National Aeronautics and
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Lyndon B. Johnson Space Center
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COMPUTER PROGRAM DOCUMENTATION
USER INFORMATION FOR THE MPAD TRAJECTORY - TAPE PRINT PROGRAM (TRJPR1)

Job Order 52-379

CPD-938

Prepared By

Lockheed Engineering and Management Services Co. Inc.
Houston Division

Contract NAS 9-15800

For

STRUCTURES AND MECHANICS DIVISION
THERMAL TECHNOLOGY BRANCH

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LYNDON B. JOHNSON SPACE CENTER
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1.0 INTRODUCTION

TRJPR1 is an applications program which prints data from the Mission Planning and Analysis Division (MPAD) Common Format Data Tape or Mass Storage (MS) File. TRJPR1 is used in the analysis of pre-flight data. The output of this trajectory tape can be useful in running the TRJGN1 option in the Thermal Radiation Analysis System (TRASYS) (ref. 1) and as general background information for performing on-orbit Mission Thermal Analysis.

2.0 DISCUSSION

Table 1 illustrates the trajectory tape format. Table 2 lists the output items read from the MPAD trajectory tape (ref. 2) and the output that is computed using data read from the trajectory tape. MPAD defined look angles, Theta and Phi (fig. 1), and TRASYS defined look angles, clock and cone (fig. 2), are computed from the pitch and yaw look angles (fig. 3) located on the trajectory tape. These three sets of look angles provide alternate conventions for defining, relative to the Shuttle, the Line of Sight (LOS) vectors to the sun and planet (earth).

The MPAD defined Vehicle Coordinate System (VCS) is illustrated in figures 1, 2, and 3. The VCS is a rotating, right handed Cartesian System whose origin is located at the vehicle's center of gravity. Users generally build their models in the coordinate system most yielding to their needs. This coordinate system, which may or may not coincide with the VCS, is referred to as the Central Coordinate System (CCS) and is user defined. TRJPR1 is capable of printing clock and cone angles with respect to the VCS, CCS or both via the TRJPR1 Option and Orient Cards. The clock and cone angles with respect to a CCS are defined in fig. 4. No model is offered because it is dependent upon the user.

The TRJPR1 Option Card specifies the number of lines of output per logical record and whether or not an Orient Card follows. The reason for providing the 1 or 2 line option is that there is insufficient space for all related trajectory tape data to be included on one line. The most pertinent information to the TRASYS user is on line 1. Line 2 includes other related information but of secondary importance.

The four possible values for the option card are the integers 0, 1, 2, or 3. Only one option is allowed. Options 0 and 1 print one line of output for every logical record on the tape. Option 0 assumes the VCS and CCS coincide, thus no Orient Card is necessary. Option 1 produces clock and cone angles in the CCS and an Orient Card must follow. Options 2 and 3 print two lines of output for every logical record. Option 2 assumes the VCS and CCS

coincide. Option 3 must be followed by an Orient Card and the clock and cone angles with respect to the CCS appear on line 2 (figures 4, 5, 6, and 7).

The TRJPR1 Orient Card consists of six values separated by commas and/or blanks ( ). These values specify the order of rotations and the magnitude of rotations necessary to transform the VCS into the user's coordinate system, the CCS.

The first 3 values of the Orient Card can be any permutation of the integer set $\{1, 2, 3\}$. These values represent the order in which the system is rotated about the current X, Y, and Z axes, respectively. Hence, if the first value is 3, the system is rotated about the X-axis third. The second 3 values on the Orient Card specify, in degrees, the angles of rotation about the current X, Y and Z-axes, respectively. The Orient card containing 3, 1, 2, 180., 0., 90. specifies rotations of 0° about the Y-axis, 90° about the Z-axis and 180°about the X-axis, respectively (figures 9, 10, 11). The TRJPR1 Orient card is similar to the last 6 arguments in the TRASYS user subroutine Orient. An echo print of the option and Orient Cards is provided before the tape data (figures 4, 5, and 6).

TRJPR1 skips the present logical record and reading resumes at the beginning of the next logical record if an error occurs while reading the tape. TRJPR1 defaults the option to 2 if an error occurs while reading the option card. If an error occurs while reading the orient card, the option defaults to 0 or 2, if the option was 1 or 3, respectively.

TRJPR1 terminates normally after reading a software end-of-file (EOF), hardware EOF or EOF flag on the tape. The message "END OF TRAJECTORY DATA" is printed (figure 8). Example runstreams for executing the TRJPR1 program are shown in figures 12 through 15.

3.0 CONCLUSION

TRJPR1 aesthetically outputs applicable information from a MPAD trajectory tape. TRJPR1 can be run in batch or demand, reading either a tape or M.S. file assigned to unit 10. The Option and Orient Cards are provided to specify the number of output lines per record and the coordinate system transformations. This document offers instruction for the utilization of Trajectory Print 1 routine (TRJPR1).

TABLE 1 SET 1 - GENERAL TRAJECTORY DATA FOR ASCENT, ENTRY & ABORT

Word	GDSD Usage(1)	Type(2)	Description (3)
1	T	SP	This flag is set to a 1.0 for all records except the last record where it is set to a-1.
2		SP	Spare
3	T	SP	Year
4	T	SP	Month
5	T	SP	Days
6	T	SP	Hours
7	T	SP	Minutes
8	T	SP	Seconds
			Greenwich mean time (GMT)
9-10		DP	Ground elapsed time from the base time, (Hr) (nominally liftoff)
11-12	T	DP	X
13-14	T	DP	Y
15-16	T	DP	Z
			Components of vehicle position (Km)
17-18	T	DP	DX
19-20	T	DP	DY
21-22	T	DP	DZ
			Components of vehicle velocity (Km/sec)
23-24		DP	DVX
25-26		DP	DVY
27-28		DP	DVZ
			Sensed velocity components (change) over the interval between the time of the previous record and the present one. (Km/sec)
29-30		DP	RGIM
31-32		DP	PGIM
33-34		DP	YGIM
			The gimbal angles with respect to the input REFSMMAT. The Euler sequence is yaw, pitch, and roll (ZYX). (Rad)

NOTES:

1. GDSD usage shows how data will be used:

   F = flight and simulation support (Attitude Timeline)
   T = testing support (Software Checkout)

2. Word types are: SP = single precision and DP = double precision

3. More detailed description and figures are provided by FM13(76-131), dated August 19, 1976

TABLE 1 SET 1 - GENERAL TRAJECTORY DATA FOR ASCENT, ENTRY & ABORT

Word	GDSD Usage	Type	Description
35		SP	Geocentric radius(Km)
36		SP	Geocentric declination(Rad)
37		SP	Geocentric right ascension(Rad)
38		SP	Inertial velocity vector magnitude(Km/sec)
39		SP	Inertial flight path angle(Rad)
40		SP	Inertial azimuth (Rad)
41		SP	Altitude above reference ellipsoid (Fischer 1960)(Km)
42		SP	Geodetic latitude(Rad)
43		SP	Longitude (Rad)
44		SP	Relative velocity vector magnitude(Km/sec)
45		SP	Relative flight path angle (Rad)
46		SP	Relative azimuth (Rad)
47		SP	Right ascension of Greenwich(Rad)
48*		SP	Orbit count - from ascending node to ascending node. Launch occurs during the first orbit. At the first ascending node, the orbit count becomes two. For orbits where the ascending node becomes ill-defined (small or zero inclination) the first point of Aries is used in place of the ascending node.
49		SP	Semimajor axis (Km)
50		SP	Eccentricity
51		SP	Inclination to equatorial plane (Rad)
52		SP	Right ascension of ascending node (Rad)
53		SP	Argument of perigee (Rad)
54		SP	True anomaly (Rad)
55		SP	Orbital period (Sec)
56		SP	Dynamic pressure (Kg/m^2)
57		SP	Axial drag force (Kg)

*Not Computed.

