Massachusetts Institute of Technology
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Cambridge, Massachusetts

MEMO

TO: Distribution

FROM: N. E. Sears

DATE: February 21, 1966

SUBJECT: Flight 207-8 Preliminary Trajectory Profile For Initial Rendezvous

This memo is a brief summary of conversations held with Mr. W. Tindall and Mr. John Gurley, of FOD on February 18, 1966, concerning preliminary ideas for the revised Flight 207-6. This flight differs from the previous 207A Mission in that a dual CSM and LEM launch will be used. The following items were considered to be the major points in current FOD plans concerning this revised mission.

1. The flight profile will be the same as that used for current Gemini Flights in that the maneuver sequences will be the same. FOD's objective is to use the current ground computer programs to control this Apollo Flight in hopes of making minimum modifications to such ground control programs. W. Tindall listed the following factors as key trajectory design objective for the 207-8 profile.
    a) Terminal rendezvous phasing will be chosen for optimum lighting conditions.
    b) All rendezvous maneuvers will be restricted to in-plane trajectories.
    c) A coelliptic trajectory approach will be used for all rendezvous.
    d) The altitude difference at the start of the final intercept trajectory will be in the order of 15 nm.
2. The CSM will be launched first in the 207-8 Mission Plan to a 150 nm altitude circular orbit. The CSM launch is required

since the LEM operating time is relatively short.

3. The LEM Launch will be delayed until an appropriate launch condition exists with respect to phasing, since the LEM lifetime is currently estimated to be only 6 hours due to limited battery life.

4. The LEM will stay in the adapter attached to the SIVB until it can be extracted by the CSM after the first rendezvous maneuver.

5. The SIVB will be attitude controlled so that initial CSM docking can be accomplished. At least two flashing lights acting as optical beacons for the CSM sextant will be installed on the SIVB to enable the CSM to achieve the initial rendezvous.

6. Current plans call for a single docking probe to be carried by the CSM. This probe is capable of four hard-docking maneuvers. As a result the nominal mission will be restricted to three hard-dockings holding one for contingency.

7. The general mission profile discussed for the 207-8 initial rendezvous trajectory is summarized in the attached figure. This figure illustrates two coordinate systems, one relative with respect to the SIVB LEM target vehicle in a 110 nm circular orbit, and the other a conventional inertial coordinate system.

8. A general sequence of maneuvers for the initial rendezvous is as follows:

   a) First CSM maneuver is a phase adjustment maneuver labled N_{C1}. The maneuver designations shown in the attached figure are the current nomenclature used by FOD for Gemini Missions. The objective of the first phase adjustment maneuver is to transfer the CSM from its 150 nm circular orbit towards a lower altitude relative to the 110 nm circular LEM orbit.

   b) The second maneuver is a corrective maneuver primarily to design to adjust the height of the CSM trajectory at

perigee to 15 nm below the LEM orbital altitude. This maneuver is called a corrective combination maneuver (N_{CC}) or height maneuver (N_H) by FOD.

c) When the Command Module arrives at the perigee of its transfer maneuver a coelliptic maneuver is performed such that the Command Module is in a 95 nm circular orbit coplaner with the LEM orbit. This maneuver is designated N_{SR} in the attached figure. All three initial maneuvers, phase adjustments, height, and coelliptic, are controlled by MFFN tracking and uplink maneuver data.

d) The CSM rendezvous program will be activated during the parking orbit between the coelliptic maneuver and the terminal phase initiation maneuver. Sextant tracking of the SIVB optical beacons will be performed over at least half of this parking orbit phase.

e) The terminal phase initiation maneuver (TPI) will be controlled and determined by the CSM primary G&N system. This maneuver is normally chosen to occur at the mid-point of darkness as shown in the attached figure. Under normal conditions the range between the two vehicles will be in the order of 33 nm at this point, and the required maneuver to establish the intercept trajectory will be in the order of 30 to 35 ft/sec.

f) The intercept trajectory between the terminal phase initiation maneuver and the final rendezvous braking maneuver (designated velocity match, TPF) will cover a earth central angle of 140°. During this interval one or possibly two CSM midcourse corrections will be made to achieve an intercept trajectory. The terminal rendezvous maneuver will consist of two to three maneuvers to reduce the relative closing velocity of approximately 40 ft/sec. to the desired 5 ft/sec. for terminal docking. The range-range rate schedule currently desired for this maneuver is as follows:

Range		Desired Closing Velocity
3 nm	-	20 ft/sec.
1 nm	-	10 ft/sec.
500 ft.	-	5 ft/sec.

