
Orbiter Flying Qualities (OFQ) Workstation User's Guide

Thomas T. Myers, Zareh Parseghian, and Jeffrey R. Hogue

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THE OFQ ARCHIVES AND WORKSTATION

The OFQ Flight Data Archives are a set of computer files containing Space Shuttle entry flight data relevant to flight control and flying qualities. The OFQ Workstation is a software package which can be installed on standard personal computers to provide a "workstation" for accessing and using the OFQ archives.

HOW TO USE THE USER'S GUIDE

This document, the OFQ Workstation User's Guide, is divided into two manuals. The first is the Reference Manual which presents the necessary background information and answers why questions about the use of the OFQ Archives and Workstation.

After you are familiar with the material in the Reference Manual, you can use the "How To Do It" Manual as a "workbook" for operating the Workstation.

INSTALLING THE OFQ WORKSTATION SOFTWARE

Instructions for installing the Workstation software package are at the end of the "How To Do It" manual (since they should be needed only rarely).

REFERENCE MANUAL

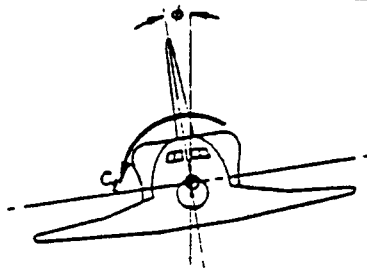
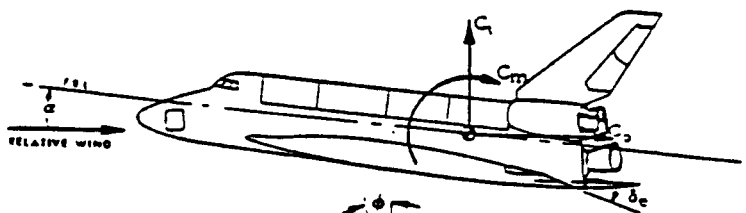
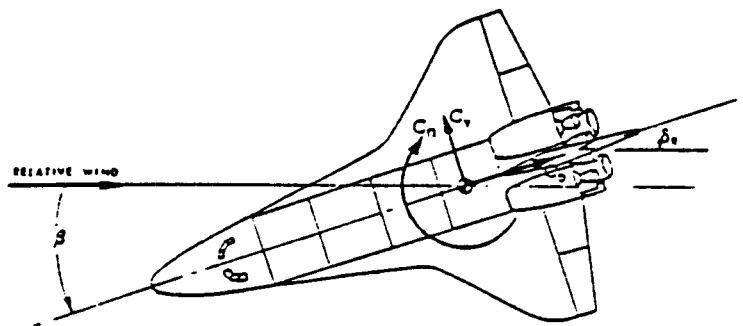


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SECTION I

THE OFQ FLIGHT DATA ARCHIVES

A. THE OFQ FLIGHT DATA ARCHIVES

The OFQ archive files have been assembled as part of the OFQ research (Refs. 1-6) in the Orbiter Experiment (OEX) to preserve and document shuttle flight data relevant to vehicle dynamics, flight control, and flying qualities. This has been done to make valuable flight control/flying quality data bases widely available, and easily accessible to the research community at large. For a complex program such as the shuttle Orbiter Flight Test (OFT), the availability of very large quantities of data creates problems as well as opportunities. Official shuttle flight data bases such as the NASA JSC Master Products Data Base (MPDP), contain thousands of signals from all aspects of shuttle operation for complete entries. However, a typical flying qualities analysis may involve less than a dozen signals over a "time slice" of less than a minute. Thus, the OFQ archives are intended to provide flight phase-oriented data subsets with relevant signals which are easily identified and used.

Strictly speaking the OFQ Archives are a set of files on the ADFRF ELXSI computer. At present there are a pair of files for each of six entries -- STS-2 through STS-7. Each of these files contains time history data for several dozen signals for the final portion of the entry (Terminal Area through touchdown). Complete copies of these files have also been created on personal computer diskettes ("floppy disks") for use on the OFQ Workstation. These are referred to as the Workstation Archives, but contain data identical to those on the ELXSI.

The OFQ Archive files were created from three other data sets as explained in Appendix A and Ref. 5. These data in turn were obtained from a variety of onboard and ground based instrumentation. The primary source of OFQ data has been the Modified Maximum Likelihood Estimator (MMLE) files created at ADFRF from onboard measurements. This has been augmented with data from ground based cinetheodolite (CINE) and Takeoff and Landing Tower (TOLT) data (Appendix B) from the Air Force Flight Test Center (AFFTC).

As noted above archive files are available on the ELXSI for STS-2 through -7. For STS-1 the CINE data is unusable since only a short section is available and no TOLT tape was generated for this lakebed landing, but an MMLE file is available. For STS-8 on, the CINE and TOLT data have not been obtained, and the MMLE files are the best available archives. Data has been archived in two files for each of the STS-2 through -7 entries. Each large (unformatted) file, named USYNCOX where X is the flight number, contains signals from the start of cinetheodolite measurements (generally 40-80 thousand feet altitude) down through the end of the final steep glide. Each small (unformatted) file, named ULANDOX where X is the flight number, contains data for the landing maneuver (preflare pullup through touchdown).

Table 1 is a directory of the variables available in the OFQ archives, however, not all files contain all variables because TOLT data is not available for all landings. This is accounted for by defining a file "type" for each file as shown in Table 2. The variables and their order for each file type is given in Table 3. Figure 1 indicates the general structure of the files as they typically appear when formatted.

B. USE OF THE OFQ ARCHIVES ON THE ELXSI

The OFQ Archives can be used directly by operating on the ADFRF ELXSI computer. This can be done from a remote facility over phone lines using a terminal or a personnel computer with a modem and communications software. The OFQ Archives can be accessed using the GETDATA program (Ref. 7) developed at ADFRF. GETDATA can be used to access a subset of archive signals over a subinterval of time. GETDATA also has powerful capability for combining data from disparate sources including synchronizing signals with differing sample rates and time skews. This program is an enhancement of the "SYNC" program which was used to create the OFQ Archives (Ref. 8).

To aid in identifying the temporal regions of interest in the Archive files, complete time histories of five basic variables (i.e., altitude, velocity, Mach number, heading and bank angle) for the archived time segments are shown in Fig. 2. Note that the time axes in Fig. 2 have their origins at the start of the large (USYNCOX) files and that the Greenwich Mean Time in seconds (GMT) is noted for each origin.

TABLE 1. SIGNAL DIRECTORY FOR SHUTTLE OFO ARCHIVE FILES

#	Signal Description	Original Data Set	Data Source	Units	Original Sample Rate (smp1/sec)	Data Set Signal #	Data Set symbol
Accelerations							
1	Acceleration normal to trajectory	CINE	CINE	ft/sec/sec	10 or 20	55	AN
2	Normal accelerometer signal	MMLE	ACIP	g's	174	5	ARZL
3	Pitch acceleration	MMLE	ACIP	rad/sec/sec	174	6	AROOT
4	Longitudinal accelerometer signal	MMLE	ACIP	g's	174	7	ARXL
5	Lateral accelerometer signal	MMLE	ACIP	g's	174	19	ARY
6	Roll acceleration	MMLE	ACIP	rad/sec/sec	174	20	AROOT
7	Yaw acceleration	MMLE	ACIP	rad/sec/sec	174	21	AROOT
Angular rates							
8	Pitch rate	MMLE	ACIP	deg/sec	174	2	AQ
9	Body axis roll rate	MMLE	ACIP	deg/sec	174	17	AP
10	Body axis yaw rate	MMLE	ACIP	deg/sec	174	18	AR
Earth Referenced Velocity							
11	Vertical speed	CINE	CINE	fps	10 or 20	23	VZ
12	Total velocity	CINE	CINE	fps	10 or 20	39	VT
13	Velocity (IMU)	MMLE	GPC	fps	1	3	VTRUE
14	Rate of climb	TOLT	TOLT	fps	4	5	
Air data							
15	Mach number (side probe)	MMLE	COMPUTED	-		69	-
16	Dynamic pressure (side probe)	MMLE	COMPUTED	psf		70	-
17	Airspeed (side probe)	MMLE	COMPUTED	fps		71	-
18	Angle of attack (side probe)	MMLE	COMPUTED	deg		72	-
19	Sideslip angle (side probe)	MMLE	COMPUTED	deg		73	-
Attitude angles							
20	Pitch attitude	MMLE	GPC	deg	5	4	THETA
21	Bank angle	MMLE	GPC	deg	5	12	PHI
22	Heading	MMLE	GPC	deg	5	86	PSI
Earth Referenced Position							
23	Distance east (unsmoothed)	CINE	CINE	feet	10 or 20	5	X
24	Distance north (unsmoothed)	CINE	CINE	feet	10 or 20	6	Y
25	Distance up (unsmoothed)	CINE	CINE	feet	10 or 20	7	Z
26	Altitude above ground level	MMLE	GPC	feet	1	13	ALT
27	Radar altitude	MMLE	GPC	feet	1	102	ALTRAD

TABLE 1. (CONCLUDED)

#	Signal Description	Original Data Set	Data Source	Units	Original Sample Rate (saml/sec)	Data Set Signal #	Data Set symbol
28	Ground distance from runway west end	TOLT	TOLT	feet	4	2	
29	Grnd dist from brk relse(TO) or stop(Lndng)	TOLT	TOLT	feet	4	3	
30	Height wrt liftoff or touchdown point	TOLT	TOLT	feet	4	4	
31	Offset from runway centerline	TOLT	TOLT	feet	4	10	
Control surface deflection							
32	Elevator deflection	MMLE	COMPUTED	deg	6.25	8	
33	Body flap deflection	MMLE	GPC	deg		9	BDFPL1
34	Aileron deflection	MMLE	COMPUTED	deg		22	
35	Rudder deflection	MMLE	ACIP	deg	174	23	ADR
36	Speed brake deflection	MMLE	OI	deg	1	26	DSPACT
Pilot controller input							
37	Left rudder pedal (Commander)	MMLE	OI	deg	1	88	CLPED
38	Right rudder pedal (Commander)	MMLE	OI	deg	1	89	CRPED
39	Left rudder pedal (Pilot)	MMLE	OI	deg	1	90	PLPED
40	Right rudder pedal (Pilot)	MMLE	OI	deg	1	91	PRPED
41	Rotational hand controller roll (BFCS)	MMLE	BFS	deg	12.5	92	PRHC
42	Rotational hand controller pitch (BFCS)	MMLE	BFS	deg	12.5	93	CRHC
43	Rotational hand controller roll (Pilot)	MMLE	GPC	deg	1	94	PRRHC
44	Rotational hand controller pitch (Pilot)	MMLE	GPC	deg	1	95	PRRHCP
45	Speed Brake Command	MMLE	GPC	deg	5	81	DSPCMD
Wind data							
46	Wind direction	CINE	CINE	fps	10 or 20	17	WD
47	Wind velocity	CINE	CINE	fps	10 or 20	18	WV

TABLE 2. SUMMARY OF FILE NAMES AND TYPES

MISSION	"USYNCOX" FILES (START OF CINE DATA TO START OF PREFLARE)		"ULANDOX" FILES (START OF PREFLARE THROUGH TOUCHDOWN)	
	<u>NAME</u>	<u>TYPE</u>	<u>NAME</u>	<u>TYPE</u>
STS-2	USYNCO2	1	ULAND02	1
STS-3	USYNCO3	1	ULAND03	1
STS-4	USYNCO4	1	ULAND04	2
STS-5	USYNCO5	1	ULAND05	2
STS-6	USYNCO6	1	ULAND06	2
STS-7	USYNCO7	1	ULAND07	1

<u>FILE TYPE</u>	<u>NUMBER OF VARIABLES (EXCLUDING TIME)</u>
1	42
2	47
3	16
4	16

TABLE 3. ORDERING OF SIGNALS BY ARCHIVE FILE TYPE

#	Signal Description	Original Signal Order by File Type			
		Data Set Type 1	Type 2	Type 3	Type 4
Accelerations					
1	Acceleration normal to trajectory	CINE	1	1	1
2	Normal accelerometer signal	MMLE	2	2	1
3	Pitch acceleration	MMLE	3	3	
4	Longitudinal accelerometer signal	MMLE	4	4	
5	Lateral accelerometer signal	MMLE	5	5	
6	Roll acceleration	MMLE	6	6	
7	Yaw acceleration	MMLE	7	7	
Angular rates					
8	Pitch rate	MMLE	8	8	2
9	Body axis roll rate	MMLE	9	9	
10	Body axis yaw rate	MMLE	10	10	
Earth Referenced Velocity					
11	Vertical speed	CINE	11	11	
12	Total velocity	CINE	12	12	
13	Velocity (IMU)	MMLE	13	13	
14	Rate of climb	TOLT	14	14	
Air data					
15	Mach number (side probe)	MMLE	14	15	
16	Dynamic pressure (side probe)	MMLE	15	16	
17	Airspeed (side probe)	MMLE	16	17	3
18	Angle of attack (side probe)	MMLE	17	18	4
19	Sideslip angle (side probe)	MMLE	18	19	
Attitude angles					
20	Pitch attitude	MMLE	19	20	5
21	Bank angle	MMLE	20	21	
22	Heading	MMLE	21	22	
Earth Referenced Position					
23	Distance east (unsmoothed)	CINE	22	23	6
24	Distance north (unsmoothed)	CINE	23	24	7
25	Distance up (unsmoothed)	CINE	24	25	8
26	Altitude above ground level	MMLE	25	26	9
27	Radar altitude	MMLE	26	27	10

TABLE 3. (CONCLUDED)

#	Signal Description	Original Signal Order by File Type			
		Data Set Type 1	Type 2	Type 3	Type 4
28	Ground distance from runway west end	TOLT	28	11	
29	Grnd dist from brk relse(10) or stop(Inrng)	TOLT	29		
30	Height wrt liftoff or touchdown point	TOLT	30	12	
31	Offset from runway centerline	TOLT	31		
Control surface deflection					
32	Elevator deflection	MMLE	27	13	11
33	Body flap deflection	MMLE	28		
34	Aileron deflection	MMLE	29		
35	Rudder deflection	MMLE	30		
36	Speed brake deflection	MMLE	31		
Pilot controller input					
37	Left rudder pedal (Commander)	MMLE	32		
38	Right rudder pedal (Commander)	MMLE	33		
39	Left rudder pedal (Pilot)	MMLE	34		
40	Right rudder pedal (Pilot)	MMLE	35		12
41	Rotational hand controller roll (BFCS)	MMLE	36		13
42	Rotational hand controller pitch (BFCS)	MMLE	37	14	14
43	Rotational hand controller roll (Pilot)	MMLE	38		
44	Rotational hand controller pitch (Pilot)	MMLE	39		
45	Speed Brake Command	MMLE	40		
Wind data					
46	Wind direction	CINE	41	15	15
47	Wind velocity	CINE	42	16	16

	BEGINNING OF FILE		1		1, FILE		1	
	BEGINNING OF RECORD		1, FILE		1		1	
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
1	4990.000	0.000	.876	-.091	-.249	-.040	4.166	.321
11	-.258	-.313	.034	0.000	0.000	842.543	.886	181.143
21	.688	6.997	-.165	-10.397	.743	56.199	0.000	0.000
31	43047.437	9000.130	7.047	-9.407	.382	.214	47.385	0.000
41	0.000	0.000	0.000	.001	-.059	-.059	55.986	0.000
51	.000	0.000	49990.040	0.000	.978	3.799	-.247	.007
61	.967	1.143	-.054	-.378	-.002	0.000	842.543	.885
71	181.152	-.846.391	7.013	-.170	-10.401	.723	56.197	0.000
81	0.000	0.000	43047.437	9000.130	7.077	-9.407	.345	.265
91	.359	0.000	0.000	0.000	.001	.001	-.059	.47
101	55.986	0.000	0.000	49990.080	0.000	.953	1.199	-.059
111	-.024	7.191	-.967	-.137	-.312	.063	0.000	0.000
121	842.543	.886	181.297	846.594	7.004	-.177	-10.406	.703
131	.196	0.000	0.000	43047.437	9000.130	7.085	-9.407	.329
141	.278	47.334	0.000	0.000	0.000	0.000	.001	.001
151	-.059	-.059	55.986	0.000	0.000	49990.120	0.000	.904
161	-1.367	-.252	-.021	-1.939	1.037	-.039	-.312	.001
171	.000	0.000	842.543	.886	181.446	846.885	7.008	-.177
181	.684	56.194	0.000	0.000	0.000	43047.437	9000.130	7.119
191	-9.407	.362	.324	47.308	0.000	0.000	0.000	0.000
201	.001	.001	-.059	-.059	55.986	0.000	0.000	0.000
211	.000	.928	-5.863	-.246	-.007	8.365	.741	-.346
221	.101	0.000	0.000	842.543				-.132

First record of 42 signals + time

continued on next line

Figure 1. Example Formatted Printout of an Archive File (42 Channel, Type 1 File "FSYNC07")

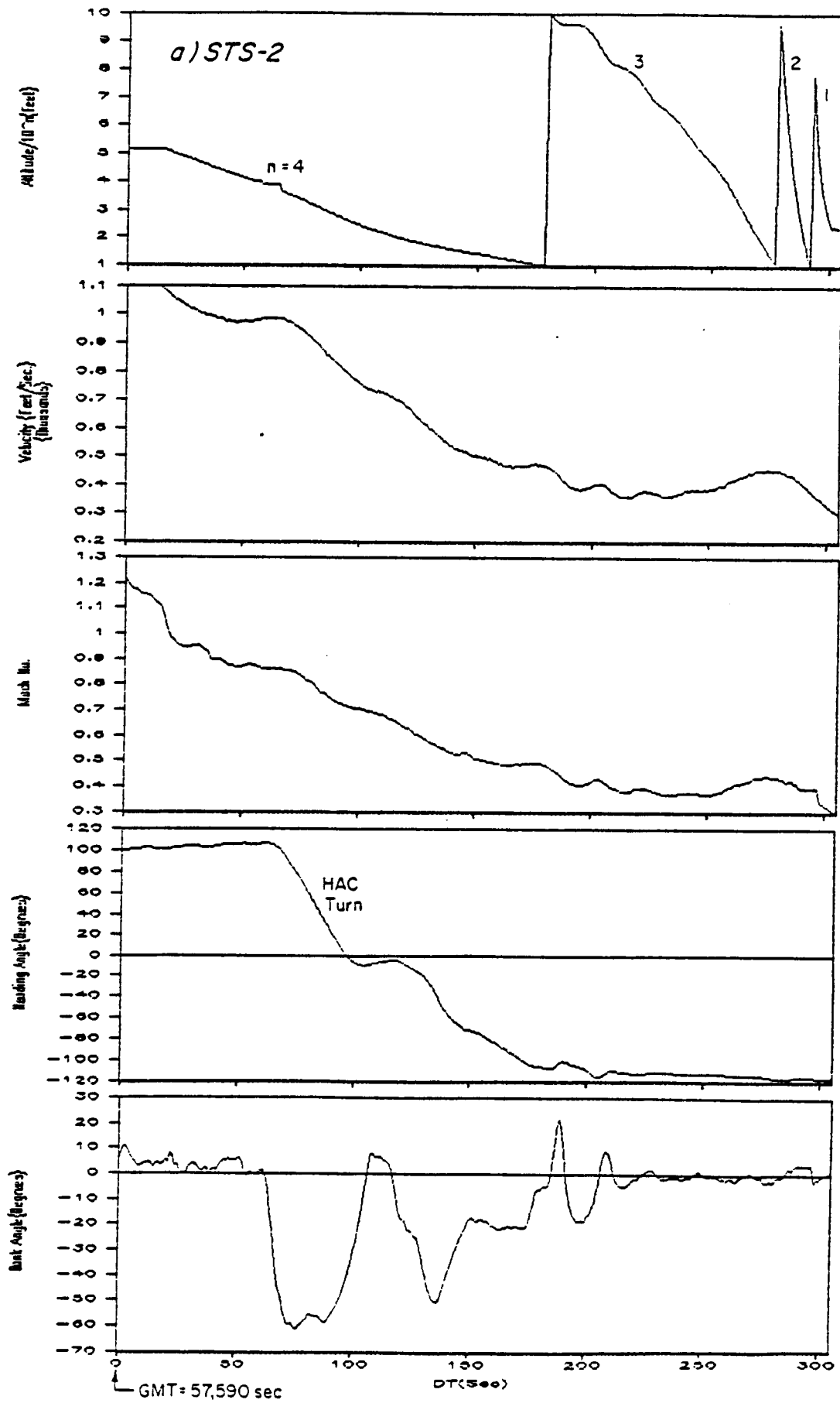


Figure 2. Primary Variable Time Histories for Selecting Working File Time Slices in the Archive Files

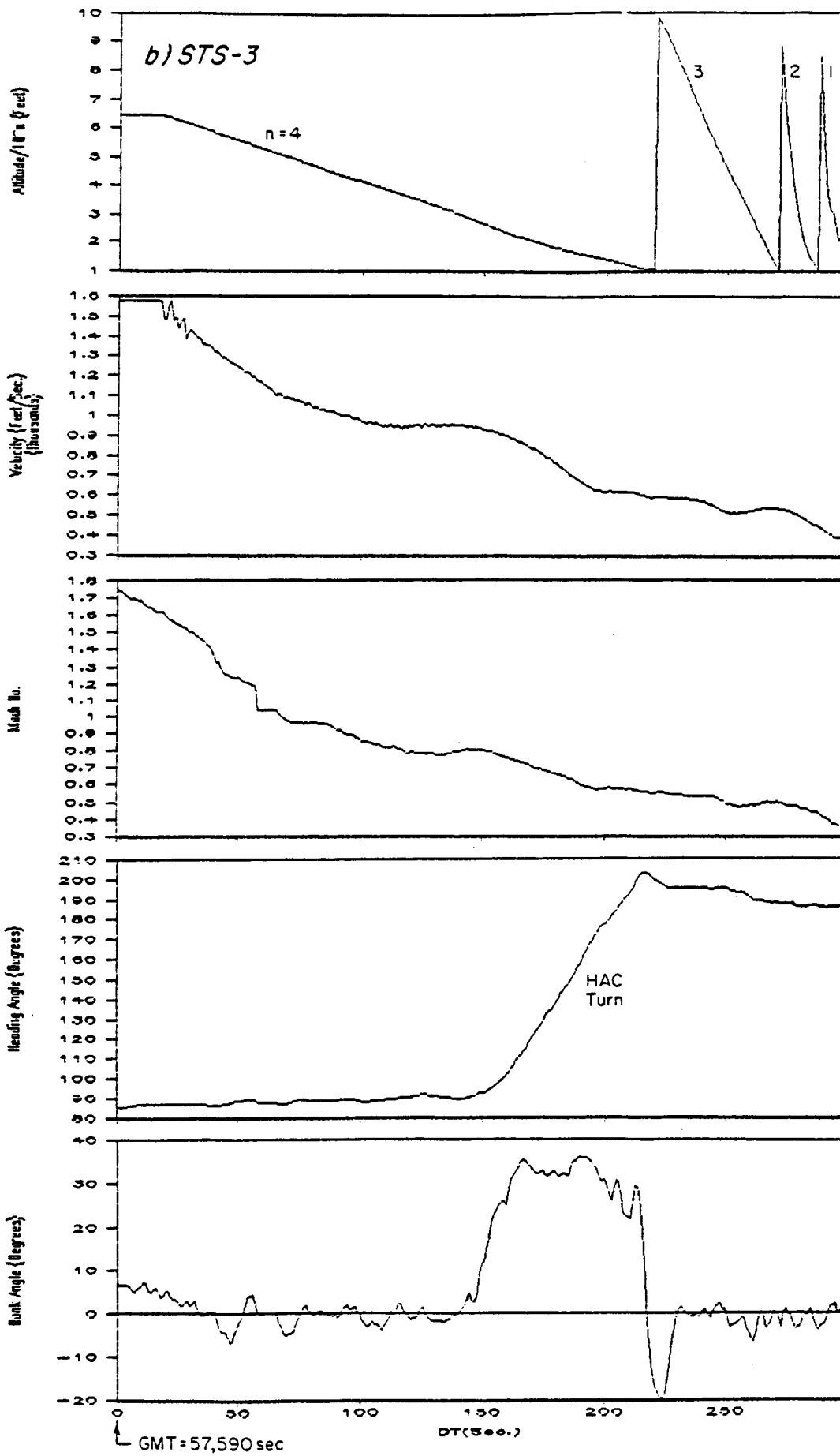


Figure 2. (Continued)

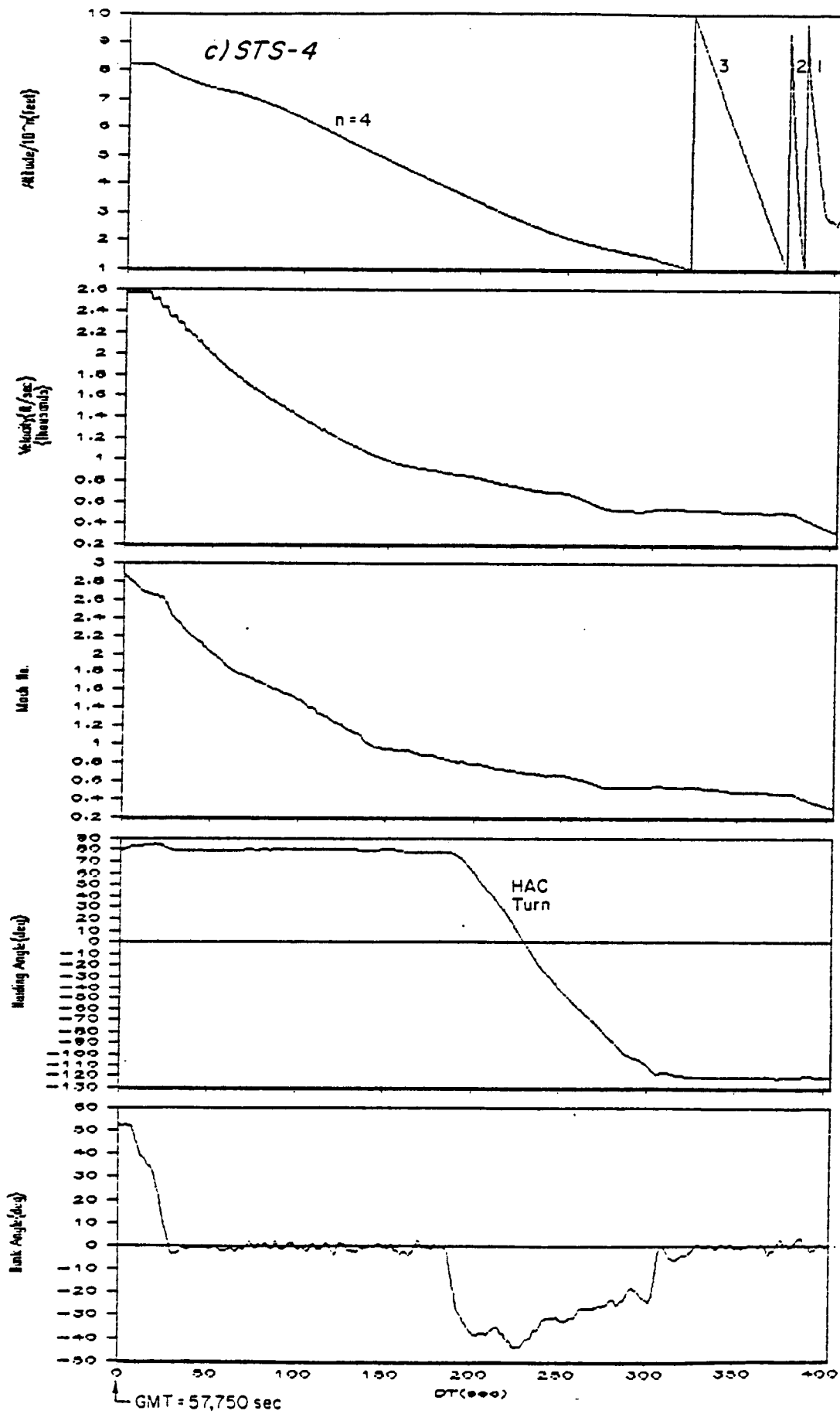


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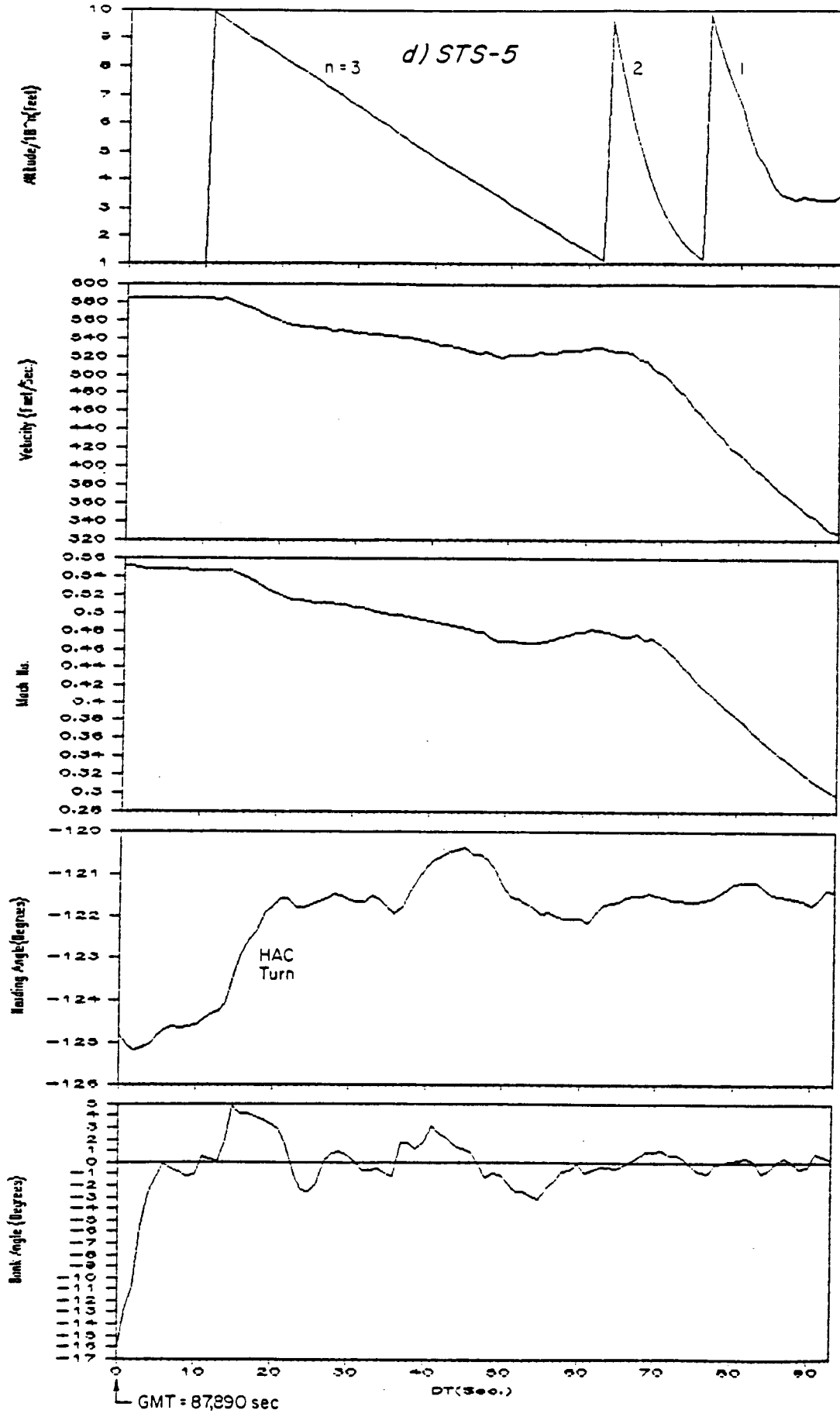


Figure 2. (Continued)

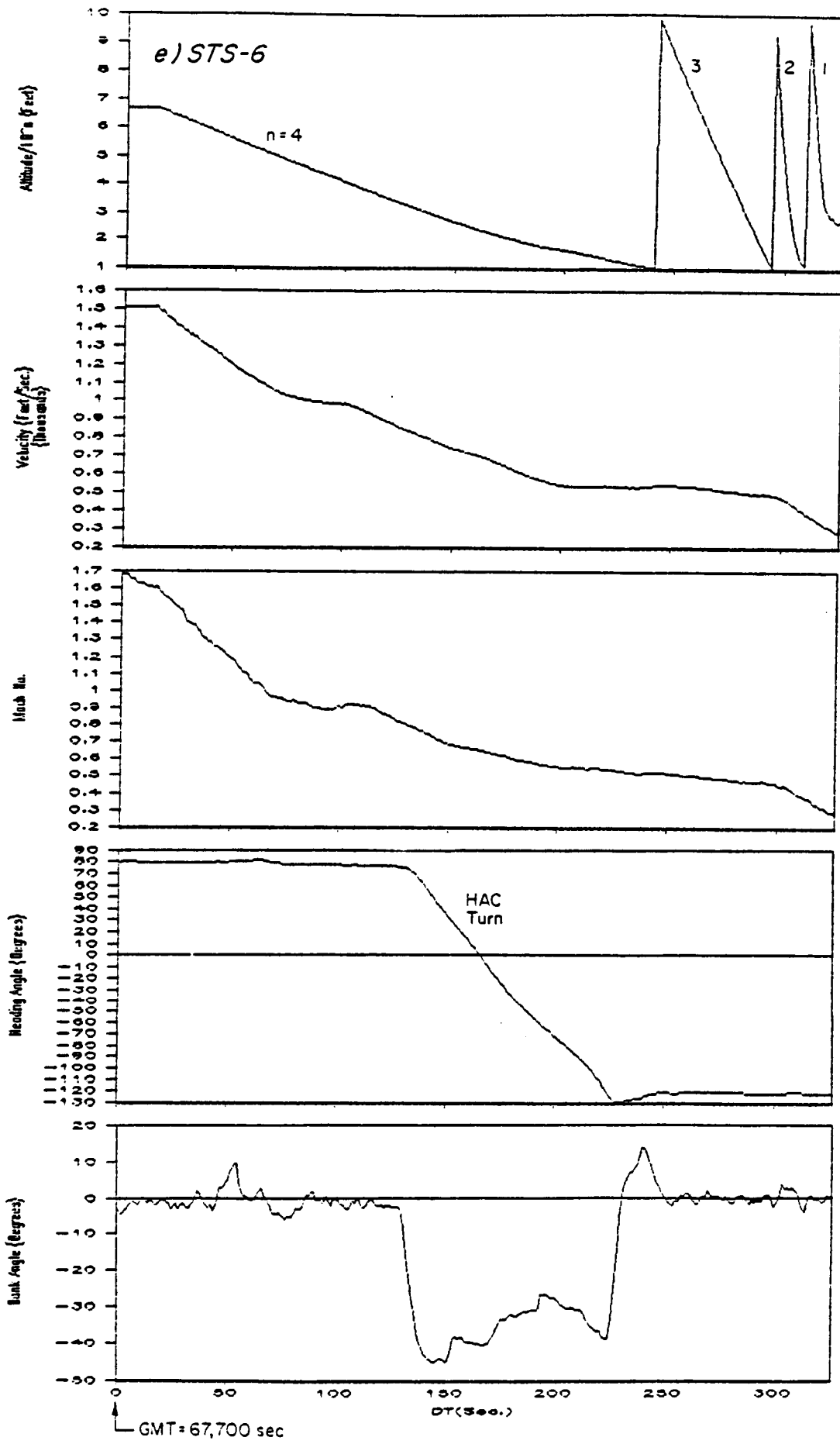


Figure 2. (Continued)

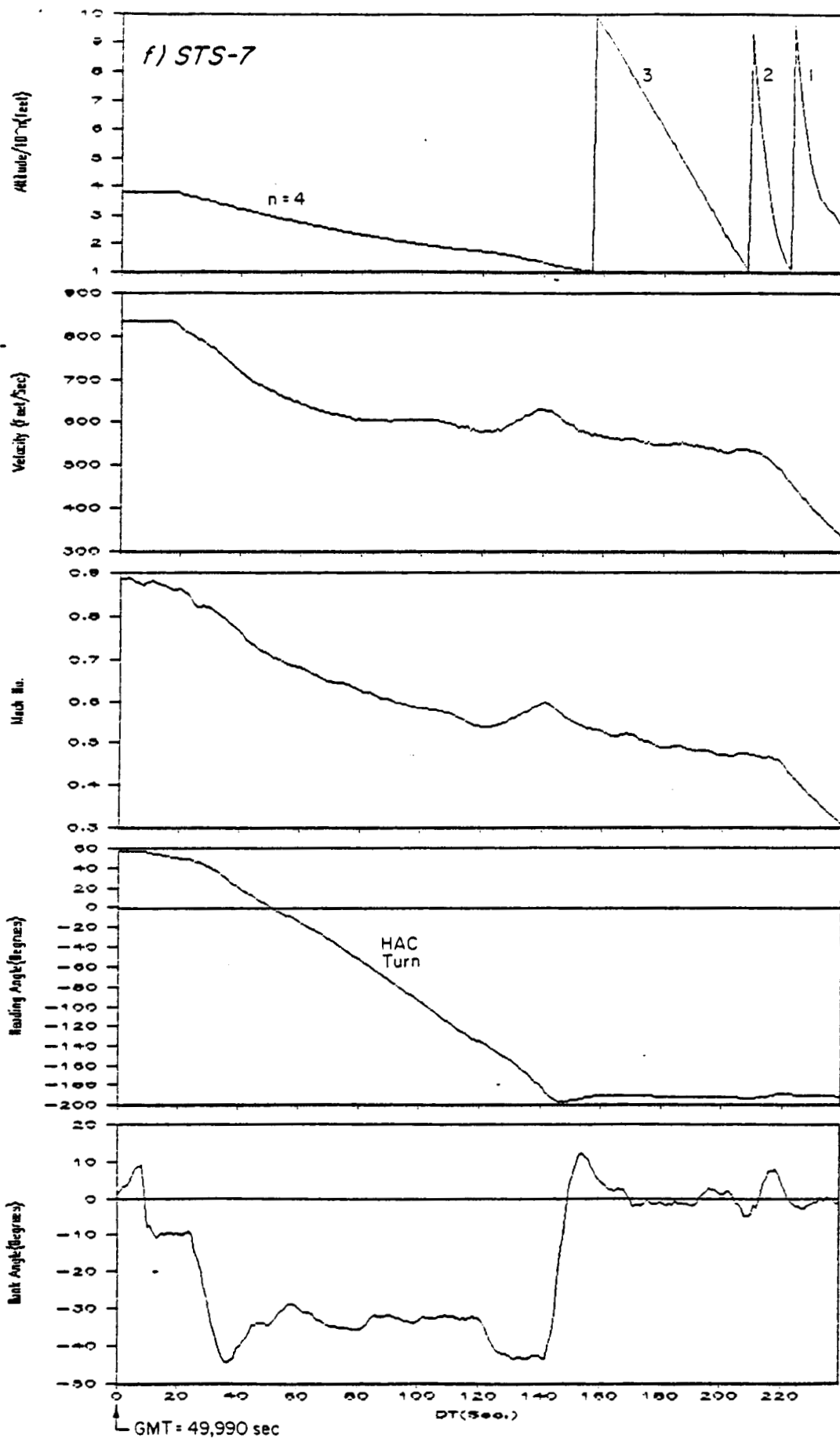


Figure 2. (Concluded)

SECTION II

THE OFQ WORKSTATION AND INTERACTIVE DATA HANDLER

A. THE OFQ WORKSTATION CONCEPT

As noted above the OFQ Workstation is a specialized software package that can be installed on any standard (IBM PC-compatible) personal computer to create a specialized "workstation" for accessing and analyzing the OFQ flight data archives. The idea is to exploit certain new developments in microcomputer software to create a better environment for using flight data in flight control/flying qualities research and to make these developments widely and economically available. Research in flight control and flying qualities has special data analysis requirements which arise from the presence of a human pilot (and the human analyst as well). While many types of analysis, such as identification of aerodynamic stability derivatives, are well suited to algorithms coded in FORTRAN and batch processing, the "fuzziness" of flying qualities research puts a premium on flexibility in data manipulation and processing which makes an interactive computer environment very desirable. It is very important that a researcher be able to extract relevant signals for the appropriate mission phase from the archive and transfer this data subset to their local computer for analysis. Once the data is available locally, interactive data handling is of particular importance to allow a researcher to quickly and easily try out a new idea -- which may just as quickly be abandoned or greatly modified. This puts a premium on the ability to setup and perform many conceptually simple but varied calculations quickly. With conventional procedures this leads to a great deal of "nuisance programming" and is a great consumer of manpower and funds. Thus anything that can improve a researcher's efficiency and productivity is much more than a convenience -- it can significantly impact the quality and quantity of research.

The basic premise of the workstation development is that there are new types of software available at low cost for personal computers with very sophisticated interactive user interfaces (often surpassing what is available on mainframes) and novel operational principles which could form

the basis for improved flight data analysis. Primary among these are relational database management systems (RDBMS) and spreadsheet programs. These products, which have high level application development features, have been used to create the specialized OFQ "applications." Many workstation features can be obtained in this approach much more easily than by writing conventional FORTRAN or BASIC programs.

The workstation also includes several specialized analysis programs for spectral analysis, fitting models to frequency response data and pilot-vehicle identification. The key to bringing all of these programs together into an efficient workstation package is a relatively new software type sometimes referred to as an "operating environment" (OE). The operating environment is an intermediary between the operating system (the DOS used for the IBM PC class computer) and the component programs. Each program is installed in the OE in a separate "window" and the user can quickly switch from one window to another and thus from one program to another. The advantage of the windowing operating environment over DOS alone is that it is not necessary to exit one program and restart another when switching windows. The OE can stop any program at any point and instantly restart another. Beyond this the OE can actually support true multi-tasking -- i.e., several programs can be operating simultaneously. The user can interact with one program in a window visible on the screen while programs in other, hidden windows continue lengthy calculations on a time-sharing basis. Windows can be resized and moved around the screen and several may be displayed at once. The windowing and multi-tasking capability are generally considered to be hallmarks of hardware workstations and this provides the justification for referring to the OFQ application programs as a "software workstation."

The ability to install a number of programs in OE windows and easily move among them and pass data among them leads to the concept of a "federated" (as opposed to "integrated") software package which is central to the creation of the OFQ workstation. The idea has been to minimize cost, time, risk and "wheel re-invention" by basing the development of the workstation on readily available, highly developed, low cost commercial software packages rather than developing the system from scratch in a programming

language like FORTRAN or C. Implicit in this approach is a willingness to sacrifice some runtime performance (at least initially), to reduce the development effort and to obtain more sophisticated user interface and other special features.

B. ORGANIZATION, ELEMENTS AND BASIC FUNCTIONS OF THE WORKSTATION

Figure 3 diagrams the basic OFQ workstation system. The workstation can be linked to the ADFRF ELXSI to access the OFQ archives through a communications program (Procomm, by Datastorm Technologies, Inc.). Alternatively the user can work with the workstation archives on floppy disks; at present all of the archive files for STS-2 through STS-7 on the ELXSI are also on the workstation archives. When the workstation archives are first read from the floppy disks they are stored on the hard disk and remain there until they are intentionally deleted.

The heart of the workstation is the Interactive Data Handler (IDH) which provides the user with efficient means of finding the data desired for a single mission and sending it to specialized applications programs. The IDH is a database and large application program created in a relational database management system (RDBMS) program (RBASE System V, by Microrim Inc., Ref. 10).

The spreadsheet program (Lotus 123, by Lotus Development Corp., Ref. 11) provides a means to try out new ideas for analysis in a very intuitive environment with minimal nuisance programming. The spreadsheet and IDH are linked such that the signals and time segment can be selected in the IDH and quickly transmitted to a standard location in a spreadsheet. While the purpose of spreadsheet analysis is to promote experimentation by users, ideas that work can be saved by creating spreadsheet "templates." The basic type is the single-mission template which contains data from only one mission plus specialized equations and macros. When a template is set up using signals from one mission, these can be quickly replaced with the corresponding signals from other missions (using the IDH) to repeat the analysis for those missions.

