NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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February 26, 1968

RTCC REQUIREMENTS FOR MISSIONS E, F, AND G: GREENWICH HOUR ANGLE FORMULATION FOR THE PREDICTOR

By Paul F. Flanagan,
Mathematical Physics Branch

MISSION PLANNING AND ANALYSIS DIVISION

MANNED SPACECRAFT CENTER
HOUSTON, TEXAS

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PROJECT APOLLO

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Mathematical Physics Branch

Approved: _____
John P. Mayer, Chief
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RTCC REQUIREMENTS FOR MISSIONS E, F, AND G:

GREENWICH HOUR ANGLE FORMULATION FOR THE PREDICTOR

By Paul F. Flanagan

SUMMARY AND INTRODUCTION

The formulation is presented for computing the hour angle from the mean equinox at the beginning of the nearest Besselian year to the Greenwich meridian for the RTCC predictor for Missions E, F, and G. The method of computing this angle is to define the angle at the reference epoch (midnight preceding launch) and then to compute the angle for any time during the epoch year using the mean sidereal rotation rate relative to a star-fixed reference frame. The validity of this procedure was established using the nutation-precession matrices and apparent Greenwich hour angles used in the RTCC Mission E orbit determination program. The formulation will be used to evaluate the earth sectoral (J_{22}, λ_{22}) gravitational acceleration.

FORMULATION

To define the hour angle at midnight preceding launch, it is first necessary to compute the universal time of the beginning of the Besselian year of the epoch (NBY). At that time the hour angle is 18^h40^m by definition. Then the angle the earth rotates through from that time to midnight prior to launch is computed using the mean sidereal rotational rate of the earth. The time of the beginning of the Bessilian year is computed by evaluating Newcomb's equation. The reference presents (page 73) Newcomb's equation for computing the Greenwich hour angle at midnight relative to a precessing reference frame, R_u:

$$R_u = 18^h38^m45.836 + 8640184.^s542T_u + 0.^s0939T_u^2$$

where T_u is the number of Julian centuries of universal time elapsed since Greenwich mean moon of 1900 January 0.

The reference also presents (page 30) the definition of the beginning of the Besselian year as the instant when the right ascension of the fictitious mean sun, affected by aberration and measured from the mean equinox, is 18^h40^m. In terms of Newcomb's equation, the beginning of the Besselian year is the time when Newcomb's equation equals $(18^h40^m + n\ 24^h)$ where n is the integral number of years from 1900.

Thus determining the beginning of the Besselian year involves solving the quadratic for the time in Julian centuries from mean moon 1900 January 0. to the beginning of the Besselian year defined by the epoch year, E. This time, T, is now converted to days from January 0. (DE) from the definition that a Julian century equals 36 525 days:

$$DE = 36525T - 365(E - 1900.) + 0.5 - XN$$

where XN is the number of leap years from 1900 to the epoch year not including the epoch year. The values for DE have been computed and agree to the accuracy shown in the reference (page 434).

Table I includes values of DE computed using these equations for epochs 1960 through 1979.

After determining the time of the beginning of the Besselian year and the hour angle associated with that time, the hour angle for midnight preceding launch during the epoch year is computed. The mean sidereal rotation rate relative to a nonprecessing axis is used (page 76): 1.00273811906 rev/day.

The following defines the base angle, BHA, at midnight prior launch: $BHA = 2\pi/3.6 + W_1$ DELTA where DELTA is days from the beginning of the Besselian year to the base midnight and W_1 is the incremental daily rotation rate (rad/day).

The hour angle for any subsequent integration step is then $HA = BHA + W_2 H$, modulo 2 where H is hours from the base midnight and W_2 is the hourly rotation rate (rad/hr).

COMPUTATIONAL PROCEDURE

Table II presents a printout of the subroutine that was developed to compute the angles to compare with the nutation-precession data used by the RTCC orbit determination program.

Table III supplies reference data generated using this procedure.

Initialization

Initialization occurs as follows:

1. Input epoch year, E, base year, Y, and base day, D. (January 1 is day 1).

2. Compute beginning of Besselian year, DE, by first finding the number of leap years from 1900 to epoch year not including the epoch year:

$$XN = \text{integral part } ((E - 1901)/4)$$

Then, find the time in Julian centuries from mean moon 1900 January 0:

$$T = 2C/(-B - \sqrt{B^2 - 4AC})$$

where

$$A = .0929$$

$$B = 8640184.542$$

$$C = -86400\ (E - 1900.) - 74.164$$

Finally, compute the days from January 0. of epoch year:

$$DE = 36525T - 365\ (E - 1900) + .5 - XN$$

3. Compute days from epoch to midnight of base day, DELTA:

If Y = E then DI = D

If Y $\neq$ E determine if Y is a leap year

X = Y modulo 4

If Y $\neq$ E and X = 0 DI = D - 366

If Y $\neq$ E and X $\neq$ 0 DI - D - 365

DELTA = DI - DE in days

4. Compute the base hour angle, BHA, (radians).

$$BHA = 2/3.6 + W_1 \text{ DELTA}$$

where

$$W_1 = 1.720217954160054 \times 10^{-2}$$

Evaluation at Each Integration Step

Each integration step is evaluated as follows:

1. Input hours from base midnight, H, and base hour angle, BHA.

2. Compute hour angle

$$HA = BHA + W_2 H, \text{ modulo } 2\pi$$

$$W_2 = 2.625161452800495 \times 10^{-1} \text{ (rad/hr)}$$

TABLE I.- BEGINNING OF THE NEAREST BESSELIAN YEAR

1.	54530199	DAYS	FROM JAN	0. 1960
	.58749612	DAYS	FROM JAN	0. 1961
	.82968996	DAYS	FROM JAN	0. 1962
1.	07188384	DAYS	FROM JAN	0. 1963
1.	31407763	DAYS	FROM JAN	0. 1964
	.55627135	DAYS	FROM JAN	0. 1965
	.79846499	DAYS	FROM JAN	0. 1966
1.	04065855	DAYS	FROM JAN	0. 1967
1.	28285202	DAYS	FROM JAN	0. 1968
	.52504542	DAYS	FROM JAN	0. 1969
	.76723875	DAYS	FROM JAN	0. 1970
1.	00943199	DAYS	FROM JAN	0. 1971
1.	25162517	DAYS	FROM JAN	0. 1972
	.49381825	DAYS	FROM JAN	0. 1973
	.73601126	DAYS	FROM JAN	0. 1974
	.97820419	DAYS	FROM JAN	0. 1975
1.	22039704	DAYS	FROM JAN	0. 1976
	.46258982	DAYS	FROM JAN	0. 1977
	.70478251	DAYS	FROM JAN	0. 1978
	.94697513	DAYS	FROM JAN	0. 1979

