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Archive Data Base and Handling System for the Orbiter Flying Qualities Experiment Program

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NOMENCLATURE AND ACRONYMS

ACIP	Shuttle Aerodynamic Coefficient Identification Package
ADFRF	Ames Dryden Flight Research Facility
AFFTC	Air Force Flight Test Center
BFCS	Shuttle Backup Flight Control System
CINE	Cinetheodolite Data
CSS	Control Stick Steering
CYBER	Mainframe Computer Used for Flight Data Analysis at ADFRF
DEPR	ADFRF Computer Program for Decompressing MMLE Data Files
EAFB	Edwards Air Force Base
ELXSI	Replacement Computer for the ADFRF CYBER
GMT	Greenwich Mean Time
GPC	Shuttle Navigation and Guidance General Purpose Computer
HAC	Heading Alignment Cylinder
$\dot{h}$	Rate of Change of Altitude
HUD	Headup Display
Hz	Hertz
IMU	Inertial Measurement Unit
JSC	Johnston Space Center
KERMIT	Computer Software for Data Transmission Between Computers
M	Mach Number
MMLE	Modified Maximum Likelihood Estimator
MPDB	NASA JSC Master Product Data Base

OEX	NASA Orbiter Experiment Program
OFQ	Orbiter Flying Qualities Experiment in the OEX Program
OFT	Shuttle Orbiter Flight Test
OI	Shuttle Operational Instrumentation
PAPI	Precision Approach Path Indicator
RHC	Shuttle Rotational Hand Controller (pilot's "stick")
STI	Systems Technology, Inc.
STS	Space Transportation System
SYNC	ADFRF Computer Program for Synchronizing and Merging Flight Data Files
TD	Touchdown
TOLT	Takeoff and Landing Tower Data
TRS	ADFRF CYBER Tape Reservation System
UCINE	Computer Program for Reading CINE Data Tapes
UMMLE	Computer Program for Reading MMLE Data Tapes
UTOLT	Computer Program for Reading TOLT Data Tapes

SECTION I

INTRODUCTION

A. CONCEPT AND PURPOSE OF THE OFQ DATA ARCHIVES

The OFQ archives have been assembled as part of the OFQ research (Refs. 1-4) in the Orbiter Experiment (OEX) to preserve and document shuttle flight data relevant to vehicle dynamics, flight control, and flying qualities. This is a first step in an effort to make valuable flight control/flying quality data bases widely available, and easily accessible to the research community at large, so that maximum use can be made of data from costly flight tests and simulations. In their complete form, the OFQ archives contain descriptive text (e.g., general information about the flight, signal descriptions and units) as well as numerical time history data. For a complex program such as the shuttle Orbiter Flight Test (OFT), the availability of very large quantities of data is a major problem. Official shuttle flight data bases such as the NASA JSC Master Products Data Base (MPDB), 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 archives are intended to provide flight phase oriented data subsets with relevant signals which are easily identified and used. Massive flight data sets require powerful and capacious computers such as the ADFRF CYBER and its replacement the ELXSI. However, flight research is done by many workers at many locations on many different computers, and thus convenient rapid data transfer among computers and research facilities is very important. The critical test of this capability is data transfer to a remote facility where "face-to-face" help with data file manipulation is not generally available. This puts a premium on documentation and is the reason for this report. Ideally much of this information should also reside in the archive computer files.

B. IMPLIED REQUIREMENTS FOR DATA HANDLING

In the OFQ landing analysis and in most flight test programs, data is obtained from a variety of on-board and ground based instrumentation, and stored on a variety of media in various formats at various sample rates. Time skews among data channels is common due to instrumentation factors such as multiplexing. Thus, a sophisticated data handling system -- hardware and software -- is required to assemble data archives. Once the archives are assembled, the data handling system must provide rapid convenient access to the files, and efficient means of setting up signal and time period subsets as "working files" for specific analyses. Magnetic tapes have traditionally been the primary means for large scale data transfer between facilities, but this requires specialized and expensive tape drives at both facilities. Rapid development of computer telecommunications makes it now feasible to routinely transfer reasonably sized working files by standard phone lines. If the data handling system is designed to accommodate this, expensive tape hardware can be eliminated by relatively inexpensive and versatile communication software with acceptable reductions in speed and capacity.

Research in flight control and flying qualities has special data handling requirements which arise from the presence of the human pilot. 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. Some of these special needs are summarized in Table 1.

C. STATUS OF THE OFQ ARCHIVE SYSTEM

The unique and sophisticated facilities at the NASA ADFRF and new developments in computer technology have made it possible to create an archive data handling system satisfying many of the above needs simply by assembling "off the shelf" software. Use of existing ADFRF, AFFTC, and commercial software has kept "software engineering" to a practical level. This OFQ data handling system discussed below will evolve in

TABLE 1. DESIRED FEATURES FOR INTERACTIVE DATA HANDLING

- Interactive operation
- Ability for remote researchers to easily access the primary archives without "face-to-face" contact with archive "stewards"
- Reference to variables by symbolic names rather than by locations in arrays
- Ability to extract a signal/time slice subset of a flight archive as a working file by stating logical and mathematical specifications on the archive variables
- Capability to easily transfer data subsets from the primary archives to remote facilities with minimal requirements for special or expensive hardware
- Directories of archive signals
- Capability to display archive text and numerical data with adequate labeling and convenient formats
- Ability to assemble raw and processed data into multiflight ensemble files and apply elementary statistical analysis
- Capability to perform calculations on file data efficiently and productively (i.e., with minimal "nuisance programming" through the availability of a "calculator mode" for vector variables)
- Convenient and flexible data display graphics (screen and hardcopy)
- Flexible data interface with other programs including input file generation for specialized analysis software (e.g., spectral analysis, estimation, identification, statistical analysis)
- Capability to augment archive files with processed data

capability, productivity, and convenience along with computer and software technology in general. This of course implies that this document will require continual revision. Recognizing this, this first edition has been written for the archive system as presently implemented on the ADFRF CYBER computer. The CYBER is scheduled for replacement by the ELXSI shortly, but the basic structure of the archive system, including major program components and data file structures, is expected to remain basically the same.

SECTION II

OFQ ARCHIVES AND DATA HANDLING SYSTEM

A. OVERVIEW

Figure 1 is a general picture of how the OFQ archives are embedded in the data handling system on the ADFRF CYBER and connected to remote facilities. In essence there is a hierarchy of archive files beginning with raw data tapes, which are linked by various data handling programs. The ELXSI implementation is expected to be essentially the same at this level.

At present OFQ archive files have been created on the CYBER for six shuttle OFT landings: STS-2 through STS-7. Mission data for these flights is given in Table 2.

B. 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 3.

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 4. Since the primary application of these files has been extraction of airframe aerodynamic coefficients, airframe response and control surface deflection variables are

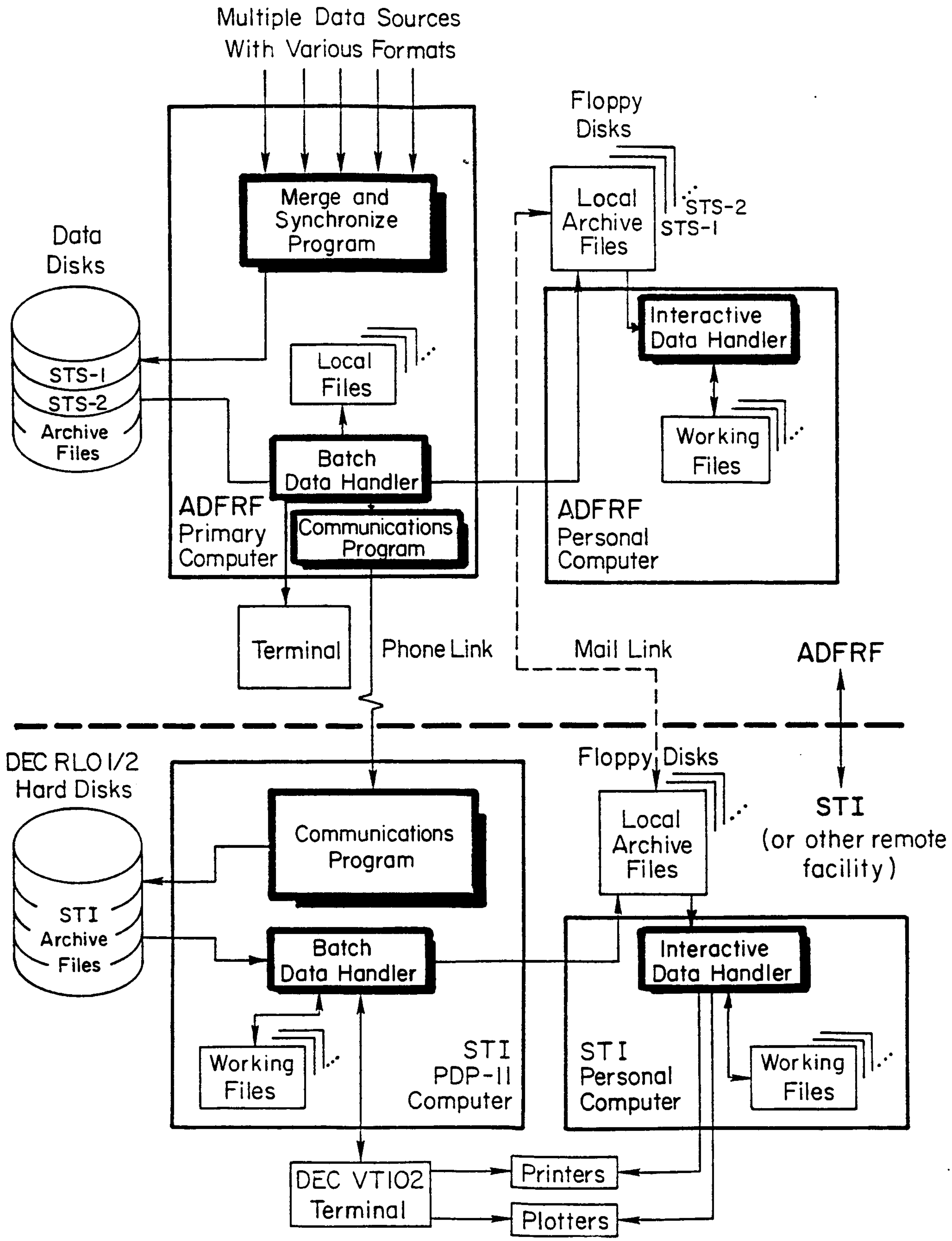

Figure 1. OFQ Data Handling System

TABLE 2. SPACE SHUTTLE MISSION DATA

Systems Technology Inc. 04-Sep-85

	Mission #	Entry date	Orbiter	Commander	Pilot	3rd crewman	Landed at
1	STS-1	14-Apr-81	Columbia	J. W. Young	R. L. Crippen	no	EAFB
2	STS-2	14-Nov-81	Columbia	J. H. Engle	R. H. Truly	no	EAFB
3	STS-3	30-Mar-82	Columbia	J. R. Lousma	C. G. Fullerton	no	White Sands
4	STS-4	04-Jul-82	Columbia	T. K. Mattingly	H. W. Hartsfield	no	EAFB
5	STS-5	16-Nov-82	Columbia	V. D. Brand	R. F. Overmyer	yes	EAFB
6	STS-6	09-Apr-83	Challenger	P. J. Weitz	K. J. Bobko	yes	EAFB
7	STS-7	24-Jun-83	Challenger	R. L. Crippen	F. H. Hauk	yes	EAFB

	Mission #	GMT @ TD	Runway	Final CSS @	Ball/Bar Indicator	PAPI Light	HUD	HAC Turn	Weight [lbs]
1	STS-1	?	#23 lakebed	115,000 ft	no	no	no	Left	196,500
2	STS-2	76993.00	#23 lakebed	@ HAC	no	no	no	220 deg Left	204,000
3	STS-3	57885.00	Runway 15	140 ft	no	no	no	Right	207,500
4	STS-4	58180.00	Runway 22	2500 ft	no	no	no	Left	209,500
5	STS-5	52405.00	Runway 22	M = 0.97	yes	yes	no	200 deg Left	204,100
6	STS-6	68023.00	Runway 22	@HAC	yes	yes	yes	200 deg Left	196,600
7	STS-7	50226.00	#15 lakebed	@HAC	yes	yes	yes		203,000

From STS-5 on, a 20 sec washout filter was added to the beta feedback to yaw control for 2<qbar<20 psf.
For earlier flights the beta feedback was cut out in this region.

Starting with STS-9 there is a change in the slapdown region (from main gear touchdown to nosewheel touchdown). No effect in flight unless orbiter bounces at touchdown.

TABLE 3. SUMMARY OF SHUTTLE FLIGHT DATA AVAILABLE FOR OFQ DATA BASE

VARIABLE		MMLE FILES				CINETHEODOLITE TAPES	TAKEOFF & LANDING TOWER TAPES
		ACIP	GPC	OI	BFCS		
TRANSLATIONAL ACCELERATION A_Z A_Y A_Z		X	X			X	
ANGULAR ACCELERATION $\dot{p}, \dot{q}, \dot{r}$		X					
TRANSLATIONAL RATE (AIR DATA) $\alpha, \beta, \dot{H}, V_{TRUE}, V_{EAS}, \bar{q}, M$			X			X	
TRANSLATIONAL RATE (EARTH REFERENCED) $\dot{X}, \dot{Y}, \dot{Z}$						X	X
ANGULAR RATE p, q, r		X	X				
EARTH REFERENCED POSITION X, Y, H			X		X	X	X
EULER ANGLES ψ, θ, ϕ			X				
CONTROL SURFACE DEFLECTION	δ_e, δ_a, δ_r	X					
	δ_{SB}			X			
	δ_{BF}		X				
MANUAL CONTROLS (COMMANDER AND PILOT SEPARATE)	$\delta_{Q_{RHC}}$, δ_{PRHC}		X		X		
	δ_{PED}			X			
	δ_{SBC}, δ_{BFC}						
MANUAL TRIM CONTROLS							
SWITCHES AND FCS DISCRETES			X				
DISPLAY AND HUD VARIABLES							
WIND DATA						X	

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TABLE 4. MMLE FILE DIRECTORY

FILE TIMES 15:38:00:0 - 16:11:20:0
FIRST WORD OF EACH RECORD IS GMT TIME IN FLOATING POINT SECONDS; DATA CHANNELS FOLLOW AS LISTED BELOW.

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	Q-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, AGL	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	AAY	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	P07H0082A	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	RCSR2R	V42P3544A	OI	20	25
44	R3R	RCSR3R	V42P3545A	OI	21	25
45	R4R	RCSR4R	V42P3546A	OI	22	25
46	LOB ELEVON	ALOBDE	P07H0079A	ACIP	37	174
47	LIB ELEVON	ALIBDE	P07H0078A	ACIP	35	174
48	ROB ELEVON	AROBDE	P07H0081A	ACIP	41	174
49	RIB ELEVON	ARIBDE	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	V42P3547A	OI	23	25

TABLE 4. (Concluded)

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57	R2U	RCSR2U	V42P3548A	OI	24	25
58	R4U	RCSR4U	V42P3549A	OI	25	25
59	R2D	RCSR2D	V42P3550A	OI	26	25
60	R3D	RCSR3D	V42P3551A	OI	27	25
61	R4D	RCSR4D	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	L4L,ACIP	AARCSY	P07P0083A	ACIP	45	174
75	JET DRIVERS L1X,R1X	JTCMD1	V72M8696P	GPC	49	12.5
76	JET DRIVERS L2X,R2X	JTCMD4	V72M8744P	GPC	52	12.5
77	JET DRIVERS L3X,R3X	JTCMD3	V72M8724P	GPC	51	12.5
78	JET DRIVERS L4X,R4X	JTCMD2	V72M8764P	GPC	50	12.5
79	BODY FLAP COMMAND	BFLCMD	V90H1580C	GPC	42	1
80	RUDDER COMMAND	DRCMD	V57K0140C	GPC	43	5
81	SPEED BRAKE COMMAND	DSPCMD	V57K0240C	GPC	44	5
82	LIB COMMAND	LIBCMD	V58K0820C	GPC	45	5
83	LOB COMMAND	LOBCMD	V58K0870C	GPC	46	5
84	RIB COMMAND	RIBCMD	V58K0920C	GPC	47	5
85	ROB COMMAND	ROBCMD	V58K0970C	GPC	48	5
86	PSI	PSI	V90H2230C	GPC	15	5
87	ALPHA, NAV	ALPHANV	V90H2246C	GPC	19	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	V98H1500C	BFS	19	12.5
93	RHC PITCH-BFCS	QRHC	V98H1501C	BFS	18	12.5
94	RHC ROLL, PILOT	PRRHCR	V72K1205C	GPC	55	1
95	RHC PITCH, PILOT	PRRHCP	V72K1206C	GPC	56	1
96	AUTOLAND BODY FLAP	ALAND	V90H1011C	GPC	57	1
97	ALPHA COMMAND	ALPCMD	V90H0803C	GPC	59	1
98	PHI COMMAND	COMPHI	V90H1044C	GPC	61	1
99	AMI ACCELERATION	ACCAMI	V72L7258B	GPC	63	1
100	AMI 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

emphasized; however, manual controller deflections are also available. There are inconsistencies between the Table 4 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."

