA FRAME CONVERSION FACTORS

Each associated telemetry quantity (T) is converted to a physical or engineering value (V) according to:

$$V = Ann1*T + Ann0$$

LDCON02	Value	APGA	Description
A011	0.01202	FCONV(1,1)	EP log current
A010	-10.0009	FCONV(2,1)	
A021	0.01	FCONV(1,2)	SM EL/AMP voltage
A020	0.0	FCONV(2,2)	
A031	0.01005	FCONV(1,3)	RPA log current
A030	-11.30128	FCONV(2,3)	
A041	0.01	FCONV(1,4)	RPA thermistor voltage
A040	0.0	FCONV(2,4)	
A051	0.01	FCONV(1,5)	EP thermistor voltage
A050	0.0	FCONV(2,5)	
A061	0.01	FCONV(1,6)	DM offset voltage
A060	0.0	FCONV(2,6)	
A071	0.01	FCONV(1,7)	SM/DM filter and range voltages
A070	0.0	FCONV(2,7)	
A081	0.01	FCONV(1,8)	DM LLA/LLB voltage
A080	0.0	FCONV(2,8)	
A091	0.01	FCONV(1,9)	DM signal level voltage
A090	0.0	FCONV(2,9)	
A101	0.01	FCONV(1,10)	Electronics temperature voltage
A100	0.0	FCONV(2,10)	
A111	0.16	FCONV(1,11)	VAPER voltage (VBIAS + VIP)
A110	-40.96	FCONV(2,11)	
A121	1.00	FCONV(1,12)	VBIAS voltage
A120	-3.0	FCONV(2,12)	
A131	-1.00	FCONV(1,13)	VIP voltage
A130	0.0	FCONV(2,13)	
A141	0.25	FCONV(1,14)	Temperature monitor voltage
A140	-35.0	FCONV(2,14)	
A151	20.00	FCONV(1,15)	MP electron temperature
A150	0.0	FCONV(2,15)	
A161	0.012	FCONV(1,16)	MP electron density
A160	-10.0	FCONV(2,16)	
A171	20.00	FCONV(1,17)	MP H^+temperature
A170	0.0	FCONV(2,17)	
A181	0.01	FCONV(1,18)	MP H^+density
A180	1.0	FCONV(2,18)	
A191	20.00	FCONV(1,19)	MP O^+temperature
A190	0.0	FCONV(2,19)	
A201	0.01	FCONV(1,20)	MP O^+density
A200	1.0	FCONV(2,20)	
A211	1.33	FCONV(1,21)	MP input current
A210	0.0	FCONV(2,21)	
A221	40.0	FCONV(1,22)	MP ram ion drift velocity
A220	-1.0E4	FCONV(2,22)	
A231	0.10	FCONV(1,23)	MP EP analysis sensor potential

DATA FRAME CONVERSION FACTORS

LDCON02	Value	APGA	Description
A230	-10.0	FCONV(2,23)	
A241	0.02	FCONV(1,24)	MP RPA analysis sensor potential
A240	-6.0	FCONV(2,24)	
A251	0.01	FCONV(1,25)	Sensor temperature voltage
A250	0.0	FCONV(2,25)	
A261	0.0	FCONV(1,26)	Spares
A260	0.0	FCONV(2,26)	
A..1	0.0	FCONV(1,..)	Spares
A..0	0.0	FCONV(2,..)	
A501	0.0	FCONV(1,50)	Spares
A500	0.0	FCONV(2,50)	

