TINDALIGRAMS 1970

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER
HOUSTON, TEXAS 77058

IN REPLY REFER TO: 70-KA-S-2

MAR 5 1970

MEMORANDUM TO: Distribution

FROM : KA/Chief, AAP Data Priority Coordination

SUBJECT : General Data Priority to talk about the AAP rendezvous

1. On March 2, 1970, we had a Data Priority to talk about the AAP rendezvous in general. We wanted a chance to review the rendezvous profile that is proposed and to be sure that no one had discovered anything of any concern that would keep us from pressing on with this rendezvous profile. We also wanted to just talk about things in general and try to identify some open areas that were of concern to the different organizations, and attempt to assign a few action items for people to begin working on. We reviewed the profile and there were several things that were of general interest to the people, and probably some of them are well known, but we went over them again anyway. The current profile consists of N_{C1} and N_{C2} (both phasing maneuvers), a corrective combination maneuver, and a coelliptic maneuver followed by TPI and TPF.

2. MPAD presented the rendezvous profile along with many of the considerations that they are using for their current mission planning effort. They are basing their launch window on landing no later than 2 hours prior to sunset and launching no earlier than sunrise. The Atlantic Ocean was not chosen as a recovery area for the ascending opportunities, primarily because there is little or no post-retrofire tracking. We also discussed at great length the proposed launching of AAP 3 80 days after launching AAP 1. There appears to be quite a bit to gain by launching 90 days after AAP 1, but this involves a day/night launch. The constraint of only supporting daylight launches appears to be very constraining in establishing the intervals and the associated opportunities for the AAP 3 and 4 launches. Walt Cunningham stated that it probably was not reasonable to continue with this as a hard constraint, and the group tended to agree with him. This item will be discussed more, but the current recommendation is that night launches be accepted for AAP. The data that MPAD presented is based on a March 19 launch, but the AAPO suggested that July 19 should be used for mission planning. It was also brought to our attention that a 48-hour duration between the launch of AAP 1 and AAP 2 would be better for the people at the Cape. The current duration is about 23½ hours and shall remain so until more reviewing has occurred. We also discussed in great detail the consideration for launching the manned AAP vehicles at the point in the window where the out-of-plane steering requirements are minimum. The primary consideration for this is the fact that the Mode IV contingency

insertion capability is very short and if we preserve the 700 lbs of propellant that is budgeted for out-of-plane steering in the nominal case, we are better able to contend with launch vehicle propulsion dispersions. Also, it appeared that some consideration should be given to not using all of the window on a given day, but attempting to place the launch window so that an opportunity of 5 minutes or so is available on 2 successive days. We came to no resolution about any of these things but they must be considered.

3. We talked again about the reason for going to the N_{C1}, N_{C2}, N_{CC} type profile and implementing a targeting capability onboard for these maneuvers. In general, I think that we would like to be able to target as many of the rendezvous maneuvers onboard as is possible in order to provide more than one solution. It is desirable certainly for AAP 3 and 4 since we won't have beacon track on the workshop at that time to be able to solve the rendezvous problem onboard with the ground serving as a check for the onboard solutions. A few of the numbers that were given out in the discussion of the rendezvous profile were that the corrective combination maneuver is always less than 300 n.m. range for all M numbers. This allows both onboard navigation from the VHF ranging and from sextant tracking. The transfer between N_{CC} and N_{SR} is probably on the order of 140°. The maximum is about 160° because of the increased ΔV requirements and the minimum of about 120° which allows 30 minutes between N_{SR} and TPI. Thirty minutes between rendezvous maneuvers is a current operating constraint. All of the rendezvous burns through TPI are planned to be larger than the minimum impulse which is about 15 fps on the SPS. There are no known SPS constraints for minimum impulse but an attempt is being made to minimize the RCS fuel required for ullage and trimming. The TPI maneuver is nominally placed 20 minutes prior to sunrise.

4. We reviewed the ground tracking for a nominal M = 5 type rendezvous and looked at the places where we would send up state vector updates and maneuver data if required. It appears that the first phasing maneuver, N_{C1}, and the plane change maneuver would be passed at the same time, since there is no real opportunity to update the plane change maneuver after N_{C1}. The computation time requirements and the crew preparation time appears to take about 20 minutes and this tends to specify where maneuver data and state vector updates would have to be uplinked prior to a maneuver. The ground requires 3 to 4 minutes to process the data and about 5 minutes to do the maneuver computations and fill out the pads. It will take about 2 minutes to read up and verify the data and then the crew needs about 10 minutes to prepare for the burn. The ground currently plans to send maneuver pads for all the maneuvers through TPI. These pads would be used for verification of the onboard solution for all the maneuvers after the plane change maneuver. The plane change maneuver is currently scheduled to occur between N_{C1} and N_{C2}. In general, the location of the update stations and the ground tracking looks pretty reasonable for an M = 5, and MSFN coverage along with the maneuver computation time requirement will be used by MPAD in the dispersion analysis. Bob Becker noted that he is expecting 3σ dispersions on TPI time of about ± 6 minutes. It should be noted that a new RTCC capability called "iterable CDH" which allows the computation of the time for

the coelliptic maneuver should tend to minimize the dispersions developed up to the time of CDH or NSR. The tracking and the MSFN solutions generally improve for M = 6 and 7.

