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Memorandum

C. W. Kraft

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FROM : FM1/Deputy Chief, Mission Planning and Analysis Division (MPAD)

66-FM1-75

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SUBJECT: Apollo spacecraft computer programs--or, a bucket of worms

Well, I just got back from MIT with my weekly quota of new ulcers, which I thought might interest you, We spent one day discussing the AS-204 situation, another on AS-501 and AS-5.02, and the third day primarily on crew procedures associated with the LEM lunar rendezvous crew time-line. I will give you my impression on each of these things, but first I would like to let you know that Ed Copps is coming down on June 16 and 17 to give us a first cut at the overall schedule situation and the status of the Program Development Plan which he has been putting together. To help Ed in this urgent task, we have asked, and IBM (RTCC) has kindly agreed, to send people experienced in this area up to MIT for the first several days of the week to assist Ed and his people in the assembly of this information we so urgently need. Ed briefly described the format of the Program Development Plan, which is obviously closely patterned after IBM's and which seemed to me to be quite good if we really get it working.

AS-204 Status:

Since this is the first time I have ever had anything to do with the AS-204 program, I am sure my understanding of the situation is far from perfect; however, perhaps thic estimate of the status of the program might cause you to get the true status from someone who does know if I say something here that interests you.

According to Ed Copps, all fixed memory of the computer is filled; and, in fact, it was necessary to take out about 500 words of the reentry program associated with super-orbital entry in order to make it fit. (Incidentally, this suggests we may have a problem on the AS-205 program which is essentially the AS-204 program with about a 500-word routine added in for support of an experiment unique to AS-205. I have asked MIT to let us know at the earliest possible date if it is their opinion that storage will preclude adding this program.) A-

A month or so ago some rather important guidance system capabilities were deleted from our requirements in order to improve the schedule situation enough to allow a June 8 release by MIT of a program which could support a nominal mission, the so-called "B release." This apparently did not do the job. The program has just been compiled in a single system and debugging is required in every area. In fact, according to

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Ed Copps, not a single program sequence has been successfully run to completion yet. Thus, it was MIT's opinion that the program should not be released at this time. In fact, some of the programs--the 30 and 40 series--have not even been unit tested, although they have been included in the program assembly currently being used far system tests. This is certainly a very unsatisfactory situation.

MIT presented an abbreviated test plan for verification of this program, and it is my impression that the tests listed were to serve as part, if not all, of the formal verification and acceptance demonstration proposed by MIT. The list presented was not at all definitive but only described the runs in very general terms. The list consisted of twelve tests primarily designed to check capability of the program to support a nominal mission; it *was* estimated that these runs could be completed within four weeks. In addition, three other tests were identified associated with a variety of non-nominal- situations for which completion was estimated to be nine weeks.

Apparently Ed Copps does not expect the AS-204 'program test results to be formally documented, although Alex Kosmala says all this material will- be readily available on file. What a shame to have to accept a situation like that, but I suppose we have no real choice now.

It had been the intention to prepare the B release program for spacecraft systems tests to be carried out in the altitude: chamber at the Cape. As I noted before, it was desired on June 8. Aaron Cohen ascertained that June 23 was the very latest date this release could be made without causing a day-for-clay slip in the launch schedule. This date is based on the assumption that Raytheon will be able to manufacture the *ropes* in four weeks as opposed to the previous time allotment of six weeks.' Thus, you *see* it is evident that a program, flight-worthy in any sense, cannot be made avail-able in time for spacecraft. systems tests. In order to avoid the schedule slip, the Apollo Spacecraft Program Office (ASPO) decided to accept a program tape release for rope manufacture on June 23, using the best program assembly MIT has had up to that time.

The final flight tape must be released for rope: manufacture at some time between July 15 and August 8. Actual freezing of the flight program must be based not only on the Cape schedule but also must take into account flight crew training since it is important that the training be carried out with the same assembly as is flown. We have every expectation that the flight program we finally must accept will be of less than desirable quality. It will not have undergone sufficient verification tests and will very likely still contain program bugs. Following the flight program test release, extensive effort will be carried out to determine the limitations and inadequacies of the program in order that operational procedures may be established to work around them. Hopefully, none of these deficiencies will be *so* serious that tho flight may not be carried out on schedule.

