Bendix

Aerospace Systems Division

Results of Solar Cell Power System
Panel Deployment Test
Final Report

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This ATM was prepared and distributed to satisfy the Final Technical Report requirements of the Solar Cell Power System study. It includes the results of the panel deployment test utilizing the updated Crew Engineering mockup.

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A. Introduction

During the course of the Solar Cell Power System study, Crew Engineering fabricated and tested a soft mockup of the solar cell panels deployment techniques in order to determine if there were problem areas which would preclude the use of a particular design approach. The results of that test, which proved the feasibility of a "tent" configuration, were published and reported in ATM-690 dated 14 September 1967. As a follow-up to the design approach, a somewhat more sophisticated and more complete panel mockup was fabricated to allow more detailed testing of the deployment technique. The following sections of this report will include a description of the hardware used, the proposed or hypothesized technique for deployment testing and the results/recommendations generated as a result of the test.

B. Hardware

The "tent" configuration of the solar cell panels had been selected during the study as the optimum design in terms of power, stability, etc. The configuration, as was mentioned earlier, was tested utilizing a soft mockup wherein only one-half (i.e., one panel set) was fabricated. No deployment problems were discovered during the previous test; however, some questions were raised concerning other aspects of the system. Off-the-shelf hardware, especially at the hinge points, was utilized in the soft mockup, whereas specially machined hardware was necessary for advanced and more readily deployable systems. For the second iteration panel set, 3/16 inch thick aluminum honeycomb panels equivalent to the recommended panels in all dimensions, were purchased and better quality hinges were fabricated and assembled by Bendix technicians. These were inserted into cutouts in the honeycomb at the appropriate points to allow the panels to fold and unfold as required to allow a high fidelity of simulation of the flight hardware.

The panel sets were attached to a Package No. 2 primary structure mockup in order to verify that there was sufficient volume for the panels and that no interferences existed between the panels and other equipment such as the sub-pallet and/or the ALHT carrier. Not all functions could be duplicated in the system because of the complexity of the hardware required, the non-availability of some parts (e.g., fasteners), and the lack of time available for fabrication of some parts. Therefore, the tie-down bracketry will be added at a later date when fasteners become available for use. However, all other aspects of the deployment of the panels was tested.

An old configuration of the battery case was available during the test period so it was decided to have the suited subject perform the panel array to battery interconnection as part of the test.

C. Approach

The test sequence required the subject to carry the battery case and interconnecting cable to the battery deployment site, perform the interconnection and return to Package No. 2 in order to deploy the panels.

The subject then approached the Package No. 2 mockup and simulated tie-down release (2 points). Following this, he grasped the lanyard ring in order to perform the first rotation task. This operation rotates and locks the support panel into position. From that point on, the subject merely unfolded the panels into the deployed configuration through the performance of rotation tasks. The sequence of panel set deployment was varied (inboard set first, outboard set followed by reverse order) in order to test the stability of Package No. 2. Some concern had been expressed by NASA/MSC personnel in the past about stability of the package during deployment of the second panel set; therefore, it was decided to thoroughly test this aspect.

As can be seen in the accompanying photographs, the subject performed the deployment tasks in the pressure suit.

D. Results

The first item test was the battery to solar cell array interconnection (see Figure #1). No problem areas were discovered during performance of this task. The subject then proceeded to perform his tasks on the solar cell mockup.

The mockup was deployed under earth G conditions and simulated the earth weight and CG fairly well. As can be seen in Figure #2, the subject deployed first the outboard panel set. It is the deployment of this set first which created the concern by some personnel as is mentioned earlier in this report. The general feeling was that deployment of that panel set first would provide a long, heavy moment arm outside the CG of Package No. 2 and that this moment arm would cause the package to rotate as the inboard panel set was deployed. This was not found to be the case. The Package No. 2 structure did not tip during this test, possibly because of the large footprint over which the weight is exhibited.

After retrieving the lanyard, the subject pulled upwards until the support panel locked in place (see Figure #3). He then rotated the upper panel set about the hinge point until the panel sets were ready for final deployment (see Figures #4, 5, 6). The subject then grasped the upper of the two panels and rotated about the hinge point the two left-hand panels (upper and lower) simultaneously. This is accomplished by tying the two panels together with a lanyard (thread or cord) which allows them to be folded for in-flight stowage. In Figure #7, the subject has walked to the front of the mockup and is ready to begin deployment. After he rotates or unfolds the left-hand panel set, he unfolds the right-hand panel set (see Figure #8) to complete deployment of one-half the solar panel system. He then walks to the other side of Package No. 2 and repeats the procedure for deploying the second set of panels (see Figure #9). Figures #10 and #11 illustrate two views of the deployed panel sets while Figure #12 shows the solar cell/battery arrangement.

