



**Aerospace
Systems Division**

Crew Engineering Evaluation of the
Array E LEAM Experiment Crew
Engineering Model

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ATM-996	
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A. Introduction

In February 1971 the BxA Crew Engineering Group performed a 1G, space-suited deployment test of the Array E LEAM Experiment Crew Engineering Mock-up to evaluate the Astronaut interface in the areas of manipulative characteristics, reach parameters and emplacement including leveling and alignment.

The Crew Engineering model was designed and fabricated from Engineering Model drawings and was equipped with a prototype UHT swivel socket.

The 5° bubble level was simulated by a mock-up.

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B. Hardware

- LEAM Experiment Crew Engineering Model (see Figs. 1 and 2)
- Array E Subpackage #2 Crew Engineering Mockup (see Fig. 3)
- UHT (Crew Engineering Model)

C. Facilities

BxA Crew Engineering Laboratory

D. Procedures

The LEAM experiment can be removed with the HFE/Subpallet in place, however prior to the start of testing the HFE Subpallet was removed from Subpackage #2. Two deployment sequences were evaluated by the space-suited test subject during this test. In one sequence the legs and gnomon were released prior to swivel socket release and experiment rotation. In the second sequence leg and gnomon deployment were accomplished after experiment rotation. The effected steps of the alternate task orders are indicated by two task numbers in the following procedures description.

- 1) Release four (4) fasteners securing the LEAM Experiment to Subpackage #2. (Note: the LEAM was not secured to the subpackage for this test)
- 2) Engage UHT in UHT swivel socket (see Fig. 4) and remove LEAM Experiment from Subpackage #2.
- 3) Transport LEAM Experiment to deployment site using UHT shaft.
- 4/7) Release leveling leg lanyard pull ring from velcro tab (Note: the gnomon was incorporated and tested after the picture series shown in the attachments).
- 5/8) Pull lanyards to release legs and gnomon.



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- 6/9) Verify that legs and gnomon are fully deployed.
- 7/4) Release pull ring for UHT swivel socket pull pin from velcro tab.
- 8/5) Remove UHT swivel socket pull pin. (see Fig. 6).
- 9/6) Rotate LEAM Experiment to swivel socket locked position while supporting Experiment using UHT shaft.
- 10) Verify that UHT swivel socket has locked in the rotated position.
- 11) Emplace LEAM Experiment.
- 12) Level and align LEAM Experiment (see Fig. 7). Note: Since an operational bubble level and gnomon were not available at the time of this test, these operations could not be fully evaluated.

E. Results and Conclusions

- 1) Additional Crew testing is required to evaluate:
 - a) Release of experiment from the subpackage.
 - b) Leveling and alignment.
 - c) Astromate connector removal and engagement.
- 2) The experiment should be rotated (swivel socket released) before the legs and gnomen are deployed to prevent potential mechanical damage to the gnomen
- 3) A direction of pull indication should be provided, on the side of the unit, for the leg release lanyard since the required direction will not be apparent to the astronaut, with the experiment rotated (see Fig 8).
- 4) The lanyards should be routed so that the leg deployment lanyard is not around the leg bracket but over the direction of pull indicator (see Fig 8).
- 5) The leg release pin should be modified, if possible, to preclude bending and possible jamming.



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- 6) The pull force required to remove the swivel socket release pin is excessive. Crew Engineering has found with previous swivel socket designs, that forces of 1 to 3 pounds is acceptable. With this one exception the swivel socket was acceptable in operation and in concept, including the angle formed between the UHT and the experiment in the rotated position.
- 7) It is desirable that the UHT shaft be in a horizontal position during swivel socket release and experiment rotation. This places the experiment C.G. in the most favorable position to prevent the experiment from rotating too rapidly.
- 8) The UHT handle should be oriented towards the experiment (away from the astronaut) when engaged for experiment removal (see Fig. 4). This will provide the proper handle orientation for leveling and alignment after experiment rotation.
- 9) Continued crew tests (KC-135) should be conducted to verify the above recommendations.