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 A. 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 5. 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 A).

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TABLE 5. 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/Sc2	Acceleration in the YZ-Plane
2	INDEX		Index Number	54	AT	Ft/Sc2	Tangential Acceleration
3	ELAPS	Sec	Elapsed Time in Seconds from Zero Time	55	AN	Ft/Sc2	Normal Acceleration
4	SECS	Sec	Time in Total Seconds	56	AWT	Ft/Sc2	Tangential Acceleration–Wind Corrected
5	X	Feet	X–Unsmoothed (EAST)	57	AWN	Ft/Sc2	Normal Acceleration–Wind Corrected
6	Y	Feet	Y–Unsmoothed (NORTH)	58	AXP	Ft/Sc2	Acceleration along the VA Vector
7	Z	Feet	Z–Unsmoothed (UP)	59	AYP	Ft/Sc2	Acceleration Horizontally Perpendicular to the VA Vector
8	XSM	Feet	X–Smoothed (EAST)	60	AZP	Ft/Sc2	Acceleration Perpendicular Upward to the VA Vector
9	YSM	Feet	Y–Smoothed (NORTH)	61	HORD	Feet	Horizontal Distance
10	ZSM	Feet	Z–Smoothed (UP)	62	ARCD	Feet	Arc Distance
11	LAT	Deg	Latitude	63	HORDW	Feet	Horizontal Distance–Wind Corrected
12	LONG	Deg	Longitude (+WEST)	64	ARCDW	Feet	Arc Distance–Wind Corrected
13	ALT	Feet	Altitude	65	ACCGD	Feet	Accumulated Ground Distance
14	RHO	Sl/Ft3	Air Density	66	QC	Lb/Ft2	Impact Pressure
15	PA	MBS	Ambient Pressure	67	QDP	Lb/Ft2	Dynamic Pressure
16	TA	Deg C	Ambient Temperature	68	RLD		Lift to Drag Ratio
17	WD	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	KD		Ballistic Coefficient of Drag
20	WY	Ft/Sec	Y–Component of Wind Velocity	72	HV	Deg	Heading with Respect to Y–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	HVW	Deg	Heading with Respect to Y–Axis–Wind Corrected
23	VZ	Ft/Sec	Z–Component of Velocity	75	HVNW	Deg	Heading with Respect to North–Wind Corrected
24	ROC	Ft/Sec	Rate of Climb	76	VNO	Ft/Sec	Northward Velocity of the Object
25	VWX	Ft/Sec	X–Component of Velocity–Wind Corrected	77	VEO	Ft/Sec	Eastward Velocity of the Object
26	VWY	Ft/Sec	Y–Component of Velocity–Wind Corrected	78	VZO	Ft/Sec	Upward Velocity of the Object
27	AX	Ft/Sc2	X–Component of Acceleration	79	HVO	Deg	Heading with Respect to North of the Object
28	AY	Ft/Sc2	Y–Component of Acceleration	80	EL	Deg	Elevation Angle
29	AZ	Ft/Sc2	Z–Component of Acceleration	81	AZY	Deg	Azimuth Angle with Respect to Y–Axis
30	AV	Ft/Sc2	Vertical Acceleration	82	AZN	Deg	Azimuth Angle with Respect to North
31	SR	Feet	Slant Range	83	AR	Ft/Sc2	Radial Acceleration
32	GR	Feet	Ground Range	84	KAPPA	Deg	Direction of Radial Acceleration
33	XZR	Feet	Range in the XZ–Plane	85	OMEGA	Dg/Sec	Angular Rate of Pull–up
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	VWXY	Ft/Sec	Velocity in the XY–Plane–Wind Corrected	96	VERT	Deg	Vertical angle between the VT and SR Vectors
45	VWXZ	Ft/Sec	Velocity in the XZ–Plane–Wind Corrected	97	SPACE	Deg	Space Angle between the VT and SR Vectors
46	VWYZ	Ft/Sec	Velocity in the YZ–Plane–Wind Corrected	98	PALT	Feet	Pressure Altitude
47	ROD	Ft/Sec	Rate of Descent	99	AZATT	Deg	Azimuth Attitude Angle
48	VS	Ft/Sec	Speed of Sound	100	ELATT	Deg	Elevation Attitude Angle
49	MACH		Mach Number	101	VATT	Deg	Vertical Attitude Angle
50	AM	Ft/Sc2	Acceleration Magnitude (Total Acceleration)	102	ELDMP	Deg	Dumped Elevation Angle
51	AXY	Ft/Sc2	Acceleration in the XY–Plane	103	RBO	Deg	Bearing of Origin with Respect to Heading with Respect
52	AXZ	Ft/Sc2	Acceleration in the XZ–Plane				to North–Wind Corrected

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 6 by channel. The TOLT 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.

C. OFQ DATA HANDLING SYSTEM

1. Data Source/Computer Interface

The integration of the three OFQ data sources on the primary ADFRF computer (upper left in Fig. 1) to create archive files is shown in greater detail in Fig. 2. Disk packs and tapes must be mounted by an operator before they can be accessed. Tape access on the CYBER is handled through the Tape Reservation System (TRS) Ref. 7.

TABLE 6. VARIABLES RECORDED ON TAKEOFF AND LANDING TOWER TAPES

CHANNEL	VARIABLE
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

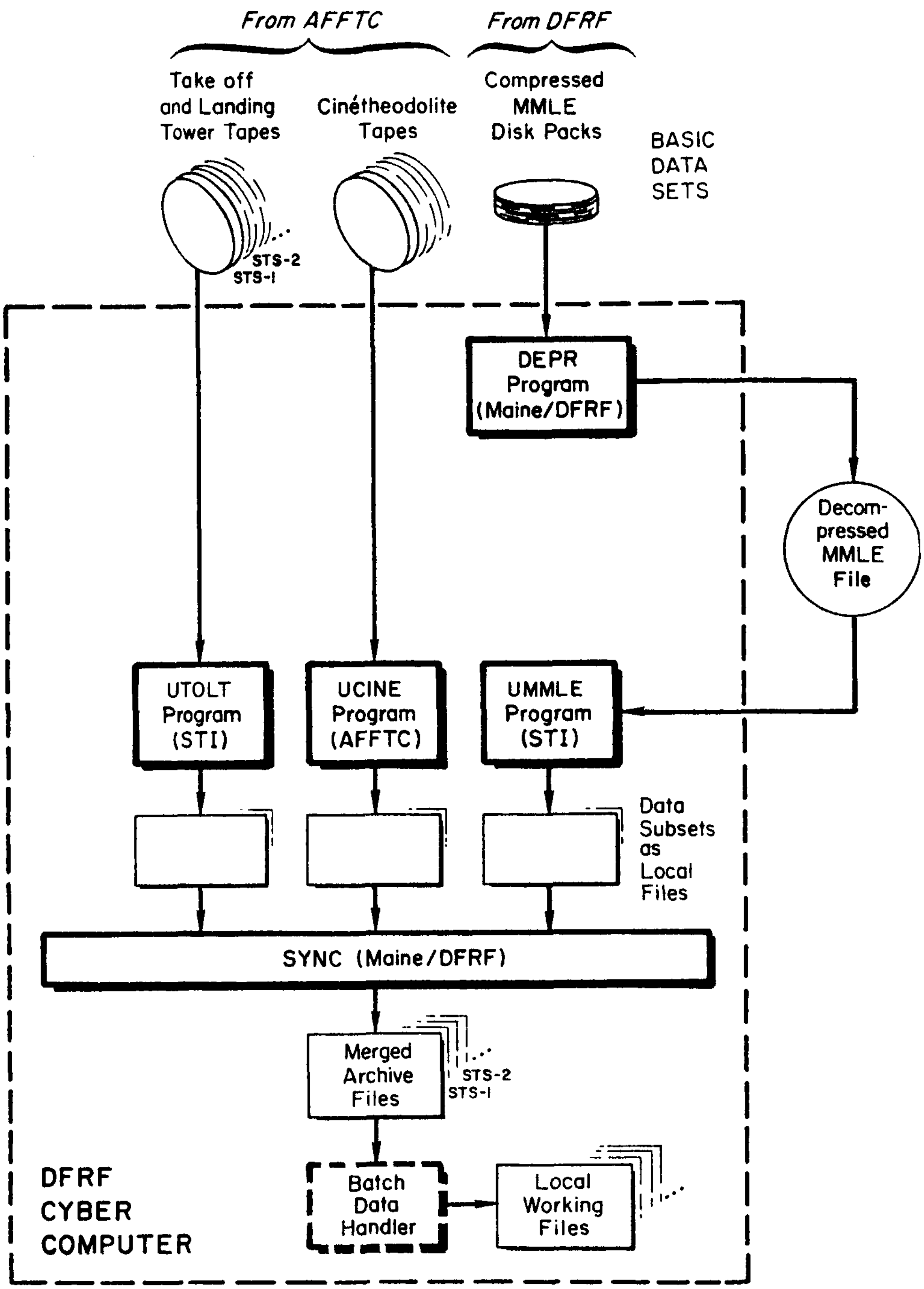

Figure 2. Creation of Shuttle Archives from Basic Data Sets

Because each of the three data sets have been stored in a different format, a unique program is required to read each one and store the desired data subset on a (mass storage) file to make it available for analysis. The data is stored in unformatted form for access by other programs. These archive-reading programs are discussed in the following subsections.

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 stored uncompressed. In the compressed form, each channel is represented at its own sample rate. Before this data can be used, it must be decompressed by the "DEPR" program developed by R. E. Maine. The decompressed data file is then read by the program "UMMLE," which also stores a subset of the data on a file. This program provides for selection of a subset of signals to be stored for a sub-interval of the entire entry period. It also provides for extraction of every n'th time slice if desired. UMMLE was created expressly for the OFQ data handling system. See Appendices B, C, and D for the procedures for running DEPR and UMMLE and related details.

b. CINE Data

The CINE data is read by the program "UCINE," 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 provides for extraction of every n'th time slice (record) of a selected subset of signals over a chosen time interval. See Appendices B and E for the procedures for running UCINE and related details.

c. TOLT Data

The TOLT archive tape is first converted to a disk file, which is then read by the program "UTOLT." 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. See Appendices B and F for the procedure for running UTOLT and related details.

2. Merging and Synchronizing the Primary Data Sets

Combination of the three primary source files MMLE, CINE, and TOLT into a single file is done by the program SYNC (Ref. 8). A subset of all available signals in the three data files can 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 consists 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. It should be noted that files will be significantly larger if formatted. In merging the data in the three input files, SYNC provides for:

- 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

See Appendices B and G for the procedure for running SYNC and related details.

3. Archive Files

The structure of the data handling system provides several possibilities for creating permanent archives listed in Table 7. The first option, merged and synchronized files on the CYBER (and later the

TABLE 7. OPTIONS FOR SHUTTLE OFQ ARCHIVES

- Merged archive files on CYBER (synchronized CINE, TOLT, and MMLE data)
- Merged archive subsets on floppy disks for personal computers
- Separate CINE, TOLT, and MMLE subsets as CYBER files with SYNC job files for recreating merged archives
- Basic data set (CINE, TOLT, and MMLE) tapes/disks with tape reading and SYNC job files for recreating merged archives
- Detailed documentation of process for creating working files from data source tapes

ELXSI), will form the primary archives. This should be the most convenient form for most potential users since great familiarity with the CYBER and the TRS is not required, and all data is at a single sample rate. As a backup for additional signals and time periods, the primary data source tapes will be retained in the ADFRF Tape Library. Finally, this document represents the last option in Table 7.

The merged archive files are set up at a sample rate of 25 samples per/sec (the MMLE rate). The primary consideration in setting sample rate is that it be at least three to five times the highest observed frequency (Ref. 2). The highest observed frequencies in Table 8 are based on experience and examination of shuttle data. The implication of Table 8 is that, if a single sample rate is used in the file, a sample rate much less than 25 samples per/sec is not feasible. Single rate

TABLE 8. SAMPLE RATE SELECTION

$$\text{Criterion: Sample Rate} > (3\text{-}4) \times \begin{pmatrix}\text{Highest}\\ \text{Observed}\\ \text{Frequency}\end{pmatrix}$$

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 ($\dot{h}$)	12.5
TOLT	4	2	0.8 ($\dot{h}$)	5

*Some signals originally sampled at other rates

file sizes can be estimated directly from Fig. 3. As a practical matter, the single rate archive files may be "compressed" (using the MMLE data compression software) for long term storage.

A final consideration for the archives is definition of all forms of information to be stored. As indicated in Table 9, this includes more than raw time history data. As a minimum, some descriptive text is desired to identify the flight and the signals. Because of inconsistencies in the header formats of the several programs in the data handling system, non-time history data is not presently stored in the archive files. Instead this information is stored in a "LOTUS 1-2-3" data base, and summary tabulations are presented in Section III.

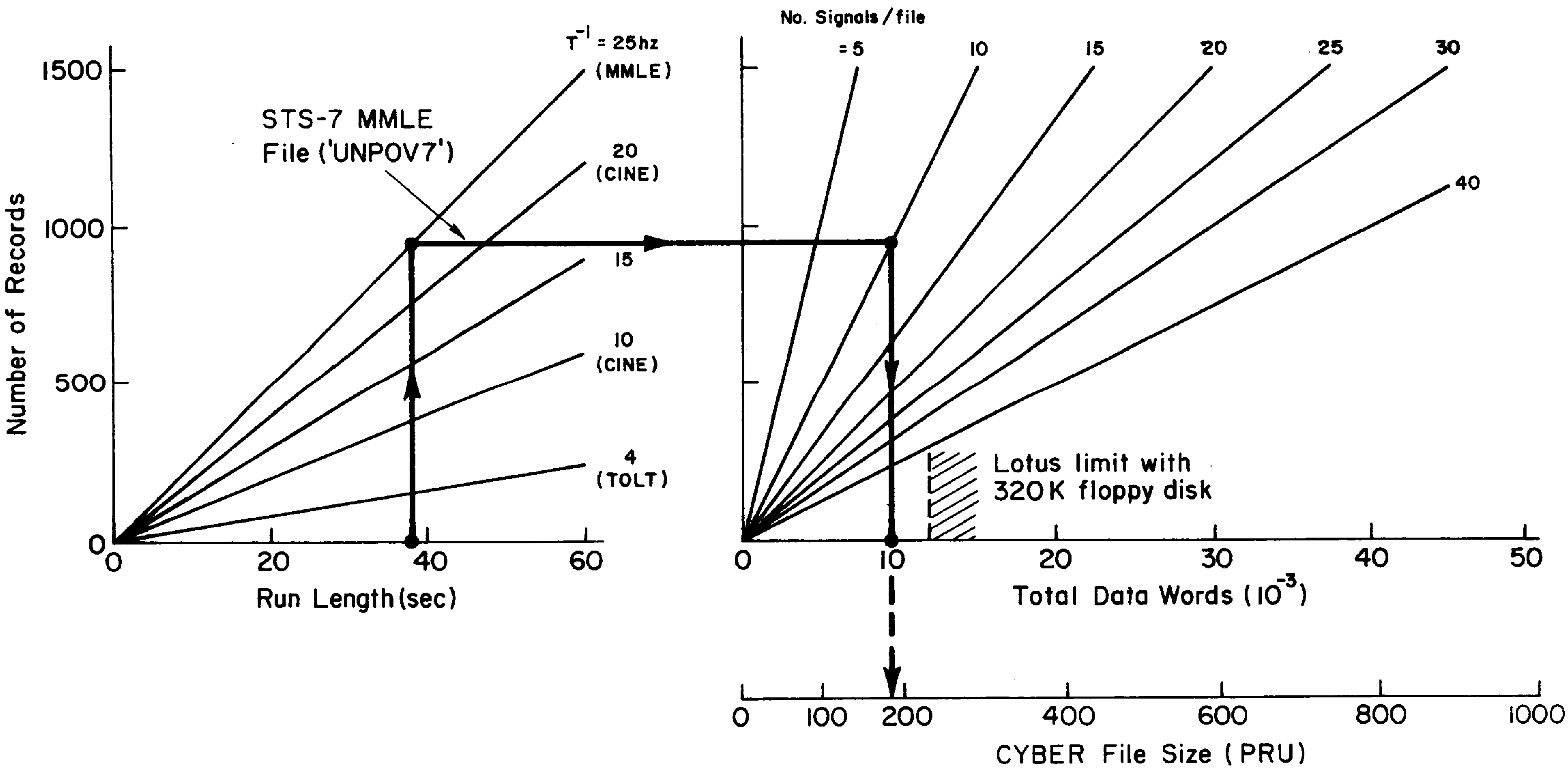

Figure 3. Archive File Size Tradeoffs

TABLE 9. LOGICAL DATA STRUCTURE FOR THE ARCHIVE FILES

Archive File	File-wide Text Block (1)	File-wide Text Line (1, n)	First Line (0,1) ⊕ First Line (0, 1)
	File-wide Constants (1)	File-wide Constant (1, n)	Number Name Value Units Descriptor
	Variable Directory (1)	Variable Datum (1, n)	Variable No. Name Units Descriptor Source I Stack No. W Stack No.
	Variable-specific Text Block (1)	Text for Specific Variable (1, n)	
	Variable-specific Constant Block (1)	Constants for Specific Variable (1, n)	Variable No. Number Name Value Units Descriptor
	Time History Block (1)	Time History Vectors (1, n)	Time Vector ⊕ Variable Vector

