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This is an unscheduled ATM dealing with the test and evaluation of the Solar Wind Spectrometer Experiment, at the BxA Mission and Crew Engineering test facility. The M & C Engineering mockup was used to test the alignment characteristics of the SWSE and the prototype model was used to evaluate the astronaut's capability of successfully removing the SWSE from Pallet I and extending the leveling legs.

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I. Alignment of the Solar Wind Spectrometer Experiment

A. Test Description

1. Hardware - Mission and Crew Engineering mockups of the Solar Wind Spectrometer Experiment and Experiment Handling Tool, 1000 watt Collimated Light Source and Sun Compass.
2. Facilities - Shirt sleeve manipulation conducted in the Mission and Crew Engineering test facility.
3. Procedures - The Solar Wind Experiment was rotated through various degrees of alignment with respect to the plane of illumination, and photographs were taken. Figures #1 through #3 depict the SWE, as seen by the astronaut, with a superimposed arrow to indicate the orange vertical surface to be used in the SWE alignment procedure. Figures #4 through #6 depict the SWE, as seen by the astronaut, with a Sun Compass placed on top of the sensor assembly for reference purposes.

The International Orange vertical surface employed in the M & C Engineering tests was Federal Standard 595 color #12246 ("gloss"); the color that has been recommended for use throughout ALSEP is #22246 ("semi-gloss"); and the color that has been proposed by Electro-Optical Systems, Inc. for use on the SWE is #32246 ("lusterless").

M & C Engineering's Lunar Illumination Design Test and Evaluation Report #27, dated 14 December 1967, evaluated various colors in the 20,000 series ("semi-gloss") and selected International Orange, color #x2246, as the color that provided the best subjective visual perception characteristics. The choice of the optimum level of reflectivity (10,000, 20,000 or 30,000 Series) will be based on a series



of tests proposed to NASA/MSC which are to include the following contributory parameters: suited subject with Apollo EV visor, vacuum, simulated lunar surface, and simulated solar source providing various sun angles.

## B. Results and Recommendations

As the black and white photographs (Figures #1 through #6) indicate, there is a definite change in the reflectivity of the two orange vertical surfaces as the SWE is rotated from the unaligned to the aligned position in which the orange vertical surfaces are oriented perpendicular to the north/south axis and within  $\pm 5$  degrees of being parallel to the plane of solar illumination. On the lunar surface, when the SWE is properly aligned with the plane of solar illumination, the orange vertical surfaces will ~~be~~ both be shadowed.

Unfortunately, the tests that have been performed to date do not provide the highest level of confidence when one considers that all the affects of solar illumination in a vacuum, lunar albedo, and the filtering of light through the EV visor have not been completely evaluated. If the technique of employing the shadowing of a vertical surface should prove unsatisfactory when the critical testing has been completed, there are two other features of the present design that could be employed for alignment purposes. Firstly, the shadow cast by the shank of the Experiment Handling Tool may be seen to be similar to that cast by the gnomon on the sun compass (in Figures #4 through #6). The lines on the sensor assembly, along with the fixed position of the Dust Cover assembly (which may be seen in Figures #7 through #9), provide good reference points for the alignment of the shadow cast by the EHT. Secondly, the shadow cast by the Sensor assembly on the Sensor Mounting plate might be used as an indication of the alignment condition. The acceptance of the technique of using a vertical surface for alignment and the selection of the best level of reflectivity for this surface should be based on the critical testing mentioned above.



II. Removal from Pallet I and Leg Extension of the Solar Wind Spectrometer Experiment

A. Test Description

1. Hardware - Prototype models of the Solar Wind Spectrometer Experiment and Pallet I; Mission and Crew Engineering mockups of the Experiment Handling Tool and the Tie-Down Release Tool.
2. Facilities - Shirt sleeve manipulation conducted at BxA.
3. Procedures - Using the Tie-Down Release Tool the four Calfax fasteners that attach the SWE to Pallet I were released. This permitted the preloaded Sun Shade to deploy. The Experiment Handling Tool was then inserted in the carrying socket, the SWE was lifted from the pallet, and the four leveling legs were pulled out to their extended position. (See Figures #7 through #9).

