Bellcomm

955 L'Enfant Plaza North, S.W.
Washington, D. C. 20024

date: September 2, 1971

to: Distribution

from: K. E. Martersteck, P. E. Reynolds

B71 09005

subject: Apollo 15 Systems Debriefing
Case 310

ABSTRACT

The Apollo 15 Systems Debriefing was held at MSC on August 18 and 19, 1971 during which system anomalies were reviewed by discussion with the crew. The most significant anomaly was the failure of one of the three main parachutes during the landing. Unfortunately the crew could add little to what was already known and the cause of failure remains undetermined at this time. Other minor problems in the various systems were reviewed and a number of minor design changes and equipment additions and deletions were suggested.

(NASA-CR-121681) APOLLO 15 SYSTEMS DEBRIEFING (Bellcomm, Inc.) 11 p

N79-71712

Unclas
00/12 12117

Bellcomm

955 L'Enfant Plaza North, S.W.
Washington, D. C. 20024

date: September 2, 1971

to: Distribution

B71 09005

from: K. E. Martersteck, P. E. Reynolds

subject: Apollo 15 Systems Debriefing
Case 310

MEMORANDUM FOR FILE

The Apollo 15 Systems Debriefing was held at MSC on August 18 and 19, 1971. The purpose of the debriefing is to complement or clarify remarks recorded by the crew in their technical debriefing in areas that are pertinent to systems problems. The agenda is listed in the attachment. A summary of the discussion by subject matter follows.

Launch Vehicle

There were no significant launch vehicle anomalies. The crew noticed a slight 10 to 12 cps steady low amplitude oscillation throughout the S-II and S-IVB burns. The fact that this was noticed at all by the crew was attributed to the quieter, smoother operation of the AS-510 vehicle compared to earlier launch vehicles. Hence, the minor motions such as this 12-cycle oscillation became more noticeable. The IU state vector was updated satisfactorily prior to TLI. The reason for the IU error which necessitated the update is still under investigation. The translunar injection burn was very nominal. The ground called up a three-second early shutdown. This was due to a higher-than-predicted launch vehicle performance. The crew was surprised at the S-IVB PU shift at one minute into the burn since it was not listed in their flight plan as was the PU shift during the launch phase. MSFC volunteered to hold a special launch vehicle crew briefing session close to launch day to pick up such items, but Scott didn't feel it would be worth the crew training time.

Lunar Roving Vehicle

The LRV experienced a number of anomalies. None of these prevented the successful deployment and operation of the LRV. During the initial phase of deployment the crew noticed that both support arm latch mechanisms were unlatched. Deployment was completed manually. After the LRV was on the ground neither the saddle nor the telescoping rods would disconnect. The crew manipulated the LRV until the saddle could be disconnected. The MSFC personnel felt this was not the proper procedure; they felt operating the backup release cable would have released the vehicle. The crew assured the MSFC people that they had tried the backup release cable to no avail. During activation the front steering was found to be inoperative. Cycling the switches did nothing. Hence, for the entire first EVA rear steering only was used. Prior to EVA-2 the switches were cycled again. This time the front steering worked. Scott attempted to drive with front steering only, but the rear wheels would not remain centered. Consequently, the rest of the EVA was performed with the double steering engaged, even though Scott would have preferred front steering only.

The most serious problem with the LRV was the seat belt arrangement. Both belts were too short and had a tendency to hang up. Both crewmen insisted on some kind of redesign prior to Apollo 16. There were other minor equipment problems such as loose cables, meters too hard to read and stiff switches.

LRV performance exceeded Scott's expectations. Scott generally drove the LRV as fast as it would go, reaching peak speeds of 13 Kph, and maintaining an average speed of 9 to 10 Kph. Particularly impressive was the LRV performance on slopes. Scott did mention that driving took all his attention and that, although dust was no factor in visibility, the subdued craters were troublesome for navigating a path. Scott had trouble seeing 1 meter craters at 3 meters distance. Generally he drove as fast as possible slowing only to make turns. Occasionally he turned too quickly and ended up sliding into a crater. Scott felt that he was never airborne, but Irwin corrected that impression. During the "Grand Prix" which Scott drove while Irwin took pictures, Scott went airborne at least once. Since he didn't feel it then, there is speculation whether the LRV was airborne at other times during the traverses. Scott commented that the LRV braking was also better than he anticipated. The LRV stopped from full speed within two vehicle lengths.