TABLE II.- SUBROUTINE HANGLE

```
      SUBROUTINE HANGLE (E,Y,D,BHA,H,HA,I)
C             HANGLE COMPUTES THE HOUR ANGLE (RAD) FROM THE MEAN
C             EQUINOX AT THE BEGINNING OF THE NEAREST BESSELIAN
C             YEAR TO GREENWICH
C
C             E    EPOCH YEAR
C             Y    YEAR
C             D    DAY
C             BHA  HOUR ANGLE AT MIDNIGHT OF  INITIALIZATION DAY
C             H    HOURS FROM  MIDNIGHT OF INITIALIZATION DAY
C             HA    HOUR ANGLE OF GREENWICH AT H
C             I    ZERO FOR INITIALIZATION , ONE AFTER
      DOUBLE PRECISION  BHA,DELTA,W1,W2,HA,PI2,H,XN,C,B,A,T,DE,YRS
     DATA W1/1.7202179541600540-2/,
     1 W2/2.6251614528004950-1/,
     2 A/0.0929D0/,
     3 B/8640184.542D0/,
     4 PI2/6.283185307179586500/
      IF (I.EQ.1) GO TO 10
      YRS =  E -1900.
     IIN=(E-1901.)/4.
     XN=IIN
      C   =  -86400.0000*  YRS -74.164000
      T   =  2.0D0 * C / (-B -DSQRT( B**2 - 4.0D00*A *C ))
C     T IS THE SOLUTION TO NEWCOMB'S  EQN. FOR THE BEGINNING OF
C     THE BESSELIAN YEAR IN JULIAN CENTURIES - EXP. SUP. EPH P.30,73
      DE  =  36525.0D00* T - 365.0D00* YRS -XN +.5D00
C     DE IS JULIAN CENTURIES CONVERTED TO DAYS FROM JAN 0.0
      X   = AMOD (Y,4.)
      DI  = 0
      IF(Y.NE.E.AND.X.EQ.0.)DI=D-366.0D00
      IF(Y.NE.E.AND.X.NE.0.)DI=D-365.0000
      DELTA = DI-DE
      BHA   = PI2/3.6D00 + W1 * DELTA
   10 HA    =  DMOD (BHA + W2 * H , PI2)
      RETURN
      END
```

TABLE III.- CHECKOUT DATA FOR SUBROUTINE HANGLE

(a) Epoch 1968

Year	Day	Hour	Hour angle, deg	Epoch
1967	151	0	-0.11218542400 03	1968
1967	152	0	-0.11119981170 03	1968
1967	153	0	-0.11021419940 03	1968
1967	154	0	-0.10922858710 03	1968
1967	155	0	-0.10824297480 03	1968
1967	156	0	-0.10725736250 03	1968
1967	157	0	-0.10627175020 03	1968
1967	158	0	-0.10528613800 03	1968
1967	159	0	-0.10430052570 03	1968
1967	160	0	-0.10331491340 03	1968
1967	161	0	-0.10232930110 03	1968
1967	162	0	-0.10134368880 03	1968
1967	163	0	-0.10035807650 03	1968
1967	164	0	-0.99372464240 02	1968
1967	165	0	-0.98386851950 02	1968
1967	166	0	-0.97401239670 02	1968
1967	167	0	-0.96415627380 02	1968
1967	168	0	-0.95430015100 02	1968
1967	169	0	-0.94444402810 02	1968
1967	170	0	-0.93458790520 02	1968
1967	171	0	-0.92473178240 02	1968
1967	172	0	-0.91487565950 02	1968
1967	173	0	-0.90501953670 02	1968
1967	174	0	-0.89516341380 02	1968
1967	175	0	-0.88530729090 02	1968
1967	176	0	-0.87545116810 02	1968
1967	177	0	-0.86559504520 02	1968
1967	178	0	-0.85573892230 02	1968
1967	179	0	-0.84588279950 02	1968
1967	180	0	-0.83602667660 02	1968
1967	181	0	-0.82617055380 02	1968
1967	182	0	-0.81631443090 02	1968
1967	183	0	-0.80645830800 02	1968
1967	184	0	-0.79660218520 02	1968
1967	185	0	-0.78674606230 02	1968
1967	186	0	-0.77688993950 02	1968
1967	187	0	-0.76703381660 02	1968
1967	188	0	-0.75717769370 02	1968

TABLE III.- CHECKOUT DATA FOR SUBROUTINE HANGLE - Continued

Year	Day	Hour	Hour angle, deg	Epoch
1967	189	0	-0.74732157090 02	1968
1967	190	0	-0.73746544800 02	1968
1967	191	0	-0.72760932510 02	1968
1967	192	0	-0.71775320230 02	1968
1967	193	0	-0.70789707940 02	1968
1967	194	0	-0.69804095660 02	1968
1967	195	0	-0.68818483370 02	1968
1967	196	0	-0.67832871080 02	1968
1967	197	0	-0.66847258800 02	1968
1967	198	0	-0.65861646510 02	1968
1967	199	0	-0.64876034230 02	1968
1967	200	0	-0.63890421940 02	1968
1967	201	0	-0.62904809650 02	1968
1967	202	0	-0.61919197370 02	1968
1967	203	0	-0.60933585080 02	1968
1967	204	0	-0.59947972790 02	1968
1967	205	0	-0.58962360510 02	1968
1967	206	0	-0.57976748220 02	1968
1967	207	0	-0.56991135940 02	1968
1967	208	0	-0.56005523650 02	1968
1967	209	0	-0.55019911360 02	1968
1967	210	0	-0.54034299080 02	1968
1967	211	0	-0.53048686790 02	1968
1967	212	0	-0.52063074510 02	1968
1967	213	0	-0.51077462220 02	1968
1967	214	0	-0.50091849930 02	1968
1967	215	0	-0.49106237650 02	1968
1967	216	0	-0.48120625360 02	1968
1967	217	0	-0.47135013070 02	1968
1967	218	0	-0.46149400790 02	1968
1967	219	0	-0.45163788500 02	1968
1967	220	0	-0.44178176220 02	1968
1967	221	0	-0.43192563930 02	1968
1967	222	0	-0.42206951640 02	1968
1967	223	0	-0.41221339360 02	1968
1967	224	0	-0.40235727070 02	1968
1967	225	0	-0.39250114780 02	1968
1967	226	0	-0.38264502500 02	1968
1967	227	0	-0.37278890210 02	1968
1967	228	0	-0.36293277930 02	1968

