National Aeronautics and
Space Administration

JSC 12750

Lyndon B. Johnson Space Center
Houston, Texas 77058

77-FD-004

ORBITER DATA REDUCTION COMPLEX DATA PROCESSING REQUIREMENTS FOR THE OFT MISSION EVALUATION TEAM (LEVEL C)

REVISION B

(NASA-TM-79943) ORBITER DATA REDUCTION COMPLEX DATA PROCESSING REQUIREMENTS FOR THE OFT MISSION EVALUATION TEAM (LEVEL C) (NASA) 120 p HC A06/MF A01 CSCL 09B

N79-21781

Unclas
G3/60 24260

ORBITER DATA REDUCTION COMPLEX DATA PROCESSING REQUIREMENTS FOR THE OFT MISSION EVALUATION TEAM (LEVEL C)

REVISION B

77-FD-004

APPROVED BY:

J. L. Fisher, Head
Test Data Reduction Section

M. D. Cassetti, Chief
Engineering and Special
Development Branch

A. W. Hambleton, Head
Mission Data Systems Section

C. R. Huss, Chief 3/26/79
Institutional Data Systems
Division

G. B. Foster

Integration Division

PREPARED BY

ENGINEERING AND SPECIAL DEVELOPMENT BRANCH
INSTITUTIONAL DATA SYSTEMS DIVISION
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LYNDON B. JOHNSON SPACE CENTER
HOUSTON, TEXAS

MARCH 1979

ABBREVIATIONS AND ACRONYMS

ALT	Approach and Landing Test
BCD	Binary Coded Decimal
BET	Best Estimate of Trajectory
BITE	Built-in Test Equipment
cal	calibration
calcs.	calculations
CCT	Computer-compatible tape
CDT	Compressed data tape
DFI	Development flight instrumentation
DLSM	Data Log Summary Message
EU	Engineering Unit
FM	Frequency Modulation
GMT	Greenwich Mean Time
GPC	General purpose computer
GSE	Ground support equipment
GSFC	Goddard Space Flight Center
HEX	Hexadecimal
ICD	Interface Control Document
ID	Identification
IDSD	Institutional Data Systems Division
IRIG	Instrumentation Interchange Information Group
JSC	Lyndon B. Johnson Space Center
kbps	Kilobits per second
MET	Mission Elapsed Time, Mission Evaluation Team
MMDBS	Master Measurements Data Base System
MPAD	Mission Planning and Analysis Division
MSFC	Marshall Space Flight Center
MSID	Measurement/Stimulus Identification
MTU	Master timing unit
NASA	National Aeronautics and Space Administration
NIP	Network Interface Processor
OD	Operational Downlink
ODRC	Orbiter Data Reduction Complex
OFI	Operational Flight Instrumentation
OFT	Orbital Flight Test
OI	Operational instrumentation
PCM	Pulse Code Modulation
rf	Radio frequency
R/T	Real time
SAIL	Shuttle Avionics Integration Laboratory
sec.	Second
SIS	Shuttle Interface Simulator
SSDB	Standard Source Data Base
TBD	To be determined
TDRS	Tracking and Data Relay Satellite
TICM	Test Interface Control Module
TOC	Test Operations Center
WB	Wide band

CONTENTS

APPENDICES

TABLES

FIGURES

1 PURPOSE AND SCOPE

This document addresses requirements for post-test data reduction in support of the OFT mission evaluation team, specifically those which are planned to be implemented in the ODRC (Orbiter Data Reduction Complex). Only those requirements which have been previously baselined by the Data Systems and Analysis Directorate configuration control board are included.

This document serves as the control document between IDSD and the Integration Division for OFT mission evaluation data processing requirements, and shall be the basis for detailed design of ODRC data processing systems.

2 SYSTEM OVERVIEW

A conceptual OFT data flow is shown in Figure 2-1 as an aid to understanding the context of the ODRC in overall JSC data planning. IDSD orbiter data reduction systems are designated "Orbiter Data Reduction Complex" (ODRC). The ODRC systems support SAIL tests, selected mission support functions, and certain ground tests in addition to Shuttle MET activities that are addressed in this document.

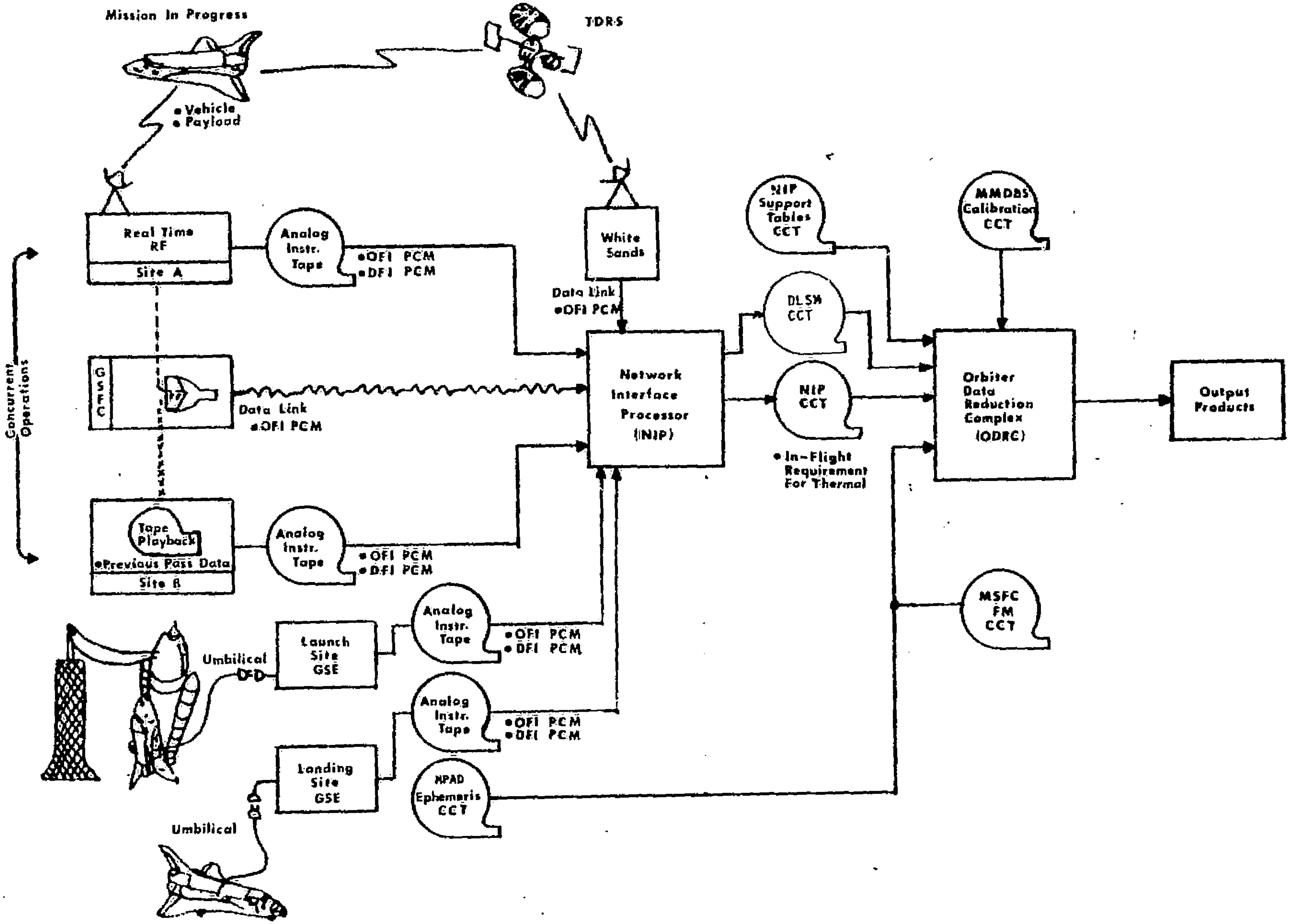


Figure 2-1. – Concept of Data Flow

3 INPUT SOURCES

The sources of Orbiter raw data will be the following:

- 64/128 kbps PCM operational[1] data downlink.
- Site recorded downlink instrumentation tapes containing 64/128 kbps OD or 128 kbps DFI PCM data (see ODRC/MET ICD for magnetic tapes).
- Orbiter onboard data via ground support equipment (GSE) recorded instrumentation tapes containing 64/128 kbps OD or 128 kbps kbps DFI PCM data (see ODRC/MET ICD for magnetic tapes).
- Orbiter FM data via GSE or site recorded instrumentation tapes, both 7 and 14 tracks.

The processed data sources will be computer-compatible tapes (CCT's) which may or may not already be converted to engineering units (EU's) (see Figure 1-1). These CCT's will contain:

- Ephemeris/BET (Format TBD)
- Orbiter FM data in EU's (see ODRC/MET ICD for magnetic tapes)
- Master Measurement Data Base System (MMDBS) calibration tape, telemetry loading tapes (see Detailed Requirements Document for the MMDBS)
- DLSM tape (see Interface Agreement for DLSM CCT, memo reference FS53-77-65, June 3, 1977)

[1]All OI and GPC formats (see Space Shuttle Telemetered and Recorded Data Format Requirements, JSC-10724, Dec. 1978)

4 TEST SUPPORT REQUIREMENTS

OFT support is required for these tests listed in Table 4-1.

TABLE 4-1.-ODRC SUPPORT

EVENT	DATE
STS-0	September 28, 1979
STS-1	November 9, 1979
STS 2	TBD
STS 3	TBD
STS 4	TBD
STS 5	TBD
STS 6	TBD

5 OUTPUT PRODUCT REQUIREMENTS

The following general product types are required by OFT data users:

- Tabulations (microfilm with option for paper)
- Page plots (microfilm)
- Continuous plots
- Computer compatible tapes (CCT's)
- Strip charts

Table 5-1 summarizes requirements for deriving the products from specific input sources. The general product requirements are described in detail in section 5.1. Specific requirements unique to individual subsystems are described in section 5.2.

5.1 GENERAL PRODUCTS

Certain general products and processing capabilities are required by the mission evaluation data manager to support all OFT tests. These required general capabilities are described in the following paragraphs.

5.1.1 Standard Tabulations

Standard time history tabulations must be available for all measurements defined in the Orbiter 64/128 kbps[1] operational downlink, and the 128 kbps DFI downlink and for all parameters on the Ephemeris CCT. Nonstandard tabulation requirements are described in section 5.2.

---

[1]All OI and GPC formats except mass and main memory dumps must be processed.

TABLE 5-1 - OFT INPUT/OUTPUT PRODUCTS

Input Data Source	Products: Non-Time-Correlated: Strip Charts	Products: Non-Time-Correlated: Continuous Plots	Products: Non-Time-Correlated: Tape Copy	Products: Time Correlated: Tabulations	Products: Time Correlated: Time History Page Plots	Products: Time Correlated: Continuous Plots	Products: Time Correlated: Formatted CCT	Products: Time Correlated: Data Merge	Products: Time Correlated: Special Calcs.	
Onboard* Downlink via instrumentation tape	X	X	X	X	X	X	X	X	X	
Onboard* via GSE instrumentation tape	X	X	X	X	X	X	X	X	X	
R/T OD downlink via data line				X	X	X	X	X	X	
MMDBS calibrations tape			X							
Ephemeris CCT				X				X	X	
MSFC digitized FM CCT							X	X	X	

* 64/128 kbps OD or 128 kbps DFI PCM

5.1.1.1 General Formats

Standard tabulations shall provide measurements in predefined page groups in standard formats. The capability to change measurement groups by special request is required. One standard format must allow up to 10 measurement columns with one time base column per page (called analog tabulation). A second standard format must allow up to 80 event measurements plus one time base column per page (called event tabulation).

5.1.1.2 Units

On analog tabulations data for analog or digital measurements must be presented in either engineering units or raw PCM counts as a user option. The capability to convert from raw PCM counts to engineering units using information from the MMDBS calibration tape is required. On event tabulations, no calibration is required.

5.1.1.3 Mixed Sample Rates

It is required that tabulation groups be capable of containing measurements with different sample rates.

5.1.1.4 Measurement/Source Combinations

It is required that OD measurements from the OI (Operational Instrumentation) and up to five GPC subcoms may be simultaneously tabulated on the same page in any requested combinations. Combinations of analog, event, and digital type measurements are required. Measurements from different sources (OD, DFI, BET, FM) must be merged to a common time base at a constant sample rate before display. Standard time corrections plus GPC skew correction will be made before merging.

5.1.1.5 Time Correlation

GMT shall be the time base for all standard tabulations and should be presented in a standard time column. For the OD source, the OI time will be used as the time base. If the OI time is unusable, any standard GPC time can be used as the OD time base. A user option to bias the time base to an event elapsed time is required. GPC time words may be assigned to data columns but may not be biased. The capability to request processing start/stop time(s) as a user option must be available.

It is required that standard tabulation formats provide for the identification of sampling time of individual measurement values, except when using GPC as the time base. Due to mixed sample rates and systematic time correlation errors, sample time for parameter values on single print lines need not be identical. A delta time value shall be included in each column heading which, when added to the time base value for a given print line, will give the sample time of a particular parameter value on the line. When tabbing time homogeneous data sets, the homogeneous data set time shall be tabbed as a parameter. An indication is required whenever subcom skew is present; the window number must be identified.

A time comparison tabulation shall display GMT, OI bitstream time, GPC bitstream time, and the MTU BITE words. Additionally, the frame counters for the OI, and GPC data subsets shall be displayed.

5.1.1.6 Event Measurements

Event measurements must be available in either of the two general formats described in paragraph 5.1.1.1. Event words to be included in an analog tab must be converted to generic meaning, such as on-off, open-closed, up-down, etc. as specified on the MMDBS calibration tape. All event tabs shall display event words in binary format ("0" or "1") with up to 80 events per page. Event words are not restricted to parent word syllables, but can be made up of up to eight bilevels from anywhere in the PCM downlink.

5.1.1.7 Annotation

It is required that standard tabulation pages be annotated such that each data value can be readily interpreted as to source, telemetry format and window, data quality, time of occurrence, units, time base, and processing parameters used. Annotation must include those items listed in Table 5-2. In addition, it is required that a listing be provided prior to each product ID for standard tabs showing nomenclature and Cal effectivity date for each measurement. For bilevels, a list of the interpretation of states, the sample rate, and the staleness is required. Measurements not in the current downlink must be so labeled.

5.1.1.8 Significant Digits

Printing of excessive digits for a given measurement shall be avoided. The number of digits printed shall be related to the granularity of the parameter and determined according to the algorithm described in Appendix A. Detailed processing and formatting are described in Appendix C.

5.1.1.9 Data Compression

A redundancy removal capability is required to avoid unnecessary printing of static tabulation lines. Redundancy removal must be selectable as an option by parameter. When selected, the first line of data printed shall be a status line. This will be an initialization line for the beginning of a tab group; but for subsequent pages of the same tab group, it will be a status line showing the last output value for each parameter in that tab group. The algorithm described in Appendix B shall be used to accomplish tabulation data compression.

TABLE 5-2.-ANNOTATION ITEMS

		Tabulations		Plot
Item	Description/Example	Page Heading	Column Heading	Pag Heac
Title	Orbital Flight	X		X
Flight/Test	Test No.	X		X
Test Date	June 1, 1979	X		X
Data Source	• R/T - Site ID • Playback R/T Site ID • Dump - Site ID • Range tape - Site ID	X		X
Tab/Plot Group ID	07-01, 90-01, etc.	X		X
Shuttle Subsystem	Structures, Avionics, etc.	X		X
Downlist/Downlink Format	(Don't Page for Main/Mass Memory Dump)	X	X	X
Processing Date	July 1, 1979	X		X
Time Correlation	Identify time listed to GMT, MET, etc.	X		X
Processing Request #		X		X
Cal. File ID	Control # or date	X		X
Status	First line of data is last printed value		X	
Measurement ID	For event groups, MSID of parent plus byte number	X	X	X
Band Pass Limits			X	X
Sample Rate	Samples/sec		X	X
Delta T	This value, when added to the time of a given line of print will give the time the parameter in question was sampled.		X	
Units	Engineering units		X	X
BITE Status		X		X
Telemetry Window	For multiple window OD		X	X

5.1.1.10 Data Quality

A. PCM Sync Status Information - Loss of data due to bad frame synchronization in the ground data processing system shall be reported on a parameter-by-parameter basis by placing a notation in the appropriate data column. Reestablishment of good sync will be evident by the presence of the first value for a given parameter being printed along with the corresponding time. The delta time between time printouts for that parameter will represent the data loss period for that parameter.

B. PCM BITE (Built-in-test-equipment) Status Information - There are two 16-bit status words; one contains status information regarding the master timing units and the other one contains status information regarding the PCM Master Unit. These words are to be checked against nominal 16-bit patterns. Whenever any one of the bits changes, a notation shall be printed on the page heading indicating that data are suspect or that status has returned to normal.

5.1.1.11 Data Availability Reports[1]

A data availability tabulation is required for each data segment produced in standard product formats. The data availability report shall include start and stop times, product ID, data source identification, and processing date. Data gaps greater than 2 seconds will be flagged.

5.1.1.12 Data Base Report[1]

A report is required immediately before each OFT mission which shows the products available. The report will be in alphanumeric order by product ID, with only

[1]Not in standard tabulation format

MET products (e.g. not SAIL) listed. (SAIL products have the letter "S" as the 6th character of the group name; others are MET.) After each product a list of the measurements on that product is required giving the following information for each measurement:

1. MSID
2. Nomenclature
3. High/low range
4. Number of bits
5. Data type
6. Bandpass (tabs) or Plot range (plots)

5.1.1.13 Measurement vs. Group Cross-Reference Report[1]

A cross-reference tabulation of measurement IDs versus the product groups that contain the measurements is required for plot groups, CCT groups, and time history tabulation groups. The cross-reference tabulation shall be sorted by measurement ID, using a two-level, ascending-magnitude sort. The primary sort shall use only characters 1, 2, 3, 5, 6, 7, and 8 of the measurement ID, and the secondary sort shall use only characters 9 and 10.

5.1.1.14 DLSM Report[1]

A report of raw data availability from the DLSM tape is required. All available parameters from the tape are to be displayed.

5.1.2 Standard Page Plots

Standard time history page plots must be available for all analog and digital measurements defined in the OD[2] 64/128 kbps or DFI 128 kbps PCM formats. Nonstandard page plot requirements are described in section 5.2.

5.1.2.1 General Format

Standard time history page plots shall provide measurements in predefined page groups in a standard format. The capability to change measurement groups by special request is required. Plotting of up to eight measurements vs. time is required per page.

5.1.2.2 Units

Data for analog and digital measurements must be plotted in either engineering units or raw PCM counts as a user option. The capability to convert from raw PCM counts to engineering units using information from the MMDBS calibration tape is required.

[1]Not in standard tabulation format
[2]See footnote page 5-1.

5.1.2.3 Mixed Sample Rates

It is required that standard page plot groups may contain measurements with different sample rates when requested.

5.1.2.4 Measurement/Source Combinations

Requirements and restrictions for grouping measurements on standard page plots are the same as those described for standard tabulations in paragraph 5.1.1.4 except that event measurements are not required on standard page plots.

5.1.2.5 Time Correlation

GMT shall be the time base for all standard page plots and shall be the x-axis plot parameter. A user option to bias the time base to an event elapsed time is required. Time correlation factors must be applied before plotting (i.e., staleness included but not GPC skew). The presence of subcom skew will be indicated by window for each page. Data before the requested start time or after the requested stop time should not be plotted.

5.1.2.6 Annotation

Annotation requirements for standard page plots are described in Table 5-2 and section 5.1.1.7.

5.1.2.7 Data Compression

A redundancy removal capability is required to avoid unnecessary plotting of static data. Plot redundancy removal must be selectable as a user option by plot group. When selected, the nonredundant points shall be step-connected starting with the initial data value. The algorithm described in Appendix B will be used to accomplish plot data compression.

5.1.2.8 Grid Requirements

Data must be plotted on grids containing major division lines and minor division tic marks, with one grid per page. Major divisions shall be labeled. The abscissa shall be scaled to the standard time base. Up to two ordinate scales must be available for a single grid per page. Grids must be lighter than plotted information.

5.1.2.9 Data Format Requirements

Plotted data points shall be represented by symbols unique to each measurement on a page. A user option by group is required to plot with or without vector connection of symbols. When vector connection is selected, symbols shall be displayed only at noncontiguous intervals. Indications on the plots shall be provided for gaps in the data as well as format changes.