B. Results and Recommendations

In a series of tests, a number of problems were uncovered. Firstly, there was a tendency of the Calfax fasteners to catch in the sockets on the pallet preventing removal of the SWE from Pallet I. Secondly, too many turns were required to release the Calfax fasteners. Thirdly, the Calfax fasteners and the inner leg extensions binded and prevented extension of the leveling legs. Fourthly, the cables in the area of the Sun Shade were misplaced so that they prevented complete self-deployment of the Sun Shade.

The Calfax fasteners that have been specified for use with the SWE are 18007-21. They have an overall length of 0.937 inch and a grip range of 0.720 to 0.750 inch. The foot pads on the SWE leveling legs are specified as  $0.645 \pm 0.005$  inch and the mounting brackets on Pallet I are specified as  $0.090 \pm 0.005$  inch, providing a range of 0.725 to 0.745 inch.

When the actual measurements of the foot pads and the mounting brackets were tested they were found to be 0.623, 0.629, 0.624 and 0.627, and 0.089, 0.092, 0.090, 0.090 inch, respectively. The thickness of the foot pads were out of spec; in part, causing binding of the



Calfax fasteners in the sockets, increasing the degrees of turning required to release the Calfax fasteners, and causing the Calfax fasteners to bind against the inner leg extensions. Since the foot pads were not manufactured to the specified thickness, the Calfax fasteners projected further below the foot pads than they should have and this increase in the projection of the Calfax fasteners contributed to the problems cited above.

When the out-of-spec condition was brought to the attention of JPL/EOS, several solutions to the problem were discussed. Since the foot pads and parts setting their thickness had already been made, it was suggested that an 0.018 inch washer be added to the foot pads by JPL/EOS or that BxA change the interface and use a shorter Calfax fastener. It was decided to take the former approach. The 0.018 inch washers were added to the foot pads and they provided the depth required to bring the foot pads up to their specified thickness. This "solution" tended to decrease the tendency of the Calfax fasteners to catch in the Pallet sockets, but did not alleviate the dual problems of the excess number of turns required to release the Calfax fasteners or the tendency of the Calfax fasteners to bind against the inner leg extensions.

Whether this solution alone will sufficiently decrease the tendency of the Calfax fasteners to catch in the mounting bracket sockets is questionable. Incorporated within the SWE A-frame leveling legs are four springs that extend the leg extensions about 0.250 inch when the Calfax fasteners are released. When three of the Calfax fasteners (that hold the SWE leveling legs down on the mounting brackets) have been released, the springs cause the leveling legs to partially extend and cause a moment of force that results in the fourth Calfax fastener catching in its mounting bracket socket. JPL/EOS have proposed that the above-mentioned springs be reduced in strength or eliminated entirely. This should further decrease the tendency of the Calfax fasteners to catch in the Pallet sockets, but this concept must be tested and all ramifications of this change must be evaluated.

The use of star washers (or retaining rings) in conjunction with the Calfax fasteners, to force the Calfax fasteners to clear their sockets without catching, has been discussed. The objections to this approach are two-fold. Firstly, the increased diameter entailed in the addition of star washers to the Calfax fasteners decreases the clearance between the Calfax assembly and the inner leg extensions, and almost guarantees that the two parts will bind and prevent the extension of the leveling legs. Secondly, a lip is provided on the Calfax fasteners to hold the star washers in place and this lip contributes to the problem of the Calfax fasteners catching in their sockets.



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It would seem that maintaining the specified foot pad thickness, decreasing the strength of the springs in the leveling legs, and using Calfax fasteners which have straight sides (versus the present projection), would probably eliminate the Calfax fasteners catching in their sockets and preventing astronaut removal of the SWE from Pallet I.

Although the Calfax fasteners are supposed to release after 3/4 of a turn, our original testing indicated that about 1.5 turns were required to release the fasteners. After the 0.018 inch washers were added to the foot pads, approximately 1.25 turns were required to release the fasteners. Several modifications are possible that will permit a 3/4 turn to release the fasteners. Firstly, the foot pads could be increased in thickness by a factor of about 0.1 inch. Secondly, a shorter Calfax fastener stud, such as 18007-19, might be used. Thirdly, some of threads in the Calfax fastener sockets or studs could be removed. Any of these approaches, by themselves, or a combination of approaches, such as increasing foot pad thickness and removing some of the threads from the sockets or studs could ensure that the astronaut would not have to turn the Calfax fasteners more than 3/4 turn to achieve their release.