TABLE III.- CHECKOUT DATA FOR SUBROUTINE HANGLE - Continued

Year	Day	Hour	Hour angle, deg	Epoch
1967	229	0	-0.35307665640 02	1968
1967	230	0	-0.34322053350 02	1968
1967	231	0	-0.33336441070 02	1968
1967	232	0	-0.32350828780 02	1968
1967	233	0	-0.31365216500 02	1968
1967	234	0	-0.30379604210 02	1968
1967	235	0	-0.29393991920 02	1968
1967	236	0	-0.28408379640 02	1968
1967	237	0	-0.27422767350 02	1968
1967	238	0	-0.26437155060 02	1968
1967	239	0	-0.25451542780 02	1968
1967	240	0	-0.24465930490 02	1968
1967	241	0	-0.23480318210 02	1968
1967	242	0	-0.22494705920 02	1968
1967	243	0	-0.21509093630 02	1968
1967	244	0	-0.20523481350 02	1968
1967	245	0	-0.19537869060 02	1968
1967	246	0	-0.18552256780 02	1968
1967	247	0	-0.17566644490 02	1968
1967	248	0	-0.16581032200 02	1968
1967	249	0	-0.15595419920 02	1968
1967	250	0	-0.14609807630 02	1968
1967	251	0	-0.13624195340 02	1968
1967	252	0	-0.12638583060 02	1968
1967	253	0	-0.11652970770 02	1968
1967	254	0	-0.10667358490 02	1968
1967	255	0	-0.96817462000 01	1968
1967	256	0	-0.86961339140 01	1968
1967	257	0	-0.77105216280 01	1968
1967	258	0	-0.67249093420 01	1968
1967	259	0	-0.57392970560 01	1968
1967	260	0	-0.47536847690 01	1968
1967	261	0	-0.37680724830 01	1968
1967	262	0	-0.27824601970 01	1968
1967	263	0	-0.17968479110 01	1968
1967	264	0	-0.81123562470 00	1968
1967	265	0	0.17437666140 00	1968
1967	266	0	0.11599889480 01	1968
1967	267	0	0.21456012340 01	1968
1967	268	0	0.31312135200 01	1968

TABLE III.- CHECKOUT DATA FOR SUBROUTINE HANGLE - Continued

Year	Day	Hour	Hour angle, deg	Epoch
1967	269	0	0.41168258060 01	1968
1967	270	0	0.51024380920 01	1968
1967	271	0	0.60880503780 01	1968
1967	272	0	0.707 [illegible] 01	1968
1967	273	0	0.80592749510 01	1968
1967	274	0	0.90448872370 01	1968
1967	275	0	0.10030499520 02	1968
1967	276	0	0.11016111810 02	1968
1967	277	0	0.12001724100 02	1968
1967	278	0	0.12987336380 02	1968
1967	279	0	0.13972948670 02	1968
1967	280	0	0.14958560950 02	1968
1967	281	0	0.15944173240 02	1968
1967	282	0	0.16929785530 02	1968
1967	283	0	0.17915397810 02	1968
1967	284	0	0.18901010100 02	1968
1967	285	0	0.19886622380 02	1968
1967	286	0	0.20872234670 02	1968
1967	287	0	0.21857846960 02	1968
1967	288	0	0.22843459240 02	1968
1967	289	0	0.23829071530 02	1968
1967	290	0	0.24814683820 02	1968
1967	291	0	0.25800296100 02	1968
1967	292	0	0.26785908390 02	1968
1967	293	0	0.27771520670 02	1968
1967	294	0	0.28757132960 02	1968
1967	295	0	0.29742745250 02	1968
1967	296	0	0.30728357530 02	1968
1967	297	0	0.31713969820 02	1968
1967	298	0	0.32699582100 02	1968
1967	299	0	0.33685194390 02	1968
1967	300	0	0.34670806680 02	1968
1967	301	0	0.35656418960 02	1968
1967	302	0	0.36642031250 02	1968
1967	303	0	0.37627643540 02	1968
1967	304	0	0.38613255820 02	1968
1967	305	0	0.39598868110 02	1968
1967	306	0	0.40584480390 02	1968
1967	307	0	0.41570092680 02	1968
1967	308	0	0.42555704970 02	1968

TABLE III.- CHECKOUT DATA FOR SUBROUTINE HANGLE - Continued

Year	Day	Hour	Hour angle, deg	Epoch
1967	309	0	0.43541317250 02	1968
1967	310	0	0.44526929540 02	1968
1967	311	0	0.45512541820 02	1968
1967	312	0	0.46498154110 02	1968
1967	313	0	0.47483766400 02	1968
1967	314	0	0.48469378680 02	1968
1967	315	0	0.49454990970 02	1968
1967	316	0	0.50440603260 02	1968
1967	317	0	0.51426215540 02	1968
1967	318	0	0.52411827830 02	1968
1967	319	0	0.53397440110 02	1968
1967	320	0	0.54383052400 02	1968
1967	321	0	0.55368664690 02	1968
1967	322	0	0.56354276970 02	1968
1967	323	0	0.57339889260 02	1968
1967	324	0	0.58325501540 02	1968
1967	325	0	0.59311113830 02	1968
1967	326	0	0.60296726120 02	1968
1967	327	0	0.61282338400 02	1968
1967	328	0	0.62267950690 02	1968
1967	329	0	0.63253562980 02	1968
1967	330	0	0.64239175260 02	1968
1967	331	0	0.65224787550 02	1968
1967	332	0	0.66210399830 02	1968
1967	333	0	0.67196012120 02	1968
1967	334	0	0.68181624410 02	1968
1967	335	0	0.69167236690 02	1968
1967	336	0	0.70152848980 02	1968
1967	337	0	0.71138461260 02	1968
1967	338	0	0.72124073550 02	1968
1967	339	0	0.73109685940 02	1968
1967	340	0	0.74095298120 02	1968
1967	341	0	0.75080910410 02	1968
1967	342	0	0.76066522700 02	1968
1967	343	0	0.77052134980 02	1968
1967	344	0	0.78037747270 02	1968
1967	345	0	0.79023359550 02	1968
1967	346	0	0.80008971840 02	1968
1967	347	0	0.80994584130 02	1968
1967	348	0	0.81980196410 02	1968

TABLE III.- CHECKOUT DATA FOR SUBROUTINE HANGLE - Continued

Year	Day	Hour	Hour angle, deg	Epoch
1967	349	0	0.82965808700 02	1968
1967	350	0	0.83951420900 02	1968
1967	351	0	0.84937033270 02	1968
1967	352	0	0.85922645560 02	1968
1967	353	0	0.86908257840 02	1968
1967	354	0	0.87893870130 02	1968
1967	355	0	0.88879482420 02	1968
1967	356	0	0.89865094700 02	1968
1967	357	0	0.90850706990 02	1968
1967	358	0	0.91836319270 02	1968
1967	359	0	0.92821931560 02	1968
1967	360	0	0.93807543850 02	1968
1967	361	0	0.94793156130 02	1968
1967	362	0	0.95778768420 02	1968
1967	363	0	0.96764380710 02	1968
1967	364	0	0.97749992990 02	1968
1967	365	0	0.98735605280 02	1968
1968	1	0	0.99721217560 02	1968
1968	2	0	0.10070682980 03	1968
1968	3	0	0.10169244210 03	1968
1968	4	0	0.10267805440 03	1968
1968	5	0	0.10366366670 03	1968
1968	6	0	0.10464927900 03	1968
1968	7	0	0.10563489130 03	1968
1968	8	0	0.10662050360 03	1968
1968	9	0	0.10760611590 03	1968
1968	10	0	0.10859172810 03	1968
1968	11	0	0.10957734040 03	1968
1968	12	0	0.11056295270 03	1968
1968	13	0	0.11154856500 03	1968
1968	14	0	0.11253417730 03	1968
1968	15	0	0.11351978960 03	1968
1968	16	0	0.11450540190 03	1968
1968	17	0	0.11549101410 03	1968
1968	18	0	0.11647662640 03	1968
1968	19	0	0.11746223870 03	1968
1968	20	0	0.11844785100 03	1968
1968	21	0	0.11943346330 03	1968
1968	22	0	0.12041907560 03	1968