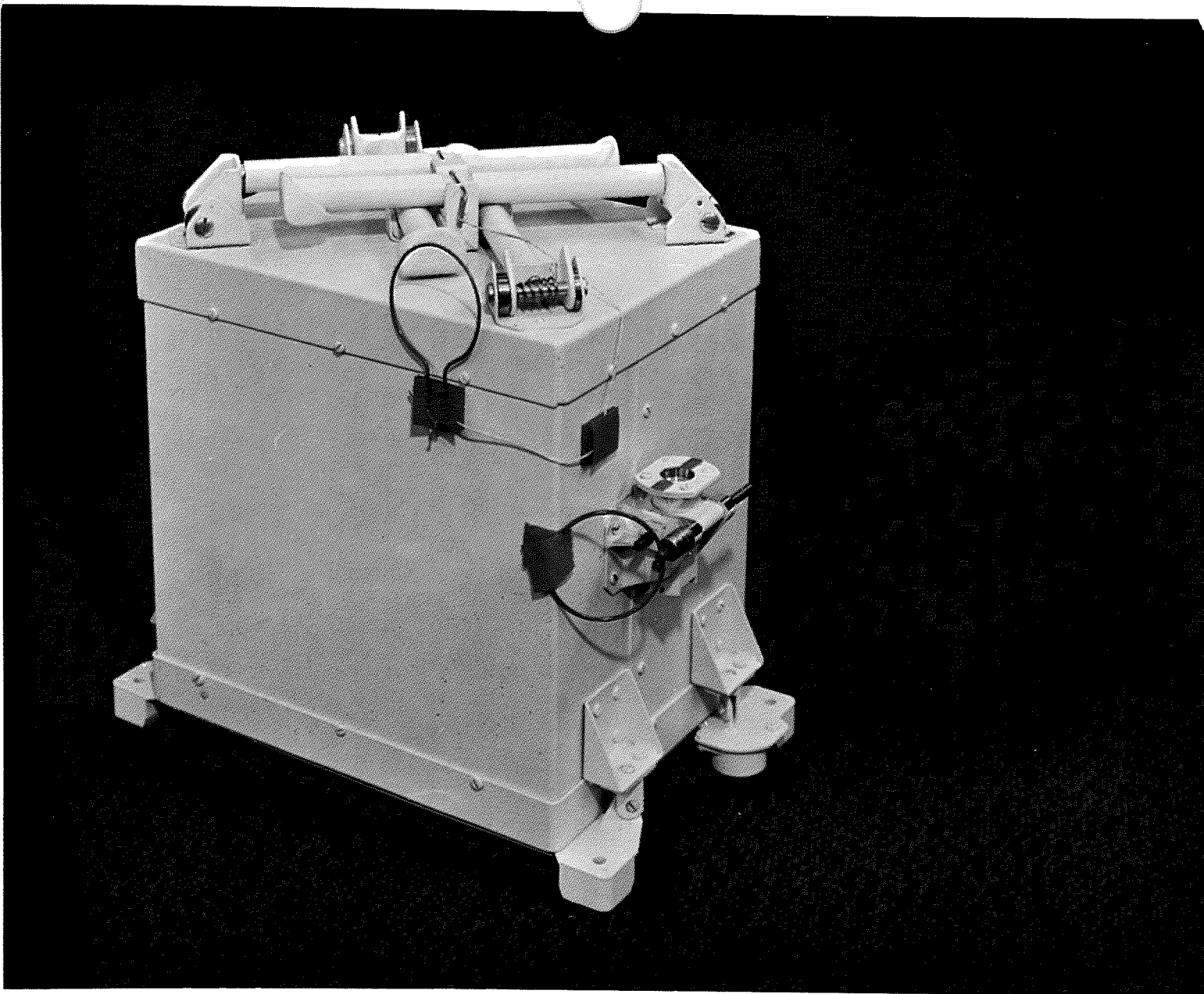


Figure 1. Lunar Ejecta and Meteorite (LEAM) Experiment
Crew Engineering Mockup - Stowed Configuration