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It is our intention at MSC to maintain a close watch by locating our people at MIT most of the time such that we are immediately aware of the situation on a day-by-day basis. In addition, we intend to assist in whatever way possible in carrying out the test; program, doing such things as supplying information upon which test results may be compared, running analyses, etc. We also intend. to re-examine the overall rope production situation since in the next several months Raytheon will be requested to manufacture a large number of ropes to the extent that their capacity may be exceeded. I certainly don't want anyone to think that we feel the situation is any better than barely tolerable; on the other hand, as far as I can tell we are pretty well committed at this time with no alternative but to march along with our fingers crossed.

AS-501 Status:

Although the discussions on AS-501 started out being even more traumatic than AS-204, it looks like, maybe, we are going to come out of this one pretty well. Basically, we were told that the AS-501 and AS-502 program would be the AS-202 program with about 15% new formulation required. It was MIT's proposal that the entire program development task for the AS-501 and AS-502 programs be assigned to AC Electronics. Their first *estimate* was that the program tapes could be released for rope manufacture on about November 15, which is exactly three months too late. Rather an interesting proposal, I thought, since it is *so* obviously so unacceptable. After recovering from our complete shock, we started looking into the alternatives available to us and came upon one which made some of us wonder why we weren't doing it that way in the first place; i.e., just using the AS-202 program as is with only minor modifications, such as changing a few *of* the constants. Theoretically, this should not only put us on schedule, but maybe ahead of schedule.. An effort has been going on at MSC, under the leadership of Carl Huss, to determine just; what impact such a plan would have on the AS-501 and 502 flights. *So* far, as problems have been identified, acceptable solutions have generally been found; and it is my current impression thaf we shall be able to fly AS-501 and AS-502 using the AS-202 program with very little modification or impact on the mission objectives.

It appears that a somewhat greater burden will- be placed on the ground support for carrying out the AS-501 and 502 flights using the AS-202 program in this way. The most significant disadvantage is that certain alternate mission flexibilities and some launch abort capability must be given up. These capabilities would certainly be worthwhile if the schedule situation permitted. As soon as we are able to determine with some accuracy exactly what the situation is, this proposal will be carried to our management for the final decision. Incidentally, John Dahlen optimistically estimates that the GSOP for AS-501 will be available in about two weeks.

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One most significant action was taken with regard to the concentric flight plan. It was the unanimous agreement of MSC and MIT personnel involved in this work that the concentric flight plan to be programmed for the Apollo guidance computer will be *as* it now exists in both the Rendezvous Analysis Branch and. MIT. It is recognized that there are certain limitations to its use wherein under dispersed conditions it does not automatically produce a usable mission plan. However, through proper use of the input controls by the pilot--changing various parameters--it is possible to arrive at *a* solution if one is available. Accordingly, it was not felt *to* be fruitful nor would. there appear to be time to permit further refinement of this formulation, and *so* we decided to proceed *as* noted with MSC accepting full responsibility for these deficiencies, Our task from now on, then, is to conduct sufficient analysis to identify these deficiencies and to provide onboard and ground backup procedures to take care of them.

Finally, if you are still. with me, you hardy reader, let me tell you what I intend to put maximum effort on next. I am willing to bet that we are going to be told. that MET is behind schedule on AS-207/208 and. maybe AS-503 and AS-504. On the other hand, unless things change, we can probably expect to see the flight schedule accelerated, making the situation even worse. Although it is a pity to reduce the potential. of this really sophisticated guidance system below its maximum, I see no other choice but to *go* through that program and ruthlessly cull out many of its refinements in order to simplify the program to its most austere form for those early Block II flights. The program paring must be done, I feel, solely for schedule reasons, which is really kind of weird when you think about how long the programs have been under development. It will mean that we fly to the moon with a system which does not minimize fuel expenditure nor provides the close guidance tolerances which are ultimately within its capability.

Once we have determined what can be removed of this nature, I will be sure to let you know, along with the costs--the waste of our precious propellants and increased miss distances. It will then be up to our management to decide whether these costs are acceptable or not. I have asked Norm Sears to prepare *a* first-cut at possible program deletions, based on this philosophy, and we will see if we can't add a few things to it when we go up there next week.

Howard W. Tindall, Jr.

Addressees:
(See attached list)

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