The second template type carries this one step further to implement a very important workstation function -- mission ensemble analysis. Here

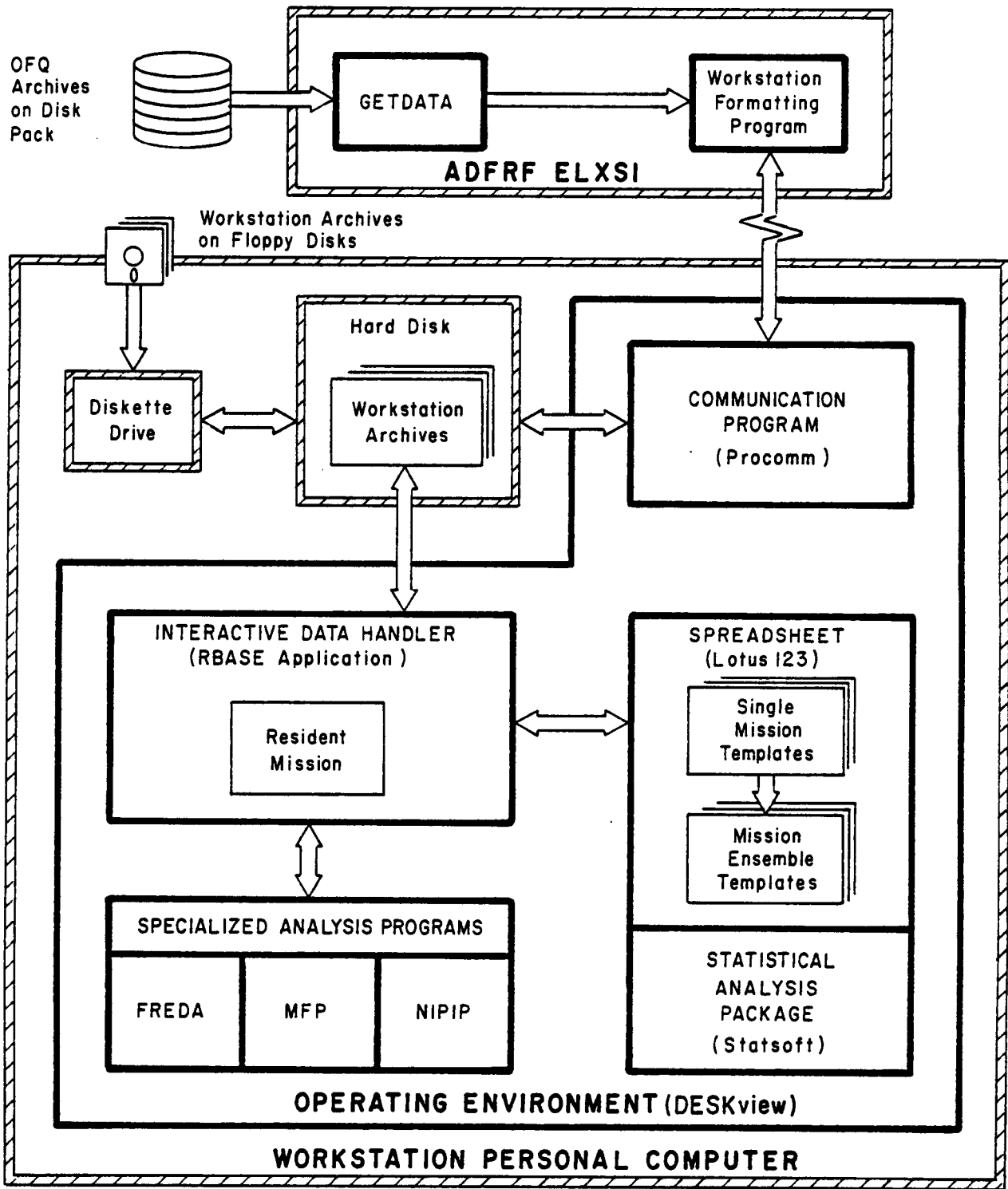


Figure 3. The OFQ Workstation

parameters computed on single mission templates are collected as mission records in a spreadsheet database. This allows graphical comparison of parameters and statistical analyses to be made over a group of missions. Basic statistical analyses (e.g., mean, standard deviation, etc.) can be performed directly in the spreadsheet and more advanced analyses can be made with the spreadsheet-oriented statistical analysis package (e.g., STATS-2 by STATSOFT, Inc., Ref. 12).

The IDH can also send signal subsets to three specialized analysis programs (all by Systems Technology Inc.) installed on the workstation. FREDA (Ref. 13) performs spectral analysis and produces power spectra and discrete frequency responses for transfer functions. MFP (Ref. 14) fits continuous transfer functions of specified form to FREDA frequency responses. NIPIP (Ref. 15) is a system identification program with special features for identifying pilot models including certain classes of nonlinear characteristics.

C. THE INTERACTIVE DATA HANDLER AS A RDBMS APPLICATION

The Interactive Data Handler provides the software link between the OFQ Archives and more specialized analysis software such as FREDA or NIPIP. Whenever the Workstation system is started the IDH window appears first and the top-level "Begin a Workstation Session" menu appears on the screen.

The IDH has been developed to make use of the OFQ flight data as convenient and efficient as possible and to make it very easy for novice users to get started. The strategy for achieving these goals with minimal risk has been to develop the IDH as an application program in the relational DBMS package (RBASE System V). To understand the IDH development it is necessary to understand something about relational database management.

Database design began with identification of just what data the OFQ Flight Data Archives were to contain. The obvious focus and the bulk of the data from the standpoint of required storage capacity are time histories of measured signals. However, there is a great deal of additional information required to use the time history data effectively. Obviously, huge files of signal data are useless unless the signals are identified and this is particularly critical for the Shuttle where there are an enormous

number of variables being measured (probably more than for any other flight test in history). Users need to know not only that a given signal is altitude but also whether it is radar altitude, from the IMU or from one of several cinetheodolite systems. There will also be questions about units, coordinate systems, reference points, time skews, and signal processing operations performed. Besides this signal-specific information there is a need for information which applies to all of the signals -- i.e., information about the mission: landing site, vehicle, crew, and landing aids in place. Beyond this some information like vehicle characteristics are the same over many missions, but there may also be elements that change from mission to mission, e.g., flight control system modifications.

The handling of bulk, discretized signal data has long been well developed in specialized FORTRAN programs such as the ADFRF GETDATA program (Ref. 7). However, keeping track of the other miscellany about signals, missions, vehicles, etc. has always been a nuisance and often "falls through the crack". This is particularly true of atypical information that often requires a written note (i.e., free format text rather than numbers), for example, a note about an accidental bias introduced in a sensor under certain conditions on one flight. One of the objectives of the OFQ Workstation effort has been to improve the means of handling this variety of information such that it is readily available to the user. Relational database management software has become a fundamental part of the workstation in part because it provides capability for developing just this sort of application program. In developing the IDH as an RDBMS application, it has been found that a formal "logical" (as distinct from physical) database design process is required and that this, not surprisingly, requires a good understanding of RDBMS principles and the practices appropriate to the RDBMS product used. Thus these issues will be discussed in the next section as a basis for understanding the IDH.

D. DATABASE CONCEPTS AND DESIGN TECHNIQUES

1. Concepts and Definitions

a. Entities

Entities are the actual real world objects and events about which data will be stored and manipulated. For any entity only specific categories of information, called attributes, will be of interest. For example an entity in the OFQ archive is the collection of shuttle missions and its attributes include landing dates and Orbiter names.

b. Files and Relations

Groups of closely related data about entities are often stored in flat files or tables. These tables can be thought of as models of an entity appropriate for a specific application. In database parlance the columns of the table are "fields" which correspond to the attributes of the entity (the term field is used in Lotus 123, but the term column is used in RBASE System V). The rows of the table, called records, represent specific instances of the entity. For the collection of data on shuttle missions, one record would correspond to the STS-4 mission. In the terminology of relational database systems, a data table is referred to as a "relation" (in RBASE System V the term is "table", while in Lotus 123 it is "database" or the "input range").

c. Files vs Databases

If all of the data for all of the entities of interest can be stored in a single table (or a collection of files with exactly the same structure), then simple database operations (sorting, selection based on criteria, etc.) can reasonably be performed in a spreadsheet program such as LOTUS 123. Operation on a OFQ time history files is, within limits, an example of this situation.

However, if we wish to store and use data about several entities with different attributes, storing all of the data in one large file is undesirable. First there will almost certainly be redundancy in the data which

leads to inefficient storage. A perhaps more critical problem is that updating a data item may require entering the same data in many records which leads to a high probability of error. Thus it is conceptually desirable to store data in a collection of files with differing fields--generally one file for each entity of interest. For example, the OFQ database might have a "missions" file and a "landing sites" file among others.

The problem with storing data in multiple independent files comes when information must be combined from several files in one retrieval operation. This is not really practical to do within the level of "database management" capability available in standard spreadsheet programs. This sort of operation is done routinely in the typical engineering application programs which have been written for many years in FORTRAN or BASIC. However, in these programs, every time a user needs a new combination of data a programmer must modify the program with new code. What relational database management systems promise over traditional programming languages is faster, more efficient implementation of a user's request for a new combination of data and advanced user interface features. There is also an important distinction to be noted between DBMS tables and the arrays used in FORTRAN and similar programming languages. All columns of an array must have the same datatype (usually numerical), whereas the datatype (real single precision, real double precision, integer, date, text, etc.), of a DBMS table may vary from column to column (but must be constant within a column). Thus in summary a relational database is a collection of files in various formats in which a user can easily access and manipulate data in several files simultaneously using the RDBMS.

d. Relationships

The design of a database involves not only identifying the entities and their attributes, but also defining the relationships among the entities. Consider first the possible relationships between two entities. There are 3 basic relationships which are illustrated below with a standard diagrammatic convention applied to two tables "A" and "B":

* One-to-one

Each record in Table A corresponds to just one record in B and vice versa. For example a signal name and a signal symbol, both of which are unique, have a one-to-one relation.

A <-----> B

* One-to-many

Each record in A corresponds to just one record in B, but each record in B can correspond to many records in A. For example each mission has only one landing site (stored in A), but each of the landing sites available to the Shuttle (stored in B) may be used for many missions.

A <<-----> B

* Many-to-many

Each record in either table can correspond to multiple records in the other table. Each mission can have many crewpersons and each crewperson can serve on many (but not all) missions.

A <<----->> B

2. Database Design

a. Logical vs Physical Design

A relational database (the collection of tables) must be properly designed so that the RDBMS machinery can be used. There are two steps to database design -- logical design and physical design. Logical design consists of identifying the entities of interest, their attributes and the relationships. For a relational database system the logical design leads to a definition of the tables and their columns. The relationships are implemented in a relational database by appropriately including certain columns in more than one table, by writing imbedded command files (programs in the RDBMS language), specifying data entry rules for tables, creating custom data entry forms, and use of other RDBMS features.

Physical design involves the issues of how the database will be represented in the hardware of a specific computer. Thus the physical design

is device-specific whereas the logical design is device-independent. The practical advantage of using a commercial RDBMS like RBASE System V is that the program effectively takes care of the physical design automatically (for the computers relevant to this effort). Thus the logical design which is directly connected to the application is the primary focus in setting up the database. There are some recognized, fairly standard procedures for logical design.

b. Entity-Relationship Diagrams

The database design technique used here includes a simplified variant of the graphical tool known as the "entity-relationship diagram." Entities are shown in boxes or ovals ("bubbles") connected by lines representing relationships. The three basic relationship types are indicated graphically with single or double headed arrows as above.

c. Design Procedure

The logical design procedure used for the OFQ workstation is outlined below:

* Identify the entities of interest

List the events, people and physical objects (including any physical data sets) about which data will be archived and retrieved. A separate table will be defined for each entity.

* Identify the attributes of each entity

List the characteristics and parameters necessary to describe each entity for the workstation application. A column will be defined for each attribute. Generally attributes are included in a table only if, for a given record, they are one-to-one with the other attributes.

* Draw the entity-relationship diagram(s) for the database.

Convert each many-to-many relationship to two one-to-one relationships by defining an intermediate table.

* Implement as a RBASE database

E. DESIGN OF THE OFQ ARCHIVE DATABASE

1. Entities and Their Attributes

The entities identified as of importance to the OFQ database are listed, along with the attributes of each, in Table C-1 and C-2 of Appendix C. Table C-1 includes events (the shuttle missions and vehicle modifications), people (astronaut crew pool) and physical objects (shuttle orbiters, runways, etc.). The physical objects also include data sets on magnetic tape, disks or any other media. For the OFQ flight data archives these are mainly time history files where the fields (corresponding to attributes) are time and a group of signals and the records consist of "time slices."

In addition to the above entities, the OFQ database also requires data about the data (sometimes referred to as "metadata"). This data has been difficult to obtain and integrate with previous shuttle data sets and is an area where improvements were sought for the OFQ workstation through the use of advanced DBMS techniques. Table C-2 lists the metadata entities and their attributes which constitute the "data dictionary." To clarify the distinctions between the data set entities and the metadata, compare the "Primary OFQ archive data set" entity in Table C-1 with the "Primary OFQ archive data sets directory" in Table C-2. The Table C-1 entity is a collection of time history files each with a set of time slices as records. Each record of the Table C-2 metadata file contains information about a specific time history file.

The entities of Tables C-1 and C-2 were laid out early in the design of the database with an eye toward exhaustiveness. Only the more basic entities have actually been implemented as tables, but this plan provides for future growth of the workstation system.

2. Relationships

The relationships among the entities are shown with simplified entity-relationship diagrams in Figs. C-1 and C-2 of Appendix C respectively. The relationships among the physical entities show some complexities in which more than two entities are linked by several relationships.

a. Physical Entities

The mission-landing site relation is one-to-many since each mission (each record in the mission table) has just one landing site associated with it, but each landing site (each record in the landing site table) can be used in many missions. The mission-runway relation is analogous. Note that the runway table would contain records for all relevant runways of all landing sites.

The many-to-many relationship of the Primary Archive Data Sets to the ADFRF MMLE files is worth noting. Certain signals in the former will be the same as ones in the latter; however, because the sample times for the two files will not necessarily be in sync interpolation will be done and thus one Primary Archive record will be related to two or more MMLE records (and vice versa).

b. Data Dictionary

The entity-relationship diagram for the Data Dictionary is shown in Fig. C-2. Among the more complex relationships here is the many-to-many relationship between the Primary Archive Directory in which each record contains information about a single archive data set and the Primary OFQ Signals file in which each record contains information about a single signal. Implementing this relation in the DBMS will be the means by which knowledge of the signals and their ordering for each data set will be stored in the database.

F. THE OFQ WORKSTATION DATABASE AS IMPLEMENTED

As noted previously only necessary portions of the overall database design have been implemented to date. An RBASE database (Ref. 10) named "OFQ" is used to implement the IDH as an RBASE application. An RBASE database has specific features and conventions and the OFQ database consists of tables, forms, and reports (Table 4). Database tables have been discussed above. Forms are specially formatted screen displays that are used to create custom data input screens for the IDH application. Reports are

TABLE 4. TABLES, FORMS AND REPORTS IN THE OFQ DATABASE

Tables in the Database OFQ

Name	Columns	Rows	Name	Columns	Rows
rules	8	7	GRPDEF	3	9
MEASRC	3	7	TimeSeg	8	3
IEWS	3	0	VIEWCOND	5	0
REPORTS	2	410	dummy1	1	48
TrnsFile	17	5	dummy3	5	2
STS-5	49	1575	Mission	11	12
TimeHist	49	801	Land5	49	876
Land6	49	1201	Land7	49	801
THbak	49	0	Land3	49	725
Land2	49	750	STS-2	49	7000
STS-3	49	6850	sts-6	49	7075
STS-7	49	5301	FORMS	2	1325
STS-4	49	9425	SigDef1	18	48
DATASETS	3	5	timhis4	10	801
dummy2	2	10			
SigDef	18	48			
SbTimHis	11	601			

Forms in Database OFQ

Form	Table served by form
-----	-----
exfreda	TrnsFile
extrform	TrnsFile
FFreda	dummy3
FslctSeg	TimeSeg
GMTlnth	TimeSeg
mform1	SIGDEF
mform2	Mission
missform	Mission
NipipFRM	dummy2
Nslctseg	TimeSeg
SlctSeg	TimeSeg
spreview	dummy2
SPRSHEET	dummy2
sprshezp	dummy2
sprshTTM	dummy2
TrnsForm	TrnsFile

Reports in Database OFQ

Report	Table served by report
-----	-----
FredaOLD	SbTimHis
FredaRH	dummy3
FREDArpt	SbTimHis
ndl	dummy2
NIPIP10	sbtimhis
NIPIP2	sbtimhis
NIPIP3	sbtimhis
NIPIP4	sbtimhis
NIPIP5	sbtimhis
NIPIP6	sbtimhis
NIPIP7	sbtimhis
NIPIP8	sbtimhis
NIPIP9	sbtimhis
NipipRH	dummy2
nipold	SbTimHis
SpreadRH	Mission

customized output files used by the IDH to pass data to other programs (except the spreadsheet).

Further detail on two of the most important tables are presented in Table 5 and 6. The Signal Definition (Sigdef) table (Table 5) contains 18 columns of information about each of the 47 signals included in the OFQ data. Each record of the Mission table contains information about just one mission. This is contained in the 11 columns explained in Table 6.

TABLE 5. COLUMNS OF THE SIGNAL DEFINITION TABLE

- 1) Archive signal number: ["signal#", integer] unique integer between 1 and 47 identifying each signal in the OFQ archives
- 2) Signal symbol: ["sglsymb1", text, up to 8 characters] unique symbolic name assigned to each signal in OFQ archives, used as column codes in time history tables
- 3) Signal short name: ["ssignal", text, up to 18 characters] unique descriptive name assigned to each signal in OFQ archives abbreviated to fit forms
- 4) Signal full name: ["signal", text, up to 80 characters] unique descriptive name assigned by STI to each signal in OFQ archives
- 5) Signal description: ["sgldscrp", text, < 1500 character] description of signal suitable for use in help files
- 6) Remarks: ["sglrmrk", note] extended text relating to a signal
- 7) Signal group number: ["group#", integer, group number must appear in Signal Group Definition table before entry is allowed in Signal Definition table] an integer between 1 and 9 that indicates the signal group, this is the common column with the SIGNAL GROUP DEFINITION table
- 8) Units: ["units", text, up to 30 characters] physical units for the signal
- 9) Positive sense: ["possence", text, up to 60 characters] convention for positive values of the signal -- e.g., "nose up, right wing down", etc.
- 10) Origin: ["origin", text, up to 60 characters] condition at which the signal is zero -- e.g., altitude = 0 at ground level (AGL)
- 11) Coordinate system: ["coordsys", text, up to 60 characters] coordinate system if relevant -- e.g., body axes
- 12) Coordinate axis: ["axis", text, up to 60 characters] Relevant axis of coordinate system -- e.g., x axis for roll rate
- 13) Sample rate: ["smprate", positive integer] effective sample rate in OFQ archives, not necessarily original sample rate, thus less than or equal to 25 hz

TABLE 5. (CONCLUDED)

- 14) Tributary data set symbol: ["dtstsymp", text, up to 8 characters, data set symbol must appear in Tributary Data Set table before entry is allowed in Signal Definition Table] symbol for data set from which archive signal was obtained -- i.e., MMLE, CINE, TOLT, MPDB; this column also appears in Tributary Data Sets table to link to data set details
- 15) Filtering: ["filter", text, up to 1500 characters] description of any filtering applied in generating the OFQ files from the tributary data set
- 16) Measurement source symbol: ["meassymb", text, up to 8 characters, measurement source symbol must appear in Measurement Source table before entry is allowed in Signal Definition table] symbol for physical system, sensor or instrument from which the signal was obtained -- e.g., ACIP, GPC, Cinetheodolite, etc; this column also appears in Measurement Sources table to link to measurement details
- 17) Residence number: ["res#", integer] unique positive integer between 0 and 47 indirectly assigned by user to each resident signal.
- 18) Signal selection number: ["select#", integer] unique positive integer between 0 and 47 indirectly assigned by user to select signals to be sent to programs.

TABLE 6. COLUMNS IN MISSION TABLE

- 1) Mission flag: ["MISSFLAG," Text, 1 Character] identifies resident mission.
- 2) Mission existence: [MISEXIST, integer] identifies mission on hard disk.
- 3) Mission Name: [MISSNAME, text, up to 8 characters] unique symbolic code for each mission.
- 4) Start time: [RESSTART, read] Greenwich Mean Time in seconds at start.
- 5) End time: [RESEND, read] Greenwich Mean Time in seconds at end of mission data set.
- 6) Enter date: [ENTRDATE, date] date of landing.
- 7) Landing site: [LANDSITE, text, up to 16 characters] landing site.
- 8) Runway: [RUNWAY, text, up to 16 characters] runway used at landing site.
- 9) Orbiter: [ORBITER, text, up to 16 characters] name of Orbiter vehicle.
- 10) Commander: [COMMANDR, text, up to 16 characters] commander's name.
- 11) Pilot: [PILOT, text, up to 16 characters] pilot's name.

SECTION III

OFQ WORKSTATION ANALYSIS PROGRAMS

A. THE SPREADSHEET PROGRAM

1. Analyzing Data in a Spreadsheet

The spreadsheet program provides a very convenient, flexible and efficient way of performing unusual or novel analyses on small data sets while avoiding conventional programming. The primary reason for including the spreadsheet in the workstation repertoire is to promote creative exploration of flight data particularly in the difficult-to-quantify aspects of manual control and pilot strategy. Effective use of the spreadsheet program requires a basic knowledge of spreadsheet operations which in turn ultimately means studying the manual (Ref. 11). A brief overview of spreadsheet concepts is given here as an introduction. More procedural details are provided in the How To Do It section.

A spreadsheet is effectively a large matrix in which each cell can contain a number, text or formulas referring to other cells. The rows are numbered and the columns are assigned letter codes alphabetically so that cells can be uniquely identified (e.g., cell H24). When the entries in any cells are changed, the spreadsheet can be recalculated so that formulas involving those cells are automatically updated anywhere in the spreadsheet. Operations are performed through a menu system in the spreadsheet program.

The IDH can be used to transfer up to 10 signals selected by the user into a spreadsheet. Greenwich Mean Time (GMT) in seconds always appears in the first column (column A). Up to 10 more signals appear in columns B through K. Thus the first 11 columns (A through K) are reserved for the "raw" signals from the IDH. Each signal column has a label (the signal symbol) in row 11 and above these there is information about the mission which applies to all signals, i.e., mission code, landing site, etc. To avoid conflicts with existing or future raw signal columns, users should make all spreadsheet modifications to the right of column K.

Making effective use of spreadsheet and setting up original analysis procedures requires a good working knowledge of spreadsheet techniques and possibilities in addition to basic knowledge of the command menus. To help familiarize new users with the potential of spreadsheets for flight data analysis, several example spreadsheets for specific applications are included with the workstation software. These examples with their "How To Do It" instructions can be used as a tutorial in spreadsheet application.

2. Performing Specialized Procedures with a Spreadsheet Template

Beyond this tutorial function, the example spreadsheets included can be used as "templates." OFQ templates are simply spreadsheets with special formulas and organization to the right of column K which can be used repeatedly for specialized analyses. A set of analyses can be worked out for one set of signals from one mission and then quickly repeated for other missions by bringing in the corresponding signal sets for other missions using the IDH.

Two example templates are included with the OFQ software. The "TEMPLT3.WK1" template can be used to display time histories on the screen for any of up to 10 signals in the spreadsheet. The "TEMPLT1.WK1" template is used to perform specialized analyses of manual control in landing such as estimation of the pilot's flare time constant. As an illustration of the level of sophistication of signal processing which can be performed in a spreadsheet, Fig. 4 shows how a first order digital filter is implemented in TEMPLT1 (use of this filter is explained on page H79 of the "How To Do It" Manual). In Fig. 4, column U contains the filtered values of the raw vertical speed VZ in column P. Implementation of the recursive difference equation for the filter makes use of the fact that spreadsheet formulas can refer to other cells using both relative and absolute location specifications (note absolute cell locations names contain dollar signs).

3. Macros for Automating Spreadsheet Operations

Spreadsheet operations are ordinarily performed manually using the extensive menu system. However, there is a procedure for storing a lengthy sequence of command codes in a empty range on the spreadsheet and then

$$y_i = \left(\frac{2 - aT}{2 + aT} \right) y_{i-1} + \left(\frac{aT}{2 + aT} \right) (x_i + x_{i-1})$$

$$= A y_{i-1} + B(x_i + x_{i-1})$$

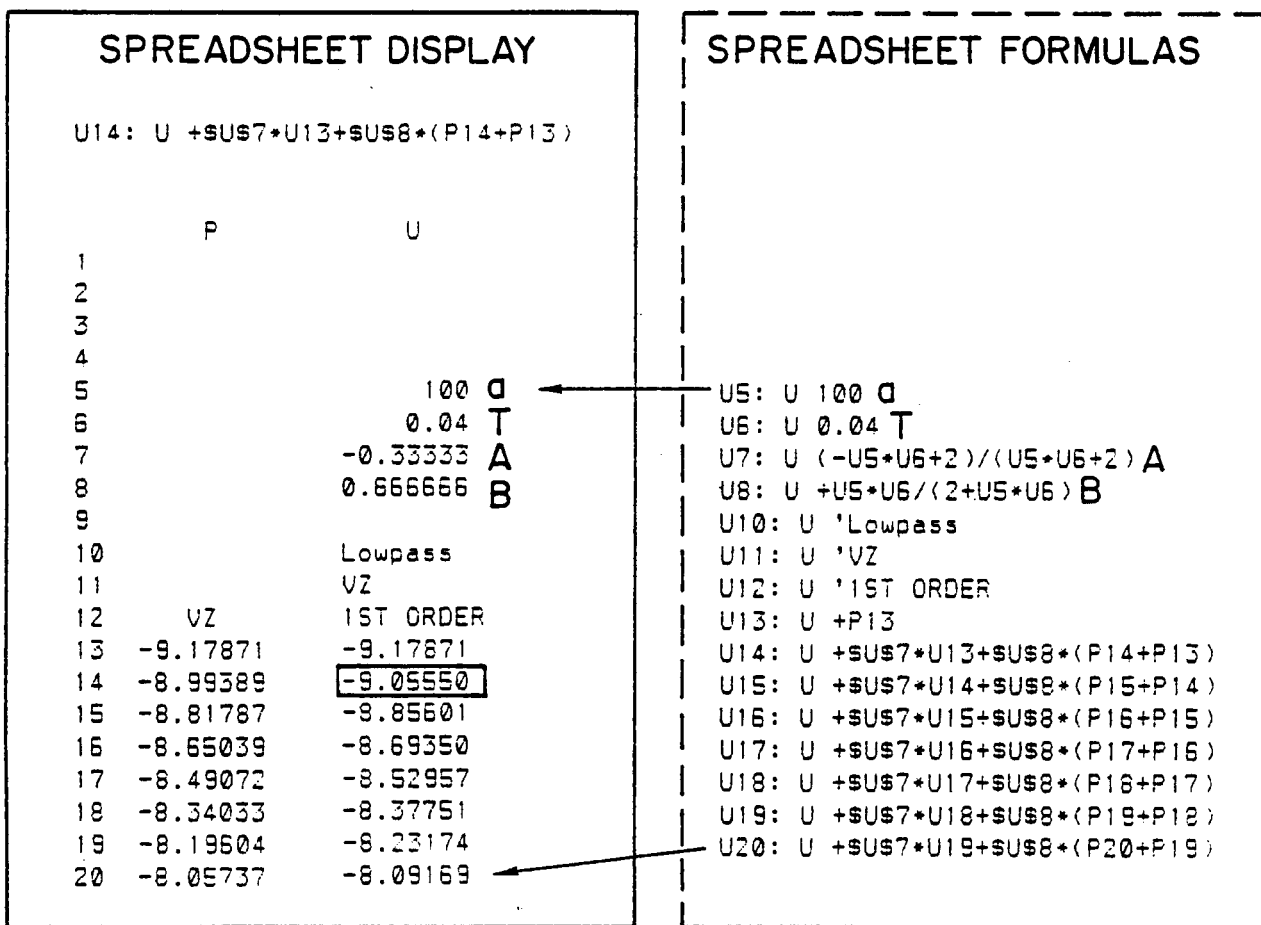


Figure 4. First Order Filter On a Spreadsheet

initiating the sequence with just two keystrokes. While templates can be set up without them, macros are a very powerful tool for this application and are central features of TEMPLT1 and TEMPLT3. Special commands are available for macros only which can be used to implement looping, branching and other control functions which provide programming capability comparable to traditional programming languages.

Macros must be stored in a "named range" on the spreadsheet, i.e., a rectangle of contiguous cells to which a name has been attached using the /Range Name Create command sequence. Macro range names must consist of "\" followed by a single letter. As an illustration of how macros are constructed, a TEMPLT3 macro, \B, which creates signal time history plots is shown in Fig. 5.

```

AN55: U +"TIME HISTORY OF "&$AX$33
      AM      AN      AO      AP
55 Macro \B TIME HISTORY OF AQ
56
57 {CALC)/gocfglq
58 tf\AN55~
59 ts\AM73~
60 txIncremental Time, seconds~
61 ty\$AX$33~qv
62

```

Figure 5. Example Spreadsheet Macro

The spreadsheet cell pointer is in cell AN55 in this screen "snapshot" and thus the contents of that cell are displayed on the top line of the screen display where the "U" after the cell identifier means that the cell is unprotected (can be edited or erased). The remainder of the line is a display of the formula which is contained in the cell. This expression is identified as a formula (rather than a number or a specific label) because the first character is the "+" operator. This is a "string" formula which produces the label (as opposed to a number) which can be seen on the spreadsheet in cell AN55. This formula concatenates (the "&" is the concatenation operator) the text string contained between the double quote marks with a

label in cell AX33. Four column labels (AM through AP) are shown and the row numbers (55 through 62) appear on the left. Below and to the right of these, the actual spreadsheet cells containing macro \B are seen as displayed.

The \B macro is contained in the column of 5 cells -- AM57 through AM61 -- and each cell contains a label string. When the macro is initiated, the command codes are executed in sequence (left to right) starting with those in the first cell (AM57) and continuing on down until a blank cell is encountered (cell AM62). The first command in the macro, {CALC}, recalculates the spreadsheet to insure that all formulas are up to date before the plot is made. In macros the { } denote commands initiated by the keyboard function keys or otherwise not available in the command menu system. The next command is "/" which is the key which would be pressed to bring up the menu system for manual operation. The rest of the line is the sequence of first letters of commands from the menu (all spreadsheet menu options can be initiated manually by typing only the first letter of the option name). Thus "/gocfglq" translates to the more comprehensible "/GraphOptionsColorFormatGraphLinesQuit", however even the expanded form requires understanding the basic menu commands. This can be obtained by reference to the manual (Ref. 11), however, a practical procedure for deciphering macros is to display the macro range on the screen and perform the command sequences manually while reading the prompt lines on the menu display. An even better way to do this is to run the macro in the "STEP" mode (Ref. 11) which allows the user to step through the macro execution manually.

In cell AN58 the sequence "tf" translates to "TitleFirst" and the "\" character indicates that the string created by the formula in cell AN55 will be used as the major title of the plot. the tilde "~" character in the macro is equivalent to a manual [ENTER/RETURN]. The next cell specifies the second title line of the plot and the last two cells specify the titles on the x and y axes respectively. The x axis title comes not from another cell, but from the string "Incremental Time, seconds", entered directly in the macro just as it would be entered directly in manual operation. It should be noted that, since axis scaling has not been specified in the macro, the default automatic scaling will be used.

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4. Mission Ensemble Analysis

The IDH is designed to access and manipulate data for one mission at a time and many analyses (e.g., determination of touchdown sink rate or the pilot's effective flare time constant) involves data for only a single mission for each calculation. However, an important aspect of flight data analysis is comparison of single-mission parameters for a group of missions. At present such ensemble analysis is provided for through a series of related spreadsheet templates. Provision has been made in the IDH menu system for using the RDBMS as the "engine" for ensemble analysis. This latter approach has a potential for valuable extension of the present capabilities, but would require further developments. In particular, while the RBASE RDBMS has extensive functions for sending data to and receiving data from other programs, the applications programs would have to be modified somewhat to transmit data to RBASE. It appears that for future development of federated software such as this, the role of the RDBMS should evolve into a more generalized "software data bus" to manage data communication among the various sovereign programs.

The present spreadsheet-based implementation of the ensemble analysis begins when one or more parameters are calculated by setting up a template for one mission. The parameter calculations can be made anywhere on the spreadsheet, but they must be summarized in a single continuous row somewhere on the spreadsheet. This row is referred to as the "mission ensemble record" and must be given the range name "ENSMBLRC". The cell immediately above each parameter value should contain a one-cell symbol for the parameter. The three cells above the symbol can contain further descriptive text about the parameter (Fig. 6).

	AM	AN	AQ	AP	AQ	AR	AS	AT
1								
2	ENSEMBLE RECORD		Mission 4					
3								
4	1	2	3	4	5	6	7	8
5	GMT @ 0	Increment	Touchdown	Touchdown	Touchdown	Flare	Altitude	Total
6	Increment	Time	Altitude	Vertical	Total Spe	Altitude	Signal	Velocity
7	Time (sec	(secs)	(ft)	Speed (fp	(fps)	(ft)	Used	Used
8	Start:GMT	IncrmtTD	HTD	VZTD	VTTD	Hf	Hused	Vused
9	ES160	19.7	26.59423	-0.41513	342.3125	34 Z		VT
10	-----							

Figure 6. The Mission Ensemble Range (Partial)

After the first single mission template is setup, copies are processed with data from the other missions of interest (see page H91). Each mission template is saved under the name "ERx" where the x corresponds to the mission code number.

Mission ensemble analysis is actually performed in a spreadsheet (temporarily) named "ENSEMBLE" where the ensemble record from each of the ERx files is stored (see page H91) as a row in an ensemble table (a Lotus 123 "database") with range name "ENSMBLDB" (Fig. 5). Here there is one record (row of parameter values for each mission), but the columns are setup by the user. The ENSMBLDB range actually includes one row of cells above the top record (which will be the parameter symbols read from spreadsheet ER2) so this range can be used as a formal spreadsheet database. The first column is reserved for the Mission code and is not taken from the ENSMBLRC ensemble record ranges in the ERx files. The ensemble table may be loaded automatically with ensemble records from individual mission spreadsheets by using a loading MACRO in the ENSEMBLE spreadsheet. Figure 7 diagrams the mission ensemble operations.

Basic statistical analysis functions are provided by the ENSEMBLE spreadsheet. These include the minimum, maximum, mean and the standard deviation for each column. Provisions are also available for generating bar charts of any parameter vs mission.

B. FREDA

FREDA is a compact program for analysis of time-series by Fourier and cross-spectral techniques (Fig. 8). It was developed for analysis of sampled data from human tracking and vibration experiments, and incorporates many features gleaned from years of experience.

The program accepts sampled arrays of an "input" and one or more "outputs." The mean and trend can be removed and several data window "tapering" options are available. This program uses an advanced FFT routine that can handle any even number of samples (i.e., not restricted to a binary number as many are). This permits the user to select a run length that contains an integer number of one (or all) of the sinusoidal components, an important requirement for the correct analysis of such signals. Special features

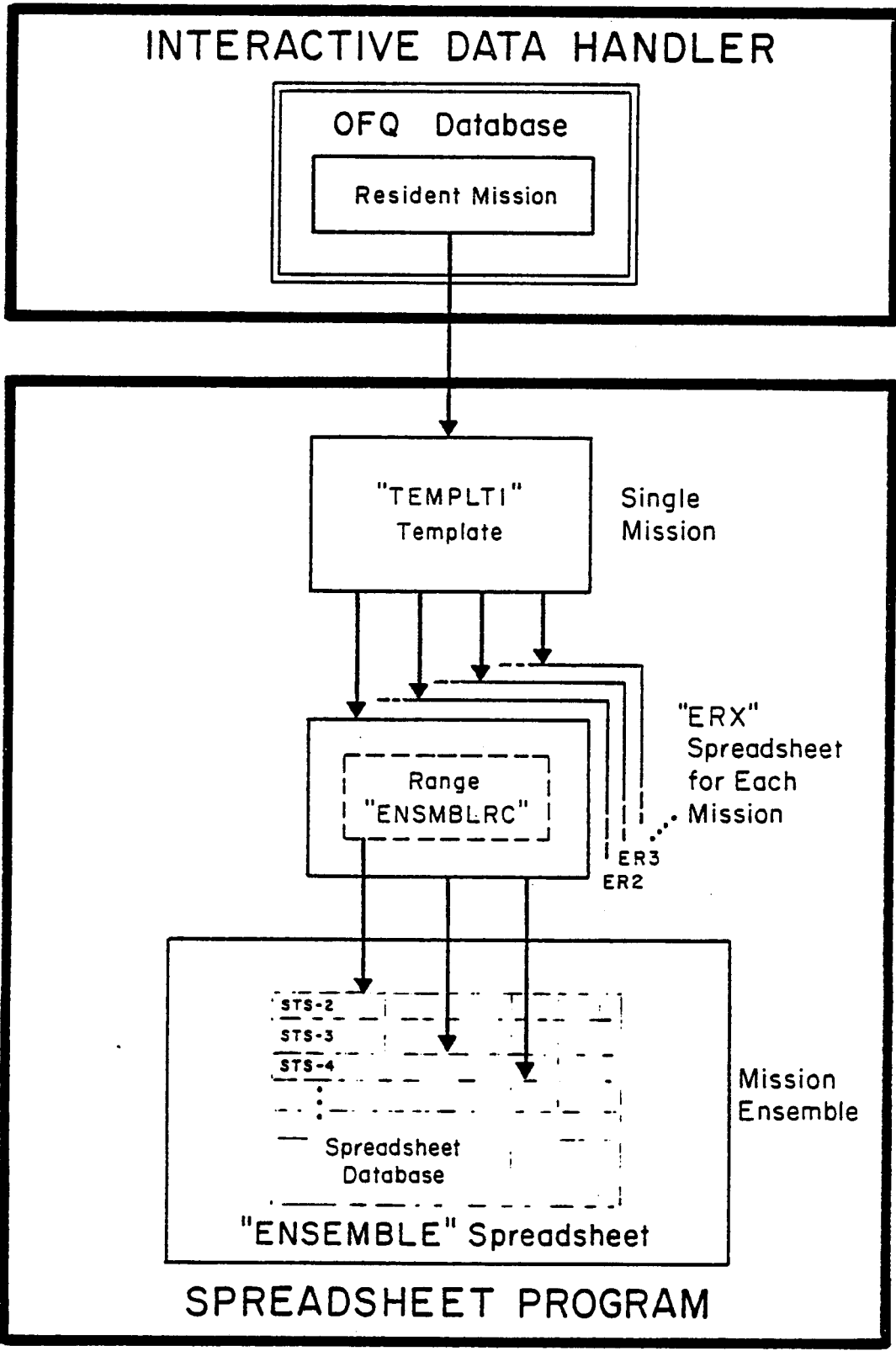
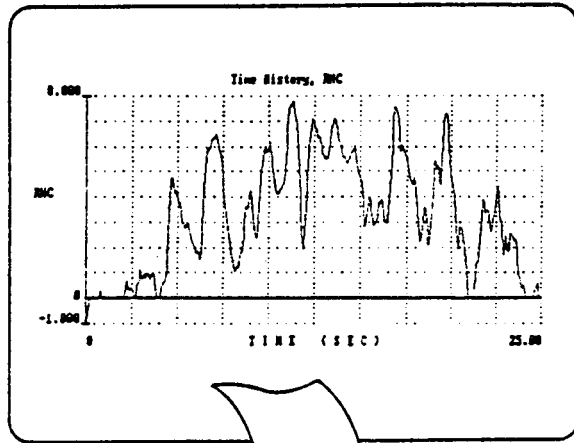
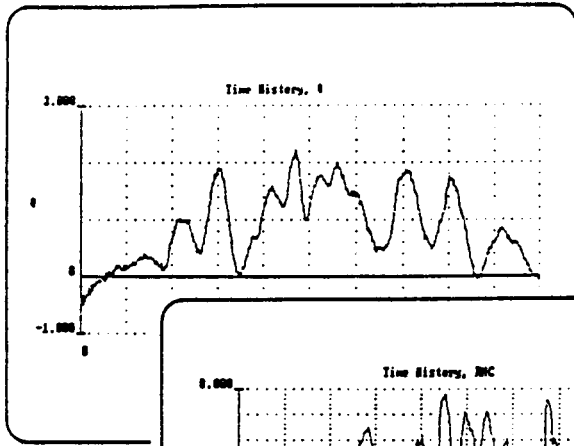


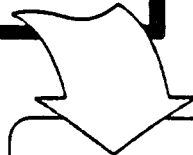
Figure 7. Mission Ensemble Generation



TIME DOMAIN



FREDa



FREQUENCY DOMAIN

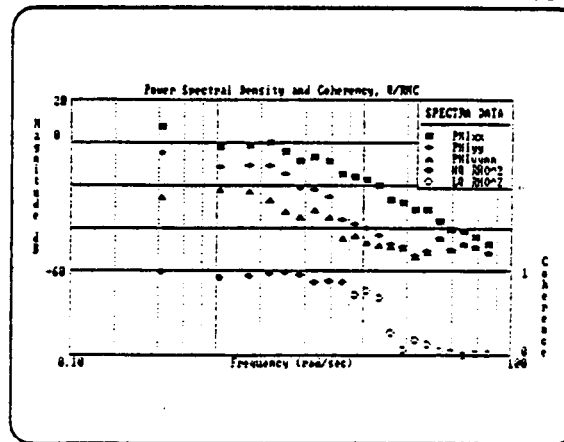
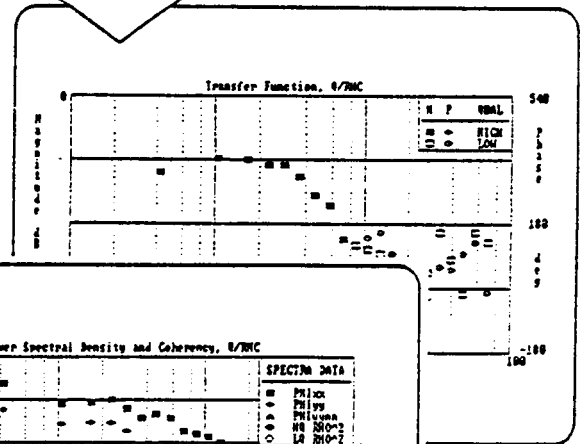


Figure 8. Fast Fourier Transform Operations in FREDa

are incorporated for dealing with signals which may be composed of: a sum-of-sinusoids, shaped white noise, or a combination of both.

The output of the program (Figs. 9 and 10) (at each analysis frequency) is the Power Spectral Density (PSD) of each signal, the transfer function (output/input), the coherence (p^2) between them, and the "remnant." (FREDA has features for averaging groups of adjacent raw frequency points to smooth the frequency response and obtain improved signal-to-noise characteristics.

Time history, transfer function and power spectral density plots can be displayed on the screen and saved as hard copy using standard graphics printers. The user's guide for FREDA is Ref. 13.

C. MFP

The Multi-inter Frequency Response Parameter Identification program (MFP) fits discrete frequency response data with a model whose precise form is defined by the user. The fit is achieved by adjusting parameters of the model to minimize the weighted "matching error" between the model and the discrete frequency response data. Basic elements of this process are illustrated in Fig. 11.

The model consists of 1 to 3 transfer functions defined by a set of simultaneous constant-coefficient linear equations. In a typical application, these are the equations-of-motion of an airframe-plus-control-system. The simultaneous equations which define the model are linear in a set of dependent and independent variables. The coefficients of the variables in these equations are second-order (maximum) constant-coefficient polynomials in s ; gains and pure time delays may also be included as multipliers of these polynomials. The equations are expressed in matrix form for input to the program.