RPA PROCESSING PARAMETERS

LDCON02	Value	APGA	Description
DSPOTD	-2.0	INFORP(1): RPDSPD	Default sensor potential value in darkness, in volts
DSPOTS	-0.5	INFORP(2): RPDSPS	Default sensor potential value in sunlight, in volts
DV0LAT	70.0	INFORP(3): RPLMAX	Apex latitude, in degrees, below which ion ram drift velocity is assumed to be zero
RPARVR	3.0	INFORP(4): RPVRNG	Sweep voltage range required for two-ion analysis
IRPAMP	20	INFORP(5): IRPMIN	Minimum number of data points required for a sweep analysis
MAXDV	11	INFORP(6): IRPMDV	Maximum number of points allowed for RPA analysis derivative determination
INITDV	3	INFORP(7): IRPSDV	Initial number of points used for RPA analysis derivative determination
ICMWDT	6	INFORP(8): IRPWID	Minimum number of sweep data points between RPA sweep minima for two-component analysis
RPASMN	-4.0	INFORP(9): RPMINV	Minimum voltage in RPA sweep
RPASMX	12.0	INFORP(10): RPMAXV	Maximum voltage in RPA sweep
RCRNGE	0.8	INFORP(11): RPCRNG	Minimum log current range, in log amperes, required for RPA sweep analysis
RPASEN	-11.2	INFORP(12): RPSENS	Minimum reportable log current, in log amperes
RPAA	5.067E-4	INFORP(13): RPAREA	Aperture area of the RPA sensor, in square centimeters
RPATRN	0.59	INFORP(14): RPTRAN	RPA sensor transparency factor {RPAA*RPATRN should equal effective DM/SM aperture areas}
CNILIM	-0.15	INFORP(15): RPNSUP	Incremental sweep noise parameter, in log amperes, for amount by which a log current value can exceed the previous good log current value
CNDL01	0.30	INFORP(16): RPNSD1	Incremental sweep noise parameter, in log amperes, for amount by which a log current value can fall below the previous good log current value, during the flat portion of the RPA sweep
CNDL02	0.60	INFORP(17): RPNSD2	Incremental sweep noise parameter, in log amperes, for amount by which a log current value can fall below the previous good log current value, during the steep portion of the RPA sweep
VINLIM	0.05	INFORP(18): DVLIM	Voltage increment limit, in volts, for termination of the iterative RPA solution, based on the difference between the maximum slope points of successive O^+ sweep fits

RPA PROCESSING PARAMETERS

LDCON02	Value	APGA	Description
RPAFIT	1.00E-22	INFORP(19): VARLIM	Threshold for variance between the RPA sweep solution and the observed sweep, which cannot be exceeded for an acceptable solution
RPACOR	0.0	INFORP(20): RPCPLG	Coupling correction term for RPA currents, due to inadvertent coupling between swept grids and sensor case (known to apply only to first three SSIES sensors)
HEBVLT	0.6	INFORP(21): RPXVB	Additional bias voltage for He^+ testing, in volts, used to differentiate between H^+ and He^+ ions for light ions present in sweep analysis
RPASVU	0.0	INFORP(22): RPSVUP	Voltage used to test start of UP sweep, in volts (obsolete)
RPASVD	8.0	INFORP(23): RPSVDN	Voltage used to test start of DOWN sweep, in volts (obsolete)
CURLIM	0.85	INFORP(24): RPMPCT	Factor for specifying low-current rejection threshold for a sweep analysis (sweeps with maximum log current less than CURLIM*RPASEN are not processed)
Spares (6)	0.0		Unused

