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# *Memorandum*

**TO** : CB/Astronauts **DATE:** SEP

**FROM** : CB/Jack Schmitt

**SUBJECT:** Critical design review (CDR) for LM-10 and subs

During the week of September 8, Gene Cernan, Joe Engle, Vance Brand and I participated at various times in the Grumman Aerospace Corporation's (GAC) CDR for LM-10 and subsequent vehicles. Dave Ballard, Elmer Taylor, and George Franklin represented FCSD. This memo summarizes the major results and actions of the CDR that affect our operations.

The CDR was conducted under a cloud of uncertainty pending the decisions of the Management Council meeting the same week in Washington. These decisions became available just prior to the CDR Board's meeting on Friday and were presented as follows:

a. LM-10 and subs will be designed to support a lunar surface stay of about 54 hours, that is, the descent stage will be provided with five batteries, two $O_2$ tanks, and two $H_2O$ tanks. Earlier CCB decisions had already called for enlarging the DPS fuel and oxidizer tanks and for qualifying the DPS for the additional 90-second burn time (25% thrust).

b. Development of a LM solar cell array will be discontinued.

c. Development of the capability to stow a roving vehicle on the LM will continue (final ? decision in two weeks).

d. Missions will assume three lunar surface EVA periods using the A7L suit (modified?), a -7 PLSS (higher pressure $O_2$ and more feedwater), and the secondary life support system or SLSS (a presently undeveloped OPS-sized system with low pressure $O_2$ and feedwater sufficient for about two hours life support). These changes in the EMU will add at least 80 pounds ascent stage weight for two crewmen.

e. A new, enlarged MESA will be developed and will include stowage for LM cabin consumables and three sample return containers.

f. Development of the so-called constant volume suit will be continued to at least a prototype stage.

An outline of major design decisions at the CDR is given below. Details are available if you are interested.

## Ascent Stage Crew Provisions

1. Major stowage consoles will be modularized for ease of pre-launch removal and change.

2. Stowage will be provided for a third rock box behind the ascent engine cover.

3. Design will provide for the heavier life support systems.

4. GAC efforts in behalf of vacuum cleaners will cease forthwith! Floor mat and whisk broom may be provided.

## Ascent Stage Shirtsleeve Environment

1. Docking tunnel insulation will be provided to cut heat leak.

2. The sublimator bypass will not be added to the ECS.

3. Suit comm, $H_2O$ and $O_2$ umbilicals will be separated, but a single enclosing zippered jacket will be investigated as a means of containing the resulting spagetti.

## Waste Management Systems

1. There will be an overboard dump system for liquid waste.

2. There will be a portable outhouse for assisting in fecal collection.

## Instrumentation

1. Three subassemblies will be added for temperature monitoring including that of the MESA consumables.

2. No changes to the CWEA are being planned at this time.

## Electrical Power Subsystems

1. Three batteries and their ECA's will be mounted on the -Z bulkhead. Placement of other two batteries and ECA's is still open pending the roving vehicle decision.

2. Instrumentation and wiring will permit flying with four batteries. Fifth battery, if present, will be brought on the line after landing.

## Other Subsystem Changes

1. Crossfeed between $H_2O$ tanks will be investigated as a means of C.G. control.

2. A high pressure (1450 psi) PLSS $O_2$ recharge capability will be provided, but present 900 psi capability will be retained as a backup system.

3. A bleed assembly will be provided on the $SH_E$ tank to extend that systems capability to 190 hours.

4. The new MESA centralizes all descent stage stowage including the S-band antenna, hand tools and carrier, most cameras and film, food, ECS LiOH, and PLSS LiOH and batteries. Additional stowage volume is available for growth. Modularized stowage simplifies the packing and transfer of consumables to the cabin.

Modifications to Increase Landed Payload and/or Delta V

1. RCS isolation valves will be deleted; electrical isolation of thrusters will still be possible (worth 25 pounds ascent stage weight). Mechanical isolation of a leaking thruster can be obtained only by isolating one entire RCS system and its fuel. GAC is to look into ways of crossfeeding RCS fuel. Note, however, that in most cases the isolated system could still be used for critical maneuvers.

2. Propellant balance lines will be removed from the DPS (worth 45 pounds descent stage weight plus 41 pounds more usable propellant).

3. Ascent engine nozzle will be recontoured (worth 41 pounds ascent stage weight plus greater certainty in oxidizer/fuel ratios and ISP).

4. The nozzle of the DPS will be lengthened by 10 inches (worth two seconds of DPS ISP and 156 pounds of payload or fuel with no clear-cut degradation in landing stability).

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