*PROBE**

A PROPOSED FLIGHT EXPERIMENT TO STUDY EVA ASSEMBLY OF PRECISION SEGMENTED REFLECTORS

Walter (Doug) Heard
NASA Langley Research Center
Hampton, VA

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*Precision Reflector Orbital Build Experiment

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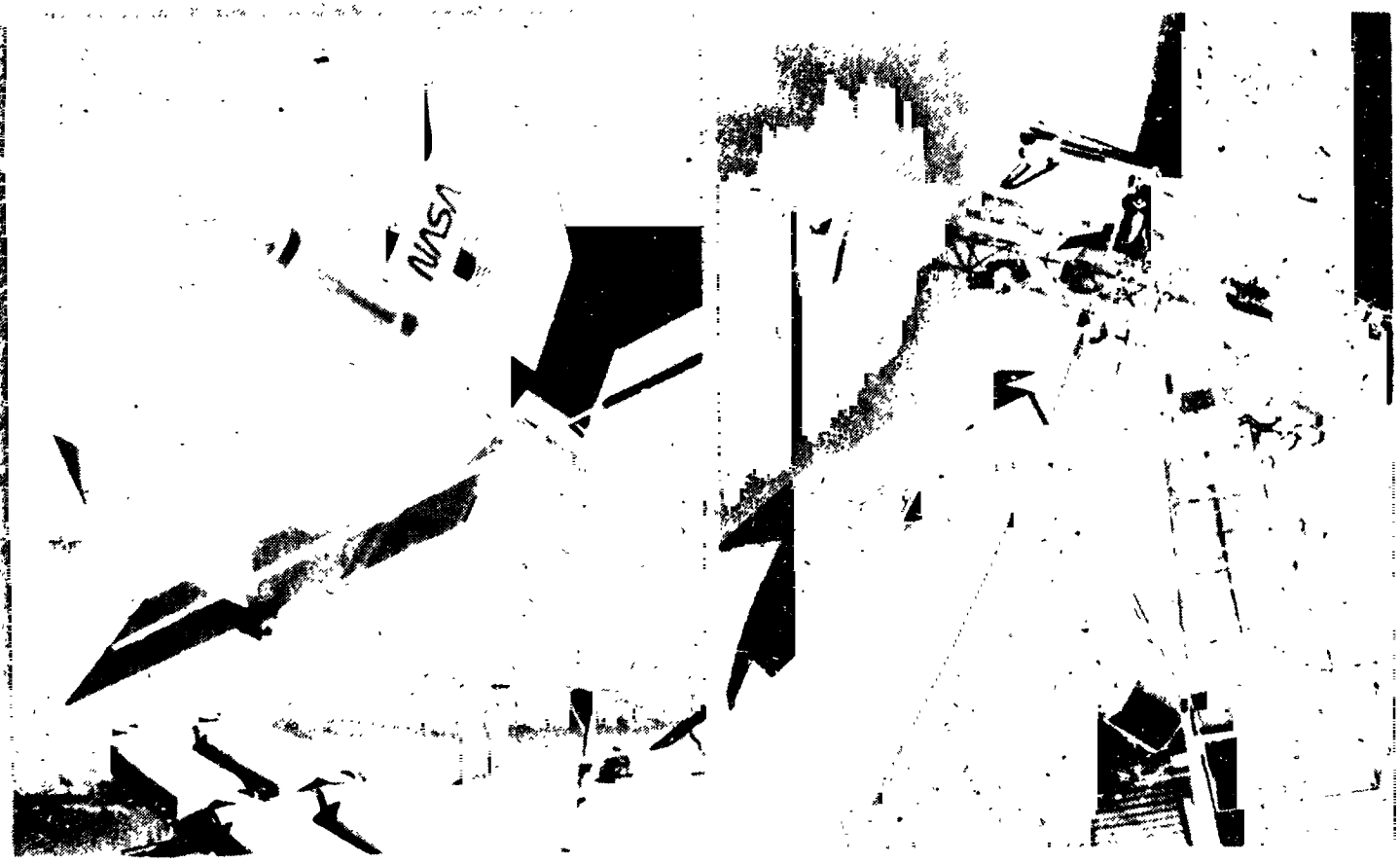
PROBE is a Shuttle flight demonstration experiment designed to study EVA assembly of precision segmented reflectors. The experiment proposal was submitted by the NASA Langley Research Center to the Office of Space Flight in February 1989. Langley was notified on November 3rd that the experiment was recommended by the review board and that funding was being sought for its implementation.