4. Archive Data Transfer

Effective use of the OFQ archives requires a means for remote users to transmit archive files or subset working files to their local computer. At STI this is now done using a new telecommunications package called KERMIT. This system uses KERMIT programs on both the CYBER and the receiving computer, which allows sophisticated error checking to be done. The KERMIT program was developed at Columbia University and is in the public domain. Documentation and software are available at nominal cost. KERMIT is becoming a defacto standard largely because it is available for a large number of computers including mainframes, minicomputers, and microcomputers. Information about KERMIT may be obtained from:

KERMIT Distribution
Columbia University
Center for Computing Activities
612 West 115th Street
New York, New York 10027

5. Interactive Data Handling

As noted in the Introduction and Table 1, flight control/flying qualities research has particular needs for interactive data processing to allow flexible but well motivated analyses with a minimum of "nuisance programming." The OFQ experience has shown that batch data handling using SYNC represents the most sophisticated practical capability on the CYBER.

SECTION III

USE OF THE OFQ ARCHIVES

Archive files are available on the CYBER for STS-2 through -7. For STS-1 the CINE data is unuseable 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 has not been examined, and the MMLE files are the best present archives. Data has been archived in two files for each of the STS-2 through -7 entries. The 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. The small (unformatted) file, named ULANDOX where X is the flight number, contains the data for the landing maneuver (pre-flare pullup through touchdown). A third set of files, named USTSOX where X is the flight number, are presently stored on the CYBER. These are not archive files but are rather subsets of the ULANDOX files containing only longitudinal data and were setup for efficient transmission to STI using KERMIT.

Table 10 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 11. The variables and their order for each file type is given in Table 12. Figure 4 indicates the general structure of the files as they typically appear when formatted.

A subset of the archive files may be extracted using the SYNC program as explained in Appendix G. The "time slice" in Greenwich Mean Time (GMT) may be defined from the basic trajectory variables time histories in Fig. 5. Note that the time axis in Fig. 5 has its origin at the start of the large (USYNCOX) file and the GMT of this point is specified on the figure.

TABLE 10. SIGNAL DIRECTORY FOR SHUTTLE OFQ ARCHIVE FILES

# Signal Description	Original Data Set	Data Source	Units	Original Sample Rate (smpl/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	AAZL
3 Pitch acceleration	MMLE	ACIP	rad/sec/sec	174	6	AQDOT
4 Longitudinal accelerometer signal	MMLE	ACIP	g's	174	7	AAXL
5 Lateral accelerometer signal	MMLE	ACIP	g's	174	19	AAY
6 Roll acceleration	MMLE	ACIP	rad/sec/sec	174	20	APDOT
7 Yaw acceleration	MMLE	ACIP	rad/sec/sac	174	21	ARDOT
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 10. (CONCLUDED)

#	Signal Description	Original Data Set	Data Source	Units	Original Sample Rate (smpl/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		8	-
33	Body flap deflection	MMLE	GPC	deg	6.25	9	BDFPL1
34	Aileron deflection	MMLE	COMUPTED	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	QRHC
43	Rotational hand controller roll (Pilot)	MMLE	GPC	deg	1	94	PRRHCR
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 11. SUMMARY OF FILE NAMES AND TYPES

MISSION	"USYNCOX" FILES (START OF CINE DATA TO START OF PREFLARE)		"ULAADOX" FILES (START OF PREFLARE THROUGH TOUCHDOWN)		"USTSOX" FILES (LONGITUDINAL LANDING DATA)	
	NAME	TYPE	NAME	TYPE	NAME	TYPE
STS-2	USYNCO2	1	ULANDO2	1	USTSO2	4
STS-3	USYNCO3	1	ULANDO3	1	USTSO3	4
STS-4	USYNCO4	1	ULANDO4	2	USTSO4	3
STS-5	USYNCO5	1	ULANDO5	2	USTSO5	3
STS-6	USYNCO6	1	ULANDO6	2	USTSO6	3
STS-7	USYNCO7	1	ULANDO7	1	USTSO7	4

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

TABLE 12. ORDERING OF SIGNALS BY ARCHIVE FILE TYPE

#	Signal Description	Original Data Set	Signal Order by File Type Type 1	Type 2	Type 3	Type 4
	Accelerations					
1	Acceleration normal to trajectory	CINE	1	1		
2	Normal accelerometer signal	MMLE	2	2	1	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	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		
	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	3
18	Angle of attack (side probe)	MMLE	17	18	4	4
19	Sideslip angle (side probe)	MMLE	18	19		
	Attitude angles					
20	Pitch attitude	MMLE	19	20	5	5
21	Bank angle	MMLE	20	21		
22	Heading	MMLE	21	22		
	Earth Referenced Position					
23	Distance east (unsmoothed)	CINE	22	23	6	6
24	Distance north (unsmoothed)	CINE	23	24	7	7
25	Distance up (unsmoothed)	CINE	24	25	8	8
26	Altitude above ground level	MMLE	25	26	9	9
27	Radar altitude	MMLE	26	27	10	10

TABLE 12. (CONCLUDED)

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

```
*
/GETPF(FSYNC07)
 GETPF COMPLETE.
/PRIMARY,FSYNC07
PRIMARY,FSYNC07.
/FILEDMP,FSYNC07,T=DIS  <---- Use of "FILEDMP" command
1 FILEDMP,FSYNC07,T=DIS.      to display file                    DISPLAY                    85/05/31. 16.32.18
0

0                          BEGINNING OF FILE       1
0                          BEGINNING OF RECORD     1, FILE     1
0      ?23456789 ?23456789 ?23456789 ?23456789 ?23456789 ?23456789 ?23456789 ?23456789 ?23456789 ?23456789
       (O) GMT         (1) AN     (2) AAZL -----
    1   49990.000      0.000       .896     -.091      -.249      -.040      4.166       .321
   11    -.268      -.313       .034      0.000      0.000    842.543       .886    181.143   [846  <-- First record of
   21  .686]      6.997      -.165    -10.397       .743     56.199      0.000      0.000     0.000       42 signals + time
   31   43047.437   9000.130     7.047     -9.407       .382       .214     47.385     0.000
   41    0.000      0.000      0.000       .001       .001      -.059      -.059     55.986    [0  <-- continued on next line
   51  .000]      0.000     49990.040    0.000       .978      3.799      -.247       .007      -6
   61  .967      1.143      -.054      -.378      -.002      0.000      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      47
   91  .359      0.000      0.000      0.000      0.000       .001       .001      -.059     -.059
  101      55.986      0.000      0.000     49990.080     0.000       .953      1.199     -.258
  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      56
  131  .196      0.000      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     -1.959      1.037      -.039      -.312       .001       0
  171  .000      0.000    842.543       .886    181.446    846.885     7.008      -.177    -10.411
  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     49990.160     0
  211  .000       .928     -5.863      -.246      -.007      8.365       .741      -.346     -.132
  221        .101      0.000      0.000    842.543
*TERMINATED*
*
```

Figure 4. Example Formatted Printout of an Archive File (42 Channel, Type 1 File "FSYNC07")

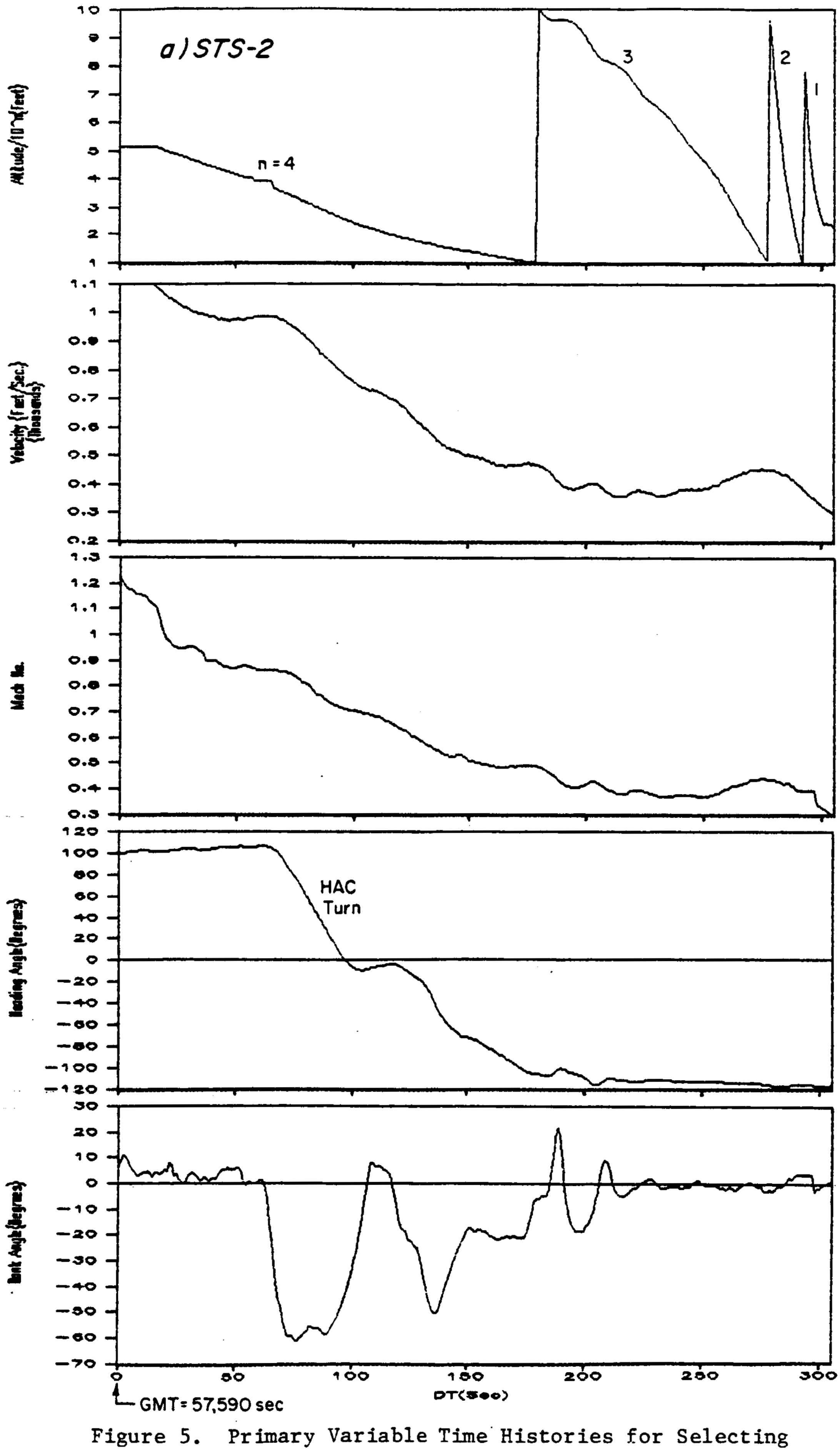

Figure 5. Primary Variable Time Histories for Selecting Working File Time Slices in the Archive Files

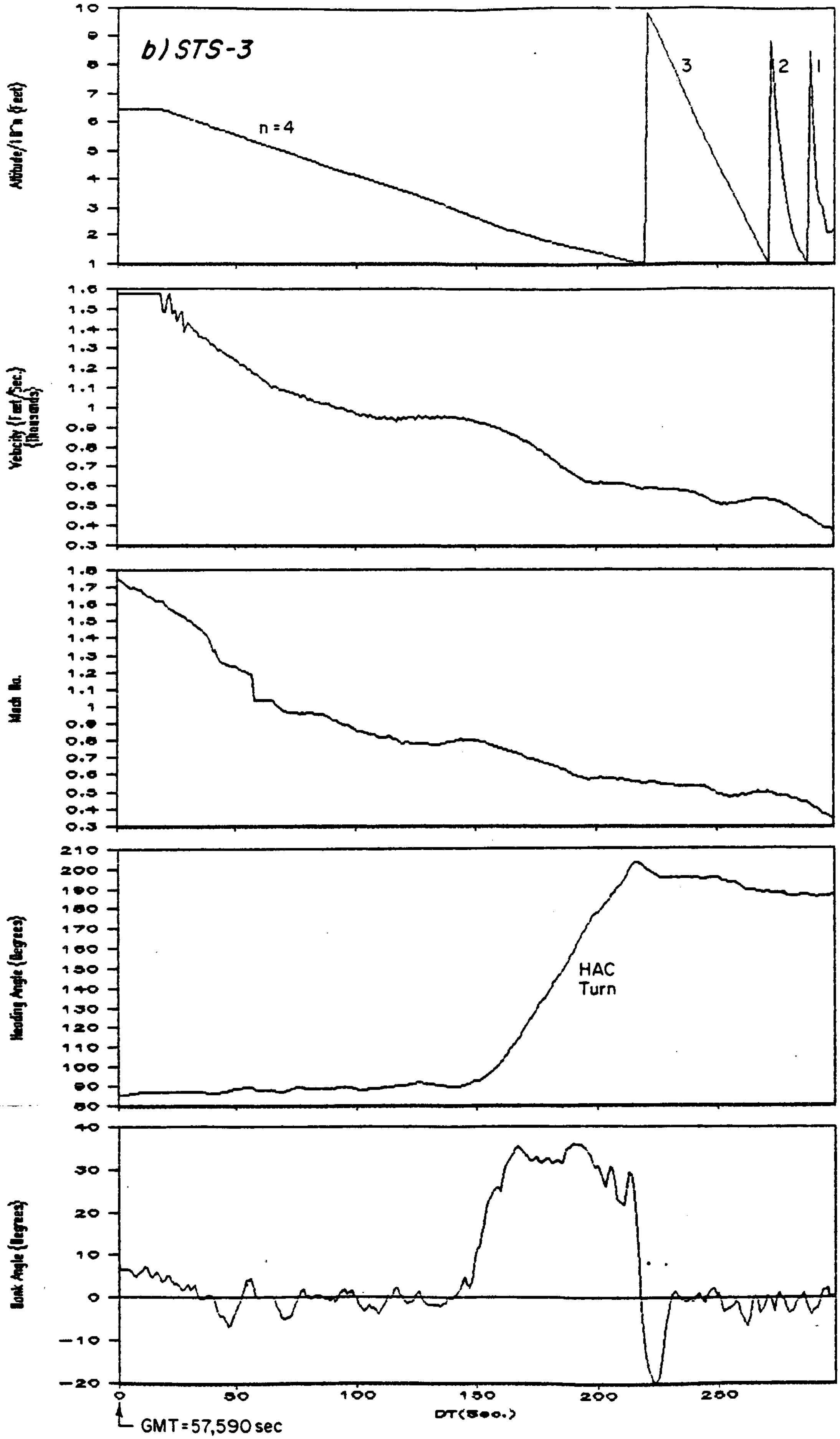

Figure 5. (Continued)