CSM and LM ECS

The first question asked was where did the dirt go? The LM cabin was filthy with dust after EVA-1, but upon awaking the next day it appeared that the dust disappeared. The solution seemed to be a combination of cleaning via the ECS loop and the crew getting used to the musty lunar dust smell. During the LM water leak, the ground support team noticed the water flow which they attributed to PLSS recharging. It was later when the crew announced that they actually were recharging the PLSS, that the ground realized there must be a leak. The suit drying procedure worked well and, in fact, the suit drying configuration is a quieter one than the LM sleep configuration. The CSM-ECS worked very well. The cabin fans were required to be on all the way home to clean the dust from the air. A significant amount of water poured from the docking tunnel at entry. A certain amount is expected to accumulate during the pre-entry chill-down, but no one told the crew wipe the water up. Contrary to pre-mission worries, the urine dump never did freeze during the flight.

The inflight EVA went very well. At no time did Worden feel warm or uncomfortable. The actual times required for the EVA tasks agreed quite well with the predicted times. There were no surprises as the actual exercise went exactly as the training had predicted. Worden was quite disappointed that other tasks were not proposed while he was out. No contaminate or RCS residue was noticed around the SIM bay or other parts of the SM. An analysis of the actual RCS duty cycle and related contaminate residue has not been done, but it appears the residue is less than had been predicted. The sun/spacecraft SIM bay relative attitude was satisfactory for seeing in the SIM bay, but areas outside of the SIM bay were in deep shadow. Worden recommended changing the requirement on the sun spacecraft attitude to include the lower handrail in the illuminated area.

PLSS and Lunar Surface EVA's

The new suit and PLSS worked quite well and the crew felt very much at home in the suit despite the sore fingers. There were a number of minor problems. Irwin's PLSS antenna broke off and was repaired by taping it down on the PLSS. The antenna had a nick in it that appeared to have been there even prior to flight. This nick was taped and the antenna broke off at a different place. The best guess for when the antenna was broken was when Irwin stepped on the OPS/antenna prior to the second sleep period. Communications were adequate even with the antenna not deployed.

In an attempt to save time, both the PLSS-oxygen and water were recharged simultaneously, but, due to a short oxygen line, the PLSS was tilted to make the connection. This tilt resulted in an incomplete water charge requiring a recharge subsequently.

Both Scott and Irwin read their EMU parameters very infrequently. They both felt the ground was monitoring things very closely and, therefore, they didn't need to read them often.

It was even suggested that these parameter meters could be eliminated or at least put in a less conspicuous position in their field of view since they are backup devices rather than prime data sources.

The suits had a number of minor design deficiencies. The suit gloves tend to stretch with use and hence are too loose for fine finger dexterity. Even when first used the fit can only be made optimum for either arms extended or arms not extended. Scott tightened his glove fit for arms not extended and consequently injured his fingers with the extra tight fit in the arms extended mode. Both astronauts experienced sore hands during EVA. The protective gloves were necessary for the drilling operation, but they impair dexterity. Scott felt his leg motion was constrained by the suit such that he could not take as long a stride as he felt would otherwise be possible. Scott noticed that his arm and shoulder got quite warm when exposed to the sun for extended lengths of time. The crew tried to avoid kneeling on the lunar surface as much as possible. This was necessary because it is very difficult to maintain balance in this position and difficult to get back up without assistance. The fruit sticks were great and the water was useful except that the valve on the water bag constantly malfunctioned. Backing out of the LM was a problem. Some type of cuff mirror was suggested to provide rear visibility.

Displays and Controls

In the main, all displays and controls worked quite satisfactorily. During the terminal phase braking the LM radar indicator needles were not functioning, but attitudes from the eight-ball and visual line-of-sight rates were sufficient to complete the rendezvous. An explanation of the failure was not offered.

The crew confirmed that there were no loose objects in the LM that could have caused the broken glass on the landing radar tape meter.

The SPS thrust light was first noticed to be on right after transposition and docking. The workaround solution worked very well. The crew first had to pound the panel to make the light come on, but later on could get the light on by manipulating the switch. The light did come on and stayed on during entry.

Because the CM AC lighting buss was off for most of the flight, the Mission Events Timer was not available. Hence, Worden had no onboard reference for ground elapsed time (GET). Worden and MCC attempted to communicate flight plan updates using local Houston time, but the flight plan is listed only in GET and there was a continual time problem.