PROBE will support missions being considered for NASA's Global Change Technology Initiative as well as other missions in astrophysics and spacecraft optical communications requiring large precision reflectors. Such reflectors are envisioned to consist of a low-mass backup truss to which the optical surface is attached. Because of their large size, these reflectors will be constructed on-orbit from smaller pieces which can be packaged in the launch vehicle. The technology to be developed with ***PROBE*** also has application for construction of solar dynamic collectors which are planned for the enhanced configuration of Space Station Freedom.

PRECISION SEGMENTED REFLECTORS

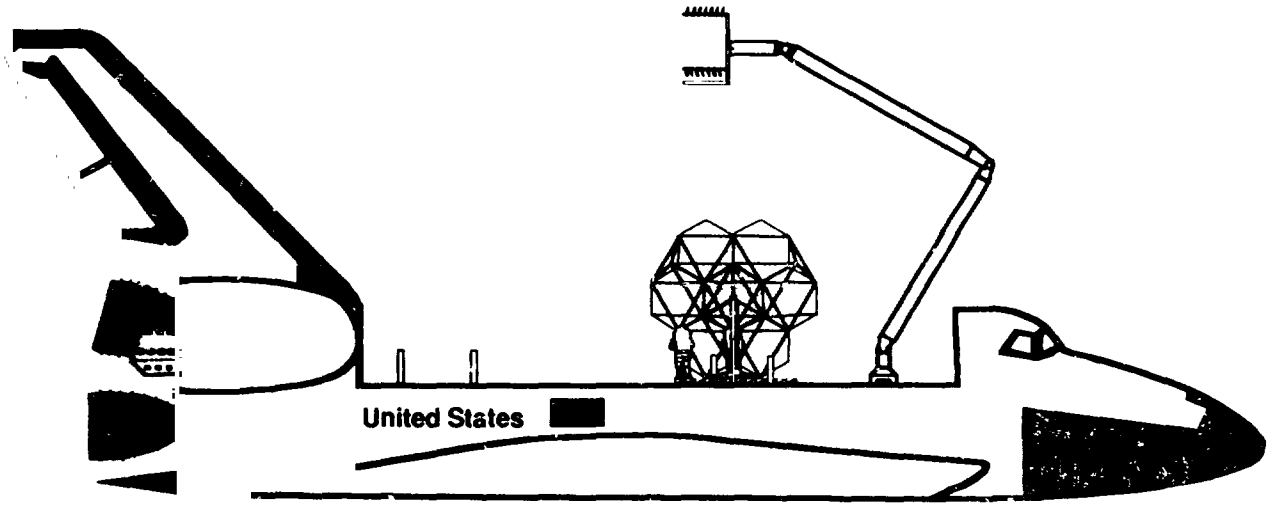


PROBE has two primary objectives: (1) to demonstrat › the in-space construction of a large precision reflector in the Shuttle cargo bay, and (2) to investigate in-space servicing of the reflector following its construction.

PROBE will demonstrate the major assembly tasks associated with on-orbit construction and servicing of a precision segmented reflector by two astronauts in EVA with Remote Manipulator System (RMS) assistance in handling the reflector surface panels. These tasks include construction of the reflector surface support structure (parabolic tetrahedral truss) and attachment of the reflector surface panels including hookup of simulated electrical cables. Although only simulated pa.nels will be used, their external appearance, mass, and overall dimensions will coincide with a baseline configuration.

PROBE OBJECTIVES

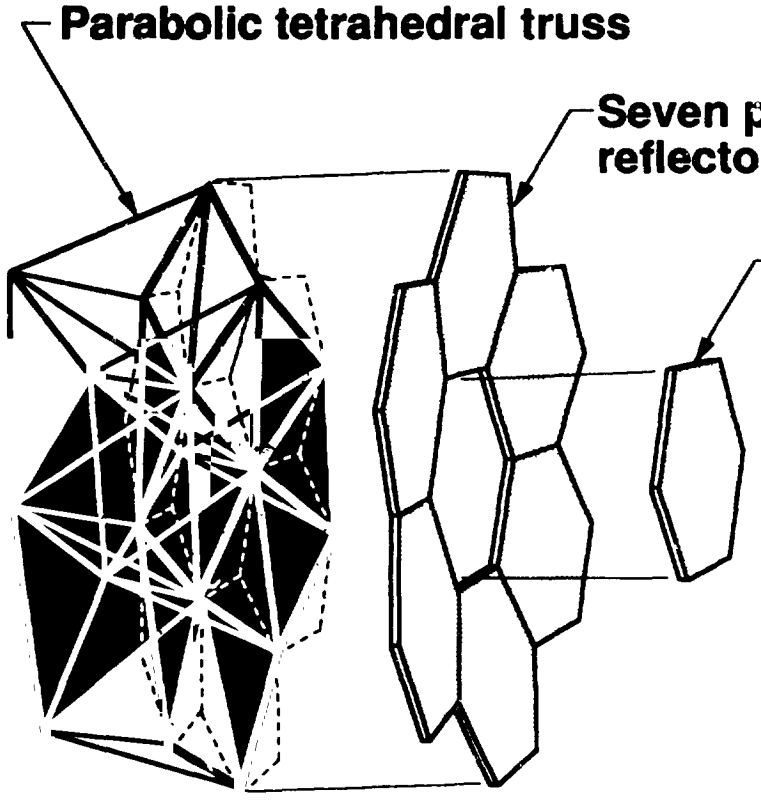
- To demonstrate the in-space construction of a large precision reflector in the Shuttle cargo bay
- To investigate in-space servicing of the reflector