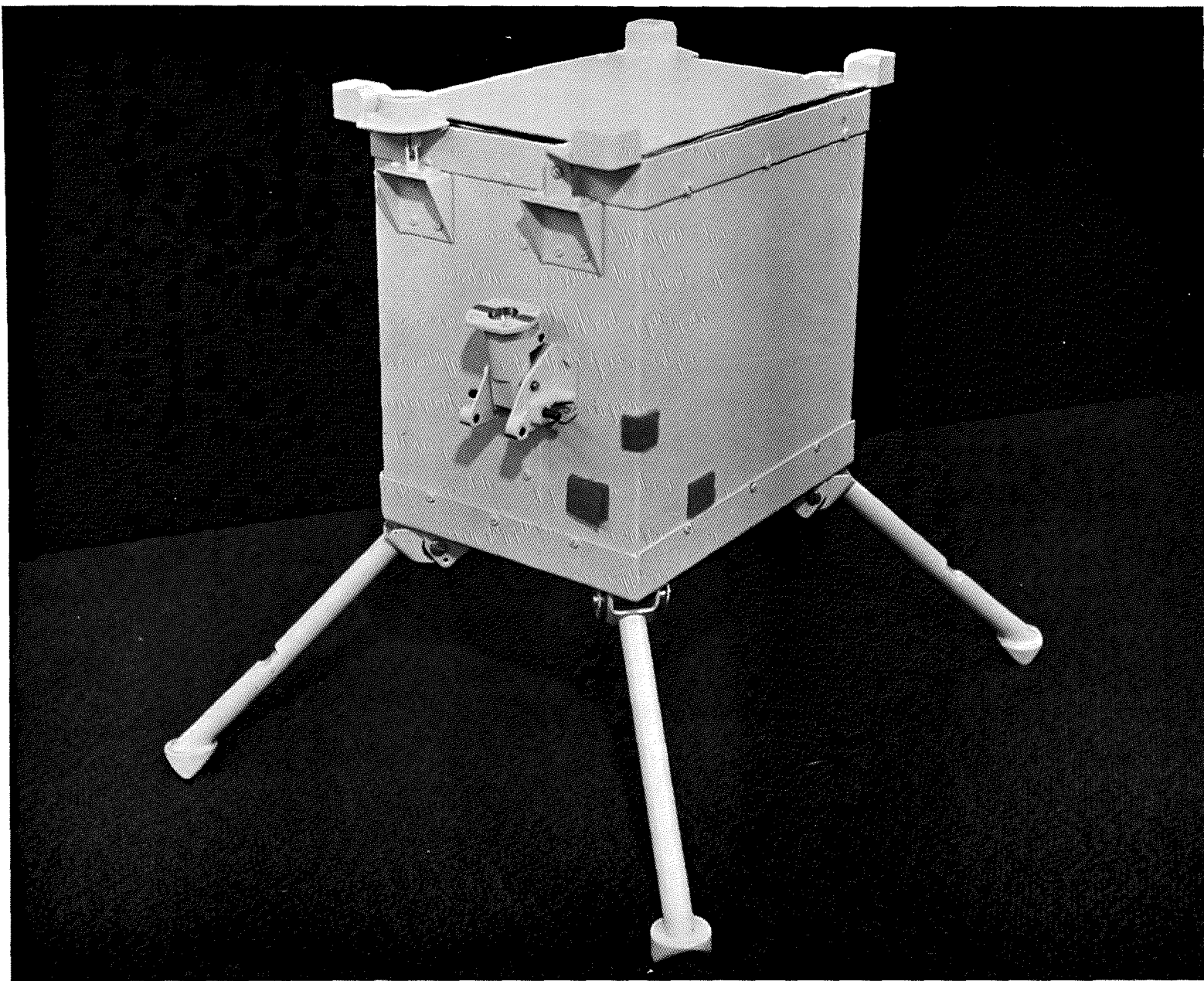


Figure 2. Lunar Ejecta and Meteorite (LEAM) Experiment Crew
Engineering Mockup - Deployed Configuration