Up to 3 of the transfer functions defined by these equations may be fit collectively to as many as 5 discrete frequency response data points each. Alternatively, a single transfer function may be fit to as many as 15 discrete data points. As many as 10 model parameters from a total of up to 6 different matrix cells may be varied at one time.

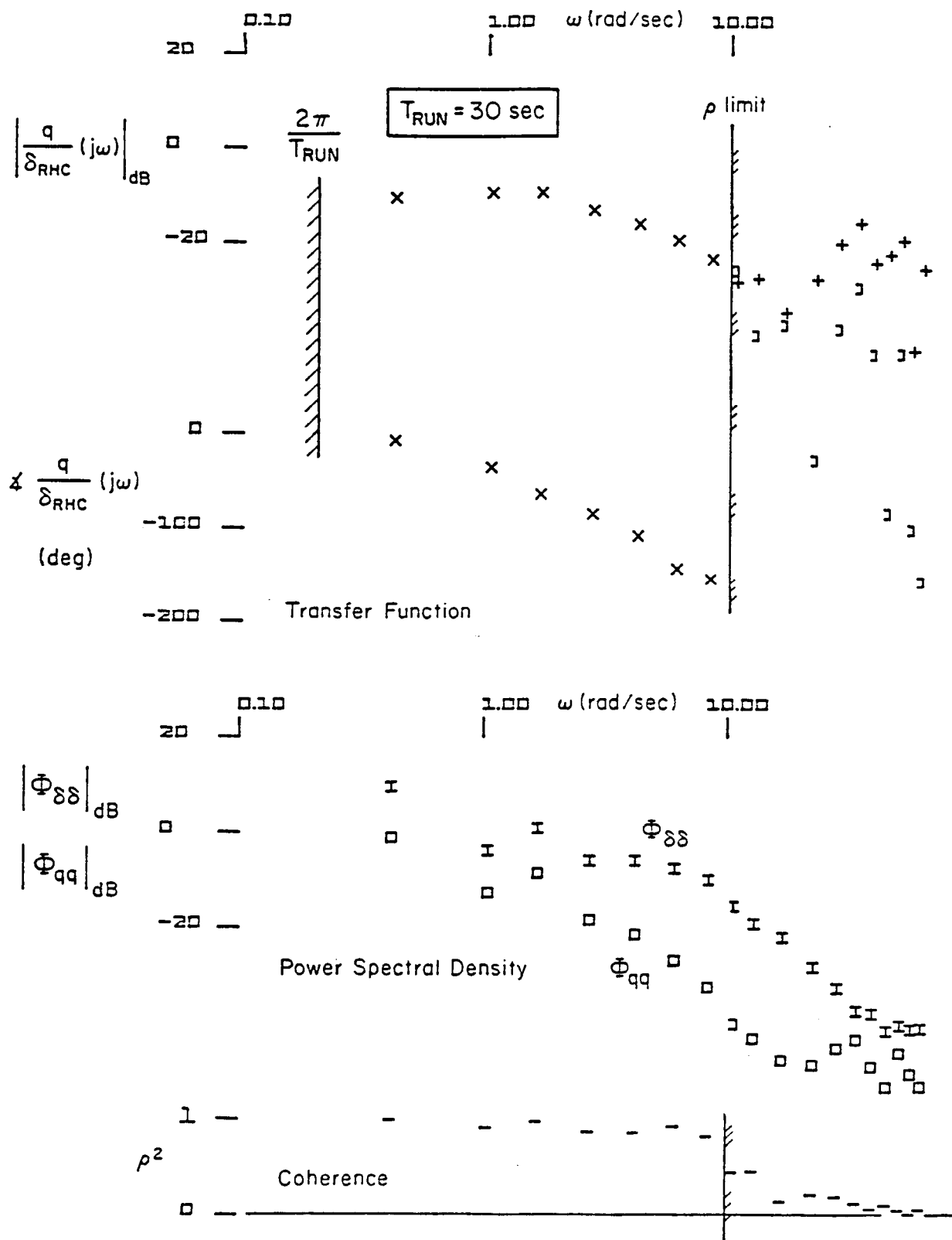
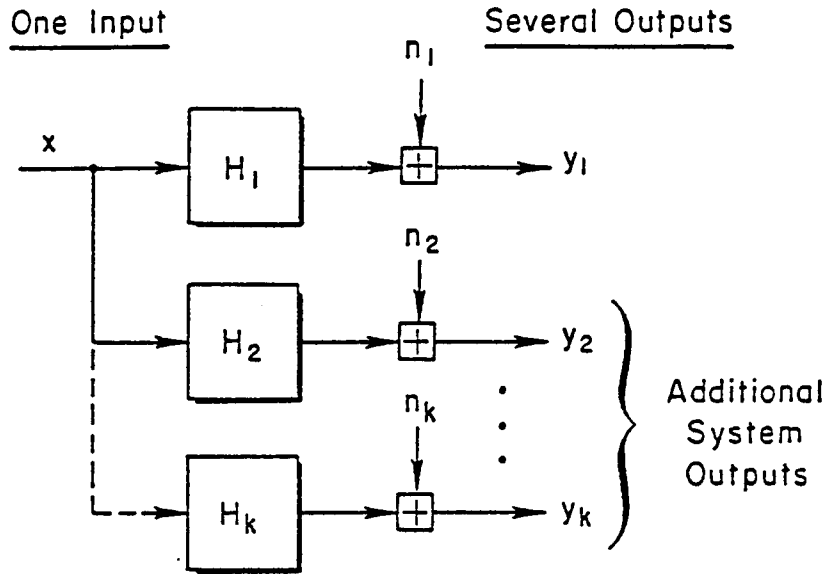
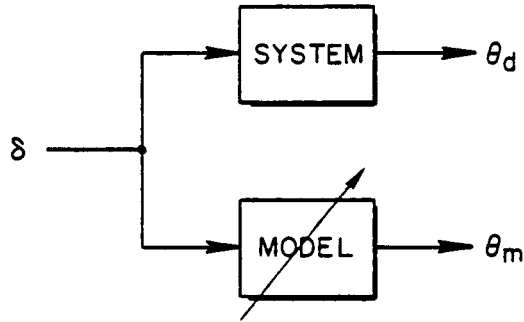


Figure 9. Typical Output from FREDA Shuttle Pitch Rate to Rotational Hand Controller (q/δ_{RHC}) STS-4 Preflare Through Touchdown (Ref. 6)



	FORMULA	DIMENSIONS
Transfer Function:	$H(j\omega) = \frac{\Phi_{xy}(j\omega)}{\Phi_{xx}(\omega)}$	$\frac{(\text{units of } y)}{(\text{units of } x)}$
Input PSD:	$\Phi_{xx}(\omega)$	$\frac{(\text{units of } x)^2}{\text{rad/sec}}$
Output PSD:	$\Phi_{yy}(\omega) = \Phi_{yy_x}(\omega) + \Phi_{yy_n}(\omega)$	$\frac{(\text{units of } y)^2}{\text{rad/sec}}$
Coherence:	$\rho_{xy}^2(\omega) = \frac{ \Phi_{xy}(j\omega) ^2}{\Phi_{xx}(\omega)\Phi_{yy}(\omega)}$	(dimensionless)
Remnant:	$\Phi_{yy_n}(\omega) = [1 - \rho_{xy}^2(\omega)]\Phi_{yy}(\omega)$	$\frac{(\text{units of } y)^2}{\text{rad/sec}}$
Overall Coherence:	$\rho_A^2 = \rho_{xy}^2(\omega)\Phi_{yy}(\omega)/\sigma_y^2$	(dimensionless)

Figure 10. Basic FREDA Output



Response at one frequency (ω_n):

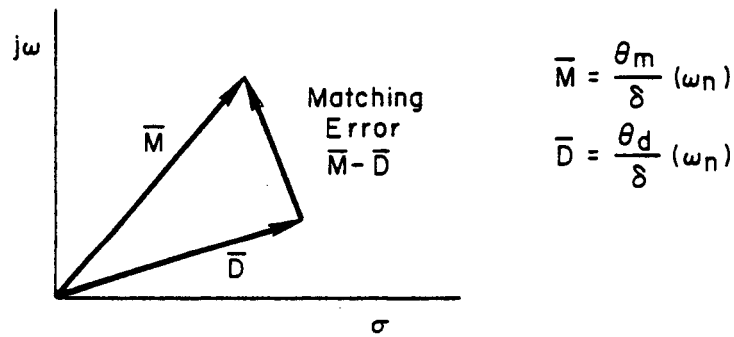


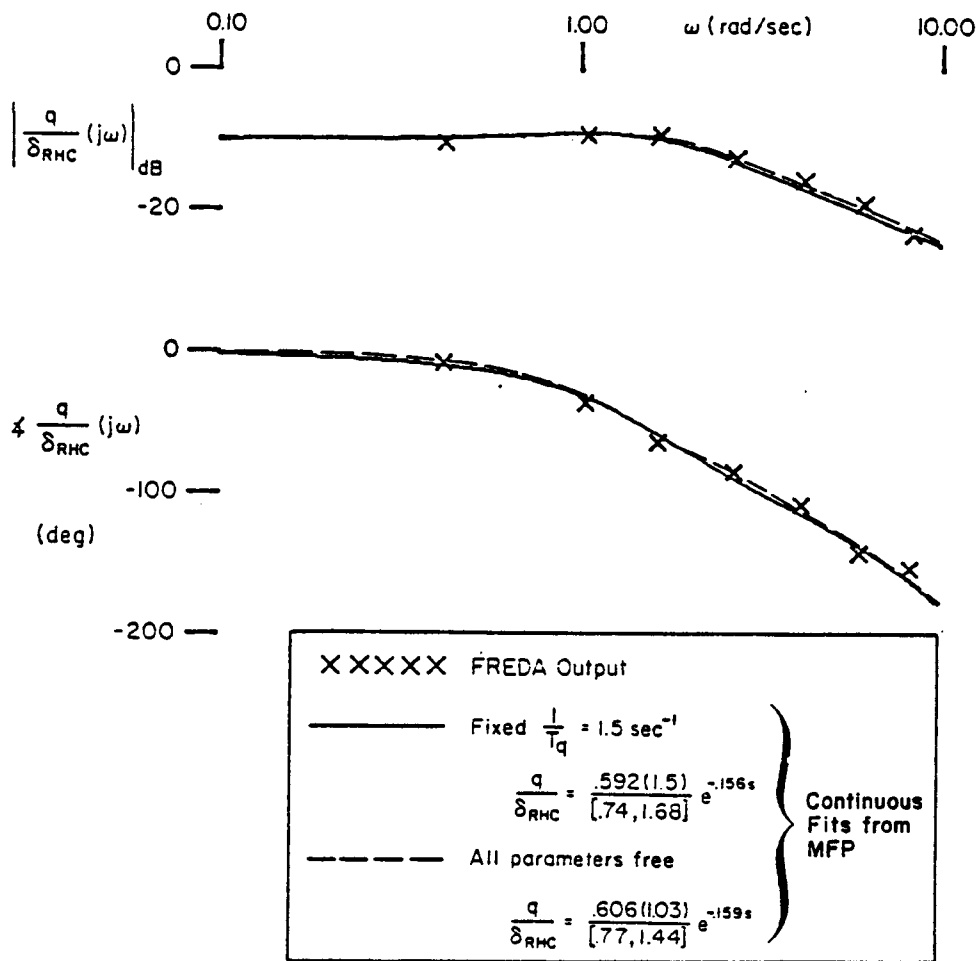
Figure 11. Basic Elements of MFP Process

The program minimizes the weighted mean square difference between the frequency response of the model and the discrete frequency response data. Weights can be specified by the user for the error at each data point and also for the overall error for each transfer function.

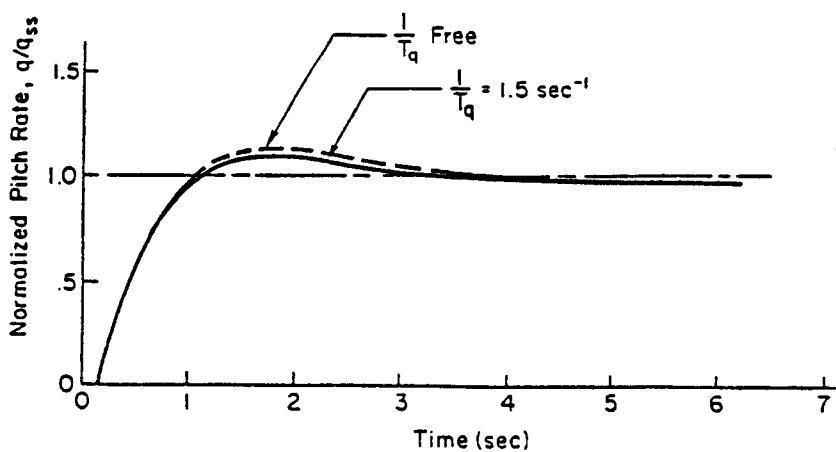
In addition to listing the incremental parameter values and the total cost for a fit, the program also provides the option to display the mismatch in gain (dB) and phase (deg) between the model transfer function and the frequency response data. An example of an MFP application is shown in Fig. 12. MFP is documented in Ref. 14.

D. NIPIP

The Non-Intrusive Parameter Identification Program (NIPIP) is a specialized system identification program developed specifically for pilot-vehicle analysis. The program can be used to identify parameters in models defined



a) Frequency Response Of Superaugmentation Forms Fitted With MFP Compared to FREDa Output



b) Normalized Pitch Rate Response To A δ_{RHC} Step

Figure 12. Example MFP Application Comparison of Flight-Derived Effective q/δ_{RHC} with $1/T_q$ Fixed and Free (Ref. 6)

a priori and expressed in terms of difference equations. The identification procedure is based on a running least-squares estimation technique. While NIPIP is designed for pilot vehicle analysis, it can be used for more basic procedures such as vehicle-alone identification -- a role in which it complements FREDA (Fig. 13).

NIPIP incorporates many features over which the user has direct control and allows the user to adapt the software package to the identification problem at hand. The capabilities of this software include the ability to identify linear as well as nonlinear relations between input and output parameters; the only restriction is that the input/output relations be linear with respect to the unknown coefficients of the estimation equation. The output of the identification algorithm can be specified to be in either the time domain (i.e., the estimation equation coefficients) or in the frequency domain (i.e., a frequency response of the estimation equation). The frame length ("window") over which the identification procedure is to take place can be specified to be any portion of the input time history thereby allowing the freedom to start and stop the identification procedure within a time history. There also is an option which allows a "sliding window." Under this option the window is "slid" to obtain new data, while the data at the beginning of the window is "dropped" as the new data is added. This option gives essentially a moving average over the time history.

The software package includes a user-defined subroutine which can manipulate the input data of the identification algorithm into a convenient form. Another user-defined subroutine specifies the form of the assumed solution. Using this subroutine it is possible to run many assumed solutions simultaneously, which is advantageous when the exact form of the solution is unknown. NIPIP is documented in Ref. 15.

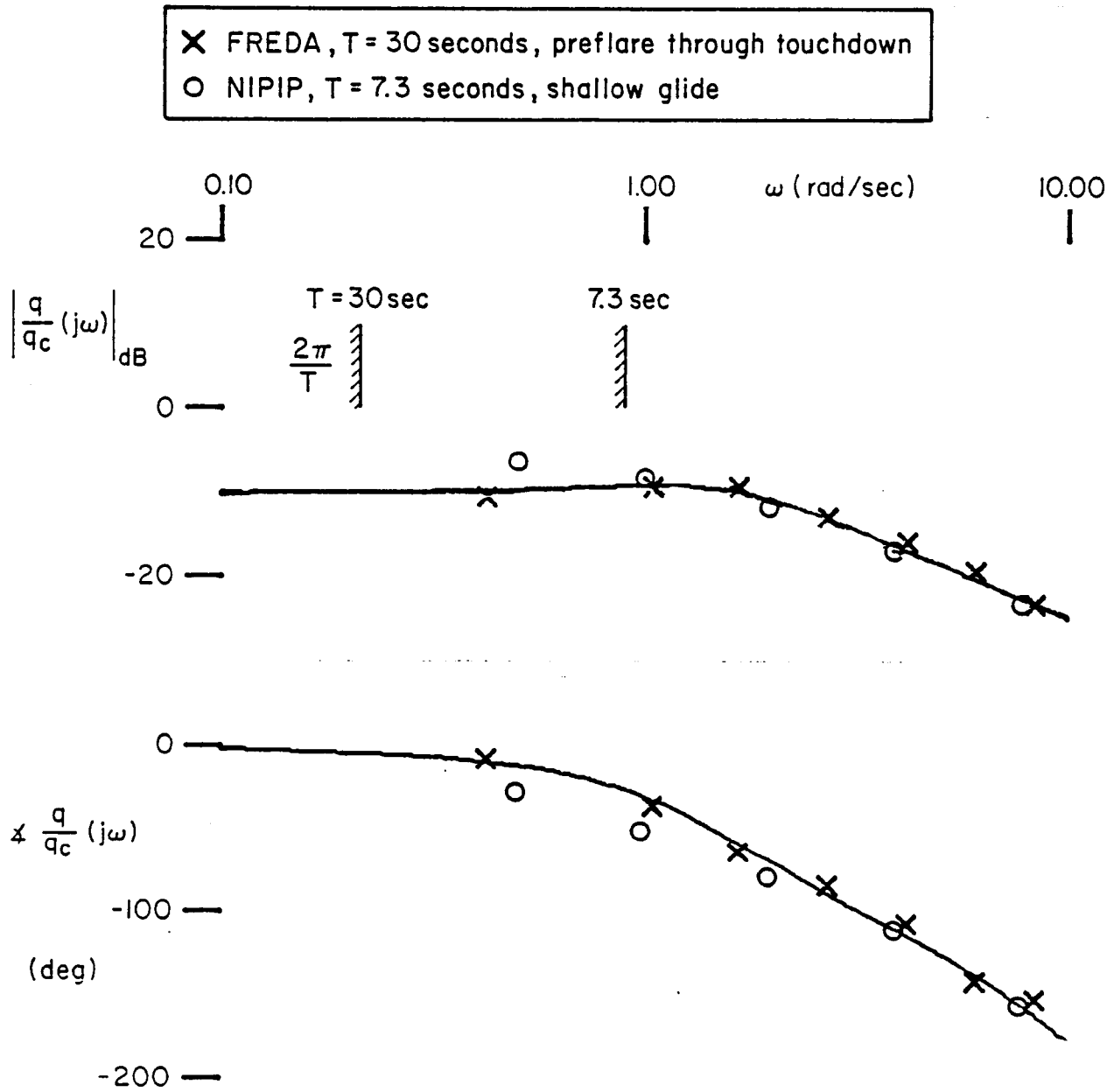


Figure 13. Comparison of NIPIP and FREDA Results for Shuttle Effective Vehicle Identification (Ref. 3)

SECTION IV

TELECOMMUNICATION BETWEEN THE WORKSTATION AND THE ADFRF ELXSI

A. THE TELECOMMUNICATIONS PROGRAM COMPONENT OF THE WORKSTATION

Remote operation on the ELXSI from a OFQ Workstation including transmission of data files in both directions is accomplished using a commercial telecommunications program. While there are numerous communications programs available which will serve the OFQ Workstation needs, use of Procomm by Datastorm Technologies, (Ref. 9) is assumed here. This is a general purpose communications program with many helpful and some essential features for ELXSI telecommunications including:

- Programmable emulation of a variety of popular terminals, providing reasonably correct screen mapping and thus file editing capability in the ELXSI editor EMACS.

- Several popular file transfer error-checking protocols, in particular a good implementation of the Kermit protocol supported on the ELXSI.

- Optional command files to automate program setup, logon, and ELXSI procedures.

- A route to PC DOS command functions which allows the user to perform DOS functions such as disk formatting while remaining functionally connected to ELXSI during a telecommunications session.

- Low purchase cost as ProComm is marketed as "User-supported" software. Despite or perhaps because of this sales approach, this is a very powerful program, continually improved, updated, and maintained.

- A very extensive list of other features including dialing automation, keyboard macros, and disk and printer logging.

B. THE KERMIT FILE TRANSFER PROTOCOL

Kermit is a family of programs which perform reliable file transfer between computers over regular TTY lines. The Kermit commands for the ELXSI version are explained in Table 7.

TABLE 7. COMMANDS FOR THE ADFRF ELXSI IMPLEMENTATION OF KERMIT

COMMAND	EXPLANATION
send	Sends a file or file group from the ELXSI to the remote host. The name of each file is passed to the remote host in a special control packet, so that the remote host can store it with the same name. Wildcarding is allowed.
receive	Receive a file or file group from the remote host. If an incoming file name is not legal, then attempt to transform it to a similar legal name, e.g., by deleting illegal or excessive characters. If the file already exists, it will be superceded.
set	Establish various system-dependent parameters, such as maximum packet length, debugging mode, transmission, delay, etc. Also allows the user to specify virtual terminal line-speed, and parity.
show	Display various system-dependent parameters established by the SET command. SHOW ALL is available.
connect	Establish a virtual terminal connection from the ELXSI to a computer hooked up to it through a TTY line. The connection uses the line speed and parity defined by the set command.
status	Give information about the last file transfer; effective baud rate, number of ACK's, NAK's, and bad packets, etc.
shell	Execute EMBOS command from Kermit.
?	Print help about various options available at a point in a command string (i.e., set ? will show all options available pertaining to set).
help	Print instructions on various commands available in Kermit. You are reading it.
exit	Exit from Kermit.
quit	Same as exit command.
CTRL-]	Control right bracket. Escape from CONNECT mode to your friendly local Kermit command mode. The connection is maintained, and you can re-establish communication with the remote by entering CONNECT at the Kermit-ELXSI prompt.

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APPENDIX A

PRIMARY FLIGHT DATA SOURCES

A. DESCRIPTION OF THE PRIMARY FLIGHT DATA SOURCES

Three independent sources of shuttle flight data have been included in the OFQ data base -- the Modified Maximum Likelihood Estimation (MMLE) disk files; the Cinetheodolite tapes; and the Takeoff and Landing Tower Tapes -- and are described below. The data available from each source is summarized in Table A-1.

1. Modified Maximum Likelihood Estimator (MMLE) Files

Specialized data files generated for Orbiter entry and landing phases for use in the ADFRF identification of aerodynamic coefficients, form an excellent starting point for OFQ data files. The original signals come from: onboard sensors in the Aerodynamic Coefficient Identification Package (ACIP); the Navigation and Guidance General Purpose Computer (GPC); Operational Instrumentation (OI); and the Backup Flight Control System (BFCS) computer. The flight variables available on the ADFRF MMLE files are indicated in Table A-2. Since the primary application of these files has been extraction of airframe aerodynamic coefficients, airframe response and control surface deflection variables are emphasized; however, manual controller deflections are also available. There are inconsistencies between the Table A-2 IMU and radar altitude signals in landing (signal #13 and #102, respectively, see Refs. 3 and 4), and the \dot{h} signal (#103) is unuseable. The switching discretes (#104-107) and "best estimated trajectory" data (#108-118) are not actually in the files. Extensive corrections for various times skews have been made, and all signals have been converted to a 25 sample per/sec rate from a wide range of original sample rates. The MMLE files are currently available on "private (disk) packs" and include flights after STS-7.

TABLE A-1. SUMMARY OF SHUTTLE FLIGHT DATA
AVAILABLE FOR OFQ DATA BASE

VARIABLE	MMLE FILES				CINETHODOLITE TAPES	TAKEOFF & LANDING TOWER TAPES
	ACIP	GPC	OI	BFCs		
TRANSLATIONAL ACCELERATION A_x, A_y, A_z	///	///			///	
ANGULAR ACCELERATION p, q, r	///					
TRANSLATIONAL RATE (AIR DATA) $\alpha, \beta, H, V_{TRUE}, V_{EAS}, \bar{q}, M$		///			///	
TRANSLATIONAL RATE (EARTH REFERENCED) $\dot{X}, \dot{Y}, \dot{Z}$					///	///
ANGULAR RATE p, q, r	///	///				
EARTH REFERENCED POSITION X, Y, H		///		///	///	///
EULER ANGLES ψ, θ, ϕ		///				
CONTROL SURFACE DEFLECTION $\delta_e, \delta_a, \delta_r$ δ_{SB} δ_{BF}	///	///	///	///		
MANUAL CONTROLS (COMMANDER AND PILOT SEPARATE) $\delta_{QRHC}, \delta_{PRHC}$ $\delta_{SBC}, \delta_{BFC}$	///	///	///	///		
MANUAL TRIM CONTROLS						
SWITCHES AND FCS DISCRETES		///				
DISPLAY AND HUD VARIABLES						
WIND DATA					///	

TABLE A-2. MMLE FILE DIRECTORY

CH	DESCRIPTION	PID DRYDEN	MSID	SOURCE CHANNEL	RATE SPS
1	ALPHA, IMU	ALPHA	V95V3021C	GPC 17	1
2	Q	AQ	P07R0069A	ACIP 27	174
3	VELOCITY, IMU	VTRUE	V95V3015C	GPC 25	1
4	THETA	THETA	V90H2217C	GPC 11	5
5	AN	AAZL	P07A0065A	ACIP 17	174
6	O-DOT	AQDOT	P07A0072A	ACIP 21	174
7	AX	AAXL	P07A0067A	ACIP 11	174
8	ELEVATOR	-	-	COMPUTED	
9	BODY FLAP	BDFPL1	V57H0065C	GPC 41	6.25
10	UP JETS	-	-	COMPUTED	
11	DOWN JETS	-	-	COMPUTED	
12	PHI	PHI	V90H2202C	GPC 13	- 5
13	ALTITUDE, ASL	ALT	V95V0165C	GPC 29	1
14	MACH, IMU	MACH	V95V3029C	GPC 23	1
15	QBAR, IMU	QBAR	V95V3011C	GPC 27	1
16	BETA, IMU	BETA	V90H2249C	GPC 21	5
17	P	AP	P07R0068A	ACIP 25	174
18	R	AR	P07R0070A	ACIP 29	174
19	AY	AAZ	P07A0066A	ACIP 13	174
20	P-DOT	APDOT	P07A0071A	ACIP 19	174
21	R-DOT	ARDOT	P07A0072A	ACIP 23	174
22	AILERON	-	-	COMPUTED	
23	RUDDER	ADR	P0740062A	ACIP 43	174
24	YAW JETS	-	-	COMPUTED	
25	ROLL JETS	-	-	COMPUTED	
26	SPEED BRAKE	DSPACT	V57H0250A	OI 31	1
27	-	-	-	-	-
28	TOT TEMP, LEFT	TTOT1	V71T7100B	GPC 35	1
29	TOT TEMP, RIGHT	TTOT2	V71T7600B	GPC 40	1
30	P-CENTER, LEFT	PAC1	V71P7080B	GPC 32	12.5
31	P-CENTER, RIGHT	PAC2	V71P7580B	GPC 37	12.5
32	P-STATIC, LEFT	PSTAT1	V71P7040B	GPC 31	12.5
33	P-STATIC, RIGHT	PSTAT2	V71P7540B	GPC 36	12.5
34	P-UPPER, LEFT	PAU1	V71P7140B	GPC 34	12.5
35	P-UPPER, RIGHT	PAU2	V71P7640B	GPC 39	12.5
36	P-LOWER, LEFT	PAL1	V71P7120B	GPC 33	12.5
37	P-LOWER, RIGHT	PAL2	V71P7620B	GPC 38	12.5
38	L1L	RCSL1L	V42P2543A	OI 8	25
39	L2L	RCSL2L	V42P2544A	OI 9	25
40	L3L	RCSL3L	V42P2545A	OI 10	25
41	L4L	RCSL4L	V42P2546A	OI 11	25
42	R1R	RCSR1R	V42P3543A	OI 19	25
43	R2R	RCSR2P	V42P3544A	OI 20	25
44	R3R	RCSR3P	V42P3545A	OI 21	25
45	R4R	RCSR4R	V42P3546A	OI 22	25
46	LOB ELEVON	ALOBDE	P07H0079A	ACIP 37	174
47	L1B ELEVON	AL1BDE	P07H0078A	ACIP 35	174
48	ROB ELEVON	AROBDE	P07H0081A	ACIP 41	174
49	R1B ELEVON	AR1BDE	P07H0080A	ACIP 39	174
50	L1U	RCSL1U	V42P2547A	OI 12	25
51	L2U	RCSL2U	V42P2548A	OI 13	25
52	L4U	RCSL4U	V42P2549A	OI 14	25
53	L2D	RCSL2D	V42P2550A	OI 15	25
54	L3D	RCSL3D	V42P2551A	OI 16	25
55	L4D	RCSL4D	V42P2552A	OI 17	25
56	R1U	RCSR1U	V42P2553A	OI 23	25

TABLE A-2. (CONCLUDED)

57	R2U	RCSR2U	V42P3548A	OI	24	25
58	R4U	RCSR4U	V42P3549A	OI	25	25
59	R2D	RCSP2D	V42P3550A	OI	26	25
60	R3D	RCSR3D	V42P3551A	OI	27	25
61	R4D	RCSP4D	V42P3552A	OI	28	25
62	P,GPC	PGPC	V79R1830C	GPC	6	25
63	Q,GPC	QGPC	V79R1831C	GPC	7	25
64	R,GPC	RGPC	V79R1832C	GPC	8	25
65	AY,GPC	NYC	V79A2040C	GPC	9	25
66	AN,GPC	NZC	V79A2041C	GPC	10	25
67	P-TOTAL, SIDE PROBE	-	-	COMPUTED		
68	P-STATIC, SIDE PROBE	-	-	COMPUTED		
69	MACH, SIDE PROBE	-	-	COMPUTED		
70	QBAR, SIDE PROBE	-	-	COMPUTED		
71	VEL, SIDE PROBE	-	-	COMPUTED		
72	ALPHA, SIDE PROBE	-	-	COMPUTED		
73	BETA, SIDE PROBE	-	-	COMPUTED		
74	LAL,ACIP	AARCSY	P07P0083A	ACIP	45	174
75	JET DRIVERS L1X,R1X	JTCMD1	V72M0696P	GPC	49	12.5
76	JET DRIVERS L2X,R2X	JTCMD4	V72M0744P	GPC	52	12.5
77	JET DRIVERS L3X,R3X	JTCMD3	V72M0724P	GPC	51	12.5
79	JET DRIVERS L4X,R4X	JTCMD2	V72M0764P	GPC	50	12.5
79	BODY FLAP COMMAND	9FLCMD	V90H1560C	GPC	42	1
80	RUDDER COMMAND	DRCMD	V57KJ140C	GPC	43	5
81	SPEED BRAKE COMMAND	DSPCMD	V57KJ240C	GPC	44	5
82	L1B COMMAND	L1BCMD	V58K0320C	GPC	45	5
83	L2B COMMAND	L2BCMD	V58K0370C	GPC	46	5
84	R1B COMMAND	R1BCMD	V58K0920C	GPC	47	5
85	R2B COMMAND	R2BCMD	V58K0970C	GPC	48	5
86	PST	PST	V90H2230C	GPC	15	5
87	ALPHA, NAV	ALPHNAV	V90H2246C	GPC	10	1
88	LEFT PEDAL, CMDR	CLPED	V51V0510A	OI	36	1
89	RIGHT PEDAL, CMDR	CRPED	V51V0515A	OI	37	1
90	LEFT PEDAL, PILOT	PLPED	V51V0530A	OI	38	1
91	RIGHT PEDAL, PILOT	PRPED	V51V0535A	OI	39	1
92	RHC ROLL-BFCS	PRHC	V90H1500C	BFS	19	12.5
93	RHC PITCH-BFCS	PRHC	V90H1501C	BFS	10	12.5
94	RHC ROLL, PILOT	PRRHC	V72K1205C	GPC	55	1
95	RHC PITCH, PILOT	PRRHC	V72K1206C	GPC	56	1
96	AUTOLAND BODY FLAP	ALAND	V90H1011C	GPC	57	1
97	ALPHA COMMAND	ALPCMD	V90H0603C	GPC	59	1
98	PHT COMMAND	COMP41	V90H1044C	GPC	61	1
99	AMT ACCELERATION	ACCAMI	V72L7259B	GPC	63	1
100	AMT ALPHA	ALPHAM	V72L7254B	GPC	64	1
101	KNOTS INDICATED	KEAS	V72L7256B	GPC	65	1
102	RADAR ALTITUDE	ALTRAD	V72L5356B	GPC	68	1
103	HDOT, IMU	HDOT	V71L2240B	GPC	66	5
104	LH SPD BRK AUTO/MAN	DW5	?	GPC	71	1
105	RH SPD BRK AUTO/MAN	DW7	?	GPC	73	1
106	LH FCS AND BF MODES	DW10	?	GPC	75	1
107	RH FCS AND BF MODES	DW11	?	GPC	76	1
108	V-BET	-	-	BET	2	1
109	BETA-BET	-	-	BET	9	1
110	ALPHA BET	-	-	BET	10	1
111	MACH-BET	-	-	BET	41	1
112	PSTAT-BET	-	-	BET	43	1
113	TEMP-BET	-	-	BET	44	1
114	RHO-BET	-	-	BET	45	1
115	QBAR-BET	-	-	BET	46	1
116	AX-BET	-	-	BET	52	1
117	AY-BET	-	-	BET	53	1
118	AZ-BET	-	-	BET	54	1

2. Cinetheodolite Tapes

A need for better altitude and sink rate signals lead to the use of cinetheodolite data (Ref. 4). The cinetheodolite system is operated by the Air Force Flight Test Center (AFFTC) and is described in Appendix B. Data is obtained from altitudes corresponding to the shuttle entry of the EAFB area through touchdown. Frame-by-frame manual reduction of film from several cinematic cameras is used to estimate the earth referenced position of the Orbiter nose, generally at 20 samples per/sec. (It also is possible to obtain the position of a second reference point on the body for use in estimating vehicle attitudes; however, this has not been done for the OFT landings.) Some undocumented optical distortion occurs near the ground; however, the quoted accuracy of the position data in the landing region is ± 2 ft. A variety of rates and accelerations are estimated in the data reduction program based on the position data. Data from meteorological sources on the ground and at altitude, are used to estimate rates and accelerations referenced to the airmass. Variables available from the Cinetheodolite tapes are listed in Table A-3. Copies of the digital magnetic data tapes for STS-1 through -7 were made available by the AFFTC, and are archived in the ADFRF Tape Library.

3. Takeoff and Landing Tower Tapes

The Takeoff and Landing Tower (TOLT) system is also operated by the AFFTC and is based on two dedicated kinetheodolites (see Appendix B). Earth-referenced shuttle position as a function of time is obtained to a stated accuracy of ± 2 ft between the runaway towers. The reference point is the center of the right main landing gear and translational rates and accelerations are calculated from the position data. The variables recorded on the tapes are listed in Table A-4 by channel. The TOLT data is available only for runway landings and the tapes for STS-4, -5, and -6 have been obtained from the AFFTC and archived in the ADFRF Tape Library.

TABLE A-3. VARIABLES AVAILABLE FROM CINETHEODOLITE TAPE

LIST OF AVAILABLE PARAMETERS							
NO.	NAME	UNITS	DESCRIPTION	NO.	NAME	UNITS	DESCRIPTION
1	HMS	HMS	Time in Hours, Minutes and Seconds	53	AYZ	Ft/Sec ²	Acceleration in the YZ-Plane
2	INDEX		Index Number	54	AT	Ft/Sec ²	Tangential Acceleration
3	ELAPS	Sec	Elapsed Time in Seconds from Zero Time	55	AN	Ft/Sec ²	Normal Acceleration
4	SECS	Sec	Time in Total Seconds	56	AWT	Ft/Sec ²	Tangential Acceleration—Wind Corrected
5	X	Feet	X—Unsmoothed (EAST)	57	AWN	Ft/Sec ²	Normal Acceleration—Wind Corrected
6	Y	Feet	Y—Unsmoothed (NORTH)	58	AXP	Ft/Sec ²	Acceleration along the VA Vector
7	Z	Feet	Z—Unsmoothed (UP)	59	ATP	Ft/Sec ²	Acceleration Horizontally Perpendicular to the VA Vector
8	XSM	Feet	X—Smoothed (EAST)	60	AZP	Ft/Sec ²	Acceleration Perpendicular Upward to the VA Vector
9	YSM	Feet	Y—Smoothed (NORTH)	61	WORD	Feet	Horizontal Distance
10	ZSM	Feet	Z—Smoothed (UP)	62	ARCD	Feet	Arc Distance
11	LAT	Deg	Latitude	63	HCRC#	Feet	Horizontal Distance—Wind Corrected
12	LONG	Deg	Longitude (=EAST)	64	ARCD#	Feet	Arc Distance—Wind Corrected
13	ALT	Feet	Altitude	65	ACGD	Feet	Accumulated Ground Distance
14	RHO	SL/F ³	Air Density	66	QC	LS/F ²	Impact Pressure
15	PA	MBS	Ambient Pressure	67	QDP	LS/F ²	Dynamic Pressure
16	TA	Deg C	Ambient Temperature	68	RLD		Lift to Drag Ratio
17	HD	Deg	Wind Direction	69	CDS	SqFt	Drag Area
18	WV	Ft/Sec	Wind Velocity	70	CD		Coefficient of Drag
19	WX	Ft/Sec	X—Component of Wind Velocity	71	CD		Baltistic Coefficient of Drag
20	WY	Ft/Sec	Y—Component of Wind Velocity	72	HV	Deg	Heading with Respect to X-Axis
21	VX	Ft/Sec	X—Component of Velocity	73	HVN	Deg	Heading with Respect to North
22	VY	Ft/Sec	Y—Component of Velocity	74	HVN#	Deg	Heading with Respect to Y—Axis—Wind Corrected
23	VZ	Ft/Sec	Z—Component of Velocity	75	HVN#	Deg	Heading with Respect to North—Wind Corrected
24	RCD	Ft/Sec	Rate of Climb	76	VND	Ft/Sec	Northward Velocity of the Carrier
25	VWX	Ft/Sec	X—Component of Velocity—Wind Corrected	77	VED	Ft/Sec	Eastward Velocity of the Carrier
26	VWY	Ft/Sec	Y—Component of Velocity—Wind Corrected	78	VZD	Ft/Sec	Upward Velocity of the Carrier
27	AX	Ft/Sec ²	X—Component of Acceleration	79	HVO	Deg	Heading with Respect to North at the Carrier
28	AY	Ft/Sec ²	Y—Component of Acceleration	80	EL	Deg	Elevation Angle
29	AZ	Ft/Sec ²	Z—Component of Acceleration	81	AZY	Deg	Azimuth Angle with Respect to Y—Axis
30	AV	Ft/Sec ²	Vertical Acceleration	82	AZN	Deg	Azimuth Angle with Respect to North
31	SR	Feet	Slant Range	83	AR	Ft/Sec ²	Radial Acceleration
32	GR	Feet	Ground Range	84	KAPPA	Deg	Direction of Radial Acceleration
33	XZR	Feet	Range in the XZ-Plane	85	CMEGA	Dg/Sec	Angular Rate of Roll—ms
34	YZR	Feet	Range in the YZ-Plane	86	PITCH	Deg	Pitch Angle
35	RN	Feet	Range in the Northward Direction	87	YAW	Deg	Yaw Angle
36	RE	Feet	Range in the Eastward Direction	88	FPA	Deg	Flight Path Angle
37	VN	Ft/Sec	Northward Component of Velocity	89	DVA	Deg	Dive Angle
38	VE	Ft/Sec	Eastward Component of Velocity	90	XINV	Feet	X—Coordinate of VT Intercept with the XY-Plane
39	VT	Ft/Sec	Total Velocity	91	YINV	Feet	Y—Coordinate of VT Intercept with the XY-Plane
40	VA	Ft/Sec	Total Velocity—Wind Corrected	92	VXP	Ft/Sec	Velocity along the SR Vector
41	VG	Ft/Sec	Ground Velocity	93	VYP	Ft/Sec	Velocity Horizontally Perpendicular to the SR Vector
42	VXZ	Ft/Sec	Velocity in the XZ-Plane	94	VZP	Ft/Sec	Velocity Perpendicular Upward to the SR Vector
43	VYZ	Ft/Sec	Velocity in the YZ-Plane	95	HORIZ	Deg	Horizontal Angle between the VT and SR Vectors
44	VXY	Ft/Sec	Velocity in the XY-Plane—Wind Corrected	96	VERT	Deg	Vertical angle between the VT and SR Vectors
45	VXZ	Ft/Sec	Velocity in the XZ-Plane—Wind Corrected	97	SPACE	Deg	Space Angle between the VT and SR Vectors
46	VYZ	Ft/Sec	Velocity in the YZ-Plane—Wind Corrected	98	PALT	Feet	Pressure Altitude
47	RCD	Ft/Sec	Rate of Descent	99	AZATT	Deg	Azimuth Altitude Angle
48	VS	Ft/Sec	Speed of Sound	100	ELATT	Deg	Elevation Altitude Angle
49	MACH		Mach Number	101	VATT	Deg	Vertical Altitude Angle
50	AM	Ft/Sec ²	Acceleration Magnitude (Total Acceleration)	102	ELDMP	Deg	Dumped Elevation Angle
51	AXY	Ft/Sec ²	Acceleration in the XY-Plane	103	RSD	Deg	Sowing of Origin with Respect to Heading with Respect to North—Wind Corrected
52	AXZ	Ft/Sec ²	Acceleration in the XZ-Plane				

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B. CREATION OF THE ARCHIVE FILES FROM THE PRIMARY SOURCES

1. Accessing the Primary Data Sets

The integration of the three primary data sources on the ADFRF CYBER computer (predecessor to the ELXSI) to create archive files is diagrammed in Fig. A-1. Tape access on the CYBER was handled through the Tape Reservation System (TRS) which has been superceded by the ELXSI system.

Because each of the three data sets were stored in a different format, a unique program was required to read each one and store the desired data subset on a (mass storage) file to make it available for further processing.