5.1.3 Continuous Form Plots (Standard)

Plots in continuous (unpaged) form must be available containing predefined combinations of measurements from the OD 64/128 kbps PCM[1] data or the DFI 128 kbps PCM data, subject to restrictions described in paragraphs 5.1.3.1-5.1.2.8 to follow. Requirements for special continuous form plots containing computed parameters and/or additional data sources will be described in Section 5.2.

5.1.3.1 General Format

Multimeasurement displays are required in continuous trace or discrete data point form (by option) with each measurement periodically identified. The capability to modify existing plots or define new plots by special request is required. Plotting of up to 30 measurements vs. time is required per plot. Data dropouts must be indicated on the output. The capability to allow overlapping measurement boundaries is required.

5.1.3.2 Units

Data for analog and digital measurements may be plotted in either EU or PCM counts as a user option. The capability to convert from PCM counts to EU from the MMDBS calibration tape is required.

[1]See footnote page 5-1.

5.1.3.3 Mixed Sample Rates

The capability to plot measurements with different sample rates on the same plot is required.

5.1.3.4 Measurement/Source Combinations

Requirements and restrictions for grouping measurements are the same as in paragraph 5.1.1.4.

5.1.3.5 Time Correlation

GMT will be the time base for all continuous plots and will be the x-axis plot parameter. A user option to bias the time base is required. Time correlation factors must be applied before plotting (i.e., staleness but not GPC skew).

5.1.3.6 Annotation

Annotation requirements for continuous plots are described in Table 5-2. All heading information will be output twice at the beginning of the plot to facilitate the user cutting one set off to use as a scaling and identification throughout the entire chart.

5.1.3.7 Data Compression

No redundancy removal is required unless described in section 5.2.

5.1.3.8 Grids and Scaling

The capability to have one user defined annotated ordinate scale with intermediate tic marks for each measurement (offset to avoid overlap) or less is required at the beginning of the continuous plot. Each parameter may have one reference line (optional) at a user defined ordinate value. The vertical position and height for each scale is user defined. Time hacks are required at the top and bottom of each continuous plot (one set labeled) with a user option to connect every nth pair. The time scale (time/unit) distance is user specified.

5.1.4 Strip Charts

Standard strip charts must be available for all measurements defined in the PCM OD[1] or DFI formats. Specifically, strip charts are defined as continuous recordings made directly from PCM instrumentation tapes for the purpose of data salvage and flight or data flow anomaly analysis. Additionally, the capability to generate bitstream strip charts in the case of severe data anomalies is required. The raw PCM bitstream will be presented as a continuous bilevel representation of the input signal without regard to individual parameters. The capability to scale time or ordinate range is required in order to provide the appropriate data resolution characteristics. Telemetry format loading information is provided by the MMDBS Downlink and Downlist Telemetry Loading Tapes.

5.1.4.1 General Formats

Multimeasurement displays are required in continuous trace form on hardcopy rolls, allowing interpretation of data trends, analysis of data quality, and approximate time correlation.

Standard strip charts shall provide measurements in predefined groups. The capability to change measurement groups by special request is required. Group definitions may specify bounding of measurement tracks to prevent overlapping (as with mechanical pen recorders) or may specify unbounded tracks with possible measurement overlap (as with oscillograms). It is not required that strip charts be formatted by specific devices (pen recorders, oscillograms, printer-plotters, etc.) provided that appropriate alternatives are available and that missing data are presented by plot gaps.

5.1.4.2 Units

Strip charts shall be generated from data in raw PCM counts. Step reference levels shall be included to allow interpretation of data in percent full scale units or PCM counts.

---

[1]See footnote page 5-1.

5.1.4.3 Mixed Sample Rates

It is required that strip chart groups may contain measurements with different sample rates.

5.1.4.4 Measurement Combinations

It is required that OI and GPC measurements may be included on the same strip chart. Combinations of analog, event, and digital type measurements are required. Grouping of measurements from more than one source is not required.

5.1.4.5 Time Correlation

The capability to select NASA 36-bit range time, OI/DFI bitstream time, or any GPC bitstream time as a time base for strip charts is required. A user option to select processing start/stop time(s) and to bias the time base to an event elapsed time is required. Time words other than the time base shall be treated as data measurements and cannot be biased.

Systematic time correlation errors are not required to be corrected in generating strip charts. The OI GMT corresponding to the beginning of each minor subframe shall be used to generate a coded time trace simultaneous with the display of immediately following OI or GPC data.

A unique time correlation group must be available as a separate strip chart. This product must include OI GMT (MTU1 and MTU2), each available subcom (up to 5) bitstream time, and either ground receipt GMT or range recorded GMT.

5.1.4.6 Annotation

Strip charts must be annotated as to data request number, calibration step levels, and measurement identification. Annotation may be manually added in handwritten form.

5.1.4.7 Word Formats

Up to 10 contiguous bits (including sign for some measurements) must be included in digital-to-analog conversion of variable length words prior to display of GPC data.

5.1.4.8 Data Quality

It is required that status of the data processing system PCM bit synchronizer be displayed with each standard measurement group.

5.1.4.9 Hardcopy Quality

Standard strip chart hardcopy must be of permanent quality. Temporary hardcopy is acceptable only when noted on specific data requests.

5.1.4.10 Signal Strength Stripchart

A special strip chart is required which displays the uplink/downlink signal strength which is FM recorded on a separate track of the site instrumentation tape.

5.1.4.11 FM Stripcharts and Oscillographs

The capability is required to demultiplex (including tape error compensation) the 15 FM frequencies listed in Table 5-3 and produce stripcharts and/or oscillographs. Any one chart may contain any mix of the composite frequencies from one track of the input tape or up to four tracks at the same frequency.

This capability is for low volume, quick turnaround anomaly investigation and is not meant to replace MSFC FM processing.

TABLE 5-3.-WIDEBAND TRACK CHARACTERISTICS

INPUT CHANNEL	CBW VCO NOMENCLATURE	CENTER FREQ. (KHz)	MAXIMUM DEVIATION (KHz)
1	NON-IRIG	12	1
2	NON-IRIG	16	1
3	NON-IRIG	20	1
4	NON-IRIG	24	1
5	NON-IRIG	28	1
6	NON-IRIG	32	1
7	NON-IRIG	36	1
8	IRIG-5B	48	4
9	IRIG-7B	64	4
10	IRIG-9B	80	4
11	IRIG-11B	96	4
12	IRIG-13B	112	4
13	IRIG-15B	128	4
14	IRIG-17B	144	4
15	NON-IRIG	184	16
	Ref. Freq.	240	N/A

5.1.5 Computer Compatible Tapes (Standard)

Computer compatible tapes must be available containing predefined combinations of measurements from any of the Orbiter data sources listed in Section 3. Units conversion and sample rate mixing options are the same as described in paragraphs 5.1.1.2 and 5.1.1.3 for standard tabulations. Two types of standard CCT's are required:

- Full sample rate - all measurements retain original sample rates. All measurements on a CCT are from only one of the sources listed in Section 3.
- Interpolated - all measurements are linearly interpolated to a common user-specified sample rate. Measurements may be mixed from any of the possible sources listed in Section 3.

Standard CCT's will be genereated in the ODRC Output CCT format, which is compatible with Univac 1108 computer systems. The format is documented in the ODRC/MET Interface Control Document for Magnetic Tapes. CCT's sent to MSFC will be in MSFC FM CCT format, which is documented in the same ICD.

Requirements for nonstandard CCT products, containing computed parameters or departing in any way from the above criteria, are described in Section 5.2.

5.1.6 Copies

The capability to copy instrumentation tapes, CCT's, strip charts, oscillograms, tabs, and plots must be available. Only one-to-one dubs of the instrumentation tapes are required.

5.2 SPECIFIC PRODUCTS

In addition to the general products described in Section 5.1 which are required to support all subsystems, certain specific products are required to support individual subsystems and specific test phases. Following is a description of specific requirements.

5.2.1 Power and Propulsion

5.2.1.1 OMS Calculations

1. Chamber Pressure Conversion

Convert units to PSIA by the following:

PCL = 1.25*PCL
PCR = 1.25*PCR

2. Data Filtering

All pressure and quantity measurements in Table 5-4 will be filtered with the following filter:

$$P_0 = f_{-5}*P_{-5}+f_{-4}*P_{-4}+.....f_0*P_0+.....f_5*P_5$$

Where the eleven filter constants (fi) are input on cards. The first five points for each parameter will be lost in initializing the filter. An option to bypass the filter must be available.

3. Flowrate

$DQOL = (QOL - QOL')*K_0$
$DQOR = (QOR - QOR')*K_0$
$DQFL = (QFL - QFL')*Kf$
$DQFR = (QFR - QFL')*Kf$

where K_0 and Kf are input on cards, and ' designates the previous value, hence flowrate is undefined for the first data point. Default values are K_0 = 80.31 and Kf = 48.99.

4. Mixture Ratio

QRR = DQOR/DQFR
QRL = DQOL/DQFL

5. System Pressures

DPUOL = PUOL - PCL
DPUFL = PUFL - PCL
DPUOR = PUOR - PCR
DPUFR = PUFR - PCR

6. Engine Pressures

DPIOL = PIOL - PCL
DPIFL = PIFL - PCL
DPIOR = PIOR - PCR
DPIFR = PIFR - PCR

7. Hypergolic Pressures and Ratios

DPHL = PIOL - PIFL
DPHR = PIOR - PIFR
PRL = PIOL/PIFL
PRR = PIOR/PIFR

8. Fuel Temperature Rise

DTL = TFL - TOL
DTR = TFR - TOR

9. X-axis Acceleration

AX = VX - VX'

where ' designates the previous value.

10. Output will be on continuous form plots and on CCT. The CCT will contain additional OD and DFI parameters to be defined later.

TABLE 5-4.-OMS INPUT MEASUREMENTS

MSID	SYMBOL	DESCRIPTION
V43P4221C	PUOL	Left oxidizer ullage pressure
V43P5221C	PUOR	Right oxidizer ullage pressure
V43P4321C	PUFL	Left fuel ullage pressure
V43P5321C	PUFR	Right fuel ullage pressure
V43P4645C	PIOL	Left oxidizer inlet pressure
V43P5645C	PIOR	Right oxidizer inlet pressure
V43P4646C	PIFL	Left fuel inlet pressure
V43P5646C	PIFR	Right fuel inlet pressure
V43P4649C	PCL	Left chamber pressure
V43P5649C	PCR	Right chamber pressure
V43Q4231C	QOL	Left oxidizer quantity
V43Q5231C	QOR	Right oxidizer quantity
V43Q4331C	QFL	Left fuel quantity
V43Q5331C	QFR	Right fuel quantity
V43T4642A	TOL	Left oxidizer injector temperature
V43T4643A	TFL	Left oxidizer inlet temperature
V43T5642A	TOR	Right oxidizer injector temperature
V43T5643A	TFR	Right oxidizer inlet temperature
V71L2200B	VX	IMU-1 accum vel. X

5.2.1.2 RCS Quantity Calculation

1. Input measurements and their substitutes are shown in Table 5-5. An option must be available by parameter to select which MSID is used for each. Constants needed for the computation are shown in Table 5-6. Those not listed in these tables must be read from input cards.

2. Vapor Pressure

   PFV(I) = F for I = 2, 4, 6
   PFV(I) = E + D1-D2/TF(I)+D3*TF(I) for I = 1, 3, 5
   E is provided on input card.

3. Helium Compressibility Factory (I=1 thru 6)

   PS(I) = (PS1(I) + PS2(I))/2
   ZS(I) = 1 + B1*PS(I)*TS(I)**(-B2)

4. Helium Supply System Volume

   VHS(I) = VHAM(I)*(1+PS(I)*A)**3+VHLI(I)

5. Weight in Helium Supply

   WHS(I) = (PS(I)*VHS(I))/(ZS(I)*TS(I))

6. Oxidizer and Fuel Quantities

   PF(I) = (PF1(I) + PF2 (I))/2
   VHU(I) + [G*(WHI(I)-WHS(I))*TF(I)*R]/(PF(I)-PFV(I))
   RHOF(I) = C1-C2*TF(I)+C3*PF(I) for I=1,3,5
   RHOF(I) = E1-E2*TF(I)+E3*PF(I) for I=2,4,6
   RWFD(I) = 100*[RHOF(I)*(VP(I)-VTP(I)-VHU(I))-WTP(I)]/
   WFDA(I)

   WHI(I) and WFDA(I) are provided on input cards.

7. Output RWFD(I) on a continuous form plot and/or a tab. Output will be labeled as follows:

I =	LABEL
1	FWD OX
2	FWD FU
3	AFT LEFT OX
4	AFT LEFT FU
5	AFT RIGHT OX
6	AFT RIGHT FU

TABLE 5-5.-RCS QUANTITY INPUTS

SYMBOL	MSID	SUBSTITUTE
TS(1)	V42T1100C	V42T1104C*
PS1(1)	V42P1110C	V42P1112C*
PS2(1)	V42P1112C	V42P1110C
PF1(1)	V42P1115C	V42P1210C*
PF2(1)	V42P1210C	V42P1115C
TF(1)	V42T1200C	V42T1300C*
TS(2)	V42T1104C	V42T1100C
PS1(2)	V42P1113C	V42P1114C*
PS2(2)	V42P1114C	V42P1113C
PF1(2)	V42P1116C	V42P1310C*
PF2(2)	V42P1310C	V42P1116C
TF(2)	V42T1300C	V42T1200C
TS(3)	V42T2100C	V42T2104C*
PS1(3)	V42P2110C	V42P2112C*
PS2(3)	V42P2112C	V42P2110C
PF1(3)	V42P2115C	V42P2210C*
PF2(3)	V42P2210C	V42P2115C
TF(3)	V42T2200C	V42T2300C*
TS(4)	V42T2104C	V42T2100C
PS1(4)	V42P2113C	V42P2114C*
PS2(4)	V42P2114C	V42P2113C
PF1(4)	V42P2116C	V42P2310C*
PF2(4)	V42P2310C	V42P2316C
TF(4)	V42T2300C	V42T2200C
TS(5)	V42T3100C	V42T3104C*
PS1(5)	V42P3110C	V42P3112C*
PS2(5)	V42P3112C	V42P3110C
PF1(5)	V42P3115C	V42P3210C*
PF2(5)	V42P3210C	V42P3115C
TF(5)	V42T3200C	V42T3300C*
TS(6)	V42T3104C	V42T3100C
PS1(6)	V42P3113C	V42P3114C*
PS2(6)	V42P3114C	V42P3113C
PF1(6)	V42P3116C	V42P3310C*
PF2(6)	V42P3310C	V42P3116C
TF(6)	V42T3300C	V42T3200C

TABLE 5-6.-RCS CALCULATION CONSTANTS

DESCRIPTION	SYMBOL	VALUE
RCS-FWD TRAPPED OX LINE VOL	VTP(1)	701.0
RCS-FWD TRAPPED FU LINE VOL	VTP(2)	620.6
RCS-L AFT TRAPPED OX LINE VOL	VTP(3)	1.0349×10^3
RCS-L AFT TRAPPED FU LINE VOL	VTP(4)	1.2217×10^3
RCS-R AFT TRAPPED OX LINE VOL	VTP(5)	1.0349×10^3
RCS-R AFT TRAPPED FU LINE VOL	VTP(6)	1.2217×10^3
FUEL DENSITY COEFFICIENT	E1	4.1538×10^{-2}
FUEL DENSITY COEFFICIENT	E2	1.8697×10^{-5}
FUEL DENSITY COEFFICIENT	E3	1.4583×10^{-7}
FUEL VAPOR PRESSURE	F	0.8
HELIUM WEIGHT COEFFICIENT	G	1.008
HELIUM GAS CONSTANT	R	4635
HELIUM SYSTEM VOLUME COEFFICIENT	A	1.4972×10^{-6}
HELIUM COMPRESSIBILITY COEFFICIENT	B1	9.7544×10^{-3}
HELIUM COMPRESSIBILITY COEFFICIENT	B2	0.897
RCS-FWD OX TK RESIDUAL WEIGHT	WTP(1)	200.0
RCS-FWD FU TK RESIDUAL WEIGHT	WTP(2)	127.0
RCS-L AFT OX TK RESIDUAL WEIGHT	WTP(3)	117.0
RCS-L AFT FU TK RESIDUAL WEIGHT	WTP(4)	68.5
RCS-R AFT OX TK RESIDUAL WEIGHT	WTP(5)	117.0
RCS-R AFT FU TK RESIDUAL WEIGHT	WTP(6)	68.5
RCS-FWD HE BOTTLE VOLUME	VHAM(1 or 2)	3.043×10^3
RCS-L AFT HE BOTTLE VOLUME	VHAM(3 or 4)	3.043×10^3
RCS-R AFT HE BOTTLE VOLUME	VHAM(5 or 6)	3.043×10^3
RCS-FWD OX HE LINE VOLUME	VHLI(1)	13.7
RCS-FWD FU HE LINE VOLUME	VHLI(2)	13.7
RCS-L AFT OX HE LINE VOLUME	VHLI(3)	23.6
RCS-L AFT FU HE LINE VOLUME	VHLI(4)	20.7
RCS-R AFT OX HE LINE VOLUME	VHLI(5)	23.6
RCS-R AFT FU HE LINE VOLUME	VHLI(6)	20.7
RCS-FWD OX SYSTEM VOLUME	VP(1)	3.1787×10^4
RCS-FWD FU SYSTEM VOLUME	VP(2)	3.18679×10^4
RCS-L AFT OX SYSTEM VOLUME	VP(3)	3.20407×10^4
RCS-L AFT FU SYSTEM VOLUME	VP(4)	3.20447×10^4
RCS-R AFT OX SYSTEM VOLUME	VP(5)	3.20407×10^4
RCS-R AFT FU SYSTEM VOLUME	VP(6)	3.20447×10^4
OXIDIZER DENSITY COEFFICIENT	C1	7.6027×10^{-2}
OXIDIZER DENSITY COEFFICIENT	C2	4.5162×10^{-5}
OXIDIZER DENSITY COEFFICIENT	C3	4.1667×10^{-7}
OXID VAPOR PRESS COEFFICIENT	D1	12.082
OXID VAPOR PRESS COEFFICIENT	D2	6111.0
OXID VAPOR PRESS COEFFICIENT	D3	4.03×10^{-3}

5.2.1.3 APU Fuel Quantities

A. Measurements Required:

Symbol	ID	Description	Units
P11	V46P0100A	APU 1 fuel tank pressure	psia
P21	V46P0200A	APU 2 fuel tank pressure	psia
P31	V46P0300A	APU 3 fuel tank pressure	psia
P12	V46P0105A	APU 1 fuel tank outlet pressure	psia
P22	V46P0205A	APU 2 fuel tank outlet pressure	psia
P32	V46P0305A	APU 3 fuel tank outlet pressure	psia
T_1	V46T0102A	APU 1 fuel tank temperature	deg F
T_2	V46T0202A	APU 2 fuel tank temperature	deg F
T_3	V46T0302A	APU 3 fuel tank temperature	deg F

B. Special Constants:

Symbol	Units	Value	Description
A	scalar	1.003	Linear coefficient for tank stretch; tentative value
B	scalar	1.1666×10^{-3}	Linear coefficient for tank stretch; tentative value
V_{01}	cubic in.	0	Volume not subject to stretch APU 1
V_{02}	cubic in.	0	Volume not subject to stretch APU 2
V_{03}	cubic in.	0	Volume not subject to stretch APU 3
VZ1	cubic in.	11,421	Tank volume at zero pressure, APU 1
VZ2	cubic in.	11,421	Tank volume at zero pressure, APU 2
VZ3	cubic in.	11,421	Tank volume at zero pressure, APU 3
Y	degrees	459.69	Conversion of Fahrenheit to Rankine Temperature
RGCF	$\frac{(psia)ft^3}{(LBM)^oR}$	.334868	Specific gas constant; preliminary value
GE_1	ft^3	.3982	Gaging error, APU 1; preliminary value
GE_2	ft^3	.3982	Gaging error, APU 2; preliminary value
GE_3	ft^3	.3982	Gaging error: APU 3; preliminary value
EFF_1	scalar	.99	Tank expulsion efficiency, APU 1; preliminary value
EFF_2	scalar	.99	Tank expulsion efficiency, APU 2; preliminary value
EFF_3	scalar	.99	Tank expulsion efficiency, APU 3; preliminary value
L	lbm/ft^3	79.484	Temperature-to-density coefficient; preliminary value
M	lbm/ft^3	-0.0315	Temperature-to-density coefficient; preliminary value

