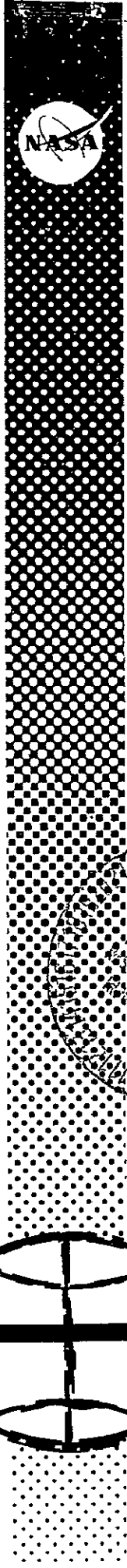


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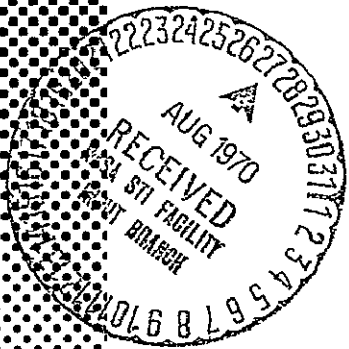
# MSC INTERNAL NOTE NO.68-FM-9

January 9, 1968

## OPERATIONAL SUPPORT PLAN FOR THE REAL-TIME AUXILIARY COMPUTING FACILITY - APOLLO 5 FLIGHT ANNEX

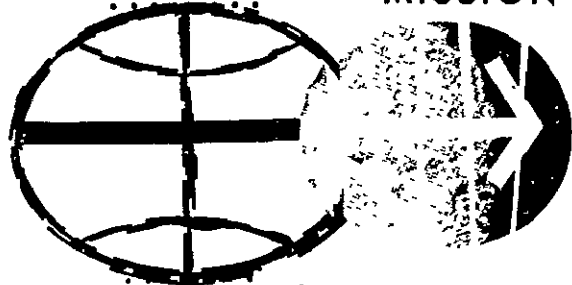
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FACILITY FORM 602	70-36139	(THRU)
	70	(CODE)
	TMX-65090	11
	(ACCESSION NUMBER)	(CATEGORY)
	(PAGES)	
	(NASA CR OR TMX OR AD NUMBER)	

MISSION PLANNING AND ANALYSIS DIVISION



MANNED SPACECRAFT CENTER  
HOUSTON, TEXAS

MSC INTERNAL NOTE NO. 68-FM-9

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PROJECT APOLLO

OPERATIONAL SUPPORT PLAN FOR THE REAL-TIME  
AUXILIARY COMPUTING FACILITY - APOLLO 5 FLIGHT ANNEX

By Larry D. Davis and Ronald D. Davis  
Flight Analysis Branch

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January 9, 1968

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

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# OPERATIONAL SUPPORT PLAN FOR THE REAL-TIME AUXILIARY COMPUTING

## FACILITY - APOLLO 5 FLIGHT ANNEX

By Larry D. Davis and Ronald D. Davis

### 1.0 SUMMARY AND INTRODUCTION

This note summarizes the requirements for the RTACF to support Apollo 5 nominal and alternate missions. It then describes the processors to be used in the RTACF to satisfy these requirements. The note is a central source of RTACF operational support information for Apollo 5 and is intended primarily as a convenience for the Apollo 5 Operational Support Team.

#### 1.1 Nominal Mission

The purpose of the Apollo 5 mission is the functional testing of a LM-1 spacecraft in a near-earth-orbit environment to verify crew safety items. For mission simulation purposes, launch is assumed to occur on January 16, 1968 at 14:00 hours G.m.t., 09:00 hours e.s.t. from launch complex 37B of the Kennedy Space Center. The major events of the mission profile are presented in table I. (This table and the nominal mission description have been taken from the Apollo 5 Spacecraft Operational Trajectory, ref. 1 and 2.) For the discussion, the mission has been divided into 12 phases:

1. Ascent-to-orbit.
2. S-IVB/SLA/LM orbital coast.
3. S-IVB/SLA/LM separation.
4. Orbital coast to DPS-1.
5. DPS-1.
6. Orbital coast to DPS-2.
7. DPS-2/FITH/APS-1 abort test.
8. Orbital coast to APS-2.

9. APS-2.
10. Orbital coast to RCS burns.
11. Five RCS burns.
12. Final orbital coast.

The ascent-to-orbit phase includes the boost of the S-IB stage and the orbital insertion of the S-IVB stage. Orbital insertion (S-IVB thrust termination) occurs at a radius vector magnitude of 21 442 060 ft (perigee altitude of approximately 87 n. mi.) and a nearly 0° inertial flight-path angle. The velocity at insertion is such that the radius vector magnitude at apogee is 21 578 806 ft, or an apogee altitude of approximately 120 n. mi.

Approximately 35 seconds after orbital insertion, the aerodynamic shroud is separated from the S-IVB/SLA/LM combination. Approximately 590 seconds after orbital insertion, the SLA panels are deployed. MSFN coverage of the shroud separation is furnished by the Bermuda tracking station; the Grand Canary Island tracking station provides coverage for SLA panel deployment.

The LM spacecraft is separated from the S-IVB/SLA combination during the first revolution by the LMRCS thrusters approximately 54 minutes after lift-off. MSFN coverage of this event is provided by a MSFN tracking ship and the Carnarvon tracking station.

Shortly after separation, the spacecraft is oriented by the RCS so that the LM X-axis is normal to the ecliptic plane and the bisector of the LM +Z- and -Y-axes is directed toward the sun.

The first DPS burn is performed during the third revolution following the two-revolution orbital coast. The "Hohmann descent" guidance technique is used to issue attitude commands. During this burn (approximately 39 seconds), a  $\Delta V$  of approximately 155 fps is used to raise apogee altitude to approximately 180 n. mi. and perigee altitude to approximately 120 n. mi.

The DPS-2/FITH/APS-1 maneuver is performed over the United States during the latter part of the third and first part of the fourth revolutions. The "lunar landing" guidance technique is used to issue attitude commands and thrust vector magnitude control during the major portion of this event. The spacecraft inertial attitude is held constant during the programmed random throttling portion of DPS-2, the FITH abort test, and APS-1; the positive spacecraft thrust axis is in the direction of the orbit angular momentum vector. The majority of the  $\Delta V$  (approximately



7450 fps) expended during the 12-minute DPS-2 is directed out of the orbit plane. The approximate apogee and perigee altitudes following this burn are 172 n. mi. and 166 n. mi., respectively. A  $\Delta V$  of approximately 55 fps is generated during the 5-second APS-1. The spacecraft orbit following this burn is essentially unchanged from the orbit following DPS-2.

APS-2 is performed over the United States near the end of the fourth revolution. The "LM ascent" guidance technique is used for APS-2. Most of the  $\Delta V$  resulting from this 7-minute burn is directed out of the orbit plane. At the shutdown of this burn, the spacecraft is on an orbit defined by an apogee altitude of approximately 170 n. mi. and a perigee altitude of 450 n. mi.

Approximately 2 hours after APS-2 the first of five RCS burns is performed. The first of these burns is in plane and pitched up approximately  $45^\circ$ . It results in a  $\Delta V$  of 325 fps. The approximate apogee and perigee altitude following this burn are 300 n. mi. and 450 n. mi. The final four RCS burns are performed with the  $\Delta V$  directed out of plane. The spacecraft orbit following these burns is essentially unchanged from the orbit following the first RCS burn.

## 1.2 Alternate Missions

By definition, an alternate mission is a non-nominal mission which may be used to accomplish part of the mission objectives if an inflight contingency prevents the execution of the nominal mission.

The Apollo 5 mission objectives require that a series of burns be performed with both the descent and ascent engines. These mission objectives further assign a priority to each of the burns. For example, the FIFTH abort test has been assigned the highest priority. Other burns will be sacrificed in order to perform this test. Also, whenever possible, all burns will be performed under the control of the PGNCS.

Within these general guidelines a large number of possible alternate missions exist. Several factors control which of these alternate missions will be chosen if a contingency arises. The more important of these are

1. Type of failure.
2. When failure occurs in mission timelines.
3. Time available to plan and execute an alternate mission.

For a more detailed description of possible alternate mission, see reference 3.

## 2.0 ABBREVIATION

APS	ascent propulsion system
APS-1	first APS burn
APS-2	second APS burn
COI	contingency orbit insertion
DMT	detailed maneuver table
DPS	descent propulsion system
DPS-1	first DPS burn
DPS-2	second DPS burn
ECI	earth-centered, inertial
e.s.t.	eastern standard time
FITH	fire-in-the-hole
g.e.t.	ground elapsed time
G.m.t.	Greenwich mean time
GRR	guidance reference release
IMU	inertial measurement unit
IU	instrumentation unit
LGC	LM guidance computer
LM	lunar module
MSFN	Manned Space Flight Network
PGNCS	primary guidance and navigation control subsystem
PRA	program reader assembly
RCS	reaction control subsystem
RTACF	Real-Time Auxiliary Computing Facility

RTCC	Real-Time Computer Complex
SLA	spacecraft-IM adapter
TK	track
TM	telemetry

### 3.0 APPROVED RTACF SUPPORT REQUIREMENTS

The requirements assigned to the RTACF according to the procedure outlined in section 6 of the Operational Support Plan (ref. 4) have been discussed and mutually agreed upon by the Mission Planning and Analysis Division and the Flight Control Division. Documentation of these requirements is listed in the bibliography. Note that other requirements can and probably will be added during flight control simulations.

#### 3.1 Launch Abort Requirements

3.1.1 Mode I abort.- Given an abort state vector, determine the zero-lift landing point and g.e.t. based on a tumbling S-IB/S-IVB/SLA/LM configuration.

3.1.2 Mode II abort.- Given an abort state vector, determine the zero-lift landing point and g.e.t. based on a tumbling S-IVB/SLA/LM (SLA panels deployed).

3.1.3 Mode III abort (LGC sequence).- Given a S-IVB cutoff vector and spacecraft attitudes, perform the LGC suborbital sequence and compute the zero-lift landing point for the ascent stage.

Given a postburn ascent stage state vector, compute the zero-lift landing point for the ascent stage.

3.1.4 PRA 4 sequence.- Given a S-IVB cutoff vector and spacecraft attitudes, perform the PRA 4 sequence and compute a zero-lift ascent stage landing point.