TABLE 1 SET 1 - GENERAL TRAJECTORY DATA FOR ASCENT, ENTRY & ABORT

Word	GDSD Usage	Type	Description
58		SP	Normal lift force (Kg)
59		SP	Weight, dynamic (Kg)
60		SP	Atmospheric thrust magnitude, total (Kg)
61		SP	Atmospheric ISP (Sec)
62 *		SP	Vehicle cross sectional area, dynamic (Km^2)
63 *		SP	Shadow Key (negative-umbra, positive otherwise)
64		SP	XTX] Body $\begin{bmatrix} XTX & XTY & XTZ \\ YTX & YTY & YTZ \\ ZTX & ZTY & ZTZ \end{bmatrix}_{M50}$ Body Matrix
65		SP	XTY]
66		SP	XTZ] Direction cosines of the X, Y, Z body axes wrt M50.
67		SP	YTX] (YTX = direction cosine of Y body axis with respect to the X inertial axis).
68		SP	YTY]
69		SP	YTZ]
70		SP	ZTX]
71		SP	ZTY]
72		SP	ZTZ]
73		SP	ROLL] The vehicle attitudes from local horizontal (LVLH). The Euler sequence is pitch, yaw, and roll (YZX). (Rad)
74		SP	PITCH]
75		SP	YAW]
76 *		SP	RLVDOT] The vehicle attitude rates with respect to the local horizontal. (Rad/Sec)
77 *		SP	PLVDOT]
78 *		SP	YLVCOT]
79 *		SP	RSI] The vehicle attitudes from solar inertial (SI) reference. The Euler sequence is pitch, yaw, and roll (YZX). (Rad)
80 *		SP	PSI]
81 *		SP	YSI]

*Not computed

TABLE 1 SET 1 - GENERAL TRAJECTORY DATA FOR ASCENT, ENTRY & ABORT

Word		Type	Description
82 *		SP	PLAS — Look angles from vehicle to sun (Rad) (pitch - yaw sequence)
83 *		SP	YLAS
84 *		SP	PLAE — Look angles from vehicle to center of the earth (pitch - yaw sequence) (Rad)
85 *		SP	YLAE
86 *		SP	XS — Components of the sun (Km)
87 *		SP	YS
88 *		SP	ZS
89		SP	XIMUX — IMU STABLE MEMBER $\begin{bmatrix} XIMUX & XIMUY & XIMUZ \\ YIMUX & YIMUY & YIMUZ \\ ZIMUX & ZIMUY & ZIMUZ \end{bmatrix}_{M50}$ REFSMMAT
90		SP	XIMUY
91		SP	XIMUZ — Direction cosines of the X, Y, and Z IMU axes wrt M50. (YIMUX = direction cosine of the Y axis of the IMU system with respect to the X inertial axis). If a REFSMMAT is not specified, set to identity matrix.
92		SP	YIMUX
93		SP	YIMUY
94		SP	YIMUZ
95		SP	ZIMUX
96		SP	ZIMUY
97		SP	ZIMUZ
98 *		SP	Look angles from vehicle to TDRS-1 satellite (azimuth - elevation sequence). Set to a negative one if vehicle - satellite line of sight occulted. (Rad)
99 *		SP	
100 *		SP	Same as 98-99 except for TDRS-2.
101 *		SP	
102-201		SP	Spares (may or may not be zeros)

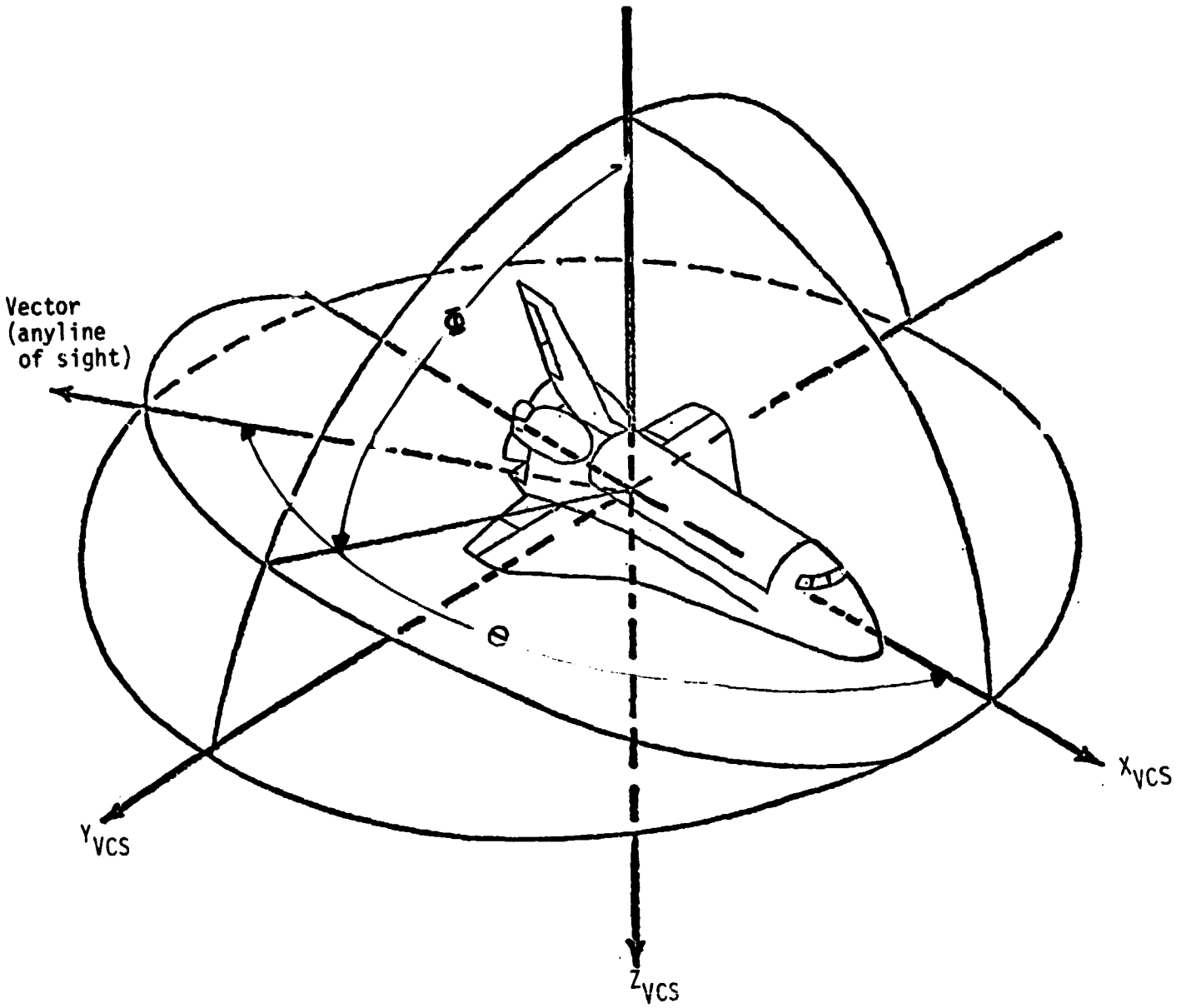
*Not computed

TABLE 2 AVAILABLE DATA AND RELATIVE OUTPUT POSITION

Line	DATA ITEM	UNITS
1	Mission Elapsed Time	Hours, minutes, seconds
	Mission Elapsed Time	Decimal hours
	Altitude	Nautical Miles
	TRASYS Clock Angle w.r.t sun*	Degrees
	TRASYS Cone Angle w.r.t sun*	Degrees
	TRASYS Clock Angle w.r.t planet*	Degrees
	TRASYS Cone Angle w.r.t planet*	Degrees
	MPAD THETA Angle w.r.t sun	Degrees
	MPAD PHI Angle w.r.t sun	Degrees
	MPAD THETA Angle w.r.t planet	Degrees
	MPAD PHI Angle w.r.t planet	Degrees
	Shadow Status	Sun or SHD (shade)
	Orbit Count	Revolutions
	Hold Mode	Solar Inertial Attitude
	BETA	Degrees
	Identity Character	N/A, Alphanumeric
2	Argument of Perigee	Degrees
	True Anomaly	Degrees
	TRASYS Clock w.r.t sun*	Degrees
	TRASYS Cone w.r.t sun*	Degrees
	TRASYS Clock w.r.t planet*	Degrees
	TRASYS Cone w.r.t planet*	Degrees
	Pitch look angle to sun**	Degrees
	Yaw look angle to sun**	Degrees
	Orbital inclination to Orbital Plane	Degrees
	Right Ascension of ascending node	Degrees
	Eccentricity	N/A