K1	scalar	61.849	Helium compressibility coefficient
K2	scalar	-9567.6	Helium compressibility coefficient
K3	scalar	21,345.1	Helium compressibility coefficient
K4	scalar	-78.803	Helium compressibility coefficient
K5	scalar	16.995	Helium compressibility coefficient
K6	scalar	-11761.6	Helium compressibility coefficient

C. Special parameters:

Symbol	Units	Value	Description	Variability
HM_1	lbm	TBD	Loaded helium mass, APU 1	Each flight
HM_2	lbm	TBD	Loaded helium mass, APU 2	Each flight
HM_3	lbm	TBD	Loaded helium mass, APU 3	Each flight
Ci1	scalar	0 to 1	User input; selector for Pil, APU(i) 1 = 1,2,3	Each processing request
Ci2	scalar	0 or 1	User input; selector for Pi2, APU(i) i = 1,2,3	Each processing request

D. Processing:

$$Pi = \frac{(Ci1)(Pi1) + (Ci2)(Pi2)}{Ci1 + Ci2}, \qquad (i = 1, 2, 3)$$

where

Pi = averaged fuel tank pressure (psia) for APU system i.

$$Vci = Voi + VZi\,[A + Pi(B)]^3, \quad (i = 1, 2, 3)$$

where

Vci = volume corrected for tank stretch, APU system i (cubic inches)

Pi = averaged fuel tank pressure, APU system i, computed above

$$Ui = Ti + Y, \quad (i = 1, 2, 3)$$

where

Ui = temperature, degrees Rankine, APU system i

$$Di = K1(Ui) + K2$$

$$Ei = K3 + K4(Ui)$$

$$Fi = K5(Ui) - Pi + K6 \quad (i = 1, 2, 3)$$

where

Di, Ei, Fi = computed coefficients for compressibility of gaseous helium

$$Zi = \frac{-Ei + \sqrt{Ei^2 - 4DiFi}}{2Di} \qquad (i = 1, 2, 3)$$

where

Zi = compressibility of the helium in APU system (i)

$$VUi = \frac{(Zi)(RGCF)(HMi)(Ui)}{Pi} \qquad (i = 1, 2, 3)$$

where

VUi = ullage volume in flight conditions (ft^3), APU system (i)

Zi = helium compressibility in APU system (i), computed above

$$VPi = (EFFi)(Vci) - VUi - GEi \qquad (i = 1,2,3)$$

where

VPi = usable fuel volume remaining (ft^3), APU system (i)

VCi = stretch-corrected tank volume, computed above

$$RHOPi = L + (M)(Ui) \qquad (i = 1, 2, 3)$$

where

RHOPi = fuel density in flight conditions, (lbm/ft^3)

Ui = Rankine temperature, computed above

$$Qci = RHOPi \cdot VPi \qquad (i = 1, 2, 3)$$

where

Qci = fuel mass remaining (lbm)

VPi = fuel volume remaining, computed above

$$Ri(j) = \frac{Qci(j) - Qci(j-1)}{t(j) - t(j-1)} \qquad (i = 1, 2, 3)$$

where

Ri(j) = mass flow rate (pounds/second) at time t(j), APU system (i)

Qci(j) = fuel mass remaining at time t(j)

Qci(j-1) = Fuel mass remaining at time t(j-1)

t(j) = sampling time associated with value Ri(j)

t(j-1) = time of sample immediately preceding t(j)

$$FCi + (1-Qci/HMi)(100) \quad (i = 1, 2, 3)$$

where

FCi = fuel consumption (percent), APU system (i)

E. Output:

Time-history page plots and tabulations of usable fuel remaining [Qci], mass flow rate [Ri], and fuel consumption [FCi].

F. Options:

Start and stop times (GMT), linear interpolation rate, output tabulation rate.

5.2.1.4 APU Performance Calculations

A. Measurements required:

Symbol	ID	Description	Units
FL_1	V46S0229E	High speed select flag, APU 1	event
FL_2	V46S0229E	High speed select flag, APU 2	event
FL_3	V46S0329E	High speed select flag, APU 3	event
IP	V07P9052A	Aft fus1 intl press no.100	psia
CP_1	V46P0120A	APU 1 gas gen chamber press	psia
CP_2	V46P0220A	APU 2 gas gen chamber press	psia
CP_3	V46P0320A	APU 3 gas gen chamber press	psia

B. Special Constants:

Symbol	Units	Value	Description and Remarks
W	RPM/percent	720	Percent to RPM conversion
TH	psia	500	Pressure threshold, APU pulses
Tmin	msec	20	Time Threshold, APU pulses
B_{10}	scalar	88.49699649	Curve fit coefficient normal speed
B_{20}	scalar	-1.29934239	Curve fit coefficient normal speed
B_{11}	scalar	95.47388913	Curve fit coefficient high speed
B_{21}	scalar	-1.258294872	Curve fit coefficient high speed
AP	psia	10	User-supplied for each run, default value of ambient pressure

Curve fit coefficients Ajkl, Cjml, Djml, supplied by user where:
j = FLi (i = 1,2,3); FLi = 0 (normal) or 1 (high) APU speed.
k = 1, 2, 3, 4, 5 indicating the powers 0, 1, 2, 3, 4, respectively, of ($Log_{10}PWi$) used in the polynomial.
l = 1, 2, 3 indicating the powers 0, 1, 2, respectively, of the fuselage pressure used in the polynomial.
For coefficients (C, D), the subscript m is used rather than k.
m = 1, 2, 3, 4, 5, 6, 7 indicating the power 0, 1, 2, 3, 4, 5, 6, respectively, of the pulse frequently used.

Therefore, 30 values of (A) and 42 values each for (C, D) are required.

C. Processing:

A pulse shall be counted for APU system (i) each time the chamber pressure (CPi) rises from below or equal to (TH) to above (TH) and remains for at least (Tmin) milliseconds. A pulse ends when the chamber pressure drops below or equal to (TH) and remains there for at least (Tmin) milliseconds. All points within that last (Tmin) are not included in the pulse. For each pulse counted, compute the pulse width PWi in seconds and for each specified interval (Δt) use the pulse count (PCi) to determine the frequency (Fi) ($Fi = PCi/\Delta t$) in pulses per second. A pulse that spans more than one interval shall be considered to be entirely within the interval in which the pulse ends, except that a pulse spanning either the start or stop time shall be ignored. Also, the start time and beginning of the first interval shall coincide, and any interval shortened by the stop time (a partial interval) shall be discarded. At the end of each interval $(\Delta)t$ compute the averaged pulse width (PWi) as well as the sum and sum of the squares of pulse chamber pressures [ΣCPi and $\Sigma(CPi)^2$] and the number of chamber pressure values (ni). If values of CPi are lost due to sync or other problems, they shall not be included in the sums, and they are considered on the same side of the threshold (TH) as the last valid data value. The values of CPi used in the sums must be pulse values (i.e., exceed TH).

$$AHPi = [Aj_{11} + Aj_{12}P + Aj_{13}P^2] + [Aj_{21} + Aj_{22}P + Aj_{23}P^2](\text{Log } PWi) + [Aj_{31} + Aj_{32}P + Aj_{33}P^2](\text{Log } PWi)^2 + [Aj_{41} + Aj_{42}P + Aj_{43}P^2](\text{Log } PWi)^3 + [Aj_{51} + Aj_{52}P + Aj_{53}P^2](\text{Log } PWi)^4$$

Test: $AHPi > B2j \cdot P + B1j$ for $j = FLi$

If true, then

$$HPi = [Cj_{11} + Cj_{12}P + Cj_{13}P^2] + [Cj_{21} + Cj_{22}P + Cj_{23}P^2]Fi +$$

$$[Cj_{31} + Cj_{32}P + Cj_{33}P^2]Fi^2 +$$

$$[Cj_{41} + Cj_{42}P + Cj_{43}P^2]Fi^3 +$$

$$[Cj_{51} + Cj_{52}P + Cj_{53}P^2]Fi^4 +$$

$$[Cj_{61} + Cj_{62}P + Cj_{63}P^2]Fi^5 +$$

$$[Cj_{71} + Cj_{72}P + Cj_{73}P^2]\ Fi^6$$

If false, then

$$HPi = [Dj_{11} + Dj_{12}P + Dj_{13}P^2] +$$
$$[Dj_{21} + Dj_{22}P + Dj_{23}P^2]\ Fi +$$
$$[Dj_{31} + Dj_{32}P + Dj_{33}P^2]\ Fi^2 +$$
$$[Dj_{41} + Dj_{42}P + Dj_{43}P^2]\ Fi^3 +$$
$$[Dj_{51} + Dj_{52}P + Dj_{53}P^2]\ Fi^4 +$$
$$[Dj_{61} + Dj_{62}P + Dj_{63}P^2]\ Fi^5 +$$
$$[Dj_{71} + Dj_{72}P + Dj_{73}P^2]\ Fi^6$$

where:

i = 1, 2, 3 (APU system i)

j = value of FLi at the end of the time interval (Δt)

HPi = refined horsepower, APU system (i)

Fi = pulse frequency computed for the time interval (Δt)

P = average value of IP over the time interval (Δt).

whenever AP>0 use P = AP and ignore IP

The following statistics should be computed over specified averaging intervals (Δt), typically 10 seconds:

$$\sigma i = \sqrt{\frac{\Sigma (CPi)^2 - (\Sigma CPi)^2/ni}{ni - 1}}$$

σi = standard deviation of those (ni) values of CPi occurring during APU pulses in APU system (i) (i = 1, 2, 3)

ACPi = $(\Sigma CPi)/ni$ = average chamber pressure (i = 1, 2, 3)

APRi = APU roughness = σi/ACPi (i = 1, 2, 3)

AEi = HPi . PWi . PCi (i = 1, 2, 3)

where

AEi = APU energy, horsepower - hours

PWi = pulse width averaged over the time interval (Δ)

PCi = pulse count over the time interval (Δt)

D. Output:

Page plots and tabulations of hoursepower (APHi, HPi), pulse count (PCi), pulse width (PWi), pulse frequency (Fi), chamber pressure averages (ACPi), standard deviations (σi), APU roughness (APRi), and energy (AEi). Each time value associated with these parameters should be the end time of the averaging interval (Δt). At the end of each tabulation report, average values of pulse count (PCi), pulse width (PWi), and horsepower (HPi) will be printed as well as a total value for energy (sum of values AEi).

E. Options:

Start-stop (GMT); averaging interval (Δt), linear interpolation rate (IR) for all input OI measurements.

5.2.2 Aerodynamics

5.2.2.1 Aerodynamics Performance Calculations

INPUT:

```
   NZ = V90A5381C                S = 2690
ALPHA = V95P3021C                G = 32.174
    D = V95V0160C                DTR = .01745329252
 QBAR = V95P3011C
   WT = Card input  (Default = 183327)
```

PROCESSING:

```
 CN = NZ*WT/(S*QBAR)
 CL = CN*COS(ALPHA*DTR)
 CD = D*WT/(S*G*QBAR)
LOD = CL/CD
```

OUTPUT:

NZ, ALPHA, D, QBAR, CN, CL, CD, LOD to standard tab and/or continuous form plot. Default sample rate is 1 s/s.

5.2.2.2 Aerodynamic Hinge Moment Calculation

<u>INPUT:</u>

	I=1	I=2	I=3	I=4
SP(I)	18.02	21.80	21.80	18.02
AP(I)	39.25	56.29	56.29	39.25
BP(I)	8.80	15.10	15.10	8.80
D(I)	87.044	83.613	83.613	87.044
HMGB(I)	15241.708	37974.820	37974.820	25241.708
DLE(I)	V58H0852A	V58H0802A	V58H0902A	V58H0952A
DPEF(I)	V90P2515C	V90P2516C	V90P2518C	V90P2517C

```
  C = 52.50270631                    NX = V34A3494A(DFI)
HMC = .1019716214E-06                NY = V90A5361C
 DO = .13089969                      NZ = V90A5381C
DTR = .01745329252                 QBAR = V95P3011C
```

<u>PROCESSING</u> (For I = 1,4)

```
     F(I) = (DLE(I)+D(I))*DTR
     R(I) = SQRT(AP(I)**2+BP(I)**2-AP(I)*BP(I)*COS(F(I)))
  HMET(I) = DPEF(I)*(SP(I)*AP(I)*BP(I)*SIN(F(I))) /(R(I)*1.0E06)
   HMG(I) = HMC*(NX*SIN(DLE(I)*DTR+DO)+NZ* .99862953
              - NY*.05233596)*COS(DLE(I)*DTR+DO))*HMGB(I)
HMAERO(I) = HMET(I)-HMG(I)
   CHE(I) = HMAERO(I)*C*1.0E06/QBAR
```

<u>OUTPUT</u>

Three standard tabs and/or continuous form plots:

1. DLE(I) AND DPEF(I)
2. HMET(I) and HMG(I)
3. HMAERO(I) and CHE(I)

Label I=1 as LOB, I=2 as LIB, I=3 as RIB, and I=4 as ROB; e.g., for tab 1.

```
LOB  LIB  RIB  ROB  LOB  LIB  RIB  ROB
DLE  DLE  DLE  DLE  DPEF DPEF DPEF DPEF
```

5.2.2.3 Aero Rate Calculations

1. Azimuth

   Vector quantities are denoted with bars. Inputs are

   $$\bar{R}=\begin{bmatrix} V95H0185C \\ V95H0186C \\ V95H0187C \end{bmatrix} \qquad \bar{V}=\begin{bmatrix} V95L0190C \\ V95L0191C \\ V95L0192C \end{bmatrix} \qquad \bar{k}=\begin{bmatrix} k1 \\ k2 \\ k3 \end{bmatrix}$$

   where k1, k2, k3 and w are card inputs.
   Calculate

   $$\bar{W} = \bar{V} - w\ (\bar{k} \times \bar{R})$$

   $$\bar{N} = \bar{R} \times \bar{W}$$

   $$AZ = \tan^{-1}[\ (\bar{N} \bullet \bar{k})\,|\bar{R}|/(\bar{N} \times \bar{R} \bullet \bar{k})\ ] \qquad (0\text{-}360^{\circ})$$

2. Flight Path Angle

   FPA = V95H0261C (deg.)

3. Mach Number

   M = V95L3029C (N.D.)

4. Rate Calculations

   Let M(I) denote the Mach number at time T(I), then the Mach rate is:

   MR = [M(I+1)-M(I)]/[T(I+1)-T(I)]

   and similarly

   AZR = [AZ(I+1)-AZ(I)]/[T(I+1)-T(I)]
   FPAR = (FPA(I+1)-FPA(I)]/[T(I+1)-T(I)]

5. Output AZ, AZR, FPA, FPAR, M, MR to a tab and/or 3 page plots. Default calculation rate is 1 S/S.

5.2.2.4 Actuator Calculations

INPUTS

DELE(1)	V58H0852A
(2)	V58H0802A
	V58H0902A
	V58H0952A

REQUIREMENT DELETED 3/22/79

EQU.

ELEVON - E(1)+DELE(2)+DELE(3)+DELE(4))

AILERN = .2 +DELE(2)-DELE(3)-DELE(4))

OUTPUT

Output ELEVON and AI ontinuous form plots and/or page plots at 25 S/S.

5.2.2.5 Ascent Air Data System Calculations

1. MSFC PCM inputs are:

SYMBOL	MSID	NAME	UNITS	S/S
PZM	T07P9061A	NOSE CAP PRESS-Z PORT	PSIA	1
PTM	T07P9550A	NOSE CAP TOTAL PRESS	PSIA	10
DPA	T07P9551A	NOSE CAP ΔP-PITCH	PSID	10
DPB	T07P9552A	NOSE CAP ΔP-YAW	PSID	10
TCM	T07T9553A	NOSE CAP SPIKE TEMP	DEG F	1

These data will be gap filled, filtered, and linearly interpolate to 10 S/S (See Section 5.2.2.6).

2. Polynomial Function

A special polynomial function will be referenced in the equations that follow.

P6[K,X] will represent a sixth order polynomial of X using coefficient set K. There will be nine card-input sets: KM, KA, KDA, KB, KDB, KS, KDS, KAI, KBI. Each will have three subsets of seven coefficients and two break points B1 and B2:

X<B1	use subset 1
B1≤X<B2	use subset 2
B2≤X	use subset 3

3. Transducer sensitivities

All CIJ values are card inputs for I = 1, 7 and J=1,7

```
TCMC = C11+C12*TCM+C13*TCM**2+C14*TCM**3
       +C15*TCM**4+C16*TCM**5+C17*TCM**6

PZMC = C21+C22*PZM+C23*PZM**2+C24+PZM**3
       +TCMC*(C25+C26*PZM+C27*PZM**2)

PTMC = C31+C32*PTM+C33*PTM**2+C34*PTM**3
       +TCMC*(C35+C36*PTM+C37*PTM**2

If DPA≥0 then DPAC = C41+C42*DPA+C43*DPA**2+C44*DPA**3
                     +TCMC*(C45+C46*DPA+C47*DPA**2)

If DPA<0 then replace C4J with C5J for J=1,7

If DPB≥0 then DPBC=C61+C62*DPB+C63*DPB**2+C64*DPB**3
                   +TCMC*(C65+C66*DPB+C67+DPB**2)
```

If DPB<0 then replace C6J with C7J for J=1,7

4. Static Pressure and Mach Number

PAVE = PZMC-.5*DPAC

MIND = $\sqrt{5*[PTMC/PAVE)**(2/7)-1]}$

MACH = P6[KM, MIND]

5. Angle of Attack and Sideslip

RA = P6[KA, MIND]
AIND = DPAC/(PTMC*RA)
DA = P6[KDA, MIND]
RB = P6[KB, MIND]
BIND = DPBC/(PTMC*RB)
DB = P6[KDB, MIND]
AINT = P6[KAI, BIND]
BINT = P6[KAB, AIND]
ALPHA = AIND+DA+AINT
BETA = BIND+DB+BINT

6. Static and Dynamic Pressures

CPSDB = P6[KS, MIND]
DCPSD = P6[KDS, MIND]
CPSD = CPSDB+DCPSD*BETA
PS = PAVE*(1-CPSD)*CF
QBAR = CQ*PS*MACH*MACH
PT = CF*PTMC*[6*MACH**2/(MACH**2+5)]**(-3.5)
*[6/(7*MACH**2-1)]**(-2.5)

where CF and CQ are card inputs.

7. Standard Atmosphere Table

A table of standard atmosphere data H(I), T(I), and P(I) for I=1, 238 will be card input, as well as normalization constants PO to TO. Using linear interpolation, enter the P(I) with the value PS/PO and determine the corresponding value of ALT from H(I) and TEMP from T(I).

8. Equivalent and True Airspeeds

VE = CE* $\sqrt{QBAR}$

VT = CT*MACH* $\sqrt{TEMP*TO}$

9. Outputs

CCT's, tabs and/or CFP's must be available from input data at full rate or from the following parameters at fixed rate:

SYMBOL	UNITS	SYMBOL	UNITS	SYMBOL	UNITS
PZMC	PSI	MIND	-	CPSD	-
PTMC	PSI	RA	-	MACH	-
DPAC	PSI	AIND	-	ALPHA	DEG
DPBC	PSI	DA	DEG	BETA	DEG
DCMC	DEG F	AINT	DEG	PS	IN-HG
PZM	PSI	RB	-	QBAR	PSF
PTM	PSI	BIND	-	PT	IN-HG
DPA	PSI	DB	DEG	ALT	FT
DPA	PSI	BINT	DEG	VE	KNTS
TCM	DEG F	CPSDB	-	VT	FPS
PAVE	PSI	DCPSD	-		

5.2.2.6 Time-Tag and Filter Calculations

1. Overview

There are four major functions this calculation encompasses, with optional paths to bypass each when desired. There is also optional output to CCT or CFP.

2. Major Functions

   a. Rolling staleness correction
   b. Gap filling
   c. Filtering
   d. Linear interpolation

The possible processing routes and outputs are shown in figure 5-1.