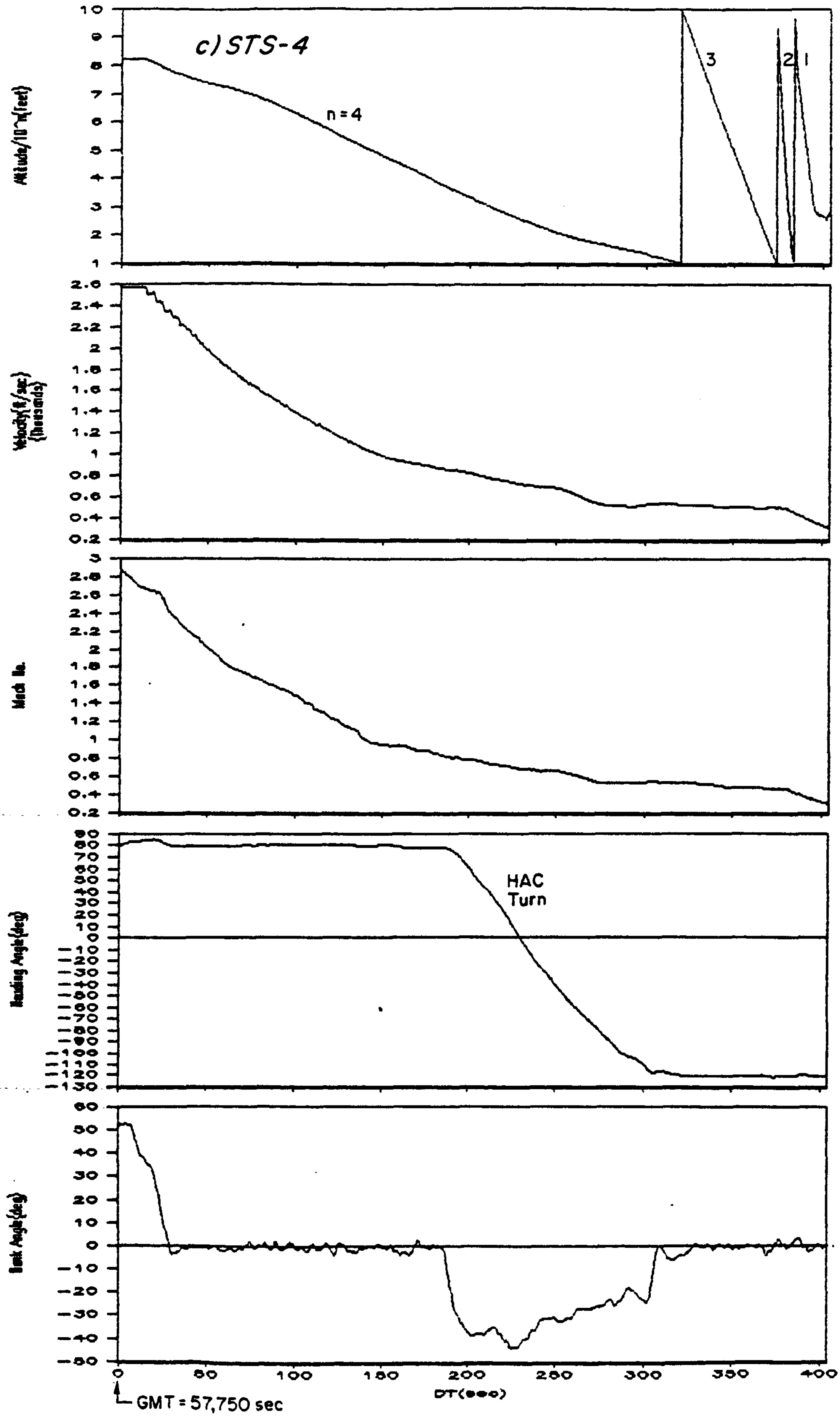

Figure 5. (Continued)

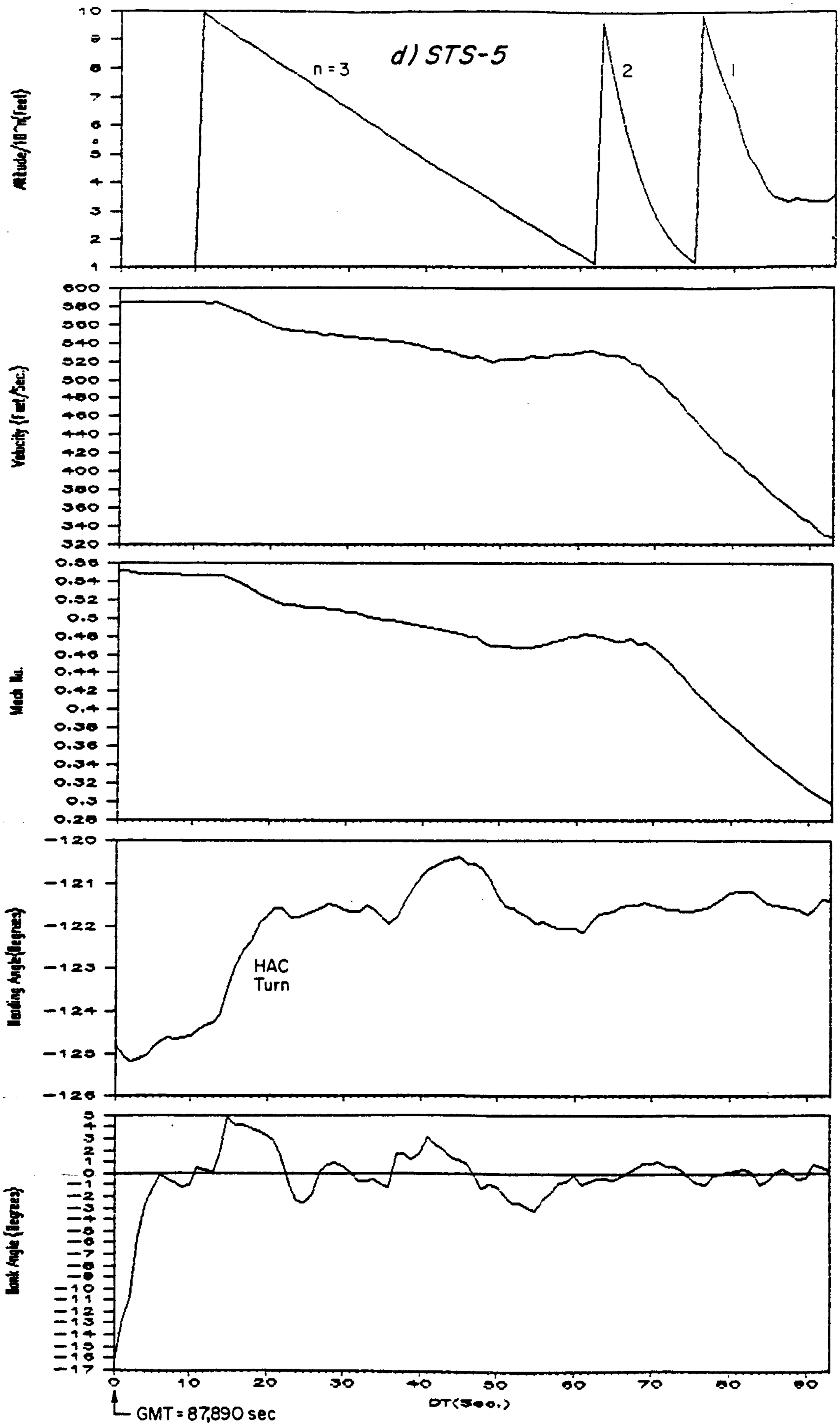

Figure 5. (Continued)

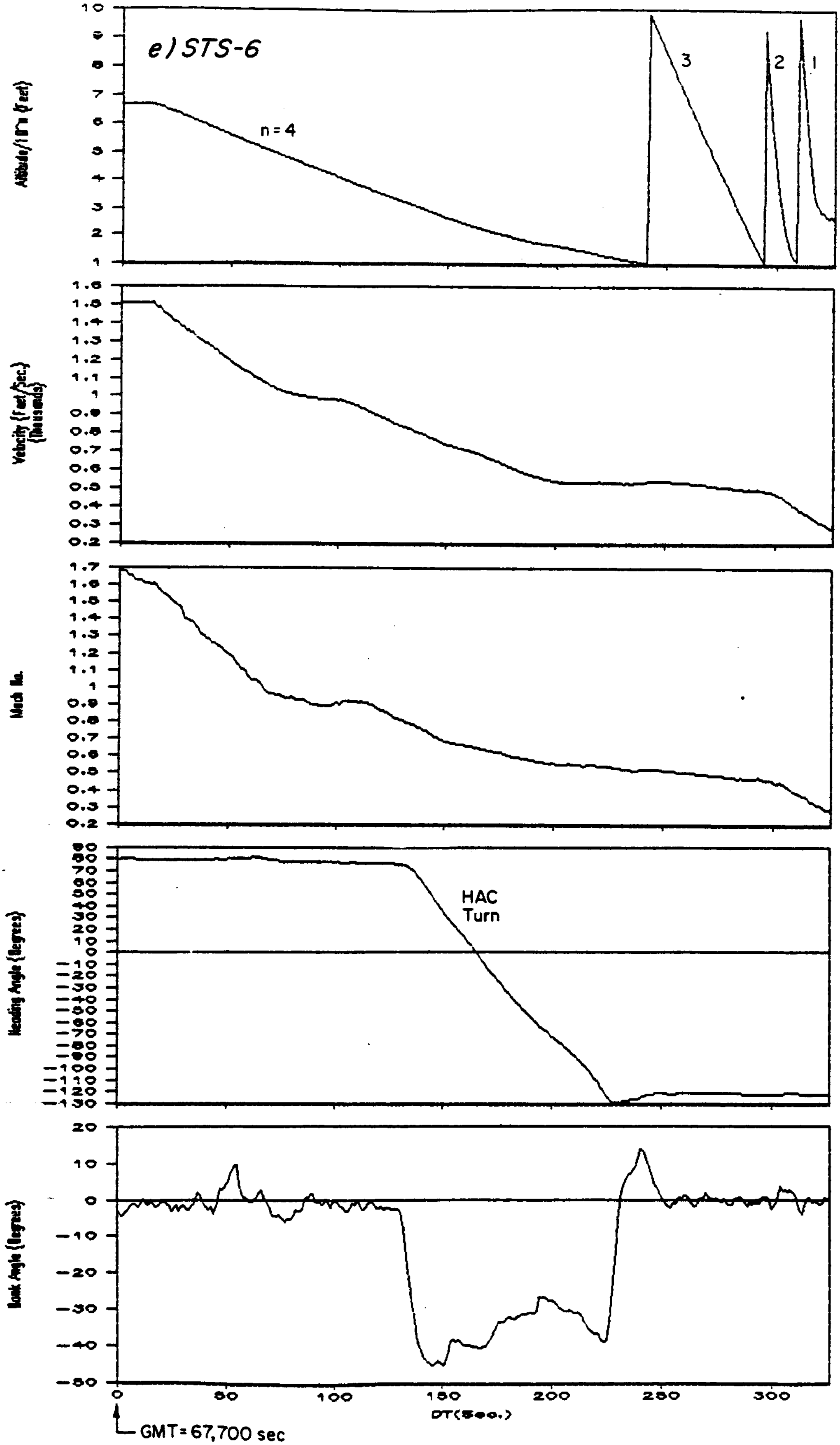

Figure 5. (Continued)

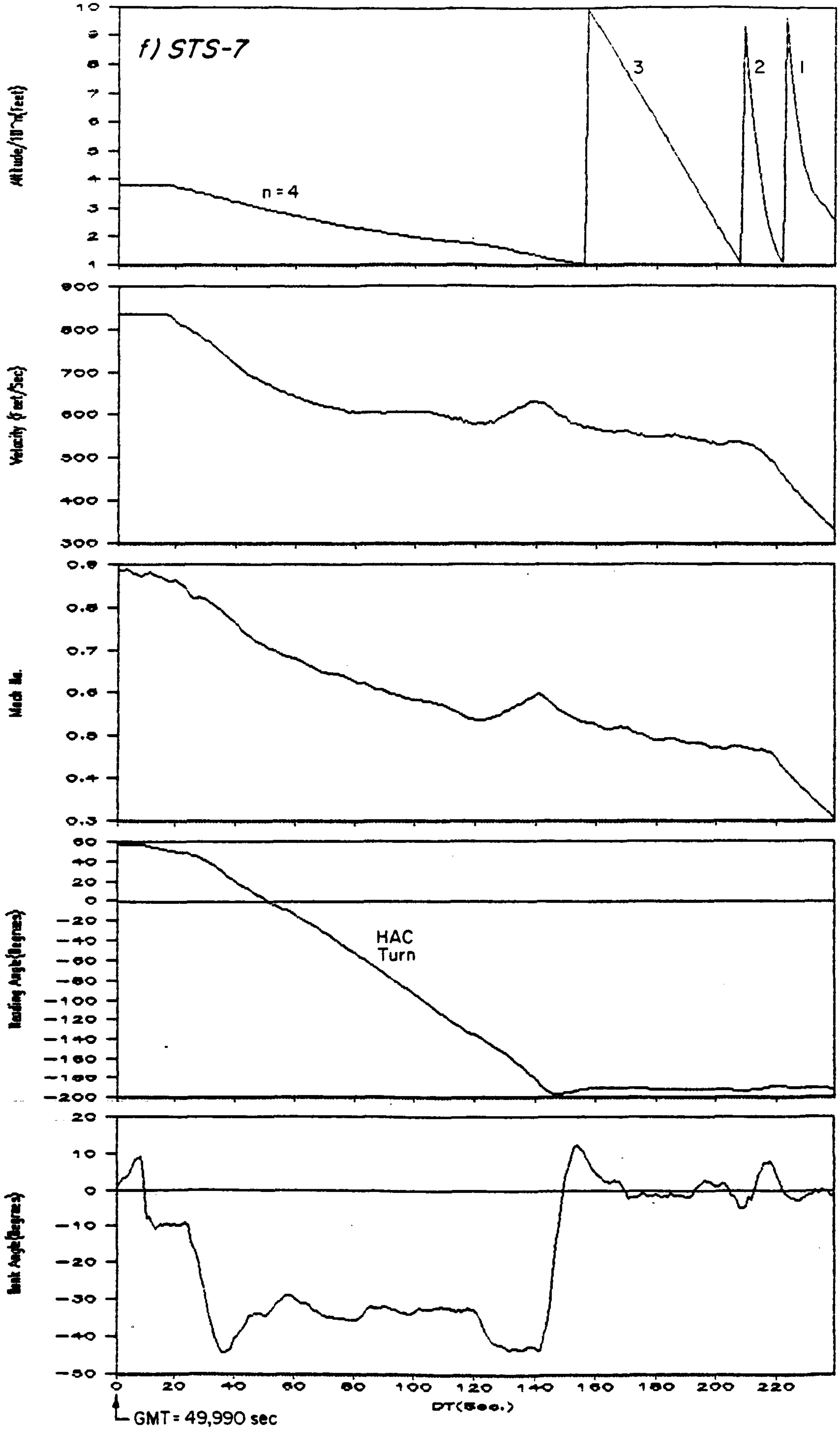

Figure 5. (Concluded)

REFERENCES

1. Myers, Thomas T., Donald E. Johnston, and Duane McRuer, Space Shuttle Flying Qualities and Flight Control System Assessment Study, NASA CR-170391, Dec. 1981.

2. Myers, T. T., D. E. Johnston, and D. T. McRuer, Space Shuttle Flying Qualities and Flight Control System Assessment Study, Phase II, NASA CR-170406, Dec. 1983.