TABLE III.- CHECKOUT DATA FOR SUBROUTINE HANGLE - Continued

Year	Day	Hour	Hour angle, deg	Epoch
1968	23	0	0.12140468790 03	1968
1968	24	0	0.12239030010 03	1968
1968	25	0	0.12337591240 03	1968
1968	26	0	0.12436152470 03	1968
1968	27	0	0.12534713700 03	1968
1968	28	0	0.12633274930 03	1968
1968	29	0	0.12731836160 03	1968
1968	30	0	0.12830397390 03	1968
1968	31	0	0.12928958610 03	1968
1968	32	0	0.13027519840 03	1968
1968	33	0	0.13126081070 03	1968
1968	34	0	0.13224642300 03	1968
1968	35	0	0.13323203530 03	1968
1968	36	0	0.13421764760 03	1968
1968	37	0	0.13520325990 03	1968
1968	38	0	0.13618887220 03	1968
1968	39	0	0.13717448440 03	1968
1968	40	0	0.13816009670 03	1968
1968	41	0	0.13914570900 03	1968
1968	42	0	0.14013132130 03	1968
1968	43	0	0.14111693360 03	1968
1968	44	0	0.14210254590 03	1968
1968	45	0	0.14308815820 03	1968
1968	46	0	0.14407377040 03	1968
1968	47	0	0.14505938270 03	1968
1968	48	0	0.14604499500 03	1968
1968	49	0	0.14703060730 03	1968
1968	50	0	0.14801621960 03	1968
1968	51	0	0.14900183190 03	1968
1968	52	0	0.14998744420 03	1968
1968	53	0	0.15097305640 03	1968
1968	54	0	0.15195866870 03	1968
1968	55	0	0.15294428100 03	1968
1968	56	0	0.15392989330 03	1968
1968	57	0	0.15491550560 03	1968
1968	58	0	0.15590111790 03	1968
1968	59	0	0.15688673020 03	1968
1968	60	0	0.15787234240 03	1968
1968	61	0	0.15885795470 03	1968
1968	62	0	0.15984356700 03	1968

TABLE III.- CHECKOUT DATA FOR SUBROUTINE HANGLE - Continued

Year	Day	Hour	Hour angle, deg	Epoch
1968	63	0	0.16082917930 03	1968
1968	64	0	0.16191479160 03	1968
1968	65	0	0.16280040390 03	1968
1968	66	0	0.16378601620 03	1968
1968	67	0	0.16477162850 03	1968
1968	68	0	0.16575724070 03	1968
1968	69	0	0.16674285300 03	1968
1968	70	0	0.16772846530 03	1968
1968	71	0	0.16871407760 03	1968
1968	72	0	0.16969968990 03	1968
1968	73	0	0.17068530220 03	1968
1968	74	0	0.17167091450 03	1968
1968	75	0	0.17265652670 03	1968
1968	76	0	0.17364213900 03	1968
1968	77	0	0.17462775130 03	1968
1968	78	0	0.17561336360 03	1968
1968	79	0	0.17659897590 03	1968
1968	80	0	0.17758458820 03	1968
1968	81	0	0.17857020050 03	1968
1968	82	0	0.17955581270 03	1968
1968	83	0	0.18054142500 03	1968
1968	84	0	0.18152703730 03	1968
1968	85	0	0.18251264960 03	1968
1968	86	0	0.18349826190 03	1968
1968	87	0	0.18448387420 03	1968
1968	88	0	0.18546948650 03	1968
1968	89	0	0.18645509870 03	1968
1968	90	0	0.18744071100 03	1968
1968	91	0	0.18842632330 03	1968
1968	92	0	0.18941193560 03	1968
1968	93	0	0.19039754790 03	1968
1968	94	0	0.19138316020 03	1968
1968	95	0	0.19236877250 03	1968
1968	96	0	0.19335438470 03	1968
1968	97	0	0.19433999700 03	1968
1968	98	0	0.19532560930 03	1968
1968	99	0	0.19631122160 03	1968
1968	100	0	0.19729683390 03	1968
1968	101	0	0.19828244620 03	1968
1968	102	0	0.19926805850 03	1968

TABLE III.- CHECKOUT DATA FOR SUBROUTINE HANGLE - Continued

Year	Day	Hour	Hour angle, deg	Epoch
Y 1968	D 103	0	0.20025367C8D 03	1968
Y 1968	D 104	0	0.20123928C3D 03	1968
Y 1968	D 105	0	0.20222489C3D 03	1968
Y 1968	D 106	0	0.20321050C7D 03	1968
Y 1968	D 107	0	0.20419611C9D 03	1968
Y 1968	D 108	0	0.20518173220 03	1968
Y 1968	D 109	0	0.20616734450 03	1968
Y 1968	D 110	0	0.20715295680 03	1968
Y 1968	D 111	0	0.20813856900 03	1968
Y 1968	D 112	0	0.20912418130 03	1968
Y 1968	D 113	0	0.21010979360 03	1968
Y 1968	D 114	0	0.21109540590 03	1968
Y 1968	D 115	0	0.21208101820 03	1968
Y 1968	D 116	0	0.21306663050 03	1968
Y 1968	D 117	0	0.21405224280 03	1968
Y 1968	D 118	0	0.21503785500 03	1968
Y 1968	D 119	0	0.21602346730 03	1968
Y 1968	D 120	0	0.21700907960 03	1968
Y 1968	D 121	0	0.21799469190 03	1968
Y 1968	D 122	0	0.21898030420 03	1968
Y 1968	D 123	0	0.21996591650 03	1968
Y 1968	D 124	0	0.22095152880 03	1968
Y 1968	D 125	0	0.22193714100 03	1968
Y 1968	D 126	0	0.22292275330 03	1968
Y 1968	D 127	0	0.22390836560 03	1968
Y 1968	D 128	0	0.22489397790 03	1968
Y 1968	D 129	0	0.22587959020 03	1968
Y 1968	D 130	0	0.22686520250 03	1968
Y 1968	D 131	0	0.22785081480 03	1968
Y 1968	D 132	0	0.22883642710 03	1968
Y 1968	D 133	0	0.22982203930 03	1968
Y 1968	D 134	0	0.23080765160 03	1968
Y 1968	D 135	0	0.23179326390 03	1968
Y 1968	D 136	0	0.23277887620 03	1968
Y 1968	D 137	0	0.23376448850 03	1968
Y 1968	D 138	0	0.23475010080 03	1968
Y 1968	D 139	0	0.23573571310 03	1968
Y 1968	D 140	0	0.23672132530 03	1968
Y 1968	D 141	0	0.23770693760 03	1968
Y 1968	D 142	0	0.23869254990 03	1968