*Clock and Cone angle can be in VCS or CCS

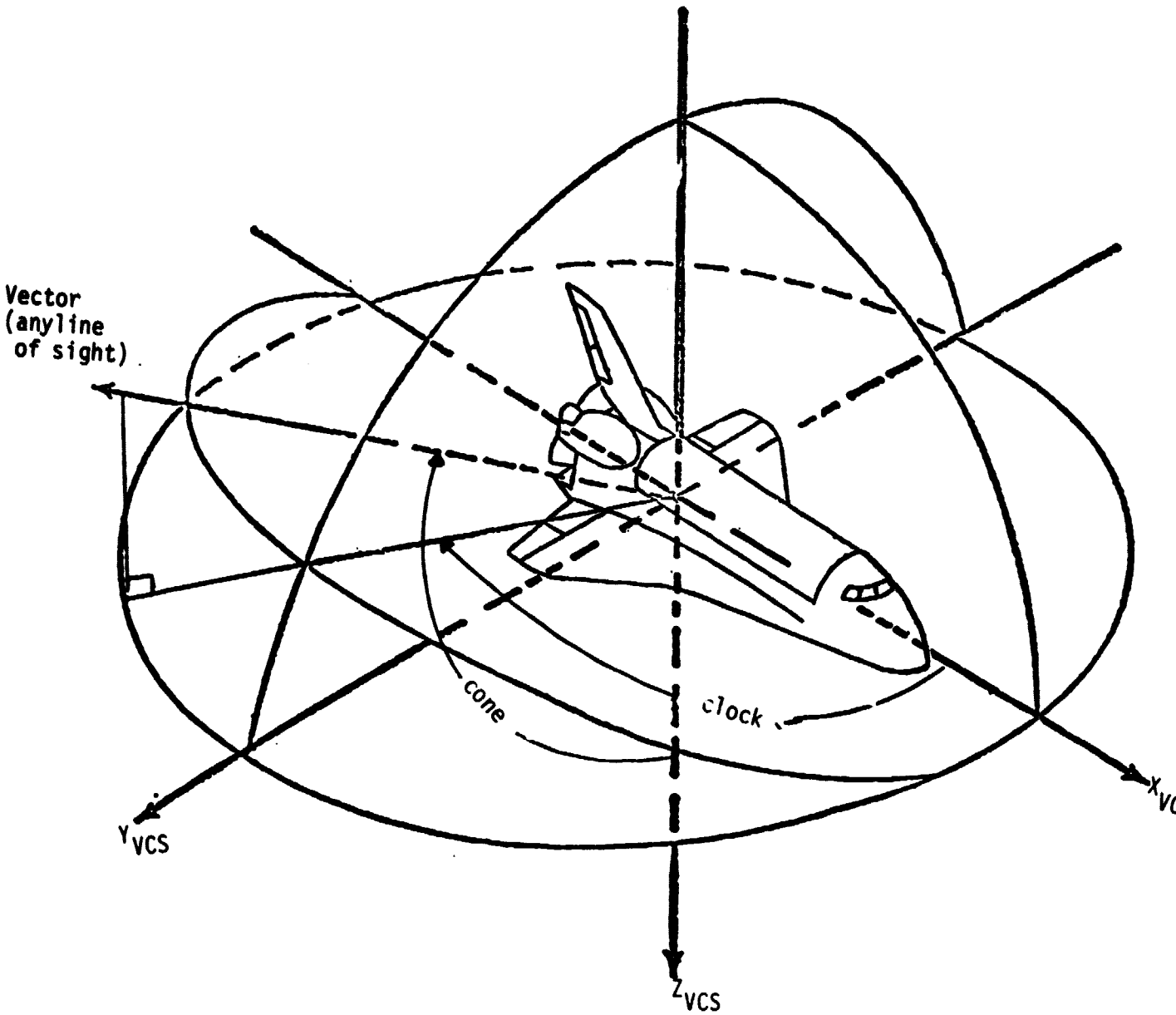
**Euler Sequence is Pitch, Yaw



θ = Smallest angle from X-body axis to vector

ϕ = Measured from Z-body axis positively about X-body axis to vector projection in Y-Z plane

Figure 1.— MPAD Theta and Phi look angles.



Clock = Angle between the line of sight vector's projection onto the X, Y plane and the +X-axis

Cone = Angle between the LOS and +Z-axis

Figure 2.—TRASYS clock and cone look angles.

Sample sketches depicting pitch, yaw look angles referenced to the body +X-axis.

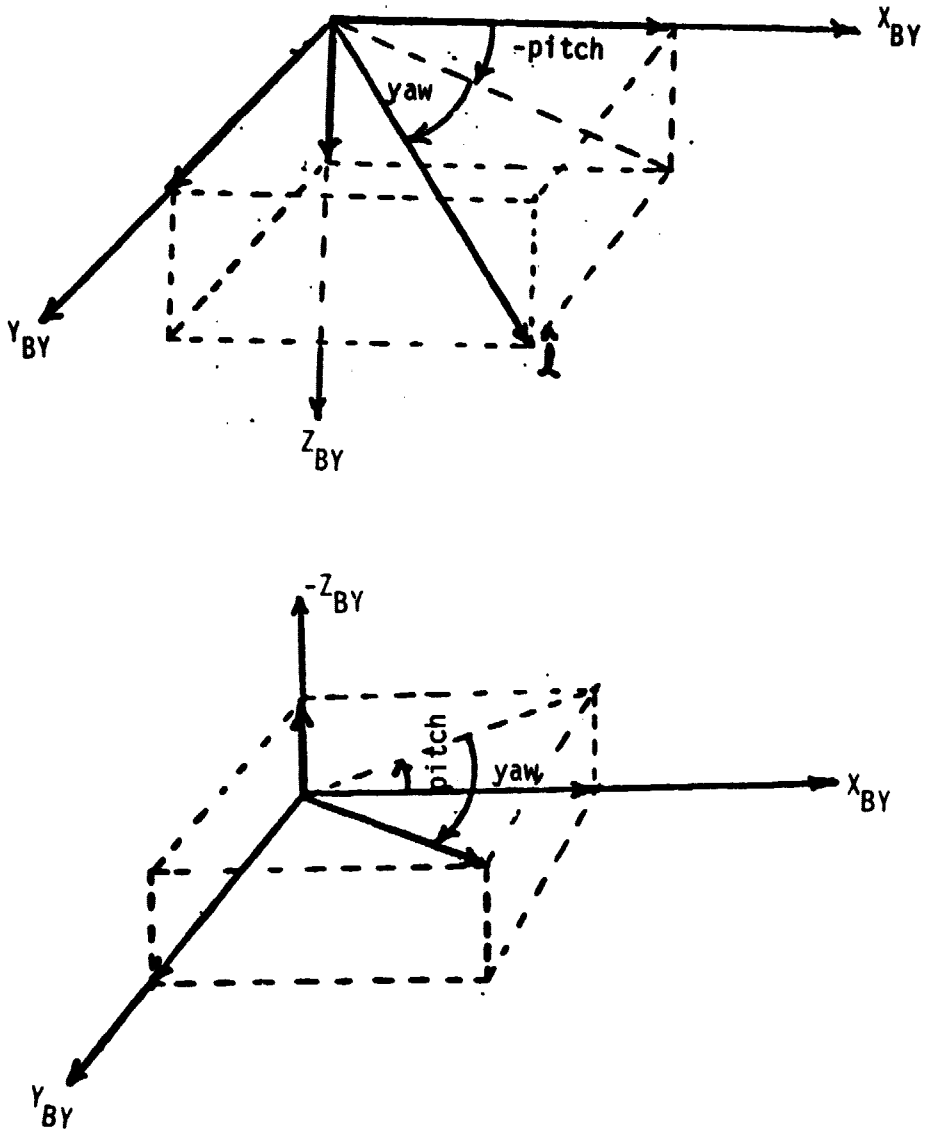


Figure 3.—Pitch and Yaw Look Angles, Euler sequence is pitch, yaw.

```
>@XQT ES3:L400062*TRASIN TS.PRI
>@
```