EP PROCESSING PARAMETERS

LDCON02	Value	APGA	Description
EPA	1.026E-2	INFOEP(1): EPARE	Area of outer sphere of EP sensor, in square centimeters
EPTRAN	0.800	INFOEP(2): EPTRAN	EP sensor transparency factor
EPRVR	1.5	INFOEP(3): EPCRN	Minimum log current range, in log amperes, required for EP sweep analysis
SNPUP	-1.3	INFOEP(4): EPNSUP	Incremental upsweep noise parameter, in log amperes, for amount by which a log current value can exceed the previous good log current value
SNPDWN	0.7	INFOEP(5): EPNSDN	Incremental downsweep noise parameter, in log amperes, for amount by which the previous log current value can exceed the present log current value
SNSTRT	0.5	INFOEP(6): EPMDEL	Noise parameter for search for maximum current in saturation region of EP sweep curve, in log amperes
ETPARM	5047.0	INFOEP(7): EPTPAR	Constant used for calculation of electron temperature from maximum slope in EP sweep
EPSMN	-4.0	INFOEP(8): EPVMIN	Minimum voltage in normal EP sweep
EPSMX	4.0	INFOEP(9): EPVMAX	Maximum voltage in normal EP sweep
IEPMP	20	INFOEP(10): IEPMIN	Minimum number of data points required for a sweep analysis
IPPCOR	1	INFOEP(11): IEPCOR	Flag for empirical quadratic correction to calculated plasma potential (0 = no correction; 1 or greater = apply correction)
PPCOR1	6.720E-2	INFOEP(12): EPCCC1	Constant term in empirical correction for plasma potential
PPCOR2	1.946E-4	INFOEP(13): EPCCC2	Linear term in empirical correction for plasma potential
PPCOR3	-1.546E-7	INFOEP(14): EPCCC3	Quadratic term in empirical correction for plasma potential
EPCSU	-1.0	INFOEP(15): EPCVUP	Voltage used to test start of calibration sweep, in volts (obsolete)
EPSVU	-2.0	INFOEP(16): EPNVUP	Voltage used to test start of UP sweep, in volts (obsolete)
EPSVD	2.0	INFOEP(17): EPNVDN	Voltage used to test start of DOWN sweep, in volts (obsolete)
DCMET0	2000.0	INFOEP(18): EPDTMP	Default electron temperature for DC mode density calculations, in degrees Kelvin
IDCSM	1	INFOEP(19): NEPSM	Flag to allow use of SM density data for EP DC mode normalization (0 = disallow use; 1 = allow use)
IDCRPA	0	INFOEP(20): NEPRP	Flag to allow use of RPA density data for EP DC mode normalization (0 = disallow use; 1 = allow use)

EP PROCESSING PARAMETERS

LDCON02	Value	APGA	Description
IDCDM	0	INFOEP(21): NEPDM	Flag to allow use of DM density data for EP DC mode normalization (0 = disallow use; 1 = allow use) Note: If all three of IDCSM, IDCRPA, and IDCDM are zero, then normalization will be based on the previously derived EP sweep density
Spares (9)	0.0		Unused

DM PROCESSING PARAMETERS

LDCON02	Value	APGA	Description
DMDVC	0.1621	INFODM(1): DMK1	Drift velocity calculation constant, in inverse volts
DMEA	4.215E-4	INFODM(2): DMAEFF	Effective aperture area of the DM sensor, in square centimeters, as the product of the actual area and the transparency factor
DMDC	1.364	INFODM(3): DMK2	Ion density calculation constant
DMNOV	2.56	INFODM(4): DMOOFF	Nominal offset voltage of the offset amplifier, in volts
AGLLA	1.027	INFODM(5): DMAG	Gain of the log-level A (LLA) amplifier
AOLLA	10.85	INFODM(6): DMAOFF	Offset of the log-level A (LLA) amplifier
AGLLB	1.027	INFODM(7): DMBG	Gain of the log-level B (LLB) amplifier
AOLLB	10.82	INFODM(8): DMBOFF	Offset of the log-level B (LLB) amplifier
ANGMAX	45.0	INFODM(9): ANGMAX	Maximum angle between velocity vector of spacecraft and that of ions for which DM sensor calculations are valid
HVSIGN	+1.0	INFODM(10): DMSH	Sign of positive horizontal DM axis in spacecraft coordinate system (+1.0, -1.0)
VVSIGN	+1.0	INFODM(11): DMSV	Sign of positive vertical DM axis in spacecraft coordinate system (+1.0, -1.0)
IHVORD	1	INFODM(12): IDMH	Sequence flag for horizontal/vertical measurements in telemetry (0 = first, 1 = second; must be complementary to IVVORD)
IVVORD	0	INFODM(13): IDMV	Sequence flag for horizontal/vertical measurements in telemetry (0 = first, 1 = second; must be complementary to IHVORD)
ILLUSE	0	INFODM(14): NOLL	Flag for use of LLA/LLB for density calculations (0 = use LLA/LLB; 1 = ignore LLA/LLB)
IHPUSE	0	INFODM(15): NOHP	Flag for use of H^+mode data (0 = ignore H^+data; 1 = use H^+data)
DSMTC0	64.1	INFODM(16): DSMTG	Offset parameter for converting DSM SENSTEMP voltages into temperatures
DSMTC1	1.9337	INFODM(17): DSMTO	Gain parameter for converting DSM SENSTEMP voltages into temperatures
IRVUSE	0	INFODM(18): IDMUR	Flag for use of ram ion drift velocity from ion RPA analysis for DM sensor (0 = do not use RPA result; 1 = use RPA result)
DMFG	0.653	INFODM(19): DMFG	Effective filter gain for DM filters
NDMFLT	6	INFODM(20): NDMFLT	Number of active DM filters
DMVTB1	0.00	INFODM(21): DMVTAB(1)	WIBAN2 Range 1 threshold
DMVTB2	0.27	INFODM(22): DMVTAB(2)	WIBAN2 Range 2 threshold