TABLE III.- CHECKOUT DATA FOR SUBROUTINE HANGLE - Continued

Year	Day	Hour	Hour angle, deg	Epoch
1968	143	0	0.23967816220 03	1968
1968	144	0	0.24066377450 03	1968
1968	145	0	0.24164938680 03	1968
1968	146	0	0.24263499910 03	1968
1968	147	0	0.24362061130 03	1968
1968	148	0	0.24460622360 03	1968
1968	149	0	0.24559183590 03	1968
1968	150	0	0.24657744820 03	1968
1968	151	0	0.24756306050 03	1968
1968	152	0	0.24854867280 03	1968
1968	153	0	0.24953428510 03	1968
1968	154	0	0.25051989730 03	1968
1968	155	0	0.25150550960 03	1968
1968	156	0	0.25249112190 03	1968
1968	157	0	0.25347673420 03	1968
1968	158	0	0.25446234650 03	1968
1968	159	0	0.25544795880 03	1968
1968	160	0	0.25643357110 03	1968
1968	161	0	0.25741918330 03	1968
1968	162	0	0.25840479560 03	1968
1968	163	0	0.25939040790 03	1968
1968	164	0	0.26037602020 03	1968
1968	165	0	0.26136163250 03	1968
1968	166	0	0.26234724480 03	1968
1968	167	0	0.26333285710 03	1968
1968	168	0	0.26431846940 03	1968
1968	169	0	0.26530408160 03	1968
1968	170	0	0.26628969390 03	1968
1968	171	0	0.26727530620 03	1968
1968	172	0	0.26826091850 03	1968
1968	173	0	0.26924653080 03	1968
1968	174	0	0.27023214310 03	1968
1968	175	0	0.27121775540 03	1968
1968	176	0	0.27220336760 03	1968
1968	177	0	0.27318897990 03	1968
1968	178	0	0.27417459220 03	1968
1968	179	0	0.27516020450 03	1968
1968	180	0	0.27614581680 03	1968
1968	181	0	0.27713142910 03	1968
1968	182	0	0.27811704140 03	1968

TABLE III.- CHECKOUT DATA FOR SUBROUTINE HANGLE - Continued

Year	Day	Hour	Hour angle, deg	Epoch
1968	183	0	0.27910265360 03	1968
1968	184	0	0.28008926590 03	1968
1968	185	0	0.28107387820 03	1968
1968	186	0	0.28205949050 03	1968
1968	187	0	0.28304510280 03	1968
1968	188	0	0.28403071510 03	1968
1968	189	0	0.28501632740 03	1968
1968	190	0	0.28600193960 03	1968
1968	191	0	0.28698755190 03	1968
1968	192	0	0.28797316420 03	1968
1968	193	0	0.28895877650 03	1968
1968	194	0	0.28994439880 03	1968
1968	195	0	0.29093000110 03	1968
1968	196	0	0.29191561340 03	1968
1968	197	0	0.29290122570 03	1968
1968	198	0	0.29388683790 03	1968
1968	199	0	0.29487245020 03	1968

TABLE III.- CHECKOUT DATA FOR SUBROUTINE HANGLE - Continued

(b) Epoch 1969

Year	Day	Hour	Hour angle, deg	Epoch
1968	151	0	-0.1124241326D 03	1969
1968	152	0	-0.1114385205D 03	1969
1968	153	0	-0.1104529082D 03	1969
1968	154	0	-0.1094672959D 03	1969
1968	155	0	-0.1084816836D 03	1969
1968	156	0	-0.1074960713D 03	1969
1968	157	0	-0.1065104590D 03	1969
1968	158	0	-0.1055248467D 03	1969
1968	159	0	-0.1045392345D 03	1969
1968	160	0	-0.1035536222D 03	1969
1968	161	0	-0.1025680099D 03	1969
1968	162	0	-0.1015823976D 03	1969
1968	163	0	-0.1005967853D 03	1969
1968	164	0	-0.9961117303D 02	1969
1968	165	0	-0.9862556075D 02	1969
1968	166	0	-0.9763994846D 02	1969
1968	167	0	-0.9665433617D 02	1969
1968	168	0	-0.9566872389D 02	1969
1968	169	0	-0.9468311160D 02	1969
1968	170	0	-0.9369749932D 02	1969
1968	171	0	-0.9271188703D 02	1969
1968	172	0	-0.9172627474D 02	1969
1968	173	0	-0.9074066246D 02	1969
1968	174	0	-0.8975505017D 02	1969
1968	175	0	-0.8876943789D 02	1969
1968	176	0	-0.8778382560D 02	1969
1968	177	0	-0.8679821331D 02	1969
1968	178	0	-0.8581260103D 02	1969
1968	179	0	-0.8482698874D 02	1969
1968	180	0	-0.8384137645D 02	1969
1968	181	0	-0.8285576417D 02	1969
1968	182	0	-0.8187015188D 02	1969
1968	183	0	-0.8088453960D 02	1969
1968	184	0	-0.7989892731D 02	1969
1968	185	0	-0.7891331502D 02	1969
1968	186	0	-0.7792770274D 02	1969
1968	187	0	-0.7694209045D 02	1969
1968	188	0	-0.7595647817D 02	1969
1968	189	0	-0.7497086588D 02	1969
1968	190	0	-0.7398525359D 02	1969