OPTION	ORDER OF ROTATION			DEGREES OF ROTATION		
	X	Y	Z	X	Y	Z
0	0	0	0	.00	.00	.00

					LOOK ANGLES SUN VCS		PLANET		LOOK ANGLES SUN MPAD		PLANET						
HR.	M.	S.	TIME	ALT NM	CLOCK	CONE	CLOCK	CONE	THETA	PHI	THETA	PHI	SUN SHADE	ORBIT COUNT	HOLD MODE	BETA	IDENTITY CHARACTER
0	45	30	.7584	154.68	211.77	86.63	.00	180.00	148.07	263.61	90.00	.00	SUN	1.0	IM	121.7	OFT1 MISSION DATA
0	49	59	.8333	154.35	211.77	86.62	180.01	162.03	148.07	263.61	107.97	.00	SUN	1.0	IM	121.7	OFT1 MISSION DATA
1	0	0	1.0000	153.88	211.77	86.62	180.04	122.04	148.07	263.59	147.96	.00	SHD	1.2	IM	121.7	OFT1 MISSION DATA
1	1	59	1.0333	153.88	211.77	86.62	180.04	114.05	148.07	263.59	155.95	.00	SHD	1.2	IM	121.6	OFT1 MISSION DATA
1	1	59	1.0333	153.88	211.77	86.62	180.04	114.05	148.07	263.59	155.95	.00	SHD	1.2	IM	121.6	OFT1 MISSION DATA
1	7	59	1.1333	154.09	263.40	148.13	.00	180.00	93.48	328.30	90.00	.00	SHD	1.2	IM	121.6	OFT1 MISSION DATA
1	7	59	1.1333	154.09	263.40	148.13	.00	180.00	93.48	328.30	90.00	.00	SHD	1.2	IM	121.6	OFT1 MISSION DATA
1	9	59	1.1667	154.21	-83.69	148.15	.00	180.00	[illegible]67	328.31	90.00	.00	SHD	1.3	IM	121.6	OFT1 MISSION DATA
1	19	59	1.3333	154.82	-41.61	127.87	.00	180.00	55.23	319.50	90.00	.00	SHD	1.4	IM	121.6	OFT1 MISSION DATA
1	30	0	1.5000	154.93	-31.75	95.24	.00	180.00	32.14	279.89	90.00	.00	SUN	1.5	IM	121.6	OFT1 MISSION DATA
1	39	59	1.6667	154.67	-36.52	61.72	.00	180.00	44.95	227.89	90.00	.00	SUN	1.6	IM	121.6	OFT1 MISSION DATA
1	49	59	1.8333	154.72	-65.55	35.12	.00	180.00	76.23	212.63	90.00	.00	SUN	1.7	IM	121.6	OFT1 MISSION DATA
2	0	0	2.0000	155.08	236.72	38.70	.00	180.00	110.0	213.82	90.00	.00	SUN	1.8	IM	121.6	OFT1 MISSION DATA
2	9	59	2.1667	155.02	214.32	67.76	.00	180.00	139.[illegible]	234.05	90.00	.00	SUN	1.9	IM	121.6	OFT1 MISSION DATA
2	19	59	2.3333	154.35	212.18	101.57	.00	180.00	146.[illegible]	291.02	90.00	.00	SUN	2.0	IM	121.5	OFT1 MISSION DATA
2	26	59	2.4500	153.94	219.28	124.46	.00	180.00	129.66	317.30	90.00	.00	SHD	2.1	IM	121.5	OFT1 MISSION DATA
2	26	59	2.4500	153.94	219.28	124.46	.00	180.00	129.66	317.30	90.00	.00	SHD	2.1	IM	121.5	OFT1 MISSION DATA
2	30	0	2.5000	153.87	120.94	126.53	72.90	106.75	114.48	40.19	73.64	72.52	SHD	2.2	IM	121.5	OFT1 MISSION DATA
2	32	59	2.5500	153.88	82.44	59.56	39.42	34.93	83.49	120.65	63.75	156.08	SHD	2.2	IM	121.5	OFT1 MISSION DATA
2	32	59	2.5500	153.88	82.44	59.56	39.42	34.93	83.49	120.65	63.75	156.08	SHD	2.2	IM	121.5	OFT1 MISSION DATA
2	38	59	2.6500	154.12	82.45	59.56	84.52	28.11	83.49	120.65	87.42	152.00	SHD	2.3	IM	121.5	OFT1 MISSION DATA
2	38	59	2.6500	154.12	82.45	59.56	84.52	28.11	83.49	120.65	87.42	152.00	SHD	2.3	IM	121.5	OFT1 MISSION DATA
2	39	59	2.6667	154.18	82.46	59.58	92.87	28.67	83.50	120.64	91.37	151.36	SHD	2.3	IM	121.5	OFT1 MISSION DATA
2	45	0	2.7500	154.51	82.50	59.66	126.08	37.73	83.53	120.55	111.12	147.98	SHD	2.3	IM	121.5	OFT1 MISSION DATA
2	45	0	2.7500	154.51	82.50	59.66	126.08	37.73	83.53	120.55	111.12	147.98	SHD	2.3	IM	121.5	OFT1 MISSION DATA
2	49	59	2.8333	154.79	82.51	59.66	145.48	52.43	83.54	120.55	130.77	143.62	SHD	2.4	IM	121.5	OFT1 MISSION DATA
3	0	0	3.0000	154.90	82.51	59.66	167.97	86.70	83.54	120.55	167.53	105.49	SUN	2.5	IM	121.5	OFT1 MISSION DATA
3	0	0	3.0000	154.90	34.54	84.80	122.38	29.46	34.88	99.11	105.27	154.50	SUN	2.5	IM	121.6	OFT1 MISSION DATA
3	0	0	3.0000	154.90	34.54	84.80	122.38	29.46	34.88	99.11	105.27	154.50	SUN	2.5	IM	121.5	OFT1 MISSION DATA
3	9	59	3.1667	154.64	34.55	84.80	161.15	60.11	34.89	99.12	145.14	150.66	SUN	2.6	IM	121.4	OFT1 MISSION DATA
3	18	59	3.3167	154.68	34.55	84.79	177.55	92.49	34.89	99.13	176.51	44.48	SUN	2.7	IM	121.4	OFT1 MISSION DATA
3	18	59	3.3167	154.68	34.55	84.79	177.55	92.49	34.89	99.13	176.51	44.48	SUN	2.7	IM	121.4	OFT1 MISSION DATA
3	19	59	3.3333	154.71	12.71	86.34	158.49	103.36	13.22	106.22	154.85	57.07	SUN	2.7	IM	121.4	OFT1 MISSION DATA
3	24	59	3.4167	154.90	264.61	31.57	.00	180.00	92.82	211.45	90.00	.00	SUN	2.8	IM	121.4	OFT1 MISSION DATA
3	24	59	3.4167	154.90	264.60	31.57	.00	180.00	92.82	211.45	90.00	.00	SUN	2.8	IM	121.4	OFT1 MISSION DATA
3	30	0	3.5000	155.09	237.08	38.38	.00	180.00	100.72	213.61	90.00	.00	SUN	2.8	IM	121.4	OFT1 MISSION DATA
3	39	59	3.6667	155.03	214.35	67.41	.00	180.00	139.67	233.59	90.00	.00	SUN	2.9	IM	121.4	OFT1 MISSION DATA
3	49	59	3.8333	154.35	212.08	101.26	.00	180.00	146.20	290.55	90.00	.00	SUN	3.0	IM	121.4	OFT1 MISSION DATA
4	0	0	4.0000	153.84	225.52	133.13	.00	180.00	120.76	322.71	90.00	.00	SHD	3.2	IM	121.3	OFT1 MISSION DATA
4	9	59	4.1667	154.14	-84.78	148.53	.00	180.00	87.28	328.64	90.00	.00	SHD	3.3	IM	121.3	OFT1 MISSION DATA
4	19	59	4.3333	154.75	-41.58	128.59	.00	180.00	54.22	320.26	90.00	.00	SHD	3.4	IM	121.3	OFT1 MISSION DATA
4	24	59	4.4167	154.88	-34.20	118.76	.00	180.00	40.30	306.73	90.00	.00	SHD	3.4	IM	121.3	OFT1 MISSION DATA
4	24	59	4.4167	154.88	-34.20	118.76	.00	180.00	40.30	306.73	90.00	.00	SHD	3.4	IM	121.3	OFT1 MISSION DATA
4	29	0	4.5000	154.86	265.15	178.67	81.96	97.25	90.11	358.68	82.02	82.00	SUN	3.5	IM	121.3	OFT1 MISSION DATA
4	30	0	4.5000	154.86	265.14	178.67	81.96	97.25	90.11	358.68	82.02	82.00	SUN	3.5	IM	121.3	OFT1 MISSION DATA
4	30	0	4.5000	154.86	265.14	178.67	81.96	97.25	90.11	358.68	82.02	82.00	SUN	3.5	IM	121.3	OFT1 MISSION DATA

Figure 4. – Sample output option 0.

```
>@XQT ES3 [488,6]EXTRACIN TRJPR1
>1
 PLEASE INPUT ORIENT CARD
>3 2 1 180. 0. 0.
```