The tendency of the Calfax fasteners to bind against the inner leg extensions could be decreased, or eliminated, by any approach that would increase the clearance between the fasteners and the SWE legs. Again, one modification or a combination of approaches could ensure that the astronaut will be able to extend the leveling legs. Some of the possible approaches are as follows: (1) increase foot pad thickness, (2) use a shorter Calfax stud, (3) decrease the angle between the leveling legs to increase the clearance between the studs and the legs, and (4) provide slots in the leg extensions to preclude contact between the studs and the legs, etc.

Finally, the problem of the Sun Shade not extending completely would be solved by ensuring (taking any of a variety of approaches) that the cables do not interfere with the Sun Shade and by providing a stronger spring device to guarantee that the Sun Shade deploys itself fully. The astronaut should not be expected to intercede if a self-deploying device does not function properly.

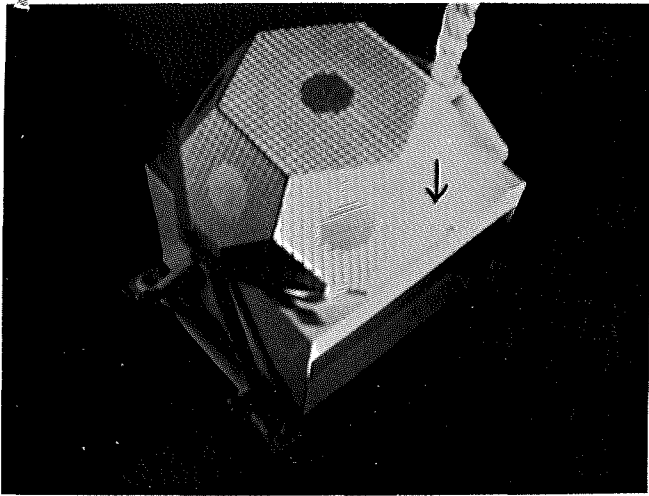


FIGURE #1

Solar Wind Experiment rotated approximately  $45^{\circ}$  with respect to the plane of illumination. (The arrow indicates the orange vertical surface to be used in the SWE alignment procedure.)

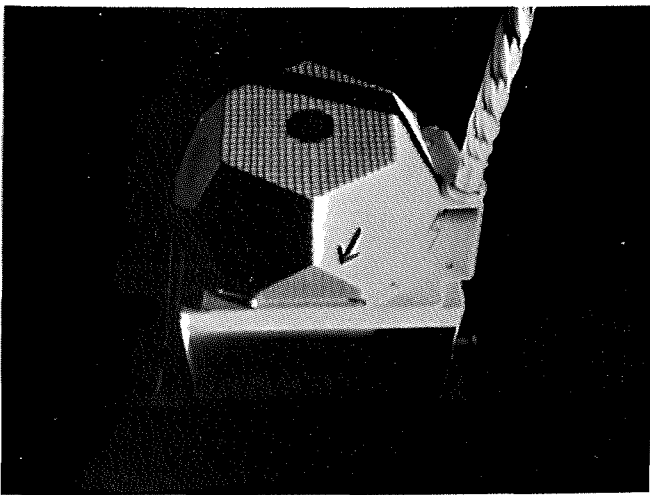


FIGURE #2

Solar Wind Experiment rotated approximately  $20^{\circ}$  with respect to the plane of illumination. (Note the diminished brightness on the orange vertical surface.)