5. The current MPAD analyses indicate that the VHF ranging capability of 200 miles is completely adequate for the nominal rendezvous, but may not be sufficient for some of the dispersed cases or the late-in-the-window cases. This problem will be continued. It was pointed out that the range ambiguity of 327 n.m. in the VHF radar is being fixed in the CMC software independent of our change in the VHF range capability. It also appears to us that the workshop should be in the Z local vertical mode from TPI -2 hours through TPI. We discussed an existing constraint that states that docking must occur over a MSFN station. This should not change the rendezvous profile and may not even be a valid constraint since it appears that this constraint came from a requirement to change gains in the ATMDC after docking. MSFC has stated that this is not required. Ken Young pointed out that he expects do[illegible]ng to nominally occur [illegible] out [illegible] minutes after the theoretical TPF time. For the next day [illegible], we generally put additional revs between insertion and N_{C1} which [illegible] tend to improve the tracking for that maneuver, a[illegible] additional [illegible] revs are taken up between N_{C1} and N_{C2}. The pro[illegible] sequence of events from N_{C2} through TPF is fixed for [illegible] was also pointed out that even though the SPS burns [illegible] larger than the minimum impulse, they still fall within [illegible] short burn logic of the CMC. The improved short burn logic that is currently planned for the CMC appears to provide acceptable performance on all burns that are at least .7 seconds in duration. The new short burn logic requires at least one complete computation cycle.

6. We talked some about the prelaunch targeting of the manned vehicles and how this targeting is transferred to the vehicle from MSC. The primary path is to pass directly from the RTCC in Houston to the IU via the command system. [illegible] backup path is to teletype the parameters to the Cape, punch up some cards, and feed them into the RCA 110. One of the things we will have to do in the future is determine how long this backup route takes, which will define the last tracking data we can include in our solution for the workshop prior to computing the targeting parameters for the manned vehicle.

7. We talked some about whether the onboard targeting programs should be exactly duplicated in the RTCC for the AAP rendezvous sequence. This has not been done in the past, even though the rendezvous sequence control logic and sequencing criteria has been compatible between the onboard and ground solutions. The primary considerations seem to be that if we were to include an exact simulation of the onboard targeting programs, this would aid greatly in the verification of the onboard computer programs. We did not resolve this question but it is something that needs to be considered some more.

8. There were several action items given out and I would now like to list the action items along with the due dates, where one was assigned.

a. MPAD will publish the presentation made to the Data Priority.

b. MPAD will develop the pros and cons of 80 versus 90 days between launches considering the tracking and maneuver profiles.

c. FCOD will develop the pros and cons of 80 versus 90 days between launches with respect to crew timelines and work days.

d. MPAD will extend the launch opportunity data to include launches of AAP 1 in the fall.

e. AAPO will determine the validity of a pending constraint for 24 hours between launch and rendezvous from the Aeromed people. This constraint is currently being considered in order to keep from degrading the baseline data that the Aeromed's are currently requiring. Walt Cunningham pointed out that this constraint is very probably not hard.

f. The AAPO will determine with the Cape the tradeoff between launch windows of approximately 5 minutes duration and the current 10 to 12 minutes duration. What we are really asking for here is a license to pick the optimum point in the total launch window instead of always having to nominally pay a 700-lb penalty to get to orbit. This 700 lbs is in the launch propellant reserves. There are several considerations including an increased cost to support the shorten window, the fact that the launch probability is slightly increased with the larger windows, and that the latter part of a given launch window may have an associated range safety problem from a more northerly launch.

g. FCSD (Paul Kramer) will evaluate the lighting conditions at docking for a solar inertial attitude and the different β angles.

h. FCD (Charley Parker) will review the effect of a docked configuration with undocked gains in the ATMDC.

i. FCSD (Duane Mosel) will publish their version of the automated onboard rendezvous programs even though these have not been accepted and are probably not final.

j. FCD and MPAD will continue to work with the MSFC people in developing the timeline for targeting the manned vehicles. It should be pointed out that the RTCC effort is also waiting for resolution of the targeting parameters; primarily has to do with which are fixed and which ones are variable. The current MSC position is that they should all be variable.

k. MPAD will define the maximum overspeed allowable for the OWS and still be able to execute a rendezvous within the ΔV constraints. With the current weights and fuel loading for AAP 1, we can get about 20 seconds of overburn at 4g's acceleration. This is well beyond the capability of the CSM to execute a rendezvous.

9. I hope to be able to establish "tiger teams" to address the several areas of AAP that need our attention. I think that this is a preferable

way to handle these different areas than to try brute-forcing them with a large group of people. These tiger teams would essentially develop proposals and bring them to a major Data Priority review before they are published as the recommendations of the AAP Data Priority. In the near future, I will be getting with some of you people to establish these tiger teams and to suggest dates for beginning work on the proposals.

10. I want all of the participants in the AAP Data Priority to feel free to suggest Agenda Items at any time.

Philip C. Shaffer

Philip C. Shaffer

Enclosure

PCS:ewp

AAP DATA PRIORITY
MARCH 2, 1970

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K. Young	FM6	4801
G. Hunt	FM13	4907
E. Pavelka	FC5	2538
G. Guthrie	FC5	2538
B. Wolfer	FC2	3838
C. Hackler	EG7	3991
O. Garriott	CB	2221
F. Littleton	KM	3831
D. Phillips	TRW	1012 H4
J. Wright	TRW	1013B H4
C. Skillern	TRW	3124
C. Osgood	FM6	4801
R. Becker	FM6	
J. Shreffler	FM4	4320
R. Williams	FC6	4616
C. Parker	FC5	3268
L. Drapela	MDAC	488-5660
P. Dugge	MDAC	488-5660 X283
J. Hutchins	CF44	3291
D. Mosel	CF44	5340
M. Contella	CF44	5348
R. Williams	FS5	4681

ENCLOSURE

NAME	CODE	EXTENSION
R. Regelbrugge	FM6	5276
W. Cunningham	CB	2323
S. Condon	FM6	4801

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
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IN REPLY REFER TO: 70-FA-T-16

February 19, 1970

MEMORANDUM TO: See list attached

FROM : FA/Chairman, Apollo Spacecraft Software Configuration Control Board

SUBJECT : "For whom does the bell toll?" ... "Delta Guidance" ... "Oh!"

