NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

MSC INTERNAL NOTE NO. 69-FM-286

November 24, 1969

REVISION 4 RTCC REQUIREMENTS FOR APOLLO 13 (MISSION H-2): EARTH ORBIT INSERTION PROCESSOR

(This revision supersedes MSC Internal Note No. 69-FM-132 dated May 9, 1969)

Lunar Mission Analysis Branch

MISSION PLANNING AND ANALYSIS DIVISION

MANNED SPACECRAFT CENTER

HOUSTON, TEXAS

MSC INTERNAL NOTE NO. 69-FM-286

PROJECT APOLLO

REVISION 4
RTCC REQUIREMENTS FOR APOLLO 13 (MISSION H-2): EARTH ORBIT INSERTION PROCESSOR

By Edward M. Jiongo
Lunar Mission Analysis Branch

November 24, 1969

MISSION PLANNING AND ANALYSIS DIVISION
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER
HOUSTON, TEXAS

Approved: _____
Ronald L. Berry, Chief
Lunar Mission Analysis Branch

Approved: _____
John P. Mayer, Chief
Mission Planning and Analysis Division

REVISION 4[a]

RTCC REQUIREMENTS FOR APOLLO 13 (MISSION H-2)

EARTH ORBIT INSERTION PROCESSOR

By Edward M. Jiongo

SUMMARY AND INTRODUCTION

For Apollo 13 (Mission H-2), the Real-Time Computer Complex (RTCC) must be able to simulate the nominal S-IVB earth orbit insertion (EOI) conditions. This document describes the equation for the EOI processor and the associated logic that allows the flight controllers to obtain nominal earth orbit insertion conditions for any launch azimuth in the launch window (72° - 108°). This revision reflects the current EOI conditions as contained in reference 1 and from the MSFC B7 tapes sent to MSC. This internal note will be updated as MSFC updates their data for future Apollo missions.

The radius, flight-path angle, and circular velocity at EOI are assumed constant. The nominal conditions at EOI which must be computed are the time from lift-off, declination, longitude, and inertial azimuth. These are computed as a function of launch azimuth by the equation

$$Y = f(x) = A_0 + A_1 x + A_2 x^2 + A_3 x^3$$

where x is the input launch azimuth in degrees and $A_0, \ldots, A_3$ are the polynomial coefficients. These coefficients are given in table I.

A typical example of the integrated flight trajectory data that are received from Marshall Space Flight Center is presented in table II. Normally, these data consist of at least five data points and are available at least 2 months or more prior to lift-off. The data in table II

---

[a]This revision supersedes MSC Internal Note 69-FM-132 dated May 9, 1969.

are curve fit as a function of launch azimuth by use of a least-squares technique. The altitude is 100 n. mi.; the flight-path angle is 0.0°; and the velocity is 25 567.72868 fps.

A set of data that corresponds to the coefficients in table I is presented in table III for each launch azimuth from 72° to 108°. Positive longitude is east; negative, west. Positive latitude is north; negative, south.

TABLE I.- POLYNOMIAL COEFFICIENTS FOR EARTH PARKING ORBIT INSERTION CONDITIONS

AS A FUNCTION OF LAUNCH AZIMUTH FROM 72° TO 108°

Coefficients	Time from launch to EOI, sec	Declination of EOI, deg	Longitude of EOI, deg	Inertial azimuth of EOI, deg	Radius of EOI, n. mi.	Flight-path angle of EOI, deg	Inertial velocity of EOI, fps
A_0	0.77751467E+3	0.60068472E+2	-0.70793413E+2	0.17412161E+2	3.5439336×10^3	0.0	25 567.72868
A_1	-0.17361830E+1	-0.32590154E+0	0.53491572E+0	0.11710481E+1	0.0	0.0	0.0
A_2	0.85128229E-2	-0.12718454E-2	-0.46400420E-2	-0.32422850E-2	0.0	0.0	0.0
A_3	0.79346266E-5	0.67024993E-5	0.80651017E-5	0.94790835E-5	0.0	0.0	0.0

