Bendix

Aerospace Systems Division

Crew Engineering Design
Effort for LRRR

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The following compilation of Crew Systems and Operations human factors engineering design inputs to the LRRR Design Group constitutes the changes required to modify the Apollo 11 LRRR design to the Apollo 14 configuration.

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The following Crew Engineering Design inputs were provided to the LRRR design group during the course of the LRRR program:

1. Remove UHT socket from leveling leg and relocate to front of pallet structure below the carry handle and in line with the LRRR center of gravity.

2. Place a light reflector behind the bubble level (with respect to the astronaut deployment station) to ensure adequate illumination of the bubble level at low sun angles.

3. If a foldable back support structure is utilized, it should be released by the same pull ring actuation that releases the leveling leg.

4. An LRRR back support structure that provides package stability on a lunar surface slope of up to 11^{o} is satisfactory for the following reasons:

   a. A taller back support structure would provide undesirable thermal inputs to the LRRR array.

   b. A removable or rotatable back support structure which would provide greater stability could fail and compromise LRRR performance.

   c. Eleven degree stability should be adequate in most instances (nominal lunar surface slope is $\pm 5^{o}$ maximum).

   d. Astronaut can partially embed (scrunch) LRRR back support structure into lunar surface to increase stability.

   e. Dust cover would protect LRRR if experiment toppled on array face.

   f. Astronaut could engage handle of UHT in LRRR carry handle to lift toppled LRRR from lunar surface if it falls.

5. Provide two UHT sockets to permit backup capability.

6. Minimize size of leveling leg foot pad (consistent with requirement of supporting lunar weight of LRRR) to facilitate leveling operations.

7. UHT sockets should be angled so that the UHT shaft will be 55^{o}-60^{o} from the horizontal during the leveling and alignment tasks.

8. Based on a 20 pound force emission capability (multidirectional) for the space-suited astronaut operating at 1/6 G, recommend 30 pound force be used for possible astronaut input in stress analysis of LRRR design. The point of application of the 30 pound force is at the midpoint of the UHT handle or any similar astronaut interface.

9. The UHT socket exterior surfaces should be painted white (improves visual contrast with International Orange, UHT alignment stripes).

10. The dust cover design used on EASEP was satisfactory to the astronaut and should be used on the Apollo 14 LRRR.

11. LRRR carry handle should be similar in design to EASEP and ALSEP package carry handles.

12. LRRR leveling leg and dust cover pull rings should meet specified 2 inch finger ingress requirement.

13. Locate bubble level on sun compass plate rather than on primary structure.