No particular or significant problems were discovered or reported during this deployment test. Stability of Package No. 2 seemed to be no problem. In general, the solar panel design appears very practical and provides a significant time saving in operation over and above the operations required of the SNAP-27 system.

E. Recommendations

Based on the results of these tests, the following recommendations are made:

1. Although no problems were encountered, the deployment sequence of the panels specify that the inboard panel set be deployed first and the outboard set last. This would preclude any problems attributable to slope or other terrain variance.

2. All the items recommended during feasibility tests (see ATM-690) be incorporated as aids in deployment.

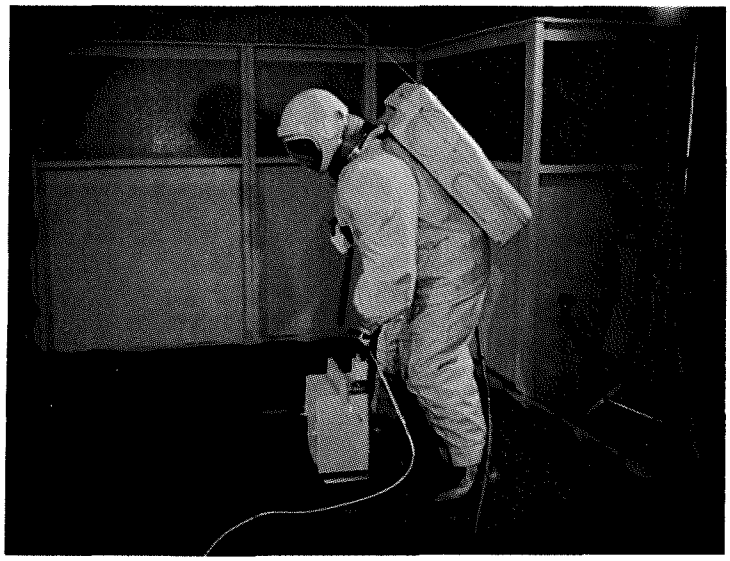

Figure #1 - Solar Cell Battery Interconnection.

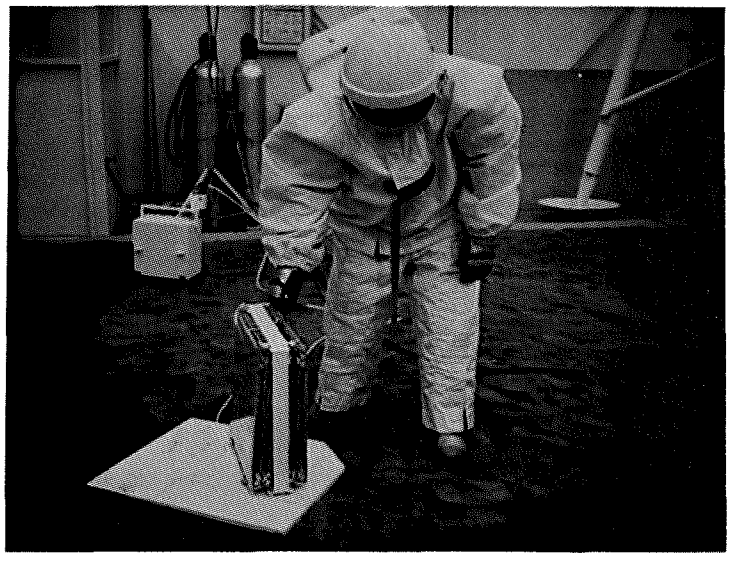

Figure #2 - Subject grasps ring on lanyard to initiate first operation.

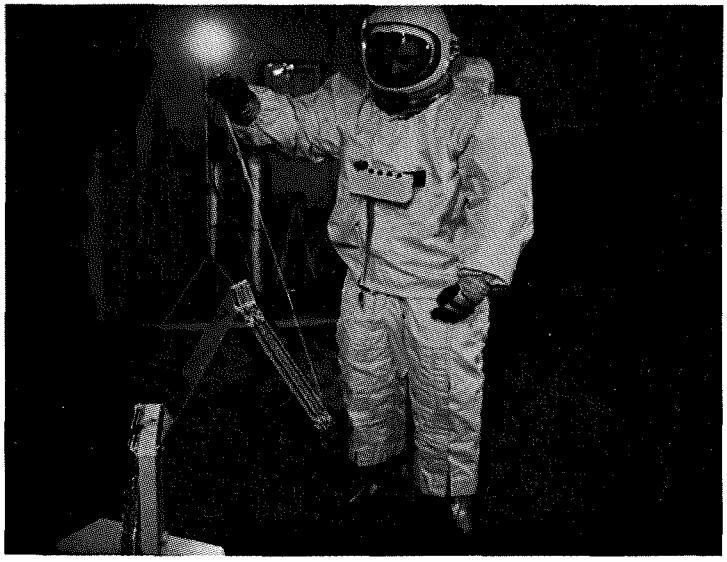

Figure #3 - Support panel locked in place by lanyard pull.