A couple of years ago, before any of the lunar flights, GCD started looking into improvements in the LM descent guidance and navigation (G&N) computer programs to compensate for possible problems in rough terrain, landing radar performance, descent targeting by the ground, etc. Actually, they were quite successful; they conceived the so-called delta guidance, prefilter, and terrain model package which substantially increases the LPD capability at a very reasonable descent propellant cost. Since then we have performed two lunar landings, including the pin-point Apollo 12, which have pretty well eliminated the original need which the modifications were to satisfy.

But, delta guidance does provide a chance to make a big ΔV saving in the earlier braking phase of descent by compensating for the inability of the descent engine to throttle near the max-thrust setting. So the decision had to be made - is the ΔV saving (i.e., 90 fps which is equivalent to 300 lbs payload to the moon's surface, or to 20 seconds of hover time) valuable enough to extensively revise the LM G&N program and to modulate the descent engine through the non-throtteable zone up to 10 times?

An additional data point to be considered before making that decision is the fact that about one-half of that ΔV savings can be obtained in other ways. One way is to change the targeting, which has no effect on the on-board guidance or procedures at all, but is not so conservative about protecting against simultaneous DPS valve failures and a low performing DPS engine. A second approach is to develop a procedure for throttling the DPS engine down only once during the braking phase for a period to be determined at the start of descent based on either on-board or ground-computed estimates of actual DPS performance.

The decision is - do not implement delta guidance (tearing up the LGC program is not worth the 40 or 50 fps extra that it would provide); do implement one or a combination of both of the alternates noted above.

Some small program and display changes may be implemented to provide an on-board capability - either auto or manual - to throttle the DPS.

Incidentally, there is one survivor from this delta guidance program change "package". There appears to be unanimous agreement that we should add the terrain model of the specific landing site we're going to in place of the present "billiard ball" moon. This will eliminate some objectionable pitch excursions and will make the LPD work better.

Howard W. Tindall, Jr.

Howard W. Tindall, Jr.

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER
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IN REPLY REFER TO: 70-FA-T-13

February 12, 1970

MEMORANDUM TO: See list attached

FROM : FA/Chairman, Apollo Spacecraft Software Configuration Control Board

SUBJECT : Software for the AAP CSM spacecraft computer

The time appeared right to try to find out exactly what the program requirements are for the CSM computer for AAP and we had meetings on January 28 and 30 to do that. As a result of these meetings, a number of PCR's will be prepared and submitted to the Apollo Spacecraft Software Configuration Control Board (SCB) meeting to be held early in March. At that time we will approve or disapprove these changes and the program will be essentially under configuration control. One thing that seems clear from our discussions is that program changes required for AAP are very few in number and, except for the docked digital autopilot, seem to be quite simple. This is no surprise, of course, but it is nice to confirm it.

Before getting into the detail of these meetings themselves, I would like to state a couple of ground rules which we established associated with the AAP computer program and how we intend to manage it. First of all, we selected the Apollo 14 command module program as our baseline since it is the latest, completely defined program we have right now. It is our intention to approve automatically any PCR for AAP which is approved for Apollo. In the case of program changes for Apollo which are not desirable for AAP we will issue an AAP PCR at the same time which deletes that particular capability. By this paper-work device we will maintain a complete list of PCR's defining the AAP program changes required for the current Apollo program to make it ready for AAP if we were to break off a flight program from Apollo for AAP at that time. In addition, it will provide an up-to-date definition of the capabilities of the AAP CSM program we plan to implement.

To get this list off with a big bang, we went through the entire Apollo 14 program and identified all those programs, routines, and extended verbs which we felt should be deleted. This list, which will be covered officially by PCR's, accompanies this memo for your information. The criteria used to decide just what should be dropped from the Apollo program for AAP was simple. If someone could not identify a firm requirement for a particular capability, it was automatically deleted. It should be pointed out that by deletion we mean that the capability will not be available for use in flight. We are not insisting that every word of code associated with that particular program needs to be torn from the assembly, but we are asking that all references to these capabilities be eliminated from all AAP program documentation such as the GSOP's, Test Plans, User's Guides, Flow Charts, and so forth. Of course, the thing we are trying to do is to minimize the work of the program developers. Obviously under certain circumstances it will be easier to leave some of these capabilities in the program, including testing them. In that case they should be retained. However, this will be by exception only and will require approval of the SCB.

By far, the largest discussion dealt with the rendezvous and how it should be performed. Basically the question was, should we use the standard Apollo techniques involving a CSI and CDH maneuver or, as some people suggested, should we change to a more flexible sequence of maneuvers used on occasion on Gemini, namely the NCC/NSR combination? The advantage of the former is that it exists in the current program. The advantage of the latter is that it provides a great deal more capability to maintain a nominal terminal phase in the face of dispersion. Its advocates expressed concern, that dispersion could be rather large on AAP due to the limited tracking available for targeting the early phasing-type maneuvers. The eventual outcome of all this was that we decided to go with the NCC/NSR sequence and this program will be changed accordingly. It should be noted that this decision also impacts the mission planning; that is, future reference trajectory documentation will reflect this decision. In addition to agreeing to the change to NCC/NSR, which is said to be rather trivial as far as the programming is concerned, we also agreed to add a new targeting program for computation of two earlier phasing maneuvers.