3.1.5 COI.- Given a S-IVB cutoff vector, compute the COI maneuver required for an acceptable orbit.

Given a S-IVB cutoff vector, the time of ignition, and time of cut-off, compute a zero-lift landing point for the ascent state resulting from an unsuccessful COI sequence.

### 3.2 Nominal Mission Requirements

3.2.1 Navigation update evaluation.- Given a spacecraft TM state vector, a MSFN state vector, and maneuver targets, compute information necessary to decide whether or not a navigation update is required to insure successful completion of planned maneuver (DPS-1, DPS-2/APS-1, APS-2). In addition, determine pseudo target if a navigation update is not required. Assuming a nominal maneuver, these are the target conditions that the spacecraft will actually achieve if a navigation update is not performed.

3.2.2 RCS maneuver gimbal angles.- Given a state vector, time of ignition for finite maneuver, and desired effective local horizontal attitudes, compute ignition gimbal angles for a RCS maneuver.

3.2.3 Cold soak attitudes.- Given a state vector, G.m.t. of lift-off, and G.m.t. of spacecraft GRR, compute cold soak gimbal angles.

Given a state vector, G.m.t. of lift-off, G.m.t. of spacecraft GRR, and desired g.e.t., for local horizontal attitudes, compute cold soak gimbal angles and local horizontal attitudes.

3.2.4 Relative motion studies.- Given two state vector (S-IVB/LM or DPS/APS) and planned maneuvers, determine the range and range rate of the two vehicles.

Given the ascent stage state vector, determine the present descent state vector and define the range and range rate of the two vehicles.

3.2.5 Radar data (PSAT).- Given a state vector and minimum elevation angle, determine ground station acquisition and loss time and other related tracking information.

3.2.6 Orbital lifetime.- Given a state vector, determine the orbital lifetime in days, hours, and minutes since lift-off and, also, the lifetime from the input vector time.

3.2.7 Ground track data.- Given a state vector, determine ground track data (g.e.t., latitude, longitude, and altitude). The interval at which data is output will be specified as well as the duration of the ground track data.

3.2.8 Navigation update.- Given a state vector and an update time, determine and output in the correct octal format a LGC navigation update.

3.2.9 Public Affair Office requirement.- Determine orbital data as required by the Public Affair Officer.

### 3.3 Alternate Mission Requirements

3.3.1 Retargeting of DPS-2 or APS-2.- Given a state vector, desired orbital conditions, and desired maneuver characteristics, compute and verify DPS-2 or APS-2 targets.

3.3.2 Location of PRA sequence.- Given a state vector, the PRA sequence planned, and the revolution of execution, determine the earliest possible ignition time which will guarantee that the spacecraft will not impact western hemisphere land masses. The computation will be based on worst attitudes.

3.3.3 Effect of PRA sequence.- Given a state vector and planned PRA sequence, determine the resulting orbit after performing the PRA sequence.

### 3.4 General Requirements

3.4.1 IM instrumentation diagnostic program.- Given a group of parameter numbers, determine the common failure mode of these input parameters.

3.4.2 Engineering units - octal conversion.- Given numbers in engineering units, convert to octal and output in the correct LGC format. Similarly given LGC octal numbers, convert to engineering units.

3.4.3 Gimbal angles to local horizontal attitude conversion.- Given a set of IU gimbal angles, convert to IMU gimbal angles or local horizontal attitudes. Also given a set of IMU gimbal angles, convert to local horizontal attitudes.

3.4.4 IU or IMU state vector to RTCC Greenwich ECI state vector.- Given a IU or IMU state vector, convert to an RTCC ECI vector.

## 4.0 RTACF PROCESSORS FOR APOLLO 5

The following section provides a general description of Apollo 5 RTACF processors. A more detailed description of processors useage can be found in reference 5.

### 4.1 Types of RTACF Output Available

There are two types of computer output available for the Apollo 5 processors to be used in the RTACF. The first type is a summary sheet; the second type is an off-line printout of a computer magnetic tape written by the processor. A tabulation of quantities printed off-line is shown in table II. The summary sheets are output immediately after the termination of computation, and provide at least the minimum number of output parameters necessary to satisfy the requirements.

There are presently thirteen different on-line summary sheets available in the RTACF. The summary sheets shown in figures 1 and 2 will be used to output the results from four of the RTACF processors. These sheets include all the required data for both the nominal guided and non-nominal retargeting processors. Even though the output of these processors are somewhat similar, no single processor is capable of providing all the data indicated on the summary sheet. However, for any processor using the summary sheets, all of the required data for that processor will be included.

Similarly the summary sheet shown in figure 3 will be used to output the data from eleven of the RTACF processors. This summary sheet will include the required data from the abort computations and the PRA sequence processors.

For this particular summary sheet, some of the processors will completely fill the format, while others will not. Thus, in order to interpret this summary sheet correctly, some detail of the outputs of each of the particular processors must be known.

The remaining ten summary sheets are formatted specifically for particular processors. Figures 4 through 13 show examples of each of the summary sheets. The details of the processors associated with each summary sheet are described in the remainder of this section.

## 4.2 Abort Processors

There are five processors in the RTACF which are used to satisfy the abort requirements. One of the processors is used to compute Mode I landing points. A second processor is used to compute Mode II landing points. Two other processors are used to compute landing points in the Mode III region. The fifth processor is used to compute COI maneuvers.

4.2.1 Mode I abort processor.- The Mode I abort region exists from lift-off until a dynamic pressure of 1 psf is reached. At this level of dynamic pressure, the nose fairing can be jettisoned and the SLA panels can be deployed for separation of the LM. This occurs on the nominal trajectory at a g.e.t. of approximately 2 minutes 44 seconds. No action will be taken to initiate a Mode I abort.

The Mode I abort processor determines the zero-lift landing point of the S-IB/S-IVB/SLA/LM (SLA panels closed).

The only input required is the RTCC state vector.

The output is shown in the summary sheet in figure 3.

4.2.2 Mode II abort processor.- At 2 minutes 44 seconds g.e.t., the dynamic pressure reaches 1 psf. At this level of dynamic pressure, the nose fairing can be jettisoned, and the SLA panels enclosing the LM can be opened. This is the earliest time that a Mode II abort can be initiated. A Mode II abort consists of a zero-lift entry of the S-IVB/SLA/LM (SLA panels deployed) after the LM fails to separate. No action will be taken to initiate a Mode II abort, although one could result from an attempted Mode III. Even as a backup for a Mode III or IV abort (COI), a Mode II is undesirable since no LM propulsion data is received.

The Mode II abort processor determines the zero-lift landing point of the S-IVB/SLA/LM (SLA panels deployed).

The RTCC state vector is the required input.

Data will be output in the summary sheet format shown in figure 3.

4.2.3 Mode III abort processor.- When the dynamic pressure reaches 1 psf at a g.e.t. of 2 minutes 44 seconds, the nose fairing can be jettisoned, and the SLA panels enclosing the LM can be opened to allow the LM to separate from the S-IVB. This is the earliest time that a Mode III launch phase abort can be initiated. The nominal Mode III region ends when the spacecraft has the capability to burn itself into an acceptable orbit. (See Mode IV.) Mode III launch phase aborts are designed to permit completion of the third mission phase LM minimum propulsion test. The test consists of a series of LM and APS burns including FITH staging. This test is performed at an inertial attitude pitched up  $10^\circ$  from the S-IVB attitude at the time of abort, and is sequenced by commands from the LM guidance computer.

The sequences of events for the Mode III aborts are given in tables III and IV. Table III gives the 175-second minimum sequence. This sequence is for a ground-commanded abort (limit line approached only) situation. The 189-second minimum sequence in table IV is for a premature engine shutdown situation. In this sequence an additional 14 seconds are required prior to S-IVB/LM separation to detect the shutdown and command an abort.

An alternate method for achieving a minimum propulsion test is through the use of PRA sequence 4. (PRA sequences 1, 2, 3, 4, 5, 15A, 15B, and 15C are tabulated in tables V through XII.) This method could be used if a spacecraft failure prevents the use of the planned LGC Mode III sequence.

The Mode III processors (LGC sequence or PRA sequence 4) will integrate through either sequence and compute a zero-lift landing point for a tumbling ascent stage. The following inputs are required:

1. RTCC state vector.
2. Spacecraft attitudes (gimbal angles or local horizontal attitudes).
3. Time of main engine on.

The output is given in summary sheet shown in figure 3.

4.2.4 Mode IV - COI processor.- The Mode IV (COI) launch phase abort region begins when the LM performance is capable of achieving a perigee radius equal to or greater than the nominal radius at insertion and a nominal perigee velocity by using a DPS burn of 500 seconds or less. This maximum burn duration insures that a second DPS ignition can be achieved for a subsequent alternate mission. The Mode IV region ends near insertion when ascent trajectory state conditions that produce an orbit with a 75-n. mi. perigee altitude are achieved. The COI burn is a guided DPS burn using basically the modified ascent guidance equations. The separation, coast, and start sequence for this guided burn is presented in table XIII.

The Mode IV processor takes a S-IVB abort cutoff vector and computes the required COI maneuver using the modified ascent equations.

This processor can also be terminated before a guidance cutoff is achieved in order to simulate a failed COI maneuver.

The inputs required are:

1. RTCC state vector.
2. Time of main engine on.
3. Time of cutoff (unsuccessful case).

The output will be in the format of the summary sheet shown in figure 4.

### 4.3 Nominal Mission Processors

4.3.1 Navigation update evaluation processor.- Prior to each guided burn during the Apollo 5 mission it will be critical to mission success to determine whether or not a navigational update is needed. The RTACF has developed a processor which can provide the data necessary to satisfy this requirement. This data will be determined prior to each of the guided burns.

This processor will use a spacecraft TM state vector, a MSFN state vector, and maneuver targets to perform the evaluation. This processor determines the effect of the spacecraft guiding through the planned burn with the TM state vector.



The acceleration time history computed and applied to the TM state vector, is also applied to the MSFN state vector. The resulting orbits, as computed for both vectors, are output for flight controller evaluation. Also, certain important guidance quantities are output for flight controller evaluation. Using these data, the flight controller will decide whether or not navigation update is required.

If a navigation update is not required, then the RTACF outputs a set of pseudo targets for the MSFN vector. These are the target conditions that the spacecraft will actually achieve if a navigation update is not performed.

Three inputs are required:

1. MSFN state vector.
2. TM state vector.
3. Maneuver targets.

The output quantities will be displayed on the summary sheets shown in figures 1 and 2.

