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USER'S GUIDE TO DATA PREPARATION

PHOTOGRAMMETRIC
NAVIGATION ANALYSIS PROGRAM
FOTONAP
September 1978

OLD DOMINION SYSTEMS, INC.
GAITHERSBURG, MARYLAND

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This report is a user's guide for the photogrammetric navigation analysis program (generally referred to as photonap) designed to provide the user with a detailed description of the control information needed to run photonap.

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PHOTOGRAMMETRIC
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FOTONAP

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PREPARED BY

OLD DOMINION SYSTEMS, INC.
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SECTION I

GENERAL

1.1 INTRODUCTION

THE USER'S GUIDE FOR THE PHOTOGRAMMETRIC NAVIGATION ANALYSIS
PROGRAM (GENERALLY REFERRED TO AS PHOTONAP) IS DESIGNED TO PROVIDE
THE USER WITH A DETAILED DESCRIPTION OF THE CONTROL INFORMATION NEEDED
TO RUN PHOTONAP. THE READER WHO INTENDS TO PREPARE INPUT FOR THIS
PROGRAM MUST HAVE A GOOD UNDERSTANDING OF THE INFORMATION CONTAINED
HEREIN. THE USER WILL FIND THAT HE WILL BE ABLE TO RECALL FROM MEMORY
THE CONTEXT OF THIS DOCUMENT AFTER SEVERAL ATTEMPTS AT DESIGNING AND
EXECUTING PARTICULAR APPLICATIONS.

1.2 GENERAL DISCUSSION

PHOTONAP IS A MULTI-ARC DATA ADJUSTMENT PROGRAM DESIGNED TO
ACCEPT SATELLITE OBSERVATIONS DATA ALONG WITH ESTIMATES OF SELECTED
ERROR MODEL PARAMETERS AND TO EXTRACT FROM THIS INPUT IMPROVED ESTI-
MATES OF THE SELECTED PARAMETERS. IT IS RECOMMENDED THAT THE USER
THOROUGHLY UNDERSTAND THE PHOTONAP PHILOSOPHY AS AN AID TO EFFICIENT
UTILIZATION OF THE PROGRAM.

TERMS USED FREQUENTLY IN THIS USER'S GUIDE ARE DEFINED IN
SECTION 1.3.

THE PROGRAM HAS BEEN DESIGNED WITH MANY STANDARDIZED CON-
STANTS AND OPTIONS (REFERRED TO AS "DEFAULTS"), SO THAT THE USER NEED
SPECIFY ONLY THOSE OPTIONS WHICH DIFFER FROM THESE. IN ADDITION,
THERE ARE VARIOUS DEBUG PRINT OPTIONS WHICH MAY BE HELPFUL IN ANAL-
YZING A PROBLEM RUN. THESE DEBUG OPTIONS ARE NOT RECOMMENDED FOR
NORMAL USE.

1.3   DEFINITION OF TERMS

        THE FOLLOWING TERMS SHOULD BE REVIEWED BEFORE ATTEMPTING TO
PREPARE THE DATA FOR A PHOTONAP REDUCTION:

ARC   DEFINED BY A SINGLE STATE
                            VECTOR AND EPOCH ASSOCI-
                            ATED WITH THE STATE VECTOR.
                            ALL TRAJECTORY POINTS OB-
                            TAINED BY INTEGRATING THE
                            DIFFERENTIAL EQUATIONS WITH
                            THE GIVEN INITIAL CONDITIONS
                            ARE INCLUDED IN THE ARC. AN
                            ARC CONTAINS ONE OR MORE
                            PASSES.

ARC NUMBER   ARBITRARY INTEGER ASSIGNED
                            BY THE USER TO EACH STATE
                            VECTOR.

ARC, PRIMARY   THE TRAJECTORY OF THE PRI-
                            MARY SATELLITE.

ARC, SECONDARY   THE TRAJECTORY OF A SECOND-
                            ARY SATELLITE RELATED TO THE
                            PRIMARY ONE THROUGH A COM-
                            MON TRACKING SYSTEM.

BODY NUMBER, JPL   THE NUMBER ASSIGNED TO MEM-
                            BERS OF THE SOLAR SYSTEM TO
                            CORRESPOND TO THE JPL EPHEM-
                            ERIS TAPE.
                                    0=SUN
                                    1=MERCURY
                                    2=VENUS
                                    3=EARTH
                                    4=MARS
                                    5=JUPITER
                                    6=SATURN
                                    7=URANUS
                                    8=NEPTUNE
                                    9=PLUTO
                                    10=MOON

BODY NUMBER, USER   NUMBER FROM 1 TO 10 ASSIGNED
ASSIGNED   BY USER TO CORRELATE THE
                            INFORMATION GIVEN IN THE
                            VARIOUS CATEGORIES FOR EACH
                            BODY.

ERROR MODEL TERM   AN ERROR MODEL DEFINES A
                            RELATION BETWEEN SYSTEMATIC
                            MEASUREMENT ERRORS AND A SET
                            OF PARAMETERS OR ERROR
                            MODEL TERMS.

ERROR MODEL TERM NUMBER — SPECIFIC INTEGER WHICH IDENTIFIES EACH OF THE ERROR MODEL TERMS. (SEE APPENDIX IV-B.)

MEASUREMENT — SATELLITE POSITION OR VELOCITY DATA OBSERVED BY THE TRACKING INSTRUMENT. EXAMPLES ARE: SLANT RANGE, SLANT RANGE RATE, AZIMUTH, ELEVATION.

MEASUREMENT NUMBER — AN ARBITRARY INTEGER ASSIGNED BY THE USER TO A MEASUREMENT. IT IS USED TO CORRELATE THE INFORMATION IN THE VARIOUS CATEGORIES.

MEASUREMENT TYPE NUMBERS — EACH OF THE VARIOUS MEASUREMENTS SUCH AS SLANT RANGE, SLANT RANGE RATE, AZIMUTH, ELEVATION, ETC., ARE IDENTIFIED BY MEANS OF A UNIQUE "MEASUREMENT TYPE NUMBER." (SEE APPENDIX IV-A.)

PARAMETERS — THE ERROR MODEL TERMS FOR WHICH IMPROVED ESTIMATES ARE DESIRED.

PARAMETER NUMBER — ARBITRARY INTEGER ASSIGNED BY THE USER TO INDICATE THE ROW/COLUMN OF THE ERROR MODEL TERMS IN THE NORMAL EQUATIONS.

PARAMETER, ARC STABLE — ALL DATA FROM AN ARC CONTRIBUTE TO THE RECOVERY OF THE PARAMETER ESTIMATE. EXAMPLE: THE STATE VECTOR.

PARAMETER, PASS STABLE — DATA FROM ONE PASS ONLY CONTRIBUTE TO THE RECOVERY OF THE PARAMETER ESTIMATE: EXAMPLE: RANGE BIAS.

PARAMETER, TOTALLY STABLE — DATA FROM ALL ARCS CONTRIBUTE TO THE PARAMETER ESTIMATE. EXAMPLE: STATION SURVEY.

PASS — DESIGNATED BY A SET OF LOGICALLY RELATED DATA FROM A GIVEN STATION.

PASS NUMBER

ARBITRARY NUMBER ASSIGNED BY THE USER TO DEFINE A SEGMENT OF THE DATA FROM A STATION. WITHIN AN ARC, EACH STATION HAS ITS OWN SEQUENCE OF PASS NUMBERS INDEPENDENT OF ANY OTHER STATION. THE STATION/PASS NUMBERS ASSIGNED IN AN ARC ARE INDEPENDENT OF THOSE IN ANOTHER ARC.

```
ARC 1, STATION 1, PASS 1
ARC 1, STATION 1, PASS 2
ARC 1, STATION 2, PASS 1
ARC 2, STATION 1, PASS 1
```

STATE VECTOR

THE INITIAL CONDITIONS (POSITION AND VELOCITY - X, Y,Z,XD,YD,ZD) OF THE TRAJECTORY AT EPOCH.

STATION

THE SITE FROM WHICH THE SATELLITE WAS OBSERVED.

STATION NUMBER

AN ARBITRARY INTEGER ASSIGNED BY THE USER TO EACH STATION. IT IS USED TO CORRELATE THE INFORMATION IN THE VARIOUS CATEGORIES (SEE "PASS NUMBER").

1.4   THE CONTROL DATA

THE CONTROL DATA HAVE BEEN CATEGORIZED FOR QUICK RECALL IN SETTING UP EACH REDUCTION. THE CATEGORIES AND THE TYPE OF INFORMATION COMMUNICATED ARE AS FOLLOWS:

CATEGORY	100	-	GENERAL CONSTANT FLAGS AND PLANETARY INFORMATION
CATEGORY	200	-	TIMING INFORMATION
CATEGORY	300	-	STATION SURVEY
CATEGORY	600	-	PARAMETERS OR ERROR MODEL TERMS
CATEGORY	700	-	MEASUREMENT DEFINITIONS
CATEGORY	999	-	TERMINAL CARD

1.4.1   GENERAL DATA SETUP

THE OUTLINE BELOW GIVES A GENERAL GUIDE FOR ORDER-
ING EACH CONTROL DATA DECK. MORE SPECIFIC INFORMATION HAS
BEEN GIVEN IN THE APPROPRIATE SECTION FOR CATEGORIES REQUIRED
TO BE IN A PARTICULAR POSITION IN THE DECK.

TYPE OF INFORMATION	CATEGORIES
GENERAL AND PLANETARY INFORMATION	101, 102, 103, 151
COMMENTS	150
STATION SURVEY	301, 302, 303
TOTALLY STABLE PARAMETERS	601, 602
MEASUREMENT DEFINITIONS	701, 702, 703, 704 (SETS 0 ONLY)
GENERAL ARC INFORMATION	104, 205, 206
ARC STABLE PARAMETERS	601, 602
GENERAL PASS INFORMATION	201, 202, 203, 204
PASS STABLE PARAMETERS	601, 602
PASS COMMENTS	152
OVERRIDES FOR MEASUREMENT DEFINITIONS FOR A PASS	701, 702, 703, 704 (SETS 1 ONLY)
END OF PASS, ARC, OR ALL CONTROL DATA	999

1.4.2   FORMATS

TWO FORMATS ARE USED IN THE PROGRAM FOR THE READING
OF CONTROL DATA. FORMAT A IS USED FOR ALL DATA EXCEPT COM-
MENTS, WHICH ARE READ WITH FORMAT B. THE TABLES GIVEN FOR
EACH CATEGORY STATE SPECIFICALLY WHICH COLUMNS ARE USED FOR
EACH ITEM.

NUMBERS USING INTEGER FORMATS MUST BE RIGHT JUSTI-
FIED. THE EXPONENT OF NUMBERS USING REAL FORMATS MUST BE
RIGHT JUSTIFIED. FAILURE TO COMPLY WITH THIS WILL CAUSE
ZEROES TO BE ADDED TO THE INTEGER AND THE EXPONENT.

A BLANK INDICATES A ZERO VALUE, CONSEQUENTLY, IT IS
NOT NECESSARY TO PUNCH THIS. A BLANK MAY ALSO BE USED FOR ANY
DEFAULT OPTION TO BE TAKEN, UNLESS NOTED OTHERWISE.

FORMAT A

NAME	COLUMN	TYPE
CATEGORY #	1- 3	INTEGER
SET #	4- 5	INTEGER
LABEL	6-13	ALPHANUMERIC
KEY 1	14-16	INTEGER
KEY 2	17-19	INTEGER
KEY 3	20-22	INTEGER
KEY 4	23-25	INTEGER
KEY 5	26-28	INTEGER
KEY 6	29-31	INTEGER
KEY 7	32-34	INTEGER
KEY 8	35-37	INTEGER
KEY 9	38-40	INTEGER
KEY 10	41-43	INTEGER
DATA1	44-65	REAL*8 (USES "D" EXPONENT)
DATA2	66-80	REAL*8 (USES "D" EXPONENT)

FORMAT B

NAME	COLUMN	TYPE
CATEGORY #	1- 3	INTEGER
SET #	4- 5	INTEGER
COMMENTS	6-80	ALPHANUMERIC

CURRENT ARRAY DIMENSIONS IMPOSE THE FOLLOWING RE-
STRICTIONS:

	MAXIMUM NUMBER
ARCS	100
STATIONS	100
MEASUREMENTS	300
ERROR MODEL TERMS PER MEASUREMENT	30
TERMS IN POWER SERIES FOR POSITION	16
TERMS IN POWER SERIES FOR VARIATIONAL EQUATIONS	12
START/STOP TIMES	100 EACH
MEASUREMENT EDITING TIMES FOR A PASS	30
NUMBER OF MEASUREMENTS PER PASS	10
* MAXIMUM NUMBER OF ROWS (OR COLUMNS) OF NORMAL EQUATIONS' MATRIX	2000

* THE NUMBER OF ROWS (OR COLUMNS) OF THE NORMAL EQUATIONS'
MATRIX IS DETERMINED BY ADDING THE NUMBER OF TOTALLY STABLE,
ARC STABLE, AND PASS STABLE PARAMETERS. THE EXAMPLE BELOW
ILLUSTRATES THE METHOD USED FOR DETERMINING THIS.

    A. THE MAXIMUM NUMBER OF PARAMETERS IS 2000.
    B. SUPPOSE THE NUMBER OF TOTALLY STABLE PARAMETERS IS 1930.
    C. THE REMAINDER LEFT FOR USE FOR EACH ARC IS 70.
    D. IF ARC 1 HAS 20 ARC STABLE PARAMETERS, THEN EACH
       PASS OF ARC 1 CAN HAVE 50 PASS STABE PARAMETERS.
    E. IF ARC 2 HAS 10 ARC STABLE TERMS, THEN EACH PASS
       OF ARC 2 CAN HAVE 60 PASS STABLE PARAMETERS.

1.4.4   SPECIAL REQUIREMENTS FOR PROCESSING PHOTOGRAMMETRIC DATA

        A.   THE CAMERA CARRYING SATELLITE MUST BE DESIGNATED AS A
STATION (SEE CATEGORY 301 CARD).

        B.   ALL ERROR MODEL PARAMETERS THAT ARE TO BE SOLVED FOR
(CATEGORY 601, KEY 8 = 0 OR 1) MUST BE DESIGNATED TOTALLY STABLE
(CATEGORY 601, KEY 4 = 1) WITH THE FOLLOWING EXCEPTIONS:

        (1)   GROUND POINT COORDINATES MUST BE DESIGNATED
              GROUND STABLE (KEY 4 =4 FOR 601 CARDS).

        (2)   IF THE TERRAIN CAMERA ORIENTATION ANGLES ARE
              DETERMINED SOLELY FROM STELLAR ANGLE MEASURE-
              MENTS, THEN THE TERRAIN CAMERA ORIENTATION
              ANGLES (ERROR MODEL TERMS 12,13,14) MAY BE
              DESIGNATED PASS STABLE (KEY 4=3 FOR 601 CARDS).

        C.   CATEGORY 601 CARDS FOR ERROR MODEL TERMS 12,13,14
SHOULD BE INSERTED IN THE INPUT DECK AS IF THEY WERE PASS STABLE
PARAMETERS, I.E., THEY SHOULD BE PLACED BETWEEN THE CATEGORY 201
AND 999 CARDS SPECIFYING THE PHOTOGRAPH TO WHICH THESE PARAMETERS
REFER.

1.4.5   STACKING OF RUNS

        ANY NUMBER OF PHOTONAP RUNS MAY BE MADE   USING THE SAME SET
OF JOB CONTROL LANGUAGE (JCL) BY INSERTING AN ASTERISK (*) IN COLUMN 1
ON A SEPARATOR CARD BETWEEN THE DIFFERENT RUNS.

1.4.6   KALMAN FILTER AND SMOOTHER

PHOTONAP HAS THE CAPABILITY TO HANDLE GPS MEASUREMENTS
THROUGH A KALMAN FILTER. 3 DIFFERENT TYPES OF RUN ARE POSSIBLE.

A.   GENERATE SIMULATED GPS MEASUREMENTS.

MUST SPECIFY RANGE MEASUREMENT ON 701 CARD, FREQUENCY
OF OBSERVATIONS ON 702 CARD, DRAG COEFFICIENT ON 601 CARD, ATMOSPHERE
ON 103 CARD, VALUES OF QP,TP,QB,TB ON 614 CARDS. KEY 5 OF 101 CARD
SHOULD BE -7. IT IS ADVISABLE TO USE 601 CARDS ALSO FOR BIAS AND BIAS
RATE, SO THAT THERE ARE 9 601 CARDS CORRESPONDING TO THE 9 PARAMETERS
INVOLVED WITH GPS MEASUREMENTS. THE PARAMETER NUMBERS (KEY 7) FOR THE
601 CARDS SHOULD BE NUMBERED CONSECUTIVELY FROM 1 THROUGH 9. IT IS
ADVISABLE TO SET KEY 5=10, KEY 1=1 ON THE 601 CARDS CORRESPONDING TO
BIAS AND BIAS RATE.

B.   USE SIMULATED OR REAL GPS MEASUREMENT DATA AS INPUT
      TO KALMAN PROCESSOR AND OUTPUT ESTIMATED PARAMETERS
      AND THEIR COVARIANCE MATRICES.

THE DATA SET UP SHOULD BE SIMILAR TO A. ABOVE, EXCEPT
THAT KEY 5 OF THE 101 CARD SHOULD BE SET TO -2. NOTE THAT DATA2 ON EACH
601 CARD SPECIFIES THE STANDARD DEVIATION OF THE ERROR IN THE A PRIORI
PARAMETER VALUE. THESE ARE USED IN THE FILTER INITIALIZATION. THE
SMOOTHER LAG CONSTANT MUST BE SPECIFIED ON A 614 CARD.

C.   USE KALMAN PROCESSOR OUTPUT AS INPUT TO REGULAR BATCH
      PROCESSING PHOTONAP.

MUST SPECIFY SIX PARAMETER STATE VECTOR INPUT ON 701
CARDS. DATA2 ON THE 701 CARDS SHOULD BE NEGATIVE (ANY NEGATIVE NUMBER).

SECTION II

PROGRAM CONSTANTS

CATEGORY 100

2.1   CATEGORY 101   -   GENERAL CONTROL FLAGS

THIS CARD IS NOT NEEDED UNLESS THE DEFAULT OPTIONS ARE TO BE MODIFIED. IF USED, IT MUST PRECEDE THE FIRST CATEGORY 999 CARD.

COLUMN	NAME	DEFAULT	DESCRIPTION OR VALUE
1- 3	CATEGORY #	NONE	101
4- 5	SET #	NONE	ZERO OR BLANK
6-13	LABEL	BLANKS	ANY 8 ALPHANUMERIC CHARACTERS
14-16	KEY 1	20	MAXIMUM NUMBER OF ITERATIONS
17-19	KEY 2	20	MAXIMUM NUMBER OF DIVERGENCES
20-22	KEY 3	(SEE NOTE 1)	SOURCE OF THE COEFFICIENTS OF THE SPHERICAL HARMONICS FOR THE EARTH'S GRAVITY FIELD (SEE APPENDIX II): 0=NWL(NAVAL WEAPONS LAB) 1=GODDARD EARTH MODEL (GEM) (SEE NOTE 1)
23-25	KEY 4	0	EARTH MODEL UNITS (SEE CATEGORY 102): 0=METERS, 1=KILOMETERS, 2=FEET, 3=OTHER UNITS (MUST BE DEFINED ON CATEGORY 102 CARD)

(CONTINUED ON NEXT PAGE)

NOTES: 1.   IF THIS CARD IS NOT USED, THE GEM MODEL IS USED.

COLUMN	NAME	DEFAULT	DESCRIPTION OR VALUE
26-28	KEY 5	3	SOURCE OF OBSERVATIONS (SEE APPENDIX I): 1=CARDS 2=BINARY FILE AS SPECIFIED IN APPENDIX I-B 3=MTAUF BINARY TAPE 4=OPTICAL DATA CARDS IN GEOS FORMAT 5=OPTICAL DATA ON BINARY FILE 6=INTERNAL STATISTICAL SIMULATION 7=WRITE INTERNALLY SIMULATED DATA ON BINARY FILE ITAPE 9=WRITE INTERNALLY SIMULATED DATA ON BINARY FILE AND THEN PROCEED TO REDUCE USING THE SIMULATED DATA AS INPUT. FOR THE REDUCTION RUN, THE A PRIORI PARAMETER VALUES WILL BE PERTURBED AT RANDOM ACCORDING TO THE A PRIORI SIGMAS AS GIVEN ON THE 601 CARD. ALL TIMING AND BIAS CORRECTIONS (704 CARD) WILL BE IGNORED. THIS OPTION COMBINES A TYPE 7 AND TYPE 2 RUN. -2=BINARY FILE AS SPECIFIED IN APPENDIX I-B (USED AS INPUT TO KALMAN FILTER) -7=WRITE INTERNALLY SIMULATED DATA ON BINARY FILE 33, SPECIFIED AS IN "KEY 5=-2" ABOVE
29-31	KEY 6	0	1=PRINT OBSERVED DATA. FOR TYPE 6 RUN PRINT RANDOM MEASUREMENT NOISE.
32-34	KEY 7	99	ITERATION ON WHICH TO BEGIN USING CALCULATED PARAMETER VALUES AS A PRIORI VALUES FOR EVALUATION TYPE 0 AND 1 PARAMETERS.
35-37	KEY 8	1	ITERATION ON WHICH TO BEGIN USING CALCULATED PARAMETER VALUES FOR ERROR MODEL TERMS WITH EVALUATION 1 (SEE CATEGORY 601, KEY 8).
38-40	KEY 9	LAST ITERATION	ITERATION ON WHICH TO BEGIN PRINTING RESIDUALS.
44-65	DATA1	.01	CONVERGENCE CRITERION
66-80	DATA2	-10.	DIVERGENCE CRITERION (NEGATIVE VALUE)

2.2   CATEGORY 102 - PHYSICAL CONSTANTS FOR THE EARTH

        THIS CARD IS OPTIONAL BUT, IF USED, MUST PRECEDE
THE FIRST CATEGORY 999 CARD. USE OF THIS CARD MODIFIES THE
EARTH MODEL CONSTANTS STORED AS DEFAULT VALUES. A SEPARATE
CARD MUST BE PREPARED FOR EACH CONSTANT TO BE OVERRIDDEN. THE
CHANGE APPLIES TO THE COMPLETE REDUCTION.

COLUMN	NAME	DESCRIPTION
1- 3	CATEGORY #	102
4- 5	SET #	0, 1, 2, OR 3
6-13	LABEL	ANY 8 ALPHANUMERIC CHARACTERS (NOT REQUIRED)
14-16	KEY 1	IDENTIFY DATA1 CONSTANT:

        2=CONVERSION CONSTANT FROM METERS
           TO OTHER UNITS (USED ONLY IF
           CATEGORY 101, KEY 4=3)
        3=SEMI-MAJOR AXIS OF SOURCE OF
           OBSERVATIONS
        6=THE ASTRONOMICAL UNIT
        7=JPL EARTH RADIUS
        8=EARTH-MOON MASS RATIO
        10=VELOCITY OF LIGHT
        11=RELATIVISTIC EFFECTS
              0=DO NOT APPLY
              1=APPLY
        12=PRINT INTERVAL (SECONDS) FOR
           INTEGRATOR PRINTOUT

13=FB(I)	(SEE NOTES 1&4)
14=A3(I)	(SEE NOTES 1&4)
15=A4(I)	(SEE NOTES 1&4)
16=XN(I,1)	(SEE NOTES 1&4)
17=XN(I,2)	(SEE NOTES 1&4)
18=XN(I,3)	(SEE NOTES 1&4)
19=XN(I,4)	(SEE NOTES 1&4)

17-43	KEYS 2 THRU 10	SEE NOTE 3
44-65	DATA1	VALUE OF CONSTANT ACCORDING TO KEY 1 ABOVE
66-80	DATA2	SEE NOTE 2

DEFAULT VALUES FOR DATA1:

KEY 1   CONSTANT

2   1.
3   (SEE CATEGORY 104, SET 6)
6   149.5979 D9
7   6378.1492 D3
8   81.301
10   299792.5 D9
11,12   0.
13   0.5 D6
14   -1558.33333333 D6
15   -2062.85 D6
16   51192.0

NOTES: 1.   I = IO, IO+1, ..., 4 (WHERE IO = SET # + 1).