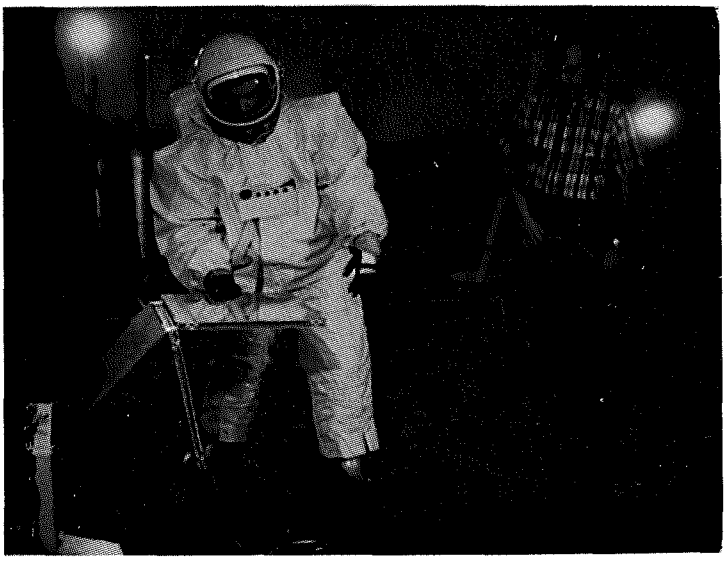

Figure #4 - Rotation of upper panel set into position.

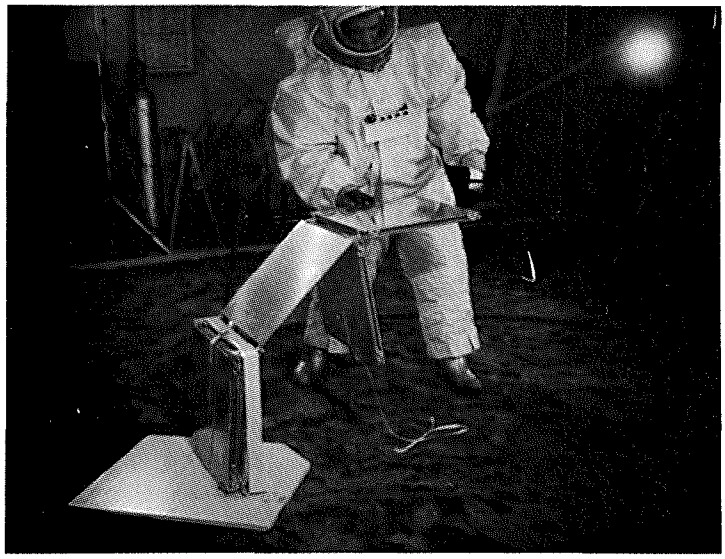

Figure #5 - Alternate view of upper panel set into position.

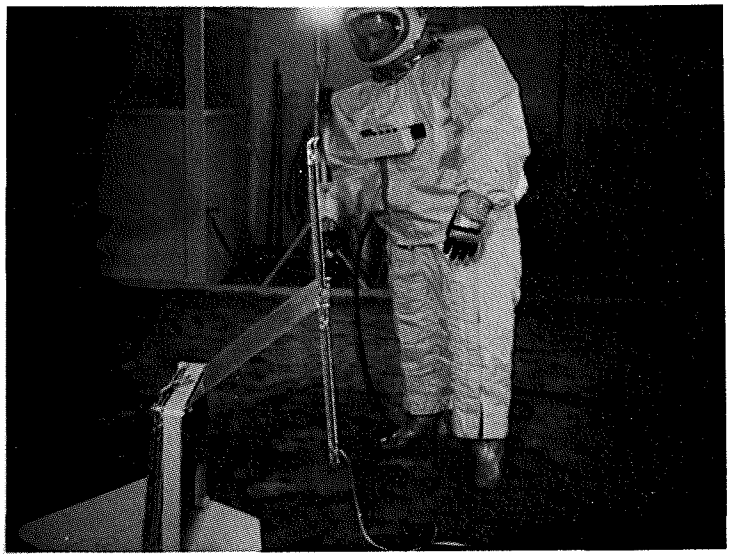

Figure #6 - Panel set rotation almost complete.