TABLE A-4. VARIABLES RECORDED ON TAKEOFF AND LANDING TOWER TAPES

<u>CHANNEL</u>	<u>VARIABLE</u>
1.	Time in Total Seconds
2.	Ground Distance in Feet from West End of Runway
3.	Ground Distance in Feet, Zeroed to Brake Release on a Takeoff, or Stop on a Landing
4.	Altitude in Feet, Relative to Lift-Off Point or Touchdown Point (same as height)
5.	Rate of Climb in Feet/Second
6.	Ground Speed in Feet/Second
7.	Tangential Acceleration in Feet/Second/Second
8.	Total Acceleration in Feet/Second/Second
9.	Energy/Weight in Feet
10.	Offset in Feet from Runway Centerline

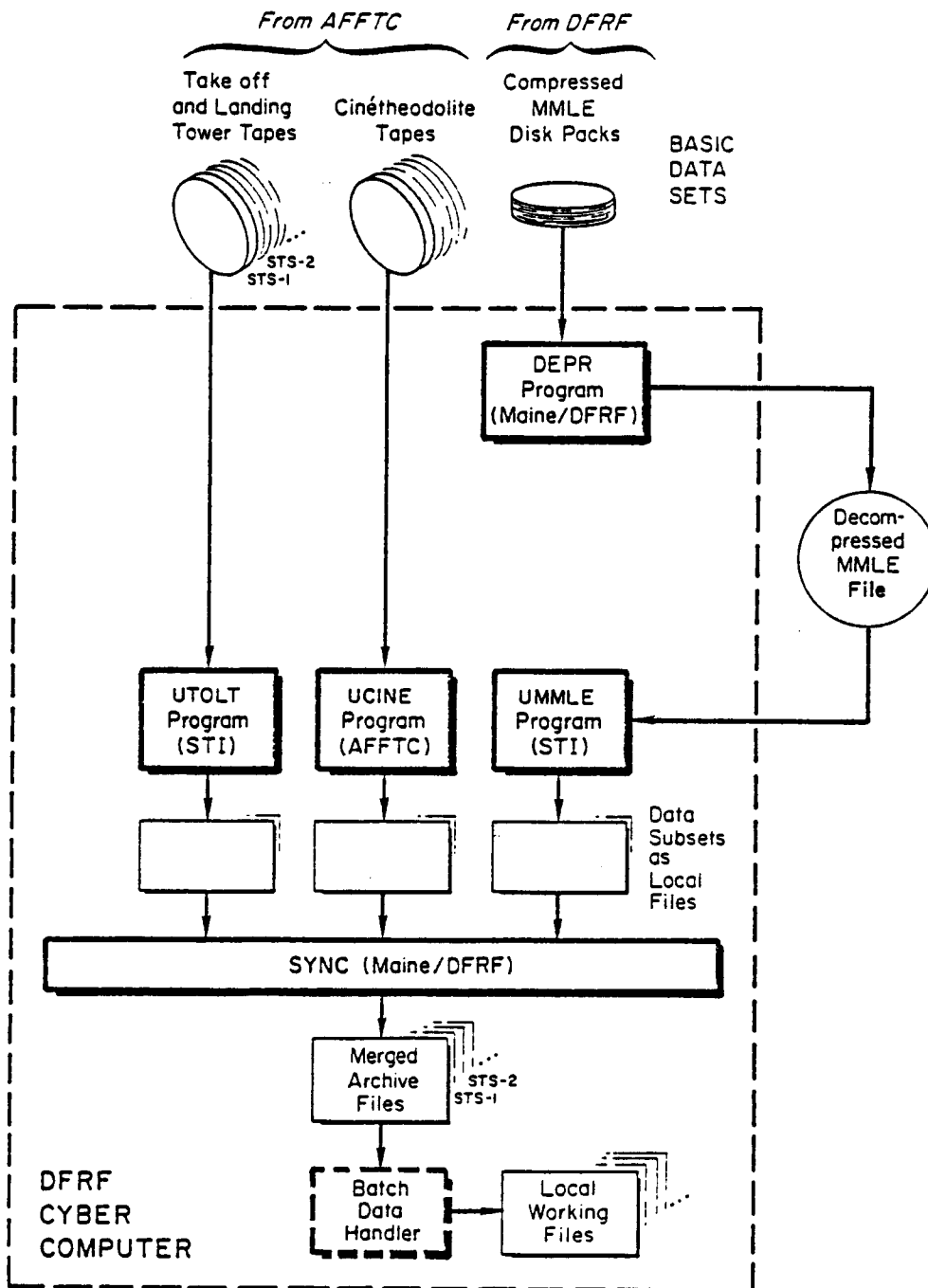


Figure A-1. Creation of Shuttle Archives from Basic Data Sets

a. MMLE Data

The MMLE data is archived in two forms -- compressed and uncompressed. Data for shuttle flights 1 through 4 are stored in the compressed form; data for later flights are uncompressed. In the compressed form, each channel is represented at its own sample rate. Before this data could be used, it had to be decompressed with the ADFRF "DEPR" program. The decompressed data file was then read by the program "UMMLE," which stored a subset of the data on a file (Ref. 5). This program provided for selection of a subset of signals to be stored for a sub-interval of the entire entry period. It also allowed extraction of every n'th time slice where desired. UMMLE was created expressly for the OFQ data handling system.

b. CINE Data

The CINE data was read by the program "UCINE," (Ref. 5) which is a modified version of the AFFTC program "LISTBC." The modifications were made to facilitate extraction of data for short time intervals and to simplify the code. Like UMMLE, UCINE provided for extraction of every n'th time slice (record) of a selected subset of signals over a chosen time interval.

c. TOLT Data

The TOLT archive tape was first converted to a disk file, which was then read by the program "UTOLT" (Ref. 5). UTOLT stores all the data from the original tape on a file. This is a relatively small amount of data consisting of only 10 signals at four samples per/sec from an altitude of a few hundred feet through touchdown and roll out.

2. Merging and Synchronizing the Primary Data Sets

Combination of the three primary source files MMLE, CINE, and TOLT into a single file was done by the program SYNC (Ref. 8) a precursor of the GETDATA program (Ref. 7) now used in this role. A subset of all available signals in the three data files would be selected for inclusion in this merged file. The merged file contains a value for each included signal at each sample time. Sample times are defined by user-specified start and end times and sample rate.

Processing consisted of passing the three unformatted source data files through SYNC, and converting the unformatted output into a formatted file which can be read by the user, used by programs which accept formatted data, or transmitted to other computers for further analysis. In merging the data in the three input files, SYNC provided:

- selection of signals
- selection of sub-interval
- correction of fixed time skews among source data files
- synchronization of the data to the single selected sample rate
- arbitrary re-ordering of the signals in the file

3. Archive File Sample Rate Selection

The merged archive files were set up at a sample rate of 25 samples per/sec (the MMLE rate). The primary consideration in setting sample rate was that it be at least three to five times the highest observed frequency (Ref. 2). The highest observed frequencies in Table A-5 are based on experience and examination of shuttle data. The implication of Table A-5 was that, if a single sample rate was to be used in the file, it would not be much less than 25 samples per/sec.

TABLE A-5. SAMPLE RATE SELECTION

$$\text{Criterion: Sample Rate} \geq (3-4) \times \left(\begin{array}{c} \text{Highest} \\ \text{Observed} \\ \text{Frequency} \end{array} \right)$$

DATA SOURCE	SAMPLE RATE (Hz)	NYQUIST FREQUENCY 1/2T (Hz)	HIGHEST OBSERVED FREQUENCY (Hz)	CRITERION RATIO
MMLE	25*	12.5	4 (RHC)	6.25
CINE'	10 or 20	5 or 10	0.8 (h)	12.5
TOLT	4	2	0.8 (h)	5

*Some signals originally sampled at other rates

APPENDIX B

AFFTC GROUND BASED TRAJECTORY MEASUREMENT EQUIPMENT

The cinetheodolite and takeoff and landing tower data is obtained from kinetheodolite equipment. This appendix presents some background information, much of it taken directly from Refs. 16 and 17 on these instruments.

1. Basic Operation

A kinetheodolite is in principle a telescope which can be easily rotated both in azimuth and elevation to track the aircraft. In most kinetheodolites the telescope is manually directed towards the aircraft. Attached to the telescope, with its optical axis aligned parallel to that of the search telescope, is another telescope with longer focal length, through which a camera takes pictures of the aircraft. The azimuth and elevation are measured and recorded with an accurately known frequency in the range of 1 to 4 per second, in a few systems up to 30 frames per second. These azimuth and elevation values provide the first-order direction in which the aircraft was seen. A correction on this direction is obtained by measuring the position of the aircraft with respect to cross hairs on the camera pictures, which are made at exactly the same time as the azimuth and elevation recordings.

If a single kinetheodolite is used for measuring a trajectory, it is usually placed to the side of the trajectory to be measured. It is then assumed that the aircraft remains in the vertical plane through the runway centreline. The position of the aircraft can then be calculated from the distance between the kinetheodolite and the runway centreline and the azimuth and elevation under which the kinetheodolite sees the aircraft. In most installations, including the AFFTC, multiple kinetheodolites are used to obtain much higher accuracy. For instance, if two instruments are used in the configuration of Fig. B-1, and the

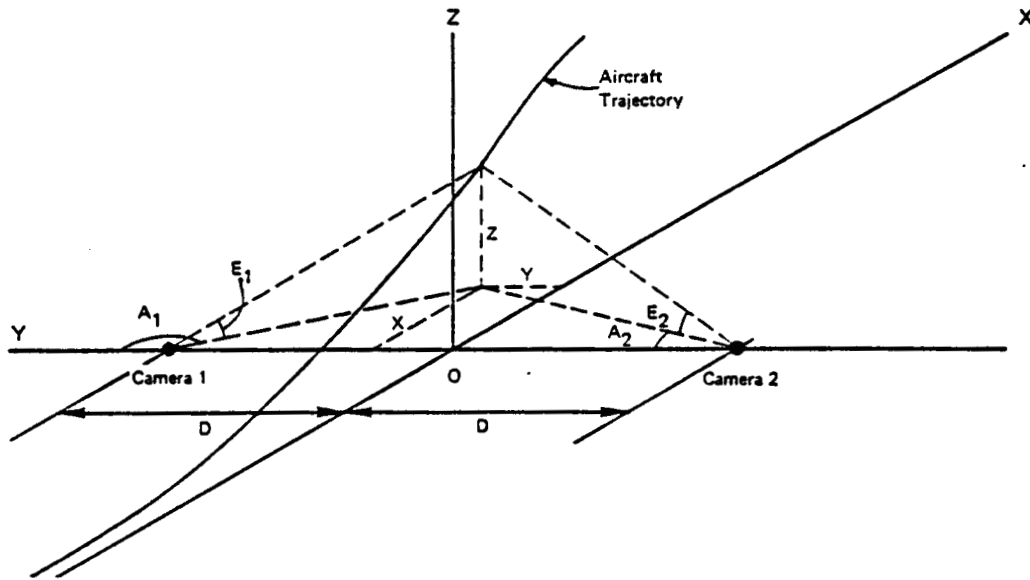


Figure B-1. Typical Deployment of Two Kinetheodolites
(taken from Ref. 16)

measurements are perfect such that the sight lines of both instruments intersect at the aircraft, then the aircraft position is given by

$$X = 2D \frac{\sin A_1 \sin A_2}{\sin (A_1 - A_2)}$$

$$Y = D \frac{\sin (A_1 + A_2)}{\sin (A_1 - A_2)}$$

$$Z = 2D \frac{\sin A_1 \tan E_2}{\sin (A_1 - A_2)} = 2D \frac{\sin A_2 \tan E_1}{\sin (A_1 - A_2)}$$

At the AFFTC more than two instruments are often used and measurement errors occur such that all sight lines do not converge on a single point. Therefore, the data is processed using modern statistical estimation techniques including Kalman filtering to obtain best estimated trajectories.

2. Instrument Details

The AFFTC uses both Askania and Contraves kinetheodolites. The latter are referred to as "cinetheodolites." The Askania instrument is probably the oldest type still in general use. More modern systems, such as the Contraves cinetheodolites generally have electrical methods for measuring elevation and azimuth, which must be read from the film in the Askania theodolites. Modern kinetheodolites have other features, such as the use of radar for early detection of an approaching target, but the Askania system provides an accuracy similar to that of the more modern systems and is relatively easily transported. For this reason Askania kinetheodolites are still used in many parts of the world where no instrumented test ranges are available.

A kinetheodolite system consists of two or more kinetheodolites and a command station. Each Askania kinetheodolite consists of three main parts:

- A pedestal, which stands on three leveling screws. Using the two bubble levels mounted on the pedestal, these screws are used to bring the azimuth axis to an exactly vertical position.

In the upper part of the pedestal are mounted:

- A toothed ring for driving the rotation of the upper parts in azimuth.
- A glass disc (the azimuth scale), accurately graduated in grads (400 grads = 360 deg) over the full 400 grads. The accuracy of the scale is ± 0.0015 grads.
- A second azimuth scale projected in the aiming system used by the operator.
- A lower casing which can turn relative to the pedestal about a vertical axis. This contains the driving mechanisms by which the operator can move the system in azimuth and elevation and the microscopes which project the azimuth and elevation and the microscopes which project the azimuth and elevation scales on the film. They provide a magnification of 35. The overall reading accuracy of the scales is ± 0.005 grads.

- An upper casing which can move relative to the lower casing about a horizontal axis. This contains:
 - The glass elevation scale, graduated from -10 to +210 grads (0 and 200 grads corresponding to horizontal positions).
 - The telescope system for use by the operators who point the system to the aircraft. There are two telescopes, one on each side. If the kinetheodolite is operated by two persons, each uses one of the telescopes and one operator moves the system only in azimuth, the other only in elevation. These telescopes have a field of view of 6 deg and a magnification of 10.
 - The camera system, that moves with the telescopes. The 35 mm camera has interchangeable lenses. The choice of the lens depends on the average distance of the aircraft from the kinetheodolite and on the type of maneuvers that are executed. Four focal lengths are available: 300 mm (field of view 7 deg), 600 mm (3.3 deg), 1000 mm (2.1 deg) and 2000 mm (1 deg). The latter two are catadioptric mirror telescopes. The exposure time is fixed at 1/150 sec. Two other systems project images on the picture: a frame number and the azimuth and elevation scales. These latter are projected in the upper corners of the frames, whereby the scales are illuminated by flashlight (10^{-4} s). The maximum frame rate of the camera is 20/sec. There is an acoustic warning if the film transport fails.

The command station is connected to all kinetheodolites being operated either by cable or by radio. The function of the command station is to generate commands to all cameras (thereby ensuring that all cameras take pictures with negligible time difference) and to record the time of each command and of the shutter contact in each camera. The commands sent to the camera operate the shutter, flashlight and film transport; the times at which the shutters actually operate are sent back to the command station. At the command station there is a capability for displaying the shutter contact signals. This is used to adjust the command signals for any differences in the delays in operation in the kinetheodolites.

3. Data Processing

The goal of the data processing is to produce the azimuth and elevation values of the reference point on the aircraft from each picture. During film reading the azimuth and elevation values and the picture number are read and the position of the reference point on the aircraft relative to the cross hairs is measured. These data define the direction of the line-of-sight from the particular camera to the aircraft. They are sent to a computer, where they are combined with the data from the pictures from the other kinetheodolite(s), with the timing data recorded at the command station, and with the position co-ordinates of the kinetheodolites. The computer then calculates the trajectory.

This film reading involves much time-consuming manual labor. Much work has been done on reducing that labour. As already mentioned, in many theodolites the elevation and azimuth scales have been replaced by coded discs, the positions of which can be directly recorded at the command station. Complex film readers are available in which variable magnification of the projector and simple movement of the picture can be used to position fiducial markings on the projection table, and in which the position of the cross hairs used to measure the reference point on the aircraft picture is recorded directly when a footswitch is pressed. These (very expensive) film readers considerably reduce the time required for reading of films and eliminate several sources of errors.

4. Shuttle Trajectory Measurements

The shuttle "cinetheodolite" data provided by the AFFTC is obtained from various combinations of Askania and Contraves instruments. The quoted position accuracy of this data (Ref. 17) is

- + 30 ft at 50,000 ft range
- + 5 ft at 5,000 ft range
- + 2 ft in rollout

The Takeoff and Landing Tower data is obtained from two Askania kinetheodolites with large azimuth but limited elevation ranges. These "cameras" are mounted in the two towers indicated in Fig. B-2 and can obtain data only for the EAFB main runway (runway 22).

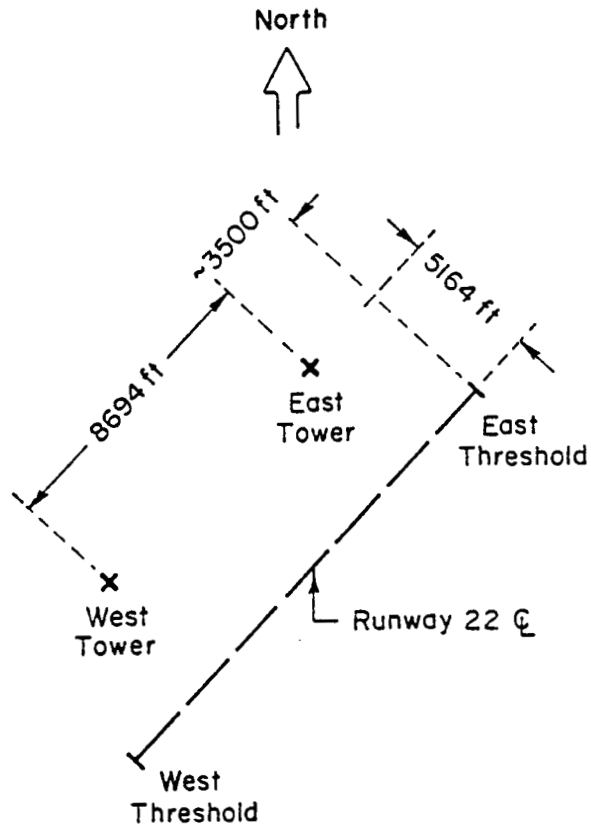


Figure B-2. Takeoff and Landing Tower System Layout

APPENDIX C
OFQ DATABASE DESIGN

TABLE C-1. DATABASE TABLES

1.0 MISSIONS

- 1.1 Mission code
(STS-1,....)
- 1.2 Launch date
- 1.3 Landing date
- 1.4 Landing site
- 1.5 Touchdown time (official)
- 1.6 Runway
- 1.7 Vehicle
- 1.8 Commander
- 1.9 Pilot
- 1.10 Third crewperson on flight deck

2.0 LANDING SITES

- 2.1 Site name
- 2.2 Landing site
- 2.3 Country
- 2.4 State
- 2.5 Geographical location
- 2.6 Latitude
- 2.7 Longitude
- 2.8 Altitude

3.0 RUNWAYS

- 3.1 Runway number
- 3.2 Landing site
- 3.3 Length
- 3.4 Width
- 3.5 Surface
- 3.6 Landing aids
- 3.7 Tracking equipment

4.0 VEHICLE FLEET

- 4.1 Vehicle ID number
- 4.2 Name
- 4.3 Commission date
- 4.4 Decommission date

TABLE C-1. (CONTINUED)

5.0 VEHICLE MODIFICATIONS

Definition of modifications to vehicles

- 5.1 Modification name
- 5.2 Date
- 5.3 Modification description
- 5.4 Vehicle modified
- 5.5 Subsystem modified

6.0 CREW

Data about each crew member

- 6.1 Crew ID number
- 6.2 Last Name
- 6.3 First name
- 6.4 Middle initial
- 6.5 Title
- 6.6 Birthdate
- 6.7 Military branch
- 6.8 Pilot ?
- 6.9 Transport hours
- 6.10 Fighter hours
- 6.11 Helicopter hours

7.0 PRIMARY OFQ ARCHIVE DATA SETS

OFQ Archive files on the ELXSI

- 7.1 Time
- 7.2 First signal
- 7.3 Second signal
- :
- :
- 7.4 Nth signal

8.0 MMLE FILES

All physical MMLE data files at ADFRF

- 8.1 Time
- 8.2 First signal
- :

TABLE C-1. (CONCLUDED)

9.0 CINETHEODOLITE TAPES

All physical Cine tapes at AFFTC plus copies at ADFRF, etc.

- 9.1 Time
- 9.2 First signal
- :

10.0 TAKEOFF AND LANDING TOWER TAPES

All physical Takeoff and Landing Tower Tapes at AFFTC plus copies at ADFRF, etc.

- 10.1 Time
- 10.2 First signal
- :

11.0 WORKSTATION ARCHIVE DATA SETS

Data sets available on floppy disks as workstation archive files. Assumes that each Workstation archive file is a subset of only one primary archive file.

- 11.1 Time
- 11.2 First signal
- :

12.0 INDIVIDUAL MISSION CALCULATION FILES

Files containing parameters calculated from data for individual missions

13.0 ENSEMBLE CALCULATION FILES

Files containing computed statistical parameters for groups of missions

TABLE C-2. DATA DICTIONARY ENTITIES AND THEIR ATTRIBUTES

The Data Dictionary contains information about the various data sets in the OFQ archives.

1.0 PRIMARY OFQ ARCHIVE DATA SET DIRECTORY

Definition OFQ Archives on the ELXSI

- 1.1 Primary archive file name
- 1.2 Mission code
- 1.3 Start time
- 1.4 End time
- 1.5 Entry segment name
- 1.6 Entry segment description (text)
- 1.7 Signals

2.0 MMLE FILES

Definition of all physical MMLE data files at ADFRF

- 2.1 File name
- 2.2 Mission
- 2.3 Creation date
- 2.4 Destruction date
- 2.5 Data problems

3.0 CINETHEODOLITE TAPES

Definition of all physical Cine tapes at AFFTC plus copies at ADFRF, etc.

- 3.1 File name
- 3.2 Mission
- 3.3 Creation date
- 3.4 Destruction date
- 3.5 Data problems

TABLE C-2. (CONTINUED)

4.0 TAKEOFF AND LANDING TOWER TAPES

Definition of all physical Takeoff and Landing Tower Tapes at AFFTC plus copies at ADFRF, etc.

- 4.1 File name
- 4.2 Mission
- 4.3 Creation date
- 4.4 Destruction date
- 4.5 Data problems

5.0 PRIMARY OFQ ARCHIVE SIGNALS

Definition of all signals in Primary OFQ Archives on ELXSI

- 5.1 Signal ID number
- 5.2 MSID number
- 5.3 Symbol
- 5.4 Signal name
- 5.5 Signal description (text)
- 5.6 Signal category
- 5.7 Units
- 5.8 Positive sense
- 5.9 Origin (signal zero)
- 5.10 Coordinate system
- 5.11 Decimation
- 5.12 Original data set
- 5.13 Filtering
- 5.14 Source
- 5.15 Source signal ID number
- 5.16 Original data set

6.0 MMLE SIGNALS

Definition of all signals appearing in MMLE files; (Table 4, TR-1220-1)

7.0 CINETHEODOLITE SIGNALS

Definition of all signals appearing on AFFTC cinetheodolite tapes; (Table 5 TR-1220-1)

8.0 TAKEOFF AND LANDING TOWER SIGNALS

Definition of all signals on AFFTC takeoff and landing tower tapes; (Table 6 TR-1220-1)

TABLE C-2 (CONCLUDED)

9.0 OI SIGNALS

Definition of all signals on Operational Instrumentation system on the Shuttle

10.0 ACIP SIGNALS

Definition of all signals on the Aerodynamic Coefficient Identification Package on the Shuttle

11.0 GPC SIGNALS

Definition of all signals available from the General Purpose Computers aboard the Shuttle

12.0 WORKSTATION ARCHIVE DATA SETS

Definition of all data sets available on floppy disks as workstation archive files. Assumes that each Workstation archive file is a subset of only one primary archive file.

- 12.1 Workstation archive file name
- 12.2 Mission code
- 12.3 Start time
- 12.4 End time
- 12.5 Entry segment name
- 12.6 Entry segment description (text)
- 12.7 Workstation signal set ID number
- 12.8 Source
(ELXSI data set ID number)

13.0 INDIVIDUAL MISSION CALCULATIONS

Definition of parameters calculated from data for individual missions

14.0 ENSEMBLE CALCULATIONS

Definition of computed statistical parameters for groups of missions

15.0 GLOSSARY

Definition of special terminology and acronyms

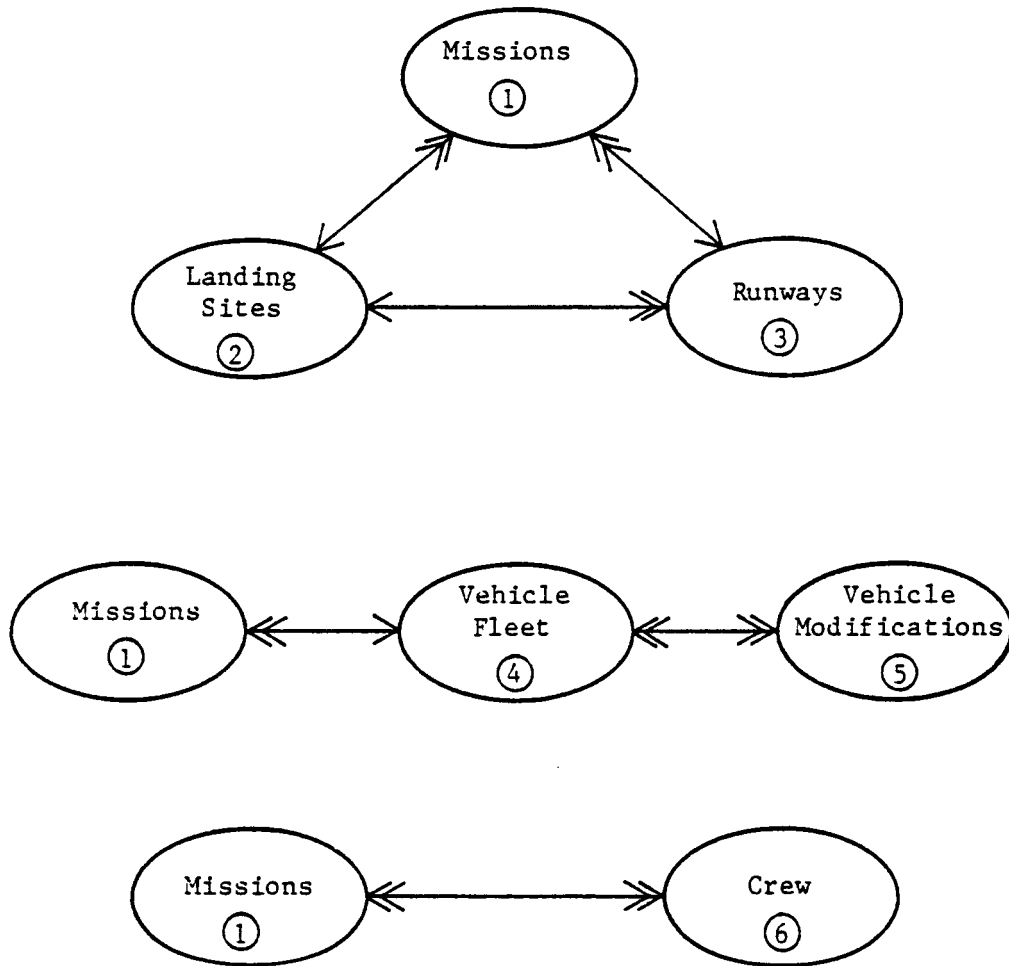
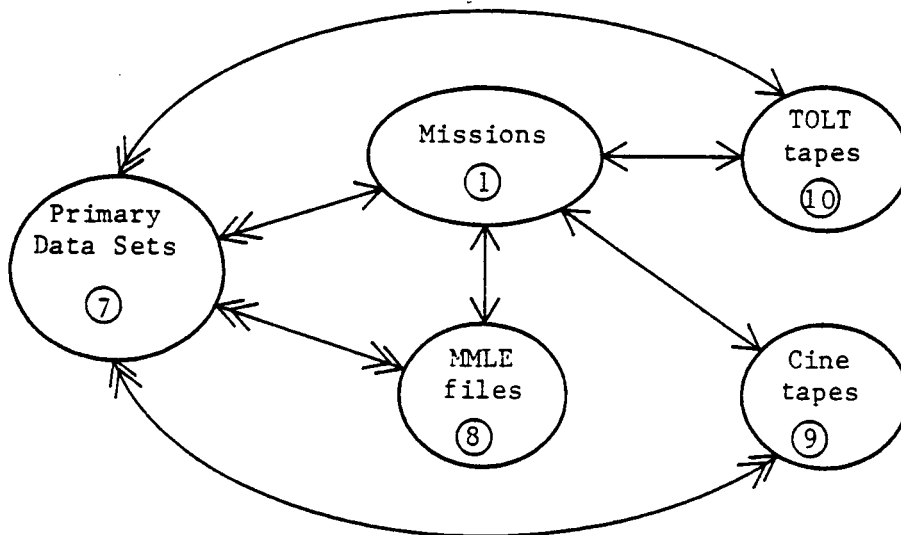


Figure C-1. Entity-Relationship Diagrams for Physical Entities in Table C-1.



Note: many-to-many relations occur because of interpolation

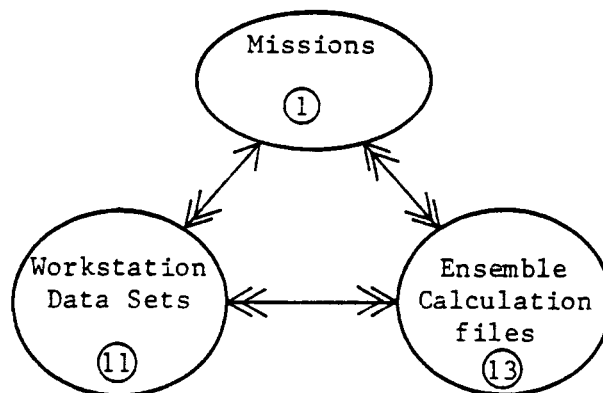
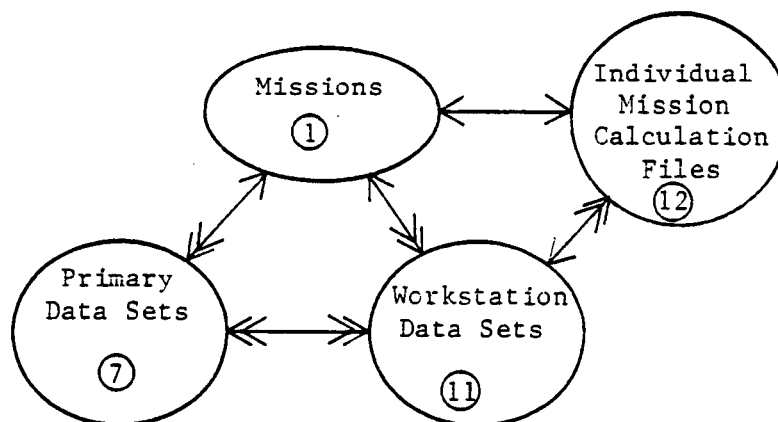


Figure C-1. (Concluded)

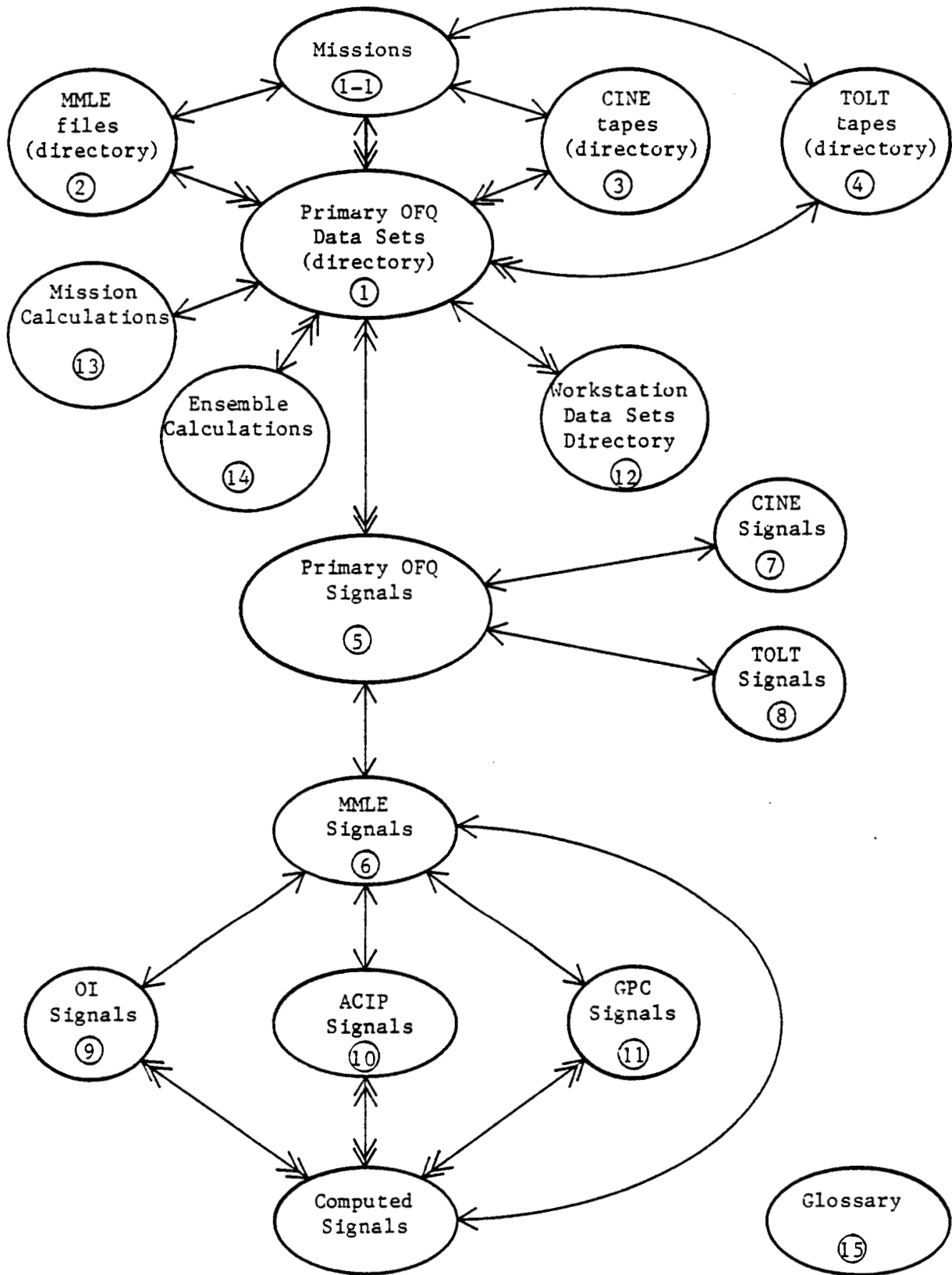
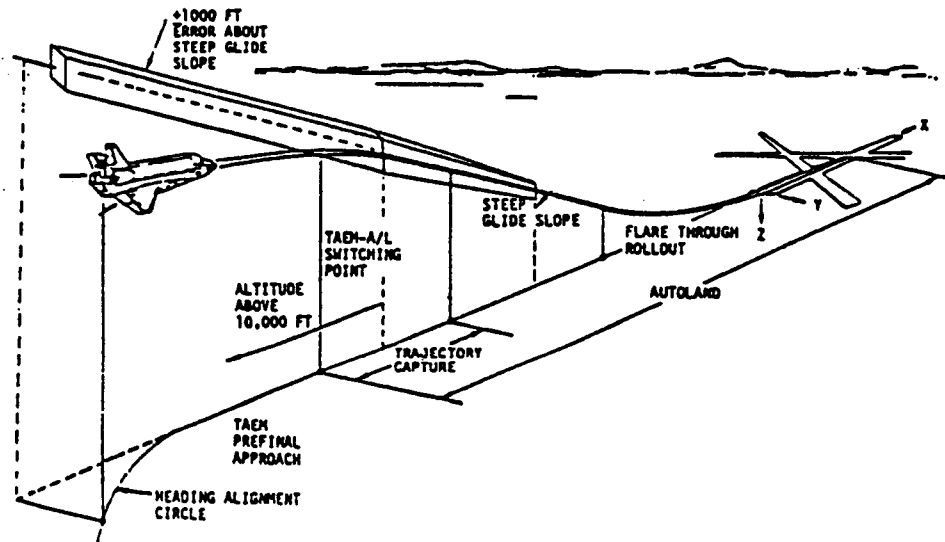


Figure C-2. Entity-Relationship Diagrams for Data Dictionary in Table C-2.

"HOW TO DO IT" MANUAL



"HOW TO DO IT" MANUAL CONTENTS

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H1 "HOW TO DO IT" MANUAL

I. Beginning and Ending Workstation Sessions A. Starting the Workstation Program

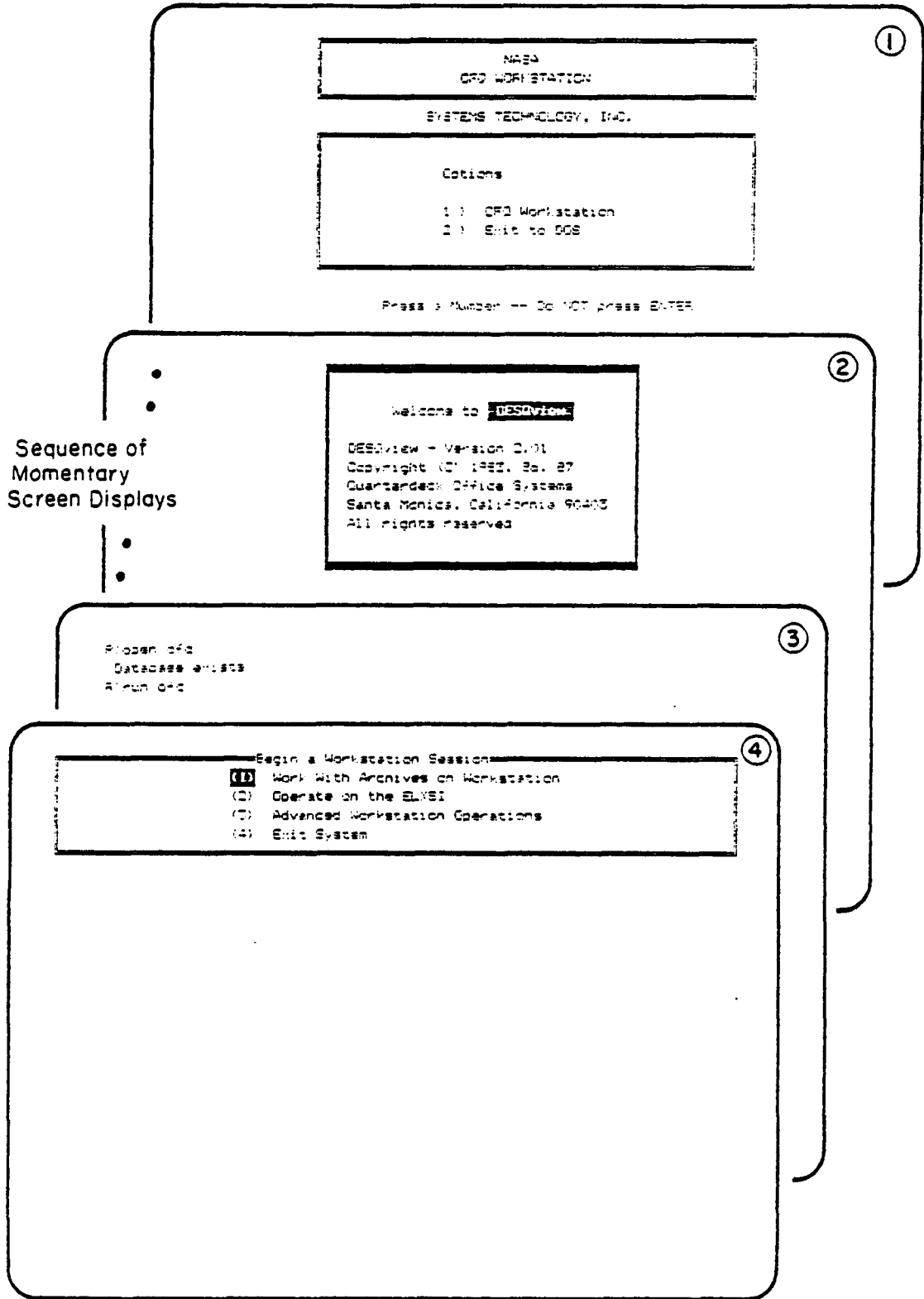
The details of the startup procedure for the OFQ Workstation may depend on the specific installation. The "standard" procedure is explained here.

When the Workstation computer is turned on and the operating system (DOS) is brought up, the Workstation startup menu (1) can be displayed by entering "OFQMENU" from the DOS prompt. If you wish to work on the computer without using the Workstation, type "2" and you will be returned to DOS.

(It is required that there are no memory resident programs initiated in the AUTOEXEC.BAT file prior to the DOS prompt. The Workstation software installation requires a minimum of 640K of system memory and DOS 3.0 or higher.)

If you do wish to use the Workstation software type "1" and the Workstation installation will begin. The startup banners for the window environment (2) (DESQview), the RDBMS (RBASE System V) and the spreadsheet program (Lotus 1-2-3) will appear momentarily as programs are installed in windows.

Wait for the screen activity to stop at which point "R>Open OFQ/Database exists" (3) should appear (if another message appears consult the RDBMS manual Ref. 10). This is a prompt from the RDBMS to run the Workstation application program and you should enter "RUN OFQ". After a few seconds the first IDH menu (4) should appear and you may make selections as explained on page H9.



H3 "HOW TO DO IT" MANUAL

- I. Beginning and Ending Workstation Sessions
 - B. Moving Through the Workstation Windows
-

Each of the programs in the "federation" which constitutes the OFQ Workstation is installed in its own window and managed by the window environment program. You will have occasion to move among the windows as explained here.

Operations involving the windows are made from the DESQview (Ref. 18) menu. To access this menu system press and release the [ALT] key and the main "DESQview" menu will appear (1). Next type "S" and the "Switch Windows" menu will appear (2) with a list of the names of programs and the numbers of the windows in which they are installed. To switch to a window, type its number and that window will be displayed and made active (i.e., you can work normally in the resident program).

Additional information on working with the windows can be obtained from the DESQview manual (Ref. 18). A few points to note are:

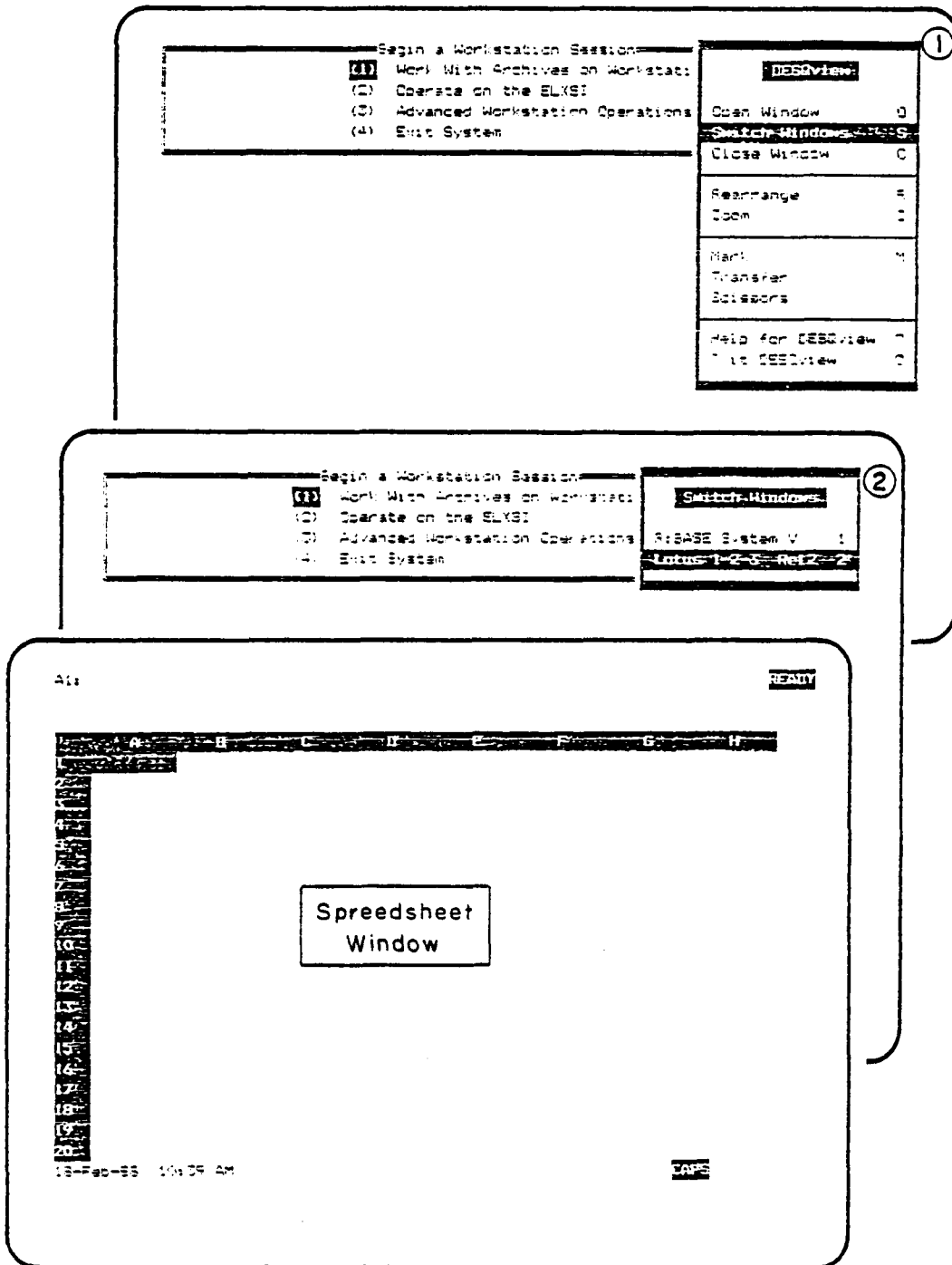
If you know the window number you can go directly to it by tapping the [ALT] key and typing the window number.

