

MEMORANDUM

7 July 1967

To: Messrs. E. D. Wilmoth, S. M. Macy, P. Seligsohn, R. Brandt, H. Newville,
B. Tyson, J. Sampson, File

Subject: TRIP REPORT ON AS-501 MEETING AT MIT ~~XL~~ ON JULY 6, 1967

PRESENT: Dan Lickly (MIT), Harry McOut (AC/MIT), Jay Sampson (AC), Jack Garman (MSC),
Judy Mitchell (MSC)

A. 501 PRELAUNCH ERASABLE MEMORY LOAD

We reviewed the NASA - supplied erasable parameters for the boost monitor, targeting, and spacecraft hardware. The applicable document is attached.

TRW has yet to generate a new operational trajectory using the new burn and splash targets. All agreed that no runs on the MIT simulator should be made until more of the erasable load is made available.

The boost polynomial parameters for the boost monitor reflect the latest Marshall booster trajectory. The new values of TROLL and TPITCH indicate that the booster will begin to roll and pitch together 10.7 seconds after lift-off. These two times will have to be adjusted to compensate for CDU drive lag and booster engine dynamic characteristics using MIT's IMU and SATURN digital models. Since the SATURN program is presently being rewritten, it will be at least two weeks before the new boost monitor parameters can be verified.

We have been using the correct launch pad 39A coordinates for the last 3 501 runs we have made. Our last abort run also used the correct Atlantic splash point coordinates. The Pacific target coordinates will be used on our next separation-to-splash run.

The cold soak gimbal angles are new. Garman explained that there will be one set for A.M. launches and another for P.M. launches, both valid for a month.

The new TFFMIN reflects the decision to start the second burn closer to free-fall flight to 400,000 feet.

TDECAY reflects NASA's best guess at how long the tailoff lasts following guidance commanded cutoff. MIT's vehicle model will have to be updated to reflect this change in the erasable load.

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NASA still has to decide on the c.g. position before each of the two burns. This will depend upon the final fuel-to-water ratio.

We asked Garman to send up the official height of the IMU above the fisher ellipsoid at liftoff for our generation of the initial position vector.

Garman explained that 501 Spacecraft integration testing was due to start on July 10. The entire launch vehicle configuration is stacked in the VAB. A late September or October launch is the best guess.

B. AGC/RNCC REFERENCE COORDINATE SYSTEM COMPATABILITY

We discussed how MSC could compute the same Reference-to-Stable Member matrix that the AGC will at liftoff so that MSC can send their state vector update in the correct coordinate frame.

C. RESCALING AND OCTAL CONVERSION OF NEW ERASABLE PARAMETERS FOR NASA

Garman and Mitchell were able to take the new erasable parameters back with them in suitable form to be used in their digital simulator.

D. FUTURE TRIPS

Don Lickly would like to get together with me every week or so to keep me up to date with 501; he and Garman talk to each other over the phone about once a day.

Jim Miller requested that I finish the summary of results of the AS-204 (IM-1) digital simulations as soon as possible. He took a rough draft of what was completed so far with him to a flight controllers meeting at Grumman. I promised him that I would have the summary ready for publication under an MIT blue cover report the next trip out there.

Jay Sampson

Jay A. Sampson
MIT/Apollo Support
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crp

J. Sampson

UNITED STATES GOVERNMENT

Memorandum

NASA-Manned Spacecraft Center
Mission Planning & Analysis Division

TO : FS/Chief, Flight Support Division

DATE: 30 JUN 1967

67-FM7-152

FROM : FM/Chief, Mission Planning and Analysis Division

SUBJECT: AS-501 prelaunch erasable memory load

- References:
- a. "Generation of AS-501 prelaunch erasable memory load", FSD Memorandum of June 6, 1967.
 - b. "Apollo Mission Data Specification D - Apollo Saturn 501"
 - c. "Spacecraft Operational Abort and Alternate Mission Plan for AS-501", Volume 1, MSC Internal Note No. 66-FM-149, dated December 22, 1966.
 - d. "Update of the AS-501 Solar Cold Soak Attitudes", TRW-IOC 3423, 9-7 of May 9, 1967.

1. Reference (a) requested that the Mission Planning and Analysis Division supply data for the guidance computer erasable load for the Apollo 4 mission. The data requested follows:

Boost Parameters

- a. The seven coefficients for the sixth order boost pitch polynomial are:

$$\begin{aligned}
 A_0 &= .4788289 \quad \text{deg} \\
 A_1 &= .3411991 \times 10^{-1} \quad \text{deg/sec} \\
 A_2 &= .1178593 \times 10^{-1} \quad \text{deg/sec}^2 \\
 A_3 &= .5318752 \times 10^{-4} \quad \text{deg/sec}^3 \\
 A_4 &= -.2937101 \times 10^{-5} \quad \text{deg/sec}^4 \\
 A_5 &= .232939 \times 10^{-7} \quad \text{deg/sec}^5 \\
 A_6 &= -.5793149 \times 10^{-10} \quad \text{deg/sec}^6
 \end{aligned}$$

convert by:

$$\frac{A_N}{(360)(100^N)} \quad B(14N-4)$$

$$\psi = A_0 + A_1 t + \dots + A_6 t^6, \text{ the boost monitor pitch attitude.}$$

t = elapsed time from booster pitch initiation.