There were only about 6 or 8 other program changes suggested specifically for AAP and they are all pretty simple, like extending the VHF ranging input capability beyond 327 n. mi. and improving the SPS short burn logic to support the small rendezvous maneuvers. I might also point out two rather substantial Apollo changes which AAP will automatically inherit. They are the rendezvous improvements to simplify the crew's procedures and the universal pointing program being added to P20. Special attention will be given this important one to assure that there are no unique requirements for AAP which have not been provided by this routine since it will probably be used for attitude control of the docked configuration.

We also assigned some action items:

a. Make sure there is no special problem involved in aligning the CSM IMU prior to launch from a Saturn I-B, rather than a Saturn V pad. (Charley Parker, FCD).

b. Verify the interface from the CMC to the Saturn IU is identical to Saturn V to make sure our P11 program is all right. (Tom Lins, GCD)

c. Identify any coarse alignment program requirement we might have for aligning the command module IMU while docked to the Cluster, using the Cluster as an attitude reference.

d. Prepare a complete PCR identifying the functional requirements for the docked DAP. This big job, of course, is the responsibility of the GCD and Tom Lins will see that it gets done.

e. Jack Williams will get everyone concerned together to scrub the telemetry downlist, identifying spares and additions, if any.

I think everyone at the meetings agreed that we are in pretty good shape with respect to the definition of the AAP programs and should have little trouble in preparing the program from the Apollo assembly at the time we decide to do so. Although that won't probably occur for at least another year, it is expected that some off-line assemblies and documentation will be prepared by MIT as often as their effort on Apollo mainline permits.

Howard W. Tindall, Jr.

Enclosure

FA:HWT:js

Re KM-60743

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
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IN REPLY REFER TO: 70-FA-T-12

February 10, 1970

MEMORANDUM TO: See list attached

FROM : FA/Chairman, Apollo Spacecraft Software Configuration Control Board

SUBJECT : Status report on the "P66" fix

There were some things about the terminal descent on the last mission that kind of spooked a lot of people. One of the things suggested as a result of this was to add a capability to the LM guidance and control system which would assist the crew during the last 100 feet or so of the descent. Specifically, fix the PGNCS so that it will provide an automatic nulling of the horizontal velocity while the crew controls the descent rate with the ROD switch.

This suggestion was made in mid-December after the Apollo 13 LM computer flight ropes modules had been manufactured. Therefore it was desirable to constrain this change to a single module and, of course the formulation, coding and verification had to be carried out very quickly. Actually the program release was accomplished in early January for Raytheon to make a new module No. 5. The plan was to finish all necessary testing and analysis after that release and, if anything were found making it non-flight worthy, we would fall back and use the original module which essentially provides the Apollo 11 and 12 capability.

Since that time the crew has really fallen for the horizontal velocity nulling feature but, unfortunately, MIT has discovered problems in the formulation which make the program unacceptable for flight. Specifically the computer cycle time is exceeded, or nearly so; the consequence of which is violent throttle commands either up or down completely without warning.

MIT has reworked the program to avoid this unacceptable feature and claims to have thoroughly tested it. Eyeball examination by other experts (MSC and TRW) and FMES testing at Grumman have revealed nothing questionable about it. MIT strongly advised making a new revised module 5.

The question resolves to which is the greater risk - a new "inmature" program which may contain undiscovered deficiencies vs. a flight without automatic horizontal nulling. A toss-up.

Mr. Kraft broke (shattered?) the tie by voting for making the new module and the tape was released to Raytheon the morning of February 5. Rope delivery to KSC is now scheduled for March 10, 1970, which means the original module must be used during the FRT now planned on February 18, 1970. However, the module will be instilled prior to CDDT, which is currently scheduled for March 19, 1970.

And, of course we'll use it unless something is discovered between now and then to prevent it. Testing, of course, continues at a rapid pace; the crew, on the other hand, is training to get along without it if they must.

Howard W. Tindall, Jr.

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CF34/T. W. Holloway (6)
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EA2/R. A. Gardiner

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EB/P. Vavra
EE/L. Packham
EE/R. Sawyer
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EE13/R. O. Irvin
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EE6/G. B. Gibson
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EE6/J. R. McCown
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EG4/O. Rice
EG5/W. Swingle
EG6/D. Gilbert
EG6/H. E. Smith
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EG7/C. T. Hackler
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EG8/B. Reina
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FA2/M. S. Henderson
FB/A. Hoboken
FC/W. H. Gray
FD/O. E. Maynard
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FD13/A. Cohen
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FD7/W. R. Morrison
FD7/R. H. Kohrs
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TJ/J. H. Sasser
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TH3/J. E. Dornbach
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FA/S. A. Sjoberg
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FC4/H. Loden (3)
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FC54/C. F. Deiterich
FC54/J. E. I'Anson
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FC6/C. B. Shelley (4)
FL/J. B. Hammack
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FL6/R. W. Blakley
FS/L. C. Dunseith
FS5/J. C. Stokes (11)
FM/J. P. Mayer
FM/C. R. Huss
FM/D. H. Owen
FM13/R. P. Parten (11)
FM2/C. A. Graves (3)
FM3/C. T. Hyle

FM4/E. R. Schiesser
FM4/P. T. Pixley
FM4/R. T. Savely (3)
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FM6/R. W. Becker (3)
FM7/S. P. Mann
FM7/D. A. Nelson
FM7/R. O. Nobles
FM/Branch Chiefs (8)
YA/F. Borman