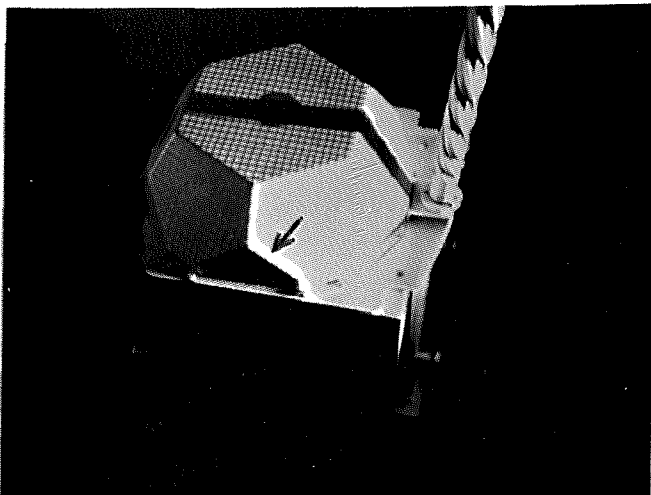


FIGURE #3

Solar Wind Experiment parallel ( $0^{\circ}$  rotation) to the plane of illumination. (Note the decreased brightness on the orange vertical surface, the shadow cast on the Sensor Head by the Experiment Handling Tool, and the shadow cast on the Sensor Mounting Plate by the Sensor Head.)

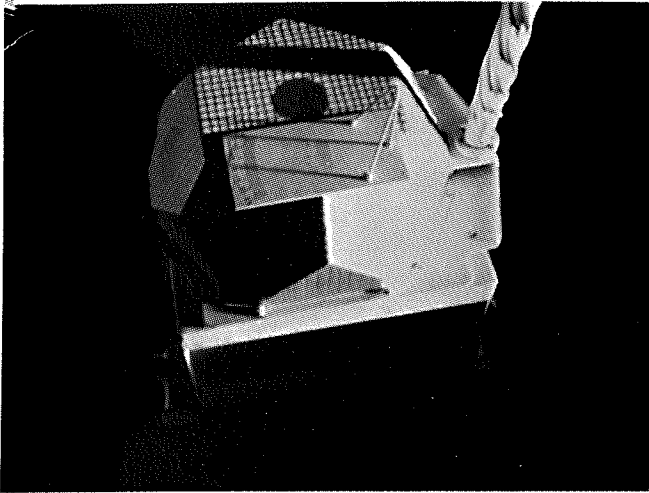


FIGURE #4

Solar Wind Experiment  
rotated  $15^{\circ}$  with respect  
to the plane of illumination.  
(Alignment of the SWE is  
not satisfactory.)

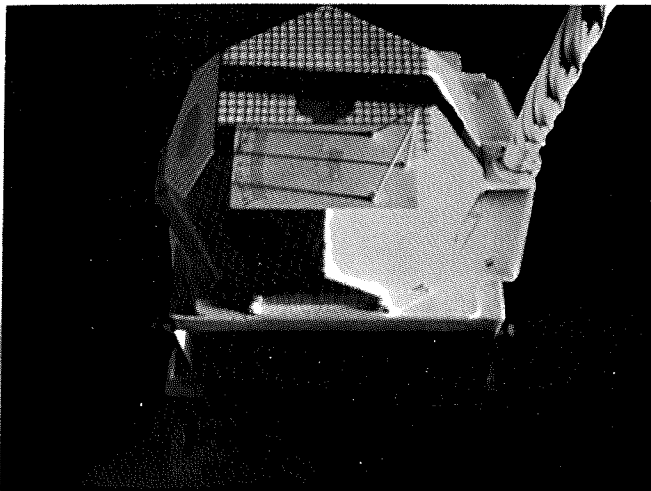


FIGURE #5

Solar Wind Experiment  
rotated  $5^{\circ}$  with respect  
to the plane of illumination.  
(Alignment of the SWE  
is satisfactory.)