The ***PROBE*** truss consists of 51 graphite-epoxy struts with aluminum end joint fittings for attachment to 18 nodal joints. Since the truss is parabolic, the struts cannot all be the same length, nor are the nodal joints identical. Thus these components will be stowed in canisters in a specified order for astronaut accessibility during on-orbit construction. Seven simulated reflector panels will be attached to the truss. Manual installation of the surface panels and removal of their protective covers will be integrated with the piece-by-piece assembly of the truss rather than accomplished after the truss is fully assembled.

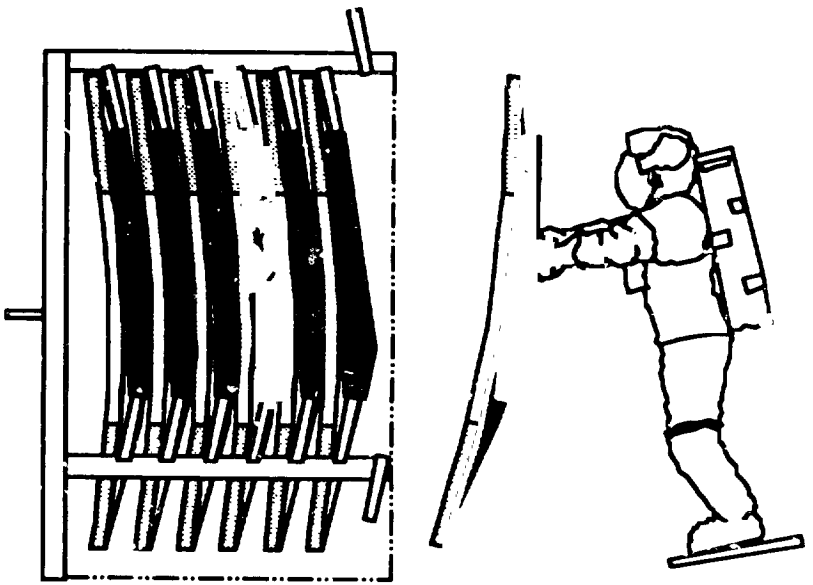
Following assembly, servicing will be demonstrated by installation and removal of a single panel. At the conclusion of these activities the structure will be disassembled and stowed for return to Earth.

TRUSS AND PANELS



The panels will be stowed in a specified order in a dispenser type canister with a grapple fixture for manipulation by the RMS. The RMS will be used to maneuver the panel canister into proximity of the truss (within arms reach of the EVA astronauts), however, the astronauts will manually remove the panels from the canister and make the final attachments to the truss.