          2.   IF (KEY1 .GE. 13) AND (DATA2 .NE. 0.), THEN
                DATA1 IS IGNORED.

          3.   IF (KEY2 .EQ. 0), THE CONSTANTS FB(IO), A3(IO), A4(IO),
                (XN(IO,J), J=1,...,4, IO=SET #+1), ARE APPLIED TO ALL
                STATIONS. IF (KEY2 .NE. 0), THE CONSTANTS FB(IO), ETC.,
                ARE APPLIED TO STATION KEY2; AND, PROVIDED THAT
                (KEY K .GT. 0, K=3,...,10), THE CONSTANTS ARE ALSO
                APPLIED TO STATION KEY K. THE VALUE OF XN TRANSMITTED
                TO TDRSS IS NORMALLY XN(IO,1). HOWEVER, THIS MAY BE
                CHANGED BY USE OF A CATEGORY 202 CARD.

          4.   CONSTANTS FB,A3,A4, AND XN ARE USED IN CONJUNCTION WITH
                MEASUREMENT TYPE 20, SATELLITE-TO-SATELLITE (OR REMOTE
                TRANSPONDER) DOPPLER OBSERVATION.

          5.   NOTE THAT DEFAULT VALUES ARE AUTOMATICALLY APPLIED TO
                THE STATIONS ONLY IN THE ABSENCE OF A CATEGORY 102
                CARD (KEY 1 = 13,14,15,... OR 19).

                EXAMPLE. STATIONS 1 AND 5 TO HAVE DEFAULT VALUES FOR
                         ALL CONSTANTS AND STATIONS 3 AND 4 DEFAULT
                         VALUES FOR FB,A3 AND A4, BUT XN(1) = 50000
                         AND XN(2) = 40000. THE FOLLOWING INPUT IS
                         THEN REQUIRED.

                              102 CARD, SET #=0, KEY1=13, DATA2=1.D0.
                              102 CARD, SET #=1, KEY1=16, KEY2=3, KEY3=4,
                                   DATA1=50000.
                              102 CARD, SET #=1, KEY1=17, KEY2=3, KEY3=4,
                                   DATA1=40000.

2.3   SPHERICAL HARMONICS AND MASCONS

        THE CATEGORY 103 CARDS CONTAIN INFORMATION RELATING
TO THE COEFFICIENTS OF THE SPHERICAL HARMONICS OF THE VARIOUS
BODIES FOR THE INTEGRATOR. ALL OF THESE CARDS ARE OPTIONAL,
BUT, IF USED, MUST PRECEDE THE FIRST CATEGORY 999 CARD.

        THE DEFAULT OPTIONS FOR BODIES 2, 3, AND 4 (EARTH,
MOON AND SUN) SHOULD BE STUDIED SO THAT THE APPROPRIATE CARDS
ARE ENTERED AS OVERRIDES (SEE APPENDIX II). NOTE THAT THE
SATELLITE (PROBE) IS FIXED AS BODY NUMBER 1.

2.3.1   CATEGORY 103

        THIS CARD IS USED (IN CONJUNCTION WITH THE CATEGORY
103, SETS 3, 4, 5, 6 AND 7 CARDS) TO ENABLE THE USER TO DE-
FINE THE SIZE OF THE C AND S MATRICES. C(N,M) AND S(N,M) ARE
THE EMPIRICALLY DETERMINED SPHERICAL HARMONIC COEFFICIENTS OF
THE POTENTIAL FUNCTION. THE DEFAULT VALUES FOR C AND S MAY BE
USED AS SPECIFIED IN APPENDIX II OR NEW VALUES MAY BE INPUT
WITH THE CATEGORY 103, SETS 6 AND 7 CARDS. ONLY THE ELEMENTS
FROM THE DIAGONAL DOWN (N.GT.M) NEED BE SPECIFIED, THERE
BEING NO SPHERICAL HARMONICS CORRESPONDING TO M.GT.N.   THE
MAXIMUM SIZE OF THE MATRICES FOR THE EARTH (BODY NUMBER 2) IS
16X16 AND FOR BODIES 3 THROUGH 10 IS 11X11.

COLUMN	NAME	DESCRIPTION OR VALUE
1- 3	CATEGORY #	103
4- 5	SET #	ZERO OR BLANK
6-13	LABEL	ANY 8 ALPHANUMERIC CHARACTERS (SEE APPENDIX II FOR THE APPROPRIATE LABEL)
14-16	KEY 1	BODY NUMBER ASSOCIATED WITH THIS DATA (SEE NOTE 2 ON THE FOLLOWING PAGE)
17-19	KEY 2	ATMOSPHERIC MODEL NUMBER (SEE NOTE 3 ON THE FOLLOWING PAGE)
20-22	KEY 3	NUMBER OF COLUMNS TO BE USED IN C (SEE NOTE 1 ON THE FOLLOWING PAGE)

COLUMN	NAME	DESCRIPTION OR VALUE

26-28	KEY 5	JPL BODY NUMBER (SEE NOTE 2)
		DEFAULT VALUES (APPLY IF KEY5 = 0):
		    0=SUN
		    1=MERCURY
		    2=VENUS
		    3=EARTH
		    4=MARS
		    5=JUPITER
		    6=SATURN
		    7=URANUS
		    8=NEPTUNE
		    9=PLUTO
		    10=MOON

32-34	KEY 7	IF POTENTIAL COEFFICIENTS ARE TO BE RECOVERED, THE VALUE OF THIS KEY IS THE SAME AS KEY 1

NOTES: 1.   VALUES GIVEN FOR C IN KEYS 3 AND 4 APPLY TO S.
THE NUMBER OF COLUMNS (KEY 3) IS EQUAL TO THE
COLUMN NUMBER M PLUS 1, SINCE THE C AND S
MATRICES ARE ORDERED FROM (0,0).

2.   THE BUILT-IN NAP BODY NUMBERS ARE AS FOLLOWS:

1=PROBE	4=SUN	7=JUPITER	10=NEPTUNE
2=EARTH	5=VENUS	8=SATURN	
3=MOON	6=MARS	9=URANUS	

THE JPL BODY NUMBERS ARE USED IN CONJUNCTION WITH THE
JPL EPHEMERIS TAPE. NOTE THAT ONLY NAP BODY 4 MAY HAVE
JPL NUMBER 0.

3.   ATMOSPHERIC

MODEL NO.	ATMOSPHERIC MODEL
1	VENUS MODEL ATMOSPHERE (NASA-X-625-70-203)
4	U.S. STANDARD ATMOSPHERE 1962
5	JACCHIA MODEL 35H ATMOSPHERE (1971)
7	MINIMUM MARS MODEL ATMOSPHERE (NASA SP8010)
8	MEAN MARS MODEL ATMOSPHERE (NASA SP8010)
9	MAXIMUM MODEL ATMOSPHERE (NASA SP8010)
-	A NEGATIVE ATMOSPHERIC MODEL NUMBER INDICATES A BOUNDED ATMOSPHERE. E.G., MODEL NUMBER -4 INDICATES THAT THE U.S. STANDARD ATMOSPHERE 1962 IS TO BE USED AND THAT THE ATMOSPHERE IS BOUNDED.

2.3.2   CATEGORY 103.   SET 1

        THIS CARD IS USED FOR (A) INPUT OF INFORMATION ASSOCIATED WITH
MASCONS AND (B) FOR MODIFYING BODY ROTATION RATE (SEE NOTE 1). A TOTAL
OF FIVE MASCONS IS ALLOWED FOR EACH BODY.

COLUMN	NAME	DESCRIPTION OR VALUE
1- 3	CATEGORY #	103
4- 5	SET #	1
6-13	LABEL	ANY 8 ALPHANUMERIC CHARACTERS
14-16	KEY 1	BODY NUMBER ASSOCIATED WITH THIS DATA
17-19	KEY 2	MASCON NUMBER (1-5). =0, BODY ROTATION RATE DEFINED IN DATA1.
20-22	KEY 3	FLAG FOR DEFINING DATA1 (1-4)
44-65	DATA1	VALUE ACCORDING TO KEY 2 OR KEY 3: KEY2=0: BODY ROTATION RATE (SEE NOTE 1). KEY3=1: GRAVITY CONSTANT OF MASCON IN SAME UNITS AS BODY GRAVITY CONSTANT. KEY3=2: RADIAL DISTANCE OF MASCON FROM CENTER OF BODY IN USER UNITS. KEY3=3: LATITUDE OF MASCON IN DEGREES. KEY3=4: LONGITUDE OF MASCON IN DEGREES.

NOTE.   1.   UNITS ARE RAD/SEC.   DEFAULT VALUES ARE

                    EARTH   .7292115854937 D-4
                    MOON   .2661699477 D-5
                    OTHER BODIES   0.D0

2.3.3   CATEGORY 103.   SET 2

        THIS CARD MODIFIES THE VALUE OF ECCENTRICITY-
SQUARED FOR THE SPECIFIED BODY.

COLUMN	NAME	DESCRIPTION OR VALUE
1- 3	CATEGORY #	103
4- 5	SET #	2
6-13	LABEL	ANY 8 ALPHANUMERIC CHARACTERS
14-16	KEY 1	BODY NUMBER ASSOCIATED WITH THIS DATA
17-19	KEY 2	=0, DATA1 IS ECC-SQUARED. =1, DATA1 IS 1/F, WHERE F IS THE FLATTENING.
44-65	DATA1	DEFAULT VALUE FOR THE EARTH. ECC**2 = 0.00669342162297, OR 1/F = 298.3. FOR OTHER BODIES ECC**2 = 0.D0.

2.3.4   CATEGORY 103.   SETS 3, 4, AND 5

        THESE CARDS MAY BE USED TO TRUNCATE THE BUILT-IN NAP GRAVITY
FIELDS AS GIVEN IN APPENDIX II.   THEY NEED NOT BE USED IF THE SIZE OF
THE FIELD IS BEING INCREASED.

        FOR EXAMPLE, IF THE USER WISHES TO TRUNCATE THE EARTH'S GRAVITY
FIELD TO 4X4, THE FOLLOWING INPUT WOULD BE REQUIRED:

            CATEGORY 103, SET 0,   KEY 1=2,   KEY 3=5

            CATEGORY 103, SET 3,   KEY 1=2,   KEY 2=5,   KEY 3=4,
                                   KEY 4=3,   KEY 5=2,   KEY 6=1.

        CATEGORY 103, SET 5 CARD HAS BEEN RESERVED FOR FUT-
URE EXPANSION OF THE SPHERICAL HARMONIC COEFFICIENT MATRICES.

SET 3

COLUMN   NAME   DESCRIPTION OR VALUE

  1- 3   CATEGORY #   103

  4- 5   SET #   3

  6-13   LABEL   ANY 8 ALPHANUMERIC CHARACTERS (NOT REQUIRED)

 14-16   KEY 1   BODY NUMBER ASSOCIATED WITH THIS DATA

THE FOLLOWING KEYS CONTAIN THE NUMBER OF ELEMENTS IN THE SPECIFIED
COLUMN OF THE C AND S MATRICES.

 17-19   KEY 2   COLUMN 0
 20-22   KEY 3   COLUMN 1
 23-25   KEY 4   COLUMN 2
 26-28   KEY 5   COLUMN 3
 29-31   KEY 6   COLUMN 4
 32-34   KEY 7   COLUMN 5
 35-37   KEY 8   COLUMN 6
 38-40   KEY 9   COLUMN 7
 41-43   KEY 10   COLUMN 8

SET 4

COLUMN	NAME	DESCRIPTION OR VALUE
1- 3	CATEGORY #	103
4- 5	SET #	4
6-13	LABEL	ANY 8 ALPHANUMERIC CHARACTERS (NOT REQUIRED)
14-16	KEY 1	BODY NUMBER ASSOCIATED WITH THIS DATA

THE FOLLOWING KEYS CONTAIN THE NUMBER OF ELEMENTS IN THE SPECIFIED
COLUMN OF THE C AND S MATRICES.

17-19	KEY 2	COLUMN 9
20-22	KEY 3	COLUMN 10
23-25	KEY 4	COLUMN 11
26-28	KEY 5	COLUMN 12
29-31	KEY 6	COLUMN 13
32-34	KEY 7	COLUMN 14
35-37	KEY 8	COLUMN 15

NOTE: 1.   THE ELEMENTS OF THE C AND S MATRICES ARE
             ORDERED FROM (0,0). THE USER MUST SPECIFY ON
             THESE CARDS THE TOTAL NUMBER OF ELEMENTS DE-
             SIRED FOR EACH COLUMN BEGINNING WITH THE DIAG-
             ONAL ELEMENT OF THAT COLUMN. APPENDIX II CON-
             TAINS DIAGRAMS FOR THE EARTH, MOON AND SUN
             SHOWING WHICH ELEMENTS ARE CURRENTLY USED IN
             EACH COLUMN.   FOR EXAMPLE:

             A. IF WE WISH TO USE IN COLUMN 0 THE DE-
                 FAULT VALUES FOR ELEMENTS 0 THROUGH 4,
                 WE SPECIFY KEY 2=5.

             B. IF WE WISH TO USE IN COLUMN 0 THE DE-
                 FAULT VALUES FOR ELEMENTS 0, 1, 2 AND 4
                 ONLY, WE STILL MUST SPECIFY KEY 2=5, DUE
                 TO THE MANNER IN WHICH THESE ARRAYS ARE
                 MOVED TO THE WORKING ARRAYS IN THE PRO-
                 GRAM. IN ADDITION, ELEMENT 3 OF COLUMN 0
                 MUST BE SET TO ZERO WITH A CATEGORY 103,
                 SET 6 CARD.

2.3.5   CATEGORY 103.   SETS 6 AND 7 -   MODIFYING THE ELE-
MENTS OF THE C AND
S MATRICES

        THESE CARDS ENABLE THE USER TO MODIFY THE ELEMENTS
OF THE SPHERICAL HARMONIC COEFFICIENT MATRICES. ONLY THE
LOWER DIAGONAL OF EACH MATRIX IS USED, I.E.,(N.GE.M). SUBS-
CRIPTING OF THE ELEMENTS BEGINS WITH (N,M) = (0,0) TO CORRES-
POND TO THE MATHEMATICAL NOTATION.

COLUMN	NAME	DESCRIPTION OR VALUE
1- 3	CATEGORY #	103
4- 5	SET #	6 OR 7 (SEE NOTE 1)
6-13	LABEL	ANY 8 ALPHANUMERIC CHARACTERS (NOT REQUIRED)
14-16	KEY 1	BODY NUMBER ASSOCIATED WITH THIS DATA
17-19	KEY 2	ROW NUMBER (N)
20-22	KEY 3	COLUMN NUMBER (M)
44-65	DATA1	COEFFICIENTS OF THE SPHERICAL HARMON-ICS FOR THE COSINE OR SINE TERM (N,M) OF THE POTENTIAL FUNCTION

NOTE: 1.   SET NUMBER 6 DEFINES THE COSINE TERM $C(N,M)$ AND
              SET 7 THE SINE TERM $S(N,M)$.

2.3.6   CATEGORY 103. SET 11   -   ATMOSPHERIC DATA

THESE CARDS PROVIDE THE USER WITH THE OPTION OF OVERRIDING
THE BUILT-IN STATIC ATMOSPHERIC MODELS FOR THE EARTH, MARS,
AND VENUS.

COLUMN	NAME	DESCRIPTION OR VALUE
1- 3	CATEGORY #	103
4- 5	SET #	11
6-13	LABEL	ANY 8 ALPHANUMERIC CHARACTERS (NOT REQUIRED)
14-16	KEY 1	NOT USED
17-19	KEY 2	MODEL NUMBER =1, FOR VENUS ATMOSPHERE =4, FOR EARTH ATMOSPHERE =9, FOR MARS ATMOSPHERE
20-22	KEY 3	ATMOSPHERIC SHELL NO. THE MAXIMUM NO. OF SHELLS IS 91, IF KEY2 = 1 60, IF KEY2 = 4 86, IF KEY2 = 9
44-65	DATA1	SHELL HEIGHT (KM)
66-80	DATA2	DENSITY (KG/KM**3)

2.4   PLANETARY INFORMATION

2.4.1   CATEGORY 104

        THIS CARD IS OPTIONAL, BUT, IF USED, MUST APPEAR
BEFORE THE FIRST CATEGORY 999 CARD. IT MAY, HOWEVER, BE USED
TO MODIFY THE SPECIFIED VALUES FOR SUBSEQUENT ARCS.

COLUMN	NAME	DEFAULT	DESCRIPTION OR VALUE
1- 3	CATEGORY #	NONE	104
4- 5	SET #	NONE	ZERO OR BLANK
6-13	LABEL	BLANK	ANY 8 ALPHANUMERIC CHARACTERS
17-19	KEY 2	0	PRECESSION/NUTATION FLAG (SEE NOTE 2 ON THE FOLLOW- ING PAGE)
20-22	KEY 3	0	KEY 3 AFFECTS SIMULATION RUNS ONLY. IF THE MAGNITUDE OF KEY 3 EXCEEDS 1, NO RANDOM MEASUREMENT NOISE IS GENER- ATED AND, PROVIDED THAT THE FILE ASSIGNED TO THE GENERATED SIMULATED DATA IS NOT A DUMMY, NEW PHOTONAP CARDS CORRESPONDING TO SATELLITE/ STATION VISIBILITIES WILL BE OUTPUT ON FILE 2 OF THE SIMULATED DATA FILE. IF KEY 3 IS NEGATIVE, SIMULATED MEAS- UREMENTS WILL NOT BE PRINTED.
23-25	KEY 4	0	IF (KEY 4 .GT. 0), FOR EACH MEASURE- MENT TYPE IN A PASS, THE DATA POINTS WILL BE COMPRESSED TO A SINGLE POINT (SEE NOTE 1 ON THE FOLLOWING PAGE).
26-28	KEY 5	0	IF (KEY 4 .GT. 0) AND (KEY 5 .GT. 0), FOR EACH MEASUREMENT TYPE IN A PASS, THE DATA POINTS WILL BE COMPRESSED TO TWO POINTS: (1) THE COMPRESSED DATA POINT ITSELF AND (2) ITS RATE OF CHANGE.
29-31	KEY 6	2(EARTH)	BODY NO. OF SOURCE OF OBSERVATIONS (SEE NOTE 3 ON THE FOLLOWING PAGE).
32-34	KEY 7	16	NUMBER OF TERMS IN X,Y,Z POWER SERIES
35-37	KEY 8	12	NUMBER OF TERMS IN POWER SERIES FOR VARIATIONAL EQUATIONS

(CONTINUED ON THE FOLLOWING PAGE)

COLUMN	NAME	DEFAULT	DESCRIPTION OR VALUE
38-40	KEY 9	3	K+1, WHERE K IS THE HIGHEST DEGREE OR ORDER OF THE SPHERICAL HARMONICS OF THE POTENTIAL USED IN THE COMPUTATION OF THE MATRIZANT (SEE NOTE 8).
41-43	KEY 10	0	IF (KEY 10 .GT. 0) VARIATIONAL EQUATIONS WILL ONLY INCLUDE EFFECT OF CENTRAL BODY.
44-65	DATA1	0	MAXIMUM INTEGRATION STEP-SIZE (SEE NOTE 7)
66-80	DATA2	5. D-15	TRUNCATION CONTROL

NOTES:

1. FOR DATA COMPRESSION, THE NUMBER OF MEASUREMENT TYPES PER PASS MUST NOT EXCEED 2 AND THE NUMBER OF MEASUREMENT POINTS PER PASS MUST NOT EXCEED 155.

2. THE FOLLOWING CODES INDICATE WHETHER OR NOT PRECESSION/NUTATION WILL BE APPLIED:
   - -1=DO NOT APPLY PRECESSION/NUTATION; DO NOT USE JPL TAPE
   - 0=APPLY PRECESSION/NUTATION; DO NOT USE JPL TAPE
   - 1=READ JPL TAPE AND APPLY PRECESSION/NUTATION.

3. THE BUILT-IN FOTONAP BODY NUMBERS ARE AS FOLLOWS:

2=EARTH	5=VENUS	8=SATURN	1=PROBE
3=MOON	6=MARS	9=URANUS	
4=SUN	7=JUPITER	10=NEPTUNE	

7. STEPSIZE WILL BE COMPUTED IF DATA1 IS INPUT AS ZERO.

8. IF K+1 IS THE INPUT NUMBER AND IF THE POTENTIAL IS DEFINED BY A SET OF COEFFICIENTS C(N,M) AND S(N,M), THEN, FOR THE COMPUTATIONS OF THE MATRIZANT, THE SET OF COEFFICIENTS IS RESTRICTED TO THE SET FOR WHICH N .LE. K AND M .LE. K.

2.4.2   CATEGORY 104.   SET 1

        USE OF THIS CARD IS OPTIONAL. THE TIME OF THE POSI-
TION AND VELOCITY OF THE SATELLITE (AS GIVEN IN CATEGORY 205
CARD) IS THE SAME AS THAT OF THE OTHER BODIES.

COLUMN	NAME	DESCRIPTION OR VALUE
1- 3	CATEGORY #	104
4- 5	SET #	1
6-13	LABEL	ANY 8 ALPHANUMERIC CHARACTERS (OPTIONAL)
17-19	KEY 2	FLAG FOR DATE OF BODY POSITIONS 0=JULIAN DAYS SINCE 1950 1=CALENDAR DATE

FOR KEY 2=0:

44-65	DATA1	JULIAN DAYS SINCE 1950
66-80	DATA2	SECONDS OF DAY

FOR KEY 2=1:

29-31	KEY 6	CALENDAR YEAR(E.G.,069)
32-34	KEY 7	MONTH
35-37	KEY 8	DAY
38-40	KEY 9	HOURS
41-43	KEY 10	MINUTES
44-65	DATA1	SECONDS

THIS CARD SPECIFIES THE NUMBER OF TERMS IN THE POWER SERIES FOR THE STATE VECTOR AND THE STATE TRANSITION MATRIX WHICH ARE DIRECTLY MODIFIED BY THE EFFECTS OF ATMOSPHERIC DRAG. ITS USE IS OPTIONAL, BUT ANY VALUES SET BY THIS CARD WILL REMAIN CONSTANT UNTIL OVERRIDDEN BY ANOTHER CATEGORY 104, SET 3 CARD.

COLUMN	NAME	DESCRIPTION OR VALUE
1- 3	CATEGORY #	104
4- 5	SET #	3
6-13	LABEL	ANY 8 ALPHANUMERIC CHARACTERS (NOT REQUIRED)
14-16	KEY 1	NUMBER OF TERMS IN X,Y,Z POWER SERIES FOR POSITION WITH DRAG
17-19	KEY 2	NUMBER OF TERMS IN POWER SERIES FOR VARIATIONAL EQUATIONS WITH DRAG

2.4.5   CATEGORY 104. SET 4-POSITION AND VELOCITY OF BODIES

        THIS CARD IS REQUIRED WHEN BODIES OTHER THAN THE
EARTH AND SATELLITE ARE INVOLVED IN THE SOLUTION. THIS INFOR-
MATION IS NEEDED FOR EACH ARC ONLY IF THE JPL EPHEMERIS TAPE
OPTION IS NOT UTILIZED.

COLUMN	NAME	DESCRIPTION OR VALUE
1- 3	CATEGORY #	104
4- 5	SET #	4
6-13	LABEL	ANY 8 ALPHANUMERIC CHARACTERS (NOT REQUIRED)
14-16	KEY 1	BODY NUMBER
17-19	KEY 2	FLAG INDICATING ELEMENT OF POSITION OR VELOCITY:

                                1=X
                                2=Y   POSITION
                                3=Z

                                4=XDOT
                                5=YDOT   VELOCITY
                                6=ZDOT

44-65	DATA1	VALUE OF POSITION OR VELOCITY ELEMENT (SEE NOTE 1)

NOTE: 1. THE POSITION/VELOCITY VECTOR FOR EACH BODY MUST
              BE INPUT IN AN INERTIAL FRAME OF REFERENCE AS
              FOLLOWS:

                (1) INERTIAL OF DATE IF NO PRECESSION/
                    NUTATION IS SPECIFIED;
                (2) MEAN EQUATOR AND EQUINOX OF 1950 IF
                    PRECESSION/NUTATION IS SPECIFIED.

              SEE KEY 2 OF CATEGORY 104, SET 0 TO SPECIFY
              PRECESSION/NUTATION AND USE OF JPL EPHEMERIS
              TAPE.

        USE OF THIS CARD IS OPTIONAL, ALLOWING THE USER TO
CHANGE THE VALUE OF THE RADIUS OF THE SPHERE OF INFLUENCE FOR
A PARTICULAR BODY (INCLUDING EARTH). THESE VALUES MAY BE
CHANGED FOR ANY ARC.

COLUMN	NAME	DESCRIPTION OR VALUE
1- 3	CATEGORY #	104
4- 5	SET #	5
6-13	LABEL	ANY 8 ALPHANUMERIC CHARACTERS (NOT REQUIRED)
14-16	KEY 1	BODY NUMBER
44-65	DATA1	RADIUS OF SPHERE OF INFLUENCE OF THE BODY

DEFAULT VALUES FOR DATA1:

BODY	CONSTANT (METERS)
EARTH	1063048. D3
MOON	76117.2 D3
SUN	1. D15

2.4.7   CATEGORY 104, SET 6-BODY RADIUS OF BODY

        THIS CARD IS USED IF IT IS DESIRED TO CHANGE THE
EQUATORIAL RADIUS OF ANY BODY. SEE NOTE 1.