OPTION	ORDER OF ROTATION			DEGREES OF ROTATION		
	X	Y	Z	X	Y	Z
1	3	2	1	180.00	.00	.00

				ALT	LOOK ANGLES SUN CCS		PLANET		LOOK ANGLES SUN MPAD		PLANET		SUN	ORBIT	HOLD		
HR.	M.	S.	TIME	NM	CLOCK	CONE	CLOCK	CONE	THETA	PHI	THETA	PHI	SHADE	COUNT	MODE	BETA	IDENTITY CHARACTER
0	45	30	.7584	154.68	211.77	86.63	.00	180.00	148.07	263.61	90.00	.00	SUN	1.0	IN	121.7	OFT1 MISSION DATA
0	49	59	.8333	154.35	211.77	86.62	180.01	162.03	148.07	263.61	107.97	.00	SUN	1.0	IN	121.7	OFT1 MISSION DATA
1	0	0	1.0000	153.88	211.77	86.62	180.04	122.04	148.07	263.59	147.96	.00	SHD	1.2	IN	121.7	OFT1 MISSION DATA
1	1	59	1.0333	153.88	211.77	86.62	180.04	114.05	148.07	263.59	155.95	.00	SHD	1.2	IN	121.6	OFT1 MISSION DATA
1	1	59	1.0333	153.88	211.77	86.62	180.04	114.05	148.07	263.59	155.95	.00	SHD	1.2	IN	121.6	OFT1 MISSION DATA
1	7	59	1.1333	154.09	263.40	148.13	.00	180.00	93.48	328.30	90.00	.00	SHD	1.2	IN	121.6	OFT1 MISSION DATA
1	7	59	1.1333	154.09	263.40	148.13	.00	180.00	93.48	328.30	90.00	.00	SHD	1.2	IN	121.6	OFT1 MISSION DATA
1	9	59	1.1667	154.21	-83.69	148.15	.00	180.00	86.67	328.31	90.00	.00	SHD	1.3	IN	121.6	OFT1 MISSION DATA
1	19	59	1.3333	154.82	-41.61	127.87	.00	180.00	53.83	319.50	90.00	.00	SHD	1.4	IN	121.6	OFT1 MISSION DATA
1	30	0	1.5000	154.93	-31.75	95.24	.00	180.00	36.14	279.89	90.00	.00	SUN	1.5	IN	121.6	OFT1 MISSION DATA
1	39	59	1.6667	154.67	-36.52	61.72	.00	180.00	44.15	227.89	90.00	.00	SUN	1.6	IN	121.6	OFT1 MISSION DATA
1	49	59	1.8333	154.72	-66.55	35.12	.00	180.00	78.23	212.63	90.00	.00	SUN	1.7	IN	121.6	OFT1 MISSION DATA
2	0	0	2.0000	155.08	236.72	38.70	.00	180.00	11.06	213.82	90.00	.00	SUN	1.8	IN	121.6	OFT1 MISSION DATA
2	9	59	2.1667	155.02	214.32	67.76	.00	180.00	12.86	234.05	90.00	.00	SUN	1.9	IN	121.6	OFT1 MISSION DATA
2	19	59	2.3333	154.35	212.18	101.57	.00	180.00	14.02	291.02	90.00	.00	SUN	2.0	IN	121.5	OFT1 MISSION DATA
2	26	59	2.4500	153.94	219.28	124.46	.00	180.00	129.66	317.30	90.00	.00	SHD	2.1	IN	121.5	OFT1 MISSION DATA
2	26	59	2.4500	153.94	219.28	124.46	.00	180.00	129.66	317.30	90.00	.00	SHD	2.1	IN	121.5	OFT1 MISSION DATA
2	30	0	2.5000	153.87	120.94	126.53	72.90	106.75	114.40	49.19	73.64	72.52	SHD	2.2	IN	121.5	OFT1 MISSION DATA
2	32	59	2.5500	153.88	82.44	59.56	39.42	34.93	83.49	120.65	63.75	156.08	SHD	2.2	IN	121.5	OFT1 MISSION DATA
2	32	59	2.5500	153.88	82.44	59.56	39.43	34.93	83.49	120.65	63.75	156.08	SHD	2.2	IN	121.5	OFT1 MISSION DATA
2	38	59	2.6500	154.12	82.45	59.56	84.52	28.11	83.49	120.65	87.42	152.00	SHD	2.3	IN	121.5	OFT1 MISSION DATA
2	38	59	2.6500	154.12	82.45	59.56	84.52	28.11	83.49	120.65	87.42	152.00	SHD	2.3	IN	121.5	OFT1 MISSION DATA
2	39	59	2.6667	154.18	82.46	59.58	92.87	28.67	83.50	120.64	91.37	151.36	SHD	2.3	IN	121.5	OFT1 MISSION DATA
2	45	0	2.7500	154.51	82.50	59.66	126.08	37.73	83.53	120.55	111.12	147.98	SHD	2.3	IN	121.5	OFT1 MISSION DATA
2	45	0	2.7500	154.51	82.50	59.66	126.08	37.73	83.53	120.55	111.12	147.98	SHD	2.3	IN	121.5	OFT1 MISSION DATA
2	49	59	2.8333	154.79	82.51	59.66	145.48	52.43	83.54	120.55	130.77	143.62	SHD	2.4	IN	121.5	OFT1 MISSION DATA
3	0	0	3.0000	154.90	82.51	59.66	167.97	86.70	83.54	120.55	167.53	105.49	SUN	2.5	IN	121.5	OFT1 MISSION DATA
3	0	0	3.0000	154.90	34.54	84.80	122.38	29.46	34.88	99.11	106.27	154.50	SUN	2.5	IN	121.5	OFT1 MISSION DATA
3	0	0	3.0000	154.90	34.54	84.80	122.38	29.46	34.88	99.11	106.27	154.50	SUN	2.5	IN	121.5	OFT1 MISSION DATA
3	9	59	3.1667	154.64	34.55	84.80	161.15	60.11	34.89	99.12	145.14	150.66	SUN	2.6	IN	121.4	OFT1 MISSION DATA
3	18	59	3.3167	154.68	34.55	84.79	177.55	92.49	34.89	99.13	176.51	44.48	SUN	2.7	IN	121.4	OFT1 MISSION DATA
3	18	59	3.3167	154.68	34.55	84.79	177.55	92.49	34.89	99.13	176.51	44.48	SUN	2.7	IN	121.4	OFT1 MISSION DATA
3	19	59	3.3333	154.71	12.71	86.34	158.49	103.36	13.22	106.22	154.85	57.07	SUN	2.7	IN	121.4	OFT1 MISSION DATA
3	24	59	3.4167	154.90	264.61	31.57	.00	180.00	92.82	211.45	90.00	.00	SUN	2.8	IN	121.4	OFT1 MISSION DATA
3	24	59	3.4167	154.90	264.60	31.57	.00	180.00	92.82	211.45	90.00	.00	SUN	2.8	IN	121.4	OFT1 MISSION DATA
3	30	0	3.5000	155.09	237.08	38.38	.00	180.00	109.72	213.61	90.00	.00	SUN	2.8	IN	121.4	OFT1 MISSION DATA
3	39	59	3.6667	155.03	214.36	67.41	.00	180.00	139.67	233.59	90.00	.00	SUN	2.9	IN	121.4	OFT1 MISSION DATA
3	49	59	3.8333	154.35	212.08	101.26	.00	180.00	146.20	290.55	90.00	.00	SUN	3.0	IN	121.4	OFT1 MISSION DATA
4	0	0	4.0000	153.84	225.52	133.13	.00	180.00	120.76	322.71	90.00	.00	SHD	3.2	IN	121.3	OFT1 MISSION DATA
4	9	59	4.1667	154.14	-84.78	148.63	.00	180.00	87.28	328.64	90.00	.00	SHD	3.3	IN	121.3	OFT1 MISSION DATA
4	19	59	4.3333	154.75	-41.58	128.59	.00	180.00	54.22	320.26	90.00	.00	SHD	3.4	IN	121.3	OFT1 MISSION DATA
4	24	59	4.4167	154.88	-34.20	112.76	.00	180.00	40.30	306.73	90.00	.00	SHD	3.4	IN	121.3	OFT1 MISSION DATA
4	24	59	4.4167	154.88	-34.20	112.76	.00	180.00	40.30	306.73	90.00	.00	SHD	3.4	IN	121.3	OFT1 MISSION DATA
4	30	0	4.5000	154.86	265.15	178.67	81.96	97.25	90.11	358.68	82.02	82.08	SUN	3.5	IN	121.2	OFT1 MISSION DATA

Figure 5. — Sample output option 1.

```
>@XQT ES3-L40006ITRASIN.TRJPR1
>2

 OPTION   ORDER OF ROTATION   DEGREES OF ROTATION

            X      Y      Z       X         Y         Z
            -      -      -    ------    ------    ------
      2     0      0      0       .00       .00       .00
```

HR. M. S. / PERIGEE	TIME / TRUE ANOMALY	ALT NM	LOOK ANGLES SUN VCS CLOCK	SUN VCS COME	PLANET CLOCK	PLANET COME	LOOK ANGLES SUN THETA	SUN PHI	MPAD THETA	MPAD PHI	PLANET THETA	PLANET PHI	SUN SHADE	ORBIT COUNT	HOLD MODE	BETA / IMCLIN	IDENTITY / ASCEMS	CHARACTER / ECCEM
0 46 30	.7584	154.68	211.77	86.63	.00	180.00	148.07	263.61	90.00	.00	90.00	.00	SUN	1.0	IH	121.7	OFT1	MISSION DATA
-130.49	-19.00		211.77	86.63	.00	180.00	183.97	-31.71	90.00	.00		40.62				53.51		.00028
0 49 59	.8333	154.35	211.77	86.62	180.01	162.03	148.07	263.61	107.97	.00	90.00	.00	SUN	1.0	IH	121.7	OFT1	MISSION DATA
-103.15	-28.35		211.77	86.62	180.01	162.03	183.97	-31.71	107.97	-.00		40.61				53.49		.00062
1 0 0	1.0000	153.82	211.77	86.62	180.04	122.04	148.07	263.59	147.96	.00	90.00	.00	SHD	1.2	IH	121.7	OFT1	MISSION DATA
-77.80	-13.67		211.77	86.62	180.04	122.04	183.98	-31.71	147.96	-.03		40.59				53.42		.00014
1 1 59	1.0333	153.88	211.77	86.62	180.04	114.05	148.07	263.59	155.95	.00	90.00	.00	SHD	1.2	IH	121.6	OFT1	MISSION DATA
-98.36	14.91		211.77	86.62	180.04	114.05	183.98	-31.71	155.95	-.04		40.59				53.40		.00016
1 1 59	1.0333	153.88	211.77	86.62	180.04	114.05	148.07	263.59	155.95	.00	90.00	.00	SHD	1.2	IH	121.6	OFT1	MISSION DATA
-98.36	14.91		211.77	86.62	180.04	114.05	183.98	-31.71	155.95	-.04		40.59				53.40		.00016
1 7 59	1.1333	154.09	263.40	148.13	.00	180.00	93.48	328.30	90.00	.00	90.00	.00	SHD	1.2	IH	121.6	OFT1	MISSION DATA
-87.61	28.18		263.40	148.13	.00	180.00	94.09	-31.64	90.00	-.00		40.60				53.35		.00046
1 7 59	1.1333	154.09	263.40	148.13	.00	180.00	93.48	328.30	90.00	.00	90.00	.00	SHD	1.2	IH	121.6	OFT1	MISSION DATA
-87.61	28.18		263.40	148.13	.00	180.00	94.09	-31.63	90.00	.00		40.60				53.35		.00046
1 9 59	1.1667	154.21	-83.69	148.15	.00	180.00	86.67	328.31	90.00	.00	90.00	.00	SHD	1.3	IH	121.6	OFT1	MISSION DATA
-78.49	25.87		-83.69	148.15	.00	180.00	86.09	-31.63	90.00	.00		40.61				53.34		.00059
1 19 59	1.3333	154.82	-41.61	127.87	.00	180.00	53.83	319.50	90.00	.00	90.00	.00	SHD	1.4	IH	121.6	OFT1	MISSION DATA
-20.64	9.23		-41.61	127.87	.00	180.00	46.12	-31.62	90.00	.00		40.63				53.31		.00109
1 30 0	1.5000	154.93	-31.75	96.24	.00	180.00	32.14	279.89	90.00	.00	90.00	.00	SUN	1.5	IH	121.6	OFT1	MISSION DATA
34.02	-6.44		-31.75	96.24	.00	180.00	6.16	-31.61	90.00	.00		40.62				53.31		.00080
1 39 59	1.6667	154.67	-36.52	61.72	.00	180.00	44.95	227.89	90.00	.00	90.00	.00	SUN	1.6	IH	121.6	OFT1	MISSION DATA
117.04	-49.37		-36.52	61.72	.00	180.00	326.20	-31.61	90.00	-.00		40.64				53.26		.00010
1 49 59	1.8333	154.72	-65.55	35.12	.00	180.00	76.23	212.63	90.00	.00	90.00	.00	SUN	1.7	IH	121.6	OFT1	MISSION DATA
31.52	77.11		-65.55	35.12	.00	180.00	286.23	-31.58	90.00	-.00		40.59				53.17		.00012
2 0 0	2.0000	155.08	236.72	38.70	.00	180.00	110.06	213.82	90.00	.00	90.00	.00	SUN	1.8	IH	121.6	OFT1	MISSION DATA
139.94	8.69		236.72	38.70	.00	180.00	246.27	-31.52	90.00	-.00		40.62				53.12		.00073
2 9 59	2.1667	155.02	214.32	67.76	.00	180.00	139.86	234.05	90.00	.00	90.00	.00	SUN	1.9	IH	121.6	OFT1	MISSION DATA
-101.88	-9.50		214.32	67.76	.00	180.00	206.34	-31.46	90.00	-.00		40.63				53.11		.00105