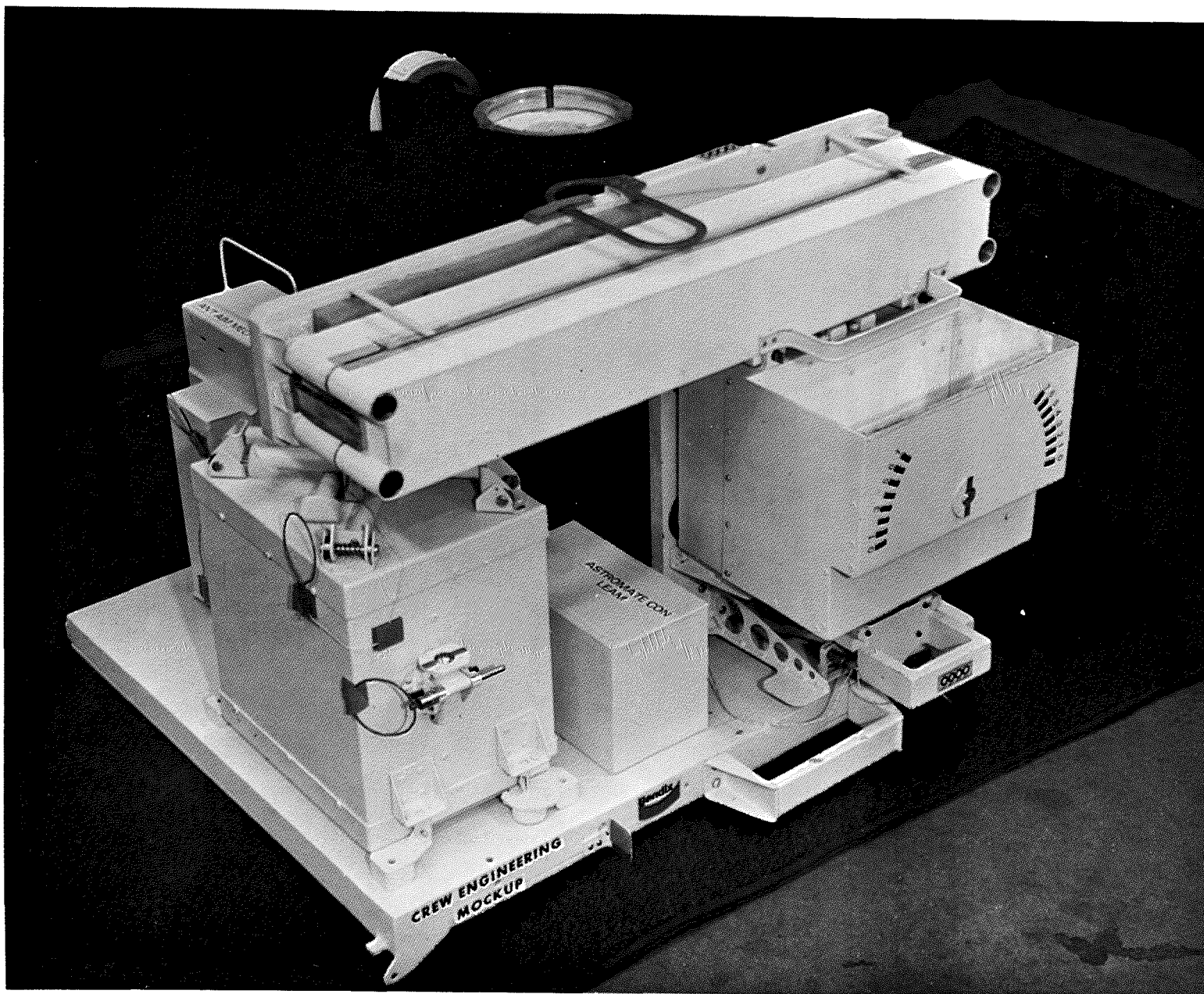


Figure 3. Subpackage #2 Crew Engineering Mockup