4.3.2 RCS maneuver gimbals processor.- Given a state vector, time of ignition for a finite maneuver, and desired effective local horizontal attitudes, this processor computes ignition gimbals angles for a RCS maneuver. This processor essentially computes finite maneuver gimbals angles given a desired impulsive maneuver attitude.

Inputs required are:

1. State vector.
2. Time of ignition.
3. Duration of burn or weight of RCS fuel to be used during burn.
4. Effective local horizontal attitudes.

The outputs for this processor will be displayed in the summary sheet shown in figure 5.

4.3.3 Cold soak attitudes processor.- Shortly after separation from the S-IVB, the LM is oriented to the cold soak attitude. In this attitude the spacecraft's X-axis is normal to the ecliptic plane and the bisector of the spacecraft's +Z and -X-axes is directed toward the sun. This RTACF processor computes the gimbals angles required to align the spacecraft in this attitude.

The following inputs are required:

1. Day of launch.
2. G.m.t. of spacecraft GRR.
3. G.m.t. of lift-off.

Note that if local horizontal attitudes are desired then two additional inputs are required.

1. State vector.
2. g.e.t. for local horizontal attitude.

The outputs for this processor will be displayed in the summary sheet shown in figure 5.

4.3.4. Relative motion processor.- During the nominal mission, this RTACF processor will be used to determine the range and range rate between the LM and the S-IVB and also between the ascent stage and the descent stage.

The inputs required are:

1. A state vector for each vehicle.
2. The time period for which the data is desired.
3. The delta time between each data point.

The outputs for this processor will be displayed in the summary sheet shown in figure 6.

4.3.5 Predicted site acquisition table (PSAT) processor.- This processor computes acquisition and loss data for ground tracking stations. Other associated data is also output. The data can be generated for the LM or the S-IVB, and may include planned maneuvers.

The inputs required are:

1. State vector.
2. Time period for which data is required.

The output satisfying this requirement will be displayed on the PSAT summary sheet shown in figure 7.

4.3.6 Orbital lifetime processor.-- This processor computes a predicted orbital lifetime using an input state vector and vehicle characteristics such as weight and reference area.

Three inputs are required:

1. State vector.
2. Area of vehicle.
3. Year, month, and day of launch.

The output for this processor is predicted lifetime since time of input state vector and also predicted lifetime since lift-off. This data will be output in the summary sheet shown in figure 8.

4.3.7 Ground track data processors.-- Ground track data will be computed using the SG-GEM programs. This data will reflect only maneuvers planned in the requested time period.

The inputs are:

1. State vector.
2. Time between data points.
3. Time period desired.

The output for this processor will be displayed in the ground track summary sheet shown in figure 9.

4.3.8 LGC navigation update processor.-- This processor takes a IM state vector, propagates it forward to the request navigation update time, and outputs the resulting state vector in the LGC octal format.

The inputs are:

1. State vector.
2. G.m.t. of lift-off.
3. Year, month, and day of launch.
4. Navigation update time.

The outputs required for this processor will be displayed on the navigation update summary sheet shown in figure 10.

4.3.9 Processors for Public Affairs Officer and postflight observer.- No special processors are planned to support these requirements. The data output by processors in support of other RTACF requirements will satisfy these requirements.

#### 4.4 Alternate Mission Requirements

4.4.1 Retargeting processors.- The RTACF has the capability to re-target either the DPS-2 or APS-2. The two processors involved require the minimum of inputs making possible rapid computation and verification of re-target parameters. Each of the retargeting processors first computes, then integrates through the planned maneuver to verify that the new targets are valid.

The inputs for the DPS-2 retargeting processor are:

1. State vector.
2. Desired time of ignition.
3. Mass of DPS fuel to be conserved.

All required data will be output in the DMT summary sheets shown in figures 1 and 2.

The inputs for the APS-2 retargeting processors are:

1. A state vector.
2. The desired time of ignition.

The required data for this processor will also be output in the DMT summary sheets shown in figures 1 and 2.

4.4.2 Effect of PRA sequence processor.- This processor computes the effect of applying a PRA sequence maneuver to an input state vector. The output defines the orbit the vehicle will be in the following PRA sequence.

The inputs are:

1. State vector.
2. PRA sequence to be applied.
3. Spacecraft attitude.
4. Initiation time of sequence.

The required data will be output in the PRA abort summary sheet shown in figure 3.

4.4.3 Location of PRA sequence processor.- The use of certain PRA sequences during the Apollo 5 mission could result in a land impact of either the ascent or descent stage. Two facts contribute to this possibility:

1. If a PRA sequence is initiated, the burn will be done in an inertial attitude-hold mode using whatever attitude the spacecraft was in when the sequence began. Thus, certain retrograde attitudes could result in an impacting trajectory if the burn could not be terminated by the Flight Dynamic Officer when the predicted perigee drops below 65 n. mi.

2. If a PRA sequence is performed, it will, if at all possible, be done over the United States because of tracking constraints.

The RTACF processor to locate the PRA sequence uses an iterative technique to determine the earliest possible ignition time (for any pass over the United States) which will guarantee that neither stage will impact the western hemisphere land masses during that pass.

This processor assumes that the spacecraft is in the worst attitude (i.e., that attitude which results in the shortest entry range).

The inputs required are:

1. State vector.
2. PRA sequence to be used.
3. Worst attitude (preflight study).
4. Pass over United States that sequence is to be performed.

The data will be output in the summary sheet shown in figure 3.

#### 4.5 General Purpose Processors

There are presently four separate processors which can be classified as general purpose processors. The first is really a system of processors. These are the LM instrumentation diagnostic processors. The second processor in this group is concerned with converting engineering units to LGC octal units. The third of these processor; converts either IU or IMU gimbal angles to local horizontal attitudes. The fourth processor converts IU or IMU state vectors to ECI Greenwich state vectors.

4.5.1 LM instrumentation diagnostic processor.- This program is capable of accepting manual inputs of parameter numbers and outputting all available data on each parameter. From these output data, the program determines the failure mode common to all parameter numbers.

The total input to the program will be a group of "parameter numbers". These groups of numbers may be from one to the maximum number on the spacecraft and may be given in any order. The numbers are alphanumeric containing two letters and four numbers (example: GC0260).

Outputs required:

The total output from the program will be as follows:

1. Analog data.
2. Electrical circuit interrupters 1, 2, and 3.
3. Digital data.
4. A summary report designating the common failure mode of the group of input parameters. It will be printed at the end of the columnized analog and/or digital data.
5. Column.
6. Signal conditioner.
7. Signal conditioner location.
8. Circuit breaker.
9. Other groups.

The analog data outputs are:

1. Parameter number.
2. PAM gate.
3. PAM sequencer.
4. ROW.

The digital data outputs are:

1. Gate.
2. Signal conditioner.
3. Signal conditioner location.
4. Circuit breaker.

4.5.2 Engineering units to octal conversion.- This processor will take any number in engineering units and convert it to the LGC octal number. Also, this processor will convert any LGC octal number to its corresponding engineering number.

Inputs required are:

1. Data in engineering units or octal.
2. Scale factor.
3. Precision of octal word.

The outputs required for this processor will be displayed in the summary sheet shown in figure 11.

4.5.3 IU/IMU gimbal angles conversion.- This processor converts either IU or IMU gimbal angles to local horizontal attitudes.

The inputs required are:

1. IU and IMU gimbal angles.
2. GRR for booster and spacecraft.
3. g.e.t. of local horizontal attitudes.

The output for this processor will be output in the summary sheet shown in figure 12.

4.5.4 IU to IMU state vector conversion.- This processor converts an input IU or IMU state vector to an ECI Greenwich state vector.

Inputs required are:

1. IU/IMU state vector.

2. GRR for booster and spacecraft.
3. Spacecraft lift-off time.

Outputs for this processor will be displayed in the summary sheet shown in figure 13.

## 5.0 APOLLO 5 RTACF WORK SCHEDULE

This section of the Flight Annex presents a schedule of RTACF activity from prelaunch (T minus 6 hours) through nominal end of mission (approximately T plus 13 hours). Additional radar coverage is provided through 20 hours g.e.t. This work schedule represents only those RTACF activities which could be established before the mission. Real-time consideration of spacecraft dispersions, contingency situations, and onboard systems reliability may cause changes in the nominal mission and thus changes in the RTACF work schedule.

The locations and tracking capabilities of the radar sites available for the Apollo 5 mission are summarized in table XIV.

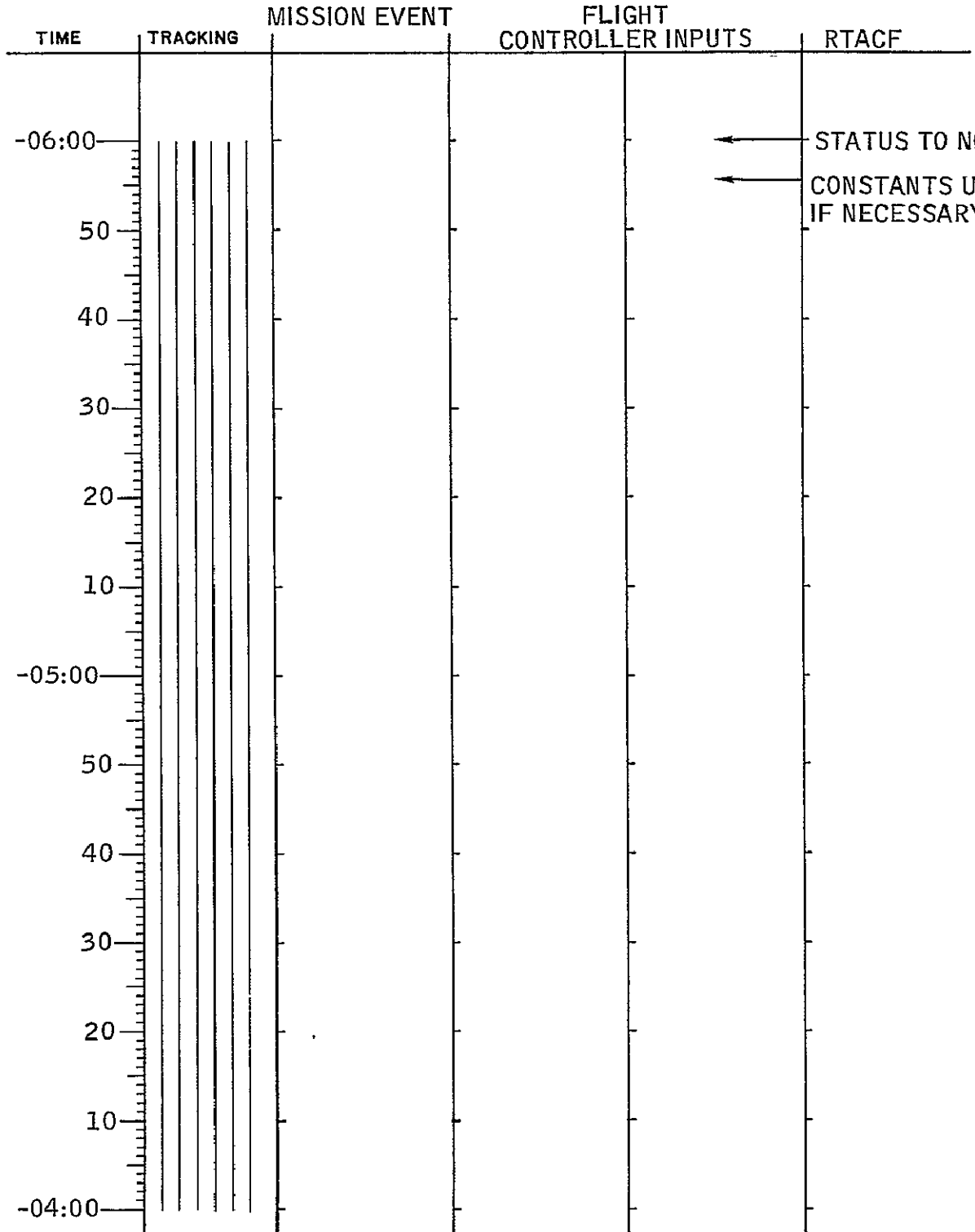
This work schedule is based on data extracted from the Apollo 5 Operational Trajectory. This work schedule reflects all accepted RTACF requirements applicable to the nominal mission.