TABLE III.- CHECKOUT DATA FOR SUBROUTINE HANGLE - Continued

Year	Day	Hour	Hour angle, deg	Epoch
1968	191	0	-0.729959641310 02	1969
1968	192	0	-0.720140290 2D 02	1969
1968	193	0	-0.710284167 3D 02	1969
1968	194	0	-0.700420044 5D 02	1969
1968	195	0	-0.690571921 0D 02	1969
1968	196	0	-0.680715798 0D 02	1969
1968	197	0	-0.670859675 90 02	1969
1968	198	0	-0.661003553 0D 02	1969
1968	199	0	-0.651147430 2D 02	1969
1968	200	0	-0.641291307 3D 02	1969
1968	201	0	-0.631435184 5D 02	1969
1968	202	0	-0.621579061 6D 02	1969
1968	203	0	-0.611722938 7D 02	1969
1968	204	0	-0.601866815 9D 02	1969
1968	205	0	-0.592010693 0D 02	1969
1968	206	0	-0.582154570 1D 02	1969
1968	207	0	-0.572298447 3D 02	1969
1968	208	0	-0.562442324 4D 02	1969
1968	209	0	-0.552586201 6D 02	1969
1968	210	0	-0.542730078 7D 02	1969
1968	211	0	-0.532873955 8D 02	1969
1968	212	0	-0.523017833 0D 02	1969
1968	213	0	-0.513161710 1D 02	1969
1968	214	0	-0.503305587 3D 02	1969
1968	215	0	-0.493449464 4D 02	1969
1968	216	0	-0.483593341 5D 02	1969
1968	217	0	-0.473737218 7D 02	1969
1968	218	0	-0.463881095 8D 02	1969
1968	219	0	-0.454024972 9D 02	1969
1968	220	0	-0.444168850 1D 02	1969
1968	221	0	-0.434312727 2D 02	1969
1968	222	0	-0.424456604 4D 02	1969
1968	223	0	-0.414600481 5D 02	1969
1968	224	0	-0.404744358 6D 02	1969
1968	225	0	-0.394888235 8D 02	1969
1968	226	0	-0.385032112 9D 02	1969
1968	227	0	-0.375175990 0D 02	1969
1968	228	0	-0.365319867 2D 02	1969
1968	229	0	-0.355463744 3D 02	1969
1968	230	0	-0.345607621 5D 02	1969

TABLE III.- CHECKOUT DATA FOR SUBROUTINE HANGLE - Continued

Year	Day	Hour	Hour angle, deg	Epoch
1968	231	0	-0.3357514986D 02	1969
1968	232	0	-0.3258553757D 02	1969
1968	233	0	-0.3160392529D 02	1969
1968	234	0	-0.3061831300D 02	1969
1968	235	0	-0.2963270072D 02	1969
1968	236	0	-0.2864708843D 02	1969
1968	237	0	-0.2766147614D 02	1969
1968	238	0	-0.2667586386D 02	1969
1968	239	0	-0.2569025157D 02	1969
1968	240	0	-0.2470463928D 02	1969
1968	241	0	-0.2371902700D 02	1969
1968	242	0	-0.2273341471D 02	1969
1968	243	0	-0.2174780243D 02	1969
1968	244	0	-0.2076219014D 02	1969
1968	245	0	-0.1977657785D 02	1969
1968	246	0	-0.1879096557D 02	1969
1968	247	0	-0.1780535328D 02	1969
1968	248	0	-0.1681974100D 02	1969
1968	249	0	-0.1583412871D 02	1969
1968	250	0	-0.1484851642D 02	1969
1968	251	0	-0.1386290414D 02	1969
1968	252	0	-0.1287729185D 02	1969
1968	253	0	-0.1189167957D 02	1969
1968	254	0	-0.1090606728D 02	1969
1968	255	0	-0.9920454992D 01	1969
1968	256	0	-0.8934842700D 01	1969
1968	257	0	-0.7949230408D 01	1969
1968	258	0	-0.6963618134D 01	1969
1968	259	0	-0.5978005848D 01	1969
1968	260	0	-0.4992393562D 01	1969
1968	261	0	-0.4006781275D 01	1969
1968	262	0	-0.3021168989D 01	1969
1968	263	0	-0.2035556703D 01	1969
1968	264	0	-0.1049944417D 01	1969
1968	265	0	-0.6433213085D-01	1969
1968	266	0	0.9212801553D 00	1969
1968	267	0	0.1906892441D 01	1969
1968	268	0	0.2892504728D 01	1969
1968	269	0	0.3878117014D 01	1969
1968	270	0	0.4863729300D 01	1969

TABLE III.- CHECKOUT DATA FOR SUBROUTINE HANGLE - Continued

Year	Day	Hour	Hour angle, deg	Epoch
1968	271	0	0.5849341586D 01	1969
1968	272	0	0.6834953872D 01	1969
1968	273	0	0.7820566158D 01	1969
1968	274	0	0.8806178445D 01	1969
1968	275	0	0.9791790731D 01	1969
1968	276	0	0.1077740302D 02	1969
1968	277	0	0.1176301530D 02	1969
1968	278	0	0.1274862759D 02	1969
1968	279	0	0.1373423988D 02	1969
1968	280	0	0.1471985216D 02	1969
1968	281	0	0.1570546445D 02	1969
1968	282	0	0.1669107673D 02	1969
1968	283	0	0.1767668902D 02	1969
1968	284	0	0.1866230131D 02	1969
1968	285	0	0.1964791359D 02	1969
1968	286	0	0.2063352588D 02	1969
1968	287	0	0.2161913816D 02	1969
1968	288	0	0.2260475045D 02	1969
1968	289	0	0.2359036274D 02	1969
1968	290	0	0.2457597502D 02	1969
1968	291	0	0.2556158731D 02	1969
1968	292	0	0.2654719959D 02	1969
1968	293	0	0.2753281188D 02	1969
1968	294	0	0.2851842417D 02	1969
1968	295	0	0.2950403645D 02	1969
1968	296	0	0.3048964874D 02	1969
1968	297	0	0.3147526103D 02	1969
1968	298	0	0.3246087331D 02	1969
1968	299	0	0.3344648560D 02	1969
1968	300	0	0.3443209788D 02	1969
1968	301	0	0.3541771017D 02	1969
1968	302	0	0.3640332246D 02	1969
1968	303	0	0.3738893474D 02	1969
1968	304	0	0.3837454703D 02	1969
1968	305	0	0.3936015932D 02	1969
1968	306	0	0.4034577160D 02	1969
1968	307	0	0.4133138389D 02	1969
1968	308	0	0.4231699617D 02	1969
1968	309	0	0.4330260846D 02	1969
1968	310	0	0.4428822075D 02	1969

TABLE III.- CHECKOUT DATA FOR SUBROUTINE HANGLE - Continued

Year	Day	Hour	Hour angle, deg	Epoch
1968	311	0	0.45273E33C3D 02	1969
1968	312	0	0.46259445320 02	1969
1968	313	0	0.47245C576CD 02	1969
1968	314	0	0.4823C669890 02	1969
1968	315	0	0.49216282180 02	1969
1968	316	0	0.502C189446D 02	1969
1968	317	0	0.5118750e75D 02	1969
1968	318	0	0.52173119c4D 02	1969
1968	319	0	0.5315E731320 02	1969
1968	320	0	0.54144343610 02	1969
1968	321	0	0.5512995509D 02	1969
1968	322	0	0.561155616D 02	1969
1968	323	0	0.5710118C47D 02	1969
1968	324	0	0.58CEe7927D 02	1969
1968	325	0	0.59C724C5040 02	1969
1968	326	0	0.6CC58C1732D 02	1969
1968	327	0	0.61C43e29610 02	1969
1968	328	0	0.62025241920 02	1969
1968	329	0	0.63C14854180 02	1969
1968	330	0	0.64CCC460470 02	1969
1968	331	0	0.6496C7876D 02	1969
1968	332	0	0.6597169104D 02	1969
1968	333	0	0.66957303330 02	1969
1968	334	0	0.67942915610 02	1969
1968	335	0	0.6892852790D 02	1969
1968	336	0	0.6991414C19D 02	1969
1968	337	0	0.7089975247D 02	1969
1968	338	0	0.7188536476D 02	1969
1968	339	0	0.7287C977C4D 02	1969
1968	340	0	0.73e56589330 02	1969
1968	341	0	0.746422C162D 02	1969
1968	342	0	0.75827813900 02	1969
1968	343	0	0.7681342619D 02	1969
1968	344	0	0.777950348D 02	1969
1968	345	0	0.7878405C76D 02	1969
1968	346	0	0.797702630D 02	1969
1968	347	0	0.80755875330 02	1969
1968	348	0	0.8174148762D 02	1969
1968	349	0	0.82727C99910 02	1969
1968	350	0	0.83712712190 02	1969