The DESQview windows can also be operated by pointing with the cursor keys and selecting with the space bar or by use of a mouse.

Windows can be made smaller so that several can be viewed at once by using the "Zoom" option from the "DESQview" menu (1). Windows can be moved and resized by using the "Rearrange" option (1).

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"HOW TO DO IT" MANUAL H4



H5 "HOW TO DO IT" MANUAL

I. Beginning and Ending Workstation Sessions C. What To Do When Things Go Wrong

Inevitably the Workstation software will not respond as you expect at some point and possibly even "hang up". Diagnosing these problems may require referring to the user's guides for the constituent programs used in the Workstation.

Because the OFQ Workstation software package is a federation of programs not originally designed to work together, there are some complexities to diagnosing problems. This section outlines a general plan of attack for handling problems.

When something appears amiss, first determine if the system will respond to keyboard inputs. It is important to note that many IDH operations trigger DESQview "macros" (canned sequences of operations). These may run for several minutes, during which time the system will generally not respond to (and should not be given) a keyboard input. Be sure a macro is not executing (i.e., make sure the hard disk light is not flashing) and then type something from the keyboard (e.g., [ESC] or [ENTER]).

If there is no response, make sure the operating environment (i.e., DESQview) is intact by tapping the [ALT] key. If the DESQview main menu does not appear the system is "hung" and it will be necessary to reboot (shut down and restart the computer). First attempt a "warm boot" by pressing the [CTRL], [ALT] and [DEL] keys simultaneously. If nothing happens turn off the computer and then turn it back on. Finally restart the Workstation session following the instructions of page H1. Note that in this case the RBASE program (only) will have been terminated abnormally and files may appear in the RBASE directory on the hard disk which should be removed. These temporary files (used by RBASE for sorting large amounts of data) appear with file names consisting of a random appearing alphanumeric string with the extension "\$\$\$" and should be erased at some point.

On the other hand, if the DESQview main menu does appear when the [Alt] key is tapped, type "S" to confirm that the necessary programs are installed in the correct windows. Note that RBASE and Lotus 123 must always appear in the first and second windows respectively; the appearance of other programs depends on what IDH operations have been performed previously. If any necessary programs are missing, reinstall them according to the instructions of page H7.

If all necessary programs appear in the proper windows, but a program is hung in one window, first identify the program and window which is hung. If you are unsure of the window number, tap the [ALT] key to bring up the DESQview main menu, then type "Z" to toggle the zoom until the window border and number appear. Repeat this process to return the window to the full screen mode.

If you can identify the problem program and an error message appears in the window, you may be able to diagnose the trouble by consulting the user's guide for the program. If you cannot restart the program, you can close the window and then reinstall the program according to the procedure of page H7. To close a window tap the [ALT] key, type "C" and then "Y". When all programs are in place, tap [ALT] and type "1" to return to the IDH (the RBASE window) and begin again. This will cause no problems, unless it was window 1 that was closed, in which case an abnormal termination as discussed above will have occurred.

If the above steps do not work, take the rest of the day off and try again tomorrow.

H7 "HOW TO DO IT" MANUAL

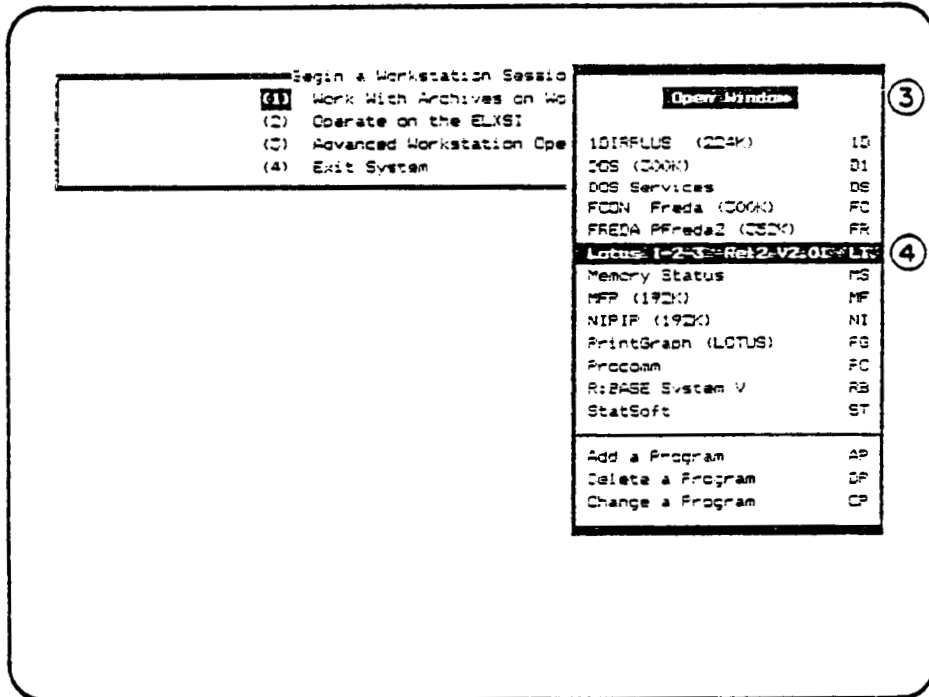
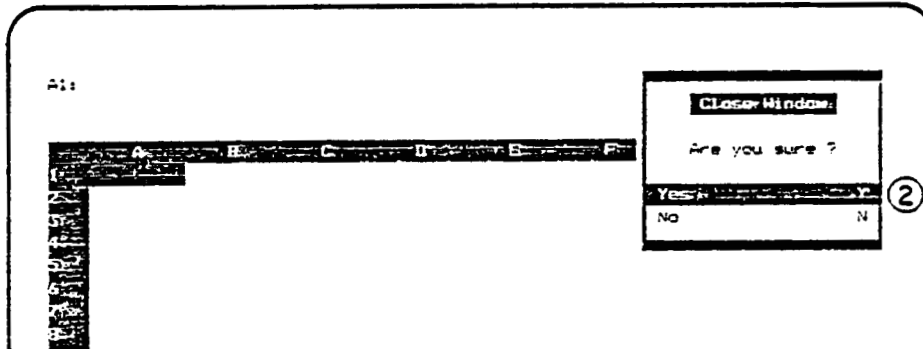
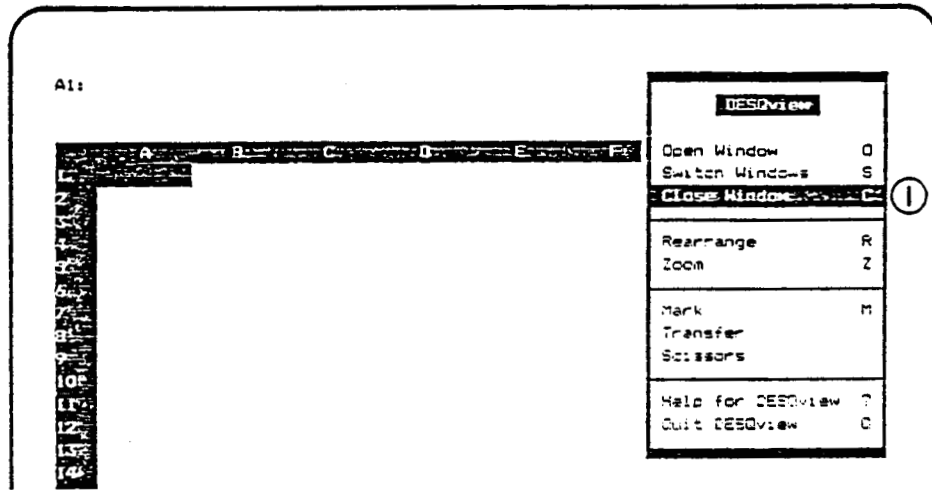
I. Beginning and Ending Workstation Sessions D. Opening Windows and Installing Programs

The IDH will normally open windows and install programs automatically, however you will have occasion to do this manually, especially when problems develop.

As noted in the previous section a program may occasionally hang up in such a way that its window must be closed and then reopened as explained here. For more information consult the DESQview user's guide (Ref. 18).

To close a window, switch to the window that is to be discarded, tap the [ALT] key, type "C" (1) and then "Y" (2).

To open a window and install a program, tap the [ALT] key. When the DESQview main menu pops up, verify that RBASE and LOTUS are installed in the first and second windows respectively and that the window to be opened is now the lowest numbered closed window (3). Type "O" and then select the desired program from the menu by typing its two letter code. As an alternative to the two letter code, move the highlight with the cursor keys (4) and select the desired program by pressing the space bar.



H9 "HOW TO DO IT" MANUAL

I. Beginning and Ending Workstation Sessions

E. Beginning a Workstation Session

When the Workstation software is started the first menu which appears presents three options for working in the IDH.

(1) Work with Archives on Workstation

In this option you can work with flight data available on the Workstation archives stored on the Workstation harddisk or on floppy disks. The Interactive Data Handler is automatically called up. [See page H13]

(2) Operate on the ELXSI

This option is not presently implemented. Access to the ELXSI is made through the telecommunications program as explained on page H93.

(3) Advanced Workstation Operations

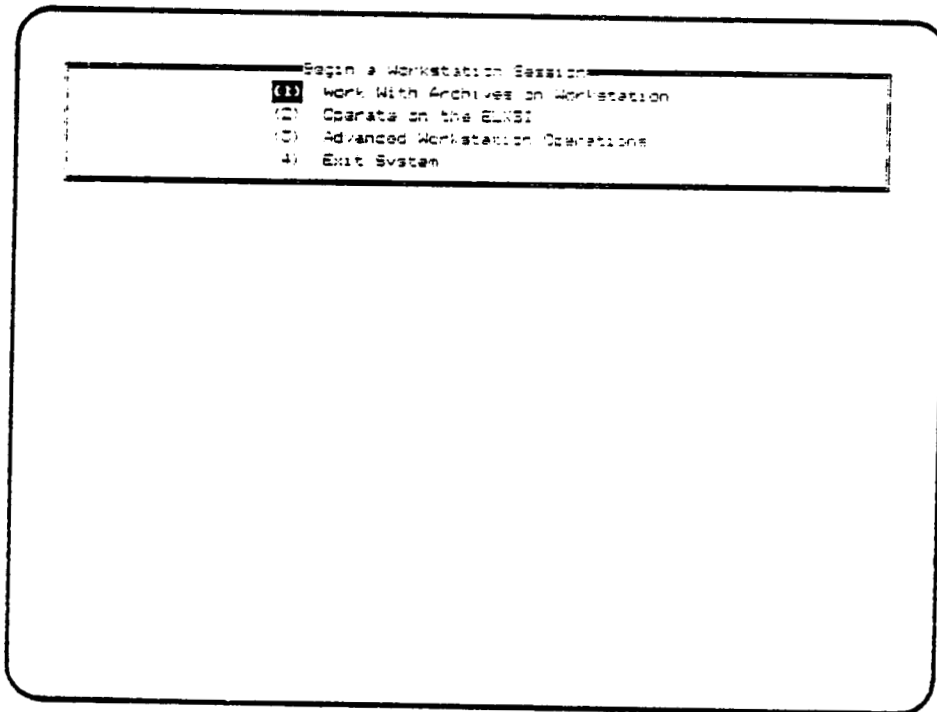
This option not currently implemented and is reserved for future development.

(4) Exit System

This option terminates the Interactive Data Handler application program in the RDBMS. From this point you can either restart the IDH or return to DOS [See page H11].

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"HOW TO DO IT" MANUAL H10



H11 "HOW TO DO IT" MANUAL

- I. Beginning and Ending Workstation Sessions
- F. Ending a Workstation Session

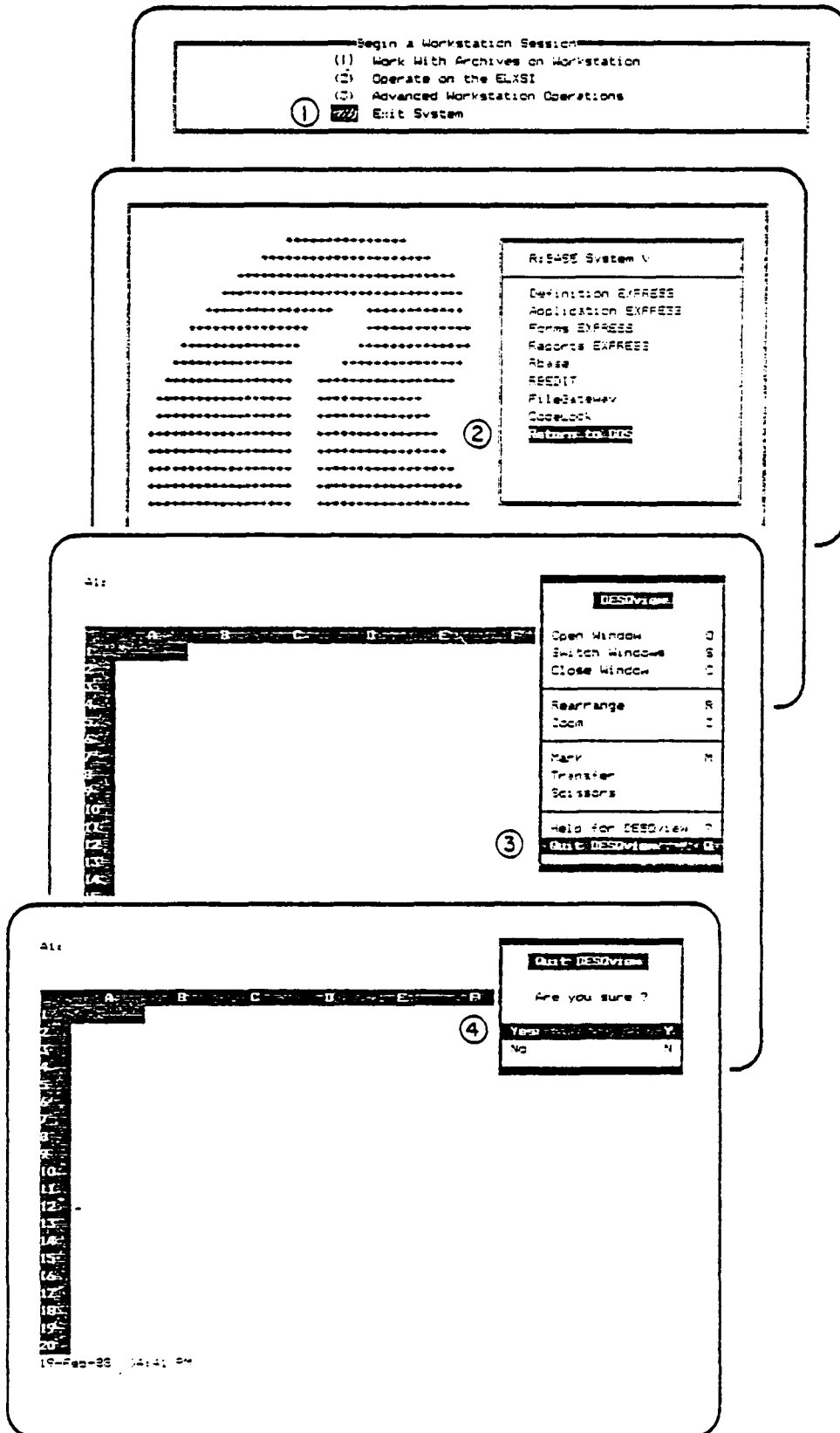
Ending a session on the Workstation is simple, but its important to follow certain steps to avoid loosing data.

Before you shut down the Workstation program at the end of a session, make sure that the current spreadsheet (if any) has been saved if you want to keep it. Likewise make sure any data files generated by FREDA or NIPIP have been saved to disk if they are to be used later.

Next switch to the IDH (RDBMS) window by tapping the [ALT] key and typing "1". Move up the hierarchy of IDH menus (by using the last option in each menu) to the main ("Begin a Workstation Session") menu and select "Exit System," option 4 (1). This will bring up the RBASE main menu. Use the cursor keys to highlight the last option "Return to DOS" (2) and press the [ENTER] key. This will execute a proper exit from the RBASE program and close its window and another window will appear. It is important to perform this step to insure that database information is not lost (Ref. 10).

Next tap the [ALT] key and the DESQview menu will appear. Select the "Quit DESQview" option by typing "Q" (3) and then confirm your desire to exit by typing "Y" in the "Quit DESQview" menu (4). The Workstation program and the window environment will be shutdown and you will be returned to DOS. To restart the workstation program follow the procedures of page H1.

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II. Working with Workstation Archive Files on the Workstation

If you elect to work with the archive data on the Workstation, you might begin by directly examining data for a single mission in the IDH. Later you might study data from multiple missions in the Ensemble database or use specialized analysis programs.

(1) Analyzing Data from a Single Mission

You can bring in data for any available mission into the IDH; however, data for only one mission can be resident in the IDH at one time.

(2) Analyzing Data from an Ensemble of Missions

This option is not presently implemented and should not be selected. Ensemble analysis is presently performed through the spreadsheet component, see page H91.

(3) Use Specialized Analysis Programs

These programs are presently accessed through the DESQview menu, see page H25.

(4) Return to the Previous Menu

This option returns you to the first system menu -- the "Begin a Workstation Session" menu.

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"HOW TO DO IT" MANUAL H14

Begin a Workstation Session

- (1) Work With Archives on Workstation
- (2) Operate on the ELXSI
- (3) Advanced Workstation Operations
- (4) Exit System

Work with Archives on Workstation

- (1) Analyze Data from a single Mission
- (2) Analyze Data from an Ensemble of Missions
- (3) Use Specialized Analysis Programs
- (4) Return to the Previous Menu (Begin a Workstation Session)

H15 "HOW TO DO IT" MANUAL

II. Working with Workstation Archive Files on the Workstation A. Analyzing Data from a Single Mission

When flight data from any mission is to be operated on, it must first be made "resident" in the IDH. You can bring data into the IDH for any available mission; however, data can be resident for only one mission at a time.

(1) Bringing in Data for a Mission

This option is used to bring signal data for some mission into the IDH from either the hard disk or from diskettes. This mission remains "resident" in the IDH until data for another mission is brought in. [See page H17]

(2) Deleting a Mission from the Database

This option provides a means of removing a time history data table from the IDH database on the hard disk. It would ordinarily be used only if more mission data is to be added and there is insufficient room in the database. The data can be restored from the Workstation Archive floppy disks using option 1. [See page H23]

(3) Sending Data to Analysis Programs

This option provides a means to select a subset of the resident mission data and transfer it to more specialized analysis programs installed in the Workstation. These programs include the spreadsheet program for quickly exploring new analysis ideas and the FREDA, MFP and NIPIP programs for more specialized analysis. [See page H25]

(4) Send Data to the Ensemble Database

This option is not presently implemented and should not be selected. Ensemble analysis is currently performed through the spreadsheet component [see page H91].

(5) Return to the Previous Menu

This option returns you to the "Work with Archives on the Workstation" menu.

Begin a Workstation Session

- (1) Work With Archives on Workstation
- (2) Operate on the ELXSI
- (3) Advanced Workstation Operations
- (4) Exit System

Work with Archives on Workstation

- (1) Analyze Data from a single Mission
- (2) Analyze Data from an Ensemble of Missions
- (3) Use Specialized Analysis Programs
- (4) Return to the Previous Menu (Begin a Workstation Session)

Analyze Data from a Single Mission

- (1) Bring in Data for a Single Mission
- (2) DELETE a Mission from the Database
- (3) Send Data to Analysis Programs
- (4) Send Data to Ensemble Database
- (5) Return to Previous Menu (Work with Archives on Workstation)

H17 "HOW TO DO IT" MANUAL

II. Working with Workstation Archive Files on the Workstation

A. Analyzing Data from a Single Mission

1. Bringing in Data for a Mission

When flight data from any mission is to be operated on, it must first be made "resident" in the IDH. This is easiest to do if the data is stored in the IDH database on the hard disk. Otherwise it must be obtained from the Workstation archive diskettes.

To make a mission "resident" in the IDH select option 1 in the IDH "Analyze Data from a Single Mission" Menu. When the "Bring in Data for a Mission" menu appears on the screen type "1" and the mission data acquisition will begin. What happens next depends on whether or not the mission data desired is in the IDH database on the hard disk. If it is, a form will be displayed listing only the missions available in the IDH database (i.e., on the hard disk). One of these missions may be selected by following the instructions of page H19.

If the mission data exists on the workstation archives diskettes, but is not presently in the IDH database on the hard disk, a different series of menus will appear to prompt you to enter the proper diskettes according to the instructions of page H21.

If the mission data does not exist on the workstation archive, but does exist on the ADFRF ELXSI, workstation archive files may be created using the procedures of page H111 and then be accessed by the above procedure.

Begin a Workstation Session

- (1) Work With Archives on Workstation
- (2) Operate on the ELXSI
- (3) Advanced Workstation Operations
- (4) Exit System

Work with Archives on Workstation

- (1) Analyze Data from a single Mission
- (2) Analyze Data from an Ensemble of Missions
- (3) Use Specialized Analysis Programs
- (4) Return to the Previous Menu (Begin a Workstation Session)

Analyze Data from a Single Mission

- (1) Bring in Data for a Single Mission
- (2) DELETE a Mission from the Database
- (3) Send Data to Analysis Programs
- (4) Send Data to Ensemble Database
- (5) Return to Previous Menu (Work with Archives on Workstation)

Bring in Data for a Mission

- (1) Select the Mission
- (2) Return to Previous Menu

II. Workstation Archive Files on the Workstation

A. Analyzing Data from a Single Mission

1. Bringing in Data for a Mission

a) Bringing in Data from the IDH Database on the Hard Disk

If you chose to bring a mission into the IDH and it exists on the hard disk, a special form will be displayed from which you can select the desired mission and data set.

When you choose option 1 "Select a Mission" in the "Bring in Data for a Mission" menu (1), a special "SELECT THE MISSION" form will appear. If a mission data set is presently resident its code will appear in the upper right (2). The last line of the form (3) displays one line from a list of information for mission datasets which are available in the Workstation archives. All of the available data sets can be reviewed by pressing the [F8] key to move down the list or pressing [F7] to move up the list. Landing data set names begin with the prefix "Land" followed by the mission number and terminal area data sets have the prefix "STS-".

When you find the data set you wish to make resident make sure it is displayed in the information line (3), then select "Edit" in the "Mission Selection Form Commands" box (4) at the top of the form and type a "#" sign in the Resident Mission column (5). Next press the [Esc] key and select "Quit" when the command box (5) reappears. If the data set presently exists in the IDH database on the hard disk it will be made resident. Otherwise, if the data set is available as a Workstation archive file, you will be prompted to enter Workstation archive diskettes according to the procedure explained in the next section.

Begin a Workstation Session

- (1) Work With Archives on Workstation
- (2) Operate on the ELXSI
- (3) Advanced Workstation Operations
- (4) Exit System

Work with Archives on Workstation

- (1) Analyze Data from a single Mission
- (2) Analyze Data from an Ensemble of Missions
- (3) Use Specialized Analysis Programs
- (4) Return to the Previous Menu (Begin a Workstation Session)

Analyze Data from a Single Mission

- (1) Bring in Data for a Single Mission
- (2) DELETE a Mission from the Database
- (3) Send Data to Analysis Programs
- (4) Send Data to Ensemble Database
- (5) Return to Previous Menu (Work with Archives on Workstation)

Bring in Data for a Mission

- (1) Select the Mission
- (2) Return to Previous Menu

4 **Exit** Quit Mission Selection Form Commands

SELECT THE MISSION Resident Mission : STS-5 (2)

Press (F7) or (F8) to Cycle New Missions

Choose New Mission by placing a (*) in the Res. Mission column

Res. Mission	Mission No.	Entry Date	Landing Site	Runway	Orbiter	Commander
(5) *	STS-2	11/14/81	Edwards (3)	#23 lake	Columbia	J. H. Engle

(ESC) Done (F7) Clear Field (Shift-F7) Clear to end (Shift-F10) More
 Form=Data Form=Tablet=Mission Fields=MissFlag Page=1

H21 "HOW TO DO IT" MANUAL

- II. Working with Workstation Archive Files on the Workstation
 - A. Analyzing Data from a Single Mission
 - 1. Bringing in Data for a Mission
 - b) Bringing in Data from Floppy Disks
-

When you select a mission that does not exist on the hard disk, you will be prompted to insert the Workstation archive diskettes in drive A.

After you select the data set you wish to make resident as discussed in the previous section, the IDH will search for the data set on the hard disk. However, if the mission is not available there, you will be prompted to insert the Workstation archive diskettes to load the data set on the hard disk. Next locate the workstation archive diskettes for the selected mission and insert the first data disk in drive A and press [ENTER] (1). The IDH will display the diskette number and request a confirmation to proceed (2). Type "y" and press [ENTER]. The floppy drive light will stay on until you are prompted to insert the next disks (3) and (4).

Note that you may abort the data restoration process by pressing "E" at the "Press [ENTER] to continue, or E to exit" prompt to return to the "Analyze Data from a Single Mission" menu (5).

After the last data disk has been restored the IDH will return you to "Analyze Data from a Single Mission" menu (5).

Please insert next disk...
Press [ENTER] to continue, or E to exit.
Insert LANDS MISSION DataDisk 1 in Drive A

1

Please insert next disk...
Press [ENTER] to continue, or E to exit.
This is disk 1, proceed with restore? (y/n)/y

2

Please insert next disk...
Press [ENTER] to continue, or E to exit.
This is disk 1, proceed with restore? (y/n)/y
Please insert next disk...
Press [ENTER] to continue, or E to exit.

3

Please insert next disk...
Press [ENTER] to continue, or E to exit.
This is disk 1, proceed with restore? (y/n)/y
Please insert next disk...
Press [ENTER] to continue, or E to exit.
This is disk 2, proceed with restore? (y/n)/y

4

Analyze Data from a Single Mission

1	Bring in Data for a Single Mission
2	DELETE a Mission from the Database
3	Send Data to Analysis Programs
4	Send Data to Ensemble Database
5	Return to Previous Menu (Work with Archives on Workstation)

5

H23 "HOW TO DO IT" MANUAL

II. Working with Workstation Archive Files on the Workstation

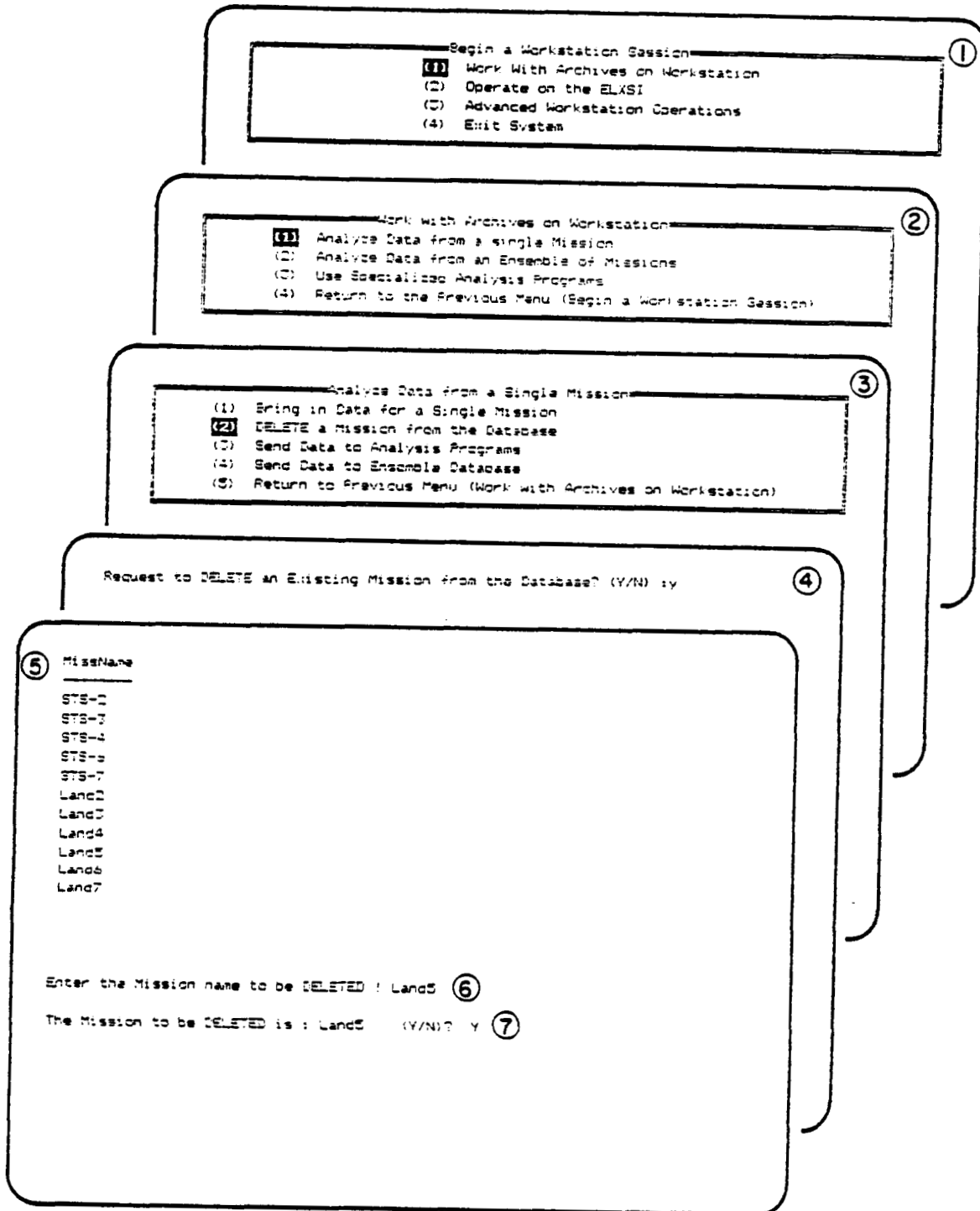
A. Analyzing Data from a Single Mission

2. Deleting a Mission from the Database

This option is used if a mission data set is to be added and there is insufficient room in the database. This option will remove a time history data table from the IDH database on the hard disk.

To remove a mission from the IDH database, use option 2 "DELETE a Mission from the database" from the "Analyze Data from a Single Mission" menu (3). You will be presented with the message "Request to DELETE an Existing Mission from the database? (Y/N):" (4). Type "y" and press [ENTER]. The IDH will display the list of missions that are currently on the hard disk (5) and prompt you to enter the mission name to be deleted (6). Type in the mission name as it appears in the list of missions and press [ENTER]. The IDH will confirm the mission to be deleted with a "(Y/N)?" prompt (7). Type "y" and press [ENTER] to delete the mission.

If you type "n" and press [ENTER] when a "(Y/N)?" prompt appears as in (4) or (7) the IDH will return you to the "Analyze Data from a Single Mission" menu (3).



H25 "HOW TO DO IT" MANUAL

- II. Working with Workstation Archive Files on the Workstation
- A. Analyzing Data from a Single Mission
- 3. Sending Data to Analysis Programs

This menu provides for the use of one of three analysis programs: a spreadsheet, FREDA or NIPIP.

A primary use of the IDH is to select a subset of resident signals over any subinterval of the resident time segment and send this to an analysis program. Alternatively you can reuse a data subset previously defined.

(1) Send Data to a Spreadsheet

This option allows you to select up to 10 resident signals and send them to a blank spreadsheet. [See the following discussion]

(2) Send Data to FREDA

You can send two signals (an input and an output) to FREDA for spectral analysis using option 2. [See page H41]

(3) Send Data to NIPIP

Signals can be sent to NIPIP using option 3. [See page H55]

(4) Return to Previous Menu

The last option returns you to the "Analyze Data from a Single Mission"

Begin a Workstation Session

- (1) Work With Archives on Workstation
- (2) Operate on the ELXSI
- (3) Advanced Workstation Operations
- (4) Exit System

Work With Archives on Workstation

- (1) Analyze Data from a single Mission
- (2) Analyze Data from an Ensemble of Missions
- (3) Use Specialized Analysis Programs
- (4) Return to the Previous Menu (Begin a Workstation Session)

Analyze Data from a Single Mission

- (1) Bring in Data for a Single Mission
- (2) DELETE a Mission from the Database
- (3) Send Data to Analysis Programs
- (4) Send Data to Ensemble Database
- (5) Return to Previous Menu (Work With Archives on Workstation)

Send Data to Analysis Programs

- (1) Send Data to a Spreadsheet
- (2) Send Data to FREDA
- (3) Send Data to NIRTIP
- (4) Return to Previous Menu

H27 "HOW TO DO IT" MANUAL

- II. Working with Workstation Archive Files on the Workstation
 - A. Analyzing Data from a Single Mission
 - 3. Sending Data to Analysis Programs
 - a. Sending Data to a Spreadsheet
-

You may select up to 10 resident signals and send them to a blank spreadsheet.

(1) Select the Signals Directly

With this option you may select up to 10 signals from a list of all resident signals [See page H29]

(2) Select the Signals by Group

This option is not currently implemented and should not be selected.

If you enter this menu and use option 5 without first selecting signals using option 1, the last signal selection made through this menu will be used.

(3) Review the Selected Signals

This displays the current selection of spreadsheet signals.

(4) Select the Time Segment

An option is available to select a subinterval of the resident time segment. [See page H33]. If you enter this menu and use option 5 to send data without first using option 4, the last time segment selection made through this menu (since mission data was last brought in) will be used.

(5) Transmit to a Blank Spreadsheet

This option allows you to send the signals selected with the above options to a blank spreadsheet. The data is then transmitted and the spreadsheet window is displayed for immediate use. [See page H37]

(6) Transmit Existing Dataset to Spreadsheet

This option allows you to reuse a data set previously defined with option 5. [See page H39]

(7) Return to Previous Menu

This option returns you to the "Send Data to Analysis Programs" menu.

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"HOW TO DO IT" MANUAL H28

Begin a Workstation Session

- (1) Work With Archives on Workstation
- (2) Operate on the ELKSI
- (3) Advanced Workstation Operations
- (4) Exit System

Work with Archives on Workstation

- (1) Analyze Data from a single Mission
- (2) Analyze Data from an Ensemble of Missions
- (3) Use Specialized Analysis Programs
- (4) Return to the Previous Menu (Begin a Workstation Session)

Analyze Data from a Single Mission

- (1) Bring in Data for a Single Mission
- (2) DELETE a Mission from the Database
- (3) Send Data to Analysis Programs
- (4) Send Data to Ensemble Database
- (5) Return to Previous Menu (Work with Archives on Workstation)

Send Data to Analysis Programs

- (1) Send Data to a Spreadsheet
- (2) Send Data to FREDA
- (3) Send Data to NIPIP
- (4) Return to Previous Menu

Send Data to a Spreadsheet

- (1) Select the Signals Directly
- (2) Select the Signals by Group
- (3) Review the Selected Signals
- (4) Select the Time Segment
- (5) Transmit to a Blank Spreadsheet
- (6) Transmit Existing Dataset to Spreadsheet
- (7) Return to Previous Menu (Send Data to Analysis Program)

II. Working with Workstation Archive Files on the Workstation

A. Analyzing Data from a Single Mission

3. Sending Data to Analysis Programs

a. Sending Data to a Spreadsheet

1) Selecting Signals Directly

With this option you may select up to 10 signals for a spreadsheet by typing a list of signal numbers. A special display of resident signals is available for reference.

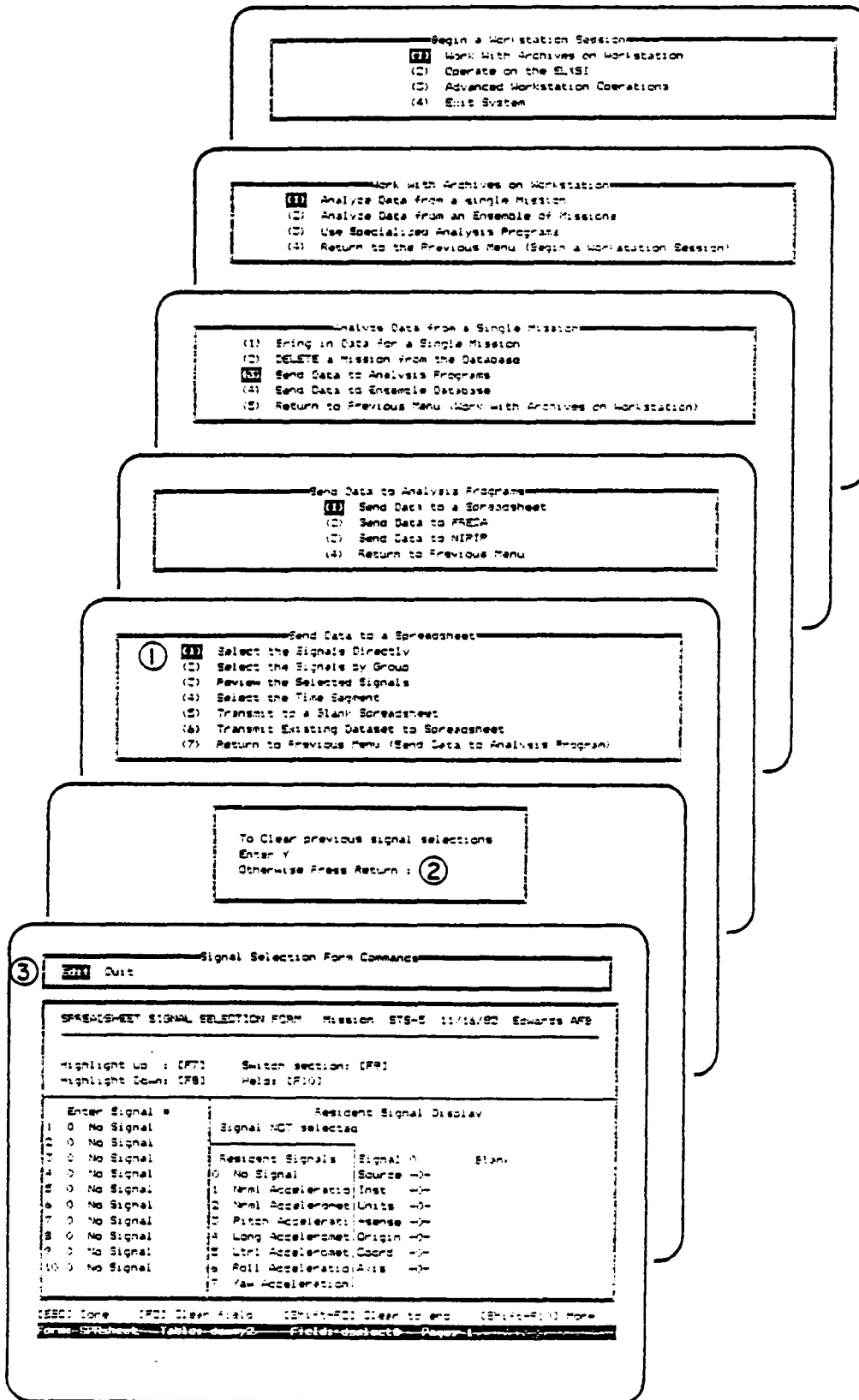
When you select option 1 in the "Send Data to a Spreadsheet" menu (1), you are next given the option of clearing out the previous signal selection by entering "Y" (2). If you wish to begin with the previous selection press the [ENTER] key. In either case a form is displayed which contains a horizontal menu at the top displaying: "Edit" and "Quit" (3). Select Edit and this top menu is replaced by "Press [ESC] when done" and you can begin selecting signals.

The lower left part of the form contains a list (in a box labeled "ENTER Signal#") of up to 10 signals previously selected (unless you cleared these at (2)). You may specify additional signals by typing in their signal numbers. To do this move the highlight to a selection number (leftmost column) using the [F8] key to move down or the [F7] key to move up and type in a signal number which is not already listed.

When you have entered all desired signal numbers, press [ESC] and the form menu reappears, then pick Quit and you will be returned to the previous "Send Data to a Spreadsheet" menu. If you should wish to change the selection number of a previously selected signal you must first change the signal number to zero, quit the form and then return to reselect the signal in a new position.

To aid you in finding the signal numbers you need, a signal information display is available in the lower right part of the screen with 2 subsections. Press [F9] repeatedly to move among the three signal display areas on the form. The center area contains a list of resident signals and to the right of that detail information is displayed for the resident signal highlighted in the center list. You can move the highlight up and down the resident signal list with the [F7] and [F8] keys. The list will scroll to reveal all resident signals. If a signal is not resident for the current mission (displayed at the upper right of the form) it cannot be selected.

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H31 "HOW TO DO IT" MANUAL

- II. Working with Workstation Archive Files on the Workstation
 - A. Analyzing Data from a Single Mission
 - 3. Sending Data to Analysis Programs
 - a. Sending Data to a Spreadsheet
- 2) Reviewing the Selected Signals
-

This option displays a summary of the signals that are presently selected to be sent to a spreadsheet.

When you select option 3 in the "Send Data to a Spreadsheet" menu a special form appears which displays a list, in the lower left, of up to 10 signals which have been selected.

Detail information about the signals in the list can be displayed on the right. The resident signals can be highlighted by switching sections with the [F9] key and moving the highlight down with the [F8] key or up with the [F7] key.

When you have finished reviewing the form press the [ENTER] or [ESC] key and you will be returned to the "Send Data to a Spreadsheet" menu.

Begin a Workstation Session

- (1) Work With Archives on Workstation
- (2) Operate on the ELXSI
- (3) Advanced Workstation Operations
- (4) Exit System

Work with Archives on Workstation

- (1) Analyze Data from a single Mission
- (2) Analyze Data from an Ensemble of Missions
- (3) Use Specialized Analysis Programs
- (4) Return to the Previous Menu (Begin a Workstation Session)

Analyze Data from a Single Mission

- (1) Bring in Data for a Single Mission
- (2) DELETE a Mission from the Database
- (3) Send Data to Analysis Programs
- (4) Send Data to Ensemble Database
- (5) Return to Previous Menu (Work with Archives on Workstation)

Send Data to Analysis Programs

- (1) Send Data to a Spreadsheet
- (2) Send Data to FREDA
- (3) Send Data to NIPAP
- (4) Return to Previous Menu

Send Data to a Spreadsheet

- (1) Select the Signals Directly
- (2) Select the Signals by Group
- (3) Review the Selected Signals
- (4) Select the Time Segment
- (5) Transmit to a Blank Spreadsheet
- (6) Transmit Existing Database to Spreadsheet
- (7) Return to Previous Menu (Send Data to Analysis Program)

Review of Selected Signals

SPREADSHEET SIGNALS SELECTED Mission: Land2 11/14/81 Edwards AFB

Highlight Up : [CF7] Switch section: [CF9]
Highlight Down: [CF8] Help: [CF10]

Selected Signal #	Resident Signal Display
1 2 Nml Acceleromet	Acceleration normal to trajectory
2 3 Pitch Rate	
3 4 Long Acceleromet	Resident Signals Signal 1 AN
4 5 Pitch Accelerati	0 No Signal Source CINE
5 11 Vertical Speed	1 Nml Acceleratio Inst CINE
6 20 Pitch Attitude	2 Nml Acceleromet Units Ft/Sec/Sec
7 18 Mach Number	3 Pitch Accelerati -sense Up
8 22 Elevator Deflect	4 Long Acceleromet Origin Straight line trajectory
9 40 FWD Pitch SPOS	5 Long Acceleromet Coord Trajectory axes
10 47 Wind Velocity	6 Roll Acceleratio Axis Z
	7 Yaw Acceleration

[ESC] Done [CF2] Clear Field [Shift-F2] Clear to end [Shift-F10] Help
Form:SPRDView;Table:SIGSEL;Field:signal;Page:1

H33 "HOW TO DO IT" MANUAL

- II. Working with Workstation Archive Files on the Workstation
 - A. Analyzing Data from a Single Mission
 - 3. Sending Data to Analysis Programs
 - a. Sending Data to a Spreadsheet
 - 3) Selecting the Time Segment
-

Presently only one option is implemented for specifying the time segment desired within that currently resident.

(1) Specify Start & End Times

You may select a time segment by directly specifying start and end times which are within the resident time segment in the IDH.

(2) Specify Start & End Events

This option is not currently implemented and should not be selected.

(3) Specify Criteria on Signals

This option is not currently implemented and should not be selected.