COLUMN	NAME	DESCRIPTION OR VALUE
1- 3	CATEGORY #	104
4- 5	SET #	6
6-13	LABEL	ANY 8 ALPHANUMERIC CHARACTERS (NOT REQUIRED)
14-16	KEY 1	BODY NUMBER
44-65	DATA1	BODY EQUATORIAL RADIUS

DEFAULT VALUES FOR DATA1:

BODY	RADIUS (METERS)
SATELLITE (PROBE)	1.
MOON	1738090.
SUN	69565.D8
EARTH	6378.165 D3

NOTES: 1. THE EQUATORIAL RADIUS AS DEFINED ON THIS CARD IS USED BOTH
              FOR SCALING THE GRAVITATIONAL POTENTIAL AND FOR DEFINING
              THE SIZE OF THE BODY (USED IN COMPUTING STATION POSITIONS).
              IF IT IS DESIRED TO ALTER THE SIZE OF THE BODY WHICH IS
              THE SOURCE OF OBSERVATIONS WITHOUT CHANGING ITS GRAVITY
              FIELD, THEN THIS SHOULD BE DONE THROUGH A CATEGORY 102,
              SET 0 CARD.

2.4.8   CATEGORY 104. SET 7-GRAVITATIONAL CONSTANT OF BODY

USE OF THIS CARD IS OPTIONAL.

COLUMN	NAME	DESCRIPTION OR VALUE
1- 3	CATEGORY #	104
4- 5	SET #	7
6-13	LABEL	ANY 8 ALPHANUMERIC CHARACTERS (NOT REQUIRED)
14-16	KEY 1	BODY NUMBER
44-65	DATA1	GRAVITATIONAL CONSTANT OF THE BODY (NOMINAL UNITS ARE METERS CUBED/SEC. SQUARED)

DEFAULT VALUES FOR DATA1:

BODY	GRAVITATIONAL CONSTANT (METERS CUBED/SEC. SQUARED)
SATELLITE (PROBE)	0.
MOON	.4902778 D13
SUN	.132715445 D21
EARTH	.3986032 D15

2.4.9   CATEGORY 104, SET 8-ANGLE OF PRIME MERIDIAN AT
                            EPOCH

        THIS CARD IS OPTIONAL AND GIVES THE VALUE OF THE
ANGLE OF THE PRIME MERIDIAN AT EPOCH FOR BODIES OTHER THAN
THE EARTH. EARTH'S VALUE IS CHANGED BY THE CATEGORY 206 CARD.

COLUMN	NAME	DESCRIPTION OR VALUE
1- 3	CATEGORY #	104
4- 5	SET #	8
6-13	LABEL	ANY 8 ALPHANUMERIC CHARACTERS (NOT REQUIRED)
14-16	KEY 1	BODY NUMBER
44-65	DATA1	ANGLE OF PRIME MERIDIAN AT EPOCH (SEE NOTE 1)

NOTE: 1. DEFAULT VALUE OF THE ANGLE OF PRIME MERIDIAN AT
             EPOCH FOR ALL BODIES IS ZERO.

2.4.10   CATEGORY 104, SET 9-BODIES IN THE SOLUTION

THIS CARD IS REQUIRED IF IT IS DESIRED TO ALTER THE
USE OF PARTICULAR BODIES IN THE SOLUTION. THIS CARD MUST AP-
PEAR BEFORE THE FIRST CATEGORY 999 CARD. DEFAULT VALUES APPLY
ONLY IF THIS CARD IS OMITTED.

COLUMN	NAME	DEFAULT	DESCRIPTION OR VALUE
1- 3	CATEGORY #	NONE	104
4- 5	SET #	NONE	9
6-13	LABEL	BLANKS	ANY 8 ALPHANUMERIC CHAR-ACTERS (NOT REQUIRED)
14-16	KEY 1	1	EARTH IS IS SOLUTION. 0=NO, 1=YES
17-19	KEY 2	1	MOON IS IN SOLUTION. 0=NO, 1=YES
20-22	KEY 3	1	SUN IS IN SOLUTION. 0=NO, 1=YES
23-25	KEY 4	0	VENUS IS IN SOLUTION. 0=NO, 1=YES
26-28	KEY 5	0	MARS IS IN SOLUTION. 0=NO, 1=YES
29-31	KEY 6	0	JUPITER IS IN SOLUTION. 0=NO, 1=YES
32-34	KEY 7	0	SATURN IS IN SOLUTION. 0=NO, 1=YES
35-37	KEY 8	0	URANUS IS IN SOLUTION. 0=NO, 1=YES
38-40	KEY 9	0	NEPTUNE IS IN SOLUTION. 0=NO, 1=YES

        THIS CARD ALLOWS THE USER TO OBTAIN DEBUG PRINTOUT
FROM ANY MAJOR SEGMENT OF THE PROGRAM. IT IS RECOMMENDED THAT
THIS OPTION BE UTILIZED WITH A MINIMUM OF ARCS AND PASSES TO
AVOID AN EXCESSIVE AMOUNT OF PRINTOUT.

COLUMN	NAME	DEFAULT	DESCRIPTION OR VALUE
1- 3	CATEGORY #	NONE	105
4- 5	SET #	BLANKS	ZERO OR BLANKS
6-13	LABEL	BLANKS	ANY 8 ALPHANUMERIC CHARACTERS (NOT REQUIRED)
14-16	KEY 1	0	DEBUG PRINTOUT FROM DATA EDITING PROGRAM: 0=NO DEBUG PRINT 1=DEBUG PRINT
17-19	KEY 2	0	NOT USED
20-22	KEY 3	0	DEBUG PRINTOUT FROM PRTIALS ROUTINE: 0=NO DEBUG PRINT 1=MINIMUM DEBUG PRINT 2=MAXIMUM DEBUG PRINT
23-25	KEY 4	0	LAST ITERATION FOR WHICH DEBUG PRINTOUT WILL OCCUR IN PRTIALS
26-28	KEY 5	0	DEBUG PRINTOUT FROM SOLVER ROUTINE: 0=NO DEBUG PRINT 1=MINIMUM DEBUG PRINT 2=MAXIMUM DEBUG PRINT
29-31	KEY 6	0	LAST ITERATION FOR WHICH DEBUG PRINTOUT WILL OCCUR IN SOLVER
41-43	KEY 10	56	MXLIN - NUMBER OF LINES PER PRINTED PAGE. DEFAULT VALUE USED IF LESS THAN 56.

USE OF THIS CARD IS OPTIONAL, EXCEPT IN SIMULATION MODE
(SEE KEY 5). IT ENABLES THE USER TO OBTAIN PRINTOUT FROM THE
INTEGRATOR WHEN SPECIFIED CONDITIONS (AS DEFINED ON THIS CARD)
ARE MET. ADDITIONALLY, THE INTEGRATION PROCESS MAY BE TERMINATED
WHEN THESE CONDITIONS ARE MET.

COLUMN	NAME	DESCRIPTION OR VALUE
1- 3	CATEGORY #	105
4- 5	SET #	1
6-13	LABEL	ANY 8 ALPHANUMERIC CHARACTERS (NOT REQUIRED)
14-16	KEY 1	BODY NUMBER OF REFERENCE BODY (SEE KEYS 2,3,4)
17-19	KEY 2	= 0, NO PRINTOUT = POSITIVE, PRINT TIME WHEN PROBE IS AT PERICENTER OR APOCENTER OF REFERENCE BODY AND DISTANCE TO REFERENCE BODY = -1 OR -3, STOP AT PERICENTER = -2 OR -3, STOP AT APOCENTER
20-22	KEY 3	= 0, NO PRINTOUT = POSITIVE, PRINT TIME WHEN PROBE IS AT THE DISTANCE DEFINED ON DATA1 FROM THE REFERENCE BODY AND DISTANCE TO REFERENCE BODY = -1, STOP AT SPECIFIED DISTANCE
23-25	KEY 4	=0, NO PRINTOUT = POSITIVE, PRINT TIME WHEN PROBE VELOCITY (SPEED) RELATIVE TO REFERENCE BODY EQUALS VELOCITY DEFINED IN DATA2 AND RELATIVE PROBE VELOCITY = -1, STOP AT SPECIFIED VELOCITY
26-28	KEY 5	= 0, NO PRINTOUT = 1, PRINT TIME WHEN PROBE IS OCCULTED AS SEEN FROM THE SOURCE OF OBSERVATIONS. SIMULATED MEASUREMENTS ARE NOT COMPUTED WHEN THE PROBE IS OCCULTED. KEY 5 MUST BE SET TO 1 WHEN NAP IS USED IN A SIMULATION MODE.
44-65	DATA1	SEE KEY 3
66-80	DATA2	SEE KEY 4

2.5.2   CATEGORY 105, SET 2 - MATRIX INVERSION OPTIONS

COLUMN	NAME	DEFAULT	DESCRIPTION OR VALUE
1- 3	CATEGORY #		105
4- 5	SET #		2
6-13	LABEL	BLANK	ANY 8 ALPHANUMERIC CHARACTERS
14-16	KEY 1	0	=0, IF MATRIX IS SINGULAR, ELIMINATE ROW AND COLUMN. =1, IF MATRIX IS SINGULAR, OBTAIN MIN NORM SOLUTION.
17-19	KEY 2	SEE NOTE 2.	NUMBER OF SIGNIFICANT FIGURES USED TO TEST FOR SINGULARITY OF MATRIX (KEY2=0 IS IGNORED).
20-22	KEY 3	0	=1, PRINT CORRELATION MATRIX
23-25	KEY 4	0	=0, COMPUTE THE COVARIANCE ON EVERY ITERATION. =K, COMPUTE THE COVARIANCE ONLY AFTER ITERATION K. HOWEVER, IF K = MAXITER (CATEGORY 101, KEY1), THEN THE COVARIANCE WILL BE COMPUTED ON THE LAST ITERATION EVEN IF THIS IS LESS THAN K.
44-65	DATA1	0.	PRINT CORRELATION COEFFICIENTS EXCEEDING INPUT VALUE. NO CORRELATION COEFFICIENTS ARE PRINTED IF DATA1 IS ZERO OR NEGATIVE.
66-80	DATA2	0.	MIN NORM SOLUTION MULTIPLIER

NOTES   1. USE OF MIN NORM SOLUTION REQUIRES AT LEAST 2 ITERATIONS UNLESS MIN NORM SOLUTION MULTIPLIER IS KNOWN.

2. THE DEFAULT VALUE VARIES WITH THE WORD LENGTH OF EACH PARTICULAR COMPUTER. IT IS AS FOLLOWS:

IBM 360/370	14
UNIVAC 1108	14
CDC 6400	12

　　　　　　THIS CARD IS USED TO DEFINE FILES USED IN PROVIDING
A RESTART CAPABILITY TO THE USER. THE TOTALLY STABLE PARA-
METERS AND THE ASSOCIATED PREWEIGHTED NORMAL EQUATIONS ARE
READ FROM THE FILE INDICATED IN KEY 1 AND/OR ARE WRITTEN ON
THE FILE INDICATED IN KEY 2. THIS ENABLES THE USER TO ALLOW
NEW DATA TO CONTRIBUTE ITS EFFECTS TO THE RECOVERY OF THE
TOTALLY STABLE PARAMETERS WITHOUT HAVING TO RERUN THE COM-
PLETE REDUCTION.

COLUMN	NAME	DESCRIPTION OR VALUE
1- 3	CATEGORY #	106
4- 5	SET #	ZERO OR BLANKS
6-13	LABEL	ANY 8 ALPHANUMERIC CHARACTERS (NOT REQUIRED)
14-16	KEY 1	NUMBER OF THE FILE CONTAINING PRE-VIOUSLY SAVED DATA (SEE NOTE 1)
17-19	KEY 2	NUMBER OF FILE TO BE WRITTEN CONTAIN-ING DATA TO BE SAVED FOR LATER RUN (SEE NOTE 1)

NOTES:　　1.　THESE FILE NUMBERS MAY ASSUME ANY ONE OR TWO DIGIT VALUE
　　　　　　　　EXCEPT 5,6,7,15,16,17, AND 21 THROUGH 39. (IF KEY 1 = -1,
　　　　　　　INPUT TOTALLY STABLE PARAMETERS AND GROUNDPOINT COORDINATES
　　　　　　　ARE IGNORED, AND THE VAUES COMPUTED IN A PREVIOUS RUN AND
　　　　　　　STORED ON FILES 41 AND 40 WILL BE USED.

THE CATEGORY 150 CARDS ALLOW THE USER TO INPUT COMMENTS TO BE PRINTED. USE OF THESE CARDS IS OPTIONAL.

COMMENT CARD FLAG

THIS CARD INDICATES TO THE PROGRAM THAT COMMENT CARDS FOLLOW. IT IS REQUIRED TO PRECEDE THE COMMENTS.

COLUMN	NAME	DESCRIPTION OR VALUE
1- 3	CATEGORY #	150
4- 5	SET #	ZERO OR BLANK
6-13	LABEL	ANY 8 ALPHANUMERIC CHARACTERS (NOT USED)

SETS 1 - 10   -   GENERAL COMMENTS

THESE CARDS MUST BE PRECEDED BY THE CATEGORY 150, SET 0 CARD AND MUST BE TERMINATED BY THE CATEGORY 150, SET 99 CARD. A MAXIMUM OF 10 COMMENT CARDS ARE ALLOWED AND ARE PRINTED IN ASCENDING ORDER BY SET NUMBER. THESE COMMENTS ARE PRINTED IN THE INITIAL AND FINAL PRINTOUTS.

COLUMN	NAME	DESCRIPTION OR VALUE
1- 3	CATEGORY #	150
4- 5	SET #	1 THROUGH 10 (ANY OTHER NUMBERS WILL CAUSE THE CARD TO BE IGNORED.)
6-80	COMMENTS	ANY ALPHANUMERIC CHARACTERS (BLANKS USED HERE WILL GIVE A LINE SPACE.)

THIS CARD MUST FOLLOW ANY CATEGORY 150 COMMENT CARDS.
FAILURE TO USE THIS WILL CAUSE THE RUN TO BE TERMINATED.

COLUMN	NAME	DESCRIPTION OR VALUE
1- 3	CATEGORY #	150
4- 5	SET #	99
6-80	BLANKS	BLANKS

2.8   CATEGORY 151   -   PAGE TITLES

        THE CATEGORY 151 CARDS ARE OPTIONAL AND ARE USED TO
OVERRIDE THE DEFAULT PAGE TITLE OF

        ******** PHOTONAP ********

PAGE TITLE FLAG

        THIS CARD INDICATES THAT A COMMENT CARD CONTAINING
A PAGE TITLE FOLLOWS. IT IS REQUIRED TO PRECEDE THAT CARD.

COLUMN	NAME	DESCRIPTION OR VALUE
1- 3	CATEGORY #	151
4- 5	SET #	ZERO OR BLANK
6-13	LABEL	ANY 8 ALPHANUMERIC CHARACTERS (NOT USED)

PAGE TITLE

        THIS CARD CONTAINS THE PAGE TITLE TO BE PRINTED.
ONLY 1 CARD IS ALLOWED, CONSEQUENTLY, NO TERMINAL CARD IS
NECESSARY.

COLUMN	NAME	DESCRIPTION OR VALUE
1- 3	CATEGORY #	151
4- 5	SET #	1
6-80	COMMENTS	PAGE TITLE COMMENTS (ANY ALPHANUMERIC CHARACTERS)

COMMENTS WHICH ARE TO BE PRINTED FOR A PARTICULAR
PASS OF DATA ARE LOADED WITH THE CATEGORY 152 CARDS. USE OF
THESE CARDS IS OPTIONAL AND ONLY ONE SET PER PASS IS ALLOWED.

PASS PECULIAR COMMENT FLAG

THIS CARD IS REQUIRED TO PRECEDE ANY PASS PECULIAR
COMMENTS.

COLUMN	NAME	DESCRIPTION OR VALUE
1- 3	CATEGORY #	152
4- 5	SET #	ZERO OR BLANK
6-13	LABEL	ANY 8 ALPHANUMERIC CHARACTERS (NOT USED)

PASS PECULIAR COMMENTS

THESE CARDS MUST BE PRECEDED BY THE CATEGORY 152,
SET 0 CARD AND TERMINATED BY A CATEGORY 152, SET 99 CARD.
THERE IS NO LIMIT TO THE NUMBER OF THESE CARDS AND THE COM-
MENTS ARE PRINTED AS THEY ARE ENCOUNTERED IN THE DECK. IF KEY 10
OF CATEGORY 101 IS NONZERO, THESE COMMENTS WILL NOT BE PRINTED.

COLUMN	NAME	DESCRIPTION OR VALUE
1- 3	CATEGORY #	152
4- 5	SET #	ANY 2 DIGIT NUMBER EXCEPT 99 (NOT USED)
6-80	COMMENTS	PASS PECULIAR COMMENTS (ANY ALPHA-NUMERIC CHARACTERS)

TERMINATE PASS PECULIAR COMMENTS

THIS CARD MUST FOLLOW THE CATEGORY 152 PASS COM-
MENTS. FAILURE TO INCLUDE THIS WILL CAUSE THE ENTIRE CONTROL
DECK TO BE STORED AS COMMENTS AND THE RUN WILL BE TERMINATED.

COLUMN	NAME	DESCRIPTION OR VALUE
1- 3	CATEGORY #	152
4- 5	SET #	99
6-80	BLANKS	BLANKS

SECTION III

TIMING INFORMATION

CATEGORY 200

3.1   START AND STOP TIMES OF DATA INTERVALS

THE CATEGORY 201 AND 202 CARDS DEFINE THE SPANS OF
DATA TO BE PROCESSED. ANY NUMBER OF THESE SPANS MAY DEFINE A
PASS AND ANY NUMBER OF PASSES MAY DEFINE AN ARC, AS THE USER
DESIGNATES. WHEN A PASS CONSISTS OF MORE THAN ONE DATA INTER-
VAL, THE EARLIEST TIME DEFINES THE START TIME OF THE PASS AND
THE LATEST TIME DEFINES THE STOP TIME OF THE PASS.

THE TIME SPANNED BY AN ARC IS THE TIME OVER WHICH
THE STATE VECTOR IS INTEGRATED. THE INITIAL TIME OF THE ARC
IS DETERMINED FROM THE EARLIEST TIME OF ANY OF ITS PASSES AND
THE TERMINAL TIME OF THE ARC FROM THE LATEST TIME OF ANY OF
ITS PASSES. IT IS RECOMMENDED THAT THESE INTERVALS BE INPUT
IN ASCENDING ORDER OF TIME TO INCREASE PROGRAM EFFICIENCY
(SEE SECTION 8).

LOCATION OF THE TIME WORD ON THE MEASUREMENT DATA
FILE NEEDS TO BE DEFINED ONLY ONCE IF IT IS DIFFERENT FROM
THE DEFAULT VALUE.

THE SET NUMBERS FOR EACH SET OF CATEGORY 201 AND
202 CARDS SHOULD BE THE SAME. AT LEAST ONE SET OF THESE CARDS
IS REQUIRED FOR EACH PASS AND MUST PRECEDE THE CATEGORY 999
CARD TERMINATING THAT PASS.

3.1.1   CATEGORY 201 -   START TIME

COLUMN	NAME	DESCRIPTION
1- 3	CATEGORY #	201
4- 5	SET #	ANY NUMBER 0 THROUGH 99
6-13	LABEL	ANY 8 ALPHANUMERIC CHARACTERS (OPTIONAL)
14-16	KEY 1	ARC NUMBER
17-19	KEY 2	STATION NUMBER
20-22	KEY 3	PASS NUMBER
23-25	KEY 4	LOCATION OF TIME WORD OF MEASUREMENT DATA (SEE NOTE 1)
29-31	KEY 6	YEAR
32-34	KEY 7	MONTH
35-37	KEY 8	DAY
38-40	KEY 9	HOURS
41-43	KEY 10	MINUTES
44-65	DATA1	SECONDS

NOTES: 1.   TIME IS INPUT IN TWO WORDS, WORD ONE CONTAINING
                JULIAN DAYS SINCE 1950 AND WORD TWO CONTAINING
                SECONDS OF DAY. KEY 4 INDICATES THE POSITION OF
                THE JULIAN DAYS. THE DEFAULT VALUE IS THE FIRST
                FLOATING POINT WORD ON THE FILE.

3.1.2   CATEGORY 202 - STOP TIME

COLUMN	NAME	DESCRIPTION OR VALUE
1- 3	CATEGORY #	202
4- 5	SET #	SAME AS THAT OF THE CORRESPONDING CATEGORY 201 CARD
6-13	LABEL	ANY 8 ALPHANUMERIC CHARACTERS (OPTIONAL)
14-16	KEY 1	ARC NUMBER
17-19	KEY 2	STATION NUMBER
20-22	KEY 3	PASS NUMBER
23-25	KEY 4	NOT USED
26-28	KEY 5	NCC2 = RECORDING RATE DIGIT FOR TDRSS DATA (SEE NOTE 1)
29-31	KEY 6	YEAR
32-34	KEY 7	MONTH
35-37	KEY 8	DAY
38-40	KEY 9	HOURS
41-43	KEY 10	MINUTES
44-65	DATA1	SECONDS

NOTES.   1. NCC2 IS USED TO CHANGE THE VALUE OF XN TRANSMITTED TO TDRSS (OR GRARR). NCC2 MAY ASSUME THE VALUES 0,1,2,3,4.

NCC2=0. THE SAME VALUE OF XN AS WAS PREVIOUSLY SPECIFIED WILL BE TRANSMITTED TO TDRSS. IF NONE WAS PREVIOUSLY SPECIFIED, THE VALUE TRANSMITTED CORRESPONDS TO NCC2=1.

NCC2=1,2,3, OR 4. THE VALUE OF XN TRANSMITTED TO TDRSS IS XN(IO,NCC2). THE VALUE OF IO FOR THIS STATION MUST BE SPECIFIED ON A CATEGORY 102 CARD AS MUST THE VALUES OF THE ARRAY XN.

DEFAULT VALUES ARE TRANSMITTED ONLY IN THE ABSENCE OF 102 CARDS (KEY1 = 13 THRU 19).

THE USER MAY DESIRE TO PROCESS ONLY SELECTED INTER-
VALS OF DATA FOR A PARTICULAR MEASUREMENT, RATHER THAN ALL OF
THAT MEASUREMENT'S DATA AS DEFINED BY THE CATEGORY 201 AND
202 CARDS. THE FOLLOWING CATEGORY 203 AND 204 CARDS ALLOW THE
USER TO SPECIFY AS MANY AS 30 OF THESE SELECTED INTERVALS FOR
EACH PASS. THESE CATEGORY 203 AND 204 INTERVALS MUST BE WITH-
IN THE TIME SPANS ALLOCATED BY THE CATEGORY 201 AND 202 CARDS
AND ARE APPLICABLE ONLY TO THE PASS IN WHICH THEY ARE DE-
FINED. FOR THIS SPECIFIED MEASUREMENT, ONLY DATA WITHIN THE
TIME SPAN WILL BE USED.