DM PROCESSING PARAMETERS

LDCON02	Value	APGA	Description
DMVTB3	0.54	INFODM(23): DMVTAB(3)	WIBAN2 Range 3 threshold
DMVTB4	0.80	INFODM(24): DMVTAB(4)	WIBAN2 Range 4 threshold
DMVTB5	1.08	INFODM(25): DMVTAB(5)	WIBAN2 Range 5 threshold
DMFOF1	0.05	INFODM(26): DMFOFF(1)	DM Filter 1 offset
DMFOF2	0.05	INFODM(27): DMFOFF(2)	DM Filter 2 offset
DMFOF3	0.05	INFODM(28): DMFOFF(3)	DM Filter 3 offset
DMFOF4	0.05	INFODM(29): DMFOFF(4)	DM Filter 4 offset
DMFOF5	0.05	INFODM(30): DMFOFF(5)	DM Filter 5 offset
DMFOF6	0.05	INFODM(31): DMFOFF(6)	DM Filter 6 offset
DMFRQ1	18.0	INFODM(32): DMFFRQ(1)	DM filter 1 center frequency
DMFRQ2	39.0	INFODM(33): DMFFRQ(2)	DM filter 2 center frequency
DMFRQ3	85.0	INFODM(34): DMFFRQ(3)	DM filter 3 center frequency
DMFRQ4	390.0	INFODM(35): DMFFRQ(4)	DM filter 4 center frequency
DMFRQ5	850.0	INFODM(36): DMFFRQ(5)	DM filter 5 center frequency
DMFRQ6	1800.0	INFODM(37): DMFFRQ(6)	DM filter 6 center frequency
DMFBW1	14.0	INFODM(38): DMFBW(1)	DM filter 1 bandwidth
DMFRW2	31.0	INFODM(39): DMFBW(2)	DM filter 2 bandwidth
DMFRW3	64.0	INFODM(40): DMFBW(3)	DM filter 3 bandwidth
DMFRW4	303.0	INFODM(41): DMFBW(4)	DM filter 4 bandwidth
DMFRW5	668.0	INFODM(42): DMFBW(5)	DM filter 5 bandwidth
DMFRW6	1360.0	INFODM(43): DMFBW(6)	DM filter 6 bandwidth
Spares (7)	0.0		Unused