TABLE III.- CHECKOUT DATA FOR SUBROUTINE HANGLE - Continued

Year	Day	Hour	Hour angle, deg	Epoch
1968	351	[illegible]	[illegible] 02	1969
1968	352	[illegible]	[illegible] 02	1969
1968	353	[illegible]	[illegible] 02	1969
1968	354	[illegible]	[illegible] 02	1969
1968	355	[illegible]	[illegible] 02	1969
1968	356	[illegible]	[illegible] 02	1969
1968	357	[illegible]	[illegible] 02	1969
1968	358	[illegible]	[illegible] 02	1969
1968	359	[illegible]	[illegible] 02	1969
1968	360	[illegible]	[illegible] 02	1969
1968	361	[illegible]	[illegible] 02	1969
1968	362	[illegible]	[illegible] 02	1969
1968	363	[illegible]	[illegible] 02	1969
1968	364	[illegible]	[illegible] 02	1969
1968	365	[illegible]	[illegible] 02	1969
1968	366	[illegible]	[illegible] 02	1969
1969	1	[illegible]	[illegible] 03	1969
1969	2	[illegible]	[illegible] 03	1969
1969	3	[illegible]	[illegible] 03	1969
1969	4	[illegible]	[illegible] 03	1969
1969	5	[illegible]	[illegible] 03	1969
1969	6	[illegible]	[illegible] 03	1969
1969	7	[illegible]	[illegible] 03	1969
1969	8	[illegible]	[illegible] 03	1969
1969	9	[illegible]	[illegible] 03	1969
1969	10	[illegible]	[illegible] 03	1969
1969	11	[illegible]	[illegible] 03	1969
1969	12	[illegible]	[illegible] 03	1969
1969	13	[illegible]	[illegible] 03	1969
1969	14	[illegible]	[illegible] 03	1969
1969	15	[illegible]	[illegible] 03	1969
1969	16	[illegible]	[illegible] 03	1969
1969	17	[illegible]	[illegible] 03	1969
1969	18	[illegible]	[illegible] 03	1969
1969	19	[illegible]	[illegible] 03	1969
1969	20	[illegible]	[illegible] 03	1969
1969	21	[illegible]	[illegible] 03	1969
1969	22	[illegible]	[illegible] 03	1969
1969	23	[illegible]	[illegible] 03	1969

TABLE III.- CHECKOUT DATA FOR SUBROUTINE HANGLE - Continued

Year	Day	Hour	Hour angle, deg	Epoch
1969	24	0	0.1231372C36D 03	1969
1969	25	0	0.1241228159D 03	1969
1969	26	0	0.1251CE4282D 03	1969
1969	27	0	0.126C94C4C5D 03	1969
1969	28	0	0.127C7965286 03	1969
1969	29	0	C.128C6526510 03	1969
1969	3C	0	0.129C5C87740 03	1969
1969	31	0	C.13CC364E56D 03	1969
1969	32	0	C.131C221C19D 03	1969
1969	33	0	0.132C0771420 03	1969
1969	34	0	C.132E9332650 03	1969
1969	35	0	0.133E7E53880 03	1969
1969	36	0	0.1349645511D 03	1969
1969	37	0	C.135E5C1634D 03	1969
1969	38	0	C.136E3577560 03	1969
1969	39	0	C.137E2138750 03	1969
1969	4C	0	0.138EC7CC02D 03	1969
1969	41	0	0.139E5261250 03	1969
1969	42	0	0.140E7E2246D 03	1969
1969	43	0	0.141E63E371D 03	1969
1969	44	0	0.142E4544540 03	1969
1969	45	0	0.143E35C616D 03	1969
1969	46	0	C.144E2C67390 03	1969
1969	47	0	0.145EC628620 03	1969
1969	48	0	0.146E9E6585D 03	1969
1969	49	0	0.14777751C8D 03	1969
1969	5C	0	0.14876312310 03	1969
1969	51	0	C.149748735 4D 03	1969
1969	52	0	0.1503734347D 03	1969
1969	53	0	C.151715556 50 03	1969
1969	54	0	0.1527055722D 03	1969
1969	55	0	0.153691184 5D 03	1969
1969	56	0	C.154E767568D 03	1969
1969	57	0	0.155E624C51D 03	1969
1969	58	0	C.156E4E3214D 03	1969
1969	59	0	0.157E3363370 03	1969
1969	6C	0	0.158E1924590 03	1969
1969	61	0	C.159EC485820 03	1969
1969	62	0	C.16CE9C47C5D 03	1969
1969	63	0	0.161E76C828D 03	1969

TABLE III.- CHECKOUT DATA FOR SUBROUTINE HANGLE - Continued

Year	Day	Hour	Hour angle, deg	Epoch
1969	64	0	0.1625616951D 03	1969
1969	65	0	0.1635473074D 03	1969
1969	66	0	0.1645329197D 03	1969
1969	67	0	0.1655185319D 03	1969
1969	68	0	0.1665041442D 03	1969
1969	69	0	0.1674897565D 03	1969
1969	70	0	0.1684753688D 03	1969
1969	71	0	0.1694609811D 03	1969
1969	72	0	0.1704465934D 03	1969
1969	73	0	0.1714322057D 03	1969
1969	74	0	0.1724178179D 03	1969
1969	75	0	0.1734034302D 03	1969
1969	76	0	0.1743890425D 03	1969
1969	77	0	0.1753746548D 03	1969
1969	78	0	0.1763602671D 03	1969
1969	79	0	0.1773458794D 03	1969
1969	80	0	0.1783314917D 03	1969
1969	81	0	0.1793171040D 03	1969
1969	82	0	0.1803027162D 03	1969
1969	83	0	0.1812883285D 03	1969
1969	84	0	0.1822739408D 03	1969
1969	85	0	0.1832595531D 03	1969
1969	86	0	0.1842451654D 03	1969
1969	87	0	0.1852307777D 03	1969
1969	88	0	0.1862163900D 03	1969
1969	89	0	0.1872020022D 03	1969
1969	90	0	0.1881876145D 03	1969
1969	91	0	0.1891732268D 03	1969
1969	92	0	0.1901588391D 03	1969
1969	93	0	0.1911444514D 03	1969
1969	94	0	0.1921300637D 03	1969
1969	95	0	0.1931156760D 03	1969
1969	96	0	0.1941012882D 03	1969
1969	97	0	0.1950869005D 03	1969
1969	98	0	0.1960725128D 03	1969
1969	99	0	0.1970581251D 03	1969
1969	100	0	0.1980437374D 03	1969
1969	101	0	0.1990293497D 03	1969
1969	102	0	0.2000149620D 03	1969
1969	103	0	0.2010005742D 03	1969