FOR EXAMPLE, WE MAY HAVE DEFINED IN THE CATEGORY
201 AND 202 CARDS A SPAN OF DATA FROM TIME 1200 TO TIME 2200.
EARLIER WE HAVE INDICATED THAT WE WILL PROCESS RANGE, AZI-
MUTH, AND ELEVATION DATA (MEASUREMENT NUMBERS 1, 2, AND 3,
RESPECTIVELY). WE NOW WISH TO USE ONLY THE FOLLOWING SELECTED
INTERVALS OF RANGE DATA FOR THIS TIME SPAN:

```
INTERVAL 1  -   TIMES 1200 TO 1400
INTERVAL 2  -   TIMES 1600 TO 1640
INTERVAL 3  -   TIMES 1800 TO 2100.
```

WE NEED TO PREPARE A CATEGORY 203 AND 204 CARD FOR EACH OF
THESE SELECTED INTERVALS. WE WOULD NEED THE FOLLOWING CARDS:

CARD 1: CATEGORY 201 - START TIME FOR TOTAL SPAN = 1200

CARD 2: CATEGORY 202 - STOP TIME FOR TOTAL SPAN = 2200

CARD 3: CATEGORY 203 - START TIME FOR INTERVAL 1 = 1200

CARD 4: CATEGORY 204 - STOP TIME FOR INTERVAL 1 = 1400

CARD 5: CATEGORY 203 - START TIME FOR INTERVAL 2 = 1600

CARD 6: CATEGORY 204 - STOP TIME FOR INTERVAL 2 = 1640

CARD 7: CATEGORY 203 - START TIME FOR INTERVAL 3 = 1800

CARD 8: CATEGORY 204 - STOP TIME FOR INTERVAL 3 = 2100

3.2.1   CATEGORY 203   -   START TIME

COLUMN	NAME	DESCRIPTION OR VALUE
1- 3	CATEGORY #	203
4- 5	SET #	ANY NUMBER FROM 0 THROUGH 29
6-13	LABEL	ANY 8 ALPHANUMERIC CHARACTERS (OPTIONAL)
14-16	KEY 1	ARC NUMBER
17-19	KEY 2	STATION NUMBER
20-22	KEY 3	PASS NUMBER
23-25	KEY 4	MEASUREMENT NUMBER (SEE APPENDIX IV-A)
26-28	KEY 5	NOT USED
29-31	KEY 6	YEAR
32-34	KEY 7	MONTH
35-37	KEY 8	DAY
38-40	KEY 9	HOURS
41-43	KEY 10	MINUTES
44-65	DATA1	SECONDS

3.2.2   CATEGORY 204 - STOP TIME

COLUMN	NAME	DESCRIPTION OR VALUE
1- 3	CATEGORY #	204
4- 5	SET #	SAME AS THAT OF THE CORRESPONDING CATEGORY 203 CARD
6-13	LABEL	ANY 8 ALPHANUMERIC CHARACTERS (OPTIONAL)
14-16	KEY 1	ARC NUMBER
17-19	KEY 2	STATION NUMBER
20-22	KEY 3	PASS NUMBER
23-25	KEY 4	MEASUREMENT NUMBER (SEE APPENDIX IV-A)
26-28	KEY 5	NOT USED
29-31	KEY 6	YEAR
32-34	KEY 7	MONTH
35-37	KEY 8	DAY
38-40	KEY 9	HOURS
41-43	KEY 10	MINUTES
44-65	DATA1	SECONDS

3.3   CATEGORY 205 - STATE VECTOR

THIS CARD GIVES INFORMATION RELATING TO THE STATE
VECTOR (THE POSITION/VELOCITY VECTOR AT EPOCH FOR THE ARC).
IT IS REQUIRED FOR EACH ARC.

COLUMN	NAME	DESCRIPTION OR VALUE
1- 3	CATEGORY #	205
4- 5	SET #	ZERO OR BLANKS
6-13	LABEL	ARC IDENTIFICATION (ANY 8 ALPHA-NUMERIC CHARACTERS)
14-16	KEY 1	ARC NUMBER
17-19	KEY 2	DEFINITION OF THE STATE VECTOR AS INPUT IN CATEGORY 601 (SEE NOTE 1).

-1 = CARTESIAN, INERTIAL 1950
 0 = CARTESIAN, INERTIAL OF DATE
 1 = CARTESIAN, BODY FIXED
 9 = KEPLERIAN, INERTIAL 1950
10 = KEPLERIAN, INERTIAL OF DATE
11 = KEPLERIAN, INERTIAL OF DATE, EXCEPT THAT
      THE ARGUMENT OF THE ASCENDING NODE (CAP.
      OMEGA) IS BODY FIXED.

COLUMN	NAME	DESCRIPTION OR VALUE
20-22	KEY 3	ARC DEFINITION:

0=PRIMARY ARC
1=SECONDARY ARC

COLUMN	NAME	DESCRIPTION OR VALUE
23-25	KEY 4	BODY NUMBER ACTING AS ORIGIN FOR THE STATE VECTOR (SEE NOTE 2)
26-28	KEY 5	NOT USED
29-31	KEY 6	YEAR
32-34	KEY 7	MONTH
35-37	KEY 8	DAY
38-40	KEY 9	HOURS
41-43	KEY 10	MINUTES
44-65	DATA1	SECONDS
66-80	DATA2	TIME DIFFERENCE FROM UT1 TO EPHEMERIS TIME (SECONDS)

NOTES. 1. THE CARTESIAN STATE VECTOR HAS COMPONENTS (X,Y,Z,XD,YD,ZD).
THE KEPLERIAN STATE VECTOR HAS COMPONENTS (A,E,I,CAP.OMEGA,
LOWER CASE OMEGA, MEAN ANOMALY). ALL ANGLES ARE TO BE
INPUT IN DEGREES. FOR DEFINITION OF COORDINATE SYSTEMS,
SEE REFERENCE (1).

2. PHOTONAP BODY NUMBERS
    2=EARTH   5=VENUS   8=SATURN
    3=MOON   6=MARS   9=URANUS
    4=SUN   7=JUPITER 10=NEPTUNE

3. THIS CARD MUST PRECEDE THE FIRST CATEGORY 201 CARD
FOR THE DEFINED ARC.

3.3.1   CATEGORY 205. SET 1 - COVARIANCE PROPAGATION

COLUMN	NAME	DESCRIPTION OR VALUE
1- 3	CATEGORY #	205
4- 5	SET #	1
6-13	LABEL	ANY 8 ALPHANUMERIC CHARACTERS (NOT REQUIRED)
14-16	KEY 1	ARC NUMBER
44-65	DATA1	DELTA TIME FOR COVARIANCE PROPAGATION

3.3.2   CATEGORY 205. SET 2 -   SPECIFIC TIMES FOR COVARI-
                                    ANCE PROPAGATION

        ONE CARD WILL BE USED FOR EACH SPECIFIC TIME FOR
COVARIANCE PROPAGATION. KEY 2 SHOULD CONTAIN THE NUMBER OF
THE TIME; THAT IS, FOR THREE SPECIFIC TIMES, THERE WILL BE
THREE CATEGORY 205, SET 2 CARDS WITH KEY 2 VARYING FROM ONE
TO THREE.

COLUMN	NAME	DESCRIPTION OR VALUE
1- 3	CATEGORY #	205
4- 5	SET #	2
6-13	LABEL	ANY 8 ALPHANUMERIC CHARACTERS (NOT REQUIRED)
14-16	KEY 1	ARC NUMBER
17-19	KEY 2	NUMBER OF THE SPECIFIC TIME (I.E., J=1,N, WHERE N IS THE TOTAL NUMBER OF SPECIFIC TIMES).
44-65	DATA1	DESIRED TIME (IN SECONDS FROM EPOCH) OF STATE COVARIANCE PRINTOUT.

USE OF THIS CARD IS OPTIONAL. IF OMITTED, THE
GREENWICH HOUR ANGLE WILL BE COMPUTED IN THE PROGRAM.

COLUMN	NAME	DESCRIPTION OR VALUE	
1- 3	CATEGORY #	206	
4- 5	SET #	ZERO OR BLANKS	
6-13	LABEL	ANY 8 ALPHANUMERIC CHARACTERS (OPTIONAL)	
14-16	KEY 1	ARC NUMBER	
38-40	KEY 9	HOURS	GHA AT ZERO HOURS
41-43	KEY 10	MINUTES	OF DAY OF EPOCH
44-65	DATA1	SEC	(SEE NOTE 1)

NOTE: 1.   THE VALUE OF THIS ANGLE MAY BE MADE NEAR ZERO
              BY USING A SMALL VALUE FOR DATA1. EXAMPLE: KEYS
              9 AND 10 = 0, DATA1 = 1. D-20. IF 0 IS USED,
              THE GHA WILL BE COMPUTED IN THE PROGRAM.

3.5   CATEGORY 207 - POLAR MOTION CORRECTIONS

        POLAR MOTION CORRECTIONS MAY BE APPLIED IN AN ARC
WITH THIS CARD. ITS USE IS OPTIONAL, BUT IF USED, IT MUST BE
DEFINED FOR EVERY APPLICABLE ARC. THE CORRECTIONS ARE APPLIED
TO ALL STATIONS TRACKING IN THE ARC.

COLUMN	NAME	DESCRIPTION OR VALUE
1- 3	CATEGORY #	207
4- 5	SET #	ZERO OR BLANKS
6-13	LABEL	EIGHT ALPHANUMERIC CHARACTERS (OPTIONAL)
14-16	KEY 1	ARC NUMBER
44-65	DATA1	X-ANGLE (SEE NOTE 1)
66-80	DATA2	Y-ANGLE (SEE NOTE 1)

NOTE: 1. DATA1 AND DATA2 ARE THE ANGULAR DISPLACEMENTS
              (IN SECONDS OF ARC) IN THE X AND Y DIRECTIONS
              OF THE INSTANTANEOUS POLE FROM THE MEAN POLE OF
              1903 AS GIVEN BY THE INTERNATIONAL POLAR MOTION
              SERVICE.

3.6   CATEGORY 208 - THRUSTING TIMES

CATEGORY 208 CARDS DEFINE THE OCCURRENCE OF DIS-
CRETE AND CONTINUOUS THRUSTS (BURNS). THEIR USE IS OPTIONAL
FOR EACH ARC. CATEGORY 208, SET 1 IS USED IN CONJUNCTION
WITH SET 0 TO SPECIFY TIMES OF CONTINUOUS THRUSTS AND ASSOCI-
ATED CONSTANTS. ONE CONTINUOUS BURN IS ALLOWED PER ARC.

COLUMN	NAME	DESCRIPTION OR VALUE
1- 3	CATEGORY #	208
4- 5	SET #	ZERO OR BLANK
6-13	LABEL	ANY 8 ALPHANUMERIC CHARACTERS
14-16	KEY 1	BURN NUMBER (1-10) FOR DISCRETE BURNS
17-19	KEY 2	GUIDANCE MODE FOR THRUST (FOR INPUT OF ACTUAL VALUES SEE CATEGORY 603 CARD)

    1=CHANGE IN COMPONENT OF INERTIAL VELOCITY
       VECTOR (FOR DISCRETE THRUSTS), DXDOT, DYDOT,
       DZDOT.
    2=CHANGE IN DIRECTION AND MAGNITUDE OF
       VELOCITY VECTOR INCREMENT (FOR DISCRETE
       THRUSTS). FOR DEFINITION OF DIRECTION SEE
       NOTE 2.
    3=COMPONENTS OF CONTINUOUS THRUST,
       $T(X), T(Y), T(Z)$.

COLUMN	NAME	DESCRIPTION OR VALUE
29-31	KEY 6	YEAR
32-34	KEY 7	MONTH (SEE NOTE 1)
35-37	KEY 8	DAY
38-40	KEY 9	HOURS
41-43	KEY 10	MINUTES (SEE NOTE 1)
44-65	DATA1	SECONDS
66-80	DATA2	INITIAL MASS AT ABOVE TIME FOR CON-TINUOUS BURN ONLY

(SEE NOTES ON THE FOLLOWING PAGE)

NOTE: 1. FOR CONTINUOUS THRUSTS, DATE AND TIME ARE THE
            INITIAL TIME OF THE BURN. CATEGORY 208, SET 1
            DEFINES THE TERMINAL TIME.

        2. THE THREE COMPONENTS FOR GUIDANCE MODE 2 ARE ALPHA, BETA,
            AND DVEL, WHERE ALPHA AND BETA ARE ANGLES (INPUT IN
            DEGREES) AND DVEL IS THE MAGNITUDE OF THE VELOCITY
            INCREMENT. ALPHA IS THE ANGLE BETWEEN THE VELOCITY
            INCREMENT AND THE TANGENT PLANE AT THE SATELLITE. BETA
            IS THE ANGLE BETWEEN THE PROJECTION OF THE VELOCITY
            INCREMENT ON THE TANGENT PLANE AND THE PLANE OF THE FLIGHT
            PATH. (THE TANGENT PLANE IS THE PLANE TANGENT TO THE
            SPHERE, WHOSE CENTER IS THE EARTH'S CENTER AND WHOSE RADIUS
            EQUALS THE SATELLITE RADIUS VECTOR. THE PLANE OF THE
            FLIGHT PATH CONTAINS THE SATELLITE POSITION AND VELOCITY
            VECTORS. VIEWED FROM ABOVE THE TANGENT PLANE, BETA IS
            MEASURED POSITIVELY CLOCKWISE.)

3.6.1   CATEGORY 208, SET 1

        THIS CARD IS USED IN CONJUNCTION WITH THE CATEGORY
208, SET 0 CARD TO SPECIFY CONTINUOUS THRUSTING TIMES AND
CONSTANTS.

COLUMN	NAME	DESCRIPTION OR VALUE	
1- 3	CATEGORY #	208	
4- 5	SET #	1	
6-13	LABEL	ANY 8 ALPHANUMERIC CHARACTERS	
14-16	KEY 1	1	
29-31	KEY 6	YEAR	TERMINAL DATE
32-34	KEY 7	MONTH	OF CONTINUOUS
35-37	KEY 8	DAY	BURN
38-40	KEY 9	HOURS	TERMINAL TIME
41-43	KEY 10	MINUTES	OF CONTINUOUS
44-65	DATA1	SECONDS	BURN
66-80	DATA2	MASS FLOW RATE (POSITIVE)	

3.9   CATEGORY 211 - ET MINUS UTC TIME DIFFERENCES

211

COLUMN	NAME	DESCRIPTION OR VALUE
1- 3	CATEGORY #	211
4- 5	SET #	SEE NOTE 1.
6-13	LABEL	NOT USED
14-28	KEYS 1-5	NOT USED
29-31	KEY 6	YEAR
32-34	KEY 7	MONTH
35-37	KEY 8	DAY
38-40	KEY 9	HOURS
41-43	KEY 10	MINUTES
44-65	DATA1	SECONDS
66-80	DATA2	EPHEMERIS TIME MINUS UTC IN SECONDS

NOTE.   1. FOR EACH ARC UP TO 20 ENTRIES OF TIME DIFFERENCES ARE
ALLOWED. EACH ENTRY IS ASSOCIATED WITH A SET NUMBER.
SET NUMBERS MAY RANGE FROM 0 TO 19.

THE ENTRIES ARE NOT DESTROYED AT THE CONCLUSION OF AN
ARC (CATEGORY 999, KEY4=2). HOWEVER, FRESH ENTRIES ARE
ACCEPTED FOR A NEW ARC.

THE SET NUMBER FOR AN EARLIER TIME (KEYS 6 THROUGH
DATA1) NEED NOT BE SMALLER THAN FOR A LATER TIME, BUT,
IF THE TIMES ARE EQUAL (AS THEY WOULD BE WHEN THE UTC
CLOCK IS STEPPED), THEN THE TIME DIFFERENCE ASSOCIATED
WITH THE SMALLER SET NUMBER IS APPLIED TO THE TIME PRIOR
TO THE UTC CLOCK ADJUSTMENT AND THE TIME DIFFERENCE
ASSOCIATED WITH THE LARGER SET NUMBER IS APPLIED TO THE
TIME AFTER THE UTC CLOCK ADJUSTMENT.

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COLUMN	NAME	DESCRIPTION OR VALUE
1- 3	CATEGORY #	212
4- 5	SET #	SEE NOTE 1 OF CATEGORY 211 CARD.
6-13	LABEL	NOT USED
14-16	KEY 1	= 0, NO DEBUG PRINT = 1, GHA DEBUG = 2, TIMETABLE DEBUG = 3, TIMETABLE DEBUG AND GHA DEBUG
17-28	KEYS 2-5	NOT USED
29-31	KEY 6	YEAR
32-34	KEY 7	MONTH
35-37	KEY 8	DAY
38-40	KEY 9	HOURS
41-43	KEY 10	MINUTES
44-65	DATA1	SECONDS
66-80	DATA2	UT1 MINUS UTC IN SECONDS

3.11   CATEGORY 220 - TRANSPONDER DELAYS FOR MEASUREMENT TYPE 19

COLUMN	NAME	DESCRIPTION OR VALUE	
1- 3	CATEGORY #	220	
4- 5	SET #	0 OR 1 (SEE DATA1/DATA2)	
6-13	LABEL	ANY 8 ALPHANUMERIC CHARACTERS.	
14-16	KEY 1	MICROSECONDS -	TRANSPONDER DELAY AT HIGH
17-19	KEY 2	NANOSECONDS -	(ATS) SATELLITE FOR GROUND RECEIVED SIGNAL.
20-22	KEY 3	MICROSECONDS -	TRANSPONDER DELAY AT HIGH
23-25	KEY 4	NANOSECONDS -	(ATS) SATELLITE FOR SIGNAL RECEIVED FROM USER SATELLITE.
26-28	KEY 5	MICROSECONDS -	TRANSPONDER DELAY AT STATION
29-31	KEY 6	NANOSECONDS -	(KEY 9) FOR SIGNAL RECEIVED FROM HIGH (ATS) SATELLITE.
32-34	KEY 7	MICROSECONDS -	TRANSPONDER DELAY AT STATION
35-37	KEY 8	NANOSECONDS -	(KEY 10) FOR SIGNAL RECEIVED FROM HIGH (ATS) SATELLITE.
38-40	KEY 9	STATION NUMBER (0=USER SAT.) TO WHICH THE TRANSPONDER DELAY (KEYS 5,6) IS REFERRED. FOR SET #1, IT IS ALSO THE STATION NUMBER TO WHICH THE DELAY RATE IS REFERRED.	
41-43	KEY 10	STATION NUMBER (0=USER SAT) TO WHICH DELAY AND DELAY RATE (FOR SET NO. 1) ARE REFERRED (SEE KEYS 7,8).	
44-65	DATA1	DATA1 AND DATA2 ARE TRANSPONDER DELAY RATES WITH	
66-80	DATA2	RESPECT TO FRACTIONAL OFFSETS IN THE RECEIVED FREQUENCIES.	

                        DATA1.   SET NO. 0 - ATS FROM GROUND
                                  SET NO. 1 - USER FROM ATS (FOR USER
                                              SEE KEY 9)

                        DATA2.   SET NO. 0 - ATS FROM USER
                                  SET NO. 1 - USER FROM ATS (FOR USER
                                              SEE KEY 10)

NOTES.   ZERO DELAYS AND DELAY RATES ARE IGNORED, I.E., ZERO
              ENTRIES DO NOT OVERRIDE PREVIOUSLY ENTERED VALUES.

              DELAYS MAY BE INPUT ON A PASS BY PASS BASIS.

              DELAYS MAY BE STORED FOR A MAXIMUM OF 18 STATIONS AND
              THERE IS NO RESTRICTION ON STATION NUMBER VALUES.

CATEGORY 230 - TIMES FOR CHANGES IN DRAG COEFFICIENTS

COLUMN	NAME	DESCRIPTION OR VALUE
1- 3	CATEGORY #	230
4- 5	SET #	ZERO OR BLANK
6-13	LABEL	ANY 8 ALPHANUMERIC CHARACTERS
20-22	KEY 3	NDRG - 1
29-31	KEY 6	YEAR
32-34	KEY 7	MONTH
35-37	KEY 8	DAY
38-40	KEY 9	HOURS
41-43	KEY 10	MINUTES
44-65	DATA1	SECONDS

NOTES: 1. EACH DRAG COEFFICIENT IS ASSOCIATED WITH A DRAG SEGMENT. THE DRAG SEGMENTS (NDRG) MUST BE NUMBERED SEQUENTIALLY. IF E.G. KEY 3=1, THE SATELLITE MOVES FROM DRAG SEGMENT 1 TO DRAG SEGMENT 2 AT THE INDICATED TIME. THE VALUE OF THE DRAG COEFFICIENT FOR EACH SEGMENT IS INPUT ON A 601 CARD. (SEE NOTE 13 OF CATEGORY 601 CARD)

2. DRAG SEGMENTATION IS QUITE INDEPENDENT OF THE EPOCH.

SECTION IV

STATION SURVEYS

CATEGORY 300

THE CATEGORY 300 CARDS CONTAIN THE SURVEY INFORMATION FOR THE TRACKING STATIONS. THESE CARDS ARE REQUIRED FOR EACH STATION IN THE REDUCTION, BUT NEED APPEAR ONLY ONCE. STATION LOCATIONS ON THE EQUATOR AND GREENWICH PRIME MERIDIAN ARE VALID. THE CATEGORY 301 CARD MAY ALSO BE USED TO SPECIFY THAT THE OBSERVING STATION IS THE SATELLITE ITSELF AS IS DONE WITH PHOTOGRAMMETRIC MEASUREMENTS.

4.1   CATEGORY 301   -   GEODETIC LATITUDE OF STATION

COLUMN	NAME	DESCRIPTION OR VALUE
1- 3	CATEGORY #	301
4- 5	SET #	ZERO OR BLANKS
6-13	LABEL	STATION NAME-ANY 8 ALPHANUMERIC CHAR-ACTERS
14-16	KEY 1	STATION NUMBER
17-19	KEY 2	SURVEY IDENTIFICATION NUMBER FROM APPENDIX III-A
20-22	KEY 3	HIGH ORDER DIGITS STATION ID NO.
23-25	KEY 4	LOW ORDER DIGITS (SEE NOTE 1)
26-28	KEY 5	HIGH ORDER DIGITS NUMBER OF GROUND POINTS
29-31	KEY 6	LOW ORDER DIGITS (SEE NOTE 2)
35-37	KEY 8	SIGN OF LATITUDE: 0=NORTHERN HEMISPHERE -1=SOUTHERN HEMISPHERE
38-40	KEY 9	DEGREES
41-43	KEY 10	MINUTES LATITUDE
44-65	DATA1	SECONDS

5.5   CATEGORY 606   -   MASCON RECOVERY   606

NOTES. 1. KEYS 3 AND 4 CONTAIN THE STATION IDENTIFICATION NUMBER TO BE CORRELATED WITH THE MEASUREMENT DATA ON TAPE OR CARDS. FOR PHOTOGRAMMETRIC DATA KEY 3 = -1.

2. KEYS 5&6 ARE USED ONLY IN CONJUNCTION WITH PHOTOGRAM-METRIC DATA. KEY5 * 1000 + KEY6 = NUMBER OF GROUND POINTS.

3. IF THE STATION SPECIFIED ON THIS CARD IS THE SATELLITE (AS IN PHOTOGRAMMETRY), THEN ONLY KEYS 1,3,5, AND 6 ARE REQUIRED.

4.2   CATEGORY 302 - STATION LONGITUDE

COLUMN   NAME   DESCRIPTION OR VALUE

1- 3   CATEGORY #   302

4- 5   SET #   ZERO OR BLANKS

6-13   LABEL   ANY 8 ALPHANUMERIC CHARACTERS (NOT USED BY
                          PROGRAM; FOR USER IDENTIFICATION ONLY)

14-16   KEY 1   STATION NUMBER (SAME AS IN CATEGORY 301 CARD)

35-37   KEY 8   SIGN OF LONGITUDE:
                             0=EAST OF PRIME MERIDIAN
                            -1=WEST OF PRIME MERIDIAN

38-40   KEY 9   DEGREES
41-43   KEY 10   MINUTES   LONGITUDE
44-65   DATA1   SECONDS

4.3   CATEGORY 303 - STATION HEIGHT

COLUMN   NAME   DESCRIPTION OR VALUE

1- 3   CATEGORY #   303

4- 5   SET #   ZERO OR BLANK

6-13   LABEL   ANY 8 ALPHANUMERIC CHARACTERS (NOT USED BY
                          PROGRAM; FOR USER IDENTIFICATION ONLY)

14-16   KEY 1   STATION NUMBER (SAME AS IN CATEGORY 301 CARD)

44-65   DATA1   HEIGHT ABOVE THE REFERENCE ELLIPSOID (SAME
                          UNITS AS THE EARTH CONSTANTS)

SECTION V

ERROR MODEL TERMS

CATEGORY 600

THIS SECTION DEFINES THE STATE VECTOR AND THE ERROR MODEL TERMS (EMT) TO BE RECOVERED IN THE REDUCTION. FOR A DISCUSSION OF ERROR MODEL TERMS, SEE APPENDIX IV. DEFINED WITH THE CATEGORY 600 SERIES WILL BE THE VARIABLES RELATED TO THE INTEGRATION SCHEME.

5.1   CATEGORY 601 - STATE VECTOR AND ERROR MODEL TERMS

THE CATEGORY 601 CARDS ARE REQUIRED TO DEFINE THE STATE VECTOR (INITIAL POSITION AND VELOCITY OF THE TRAJEC-TORY) AND ANY OTHER ERROR MODEL TERMS THE USER MAY WISH TO RECOVER.

THE STATE VECTOR IS EITHER TOTALLY STABLE OR ARC STABLE, WHEREAS ANY OTHER ERROR MODEL TERMS MAY BE TOTALLY, ARC, OR PASS STABLE. (REFER TO SECTION 1.3 FOR DEFINITIONS OF THESE TERMS).