(4) Return to Previous Menu

This option returns you to the "Send Data to a Spreadsheet" menu.

- Begin a Workstation Session
- (1) Work With Archives on Workstation
 - (2) Operate on the SLXSI
 - (3) Advanced Workstation Operations
 - (4) Exit System

- Work With Archives on Workstation
- (1) Analyze Data from a single Mission
 - (2) Analyze Data from an Ensemble of Missions
 - (3) Use Specialized Analysis Programs
 - (4) Return to the Previous Menu (Begin a Workstation Session)

- Analyze Data from a Single Mission
- (1) Bring in Data for a Single Mission
 - (2) DELETE A Mission from the Database
 - (3) Send Data to Analysis Programs
 - (4) Send Data to Ensemble Database
 - (5) Return to Previous Menu (Work with Archives on Workstation)

- Send Data to Analysis Programs
- (1) Send Data to a Spreadsheet
 - (2) Send Data to FREDA
 - (3) Send Data to NIRIP
 - (4) Return to Previous Menu

- Send Data to a Spreadsheet
- (1) Select the Signals Directly
 - (2) Select the Signals by Group
 - (3) Review the Selected Signals
 - (4) Select the Time Segment
 - (5) Transmit to a Blank Spreadsheet
 - (6) Transmit Existing Database to Spreadsheet
 - (7) Return to Previous Menu (Send Data to Analysis Program)

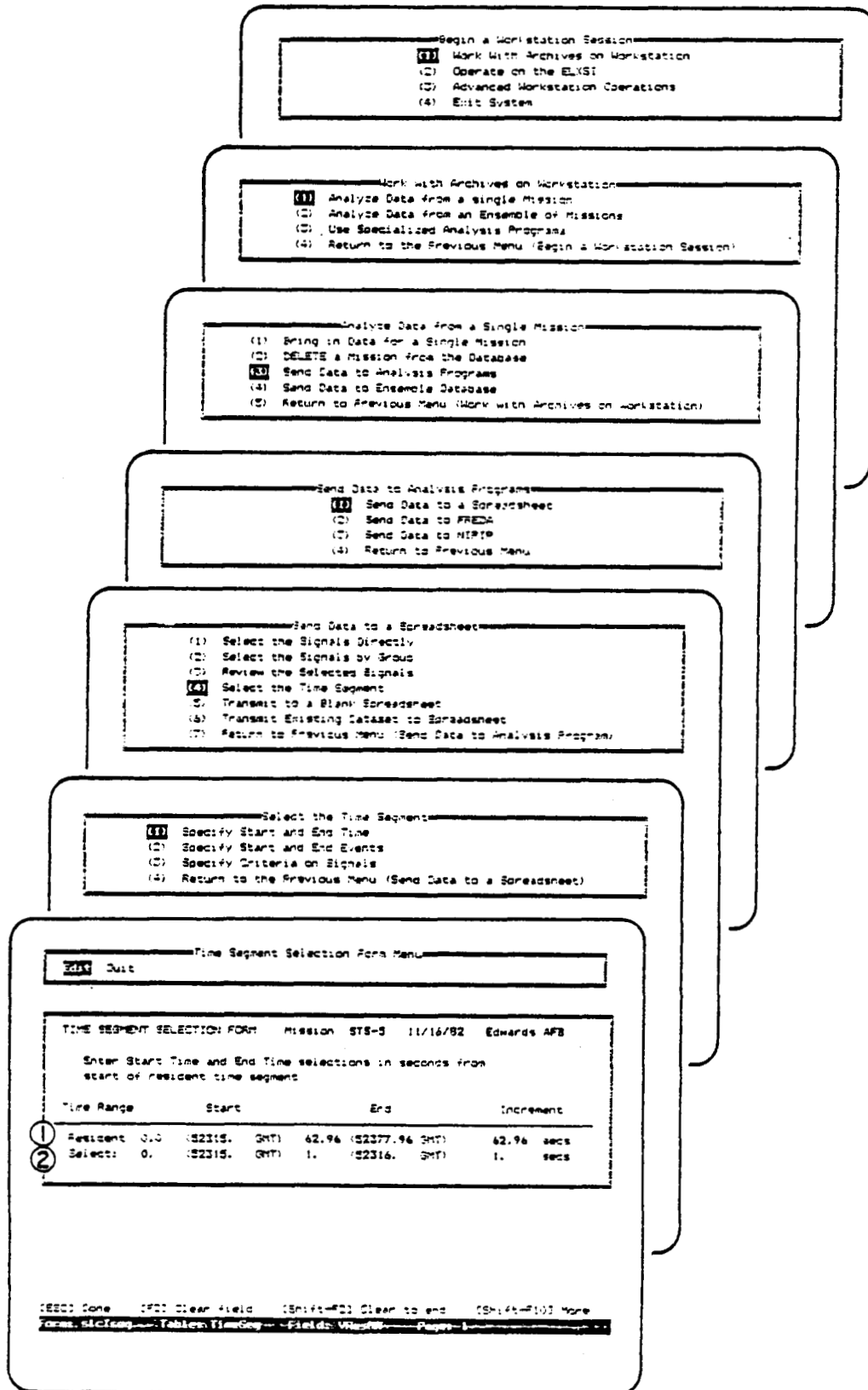
- Select the Time Segment
- (1) Specify Start and End Time
 - (2) Specify Start and End Events
 - (3) Specify Criteria on Signals
 - (4) Return to the Previous Menu (Send Data to a Spreadsheet)

- II. Working with Workstation Archive Files on the Workstation
 - A. Analyzing Data from a Single Mission
 - 3. Sending Data to Analysis Programs
 - a. Sending Data to a Spreadsheet
 - 3) Selecting the Time Segment
 - a) Specify Start and End Times

You may select a time segment by specifying start and end times within the resident time segment.

When you select option 1 "(1) Specify Start & End Times" in the "Select the Time Segment" menu, a form will appear which displays the resident mission data set code and its time segment in the second line from the bottom (1). The line at the bottom displays the time segment presently selected for the spreadsheet (2). In these two lines the first column contains the start time of the segment measured in seconds from the start of the resident segment. Thus this will always be 0 for the resident segment. The next column (in parentheses) contains the corresponding starting times in Greenwich Mean Time (GMT) secs. The third column contains the end times and the fourth the end times in GMT seconds. The last column contains the length of each time segment.

To change the selected time segment pick "Edit" from the menu at the top of the form, then move the highlight to the selected start or end time fields using the [F7] or [F8] key and enter a new time. The selected GMT times and time increment will be updated automatically. When you have finished press [ESC], then pick "Quit" from the menu at the top of the form and you will be returned to the "Send Data to a Spreadsheet Menu"



II. Working with Workstation Archive Files on the Workstation

A. Analyzing Data from a Single Mission

3. Sending Data to Analysis Programs

a. Sending Data to a Spreadsheet

4) Transmitting Selected Data to a Spreadsheet

This option is used to send the selected data to a blank spreadsheet. The system then switches to the spreadsheet window.

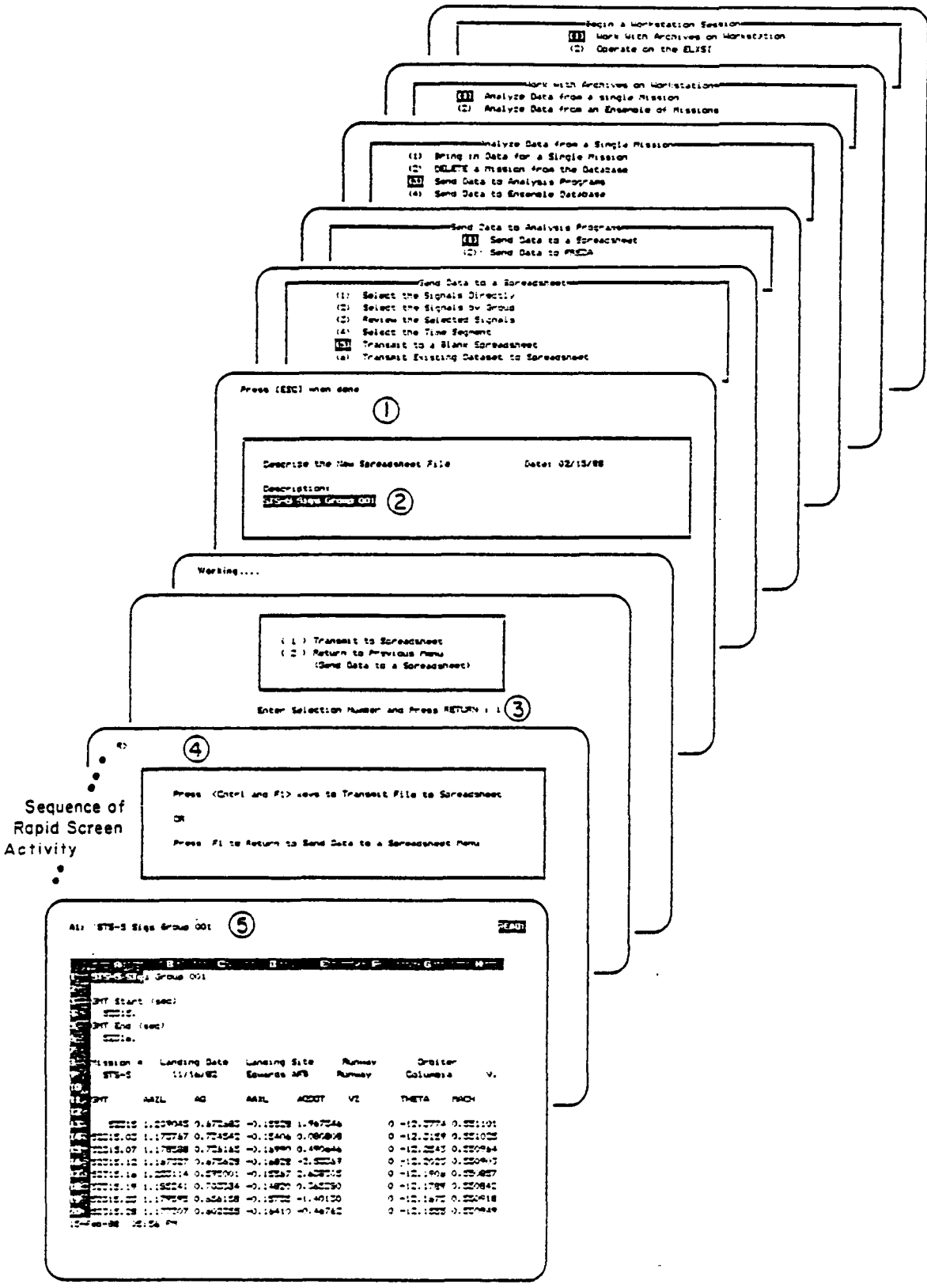
From the "Send Data to a Spreadsheet" menu you have two options for transmitting signal data to a spreadsheet -- i.e. the selected data can be sent to a spreadsheet (Option 5) or a previously defined spreadsheet data set can be retransmitted (Option 6). Option 5 is explained here and Option 6 is explained in the next section.

When you select Option 5, a form appears (1) with a field (2) on the form displayed for you to enter a descriptive name for the spreadsheet. This name is optional, but if entered it will appear on the spreadsheet. When you've finished press [ESC] and the horizontal menu will reappear above the form. Pick "Quit" and the transmission process will begin. The message "Working ... " will appear while database operations are performed.

Next a message will appear (3) which gives you the option of proceeding with the transmission by entering "1" or aborting by entering "2". If you choose to continue with the transmission, another message will eventually appear (4) which again gives you the option of continuing with the transmission by pressing the [Ctrl] and [F1] keys simultaneously or of aborting by pressing only the [F1] key. If you chose to continue, there will be a sequence of rapid screen activity for several minutes. This will terminate when the spreadsheet with the selected data is finally displayed (5).

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"HOW TO DO IT" MANUAL H38



- II. Working with Workstation Archive Files on the Workstation
 - A. Analyzing Data from a Single Mission
 - 3. Sending Data to Analysis Programs
 - a. Sending Data to a Spreadsheet
 - 5) Transmitting an Existing Data Set to a Spreadsheet
-

If you have previously defined a spreadsheet data set using Option 5, you can retransmit it to a spreadsheet with this option.

From the "Send Data to a Spreadsheet" menu you have two options for transmitting signal data to a spreadsheet -- i.e. the selected data can be sent to a spreadsheet (Option 5) or a previously defined spreadsheet data set can be retransmitted (Option 6). Option 6 is explained here.

When you select this option a form appears with a horizontal menu on top (1). Pick "Edit", the menu disappears and one of the spreadsheet data sets previously defined is highlighted. You may view other data set definitions by pressing the [F8] or [F7] keys. When the desired data set is displayed, you may specify it for retransmission by entering a pound sign (#) in the "flag field" (2). (If this is done for more than one data set an error will result). When you've finished press [Esc] and the menu (1) reappears above. Pick "Quit" and the transmission process will begin. The message "Working ... " will appear while database operations are performed.

Next a message will appear (3) which gives you the option of proceeding with the transmission by entering "1" or aborting by entering "2". If you choose to continue with the transmission, another message will eventually appear (4) which again gives you the option of continuing with the transmission by pressing the [Ctrl] and [F1] keys simultaneously or of aborting by pressing only the [F1] key. If you chose to continue, there will be a sequence of rapid screen activity for several minutes. This will terminate when the spreadsheet with the selected data is finally displayed.

- II. Working with Workstation Archive Files on the Workstation
 - A. Analyzing Data from a Single Mission
 - 3. Sending Data to Analysis Programs
 - b. Sending Data to FREDa
-

You may select two resident signals, an input and an output, and send them to FREDa for spectral analysis.

(1) Select the Signals Directly

With this option you may select the input and output signals from a list of all resident signals. [See page H43]

(2) Select the Signals by Group

This option is not currently implemented and should not be selected.

If you enter this menu and use option 5 without first selecting signals using option 1, the last selection made through this menu will be used.

(3) Review the Selected Signals

This option is not currently implemented and should not be selected.

(4) Select the Time Segment

An option is available for you to select a subinterval of the resident time segment. [See page H45]. If you enter this menu and use option 5 to send data without first using option 4, the last time segment selection made through this menu (since mission data was last brought in) will be used.

(5) Create a New FREDa file

This option allows you to send the signals selected with the above options to a new FREDa file. The data is then transmitted and the FREDa window is displayed for immediate use. [See page H49]

(6) Transmit Existing Dataset to Spreadsheet

This option allows you to reuse a data set previously defined with option 5 [see page H51].

(7) Return to Previous Menu

This option returns you to the "Send Data to Analysis Programs" menu.

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"HOW TO DO IT" MANUAL H42

Begin a Workstation Session

- (1) Work With Archives on Workstation
- (2) Operate on the ELXSI
- (3) Advanced Workstation Operations
- (4) Exit System

Work with Archives on Workstation

- (1) Analyze Data from a single Mission
- (2) Analyze Data from an Ensemble of Missions
- (3) Use Specialized Analysis Programs
- (4) Return to the Previous Menu (Begin a Workstation Session)

Analyze Data from a Single Mission

- (1) Bring in Data for a Single Mission
- (2) DELETE a Mission from the Database
- (3) Send Data to Analysis Programs
- (4) Send Data to Ensemble Database
- (5) Return to Previous Menu (Work with Archives on Workstation)

Send Data to Analysis Programs

- (1) Send Data to a Spreadsheet
- (2) Send Data to FREDA
- (3) Send Data to NIPIP
- (4) Return to Previous Menu

Send Data to FREDA

- (1) Select the Signals Directly
- (2) Select the Signals by Group
- (3) Review the Selected Signals
- (4) Select the Time Segment
- (5) Create a New FREDA File
- (6) Use Existing FREDA Dataset
- (7) Return to Previous Menu (Send Data to Analysis Program)

II. Working with Workstation Archive Files on the Workstation

A. Analyzing Data from a Single Mission

3. Sending Data to Analysis Programs

b. Sending Data to a FREDA

1) Selecting Signals Directly

With this option you may select input and output signals for spectral analysis in FREDA. A special display of resident signals is available for reference.

When you select option 1 in the "Send Data to a Spreadsheet" menu (1), a form is displayed which contains a horizontal menu at the top displaying: "Edit" and "Quit" (2). Select Edit and this top menu is replaced by "Press [ESC] when done" and the signal number field for the input signal will be highlighted. The previous selection (if any) can be changed by entering a new signal number. When this is done, the output signal number field is highlighted and a new selection can be made by entering a signal number here. Selections can be revised by moving the highlight with the [F7] and [F8] keys.

When you have selected the desired signal pair, press [ESC] and the form menu will reappear, then pick Quit and you will be returned to the previous "Send Data to a Spreadsheet" menu.

To aid you in finding the signal numbers you need, a signal information display is available in the lower right part of the screen with 2 subsections. Press [F9] repeatedly to move among the three display areas on the form. The center area contains a list of resident signals and to the right of that detail information is displayed for the resident signal highlighted in the center list. You can move the highlight up and down the resident signal list with the [F7] and [F8] keys. The list will scroll to reveal all resident signals. If a signal is not resident for the current mission (displayed at the upper right of the form) it cannot be selected.

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"HOW TO DO IT" MANUAL H44

Begin a Workstation Session

- (1) Work With Archives on Workstation
- (2) Operate on the ELXSI
- (3) Advanced Workstation Operations
- (4) Exit System

Work with Archives on Workstation

- (1) Analyze Data from a single Mission
- (2) Analyze Data from an Ensemble of Missions
- (3) Use Specialized Analysis Programs
- (4) Return to the Previous Menu (Begin a Workstation Session)

Analyze Data from a Single Mission

- (1) Bring in Data for a Single Mission
- (2) DELETE a Mission from the Database
- (3) Send Data to Analysis Programs
- (4) Send Data to Ensemble Database
- (5) Return to Previous Menu (Work with Archives on Workstation)

Send Data to Analysis Programs

- (1) Send Data to a Spreadsheet
- (2) Send Data to FREDA
- (3) Send Data to NIPIP
- (4) Return to Previous Menu

Send Data to FREDA

- (1) Select the Signals Directly
- (2) Select the Signals by Group
- (3) Review the Selected Signals
- (4) Select the Time Segment
- (5) Create a New FREDA File
- (6) Use Existing FREDA Dataset
- (7) Return to Previous Menu (Send Data to Analysis Program)

Press [ESC] when done

```

FREDA SIGNAL SELECTION FORM      Mission STS-5 11/16/80 Edwards AFB
-----
Specify INPUT and OUTPUT Signals
INPUT : 5 Lateral accelerometer
OUTPUT : 4 Longitudinal accel

Highlight UP : [F7]
Highlight DOWN: [F8]
Switch Sections:[F9]
Help: [F10]

Resident Signal Display
Lateral accelerometer signal

Resident Signals  Signal 5      AAY
0 Signal NOT select Source MMLE
1 Acceleration nor Inst ACIP
2 Normal acceleration Units g's
3 Pitch acceleration sense -0-
4 Longitudinal acc Origin Straight flight
5 Lateral accel Coord Bodv axis
6 Roll acceleration axis Y
7 Yaw Acceleration

[ESC] Done [F2] Clear field [Shift-F2] Clear to end [Shift-F10] More
Format: FFreda Tables SIGDEF Fields signals Page 1
    
```

- II. Working with Workstation Archive Files on the Workstation
 - A. Analyzing Data from a Single Mission
 - 3. Sending Data to Analysis Programs
 - b. Sending Data to FREDA
 - 2) Selecting the Time Segment
-

Presently only one option is implemented for specifying the time segment desired within that currently resident.

(1) Specify Start & End Times

You may select a time segment by directly specifying start and end times which are within the resident time segment in the IDH.

(2) Specify Start & End Events

This option is not currently implemented and should not be selected.

(3) Specify Criteria on Signals

This option is not currently implemented and should not be selected.

(4) Return to Previous Menu

This option returns you to the "Send Data to a Spreadsheet" menu.

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"HOW TO DO IT" MANUAL H46

Begin a Workstation Session

- (1) Work With Archives on Workstation
- (2) Operate on the ELXSI
- (3) Advanced Workstation Operations
- (4) Exit System

Work with Archives on Workstation

- (1) Analyze Data from a single Mission
- (2) Analyze Data from an Ensemble of Missions
- (3) Use Specialized Analysis Programs
- (4) Return to the Previous Menu (Begin a Workstation Session)

Analyze Data from a Single Mission

- (1) Bring in Data for a Single Mission
- (2) DELETE a Mission from the Database
- (3) Send Data to Analysis Programs
- (4) Send Data to Ensemble Database
- (5) Return to Previous Menu (Work with Archives on Workstation)

Send Data to Analysis Programs

- (1) Send Data to a Spreadsheet
- (2) Send Data to FREDA
- (3) Send Data to NIPIP
- (4) Return to Previous Menu

Send Data to FREDA

- (1) Select the Signals Directly
- (2) Select the Signals by Group
- (3) Review the Selected Signals
- (4) Select the Time Segment
- (5) Create a New FREDA File
- (6) Use Existing FREDA Dataset
- (7) Return to Previous Menu (Send Data to Analysis Program)

Select the Time Segment

- (1) Specify Start and End Time
- (2) Specify Start and End Events
- (3) Specify Criteria on Signals
- (4) Return to Previous Menu (Send Data to FREDA)

- II. Working with Workstation Archive Files on the Workstation
 - A. Analyzing Data from a Single Mission
 - 3. Sending Data to Analysis Programs
 - b. Sending Data to FREDA
 - 2) Selecting the Time Segment
 - a) Specify Start and End Times

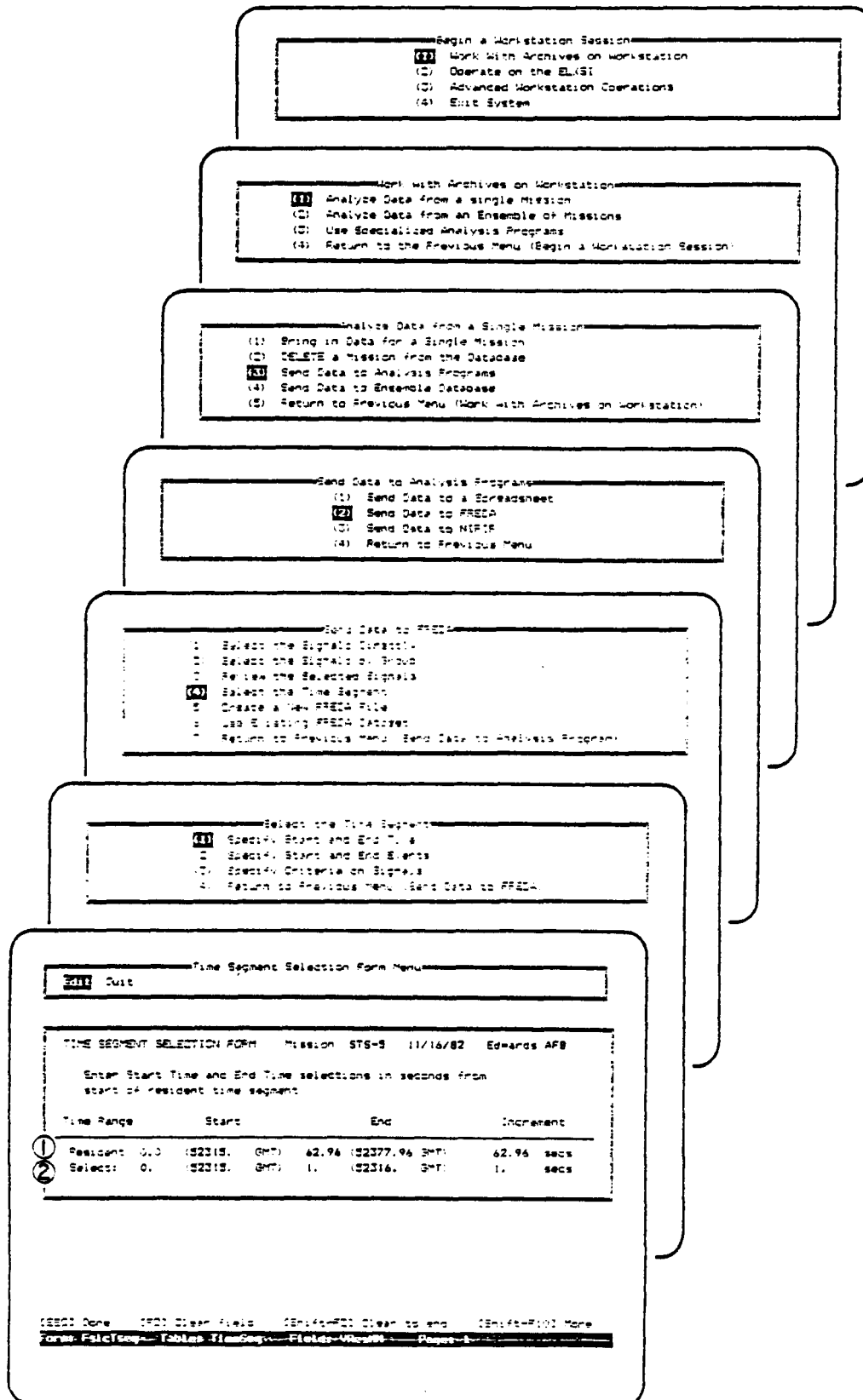
You may select a time segment by specifying start and end times within the resident time segment.

When you select option 1 "Specify Start & End Times" in the "Select the Time Segment" menu, a form will appear which displays the resident mission data set code and its time segment in the second line from the bottom (1). The line at the bottom displays the time segment presently selected for FREDA (2). In these two lines the first column contains the start time of the segment measured in seconds from the start of the resident segment. Thus this will always be 0 for the resident segment. The next column (in parentheses) contains the corresponding starting times in Greenwich Mean Time (GMT) secs. The third column contains the end times and the fourth the end times in GMT seconds. The last column contains the length of each time segment.

To change the selected time segment pick "Edit" from the menu at the top of the form, then move the highlight to the selected start or end time fields using the [F7] or [F8] key and enter a new time. The selected GMT times and time increment will be updated automatically. When you have finished press [ESC], then pick "Quit" from the menu at the top of the form and you will be returned to the "Send Data to FREDA" menu.

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"HOW TO DO IT" MANUAL H48



- II. Working with Workstation Archive Files on the Workstation
 - A. Analyzing Data from a Single Mission
 - 3. Sending Data to Analysis Programs
 - b. Sending Data to FREDA
 - 3) Creating a New FREDA file -- Initial Steps
-

This option is used to send selected signals to FREDA.

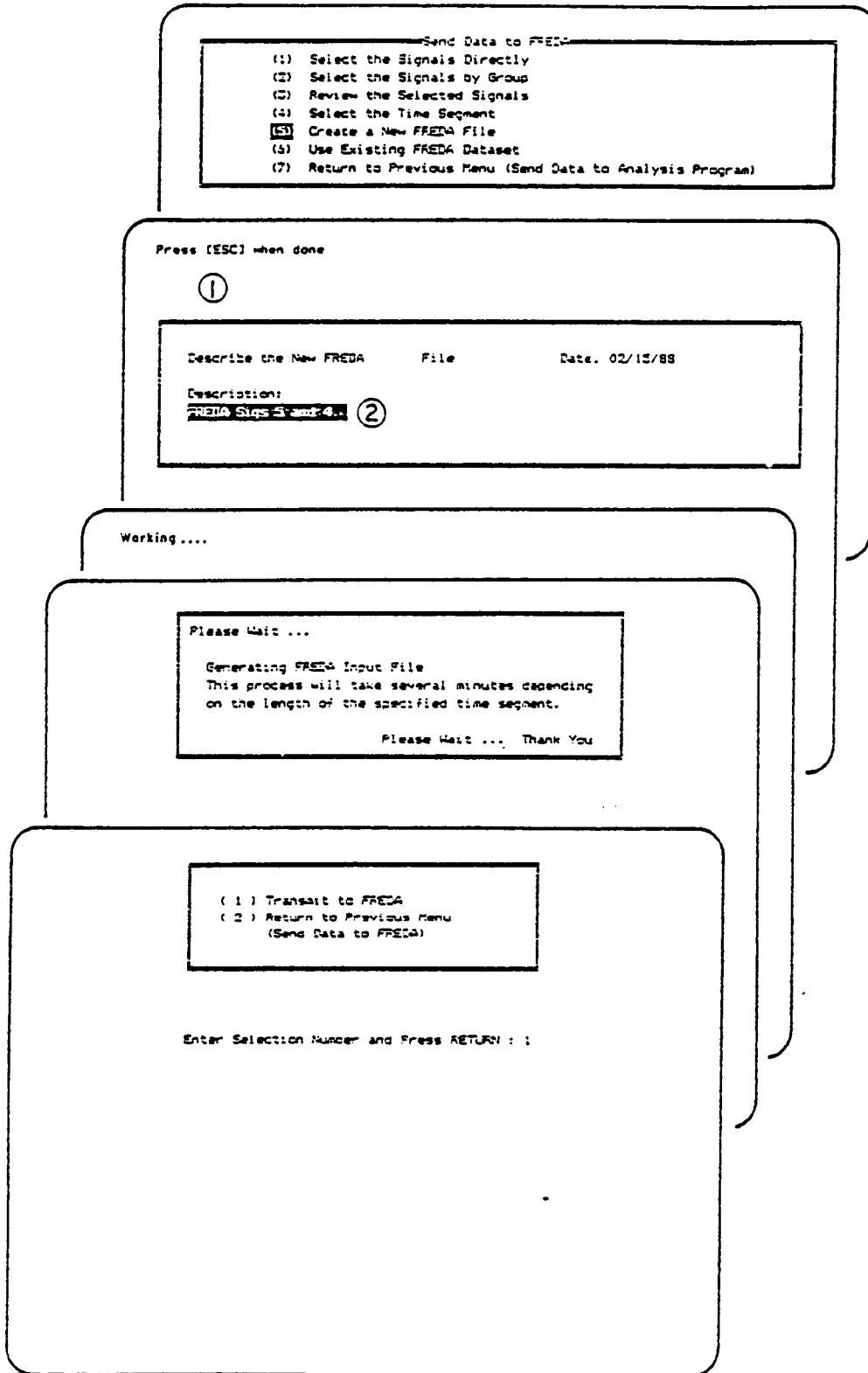
From the "Send Data to FREDA" menu you have two options for creating a FREDA input file -- i.e., the selected data can be sent to a new file (Option 5) or a previously defined FREDA file can be recreated (Option 6). Option 5 is explained here and Option 6 is explained in the next section.

When you select Option 5, a form (1) with a field (2) on the form is displayed for you to enter a descriptive phrase for the data set. This phrase is optional, but if entered it will appear in the file. When you've finished press [ESC] and the horizontal menu reappears above the form. Pick "Quit" and the file creation process will begin.

Completion of the FREDA file generation from this point is the same for Option 5 or Option 6 and is explained on page H53.

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"HOW TO DO IT" MANUAL H50



- II. Working with Workstation Archive Files on the Workstation
 - A. Analyzing Data from a Single Mission
 - 3. Sending Data to Analysis Programs
 - b. Sending Data to FREDA
 - 4) Reusing an Existing FREDA Data Set -- Initial Steps

If you have previously defined a FREDA data set using Option 5, you can reuse it through this option.

From the "Send Data to FREDA" menu you have two options for creating a FREDA input file -- i.e., the selected data can be sent to a new file (Option 5) or a previously defined FREDA file can be recreated (Option 6). Option 6 is explained here.

When you select Option 6 (1), a form appears (2) with information about one of the FREDA data sets previously defined. You may view other data set definitions by pressing the [F8] or [F7] keys. When the desired data set is displayed, you may specify it for recreation by entering a pound sign (#) in the "flag field" (3). (If this is done for more or less than one data set an error will result). When you've finished press [ESC] and a menu reappears above the form. Pick "Quit" and the file recreation process will begin. The message "Working ..." and others will appear while database operations are performed.

Completion of the process from this point is the same as Option 5 and is explained in the next section.

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"HOW TO DO IT" MANUAL H52

Send Data to FREDA

- (1) Select the Signals Directly
- (2) Select the Signals by Group
- (3) Review the Selected Signals
- (4) Select the Time Segment
- (5) Create a New FREDA File
- (6) Use Existing FREDA Dataset**
- (7) Return to Previous Menu (Send Data to Analysis Program)

①

SELECT AN EXISTING DATASET Mission: Land2 11/14/81 Edwards AFB

Press (F7) or (F8) to Cycle through Existing Datasets

Flag the file desired to Transmit by placing a flag in the FLAG FIELD

FLAG FIELD : (0) ③ Data Created : 02/26/88

GMT Start Time: 76965. sec
GMT End Time : 76966. sec

Description: Land2 Group 001

	Signal Name	Signal Description
INPUT	AAY	Lateral accelerometer signal
OUTPUT	AAXL	Longitudinal accelerometer signal

FREDA

②

Working....

Please Wait ...

Generating FREDA Input File

This process will take several minutes depending on the length of the specified time segment.

Please Wait ... Thank You

- (1) Transit to FREDA
- (2) Return to Previous Menu (Send Data to FREDA)

Enter Selection Number and Press RETURN : 1

- II. Working with Workstation Archive Files on the Workstation
 - A. Analyzing Data from a Single Mission
 - 3. Sending Data to Analysis Programs
 - b. Sending Data to FREDa
 - 5) Completing FREDa File Generation
-

Whether FREDa file generation is initiated through Option 5 or 6, it is completed through use of the FCON program.

From the "Send Data to FREDa" menu you have two options for transmitting signal data to FREDa -- i.e., the selected data can be sent to a FREDa file (Option 5 page H49) or a previously defined FREDa data set can be recreated (Option 6 page H51).

In either case the messages "Working ..." and "Please Wait ..." will appear while database operations are performed. Next a message will appear (1) which gives you the option of continuing by pressing the [CTRL] and [F2] keys simultaneously, or of aborting by pressing only the [F2] key. If you choose to continue, another message will eventually appear (2) which gives you the option of proceeding with the file generation by entering "1" or aborting by entering "2." If you chose to continue, there will be a sequence of rapid screen activity for several minutes. This will terminate when the FREDa File Conversion program FCON appears on the screen (3). The IDH will run this program for you until a FREDa binary input file name is required. Enter any valid file name (4) and then type Y (must be upper-case) to confirm its use (5). When prompted for "digitizer sensitivity," enter "10,2048," (6) and complete the session with [Q]. This will close the FCON window and return you to the "Send Data to FREDa" menu.

Operation of FREDa is explained on page H83.

RD

①

Press <Ctrl and FD> keys to Transmit File to FREDA

OR

Press FD to Return to Send Data to FREDA Menu

②

(1) Transmit to FREDA
(2) Return to Previous Menu
(Send Data to FREDA)

Sequence of
Momentary
Screen Displays

Enter Selection Number and Press RETURN :

③

```

D>PCON.EXE
FILE CONVERSION PROGRAM
      03-24-88      23:07:39

ENTER INPUT FILE NAME FREDA.RPT
HEADER IN FILE? Y
PRINT HEADER? Y
Input File for FREDA
Description: AG/CRHC Data
Report Date: 03/24/88      Time: 22:55:28
Mission STS-3 from R:Base System V Database
      3. Seconds at 25 Samples per second
S7504. , GMT Start Time (sec)
S7507. , GMT End Time (sec)

      Signal      Units
INPUT      CR-C      deg
OUTPUT      AG      deg/sec

-----
(EN, FB,0, IX, E12,0, IX, E12,0)
USE FILE FORMAT TO READ DATA? Y
23:08:07
23:08:34
(F)recd, (T)able or (E)xtreme? F
ENTER START SAMPLE NO, ALSO NCHAN 1,2
enter 1 to skip first value per slice, 0, or 1 if not 1
ENTER FREDA BINARY FILE NAME : FRESTN ④
OLD file, write over it ( Y/N )? Y ⑤
data in FREDA BINARY file multiplied by S576
enter digitizer sensitivity = volts, bins 10,000 ⑥
In FREDA SETUP FILE use Overall analog gain = 1,
and a scale factor (units/volt) = 330.78
    
```

- II. Working with Workstation Archive Files on the Workstation
 - A. Analyzing Data from a Single Mission
 - 3. Sending Data to Analysis Programs
 - c. Sending Data to NIPIP
-

You may select up to 10 resident signals and send them to a NIPIP input file.

(1) Select the Signals Directly

With this option you may select up to 10 signals from a list of all resident signals. [See page H57]

(2) Select the Signals by Group

This option is not currently implemented and should not be selected.

If you enter this menu and use option 5 without first selecting signals using option 1, the last selection made through this menu will be used.

(3) Review the Selected Signals

This option is not currently implemented and should not be selected.

(4) Select the Time Segment

An option is available for you to select a subinterval of the resident time segment. [See page H59]. If you enter this menu and use option 5 to send data without first using option 4, the last time segment selection made through this menu (since mission data was last brought in) will be used.

(5) Create a New NIPIP file

This option allows you to send the signals selected with the above options to a new NIPIP file. The data is then transmitted and the NIPIP window is displayed for immediate use. [See page H63]

(6) Use Existing NIPIP Dataset

This option allows you to reuse a data set previously defined with option 5 [see page H65].

(7) Return to Previous Menu

This option returns you, to the "Send Data to Analysis Programs" menu.

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"HOW TO DO IT" MANUAL H56

Begin a Workstation Session

- (1) Work With Archives on Workstation
- (2) Operate on the ELXSI
- (3) Advanced Workstation Operations
- (4) Exit System

Work with Archives on Workstation

- (1) Analyze Data from a single Mission
- (2) Analyze Data from an Ensemble of Missions
- (3) Use Specialized Analysis Programs
- (4) Return to the Previous Menu (Begin a Workstation Session)

Analyze Data from a Single Mission

- (1) Bring in Data for a Single Mission
- (2) DELETE a Mission from the Database
- (3) Send Data to Analysis Programs
- (4) Send Data to Ensemble Database
- (5) Return to Previous Menu (Work with Archives on Workstation)

Send Data to Analysis Programs

- (1) Send Data to a Spreadsheet
- (2) Send Data to FREDA
- (3) Send Data to NIPIP
- (4) Return to Previous Menu

Send Data to NIPIP

- (1) Select the Signals Directly
- (2) Select the Signals by Group
- (3) Preview the Selected Signals
- (4) Select the Time Segment
- (5) Create a New NIPIP File
- (6) Use Existing NIPIP Dataset
- (7) Return to Previous Menu (Send Data to Analysis Program)

- II. Working with Workstation Archive Files on the Workstation
 - A. Analyzing Data from a Single Mission
 - 3. Sending Data to Analysis Programs
 - c. Sending Data to NIPIP
 - 1) Selecting Signals Directly
-

With this option you may select up to 10 signals for a NIPIP file by typing a list of signal numbers. A special display of resident signals is available for reference.

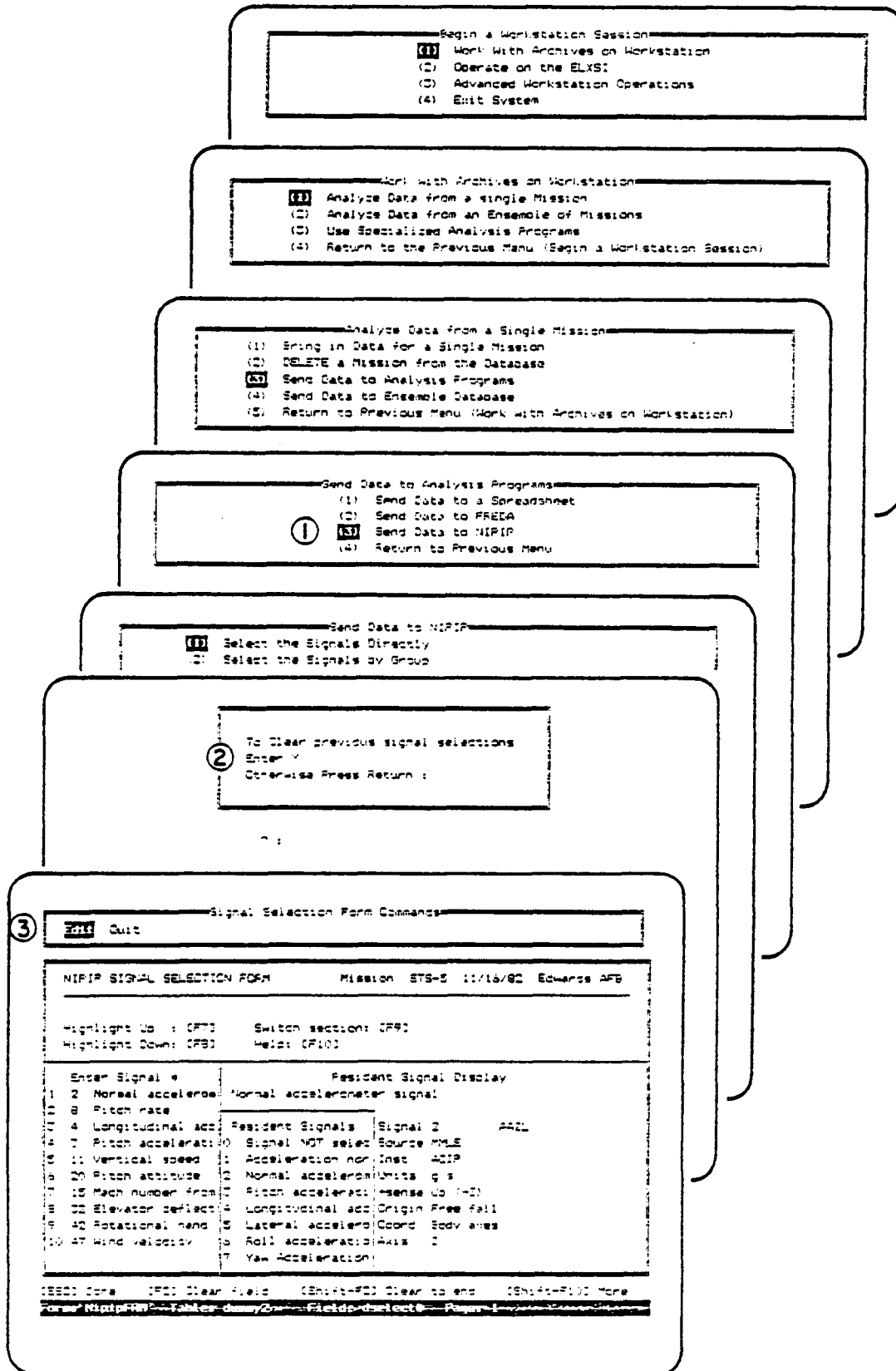
When you select option 1 in the "Send Data to NIPIP" menu (1), you are next given the option of ignoring the previous signal selections (the default) by entering "Y" (2). If you wish to begin with the previous selection, press the [ENTER] key. In either case a form is displayed which contains a horizontal menu at the top displaying: "Edit" and "Quit" (3). Select Edit and this top menu is replaced by "Press [ESC] when done" and you can begin selecting signals.

The lower left part of the form contains a list (in a box labeled "ENTER Signal#") of up to 10 signals previously selected (unless you cleared these at (2)). You may specify additional signals by typing in their signal numbers. To do this move the highlight to a selection number (leftmost column) using the [F8] key to move down or the [F7] key to move up and type in a signal number (second column) which is not already listed.

When you have entered all desired signal numbers, press [Esc] and the form menu reappears, then pick Quit and you will be returned to the previous "Send Data to NIPIP" menu. If you should wish to change the selection number of a previously selected signal you must first change the signal number to zero, quit the form and then return to reselect the signal in a new position.

To aid you in finding the signal numbers you need, a signal information display is available in the lower right part of the screen with 2 subsections. Press [F9] repeatedly to move among the three signal display areas on the form. The center area contains a list of resident signals and to the right of that detail information is displayed for the resident signal highlighted in the center list. You can move the highlight up and down the resident signal list with the [F7] and [F8] keys. The list will scroll to reveal all resident signals. If a signal is not resident for the current mission (displayed at the upper right of the form) it cannot be selected.

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- II. Working with Workstation Archive Files on the Workstation
 - A. Analyzing Data from a Single Mission
 - 3. Sending Data to Analysis Programs
 - c. Sending Data to NIPIP
- 2) Selecting the Time Segment

Presently only one option is implemented for specifying the time segment desired within that currently resident.