# WORK SCHEDULE

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COMMENTS:

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TIME	TRACKING	MISSION EVENT	FLIGHT CONTROLLER INPUTS	RTACF
-04:00				
50				
40				
30				
20				
10				
-03:00				
50				
40				
30				
20				
10				
-02:00				

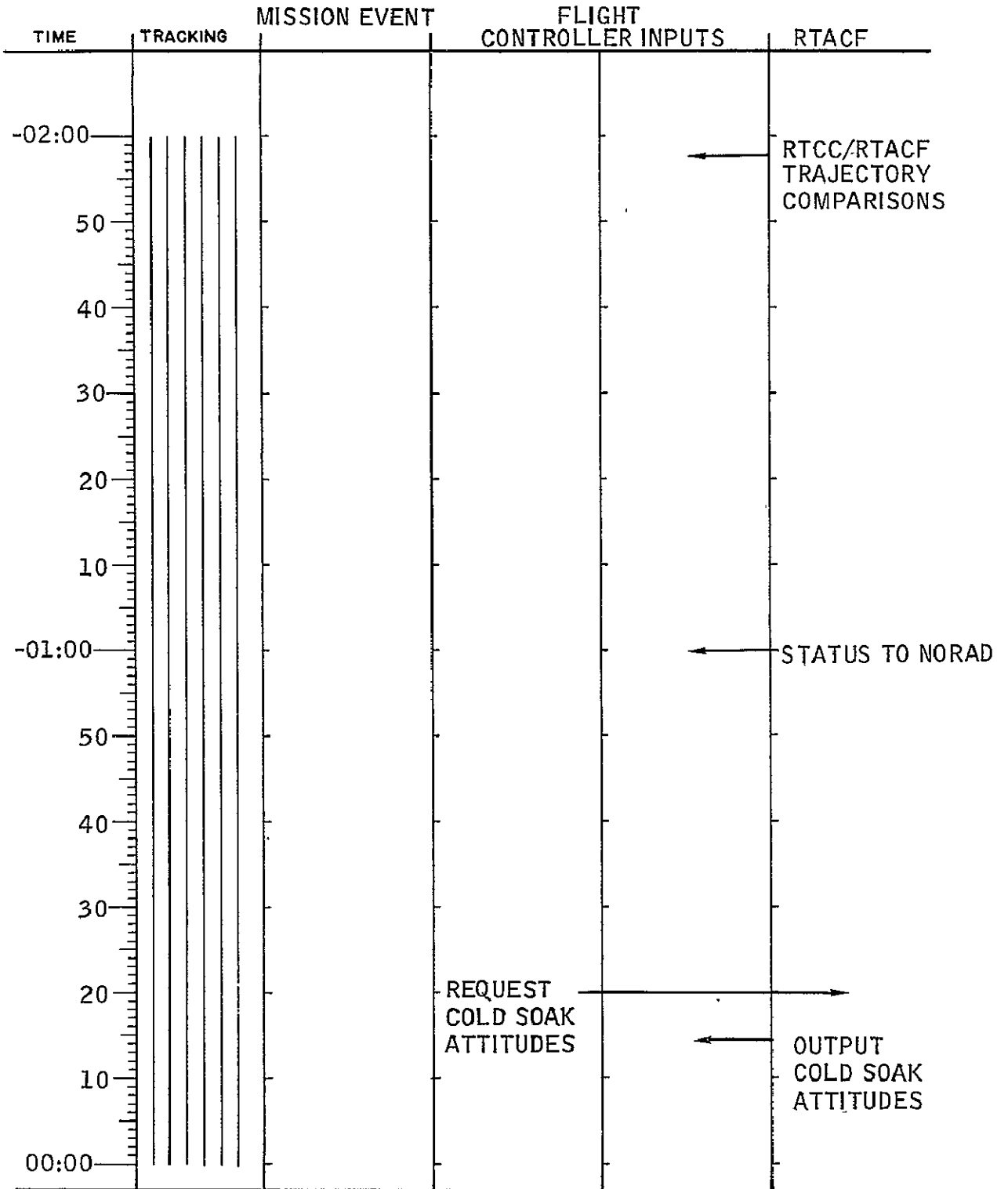
← RTCC/RTACF  
TRAJECTORY  
COMPARISONS

COMMENTS

# WORK SCHEDULE

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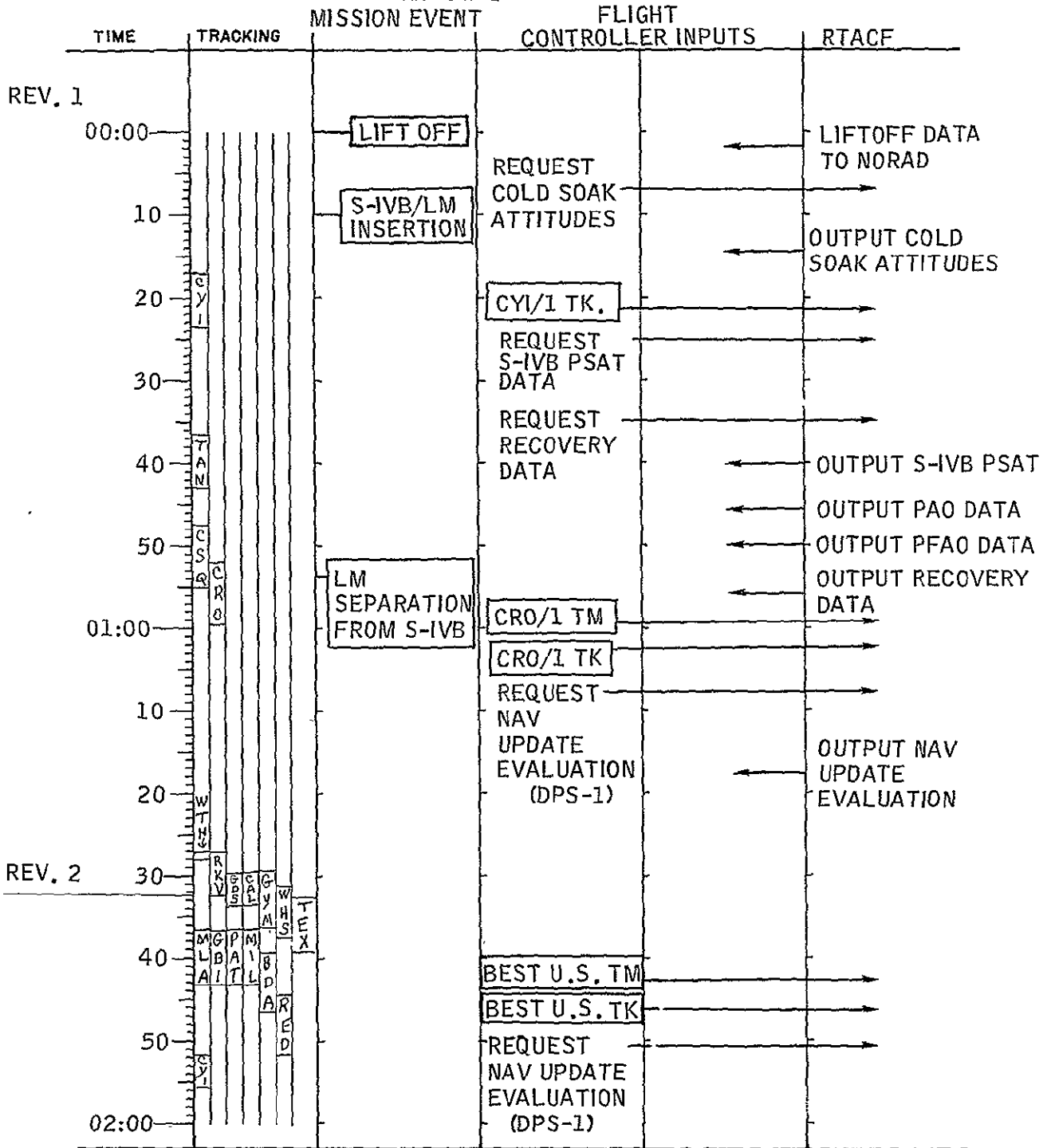


COMMENTS:

WORK SCHEDULE

MISSION APOLLO 5

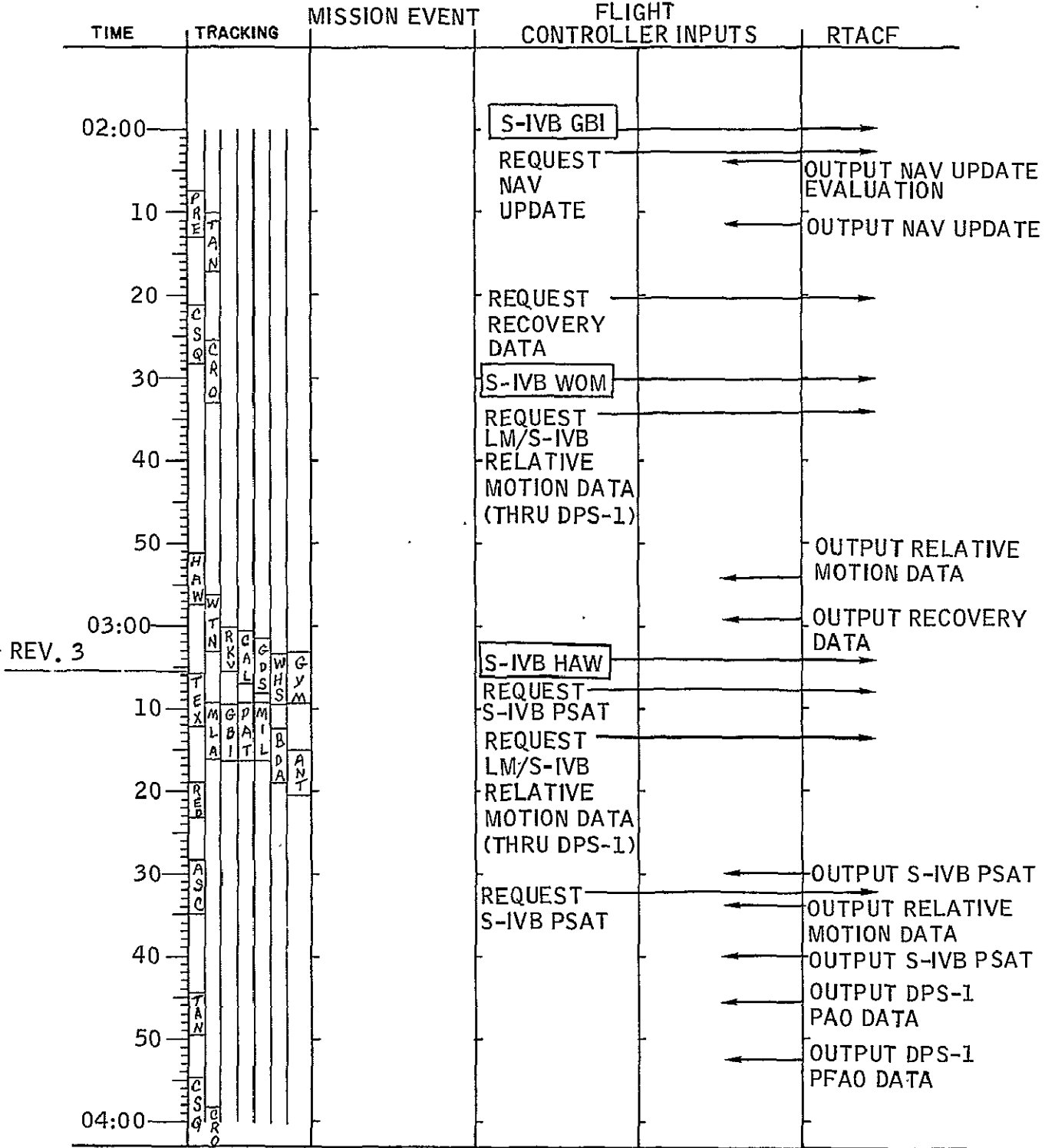
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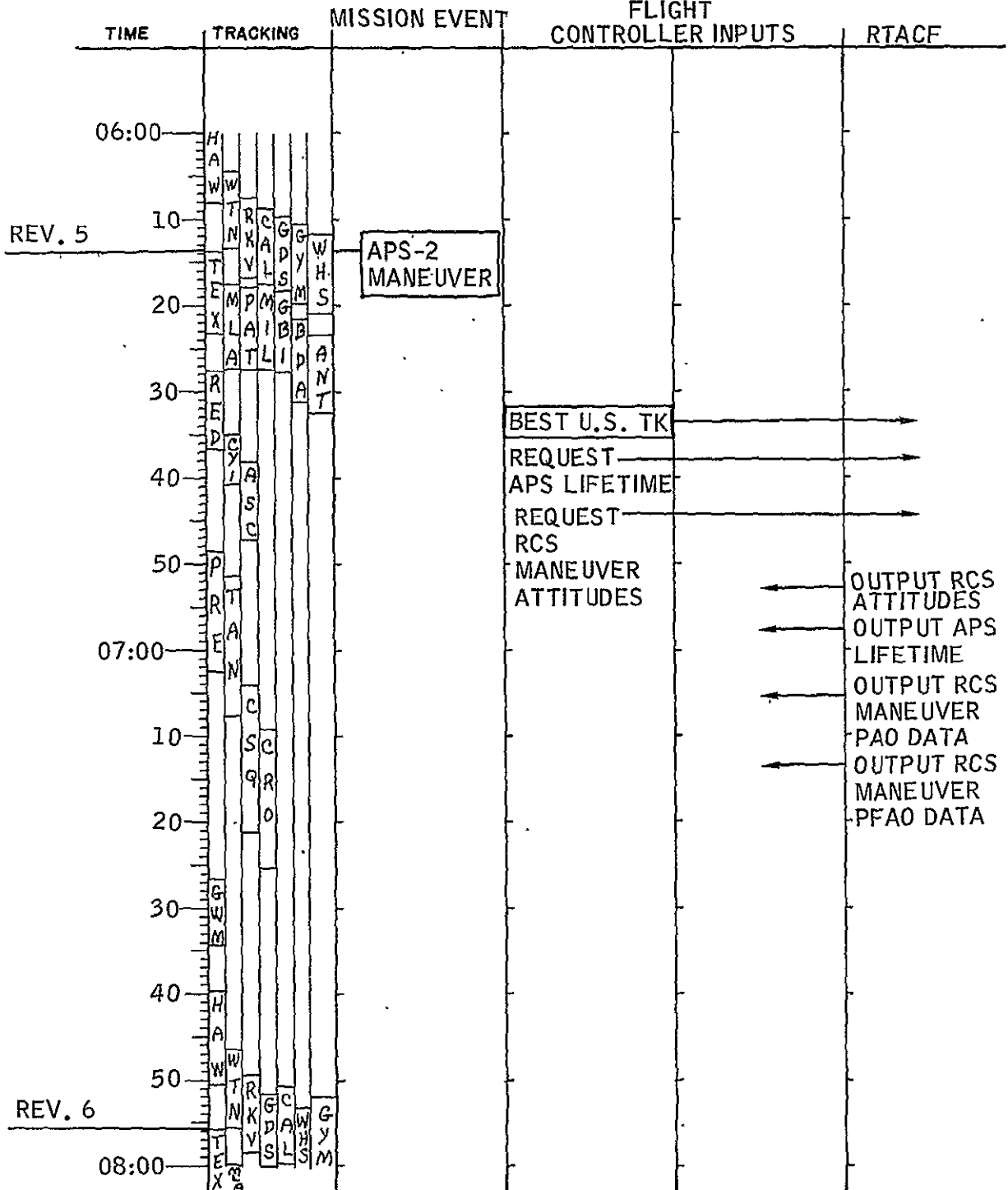
TIME	TRACKING	MISSION EVENT	FLIGHT CONTROLLER INPUTS	RTACF
04:00	CRO	DPS-1 MANEUVER	CRO/3 TM	
			COR/3 TK	
10			REQUEST NAV UPDATE EVALUATION (DPS-2)	
20			REQUEST NAV UPDATE	OUTPUT NAV UPDATE
				OUTPUT NAV UPDATE EVALUATION
30				OUTPUT DPS-2/APS-1 PAO DATA
		DPS-2/APS-1 MANEUVER		OUTPUT DPS-2/APS-1 PFAO DATA
40			BEST U.S. TM	
			BEST U.S. TK	
50			REQUEST NAV UPDATE EVALUATION (APS-2)	
05:00			REQUEST RECOVERY DATA	
10			REQUEST NAV UPDATE	OUTPUT NAV UPDATE EVALUATION
20			REQUEST APS/DPS RELATIVE MOTION DATA	OUTPUT RECOVERY DATA
30			REQUEST DPS LIFETIME	OUTPUT NAV UPDATE
40				OUTPUT RELATIVE MOTION DATA
				OUTPUT DPS LIFETIME
50				OUTPUT APS-2 PAO DATA
06:00				OUTPUT APS-2 PFAO DATA

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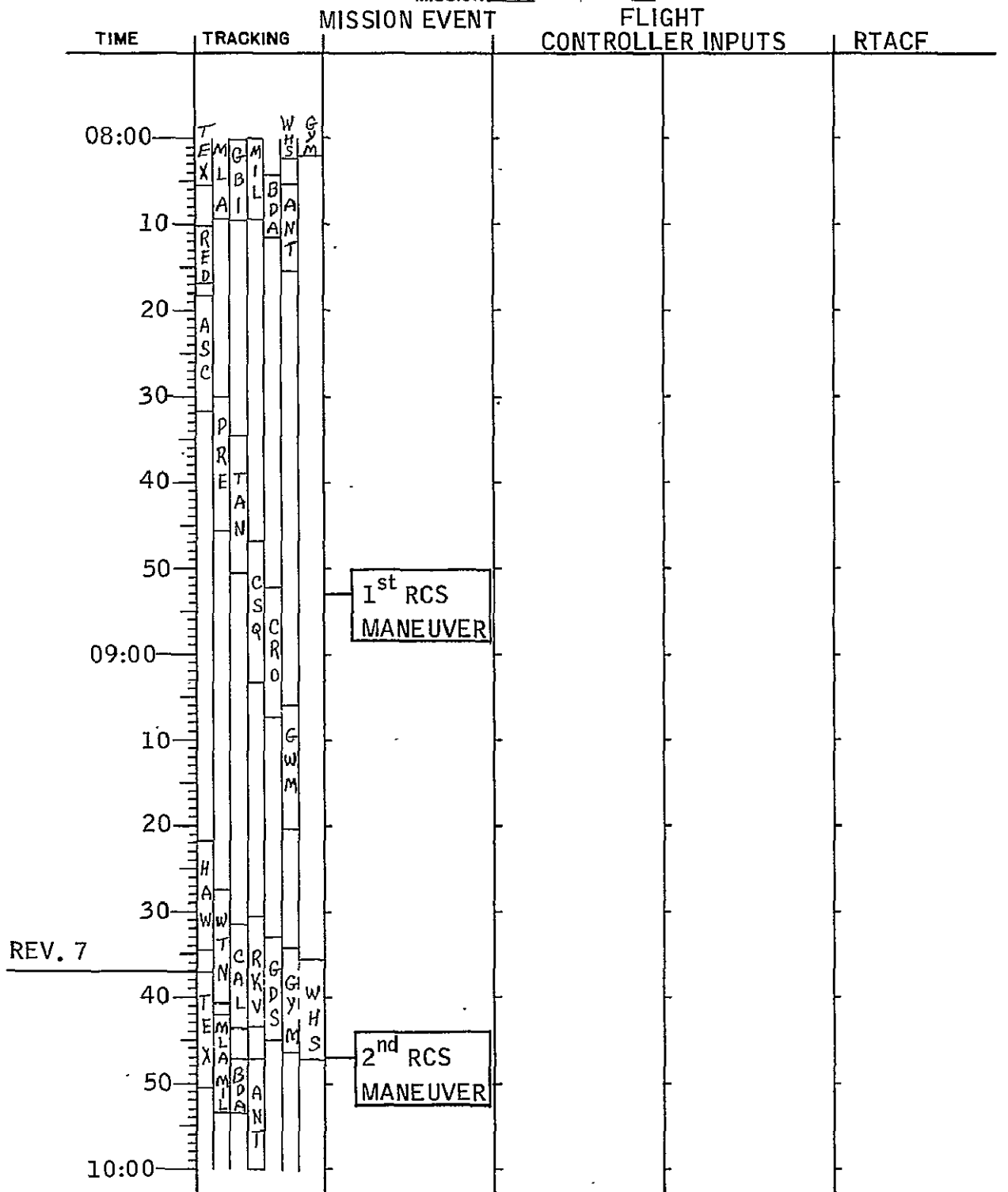