Figure 4. UHT Engagement in LEAM Swivel Socket

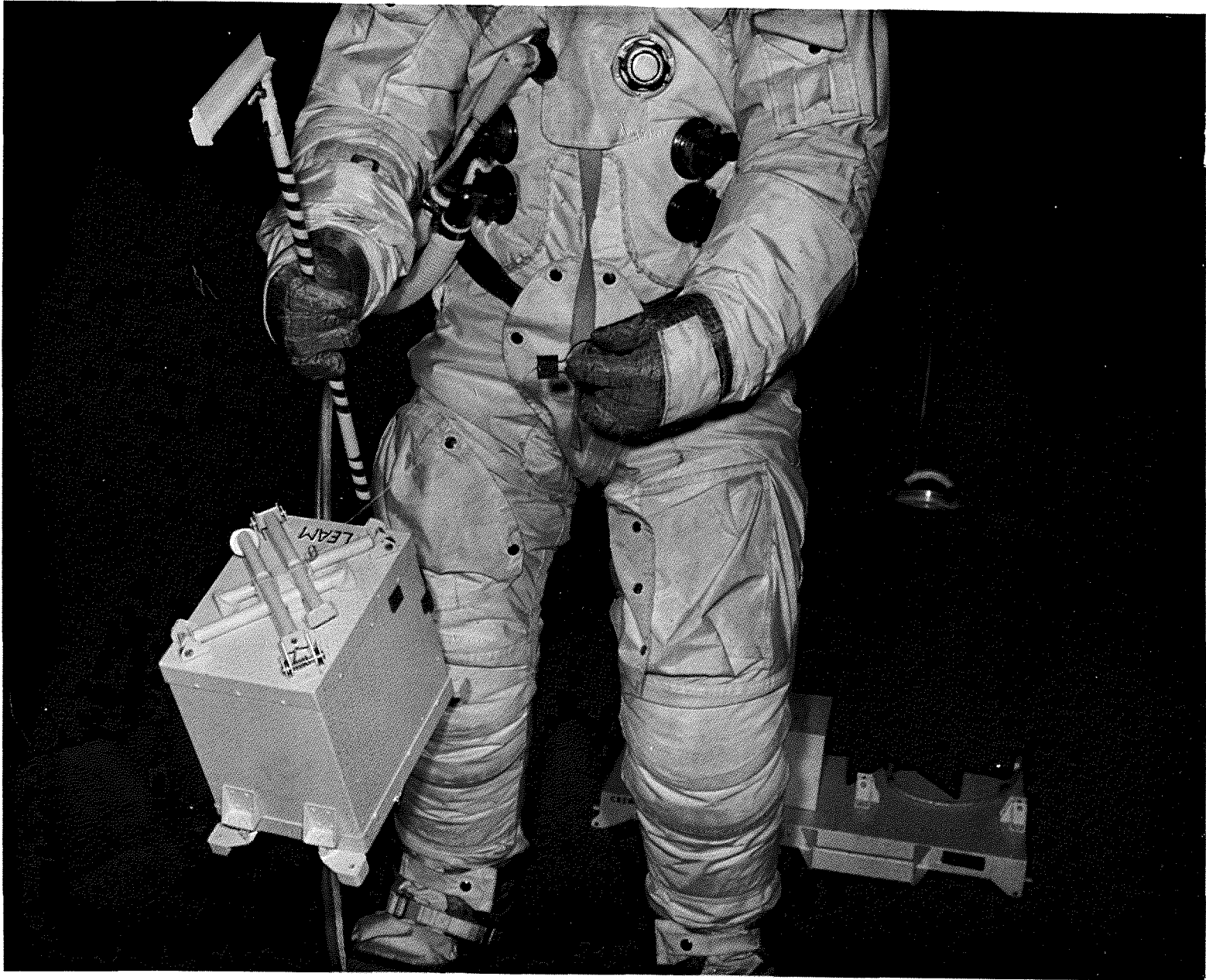


Figure 5. LEAM Leg Release