CSM/LM Electrical Power and Propulsion Systems

There were no significant anomalies that had not been fully covered elsewhere. The only question raised was a better definition of the descent engine skirt buckling. Scott described this as a wrinkle ridge completely around the circumference which should be quite noticeable in the photos. He also claimed that there was clearance between the nozzle and the ground all the way around.

Scientific Instrument Module (SIM) Experiments

Generally the SIM experiments operated as advertised. The timeline was crowded at times and the control panel is poorly designed, e.g., the indicators read gray in both the stowed and operate positions, so that unless the crew has remembered which way they were last reconfigured, there is no way to determine the experiment status.

The laser altimeter malfunctioned in flight. During inspections neither the LM crew nor Worden could see any externally obvious problem with the unit. The V/H sensor on the pan camera seemed perfectly clear and clean. There was also no obvious reason for the mapping camera to jam in the extended position. Worden checked the clearances between the cover and the camera and around the edges for some binding foreign material, but found nothing. Worden examined the mass spec to see why it had not retracted properly. He noticed that the guidepins were through the guideslots so that retract should have been possible. The system experts explained that unless cylindrical part of guidepin could be seen, the retract was not complete. Worden wasn't quite sure whether he could see that part of the guidepins.

CSM/LM Guidance, Navigation, Control, Landing and Rendezvous Radars

Both the CSM and LM guidance systems operated without problems. The ORDEAL unit worked but was very loosely mounted to the CM support. The systems people explained that they had tried to process a fix to that mounting earlier, but it had been rejected. Most of the questions were directed to exactly how Worden performed the horizon sightings for the return-to-earth-without-MSFN mode because he really did so very well. Worden explained that the training at the MIT facility was invaluable and that the sightings as executed were really a two-man job with Scott controlling attitude while Worden did the sextant sightings.

The rendezvous radar would not lock up during LM ascent, but it did lock up after insertion. One possible reason offered was that the rendezvous radar transponder had an abnormally slow warm-up time. The VHF ranging did work prior to insertion.

ALSEP, Lunar Surface Drill and Lunar Surface Equipment

As is well known, the lunar surface drill took much time and effort. Scott explained that the first part of the drilling operation for the heat flow experiment went very well. He estimated that he hit solid rock at three feet on the first hole and at two feet for the second hole. When placing the heat flow probes he could feel the first probe hit bottom, but the second probe did not. He could not see any reason for an obstruction in the second hole, but he could feel the probe hang up. He didn't want to push the probe too hard for fear it might break. Scott mentioned that the drill torque varied as the drill penetrated different layers. Coring was not too difficult other than for his tendency to push or lean on the drill too hard to attempt to save time. The drill did cut through the harder rock but only at a slow rate. Getting the core out was a tremendous chore. Scott did try to use the power-on mode to assist the extraction but it did not work. A reverse drill mode was suggested but the systems people pointed out that the core stems only screw together one way and a reverse mode would unscrew the stem segments. The extraction method used was to pull the total core out with the drill by sheer human strength and then use the vise to break the cores apart. A simple lever device was suggested to assist this operation. The systems people suggested a number of possible drill fixes but Scott cautioned them that the Apollo 15 site might be quite different than other sites and that fixes should be reviewed in the context of other potential soil conditions.

The ALSEP deployed quite well. Minor problems were: stuck Boyd bolts on the SIDE, no dust covers on the LSM, broken deployment lanyard on the sunshield. Normally a shorting plug is engaged in the central station so that power is not supplied from the RTG power plant to central station until the astronaut deployed and aligned the ALSEP antenna. During the initial deployment it appeared that Irwin had released the shorting plug prematurely and a signal was received by MSFN. The shorting plug anomaly may be explained by ground procedures at Canary Island as it was the only station reading an r-f signal on the ALSEP frequency when data should not have been transmitted. There were a number of minor lunar surface equipment problems. Both Yo-Yo's broke. The flight Yo-Yo's used string while the training units used metal cable. Scott recommended that the crew either train with flight units or fly with the training units! No one in the audience could offer an explanation of why they are different. Obviously, the gnomon needs a damper. It never did damp out when required. It was mentioned that the gnomon did have a damper at one time but it was removed. Both Scott and Irwin thought the lunar equipment conveyor was a lot of trouble for nothing. Specifically, it dumps dirt everywhere, especially on the CDR. Scott felt he could carry everything up the ladder without assistance. Irwin wasn't as sure, but agreed one probably could do it by using a wrist tether.

