BELLCOMM, INC.

SUBJECT: Extravehicular Mobility Unit (EMU) Operational Design Review - Case 330

DATE: January 19, 1967

FROM: T. A. Bottomley, Jr.

ABSTRACT

An Extravehicular Mobility Unit (EMU) Design Review was held at MSC on November 14 to assess the adequacy of the design criteria, checkout procedures, and operational requirements of the EMU in the performance of the Apollo LOR mission.

Of the twenty-nine items submitted for Board review, fifteen had action deferred pending further study. Subsequent reviews on December 9 and 16, have reduced the number of open items to nine.

Significant areas of discussion were the following:

1. An update of lunar surface design criteria is needed.
2. Pacing items in suit development are the communications cap, extravehicular visor and thermal gloves.
3. EVA go/no-go conditions are not established.
4. Constraints on checkout and operations result from specific requirements for both pressurized and unpressurized LM cabin environments.
5. The provision of one PLSS for undocked transfer between the CM and LM is unacceptable from a crew safety standpoint.
6. The MSC recommended design criterion for total suit pressure is now 3.8 $\pm$ 0.1 psia.
7. The requirements and capabilities for voice communications and telemetry for two crewman performing simultaneous EVA requires re-evaluation.

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MEMORANDUM FOR FILE

An Extravehicular Mobility Unit (EMU) Design Review was held at MSC, November 14, 1966.

The purpose of this review was to assess the adequacy of the design criteria, checkout procedures, and operational requirements of the EMU in the performance of the Apollo LOR Mission.

The review board consisted of the following MSC personnel:

Mr. J. A. Chamberlin (EA2) Chairman

Mr. J. V. Correale (EC)

Mr. W. C. Kincaide (EC9)

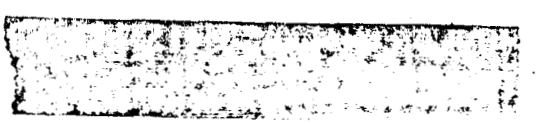
Mr. J. P. Loftus (PM5)

Mr. J. Young (CB)

Attachment A is a list of attendees. It is understood by the author that this is the first formal Block II suit review attended by astronaut representatives.

The following reports cover information used during the review for design evaluation:

1. EMU Stowage in CM
2. EMU Design Criteria
3. EMU Theory of Operation and Schematics
4. EMU Checkout Procedures
5. EMU Modifications In-Process



These reports and the current status of Review Item Dispositions (RID's) generated at the meeting are available from the writer.

A total of twenty-nine (29) RID's were submitted for review board action. Of these, action on fifteen (15) was deferred pending additional study. The latest suspense date for completion of the various position papers was December 6, 1966.

Two additional reviews were held December 9th and 16th at MSC. As a result of these reviews, action on nine (9) open items has been deferred pending receipt of additional information.

The following areas of discussion are felt to have special significance:

1. An update of lunar surface design criteria is required by CSD (to include the scientific experiments for the lunar EVA mission) in order to fully assess EMU performance sensitivities or mission constraints. ASPO is recommending a maximum sun angle of 48° and crater dimensions of 8-12:1 (diameter to depth) for the LOR mission.

2. The EMU flight configuration is Type A6L. The pacing items in suit development are the communications cap and the extravehicular visor. MIT has reported on the feasibility of using the Gemini EVA visor with the navigation optics for Apollo. Their preliminary report states:

   (a) Transmissibility would be reduced from 80 percent (Apollo visor) to 60 percent (Gemini visor). The effect would be to decrease the number of stars visible by one-third and the degree of brightness by one-half magnitude.

   (b) Backscatter would be increased.

   (c) The Apollo optical system is considered marginal and any further degradation would be considered serious.

   In addition, the crew has expressed dissatisfaction with thermal glove development.

3. EVA go/no-go conditions are not established. For example, no decision has been reached on a go/no-go ground rule for loss of telemetry.

4. If LM cabin pressure is lost while landing, EVA will not be possible as the astronaut cannot change from intravehicular to extravehicular gloves.

5. The astronauts have requested procedures be established to avoid breaking any suit connections in a vacuum. Connection to a Portable Life Support System (PLSS) in a pressurized cabin introduces a time constraint for LM depressurization due to thermal reasons. The PLSS sublimator will not function above 0.5 psia cabin pressure and it is estimated that

   (a) the LM ECS oxygen stream will approach 250°F after five minutes due to the LiOH reaction, and

   (b) the PLSS communications equipment will approach a critical temperature of 130°F (the temperature at which internal shorts may develop) in about 10 minutes.

   A new procedure for connecting to the PLSS was proposed. It is to be evaluated at Grumman December 19-20, 1966.

6. Current plans for using one PLSS and one Emergency Oxygen System (EOS) to effect an undocked transfer between the CM and LM are not acceptable to the astronauts. An ASPO/EVA panel will be convened to consider this problem in detail.