3. Rolling Staleness Correction

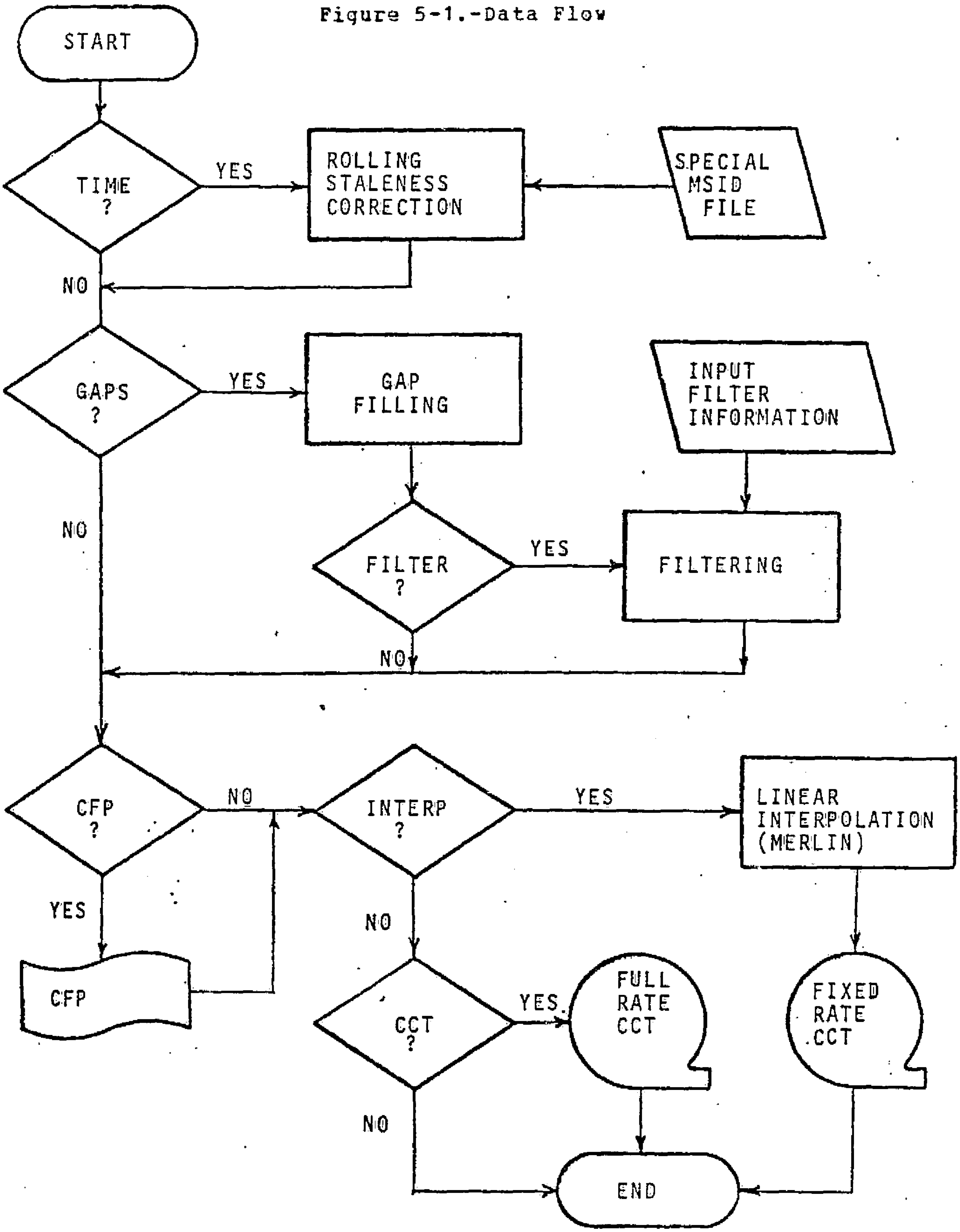
   a. Special MSID Table

   This table will be a card-generated and card-updated file (≤400 MSID's) containing by MSID the onboard rate of acquisition or calculation (RATE), the smallest GPC cycle number (ACN) when acquisition or calculation took place and a special flag (FLAG). Each MSID needed for output is checked to see if it is in the table. If it is, then stalenss is calculated and an appropriate full rate source file is generated; but if it isn't in the file, a standard full rate source file is generated.

   b. GPC Minor Cycle Determination

   The parent word V93Q0020PX (tenth character may also be W, Y, or Z for various formats) contains the GPC Phase Count (bits 0-1) and the Downlist Frame (bits 2-7). Whenever the Phase Count changes from 0 to 1, set the GPC minor cycle =0. Each time the Downlist Frame changes, the GPC Minor Cycle is incremented by one. The GPC Minor Cycle must be initialized for each CDS and a correspondence to the Downlist Frame maintained so that for each sample of an MSID, a GPC Minor Cycle number (DCN) can be assigned to its downlist frame.

Figure 5-1.-Data Flow



c. Staleness Determination

Using the smallest acquisition cycle number (ACN) and the number of cycles between acquisitions ($\Delta = 25/RATE$) the rolling staleness (RS) is then

$$RS = MOD[DCN+\Delta-ACN-1,\Delta]*40 \text{ msec}$$

where MOD is the modulo or remainder function. If $RS = (\Delta-1)*40$ and FLAG = 1 then set RS = -40 msec.

d. Full-Rate Source

Subtracting the RS from the normal time tag results in the proper time for each sample. Now the original onboard sample rate is reconstructed, giving evenly spaced (in time) data samples, except for some missing samples (gaps) if the downlist rate is less than the onboard rate. Gaps must be filled with a special fill pattern so they can be recognized on output or during further calculations. Note that if the downlist rate is greater, redundant samples will be lost (overstored). Also note that if the onboard rate is 25 S/S, no rolling staleness occurs. Rates slower than 1.04/sec ($\Delta = 24$) will be redundantly filled to that rate.

4. Gap Filling

Missing data values, whether from staleness computations, sync losses, or tape errors, cause "gaps" in the sequential series of real data values. If the time difference between the real values on each side of the gap is not greater than 2 seconds, the intermediate point(s) will be replaced by linearly interpolated data. Each measurement will then have a gap-filled full-rate source. In addition, a difference array (or source) will be created for each measurement at its own sample rate. Each value in the array will be zero except at the times where gaps were filled and there the values will be one. The difference array must be available for output to CCT or CFP.

5. Filtering

A gap-filled array and a difference array for each measurement is available from part 4 above. Input at run time will be a set of filter information including which measurements to filter and cut-off frequencies for each sample rate; i.e., 25, 12.5, 5, 1.04 and 1. A fourth order Butterworth forward and backward filtering will be used to generate the output array. The input array must be saved and the output array subtracted from it to form the difference array.

6. Linear Interpolation

The full-rate source arrays will be linearly interpolated to a card-input sample rate, with all arrays aligned to the same time points using an existing program MERLIN.

5.2.3 Avionics

5.2.3.1 RGA Calculations

1. Inputs

   Input parameters and symbols are listed in Table 5-7 for reference. Computations are at 5 S/S except where noted.

2. Orbiter RGA

   Compute DP12, DP23, DP34, DP41, DY12, DY23, DY34, DY41, DR12, DR23, DR34, DR41 where DP12=PR1-PR2; DY41=YR4-YR1, etc. Output to a tab whenever the absolute value of any computed parameter exceeds a card input value.

   Also compute MP12, MP23, MP34, MP41, MY12, MY23, MY34, MY41, MR12, MR23, MR34, MR41 where MP12=TP-DP12, MY23=TY-DY23, MR41=TR-DR41, etc, and

   TP = CP1 + CP2*|SOPR|
   TY = CY1 + CY2*|SOYR|
   TR = CR1 + CR2*|SORR|
   where CP1, CP2, CY1, CY2, CR1, CR2 are card-input values.

   Output to tab whenever the absolute value of any computed parameter is less than a card input value.

3. Orbiter Accelerometer Assembly

   Compute DL12, DL23, DL34, DL41, DN12, DN23, DN34, DN41 where DL12 = LA1-LA2, DN41=NA4-NA1, etc. Output to a tab.

   Also compute ML12, ML23, ML34, ML41, MN12, MN23, MN34, MN41 where ML12=TL-DL12, MN23=TN-DN23, etc., and TL and TN are card-input values. Output to a tab.

4. <u>SRB RGA's</u>

Compute at 1 S/S DLP12, DLP23, DLP31, DRP12, DRP23, DRP31, where DLP12 = LPR1-LPR2, DRP31 = RPR3-RPR1, etc., and at 5 S/S

DPLR = SLPR - SRPR
DPLO = SLPR - SOPR
DPRO = SRPR - SOPR

Similarly compute DLY12, DLY23, DLY31, DRY12, DRY23, DRY31 at 1 S/S and DYLR, DYLO, DYRO at 5 S/S. Output to tabs, groupings TBD.

Also compute MPL12, MPL23, MPL31, MPR12, MPR23, MPR31, MYL12, MYL23, MYL32, MPR12;MPR23, MPR31, MYR12, MYR23, MYR31 where MPL12=TS-DLP12, MYR31=TS-DRY31, etc., where TS is a card-input value. Output to a tab.

TABLE 5-7.-RGA PARAMETERS

MSID	SYMBOL	DESCRIPTION
V95R4031C	PR1	Compensated Pitch Rate 1
V95R4032C	PR2	Compensated Pitch Rate 2
V95R4033C	PR3	Compensated Pitch Rate 3
V95R4034C	PR4	Compensated Pitch Rate 4
V95R4061C	YR1	Compensated Yaw Rate 1
V95R4062C	YR2	Compensated Yaw Rate 2
V95R4063C	YR3	Compensated Yaw Rate 3
V95R4064C	YR4	Compensated Yaw Rate 4
V95R4001C	RR1	Compensated Roll Rate 1
V95R4002C	RR2	Compensated Roll Rate 2
V95R4003C	RR3	Compensated Roll Rate 3
V95R4004C	RR4	Compensated Roll Rate 4
V95A4101C	LA1	Compensated Lateral AA 1
V95A4102C	LA2	Compensated Lateral AA 2
V95A4103C	LA3	Compensated Lateral AA 3
V95A4104C	LA4	Compensated Lateral AA 4
V95A4151C	NA1	Compensated Normal AA 1
V95A4152C	NA2	Compensated Normal AA 2
V95A4153C	NA3	Compensated Normal AA 3
V95A4154C	NA4	Compensated Normal AA 4
V95R4181C	LPR1	LH SRB Pitch Rate 1
V95R4182C	LPR2	LH SRB Pitch Rate 2
V95R4183C	LPR3	LH SRB Pitch Rate 3
V95R4211C	RPR1	RH SRB Pitch Rate 1
V95R4212C	RPR2	RH SRB Pitch Rate 2
V95R4213C	RPR3	RH SRB Pitch Rate 3
V95R4191C	LYR1	LH SRB Yaw Rate 1
V95R4192C	LYR2	LH SRB Yaw Rate 2
V95R4193C	LYR3	LH SRB Yaw Rate 3
V95R4221C	RYR1	RH SRB Yaw Rate 1
V95R4222C	RYR2	RH SRB Yaw Rate 2
V95R4223C	RYR3	RH SRB Yaw Rate 3
V90R5321C	SOPR	Selected Orbiter Pitch Rate
V90R5341C	SOYR	Selected Orbiter Yaw Rate
V90R2525C	SLPR	Selected LH SRB Pitch Rate
V90R2527C	SRPR	Selected RH SRB Pitch Rate
V90R2526C	SLYR	Selected LH SRB Yaw Rate
V90R2528C	SRYR	Selected RH SRB Yaw Rate
V90R5301C	SORR	Selected Orbiter Roll Rate

5.2.3.2 Runway Coordinate Conversion

Inputs

SYMBOL	MSID	UNITS
MLSAZ	V90H3002C	Deg.
MLSEL	V90H3032C	Deg.
MLSRNG	V90H3062C	Ft.
TRA	V95W7000C	Sec.
HRA	V90H4002C	Ft.
THETAR	V90H2217C	Deg.
V3	V95L0192C	Ft/Sec
TSTATE	V90W0534C	Sec.
B1	V90X3003X	-
B2	V90X3033X	-
B3	V90X3063X	-
B4	V90X4003X	-
TAZ	V95W6000C	Sec.
TEL	V95W6010C	Sec.
TRNG	V95W6020C	Sec.

Calculations

1. Search for first time B1*B2*B3 = 1, then compute:

   $A = 1 + TAN^2(MLSEL) + TAN^2(MLSAZ)$
   $B = 2*(K1-K2)*TAN^2(MLSEL)$
   $C = (K1-K2)^2*TAN^2(MLSEL) - (MLSRNG)^2$
   $X = (B - SQRT(B*B-4*A*C))/(2*A)$

   where TAN is two quadrant tangent, SQRT is square root, and K1, K2, and K3 are input on cards.

   R1 = K2 + X
   R2 = (K2 - K1)*TAN(MLSAZ) + K3
   R3 = (R1-K1)*TAN(MLSEL)
   TAVG = (TAZ + TEL + TRNG)/3

2. Search for first time B4 = 1, then compute:

   R4 = HBIAS + (TSTATE+T1-TRA)*V3-SIN (THETA1-THETAR)*DRANB-HRA where SIN is the sine, and HBIAS, T1, THETAI, DRANB are input on cards.

Outputs:

Output TAVG, R1, R2, R3, R4, to a tab and/or continuous form plot (except TAVG). TAVG and TSTATE will be output as Day-Hr-Min_Sec. Labels will be:

OUTPUT	LABEL
TAVG	MLS AVG TIME
R1	VEH X WRT RUNWAY
R2	VEH Y WRT RUNWAY
R3	VEH Z WRT RUNWAY
R4	ALT Z WRT RUNWAY
TSTATE	TSTATE

5.2.3.3 Avionics Aerodynamic Calculations

1. Surface Movement Calculation

Inputs

MSID	Description
V90H7505C	LIB fdbk
V90H7525C	LOB fdbk
V90H7555C	RIB fdbk
V90H7575C	ROB fdbk
V90H7010C	Rudder fdbk
V90H6701C	Speedbrake fdbk
V90H6410C	Body flap bdbk

Sum the absolute value of the difference between the current value and previous value for each parameter. The first data point will be lost during initialization of the sum, and sync dropouts will be ignored (skipped). Output will be to continuous form plots or page plots.

2. Integrated Pitch and Roll Rates

Inputs

MSID	Description
V90R5321C	Pitch rate
V90R5301C	Roll Rate

Sum the absolute value of each rate divided by its current sample rate (s/s from Descriptor Data Base). Sync dropouts will be replaced by the last in-sync value and used in the sums. Output to continuous form plots or page plots.

3. Aerosurfaces Calculations

Inputs

MSID	Description
V90H7505C	LIB elevon fdbk
V90H7525C	LOB elevon fdbk
V90H7555C	RIB elevon fdbk
V90H7575C	ROB elevon fdbk

Calculations

```
DL = (LOB + LIB) *.5
DR = (ROB + RIB) * .5
DELV = (DL + DR) * .5
DAIL = (DL - DR) * .5
```

Output to a contiuous fcrm plot and/or tab.

5.2.3.4 Main Engine Distances

1. Inputs

SYMBOL	MSID	UNITS
DY1	V58H1100A	Deg.
DY2	V58H1200A	Deg.
DY3	V58H1300A	Deg.
DZ1	V58H1150A	Deg.
DZ2	V58H1250A	Deg.
DZ3	V58H1350A	Deg.

2. Z-Components

DZ12 = 157*[sin(DY1-3) -sin(DY2+3)]
DZ13 = 157*[sin(DY1-3) -sin(DY3+3)]
DZ23 = 157*[sin(DY2-3) -sin(DY3+3)]

3. Y-Components

DY12 = 157*[sin(DZ1) -sin(DZ2+3.5)]
DY13 = 157*[sin(-DZ1) -sin(3.5-DZ3)]
DY23 = -157*[sin(DZ2+3.5) -sin(-DZ3-3.5)]

4. Engine Distances

$$R12 = \sqrt{(53-DY12)^2 + (103-DZ12)^2 - 102.625}$$

$$R13 = \sqrt{(53-DY13)^2 + (103-DZ13)^2 - 102.625}$$

$$R23 = \sqrt{(106-DY23)^2 + (DZ23)^2 - 102.625}$$

Output R12, R13, R23 to continuous form plot and/or tab (default is 1 S/S).

5.2.3.5 Avionics DEU Display

1. Overview

There are four DEU's each downlisting 16 words at 1 s/s. The first 15 words will be decoded into a message line that will be output on a tab, one tab per DEU. See Table 5-8 for input MSID's.

2. Keystroke Conversion

The number of valid keystrokes is in bits 11-16 of word 2. Up to 30 keystrokes are packed three per word in words 3 thru 12, bits 0-4, 5-9, 10-14. The valid keystrokes are converted to acronyms (see Table 5-9) and concatenated to form the text message. If bit 4 and/or 10 of word 1 is set to one, the appropriate acronym will be added to the end of the text message.

3. Header Processing

The DEU ID (bits 5-7), the major function (bits 8-9) and the message type (bits 0-3) will be extracted from word 1 and displayed in decimal, and status bits (bits 11-15) from word 1 will be displayed in binary to form a leader for the message line.

4. Status Checking

Words 13, 14, and 15 will be checked and if they do not equal the appropriate hex value, a flag will appear on the message line.

WORD	NOMINAL HEX VALUE
13	8200
14	8000
15	0000

5. Output

The leader, the status flags, and the text message will form the message line which will be output to a tab along with the GPC time for word 1. If the message line is the same as the previous message line, it will not be output.

TABLE 5-8.-DEU Input Words

WORD	DEU1	DEU 2	DEU 3	DEU4
1*	V92M6721PX	V92M6780PX	V92M6844PX	V92M6904PX
2	V92U6725CX	V92U6784CX	V92U6848CX	V92U6908CX
3	V92J6728CX	V92J6792CX	V92J6852CX	V92J6912CX
4	V92J6732CX	V92J6796CX	V92J6856CX	V92J6916CX
5	V92J6736CX	V92J6800CX	V92J6860CX	V92J6920CX
6	V92J6740CX	V92J6804CX	V92J6864CX	V92J6924CX
7	V92J6744CX	V92J6808CX	V92J6868CX	V92J6928CX
8	V92J6748CX	V92J6812CX	V92J6872CX	V92J6932CX
9	V92J6752CX	V92J6816CX	V92J6876CX	V92J6936CX
10	V92J6756CX	V92J6820CX	V92J6880CX	V92J6940CX
11	V92J6760CX	V92J6824CX	V92J6884CX	V92J6944CX
12	V92J6764CX	V92J6828CX	V92J6888CX	V92J6948CX
13	V72H5650PX	V72H5720PX	V72H5810PX	V72H5910PX
14	V72H5670PX	V72H5740PX	V72H5830PX	V72H5930PX
15	V72H5680PX	V72H5750PX	V72H5840PX	V72H5940PX

*MSID's for children may be used, if desired.

TABLE 5-9.-DEU Keystroke Conversion

D/L HEX	ACRONYM (Δ=BLANK)	D/L HEX	ACRONYM (Δ = BLANK)
00	0	10	SYSΔ
01	1	11	OPSΔ
02	2	12	SPECΔ
03	3	13	FAULTΔSUMM
04	4	14	ITEMΔ
05	5	15	Δ-
06	6	16	Δ+
07	7	17	.
08	8	18	I/OΔRESET
09	9	19	GPC/CRT
0A	A	1A	Δ*1AΔ
0B	B	1B	RESUME
0C	C	1C	Δ*1CΔ
0D	D	1D	Δ*1DΔ
0E	E	1E	ΔEXECΔ
0F	F	1F	ΔPROΔ

Supplemental conversions:

ACRONYM	CONDITION
ΔACK	Word 1 bit 4 = 1 (at end of message line)
ΔMSGΔRESET	Word 1 bit 10 = 1 (at end of message line)
Δ*TAPΔ	Input tape error (replaces keystroke lost)
Δ*SYNΔ	Telemetry sync error (replaces keystroke lost)
Δ*DMPΔ	Dump data interupt (replaces keystroke lost)

5.2.3.6 Duty Cycle Calculation

This calculation will monitor a set of MSID's and compute the percent of the time that each is greater than a given threshold. The program should be written to read the set of MSID's and thresholds from a card-driven file, because RCS engine firing, MOS engine firing, and heater duty cycles will each have a different table and process different time segments. An option must be available at run time to select total time or running time for the % calculation. An option must be availabe to select high or low duty cycle.

1. For each MSID (Mi) and its threshold (Ti), whenever Mi≥Ti then ti = ti + 1/SRi, where t is the running sum of "on" time and SR = current samples per second from Descriptor Data Base. If Mi is out of sync, it is assumed to have the same value as the last in-sync data point.

2. Whenever <u>total time</u> is selected:
   Dt = stop time - start time.
   Whenever <u>running time</u> is selected:
   Dt = current time - start time.