3. Myers, T. T., D. E. Johnston, and D. T. McRuer, Space Shuttle Flying Qualities Criteria Assessment, Phase III, NASA CR-170407, Feb. 1984.

4. Myers, T. T., D. E. Johnston, and D. T. McRuer, Space Shuttle Flying Qualities Criteria Assessment Phase IV - Data Acquisition and Analysis, Systems Technology, Inc., TR-1206-1, Feb. 1985.

5. Hobbs, R. L., Trajectory Analysis Report for the Space Shuttle OFT, Kentron International, Inc., K4E-103B-81, 18 Feb. 1981.

6. Anon., "Final Analysis Output Program (FALOUT)," Kentron International, Inc., Memo No. K4E-007B-81, 10 Dec. 1980.

7. Maynard, Ray W., Introduction to TRS, (Tape Reservation System), Control Data Corporation, April 7, 1981.

8. Maine, Richard E., Users Manual for SYNC, a FORTRAN Program for Merging and Time-Synchronizing Data, NASA TM-81355, Mar. 1981.

APPENDIX A

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. A-1 and A-2 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. A-1, and the

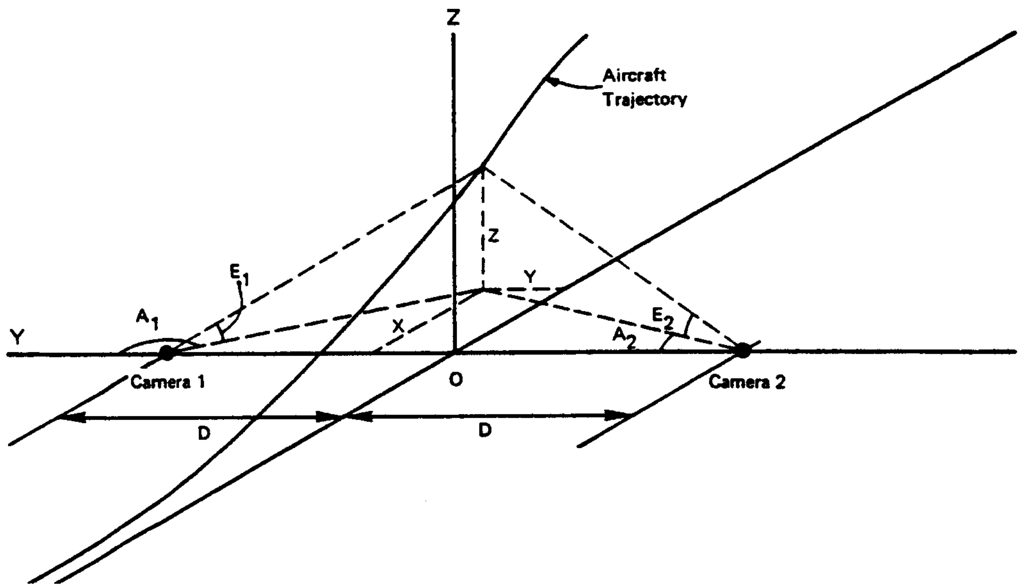

Figure A-1. Typical Deployment of Two Kinetheodolites (taken from Ref. A-1)

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 Kalsman 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-comsuming 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 Trjectory 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. A-2) 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. A-2 and can obtain data only for the EAFB main runway (runway 22).

REFERENCES

A-1. de Benque d'AGUT, P., H. Riebeek, and A. Pool, Trajectory Measurements for Take-Off and Landing Tests and Other Short-Range Applications, AGARD AG-160, Vol. 16, Jan. 1985.

A-2. Hobbs, R. L., Trajectory Analysis Report for the Space Shuttle OFT, Kentron International, Inc., K4E-103B-81, 18 Feb. 1981.

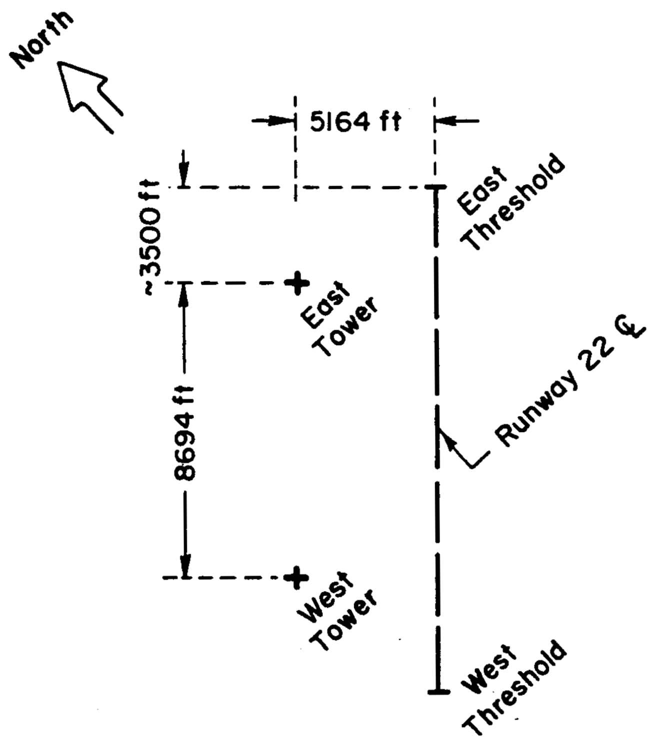

Figure A-2. Takeoff and Landing Tower System Layout

APPENDIX B

GENERAL INFORMATION ON OFQ DATA HANDLING PROGRAMS AND ARCHIVE FILES

This appendix defines the program and archive data file handling conventions for the ADFRF CYBER, and gives the general procedure for running the OFQ data handling programs, which extract data from the shuttle master archives and merge it into a single file. The sources from which the data is extracted are the Modified Maximum Likelihood Estimator (MMLE) files, the AFFTC Cinetheodolite (CINE) tapes, and the AFFTC Takeoff and Landing Tower (TOLT) tapes. The program DEPR decompresses compressed MMLE data. The programs which extract data from these sources are called UMMLE, UCINE, and UTOLT* respectively. The program SYNC merges a selectable subset of the extracted data into a single file. Appendices C, D, E, F, and G, respectively contain detailed information on these programs. The information consists of:

- A listing of the terminal I/O required to run the programs and verify proper operation.
- The "job" file used to run the program.
- The output file which contains the job dayfile and any program output directed to it.

All of the listings above are from the actual generation of the archive files.

PROCEDURE FOR RUNNING PROGRAM

All programs are run as batch jobs. The job file makes the data to be processed accessible to the processing program, compiles and runs the program, and saves the processed data as a mass storage file. The basic

*The files which contain the source code for these programs have these same names with the suffix I to designate compiler Input.

procedure for running any of the programs consists of the following steps:

1) Make a "local" copy of the job file and designate it the primary file.

2) Edit the job file as necessary to:

   - change the input file name

   - change the output file name

   - change the output data specifications

3) List the job file to verify changes and to document what was done

4) Submit the job file for batch processing

5) Wait for the job to finish

6) Get the job output file from the queue

7) List the job output file to verify proper program execution

8) Get a catalog listing of any file created by the program to verify its creation

The terminal I/O listings and job files which are included in Appendices C through G contain the required user input for each of the programs. These listings are annotated with the required user input underlined.

Job, program, and program output data file-naming conventions are summarized in Fig. B-1.

File names are composed of concatenated prefix, root, and suffix.

The prefix indicates the output data form:

U = unformatted
F = formatted

The root indicates the data source:

TOLT = Takeoff and Landing Tower
CINE = Cinetheodolite
MMLE = Modified Maximum Likelihood Estimator
SYNC = All of Above, Synchronized

The suffix indicates the file contents:

I = Program source code
J = Batch job file which runs program
L = Compiler source listing for program
nn = Time slice data for STS flight number nn, i.e., 01, 02, etc.

Examples:

UTOLTJ is the batch job file that runs the program UTOLTI

FSYNC04 contains time slice data for flight STS-4 in formatted form

Figure B-1. File-Naming Conventions

APPENDIX C

USE OF PROGRAM DEPR

This appendix contains the terminal I/O listing, the job file, and the job output file for decompressing the MMLE data.

```
 BYE
UN=HORTON   LOG OFF  11.15.13.
JSN=BCQF      SRU-S       2.641
IAF     CONNECT TIME 00.42.33.
LOGGED OUT.

HOST DISCONNECTED   CONTROL CHARACTER=(ESC)
ENTER INPUT TO CONNECT TO HOST
:


83/10/20. 12.00.21. DU1B
NASA DRYDEN FLIGHT RESEARCH FACILITY.   NOS 2.1-580/577-4.  USER NAME: HORTON
PASSWORD:
           JSN: BDAH, NAMIAF
  2 DIGIT TASK:
? [redacted](
 2 DIGIT SUBTASK
? [redacted]

/TRS(SYM=STIOV4T)
*TRS* V1.1-80192  83/10/20  12.02.01
 OP/INFO PARAMETERS MUST BE SPECIFIED.
 T R S  ABORT
/TRS(SYM=STIOV4T,OP=RELEASE)
*TRS* V1.1-80192  83/10/20  12.02.44


   ************************************************
   *                                              *
   *        T R S   T A P E   I N F O             *
   *                                              *
   *                 HORTON                       *
   *                                              *
   * <SYM ID>    : STIOV4T  <VSN>   : 004293      *
   * <APW>       :          <WPW>   :             *
   * <DATE-L-R>  :          <NO R>  :     0       *
   * <DATE-L-W>  : 83/10/20 <NO W>  :     3       *
   * <TC>        :          <PO>    :             *
   * <FORMAT>    :          <FA>    :             *
   * <TRACK>     : NT       <DEN>   : PE          *
   * <LB>        :          <CV>    :             *
   * <ACQ.DATE>  : 83/10/19 <CT>    : PU          *
   * <RET.PER>   :                                *
   * <FAMILY>    :    1     <REEL>  :     1       *
   * <OWNER>     :  LIBRARY <LOCK>  : UNLOCKED    *
   * <LABEL>     : STIOV4T                        *
   * <COMMENTS>  : DEPRTST                        *
PL=0
   *                                              *
   ************************************************
 VSN 004293, REEL# 1, ENTER Y TO DELETE
? PL ACCEPTED..
 Y
  004293 MOVED TO CERTIFY QUEUE
 /TRS(INFO=DY,SYM=STIOV4T)
 *TRS* V1.1-80192  83/10/20  12.04.04
```

```
 TAPE DESCRIBED DOES NOT EXIST.
 T R S  ABORT
/TRS(COM=DEPRTST,CT=PU,L=STIOV4T,OP=RESERVE,SYM=STIOV4T,RN=1)
*TRS* V1.1-80192  83/10/20  12.07.33
 ENTER PARAMETERS. (HELP IS AVAILABLE)
? HELP
LEGAL FORMAL PARAMETERS ARE :
 LFN       UN        SYM       VSN       APW       WPW       FA        F
 D         TR        CV        LB        CT        FN        RN        QN
 SI        ALTVSN    TC        PO        L         COM       T
ENTER PARAMETERS IN THE FORM :
 <FORMAL PARAMETER> = <ACTUAL VALUE>
  TERMINATE THE INPUT WITH A <CR>. FOR EXAMPLE :
  TR=MT, D=HI, APW=PASSW <CR>                                  reel #1
  <CR>
? COM=DEPRTST, CT=PU, L=STIOV4T, SYM=STIOV4T, RN=1,
?
 VSN 004297 ASSIGNED FROM LIBRARY.


   **********************************************
   *                                            *
   *        T R S    T A P E    I N F O         *
   *                                            *
   *                 HORTON                     *
   *                                            *
   * <SYM ID>    : STIOV4T  <VSN>   : 004297    *
   * <APW>       :          <WPW>   :           *
   * <DATE-L-R>  :          <NO R>  :     0     *
   * <DATE-L-W>  :          <NO W>  :     0     *
   * <TC>        :          <PO>    :           *
   * <FORMAT>    :          <FA>    :           *
   * <TRACK>     : NT       <DEN>   : PE        *
   * <LB>        :          <CV>    :           *
   * <ACQ.DATE>  : 83/10/20 <CT>    : PU        *
   * <RET.PER>   :                              *
   * <FAMILY>    :    1     <REEL>  :     1     *    reel #1
   * <OWNER>     :  LIBRARY <LOCK>  : UNLOCKED  *
   * <LABEL>     : STIOV4T                      *
   * <COMMENTS>  : DEPRTST                      *
   *                                            *
   **********************************************
```

```
/TRS(OP=RESERVE,SYM=STIOV4T)
*TRS* V1.1-80192  83/10/20  12.11.42
 ENTER PARAMETERS. (HELP IS AVAILABLE)
? COM=DEPRTST, CT=PU, L=STIOV4T,SYM=STIOV4T,RN=2
?
 VSN 004298 ASSIGNED FROM LIBRARY.


   **********************************************
   *                                            *
   *       T R S    T A P E    I N F O          *
   *                                            *
   *               HORTON                       *
   *                                            *
   * <SYM ID>    : STIOV4T  <VSN>   : 004298    *
   * <APW>       :          <WPW>   :           *
   * <DATE-L-R>  :          <NO R>  :     0     *
   * <DATE-L-W>  :          <NO W>  :     0     *
   * <TC>        :          <PO>    :           *
   * <FORMAT>    :          <FA>    :           *
   * <TRACK>     : NT       <DEN>   : PE        *
   * <LB>        :          <CV>    :           *
   * <ACQ.DATE>  : 83/10/20 <CT>    : PU        *
   * <RET.PER>   :                              *
   * <FAMILY>    :    1     <REEL>  :     2 <---*---- reel #2
   * <OWNER>     :  LIBRARY <LOCK>  : UNLOCKED  *
   * <LABEL>     : STIOV4T                      *
   * <COMMENTS>  : DEPRTST                      *
   *                                            *
   **********************************************
```

```
 OLD,MMLETPT
/SUBMIT,MMLETPT,TO
 14.48.46. SUBMIT COMPLETE.  JSN IS BDUC.
/~BYE
UN=HORTON   LOG OFF  14.50.48.
JSN=BDSB     SRU-S        2.220
IAF     CONNECT TIME 00.17.43.
LOGGED OUT.

HOST DISCONNECTED   CONTROL CHARACTER=(ESC)
ENTER INPUT TO CONNECT TO HOST
~


83/10/20. 15.17.09. DU1B
NASA DRYDEN FLIGHT RESEARCH FACILITY.   NOS 2.1-580/577-4.  USER NAME: HORTON
PASSWORD:
           JSN: BDXQ, NAMIAF
  2 DIGIT TASK:
? [redacted](
 2 DIGIT SUBTASK
? [redacted]

/ENQ,JSN

 JSN SC LID STATUS                   JSN SC LID STATUS

 BDXQ.T.    .EXECUTING               ARDS.B.    .WAIT QUEUE
 BDUC.B.    .WAIT QUEUE
/
IDLE
QGET,JSN=BDUC
 QGET COMPLETE.
/PL=0
PL ACCEPTED..
LIST,F=BDUC
S
1         LOAD MAP - DEPR                                          CYBER LO
ADER 1.5-577       83/10/20. 14.50.32.      PAGE     1


          FWA OF THE LOAD              111
          LWA+1 OF THE LOAD          16434

          TRANSFER ADDRESS -- DEPR               316

          PROGRAM ENTRY POINTS --       DEPR               316


                .657 CP SECONDS              34400B CM STORAGE USED
                17 TABLE MOVES


S
1                                         DEPR PROGRAM FOR DATA DECOMPRESSI
ON
0                                                   RICHARD E. MAINE
                                                      NASA DRYDEN
                                                       6 NOV 80
```

```
OREADING COMPRESSED FILE WRITTEN ON DATE:  82/11/16. TIME:  12.06.42. CH
ANNELS:  118 NFULL:  500 IDBITS:    7
OCOMMENTS:

 STS-4 MERGED DATA FILE.  FLIGHT JUL 82. ARCHIVED 16 NOV 82.   RICHARD E
 MAINE.
 MERGED ACIP, OI, GPC (PASS), BFCS, AND LANGLEY BET DATA.
 ONBOARD DATA.
 6/7/8/9
 STS-4 MERGE FILE PARAMETERS, PART 1.  16 NOV 82.  RICH MAINE
OCHANNEL       NAME                               BITS           MIN              SL
OPE

      1    ALPHA-IMU                              20           -1.2216           .43
703E-04
      2    Q-ACIP                                 15           -4.6511           .22
685E-03
      3    V-IMU                                  20            113.30           .23
304E-01
      4    THETA-GPC                              20           -16.141           .53
747E-04
      5    AN-ACIP                                15           -.15327E-01       .56
400E-04
      6    QDOT-ACIP                              15           -12.360           .91
349E-03
      7    AX-ACIP                                15           -.40439           .13
338E-04
      8    ELEVATOR-ACIP                          16           -15.509           .46
089E-03
      9    BODFLP-GPC                             11           -11.259           .14
513E-01
     10    UP-JETS                                10            .52529E-02       .20
143E-02
     11    DOWN-JETS                              10            .52529E-02       .20
475E-02
     12    PHI-GPC                                20           -88.275           .14
096E-03
     13    ALT,AGL                                20           -8.2834           .46
459
     14    MACH-IMU                               20            .99993E-01       .23
317E-04
     15    QBAR-IMU                               20            .95368E-03       .28
259E-03
     16    BETA-IMU                               20           -1.7964           .57
817E-05
     17    P-ACIP                                 15           -7.1014           .41
656E-03
     18    R-ACIP                                 15           -2.2613           .17
563E-03
     19    AY-ACIP                                15           -.13959           .68
150E-05
     20    PDOT-ACIP                              15           -23.971           .15
682E-02
     21    RDOT-ACIP                              15           -5.9995           .41
548E-03
     22    AILERON-ACIP                           16           -3.8226           .11
886E-03
     23    RUDDER-ACIP                            16           -6.0439           .13
719E-03
```