(1) Specify Start & End Times

You may select a time segment by directly specifying start and end times which are within the resident time segment in the IDH.

(2) Specify Start & End Events

This option is not currently implemented and should not be selected.

(3) Specify Criteria on Signals

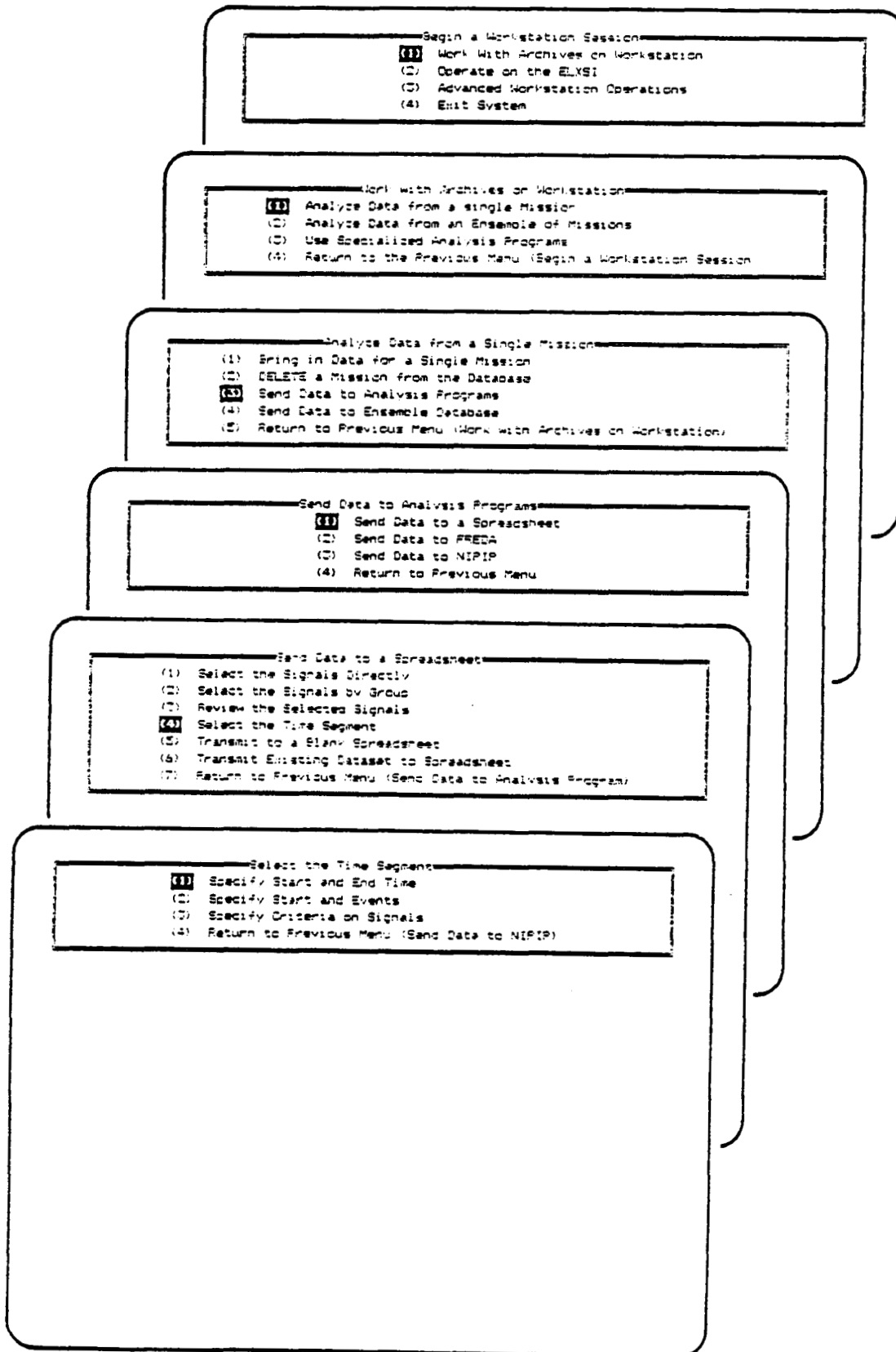
This option is not currently implemented and should not be selected.

(4) Return to Previous Menu

This option returns you to the "Send Data to a Spreadsheet" menu.

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"HOW TO DO IT" MANUAL H60



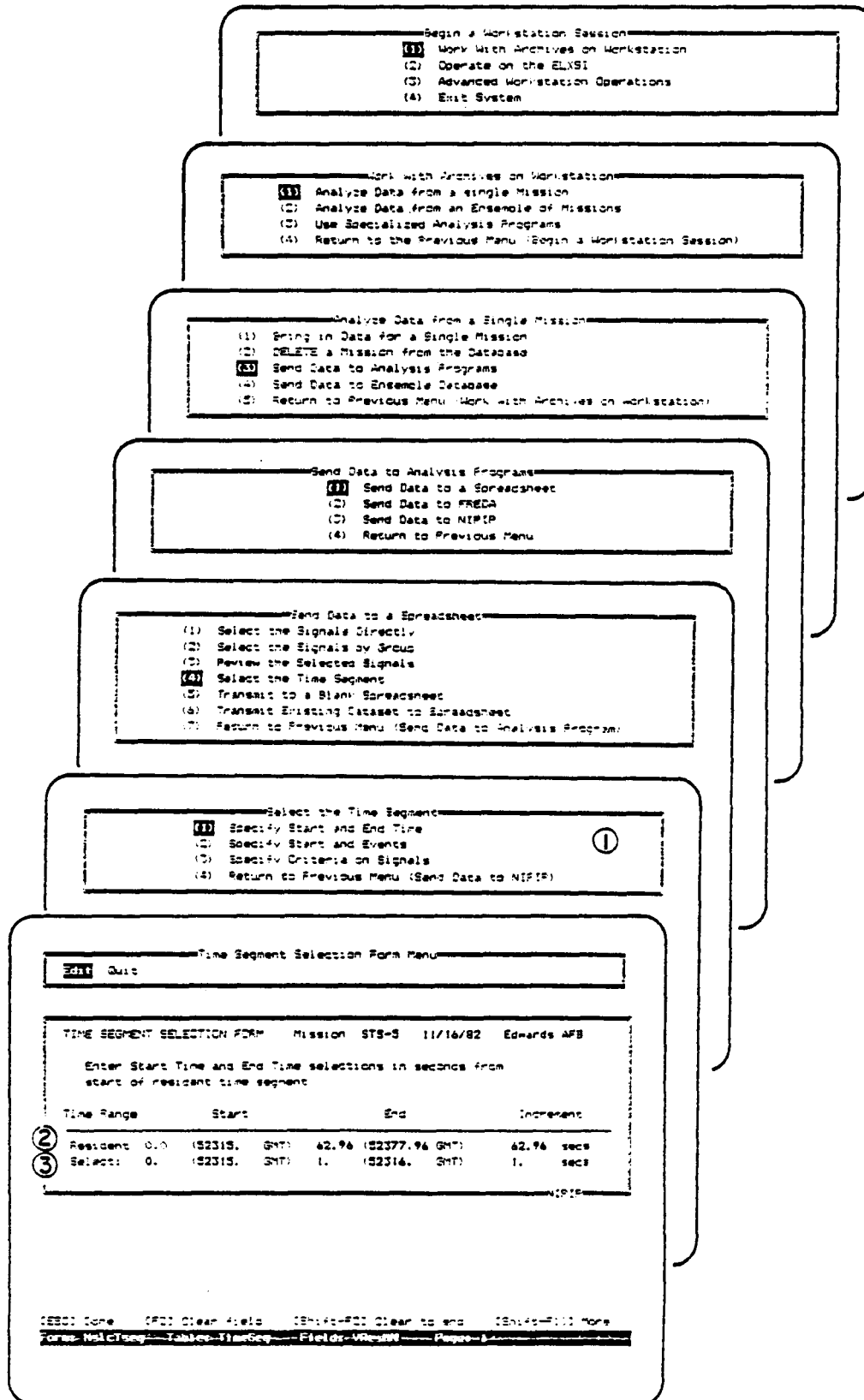
H61 "HOW TO DO IT" MANUAL

- II. Working with Workstation Archive Files on the Workstation
 - A. Analyzing Data from a Single Mission
 - 3. Sending Data to Analysis Programs
 - c. Sending Data to NIPIP
 - 2) Selecting the Time Segment
 - a) Specify Start and End Times

You may select a time segment by specifying start and end times within the time segment resident in the Single Mission database.

When you select "Specify Start & End Times" in the "Select the Time Segment" menu (1), a form appears which displays the resident mission data set code and its time segment in the second line from the bottom (2). The line at the bottom displays the time segment presently selected for NIPIP (3). In these two lines the first column contains the start time of the segment measured in seconds from the start of the resident segment. Thus this will always be 0 for the resident segment. The next column (in parentheses) contains the corresponding starting times in Greenwich Mean Time (GMT) secs. The third column contains the end times and the fourth the end times in GMT seconds. The last column contains the length of each time segment.

To change the selected time segment pick "Edit" from the menu at the top of the form, then move the highlight to the selected start or end time fields using the [F7] or [F8] key and enter a new time. The selected GMT times and time increment will be updated automatically. When you have finished press [Esc], then pick "Quit" from the menu at the top of the form and you will be returned to the "Send Data to NIPIP" menu.



- II. Working with Workstation Archive Files on the Workstation
 - A. Analyzing Data from a Single Mission
 - 3. Sending Data to Analysis Programs
 - c. Sending Data to NIPIP
- 3) Creating a New NIPIP File -- Initial Steps

This option is used to send selected signals to NIPIP. The system then switches to the NIPIP window.

From the "Send Data to NIPIP" menu you have two options for creating a NIPIP input file -- i.e., the selected data can be sent to a new file (Option 5) or a previously defined NIPIP file can be recreated (Option 6). Option 5 is explained here and Option 6 is explained in the next section.

When you select Option 5, a form appears (1) with a field (2) displayed for you to enter a descriptive phrase for the data set. This phrase is optional, but if entered it will appear in the file. When you've finished press [ESC] and the horizontal menu reappears above the form. Pick "Quit" and the file creation process will begin. The message "Working ..." and others will appear while database operations are performed.

Completion of the NIPIP file generation from this point is the same for Option 5 or 6 and is explained on page H67.

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"HOW TO DO IT" MANUAL H64

Send Data to NIPIP

- (1) Select the Signals Directly
- (2) Select the Signals by Group
- (3) Review the Selected Signals
- (4) Select the Time Segment
- (5) Create a New NIPIP File**
- (6) Use Existing NIPIP Dataset
- (7) Return to Previous Menu (Send Data to Analysis Program)

Press (ESC) when done

①

Describe the New NIPIP	File	Date: 02/16/88
Description:		
<u>SIS-S Sigst Group-001</u>		

Working.....

Please Wait ...

Generating NIPIP Inout File
This process will take several minutes depending
on the length of the specified time segment.

Please Wait ... Thank You

(1) Transmit to NIPIP
(2) Return to Previous Menu (Send Data to NIPIP)

Enter Selection Number and Press RETURN : 1

- II. Working with Workstation Archive Files on the Workstation
 - A. Analyzing Data from a Single Mission
 - 3. Sending Data to Analysis Programs
 - c. Sending Data to NIPIP
 - 4) Reusing an Existing NIPIP Data Set -- Initial Steps
-

If you have previously defined a NIPIP data set using Option 5, you can reuse it through this option.

From the "Send Data to NIPIP" menu you have two options for creating a NIPIP input file -- i.e., the selected data can be sent to a new file (Option 5) or a previously defined NIPIP file can be recreated (Option 6). Option 6 is explained here.

When you select Option 6, a form appears (1) with information about one of the NIPIP data sets previously defined (2). You may view other data set definitions by pressing the [F8] or [F7] keys. When the desired data set is displayed, you may specify it for recreation by entering a pound sign (#) in the "flag field" (3). (If this is done for more or less than one data set an error will result). When you've finished press [ESC] and a menu reappears above the form. Pick "Quit" and the transmission file recreation process will begin. The message "Working ..." and others will appear while database operations are performed.

Completion of the process from this point is the same as Option 5 and is explained on page H67.

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"HOW TO DO IT" MANUAL H66

Send Data to NIPIP

- (1) Select the Signals Directly
- (2) Select the Signals by Group
- (3) Review the Selected Signals
- (4) Select the Time Segment
- (5) Create a New NIPIP File
- (6)** Use Existing NIPIP Dataset
- (7) Return to Previous Menu (Send Data to Analysis Program)

①

SELECT AN EXISTING DATASET Mission STS-5 11/16/82 Edwards AFB
Press (F7) or (F8) to Cycle through Existing Datasets
Flag the file desired to Transmit by placing a (*) in the flag field

Flag Field :	(*)	③	Date Created: 02/16/88	52315.	52316.
NIPIP :			STS-5 Sigs Group 001	②	

Signal #	Signal Name	Signal Description
1	AAZL	Normal accelerometer signal
2	AQ	Pitch rate
3	AAXL	Longitudinal accelerometer signal

Working.....

Please Wait ...

Generating NIPIP Input File
This process will take several minutes depending
on the length of the specified time segment.

Please Wait ... Thank You

So ... Why Does the Chicken Cross the ROAD ???

- (1) Transmit to NIPIP
- (2) Return to Previous Menu
(Send Data to NIPIP)

Enter Selection Number and Press RETURN : 2

- II. Working with Workstation Archive Files on the Workstation
 - A. Analyzing Data from a Single Mission
 - 3. Sending Data to Analysis Programs
 - c. Sending Data to NIPIP
 - 5) Completing NIPIP File Generation
-

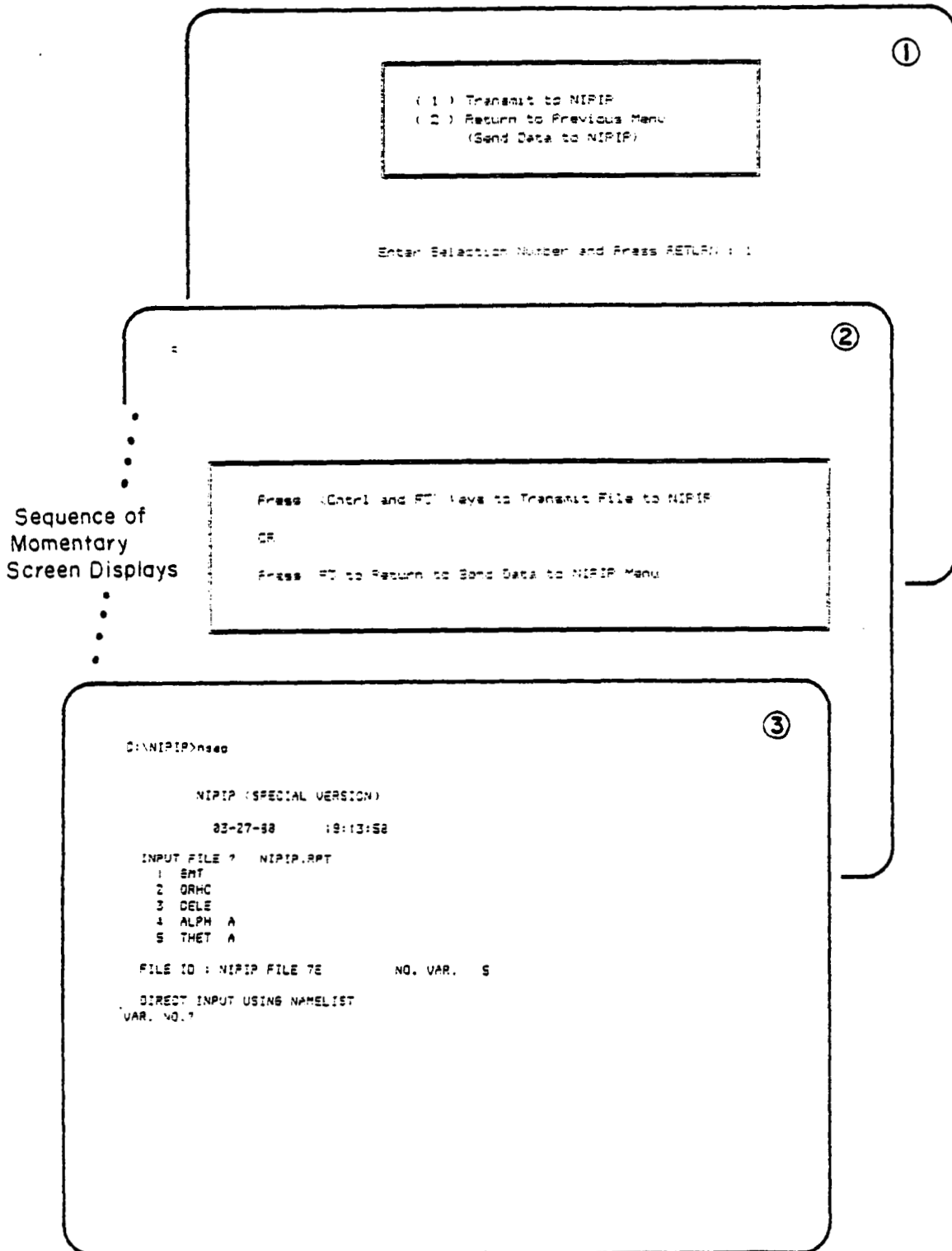
Whether NIPIP file generation is initiated through Option 5 or 6, it is completed in the same way.

From the "Send Data to NIPIP" menu you have two options for NIPIP -- i.e., the selected data can be sent to a new file (Option 5) or a previously defined NIPIP data set can be recreated (Option 6).

When generation of a NIPIP file is initiated with either option, the messages "Working ..." and "Please Wait ..." will appear while database operations are performed. Next a message will appear (1) which gives you the option of proceeding with the file generation by entering "1" or aborting by entering "2." If you choose to continue another message will eventually appear (2) which again gives you the option of continuing by pressing the [CTRL] and [F3] keys simultaneously, or of aborting by pressing only the [F3] key. If you chose to continue, there will be a sequence of rapid screen activity for several minutes. This will terminate when the NIPIP file is written and the NIPIP window appears.

The operation of NIPIP is discussed on page H88.

WARNING: The IDH stores the NIPIP input file on disk under the name "NIPIP.RPT." If there is an earlier data set stored under this name it will be overwritten.



II. Working with Workstation Archive Files on the Workstation

A. Analyzing Data from a Single Mission

4. Analyzing Data in a Spreadsheet

The spreadsheet provides a very convenient, flexible and efficient way of performing unusual or novel analyses on small data sets while avoiding conventional programming.

Up to 10 signals can be automatically transferred into a spreadsheet using the "Send Data to a Spreadsheet" options page H25. Spreadsheets are easy to use once you are familiar with basic operations. This is best obtained by reading the spreadsheet program user's manual (Ref. 11). It is assumed that you are familiar with basic spreadsheet operations, but some points are further explained here to help you get started.

A spreadsheet is a matrix in which each cell can contain a number, text or a formula referring to other cells. When the entries in any cells are changed, the spreadsheet is recalculated so that formulas involving those cells are automatically updated anywhere in the spreadsheet. Special operations are performed through a menu system which appears when you press the [/] key.

When you send data to a spreadsheet from the IDH, each signal appears as a column with Greenwich Mean Time (GMT) in seconds in column A. Up to 10 more signals appear in columns B through K. Anything you add to the spreadsheet should always be to the right of column L to avoid conflicts with existing or future signal columns. Each signal column has a label and above these there is information about the mission, i.e., mission code, landing site, etc.

Ideas on how to use spreadsheets for data analysis can be obtained from working with the example spreadsheets for specific applications which follow. These examples with their "How To Do It" instructions can be used as a tutorial in spreadsheet application. Beyond this, example spreadsheets can be used as "templates." These are spreadsheets with special formulas and organization for specialized analyses to the right of column L. Copies of these templates can be made and then new signal data can be brought into them from the IDH to repeat specialized analyses for multiple missions. This is the first step in performing mission ensemble analysis (page H83). You can create your own spreadsheet templates by following the examples.

Whenever the IDH is used to send data to a spreadsheet, the signals are written into columns A through K overwriting anything already in this region of the spreadsheet. To avoid losing previous work you must know how to save spreadsheets on disk. To do this enter the spreadsheet window and press the [/] key to bring up the menus. Execute File Save (i.e., type "F" then "S") and you will be queried for the file name on which to store the file. If a previously entered name appears it can be accepted by pressing the [ENTER/RETURN] key.

If you wish to use a spreadsheet previously stored on disk, for example a template, first save the current spreadsheet (if you wish to use it again), then execute /File Retrieve and you will be prompted for a file name. If there are any worksheets on the default disk their names will appear on the third line of the menu. You can select one of these files by highlighting it by use of the cursor keys and then pressing [ENTER/RETURN].

H71 "HOW TO DO IT" MANUAL

- II. Working with Workstation Archive Files on the Workstation
 - A. Analyzing Data from a Single Mission
 - 4. Analyzing Data in a Spreadsheet
 - a. Performing Specialized Procedures with a Spreadsheet Template

Special spreadsheet analyses which are to be repeated for several missions can be conveniently implemented on a spreadsheet template. This is a preliminary step toward mission ensemble analysis.

A spreadsheet "template" is simply a spreadsheet that has some specialized equations and macros to the right of the raw signal data area (columns A through K). A set of analyses can be worked out for a set of signals from one mission and then quickly repeated for other missions by bringing in the corresponding signal sets for other missions using the IDH. Several templates are included with the OFQ software to serve as examples as well as for performing special operations.

To use a template, switch to the spreadsheet window, save the old spreadsheet (if any), issue the command sequence /File Retrieve and you will be prompted for template's filename. When the template appears, first clear out the signal area with the command sequence /Range Erase. When you are prompted for the "range to erase" enter A1..K8192. Next switch to the IDH window and transmit the appropriate signal set to the spreadsheet (page H25).

When the data appears in the template, you must initialize the template by executing the "\A" macro. To do this press [A] while holding down the [Alt] key. This macro will read the input signal names, assign some range names and perform other operations that must be done before the template can be used.

Two example templates are included with the OFQ software. The "TEMPLT3.WK1" template can be used to display time histories on the screen for any of up to 10 signals in the spreadsheet. The "TEMPLT1.WK1" is used to perform specialized analysis of manual control in landing such as estimation of the pilot's flare time constant.

WARNING: It should be remembered that templates are just ordinary spreadsheets and you can perform manual operations and modifications as with any spreadsheet. However, as with any spreadsheet, certain operations can prevent template elements from working properly. Thus you should always keep archive copies of the original templates and you should be familiar with general spreadsheet procedures (Ref. 11) and the workings of the template before making modifications.

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K15: 301.2421875 ← Number in Cell K15

READY

	A	B	C	I	J	K	L	M
1	Landing Data							
2	Row Data →							
3	GMT Start (sec)							
4	S8150.							
5	GMT End (sec)							
6	S8184.							
7								
8	Mission #	Landing Date	Commander	Pilot		Incremental		
9	Land#	07/04/82	T. K. Mattingly	H. W. Harts		(secs)	K-- SPRE	
10	GMT	CRHC	AO	ALTTD	ALT	ALTRAD		
11	GMT	CRHC	AO	ALTTD	ALT	ALTRAD	DELT	DELT
12	S8150	7.052773	2.514379	0	0	325.2890	301.2421	0
13	S8150.02	7.185845	2.588255	0	0	325.2890	301.2421	0.035052
14	S8150.07	7.465387	2.587585	0	0	325.2890	301.2421	0.078125
15	S8150.12	7.745349	2.584604	0	0	325.2890	301.2421	0.121053
16	S8150.15	7.834632	2.581035	0	0	229.8582	301.2421	0.160153
17	S8150.16	8.122214	2.517309	0	0	229.8582	301.2421	0.198218
18	S8150.23	8.248291	2.558776	0	0	229.8582	301.2421	0.238291
19	S8150.28	8.273291	2.533142	0	0	229.8582	301.2421	0.28125
20	01-Jan-80 05:14 AM							
	CALC							

U15: U = S097*U14+S088*(P15=214) ← Formula in Cell U15

READY

	O	R	S	T	U	V	W	X
1								
2								
3								
4								
5	Zeta 0.5							
6	1 Omega 1							
7	0.04 T 0.04 T 0.04 T							
8	0.550784 0.550784 0.550784 A 4.2315							
9	0.993322 0.015537 0.015537 B -7.9558							
10	UMNS --> Washout Washout C 3.8215							
11	VZ Estnr VZ Estnr Lowpass D 0.0016							
12	w Lag VZ 1ST ORDER 2ND ORDER							
13	0 0 0 0 0 0							
14	0 0 0 0 0 0							
15	0 0 0 0 0 0							
16	0 0 0 0 0 0							
17	0 0 0 0 0 0							
18	0 0 0 0 0 0							
19	0 0 0 0 0 0							
20	0 0 0 0 0 0							
21	01-Jan-80 05:16 AM							
	CALC							

II. Working with Workstation Archive Files on the Workstation

A. Analyzing Data from a Single Mission

4. Analyzing Data in a Spreadsheet

b. Displaying Time Histories Using a Spreadsheet Template

The spreadsheet template "TEMPLT3" can be used to quickly display time histories of any of ten selected signals.

The most convenient way of displaying time histories of signals is through use of the spreadsheet template "TEMPLT3". Install TEMPLT3.WK1 in the spreadsheet window and bring in up to 10 signals using the IDH (page H25). After the signals have been brought in initialize the template by pressing [Alt] and [A] simultaneously.

Next press [Alt] and [B] simultaneously to initiate the plotting macro. You will immediately be prompted for the time at the origin of the plot (1). Enter the number of seconds after the start time of the (spreadsheet) signals at which the plot should begin. Next you will be prompted to enter the length of the plot in seconds (2). A horizontal list of signal symbols will then appear and you can select one of these for plotting by moving the highlight with cursor keys and pressing [ENTER]. If there are more than 5 signals in the spreadsheet, you can select one of these by first selecting the last entry ("More") in the menu (3).

Once you select a signal, the template macro will immediately begin generating the plot with scales selected automatically. The signal symbol appears in the first title and on the Y axis. The second title line lists, starting from the left, the Greenwich Mean Time (GMT) at which the current spreadsheet signals begin, followed by the dataset/mission code and the date and place of the landing. Thus in the example on the right, the time history plot begins at GMT 58170 seconds, 10 seconds after the start of the spreadsheet signals at GMT 58160 seconds.

After a plot appears on the screen, you can continue by pressing [Esc]. The plot is then replaced by the spreadsheet graph menu (4) which can be used to customize the plot (see Ref. 11). Hardcopies of plots can be made using standard spreadsheet procedures (Ref. 11). Additional plots can be made by repeating the above procedure.

H75 "HOW TO DO IT" MANUAL

II. Working with Workstation Archive Files on the Workstation

A. Analyzing Data from a Single Mission

4. Analyzing Data in a Spreadsheet

c. Performing Landing Analyses with Template "TEMPLT1"

A series of specialized analyses of manual control in landing can be performed using the spreadsheet template TEMPLT1. The results can be sent to the mission ensemble database.

The Landing analysis spreadsheet "TEMPLT1" provides for six specialized procedures for analysis of manual control in landing. After the template is retrieved, erase any old signal data with the command sequence /Range Erase Al..K8192, then bring in one of the allowed signal sets (see Table on facing page) using the IDH (page H25). Next initialize the template by pressing [Alt] and [A] simultaneously and then bring up the main menu (1) by pressing [Alt] and [M] simultaneously. Any of six operations on the menu can be initiated by using the cursor key to highlight the item and then pressing [Enter]. The six operations are outlined below.

Touchdown: Determine approximate touchdown time from Az and H signals

This procedure applies database criteria on altitude and speed to display superimposed time histories of altitude and the normal accelerometer signal around touchdown. Main gear touchdown can then be identified from the characteristic accelerometer signature.

RefineTD: Examine the time segment around touchdown

This option allows you to expand the time scale of the normal accelerometer time history around an approximate touchdown time to more precisely determine main gear touchdown.

Hodograph: Generate an Altitude-Vertical Speed hodograph

A "hodograph" -- a plot of vertical speed versus altitude used to analyze the pilot's landing strategy -- can be made with this option.

Filters: Generate a hodograph with filtered vertical speed

With this option a vertical speed -- altitude hodograph can be generated with first and/or second order low pass filters applied to the vertical speed signal. This provides a "first cut" procedure for filtering out the pilot's inner loop (pitch attitude) dynamics to obtain a better indication of his desired trajectory.

Tf: Estimate pilot's flare time constant

This option generates an estimate of the pilot's flare time constant in landing and displays a corresponding slope on the vertical speed -- altitude hodograph.

Ensemble: Store the Ensemble Record for this mission

This option can be used to store the ensemble record for the resident mission in a standard form that can be accessed by the ensemble database template.

Table of Allowed Signal Sets for TEMPLT1						
Selection #:	1	2	3	4	5	6
Signal Set A:	QRHC	AQ	AAZL	VT	VZ	Z
Signal Set B:	QRHC	AQ	AAZL	VT	ROC	ALTD

The 7th through 10th columns can be contain any other signals or be blank

```

F4: Touchdown RefineTD Hodograph Filters Tf Ensemble ① MENU
Generate an Altitude-Vertical Speed hodograph
      A   B   C   D   E   F   G   H   I   J
1  Landing Data
2
3  SMT Start (sec)
4  SB1S0.
5  SMT End (sec)
6  SB1S4.
7
8  Mission #   Landing Date   Landing Site   Runway   Orbiter
9  Land4      07/04 80      Edwards AFB   Runway   Columbia
    
```

H77 "HOW TO DO IT" MANUAL

II. Working with Workstation Archive Files on the Workstation

A. Analyzing Data from a Single Mission

4. Analyzing Data in a Spreadsheet

c. Performing Landing Analyses with Template "TEMPLT1"

1. Determining Main Gear Touchdown

A rough estimate of the time of touchdown can be made with the "Touchdown" menu option and this can be refined using "RefineTD".

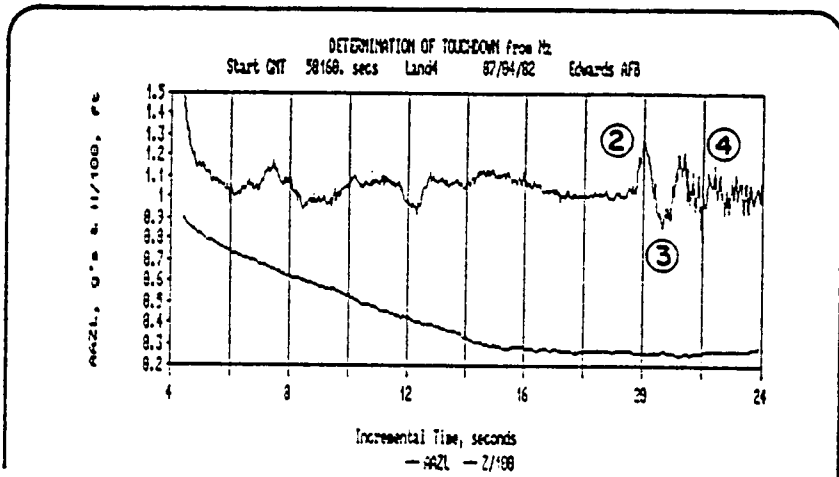
To determine the approximate main gear touchdown time, press [Alt] and [M] simultaneously to bring up the main menu and select the first option (Touchdown) (1). This initiates a macro which performs a spreadsheet database operation to extract and plot the altitude and normal accelerometer signals where the altitude is below 90 ft and the speed is above 180 kts - criteria which should usually capture the touchdown region.

In the first example plot on the facing page, the altitude (actually the altitude divided by 100) steadily decreases to a roughly constant value just under 30 ft. This is the approximate height of the (cinetheodolite) reference point (the nose) above the runway at touchdown. Main gear touchdown (at just over 19 seconds) is identified from an abrupt, large positive AAZL pulse (2) (as the gear compresses) immediately followed by comparable negative pulse (3) to form an approximate sinusoid with a period on the order of a second. Following this the AAZL signal shows characteristic relatively large magnitude, high frequency noise (4) from structural vibration.

To refine the estimate of touchdown time, press [Esc] to clear the screen plot, press [Alt] and [M] simultaneously to bring back the main menu and select the second option "RefineTD" (5). You will be immediately prompted for an approximate touchdown time -- this should be in seconds from the start of the (spreadsheet) data set. Here (6) 20 secs is entered and a prompt appears (7) for the time increment (seconds) to be viewed on either side of touchdown. Entering 1 or 2 seconds here will immediately produce a plot with an expanded time scale from which the touchdown time can be determined more precisely (8).

WARNING: When you have determined the touchdown time, you should immediately enter this as incremental time (i.e., as shown on the plots) in seconds in the touchdown time cell (rangelname "TTD") of the ensemble record range. To do this press [F5], enter "TTD" after the "address" prompt, the cell pointer will jump to the tTD cell, and you can enter the touchdown time. This value will be used by other procedures in the spreadsheet including filling in the ensemble record cells for altitude, total speed and vertical speed at touchdown (see page H83).

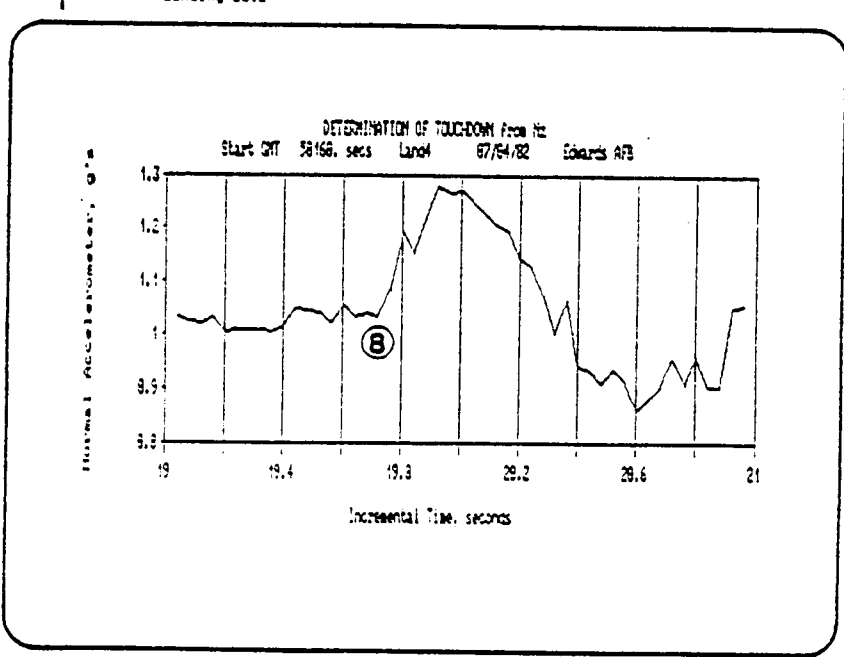
A1: Landing Data ① MENU
 Touchdown RefineTD Hodograph Filters TF Ensemble
 Determine approximate touchdown time from Az and H signals
 A B C D E F G H
 1 Landing Data



A1: Landing Data ⑤ MENU
 Touchdown RefineTD Hodograph Filters TF Ensemble
 Examine the time segment around touchdown
 A B C D E F G H
 1 Landing Data

A1: Landing Data ⑥ MENU
 Enter approximate touchdown time (secs) from start of data set 20
 A B C D E F G H
 1 Landing Data

A1: Landing Data ⑦ READY
 Enter display time -- increment (secs) about approximate TD time 1
 A B C D E F G H
 1 Landing Data



H79 "HOW TO DO IT" MANUAL

II. Working with Workstation Archive Files on the Workstation

A. Analyzing Data from a Single Mission

4. Analyzing Data in a Spreadsheet

b. Performing Landing Analyses with Template "TEMPLT1"

2. Plotting Altitude -- Vertical Speed Hodographs

The Hodograph and Filter menu options can be used to create hodographs - plots of vertical speed versus altitude -- that can be used to analyze the pilot's landing strategy.

Before creating a landing hodograph, make sure a valid touchdown time is specified in the mission ensemble record (rangenname "TTD," page H75), then bring up the main menu by pressing [Alt] and [M] simultaneously. When the menu appears select the third option -- Hodograph (1) -- and you will be prompted to enter the maximum altitude (feet) for the plot. A value in the 100 to 200 foot range is usually a good start and this can be revised later (2).

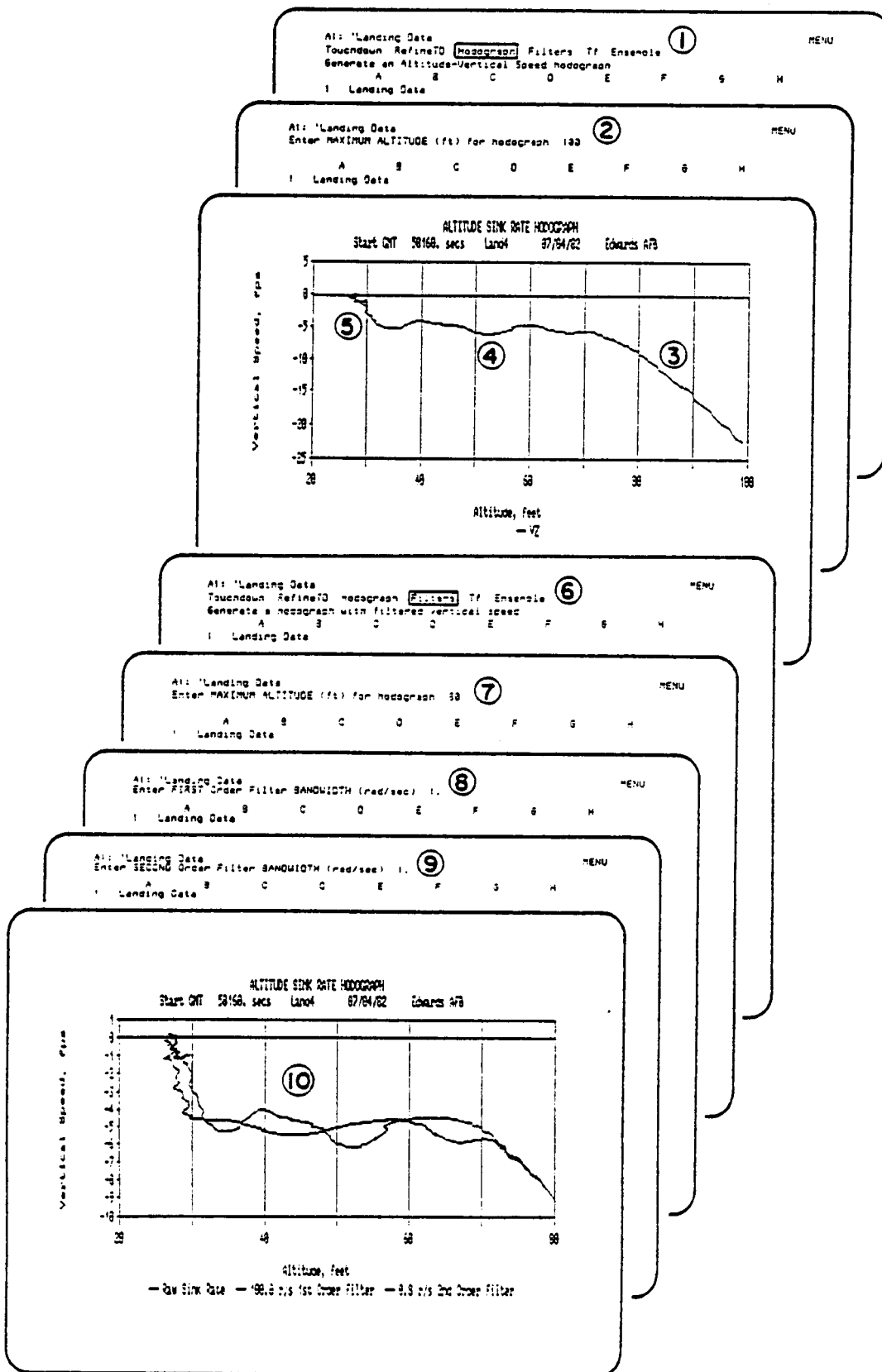
A hodograph will shortly appear on the screen. The steep region on the right (3) is the end of the Shuttle's preflare pullup maneuver. This is followed by the shallow glide (4) where the sink rate is roughly constant (about 5 fps in the example). The last section (5) is the flare, where the sink rate usually decreases roughly in proportion to the altitude.

The hodograph trajectory will usually show some oscillatory character most visible in the shallow glide range. These correspond to pilot-vehicle attitude modes with natural frequencies of several rad/sec. These dynamics somewhat obscure the pilot's intended trajectory. As a first cut procedure for removing much of the attitude dynamics to focus on the path dynamics, low pass first and second order filters can be applied to the vertical speed signal for plotting the hodograph. To do this bring up the main menu ([Alt][M]) and select the fourth option -- Filters (6). You will be immediately prompted to enter maximum altitude as above (7). Next you must enter the bandwidth (rad/sec) for the first order filter (8) and after that the bandwidth for the second order filter (9). The unfiltered and two filtered hodographs will then be superimposed on the same plot (10).

These filters provide only a very simpleminded treatment of pilot-vehicle inner-loop dynamics and a more sophisticated treatment could incorporate additional measurements (e.g., pitch rate) and models. However such approaches would probably be better done with NIPIP. Warning: At high bandwidths the second order filter may become "fuzzy" due to aliasing effects.

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"HOW TO DO IT" MANUAL H80



H81 "HOW TO DO IT" MANUAL

- I. Working with Workstation Archive Files on the Workstation
 - A. Analyzing Data from a Single Mission
 4. Analyzing Data in a Spreadsheet
 - b. Performing Landing Analyses with Template "TEMPLT1"
 3. Estimating the Pilot's Flare Time Constant
-

The pilot's flare time constant is determined from the slope of the altitude -- vertical speed hodograph in the flare region. This time constant indicates the extent of closed loop control in the flare.

In the TEMPLT1 template, the pilot's flare time constant T_f is determined from the slope of a line fitted, using linear regression, to the flare portion of the hodograph trajectory. Before beginning the T_f estimation, make sure a valid touchdown time is specified in the mission ensemble record (rangename "TTD," page H77), then bring up the main menu by pressing [Alt] and [M] simultaneously. When the menu appears select the fifth option, T_f , (1) and you will be prompted to enter the flare altitude (2). This should be your estimate of the altitude (ft) at which the flare begins-- i.e., where the hodograph trajectory transitions from the roughly constant shallow glide section to the final flare where sink rate decreases steadily with altitude. When this number is entered it will also be stored in the mission ensemble record as the flare height.

You will next be prompted to enter the maximum altitude for which the hodograph will be plotted (3). This should generally be well above the flare height and include much of the shallow glide. A hodograph will then appear with a straight line through the flare whose slope ($-\Delta \text{altitude} / \Delta \text{vertical speed}$) is the flare time constant (1.30 sec in the example). The flare altitude, the touchdown altitude and the estimated flare time constant are listed in the second title line of the plot (4).