3. Duty cycle percent (DCPi) is:

   DCPi = 100 * ti/Dt, for <u>high</u> duty cycle
   DCPi = 100 * (Dt-ti)/DT, for <u>low</u> duty cycle. The DCP values are output to continuous form plots in groups to be defined in Level D.

4. Heater duty cycle calculations require two thresholds THi and TLi and an input option by parameter to decide which to use first. Then Ti = THi or Ti = TLi by option at the start of the run. Whenver the threshold is crossed, then set Ti to the other value and proceed as in steps 1-3.

5.2.3.7 Landing Approach Calculations

1. <u>Overview</u>

MSBLS, TACAN, and Radar Altimeter PCM outputs will be compared to parameters calculated from the BET. TACAN will be run at long range (about 20 to 200 miles) while MSBLS and Altimeter will be run near the runway (less than about 20 miles). Default calculation rate is 1 S/S.

2. <u>PCM Input</u>

Table 5-10 lists the MSID's needed and symbols used in the calculation equations.

3. <u>BET Input and Transformation</u>

The navigation position XLF, YLF, ZLF with respect to the runway and the geodetic altitude of the navigation base h, all in feet, will be extracted from the BET. The position will be transformed

$$X = XLF \sin\theta + YLF \cos\theta$$

$$Y = XLF \cos\theta - YLF \sin\theta$$

$$Z = -ZLF$$

where θ = runway azimuth from true north which is card input.

4. <u>Station Location and Transformation</u>

The TACAN station number (Best 2 out of 3 from STA1, STA2, and STA3) will be used to look up the coordinates of the TACAN station (LT, λT, AT) from 10 card input sets. These coordinates are then transformed to produce (XT, YT, ZT)

$$YT = (RE+AT)*[\sin\lambda T*\cos\lambda 0-\cos\lambda T*\sin\lambda 0*\cos(LO-LT)]$$

$$XT = -(RE+AT)*[\cos\lambda T*\sin(LO-LT)]$$

$$ZT = (RE+AT)*[\cos\lambda T*\cos\lambda 0*\cos(LO-LT)-\sin\lambda T*\sin\lambda 0] -RE-AO$$

TABLE 5-10.-INPUT PCM PARAMETERS

SYMBOL	MSID	NAME	UNITS	STATUS
B1	V74H1535B	TACAN 1 Bearing	Deg.	SB1
B2	V74H1635B	TACAN 2 Bearing	deg.	SB2
B3	V74H1735B	TACAN 3 Bearing	deg.	SB3
RA1	V74H1554B	TACAN 1 Range A	n.m.	SRT1
RA2	V74H1654B	TACAN 2 Range A	n.m.	SRT2
RA3	V74H1754B	TACAN 3 Range A	n.m.	SRT3
RB1	V74H1555B	TACAN 1 Range B	n.m.	SRT1
RB2	V74H1655B	TACAN 2 Range B	n.m.	SRT2
RB3	V74H1755B	TACAN 3 Range B	n.m.	SRT3
AZ1	V74H1012B	MSBLS 1 Azimuth	deg.	SA1
AZ2	V74H1112B	MSBLS 2 Azimuth	deg.	SA2
AZ3	V74H1212B	MSBLS3 Azimuth	deg.	SA3
EL1	V74H1032B	MSBLS 1 Elevation	deg.	SE1
EL2	V74H1132B	MSBLS 2 Elevation	deg.	SE2
EL3	V74H1232B	MSBLS 3 Elevation	deg.	SE3
RM1	V74H1052B	MSBLS 1 Range	n.m.	SRM1
RM2	V74H1152B	MSBLS 2 Range	n.m.	SRM2
RM3	V74H1252B	MSBLS 3 Range	n.m.	SRM3
H1	V74H1804B	RADAR ALT 1	ft.	SH1
H2	V74H1854B	RADAR ALT 2	ft.	SH2
HSNAP	V90H4002C	RADAR ALT SNAP	ft.	-
STA1	V74K1514B	TACAN 1 Chan. Number	-	-
STA2	V74K1614B	TACAN 2 Chan. Number	-	-
STA3	V74K1714B	TACAN 3 Chan. Number	-	-

where (LO, λO, and AO) are card-input longitude, latitude, and altitude above MSL of the center of the BET runway coordinate system and RE = 20925721.78 ft. MSBLS has a range/azimuth station location (LRA, λRA, ARA), and an elevation station location (LE, λE, AE), both card inputs. Each must be transformed as above to produce (XRA, YRA, ZRA) and (XE, YE, ZE).

5. <u>TACAN Calculation</u>

The range for TACAN is

$$RT = (1/C) \sqrt{(X-XT)^2 + (Y-YT)^2 + (Z-ZT)^2} \text{ nm.}$$

where C = 6076.115485 ft/nm, and the relative velocity is

$$VT(t) = (RT(t)-RT(t-\Delta t))\Delta t$$

where RT(t) is RT at time t and Δt is the computation interval.

RERR1 = RT - RA1 - RB1
RERR2 = RT - RA2 - RB2
RERR3 = RT - RA3 - RB3
PRERR1 = 100*RERR1/RT
PRERR2 = 100*RERR2/RT
PRERR3 = 100*RERR3/RT
$ET = \sin^{-1}[(Z-ZT)/C/RT]$ deg.
$BT = \tan^{-1}[(XT-X)/(YT-Y)]-\gamma$ deg. (Adjust to 0-360°)

where γ is the card-input magnetic variation.

BERR1 = BT-B1
BERR2 = BT-B2
BERR3 = BT-B3
PBERR1 = 100*BERR1/BT
PBERR2 = 100*BERR2/BT
PBERR3 = 100*BERR3/BT

6. <u>Status Checking</u>

Each TACAN, MSBLS and altimeter data word has validity, self-test and/or fail bits which must be built into a status word for output plots and histogram logic. Each status word is "good" if =0 and "bad" if

=1. Status words are logical variables, hence set =1 if the computation ≠0.

```
SB1 = [V74M1530P bits 1 and 2]+[V74M2531P bits 5 and 6]
SB2 = [V74M1630P bits 1 and 2]+[V74M1631P bits 5 and 6]
SB3 = [V74M1730P bits 1 and 2]+[V74M1731P bits 5 and 6]
SRT1= [V74M1550P bits 0 and 1]+[V74M1551P bits 5 and 6]
SRT2= [V74M1650P bits 0 and 1]+[V74M1651P bits 5 and 6]
SRT3= [V74M1750P bits 0 and 1]+[V74M1751P bits 5 and 6]
SRM1= [V74X1051B]+[V74X1053B]+[V74X1054B]
SRM2= [V74X1151B]+[V74X1153B]+[V74X1154B]
SRM3= [V74X1251B]+[V74X1253B]+[V74X1254B]
SE1 = [V74X1031B]+[V74X1033B]+[V74X1034B]
SE2 = [V74X1131B]+[V74X1133B]+[V74X1134B]
SE3 = [V74X1231B]+[V74X1233B]+[V74X1234B]
SA1 = [V74X1013B]+[V74X1014B]
SA2 = [V74X1113B]+[V74X1114B]
SA3 = [V74X1213B]+[V74X1214B]
SH1 = 1-[V74X1805B]
SH2 = 1-[V74X1855B]
```

7. Histograms and Statistics

Each parameter which is to be histogramed will have a histogram minimum (MIN), maximum (MAX) and resolution (SS) as well as a status MSID as shown in Table 5-10. For any parameter Pi, i = 1 to N, count the number of points which fall in bin J; i.e., MIN + (J-1)*SS ≤Pi< MIN+J*SS. Points Pi<MIN and Pi≥MAX are "wild" points and are not included in the histogram. Points occurring while the status is "bad: (see part 6) are not included either. The total number of "net" points (not bad nor wild) is counted and used to convert histogram numbers to percent, and also to compute the mean and standard deviation for the histogram. Histograms will be plotted with % on the Y-axis and MIN to MAX on the X-axis.

The following statistics will be printed on or near the plot:

DATA POINTS		HISTOGRAM (NET)
TOTAL	XXXX	RESOLUTION XXX.XXX
WILD	XXXX	ERROR MEAN XXX.XXX
BAD	XXXX	ERROR STD. DEV. XXX.XXX
NET	XXXX	

8. TACAN Output

a. Time History Plots:

a. BERR1 and SB1, BERR2 and SB2, BERR3 and SB3, RERR1 and SRT1, RERR2 and SRT2, RERR3 and SRT3

b. Histograms: (Ref. section 6)

BERR1, BERR2, BERR3, RERR1, RERR2, RERR3

c. Crossplots:

BERR1 and PBERR1 vs. RT and also vs. ET
BERR2 and PBERR2 vs. RT and also vs. ET
BERR3 and PBERR3 vs. RT and also vs. ET
RERR1 and PRERR1 vs. RT and also vs. ET
RERR2 and PRERR2 vs. RT and also vs. ET
RERR3 and PRERR3 vs. RT and also vs. ET

d. Time history tabs

- RT, RERR1, PRERR1, BT, BERR1, PBERR1, VT, ET
- RT, RERR2, PRERR2, BT, BERR2, PBERR2, VT, ET
- RT, RERR3, PRERR3, BT, BERR3, PBERR3, VT, ET

9. MSBLS/Altimeter Calculations

$RM = (1/C)\sqrt{(X-XRA)^2+(Y-YRA)^2+(Z-ZRA)^2}$ nm
MRERR1 = RM-RM1
MRERR2 = RM-RM2
MRERR3 = RM-RM3
MPRERR1 = 100*MRERR1/RM
MPRERR2 = 100*MRERR2/RM
MPRERR3 - 100*MRERR3/RM
$AZ = -\tan^{-1}[(X-XRA)/(Y-YRA)]+360-\theta$ deg.
AERR1 = AZ-AZ1
AERR2 = AZ-AZ2
AERR3 = AZ-AZ3
PAERR1 = 100*AERR1/AZ
PAERR2 = 100*AERR2/AZ
PAERR3 = 100*AERR3/AZ

$RE = (1/C)\sqrt{(X-XE)^2+(Y-YE)^2+(Z-ZE)^2}$
$EM = \tan^{-1}[(Z-ZE)/|(X-XE)\sin\theta+(Y-YE)\cos\theta|]$
EERR1 = EM-EL1
EERR2 = EM-EL2
EERR3 = EM-EL3
PEERR1 = 100*EERR1/EM
PEERR2 = 100*EERR2/EM

```
PEERR3 = 100*EERR3/EM
Dh = h-HBIAS      where HBIAS is card input
HERR1 = Dh-H1
PHERR1 = 100*HERR1/Dh
HERR2 = H1-H2
PHERR2 - 100*HERR2/Dh
HM = RE*sin(EM)
HERR3 = HM-HSNAP
PHERR3 = 100*HERR3/Dh
```

10. <u>MSBLS/Altimeter Output</u>

a. Time history plots:

MRERR1 and SRM1, MRERR2 and SRM2, MRERR3 and SRM3,
AERR1 and SA1, AERR2 and SA2, AERR3 and SA3,
EERR1 and SE1, EERR2 and SE2, EERR3 and SE3,
HERR1 and SH1, HERR2 and SH2

b. Histograms:

MRERR1, MRERR2, MRERR3, AERR1, AERR2, AERR3, EERR1,
EERR2, EERR3, HERR1, HERR2

c. Crossplots

MRERR1 and MPRERR1 vs. RM
MRERR2 and MPRERR2 vs. RM
MRERR3 and MPRERR3 vs. RM
AERR1 and PAERR1 vs. RM and also vs. AZ
AERR2 and PAERR2 vs. RM and also vs. AZ
AERR3 and PAERR3 vs. RM and also vs. AZ
EERR1 and PEERR1 vs. RM and also vs. EM
EERR2 and PEERR2 vs. RM and also vs. EM
EERR3 and PEERR3 vs. RM and also vs. EM
HERR1 and PHERR1 vs. RM
HERR2 and PHERR2 vs. Dh and also vs. RM
HERR3 and PHERR3 vs. Dh

5.2.3.8 TACAN Runway Coordinates Conversion

1. <u>Inputs</u>

SYMBOL	SOURCE	UNITS	DESCRIPTION
TIME	V95W5001C	SEC	TACAN time
RANGE	V95H5010C	MFT	TACAN selected range
BEAR	V95H5015C	RAD	TACAN selected bearing
HBARO	V95H3001C	KFT	Barometric altitude
ALT	CARDS	FT	
RD	CARDS	FT	
$\overline{R}$	CARDS	FT	Three vector components RX,RY,RZ
MSL	CARDS	FT	
MAGCOR	CARDS	RAD	
$\overline{RLS}$	CARDS	FT	Three vector components
[M1]	CARDS	-	Nine matrix components (3x3)
[M2]	CARDS	-	Nine matrix components (3x3)

2. <u>Computations</u>

Multiply RANGE by 10^6 and HBARO by 10^3 to get feet.

RTAC = RD+ALT-MSL
RVEH = RD+HBARO
A = BEAR+MAGCOR+3.1415926
COSB = (R*R+RANGE**2-RVEH**2)/(2*RTAC*RANGE)
D = RANGE*(1-COSB**2)**.5
RTD1 = D*cos(A)
RTD2 = D*sin(A)   } = $\overline{RTD}$
RTD3 = RANGE*COSB
$\overline{REF}$ = [M1]T.$\overline{RTD}$ + $\overline{R}$ where T indicates transpose
$\overline{RRW}$ = [M2] . ($\overline{REF}$-$\overline{RLS}$)

3. <u>Output</u>

Output TIME and $\overline{RRW}$ components to tab and/or CFP.

5.2.4 Environmental Control Life Support Subsystem

The following calculations are required by the Environmental Control and Life Support Subsystem (ECLSS) for the OFT missions.

5.2.4.1 Cabin and Avionics Bays Flow Rates (Wi)

Wi = 161.94*PC*CFMi/(Ti+460) (LBS/HR)

i = 1 for Cabin
i = 2 for Bay 1
i = 3 for Bay 2
i = 4 for Bay 3

Measurements Required:

Symbol	Meas. No.	Description	Unit
Pc	V61P2405A	Cabin pressure	Psia
T_1	V61T2552A	Cabin temperature	°F
T_2	V61T2645A	Bay 1 fan out temp.	°F
T_3	V61T2650A	Bay 2 fan out temp.	°F
T_4	V61T2661A	Bay 3 fan out temp.	°F

Constants:

CFM_1 = 306
CFM_2 = 198
CFM_3 = 201
CFM_4 = 170

5.2.4.2 Cabin Compartment and Avionics Bay HX Air Heat Loads (HLi)

HLi = 0.24 * Wi * (TOi - TIi) (BTU/HR)

i = 1 for cabin compartment
i = 2 for avionics Bay 1
i = 3 for avionics Bay 2
i = 4 for avionics Bay 3

Measurements Required:

Symbol	Meas. No.	Description	Unit
TO_1	V61T2552A	Cabin Temperature	°F
TI_1	V61T2635A	Cabin HX air out temp.	°F
TO_2	[1]V61T9121A	Bay 1 HX air out temp.	°F

[1]DFI

TI_2	V61T2645A	Bay 1 HX air in temp.	°F
TO_3	[1]V61T9127A	Bay 2 HX air out temp.	°F
TI_3	V61T2650A	Bay 2 HX air in temp.	°F
TO_4	[1]V61T9133A	Bay 3 HX air out temp.	°F
TI_4	V61T2661A	Bay 3 HX air in temp.	°F
WI computed in Section 5.2.4.1			LBS/HR

5.2.4.3 Water Loops 1 & 2 Flow Rates (Wi)

$$\Delta Pi = POi - PIi$$
$$Wi = 0 \text{ if } \Delta P < 5$$
$$Wi = Ai + Bi\,\Delta Pi + Ci\,\Delta Pi^2 + Di\,\Delta Pi^3 \quad \text{(LBS/HR)}$$

i = 5 for water loop 1
i = 6 for water loop 2

Measurements Required:

Symbol	Meas. No.	Description	Unit
PO_5	V61P2600A	WL1 pump out pressure	Psia
PI_5	V61P2605A	WL1 pump in pressure	Psia
PO_6	V61P2700A	WL2 pump out pressure	Psia
PI_6	V61P2705A	WL2 pump in pressure	Psia

Constants:

Ai = 3563.7 Ci = 2.440
Bi = -120.1 Di = -0.0225
for i = 5 and 6

5.2.4.4 Cabin HX Water Side Heat Load (HL_5)

$$HLW1 = W_7 * (T01 - TI1)$$
$$HLW2 = W_8 * (T01 - TI2)$$
$$HL_5 = HLW1 + HLW2 \quad \text{(BTU/HR)}$$

Measurements Required:

Symbol	Meas. No.	Description	Unit
W_7	V61R2742A	I/C WL1 flow rate	lbs/hr
W_8	V61R2722A	I/C WL2 flow rate	lbs/hr
TI1	V61T2663A	Cabin HX WL1 in temp.	°F

[1] DFI

TI2	V61T2665A	Cabin HX WL2 in temp.	°F
TO1	[1]V61T9067A	Cabin HX WL1 out temp.	°F

5.2.4.5 IMU Air Heat Load (HL_6)

Tave = (T1 + T2 + T3)/3

W_6 = 161.94 * CFM * P/(Tave + 460)

HL_6 = 0.24 * W_6 * * (Tave - T4) (BTU/LB)

Measurements Required:

Symbol	Meas. No.	Description	Unit
T1	[1]V61T9151A	IMU 1 out temp.	°F
T2	[1]V61T9152A	IMU 2 out temp.	°F
T3	[1]V61T9153A	IMU 3 out temp.	°F
T4	V61T2552A	Cabin temperature	°F
P	V61P2405A	Cabin pressure	PSIA

CFM = 34

5.2.4.6 Avionics Bays HX Water Side Heat Loads (HLi)

HLW1i = Ai * W_5* (T01i - TI1i)
HLW2i = Bi * W_6 * (T02i - TI2i)
HLi = HLW1i + HLW2i (BTU/HR)
i = 7 for Bay 1
i = 8 for Bay 2
i = 9 for Bay 3A

Measurements Required:

Symbol	Meas. No.	Description	
$T01_7$	V61T2615A	Bay 1 HX water out temp. (WL1)	°F
$T02_7$	V61T2616A	Bay 1 HX water out temp. (WL2)	°F
$TI1_7$	[1]V61T9125A	Bay 1 HX water in temp. (WL1)	°F
$TI2_7$	[1]V61T9126A	Bay 1 HX water in temp. (WL2)	°F
$T01_8$	V61T2618A	Bay 2 HX water out temp. (WL1)	°F

[1]DFI

$TO2_8$	V61T2619A	Bay 2 HX water out temp. (WL2)	°F
$TI1_8$	[1]V61T9131A	Bay 2 HX water in temp. (WL2)	°F
$TI2_8$	[1]V61T9132A	Bay 2 HX water in temp. (WL2)	°F
$TO1_9$	V61T2621A	Bay 3A HX water out temp.(WL1)	°F
$TO2_9$	V61T2622A	Bay 3A HX water out temp. (WL2)	°F
$TI1_9$	[1]V61T9137A	Bay 3A HX water in temp. (WL1)	°F
$TI2_9$	[1]V61T9138A	Bay 3A HX water in temp. (WL2)	°F
W_5	computed in Section 5.2.4.3		
W_6	computed in Section 5.2.4.3		

constants:

$A_7 = 0.2785$ $B_7 = 0.2785$
$A_8 = 0.2677$ $B_8 = 0.2677$
$A_9 = 0.3931$ $B_9 = 0.3931$

5.2.4.7 Avionics Bays Cold Plate Heat Loads (HLi)

$$Wi = (Ai * W_5) + (Bi * W_6)$$
$$HLW1i = Ai * W_5 * (TO1i + TI1i)$$
$$HLW2i = Bi * W_6 * (TO2i - TI2i)$$
$$HLi = HLW1i + HLW2i$$

i = 10 for Bay 1
i = 11 for Bay 2
i = 12 for Bay 3A
i = 13 for Bay 3B

Measurements Required:

Symbol	Meas. No.	Description	Unit
$TO1_{10}$	V61T2624A	Bay 1 CP WL1 out temp.	°F
$TO2_{10}$	V61T2625A	Bay 1 CP WL2 out temp.	°F
$TI1_{10}$	V61T2615A	Bay 1 CP WL1 in temp.	°F
$TI2_{10}$	V61T2616A	Bay 1 CP WL2 in temp.	°F
$TO1_{11}$	V61T2627A	Bay 2 CP WL1 out temp.	°F
$TO2_{11}$	V61T2628A	Bay 2 CP WL2 out temp.	°F
$TI1_{11}$	V61T2618A	Bay 2 CP WL1 in temp.	°F
$TI2_{11}$	V61T2619A	Bay 2 CP WL2 in temp.	°F
$TO1_{12}$	V61T2630A	Bay 3 CP WL1 out temp.	°F
$TO2_{12}$	V61T2631A	Bay 3 CP WL2 out temp.	°F
$TI1_{12}$	V61T2621A	Bay 3 CP WL1 in temp.	°F
$TI2_{12}$	V61T2622A	Bay 3 CP WL2 in temp.	°F

[1] DFI

$TO1_{13}$	[1]V61T9147A	Bay 3B CP WL1 out temp.	°F
$TO2_{13}$	[1]V61T9148A	Bay 3B CP WL2 out temp.	°F
$TI1_{13}$	[1]V61T9137A	Bay 3B CP WL1 in temp.	°F
$TO2_{13}$	[1]V61T9138A	Bay 3B CP WL2 in temp.	°F
W_5	computed in Section 5.2.4.3		
W_6	computed in Section 5.2.4.3		

Constants:

$A_{10} = 0.2785$	$B_{10} = 0.02785$
$A_{11} = 0.2677$	$B_{11} = 0.2677$
$A_{12} = 0.3931$	$B_{12} = 0.3931$
$A_{13} = 0.0607$	$B_{13} = 0.0607$

5.2.4.8 IMU HX Water Side Heat Load (HL_{14})

$HL_{14} = (W_7 + W_8) * (TO - TI)$ (BTU/HR)

Measurements Required:

Symbol	Meas. No.	Description	Unit
TO	[1]V61T9005A	IMU HX water out temp.	°F
TI	[1]V61T9067A	IMU HX water in temp.	°F
W_7	V61R2742A	I/C WL1 flow rate	lbs/hr
W_8	V61R2722A	I/C WL2 flow rate	lbs/hr

5.2.4.9 IMU HX Air Inlet and Outlet Temperatures (TUI and TUO)

$Tave = (T1 + T2 + T3)/3$

$TUI = Tave + 136.5/W_9$ (°F)

$TUO = TUI - HL_{14}/W_9$ (°F)

Measurements Required:

Symbol	Meas. No.	Description	Unit
T1	[1]V61T9151A	IMU 1 out temp.	°F
T2	[1]V61T9152A	IMU 2 out temp.	°F
T3	[1]V61T9153A	IMU 3 out temp.	°F
W_9	computed in Section 5.2.4.5		lbs/hr
P	V61P2405A	Cabin pressure	Psia
HL_{14}	computed in Section 5.2.4.8		BTU/HR

[1]DFI

5.2.4.10 DFI Plus Dry Wall Heat Loads (HL_{15})

$$TJ1 = A_{10}*T1_{10} + A_{11}*T1_{11} + A_{12}*T1_{12} + A_{13}*T1_{13} \quad (^{o}F)$$
$$TJ2 = B_{20}*T2_{10} + B_{11}*T1_{11} + B_{12}*T2_{12} + B_{13}*T2_{13} \quad (^{o}F)$$
$$HL_{15} = W_5 * (T01 - TJ1) + W_6 * (T02 - TJ2) \quad (BTU/HR)$$

Measurements Required:

Symbol	Meas. No.	Description	Unit
$T1_{10}$	V61T2624A	Bay 1 CP WL1 out temp.	^{o}F
$T2_{10}$	V61T2625A	Bay 1 CP WL2 out temp.	^{o}F
$T1_{11}$	V61T2627A	Bay 2 CP WL1 out temp.	^{o}F
$T2_{11}$	V61T2628A	Bay 2 CP WL2 out temp.	^{o}F
$T1_{12}$	V61T2630A	Bay 3A CP WL1 out temp.	^{o}F
$T2_{12}$	V61T2631A	Bay 3A CP WL2 out temp.	^{o}F
$T1_{13}$	[1]V61T9147A	Bay 3B CP WL1 out temp.	^{o}F
$T2_{13}$	[1]V61T9148A	Bay 3B CP WL2 out temp.	^{o}F
T01	V61T2743A	I/C WL1 in temperature	^{o}F
T02	V61T2723A	I/C WL2 in temperature	^{o}F
Ai,Bi	Computed in section 5.2.4.7		
W_5	Computed in Section 5.2.4.3		lbs/hr
W_6	Computed in Section 5.2.4.3		lbs/hr

5.2.4.11 Interchanger Water Side Heat Load (HL_{16})

$$HLW1 = W_7 * (T01 - TI1)$$
$$HLW2 = W_8 * (T02 - TI2)$$
$$HL_{16} = HLW1 + HLW2 \quad (BUT/HR)$$

Measurements Required:

Symbol	Meas. No.	Description	Unit
T01	V61T2744A	I/C WL1 out temperature	^{o}F
T02	V61T2724A	I/C WL2 out temperature	^{o}F
TI1	V61T2743A	I/C WL1 in temperature	^{o}F
TI2	V61T2723A	I/C WL2 in temperature	^{o}F
W_7	V61R2742A	I/C WL1 flow rate	lbs/hr
W_8	V61R2722A	I/C WL2 flow rate	lbs/hr

[1] DFI

In the following sections, f(T) is the function for freon specific heat

f(T) = 0.2233 + 0.015207 * EXP (0.008755 * T)
T = Average of inlet and outlet temperatures
Primed variable represents the last previously measured value recorded or computed. For initial values TC01' = TCI1 and TC02' = TCI2.

5.2.4.12 Interchanger Freon Inlet and Outlet Temperature

TCI2 = T2 + (TCI1 - T1) (°F)
CP1 = f((TCI1 _ TC01')/2)
CP2 = f(TCI2 + TC02')/2)
TC01 = TCI1 + (HL_{16}/(2* CP1 * W1))
TC02 = TCI2 + (HL_{16}/(2 * CP2 * W2))

Measurements Required:

Symbol	Meas. No.	Description	Unit
TCI1	V63T1155A	I/C FCL 1 in temp.	°F
T1	V63T1207A	FCL 1 sink temp.	°F
T2	V63T1407A	FCL 2 sink temp.	°F
W1	V63R1100A	FCL 1 I/C flow rate	lbs/hr
W2	V63R1300A	FCL 2 I/C flow rate	lbs/hr
HL_{16}	Computed in Section 5.2.4.11		

5.2.4.13 ATCS DFI Bays 1 + 3 and 2 Heat Loads (HL_{17} and HL_{18})

CP1 = f((T1 + T2)/2)
HL_{17} = CP1 * W * (T2 - T1)
CP2 = f((T2 + T3)/2)
HL_{18} = CP2 * W * (T3 - T2)

Measurements Required:

Symbol	Meas. No.	Description	Unit
T1	V63T9162A	DFI Bay 3 in temp.	°F
T2	[1]V63T9160A	DFI Bay 1 out temp.	°F
T3	V63T9161A	DFI Bay 2 out temp.	°F
W	V63R9159A	DFI Freon loop flow rate	lbs/hr

[1]DFI

5.2.4.14 AFT Avionics Bays 4, 5, and 6 Heat Loads

CP1i = f((T01i + TI1i)/2)
CP2i = f((T02i + TI2i)/2)
HLF1i = CP1i * W1 * (T01i - TI1i)
HLF2i = CP2i * W2 * (T02i - TI2i)
HLi = HLF1i + HLF2i

i = 19 for Bay 4
i = 20 for Bay 5
i = 21 for Bay 6

Measurements Required:

Symbol	Meas. No.	Description	Unit
$TO1_{19}$	V63T9166A	Bay 4 FCL 1 out temp.	°F
$TO2_{19}$	V63T9172A	Bay 4 FCL 2 out temp.	°F
$TI1_{19}$	V63T9163A	Bay 4 FCL 1 in temp.	°F
$TI2_{19}$	V63T9167A	Bay 4 FCL 2 in temp.	°F
$TO1_{20}$	V63T9163A	Bay 5 FCL 1 out temp.	°F
$TO2_{20}$	V63T9167A	Bay 5 FCL 2 out temp.	°F
$TI1_{20}$	V63T9164A	Bay 5 FCL 1 in temp.	°F
$TI2_{20}$	(assume same as V63T9164A)		
$TO1_{21}$	V63T9164A	Bay 6 FCL 1 out temp.	°F
$TO2_{21}$	(assume same as V63T9164A)		°F
$TI1_{21}$	V63T1207A	Bay 6 FCL 1 in temp.	°F
$TI2_{21}$	V63T1407A	Bay 6 FCL 2 in temp.	°F
W1	V63R1105A	Bay FCL 1 flow rate	lbs/hr
W2	V63R1305A	Bay FCL 2 flow rate	lbs/hr

5.2.4.15 Payload HX Heat Load (HL_{22})

CP = f ((T1 + T2)/2)
HL_{22} = CP * W * (T2 - T1) + 1433

Measurements Required:

Symbol	Meas. No.	Description	Unit
T1	V63T9162A	DFI Bay 3 in temp.	°F
T2	V63T9161A	DFI Bay 2 out temp.	°F
W	V63R9159A	DFI freon loop flow rate	lbs/hr

5.2.4.16 Payload HX ATCS Freon Outlet Temperatures (TP01, TP02)

CP1 = f ((TPI1 + TP01')/2)
CP2 = f ((TP12 + TP02')/2)
TP01 = TPI1 + HL_{22}/(2 * CP1 * W1)
TP02 = TPI2 + HL_{22}/(2 * CP1 * W2)

Measurements Required:

Symbol	Meas. No.	Description	Unit
TPI1	V63T1155A	I/C FCL 1 in temp.	°F
W1	V63R1103A	P/L HX FCL 1 flow rate	lbs/hr
W2	V63R1303A	P/L HX FCL 2 flow rate	lbs/hr
TP12	computed in Section 5.2.4.12		
HL_{22}	computed in Section 5.2.4.15		

5.2.4.17 ATCS Pump Freon Inlet Temperatures (TWI1, TWI2)

$$TWI1 = \frac{(T1 * WA1) + (TP01 * WP1) + (TC01 * WC1)}{WA1 + WP1 + WC1} \quad (^{o}F)$$

$$TWI2 = \frac{(T2 * WA2) + (TP02 * WP2) + (TC02 * WC2)}{WA2 + WP2 + WC2} \quad (^{o}F)$$

Measurements Required:

Symbol	Meas. No.	Description	Unit
T1	V63T9166A	Aft Bay FCL 1 out temp.	°F
T2	V63T9172A	Aft Bay FCL 2 out temp.	°F
WA1	V63R1105A	Aft Bay FCL 1 flow rate	lbs/hr
WA2	V63R1305A	Aft Bay FCL 2 flow rate	lbs/hr
WP1	V63R1103A	P/L HX FCL 1 flow rate	lbs/hr
WP2	V63R1303A	P/L HX FCL 2 flow rate	lbs/hr
WC1	V63R1100A	I/C FCL 1 flow rate	lbs/hr
WC2	V63R1300A	I/C FCL 2 flow rate	lbs/hr
TP01	computed in Section 5.2.4.16		°F
TP02	computed in Section 5.2.4.16		°F
TC01	computed in Section 5.2.4.12		°F
TC02	computed in Section 5.2.4.12		°F

5.2.4.18 ATCS Pump Freon Flow Rates (W_{14}, W_{15})

W_{14} = WA1 + WP1 + WC1 (lbs/hr)
W_{15} = WA2 + WP2 + WC2 (lbs/hr)

Measurements Required:

Symbol	Meas. No.	Description	Unit
WA1	V63R1105A	Aft Bay FCL 1 flow rate	lbs/hr
WA2	V63R1305A	Aft Bay FCL 2 flow rate	lbs/hr
WP1	V63R1103A	P/L HX FCL 1 flow rate	lbs/hr
WP2	V63R1303A	P/L HX FCL 2 flow rate	lbs/hr
WC1	V63R1100A	I/C FCL 1 flow rate	lbs/hr
WC2	V63R1300A	I/C FCL 2 flow rate	lbs/hr

5.2.4.19 ATCS Pump Freon Outlet Temperatures (TW01, TW02)

CP1 = f(TWI1)
CP2 = f(TWI2)
$TW01 = TWI1 + 1331/(CP1 * W_{14})$ °F
$TW02 = TWI2 + 1331/(CP1 * W_{15})$ °F

Measurements Required:

Symbol	Meas. No.	Description	Unit
TWI1	computed in Section 5.2.4.17		°F
TWI2	computed in Section 5.2.4.17		°F
W_{14}	computed in Section 5.2.4.18		lbs/hr
W_{15}	computed in Section 5.2.4.18		lbs/hr

5.2.4.20 Fuel Cell HX Freon Heat Load (HL_{23})

CP1 = f ((TW01 + T1)/2)
CP2 = f ((TW02 + T2)/2)
$HLF1 = CP1 * A_{14} * W_{14} * (T1 - TW01)$
$HLF2 = CP2 * B_{14} * W_{15} * (T2 - TW02)$
$HL_{23} = HLF1 + HLF2$ (BTU/lb)

Measurements Required;

Symbol	Meas. No.	Description	Unit
T1	[1]V63T9071A	F/C HX FCL 1 out temp.	°F
T2	[1]V63T9073A	F/C HX FCL 2 out temp.	°F
TW01	computed in Section 5.2.4.19		°F
TW02	computed in Section 5.2.4.19		°F
W_{14}	computed in Section 5.2.4.18		lbs/hr
W_{15}	computed in Section 5.2.4.18		lbs/hr

Constants: $A_{14} = 0.871$ $B_{14} = 0.871$

5.2.4.21 Mid-Body Cold Plate Panels 1 + 2 + 4 and Panels 3 + 5 Heat Loads (HL_{24} and HL_{25})

CP1 = f ((TW01 + T1)/2)
CP2 = f ((TW02 + T2)/2)
CP3 = f ((TW01 + T3)/2)

---
[1]DFI

$CP4 = f((TW02 + T4)/2)$

$HLM1 = CP1 * A_{15} * W_{14} * (T1 - TW01)$	BTU/Hr
$HLM2 = CP2 * B_{15} * W_{15} * (T2 - TW02)$	BTU/Hr
$HLM3 = CP3 * A_{16} * W_{14} * (T3 - TW01)$	BTU/Hr
$HLM4 = CP4 * B_{16} * W_{15} * (T4 - TW02)$	BTU/Hr

$HL_{24} = HLM1 + HLM2$

$HL_{25} = HLM3 + HLM4$

Measurements Required:

Symbol	Meas. No.	Description	Unit
T1	[1]V63T9012A	Pn1 1 + 2 + 4 out temp.	°F
T2	[1]V63T9012A	Pn1 1 + 2 + 4 out temp.	°F
T3	[1]V63T9013A	Pn1 3 + 5 out temp.	°F
T4	[1]V63T9013A	Pn1 3 + 5 out temp	°F
TW01	computed in	Section 5.2.4.19	°F
TW02	computed in	Section 5.2.4.19	°F
W_{14}	computed in	Section 5.2.4.18	lbs/hr
W_{15}	computed in	Section 5.2.4.18	lbs/hr

Constants:

$A_{15} = 0.0834$ $A_{16} = 0.0454$

$B_{15} = 0.0834$ $B_{16} = 0.0454$

5.2.4.22 Hydraulic HX Inlet Temperature (THI1, THI2)

$THI1 = (T1 * A_{14}) + (T3 * A_{15}) + (T4 * A_{16})$ (°F)

$THI2 = (T2 * B_{14}) + (T3 * B_{15}) + (T4 * B_{16})$ (°F)

Measurements Required

Symbol	Meas. No.	Description	Unit
T1	[1]V63T9071A	F/C HX FCL 1 out temp.	°F
T2	[1]V63T9073A	F/C HX FCL 2 out temp.	°F
T3	[1]V63T9012A	Mid-body pnl 4 out temp.	°F
T4	[1]V63T9013A	Mid-body pnl 5 out temp.	°F

Constants:

$A_{14} = 0.871$ $A_{15} = 0.0834$ $A_{16} = 0.0454$

$B_{14} = 0.871$ $B_{15} = 0.0834$ $B_{16} = 0.0454$

[1]DFI

5.2.4.23 Hydraulic HX Heat Load (HL_{26})

$CP1 = f\ ((THI1 + T1)/2)$
$CP2 = f\ ((THI2 + T2)/2)$
$HLH1 = CP1 * W_{14} * (THI1 - T1)$ (BTU/HR)
$HLH2 = CP2 * W_{15} * (THI2 - T2)$ (BTU/HR)
$HL_{26} = HLH1 + HLH2$

Measurements Required:

Symbol	Meas. No.	Description	Unit
T1	V63T1209A	Hyd. HX FCL 1 out temp.	oF
T2	V63T1409A	Hyd. HX FCL 2 out temp.	oF
THI1	computed in Section 5.2.4.22		oF
THI2	computed in Section 5.2.4.22		oF
W_{14}	computed in Section 5.2.4.18		lbs/hr.
W_{15}	computed in Section 5.2.4.18		lbs/hr

5.2.4.24 Radiator LH and RH Panels Heat Loads (HL_{27}, HL_{28})

$CP1 = f\ ((T1 + T3)/2)$
$CP2 = f\ ((T2 + T4)/2)$
$HL_{27} = CP1 * W_{14} * (T3 - T1)$ (BTU/HR)
$HL_{28} = CP2 * W_{15} * (T4 - T2)$ (BTU/HR)

Measurements Required:

Symbol	Meas. No.	Description	Unit
T1	V63T1209A	Rad. LH pnl in temp.	oF
T2	V63T1409A	Rad. RH pnl in temp.	oF
T3	V63T1208A	Rad. LH pnl out temp.	oF
T4	V63T1408A	Rad. RH pnl out temp.	oF
W_{14}	computed in Section 5.2.4.18		lbs/hr
W_{15}	computed in Section 5.2.4.18		lbs/hr

5.2.4.25 Radiator LH and RH Panels Freon Flow Rates (W_{16}, W_{17})

$CP1 = f\ ((T1 + T3)/2)$
$CP2 = f\ ((T2 + T4)/2)$
$W_{16} = HL_{27}/(CP1 * (T3 - T1))$ (LBS/HR)
$W_{17} = HL_{28}/(CP2 * (T4 - T2))$ (LBS/HR)

Measurements Required:

Symbol	Meas. No.	Description	Unit
T1	V63T1209A	Rad. LH pnl in temp.	oF
T2	V63T1409A	Rad. RH pnl in temp.	oF

T3	V63T1210A	Rad. L-1 pnl out temp.	°F
T4	V63T1410A	Rad R-1 pnl out temp.	°F
HL_{27}	computed in Section 5.2.4.24		btu/hr
HL_{28}	computed in Section 5.2.4.24		but/hr

5.2.4.26 Radiator Panels L-1, L-4, R-1 and R-2 Heat Loads

CP1 = f ((T1 + T2)/2)
CP2 = f ((T3 + T4)/2)
CP3 = f ((T5 + T6)/2)
CP4 = f ((T7 + T6)/2)
HL_{29} = CP1 * W_{16} * (T1 - T2) (BTU/LB)
HL_{30} = CP2 * W_{16} * (T3 - T4) (BTU/LB)
HL_{31} = CP3 * W_{17} * (T5 - T6) (BTU/LB)
HL_{32} = CP4 * W_{17} * (T6 - T7) (BTU/LB)

Measurements Required:

Symbol	Meas. No.	Description	Unit
T1	V63T1210A	Pnl L-1 out temp.	°F
T2	[1]V63T9002A	Pnl L-1 in temp.	°F
T3	[1]V63T9004A	Pnl L-4 out temp.	°F
T4	V63T1209A	Pnl L-4 in temp.	°F
T5	V63T2410A	Pnl R-1 out temp.	°F
T6	[1]V63T9021A	Pnl R-1 in temp.	°F
T7	[1]V63T9022A	Pnl R-2 in temp.	°F
W_{16}	computed in Section 5.2.4.25		lbs/hr
W_{17}	computed in Section 5.2.4.25		lbs/hr

5.2.4.27 Flash Evaporator, Ammonia Boiler or GSE HX Heat Load (HL_{33})

CP1 = f ((T1 + T3)/2)
CP2 = f ((T2 + T4)/2)
HLB1 = CP1 * W_{14} * (T1 - T3)
HLB2 = CP1 * W_{15} * (T2 - T4)
HL_{33} = HLB1 + HLB2