SM PROCESSING PARAMETERS

LDCON02	Value	APGA	Description
SMEA	2.553E-3	INFOSM(1): SMAEFF	Effective aperture area of the SM sensor, in square centimeters, as the product of the actual area and the transparency factor
AGEL	6.27E-9	INFOSM(2): SMEG	Effective gain of the electrometer amplifier
AGAMP	10.06	INFOSM(3): SMAG	Effective gain of the differencing amplifier
AOAMP	2.703	INFOSM(4): SMAOFF	Offset voltage of the differencing amplifier, in volts
RDFIT	0.015	INFOSM(5): SMRFIT	Parameter defining maximum difference between actual range flag voltage and nominal tabulated value
RT11	0.70	INFOSM(6): VTABLE(1)	Electrometer/WIBAN1 range flag voltage for EL:1, WIBAN1:1
RT12	0.60	INFOSM(7): VTABLE(2)	Electrometer/WIBAN1 range flag voltage for EL:2, WIBAN1:1
RT13	0.50	INFOSM(8): VTABLE(3)	Electrometer/WIBAN1 range flag voltage for EL:3, WIBAN1:1
RT14	0.40	INFOSM(9): VTABLE(4)	Electrometer/WIBAN1 range flag voltage for EL:4, WIBAN1:1
RT15	0.30	INFOSM(10): VTABLE(5)	Electrometer/WIBAN1 range flag voltage for EL:5, WIBAN1:1
RT21	1.49	INFOSM(11): VTABLE(6)	Electrometer/WIBAN1 range flag voltage for EL:1, WIBAN1:2
RT22	1.39	INFOSM(12): VTABLE(7)	Electrometer/WIBAN1 range flag voltage for EL:2, WIBAN1:2
RT23	1.29	INFOSM(13): VTABLE(8)	Electrometer/WIBAN1 range flag voltage for EL:3, WIBAN1:2
RT24	1.19	INFOSM(14): VTABLE(9)	Electrometer/WIBAN1 range flag voltage for EL:4, WIBAN1:2
RT25	1.09	INFOSM(15): VTABLE(10)	Electrometer/WIBAN1 range flag voltage for EL:5, WIBAN1:2
RT31	2.28	INFOSM(16): VTABLE(11)	Electrometer/WIBAN1 range flag voltage for EL:1, WIBAN1:3
RT32	2.18	INFOSM(17): VTABLE(12)	Electrometer/WIBAN1 range flag voltage for EL:2, WIBAN1:3
RT33	2.08	INFOSM(18): VTABLE(13)	Electrometer/WIBAN1 range flag voltage for EL:3, WIBAN1:3
RT34	1.98	INFOSM(19): VTABLE(14)	Electrometer/WIBAN1 range flag voltage for EL:4, WIBAN1:3
RT35	1.88	INFOSM(20): VTABLE(15)	Electrometer/WIBAN1 range flag voltage for EL:5, WIBAN1:3
RT41	3.08	INFOSM(21): VTABLE(16)	Electrometer/WIBAN1 range flag voltage for EL:1, WIBAN1:4
RT42	2.98	INFOSM(22): VTABLE(17)	Electrometer/WIBAN1 range flag voltage for EL:2, WIBAN1:4
RT43	2.88	INFOSM(23): VTABLE(18)	Electrometer/WIBAN1 range flag voltage for EL:3, WIBAN1:4