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BELLCOMM/HQS./MAS/A. Merritt
BELLCOMM/HQS./D. Corey
BELLCOMM/HQS./G. Heffron
GAEC/Bethpage/J. A. Wachtel
GAEC/Bethpage/R. Schindwolf (3)
GAEC/Bethpage/R. Mangulis
GAEC/Bethpage/R. Pratt
GAEC/Bethpage/Consulting Pilot's Off.
GAEC/Bethpage/B. O'Neal

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NR/Downey/M. Vucelic, FB84
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NR/Downey/J. E. Roberts, AE23
NR/Downey/B. C. Johnson (4), AB46
NR/Downey/W. H. Markarin, AE23
NR/Downey/J. Janss, BB48
NR/Downey/M. B. Chase, AB33
NR/Downey/D. W. Patterson, AC50
MITRE/Houston/W. P. Kincy
GSFC/500/F. O. Vonbun
NASA/HQS./MAO/R. B. Sheridan
NASA/HQS./MAOP/Land (2)
NASA/HQS./XS/R. Sherrod
NASA/HQS./Colonel T. McMullen, MA
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KSC/CFK/P. Baker
KSC/CFK/C. Floyd
KSC/CFK/M. Walters
KSC/CFK/F. Hughes
KSC/CFK/MIT/R. Gilbert
TRW/Redondo Beach/R. Braslau
TRW/Houston/W. J. Klenk
TRW/Houston/R. J. Boudreau
TRW/Houston/C. R. Skillern
TRW/Houston/M. Fox
TRW/Houston/K. L. Baker
TRW/Houston/F. A. Evans
TRW/Houston/W. Hill
Boeing/Houston/R. Allen, HA-58
TRW/Houston/G. L. Duncan, H-3

[illegible]

File Tindall

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER
HOUSTON, TEXAS 77058

IN REPLY REFER TO: 70-PA-T-11A

February 9, 1970

MEMORANDUM TO: See list attached

FROM : PA/Chief, Apollo Data Priority Coordination

SUBJECT : Mission H-2 and Subsequent Lunar Orbit Activities

Attached is your copy of the Apollo Mission Techniques Document for the Mission H-2 and Subsequent Lunar Orbit Activities.

No further Mission Techniques documentation is planned after the Apollo 13 mission.

Howard W. Tindall, Jr.

Enclosure

PA:HWT:js

DISTRIBUTION LIST

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CF34/J. V. Rivers
CF34/T. A. Guillory
CF34/E. B. Pippert
CF34/C. L. Stough
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EB/P. Vavra
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EG7/C. T. Hackler
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EG8/A. R. Turley
EG44/C. W. Frasier
EG/MIT/T. Lawton
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PA/O. G. Morris
PA/K. S. Kleinknecht
PA/S. H. Simpkinson
PA2/M. S. Henderson
PB/A. Hobokan
PC/W. H. Gray
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PD12/J. G. Zarcaro
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HOUSTON, TEXAS 77058

IN REPLY REFER TO: 70-FM-T-7

January 19, 1970

MEMORANDUM TO: See list attached

FROM : FM/Deputy Chief

SUBJECT : MSFC/MSC OWS Computer Program Meeting

On January 15, 1970 we had a get-acquainted session for MSFC and MSC people who will be involved in the development and use of the Orbital Workshop (OWS) spacecraft computer program. Our basic objectives were:

a. For the working troops at these two centers to become acquainted with each other and understand how they work within their center and

b. To get some insight on how the two centers might work together in the most efficient and cooperative way.

In other words, we wanted to get frequent, informal communications started among the working people, which is absolutely essential if this job is going to get done properly. I think everyone present will agree that we satisfied these meeting objectives very nicely.

There is no reason to document here the little introduction speeches that made up most of the meeting, although accompanying this memo are copies of the viewgraphs Bill Chubb used. On the other hand, there were a few significant work areas needing attention and agreements reached worthy of reporting and the rest of this memo is devoted to that.

a. At the present time there appears to be no plan for an end-to-end software interface test between the MCC/RTCC and the OWS computer. Apparently it is not possible to carry out such a test when the spacecraft is on the pad. It may be possible to do something like this while the spacecraft is still in the VAB and people are going to look into that.

b. RTCC program verification is obviously a task that must be carried out with precision. This task for those programs used in conjunction with the OWS computer, such as the command and telemetry subsystems, will require assistance and support from MSFC people. In conjunction with this, MSC requested MSFC to informally explain in detail what their onboard program verification plans are during a get together in the near future. It seems quite probable that some of that effort may be utilized directly in the RTCC program verification such as telemetry tapes these tests must produce, and things of that nature. Basically, however, we are just identifying this as an area which will require some attention and coordination.

c. MSC people responsible for developing the MCC simulation complex and those responsible for the crew simulators have a similar need for detailed OWS computer program definition. Specifically, flight type program tapes and/or listings. They need these to develop high fidelity crew and flight control training aids and could use them as soon as they are available, even in bits and pieces. MSFC was made aware of this need and MSC will establish a single point of contact for receipt of this material.

d. Another point made on this same subject - the simulator - is brought about by the fact that the crew simulator for the OWS may not be set up to utilize actual flight programs as they do for mainline Apollo. On the other hand, in order to make sure training is true and that crew procedures and workarounds are really proper, it is necessary that some procedure be established for maintaining the simulator up-to-date as program changes are made and idiosyncrasies are discovered.