8. It is estimated that the LEM will be launched about 1.25 orbits before the first phase adjustment maneuvers (N_{C1}) resulting in the first rendezvous being established approximately three orbits after LEM launch.

9. FOD assumed that CSM-RCS would be used for all rendezvous maneuvers controlled by the CSM primary G&N system. This would involve the terminal phase initiation maneuver (TPI), the two midcourse corrections, and the final two or three terminal rendezvous maneuvers. The three maneuvers used to establish the initial coelliptic orbit; phase adjustment maneuver, corrective height maneuver, and coelliptic maneuver, may be controlled by the SPS or RCS depending on the size of these maneuvers.

10. J. Gurley of FOD indicated that the preliminary reference trajectory for the 207-8 Mission is due April 1, 1966.

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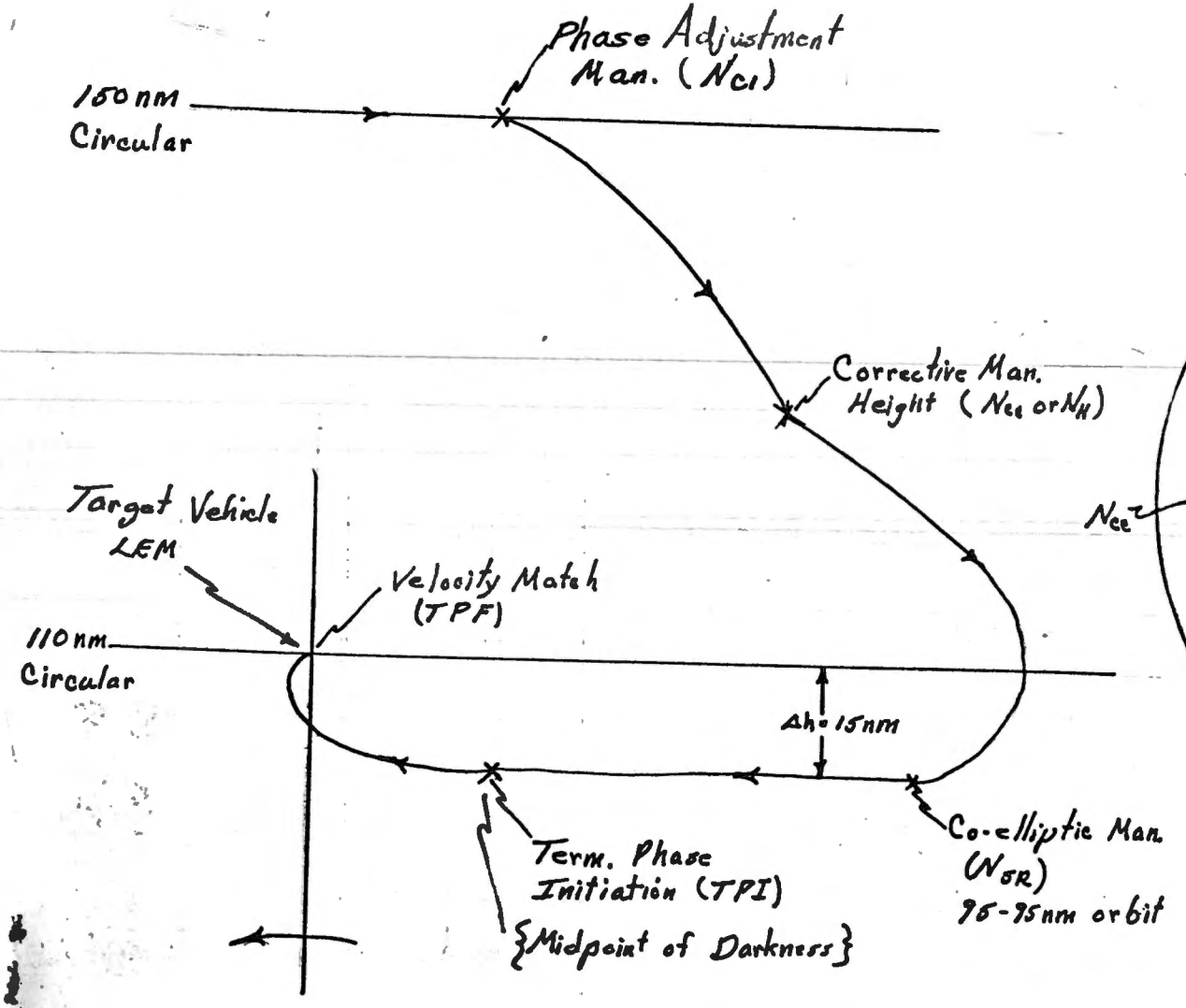
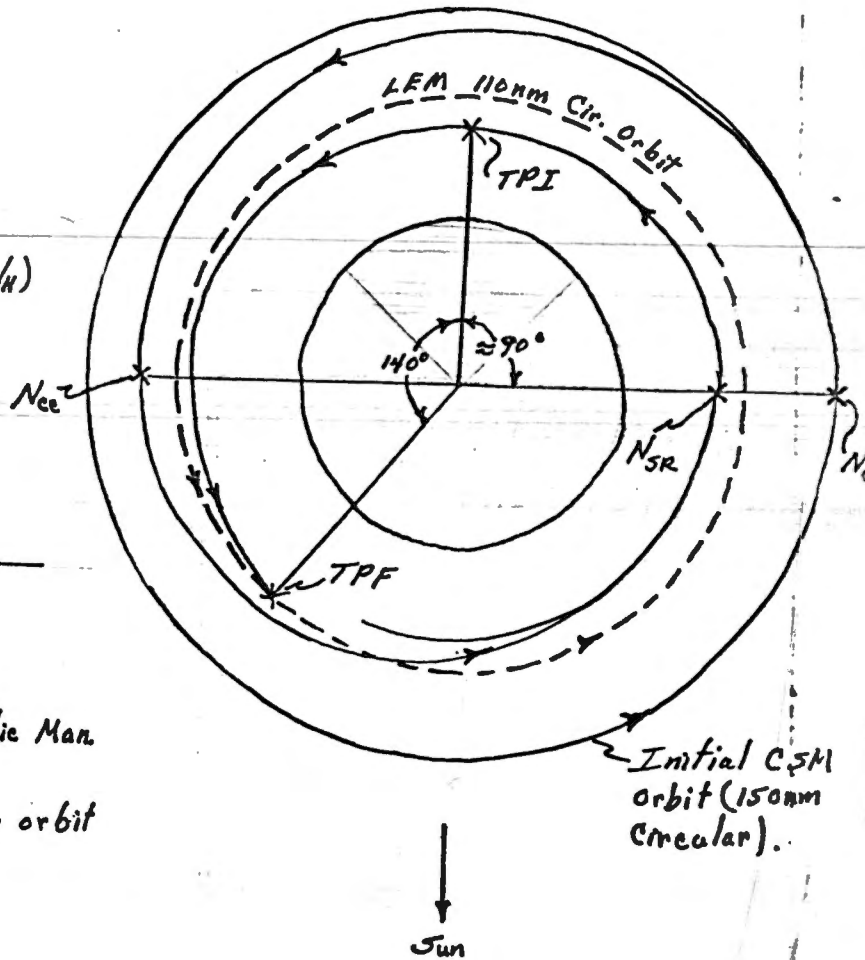
Preliminary 207-8 Rendezvous Profile (2-18-66 from W. Tindall)



Relative Coordinate System



Inertial Coordinate System