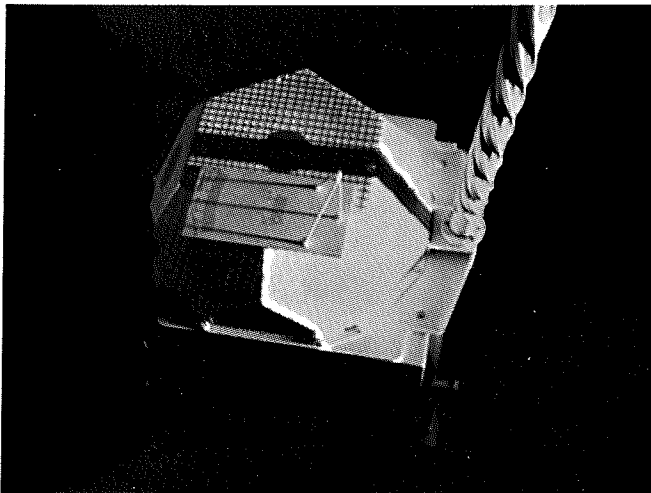
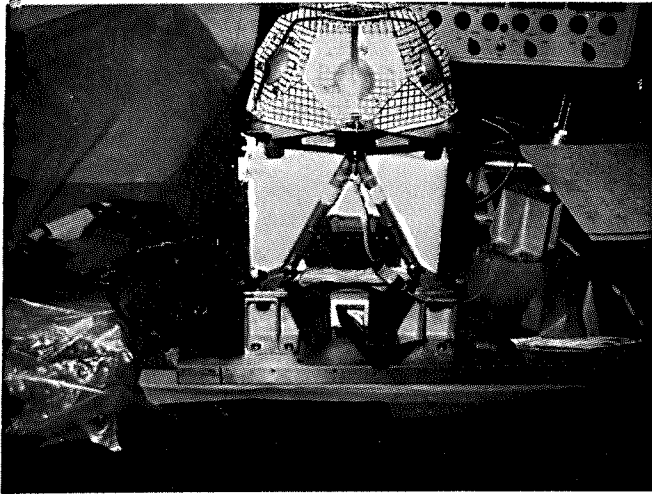


FIGURE #6

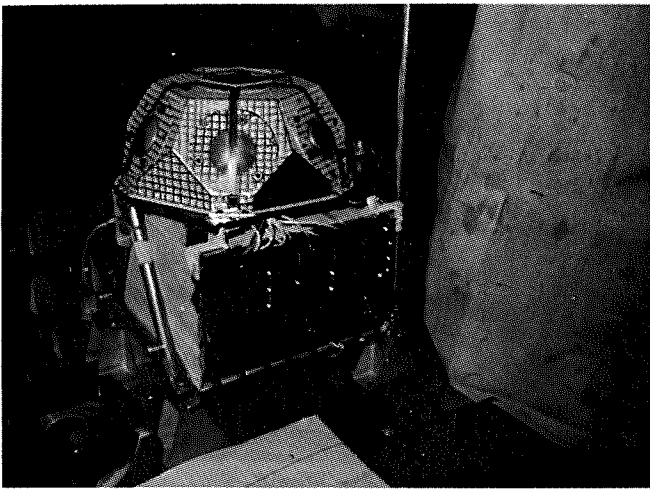
Solar Wind Experiment  
parallel ( $0^{\circ}$  rotation) to  
the plane of illumination.  
(Alignment of the SWE is  
most satisfactory.)





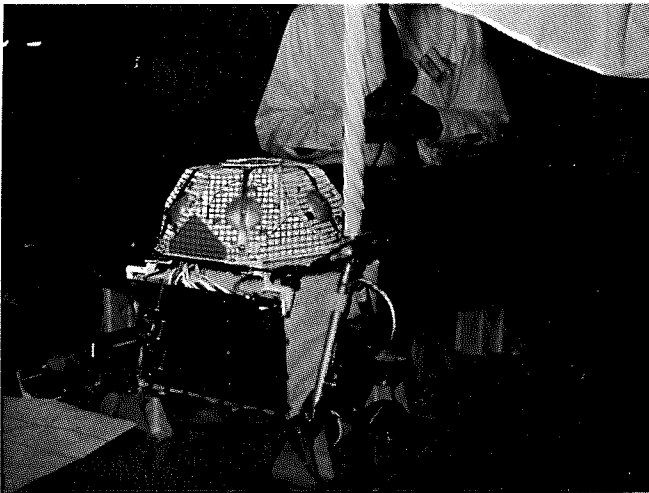
**FIGURE #7**

**Solar Wind Experiment  
mounted on the ALSEP  
Pallet No. 1.**



**FIGURE #8**

**Tie-Down Release Tool  
being used to release  
Calfax fasteners which  
attach the Solar Wind  
Experiment to Pallet  
No. 1.**



**FIGURE #9**

**Experiment Handling Tool  
being used to lift the  
Solar Wind Experiment  
from Pallet No. 1.**