COMMENTS:

WORK SCHEDULE

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COMMENTS:



WORK SCHEDULE  
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TIME	TRACKING	MISSION EVENT	FLIGHT CONTROLLER INPUTS	RTACF
10:00	ASC			
10:10	ASC			
10:20	PRE			
10:30	TAN			
10:40	CSC			
10:50	RC			
11:00	RC			
11:10	GW			
11:20	M			
11:30	HA			
11:40	WT			
11:50	WT			
12:00	NT			
12:10	CK			
12:20	ALY			
12:30	TE			
12:40	EX			
12:50	ASC			
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TIME	TRACKING	MISSION EVENT	FLIGHT CONTROLLER INPUTS	RTACF
12:00	AS P R E T A N			
10				
20	G W M			
30				
40				
50	H A W T N	5 <sup>th</sup> RCS MANEUVER		
13:00				
10	C A L K Y M			
20				
30				
40	A S C			
50	P R E T A N			
14:00				

REV. 9

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TIME	TRACKING	MISSION EVENT	FLIGHT CONTROLLER INPUTS	RTACF
14:00	PRE TAN  GW M  HA W T N  AS C  PR E T A N  AS C  PR E T A N			
10				
20				
30				
40				
50				
15:00				
10				
REV. 10				
20				
30				
40				
50				
16:00				

COMMENTS:

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TIME	TRACKING	MISSION EVENT	FLIGHT CONTROLLER INPUTS	RTACF
16:00				
10	G			
	W			
20	M			
	A			
30	A			
	W			
40				
50				
17:00				
REV. 11				
10	A			
	S			
	C			
20				
30				
40				
50				
18:00	G			
	W			
	M			

COMMENTS:

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TIME	TRACKING	MISSION EVENT	FLIGHT CONTROLLER INPUTS	RTACF
18:00	G W M			
10				
20				
30				
40				
50				
19:00				
10				
20				
30				
40				
50				
20:00				

COMMENTS:

TABLE I.- MAJOR MISSION EVENTS

Event	Rev. no.	Time, hr:min:sec	LM location			Inertial velocity vector		
			Geodetic latitude, deg	Longitude, deg	Altitude, n. mi.	Velocity, fps	Flight-path angle, deg	Azimuth, deg
S-IVB orb. insertion - maintain cut-off inert. att. - cont. venting	1.05	00:10:10.15	31.58	-61.33	88.12	25684.550	.019	86.21
Enable mission phase six (S-IVB/IM coast)		00:10:14.15	31.59	-61.02	88.13	25684.994	.020	86.38
Terminate S-IVB vox venting	1.06	00:10:38.55	31.69	-59.16	88.17	25687.639	.027	87.40
Jettison nose cap		00:10:43.35	31.70	-58.80	88.18	25687.578	.028	87.61
Initiate pitch maneuver to align longitudinal axis with local horizontal plane	1.07	00:11:28.35	31.78	-55.36	88.29	25686.842	.037	89.51
Terminate pitch maneuver - maintain local attitudes	1.08	00:12:04.46	31.77	-52.60	88.40	25686.040	.044	91.04
Deploy SLA panels	1.17	00:19:58.35	25.84	-18.00	91.60	25658.976	.137	109.11
Disable mission phase six	1.20	00:22:10.15	22.58	-9.32	93.06	25646.545	.162	112.89
Terminate S-IVB LH2 venting	1.28	00:30:58.75	5.59	21.48	101.15	25582.010	.246	121.21
S-IVB/LM begin inertial attitude hold for separation	1.47	00:50:05.00	-29.01	89.21	119.73	25458.194	.097	103.53
Enable mission phase seven (S-IVB/LM separation)	1.48	00:50:32.49	-29.43	91.16	119.91	25457.139	.086	102.53
RCS ignition with S-IVB attached	1.52	00:54:27.49	-31.63	108.38	120.61	25453.588	-.006	93.24
Sever restraining straps - extract LM from SLA	1.53	00:54:32.49	-31.65	108.76	120.61	25454.461	-.008	93.04
RCS shutdown		00:54:37.49	-31.67	109.13	120.60	25456.381	-.008	92.83
RCS ignition		00:54:42.49	-31.68	109.50	120.60	25456.417	-.010	92.63
RCS shutdown - set dap at maximum deadband - disable mission phase seven		00:54:47.49	-31.70	109.88	120.60	25458.334	-.011	92.42
Enable mission phase eight (estab. cold soak att.)		00:55:07.49	-31.74	111.38	120.58	25458.524	-.018	91.59
Disable mission phase eight - set dap at maximum deadband	1.56	00:57:37.49	-31.47	122.60	120.05	25462.084	-.076	85.38
Enable mission phase nine, (first DPS burn)	3.45	03:55:08.50	-31.02	82.32	119.24	25466.198	-.093	82.72
RCS ignition	3.51	03:59:30.00	-26.96	101.99	116.41	25483.941	-.183	72.56
First DPS ignition - execute guidance commands - begin thrust buildup		03:59:37.50	-26.81	102.50	116.31	25487.387	-.182	72.32
RCS shutdown		03:59:38.00	-26.80	102.54	116.30	25487.617	-.182	72.30

TABLE I - MAJOR MISSION EVENTS - Continued

Event	Rev. no.	Time hr:min:sec	LM location			Inertial velocity vector		
			Geodetic latitude, deg	Longitude, deg	Altitude, n. mi.	Velocity, fps	Flight-path angle, deg	Azimuth deg
Terminate thrust buildup		03:59:40.20	-26.75	102.69	116.27	25488.967	-.181	72.23
Guidance commanded shutdown - begin DPS tailoff	3.52	04:00:15.50	-25.99	105.08	115.88	25628.825	-.050	71.12
Disable mission phase nine - dap to maximum deadband		04:00:16.10	-25.98	105.12	115.88	25630.637	-.044	71.10
Enable mission phase eleven (second DPS/fifth/first APS Burn)	3.84	04:33:00.30	30.64	-138.35	164.15	25290.918	.371	81.18
RCS ignition	3.88	04:36:40.70	31.77	-122.31	169.27	25253.884	.264	89.99
Second DPS ignition	3.89	04:36:48.20	31.77	-121.76	169.41	25252.960	.261	90.29
RCS shutdown		04:36:48.70	31.77	-121.72	169.42	25252.900	.260	90.31
Terminate thrust buildup		04:36:50.90	31.77	-121.56	169.46	25252.641	.259	90.39
Begin preprogrammed random throt- tling - set throttle to 10 percent	4.03	04:48:30.74	27.32	- 71.47	167.73	25358.025	-.076	101.12
Set throttle to 50 percent		04:48:40.74	27.19	- 70.78	167.67	25357.674	-.071	101.40
Set throttle to 30 percent		04:48:50.84	27.06	- 70.10	167.62	25355.460	-.050	101.47
Set throttle to 40 percent		04:49:00.74	26.93	- 69.41	167.56	54.306	-.038	101.64
Set throttle to 20 percent		04:49:10.74	26.79	- 68.73	167.51	25352.839	-.022	101.71
Set throttle to maximum		04:49:20.74	26.65	- 68.04	167.47	25352.157	-.013	101.99
Initiate fire in the hole - abort test	4.04	04:49:22.74	26.63	- 67.91	167.46	25351.555	-.006	101.95
Jettison descent stage		04:49:23.19	26.62	- 67.88	167.45	25351.498	-.005	101.97
First APS ignition - began thrust buildup		04:49:23.46	26.62	- 67.86	167.45	25351.498	-.005	101.97
Terminate APS thrust buildup		04:49:23.86	26.61	- 67.83	167.45	25350.241	-.000	101.97
Command APS shutdown - begin thrust tailoff		04:49:28.46	26.55	- 67.52	167.43	25351.042	.006	102.01
Terminate APS tailoff - disable phase eleven - set dap to maximum deadband		04:49:28.76	26.54	- 67.50	167.43	25351.065	.006	102.01
Enable mission phase thirteen (second APS burn)	4.88	06:12:23.23	28.69	-123.04	168.56	25355.774	.023	85.76
RCS ignition	4.91	06:15:00.70	28.94	-111.82	168.33	25353.353	.017	91.91
Second APS ignition - begin thrust buildup command guidance execution	4.92	06:15:13.23	28.91	-110.92	168.31	25353.353	.017	91.91