SM PROCESSING PARAMETERS

LDCON02	Value	APGA	Description
RT44	2.78	INFOSM(24): VTABLE(19)	Electrometer/WIBAN1 range flag voltage for EL:4, WIBAN1:4
RT45	2.68	INFOSM(25): VTABLE(20)	Electrometer/WIBAN1 range flag voltage for EL:5, WIBAN1:4
RT51	3.88	INFOSM(26): VTABLE(21)	Electrometer/WIBAN1 range flag voltage for EL:1, WIBAN1:5
RT52	3.78	INFOSM(27): VTABLE(22)	Electrometer/WIBAN1 range flag voltage for EL:2, WIBAN1:5
RT53	3.68	INFOSM(28): VTABLE(23)	Electrometer/WIBAN1 range flag voltage for EL:3, WIBAN1:5
RT54	3.58	INFOSM(29): VTABLE(24)	Electrometer/WIBAN1 range flag voltage for EL:4, WIBAN1:5
RT55	3.48	INFOSM(30): VTABLE(25)	Electrometer/WIBAN1 range flag voltage for EL:5, WIBAN1:5
RVLT01	0.28	INFOSM(31): VTABLE(26)	Electrometer range flag voltage for range 1
RVLT02	0.24	INFOSM(32): VTABLE(27)	Electrometer range flag voltage for range 2
RVLT03	0.20	INFOSM(33): VTABLE(28)	Electrometer range flag voltage for range 3
RVLT04	0.16	INFOSM(34): VTABLE(29)	Electrometer range flag voltage for range 4
RVLT05	0.12	INFOSM(35): VTABLE(30)	Electrometer range flag voltage for range 5
AGFILT	0.653	INFOSM(36): SMFG	Effective filter gain for SM filters
AOFLT1	11.170	INFOSM(37): SMFOFF(1)	SM filter 1 offset
AOFLT2	11.090	INFOSM(38): SMFOFF(2)	SM filter 2 offset
AOFLT3	11.050	INFOSM(39): SMFOFF(3)	SM filter 3 offset
AOFLT4	11.110	INFOSM(40): SMFOFF(4)	SM filter 4 offset
AOFLT5	11.050	INFOSM(41): SMFOFF(5)	SM filter 5 offset
AOFLT6	11.080	INFOSM(42): SMFOFF(6)	SM filter 6 offset
AOFLT7	0.0	INFOSM(43): SMFOFF(7)	SM filter 7 offset
AOFLT8	0.0	INFOSM(44): SMFOFF(8)	SM filter 8 offset
AOFLT9	0.0	INFOSM(45): SMFOFF(9)	SM filter 9 offset

SM PROCESSING PARAMETERS

LDCON02	Value	APGA	Description
CFFLT1	18.0	INFOSM(46): SMFFRQ(1)	SM filter 1 center frequency
CFFLT2	39.0	INFOSM(47): SMFFRQ(2)	SM filter 2 center frequency
CFFLT3	85.0	INFOSM(48): SMFFRQ(3)	SM filter 3 center frequency
CFFLT4	390.0	INFOSM(49): SMFFRQ(4)	SM filter 4 center frequency
CFFLT5	850.0	INFOSM(50): SMFFRQ(5)	SM filter 5 center frequency
CFFLT6	1800.0	INFOSM(51): SMFFRQ(6)	SM filter 6 center frequency
CFFLT7	0.0	INFOSM(52): SMFFRQ(7)	SM filter 7 center frequency
CFFLT8	0.0	INFOSM(53): SMFFRQ(8)	SM filter 8 center frequency
CFFLT9	0.0	INFOSM(54): SMFFRQ(9)	SM filter 9 center frequency
EBFLT1	14.0	INFOSM(55): SMFBW(1)	SM filter 1 bandwidth
EBFLT2	31.0	INFOSM(56): SMFBW(2)	SM filter 2 bandwidth
EBFLT3	64.0	INFOSM(57): SMFBW(3)	SM filter 3 bandwidth
EBFLT4	303.0	INFOSM(58): SMFBW(4)	SM filter 4 bandwidth
EBFLT5	668.0	INFOSM(59): SMFBW(5)	SM filter 5 bandwidth
EBFLT6	1360.0	INFOSM(60): SMFBW(6)	SM filter 6 bandwidth
EBFLT7	0.0	INFOSM(61): SMFBW(7)	SM filter 7 bandwidth
EBFLT8	0.0	INFOSM(62): SMFBW(8)	SM filter 8 bandwidth
EBFLT9	0.0	INFOSM(63): SMFBW(9)	SM filter 9 bandwidth
NFILTS	6	INFOSM(64): NSMFILT	Number of active SM filters
IRVUSE	0	INFOSM(65): ISMUR	Flag for use of ram ion drift velocity from ion RPA analysis for SM sensor (0 = do not use RPA result; 1 = use RPA result)
Spares (5)	0.0		Unused