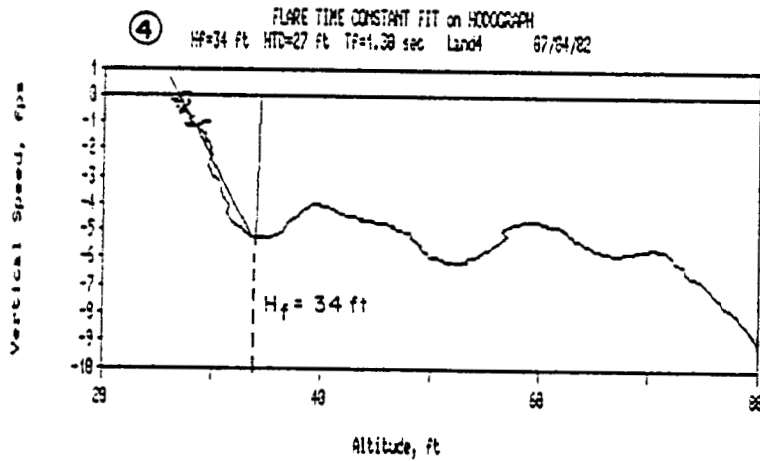
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"HOW TO DO IT" MANUAL H82

01: Touchdown RefineTD Hodograph Filters Ensemble ① MENU
Estimate pilot's flare time constant
A B C D E F G H
1 Landing Data

01: Enter FLARE ALTITUDE (ft) for computing T/ 34 ② MENU
A B C D E F G H
1 Landing Data

01: Enter MAXIMUM ALTITUDE (ft) for hodograph 50 ③ READY
A B C D E F G H
1 Landing Data



H83 "HOW TO DO IT" MANUAL

- II. Working with Workstation Archive Files on the Workstation
 - A. Analyzing Data from a Single Mission
 - 4. Analyzing Data in a Spreadsheet
 - b. Performing Landing Analyses with Template "TEMPLT1"
 - 4. Storing Data for Mission Ensemble Analysis
-

Parameters calculated on the TEMPLT1 template are stored in a specific row of the spreadsheet for transmittal to the ensemble data base. When this operation is performed for several missions, mission ensemble analysis can be performed.

The TEMPLT1 template contains a spreadsheet range -- a row of 12 cells (1) -- which contain 12 parameters that are determined through operations in the template. The row of 12 cells above the parameter values contains the symbolic names of the parameters (2). The vertical stack of three cells above each symbolic name (3) contain further text describing each parameter. This mission record can be stored on disk using the last option in the main menu so that it, along with those for other missions, can be accessed by the mission ensemble analysis template (page H89). Before doing this you must verify that the information in the record is current. This requires that, as a minimum, the touchdown time has been entered in rangename "TTD" (page H77) and the Tf option in the main menu has been exercised (page H81). To examine the ensemble record press [F5] and enter "ENSMBLRC" when the "address" prompt appears.

When the ensemble record contains the correct data, press [Alt] and [M] simultaneously to bring up the main menu and select the last option, Ensemble (4). The ensemble record, with its symbol and text rows, will be stored on the default disk in a spreadsheet file with name ERx.WK1 where x is the mission number. Files with this name may exist from operations with other templates, so these should be renamed or collected into ensemble analysis templates first.

The elements of the TEMPLT1 ensemble record, from left to right, are explained below:

StartGMT: Greenwich Mean Time (seconds) at which the spreadsheet data set begins

IncrmtTD: time of main gear touchdown in seconds measured from the start of the spreadsheet dataset (entered manually by user)

HTD: altitude of the measurement reference point at touchdown

VZTD: vertical speed at touchdown

VTTD: total speed at touchdown

Hf: altitude of the measurement reference point at touchdown

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"HOW TO DO IT" MANUAL H84

Hused: symbolic name of altitude signal used (6th signal)

Vused: symbolic name of total velocity signal used (4th signal)

VZused: symbolic name of vertical speed signal used (5th signal)

Date: date ensemble record was saved on disk

Time: time ensemble record was saved on disk

MissDes: Mission descriptor string including dataset/mission, etc.

```

AHT: U                                     READY
      AM  AN  AO  AP  AQ  AR  AS  AT
1
2      ENSEMBLE RECORD Mission 4
3
4      1  2  3  4  5  6  7  8
5  BMT # 0 IncrementTouchdownTouchdownTouchdown  Plane  Altitude  Tot.
6  Increment Time  Altitude Vertical Total SpcAltitude  Signal  Velocity
7  Time (sec) (ft) Speed (ft/sec) (ft) Used  Used
8  StartBMT IncremTD HTD VCTD UTTO HF Hused Vused
9  SB150 19.7 25.55423 -0.41613 340.3125 34 2 UT
10
  
```

```

A21:                                       READY
      AT  AU  AV  AW  AX  AY  AZ
1
2
3
4      8  9  10  11  12
5  Total Vertical Date of Time of Mission
6  Velocity Speed Record Record Descriptor
7  Used Used
8  Vused VZused Date Time MissDes
9  UT VZ 12/01/87 00:05 Land4 07/04/80 Edward A
10
  
```

```

A1: Landing Data                               MENU
Touchdown RefineTD HooGraph Filters TF Ensemble
Store the Ensemble Record for this mission
      A  B  C  D  E  F  G  H
1  Landing Data
2
3  BMT Start (sec)
4  SB150.
5  BMT End (sec)
6  SB184.
  
```

H85 "HOW TO DO IT" MANUAL

II. Working with Workstation Archive Files on the Workstation

A. Analyzing Data from a Single Mission

5. Performing Spectral Analysis with FREDa

The FREDa program can be used for analysis of time series and generates the power spectral density of the input and output signals, the transfer function (output/input) frequency response, the coherence and remnant.

The FREDa data file initially created by the IDH is an ASCII file and this must be converted to a special binary file for use in FREDa. This is done with the FCON program which is a stand-alone program, but part of the FREDa package. FCON is installed and operated automatically by the IDH, however you must manually enter information at several points as explained on page H53. Of these entries you should remember the name under which the FREDa binary input file is saved in FCON so that it can be retrieved for input to FREDa.

After the FREDa binary file has been generated and you have closed the FCON window (page H53) you may run FREDa. To do this, tap the [ALT] key to display the DESQview menu, type "O" to display the "Open Window" menu, and then type "FR" (FREDa PFreda2). The FREDa window will open and you can proceed according to the instructions of the FREDa User's Manual (Ref. 13).

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"HOW TO DO IT" MANUAL H86

FREQUENCY DOMAIN ANALYSIS

(Version 1.2)



(C) Copyright Systems Technology, Inc. 1987

Compiled with:

Microsoft QuickBasic Compiler
Math Coprocessor Version, Version 3.00
(C) Copyright Microsoft Corp. 1982, 1983, 1984, 1985, 1986, 1987

PRESS ANY KEY

FREQUENCY DOMAIN ANALYSIS (Version 1.4)

- (1) CONVERT ASCII FILES TO BINARY FILES (FCON)
- (2) FREQUENCY DOMAIN ANALYSIS ROUTINE (FREDA)
- (3) READ A FREQUENCY RESPONSE DATA FILE
- (4) PLOT FREQUENCY RESPONSES
- (5) CHANGE DATA QUALITY CRITERIA CURRENT = .8
- (6) CHANGE TOP OF PHASE VALUE CURRENT = 180
- (E) EXIT THE PROGRAM

CURRENT FILE BEING USED - NONE

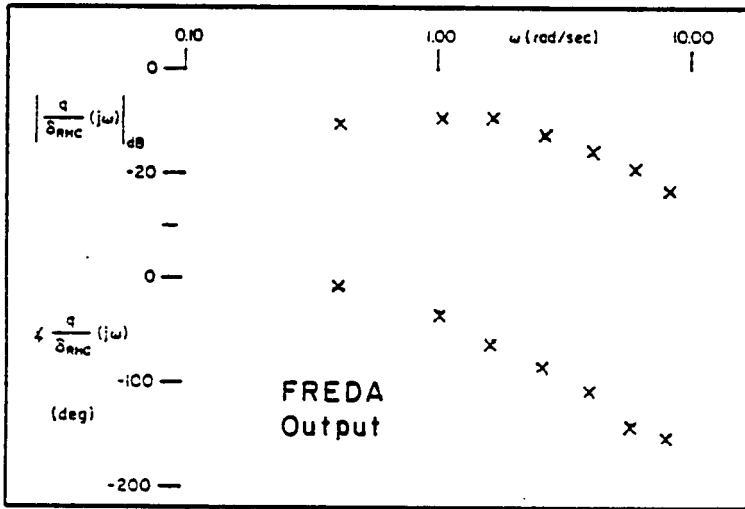
*** CHOOSE THE DESIRED OPTION BY SYMBOL ***
NO ENTER (↵) NEEDED

- II. Working with Workstation Archive Files on the Workstation
 - A. Analyzing Data from a Single Mission
 - 6. Fitting Transfer Function Models to FREDA Output with MFP
-

The MFP program can be used to fit multiple continuous transfer function models to frequency response data from FREDA and to identify individual model parameters.

The output of the FREDA program which is typically of primary interest is the frequency response of the transfer function relating the output and input signals. This appears in discrete form with magnitude and phase angle specified for a finite number of frequencies (typically up to several dozen points depending on run length and the FREDA smoothing options used). The MFP program can be used to fit a continuous transfer function model to a FREDA frequency response. The MFP model can be setup to identify multiple parameters and several transfer functions can be fitted simultaneously with customized frequency dependant weightings.

To access MFP, tap the [ALT] key to display the DESQview menu, type "O" to display the "Open Window" menu and then type MF. The MFP window will open and you can proceed according to the instructions of the MFP Users Manual (Ref. 14).



$$\frac{q}{\delta_{RHC}} = \frac{K(s+1/T_q)}{[\zeta, \omega_n]}$$

Fitting Form

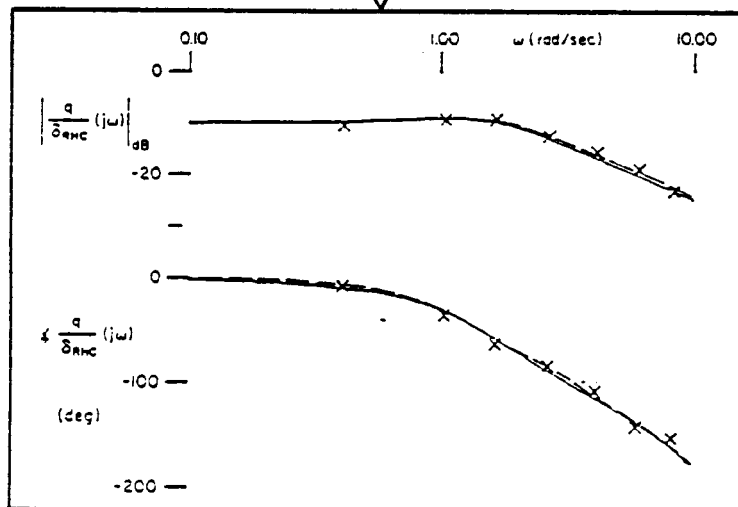
M F P

Fixed $\frac{1}{T_q} = 1.5 \text{ sec}^{-1}$

$$\frac{q}{\delta_{RHC}} = \frac{.592(1.5)}{[.74, 1.66]} s^{-1}$$

All parameters free

$$\frac{q}{\delta_{RHC}} = \frac{.506(1.03)}{[.77, 1.44]} s^{-1}$$

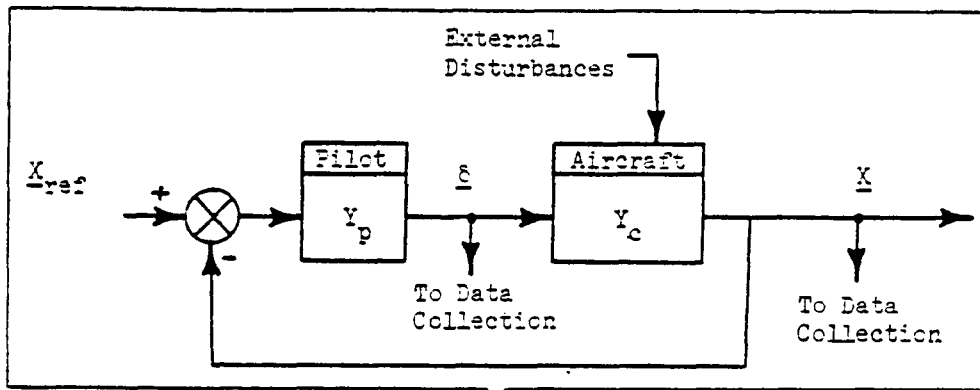


- II. Working with Workstation Archive Files on the Workstation
 - A. Analyzing Data from a Single Mission
 - 7. Performing Identification with NIPIP

NIPIP is a system identification program based on a running least-squares estimation technique. NIPIP has been specially developed for use in pilot-vehicle system identification.

The operation of the NIPIP system identification program is explained in Ref. 15. The most complex aspects of setting up NIPIP are the creation of the model to be identified, transformation of the model to a system of difference equation and specification of the program parameters. The input data file which contains the signals as required by the model is generated through use of the IDH as explained on page H67.

The NIPIP window is opened automatically when a NIPIP file is created (see page H67).



$$Y_p(s) = \underbrace{K_p}_{\text{Pilot Gain}} \underbrace{\frac{(T_L s + 1)}{(T_I s + 1)}}_{\text{Series Equilization}} \underbrace{\exp(-\tau_e s)}_{\text{Pure Time Delay}} = \frac{\delta(s)}{\theta_e(s)}$$

$$Y_p(z) = \frac{b_1 z^{-1} + b_2 z^{-2}}{1 - a_1 z^{-1}} \equiv \frac{\delta(z)}{\theta_e(z)}$$

$$\delta = a_1 \delta z^{-1} + b_1 \theta_e z^{-1} + b_2 \theta_e z^{-2}$$

$$\delta_n = a_1 \delta_{n-1} + b_1 \theta_{e_{n-1}} + b_2 \theta_{e_{n-2}}$$

NIPIP

H91 "HOW TO DO IT" MANUAL

- II. Working with Workstation Archive Files on the Workstation
 - B. Analyzing an Ensemble of Mission Data
 - 1. Basic Ensemble Analysis

An ensemble of data from several missions can be analyzed by using a special spreadsheet template.

Analysis over a group of missions can be made through mission ensemble analysis. The essence of this is comparison of one or more parameters (e.g., touchdown sink rate) calculated from the signal data for each mission. This is done by use of a series of related spreadsheet templates. Ensemble analysis begins when one or more parameters are calculated by setting up a spreadsheet for one mission (for concreteness this is assumed here to be from STS-2 through STS-7). The parameter calculations can be made anywhere on the spreadsheet, but they must be summarized in a single continuous row somewhere on the spreadsheet. This row is referred to as the "mission ensemble record" and must be given the range name "ENSMBLRC" (page H83). The cell immediately above each parameter value should contain a one-cell symbol for the parameter. The three cells above the symbol can contain further descriptive text about the parameter. The four rows of cells above the ENSMBLRC range must be given the range name "HEADER."

Save this spreadsheet to a name of your choice and save a copy to the name "ERx" where the x corresponds to the mission code number. ERx is the standard name of the mission ensemble record template (e.g., ER2 contains the ensemble record for STS-2). Next you should make copies of the ERx template for the other 5 missions and save them under the corresponding distinct ERx names. Then, using the IDH, bring the appropriate signals into these spreadsheets and recalculate to obtain the mission-specific values for the parameters in the ensemble record for all of the ERx files.

After all six ERx files have been updated and saved, retrieve the mission ensemble template "ENSEMBLE." In this worksheet the ensemble record from each of the six ERx files will be stored as a row in an ensemble table with range name "ENSMBLDB." Thus there is one row of parameter values for each mission so at present there are 6 rows corresponding to Missions STS-2 through STS-7, but the number of columns is set by the user. The ENSMBLDB range actually includes one row of cells above the top record which will be the parameter symbols from spreadsheet ER2 so this range can be used as a formal spreadsheet database. The first column is reserved for the Mission code and is not taken from the ENSMBLRC ensemble record ranges in the ERx files.

The ensemble table may be loaded automatically with ensemble records from individual mission spreadsheets by using a loading MACRO in range "\A". To initiate this macro press the [Alt] and [A] keys simultaneously. A record will be read from each of the ERx spreadsheets for STS-2 through 7. All of these ERx spreadsheets must be present on the default disk, even if the ensemble records are empty, or an error will result. The macro will take the range named "HEADER" from spreadsheet "ER2.WK1" and copy it above into this spreadsheet as a header above the ensemble table. It will also copy the mission code into the ensemble table from each ERx file.

Basic statistical analysis is provided immediately below the ensemble table. The first row gives the minimum value in each column and the second row gives the maximum. The third row gives the mean and the fourth the standard deviation. The ENSEMBLE template provides the four statistical rows for three parameters, if more parameters are included the statistical rows may be extended as required using the spreadsheet COPY command. Each column of parameters in the ENSEMBLE table must have the range name ECOLx where x is the column number from the column of the first parameter.

Basic comparison of a parameter over all six flights can be made graphically with a bar chart. A bar chart can be generated very quickly for the first parameter using a macro on the ENSEMBLE spreadsheet. To initiate this macro press the [ALT] and [B] keys simultaneously and a bar chart will appear on the screen. To plot other parameters copy the macro located in range "\B" and edit the spreadsheet cell references as required.

H93 "HOW TO DO IT" MANUAL

III. Operating on the ELXSI from the Workstation A. Starting the Telecommunication Program

The detailed operation of the telecommunication program (ProComm) is well covered in the Reference Manual (Ref. 9) provided with the program. Only the information essential to ELXSI telecommunications is provided here.

To start the program type PROCOMM (upper/lower case insensitive) and check that the program is set to ANSI-BBS terminal emulation mode prior to auto-dialing the ELXSI. Otherwise you will see the ELXSI transmitting what appear to be spurious characters to the PC Workstation screen. These are actually screen control codes which do not map correctly. To set the terminal emulation mode type [Alt-S] to bring up the screen setup utility function and the first menu on the facing page will appear (1).

Next enter "2" to select the Terminal Setup Menu which will appear as shown in the second screen (2). If a terminal emulation other than ANSI-BBS appears at the first menu item (3), you should enter 1 and use the up or down cursor keys to step through the available terminal emulations until the bottom of the screen appears as follows:

```
TERMINAL EMULATION    > ANSI-BBS  
Terminal type to emulate.
```

At this point, typing Esc will switch back to the Setup Menu (1). Enter S to save the selection by updating the default parameter file. Another Esc will return to the normal screen, which has "ALT-F10 HELP" on the bottom line.

Next setup the Dialing Directory as explained in the next section.

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"HOW TO DO IT" MANUAL H94

① | PROCOMM SETUP |

- 1) MODEM SETUP
- 2) TERMINAL SETUP
- 3) KERMIT SETUP
- 4) GENERAL SETUP
- 5) HOST MODE SETUP
- 6) ASCII TRANSFER SETUP
- 8) SAVE SETUP TO DISK

OPTION ==> 2

ESC> Exit

② | TERMINAL SETUP |

- ③ 1) Terminal emulation ... ANSI-3BS
- 2) Duplex FULL
- 3) Handshake NONE
- 4) CR translation (in) .. CR
- 5) CR translation (out) . CR
- 6) BS translation DEST
- 7) Line wrap ON
- 8) Scroll ON
- 9) Answerback OFF

OPTION == 1

ESC> Exit

H95 "HOW TO DO IT" MANUAL

III. Operating on the ELXSI from the Workstation B. Setting up the Dialing Directory

After the telecommunication program is started in the correct emulation mode (see previous section), type [Alt-D] to bring up the Dialing Directory screen.

If the ELXSI data were not already setup (as they are here (1)), you should type R, to pop up the revision window. Enter 2 to start changing item 2 (2). Enter the appropriate information as prompted by the program. Type in changes or accept existing values by pressing the Enter key. The ProComm communication parameters should be set as shown to 1200 baud, even parity, 7 data bits, 1 stop bit, and echo off (full duplex). The example screens show a CMD file, which will be explained later. For now, skip this by entering a space when a CMD File name is requested.

If the entry is correct, type Y when prompted:

Save entry 3 to disk? (Y/N) Y

It is recommended and assumed here that the workstation will include a Hayes-command-compatible internal or external modem. However, ProComm can accommodate other modems via specification of Output String Translation and other Modem Setup commands (see Ref. 9). In general, the default ProComm settings work well, except for the need for even parity and 7 data bits as mentioned earlier.

When the revision window is removed, the ELXSI can be dialed by entering its entry number (i.e., 2) or by exiting with an Esc and typing Alt-R to bring up the auto-redialing window (3) to provide automatic redialing when the user encounters problems in establishing a connection. Entering the selection number from the Dialing window brings up the redial status window (4).

```
          D I A L I N G   D I R E C T O R Y

  ①
  Name      Number      Baud P D S E CMD File
  1- PIL Software Sys. 1 014 449-9401 1200-N-8-1 N
  2- NASA Dryden ELXS: 1 805 233      1200-E-7-1 N ELXS:
  3- ..... 1200-N-8-1 N
  4- ..... 1200-N-8-1 N
  5- ..... 1200-N-8-1 N
  6- ..... 1200-N-8-1 N
  7- ..... 1200-N-8-1 N
  8- ..... 1200-N-8-1 N
  9- ..... 1200-N-8-1 N
  10- ..... 1200-N-8-1 N

  ==> R Revise      M Manual Dialing Entry to Dial
      P LD Codes    D Delete Entry   F Find
      PgUp/PgDn Page L Print Entries  ^/v Scroll
      Home Top Page End Bottom Page  ESC Exit

  Modem command: ATDT      LD Codes Active:

----- AUTO DIALER -----
```

```
2- NASA Dryden ELXS: 1 805 233 4441 1200-E-7-1 N ELXS:

Entry to revise? 2 ② Number, Modem, -, -, @, #

10- ..... 1200-N-8-1 N

==> R Revise      M Manual Dialing Entry to Dial
```

```
Number(s) to dial: 2 ③
(CR For Previous Numbers)
```

```
          D I A L I N G: NASA Dryden ELXS
          PASS NUMBER: 1
          ELAPSED TIME THIS TRY: 4
          TIME AT START OF DIAL: 01:53:43PM ④
          TIME AT START OF THIS CALL: 01:53:44PM
          DELAY TIME: 30
          PAUSE TIME: 1
          LINKED COMMAND FILE: ELXS:
          LAST CALL RESULT:

SPACE: Recycle DEL: Remove from list END: Change delay time
          Press ESC to Abort

----- ALT-F10 for HELP -----
```


H97 "HOW TO DO IT" MANUAL

III. Operating on the ELXSI from the Workstation C. Logging on to the ELXSI

When a connection is established, ProComm alerts you with series of alarm beeps, a message, and by removing the automatic redial window. A typical user logon dialog is shown (1) with the user input underlined and modified for generality and security reasons. The actual user would type in his authorized account numbers, group code string, user name, and password assigned by NASA ADFRF.

When you get the colon prompt (2), log in and proceed with your session.

When finished, log off by typing BYE. This should produce a ProComm disconnect message. You can then close any open ASCII download capture file by typing Esc followed by Alt-X to exit. This produces the exit window (3)

Typing y will close ProComm and exit to DOS.

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"HOW TO DO IT" MANUAL H98

10/27/85 07:14:00
HAVE A GOOD DAY.....

①

ENTER ACCOUNT CODE:
ACCOUNT CODE NUMBER
ENTER NUMBER:
GROUP CODE STRING
CALLING 6402

CALL COMPLETE
USERNAME
Enter user password: PASSWORD
domain /user/name is now ONLINE

Welcome to NASA Dryden's ELXSI System 6400 (ALEXIS) running SR-11

②

***** 4 CPUs, 32 MB, 2 ATCs, 3 DCs, 2 TPCs *****

*** FREESPACE REMAINING ON USER DOMAIN U1 IS n.nM n% ***

name logged in at time PST on weekday, month day, year

:

----- ALT-F10 for HELP -----

	EXIT TO DOS? (Y/N)	

③

III. Operating on the ELXSI from the Workstation
D. Basic Operations on the ELXSI

Using system commands

Once you're logged in (see previous section), you're working within EMBOS (ELXSI Message-Based Operating System). EMBOS is structurally similar to UNIX, but with a number of syntax differences. Both systems (and PC DOS) provide features such as subdirectories, domains, tree structures, etc. but certain identical command statements in each system produce different results. Consult the EMBOS documents, in particular The EMBOS User's Guides, for complete command details. Rather than duplicate those manuals here, this report will provide examples particularly relevant to remote operation from the OFQ Workstation.

Subdirectories, domains, tree structures

As a OFQ Workstation user, you will need to access flight data files, manipulate and select segments of data within them, and transmit this data to your local computer. As discussed in the EMBOS User's Guide, you will be working in your local subdirectory and domain, and the programs and data required will most frequently be located in the subdirectories of other users or the EMBOS system.

Changing directory location

You can change directory location with the DIR command or by adding parameters to a command string. In the following examples the user gets a list of the files in the /user/HOGUE area with the FILES command.

```
:dir /user/HOGUE  
:files
```

or

```
:files /user/HOGUE  
uland04.log      usts03.data      usts05.log      usync05.data  
uland05.data     usts03.log       usync03.data    usync05.log  
uland03.data     uland05.log      usts04.data     usync03.log  
uland03.log      usts04.log       usync04.data    uland04.data  
sts05.data       usync04.log      USEPEST
```

The obvious advantage of the DIR command is eliminating the need to type in a long string to specify a subdirectory location. Note that the user will be limited in what he can do with data files in another's subdirectories. For most operations other than simply finding and examining files, you must first transfer (COPY) them to your local area:

SHELLFILE commands LISTing text and data files

Another way to access other users areas is to setup and issue a SHELLFILE set of commands to add their subdirectories to the search rule used by the EMBOS shell for this particular user. The first thing to do is to create a file in the EMACS editor or locally on the OFQ Workstation with an ASCII text editor like the Norton Editor (as opposed to the typical word processing editors which create files containing numerous special page formatting characters) and upload it within EMACS. EMACS operations will be discussed later.

A SHELLFILE is a file of commands to, or procedures to be done automatically within and by the EMBOS shell (or operating system). The PC/MS DOS equivalents are files with a .BAT extension. First the user tells EMBOS that file is a shellfile and then he tells it execute it. For a shellfile USEPEST to add the Getdata (flight data manipulation) and Pest (parameter identification) program user area help and command search areas to the shell's rules for a user, we list (not PC DOS's TYPE) the file and then show its use:

```
:LIST USEPEST
-- shell file to get access to pest commands.
-- Richard Maine.  11 Jan 85.
-- adds appropriate directories to search list.
--
checkargs
addSearch /user/maine/commands
addHelp /user/maine/helpfiles
addSearch /user/murray/commands
addHelp /user/murray/helpfiles
echo pest commands are now accessible.
:SHELLFILE USEPEST
:USEPEST
pest commands are now accessible.
:
```

The user can now issue commands like GETDATA instead of /user/maine/helpfiles/GETDATA .

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E. Checking FILES Directory, file size, and account limit

Getting a list of the files in a particular user directory with the FILES command was explained in the previous section. You can also get the file sizes with the I=S option. This is particularly useful information before attempting a data transfer to the OFQ Workstation:

```
:FILES I=S
90K uland05.data      38K usts04.data      902K usync04.data
2K uland05.log        2K usts04.log         2K usync04.log
70K uland03.data      36K usts05.data      150K usync05.data
2K uland03.log         2K usts05.log         2K usync05.log
88K uland04.data      30K usts03.data      650K usync03.data
2K uland04.log         2K usts03.log         2K usync03.log
2K USEPEST
```

```
-- directories
4K aux      8K mail
:
```

Other information about file type and modification date can be obtained by including the INFO=TYPE, DATE option in the FILES command. The user is referred to the EMBOS manual for details.

It should be stressed here, and certainly is by the ELXSI system, that file space for the system and individual users is finite, with little possibility for expansion. Whenever you logon you see a reminder about the remaining freespace:

```
*** FREESPACE REMAINING ON USER DOMAIN U1 IS 303.9M 14% ***
```

When working with large flight data files, it is very easy to fill ones allotment of ELXSI storage. You should periodically check your status as follows:

```
:ACCTLIMIT
domain      account limit      used      files %limit domain
-----
/(System Domain) hogue      .01M      6      .0%
/subdomain/U1 hogue      5.00M     2.13M    23 42.6% .1%
:
```

Other file operations

DELETEing files is straight-forward; the EMBOS manual notes that you can include the +confirm switch (option) so that you will be prompted for confirmation before deletion occurs. This is particularly useful when wildcards (here the "?" character) are used in a filename. See the EMBOS manual on filenames and pattern matching.

COPYing a file can also be done much like its PC-DOS equivalent; specification of multiple file operations is somewhat different.

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III. Operating on the ELXSI from the Workstation

F. Editing Files via the ELXSI EMACS Editor

The ELXSI screen text editor EMACS does not work correctly with the ProComm program set to ANSI-BBS terminal emulation. The most satisfactory mode in EMACS seems to occur when the ELXSI is told to set itself for a DEC vt100a and the ProComm program is told to emulate a DEC VT100 terminal. If EMACS is entered without setting this emulation in EMBOS and ProComm, EMACS will not be able to correctly control the display on the PC screen and the PC keyboard inputs will not produce the correct effects on the file.

Unfortunately if ProComm is set to VT100 mode at ELXSI logon, the PC screen will be badly scrambled. The solution seems to be to logon in ProComm ANSI-BBS mode, change the ELXSI to VT100 mode with the TERMENU command, and then issue Alt-S, etc., to ProComm to set the PC in VT100 emulation. The following illustrates the ELXSI portion:

:TERMENU

The valid terminal type numbers are:

0 - other	5 - DECmate II
1 - wysel00e	6 - dgl32b
2 - hp2626	7 - IBM PC
3 - vt100a	8 - vt52
4 - hp125	9 - wyse50e

Enter your terminal type number: 3

0"term vt100a" done

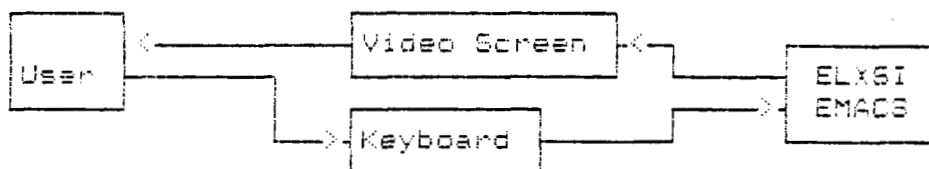
:

Now you should switch ProComm to VT100 and proceed with EMACS. If you've been documenting your session by download capturing it via an ASCII-protocol transfer or by echoing it to a printer, this should be turned off before issuing the EMACS command -- otherwise the EMACS special screen control character strings will be injected into this documentation.

Next enter EMACS and the filename

:EMACS FILENAME

The problem then becomes one of what works, and what doesn't, and why. A user on a standard local ELXSI terminal (which is nominally a Wyse100e) presses keys causing certain functions to occur to the file as displayed on his screen:



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A remote user on a PC works through a communication program which can convert or remap the keyboard code signals to those sent out by a particular brand of terminal, say a DEC VT100. Since a PC keyboard is laid out differently from a VT100, different PC keys are used to produce VT100 functions. Moreover, the PC has a different method of changing its screen display so the program must convert the VT100 signals to produce the desired results on the PC screen.

In addition, the ELXSI has expectations about what terminals will be located on its various ports to different users. A caller via a telephone modem seems to get the ELXSI in what ProComm calls its ANSI-BBS mode. Local users presumably see the ELXSI in its Wysel00e mode. Theoretically, a remote PC user would change to ProComm's WYSEL00E emulation after logon but all these conversions by the PC and the ELXSI are very complicated and some (VT100) work much better than others (Wysel00e screen mapping is scrambled).

Given the recommended VT100 setup, the following is a map of the EMACS editing functions on a standard IBM-PC-type key board:

Function Keys
(Shift Pad)

F1 Split Screen Sh-F1	F2 Sh-F2
F3 Sh-F3	F4 Search Forward Sh-F4 (Top of File)
F5 Replace Sh-F5 (Set Mark)	F6 Del to EOL Sh-F6 (Split Line)
F7 Del Char Sh-F7 (E:it)	F8 Del Line Sh-F8 (Help)
F9 Del Region Sh-F9	F10 Sh-F10

Numerical key pad (when not in NUM-LOCK):

<- Delete left	Num Lock	Scroll Lock
	7 Home	8 Cursor ^ Up 1 Pg Up
< Enter	4 Cursor Left 1 ←	5 6 Cursor Right 1 →
ProScr +	1 End	↓ Cursor Down 1 ↓ ProComm Download Pg Dn
0 Ins	Del	+

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G. Accessing Subsets of OFQ Archives on the ELXSI using GETDATA

Flight test data can be accessed selectively via the NASA ADFRF Getdata Program (Ref. 7). This program is located in /user/maine/commands; using it here can be simplified with the Usepest Shellfile command procedure (page H100). Before this program is used, the flight data files to be manipulated by Getdata should be located in an individual user's subdirectory. This might occur by copying them from another user's subdirectory or requesting that they be loaded directly from source tapes into your subdirectory.

Getdata Overview

The purpose of this program is to interactively select signals over specified time intervals from a time history data file or even from several asynchronous files. The signal time samples in the files can be time skewed with linear or hold-last-value interpolation applied. The output or destination file can contain parameters computed from the input signals for simple linear combinations by user interaction, or for more complex algorithms, by user-supplied subroutines. The destination file can be written in formats different from the source files.

Detailed information on use of the Getdata program can be obtained by issuing Getdata help commands and so will be only briefly discussed here.

Typical Getdata Usage

A typical Getdata session might consist of:

- specifying the input data file(s) with Read commands.

- checking that the desired data was obtained by issuing a Show command.

- defining the signals required, and any simple linear computation expressions to be applied to them with Signals commands.

- defining the signal interpolations with a Method commands.

- setting individual signal time skews with Skew commands.

- specifying the output data file name and format with a Write command.

- defining a time interval to be extracted from the input file, have computations performed and written into the output file with a Copy command.

- exiting with a Quit command.

These procedures can be done in an interactive mode with a series of commands typed on the keyboard or via a command file prepared in advance with EMACS or a local text editor and activated in Getdata with a Do command. During a Getdata session, if the need arises to perform an EMBOS system function (such as checking file status) while retaining the work already done in Getdata, the user can issue a Svs command containing the command structure he would normally use in EMBOS.

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III. Operating on the ELXSI from the Workstation
H. Sample Getdata Case

The following is a simple sample case where 3 signals were extracted from a file named USTS04.DATA. User input is underlined. The file listing at the end has been cut short.

:FILES

```
uland03.log   usts04.log   usync04.data  uland04.data  USEPEST
usts05.data   usync04.log   uland04.log   usts03.data   usts05.log
usync05.data  uland05.data  usts03.log    usync03.data  usync05.log
uland03.data  uland05.log   usts04.data   usync03.log
```

:GETDATA

```
getData program
time history data selection
Richard Maine - NASA Dryden
version 3.1.1 11 Sept 86
this run date: 29-Oct-86 time: 10:36:46
```

Help is available

```
getData: READ USTS04.DATA
16 signals on USTS04.DATA
```

```
getData: SHOW
1 input files open.
16 signals on inFile: USTS04.DATA
```

AAZL	AQ	VSP	ALPHA
THETA	X	Y	Z
ALT	ALTRAD	XWEST	HRWY
DELE	QRHC	WD	WV

0 output signals defined.

```
getData: LIST
1 input files open.
16 signals on inFile: USTS04.DATA
```

AAZL	AQ	VSP	ALPHA
THETA	X	Y	Z
ALT	ALTRAD	XWEST	HRWY
DELE	QRHC	WD	WV

0 output signals defined.

getData: SIGNALS +ADD AQ ALPHA DELE
3 output signals defined.

getData: WRITE TEMP LIS1
3 signals will be written in format LIS1

getData: COPY
actual interval start time is 16.09.12.000
actual interval end time is 16.09.44.000
801 time points written in interval

getData: QUIT

:FILES

uland03.log	usts04.log	usync04.data	uland04.data	USEPEST
usts05.data	usync04.log	TEMP	uland04.log	usts03.data
usts05.log	usync05.data	uland05.data	usts03.log	usync03.data
usync05.log	uland03.data	uland05.log	usts04.data	usync03.log

-- directories
aux mail

:LIST TEMP

	AQ	ALPHA	DELE
16.09.12.000	.39127	5.8949	3.0014
16.09.12.039	.42802	5.9003	2.9807
16.09.12.079	.50107	5.9119	2.9627
16.09.12.119	.55460	5.9237	2.9595

III. Operating on the ELXSI from the Workstation

I. Transmitting Archive Subsets by Phone to the Workstation

After an archive data file subset has been selected by the Getdata program, it can be transmitted to the OFQ workstation over regular phone lines for further analysis. Telecommunication transmission and reception errors can be minimized through the use of an error checking protocol. ProComm has implemented a number of protocols, including the Kermit protocol available on the ELXSI in a program with the same name.

Activate the ELXSI Kermit telecommunications program by typing "Kermit." Then you can issue a command to send or receive a file. A number of other commands are available; see the Kermit help file. A typical session starts on the ELXSI as shown in the first screen (1).

Next, set ProComm to receive a file by pushing the PgDn key, which pops up the download key (2).

Selecting 2 then pops on the transfer status window (3) and automatically starts the transfer; it will proceed till complete or until manually halted as explained at the bottom of the screen.

When the transfer status window indicates that the transfer is done, shut off the ELXSI Kermit program by typing quit or exit (4).

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OF POOR QUALITY

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:KERMIT

Kermit-ELXSI> SEND TEMP

①

```
==== DOWNLOAD ====
|| 1) YMODEM      ||
|| 2) Kermit     ||
|| 3) Telink     ||
|| 4) MODEM7     ||
|| 5) YMODEM     ||
|| 6) YMODEM Batch ||
|| 7) ASCII      ||
|| ESC Abort     ||
||              ||
|| Protocol:     ||
```

②

```
====
|| PROTOCOL: Kermit ||
|| FILE NAME:       ||
|| FILE SIZE:       ||
|| FILE TYPE:       ||
|| FILE NUMBER:     ||
|| COMPRESSION:     ||
|| 8TH BIT PREFIX:  ||
|| WINDOW SIZE:     ||
|| BLOCK CHECK:     ||
|| TRANSFER TIME:   ||
|| BYTES TRANSFERRED: ||
|| LAST ERROR: PACKET NAK ||
|| LAST MESSAGE:   ||
||                 ||
||                 ||
```

③

CTRL-A Abort Transfer CTRL-B Cancel Batch CTRL-F Cancel File

Kermit-ELXSI> EXIT

④

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III. Operating on the ELXSI from the Workstation J. Bulk Transfer of Data and Creation of Workstation Archive Files

While it is practical to transmit data files of useful size from the ELXSI to a remote PC by phone, transferring large quantities of data by phone is generally not practical, neither is transfer of data using only floppy disks. This does not represent a problem at present because all OFQ data now on the ELXSI (STS-2 through STS-7) is now available on PC floppy disks. However, need for bulk data transfer from the ELXSI may arise in the future and thus the procedure used to generate the Workstation Archives on floppy disks is explained here. Future users may have to modify this procedure depending on the equipment available on the ELXSI and at the receiving facility.

For the present Workstation archives, data was transferred on high capacity removable magnetic disks (the Bernoulli Box system). This unit has two drives which accept 20 megabyte cartridges and functions like a standard PC floppy disk system with very high capacity. Media of this type was found to be a practical necessity to handle the data in acceptable volume and time with appropriate backup. The highly compressed ELXSI data expands 10 to 1 when converted to ASCII format for transfer to the PC and special arrangements were required to temporarily increase the ELXSI storage space used in making the transfer to 75 megabytes.

After decompression with the ADFRF GETDATA program, the ASCII data was reformatted for input to the PC using a specially developed FORTRAN program operated on the ELXSI. The Bernoulli unit was installed on an ADFRF PC which functioned as an ELXSI terminal receiving data using the Procomm communications program under the Kermit protocol (page H107). Batch wildcard transmissions could be made automatically up to the capacity of the Bernoulli cartridges. With this procedure data can be transferred at 9600 baud which corresponds to at best about 2 megabytes/hour. Some transmission errors still occur so it appears that no more than about 10 megabytes/day is practical in routine operation (when converted to ASCII on the ELXSI the present OFQ files are typically 6-7 megabytes and one is over 10 megabytes). However a full 20 megabyte Bernoulli cartridge can be backed up on another cartridge in just a few minutes.

When the data was received on Bernoulli cartridges, it was entered into the Workstation database (i.e., stored as a table in the RBASE database OFQ using the procedure of Ref. 10) which again compressed the data. Copies of the original data returned from ADFRF has been retained on Bernoulli cartridges as a backup. Workstation archive files on PC floppy disks were then created using the RBASE backup facility (Ref. 10).

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Several other possible approaches should be noted. An existing Ethernet connection to the ELXSI was tested by downloading one OFQ file and this reduced the transfer time from over 3 hours for the above procedure to 110 secs for ASCII files. Also the ELXSI uses computer standard nine-track tape which would be convenient if the appropriate tape drives were available at the receiving facility.

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IV. OFQ Workstation Installation

A. System Requirements

An IBM PC-Compatible personal computer with a hard disk having a minimum of 17 megabytes of available memory, an extended memory board (e.g. AST Rampage) with 2 megabytes of memory, 640 kilobytes of Random Access Memory (RAM), one 5 1/4 inch floppy disk drive, and an 8087, 80287, or 80387 math coprocessor chip.

B. Installation Procedure:

Default to the root directory of the drive where the OFQ Workstation is to be installed.

- 1) Place the "OFQMENU Install Disk" in drive A: and ENTER the following command at the DOS prompt:

A:INSTALL

- 2) Replace the disk in drive A: with the "Applications and Commands" disk and enter the following command at the DOS prompt:

RESTORE A: /S

Where RESTORE is a DOS program and the appropriate path should be SET in the PATH command for the program to be executed.

- 3) Replace the disk in drive A: with the "Desqview Support Files" disk and enter the following command at the DOS prompt:

RESTORE A: /S

- 4) Replace the disk in drive A: with the "OFQ DATA BASE" disk 1, and enter the following command at the DOS prompt:

RESTORE A: /S

Replace the "OFQ DATA BASE" Disks at each prompt until all data from disks are restored.

- 5) Replace the disk in drive A: with the "Lotus-Data Disk 1" and enter the following command at the DOS prompt:

RESTORE A: /S

Replace disks in drive A: until all Lotus-Data disks are restored.

IV. OFQ Workstation Installation
C. Additional Required Programs

The programs listed below must also be installed on the same drive as the OFQ Workstation files, and they may be purchased from the following sources.

FREDA	-	Systems Technology Inc
NIPIP		136766 S. Hawthorne Blvd.
MFP		Hawthorne, CA 90250
DesQview	-	Quarterdeck Office Systems
Version 2.01		150 Pico Blvd.
		Santa Monica, CA 90405
R:BASE System V	-	Microrim
Version 1.1		P.O. Box 97022
		3925 159th Ave., N.E.
		Redmond, WA 98073
Lotus 1-2-3	-	Lotus Development Corporation
Version 2.01		
PROCOMM	-	Datastorm Technologies, Inc.
Version 2.4.2		PO Box 1471
		Columbia, MO 65205

- 1) To install FREDA, place the "FREDA Program Disk" in Drive A:
and Enter the following command.

A:Finstall

- 2) To install NIPIP, place the "NIPIP Program Disk" in Drive A:
and Enter the following command.

A:Ninstall

- 3) To install MFP, place the "MFP Program Disk" in Drive A:
and Enter the following command.

A:Minstall

- 4) Desqview; Use the installation procedure supplied by Desqview.
The files Should be installed in a subdirectory called "DV".
- 5) R:BASE System V; Use the installation procedure supplied by Microrim
and install the files in the subdirectory called "RBFILES".
- 6) Lotus 1-2-3; Install the 1-2-3 files in a subdirectory called "LOTUS"
- 7) PROCOMM; Install the Procomm files in a subdirectory called "PROCOMM".



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16. Abstract <p>This project was devoted to the development of a software package, called the "OFQ Workstation," for working with the OFQ Archives which are specially selected sets of Space Shuttle entry flight data relevant to flight control and flying qualities. The basic approach to creation of the workstation software was to federate and extend commercial software products to create a low cost package that operates on personal computers. Provision was made to link the workstation to large computers, but the OFQ Archive files were also converted to personal computer diskettes and can be stored on workstation hard disk drives. The primary element of the workstation developed in the project is the Interactive Data Handler (IDH) which allows the user to select data subsets from the archives and pass them to specialized analysis programs. The IDH was developed as an application in a relational database management system product. The specialized analysis programs linked to the workstation include a spreadsheet program, FREDa for spectral analysis, MFP for frequency domain system identification, and NIPIP for pilot-vehicle system parameter identification. The workstation also includes capability for ensemble analysis over groups of missions.</p>					
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