e. It was recognized by everyone that some sort of MSFC support will be required in real time during the AAP missions. We made no attempt at this time to define just what this would be or where the people would be located.

f. MSC has the job of defining exactly how we want to handle MSC distribution of the software related documentation generated by MSFC.

g. It was agreed that informal reviews of OWS computer program development should be held by a small number of people directly involved in this work as their need becomes apparent. For example, the first of these should occur around the last week of February to go over the Interface Program Requirements Document (IPRD) that MSFC will distribute in about a week. Another should occur in May to review the Interface Program Definition Document (IPDD) and to prepare ourselves to support the upcoming hardware CDR.

h. Our final discussion centered on the need for some sort of Operational Handbook to be used by the crew and flight controllers working with the OWS computer. Apparently some arrangements are already in the works to develop something like this, which may be entirely adequate. MSC has an immediate job to define exactly what is needed here and to determine if the documentation currently planned will be adequate and timely. If it is not, MSC may want to arrange for some assistance by MSFC not currently planned.

All in all, the consensus seemed to be that this was a pretty worthwhile session. The ball seems to be rolling now and we really don't foresee any particular obstacle.

Howard W. Tindall, Jr.

Howard W. Tindall, Jr.

Enclosures 10

FM:HWT:js

AAP SOFTWARE INTERFACE MEETING
MSFC/MSC
January 15, 1970

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P. Segota	MSC-FSD	FS63	2051
J. C. Lyon	MSC-FSD	FS63	2051
G. E. Coen	MSC-FCD	FC35	5283
L. S. Canin	MSC-FCD	FC35	5283
W. E. Koons	MSC-FOD	FA	5135
R. W. Cole	MSC-FSD	FS26	2201
J. L. Cole	MSC-FSD	FS	4085
N. B. Hutchinson	MSC-FCD	FC3	4604
L. A. Reitan	MSC-FCD	FC6	4616
H. E. Whitacre	MSC-AAPO/KM	KM	3831
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F. E. Hughes	KSC-FCSD	CFK (KSC)	867-8170
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G. E. Hall	MSFC/PM-MO-O		453-3653
J. Igou	MSFC/PM-SE-ATM		453-0842
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O. Garriott	MSC-FCOD-CB	CB	

Enclosure /

NOMINAL DEVELOPMENT CYCLE FOR THE ATMDC SOFTWARE/AND RELATED ACTIVITIES

ITEM	MILESTONE	DUE DATE
1	INTERFACE PROGRAM REQUIREMENTS DOCUMENT (IPRD)	JAN 15 70
2	INTERFACE PROGRAM DEFINITION DOCUMENT (IPDD)	APR 15 70
3	INTERFACE PROGRAM (IP)	JUL 1 70
4	PROGRAM REQUIREMENTS DOCUMENT (PRD)	JUL 1 70
5	PROGRAM DEFINITION DOCUMENT	
	A. PRELIMINARY PART I	NOV 4 70
	B. FINAL PART I AND PART II	FEB 3 71
6	FINAL PROGRAM DEFINITION DOCUMENT (FPDD)	FEB 3 71
7	REVIEW AND ASSESSMENT OF FPDD	FEB 17 71
8	PRELIMINARY DESIGN REVIEW (PDR) OF PDD	MAR 3 71
9	PROGRAM VERIFICATION PLAN (PVP)	MAR 17 71
10	PRELIMINARY DESIGN REVIEW (PDR) OF PVP	APR 28 71
11	PHASE I PROGRAM AND DOCUMENTATION	AUG 4 71
12	CRITICAL DESIGN REVIEW (CDR) OF PVP, PDD, & PHASE I PROGRAM	AUG 4 71

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PRELIMINARY DESIGN REVIEW OF PDD

FORMAL TECHNICAL REVIEW OF THE BASIC DESIGN APPROACH USED IN THE PDD; CONDUCTED BY THE ATMDC CONTRACTOR FOR MSFC.

PRESENTS

- DESIGN PHILOSOPHY
- COMPUTER MEMORY UTILIZATION
- CRITERIA FOR SCALING REQUIREMENTS
- RESULTS OF MATH MODEL SIMULATIONS
- POSSIBLE PROBLEM AREAS
- KNOWN DEVIATIONS FROM ORIGINAL DEFINITION

ASSURES

- PROGRAM DEFINITION DOCUMENT IS A SOUND BASELINE FOR THE FLIGHT PROGRAM.

PROGRAM DEFINTION DOCUMENT CONTENTS

GENERAL MISSION DESCRIPTION, OBJECTIVES

MISSION REQUIREMENTS, CONSTRAINTS, SPECIAL FLIGHT CREW REQUIREMENTS

PRELIMINARY ATMDC PROGRAM REQUIREMENTS

- ATM EXPERIMENT COMPUTATIONS
- ORBITAL PARAMETER UPDATE COMPUTATIONS
- SYSTEM TIMING COMPUTATIONS
- STAR TRACKER COMPUTATIONS
  - ROLL REFERENCE
  - EARTH/STAR OCCULTATION
- MOMENTUM DESATURATION COMPUTATIONS
- BACK UP ORBITAL PLANE UPDATE COMPUTATIONS
- DISCRETE AND INTERRUPT PROCESSING
- PCS PANEL DISPLAYS
- TELEMETRY
- SIGNAL PROCESSING
- ETC.