MP PROCESSING PARAMETERS

LDCON02	Value	APGA	Description
IMP01	0	INFOMP(1)	Spare
Spares (14)	0.0		Unused

CKL PROCESSING PARAMETERS

LDCON02	Value	APGA	Description
RMSLIM	0.8	INFOCK(1): RMSLIM	Percentage threshold RMS variation in density required for CKL analysis
FFRQLF	0.5	INFOCK(2): FL	Low frequency limit, in Hertz, for log-linear fit to PDS to determine p_1 and T_1 (0.0468 Hz for 512-point FFT; 0.0938 Hz for 256-point FFT)
FFRQUF	10.0	INFOCK(3): FU	High frequency limit, in Hertz, for log-linear fit to PDS to determine p_1 and T_1 (11.953 Hz for FFT; 8500 Hz for filter output)
MP1USE	0	INFOCK(4): MODP1	Flag to use model value for p_1 instead of fit value (0 = use fit; 1 = use model)
SMFDAF	1.0	INFOCK(5): FILFAC	SM filter data adjustment value, to match filter data to PDS
FFTNF	1.0E-5	INFOCK(6): FFTNF	Noise floor of FFT, to exclude low values from PDS fit
IDWUSE	3	INFOCK(7): IWNDOW	Parameter for use of a split-cosine bell taper window prior to performing the FFT (0 = no window; 1 to 10 = use percent taper given by 10 times parameter value)
IDTUSE	0	INFOCK(8): IDTRND	Flag for de-trending prior to performing FFT (0 = de-trend data; 1 = de-trend data for RMS calculation only [non-de-trended data is used for FFT]). Windowing is not recommended if de-trending is disabled
IPSUSE	0	INFOCK(9): LSFPDS	Flag for use of decimated PDS for log-linear fit (0 = use full PDS; 1 = use decimated PDS)
ISMOO	3	INFOCK(10): ISMOO	Parameter for smoothing PDS (0 = no smoothing; N = 1 to 5 = use centered binomial smoother of 2*N+1 points)
IDVUSE	0	INFOCK(11): ICKLU	Flag for use of ion drift velocity from ion RPA or DM analyses for CKL analysis (0 = use only spacecraft orbital velocity; 1 = use DM drift velocities; 2 = use RPA ram drift velocity)
SMNKP	3.0	INFOCK(12): CKLKP	Nominal value of K_p, for determination of high-latitude scintillation boundary, and calculation of irregularity parameters "a" and "b" and effective layer thickness
Spares (8)	0.0		Unused

8.5 IESPROLIMITS File Format and Content.

IESPROLIMITS is an optional free format ASCII input file for APGA. The file, normally used for diagnostic and testing purposes, will limit the time span of data processed by the APGA program. If the APGA program senses an error when attempting to open this file, the error is ignored, and processing proceeds normally. If the file is opened and read successfully, the time span of the run will be limited by the data specified in the IESPROLIMITS file.

IESPROLIMITS Data Block

Item #	Name (Type)	Units	Description
1	Jday (INT)	N/A	Julian day of year when processing will start
2	IPTime (INT)	Seconds	Time of day, in seconds since midnight, when processing will start.
3	NSecsP (INT)	Seconds	Total number of seconds of data to process.

8.6 Data File Format Output by APGA.

Environmental Data Records, the primary results from the APGA analysis, are written as direct access binary records, 1791 words in length, to the file IESEDRFILE. When the IESEDRFILE is opened, the first physical record of the file is initialized with (now obsolete) AFGWC UNIVAC specific directory information. Each successive IESEDRFILE data record contains 6 words of (now obsolete) directory information and three one-minute EDR logical records. The specific contents of the EDR logical record depend upon the operating mode of the instruments and specifications provided to the APGA program in the file IESCNTRLFILE.

Because of the method of accumulating data for the EDR, a one-minute logical record can appear recurrently in the IESEDRFILE, as a consequence of not being superseded by the successful processing of a subsequent minute. The one-minute logical records are individually time-tagged, so this recurrence is detectable when utilizing the IESEDRFILE, but only the first occurrence of a time tag should be regarded as a valid one-minute record.