87	ALPHA-NAV	20	-4.5004	.46
829E-04				
88	LPED, CMDR	9	0.	.50
168E-02				
89	RPED, CMDR	9	0.	.45
764E-02				
90	LPED, PILOT	0	0.	0.
91	RPED, PILOT	9	0.	.24
318E-02				
92	RHC ROLL-BFCS	20	-13.313	.21
516E-04				
93	RHC PITCH-BFCS	20	-16.000	.25
570E-04				
94	RHC ROLL,PILOT-GPC	11	-.59489E-01	.58
064E-04				
95	RHC PITCH,PILOT-GPC	11	-.72509	.32
516E-03				
96	ALAND-BFLP	20	.95368E-04	.94
032E-04				
97	ALPHA CMD	20	15.284	.25
229E-04				
98	PHI CMD	20	-101.33	.16
357E-03				
99	AMI ACCEL	15	-41.485	.12
669E-02				
100	AMI ALPHA	14	-2.0554	.28
474E-02				
101	KEAS	13	0.	.36
107E-01				
102	RADAR ALT	15	-2.0573	.27
473				
103	HDOT-IMU	13	.20742	.27
554				
104	LH SPD BRK AUTO/MAN	16	0.	0.
105	RH SPD BRK AUTO/MAN	16	0.	0.
106	LH FCS AND BF MODES	16	0.	0.
107	RH FCS AND BF MODES	16	0.	0.
108	V-BET	20	20.389	.23
392E-01				
109	BETA-BET	20	-1.3039	.11
893E-04				
110	ALPHA-BET	20	-3.8441	.46
247E-04				
111	MACH-BET	20	.18138E-01	.26
043E-04				
112	PSTAT-BET	20	.10069E-04	.18
630E-02				
113	TEMP-BET	20	334.53	.72
942E-03				
114	RHO-BET	20	.42311E-11	.20
633E-08				
115	QBAR-BET	20	.12520E-02	.28
717E-03				
116	AX-BET	20	-13.028	.12
463E-04				
117	AY-BET	20	-.93714	.25
888E-05				
118	AZ-BET	20	-57.684	.55
057E-04				

```
IOSTAT FOR FILE SMALL IS -63
50001 RECORDS WRITTEN.
S
1         ITEMIZE OF TAPE1                FILE      1              STIOV4T
                   83/10/20. 15.10.56.        PAGE      1
   REC    NAME     TYPE          LENGTH    CKSUM        DATE     COMMENTS
                                           ITEMIZE 83155

     1    :Q :I$L   TEXT          4610744    0267


          * EOI *       SUM =   4610744
1 BDUC    NASA DRYDEN FLIGHT RESEARCH FACILITY.   NOS 2.1-580/577-4.    8
3/10/20.
```

DAYFILE

```
14.48.47.STI.
14.48.48.USER(HORTON,)
14.48.48.CHARGE,,.
14.48.48. WARNING...SRU ALLOCATION EXCEEDED.
14.48.49.COMMENT.RESERVE 1 DISKPACK & PHASEENCODED TAPEDRIVE.
14.48.50.RESOURC(DJ1=1,PE=1)
14.48.51.COMMENT. ENTER MMLE FILE DECOMPRESSION PROCEDURE
14.48.51.GET,PROCFIL/UN=MAINE,NA.
14.48.55.SETTL,2000.
14.48.56.ATTACH,REML/UN=MAINE,NA.
14.48.57.ATTACH(SMALL=OV4DAT/UN=MAINE,PN=AKWI6,R=DJ,NA)
14.50.22.BEGIN,RUN,,DEPR,COMPRL,UN=MAINE,LIBS=REML.
14.50.24.  IFE,NUM(DEPR).OR.NUM(COMPRL),BYE.
14.50.24.  ENDIF,BYE.
14.50.25.  UNLOAD,LD.
14.50.25.  NOTE,LD,NR.$.PROC,DEPR.
14.50.25.  NOTE,LD,NR.$  LDSET,MAP=S.
14.50.25.  NOTE,LD,NR.$  LDSET,LIB=RUNLIB.
14.50.25.  NOEXIT.
14.50.25.  IFE,($REML$.NE.$0$),AUXLIBS.
14.50.25.    NOTE,LD,NR.$  LDSET,LIB=REML.
14.50.26.  ENDIF,AUXLIBS.
14.50.26.  ONEXIT.
14.50.26.  IFE,($0$.NE.$0$),ELDIRS.
14.50.26.  ENDIF,ELDIRS.
14.50.26.  IFE,.NOT.NUM(0),UPDATE.
14.50.26.  ENDIF,UPDATE.
14.50.26.  NOTE,LD,NR.$  LIBLOAD,RUNLIB,DEPR.
14.50.26.  NOTE,LD,NR.$  EXECUTE.$REVERT. DEPR.
14.50.26.  NOTE,LD,NR.$  EXIT.
14.50.26.  NOTE,LD,NR.$REVERT,ABORT. DEPR.
14.50.26.  PACK,LD.
14.50.27. PACK COMPLETE.
14.50.27.  GETPF,RUNLIB=COMPRL/UN=MAINE,NA.
14.50.28. GETPF COMPLETE.
14.50.28.BEGIN,DEPR,LD.
14.50.29.  LDSET,MAP=S.
14.50.29.  LDSET,LIB=RUNLIB.
14.50.29.  LDSET,LIB=REML.
14.50.29.  LIBLOAD,RUNLIB,DEPR.
14.50.29.  EXECUTE.
15.03.23.     END  DEPR
15.03.23.     32500 MAXIMUM EXECUTION FL.
```

```
15.03.23.   361.522 CP SECONDS EXECUTION TIME.
15.03.23.REVERT. DEPR.
15.03.23.  UNLOAD,LD,LGOUP,RUNLIB.
15.03.24.REVERT. RUN.
15.03.24.COMMENT. DECOMPRESSED MMLE FILE CALLED BIG
15.03.24.REWIND,BIG.
15.03.24.COMMENT. PUT BIG ONTO A TAPEFILE CALLED TAPE1
15.03.24.COMMENT. TWO REELS ARE REQD FOR TAPE1
15.03.24.TRS(COM=DEPRTST,CT=PU,L=STIOV4T,LFN=TAPE1,OP=W,SYM=STIOV4T)
15.03.24.*TRS* V1.1-80192  83/10/20  15.03.24
15.03.30.$BEGIN,ZZZTRS,ZZZTRS.
15.03.32.$RETURN(ZZZTRS)
15.03.32.$VSN(TAPE1=004297/004298)
15.03.33.$LABEL(TAPE1,PO=W ,D=PE,L=$STIOV4T$,NT)
15.04.20.NT31, ASSIGNED TO TAPE1   , VSN=004297.
15.04.22.$REVERT.
15.04.22.COPYEI,BIG,TAPE1.
15.04.29.NT,C12-0-01,004297,WD,31,S0,GS43012250.
15.04.29.NT,C12,D1000000000000000000012000040000O
15.04.29.NT,C12,U404600000003013200000002,T4000.
15.04.29.NT,C12,F11,I00,B000313,L5004,P00000000.
15.04.29.NT,C12,E32,H42616646, STATUS.
15.04.29.NT,C12-0-01,004297,WD,31,S0,GS03012250.
15.04.29.NT,C12,D0000000000000000000012000000270O
15.04.29.NT,C12,U404600000043013200000042,T4000.
15.04.29.NT,C12,F11,I01,B000313,L5004,P40000001.
15.04.29.NT,C12,E00,H42616646, RECOVERED.
15.04.48.NT,C12-0-01,004297,WD,31,S0,GS43010270.
15.04.48.NT,C12,D1000000000000000000012000040000O
15.04.48.NT,C12,U404600000003013200000002,T4000.
15.04.48.NT,C12,F11,I00,B001526,L5004,P00000000.
15.04.48.NT,C12,E32,H42616646, STATUS.
15.04.48.NT,C12-0-01,004297,WD,31,S0,GS03010270.
15.04.48.NT,C12,D0000000000000000000012000000270O
15.04.48.NT,C12,U404600000043013200000042,T4000.
15.04.48.NT,C12,F11,I01,B001526,L5004,P40000001.
15.04.48.NT,C12,E00,H42616646, RECOVERED.
15.04.49.NT,C12-0-01,004297,WD,31,S0,GS43015500.
15.04.49.NT,C12,D1000000000000000000012000040270O
15.04.49.NT,C12,U404600000003013200000002,T4000.
15.04.49.NT,C12,F11,I00,B001607,L5004,P00000000.
15.04.49.NT,C12,E32,H42616646, STATUS.
15.04.50.NT,C12-0-01,004297,WD,31,S0,GS03015500.
15.04.50.NT,C12,D0000000000000000000012000000270O
15.04.50.NT,C12,U404600000043013200000042,T4000.
15.04.50.NT,C12,F11,I01,B001607,L5004,P40000001.
15.04.50.NT,C12,E00,H42616646, RECOVERED.
15.07.33.NT,C02-0-01,004297,WD,31,S0,GS43011040.
15.07.33.NT,C02,D1000400142000000000112000000000O
15.07.33.NT,C02,U404600000003013200000002,T4000.
15.07.33.NT,C02,F11,I00,B015050,L5004,P00000000.
15.07.33.NT,C02,E32,H42616646, STATUS.
15.07.34.NT,C02-0-01,004297,WD,31,S0,GS03014320.
15.07.34.NT,C02,D0000000000000000000012000000270O
15.07.34.NT,C02,U404600000043013200000042,T4000.
15.07.34.NT,C02,F11,I01,B015050,L5004,P40000001.
15.07.34.NT,C02,E00,H42616646, RECOVERED.
```

```
 15.08.44. END OF TAPE, TAPE1 AT 137.
 15.10.01.NEXT VSN, 31, 004298.
 15.10.55. EOI ENCOUNTERED.
 15.10.55.ENQUIRE(O=ENQFIL)
 15.10.55. ENQUIRY COMPLETE.
 15.10.56.REPPF,ENQFIL.
 15.10.56. REPPF COMPLETE.
 15.10.56.UNLOAD,BIG.
 15.10.56.ITEMIZE(TAPE1)
 15.12.03. ITEMIZE COMPLETE.
 15.12.04.UEAD,       0.006KUNS.
 15.12.04.UEPF,       0.155KUNS.
 15.12.04.UEMT,      56.831KUNS.
 15.12.04.UEMS,     832.737KUNS.
 15.12.04.UECP,     390.751SECS.
 15.12.04.AESR,     565.753UNTS.
 15.12.04.$OUT(*/OP=E)
 15.12.19. NO FILES PROCESSED.
 15.12.19.$DAYFILE(OUTPUT,JT=D)
/IDLE
DAYFILE
 15.17.24.TWHQ.
 15.17.25.USER,HORTON,,DFRF.
 15.17.25.CHARGE,.
 15.17.38. WARNING...SRU ALLOCATION EXCEEDED.
 15.17.38.RECOVER,OP=T.
 15.18.10.ENQ,JSN.
 15.18.35.QGET,JSN=BDUC.
 15.18.35. QGET COMPLETE.
 15.18.50.$SCOPY,BDUC,,,,,,R,D,        ,           ,NS.
 15.28.05. EOI ENCOUNTERED.
 15.30.15.DAYFILE.
 USER DAYFILE PROCESSED.
/DAYFILE(OUTPUT,JT=D)
1 BDXQ    NASA DRYDEN FLIGHT RESEARCH FACILITY.   NOS 2.1-580/577-4.   8
3/10/20.


 15.30.15. USER DAYFILE PROCESSED.
 15.30.54.DAYFILE(OUTPUT,JT=D)
 DSP - FILE NOT ON MASS STORAGE.
/OLD,ENQUIRE
 ENQUIRE NOT FOUND.
/OLD,ENQFIL
/LIST
1

 SYSTEM ACTIVITY.

   USER NAME         HORTON
   USER INDEX HASH   TWHQ
   JOB SEQ. NAME     BDUC
   FAMILY            DFRF
   PACKNAME          *NONE*.
   PRIMARY FILE      *NONE*.
   SUB SYSTEM        NULL.
   CPU PRIORITY      30
   MAX FL (CM)       376500
   MAX FL (EC)       0
   LAST FL (CM)      0
   LAST FL (EC)      0
```

```
RESOURCE DEMAND INFORMATION.

 RESOURCE   DEMAND   ASSIGNED

   PE          1         1
   DJ1         1         1

RESOURCES USED.

  CPU TIME               385.606 SECS.
  MS ACTIVITY            832.625 KUNS.
  MT ACTIVITY             47.063 KUNS.
  PF ACTIVITY              0.141 KUNS.
  ADDER                    0.006 KUNS.
  SRU                    558.856 UNTS.

RESOURCE USAGE ALLOWED.

  SECONDS             2000
  JOB STEP SRU        NO LIMIT
  ACCOUNT BLK SRU     NO LIMIT
  DAYFILE MESSAGES    NO LIMIT
  CONTROL STATMTS     NO LIMIT
  MASS STORAGE        NO LIMIT

JOB CONTROL REGISTERS.

  R1 =    0
  R2 =    0
  R3 =    0
  EF =    0
 EFG =    0
 R1G =    0

CONTROL STATEMENT(S).

 REPPF,ENQFIL.
 UNLOAD,BIG.
 ITEMIZE(TAPE1)
  *EOR*

LOADER INFORMATION.
   MAP OPTIONS  =  DEFAULT
   DEBUG = OFF
   GLOBAL LIBRARY SET IS -
EMPTY.
```

LOCAL FILE INFORMATION.