Figure 6. — Sample output option 2.

```
>@XQT ES3-L40006:TRASIN.TRJPR1
>3
 PLEASE INPUT ORIENT CARD
>2,1,3,0.,0.,180.

 OPTION   ORDER OF ROTATION   DEGREES OF ROTATION

            X      Y      Z       X        Y        Z
            -      -      -     ------   ------   ------
      3     2      1      3       .00      .00   180.00
```

HR. M. S. / PERIGEE	TIME / TRUE ANOMALY	ALT NM	LOOK ANGLES SUM CLOCK / SUM COME	VCS CLOCK / PLANET COME	LOOK ANGLES SUN THETA / SUN PITCH	MPAD PHI / MPAD YAW	PLANET THETA / PLANET PITCH	PLANET PHI / PLANET YAW	SUN SHADE	ORBIT COUNT	HOLD MODE	BETA / INCLIN	IDENTITY CHARACTER / ASCEMS	ECCEM
0 45 30	.7584	154.68	211.77	86.63 .00	148.07	263.61	90.00	.00	SUM	1.0	IH	121.7	OFT1 MISSION DATA	
-130.49	-19.00		31.77	86.63 180.00	183.97	-31.71	90.00	.00		40.62		53.51		.00028
0 49 59	.8333	154.35	211.77	86.62 180.01	148.07	263.61	107.97	.00	SUM	1.0	IH	121.7	OFT1 MISSION DATA	
-103.15	-28.35		31.77	86.62 .01	183.97	-31.71	107.97	-.00		40.61		53.49		.00062
1 0 0	1.0000	153.88	211.77	86.62 180.04	148.07	263.59	147.96	.00	SHD	1.2	IH	121.7	OFT1 MISSION DATA	
-77.80	-13.67		31.77	86.62 .04	183.98	-31.71	147.96	-.03		40.59		53.42		.00014
1 1 59	1.0333	153.88	211.77	86.62 180.04	148.07	263.59	155.95	.00	SHD	1.2	IH	121.6	OFT1 MISSION DATA	
-98.36	14.91		31.77	86.62 .04	183.98	31.71	155.95	-.04		40.59		53.40		.00016
1 1 59	1.0333	153.88	211.77	86.62 180.04	148.07	263.59	155.95	.00	SHD	1.2	IH	121.6	OFT1 MISSION DATA	
-98.36	14.91		31.77	86.62 .04	183.98	-31.71	155.95	-.04		40.59		53.40		.00016
1 7 59	1.1333	154.09	263.40	148.13 .00	180.00	93.48	328.30	90.00	.00	SHD	1.2	IH	121.6	OFT1 MISSION DATA
-87.61	28.18		83.40	148.13 .00	180.00	94.09	-31.64	90.00	-.00		40.60		53.35	.00046
1 7 59	1.1333	154.09	263.40	148.13 .00	180.00	93.48	328.30	90.00	.00	SHD	1.2	IH	121.6	OFT1 MISSION DATA
-87.61	28.18		83.40	148.13 .00	180.00	94.09	-31.63	90.00	.00		40.60		53.35	.00046
1 9 59	1.1667	154.21	-83.69	148.15 .00	180.00	86.67	328.31	90.00	.00	SHD	1.3	IH	121.6	OFT1 MISSION DATA
-78.40	25.07		96.31	148.15 .00	180.00	86.09	-31.63	90.00	.00		40.61		53.34	.00059
1 19 59	1.3333	154.82	-41.61	127.87 .00	180.00	53.83	319.50	90.00	.00	SHD	1.4	IH	121.8	OFT1 MISSION DATA
-80.64	9.23		138.39	127.87 .00	180.00	46.12	-31.62	90.00	.00		40.63		53.31	.00109
1 30 0	1.5000	154.93	-31.75	96.24 .00	180.00	32.14	279.89	90.00	.00	SUM	1.5	IH	121.6	OFT1 MISSION DATA
34.88	-6.44		148.25	96.24 .00	180.00	6.16	-31.61	90.00	.00		40.62		53.31	.00080
1 38 59	1.8667	154.67	-36.52	61.72 .00	180.00	44.95	227.89	90.00	.00	SUM	1.6	IH	121.8	OFT1 MISSION DATA
117.84	-40.37		143.48	61.72 .00	180.00	326.20	-31.61	90.00	-.00		40.64		53.86	.00010
1 40 59	1.8333	154.72	-65.55	35.12 .00	180.00	76.23	212.63	90.00	.00	SUM	1.7	IH	121.8	OFT1 MISSION DATA
31.52	77.11		114.45	35.12 .00	180.00	286.23	-31.58	90.00	-.00		40.59		53.17	.00012
2 0 0	2.0000	155.00	236.72	38.70 .00	180.00	110.06	213.82	90.00	.00	SUM	1.8	IH	121.6	OFT1 MISSION DATA
138.94	8.89		56.72	38.70 .00	180.00	246.27	-31.52	90.00	-.00		40.62		53.18	.00073
2 9 59	2.1667	155.02	214.32	67.78 .00	180.00	139.86	234.05	90.00	.00	SUM	1.9	IH	121.6	OFT1 [illegible]

Figure 7. — Sample output output option 3.

```
 9 59   52.1667   153.35   124.11    62.86   121.48    36.54   119.94   121.77   108.11   147.71 SHD   35.3 IM     115.4 OFT1 REGRESSION DATA
52 13 59   52.2333   153.43   124.12    62.86   145.42    41.98   119.94   121.77   123.41   152.95 SHD   35.3 IM     115.4 OFT1 REGRESSION DATA
52 13 59   52.2333   153.43    36.10    82.88    21.50    60.02    36.71   101.97    36.30   147.58 SHD   35.3 IM     115.4 OFT1 REGRESSION DATA
52 19 59   52.3333   153.57    36.11    82.87    43.46    43.03    36.71   101.98    60.31   147.30 SHD   35.4 IM     115.4 OFT1 REGRESSION DATA
52 30  0   52.5000   153.67    36.11    82.87   108.50    34.37    36.72   101.99   100.32   147.03 SUM   35.5 IM     115.4 OFT1 REGRESSION DATA
52 39 59   52.6667   153.88    36.12    82.86   155.50    57.74    36.72   101.99   140.31   146.79 SUM   35.6 IM     115.3 OFT1 REGRESSION DATA
52 49 59   52.8333   154.65    36.12    82.86   179.92    90.00    36.73   102.00   179.60      .00 SUM   35.7 IM     115.3 OFT1 REGRESSION DATA
53  0  0   53.0000   155.54    36.12    82.85   204.56   122.95    36.73   102.01   139.75   387.33 SUM   35.8 IM     115.3 OFT1 REGRESSION DATA
53  0  0   53.0000   155.54    58.35   136.34   199.02    47.20    68.76    39.09   133.92   199.39 SUM   35.8 IM     115.3 OFT1 REGRESSION DATA
53  0  0   53.0000   155.54    58.35   136.34   199.02    47.20    68.76    39.09   133.92   199.39 SUM   35.8 IM     115.3 OFT1 REGRESSION DATA
53  9 59   53.1667   155.56    58.35   136.33   196.85    87.12    68.76    39.00   162.92   260.14 SUM   35.9 IM     115.3 OFT1 REGRESSION DATA
53 19 59   53.3333   154.57    58.34   136.33   194.83   127.04    68.75    39.10   140.50   341.27 SUM   36.0 IM     115.2 OFT1 REGRESSION DATA
53 30  0   53.5000   153.56    58.33   136.32   185.84   166.82    68.74    39.10   103.11   358.64 SHD   36.1 IM     115.2 OFT1 REGRESSION DATA
53 31  9   53.5194   153.49    58.33   136.32   179.78   171.35    68.74    39.10    98.65      .00 SHD   36.2 IM     115.2 OFT1 REGRESSION DATA
53 31  9   53.5194   153.49    58.38   136.42   180.33   171.29    68.81    39.02    98.71      .00 SHD   36.2 IM     115.2 OFT1 REGRESSION DATA
53 31 11   53.5200   153.49    58.38   136.42   180.07   171.42    68.81    39.02    98.58      .00 SHD   36.2 IM     115.2 OFT1 REGRESSION DATA
END OF TRAJECTORY DATA
>
```

Figure 8. — Output from normally terminating TRJPR1 execution.