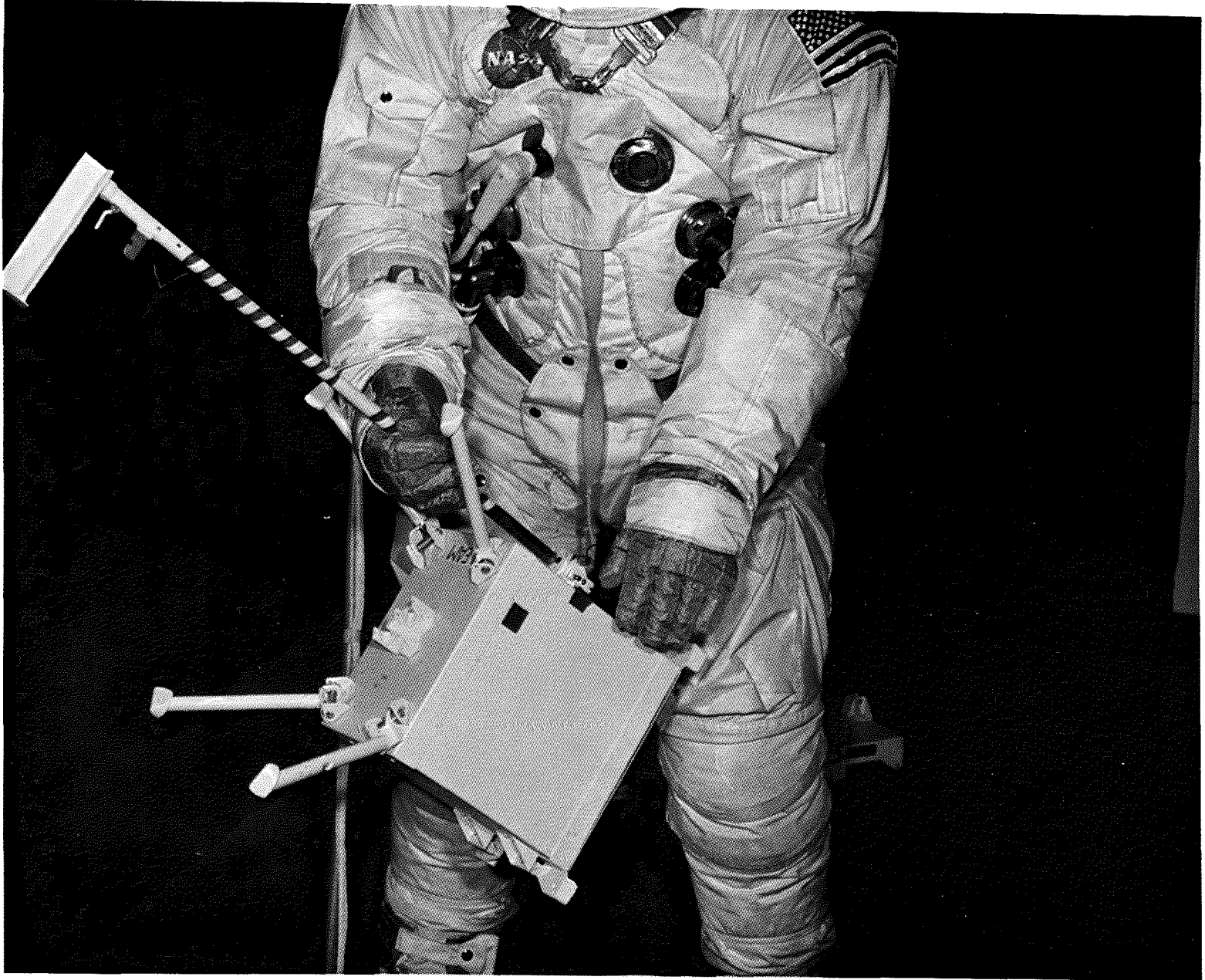


Figure 6. LEAM Swivel Socket Release