TABLE II.- INTEGRATED EARTH PARKING ORBIT INSERTION CONDITIONS[a]

(a) Variables

Launch azimuth, deg	Time from launch to EOI, sec	Declination, deg	Longitude, deg	Inertial azimuth, deg
72.029	699.609	32.512	-53.323	88.456
81.0	696.950	28.888	-53.622	96.035
90.0	695.966	25.321	-54.358	103.455
99.0	696.808	21.843	-55.486	110.762
108.0	699.280	18.479	-56.985	118.010

(b) Constants

Radius, n. mi.	3543.9336
Inertial flight-path angle, deg	0.0
Inertial velocity, fps	25 567.72868

TABLE III.- TYPICAL DATA FOR EACH LAUNCH AZIMUTH AT EOI

Launch azimuth, deg	Elapsed time from launch, sec	Longitude, deg	Declination, deg	Inertial azimuth, deg
72.00000000	699.60154724	-53.32317638	32.51200914	88.45766830
73.00000000	699.22484589	-53.33388805	32.10738182	89.30805969
74.00000000	698.86863708	-53.35034704	31.70314646	90.15611935
75.00000000	698.53299713	-53.37250566	31.29934359	91.00190449
76.00000000	698.21793365	-53.40031576	30.89601254	91.84546947
77.00000000	697.92352295	-53.43372726	30.49319482	92.68687153
78.00000000	697.64979553	-53.47269249	30.09092927	93.52616978
79.00000000	697.39682007	-53.51716375	29.68925738	94.36341858
80.00000000	697.16461945	-53.56709194	29.28821778	95.19867611
81.00000000	696.95326233	-53.62243032	28.88785291	96.03199863
82.00000000	696.76277924	-53.68312788	28.48820090	96.86344337
83.00000000	696.59323120	-53.74913740	28.08930349	97.69306850
84.00000000	696.44465637	-53.82041121	27.69119978	98.52092838
85.00000000	696.31710815	-53.89689970	27.29393101	99.34708214
86.00000000	696.21063232	-53.97855616	26.89753604	100.17158508
87.00000000	696.12528229	-54.06533003	26.50205612	100.99449539
88.00000000	696.06108856	-54.15717411	26.10753155	101.81586838
89.00000000	696.01811981	-54.25404024	25.71400189	102.63576317
90.00000000	695.99641418	-54.35587931	25.32150817	103.45423412
91.00000000	695.99600983	-54.46264410	24.93008947	104.27133846
92.00000000	696.01696777	-54.57428503	24.53978705	105.08713531
93.00000000	696.05933380	-54.69075394	24.15064073	105.90167904
94.00000000	696.12314606	-54.81200218	23.76269031	106.71502781
95.00000000	696.20846558	-54.93798304	23.37597680	107.52723694
96.00000000	696.31532288	-55.06864595	22.99053955	108.33836746
97.00000000	696.44378662	-55.20394325	22.60641956	109.14847088
98.00000000	696.59389496	-55.34382725	22.22365665	109.95760536
99.00000000	696.76569366	-55.48824835	21.84229112	110.76583385
100.00000000	696.95922852	-55.63716030	21.46236348	111.57320499
101.00000000	697.17454529	-55.79051208	21.08391356	112.37977886
102.00000000	697.41170502	-55.94825649	20.70698142	113.18561363
103.00000000	697.67074585	-56.11034584	20.33160758	113.99076557
104.00000000	697.95170593	-56.27673054	19.95783257	114.79528809
105.00000000	698.25464630	-56.44736290	19.58569598	115.59924412
106.00000000	698.57962036	-56.62219429	19.21523809	116.40268517
107.00000000	698.92665100	-56.80117607	18.84649944	117.20567226
108.00000000	699.29581451	-56.98425961	18.47952008	118.00825977

REFERENCE

1. Saturn V AS-507 "H-1" Mission Launch Vehicle Operational Flight Trajectory - November Launch Month, D5-15551(F)-7, August 12, 1969.