TABLE I.- MAJOR MISSION EVENTS - Concluded

Event	Rev. no.	Time hr:min:sec	LM location			Inertial velocity vector		
			Geodetic latitude, deg	Longitude deg	Altitude, n. mi.	Velocity, fps	Flight-path angle, deg	Azimuth
Terminate APS buildup		06:15:13.63	28.91	-110.90	168.31	25353.219	.017	91.92
RCS shutdown		06:15:13.73	28.91	-110.89	168.31	25353.213	.017	91.92
APS shutdown on APS fuel depletion - set dap to maximum deadband	5.00	06:22:31.17	27.36	- 80.04	170.01	25803.00	-.147	92.41
Orient for first RCS test	6.40	08:52:24.58	-23.96	87.53	425.52	23987.172	-.655	77.12
First RCS burn test - deplete system B	6.46	08:52:44.016	-23.68	88.66	424.51	23992.824	-.697	76.63
RCS shutdown - set dap to minimum deadband	6.50	08:56:58.81	-18.77	104.21	411.61	24265.618	-.497	70.80
Orient for second RCS test	6.98	09:46:20.40	18.09	- 86.39	313.97	25059.061	.458	110.11
Second RCS burn test	6.98	09:46:39.99	17.64	- 85.27	314.59	25054.534	.477	110.51
RCS shutdown - set dap to minimum deadband	6.99	09:47:23.859	16.62	- 82.78	316.07	25053.581	.525	111.22
Third RCS burn test	7.94	11:27:39.00	13.46	-100.65	320.57	25025.394	.624	113.11
RCS shutdown - set dap to minimum deadband	7.95	11:28:23.96	12.30	- 98.21	322.52	25021.084	.674	113.64
Fourth RCS burn test	7.97	11:31:23.96	7.46	- 88.67	331.44	24955.668	.837	115.71
RCS shutdown - set dap to minimum deadband	7.97	11:31:33.70	7.19	- 88.16	331.97	24953.718	.847	115.76
Orient for fifth RCS test	8.72	12:52:11.00	26.96	-175.95	308.01	25106.192	-.331	91.38
Fifth RCS burn test	8.72	12:52:16.10	26.92	-175.48	307.92	25107.286	-.323	91.61
RCS shutdown - set dap to minimum deadband	8.73	12:52:58.59	26.72	-172.80	307.44	25131.819	-.271	92.67



TABLE II.- PARAMETERS AVAILABLE FROM OFF-LINE COMPUTER OUTPUT

Current Greenwich mean time, day :hr :min :sec  
 Current ground elapsed time, hr :min :sec  
 Current ground elapsed time, sec  
 Geodetic longitude of TM and TK vectors, deg  
 Geodetic latitude of TM and TK vectors, deg  
 Altitude above oblate earth for TM and TK vectors, ft and n. mi.  
 Radius from earth center for TM and TK vectors, ft  
 X, Y, Z RTCC ECI position coordinates for TM and TK vectors, ft and e.r.  
 $\dot{X}$ ,  $\dot{Y}$ ,  $\dot{Z}$  RTCC ECI velocity coordinates for TM and TK vectors, fps and e.r./hr  
 Inertial velocity for TM and TK vectors, fps and n. mi./hr  
 Geodetic flight-path angle for TM and TK vectors, deg  
 Local roll angle, deg  
 Local pitch angle, deg  
 Body azimuth angle, deg  
 Angle of attack, deg  
 Angle of side slip, deg  
 Aerodynamic reference area, ft<sup>2</sup>  
 Geocentric flight-path angle for TM and TK vectors, deg  
 Geocentric body azimuth for TM and TK vectors, deg  
 Predicted altitude of perigee and apogee of TM and TK vectors, n. mi.  
 Actual altitude of perigee and apogee of TM and TK vectors, n. mi.  
 Semimajor axis for TM and TK vectors, n. mi.  
 Eccentricity for TM and TK vectors, n. d.  
 Period for TM and TK vectors, min  
 Angle of inclination, deg  
 True anomaly of TM and TK vectors, deg  
 Eccentric anomaly, deg  
 Longitude of ascending node, deg  
 Argument of perigee, deg  
 Phase time, sec

TABLE II.- PARAMETERS AVAILABLE FROM  
OFF-LINE COMPUTER OUTPUT - Continued

Aerodynamic force coefficient along  $X_B$ , n.d.  
Delta V along velocity vector, fps  
Total delta V, fps  
Inner gimbal angle, deg  
Middle gimbal angle, deg  
Outer gimbal angle, deg  
Matrix to convert from RTCC ECI Greenwich to stable member  
Inertial velocity to be gained, fps  
Minimum perigee altitude, n. mi.  
X, Y, Z IMU position coordinates (APS-2 target parameter)  
Time of arrival - APS-2 target parameter, sec  
Radius of burnout - APS-2 target parameter, ft  
Latitude and longitude of apogee and perigee, deg  
Current vehicle weight, lb  
Propellant remaining, lb  
Stop condition  
Total acceleration, G's  
Thrust during burn phases, lb  
Flow rate during burn phase, lb/hr  
Remaining time required during DPS SPS burn to achieve desired target, sec  
Velocity required during DPS SPS burn to achieve desired target, fps  
Time of ignition computed by algorithm, sec  
X, Y, Z unit vector target for DPS-2  
Desired thrust, lb  
Desired LM pitch rate, deg/sec  
Desired LM roll rate, deg/sec  
LM thrust misalignment

## TABLE II.- PARAMETERS AVAILABLE FROM

OFF-LINE COMPUTER OUTPUT - Concluded

X, Y, Z position coordinates for average G vector

$\dot{X}$ ,  $\dot{Y}$ ,  $\dot{Z}$  velocity coordinates for average G vector

X, Y, Z commanded acceleration thrust vector

Target tolerance allowed for boundary value problems

Target minimums allowed for boundary value problems

TABLE III.- SEQUENCE OF EVENTS FOR MODE III LAUNCH PHASE ABORTS  
[175-second minimum sequence]

Time, seconds, g.e.t.	Event
0	S-IVB shutdown, pitch up 10°
15	SLA panels deployed (enter mission phase 3)
25	+X-axis RCS on (4 jets)
26	S-IVB/LM separation
39	DPS on at 10-percent thrust level
44	DPS off
49	DPS on at 10-percent thrust level
51	+X-axis RCS off
75	DPS increased to 94-percent thrust level
80	DPS off, FITH staging, APS on
85	APS off
113	+X-axis RCS on (4 jets)
115	APS on
117	+X-axis RCS off
175	APS off

TABLE IV.- SEQUENCE OF EVENTS FOR MODE III LAUNCH PHASE ABORTS  
[189-second minimum sequence]

Time, second, g.e.t	Event
0	S-IVB shutdown, pitch up 10°
29	SLA panels deployed (enter mission phase 3)
39	+X-axis RCS on (4 jets)
40	S-IVB/LM separation
53	DPS on at 10-percent thrust level
58	DPS off
63	DPS on at 10-percent thrust level
65	+X-axis RCS off
89	DPS increased to 94-percent thrust level
94	DPS off, FITH staging (APS on)
127	+X-axis RCS on (4 jets)
129	APS on
131	+X-axis RCS off
189	APS off

TABLE V.- PRA SEQUENCE 1 - NOMINAL SEPARATION

Time in sequence, seconds	Function
00	Sequence initiate
43	+X translation on (on straps)
48	IM/SLA separation
53	+X translation off
	5-second coast
58	+X translation on
1:03	+X translation off

TABLE VI.- PRA SEQUENCE 2 - NC PRESSURE SEPARATION

Time in sequence, seconds	Function
00	+X translation on (on straps)
5	IM/SLA separation
10	+X translation off
	5-second coast
15	+X translation on
20	+X translation off

TABLE VII.- PRA SEQUENCE 3 - MINIMUM REQUIREMENTS SEQUENCE  
 [INCLUDES SEPARATION]

Time in sequence, min:sec	Function
00	Sequence initiate
05	+X translation for Separation
10	Separation (on straps)
15	+X translation off 5-second coast
20	+X translation on
25	+X translation off 6-second coast
31	+X translation on
39	DPS on 10-percent thrust
44	+X translation off
1:05	Thrust to 100 percent
1:12	DPS off 32-second coast
1:36	+X translation on
1:44	DPS on 10-percent thrust
1:49	+X translation off
2:10	Thrust to 100 percent
2:12	FITH
3:12	APS off 40-second coast
3:39	+X translation on
3:52	APS on
3:57	+X translation off To depletion

TABLE VIII.- PRA SEQUENCE 4 - PRA SUBORBITAL SEQUENCE  
[INCLUDES SEPARATION]

Time in sequence, min:sec	Function
00	Sequence initiate
04	+X translation on
06	LM/SLA, separation
16	DPS on 10-percent thrust
42	Thrust to 100 percent
49	DPS off
	5-second coast
54	DPS on 10-percent thrust
59	Thrust to 100 percent
1:04	FITH
1:14	APS off
	3-second coast
1:17	APS on
1:22	APS off
1:24	+X translation off

TABLE IX.- PRA SEQUENCE 5 - NO DPS FITH/APS TO DEPLETION

Time in sequence, min:sec	Function
00	Sequence initiate
02	+X translation on
14	Abort stage
19	+X translation off
1:13	+X translation on
1:14	APS off
	10-second coast
1:24	APS on
1:29	+X translation off
	To depletion

TABLE X.- PRA SEQUENCE 15 A  
[60-sec. APS]

Time in sequence, seconds	Function
00	+X on (Seq. initiate command)
13	Abort stage (PYRO separation) (DPS off)
13	APS on
1:13	APS off
1:13	+X off

TABLE XI.- PRA SEQUENCE 15 B  
(DPS-A/S-APS)

Time in sequence, seconds	Function
00	+X on (Seq. initiate command)
07	DPS on at 10 percent - 30 percent throttle
11	DPS to 100 percent throttle
13	Abort stage (DPS off)
13	APS on
1:13	APS off
1:13	+X off

TABLE XII.- PRA SEQUENCE 15 C  
(DPS-No APS)

Time in sequence, seconds	Function
00	+X on (Seq. initiate command)
07	DPS on at 10 percent - 30 percent throttle
11	DPS to 100 percent throttle
13	Abort stage (no APS ignition) (DPS off)
1:13	+X off



TABLE XIII.- SEQUENCE OF EVENTS FOR MODE IV LAUNCH PHASE ABORTS<sup>a</sup>

Time, seconds	Event
0	S-IVB shutdown, pitch up 10°
29	SLA panels deployed (enter Mission Phase IV)
39	+X-axis RCS on (4 jets)
40	LM/S-IVB separation
53	+X-axis RCS off
82.5	+X-axis RCS on (4 jets)
90	DPS on at 10 percent thrust
93	+X-axis RCS off
116	DPS increased to 94-percent thrust
X	DPS off (guidance-commanded shut-down)

<sup>a</sup>Reference 9.



```

*****      TM-VEC      *****
R-M      XXX.X      GETBI  XX XX XX.X      GET-TR      DT-TC
P-I      XXX.X      GETCO  XX XX XX.X      XX XX XX      XX XX
H-P      XXX.X      DT-BD   XX XX.X      XX XX XX      XX XX
H-A      XXX.X      ITER   XXX      XX XX XX      XX XX
DV-M     XXXXX.X    M-DPS  XXXXX.X    T-M=0  0      0  0

```

```

*****      TK-VEC      *****
H-BI      XXXX.X      LON-BI  XXX.XX E
H-P      XXXX.X      HP-MINI  XX.X      T-HP-MINI
H-A      XXXX.X      HA-MAX   XXX.X      X XX XX

```

Figure 2.- Condensed RTACF Fido detailed maneuver table.