Figure #7 - Subject prepares to unfold panel set to deployed configuration.

Figure #8 - Subject near completion of deployment of one-half of the solar cell array.

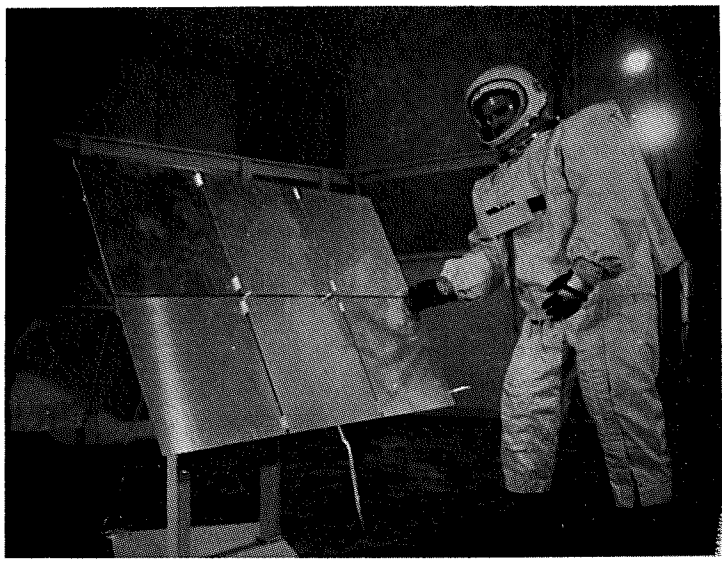

Figure #9 - Subject nears completion of deployment of the solar cell array.

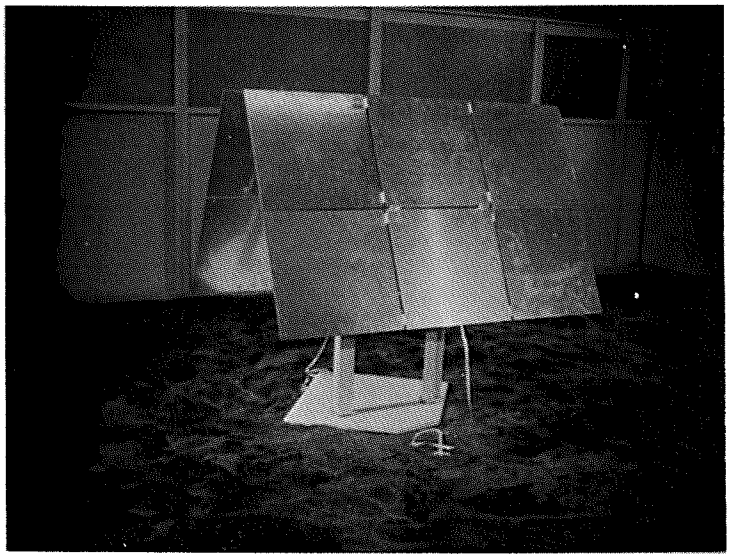

Figure #10 - Deployed Solar Cell array.

Figure #11 - Alternate view of deployed solar cell array.

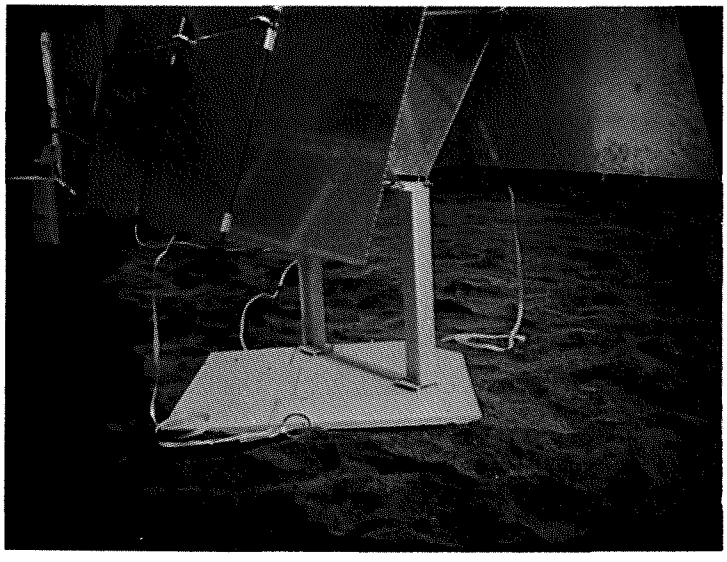

Figure #12 - View illustrating the relationship of solar cell panels to battery case.