---
[1]DFI

Measurements Required:

Symbol	Meas. No.	Description	Unit
T1	V63T1207A	Evap. FCL 1 out temp.	°F
T2	V63T1407A	Evap. FCL 2 out temp.	°F
T3	V63T1208A	Radiator FCL 1 out temp.	°F
T4	V63T1408A	Radiator FCL 2 out temp.	°F
W_{14}	computed in	Section 5.2.4.18	
W_{15}	computed in	Section 5.2.4.18	

5.2.4.28 Overall ATCS Heat Load (HL_{34})

$HL_{34} = HL_{27} + HL_{28} + HL_{33}$
HL_{27} Computed in Section 5.2.4.24
HL_{28} Computed in Section 5.2.4.24
HL_{33} Computed in Section 5.2.4.27

5.2.4.29 Ammonia Systems A and B Quantities (QA1, QA2)

$$PS = 4.16 \times 10^{-5}\ Ti^3 + 6.62 \times 10^{-3}\ Ti^2 + .736Ti + 30.57$$

$$Qi = VT - \frac{Ci\ (Ti + 460)}{Pi - PS}\ (41.3 - .0484Ti) \qquad \text{(LBS)}$$

i = 1 for System A
i = 2 for System B

Measurements Required:

Symbol	Meas. No.	Description	Unit
T_1	V63T1180A	NH_3 Sys. A temperature	°F
T_2	V63T1188A	NH_3 Sys. B temperature	°F
P_1	V63P1196A	NH_3 Sys. A pressure	psia
P_2	V63P1197A	NH_3 Sys. B pressure	psia

Constants: Tank Volume VT = TBD

5.2.4.30 Ammonia Heat Absorption Capacity and Use Rate (C, W_{18})

$A = 205.6617 + .3171TD - .0012TD^2$
$B = 4.16 \times 10^{-5}TD^3 + 6.62 \times 10^{-3}TD^2 + .736TD + 30.57$
$D = (TA + TB)/2$
$C = A + (-.30 + .00125TD)\ (P - B) + 363.82 - 1.0813D - .0005D^2$
$W_{18} = HL_{33}/C$ (LBS/HR)

Measurements Required:

Symbol	Meas. No.	Description	Unit
TA	V63T1180A	NH_3 Sys. A temperature	°F
TB	V63T1188A	NH_3 Sys. B temperature	°F
TD	[1]V63T9152A	NH_3 Boiler out temp	°F
P	[1]V63P9154A	NH_3 Boiler out press	psia
HL_{33}	computed in Section 5.2.4.27		

5.2.4.31 Flash Evaporator Water Use Rate (W_{19})

$W_{19} = HL_{33}/1000$ (LBS/HR)
HL_{33} computed in Section 5.2.4.27

5.2.4.32 Fuel Cell Power (PWR)

PWR = (E1 * I1) + (E2 *I2) + (E3 * I3) (WATTS)

Measurements Required:

Symbol	Meas. No.	Description	Unit
E1	V45V0100A	Fuel Cell 1 voltage	volts
E2	V45V0200A	Fuel cell 2 voltage	volts
E3	V45V0300A	Fuel Cell 3 voltage	volts
I1	V45C0101A	Fuel Cell 1 current	amp
I2	V45C0201A	Fuel Cell 2 current	amp
I3	V45C0301A	Fuel Cell 3 current	amp

5.2.4.33 Fuel Cell Water Generation Rate (W_{20})

W_{20} = PWR * 0.00082 (LBS/HR)
PWR computed in section 5.2.4.32

5.2.4.34 Potable Water Use Rate (W_{21})

$H2Oi = [(Qi\ (t) - Qi\ (t + \Delta t))/\Delta t]*1.683$
$W_{21} = H2O_1 + H2O_2 + H2O_3 + H2O_4 + H2O_5 + H2O_6 - W_{20}$
i = 1 for Tank A use rate
i = 2 for Tank B use rate
i = 3 for Tank C use rate
i = 4 for Tank D use rate
i = 5 for Tank E use rate

[1]DFI

i = 6 for Tank F use rate
t = present time (hrs.)
Δt = time increment (hrs.)

Measurements Required:

Symbol	Meas. No.	Description	Unit
Q_1	V62Q0410A	Tank A Quantity	%
Q_2	V62Q0420A	Tank B quantity	%
Q_3	V62Q0548A	Tank C quantity	%
Q_4	V62Q0540A	Tank D quantity	%
Q_5	V62Q9150A	Tank E quantity	%
Q_6	V62Q9160A	Tank F quantity	%
Q_{20}	Computed in Section 5.2.4.33		

5.2.4.35 Auxiliary O_2 Quantity (Q02)

Q02 = 14.12*P/(T + 460) (LBS)

Measurements Required:

Symbol	Meas. No.	Description	Unit
P	V61P2161A	Aux GO_2 tank pressure	psia
T	V61T2216A	Aux GO_2 tank temp.	°F

5.2.4.36 Nitrogen Systems 1 and 2 Quantities (QN1, QN2)

QN1 = 12.36 * (P1/(T1 + 460) + P1/(T2 + 460))
QN2 = 12.36 * (P2/(T3 + 460) + P2/(T4 + 460))

Measurements Required:

Symbol	Meas. No.	Description	Unit
P1	V61P2301A	Pri GN_2 tank man. press	psia
P2	V61P2309A	Sec GN_2 tank man. press	psia
T1	V61T2406A	Pri GN_2 tank 1 temp.	°F
T2	V61T2407A	Pri GN_2 tank 2 temp.	°F
T3	V61T2408A	Sec GN_2 tank 1 temp.	°F
T4	V61T2409A	Sec GN_2 tank 2 temp.	°F

5.2.4.37 Waste Water Dump Rate (W_{22})

$W_{22} = [(Q(t) - Q(t+\Delta t))/\Delta t]*1.683$ LB/HR

Δt = time increment (hrs)

Measurements Required:

Symbol	Meas. No.	Description	Unit
Q	V62Q0540A	Waste Tank Quantity	PCT

Output requirements are 41 tab/continuous-form-plot groups. Groups 1-29 and the necessary calculations must be available from OD data only. Groups 30-41 require both OD and DFI data. Groupings will be shown in the data processing plan.

5.2.5 Structures Pressure Calculations

INPUT:

Special atmospheric CCT containing data points of Density, Ambient Pressure, Ambient Temperature, Wind Velocity, and Wind Azimuth vs. Altitude.

```
  DATAIN(I)  = PCM MSID's in Tables 5-11 through 5-22
 CFACT(I)    = card input for each MSID (Default = 1)
 BIAS(I)     = Card input for each MSID (Default = 0)
          K  = Card input value of I to select VEL from
               table 5-19 (Default = V95H3015C)
          L  = Card input value of I to select ALT from
               Table 5-18 (Default = V95H3001C)
          M  = Card input value of I to select RHO from
               Table 5-20 (Default = DENS calc below)
          N  = Card input value of I to select STATIC from
               Table 5-20 (Default = AMBPRS calc below)
          P  = Card input value of I to select Q from Table 5-20
               (Default = DYNP calc below)
```

PROCESSING:

```
DATOUT(I)   = DATAIN(I)*CFACT(I)+BIAS(I)
      ALT   = DATOUT(L)
     DENS   = Linearly interpolated density using ALT
   AMBPRS   = Linearly interpolated Ambient Pressure using ALT
   AMBTMP   = Linearly interpolated Ambient Temperature using ALT
   WNDVEL   = Linearly interpolated Wind Velocity using ALT
    WNDAZ   = Linearly interpolated Wind Azimuth usingALT
      VEL   = DATOUT(K)
      RHO   = DATOUT(M) or DENS if M=0
   STATIC   = DATOUT(N) or AMBPRS if N=0
     DYNP   = .5*RHO*VEL*VEL
DELTAP(J)   = DATOUT(J)-STATIC for MSID's in Tables 5-11, 13, 14
        Q   = DATOUT(P) or DYNP if P = 0
    CP(IJ)  = (DATOUT(IJ)-STATIC)/Q for MSID's in Tables 5-13, 14, 15.
```

OUTPUT:

1. CCT of all MSID's in Tables 5-11 through 5-23 in engineering units and at full rate.

2. CCT of all calculated values at fixed rate (Default = 10 S/S). Date, time, and location of atmospheric data should also be on this tape.

3. CCT of all MSID's in Tables 5-12, 14, 16, 21, 22, 23 in engineering units at full rate.

SPECIAL CONSIDERATIONS:

The MSID's in Tables 5-11 through 5-23 are the reflection of current TLM loading. Provision should be made to be able to update the MSID's in the tables without a software change. Provision should also be made to run without the atmospheric CCT as long as M and N $\neq$ 0.

TABLE 5-11.-INTERNAL COMPARTMENT PRESSURES

MEASUREMENT NUMBER	NAME
V07P9000A	Nose Cap
V07P9021A	Forward Fuselage
V07P9050A	Forward Fuselage #79
V07P9052A	Aft Fuselage #100
V07P9055A	Left OMS pod
V07P9056A	Left Main Window Outer Cavity
V07P9057A	Left Main Window Inner Cavity
V07P9058A	Hatch Window Outer Cavity
V07P9060A	Inboard Wing Leading Edge
V07P9061A	Inboard Wing Leading Edge
V07P9063A	Forward Wing
V07P9065A	Inboard Elevon
V07P9066A	Outboard Elevon
V07P9083A	[1]PLB Liner Differential Pressure
V07P9085A	Payload Bay
V07P9090A	Nose Wheel Well
V07P9095A	Main Wheel Well
V07P9154A	Vertical Stabilizer
V07P9155A	Rudder
V07P9156A	Left Rudder
V07P9161A	Body Flap

[1]Do not calculate DELTAP

TABLE 5-12.-ON-ORBIT COMPARTMENT PRESSURES

MEASUREMENT NUMBER	NAME
V07P9019	Forward RCS MLI
V07P9020	Forward Fuselage
V07P9040	Left OMS Pod Internal
V07P9042	Left OMS Pod MLI
V07P9045	Aft Fuselage Compartment
V07P9049	Forward Fuselage Compartment
V07P9081	Mid Fuselage Equipment Bay MLI
V07P9084	Mid Fuselage Lower Equipment Bay

MEASUREMENT DATA RANGE 0.0001 to 5.0 TORR

TABLE 5-13.-BASE HEATSHIELD EXTERNAL PRESSURES

MEASUREMENT NUMBER	NAME	
V07P9371A	Vert. Stab. Base Press.	1
V07P9373A	Right OMS pod Base Press	3
V07P9376A	Fuselage Base Pressure	6
V07P9379A	Fuselage Base Pressure	9
V07P9380A	Fuselage Base pressure	10
V07P9381A	Fuselage Base Pressure	11
V07P9382A	Fuselage Base Pressure	12
V07P9383A	Fuselage Base Pressure	13
V07P9384A	Fuselage Base Pressure	14
V07P9385A	Fuselage Base Pressure	15
V07P9386A	Fuselage Base Pressure	16
V07P9387A	Fuselage Base Pressure	17
V07P9388A	Fuselage Base Pressure	18
V07P9389A	Fuselage Base Pressure	19

MEASUREMENT DATA RANGE 0.0 to 15.0 PSIA

TABLE 5-14.-ORBITER BASE PRESSURES

MEASUREMENT NUMBER	NAME
V07P9390A	Orbiter Base Pressure
V07P9391A	Orbiter Base Pressure
V07P9392A	Orbiter Base Pressure
V07P9393A	Orbiter Base Pressure
V07P9394A	Orbiter Base Pressure
V07P9395A	Orbiter Base Pressure
V07P9396A	Orbiter Base Pressure

MEASUREMENT DATA RANGE 0.0 to 0.1 PSIA

TABLE 5-15.-MISCELLANEOUS EXTERNAL PRESSURES

MEASUREMENT NUMBER	NAME
V07P9100A	Nose Cap Surface X/L = 0.0
V07P9104A	Fuselage Upper Surface C.L. X/L - 0.15
V07P9108A	Forward Fuselage Hatch X/L = .25
V07P9114A	Left Fuselage X/L = 0.15
V07P9115A	Right Fuselage X/L = 0.15
V07P9120A	Left Fuselage X/L - 0.40
V07P9121A	Right Fuselage X/L = 0.40
V07P9126A	Left Fuselage X/L = 0.50
V07P9128A	Left Fuselage X/L = 0.53
V07P9129A	Right Fuselage X/L = 0.53
V07P9130A	Left Fuselage X/L = 0.60
V07P9132A	Left Fuselage X/L = 0.70
V07P9134A	Left Fuselage X/L = 0.83
V07P9136A	Left Fuselage X/L = 0.87
V07P9137A	Right Fuselage X/L = 0.87
V07P9138A	Left Fuselage X/L = 0.92
V07P9140A	OMS Pod Left Surface X/L = 0.92

TABLE 5-16.-MISCELLANEOUS INTERNAL PRESSURES

MEASUREMENT NUMBER	NAME
V61T2552A	Crew Cabin Temperature
V61R2556A	Crew Cabin Air Flow Rate
V61P2405A	Crew Cabin Pressure
V61T2401A	Crew Cabin Press. Rate of Change
V64P0101A	Airlock Differential Pressure 1
V64P0102A	Airlock Differential Pressure 2
V64P0103A	Airlock Differential Pressure 3
V64P0105A	Airlock/Cabin Differential Pressure
V64P0106A	Docking Module/Airlock Diff. Pressure
V64P0107A	Airlock/Docking Module Diff. Pressure
V64P0108A	Cabin/Airlock Differential Pressure
V64P0110A	Tunnel Adapter/Payload Diff. Pressure
V64P0115A	Tunnel Adapter/Airlock Diff. Pressure
V64P0120A	Payload/Tunnel Adapter Diff. Pressure
V64P0125A	Airloack/Tunnel Adapter Diff. Pressure

TABLE 5-17.-CONTROL SURFACE DEFLECTIONS

MEASUREMENT NUMBER	NAME
V94H2600C	Speed Brake Position
V94H5530C	Body Flap Position
V94H5540C	Rudder Position
V94H5550C	Speed Brake Position
V94H5560C	Aileron Position
V94H5570C	Elevator Position
V95H8210C	Compensated Rudder Pos. FDBK
V95H8310C	Compensated Body Flap Pos. FDBK
V95H8001C	Elevator Position
V95H8010C	Compensated LIB Elevon Position
V95H8060C	Compensated LOB Elevon Position
V95H8110C	Compensated RIB Elevon Position
V95H8160C	Compensated ROB Elevon Position
V72H5100C	Computed Rudder Position
V72H5105C	Computed Speedbrake Position
V72H5106C	Commanded Speed Brake Position
V72H5110C	Computed LIB Elevon Position
V72H5112C	Computed LOB Elevon Position
V72H5120C	Computed RIB Elevon Position
V72H5122C	Computed ROB Elevon Position
V72H5130C	Computed Body Flap Position
V72H5131C	Computed Aileron Position

C-2

TABLE 5-18.-ALTITUDE MEASUREMENTS

MEASUREMENT NUMBER	NAME
V72H5352B	Left AVVI Indicated Altitude
V72H5356B	Left AVVI Radar Altitude
V72H5392B	Right AVVI Indicated Altitude
V72H5396B	Right AVVI Radar Altitude
V95H3001C	GNC Corrected Pressure Altitude
V95H3003C	GNC Uncorrected Pressure Altitude
V95H3123C	Left Corrected Pressure Altitude
V95H3125C	Right Corrected Pressure Altitude

TABLE 5-19.-VELOCITY MEASUREMENTS

MEASUREMENT NUMBERS	NAME
V72L7258B	Left AMI Vehicle Acceleration
V72L7292B	Right AMI Mach/Velocity
V72L7296B	R. AMI Equivalent Airspeed
V72L7298B	R. AMI Vehicle Acceleration
V90L0811C	Ground Relative Velocity
V90L0847C	Nav Derived Mach Number
V72R5354B	Left AVVI Vertical Velocity
V72A5358B	Left AVVI Vertical Acceleration
V72R5394B	Right AVVI Vertical Velocity
V72A5398B	Right AVVI Vertical Acceleration
V72L7252B	Left AMI Mach/Velocity
V72L7256B	Left AMI Equivalent Airspeed
V95H3015C	GNC True Airspeed
V95H3029C	GNC Mach Number
V95L3101C	Left Mach Number
V95L3103C	Right Mach Number
V95L3141C	Left Equivalent Airspeed

TABLE 5-20.-MISCELLANEOUS TRAJECTORY PARAMETERS

MEASUREMENT NUMBER	NAME
V71P7040B	*ADTA 1 Static Pressure
V71P7540B	*ADTA 2 Static Pressure
V71P8040B	*ADTA 3 Static Pressure
V71P8540B	*ADTA 4 Static Pressure
V95P3201C	GNC Corrected Total Pressure
V95P3203C	Right Corrected Total Pressure
V95P3205C	Left Corrected Total Pressure
V95P3211C	*GNC Corrected Static Pressure
V95P3213C	*Right Corrected Static Pressure
V95P3215C	*Left Corrected Static Pressure
V72H7254B	Left AMI ALPHA
V95H3011C	+GNC Dynamic Pressure
V95H3021C	GNC Angle of Attack
V95H3025C	**GNC Air Density
V95H3105C	Left True Angle of Attack
V95L3133C	Left Pressure Altitude Rate
V72H7294B	Right AMI ALPHA
V90H0803C	Nav Angle of Attack

*May be used for value of STATIC
**May be used for value of RHO
+May be used for value of Q

TABLE 5-21.-ACCELERATION DATA

MEASUREMENT NUMBER	NAME
V73A1043A	Z Axis Acceleration
V79A2040C	Lateral Acceleration Assy 1
V79A2041C	Normal Acceleration Assy 1
V79A2043C	Lateral Acceleration Assy 2
V79A2044C	Normal Acceleration Assy 2
V79A2046C	Lateral Acceleration Assy 3
V79A2047C	Normal Acceleration Assy 3
V79A2048C	Lateral Acceleration Assy 4
V79A2049C	Normal Acceleration Assy 4

TABLE 5-22.-TEMPERATURE MEASUREMENTS

OFI

V38T9272A	AFT FUSE UPR BLK AIR
V38T9275A	AFT FUSE TOP REAR BLK AIR
V38T9276A	AFT FUSE UPR CENTER BLK AIR
V38T9277A	AFT FUSE LWR CENTER BLK AIR
V38T9278A	AFT FUSE LWR RT BLK AIR
V38T9282A	AFT FUSE LH VENT DOOR MOTOR
V38T9421A	RH OMS/RCS POD VENT & PURGE

DFI

V38T9001A	WINDOW CAVITY OUTER SIDE TEMP - SIDE HATCH
V38T9022A	WINDOW CAVITY-LH CTR WSHLD
V38T9025A	WINDOW CAVITY-LH OTR FWD WSHLD
V38T9111A	MID FUS PLD BAY PURGE LN VENT
V38T9261A	FWD FUS CM UPR BLK AIR
V38T9262A	FWD FUS ST CAVITY BLK AIR
V38T9263A	FWD FUS R RCS FTK BLKAIR
V38T9264A	FWD FUS R RCS FTK BLKAIR
V38T9265A	FWD FUS CM LWR BLK AIR
V38T9268A	MID FUS UPR FRONT BLK AIR
V38T9269A	MID FUS UPR AFT BLK AIR
V38T9270A	MOD FUS LWR FRONT BLK AIR
V38T9271A	MID FUS LWR AFT BLK AIR
V38T9320A	RH FWD RCS VENT GAS
V38T9334A	LH FWD FUSLG VENT GAS
V38T9373A	LH PLB VENT-AFT GAS
V38T9380A	RH PLB VENT-FWD GAS
V38T9406A	RH FUSLG VENT GAS