EVALUATION FLAGS ARE USED TO INDICATE HOW THE EMT IS TO BE USED IN THE REDUCTION (KEY 8). AN EVALUATION FLAG OF

0   INDICATES THAT THE EMT IS EVALUATED AND CONTRI-BUTES TO THE SOLUTION OF THE NORMAL EQUATIONS; I.E., RECOVER AN ESTIMATED VALUE FOR THE EMT;

1   INDICATES THAT ONLY THE A PRIORI ESTIMATE OF THE EMT IS USED TO CONTRIBUTE TO THE SOLUTION OF THE NORMAL EQUATIONS;

2   INDICATES THAT THE EMT DOES NOT CONTRIBUTE TO THE SOLUTION OF THE NORMAL EQUATIONS, BUT ONLY TO THE EVALUATION OF THE MEASUREMENT DISCREP-ANCY.

COLUMN	NAME	DESCRIPTION
1- 3	CATEGORY #	601
4- 5	SET #	USED ONLY IF THE PARAMETER NUMBER EXCEEDS 999. (SEE NOTE 2)
6-13	LABEL	ANY 8 ALPHANUMERIC CHARACTERS (THIS IDENTIFIES THE EMT IN PRINTOUT)
14-16	KEY 1	ARC NUMBER (SEE NOTE 8 ON THE FOLLOWING PAGE)
17-19	KEY 2	STATION NUMBER (NOT REQUIRED FOR TO-TALLY OR ARC STABLE PARAMETERS)
20-22	KEY 3	PASS NUMBER (NOT REQUIRED FOR TOTALLY OR ARC STABLE PARAMETERS)
23-25	KEY 4	STABILITY FLAG (SEE NOTE 5 ON THE FOLLOWING PAGE): 1=TOTALLY STABLE 2=ARC STABLE 3=PASS STABLE
26-28	KEY 5	EMT NUMBER (SEE APPENDIX IV-B AND NOTE 12)
29-31	KEY 6	MEASUREMENT NUMBER (SEE NOTE 1 ON THE FOLLOWING PAGE)
32-34	KEY 7	PARAMETER NUMBER ASSIGNED BY USER TO EMT'S WITH EVALUATION OF 0 OR 1 (SEE NOTE 2 ON THE FOLLOWING PAGE)
35-37	KEY 8	EVALUATION FLAG OF 0, 1, OR 2 (SEE TEXT ON THE PRECEDING PAGE AND NOTE 3 ON THE FOLLOWING PAGE)
38-40	KEY 9	ARC DEFINITION (SEE NOTE 12) 0=PRIMARY ARC 1=SECONDARY ARC
41-43	KEY 10	SEE NOTES 10 AND 12
44-65	DATA1	A PRIORI ESTIMATE OF EMT (SEE NOTES 6 AND 7 ON THE FOLLOWING PAGE)
66-80	DATA2	A PRIORI SIGMA OF EMT (SEE NOTE 4 ON THE FOLLOWING PAGE)

NOTES: 1. A NUMBER .LE. 300 ASSIGNED BY THE USER TO COR-
              RELATE DATA IN VARIOUS CATEGORIES PERTAINING TO
              A PARTICULAR MEASUREMENT (NOT REQUIRED FOR SOLAR
              PRESSURE, DRAG, OR PRIMARY ARC STATE VECTOR).

          2. THE SET NUMBER IS USED AS A CONTINUATION OF KEY 7.
              PARAMETER NUMBERS EXCEEDING 999 ARE SPECIFIED BY
              1000 * SET # + KEY 7.

              IT IS RECOMMENDED THAT TOTALLY STABLE PARAMETERS BE
              ASSIGNED CONSECUTIVE PARAMETER NUMBERS STARTING WITH
              NUMBER 1. SIMILARLY, FOR EACH ARC (PASS) IT IS
              RECOMMENDED THAT THE ARC(PASS)/STABLE PARAMETERS
              BE ASSIGNED CONSECUTIVE PARAMETER NUMBERS STARTING
              WITH NUMBER 1. HOWEVER, IF POTENTIAL IS BEING
              RECOVERED, THEN A GAP (EQUAL TO THE NUMBER OF POTEN-
              TIAL TERMS BEING RECOVERED) SHOULD BE LEFT IN THE
              NUMBERING OF THE TOTALLY STABLE PARAMETERS BETWEEN THE
              TWO '601' CARDS SEPARATED BY THE FIRST '201' CARD.
              (THIS OBVIOUSLY APPLIES ONLY WHEN THE '601' CARDS ARE
              SO ARRANGED.)

              THE PRESENT VERSION OF FOTONAP IS RESTRICTED TO 7000
              TOTALLY STABLE, 83 ARC STABLE, AND 83 PASS STABLE
              PARAMETERS. (THERE IS NO LIMIT ON THE NUMBER OF
              GROUND-POINTS.)

          3. PARAMETERS INITIALLY DEFINED AS EVALUATION TYPE
              1 ARE UPDATED TO EVALUATION TYPE 0 WHEN NUMBER
              OF ITERATIONS SPECIFIED BY KEY 8 OF CATEGORY
              101 IS REACHED.

          4. CALCULATED PARAMETER VALUES REPLACE THE A PRIORI
              VALUES WHEN NUMBER OF ITERATIONS SPECIFIED BY
              KEY 7 OF CATEGORY 101 IS REACHED.

          5. PASS STABLE PARAMETER CARDS MUST BE PLACED WITH
              THE CARDS DEFINING THE SPANS OF DATA TO BE PRO-
              CESSED (CATEGORY 201 AND 202 CARDS).

          6. SOLAR PRESSURE CONSTANT = K*(A/M)*(1+GAMMA)*AU**2,
              WHERE

              K = SOLAR PRESSURE AT ONE ASTRONOMICAL UNIT
                  (NEWTONS/METER**2)
                  (=4.5 D-6)

              A = CROSS SECTIONAL AREA (METERS**2)

              M = MASS (KG)

              GAMMA = REFLECTIVITY
                      (=1 FOR PERFECT REFLECTIVITY,
                       =0 FOR BLACK BODY,
                       =-1 FOR TRANSPARENT BODY)

              AU = ONE ASTRONOMICAL UNIT (METERS)
                   (= 149597900.D3)

7. THE DRAG COEFFICIENT = C(D)A/M AS DEFINED IN
REFERENCE (2) WHERE

C(D) = PROPORTIONALITY CONSTANT,
A   = SATELLITE CROSS-SECTIONAL AREA,
M   = SATELLITE MASS.

UNITS ARE METERS SQUARED/GRAM.

8. ARC NUMBER IS NOT REQUIRED FOR TOTALLY STABLE
PARAMETERS WITH THE EXCEPTION OF STATE VECTORS,
SOLAR PRESSURE AND DRAG.

9. THIS APPLIES ONLY TO ERROR MODEL TERMS 24,25,26 (GROUND
POINT COORDINATES) FOR PHOTOGRAMMETRIC MEASUREMENTS.
FOR THESE ERROR MODEL TERMS, KEY4 MUST BE SET EQUAL TO 4.

10. IF THE ERROR MODEL TERM IS 24,25, OR 26 (GROUND POINT
COORDINATES) FOR A PHOTOGRAMMETRIC MEASUREMENT, THEN
KEYS 9 AND 10 ARE USED TO SPECIFY THE GROUND POINT NUM-
BER (=1000*KEY9 + KEY10). IF THE GROUND POINT NUMBER
IS GREATER THAN ONE, KEY 6 SHOULD BE SET EQUAL TO ZERO.
KEY 7 SHOULD BE GIVEN THE VALUE 1,2, OR 3 (REPRESENT-
ING THE GROUND POINT COORDINATES X,Y,Z RESPECTIVELY).

11. THIS APPLIES ONLY TO ERROR MODEL TERMS 24,25, AND 26
(GROUND POINT COORDINATES) FOR PHOTOGRAMMETRIC MEASURE-
MENTS AND THEN ONLY IF THE PROGRAM IS USED IN A SIMULA-
TION MODE. RANGE MEASUREMENTS WILL BE SIMULATED FOR THIS
GROUND POINT IF KEY 3 = 1. IF KEY 3 = 0, NONE WILL BE
SIMULATED.

12. IF KEY5 = 0, ALL A PRIORI PARAMETER VALUES WILL BE
RANDOMLY MODIFIED (CONSISTENT WITH THE INPUT SIGMA).
THIS APPLIES ONLY TO THOSE PARAMETERS THAT ARE INPUT
AFTER THIS CARD. ALSO, IT DOES NOT APPLY TO THE TYPE 7
PART OF A TYPE 9 RUN.

THIS CARD MAY ALSO BE USED TO START THE RANDOM NUMBER
GENERATOR (FOR PARAMETER VALUES, NOT FOR SIMULATED
DATA) AT THE N-TH POINT IN THE BUILT-IN SEQUENCE,
WHERE N = 1000 * KEY9 + KEY 10.

13. DRAG SEGMENTS. THE USER MAY DIVIDE AN ARC INTO SEVERAL
DRAG SEGMENTS BY SPECIFYING A SEGMENT NUMBER ON KEY 3. THE
DRAG COEFFICIENT FOR EACH SEGMENT MAY BE CONSTRAINED
EITHER TO SOME ABSOLUTE VALUE (ABSOLUE CONSTRAINT) OR TO
THE COEFFICIENT OF THE PREVIOUS SEGMENT (RELATIVE
CONSTRAINT). (THE COEFFICIENT FOR THE FIRST SEGMENT IS
ALWAYS ABSOLUTELY CONSTRAINED). THE VALUE OF KEY 3 IS:
KEY 3 = K*(NDRG-1)   ,WHERE K EQUALS PLUS OR MINUS
ONE, POSITIVE FOR ABSOLUTE CONSTRAINT AND NEGATIVE OTHER-
WISE, AND NDRG EQUALS DRAG SEGMENT NUMBER.
A MAXIMUM OF 15 DRAG SEGMENTS MAY BE INPUT. THE START TIMES
FOR ALL DRAG SEGMENTS, EXCEPT THE FIRST, ARE SPECIFIED ON
230 CARDS (THE INITIAL DRAG SEGMENT OBVIOUSLY DOES NOT
NEED A START TIME)

5.2   CATEGORY 602 -   ADDITIONAL MEASUREMENTS FOR EMT
                           RECOVERY

        THE CATEGORY 602 CARDS ENABLE THE USER TO SPECIFY
ADDITIONAL MEASUREMENTS WHICH WILL CONTRIBUTE TO THE RECOVERY
OF THE ERROR MODEL TERM DEFINED IN THE CATEGORY 601 CARD.
THEIR USE IS OPTIONAL, BUT IF USED THEY MUST BE PRECEDED
BY THE DEFINING CAT. 601 CARD.   KEYS 1 AND 2 OF THE CATEGORY
602 CARDS MUST MATCH KEYS 5 AND 6 OF THE CATEGORY 601 CARDS.

        ADDITIONAL MEASUREMENTS CONTRIBUTING TO THE RE-
COVERY OF THE STATE VECTOR ARE DEFINED BY THE CATEGORY 701
CARDS, RATHER THAN THESE.

COLUMN	NAME	DESCRIPTION OR VALUE
1- 3	CATEGORY #	602
4- 5	SET #	ANY NUMBER (NOT USED IN PROGRAM)
6-13	LABEL	ANY 8 ALPHANUMERIC CHARACTERS (NOT USED)
14-16	KEY 1	EMT NUMBER (MUST MATCH KEY 5 OF COR-RESPONDING CATEGORY 601 CARD).
17-19	KEY 2	MEASUREMENT NUMBER USED IN KEY 6 OF CATEGORY 601 CARD.
20-22	KEY 3	
23-25	KEY 4	
26-28	KEY 5	
29-31	KEY 6	ADDITIONAL MEASUREMENTS CONTRIBUTING
32-34	KEY 7	TO THE RECOVERY OF THE EMT
35-37	KEY 8	
38-40	KEY 9	
41-43	KEY 10	

NOTE.   1. CATEGORY 602 CARDS SHOULD NOT BE USED IN CONJUNCTION
             WITH DRAG OR SOLAR PRESSURE.

5.3   CATEGORY 603 - THRUSTING PARAMETERS

THE CATEGORY 603 CARDS ENABLE THE USER TO RECOVER DISCRETE AND CONTINUOUS THRUST (BURN) PARAMETERS FOR EACH ARC.

COLUMN	NAME	DESCRIPTION OR VALUE
1- 3	CATEGORY #	603
4- 5	SET #	ZERO OR BLANK
6-13	LABEL	ANY 8 ALPHANUMERIC CHARACTERS FOR PARAMETER LABEL
14-16	KEY 1	ARC NUMBER
17-19	KEY 2	BURN NUMBER (SEE NOTE 1)
20-22	KEY 3	PARAMETER FLAG (SEE NOTE 2):
23-25	KEY 4	TYPE OF BURN: 0=DISCRETE BURN 1=CONTINUOUS BURN
26-28	KEY 5	EVALUATION FLAG OF 0, 1, OR 2 (SEE INTRODUCTORY REMARKS FOR CATEGORY 601)
44-65	DATA1	A PRIORI ESTIMATE OF PARAMETER AS DEFINED IN KEY 3
66-80	DATA2	A PRIORI SIGMA OF PARAMETER AS DEFINED IN KEY 3

NOTES:
1. FOR EACH ARC, THERE MAY BE A MAXIMUM OF TEN DISCRETE BURNS (NUMBERED 1-10) AND ONE CONTINUOUS BURN.

2. GUIDANCE MODE AS DEFINED IN KEY 2 OF CATEGORY 208 DETERMINES WHICH ELEMENT DESCRIBED BY THE PARAMETER FLAG WILL BE USED.

   1=DXDOT OR DELTA FOR DISCRETE BURN OR T(X) FOR CONTINUOUS BURN.

   2=DYDOT, T(Y)

   3=DZDOT, T(Z)

5.4   CATEGORIES 604 AND 605 - RECOVERY OF HARMONIC
                              COEFFICIENTS

        CATEGORIES 604 AND 605 DEFINE THE ELEMENTS OF THE C
AND S MATRICES TO BE RECOVERED. THE INFORMATION ON THE CARDS
IS CONDENSED IN A MANNER WHICH ENABLES THE USER TO SPECIFY
THE FOLLOWING:

        1.   ROW AND COLUMN NUMBER OF THE ELEMENT

        2.   EVALUATION FLAG OF THE PARAMETER (0 OR 1
             ONLY) AS DEFINED IN CATEGORY 601

        3.   A PRIORI SIGMA OF THE ELEMENT (IN POSITIVE
             OR NEGATIVE POWERS OF 10).

        KEY 1 IS THE COLUMN NUMBER IN THE C AND S MATRICES,
RESPECTIVELY. IT RANGES IN VALUE FROM 0 TO 15 FOR BODY NUMBER
2 AND 0 TO 10 FOR ALL OTHER BODIES. IF KEY 1 IS NOT DEFINED,
THE ELEMENTS ON THE CARD WILL REFER TO THE FIRST COLUMN
(M=0).

        KEYS 2 THROUGH 10 OF THE SET 0 CARD DEFINE THE ROWS
OF THE COLUMN STARTING WITH ROW NUMBER=KEY 1 THROUGH ROW
NUMBER=KEY 1+8, RESPECTIVELY. SHOULD THE COLUMN HAVE MORE
THAN 9 ELEMENTS, THE SET 1 CARD IS USED TO DEFINE THE REMAIN-
ING ELEMENTS, ALLOWING THE USER TO DEFINE A MATRIX UP TO
(M,N)=(17,17). BLANKS IN ANY OF THESE KEYS INDICATE THAT THE
ELEMENT IS NOT BEING RECOVERED.

        THE FOLLOWING EXAMPLE ILLUSTRATES THE PREPARATION
OF THESE CARDS.

KEY 1=0   FIRST COLUMN OF C

KEY 3=100   ELEMENT (1,0) HAS EVALUATION=0, SIGMA=1.0

KEY 8=435   ELEMENT (6,0) HAS EVALUATION=1, SIGMA=1. D-35

5.4.1   CATEGORIES 604 AND 605.   SET 0

COLUMN	NAME	DESCRIPTION OR VALUE
1- 3	CATEGORY #	604 OR 605
4- 5	SET #	0
6-13	LABEL	ANY 8 ALPHANUMERIC CHARACTERS
14-16	KEY 1	COLUMN # OF C OR S MATRIX TO BE SELECTED (M=0, 1, ...)
17-19	KEY 2	SPP FOR ELEMENT (KEY 1, KEY 1)
20-22	KEY 3	SPP FOR ELEMENT (KEY 1+1, KEY 1)
23-25	KEY 4	SPP FOR ELEMENT (KEY 1+2, KEY 1)
26-28	KEY 5	SPP FOR ELEMENT (KEY 1+3, KEY 1)
29-31	KEY 6	SPP FOR ELEMENT (KEY 1+4, KEY 1)
32-34	KEY 7	SPP FOR ELEMENT (KEY 1+5, KEY 1)
35-37	KEY 8	SPP FOR ELEMENT (KEY 1+6, KEY 1)
38-40	KEY 9	SPP FOR ELEMENT (KEY 1+7, KEY 1)
41-43	KEY 10	SPP FOR ELEMENT (KEY 1+8, KEY 1)

IF (SPP .GE. 100 .OR. SPP .LT. 500), THE FOLLOWING APPLIES:

WHERE S = SIGN OF EXPONENT AND EVALUATION FLAG AS FOLLOWS:

1 = POSITIVE EXPONENT, EVALUATION 0
2 = POSITIVE EXPONENT; EVALUATION 1
3 = NEGATIVE EXPONENT; EVALUATION 0
4 = NEGATIVE EXPONENT; EVALUATION 1

PP = A PRIORI SIGMA OF THE ELEMENT IN POSITIVE OR NEGATIVE POWERS OF 10.

IF (SPP .LT. 100 .OR. SPP .GE. 500), THE FOLLOWING APPLIES:

IF SPP .GT. 0,   SPP = 100 * S + PP
IF SPP .LT. 0,   SPP = S

FOR ELEMENT (N,M)   SIGNM IS GIVEN BY (KAULA'S RULE OF THUMB):

        IF N .EQ. M .EQ. 0,   SIG00 = 10 ** (-5)
        IF N .GT. M .EQ. 0,   SIGN0 = 10 ** (-5) * SQRT (2N+1)/N ** 2
        IF N .GE. M .GT. 0,   SIGNM = SIGN0 *
                                        SQRT(2* FACT(N-M)/FACT(N+M))

SIGMA = K * SIGNM, WHERE K IS GIVEN BY THE FOLLOWING:

        IF S IS ODD AND POSITIVE,   K = PP/100
        IF S IS EVEN AND POSITIVE,   K = PP/1000

        IF S IS NEGATIVE, K ASSUMES THE FOLLOWING 'LERCH' VALUES
                        (AS A FUNCTION OF N):

        K = KD (N+1), WHERE KD =

           /.100, .033, .033, .033, .044, .071, .109,
            .141, .196, .250, .340, .440, .610, 10 * 1.0/

    S ALSO DETERMINES THE EVALUATION TYPE:

              EVALUATION 0,   IF S = 5, 6, OR -5
              EVALUATION 1,   IF S = 7, 8, OR -7
              EVALUATION 2,   IF S = 9, 0, OR -9

    NOTE: EVALUATION 2 MAY ONLY BE USED FOR THE EARTH'S GRAVITY
           FIELD. ITS FUNCTION IS TO RANDOMLY (BUT CONSISTENT
           WITH SIGMA) MODIFY THE GRAVITY COEFFICIENTS. IN A
           TYPE 9 RUN, THE MODIFICATION OCCURS ONLY IN THE TYPE 2
           PART OF THE RUN.

5.4.2   CATEGORIES 604 AND 605.   SET 1

COLUMN	NAME	DESCRIPTION OR VALUE
1- 3	CATEGORY #	604 OR 605
4- 5	SET #	1
6-13	LABEL	ANY 8 ALPHANUMERIC CHARACTERS
14-16	KEY 1	COLUMN # OF C OR S MATRIX TO BE SELECTED (M=0, 1,...)
17-19	KEY 2	SPP FOR ELEMENT (KEY 1+9, KEY 1)
20-22	KEY 3	SPP FOR ELEMENT (KEY 1+10,KEY 1)
23-25	KEY 4	SPP FOR ELEMENT (KEY 1+11,KEY 1)
26-28	KEY 5	SPP FOR ELEMENT (KEY 1+12,KEY 1)
29-31	KEY 6	SPP FOR ELEMENT (KEY 1+13,KEY 1)
32-34	KEY 7	SPP FOR ELEMENT (KEY 1+14,KEY 1)
35-37	KEY 8	SPP FOR ELEMENT (KEY 1+15,KEY 1)
38-40	KEY 9	SPP FOR ELEMENT (KEY 1+16,KEY 1)
41-43	KEY 10	SPP FOR ELEMENT (KEY 1+17,KEY 1)

5.4.3   CATEGORIES 604 AND 605.   SET 2

COLUMN	NAME	DESCRIPTION OR VALUE
1- 3	CATEGORY #	604 OR 605
4- 5	SET #	2
6-13	LABEL	ANY 8 ALPHANUMERIC CHARACTERS
14-16	KEY 1	COLUMN NUMBER OF C OR S MATRIX TO BE SELECTED
17-19	KEY 2	SPP FOR ELEMENT (KEY 1 + 18, KEY 1)
20-22	KEY 3	SPP FOR ELEMENT (KEY 1 + 19, KEY 1)
23-25	KEY 4	SPP FOR ELEMENT (KEY 1 + 20, KEY 1)
26-28	KEY 5	SPP FOR ELEMENT (KEY 1 + 21, KEY 1)
29-31	KEY 6	SPP FOR ELEMENT (KEY 1 + 22, KEY 1)
32-34	KEY 7	SPP FOR ELEMENT (KEY 1 + 23, KEY 1)
35-37	KEY 8	SPP FOR ELEMENT (KEY 1 + 24, KEY 1)

5.5   CATEGORY 606 - MASCON RECOVERY

COLUMN	NAME	DESCRIPTION OR VALUE
1- 3	CATEGORY #	606
4- 5	SET #	ZERO OR BLANK
6-13	LABEL	ANY 8 ALPHANUMERIC CHARACTERS
14-16	KEY 1	SPP FOR MASCON 1
17-19	KEY 2	SPP FOR MASCON 2
20-22	KEY 3	SPP FOR MASCON 3
23-25	KEY 4	SPP FOR MASCON 4
26-28	KEY 5	SPP FOR MASCON 5

WHERE   S = SIGN OF EXPONENT AND EVALUATION FLAG

S = 0, NO MASCON RECOVERY
S = 1, POSITIVE EXPONENT, EVALUATION 0
S = 2, POSITIVE EXPONENT, EVALUATION 1
S = 3, NEGATIVE EXPONENT, EVALUATION 0
S = 4, NEGATIVE EXPONENT, EVALUATION 1
PP = A PRIORI SIGMA OF MASCON MASS IN POSITIVE
     OR NEGATIVE POWERS OF 10. UNITS ARE SAME
     AS THOSE FOR MU.

5.6   CATEGORY 610 - METEOROLOGICAL DATA AND GEOCEIVER TIME INTERVAL

COLUMN   NAME   DESCRIPTION OR VALUE

  1- 3   CATEGORY #   610

  4- 5   SET #   ZERO OR BLANK

  6-13   LABEL   ANY 8 ALPHANUMERIC CHARACTERS

 14-16   KEY 1   STATION NUMBER (IF THE STATION NUMBER IS NOT
                              A NUMBER BETWEEN 1 AND 100, THEN THE DATA WILL
                              BE APPLIED TO ALL STATIONS).

 17-19   KEY 2   IF KEY2 EXCEEDS KEY1, THEN THE DATA WILL BE
                              APPLIED TO ALL STATIONS WITH STATION NUMBERS
                              IN THE RANGE KEY1 THROUGH KEY2.

 20-22   KEY 3   SEE KEY 4.

 23-25   KEY 4   KEY3 + 0.001 * KEY4 = PER CENT RELATIVE HUMIDITY

 26-28   KEY 5   SEE KEY 6.

 29-31   KEY 6   1000 * KEY5 + KEY6 + 0.001 * KEY7 = TOTAL
                              PRESSURE (MB)

 32-34   KEY 7   SEE KEY 6

 35-37   KEY 8   NOT
 38-40   KEY 9   USED

 41-43   KEY 10   IF (KEY10 .GE. 0), DATA APPLIED AS IS.

                              IF (KEY10 .LT. 0), DATA ASSUMED APPLICABLE FOR
                              SEA LEVEL ONLY. THE PROGRAM ACCORDINGLY
                              ADJUSTS TEMPERATURE AND PRESSURE TO COMPENSATE
                              FOR STATION HEIGHT.