FILENAME	LENGTH/PRUS	TYPE	STATUS	FS
INPUT	3	IN.*	EOR	
PROCFIL	37	LO.	EOR	
REML	243	PM.*	EOR	
SMALL	13920	PM.*	EOI	
ENQFIL	2	LO.	I/C WRITE	
OUTPUT	19	LO.	EOR WRITE	
TAPE1		LO.	I/C	
BIG	94120	LO.	EOI	

TOTAL = 8

/

```
 TRS(SYM=STIOV4T,LFN=TAPE)
*TRS* V1.1-80192  83/10/20  15.40.02
 OP/INFO PARAMETERS MUST BE SPECIFIED.
 T R S  ABORT
/TRS(SYM=STIOV4T,LFN=TAPE,OP=R)
*TRS* V1.1-80192  83/10/20  15.40.42
T R S WILL MOUNT YOUR TAPE

$REVERT.
/IDLE
ITEMIZE(TAPE,L=LTAPE)

 ITEMIZE COMPLETE.
/IDLE
 IDLE
LIST,F=LTAPE
S
1          ITEMIZE OF TAPE              FILE      1              STIOV4T
                    83/10/20. 15.45.11.       PAGE      1
    REC    NAME       TYPE         LENGTH    CKSUM       DATE    COMMENTS
                                             ITEMIZE 83155

      1    ::A:::A    TEXT        26764744    7374


           * EOI *       SUM = 26764744
/
```

DEPR JOB FILE

```
?? FILE ,MMLETPT,R
MMLETPT REPLACED
?? T
?? P*
/JOB
STI.
USER(HORTON,TIMH)
CHARGE,xx,xx.
COMMENT.RESERVE 1 DISKPACK & PHASEENCODED TAPEDRIVE.
RESOURC(DJ1=1,PE=1)
COMMENT. ENTER MMLE FILE DECOMPRESSION PROCEDURE
GET,PROCFIL/UN=MAINE,NA.
SETTL,2000.
ATTACH,REML/UN=MAINE,NA.
ATTACH(SMALL=OV4DAT/UN=MAINE,PN=AKWI6,R=DJ,NA)
BEGIN,RUN,,DEPR,COMPRL,UN=MAINE,LIBS=REML.
COMMENT. DECOMPRESSED MMLE FILE CALLED BIG
REWIND,BIG.
COMMENT. PUT BIG ONTO A TAPEFILE CALLED TAPE1
COMMENT. TWO REELS ARE REQD FOR TAPE1
TRS(COM=DEPRTST,CT=PU,L=STIOV4T,LFN=TAPE1,OP=W,SYM=STIOV4T)
COPYEI,BIG,TAPE1.
ENQUIRE(O=ENQFIL)
REPPF,ENQFIL.
UNLOAD,BIG.
ITEMIZE(TAPE1)
/EOR
```

APPENDIX D

USE OF PROGRAM UMMLE

This appendix contains the terminal I/O listing, the job file, and the job output file for processing the MMLE data.

```
*
/LIST
/JOB
STI.
USER(SYSTECH,STII)
CHARGE,xx,xx.
TRS,LFN=TAPE1,L=STIOV4T,SYM=STIOV4T,OP=R.
GETPF,UMMLEI.
FTN5,I=UMMLEI,ET,DB,ANSI,LO=M/A/R,PW=129,L=UMMLEL.
REPPF(UMMLEL)
SETTL,100.
LGO.
REPPF(TAPE2=UMMLE04)
/NOSEQ
/EOR
57780.  <------------    Start Time
58151.  <------------    End Time
034 NPTR <-----------    Number of Signals
005  AAZL
006  AQDOT                List of Selected Signals
007  AAXL
019  AAY
020  APDOT
021  ARDOT
002  AQ
017  AP
018  AR
003  VTRUE
069  MACHSP
070  DPSP
071  SPEEDSP
072  AASP
073  SSSP
004  THETA
012  PHI
086  PSI
013  ALT
102  ALTRAD
008  DELEV
009  BDFPL1
022  DAIL
023  ADR
026  DSPACT
088  CLPED
089  CRPED
090  PLPED
091  PRPED
092  PRHC
093  QRHC
094  PRRHCR
095  PRRHCP
081  DSPCMD
/SUBMIT,,TO ----------    Submit Batch UMMLE Job
 13.01.51. SUBMIT COMPLETE.  JSN IS CLJQ. ------ Job #
/*
```

```
*
/QGET,CLJQ  ◄────────     Get Job "CLJQ"
 QGET COMPLETE.
/LIST,F=CLJQ ◄────────     List Dayfile
1
1 CLJQ    NASA AMES-DFRF CYBER 170-730.          NOS 2.1-580/577-8.   85/05/28.


 13.01.51.STI.
 13.01.51.USER(SYSTECH,)
 13.01.51.CHARGE,,.
 13.01.52. WARNING...SRU ALLOCATION EXCEEDED.
 13.01.53.PROC1.
 13.01.56.  $FCOPY(P=UUNEWS1,N=UUUSCR1,PC=ASCII,NC=DIS)
 13.01.57. FCOPY COMPLETE.
 13.01.57.  $REWIND(UUUSCR1)
 13.01.58.  $COPYSBF(UUUSCR1,OUTPUT)
 13.01.58. EOI ENCOUNTERED.
 13.01.58.  $BKSP(OUTPUT)
 13.01.58.  $NOTE(OUTPUT,NR);1
 13.01.58.  $RETURN(PROC1,UUNEWS1,UUUSCR1)
 13.01.59.  $REVERT. ***** SYSTEM PROLOGUE COMPLETE *****
 13.02.01.TRS,LFN=TAPE1,L=STIOV4T,SYM=STIOV4T,OP=R.
 13.02.01.*TRS* V1.1-80192  85/05/28  13.02.01
 13.02.05.$BEGIN,ZZZTRS,ZZZTRS.
 13.02.06.$RETURN(ZZZTRS)
 13.02.07.$VSN(TAPE1=001001/001665)
 13.02.08.$LABEL(TAPE1,PO=R ,D=PE,L=$STIOV4T$,NT)
 13.10.19.NT33, ASSIGNED TO TAPE1  , VSN=001001.
 13.10.20.$REVERT.
 13.10.21.GETPF,UMMLEI.
 13.10.21. GETPF COMPLETE.
 13.10.23.FTN5,I=UMMLEI,ET,DB,ANSI,LO=M/A/R,PW=129,L=UMMLEL.
 13.10.24.     62200 CM STORAGE USED.
 13.10.24.     0.267 CP SECONDS COMPILATION TIME.
 13.10.24.REPPF(UMMLEL)
 13.10.26. REPPF COMPLETE.
 13.10.26.SETTL,100.
 13.10.27.LGO.
 13.14.38. END OF TAPE, TAPE1 AT 14561.
 13.16.18.NEXT VSN, 33, 001665.

 13.18.47.    STOP   UNFORMATTED DATA FILE WRITTEN
 13.18.47.     27400 MAXIMUM EXECUTION FL.
 13.18.47.    82.714 CP SECONDS EXECUTION TIME.
 13.18.47.REPPF(TAPE2=UMMLE04)
 13.19.09. REPPF COMPLETE.
 13.19.10.UEAD,      0.004KUNS.
 13.19.10.UEPF,      0.109KUNS.
 13.19.10.UEMT,     44.036KUNS.
 13.19.10.UEMS,     72.593KUNS.
 13.19.10.UECP,     85.472SECS.
 13.19.10.AESR,    112.250UNTS.
 13.19.10.$OUT(*/OP=E)
 13.19.12. NO FILES PROCESSED.
 13.19.13.$DAYFILE(OUTPUT,JT=D)
```

APPENDIX E

USE OF PROGRAM UCINE

This appendix contains the terminal I/O listing, the job file, and the job output file for processing the CINE data.

```
*
/LIST
/JOB
STILIST.
USER,SYSTECH,STII.
CHARGE,xx,xx.
SETTL,100.
TRS,OP=R,SYM=CINE04,L=CINE04,LFN=CFILE,UN=SHAFER.
GETPF,UCINEI.
FTN5,I=UCINEI,LO=M/A/R,PW=129,L=UCINEL.
REPPF,UCINEL.
LGO.
REPPF,TAPE3=UCINE04.
/NOSEQ
/EOR
57780. <----------   Start Time
58151. <----------   End Time
008  NLIST <-------  Number of Signals
055  AN
023  VZ
039  VT
005  X
006  Y
007  Z
017  WD              If IPRATE = 1, Store Every Time Slice
018  WV              If IPRATE = n, Store Every nth Time Slice
001  IPRATE <-----
/EOF                 Submit Batch UCINE Job
/SUBMIT,,TO <-----
 16.24.43. SUBMIT COMPLETE.  JSN IS CIUM.
```

```
/QGET,CIUM
 QGET COMPLETE.
/LIST,F=CIUM
1
1           SUBROUTINE OPTION   73/74   OPT=0,ROUND= A/ S/ M/-D,-DS     FTN 5.11

      20                 RETURN
 TRIVIAL  *        NO PATH TO THIS STATEMENT
1

 ****************************************************************************
 ENTER LISTBC (LIST B OR C FILE) UFTAS UTILITY PROGRAM

 ------------------------------------------------
 THE PRINT RATE IS    1
 ------------------------------------------------


 CFILE LABEL RECORD INFORMATION:

 JON=                    921EB
 TAIL=                     0
 TITLE=                  NAD-27              07/16 15.30
 TEST=                       0
 FLIGHT=                 185-0
 FLIGHT DATE=            04JUL8
 DATE REQUEST=

 ------------------------------------------------- SECTION NO.   1 ------------
 SECTION=                  1
 REMARKS=                 11
 NUMBER OF PARAMETERS=  106


 --- PARAMETER LIST ---
 NUM   ORD   PARAMETER
 ---   ---   ---------
   1     1     HMS   HMS
   2     2     INDEX
   3     3     ELAPS SEC
   .     .       .
   .     .       .
   .     .       .
  98    98     PALT  FEET
  99    99     AZATT DEG
 100   100     ELATT DEG
 101   101     VATT  DEG
 102   102     ELDMP DEG
 103   103     RBO   DEG
 104   104
 105   105
 106   106
1 CIUM    NASA AMES-DFRF CYBER 170-730.         NOS 2.1-580/577-8.   85/05/24.
```

```
16.24.43.STILIST.
16.24.43.USER,SYSTECH,.
16.24.43.CHARGE,,.
16.24.43. WARNING...SRU ALLOCATION EXCEEDED.
16.24.46.PROC1.
16.24.49.  $FCOPY(P=UUNEWS1,N=UUUSCR1,PC=ASCII,NC=DIS)
16.24.50. FCOPY COMPLETE.
16.24.50.  $REWIND(UUUSCR1)
16.24.50.  $COPYSBF(UUUSCR1,OUTPUT)
16.24.51. EOI ENCOUNTERED.

16.24.51.  $BKSP(OUTPUT)
16.24.51.  $NOTE(OUTPUT,NR);1
16.24.51.  $RETURN(PROC1,UUNEWS1,UUUSCR1)
16.24.52.  $REVERT. ***** SYSTEM PROLOGUE COMPLETE *****
16.24.52.SETTL,100.
16.24.54.TRS,OP=R,SYM=CINE04,L=CINE04,LFN=CFILE,UN=SHAFER.
16.24.54.*TRS* V1.1-80192  85/05/24  16.24.54
16.24.59.$BEGIN,ZZZTRS,ZZZTRS.
16.25.00.$RETURN(ZZZTRS)
16.25.00.$VSN(CFILE=001307)
16.25.01.$LABEL(CFILE,PO=R ,F=SI,D=PE,L=$CINE04$,NT)
16.28.05.NT31, ASSIGNED TO CFILE  , VSN=001307.
16.28.07.$REVERT.
16.28.07.GETPF,UCINEI.
16.28.08. GETPF COMPLETE.
16.28.09.FTN5,I=UCINEI,LO=M/A/R,PW=129,L=UCINEL.
16.28.15.        1  TRIVIAL   ERROR IN  OPTION
16.28.16.     64200 CM STORAGE USED.
16.28.16.     1.171 CP SECONDS COMPILATION TIME.
16.28.16.REPPF,UCINEL.
16.28.18. REPPF COMPLETE.
16.28.20.LGO.
16.28.22.  CM LWA+1 = 23465B, LOADER USED  41600B
16.29.46.    STOP   UNFORMATTED FILE WRITTEN
16.29.46.     44400 MAXIMUM EXECUTION FL.
16.29.46.    20.969 CP SECONDS EXECUTION TIME.
16.29.47.REPPF,TAPE3=UCINE04.
16.29.55. REPPF COMPLETE.
16.29.55.UEAD,      0.004KUNS.
16.29.55.UEPF,      0.113KUNS.
16.29.55.UEMT,      6.139KUNS.
16.29.55.UEMS,     72.179KUNS.
16.29.55.UECP,     24.673SECS.
16.29.55.AESR,     45.923UNTS.
16.29.55.$OUT(*/OP=E)
16.29.56. NO FILES PROCESSED.
16.29.56.$DAYFILE(OUTPUT,JT=D)
```

```
/CATLIST,LO=F,FN=UCINE04
 CATALOG OF  SYSTECH          FM/DFRF    85/05/24. 16.45.32.

    FILE NAME ACCESS FILE-TYPE LENGTH DN CREATION  ACCESS    DATA MOD
     PASSWORD MD/CNT INDEX  PERM. SUBSYS DATE/TIME DATE/TIME DATE/TIME
     PR BR RS

    1 UCINE04  DIR. PRIVATE      1124 14 85/05/16. 85/05/24. 85/05/24.
                   4        WRITE        12.34.54. 16.29.47. 16.29.47.
      N MD D

         1 DIRECT ACCESS FILE(S),     TOTAL PRUS =      1124.
```

APPENDIX F

USE OF PROGRAM UTOLT

This appendix contains the terminal I/O listing, the job file, and the job output file for processing the Takeoff and Landing Tower (TOLT) Data.

```
DATE
29-Jan-85

.TIME
12:40:30

/OLD,UTOLTJ
/*
*
/SUBMIT,,TO
 12.49.03. SUBMIT COMPLETE.  JSN IS ABJX.
/*
*
/LIST
/JOB
STI.
USER(SYSTECH,STII)
CHARGE,xx,xx.
GETPF(UTOLTI)
GETPF,TAPE=CAMRA04.
REWIND,TAPE.
FTN5(I=UTOLTI,L=UTOLTL,LO=S/A/R/M,ANSI,BL,DB,ET)
*TRS,OP=R,SYM=CAMRA04,L=CAMRA04,LFN=TAPE1,UN=SHAFER.
REPPF(UTOLTL)
SETTL,1000.
LDSET(PRESET=ZERO)
LGO.
REPPF(TAPE3=UTOLT04)
/EOR
/
IDLE
*
*
/CATLIST,FN=UTOLT04
 UTOLT04  FOUND.
/CATLIST,FN=UTOLT04,,LO=F
 ILLEGAL PARAMETER.
/CATLIST,LO=F,FN=UTOLT04
 CATALOG OF  SYSTECH          FM/DFRF    85/01/29. 12.57.26.

    FILE NAME ACCESS FILE-TYPE LENGTH DN CREATION  ACCESS    DATA MOD
     PASSWORD MD/CNT INDEX  PERM. SUBSYS DATE/TIME DATE/TIME DATE/TIME
     PR BR RS

    1 UTOLT04  IND. PRIVATE        57    85/01/25. 85/01/29. 85/01/29.
                  5         WRITE        17.05.44. 12.49.32. 12.49.32.
      N MD D

         1 INDIRECT ACCESS FILE(S),   TOTAL PRUS =       57.

/
```

```
ATPD
NO CARRIER
/XEDIT,ACIY
 XEDIT 3.1.00

--EOR--
1
--EOR--


 TAKEOFF AND LANDING TOWER DATA -- HEADER
        327
 0.
 WEST
 EAST
 EAST
 WEST
         0

 01
 04
 07
 82
        16
         9
  21.00
 185-03  921EB0    STS4     04 JULY 82 16/09/21.00  REAR MAIN WHEEL  LANDING
```

58161.00	21240.13	17089.37	134.5442	-51.06565	487.5429	-10.60603	18.59936	3828.485	-17.04404
58161.25	21119.10	16968.35	122.2489	-47.17784	484.6643	-12.36546	19.72024	3772.698	-15.95168
58161.50	20998.49	16847.74	110.9471	-43.29003	481.7894	-14.12490	20.95382	3718.218	-15.08206
58161.75	20878.30	16727.55	100.6387	-39.40222	478.9184	-15.88433	22.28137	3665.045	-14.43520
58162.00	20758.12	16607.37	91.25464	-35.51082	474.7069	-16.36006	22.67069	3593.249	-13.97582
58162.25	20639.49	16488.74	82.82540	-31.59847	469.8373	-15.41074	21.98444	3513.340	-14.
??									
?? N395									
58241.75	4153.139	2.387298	0.	0.	3.986124	-3.081357	3.120499	.2469254	6.976781
?? P*									
58241.75	4153.139	2.387298	0.	0.	3.986124	-3.081357	3.120499	.2469254	6.976781
58242.00	4152.232	1.480009	0.	0.	3.196592	-3.271567	3.374829	.1587957	6.941200
58242.25	4151.540	.7887229	0.	0.	2.300677	-2.975525	3.560479	.8225751E-01	7.024392
58242.50	4151.076	.3241944	0.	0.	1.382242	-2.583339	3.713277	.2969151E-01	6.985059
58242.75	4150.837	.8574171E-010.		0.	.5387103	-2.191153	3.873824	.4509983E-02	6.922542
58243.00	4150.752	0.	0.	0.	.6572400	-1.798967	4.041198	.6712931E-02	6.836841

```
--EOR--
1 ACIY    NASA AMES-DFRF CYBER 170-730.          NOS 2.1-580/577-8.   85/02/01.
```