Communications and Television

All communications were great. One CM lightweight headset was broken. Perhaps a spare might be provided on the next flight. Scott was asked a number of questions relating to a potential fix to the LRV antenna to provide television while in motion. Scott felt the antenna alignment sight could be improved. Alignment using the AGC meter was satisfactory but slow. However, as a backup method the AGC meter was quite satisfactory. During the one test using the TV while driving the LRV, the crew did not hear any noise bursts, indicating that they never lost the uplink even though the TV picture was lost. Scott thought he could see discoloration due to heat on both the camera and the LCRU.

Entry

The crew described entry as quite nominal up to the call that one chute failed. They took excellent pictures of the entry systems deployment sequence but the photography stopped prior to the critical time when one main chute failed. Worden could see the heat shield go above the deployed drogue chutes and he felt it did not recontact any of the chutes. It was sometime after the end of the RCS dump cycle that the crew noticed a high rate of fall and looked out and saw the failed chute. They were not sure of any of the times of events as they train for a deployment sequence rather than specific event times. The systems people still had no sure answer to the chute failure (the failed chute was not recovered). They have examined the one good chute which was recovered and have discovered that one of six riser clamps was broken. The capsule motion at landing was down, up and stop--no hint of anything but Stable I position.

Cameras

As usual the cameras caused some problems. The lunar surface 16 mm camera experienced a great number of jammed film magazines. Only one magazine worked totally. The astronauts felt that the trouble was with the film, not the camera. The LMP Hasselblad failed during the EVA, but was subsequently fixed. Scott felt that lunar dirt was the culprit. He recommended some kind of a protective covering over the camera body to protect it from dirt. Both crewmen recommended doing away with the handle and trigger for the cameras and save the weight. The 500 mm camera worked well. Scott held the camera by the lens body and stabilized the camera by placing it against his helmet visor. Almost all the 500 mm pictures were excellent without image smear. The LM 16 mm camera and the LMP Hasselblad cameras were returned.

K. E. Martersteck

K. E. Martersteck

P. E. Reynolds

$2013-\frac{\text{KEM}}{\text{PER}}$-jab P. E. Reynolds

SYSTEMS DEBRIEFING SCHEDULE

R + 11 DAYS

August 18, 1971

9:00 - 9:30	Launch Vehicle and Emergency Detection System
9:30 - 10:15	Lunar Rover Vehicle
10:15 - 10:45	CSM/LM Environmental Control System
10:45 - 12:00	PLSS and Lunar Surface EVA's
12:00 - 1:00	Lunch
1:00 - 1:30	CSM/LM Crew Station, Displays and Controls, Provisions, and Food
1:30 - 2:00	CSM/LM Batteries, Electrical Power Distribution, Instrumentation, Fuel Cells, and Cryogenics
2:00 - 2:30	CSM/LM Propulsion
2:30 - 3:30	Scientific Instrument Module Experiments, and Command Module EVA
3:30 - 5:00	CSM/LM Guidance, Navigation, Control, Landing, and Rendezvous Radars

R + 12 DAYS

August 19, 1971

9:00 - 11:00	ALSEP, Lunar Surface Drill, and Lunar Surface Equipment
11:00 - 11:30	CSM/LM Communications and TV
11:30 - 12:00	CSM/LM Structures, Mechanical, and Thermal
12:00 - 12:30	Cameras and Photographic Systems

Subject: Apollo 15 Systems Debriefing
Case 310

From: K. E. Martersteck, P. E. Reynolds

Distribution List

NASA Headquarters

D. A. Beattie/MAL
G. F. Esenwein/MAL
J. K. Holcomb/MAO
E. W. Land/MAO
C. M. Lee/MA
A. S. Lyman/MR
L. R. Scherer/MAL
R. B. Sheridan/MAO
W. E. Stoney/MAE

Bellcomm, Inc.

R. A. Bass
A. P. Boysen, Jr.
J. O. Cappellari, Jr.
D. R. Hagner
W. G. Heffron
N. W. Hinners
J. Z. Menard
J. W. Timko
R. L. Wagner
All Members Department 2013
Central Files
Department 1024 File
Library

Abstract Only to

Bellcomm, Inc.

J. P. Downs
D. P. Ling
M. P. Wilson