Environmental Data Record (EDR) Contents

Word #	Contents
1	Satellite Flight ID (two digit integer)
2	Date (YYMMDD, integer)
3	Time (HHMM, integer)

Word #	Contents
4-21	Location information (every 20 seconds). There are three sets of location information, the first valid for time HHMM00, the second for time HHMM20, and third for time HHMM40. Each set contains the following six parameters pertaining to the spacecraft location: 1: Geographic latitude (degrees, north) 2: Geographic longitude (degrees, east) 3: Apex latitude (degrees, north) 4: Apex longitude (degrees east) 5: Apex local time (hours) 6: Satellite altitude (km)
22-36	Satellite potential $V_{bias}+V_K$ (every 4 seconds) (volts)
37	Satellite potential source (integer) 1 - As set by on-board microprocessor 2 - As set by SENPOT sensor
38-97	Primary plasma density (one-second averages) (cm^3)
98	Plasma density source (SM, DM, EP) (integer) 1 - Ion density from SM sensor 2 - Ion density from DM sensor 3 - Electron density from EP sensor (DC Mode)
99-158	Horizontal ion drift velocity (m/s)
159-218	Vertical ion drift velocity (m/s)
219-338	C_kL Analyses (every 10 seconds). There are six C_kL analysis sets. The first is valid for the time period centered on HHMM05, the second for HHMM15, etc. Each analysis set contains the following parameters: 1: (RMS ΔN)/N (%) 2: T_1 3: p_1 4: C_kL 5-19: Decimated power density spectrum (PDS) 20: Analysis qualifier (integer) 0 - No analysis attempted 1 - No analysis, not enough good data. 2 - No analysis, (RMS ΔN)/N below threshold 3 - Analysis used 256 data points 4 - Analysis used 512 data points
339	Data used for C_kL calculation (integer) 1 - SM density data only 2 - SM density and filter data 3 - EP DC mode density data

Word #	Contents
340-414	EP Sweep analyses (every 4 seconds). There are 15 EP sweep analysis sets. Each is valid for either 4 (modes A, B and BS) or 2 (mode E) seconds centered on the time specified in the set. Each analysis set contains the following parameters: 1: Sweep center time (UT_3 seconds) (integer) 2: Electron density (el/cm^3) 3: Electron temperature (^oK) 4: Satellite potential (volts) 5: Analysis qualifier (integer) 0 - Analysis terminated unsuccessfully 1 - Successful analysis for DC mode (see below) 2 - Successful analysis for sweep mode
--- or ---	
340-399	EP one-second average densities (Modes C, D and DS) (el/cm^3)
400-414	EP sweep analyses (up to three) structured as words 340-414 in sweep modes.
415	EP analysis source (integer) 1 - Ground processing analysis 2 - On-board microprocessor analysis
416-520	RPA Sweep analyses (every 4 seconds). There are 15 RPA sweep analysis sets. Each is valid for the 4 seconds centered on the time specified in the set. Each analysis set contains the following parameters: 1: Sweep center time (UT, seconds) (integer) 2: O^+ density (ion/cm^3) 3: H^+ density (ion/cm^3) 4: Light ion flag (integer) 0 - No light ion 1 - Light ion is H^+ 2 - Light ion is He^+ 5: Ion temperature (^oK) 6: Ram ion drift velocity (m/s) 7: Analysis qualifier (integer) 0 - Analysis terminated unsuccessfully 1 - Successful analysis
521	RPA analysis source (integer) 1 - Ground processing analysis 2 - On-board microprocessor analysis
522-581	DM ion density (ion/cm^3)
582-588	Engineering data 582: Electrometer temperature (^oC) 583: ADC temperature (^oC) 584: DSM temperature (^oC) 585: DM offset voltage (volts) 586: DM mode (0-9) (integer) 587: EP mode (0-6 : A,B,BS,C,D,DS,E) (integer) 588: V_{Ipat} EDR start (volts)

Word #	Contents
589-595	Filler