7. The MSC design criteria for suit total pressure will be 3.8 $\pm$0.1. Current design criteria require a total pressure of 3.75 $\pm$0.25 psia.* The NASA Headquarters position was that minimum partial pressure of oxygen should not be less than 180 mm Hg, which, with other pressure criteria (e.g., CO_2, pH_2O) remaining the same, would require raising total suit pressure to approximately 205 mm Hg (3.97 psi). MSC expressed concern that reduced mobility and pressure regulator design impact would result if suit pressure were established at this level.

8. A need was indicated for assessing the communications requirements and existing capabilities of the EMU for two crewmen out simultaneously (refer to Item 16). Based on existing hardware constraints, the Flight Operations Division requires continuous telemetry from one of two EVA astronauts, duplex voice communications between the two EVA crewmen, and duplex voice communicating between one crewman and the MSFN at all times. The Directorate of Medical Operations (MSC) has specified

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*MSC Master End Item Specification CSD-A-096, dated January 1, 1966, Performance Design and Product Configuration Requirements, Extravehicular Mobility Unit for Apollo Block II Missions.

minimum biomedical monitoring requirements as full time telemetry of one lead of electrocardiogram (EKG) data and two-way voice communication with earth from both EVA astronauts simultaneously.

T. A. Bottomley

2031-TAB-sk

Attachment A
List of Attendees

Copy to
Messrs. L. E. Day - NASA/MAT
C. C. Gay, Jr. - NASA/MAT
J. K. Holcomb - NASA/MAO
T. A. Keegan - NASA/MA-2
T. U. McElmurry - NASA/MOC
F. A. Phillips - NASA/MAT
M. L. Seccomb - NASA/MAP
J. H. Turnock - NASA/MA-4
G. C. White, Jr. - NASA/MAR

G. M. Anderson
C. Bidgood
D. R. Hagner
W. C. Hittinger
B. T. Howard
B. Kaskey
J. Z. Menard
I. D. Nehama
T. L. Powers
I. M. Ross
T. H. Thompson
G. B. Troussoff
R. L. Wagner
Department 2031
Department 1023
Central Files
Library

ATTENDEES

NAME	REPRESENTING	ORGANIZATION	CODE
J. Chamberlin	NASA	Engineering & Development Division	EA2
J. Young	"	Astronaut Office	CB
A. F. Smith	"	Flight Crew Support Division	CF22
W. R. Carpentier	"	Program Support Branch	DD3
A. D. Aldrich	"	Flight Control Division	FC
J. P. Loftus	"	Apollo Spacecraft Program Office	PM
C. C. Gay	"	NASA Headquarters	MAT
L. E. Day	"	NASA Headquarters	MAT
A. F. Phillips	"	NASA Headquarters	MAT
J. P. Kerwin	"	Astronaut Office	CB
E. G. Gibens, Jr.	"	Astronaut Office	CB
J. Goodman	"	Apollo Spacecraft Program Office	PM5
J. C. Marshall	"	" " " "	PM5
L. D. McBride	"	Flight Crew Support Division	CF25
M. W. Hix	"	" " " "	CF23
J. L. Lewis	"	" " " "	CF23
D. R. Puddy	"	Flight Control Division	FC451
J. A. Joki	"	" " "	FC451
F. A. Frere	Grumman	" " "	FC451
C. C. Watros	NASA	" " "	FC451
L. V. Howard	"	" " "	FC120
M. E. Franklin	"	" " "	FC
R. S. Johnston	"	Crew Systems Division	EC
E. L. Hays	"	" " "	EC
J. V. Correale	"	" " "	EC
W. Draper	"	" " "	EC
W. Gill	"	" " "	EC
P. Kiehl	"	" " "	EC
J. Poradek	"	" " "	EC
C. C. Lutz	"	" " "	EC9
W. C. Kincaide	"	" " "	EC9
J. L. Gibson	"	" " "	EC9
J. W. McBarron	"	" " "	EC9
H. L. Stutesman	"	" " "	EC9
W. J. Van Dyke	"	" " "	EC9
M. Rodriguez	"	" " "	EC9
R. L. Grafe	"	" " "	EC9
D. Boydston	"	" " "	EC9
F. DeVos	"	" " "	EC9
M. Carson	"	" " "	EC9
R. Edmiston	"	IESD	EE2
J. Rayfield	"	Crew Systems Division (CSD)	EC9
J. Fernandez	"	CSD/General Electric	EC9
C. Castle	HSD	CSD	EC9
J. W. Schroder	HSD	CSD	EC9
J. E. Swider	HSD	Windsor Locks, Conn.	

ATTENDEES (CONTINUED)

NAME	REPRESENTING	ORGANIZATION	CODE
R. Lang	HSD	Windsor Locks, Conn.	
C. F. Shine	Lockheed	CSD	EC9
T. A. Bottomley	Bellcomm		MAS
R. K. Johnston	Grumman	Crew Systems	
H. D. Reihm	ILC	Dover, Delaware	
G. P. Durney	ILC	Dover, Delaware	
W. F. Ditolla	ILC	Dover, Delaware	