 44-65   DATA1   TEMPERATURE (DEGREES CELSIUS)

 66-80   DATA2   GEOCEIVER TIME INTERVAL (SECONDS)

(SEE NOTES ON THE FOLLOWING PAGE REGARDING DEFAULT VALUES)

NOTES.   1.   THE FOLLOWING DEFAULT VALUES ARE USED

RELATIVE HUMIDITY   50 PER CENT
PRESSURE   1013 MB
TEMPERATURE   15 DEG CELSIUS
GEOCEIVER TIME   20 SECONDS

THE DEFAULT VALUES FOR PRESSURE AND TEMPERATURE ARE ASSUMED
APPLICABLE FOR SEA LEVEL CONDITIONS. FOR STATIONS
ABOVE OR BELOW SEA LEVEL, THE PROGRAM ESTIMATES APPRO-
PRIATE ADJUSTMENTS TO THE DATA. THE OPTION (KEY 10 .LT. 0)
IS INTENDED TO BE USED IN CASE THE USER WISHES TO CHANGE
THE BUILT-IN DEFAULT VALUES.

2.   IN ORDER TO OVERRIDE THE DEFAULT VALUES, A NONZERO INPUT
MUST BE USED. IT IS THUS NOT POSSIBLE TO INPUT A ZERO
RELATIVE HUMIDITY, THE SMALLEST VALUE BEING 0.001 PER CENT
(KEY 4 = 1). SIMILARLY, THE TEMPERATURE CANNOT BE INPUT
AS EXACTLY 0 DEGREES CELSIUS.

3.   THE GEOCEIVER TIME INTERVAL MAY ALSO BE INPUT AS THE
LAST WORD OF EACH MEASUREMENT POINT RECORD (SEE APP. I),
THUS ALLOWING FOR DIFFERENT TIME INTERVALS FOR EACH
MEASUREMENT POINT. A NON-ZERO TIME INTERVAL ON THE
MEASUREMENT POINT RECORD WILL OVERRIDE THE VALUE INPUT
ON DATA2.

5.7   CATEGORY 612 - LOCKHEED-JACCHIA ATMOSPHERE CONSTANTS

COLUMN	NAME	DEFAULT	DESCRIPTION OR VALUE
1- 3	CATEGORY #	NONE	612
4- 5	SET #	0	0
6-13	LABEL	BLANKS	ANY 8 ALPHANUMERIC CHARACTERS
14-16	KEY 1	0	CONSTANT IDENTIFIER (SEE DATA1 AND DATA2)
44-65	DATA1	7.18	CONSTANT D1 (KEY 1=0) F, 10.3 CM. FLUX (KEY 1=1) (SEE NOTE 2)
66-80	DATA2	-15.738	CONSTANT D2 (KEY 1=0)

NOTES: 1.   DEFAULT VALUES APPLY TO CONSTANTS D1 AND D2 UNLESS
              NON-ZERO VALUES ARE INPUT.

          2.   F SHOULD BE INPUT IN UNITS OF 100D-22 WATT/
              SQ. METER/CYCLE/SEC. THE DEFAULT VALUE IS GIVEN BY
              F = 1.5 + 0.8 * COS(TWOPI*T/11), WHERE T IS TIME
              IN YEARS MEASURED FROM JANUARY 1, 1958.

5.8   CATEGORY 614 - GPS FILTER CONSTANTS

COLUMN	NAME	DEFAULT	DESCRIPTION OR VALUE
1- 3	CATEGORY #	NONE	614
4- 5	SET #	0	0
6-13	LABEL	BLANKS	ANY 8 ALPHANUMERIC CHARACTERS
14-16	KEY 1	0	IDENTIFYING CONSTANT FOR DATA1 AND DATA2
17-19	KEY 2	0	SMOOTHER LAG CONSTANT
44-65	DATA1	0	Q
66-80	DATA2	0	T

NOTES: 1.   IF KEY 1=0, QP=Q, TP=T.
                 IF KEY 1=1, QB=Q, TB=T.

            2.   PREVIOUSLY ENTERED VALUES FOR KEY 2 CAN BE OVERRIDDEN
                 ONLY BY NON-ZERO ENTRIES.

            3.   THE SMOOTHER LAG CONSTANT IS THE NUMBER OF STEPS THAT
                 THE SMOOTHER LAGS THE FILTER. THE MAXIMUM LAG CONSTANT
                 IS 16. IF KEY 2=0 THE SMOOTHER DEGENERATES TO A FILTER.

SECTION VI

MEASUREMENT DATA

CATEGORY 700

THIS SERIES CONTAINS INFORMATION PERTAINING TO THE OBSERVED MEASUREMENT DATA FROM A STATION. A MEASUREMENT IS DEFINED AS A TYPE OF DATA, I.E., RANGE, AZIMUTH. APPENDIX IV-A LISTS THE TYPES OF MEASUREMENTS USED AND THE CORRESPONDING MEASUREMENT TYPE NUMBER.

EACH CATEGORY IN THIS SERIES HAS A SET 0 AND A SET 1 CARD. INFORMATION DEFINED ON THE SET 0 CARD REMAINS CONSTANT FOR A TOTAL RUN UNTIL ANOTHER SET 0 CARD FOR THE SAME MEASUREMENT IS ENCOUNTERED. HOWEVER, IT IS POSSIBLE TO ALTER THE MEASUREMENT DATA INFORMATION FOR A PASS ONLY BY INSERTING THE APPROPRIATE SET 1 CARDS PRIOR TO THE CATEGORY 999 CARD TERMINATING THAT PASS.

6.1   CATEGORY 701   -   GENERAL FLAGS

CATEGORY 701 PROVIDES GENERAL INFORMATION FLAGS FOR EACH MEASUREMENT. THE SET 0 CARD IS REQUIRED ONCE FOR EVERY MEASUREMENT AND MAY APPEAR ANYWHERE IN THE DECK PRIOR TO THE FIRST USAGE OF THE MEASUREMENT DATA IT DEFINES.

THE CARD FORMAT FOR CATEGORY 701 IS LISTED ON THE FOLLOWING PAGE.

COLUMN	NAME	DESCRIPTION OR VALUE
1- 3	CATEGORY #	701
4- 5	SET #	ZERO OR 1 (SEE NOTE 2 ON THE FOLLOWING PAGE)
6-13	LABEL	MEASUREMENT LABEL TO BE PRINTED (ANY 8 ALPHANUMERIC CHARACTERS)
14-16	KEY 1	MEASUREMENT NUMBER LESS THAN OR EQUAL TO 300, ASSIGNED BY USER TO CORRELATE INFORMATION PERTAINING TO THIS MEASUREMENT IN ALL CATEGORIES
17-19	KEY 2	STATION NUMBER ASSIGNED IN KEY 1 OF CATEGORY 301 CARD FOR APPLICABLE STATION
20-22	KEY 3	MEASUREMENT TYPE NUMBER FROM APPENDIX IV-A
23-25	KEY 4	LOCATION OF MEASUREMENT WORD IN OBSERVATIONAL DATA INPUT (SEE APPENDIX I)
26-28	KEY 5	REFRACTION CORRECTIONS (SEE NOTE 3 ON THE FOLLOWING PAGE): 0=DO NOT APPLY CORRECTIONS 1=APPLY TROPOSPHERIC CORRECTIONS 2=APPLY IONOSPHERIC CORRECTIONS 3=APPLY BOTH TROPOSPHERIC AND IONOSPHERIC CORRECTIONS
29-31	KEY 6	TIME CORRECTIONS (-R/C) - (SEE NOTE 4 ON THE FOLLOWING PAGE): 0=DO NOT APPLY CORRECTIONS 1=APPLY CORRECTIONS
32-34	KEY 7	RECOVERY OF STATE VECTOR: 0=MEASUREMENT CONTRIBUTES TO RECOVERY 1=MEASUREMENT DOES NOT CONTRIBUTE TO RECOVERY
35-37	KEY 8	MEASUREMENT TYPES 21-26: COORDINATE SYSTEM FOR STATE VECTOR OBSERVATIONS: 0=INERTIAL, MEAN OF 1950 1=INERTIAL OF DATE 2=EARTH FIXED MEASUREMENT TYPE 27: GEOCEIVER 0=SATELLITE TO STATION 1=SATELLITE TO SATELLITE

(CONTINUED ON THE FOLLOWING PAGE)

38-40	KEY 9	NOT USED
41-43	KEY 10	NOT USED
44-65	DATA1	DATA CONVERSION CONSTANT (SEE NOTE 1)
66-80	DATA2	A PRIORI SIGMA OF THE MEASUREMENT (IN UNITS OF EARTH'S PHYSICAL CONSTANTS)

NOTES:

1. THIS CONSTANT IS USED FOR CONVERSION OF DATA TO THE UNITS OF THE PHYSICAL CONSTANTS OF THE EARTH OR ANY OTHER CONVERSIONS REQUIRED. FOR EXAMPLE:

> A. EARTH CONSTANTS MAY BE IN METERS AND RANGE DATA ARE IN KM. WE NEED A CONVERSION CONSTANT OF 1000.D0.

> B. ANGULAR DATA MUST BE CONVERTED TO RADIANS. IF AZIMUTH DATA ARE IN DE-GREES, WE NEED A CONVERSION CONSTANT OF .01745329252 D0.

2. SET NUMBER 1 IS USED TO OVERRIDE THE FLAGS DE-FINED IN THE SET 0 CARD FOR A PARTICULAR PASS. IT MUST APPEAR BEFORE THE CATEGORY 999 CARD TERMINATING THAT PASS.

3. TROPOSPHERIC INDEX OF REFRACTION AND STADAN OP-ERATING FREQUENCY (FOR IONOSPHERIC REFRACTION) ARE ENTERED BY MEANS OF THE CATEGORY 702 CARD. ELEVATION ANGLE DATA MUST BE CORRECTED FOR TROPOSPHERIC REFRACTION (EITHER ON THE DATA TAPE OR BY MEANS OF THIS CARD).

4. R/C CORRECTIONS MAY ONLY BE APPLIED TO MEASUREMENT TYPES 1,2,3,4,5,8,9,10,11,14,15 AND 18. FOR ALL OTHER MEASUREMENT TYPES, THE CORRECTIONS ARE EITHER APPLIED AUTOMATICALLY OR ELSE CANNOT BE APPLIED.

5. A NEGATIVE VALUE FOR DATA2 INDICATES THAT THE MEASUREMENTS ARE CORRELATED AND THAT THEIR CO-VARIANCE WILL BE INPUT AS PART OF THE MEASURE-MENT RECORD. (SEE APPENDIX I-B: KALMAN FILTER OUTPUT TAPE)

6.2   CATEGORY 702

        THIS CARD IS OPTIONAL AND DEFAULT VALUES WILL BE
USED IF THE CARD IS OMITTED. IT MAY APPEAR ANYWHERE IN THE
DECK PRIOR TO THE FIRST USAGE OF THE DATA IT DEFINES.

COLUMN	NAME	DEFAULT	DESCRIPTION OR VALUE
1- 3	CATEGORY #	NONE	702
4- 5	SET #	BLANKS	ZERO OR 1 (SEE NOTE 2)
6-13	LABEL	BLANKS	ANY 8 ALPHANUMERIC CHAR-ACTERS (NOT USED)
14-16	KEY 1	NONE	MEASUREMENT NUMBER AS DE-FINED IN THE CATEGORY 701 CARDS
17-19	KEY 2	0	HOURS MINIMUM
20-22	KEY 3	0	MINUTES SEPARATION
23-25	KEY 4	1	SECONDS (SEE NOTE 1)
26-28	KEY 5	0	MILLISECONDS
29-31	KEY 6	0	DEGREES MINIMUM
32-34	KEY 7	0	MILLIDEGREES ELEVATION
35-37	KEY 8	90	DEGREES MAXIMUM
38-40	KEY 9	0	MILLIDEGREES ELEVATION
41-43	KEY 10	0	IF KEY 10 EXCEEDS VALUE OF KEY 1, THE VALUES ENTERED ON THIS CARD WILL APPLY TO MEASUREMENT NUMBERS M1 TO M2 WHERE M1=KEY1 AND M2=KEY10. OPTION MAY BE USED FOR SET #=1 ONLY IF ALL THE MEASUREMENTS (M1 THRU M2) APPEAR IN THE PASS.
44-65	DATA1	1.	TROPOSPHERIC INDEX OF REFRACTION (SEE NOTE 4)
66-80	DATA2	NONE	STADAN OPERATING FREQUENCY IN HERTZ FOR USE WITH IONOSPHERIC REFRACTION (SEE NOTE 3)

(NOTES CONTINUED ON THE FOLLOWING PAGE)

NOTES: 1. MINIMUM SEPARATION DENOTES THE INTERVAL AT
WHICH DATA POINTS WILL BE ACCEPTED. THE SMALL-
EST INTERVAL ALLOWED IS ONE MILLISECOND.

2. SET NUMBER 1 IS USED TO OVERRIDE THE INFORMA-
TION SPECIFIED IN THE SET 0 CARD FOR A PARTI-
CULAR PASS. IT MUST APPEAR BEFORE THE CATEGORY
999 CARD TERMINATING THAT PASS.

3. KEY 5 OF THE CATEGORY 701 CARD MUST BE SET TO 2
OR 3 IF IONOSPHERIC REFRACTION IS TO BE
APPLIED. IF THE STADAN OPERATING FREQUENCY IS
NOT INPUT, IONOSPHERIC REFRACTION WILL NOT BE
APPLIED.

4. INDEX OF REFRACTION = $1 + N * 10^{**(-6)}$
WHERE

N = $(77.6/T) * (P + 4810E/T)$
P = TOTAL ATMOSPHERIC PRESSURE IN MILLIBARS
T = TEMPERATURE (DEGREES K)
E = PARTIAL PRESSURE OF WATER VAPOR (MILLIBARS)
P = $P0 * E^{**(-A/H)}$ (A IN KM)
H = $8.47 * T/289.25$
A = HEIGHT

AS DEFAULT, USE N = 300, INDEX OF REFRACTION = 1.000300.

NOTE THAT THIS INDEX OF REFRACTION IS NOT EMPLOYED
IN THE HOPFIELD MODEL USED FOR GEOCEIVER MEASUREMENTS
(FOR HOPFIELD MODEL CONSTANTS SEE CATEGORY 610 CARD).

6.4   CATEGORY 704 - TIMING AND BIAS CORRECTIONS

        THIS CATEGORY ENABLES THE USER TO ADD A TIMING COR-
RECTION TO THE OBSERVATION TIME AND A BIAS CORRECTION TO THE
OBSERVATION OF THE SPECIFIED MEASUREMENT. THE TIME COR-
RECTION NEED BE GIVEN ONLY ONCE SINCE IT APPLIES TO ALL THE
DATA RECOVERED BY THE STATION (THE MEASUREMENT AND STATION
HAVE BEEN DEFINED BY THE CATEGORY 701 CARD). THE BIAS MUST BE
DEFINED FOR EACH MEASUREMENT TO WHICH IT IS TO BE APPLIED. IT
MAY BE DESIRABLE TO USE THE CATEGORY 704, SET 1 CARD INSTEAD
OF THIS ONE.

COLUMN	NAME	DESCRIPTION OR VALUE
1- 3	CATEGORY #	704
4- 5	SET #	ZERO OR 1 (SEE NOTE 1)
6-13	LABEL	ANY 8 ALPHANUMERIC CHARACTERS (NOT USED)
14-16	KEY 1	MEASUREMENT NUMBER AS DEFINED IN THE CATEGORY 701 CARD
44-65	DATA1	BIAS TO BE ADDED TO THE OBSERVATION OF THE MEASUREMENT SPECIFIED IN KEY 1. UNITS ARE AS THOSE OF THE EARTH'S PHYSICAL CONSTANTS OR IN RADIANS FOR ANGULAR DATA.
66-80	DATA2	TIMING CORRECTION TO BE ADDED TO THE OBSERVATION TIME

NOTE: 1. SET NUMBER 1 IS USED TO OVERRIDE THE INFORMA-
                TION SPECIFIED IN THE SET 0 CARD FOR A PARTI-
                CULAR PASS. IT MUST APPEAR BEFORE THE CATEGORY
                999 CARD TERMINATING THAT PASS.

SECTION VII

TERMINAL CARD

7.1   CATEGORY 999

THE CATEGORY 999 CARD IS USED TO INDICATE TERMINA-
TION OF A SET OF CONTROL CARDS. IT IS REQUIRED TO HAVE A
CATEGORY 999 CARD WITH THE APPROPRIATE FLAG DEFINING END OF
PASS, END OF ARC, OR END OF ALL CONTROL CARDS.

COLUMN	NAME	DESCRIPTION OR VALUE
1- 3	CATEGORY #	999
4- 5	SET #	ZERO OR BLANK
6-13	LABEL	ANY 8 ALPHANUMERIC CHARACTERS (NOT USED)
14-16	KEY 1	ARC NUMBER
17-19	KEY 2	STATION NUMBER
20-22	KEY 3	PASS NUMBER
23-25	KEY 4	TERMINATION FLAG (SEE NOTE 1):

1=END OF THE STATION/PASS
2=LAST PASS OF THIS ARC DEFINED BY
   KEY 1, BUT MORE ARCS FOLLOW
3=END OF CONTROL CARDS. IF THE
   MEASUREMENT OBSERVATIONS ARE ON
   CARDS, THAT DECK FOLLOWS.

| 29-31 | KEY 6 | IF MEASUREMENT TYPES 19 OR 20 APPEAR IN THE PASS, KEY 6 SPECIFIES THE MEASUREMENT AS FOLLOWS: |

KEY 6 .LT. 0   GRARR
KEY 6 .EQ. 0   TDRSS (SATELLITE TO SATELLITE)
KEY 6 .GT. 0   STATION (KEY 2) TO SATELLITE TO
                  STATION (KEY 6) TO SATELLITE TO
                  STATION (KEY 2).

FOR SIMULATED PHOTOGRAMMETRIC MEASUREMENTS,
SEE NOTE 2 ON THE FOLLOWING PAGE.

NOTE: 1. ONE TERMINAL CARD IS SUFFICIENT FOR A PARTICU-
             LAR SUBSET OF THE CONTROL CARDS (E.G., AT THE
             END OF AN ARC, IT IS NOT NECESSARY TO HAVE AN
             END OF PASS INDICATOR AS WELL AS AN END OF ARC
             INDICATOR, AND, SIMILARLY, FOR THE END OF ALL
             CONTROL CARDS).

         2. THIS APPLIES ONLY FOR SIMULATED PHOTOGRAMMETRIC MEASURE-
             MENTS. DEPENDING ON THE VALUE OF KEY 6, STELLAR
             ANGLE MEASUREMENTS ARE SIMULATED FOR THE FOLLOWING:
             KEY 6 = 0, STELLAR CAMERAS 1 & 2
                   = 1, STELLAR CAMERA 2
                   = 2, STELLAR CAMERA 1
                   = 3, NO STELLAR ANGLES SIMULATED

             NOTE THAT NO CONFLICT OCCURS WITH THE 2 SEPARATE
             DESIGNATIONS FOR KEY 6, SINCE THERE CANNOT BE DATA
             FOR MEASUREMENTS 19 AND 20 IN THE SAME PASS AS PHOTO-
             GRAMMETRIC DATA.

APPENDIX I

OBSERVATIONAL DATA

SOURCE OF INPUT

THE OBSERVATIONS FROM THE TRACKING STATION WILL BE INPUT ON CARDS OR TAPE. DATA TAPES WILL BE BINARY (SEE SECTION 8). A DETAILED DESCRIPTION OF EACH MODE OF INPUT FOLLOWS. THE MODE IS INDICATED IN KEY 5 OF THE CATEGORY 101 CARD. ANY TYPE OF DATA MAY BE INPUT WITH ANY OF THE FOLLOWING INPUT MODES, UNLESS OTHERWISE SPECIFIED.

A.   CARD DATA

OBSERVATIONS ON CARDS ARE ORDERED BY ARC/STATION/ PASS. AN IDENTIFICATION CARD PRECEDES EACH SET OF OBSERVATIONS GIVING THE ARC, STATION, AND PASS NUMBER AND A TERMINAL CARD IS NEEDED AT THE END OF THE DECK.

1.   IDENTIFIER

COLUMN	NAME	DESCRIPTION OR VALUE	TYPE
5	ID FLAG	ZERO OR BLANK (SIGNIFIES START OF A NEW PASS)	INTEGER*4
6-20	ARC #	SAME AS IN CATEGORY 201/202 CARDS	REAL*8
21-35	STATION #	SAME AS IN CATEGORY 301, KEYS 3 AND 4	REAL*8
36-50	PASS #	SAME AS IN CATEGORY 201/202 CARDS	REAL*8

2.   OBSERVATIONS

COLUMN	DESCRIPTION	TYPE
1- 5	JULIAN DAYS SINCE 1950	INTEGER*4
6-20	SECONDS OF DAY	REAL*8
21-35	OBSERVATION 1	REAL*8
36-50	OBSERVATION 2	REAL*8
51-65	OBSERVATION 3	REAL*8
66-80	OBSERVATION 4	REAL*8

3.   TERMINAL CARD

COLUMN	VALUE
1- 5	-1
6-80	BLANK

NOTE.   IF EITHER GEOCEIVER OR AVERAGE RANGE RATE DATA ARE PRESENT IN
        THE MEASUREMENT POINT RECORD, THEN THE NUMBER OF OBSERVATIONS
        PER RECORD IS LIMITED TO 3, THE LAST WORD IN THE RECORD BEING
        RESERVED FOR THE AVERAGING TIME (SECONDS). E.G., IF THERE ARE
        TWO OBSERVATIONS IN THE RECORD AND ONE IS A GEOCEIVER MEASURE-
        MENT, THEN THE AVERAGING TIME SHOULD BE WRITTEN IN COLUMNS
        51 THROUGH 65.

B.   SIMULATED DATA

THE OUTPUT OF THE DATA SIMULATOR IS WRITTEN AS A
BINARY TAPE. AN IDENTIFYING RECORD PRECEDES EACH PASS OF DATA
AND A TERMINAL RECORD INDICATES THE END OF ALL DATA. AN END
OF FILE FOLLOWS THE TERMINAL RECORD.

1.   IDENTIFYING RECORD

DATA WORD	NAME	DESCRIPTION OR VALUE	TYPE
1	ID FLAG	ZERO OR BLANK (SIGNI-FIES START OF A NEW PASS)	REAL*8
2	ARC #	SAME AS IN CATEGORY 201/202 CARDS	REAL*8
3	STATION #	SAME AS IN CATEGORY 301, KEYS 3 AND 4	REAL*8
4	PASS #	SAME AS IN CATEGORY 201/202 CARDS	REAL*8
5-9	NOT USED	0.D0	REAL*8

2.   OBSERVATIONS

DATA WORD	DESCRIPTION	TYPE	WORD LOCATION FOR CATEGORY 701, KEY 4
1	JULIAN DAYS SINCE 1950	REAL*8	1
2	SECONDS OF DAY	REAL*8	
3-8	OBSERVATIONS 1-6, RESPECTIVELY	REAL*8	3-8, RESPECTIVELY

(CONTINUED ON THE FOLLOWING PAGE)

NOTE.   IF EITHER GEOCEIVER OR AVERAGE RANGE RATE DATA ARE PRESENT
IN THE MEASUREMENT POINT RECORD, THEN THE AVERAGING TIME (SEC)
SHOULD APPEAR IN DATA WORD (N+3), WHERE N IS THE NUMBER OF
OBSERVATIONS IN THE RECORD.

3.   TERMINAL RECORD

DATA WORD	VALUE	TYPE
1	-1.D0	REAL*8
2 THROUGH 8	0.D0	REAL*8

B.1   KALMAN FILTER OBSERVATION TAPE (FILE 33)

1A.   NO HEADER RECORD IS USED

2A.   OBSERVATIONS

DATA WORD	DESCRIPTION	TYPE
1	JULIAN DAYS SINCE 1950	REAL*8
2	SECONDS OF DAY	REAL*8
3-6	OBSERVATIONS	REAL*8
6-9	ASSOCIATED SATELLITES	I4

NOTE. OBSERVATIONS CONSIST OF DISTANCE MEASUREMENTS TO SELECTED
GPS SATELLITES, WHOSE NUMBERS ARE SPECIFIED ON DATA WORDS
6 THROUGH 9.

3A.   NO TERMINAL RECORD IS WRITTEN

B.2   KALMAN FILTER OUTPUT TAPE (FILE 29)

1B.   HEADER RECORD CONSISTS OF 10 REAL*8 WORDS, EACH ONE OF WHICH
          IS 0.D0.