DAYFILE

```
 15.59.19.STI.
 15.59.19.USER(SYSTECH,)
 15.59.19.CHARGE,,.
 15.59.19. WARNING...SRU ALLOCATION EXCEEDED.
 15.59.23.PROC1.
 15.59.28.  $FCOPY(P=UUNEWS1,N=UUUSCR1,PC=ASCII,NC=DIS)
```

```
15.59.29. FCOPY COMPLETE.
15.59.29.  $REWIND(UUUSCR1)
15.59.30.  $COPYSBF(UUUSCR1,OUTPUT)
15.59.30. EOI ENCOUNTERED.
15.59.30.  $BKSP(OUTPUT)
15.59.30.  $NOTE(OUTPUT,NR);1
15.59.31.  $RETURN(PROC1,UUNEWS1,UUUSCR1)
15.59.32.  $REVERT. ***** SYSTEM PROLOGUE COMPLETE *****
15.59.32.GETPF(UTOLTI)
15.59.33. GETPF COMPLETE.
15.59.33.GETPF,TAPE=CAMRA04.
15.59.36. GETPF COMPLETE.
15.59.37.REWIND,TAPE.
15.59.38.FTN5(I=UTOLTI,L=UTOLTL,LO=S/A/R/M,ANSI,BL,DB,ET)
15.59.47.     62200 CM STORAGE USED.
15.59.47.     0.573 CP SECONDS COMPILATION TIME.
15.59.47.*TRS,OP=R,SYM=CAMRA04,L=CAMRA04,LFN=TAPE1,UN=SHAFE
15.59.47.R.
15.59.47.REPPF(UTOLTL)
15.59.49. REPPF COMPLETE.
15.59.49.SETTL,1000.
15.59.50.LDSET(PRESET=ZERO)
15.59.50.LGO.
16.00.04.    STOP    ALL THE DATA HAS BEEN READ
16.00.04.     41400 MAXIMUM EXECUTION FL.
16.00.04.     2.041 CP SECONDS EXECUTION TIME.
16.00.04.REPPF(TAPE3=UTOLT04)
16.00.07. REPPF COMPLETE.
16.00.07.UEAD,      0.002KUNS.
16.00.07.UEPF,      0.089KUNS.
16.00.07.UEMS,      3.881KUNS.
16.00.07.UECP,      5.059SECS.
16.00.07.AESR,      8.362UNTS.
16.00.07.$OUT(*/OP=E)
16.00.07. NO FILES PROCESSED.
16.00.09.$DAYFILE(OUTPUT,JT=D)
END OF FILE
/
```

APPENDIX G

USE OF PROGRAM SYNC

This appendix contains the terminal I/O listing, the job file, and the job output file for merging data files with SYNC.

SYNC JOB FILE LISTING

```
IDLE
LIST
/JOB
STI.
USER(SYSTECH,STII)
CHARGE,xx,xx.
***
GETPF(FILE1=UTOLT04)
GETPF(FILE2=UCINE04)
GETPF(FILE3=UMMLE04)
REWIND,FILE1.
REWIND,FILE2.
REWIND,FILE3.
**
GET,PROCFIL/UN=MAINE,NA.
SETTL,200.
BEGIN,RUN,,SYNC,SYNCL.
COPYEI,DATA,INFIL,RW.
REPPF(DATA=ULAND04)
UNLOAD,LGO.
**
GETPF(FSYNCI)
FTN5,I=FSYNCI,ET,LO,DB,L=FSYNCL.
REPPF(FSYNCL)
SETTL,200.
LDSET(PRESET=ZERO)
LOAD(LGO)
EXECUTE.
UNLOAD,INFIL.
REPPF(OUTFIL=FLAND04)
/NOSEQ
/EOR
INFILE 1:
  SKEW = 0.
  CHANNELS = 9
  METHOD = 0.25  /
INFILE 2:
  SKEW = 1.25
  CHANNELS = 8
  METHOD = 0.05  /
INFILE 3:                      Tape 2 (CINE) Channel 1
  SKEW = 0.                    Tape 3 (MMLE) Channels 1 through 9
  CHANNELS = 34
  METHOD = 0.04  /
OUTFILE
  DT = 0.04
  FROM  2.1 3.1-9 2.2,3 3.10 1.4 3.11-18 2.4-6 3.19,20 1.1-3,9 3.21-34 2.7,8   /
TIME
  0:0:58152:000  0:0:58184:000       Start Time     Stop Time
/EOR
048 NUMBER OF SIGNALS IN 'INFIL' (INCLUDING TIME)
/EOR
/EOF
/*
*
/SUBMIT,,TO
 14.37.59. SUBMIT COMPLETE.  JSN IS DXTB.
/*
*
```

```
*
/QGET,DXTB
 QGET COMPLETE.
/LIST,F=DXTB
1
      NEWS EVENTS OF GENERAL INTEREST.  CREATED 85/04/30; 14:00 HRS.

      FINAL NOTICE... THE CDC PASCAL CONTRACT EXPIRES ON 31 MAY 1985!

                          * * * * * * * * * *

      CYBER USERS ARE REMINDED THAT ANY JOBS INVOLVING LARGE NUMBERS
      OF CARDS TO BE LOADED  OR DUMPED  SHOULD BE DONE NOW WHILE THE
      HIGH-SPEED CARD-READER/PUNCH ARE AVAILABLE.  THESE DEVICES, AS
      THEY EXIST ON THE ELXSI, ARE RELATIVELY LOW-SPEED UNITS  SINCE
      IT IS AN INTERACTIVE-ORIENTED SYSTEM.  AFTER THE CYBER PLUG IS
      PULLED (30 SEPT. 85) CARDS WILL AUTOMATICALLY BE DISCOURAGED!!

                        * * *   N O T E   * * *

      ALTHOUGH  WE TRY TO KEEP YOU INFORMED OF THINGS THAT  YOU NEED
      TO KNOW THROUGH THIS "BULLETIN", DON'T FORGET TO CHECK SYSBULL
      PERIODICALLY  FOR DETAILS  AND  OTHER SYSTEM DEVELOPMENTS THAT
      AFFECT ALL CYBER USERS.  THE SYSTEM BULLETIN THAT IS CURRENTLY
      RUNNING IS NO. 28 AND WAS CREATED ON 84/12/21.     THANK YOU!

1
S
1      LOAD MAP - SYNC                              CYBER LOADER 1.5-577      85/06/05. 14.40.27.      PAGE     1



       FWA OF THE LOAD           111
       LWA+1 OF THE LOAD       67602

       TRANSFER ADDRESS -- SYNC           446

       PROGRAM ENTRY POINTS --      SYNC            446



            1.556 CP SECONDS          107000B CM STORAGE USED                 128 TABLE MOVES




S
1                                       SYNC PROGRAM

                                        1 SEPT 1980
                                      RICHARD E MAINE
                                        NASA DRYDEN

0INFILE NUMBER 1
  UNIT: 1 NAME: FILE1   FORMAT:         CHANNELS: 9 SKEW: 0. DT: .25
0INFILE NUMBER 2
  UNIT: 2 NAME: FILE2   FORMAT:         CHANNELS: 8 SKEW: 1.25 DT: .05
0INFILE NUMBER 3
  UNIT: 3 NAME: FILE3   FORMAT:         CHANNELS: 34 SKEW: 0. DT: .04
0OUTFILE DESCRIPTION.
  NAME: DATA    UNIT: 10 DT: .04 TTOL: .0001
  OUTPUT CHANNEL SOURCES:
```

```
 FROM INFILE 2 CHANNELS:
 1=    1
 FROM INFILE 3 CHANNELS:
 2=    1
    TO 9
 FROM INFILE 2 CHANNELS:
11=    2
12=    3
 FROM INFILE 3 CHANNELS:
13=    10
 FROM INFILE 1 CHANNELS:
14=    4
 FROM INFILE 3 CHANNELS:
15=    11
    TO 18
 FROM INFILE 2 CHANNELS:
23=    4
    TO 6
 FROM INFILE 3 CHANNELS:
26=   -19
27=    20
 FROM INFILE 1 CHANNELS:
28=    1
    TO 3
31=    9
 FROM INFILE 3 CHANNELS:
32=    21
    TO 34
 FROM INFILE 2 CHANNELS:
46=    7
47=    8
47 TOTAL OUTPUT CHANNELS.
1                                   SYNC. TIME INTERVALS.

OREQUESTED TIME INTERVAL NUMBER  1 IS  0  0***   0 TO  0  0***   0
 DROPOUT ON INFILE 1. OUTFILE TIME IS 0 0 0 0. NEXT INFILE TIME IS 16 9 21 1
 ACTUAL START TIME FOR INTERVAL IS 16 9 12 0
 DROPOUT ON INFILE 3. OUTFILE TIME IS 16 9 43 920. NEXT INFILE TIME IS 9999 59 59 0
 END OF REQUESTED TIME INTERVAL. 801 FRAMES WRITTEN IN INTERVAL. LAST WAS 16 9 44 0
 NO MORE TIME SEGMENTS REQUESTED.
 FILES CLOSED. 801 TOTAL FRAMES ON OUTFILE. LAST IS 16 9 44 0
1            PROGRAM FSYNC       73/74   OPT=0,ROUND= A/ S/ M/-D,-DS     FTN 5.1+577        85/06/05. 14.44.52        PAGE     1

      20             10 FORMAT( 100F12.3 )
 TRIVIAL  *          RECORD LENGTH EXCEEDS 137 COLUMNS -- MAY EXCEED I/O DEVICE
1 DXTB    NASA AMES-DFRF CYBER 170-730.          NOS 2.1-580/577-8.   85/06/05.


 14.37.59.STI.                                     DAYFILE
 14.38.00.USER(SYSTECH,)
 14.38.00.CHARGE,,.
 14.38.00. WARNING...SRU ALLOCATION EXCEEDED.
 14.38.02.PROC1.
 14.38.07.  $FCOPY(P=UUNEWS1,N=UUUSCR1,PC=ASCII,NC=DIS)
 14.38.08. FCOPY COMPLETE.
 14.38.08.  $REWIND(UUUSCR1)
 14.38.08.  $COPYSBF(UUUSCR1,OUTPUT)
 14.38.09. EOI ENCOUNTERED.
 14.38.09.  $BKSP(OUTPUT)
 14.38.09.  $NOTE(OUTPUT,NR);1
 14.38.09.  $RETURN(PROC1,UUNEWS1,UUUSCR1)
 14.38.10.  $REVERT. ***** SYSTEM PROLOGUE COMPLETE *****
 14.38.10.***
```

ORIGINAL PAGE IS OF POOR QUALITY

```
14.38.10.GETPF(FILE1=UTOLT04)
14.38.13. GETPF COMPLETE.
14.38.13.GETPF(FILE2=UCINE04)
14.38.14. GETPF COMPLETE.
14.38.14.GETPF(FILE3=UMMLE04)
14.38.17. GETPF COMPLETE.
14.38.17.REWIND,FILE1.
14.38.17.REWIND,FILE2.
14.38.17.REWIND,FILE3.
14.38.17.**
14.38.17.GET,PROCFIL/UN=MAINE,NA.
14.38.19.SETTL,200.
14.38.20.BEGIN,RUN,,SYNC,SYNCL.
14.38.23.  IFE,NUM(SYNC).OR.NUM(SYNCL),BYE.
14.38.23.  ENDIF,BYE.
14.38.24.  UNLOAD,LD.
14.38.24.  NOTE,LD,NR.$.PROC,SYNC.
14.38.24.  NOTE,LD,NR.$  LDSET,MAP=S.
14.38.24.  NOTE,LD,NR.$  LDSET,LIB=RUNLIB.
14.38.24.  NOEXIT.
14.38.24.  IFE,($0$.NE.$0$),AUXLIBS.
14.38.24.  ENDIF,AUXLIBS.
14.38.24.  ONEXIT.
14.38.24.  IFE,($0$.NE.$0$),ELDIRS.
14.38.24.  ENDIF,ELDIRS.
14.38.26.  IFE,.NOT.NUM(0),UPDATE.
14.38.26.  ENDIF,UPDATE.
14.38.26.  NOTE,LD,NR.$  LIBLOAD,RUNLIB,SYNC.
14.38.26.  NOTE,LD,NR.$  EXECUTE.$REVERT. SYNC.
14.38.27.  NOTE,LD,NR.$  EXIT.
14.38.27.  NOTE,LD,NR.$REVERT,ABORT. SYNC.
14.38.30.  PACK,LD.
14.38.30. PACK COMPLETE.
14.38.30.  GETPF,RUNLIB=SYNCL/UN=MAINE,NA.
14.38.32. GETPF COMPLETE.
14.38.33.BEGIN,SYNC,LD.
14.38.34.  LDSET,MAP=S.
14.38.34.  LDSET,LIB=RUNLIB.
14.38.34.  LIBLOAD,RUNLIB,SYNC.
14.38.34.  EXECUTE.
14.44.37.     END  SYNC
14.44.37.    112100 MAXIMUM EXECUTION FL.
14.44.37.     8.903 CP SECONDS EXECUTION TIME.
14.44.37.REVERT. SYNC.
14.44.38.  UNLOAD,LD,LGOUP,RUNLIB.
14.44.39.REVERT. RUN.
14.44.39.COPYEI,DATA,INFIL,RW.
14.44.43. EOI ENCOUNTERED.
14.44.43.*  VERIFY,DATA,INFIL,A,R,L=OUTPUT,N.
14.44.47. VERIFY GOOD.
14.44.47.REPPF(DATA=ULAND04)
14.44.50. REPPF COMPLETE.
14.44.50.UNLOAD,LGO.
14.44.50.**
14.44.50.GETPF(FSYNCI)
14.44.51. GETPF COMPLETE.
14.44.52.FTN5,I=FSYNCI,ET,LO,DB,L=FSYNCL.
14.44.53.        1  TRIVIAL   ERROR IN  FSYNC
14.44.53.     62200 CM STORAGE USED.
14.44.53.     0.199 CP SECONDS COMPILATION TIME.
14.44.54.REPPF(FSYNCL)
14.44.54. REPPF COMPLETE.
14.44.54.SETTL,200.
```

```
14.44.56.LDSET(PRESET=ZERO)
14.44.56.LOAD(LGO)
14.44.56.EXECUTE.
14.46.36.    STOP  END-OF-FILE ENCOUNTERED
14.46.36.     30200 MAXIMUM EXECUTION FL.
14.46.36.    15.995 CP SECONDS EXECUTION TIME.
14.46.36.UNLOAD,INFIL.
14.46.36.REPPF(OUTFIL=FLAND04)
14.46.43. REPPF COMPLETE.
14.46.43.UEAD,       0.002KUNS.
14.46.43.UEPF,       0.165KUNS.
14.46.43.UEMS,      43.170KUNS.
14.46.43.UECP,      29.868SECS.
14.46.43.AESR,      42.755UNTS.
14.46.43.$OUT(*/OP=E)
14.46.43. NO FILES PROCESSED.
14.46.44.$DAYFILE(OUTPUT,JT=D)
/*
```

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15. Supplementary Notes

NASA Technical Monitor: Donald T. Berry, Ames Research Center, Dryden Flight Research Facility, Edwards, California 93523-5000

16. Abstract

This report documents the OFQ archives data base and handling system assembled as part of the Orbiter Flying Qualities (OFQ) research of the Orbiter Experiments Program (OEX). The purpose of the OFQ archives is to preserve and document shuttle flight data relevant to vehicle dynamics, flight control, and flying qualities in a form that permits maximum use for qualified users. In their complete form, the OFQ archives contain descriptive text (general information about the flight, signal descriptions and units) as well as numerical time history data. Since the shuttle program is so complex, the official data base contains thousands of signals and very complex entries are required to obtain data. The OFQ archives are intended to provide flight phase oriented data subsets with relevant signals which are easily identified for flying qualities research. This report describes the OFQ archives and the computer programs used to implement it.

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