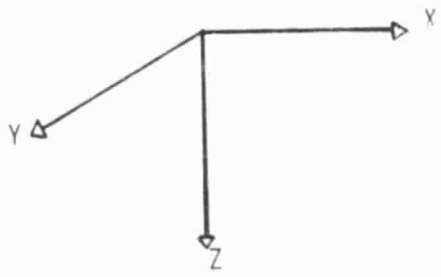


Figure 9. — Orientation of MPAD VCS.

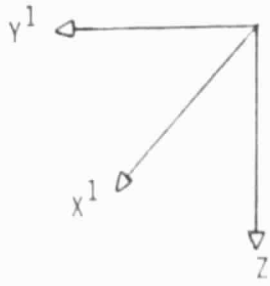


Figure 10. – Coordinate system achieved by rotating the VCS 90° about the +Z-axis.

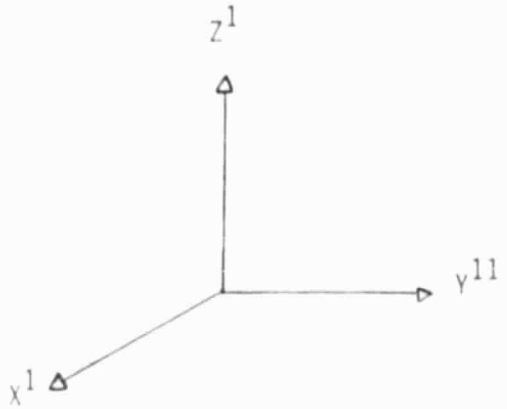
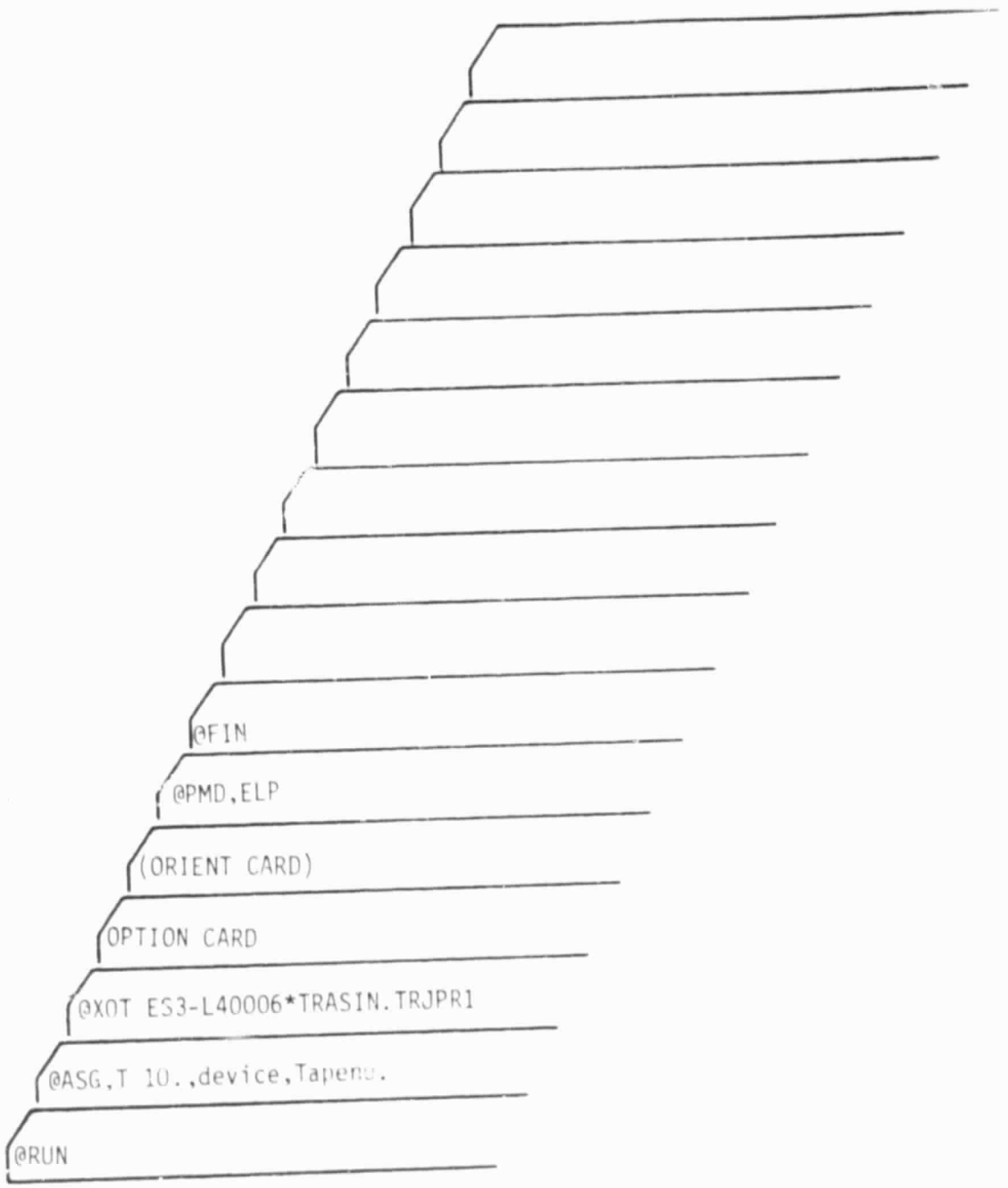


Figure 11. — Coordinate system achieved by rotating figure 10. 180^{0} about the X axis.



( ) denotes optional

Figure 12. – General form for typical deck setup using Trajectory Tape.

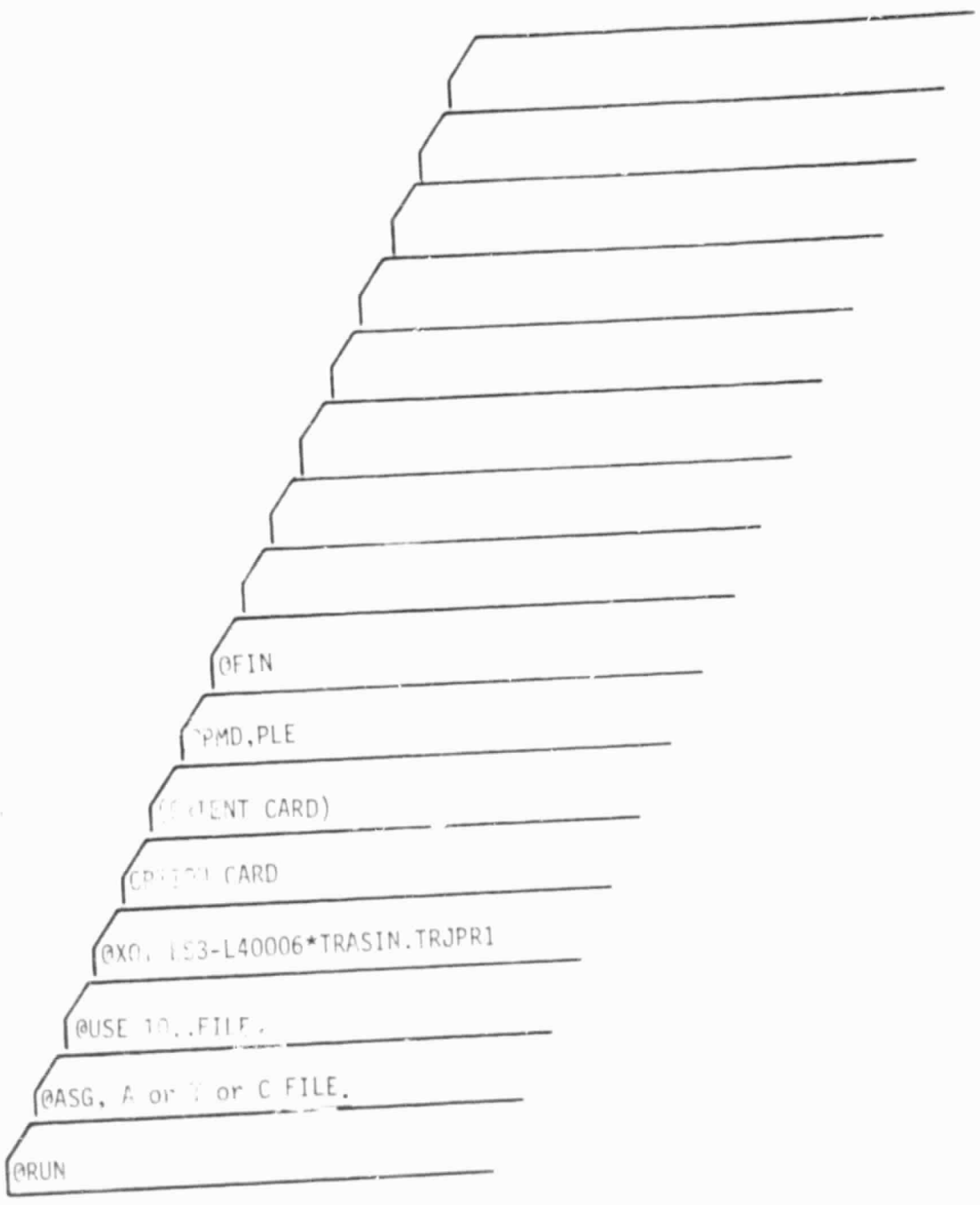


Figure 13. – General form for typical deck setup using MS file.