NOTE.   HEADER RECORD 1B DOES NOT SPECIFY ARC OR PASS NUMBER. IN PROCESS-
        ING THE DATA THE USER MAY SPECIFY ANY ARC AND PASS NUMBER ON THE
        201,202 AND 999 CARDS. THE OUTPUT FROM THE FILTER (SMOOTHER) MAY
        THUS IN ANY SUBSEQUENT PROCESSING BE TREATED AS COMING FROM DIFF-
        ERENT ARCS. THE REASON FOR THIS IS THAT IN A BATCH MODE NO SINGLE
        ARC CAN MATCH THE SMOOTHER OUTPUT.

2B.   ESTIMATED PARAMETER VECTOR

DATA WORD	DESCRIPTION	TYPE
1	JULIAN DAYS SINCE 1950	REAL*8
2	SECONDS OF DAY	REAL*8
3-11	ESTIMATED 9 PARAMETER STATE VECTOR	REAL*8

NOTE.   STATE VECTOR CONSISTS OF POSITION (3), VELOCITY (3), DRAG
        COEFFICIENT (1), CLOCK BIAS (1) AND BIAS RATE (1). THE
        ESTIMATED PARAMETER RECORD IS ALWAYS FOLLOWED BY A COVARIANCE
        RECORD.

3B.   COVARIANCE MATRIX

DATA WORD	DESCRIPTION	TYPE
1-21	(6X6) COVARIANCE MATRIX (IN UPPER TRIANGULAR FORM) FOR FIRST 6 COMPONENTS OF STATE VECTOR	REAL*8

4B.   NO TERMINAL RECORD IS WRITTEN

THE MISSION TRAJECTORY AND ANALYSIS UNIFIED FORMAT (MTAUF) DATA MUST BE WRITTEN ON A BINARY TAPE. THIS FORMAT MAY, OF COURSE, BE USED FOR ANY DATA AS LONG AS THE OBSERVATIONS FOR A STATION ARE IN ASCENDING ORDER OF TIME FOR A GIVEN PASS. THE UNITS OF DATA WORDS 4 THROUGH 9 MAY BE LEFT TO THE USER'S DISCRETION, BUT MUST BE CONVERTED THROUGH THE CATEGORY 701 CARD IF DIFFERENT FROM THE EARTH MODEL UNITS, AND ANGULAR DATA MUST BE CONVERTED TO RADIANS.

DATA WORD	DESCRIPTION OR VALUE	TYPE	WORD LOCATION FOR CAT. 701, KEY 4
1	STATION IDENTIFICATION	INTEGER*4	
2	NUMBER OF FLOATING POINT WORDS FOLLOWING	INTEGER*4	
3	JULIAN DAYS SINCE 1950	REAL*8	1
4	SECONDS OF DAY	REAL*8	
5	X-ANGLE	REAL*8	3
6	Y-ANGLE	REAL*8	4
7	AZIMUTH	REAL*8	5
8	ELEVATION	REAL*8	6
9	RANGE	REAL*8	7
10	RANGE RATE	REAL*8	8
11	TIME INCREMENT ASSOCIATED WITH AVERAGE RANGE RATE DATA	REAL*8	9

D.   GEOS FORMATTED DATA

        DATA IN THE STANDARD GEOS FORMAT MAY BE INPUT VIA
CARDS (OPTICAL DATA ONLY) OR TAPE, WHICH IS PRODUCED EXTERNALLY.

1.   CARD FORMAT

COLUMN	DESCRIPTION		TYPE	WORD LOCATION FOR CAT. 701, KEY 4
1- 2	YEAR OF LAUNCH		INTEGER*4	
3-14	NOT USED			
15-17	STATION ID		INTEGER*4	
18	STATION ID		INTEGER*4	
19-20	YEAR		INTEGER*4	
21-22	MONTH		INTEGER*4	
23-24	DAY	TIME OF	INTEGER*4	
25-26	HOURS	OBSERVATION	INTEGER*4	1
27-28	MINUTES		INTEGER*4	
29-30	SECONDS		INTEGER*4	
31-34	MILLISECONDS		INTEGER*4	
35-37	HOURS		INTEGER*4	
38-39	MINUTES	RIGHT	INTEGER*4	3
40-41	SECONDS	ASCENSION	INTEGER*4	
42-44	MILLISECONDS		INTEGER*4	
45	SIGN OF DECLINATION (PLUS OR MINUS)		ALPHANUMERIC	
46-47	HOURS		INTEGER*4	
48-49	MINUTES DECLINATION		INTEGER*4	4
50-51	SECONDS		INTEGER*4	
52-53	MILLISECONDS		INTEGER*5	

E.   PHOTOGRAMMETRIC DATA

      PHOTOGRAMMETRIC DATA IS INPUT IN BINARY FORM. EACH INPUT RECORD CONSISTS OF 6 FLOATING POINT WORDS.   THERE ARE THREE TYPES OF RECORDS ASSOCIATED WITH EACH PHOTOGRAPH.

      1.   THE IDENTIFYING RECORD. THIS MUST ALWAYS BE THE FIRST RECORD FOR EACH PHOTOGRAPH.

      2.   THE STELLAR ANGLE RECORD. IF STELLAR CAMERA ORIENTATION ANGLE MEASUREMENTS HAVE BEEN MADE, THEN THIS RECORD MUST FOLLOW THE IDENTIFYING RECORD.

      3.   THE GROUND POINT IMAGE RECORD. THERE IS ONE RECORD ASSOCIATED WITH EACH GROUND POINT IMAGE APPEARING ON THE PHOTOGRAPH. THESE RECORDS MUST FOLLOW THE STELLAR ANGLE RECORD. (IF THE STELLAR ANGLE RECORD IS NOT PRESENT, THEY MUST FOLLOW THE IDENTIFYING RECORD.)

FOLLOWING IS A DESCRIPTION OF THE ABOVE THREE TYPES OF RECORDS.

IDENTIFYING RECORD.

DATA WORD	NAME	DESCRIPTION OR VALUE
1	ID FLAG	ZERO
2	ARC #	SAME AS KEY 1 IN CATEGORY 201/202
3	N	STELLAR ANGLE INDICATOR. -2, STELLAR ANGLE RECORD FOLLOWS. -1, OTHERWISE.
4	PHOTO #	SAME AS KEY 3 IN CAT 201/202 CARDS
5	TIME WD1	TIME OF PHOTOGRAPH (SEE NOTE 1).
6	TIME WD2	WD1 = JULIAN DAYS SINCE 1950 WD2 SECONDS OF DAY

STELLAR ANGLE RECORD.

DATA WORD	NAME	DESCRIPTION
1	B1(1)	VECTOR OF STELLAR CAMERA 1 ORIENTATION
2	B1(2)	ANGLES (IN RADIANS) W.R.T. INERTIAL
3	B1(3)	SPACE.
4	B2(1)	VECTOR OF STELLAR CAMERA 2 ORIENTATION
5	B2(2)	ANGLES (IN RADIANS) W.R.T. INERTIAL
6	B2(3)	SPACE.

GROUND POINT IMAGE RECORD.

DATA WORD	DESCRIPTION
1	GROUND POINT NUMBER (SAME AS KEYS 9 & 10 OF CATEGORY 601 CARD)
2	X PLATE MEASUREMENT
3	Y PLATE MEASUREMENT
4	RANGE MEASUREMENT
5&6	0

NOTES.   1. JANUARY 1, 1950 IS JULIAN DAY 1 (SINCE 1950). DAY NUMBERS CHANGE AT MIDNIGHT.

2. A ZERO IN ANY MEASUREMENT WORD INDICATES THE ABSENCE OF THAT MEASUREMENT.

THE GEOS DATA TAPE MUST BE BINARY.

DATA WORD	DESCRIPTION	TYPE	WORD LOCATION FOR CAT. 701, KEY 4
1	STATION NUMBER (SEE NOTE 1)	INTEGER*4	
2	JULIAN DAYS SINCE 1950	REAL*8	1
3	SECONDS OF DAY	REAL*8	
4	OBSERVATION 1	REAL*8	3
5	OBSERVATION 2	REAL*8	4

THE DATA WORDS ARE AS FOLLOWS FOR THE TYPE OF DATA SPECIFIED:

DATA TYPE	OBSERVATION 1	OBSERVATION 2
OPTICAL	RIGHT ASCENSION	DECLINATION
RANGE	RANGE	0.
RANGE RATE	0.	RANGE RATE
RANGE AND RANGE RATE	RANGE	RANGE RATE

NOTE: 1.   STATION NUMBER FOR GEOS-A DATA IS OBTAINED FROM
               COLUMNS 15-18 OF THE CARD DATA; FOR GEOS-B DATA
               FROM COLUMNS 15-17.

PLANETARY INFORMATION

THIS INFORMATION RELATING TO THE VARIOUS BODIES USED IN THE REDUCTION IS IN THE PHOTONAP PROGRAM AS "DEFAULTS." ANY DEFAULT MAY BE OVERRIDDEN AS SPECIFIED IN THE APPROPRIATE CATEGORIES. CATEGORIES.

A.   GENERAL CONSTANTS

BODY #	LABEL	RADIUS OF INFLUENCE (METERS)	BODY RADIUS (METERS)	GRAVITATIONAL CONSTANT	
1	PROBE	1.	1.	0.	
2	EARTH	10630480.	6378165.	.3986032	D15
3	MOON	76117200.	1738090.	.49027780	D13
4	SUN	1.	69565. D8	.132715445	D21
5	BLANKS	--	--	--	

DESCRIPTION	VALUE
TIME UNITS PER DAY	86400.SECONDS
TRUNCATION ERROR	5. D-16
NUMBER OF BODIES	4
NUMBER OF TERMS IN POWER SERIES FOR POSITION AND VELOCITY	16
NUMBER OF TERMS IN POWER SERIES FOR VARIATIONAL EQUATIONS	12

B.   COEFFICIENTS OF THE SPHERICAL HARMONICS FOR EARTH

BODY NUMBER: 2

SOURCE OF SPHERICAL HARMONIC
COEFFICIENTS   GODDARD EARTH MODEL

NUMBER OF ATMOSPHERIC SHELLS: 8

ANGLE OF PRIME MERIDIAN
AT EPOCH: COMPUTED INTERNALLY

ROTATION RATE: .7292115854937 D-4
                                          (RAD/SEC)

ECCENTRICITY-SQUARED   .669342162296594 D-2

1/FLATTENING   298.3

NUMBER OF COLUMNS EACH
IN C AND S MATRICES: 15

COLUMN	NUMBER OF ELEMENTS
0	22
1	14
2	11
3	10
4	9
5	8
6	7
7	6
8	5
9	7
10	3
11	4
12	11
13	10
14	9

C.   COEFFICIENTS OF THE SPHERICAL HARMONICS FOR MOON

BODY NUMBER: 3

NUMBER OF ATMOSPHERIC
SHELLS: 0

ANGLE OF PRIME MERIDIAN
AT EPOCH: 0

ROTATION RATE: .266169947699999 D-5
                                (RAD/SEC)

ECCENTRICITY-SQUARED: 0

NUMBER OF COLUMNS EACH
IN C AND S MATRICES: 5

TOTAL NUMBER OF ELEMENTS
IN LOWER DIAGONAL: 19

| | NUMBER OF |
COLUMN	ELEMENTS
0	9
1	4
2	3
3	2
4	1

D.   COEFFICIENTS OF THE SPHERICAL HARMONICS FOR SUN

BODY NUMBER: 4

NUMBER OF ATMOSPHERIC SHELLS: 0

NUMBER OF COLUMNS EACH IN
C AND S MATRICES: 1

SUM OF ELEMENTS IN LOWER
DIAGONAL: 1
C00=1.
S00=0.

E.   COEFFICIENTS OF THE SPHERICAL HARMONICS FOR EARTH
        (GODDARD EARTH MODEL)

        THE VALUES GIVEN BELOW FOR THE C AND S MATRICES (22X22) ARE
STORED IN PHOTONAP AS "DEFAULT" CONSTANTS. ONLY THE ELEMENTS OF THE
LOWER DIAGONAL (N .GE. M) WHICH ARE USED IN THE PROGRAM HAVE BEEN
LISTED.

(N,M)	C-MATRIX	S-MATRIX
(0,0)	1.0	0.0
(1,0)	0.0	0.0
(2,0)	-0.10826517D-02	0.0
(3,0)	0.25450306D-05	0.0
(4,0)	0.16714987D-05	0.0
(5,0)	0.20672093D-06	0.0
(6,0)	-0.64006172D-06	0.0
(7,0)	0.40721283D-06	0.0
(8,0)	0.32926529D-06	0.0
(9,0)	0.32915584D-07	0.0
(10,0)	0.96906194D-07	0.0
(11,0)	-0.94884616D-07	0.0
(12,0)	0.29707418D-06	0.0
(13,0)	0.89284830D-08	0.0
(14,0)	-0.19891468D-06	0.0
(15,0)	0.26186879D-06	0.0
(16,0)	-0.75301456D-07	0.0
(17,0)	-0.20718909D-06	0.0
(18,0)	0.10964665D-06	0.0
(19,0)	0.28080415D-06	0.0
(20,0)	-0.10442261D-07	0.0
(21,0)	-0.19968655D-06	0.0
(1,1)	0.0	0.0
(2,1)	-0.13267386D-08	-0.13743463D-07
(3,1)	0.21618749D-05	0.25715961D-06
(4,1)	-0.50522563D-06	-0.41990625D-06
(5,1)	-0.51413652D-07	-0.84962448D-07
(6,1)	-0.62776599D-07	-0.24097526D-07
(7,1)	0.18536930D-06	0.82971843D-07
(8,1)	0.16810163D-07	0.67416070D-07
(9,1)	0.10635335D-06	-0.11634359D-08
(10,1)	0.50475862D-07	-0.11855531D-06
(11,1)	-0.11283302D-07	0.14439649D-07
(12,1)	-0.43369864D-07	-0.61199952D-08
(14,1)	-0.78800000D-08	0.28000000D-08

E.   COEFFICIENTS OF THE SPHERICAL HARMONICS FOR EARTH
     (GODDARD EARTH MODEL)   (CONTINUED)

(N,M)	C-MATRIX	S-MATRIX
(2,2)	0.15665105D-05	-0.88699319D-06
(3,2)	0.31721424D-06	-0.20782031D-06
(4,2)	0.77399648D-07	0.15154184D-06
(5,2)	0.10362962D-06	-0.49163518D-07
(6,2)	0.58964246D-08	-0.43267643D-07
(7,2)	0.32696349D-07	0.91811314D-08
(8,2)	0.36483558D-08	0.56508118D-08
(9,2)	0.14393189D-09	0.63503600D-09
(10,2)	-0.31904367D-08	-0.19927902D-08
(11,2)	0.15401263D-08	-0.56596101D-08
(12,2)	-0.55840112D-09	0.47235306D-09
(3,3)	0.10250545D-06	0.19490364D-06
(4,3)	0.59014036D-07	-0.12753734D-07
(5,3)	-0.13284881D-07	-0.82141685D-08
(6,3)	0.75677410D-09	-0.12504920D-09
(7,3)	0.40969843D-08	-0.32386590D-08
(8,3)	-0.23497889D-09	-0.69429031D-09
(9,3)	-0.78604634D-09	-0.10403207D-08
(10,3)	-0.27093037D-09	-0.67882562D-09
(11,3)	0.28624221D-11	-0.59198013D-09
(12,3)	0.32492286D-09	0.30174968D-09
(4,4)	-0.36085115D-08	0.63866591D-08
(5,4)	-0.22939341D-08	0.27915369D-09
(6,4)	-0.36861988D-09	-0.17000671D-08
(7,4)	-0.59353936D-09	-0.20564594D-09
(8,4)	-0.30416145D-09	0.68776175D-10
(9,4)	0.18185857D-10	0.39600605D-10
(10,4)	-0.41988092D-10	-0.66383804D-10
(11,4)	0.21706830D-10	-0.31426307D-10
(12,4)	-0.16103314D-11	-0.13075824D-10
(5,5)	0.32954778D-09	-0.16403877D-08
(6,5)	-0.21086437D-09	-0.42858549D-09
(7,5)	-0.61152550D-12	0.20537255D-10
(8,5)	-0.13386969D-10	0.10644993D-10
(9,5)	-0.28465477D-11	-0.95455361D-11
(10,5)	-0.70420595D-11	-0.46278478D-11
(11,5)	0.90622364D-12	0.13456119D-11
(12,5)	0.46838397D-12	-0.70876758D-13

E.   COEFFICIENTS OF THE SPHERICAL HARMONICS FOR EARTH
        (GODDARD EARTH MODEL) (CONTINUED)

(N,M)	C-MATRIX	S-MATRIX
(6,6)	0.64295796D-11	-0.56608237D-10
(7,6)	-0.22248062D-10	0.11624302D-10
(8,6)	-0.16723529D-11	0.86346303D-11
(9,6)	0.81164769D-12	0.33870581D-11
(10,6)	-0.86576526D-13	-0.45648118D-12
(11,6)	-0.22851966D-13	0.31873203D-12
(12,6)	0.14076353D-12	0.12951053D-12
(7,7)	0.28436247D-12	0.18184031D-11
(8,7)	0.40186111D-12	0.35238946D-12
(9,7)	-0.14485196D-12	-0.89473858D-13
(10,7)	0.75899831D-15	-0.27812394D-13
(11,7)	0.25118064D-14	-0.46294005D-13
(12,7)	-0.22689660D-14	-0.17729187D-14
(8,8)	-0.11440856D-12	0.10813679D-12
(9,8)	0.57680608D-13	-0.70069340D-14
(10,8)	0.32707442D-14	-0.15419090D-13
(11,8)	-0.79710182D-15	0.27602137D-14
(12,8)	-0.59655886D-15	-0.53289681D-15
(9,9)	-0.27852107D-14	0.68246085D-14
(10,9)	0.21771546D-14	-0.59644097D-15
(11,9)	0.20255688D-15	0.29791962D-15
(12,9)	0.80040502D-16	0.15299252D-15
(13,9)	0.11669343D-15	0.72904407D-16
(14,9)	0.21429960D-16	0.39336402D-16
(15,9)	0.19111588D-16	0.12950356D-16
(10,10)	0.23845364D-15	-0.16547946D-15
(11,10)	-0.11441825D-15	-0.63795139D-17
(12,10)	-0.41115119D-18	0.92092414D-17
(11,11)	0.10895643D-16	-0.72917983D-17
(12,11)	-0.12096806D-18	0.17660793D-17
(14,11)	0.94700000D-21	-0.47300000D-21

E.   COEFFICIENTS OF THE SPHERICAL HARMONICS FOR EARTH
     (GODDARD EARTH MODEL)   (CONTINUED)

(N,M)	C-MATRIX	S-MATRIX
(12,12)	-0.16126775D-18	-0.10248546D-18
(13,12)	-0.53717746D-19	0.18737420D-18
(14,12)	0.14184646D-20	-0.21497760D-19
(15,12)	-0.68609172D-20	0.26801588D-20
(16,12)	0.14526655D-20	-0.85449803D-21
(17,12)	0.33392679D-21	-0.13396800D-21
(18,12)	-0.85843786D-21	-0.32550995D-21
(19,12)	-0.21429342D-21	-0.25192098D-21
(20,12)	-0.10002395D-23	-0.19296444D-22
(21,12)	-0.67334600D-22	-0.38649635D-22
(22,12)	-0.45549188D-22	0.55756132D-23
(13,13)	-0.23167104D-19	0.25774183D-19
(14,13)	0.12735201D-20	0.33889121D-20
(15,13)	-0.53201984D-21	0.10528166D-22
(16,13)	0.10899755D-21	-0.22497911D-22
(17,13)	0.14060790D-22	0.27931267D-22
(18,13)	-0.90043288D-23	-0.39534429D-22
(19,13)	-0.13189508D-22	-0.20960077D-22
(20,13)	0.45213213D-24	0.31786838D-24
(21,13)	-0.31385394D-23	0.10903924D-24
(22,13)	-0.23237609D-23	0.28014205D-24
(14,14)	-0.62973273D-21	-0.62607011D-22
(15,14)	0.13944315D-22	-0.49026213D-22
(16,14)	-0.14703747D-22	-0.27300938D-22
(17,14)	-0.31001266D-23	-0.64746352D-24
(18,14)	-0.69208627D-24	-0.45186540D-24
(19,14)	0.76819701D-25	0.10456152D-24
(20,14)	0.97777069D-25	-0.13634787D-24
(21,14)	0.78997767D-25	0.44469234D-25
(22,14)	-0.38730925D-25	0.86391484D-26

F.   COEFFICIENTS OF THE SPHERICAL HARMONICS FOR EARTH
       (NWL MODEL)

       THE VALUES GIVEN BELOW FOR THE C AND S MATRICES (8X8) ARE
STORED IN PHOTONAP AS "DEFAULT" CONSTANTS. ONLY THE ELEMENTS OF THE
LOWER DIAGONAL (N .GE. M) WHICH ARE USED IN THE PROGRAM HAVE BEEN
LISTED.

(N,M)	C-MATRIX		S-MATRIX	
(0,0)	1.		0.	
(1,0)	0.		0.	
(2,0)	-0.10826817	D-2	0.	
(3,0)	0.25928363	D-5	0.	
(4,0)	0.153	D-5	0.	
(5,0)	0.16583124	D-6	0.	
(6,0)	-0.793221286	D-6	0.	
(7,0)	0.426028163	D-6	0.	
(1,1)	0.		0.	
(2,1)	0.25819888	D-7	0.7733	D-7
(3,1)	2.32226542	D-6	0.302	D-6
(4,1)	-0.47434165	D-6	-0.549	D-6
(5,1)	0.256904652	D-7	-0.107	D-6
(6,1)	-0.708116211	D-7	0.1495	D-6
(7,1)	0.219577515	D-7	0.659	D-8
(2,2)	0.158146814	D-5	-0.985	D-6
(3,2)	0.33131808	D-6	-0.311	D-6
(4,2)	0.603738364	D-7	0.149	D-6
(5,2)	0.987191792	D-7	-0.493	D-7
(6,2)	0.199045344	D-7	-0.597135	D-7
(7,2)	0.298807137	D-7	-0.1985	D-7
(3,3)	0.794827	D-7	0.23	D-6
(4,3)	0.59761426	D-7	-0.101594	D-7
(5,3)	-0.9910308	D-8	-0.397	D-8
(6,3)	-0.4146778	D-9	0.289	D-8
(7,3)	0.49300664	D-8	0.985	D-9
(4,4)	-0.99305623	D-8	0.99305623	D-8
(5,4)	-0.397100076	D-8	0.107	D-8
(6,4)	-0.98422298	D-9	-0.98422298	D-9
(7,4)	-0.9980591	D-9	-0.51	D-9
(5,5)	0.4924474	D-9	-0.105	D-8
(6,5)	-0.9684786	D-10	-0.596	D-9
(7,5)	0.21235299	D-10	0.10598	D-10
(6,6)	-0.100181314	D-9	-0.100181314	D-9
(7,6)	-0.3054029	D-10	-0.200917	D-10

G.   COEFFICIENTS OF THE SPHERICAL HARMONICS FOR MOON

THE VALUES GIVEN BELOW FOR THE C AND S MATRICES (11X11) ARE
STORED IN PHOTONAP AS "DEFAULT" CONSTANTS. ONLY THE ELEMENTS OF THE
LOWER DIAGONAL (N .GE. M) WHICH ARE USED IN THE PROGRAM HAVE BEEN
LISTED.

(N,M)	C-MATRIX		S-MATRIX	
(0,0)	1.		0.	
(1,0)	0.		0.	
(2,0)	-.20263	D-3	0.	
(3,0)	.2223	D-4	0.	
(4,0)	- .941	D-5	0.	
(5,0)	.1614	D-4	0.	
(6,0)	.1089	D-4	0.	
(7,0)	- .1734	D-4	0.	
(8,0)	.2011	D-4	0.	
(1,1)	0.		0.	
(2,1)	- .878	D-5	.15	D-5
(3,1)	.3636	D-4	.74	D-5
(4,1)	- .1236	D-4	.564	D-5
(2,2)	.2191	D-4	.131	D-4
(3,2)	- .259	D-5	- .2	D-5
(4,2)	.361	D-5	.51	D-6
(3,3)	.265	D-5	- .496	D-5
(4,3)	.164	D-5	- .276	D-5
(4,4)	.91	D-6	.76	D-6

STATION SURVEYS

A.   SURVEY DATUM

PROGRAM ID
NUMBER   DATUM

1   NAD-27, CLARKE 1866 SPHEROID
2   MERCURY DATUM, FISCHER SPHEROID
3   CAPE ARC MODIFIED, CLARKE 1880 SPHEROID
4   TOKYO DATUM, BESSEL SPHEROID
5   C-5
6   OTHER

B.   CURRENT MSFN STATIONS

        THE FOLLOWING TABLES GIVE THE COORDINATES OF THE
CURRENT MSFN STATIONS FOR S-BAND, C-BAND AND STADAN NETWORKS.

