THE CHARLES STARK DRAPER LABORATORY
A DIVISION OF MASSACHUSETTS INSTITUTE OF TECHNOLOGY
68 ALBANY STREET
CAMBRIDGE, MASSACHUSETTS 02139

MEMO

TO: R. Battin
FROM: M. Hamilton
DATE: February 18, 1971
SUBJECT: Post Release Testing

The following is a brief summary of discussions we've had concerning the cutting down on Machine Time costs for APOLLO 16, APOLLO 17, and SKYLAB. First of all, what types of testing have gone on in the past during post release testing? The categories that come to mind are:

1) Formal Level 6 testing - these are tests agreed upon by MSC and MIT before the start of the Level 6 testing period. They are officially recorded in the Software Development Plan.

2) New pad load testing - In the past, some pad loads have changed frequently (especially in the descent area) and with each change, the rerun of the formal Level 6 package has been deemed necessary.

3) Potential anomaly tests - Reports of potential anomalies come from such places as the LMS, Grumman, North American, and MIT. Tests must be run to

A. try to duplicate the problem
B. check out workarounds if there is a problem
C. prove that there was no problem.

4) Response to what-if questions - In the past MSC has come up with questions such as, "If we want to use the COAS for landmark tracking, what happens?"

5) Stress testing - Unofficial runs are made by experts as a result of new information concerning the flight.

6) Back-up nominal runs - sometimes a run with an n-sigma error might look a little questionable. Nominal runs or partially nominal runs are made to discover this questionable behavior.

7) Mission procedure/technique changes - A rerun of Level 6 tests might have to be made, or whole new tests must sometimes be designed and run due to a last minute change in the Mission procedures.

8) Mistake runs - some runs are run more than once due to human errors such as programming errors, input errors, etc.

9) Re-release runs - All Level 6 runs are rerun as well as Level 4, etc. for a re-manufacture.

10) RTCC testing

How can we cut down on the testing described above? Here are suggestions that have been discussed by several of us over the last few days:

1) Now that we have frozen ropes and close to frozen hardware, we could cut down the number of tests previously run for the official Level 6 testing effort. The general opinion is that we should consider as a bare minimum the following tests:

A. Descent Level 6
B. RTE Level 6

The decision to run Level 6 tests in any other area would have to be based upon the engineering judgement of both MIT and MSC.

2) New pad load testing could only be performed after approval by an internal MIT Board set up for the purpose of monitoring post release testing. The Board could decide if the pad loads had changed enough to rerun the tests or at least cut down the number of times that Level 6 tests were rerun by forcing a minimum time limit between re-runs (unless, of course, the change in pad loads was too close to lift-off time.) Some pad load changes could be tested by running only MAC runs.

3) Potential anomalies should always be looked into unless, even if they existed, they were harmless anyway. This is a hard area to cut down on.

4) What-if questions should come officially from Houston and perhaps signed off like a PCR.

5) The amount of stress testing performed could be decided upon by the same

internal Board discussed above. From now on, the landing areas probably will be the only areas where any amount of stress testing will be necessary.

6) The less runs that are made, the less back-up runs needed to explain them!

7) Frozen Mission procedures would eliminate runs in this category.

8) A closer monitoring by supervisors may help a little on cutting down the "mistake runs."

9) Re-release runs are no longer a consideration if all goes well.

10) RTCC tests maybe could be cut out completely.

It might be worthwhile at this point to add some benefits we have gained from post release testing, aside from those hidden in the reasons given above:

1) Program anomalies are discovered. Some anomalies found in post release testing have flown on previous missions and we were lucky enough not to have had them occur during flight. I mention this to show that frozen ropes, no matter how old, can still have potential anomalies that could be serious.

2) Pad load errors are found. This happened in the landing area for APOLLO 14.

3) Many potential anomalies from places such as the LMS, Grumman, etc., are proven to be false alarms. This could prevent unnecessary workarounds and concern among the engineers, the flight controllers, and, in fact, the crew.

4) More is learned about how portions of the mission will perform at flight time when the parameters are tested ahead of time.

I have just finished discussing how we can save on computer time by elimination of certain tests that have been run in the past. Another way of saving on computer time is by shortening the tests we have. We performed a study several months ago and took measures to improve the computer time efficiency. Still more can be done. They can vary all the way from things like changing from an accurate to a fast IMU, to running a simulation with almost no Special Requests except when a debugging run is needed. MIT ran a descent run without Special Requests and this run ran in 1/3 the machine time that our normal Level 6 descent run took.

If there were more time in which to do a series of tests, all runs would not have to be put in at once and be run with the same deck input errors. One run could be debugged first and the other runs benefit from the knowledge of the first. The descent people estimate that the official Level 6 test effort could have been cut in half if there were enough time to debug one run before the others.

A rough study has been made on the history of past 23B post release testing made during the APOLLO 14 effort. During this time the total post release testing effort on COLOSSUS took 105 hours. Of this time, 23 hours were taken up with anomaly testing. The remaining time was taken up with the official Level 6 test effort. The total post-release effort on LUMINARY took about 175 hours. Of this effort, the descent effort took about 90 hours. Most of the hours spent on non-descent runs were for official Level 6 runs. The landing area, however, took about 16 hours for anomalies, 4 hours for new pad loads, 8 hours for pad load anomalies, 16 hours for stress testing, etc.

If we were to propose doing the minimum amount of post release 23B testing, we could suggest the following:

1) Run official Level 6 tests for descent and RTE.* If descent tests were the same as at the APOLLO 14 level, they would take 24 hours of computer time. RTE tests would take 10 hours.

2) Test only serious anomalies or serious potential anomalies. Judging from APOLLO 14 experience, this might take about 50 hours of computer time. (This was high, I think)

3) Run required stress testing for descent runs. This will take about 13 hours of computer time.

This minimum effort would take about 100 hours of post release testing a mission for both COLOSSUS and LUMINARY.

*Terrain changes affect descent runs. W-matrix changes affect RTE runs.

If this were to be distributed evenly over 5 months, our effort would be about 20% of the 100 hours a month that has been discussed as a strawman. Also, it would require just a little over 1/3 of our present post release testing effort.

In order to maintain the post release testing at the proposed minimum, we would have to be guaranteed:

1) same ropes
2) same trajectories (we have allowed for landing site differences)
3) same vehicle
4) same mission procedures
5) same capabilities
6) no more anomalies than we tested for on APOLLO 14 (we expect less)
7) no what-if questions

So far discussion has taken place considering 2 ways of saving on machine costs. By cutting down on the required testing and by changing somewhat our way of testing, considerable time can be saved. The third proposed way of saving costs is to run our simulations on a different facility. Keith Glick will discuss the AC facility, which has been suggested as an alternative.

NOTE: Only 23B type simulations have been discussed here. It is assumed that MAC runs are not considered in this study.