- b. *TROLL = 1070.0 centiseconds, time from liftoff at which roll monitor begins.
- c. *TPITCH = 1070.0 centiseconds, time from liftoff at which pitch monitor begins.
- d. TENDPITCH = 13400.0 centiseconds, the length of pitch monitor.
- e. TTUMON = 4355.0 centiseconds, the time from end of pitch monitor to start of tumble monitor.
- f. MAXROLL = 005 revolution, final minus initial boost roll angle.
- f. 1/ROLLRATE = 36000 centiseconds/revolution, the inverse of the booster roll rate.

*TROLL and TPITCH values given are the elapsed time from liftoff when pitch and roll attitude commands are initiated for the launch vehicle, and have not been adjusted to account for CDU drive lags. These drive lags can not be accurately simulated in our program.

Splash Targets

$RT_{Atlantic}$ and $RT_{Pacific}$ are unit target vectors in the IMU coordinate system. The system is aligned such that the positive X_{GM} axis is along the launch pad local vertical, the position Z_{GM} axis along the launch azimuth (72° from North) and the Y_{GM} axis completes a right handed system. Coordinates used for launch pad 39A are as follows:

28.608422° N geodetic latitude and
80.604133° W longitude

Abort

$T_{Atlantic}$ = 140000. centiseconds

$RT_{Atlantic}$ $x = .5288398519$
 $y = .0143272905$
 $z = .8486006953$

The value of $T_{Atlantic}$ given is the average time to drogue deployment for guided entry from a mode III abort (ref. c). $RT_{Atlantic}$ is based on an impact point from ref. c of

28.13° N geocentric latitude, and
19.5° W longitude

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Nominal

$T_{\text{Pacific}} = 3092141.8$ centiseconds

RT_{Pacific} $x = .8318156311$
 $y = .0596604122$
 $z = .5518363806$

This target is based on a nominal impact point obtained from the Mission Analysis Branch (FM5):

29.88° N geocentric latitude, and $= 30.04649677^{\circ}$ geodetic
 171.00° W longitude

Cold Soak Attitude Angles

ANGLE X = 35.68° (outer gimble angle)
 ANGLE Y = 279.25° (inner gimble angle)
 ANGLE Z = -4.86° (middle gimble angle)

The above angles are optimized for a four hour launch window beginning 1200 GMT, July 27, 1967, and were obtained from reference (d). These values will have to be updated for the actual launch date.

SPS Burn TargetsSPS-1

ESQ = .35218172
 SEMILAT = 10033120 meters
 ATDT = 9.589 meters/second

SPS-2

ESQ = .99814412
 SEMILAT = 12789028 meters
 ATDT = 30.48 meters/second
 TFFMIN = 687 seconds

where:

ESQ is eccentricity squared of target ellipse.

SEMILAT is semilatus rectum of target ellipse.

ATDT is integrated initial thrust acceleration magnitude. For SPS-1, DT = 2 seconds. For SPS-2, DT = 4 seconds, thus the large difference between the values of ATDT between SPS-1 and SPS-2.

TFFMIN is the time of free flight to 400K for determination of SPS-2 ignition. This value of TFFMIN gives a 240 sec. coast between SPS-2 cutoff and 400K.

The above targets were obtained from Mission Analysis Branch (FM5) and verified by Guidance and Performance Branch (FM7) with an AS-501 6-degree-of-freedom program simulation.

Tailoff Δt for SPS burn

TDECAY = .487 sec., the Δt at full thrust that gives the same impulse as nominal tailoff. TDECAY computed from $I = 10465$ lb-sec., tailoff impulse and $T = 21500$ lb, full thrust. Values obtained from an unpublished revision to ref. (b).

2. It is suggested that the following bit-by-bit simulations be run for E-memory load verification.

a. Nominal Mission, end to end

b. Aborted Mission to the Atlantic target initiated as follows:

$t_{\text{abort}} + 0.0 = 595.0$ seconds, S-IVB shutdown, initiate direct ullage

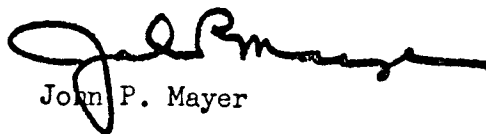
$t_{\text{abort}} + 1.7$ sec = 596.7 seconds, S-IVB/CSM physical separation

ΔV (S-IVB tailoff) = 0

ΔV (SPS) = 0

It is requested that these runs be transmitted to the Guidance and Performance Branch (FM7) for evaluation as soon as they become available.

Questions concerning the data contained herein should be directed to Mr. R. M. Moore of the Guidance and Performance Branch.


John P. Mayer

cc:

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