DATA FOR SIMULATIONS

- CONTROL GAINS
- MASS AND INERTIA DATA
- AERODYNAMIC DATA

CRITICAL DESIGN REVIEW

FORMAL TECHNICAL REVIEW OF THE IMPLEMENTED DESIGN OF THE PROGRAM DEFINITION DOCUMENT, THE PROGRAM VERIFICATION PLAN, AND THE PHASE I PROGRAM: CONDUCTED BY ATMDC CONTRACTOR FOR MSFC.

PRESENTS

- CHANGES TO PDD AND PROGRAM IMPACT
- IMPACT OF FINAL MISSION DEFINITION DOCUMENT
- BASIS AND LIMITATION OF PROGRAM VERIFICATION PLAN
- FINAL CONFIGURATION OF FLIGHT PROGRAM
- OUTSTANDING CHANGES TO FLIGHT PROGRAM

ASSURES

- PDD PLUS CHANGES ADEQUATELY DEFINES THE DESIGN FOR THE FLIGHT PROGRAM.
- PROGRAM VERIFICATION PLAN SPECIFIES AN ADEQUATE VERIFICATION PROCEDURE FOR THE FLIGHT PROGRAM.
- FLIGHT PROGRAM DESIGN WILL SATISFY ALL KNOWN REQUIREMENTS EXISTING THROUGH FINAL PROGRAM DEFINITION DOCUMENT DELIVERY.

Enc. 8

FINAL PROGRAM DEFINITION DOCUMENT (FPDD)

UPDATES AND COMPLEMENTS PDD

- FINAL LOGIC REQUIREMENTS
- FINAL ORBITAL DATA
- OTHER CHANGED INPUT DATA

<u>FINAL DATA DOCUMENT</u>

FINAL ORBITAL PARAMETERS, ETC.

OTHER PROGRAM CONSTANTS

TO: S&E-ASTR-SG

DATE:

TECHNICAL EVALUATION

___ ACCEPTED

___ NOT ACCEPTED

I. REMARKS:

____

S&E-ASTR-SG

TO: S&E-ASTR-S

DATE:

I. CHANGE TO BE IMPLEMENTED

___ YES

___ NO

____

S&E-ASTR-SG

TO: S&E-ASTR-B

ATMDC SOFTWARE DESIGN REQUIREMENTS (SDR)

TO : S&E-ASTR-B

DATE:

FROM :

SUBJECT :

1. DESCRIPTION OF CHANGE:

2. JUSTIFICATION FOR CHANGE:

CONCURRENCE: ______

______

NASA — MSC — Coml., Houston, Texas

Enc 10

NASA HQs / RS / Robert [illegible]

Mission Planning and Analysis Division
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER
HOUSTON, TEXAS 77058

IN REPLY REFER TO: 70-FM-T-6

January 15, 1970

MEMORANDUM TO: See list attached

FROM : FM/Deputy Chief

SUBJECT : Cabbages and Kings

During an informal conversation with a couple of different guys, I have been asked if MPAD may have some suggestions in a couple of areas. I wouldn't be surprised if we do, so I thought I would send this little note around to ask you.

1. The other day Jay Honeycutt asked if we might suggest some neat situations he might include in the simulations to train the flight controllers and crew. You remember before the last mission we suggested several lulus for powered descent which were not only a lot of fun for us but quite profitable for the operations team. This time we should get our suggestions in much sooner and, of course, they need not be constrained to powered descent. Maybe we can strain the system for the DOI burn or entry. To be really dirty, it seems to me we should take advantage of our knowledge of limitations in the RTCC programs and tight spots in the mission plan itself.

2. As a result of my bellyaching about how our Mercury and Gemini experience with venting didn't seem to help in the design of the Apollo spacecraft, I was made aware of an on-going effort at MSC to develop a document called the "Manned Spacecraft Criteria and Standards." A guy from the Standards Engineering Office, Jim Donnell, came over to discuss modification to the venting standard and asked for suggestions regarding other things that have been bugging us. Plume impingment came immediately to my mind and I am going to write him one for that. According to Jim, the spacecraft contractor must comply with material listed in this document. It apparently becomes part of their contract. If that's the case, it struck me quite worthwhile to take this opportunity to put our complaints into this document. If you have any suggestions, why don't you get in touch with me or Jim Donnell. If you're interested in what the document looks like, come by my office.

Bill T

Howard W. Tindall, Jr.

FM:HWT:js

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER
HOUSTON, TEXAS 77058

IN REPLY REFER TO: 70-PA-T-8A

January 20, 1970

MEMORANDUM TO: See list attached

FROM : PA/Chief, Apollo Data Priority Coordination

SUBJECT : The Apollo rendezvous can be shortened by 2 hours

As you no doubt are aware, there is a movement afoot to shorten the Apollo rendezvous by 2 hours. This would be done by eliminating the CSI and CDH maneuvers and executing TPI about ½ hour after insertion. I thought the reason this was being considered was to reduce the crew's workday, which has been pretty long. Apparently it is also to permit more EVA time on the lunar surface. In any case, a gang of us got together January 14 to talk it over. We were interested in hearing about what work has gone on, what the feasibility of doing this is, and to decide where to go from there. This memo is to briefly describe the technique (Ed Lineberry's people are documenting this in detail and if you are interested you should call him) and to let you know that it does appear feasible. I will also note what has to be done now - the first thing being, to obtain MSC management approval to go on with it.