S-BAND

STA	LO	HI	STATION NAME	TYPE	LAT (DEGREES)	LONG (DEGREES)	HEIGHT (METERS)
MIL	71	1	MERRITT IS.	USBS30	28.508272	-80.693417	10
BDA	2	2	BERMUDA	USBS30	32.351286	-64.658181	21
GBM	41	4	GRAND BAHAMA	USBS30	26.632858	-78.237664	5
ANG	91	5	ANTIGUA IS.	USBS30	17.016692	-61.752689	50
CRO	8	8	CARNARVON, AUSTRALIA	USBS30	-24.907592	113.724247	58
HAW	12	9	HAWAII	USBS30	22.124897	-159.664989	1150
GYM	14	10	GUAYMAS, MEXICO	USBS30	27.963206	-110.720850	19
TFX	16	11	CORPUS CHRISTI, TEXAS	USBS30	27.653750	-97.378469	10
GWM	24	12	GUAM	USBS30	13.309244	144.734414	127
GDS	28	13	GOLDSTONE, CALIFORNIA	USBS85	35.341694	-116.873289	965
GLD	92		PIONEER	USBS85	35.389669	-116.849061	1029
ACN	75	14	ASCENSION	USBS30	-7.955056	-14.327578	592
CNB	25	15	CANBERRA, AUSTRALIA	USBS85	-35.597222	148.979167	1097
NBF	93		TIDBINBILLA, AUSTRALIA	USBS85	-35.402233	148.980058	673
MAD	23	17	MADRID, SPAIN	USBS85	40.455358	-4.167394	825
RID	94		CEREBROS, SPAIN	USBS85	40.452983	-4.366767	778
CYI	4	18	GRAND CANARY IS.	USBS30	27.764536	-15.634536	173

CURRENT MSFN STATIONS

C-BAND

STA	LO	HI	STATION NAME	TYPE	LAT (DEGREES)	LONG (DEGREES)	HEIGHT (METERS)
BDA	2	2	BERMUDA	FPQ-6	32.347964	-64.653742	19
BDA	2	2	BERMUDA	FPS-16	32.348103	-64.653800	18
CYI	4	4	GRAND CANARY IS.	MPS-26	27.763206	-15.634814	168
CRO	8	8	CARNARVON, AUSTRALIA	FPQ-6	-24.897378	113.716078	62
WOM	9	9	WOOMERA, AUSTRALIA	FPS-16	-30.819728	136.836989	151
HAW	12	12	HAWAII	FPS-16	22.122092	-159.665383	1140
CAL	13	13	PT. ARGUELLO, CALIF.	FPS-16	34.582903	-120.561150	646
EGL	17	17	EGLIN AFB	FPS-16	30.421767	-86.798114	28
PAF	21	21	PATRICK AFB	FPQ-6	28.226553	-80.599292	15
CNV	31	31	CP. KENNEDY	FPS-16	28.481767	-80.576514	14
GBI	41	41	GRAND BAHAMA	FPS-16	26.615778	-78.347833	14
GBI	41	41	GRAND BAHAMA	TPQ-18	26.636350	-78.267722	12
GTI	51	51	GRAND TURK IS.	TPQ-18	21.462889	-71.132114	28
SSI	61	61	SAN SAL.	FPS-16	24.118825	-74.504136	5
MLA	71	71	MERRITT IS.	TPQ-18	28.424860	-80.664417	12
ASC	75	75	ASCENSION IS.	FPS-16	-7.934847	-14.412606	110
ASC	75	75	ASCENSION IS.	TPQ-18	-7.972761	-14.401694	143
PRE	76	76	PRETORIA	MPS-25	-25.943734	28.358489	1626
WHS	85	85	WHITE SANDS, N.M.	FPS-16	32.358222	-106.369564	1232
ANT	91	91	ANTIGUA IS.	FPQ-6	17.144031	-61.792850	58

STADAN

STA	LO	HI	STATION NAME	TYPE	LAT (DEGREES)	LONG (DEGREES)	HEIGHT (METERS)
TAN	22	22	TANANARIVE	SBAND	-19.019844	47.302625	1385
TAN	22	22	TANANARIVE	VHF	-19.020939	47.302625	1385
ROS	26	26	ROSMAN, N.C.	SBAND	35.196034	-82.875864	876
ROS	26	26	ROSMAN, N.C.	VHF	35.194934	-82.875864	876
SAN	27	27	SANTIAGO, CHILE	SBAND	-33.156481	-70.666742	695
SAN	27	27	SANTIAGO, CHILE	VHF	-33.151167	-70.666742	695
FRB	28	28	FAIRBANKS, ALASKA	SBAND	64.972167	-147.512389	371
FRB	28	28	FAIRBANKS, ALASKA	VHF	64.971696	-147.510803	371
CRO	52	52	CARNARVON	SBAND	-24.904128	113.715294	51
CRO	52	52	CARNARVON	VHF	-24.905228	113.715294	51

MEASUREMENTS AND ERROR MODEL TERMS

A.   MEASUREMENTS

        A MEASUREMENT MUST BE DENOTED BY ITS TYPE NUMBER ON THE APPRO-
PRIATE CATEGORY CARD FOR CORRECT ASSOCIATION WITHIN THE PROGRAM. PHOTO-
GRAMMETRIC DATA FALLS INTO A SPECIAL CLASS AND IS GIVEN IN SECTION A.1.

MEASUREMENT
TYPE NUMBER   DESCRIPTION

   1   RANGE.   THE DISTANCE BETWEEN THE OBSERVING STATION AND
             THE SPACECRAFT.   NOMINAL UNITS ARE IN METERS.

   2   AZIMUTH.   THE ANGLE IN THE LOCAL TANGENT MEASURED CLOCK-
             WISE FROM NORTH TO THE PROJECTION OF STATION TO SPACE-
             CRAFT IN THE LOCAL TANGENT PLANE.   UNITS ARE RADIANS.

   3   ELEVATION.   THE ANGLE BETWEEN THE STATION TO SPACECRAFT
             VECTOR AND ITS PROJECTION ONTO THE LOCAL TANGENT PLANE.
             UNITS ARE IN RADIANS.

   4   TOPOCENTRIC RIGHT ASCENSION.   THE ANGLE BETWEEN THE PRO-
             JECTION OF THE STATION-SPACECRAFT VECTOR ONTO THE EARTH'S
             EQUATORIAL PLANE AND THE EARTH CENTER-EQUINOX OF DATE
             VECTOR.   UNITS ARE IN RADIANS.

   5   TOPOCENTRIC DECLINATION.   THE ANGLE BETWEEN THE STATION-
             SPACECRAFT VECTOR AND ITS PROJECTION ONTO THE EARTH'S
             EQUATORIAL PLANE.   UNITS ARE IN RADIANS.

   6   DIRECTION COSINE L.   THE COSINE OF THE ANGLE BETWEEN THE
             STATION-SPACECRAFT VECTOR AND THE LOCAL TANGENT EAST
             POINTING AXIS.   L   IS POSITIVE WHEN THE SPACECRAFT IS
             EAST OF THE STATION.

   7   DIRECTION COSINE M.   THE COSINE OF THE ANGLE BETWEEN THE
             STATION-SPACECRAFT VECTOR AND THE LOCAL TANGENT NORTH
             POINTING AXIS.   M IS POSITIVE WHEN THE SPACECRAFT IS
             NORTH OF THE STATION.

   8   X30.   X-ANGLE FOR 30 FOOT DISH ANTENNA IS DEFINED AS THE
             ANGLE BETWEEN THE PROJECTION OF THE STATION-SPACECRAFT
             THE LOCAL VERTICAL AXIS.   IT IS POSITIVE WHEN THE SPACE-
             CRAFT IS EAST OF THE STATION.   UNITS ARE IN RADIANS.

   9   Y30.   Y-ANGLE FOR 30 FOOT DISH ANTENNA IS DEFINED AS THE
             ANGLE BETWEEN THE STATION-SPACECRAFT VECTOR AND THE PRO-
             JECTION OF THIS VECTOR ONTO THE EAST-VERTICAL PLANE.   IT
             IS POSITIVE WHEN THE SPACECRAFT IS NORTH OF THE STATION.

10   ALTIMETER. THE HEIGHT OF THE SPACECRAFT ABOVE THE REFER-
            ENCE PLANETARY (EARTH) SURFACE. NOMINAL UNITS ARE METERS.

11   RANGE RATE. TIME DERIVATIVE OF RANGE (MEAS. TYPE 1).
            NOMINAL UNITS ARE METERS/SEC.

12   DIRECTION COSINE L RATE.

13   DIRECTION COSINE M RATE.

14   X85. X-ANGLE FOR 85 FOOT ANTENNA. THE ANGLE BETWEEN
            THE PROJECTION OF THE STATION-SPACECRAFT VECTOR ONTO
            THE NORTH-VERTICAL PLANE AND THE STATION VERTICAL AXIS.
            IT IS POSITIVE WHEN THE SPACECRAFT IS SOUTH OF THE STA-
            TION. UNITS ARE IN RADIANS.

15   Y85. Y-ANGLE FOR 85 FOOT ANTENNA. THE ANGLE BETWEEN
            THE STATION-SPACECRAFT VECTOR AND ITS PROJECTION ONTO
            THE NORTH-VERTICAL PLANE. IT IS POSITIVE WHEN THE
            VEHICLE IS EAST OF THE STATION. UNITS ARE IN RADIANS.

16   RANGE SUM. THIS MEASUREMENT IS ASSOCIATED WITH SATEL-
            LITE TO SATELLITE TRACKING. IT IS DEFINED AS THE DIS-
            TANCE BETWEEN THE OBSERVING STATION TO THE SECONDARY
            (SYNCHRONOUS) SATELLITE PLUS THE DISTANCE BETWEEN THE
            LATTER SATELLITE AND THE PRIMARY (USER) SATELLITE.
            NOMINAL UNITS ARE IN METERS.

17   RANGE SUM RATE. THE TIME DERIVATIVE OF RANGE SUM (MEAS.
            TYPE 16). NOMINAL UNITS ARE METERS/SEC.

18   AVERAGE RANGE RATE. THE CHANGE IN RANGE DIVIDED BY
            THE ELAPSED TIME INCREMENT DURING WHICH THIS CHANGE
            IN RANGE OCCURRED. FOR SMALL TIME INCREMENTS, THIS
            MEASUREMENT TENDS TO BE IDENTICAL WITH RANGE RATE.

19 *   ELAPSED TIME FOR RANGING. THIS MEASUREMENT TYPE IS
            ASSOCIATED WITH SATELLITE TO SATELLITE TRACKING OR
            TRACKING TO A REMOTE GROUND TRANSPONDER. IT IS DEFINED
            AS (1) THE TOTAL SIGNAL PROPAGATION TIME OVER THE PATH:
            GROUND TRANSMITTER-SECONDARY (SYNCHRONOUS) SATELLITE-
            PRIMARY (USER) SATELLITE-SECONDARY SATELLITE-GROUND
            RECEIVER, OR (2) GROUND TRANSMITTER-PRIMARY SATELLITE-
            REMOTE TRANSPONDER-PRIMARY SATELLITE-GROUND RECEIVER.
            FOR FURTHER DETAILS SEE CATEGORY 999 CARD. UNITS ARE IN
            SECONDS.

20 *   ELAPSED TIME FOR DOPPLER. THIS MEASUREMENT IS ASSOCIATED
            WITH SATELLITE TO SATELLITE TRACKING OR REMOTE TRANS-
            PONDER TRACKING. IT IS DEFINED AS THE ELAPSED TIME
            REQUIRED TO COUNT A FIXED NUMBER OF DOPPLER PLUS BIAS
            FREQUENCY CYCLES. FOR FURHTER INFORMATION SEE CATEGORY
            999 CARD. UNITS ARE IN SECONDS.

* THESE MEASUREMENTS ARE ALSO USED FOR RAW GRARR DATA GENERATION. A
  SECONDARY ARC IS NOT REQUIRED FOR RAW GRARR DATA.

21-26   THESE MEASUREMENT TYPES CORRESPOND TO GEOCENTRIC STATE
VECTOR (SIX ELEMENTS) OBSERVATIONS X,Y,Z,XDOT,YDOT,
ZDOT RESPECTIVELY. STATE VECTOR OBSERVATIONS MAY BE
IN ANY ONE OF 3 COORDINATE SYSTEMS: INERTIAL OF DATE,
MEAN OF 1950, OR EARTH FIXED. NOMINAL UNITS ARE IN
METERS AND METERS/SEC.

27   GEOCEIVER MEASUREMENT (RANGE DIFFERENCES)

A.1   PHOTOGRAMMETRIC MEASUREMENTS

FOR PHOTOGRAMMETRIC TYPE MEASUREMENTS, THE FIRST NINE MEAS-
UREMENT TYPES ARE MODIFIED AS FOLLOWS. MEASUREMENTS ARE IDENTIFIED AS
BEING PHOTOGRAMMETRIC BY A NEGATIVE STATION IDENTIFICATION FOR THE
STATION ASSOCIATION WITH PHOTOGRAMMETRIC MEASUREMENTS (SEE KEY 2 OF
CATEGORY 701 CARD AND KEY 3 OF CATEGORY 301 CARD).

MEASUREMENT
TYPE NUMBER   DESCRIPTION

1   B1(1)   (STELLAR CAMERA 1
2   B1(2)   ORIENTATION
3   B1(3)   ANGLES)

4   B2(1)   (STELLAR CAMERA 2
5   B2(2)   ORIENTATION
6   B2(3)   ANGLES)

7   X-PLATE. X COORDINATE MEASURED ON PHOTOGRAPH. UNITS
NORMALLY IN MILLIMETERS OR MICRONS. UNITS MUST BE IN
METERS IN PROGRAM.

8   Y-PLATE. Y COORDINATE MEASURED ON PHOTOGRAPH. UNITS
NORMALLY IN MILLIMETERS OR MICRONS. UNITS MUST BE IN
METERS IN PROGRAM.

9   RANGE. DISTANCE FROM SATELLITE TO GROUND POINT. UNITS
IN METERS.

B.   ERROR MODELS AND PARAMETERS

        THE GENERALIZED LEAST SQUARES ESTIMATION PROCESS UTILIZED BY
THE PROGRAM MAKES USE OF A SET OF LINEARIZED OBSERVATIONAL EQUATIONS
OF THE FORM

        M(T) = A(T,1)*P(1) + A(T,2)*P(2) + ... A(T,N)*P(N)

WHERE

        M(T)   REPRESENTS THE MEASUREMENT DISCREPANCY AT TIME T
                    (OBSERVED MINUS COMPUTED).

        A(T,K)   REPRESENTS THE PARTIAL DERIVATIVE OF THE MEASUREMENT
                    (AT TIME T) WITH RESPECT TO ERROR MODEL PARAMETER
                    NUMBER K.

        P(K)   REPRESENTS THE K-TH ERROR MODEL PARAMETER DISCREPANCY
                    (TRUE MINUS NOMINAL).

        FOR EACH MEASUREMENT TYPE THE USER MAY SPECIFY ANY COMBINATION
(OUT OF THE ALLOWABLE SET) OF ERROR MODEL PARAMETERS TO BE RECOVERED OR
ESTIMATED. THESE MAY INCLUDE SATELLITE STATE VECTOR ELEMENTS AT EPOCH,
SPHERICAL HARMONIC COEFFICIENTS ASSOCIATED WITH THE GRAVITY FIELD, SATEL-
LITE DRAG AND SOLAR PRESSURE COEFFICIENTS, TRACKING STATION COORDINATES,
PLUS A NUMBER OF MEASUREMENT PECULIAR BIAS AND TIMING PARAMETERS.

        EACH OF THE PERMISSIBLE ERROR MODEL PARAMETERS IS IDENTIFIED IN
THE PROGRAM BY MEANS OF A SO-CALLED "ERROR MODEL PARAMETER NUMBER" AS
DESCRIBED ON THE FOLLOWING PAGE.

ERROR MODEL PARAMETER NO.	DESCRIPTION	APPLIES TO MEAS. TYPES
1	1ST COMPONENT OF STATE VECTOR AT EPOCH	ALL
2	2ND COMPONENT OF STATE VECTOR AT EPOCH	ALL
3	3RD COMPONENT OF STATE VECTOR AT EPOCH	ALL
4	4TH COMPONENT OF STATE VECTOR AT EPOCH	ALL
5	5TH COMPONENT OF STATE VECTOR AT EPOCH	ALL
6	6TH COMPONENT OF STATE VECTOR AT EPOCH	ALL
7	CORRECTION TO STATION SURVEY (EAST)	1-9,11-20 AND 27
8	CORRECTION TO STATION SURVEY (NORTH)	1-9,11-20 AND 27
9	CORRECTION TO STATION SURVEY (VERTICAL)	1-9,11-20 AND 27
10	MEASUREMENT BIAS (ZERO SET)	ALL
11	MEASUREMENT TIMING ERROR	ALL EXCEPT 24,25,26
12	REFRACTION	1,3,11,18 AND 27
13	PARAMETER WHICH IS PROPORTIONAL TO ELAPSED TIME FROM EPOCH	ALL EXCEPT 16,17,21-26
14	SCALE, PARAMETER WHICH IS PROPORTIONAL TO VALUE OF MEASUREMENT	ALL
15	DYNAMIC LAG (PROPORTIONAL TO SECOND TIME DERIVATIVE OF MEASUREMENT)	1,2,3,11,13
16	AZIMUTH PLANE TILT ERROR	2,3
18	NON-PERPENDICULARITY OF RADAR ELEVATION SHAFT	2
18	ERROR DUE TO DEFLECTION OF RF RADAR AXIS FROM MECHANICAL AXIS	3
19	ERROR DUE TO NON-PERPENDICULARITY OF RADAR RF AXIS AND ELEVATION BEARING SHAFT	2
19	ERROR MODEL TERM PROPORTIONAL TO SIN(ELEVATION)	3
20	ERROR MODEL TERM PROPORTIONAL TO SIN(AZIMUTH)	2
21	ERROR MODEL TERM PROPORTIONAL TO COS(AZIMUTH)	2

22	1ST COMP. OF SECONDARY SATELLITE AT EPOCH	16,17,19,20 AND 27
23	2ND COMP. OF SECONDARY SATELLITE AT EPOCH	16,17,19,20 AND 27
24	3RD COMP. OF SECONDARY SATELLITE AT EPOCH	16,17,19,20 AND 27
25	4TH COMP. OF SECONDARY SATELLITE AT EPOCH	16,17,19,20 AND 27
26	5TH COMP. OF SECONDARY SATELLITE AT EPOCH	16,17,19,20 AND 27
27	6TH COMP. OF SECONDARY SATELLITE AT EPOCH	16,17,19,20 AND 27
28	SATELLITE SOLAR PRESSURE COEFFICIENT	ALL
29	SATELLITE DRAG COEFFICIENT	ALL

THE INPUT CONTROL INFORMATION ASSOCIATED WITH EACH OF THE ABOVE TYPES OF ERROR MODEL PARAMETERS IS SPECIFIED BY THE PROGRAM USER BY MEANS OF THE CATEGORY 601 INPUT CARDS. THE USER IDENTIFIES THE ERROR MODEL TYPE BY MEANS OF KEY 5 (COLUMNS 26-28) AND THE APPLICABLE MEAS- UREMENT NUMBER BY MEANS OF KEY 6 (COLUMNS 29-31). IF MORE THAN ONE MEASUREMENT NUMBER IS CONTRIBUTING TO THE RECOVERY OF A GIVEN PARAM- ETER TYPE, THE USER INPUTS SUCH INFORMATION BY MEANS OF THE CATE- GORY 602 CONTROL CARDS.

THE RECOVERY OF GRAVITY COEFFICIENT PARAMETERS IS SPECIFIED BY MEANS OF THE CATEOGRY 604 AND 605 CONTROL CARDS AND ALL MEASUREMENT TYPES CON- TRIBUTE TO THEIR RECOVERY OR ESTIMATION. THESE PARAMETERS ARE ALWAYS TREATED BY THE PROGRAM AS TOTALLY STABLE AND ARE ASSIGNED PARAMETER NUM- BERS (BY THE PROGRAM) STARTING WITH THE NUMBER FOLLOWING THE LARGEST TOTALLY STABLE PARAMETER NUMBER SPECIFIED BY THE USER VIA THE CATEGORY 601 CARDS.

STATE VECTOR COMPONENTS MAY BE CARTESIAN OR KEPLERIAN. SEE CATEGORY 205 CARD.

GEOCEIVER MEASUREMENTS (TYPE 27) ARE MODELLED AS RANGE DIFFER- ENCES. FOR THESE MEASUREMENTS, THEREFORE, A BIAS (ERROR MODEL TERM 10) HAS NO EFFECT. THE EFFECT OF A FREQUENCY BIAS IN THE TRANSMITTER IS REPRESENTED BY ERROR MODEL TERM 13.

ERROR MODEL PARAMETER NO.	DESCRIPTION	APPLIES TO MEAS. TYPES
1	1ST COMPONENT OF STATE VECTOR AT EPOCH	7,8,9
2	2ND COMPONENT OF STATE VECTOR AT EPOCH	7,8,9
3	3RD COMPONENT OF STATE VECTOR AT EPOCH	7,8,9
4	4TH COMPONENT OF STATE VECTOR AT EPOCH	7,8,9
5	5TH COMPONENT OF STATE VECTOR AT EPOCH	7,8,9
6	6TH COMPONENT OF STATE VECTOR AT EPOCH	7,8,9
11	MEASUREMENT TIMING ERROR	7,8,9
12	TERRAIN CAMERA ORIENTATION ANGLE (A1)	1-9
13	TERRAIN CAMERA ORIENTATION ANGLE (A2)	1-9
14	TERRAIN CAMERA ORIENTATION ANGLE (A3)	1-9
15	TERRAIN CAMERA/STELLAR CAMERA 1 INTERLOCK ANGLE (E1)	1,2,3
15	X COORDINATE OF PRINCIPAL POINT IN IMAGE PLANE	7,8
16	TERRAIN CAMERA/STELLAR CAMERA 1 INTERLOCK ANGLE (E2)	1,2,3
16	Y COORDINATE OF PRINCIPAL POINT IN IMAGE PLANE	7,8
17	TERRAIN CAMERA/STELLAR CAMERA 1 INTERLOCK ANGLE (E3)	1,2,3
17	CAMERA FOCAL LENGTH (C)	7,8
18	TERRAIN CAMERA/STELLAR CAMERA 2 INTERLOCK ANGLE (F1)	4,5,6
18	SYMMETRIC RADIAL LENS DISTORTION PARAMETER (K1)	7,8
19	TERRAIN CAMERA/STELLAR CAMERA 2 INTERLOCK ANGLE (F2)	4,5,6
19	SYMMETRIC RADIAL LENS DISTORTION PARAMETER (K2)	7,8
20	TERRAIN CAMERA/STELLAR CAMERA 2 INTERLOCK ANGLE (F3)	4,5,6

PARAMETER NO.	DESCRIPTION	MEAS. TYPES
21	LENS DECENTERING DISTORTION PARAMETER (P1)	7,8
22	LENS DECENTERING DISTORTION PARAMETER (P2)	7,8
23	LENS DECENTERING DISTORTION PARAMETER (P3)	7,8
24	X COORDINATE OF GROUND POINT (GX)	7,8,9
25	Y COORDINATE OF GROUND POINT (GY)	7,8,9
26	Z COORDINATE OF GROUND POINT (GZ)	7,8,9
28	SATELLITE SOLAR PRESSURE COEFFICIENT	7,8,9
29	SATELLITE DRAG COEFFICIENT	7,8,9

A.   JOB CONTROL LANGUAGE FOR RUNNING PHOTONAP ON CDC 6400 (EXAMPLE)

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ETGEM,T700.

TASK(TNET74549,PW=*****,TRTS)MORDUCH

ATTACH(DTEMP,TEST,ID=ET74549)

UPDATE(D,K=CARDS,P=DTEMP,L=7,8,*=-)

ATTACH(NAPO,ID=ET74549)

RFL(176000)

SEGLOAD(I=CARDS)

LOAD(NAPO)

EXECUTE(,CARDS)

CLIST(T=U)

EXIT(S)

CLIST(T=U)

789

-COMPILE SEG

-COMPILE PB4

789

6789
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NOTE.   THE ABOVE EXAMPLE IS SET UP TO RUN TEST CASE PB4, WHICH IS
        STORED ON FILE TEST. TO RUN A USER SUPPLIED DECK:

        (I)   REPLACE ABOVE EXECUTE CARD BY   EXECUTE.

        (II)   DELETE   -COMPILE PB4   CARD

        (III) INSERT USER SUPPLIED DECK BETWEEN 789 AND 6789 CARDS

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