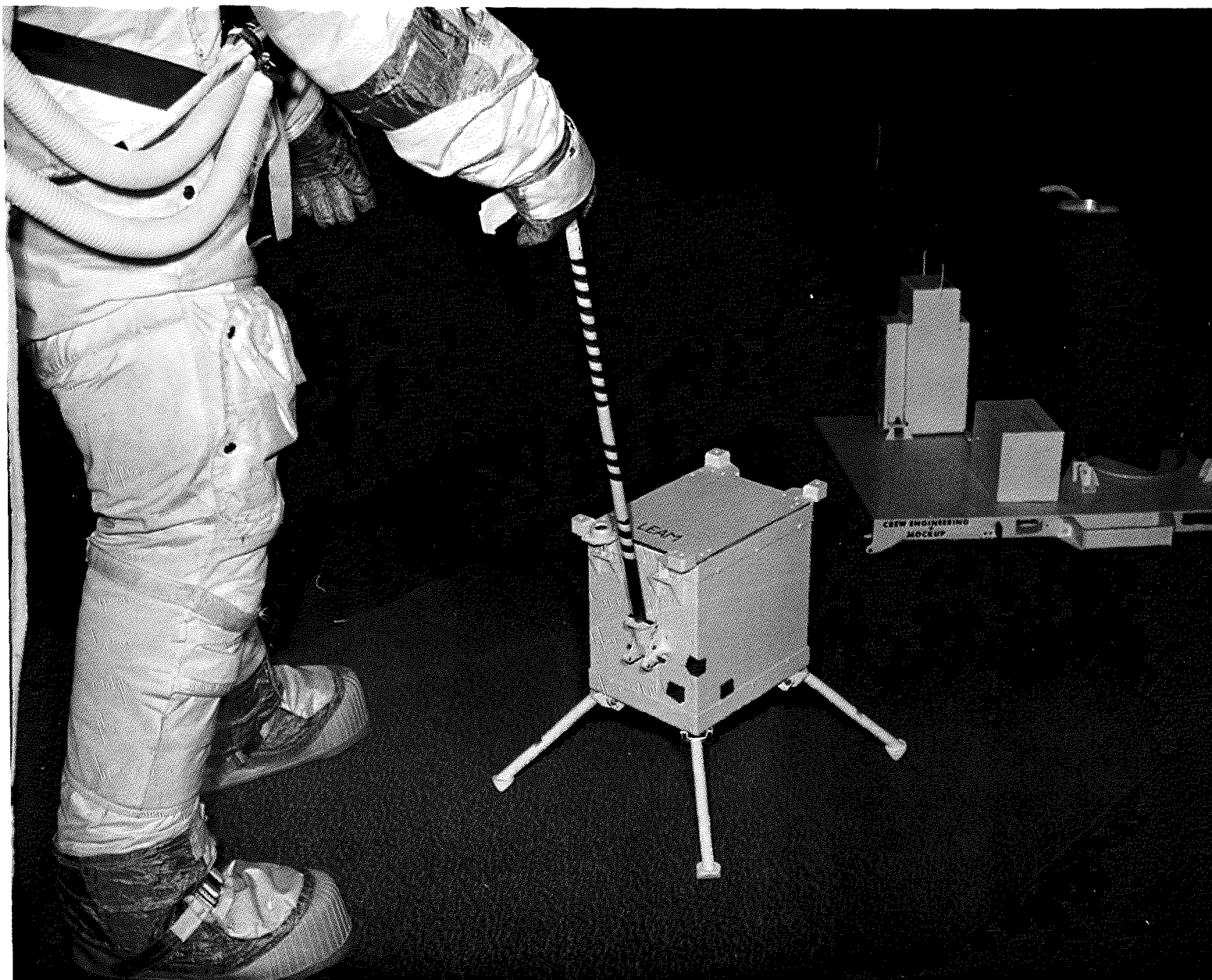


Figure 7. LEAM Leveling and Alignment

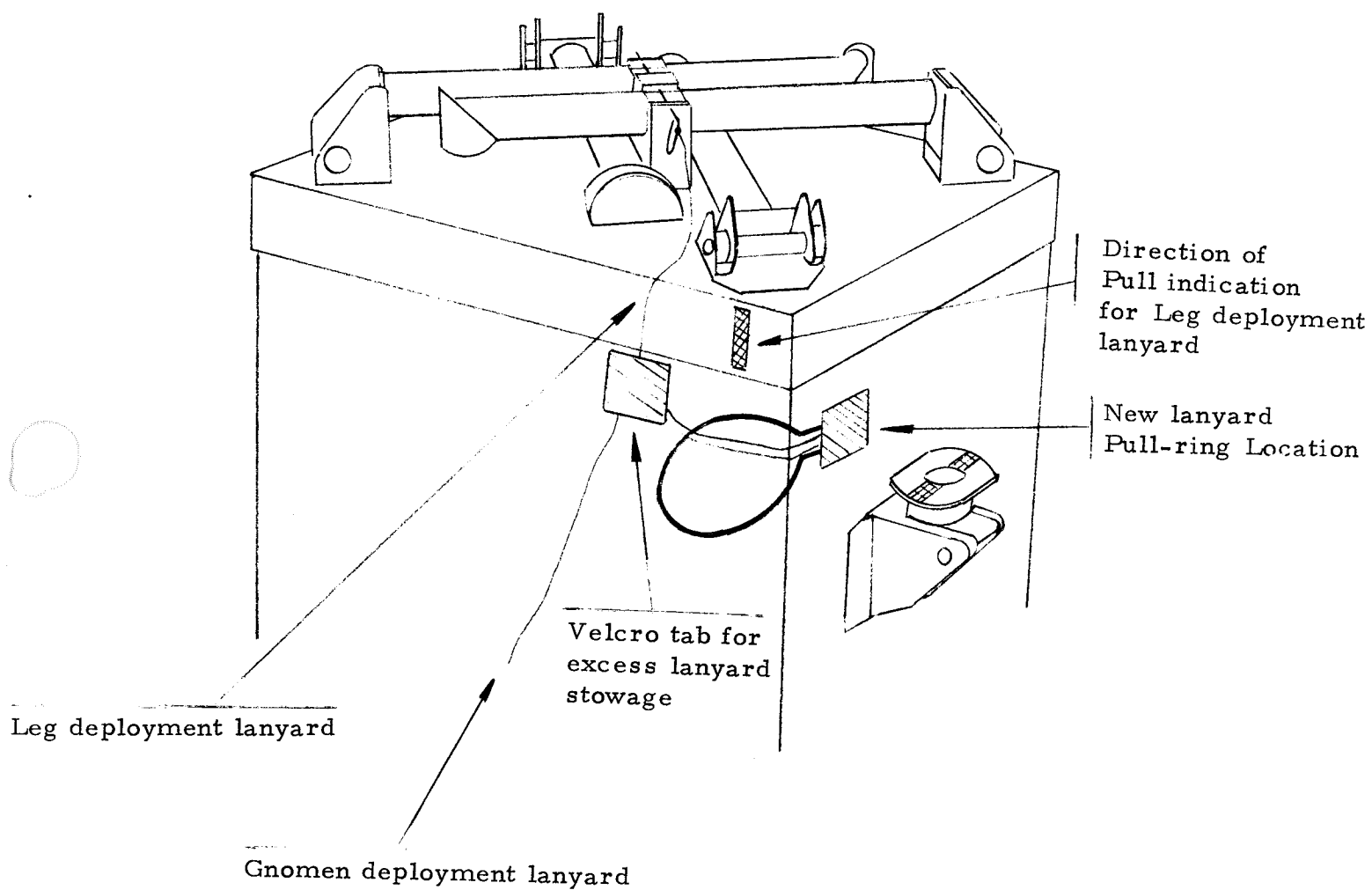


Figure 8. Recommended Lanyard Routing and Leg Deployment Lanyard Direction of Pull Indication.