TABLE 5-23.-EVENTS MEASUREMENTS

V59X3005X	L Fwd Vents 1 & 2 Closed 1
V59X3015X	L Fwd Vents 1 & 2 Closed 2
V59X3055X	L Fwd Vents 1 & 2 Open 1
V59X3065X	L Fwd Vents 1 & 2 Open 2
V59X3105X	L Fwd Vents 1 & 2 Purge Ind. 1
V59X3115X	L Fwd Vents 1 & 2 Purge Ind. 2
V59X3205X	L PLB Vent 3 Closed 1
V59X3215X	L PLB Vent 3 Closed 2
V59X3255X	L PLB Vent 3 Open 1
V59X3265X	L PLB Vent 3 Open 2
V59X3305X	L PLB/Wing Vents 4 & 7 Closed 1
V59X3315X	L PLB/Wing Vents 4 & 7 Closed 2
V59X3355X	L PLB/Wing Vents 4 & 7 Open 1
V59X3365X	L PLB/Wing Vents 4 & 7 Open 2
V59X3405X	L PLB Vent 5 Closed 1
V59X3415X	L PLB Vent 5 Closed 2
V59X3455X	L PLB Vent 5 Open 1
V59X3465X	L PLB Vent 5 Open 2
V59X3505X	L PLB Vent 6 Closed 1
V59X3515X	L PLB Vent 6 Closed 2
V59X3555X	L PLB Vent 6 Open 1
V59X3565X	L PLB Vent 6 Open 2
V59X3605X	L PLB Vent 6 Purge Pos. 1 Ind. 1
V59X3615X	L PLB Vent 6 Purge Pos. 1 Ind. 2
V59X3705X	L PLB Vent 6 Purge Pos. 2 Ind. 1
V59X3715X	L PLB Vent 6 Purge Pos. 2 Ind. 2
V59X3805X	L AFT Vents 8 & 9 Closed 1
V59X3815X	L Aft Vents 8 & 9 Closed 2
V59X3855X	L Aft Vents 8 & 9 Open 1
V59X3865X	L Aft Vents 8 & 9 Open 2
V59X3905X	L Aft Vents 8 & 9 Purge 1
V59X3915X	L Aft Vents 8 & 9 Purge 2
V59X4005X	R. Fwd Vents 1 & 2 Closed 1
V59X4105X	R. Fwd Vents 1 & 2 Closed 2
V59X4055X	R. Fwd Vents 1 & 2 Open 1
V59X4065X	R. Fwd Vents 1 & 2 Open 2
V59X4105X	R. Fwd Vents 1 & 2 Purge 1
V59X4115X	R. Fwd Vents 1 & 2 Purge 2
V59X4205X	R. PLB Vent 3 Closed 1
V59X4215X	R. PLB Vent 3 Closed 2
V59X4255X	R. PLB Vent 3 Open 1
V59X4265X	R. PLB Vent 3 Open 2
V59X4305X	R. PLB/Wing Vents 4 & 7 Closed 1
V59X4315X	R. PLB/Wing Vents 4 & 7 Closed 2
V59X4355X	R. PLB/Wing Vents 4 & 7 Open 1
V59X4365X	R. PLB/Wing Vents 4 & 7 Open 2
V59X4405X	R. PLB Vent 5 Closed 1
V59X4415X	R. PLB Vent 5 Closed 2

TABLE 5-23.-EVENTS MEASUREMENTS (CONTINUED)

V59X4455X	R. PLB Vent 5 Open 1
V59X4465X	R. PLB Vent 5 Open 2
V59X4505X	R. PLB Vent 6 Closed 1
V59X4515X	R. PLB Vent 6 Closed 2
V59X4555X	R. PLB Vent 6 Open 1
V59X4565X	R. PLB Vent 6 Open 2
V59X4605X	R. PLB Vent 6 Purge Pos. 1 Ind. 1
V59X4615X	R. PLB Vent 6 Purge Pos. 1 Ind. 2
V59X4705X	R. PLB Vent 6 Purge Pos. 2 Ind. 1
V59X4715X	R. PLB Vent 6 Purge Pos. 2 Ind. 2
V59X4805X	R. Aft Vents 8 & 9 Closed 1
V59X4815X	R. Aft Vents 8 & 9 Closed 2
V59X4855X	R. Aft Vents 8 & 9 Open 1
V59X4865X	R. Aft Vents 8 & 9 Open 2
V59X4905X	R. Aft Vents 8 & 9 Purge 1
V59X4915X	R. Aft Vents 8 & 9 Purge 2
V61X2005E	Cabin Vent Isol - Closed
V61X2025E	Cabin Vent Isol - Open
V61X2045E	Cabin Vent -Closed
V61X2065E	Cabin Vent - Open

6 RESPONSE TIME

The ODRC is required to produce predefined standard and specific output products from 25% of the downlinked PCM data for an OFT mission within 6 weeks after landing. Low output volume high priority data requests will have a turnaround requirement of 24 hours. The latter time assumes that the source data is available and time to obtain hardcopy from microfilm is not included.

7 DATA MANAGEMENT REQUIREMENTS

IDSD will be responsible for data management functions which are required to provide the products described in section 5. In addition, IDSD will provide storage, retrieval, and distribution support for wide band FM products produced at MSFC. The Level D Requirements Document will specify the number of products to be handled.

7.1 STORAGE AND RETRIEVAL

- Storage of the following tapes will be provided for a period of time to be specified in the Level D Requirements Document:

  1. Instrumentation Tapes (7- or 14-track)
     OFT Flight Data (master copy)
     WB Master
     Range PCM
     Onboard Recorder Dump

  2. Computer-Compatible Tapes
     NIP (intermediate PCM CCT)
     Ephemeris/BET
     Calibration
     FM
     DLSM
     Telemetry Loading

- Permanent onsite storage of microfilm data products.

- Maintenance of an index adequate for locating tapes and microfilm based upon single parameters (flight, date, time, data source).

7.2 DATA PREPARATION AND DISTRIBUTION

It is required that IDSD:

- Obtain hardcopies and copies of microfilm by utilizing central reproduction facilities.

- Prepare data books.

- Package and mail to designated recipients.

- Deliver onsite by courier.

7.3 STATUS TRACKING

It is required that IDSD:

- Receive and implement data processing requests from the Shuttle Evaluation Team Data Manager.
- Maintain status of data processing requests and provide timely status information to the Shuttle Evaluation Team Data Manager or his representative.

7.4 DATA SELECTION

Since overlapping (in time) data will be received at JSC, it is required that IDSD select a Standard Source Data Base (SSDB) for processing MET data requests. Selection is to be made based on data transmission quality (i.e., % of frames missing, sync drops) and not data content. The MET reserves the right to ask for alternate sources to investigate anomalies. IDSD will provide the MET with a report of the SSDB listing the source for each time interval.

8 DATA MAGNITUDES

Detailed requirements for the amount of data to be processed into various products will be specified in the Level D requirements document.

APPENDIX A

DETERMINATION OF DISPLAYED SIGNIFICANT DIGITS

APPENDIX A

DETERMINATION OF DISPLAYED SIGNIFICANT DIGITS

The capability to limit the number of significant digits necessary to describe a given parameter to those which convey meaningful intelligence is required. The following procedure describes the algorithm to be utilized for the determination of the number of places to the right of the decimal (D) for each parameter:

- Extract the number of bits (n) in the telemetry word and the calibration coefficients from the MMDBS and calculate the high (H) and low (L) value for the parameter. If linear, substitute (2**n-1) and zero; if higher order, substitute 256 evenly spaced points from zero to (2**n-1), checking for max and min; if piecewise, check each data point for max and min.

- Calculate the data range (R), R = ABS (H-L). If R=0, set D=2 and skip to the end.

- Calculate the granularity indicator (G), G = LOG10 (R/(2**(n+1))). This effectively adds one bit to the granularity as a built-in conservatism so that significance will not be lost in nonlinear calibrations.

- Calculate the number of decimal places (D):

  1. If $G \geq 0$, then D=0

  2. If $G < 0$, then D = Truncation (1-G)

This procedure shall be used for the determination of significant digits in all nominal tabulation groups. The capability to manually override at run time the automatic shall be provided on a per parameter basis for exceptional cases.

APPENDIX B

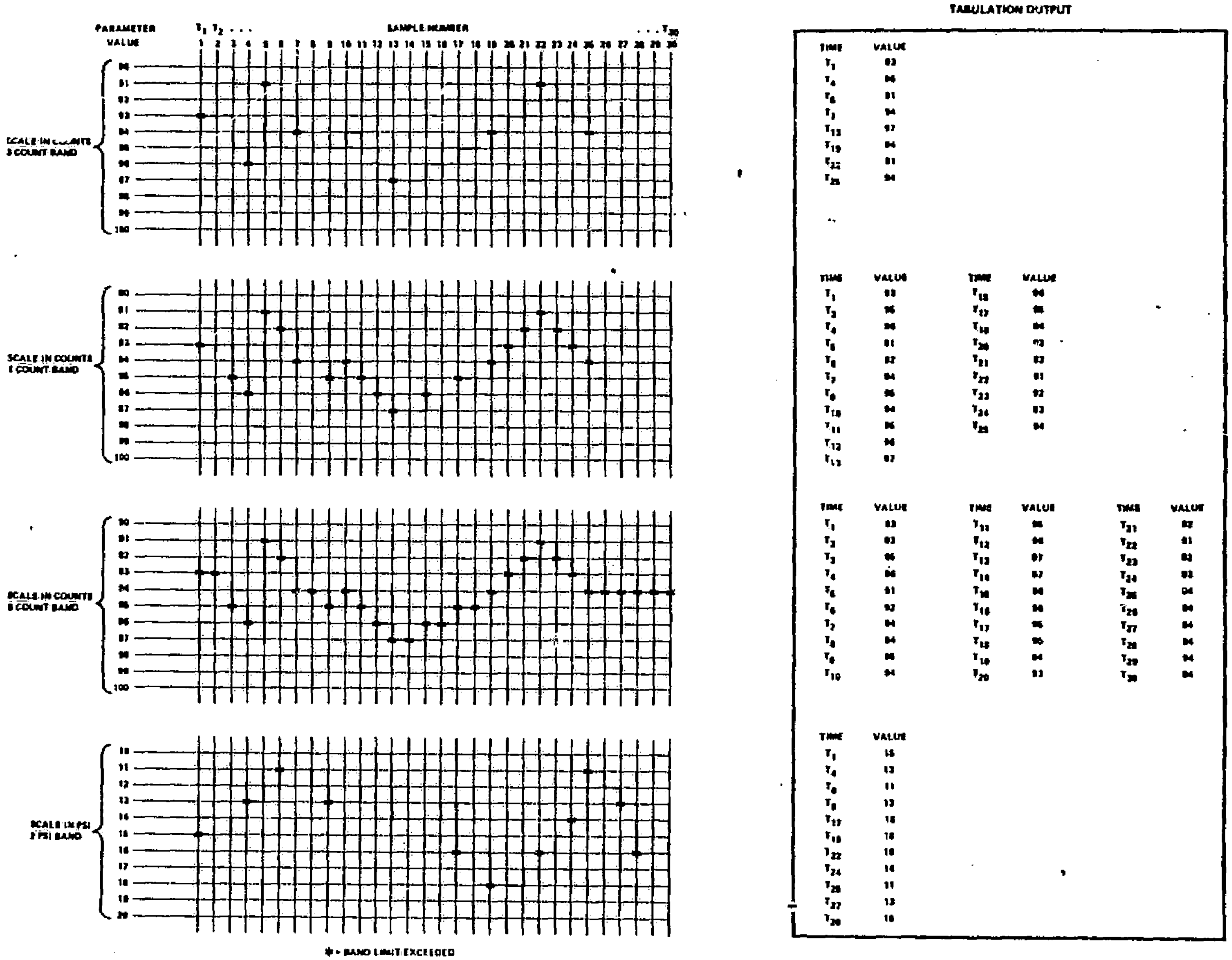
REDUNDANCY REMOVAL

APPENDIX B

REDUNDANCY REMOVAL

The capability to apply redundancy removal techniques to tabulated Orbiter OD PCM data parameters is required. Data bandpass limits are expressed in raw bitstream units. Bandpass limits are symmetrical about the initial "in-band" value; i.e., an "in-band" value may move up-scale or down-scale by an amount less than the bandpass limit without forcing an output.

If the in-band value changes in magnitude are equal to or greater than the specified bandpass limit, that value will be output and become the new initial in-band value, with further output being inhibited until such time as another change in magnitude occurs equal to or greater than the bandpass limit. This relationship is depicted in Figure B-1, Redundancy Removal Criteria.


PARAMETER VALUE
SAMPLE NUMBER
SCALE IN COUNTS 3 COUNT BAND
SCALE IN COUNTS 1 COUNT BAND
SCALE IN COUNTS 5 COUNT BAND
SCALE IN PSI 2 PSI BAND
* = BAND LIMIT EXCEEDED
TABULATION OUTPUT
TIME
VALUE

APPENDIX C

STANDARD MEASUREMENT PROCESSING

APPENDIX C

STANDARD MEASUREMENT PROCESSING

C.1 GENERAL

Each measurement output on a standard data product will be identified by its MSID, a ten-character identifier. Data processing for each measurement consists of three basic steps: Retrieval, interpretation, and formatting. This appendix outlines particular procedures to be followed for various input data sources, types of parameters, and types of output products.

C.2 RETRIEVAL

The procedure for retrieving data for a measurement is dependent on the data source: Instrumentation tape via NIP CCT, TOC CDT, or TICM CDT. Retrieval is limited to 48 bits for all data types except DPL (double precision) which retrieves 56 bits, dropping the 8 least significant bits.

C.2.1 NIP CCT

The Support Table CCT (described in the GDSD/IDSD ICD for OFT) gives the location and length of each parameter on the NIP CCT.

C.2.2 TOC CDT

The SAIL Data Base Tape (described in the ODRC/SAIL ICD for SAIL OFT Data Tapes) gives the System ID number for each MSID on the TOC CDT as well as its length. TOC CDT records must be searched to find the System ID, then the data word(s) masked to extract the correct length. Only System ID's from 0201 to 1FFF (hexadecimal) are standard measurements.

C.2.3 TICM CDT

Retrieval is basically the same as for TOC CDT when differences in tape format are taken into account. Only System ID's from 0201 to OFFF and from 8201 to 8FFF are standard measurements.

C.3 INTERPRETATION

Interpreting the data values consists of converting the raw retrieved bit pattern into a usable numeric value (evaluation), and then scaling it into engineering units (calibration). Calibration is optional.

C.3.1 EVALUATION

Evaluation is done on the basis of data type or its equivalent processing code (see Table C-1). For the NIP CCT the processing code comes from the Support Table CCT. For TOC and TICM CDT's the processing code comes from the SAIL Data Base CCT.

C.3.2 CALIBRATION

Calibrations for the NIP CCT come from the MMDBS calibration tape. They may take the form of polynomial coefficients, MSB value and offset, or data points (see JSC 12750 for clarification). Calibrations for TOC or TICM CDT come from the SAIL Data Base CCT. They are in data point form only.

C.4 FORMATTING

The form in which data will be displayed is dependent upon the type of product. For plots, the value is displayed at its relative location with respect to the grid, no matter what processing code is used. For CCT's the value is output in Univac 36 or 72 bit format (described in JSC 12865), with choice of length based on the length of the original data so that no information is lost. Event tabulations bypass the interpretation phase altogether and display the retrieved data in binary form. Analog tabulations handle data from different processing codes in different ways which are described below.

TABLE C-1

PROCESSING CODES

PC	EXAMPLE[1]	DATA TYPE	COMMENT
0	-	-	Undefined or N/A
1	MXXXXL	HXU, FXU BD, BSU[2] BMD[2]	Fixed point unsigned
2	SMXXXL	HXS, FXS BSS, AMB	Fixed point signed-two's complement
3	SNMXXL	HFS	Fixed point signed magnitude with a notification bit (N) of an overflow
4	SEF	SPL	Floating point signed, 32 bits
5	SEFF	DPL	Floating point signed, 64 bits
6	OMXXXL	AMU	Fixed point, sign bit fixed at zero
7	XXXXXX	HMD, FMD	Parent Measurement. Must examine submeas for processing
			TIME WORDS
8	DHMS.S	BMD, EMD	OI GMT, MET time measurements
9	MS.S	BSU, EMD	GPC time measurement first 16-bits LSB = 30 min.. Remaining 32 bits-- LSB = 1 micro sec (reset at 30 Min).
16	RMXXXL	BMS, HMS	Fixed point with directional bit - do not complement R = 0 is positive, R = 1 is negative
		CODED DECIMAL WORDS (BCD)	
10	OKKHHHHTTTTUUUUO		Measurements with bits representing

[1]See Space Shuttle Telemetry and Command Data Characteristics Handbook, Vol. 1 for detail formats.

[2]Time measurements and special measurements are exceptions.

		thousands (K-kilo), hundreds (H), tens (T), Units (U)
11	HHTTTTUUUUDDDD	tenths (D-deci), and hundredths (C-centi)
12	CCCC	
13	HHTTTTUUUU	Each letter represents one bit.
14	TTUUUU	
15	TTTUUUU	

CHARACTER CODES FOR TABLE C-1

<u>One Character Per Bit</u>

S	Sign bit 0=positive 1=negative--If negative two's complement data bits.
M	Most significant bit
L	Least significant bit
N	Notifier bit that a measurement has exceeded its maximum value.
K	Thousands bit (kilo)
H	Hundred bit
T	Tens bit
U	Units bit
D	Tenths bit (deci)
C	Hundredths bit (centi)
0	Bit always = 0
1	Bit always = 1
R	Reverse direction bit--Do not complement data bits.

<u>One Character for Several Bits</u>

E	Exponent bits
F	Fraction bits
X	Middle data bits
D	Day bits
H	Hour bits
M	Minute bits
S	Second bits
.S	Fraction of seconds bits

C.4.1 TAB COLUMNS

Each tab column has nine usable characters displaying data plus one blank for separation. Each double tab column has 19 usable characters. The user should have the option of choosing either size.

C.4.2 DATA LENGTH AND TYPE

For NIP CCT's, the data length and type are extracted from the MMDBS calibration CCT. For TOC and TICM CDT's the length and processing code is extracted from the SAIL Data Base CCT.

C.4.3 DECIMAL FORMATS

Most measurements will appear in normal decimal format; e.g., 16.32, -4532.992. Processing codes 1 (except BD and BMD), 2, 3, 6, and 16 will be decimal format with the number of decimal places determined as shown in Appendix A. For length greater than 26 bits, a double column should be used. For data type BCD, codes 10-15, two decimal places will be used. For data type SPL, code 4, three decimal places will be used.

C.4.4 EXPONENTIAL FORMAT

Processing code 5 may have a dynamic range that makes decimal format unsatisfactory, hence scientific notation and a double column is used; e.g., -6.1234567890l2E-07. Some code 4 words may need scientific notation by user override.

C.4.5 TIME FORMAT

Processing codes 8 and 9 will be displayed in a double column as days, hours, minutes, and seconds (with fractions to at least milliseconds).

C.4.6 OTHER FORMATS

Processing code 7 and type BMD (except time) will be displayed in hexadecimal characters. For greater than 36 bits, a double column is required.

C.4.7 USER OPTIONS

While paragraphs C.4.1-6 above give standard or default formats, the user may exercise an override option when the tab group is built, which is normally long before run time. The user may redefine a temporary tab group at run time which will in effect change the format of one or more measurement, but this will require extra computer time, extra deck setup time, and is error prone.

C.5 SPECIAL MEASUREMENT PROCESSING

Standard measurements have a single data value which is output in a standard column. Special measurements may not be on Support Tables or SAIL Data Base CCT, and also may have more than one value per occurrence.

C.5.1 TOC CDT

A. GPC Sync

System ID 0000 (hex) is monitored for sync state with each GPC treated independently. The initial state and any subsequent state change initiates a one line message giving time, GPC, and sync condition (sync loss or sync regained).
Redundant messages for each GPC are suppressed.

B. PCM Sync

System ID 0002 (hex) is processed similar to GPC sync.

C. TICM/SIS Sync

System ID 0004 (hex) is processed similar to GPC sync.

C.5.2 TICM CDT

A. Hardware Errors

System ID 0002 (hex) is processed with occurrence outputting a one line error message giving time and the device and error by number.

B. SIS Frame Error/Status

System ID 0003 (hex) is processed with each occurrence outputting a one line status message giving time and status value.

C. SIS Frame Parity Error
System ID 8005 (hex) is processed with each occurrence outputting a one line message giving previous and current frame count.

D. Read Not Ready

System ID 8006 (hex) is processed with each occurrence outputting a one line message giving expected and current frame count.

E. SIS Frame Out of Time

System ID 8007 (hex) is processed with each occurrence outputting a one line message giving frame counts one and two.

F. SIS Frame Count Error

System ID 8008 (hex) is processed just like D above.

G. SIS Frame Count

System ID 8004 (hex) is processed just like a normal 32-bit data word, providing it is on the SAIL Data Base.

H. Message Limit

A maximum number of one-line error/status messages (default value 25 with card override) are permitted with a final message output saying the limit has been exceeded.

☆ U.S. GOVERNMENT PRINTING OFFICE: 979-671-014/321