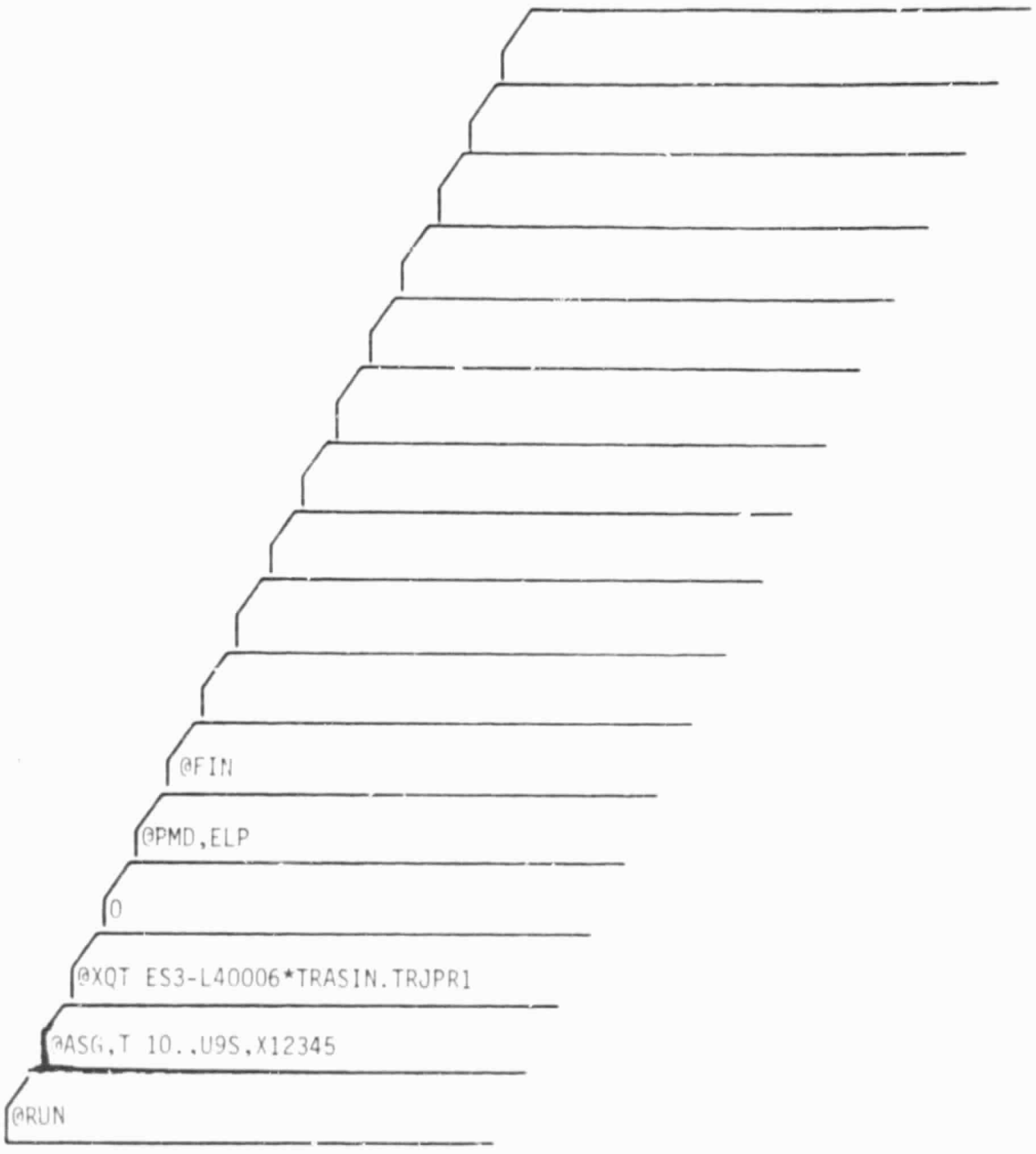


Figure 14.— Sample form for typical deck setup.

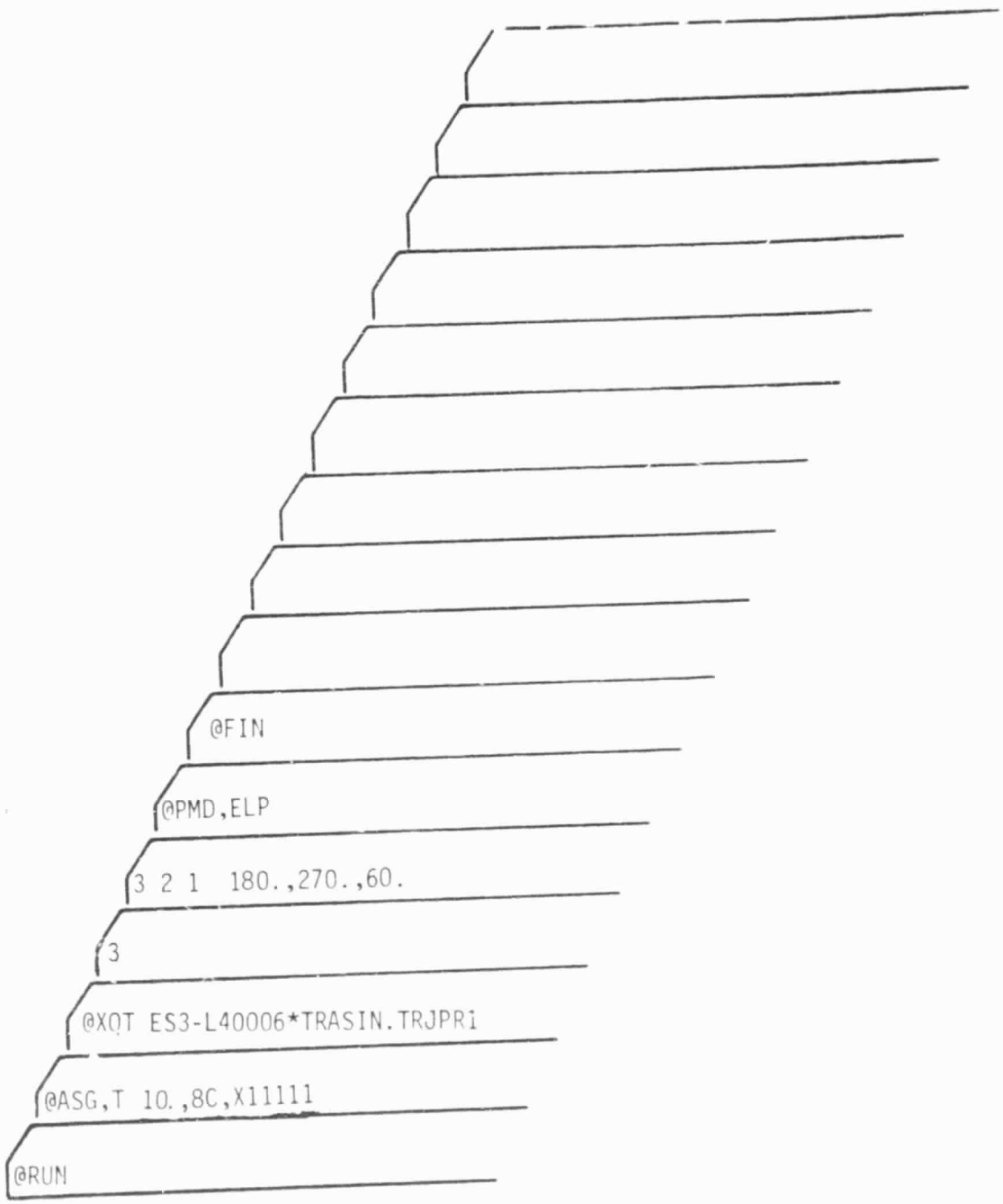


Figure 15. — Sample form for typical deck trajectory tape setup.

4.0 REFERENCES

1. Thermal Radiation Analysis System (TRASYS II) Martin Marrietta 6/79.
2. OFT Trajectory Interface Control Document NASA/JSC 12/79.