Following is a brief description of what the technique is:

a. Both the CSM and LM platform are aligned prior to LM lift-off. They are not ordinarily realigned during the rendezvous.

b. The CSM orbital should be 60 n. mi. circular as before. The LM insertion orbit will be 10 x 48 n. mi., instead of 10 x 45 n. mi. This small change will cause the post-TPI trajectory to be virtually identical to that utilized in the past.

c. Lift-off will be timed to provide the proper relative position of the LM to the CSM at the time of TPI execution which will occur 38 minutes after insertion. Thus, lift-off would be about 2½ minutes earlier than on previous missions.

d. It should be possible to obtain at least 25 marks by each spacecraft for their rendezvous navigation. Since we intend to always use the time option of the TPI targeting program, it should be possible to continue navigation significantly later than in the past. It can't slip early on us.

e. The TPI maneuver is significantly different than before. It is about 85 fps and rather than along the line-of-sight, it is almost perpendicular to it (i.e., pitched down about 45°). Also, in order to provide an in-plane braking, the TPI maneuver will be made to force a node 90° later, that is, at the second midcourse maneuver.

f. We concluded that, since the LM TPI maneuver is RCS, the probability of an unexpected LM inability to execute the maneuver is almost zero. Accordingly there should be no requirement for the CSM to prepare to execute a mirror image TPI maneuver. Of course, if a LM failure has occurred which would preclude its performing TPI, the CSM would do it. It was noted that, since a CSM TPI would result in a very low orbit, it must also be active for braking.

Although we probed all related areas, we could find very little adverse impact by going to this plan. Certainly we have not changed the descent aborts and their associated rendezvous techniques - that is, one and two rev plans, including the CSI and CDH would still be utilized exactly as before and, of course, the crew and ground control must be trained and prepared to do them. This plan essentially consists of eliminating part of that standard rendezvous and, therefore crew training is unaffected. One area that FCSD will probably look into is the provision of TPI chart for the crew to backup the PGNCS and AGS. If these are required, they must be substantially different from the current ones.

The only other open area deals with changes to the RTCC. Only two were identified - the lift-off time computation and a program to determine a trim maneuver after LM insertion into orbit. The former should be extremely simple, if it is required at all. The need for the latter will depend to some extent on the sensitivity of the rendezvous to small errors in actual LM lift-off time and other insertion dispersions. Ed Lineberry's people will continue their work in pinning down this sensitivity. The three involved FOD divisions will then establish whatever new RTCC requirements are really needed. This should be done within a week or so.

One pseudo-mission rule we agreed on was that this rendezvous approach should only be used in the nominal case when all important systems and trajectory conditions are as they should be. That is, if things like the rendezvous radar, the tracking light, or any of the other systems used for rendezvous are known to be broken, or if we have targeting problems, such as poor definition of the LM's position, or of the CSM orbital elements we would, in real time, switch from this quick rendezvous to the standard approach used on all previous flights. Of course, this switchover must be made before lift-off since after that time we will have created a phasing situation that pretty well commits us to go on with the shortened plan.

In summary, a simple approach to shortening the Apollo rendezvous by 2 hours was agreed upon by just about everyone interested in this subject. The impact seems quite limited and, to me, well worth paying for the rather attractive benefit. I would be surprised if we have overlooked anything that would change this picture although, of course, it is possible, I suppose. Accordingly, we will continue working on this approach - cleaning up the loose ends noted above and will approach our leaders to see if it should be incorporated into the Apollo 14 mission. Essentially what we are offering is an increased capability which can be used either to extend the lunar surface work or to just shorten a long, tough day.

Howard W. Tindall, Jr.

PA:HWT:js

Memo of 1/7/70 removed + filed under APOLLO-11. RS made a note that he would need it for APOLLO-11 + 12 chronicling. Subject: Important LM Computer program change for APOLLO 13 descent

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER
HOUSTON, TEXAS 77058

IN REPLY REFER TO: 70-PA-T-2A

January 5, 1970

MEMORANDUM TO: See list attached

FROM : PA/Chief, Apollo Data Priority Coordination

SUBJECT : A small change in CSM DOI confirmation procedures

We ran into a little snag on confirming the CSM DOI maneuver which has forced us to change the mission technique a little bit and I think you should know about it.

The CSM DOI burn brings perigee to about 8-miles altitude and it only takes an overspeed of 10 fps to cause an impact. Accordingly, we must have absolute confidence that such an overspeed has not occurred. On the other hand, we strongly desire to give the G&N every chance to do its job since it almost certainly will do it right. For this reason we have retained the simple crew technique for protecting against a malfunctioning G&N by manually shutting down the engine if the predicted burn time is exceeded by 1 second, and we are not including the EMS in the logic. If at the conclusion of the maneuver the EMS confirms that the G&N did right, we should have confidence that everything is okay since that has got to be more than just coincidence. Our only problem occurs if both the G&N and EMS appear to be operating properly, but the EMS indicates an overspeed. Then something must be done to determine which of the two systems is correct. If the G&N proves to be correct, we should press on with the mission. If the EMS is right, an emergency maneuver must be executed within ½ hour to get out of there and, since the G&N must be broken, the landing will probably have to be abandoned. Originally we intended to solve this dilemma in the unlikely event it occurred by having the crew note the time of earth rise. It was originally felt that this observation would provide the crew an absolutely dependable, simple onboard technique for making this critical decision. We have since found that that is not so dependable and have chosen to use an alternate procedure. Namely, we have been unable to find dependable onboard techniques and have decided to depend on the MSFN tracking and MCC processing to determine which of the sources is correct if the G&N and EMS disagree with each other. This can be done dependably to inform the crew in time for them to execute the bail-out maneuver. This procedure has been agreed to -

over the phone by key flight controllers and the prime Apollo 13 crew, and it will be used during the simulations starting this week. Work on earth-rise procedures is being terminated.

Howard W. Tindall, Jr.

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