PROCESSOR IDENTIFICATION

VECTOR IDENTIFICATION

MANEUVER	G.E.T.				LATITUDE			LONGITUDE		
	DAY	HR	MIN	SEC	DEG	MIN	SEC	DEG	MIN	SEC
SEQUENCE INITIATE	XX	XX	XX	XX.X	XX	XX	XX.X	XX	XX	XX.X
SEQUENCE CUTOFF	XX	XX	XX	XX.X	XX	XX	XX.X	XX	XX	XX.X
DELTA V	XXXXX.X	P-H	XXX.X	A	XXXXXXXXX.X	LONG-AN	XXX.XX	E/W		
DELTA T SEQ	XX XX.X	Y-H	XXX.X	E	X.XXXX	WT-BI	XXXXX.X			
DELTA T APS DEP	XX XX.X	R-H	XXX.X	I	XX.X	WT-BO	XXXXX.X			

	ALTITUDE			LATITUDE			LONGITUDE			
	N.M.	DEG	MIN	SEC	DEG	MIN	SEC	DEG	MIN	SEC
300K OR APOGEE	XXXXX.X	XXX	XX	XX.X	N/S	XXX	XX	XX.X	E/W	
25K OR PERIGEE	XXXXX.X	XXX	XX	XX.X	N/S	XXX	XX	XX.X	E/W	

5

Figure 3.- PRA/abort summary sheet.

GET TIME			ALTITUDE	INER VELOCITY	PATH ANGLE	AXIMUTH	GEOD LAT			LONGITUDE			SENSED VEL.	GUID VGO
HRS	MIN	SECS	N. MI.	FEET/SEC	DEGREES	DEGREES	DEG	MIN	SECS	DEG	MIN	SECS	FEET/SEC	
APS GUIDANCE AND RCS ON FOR INITIAL ORIENTATION														
XXX	XX	XX.XXX	XXX.XXX	XXXXX.XXX	XX.XXX	XXX.XXX	XX	XX	XX.X N/S	XX	XX	XX.X E/W	XXXX.X	XXX.X
RCS ON HOLD ATTITUDE														
XXX	XX	XX.XXX	XXX.XXX	XXXXX.XXX	XX.XXX	XXX.XXX	XX	XX	XX.X N/S	XX	XX	XX.X E/W	XXXX.X	XXX.X
DPS ON AT 10 PCT WITH RCS ON HOLD ATTITUDE														
XXX	XX	XX.XXX	XXX.XXX	XXXXX.XXX	XX.XXX	XXX.XXX	XX	XX	XX.X N/S	XX	XX	XX.X E/W	XXXX.X	XXX.X
RCS OFF DPS STILL ON AT 10 PCT HOLD ATTITUDE														
XXX	XX	XX.XXX	XXX.XXX	XXXXX.XXX	XX.XXX	XXX.XXX	XX	XX	XX.X N/S	XX	XX	XX.X E/W	XXXX.X	XXX.X
DPS ON AT 94 PCT CALL APS GUIDANCE AND STEER														
XXX	XX	XX.XXX	XXX.XXX	XXXXX.XXX	XX.XXX	XXX.XXX	XX	XX	XX.X N/S	XX	XX	XX.X E/W	XXXX.X	XXX.X
DPS OFF														
XXX	XX	XX.XXX	XXX.XXX	XXXXX.XXX	XX.XXX	XXX.XXX	XX	XX	XX.X N/S	XX	XX	XX.X E/W	XXXX.X	XXX.X
IMPACT POINT														
XXX	XX	XX.XXX	XXX.XXX	XXXXX.XXX	XX.XXX	XXX.XXX	XX	XX	XX.X N/S	XX	XX	XX.X E/W	XXXX.X	XXX.X

Figure 4.- COI maneuver summary table.

\*\*\*\*\* IDENTIFICATION \*\*\*\*\*

GET	XXX XX XX.X	GMT	XXX XX XX.X		
GMTLO	XXX XX XX.X	GMTGRR	XXX XX XX.X		
R-M	XXX.X	P-I	XXX.X	Y-O	XXX.X
P-H	XXX.X	R-H	XXX.X	Y-H	XXX.X

Figure 5.- Attitude conversion summary sheet.

GET TIME			RELATIVE RANGE	RELATIVE RANGE RATE	ELEVATION	AZIMUTH
HRS	MIN	SECS	N. MI	FEET/SEC	DEG	DEG
XX	XX	XX.X	XXXXX.X	XXXXX.X	XXX.XX	XXX.XX
XX	XX	XX.X	XXXXX.X	XXXXX.X	XXX.XX	XXX.XX
XX	XX	XX.X	XXXXX.X	XXXXX.X	XXX.XX	XXX.XX
XX	XX	XX.X	XXXXX.X	XXXXX.X	XXX.XX	XXX.XX

Figure 6.- Relative motion summary sheet.

```

*****
**          P R E D I C T E D   S I G H T   A C Q U I S I T I O N   T A B L E
**          LV 204/LM-01 MISSION           SIVB PSAT           VECTOR ID
**
*****

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STATION NAME	EQUIP	REV NO.	ACQUISITION				LOSS			DURATION			ACQ GMT				MAX ELEV DEGREES	ACQ RANGE N. MILES	MIN RANGE N. MILES
			D	H	M	S	D	H	M	S	M	S	D	H	M	S			
XXX	XXXX	XXX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX.X	XXXX.	XXXX.	
XXX	XXXX	XXX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX.X	XXXX.	XXXX.		
XXX	XXXX	XXX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX.X	XXXX.	XXXX.		
XXX	XXXX	XXX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX.X	XXXX.	XXXX.		

Figure 7.- Predicted sight acquisition table.

PREDICTED LIFETIME VECTOR IDENTIFICATION

LIFETIME FROM LIFTOFF = XXX DAYS XX HRS XX MINS  
LIFETIME FROM VECTOR = XXX DAYS XX HRS XX MINS

AVERAGE K-FACTOR COMPUTATION

APOGEE = XXX.X NM  
PERIGEE = XXX.X NM  
GET START = XX XX XX  
GMT START = XX XX XX  
K-FACTOR = X.XXXXXXX  
GET STOP = XX XX XX  
GMT STOP = XX XX XX

Figure 8.- RTACF orbital lifetime summary sheet.

REV NO	GET			LATITUDE		LONGITUDE		ALTITUDE		
	HOUR	MIN	SEC	DEG	MIN	DEG	MIN	N.M.		
X	XX.	XX.	XX.X	XX.	XX.	N/S	XX.	XX.	E/W	XXX.
X	XX.	XX.	XX.X	XX.	XX.	N/S	XX.	XX.	E/W	XXX.
X	XX.	XX.	XX.X	XX.	XX.	N/S	XX.	XX.	E/W	XXX.
X	XX.	XX.	XX.X	XX.	XX.	N/S	XX.	XX.	E/W	XXX.

Figure 9.- Recovery data (ground track) summary sheet.

#### NAVIGATION UPDATE SUMMARY SHEET

	ENGINEERING UNITS	OCTAL
X	XXXXXXXXX.	XXXXX XXXXX
Y	XXXXXXXXX.	XXXXX XXXXX
Z	XXXXXXXXX.	XXXXX XXXXX
X DOT	XXXXX.XXX	XXXXX XXXXX
Y DOT	XXXXX.XXX	XXXXX XXXXX
Z DOT	XXXXX.XXX	XXXXX XXXXX
TIME		XXXXX XXXXX

Figure 10.- Navigation update summary sheet.



ENGINEERING UNITS/OCTAL CONVERSION

SCALE FACTOR = XX                      PRECISION = X

ENGINEERING DATA                      OCTAL

XXXXXX.X UNITS                      XXXXXX.X UNITS                      XXXXX XXXXX

Figure 11.- Engineering units/octal conversion summary sheet.

CONVERSION FROM IU GIMBAL ANGLES TO LVLH ATTITUDES

TIME OF CONVERSION IS  
6HRS 15MIN 32.3SEC (GET)

	IU GIMBAL ANGLES (DEG)	IMU GIMBAL ANGLES (DEG)	LVLH ATTITUDES (DEG)
PITCH	XXX.XX	XXX.XX	XXX.XX
ROLL	XXX.XX	XXX.XX	XXX.XX
YAW	XXX.XX	XXX.XX	XXX.XX

Figure 12.- IU-IMU gimbal angles to LVLH attitudes.

CONVERSION OF LGC OR IU VECTORS TO RTCC ECI FORM

VECTOR INPUT IS LGC

TIME OF GRR IS XXXHRS XXMIN XX.XXSEC  
TIME OF VEC IS XXXHRS XXMIN XX.XXSEC

	INPUT (FT-FT/SEC)	INPUT (KM-M/SEC)	OUTPUT (FT-FT/SEC)	OUTPUT (ER-ER/HR)
X	XXXXXXXXX.	XXXXX.XXX	XXXXXXXXX.	.XXXXXXXXXX
Y	XXXXXXXXX.	XXXXX.XXX	XXXXXXXXX.	.XXXXXXXXXX
Z	XXXXXXXXX.	XXXXX.XXX	XXXXXXXXX.	.XXXXXXXXXX
X-DOT	XXXXX.XXX	XXXXX.XXXX	XXXXX.XXX	X.XXXXXXXXX
Y-DOT	XXXXX.XXX	XXXXX.XXXX	XXXXX.XXX	X.XXXXXXXXX
Z-DOT	XXXXX.XXX	XXXXX.XXXX	XXXXX.XXX	X.XXXXXXXXX

Figure 13.- Conversion of LGC or IU vectors to RTCC ECI form

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