TABLE III.- CHECKOUT DATA FOR SUBROUTINE HANGLE - Continued

Year	Day	Hour	Hour angle, deg	Epoch
1969	104	0	0.201988618650 03	1969
1969	105	0	0.202971758880 03	1969
1969	106	0	0.203957411100 03	1969
1969	107	0	0.204943023400 03	1969
1969	108	0	0.205928635700 03	1969
1969	109	0	0.206914248000 03	1969
1969	110	0	0.207899860200 03	1969
1969	111	0	0.208885472500 03	1969
1969	112	0	0.209871084800 03	1969
1969	113	0	0.210856697100 03	1969
1969	114	0	0.211842309400 03	1969
1969	115	0	0.212827921700 03	1969
1969	116	0	0.213813534000 03	1969
1969	117	0	0.214799146300 03	1969
1969	118	0	0.215784758500 03	1969
1969	119	0	0.216770370800 03	1969
1969	120	0	0.217755983100 03	1969
1969	121	0	0.218741595400 03	1969
1969	122	0	0.219727207700 03	1969
1969	123	0	0.220712820000 03	1969
1969	124	0	0.221698432300 03	1969
1969	125	0	0.222684044500 03	1969
1969	126	0	0.223669656800 03	1969
1969	127	0	0.224655269100 03	1969
1969	128	0	0.225640881400 03	1969
1969	129	0	0.226626493700 03	1969
1969	130	0	0.227612106000 03	1969
1969	131	0	0.228597718300 03	1969
1969	132	0	0.229583330500 03	1969
1969	133	0	0.230568942800 03	1969
1969	134	0	0.231554555100 03	1969
1969	135	0	0.232540167400 03	1969
1969	136	0	0.233525779700 03	1969
1969	137	0	0.234511392000 03	1969
1969	138	0	0.235497004300 03	1969
1969	139	0	0.236482616500 03	1969
1969	140	0	0.237468228800 03	1969
1969	141	0	0.238453841100 03	1969
1969	142	0	0.239439453400 03	1969

TABLE III.- CHECKOUT DATA FOR SUBROUTINE HANGLE - Continued

Year	Day	Hour	Hour angle, deg	Epoch
1969	143	0	0.24C425C0570 03	1969
1969	144	0	0.24141C678C0 03	1969
1969	145	0	0.2423962SC3D 03	1969
1969	146	0	0.243381SC26D 03	1969
1969	147	0	0.24436751480 03	1969
1969	148	0	0.24535312710 03	1969
1969	149	0	0.24623873940 03	1969
1969	150	0	0.24732435170 03	1969
1969	151	0	0.2483C9S64C0 03	1969
1969	152	0	0.24929557630 03	1969
1969	153	0	0.25028118860 03	1969
1969	154	0	0.2512668C080 03	1969
1969	155	0	0.25225241310 03	1969
1969	156	0	0.253238C2540 03	1969
1969	157	0	0.25422363770 03	1969
1969	158	0	0.2552C925CC0 03	1969
1969	159	0	0.25619486230 03	1969
1969	160	0	0.2571804746D 03	1969
1969	161	0	0.258166C868D 03	1969
1969	162	0	0.2591516991D 03	1969
1969	163	0	0.26013731140 03	1969
1969	164	0	0.2611229237D 03	1969
1969	165	0	0.26210853600 03	1969
1969	166	0	0.263C9414830 03	1969
1969	167	0	0.264C7976C6D 03	1969
1969	168	0	0.265C6537280 03	1969
1969	169	0	0.266C5C9851D 03	1969
1969	170	0	0.267C3659740 03	1969
1969	171	0	0.268C222C970 03	1969
1969	172	0	0.269C07822C0 03	1969
1969	173	0	0.26955343430 03	1969
1969	174	0	0.270S7904660 03	1969
1969	175	0	0.27156465880 03	1969
1969	176	0	0.272S5C2711D 03	1969
1969	177	0	0.27353588340 03	1969
1969	178	0	0.2745214957D 03	1969
1969	179	0	0.275SC71C8C0 03	1969
1969	180	0	0.2766S272030 03	1969
1969	181	0	0.27787833260 03	1969

TABLE III.- CHECKOUT DATA FOR SUBROUTINE HANGLE - Concluded

Year	Day	Hour	Hour angle, deg	Epoch
1969	182	0	0.27886394490 03	1969
1969	183	0	0.27984955710 03	1969
1969	184	0	0.28083516940 03	1969
1969	185	0	0.28182078170 03	1969
1969	186	0	0.28280639400 03	1969
1969	187	0	0.28379200630 03	1969
1969	188	0	0.28477761860 03	1969
1969	189	0	0.28576323090 03	1969
1969	190	0	0.28674884310 03	1969
1969	191	0	0.28773445540 03	1969
1969	192	0	0.28872006770 03	1969
1969 D	193 H	0	0.28970568000 03	E 1969
1969 D	194 H	0	0.29069129230 03	E 1969
1969 D	195 H	0	0.29167690460 03	E 1969
1969 D	196 H	0	0.29266251690 03	E 1969
1969 D	197 H	0	0.29364812910 03	E 1969
1969 D	198 H	0	0.29463374140 03	E 1969
1969 D	199 H	0	0.29561935370 03	E 1969

REFERENCE

1. Nautical Almanac Offices: Explanatory Supplement to the Astronomical Ephemeris and the American Ephemeris and Nautical Almanac. Prepared jointly by the Nautical Almanac Offices of the United Kingdom and the United States of America, 1961.

Memorandum

TO : See List Below

DATE: FEB 1968
68-FM47-61

FROM : FM/Mission Planning and Analysis Division

SUBJECT: Transmittal of formulation for Greenwich hour angle for the RTCC mission E, F, and G predictor

The enclosed internal note presents formulation for the Greenwich hour angle used to evaluate the earth sectoral gravitational acceleration in the RTCC predictor. The attached data and the fortran listing of the program used to generate the data is not considered part of the formulation requirement but was included in the internal note for test case and formulation verification.

James C. McPherson, Chief
Mathematical Physics Branch

The Flight Software Branch concurs with the above recommendation and requests IBM to proceed accordingly.

James C. Stokes, Jr., Chief
Flight Software Branch

APPROVED BY:

John P. Mayer
Chief, Mission Planning
and Analysis Division

Enclosure

Distribution: (See attached page)