PANEL DISPENSER CANISTER CONCEPT

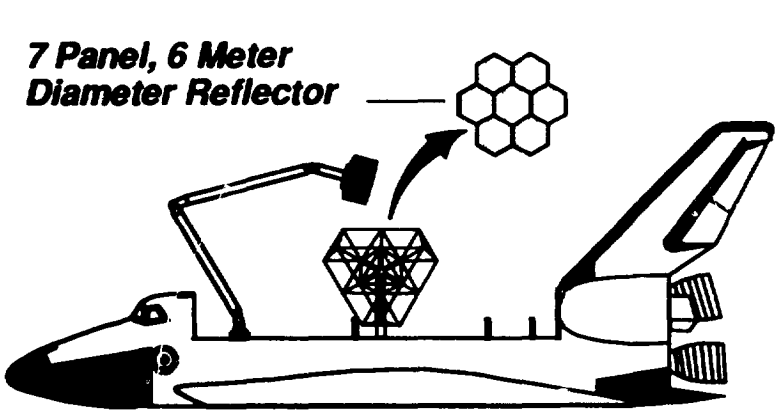


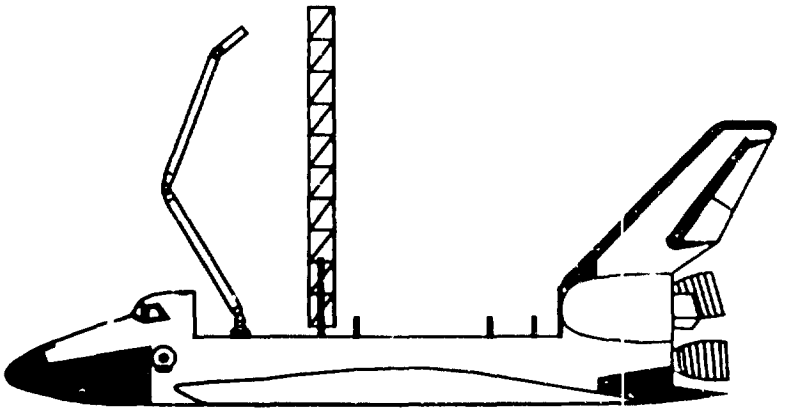
The method of construction used for ***PROBE*** will draw heavily on the techniques used and knowledge gained from the ***ACCESS*** flight experiment (launched Nov. 26, 1985) in which a 45-foot long truss beam consisting of 93 aluminum struts (4.5 and 6.4 ft in length) and 33 aluminum nodes was manually assembled on-orbit in approximately 25 minutes.

ACCESS
EVA STRUCTURAL ASSEMBLY EXPERIMENT

PROBE is anticipated to be approximately twice as involved as *ACCESS* because of the added integration complexity associated with installation of the panels. As with *ACCESS*, *PROBE* will be assembled on an assembly fixture attached to a pallet in the Shuttle cargo bay. The assembly fixture will consist of a telescoping mast with a turnstile located at its upper end for supporting the truss. The assembly fixture will be manually deployed and operated during construction of the reflector (telescoping and turnstile rotation operations) by the two EVA astronauts, thus no electrical power is required. The astronauts will be required to work from several locations, therefore movable and/or multiple foot restraints will be required.

PROBE APPROXIMATELY TWICE* AS INVOLVED AS *ACCESS*





PROBE

51 Struts

7 Panels

1.5 Hour Assembly

No Electronics

ACCESS

93 Struts

.....

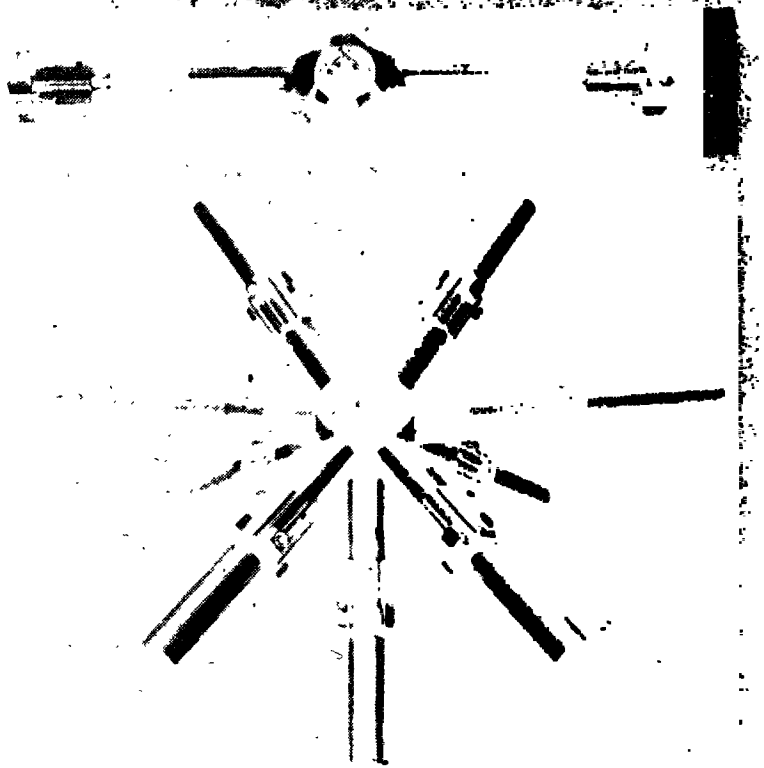
25 Minute Assembly

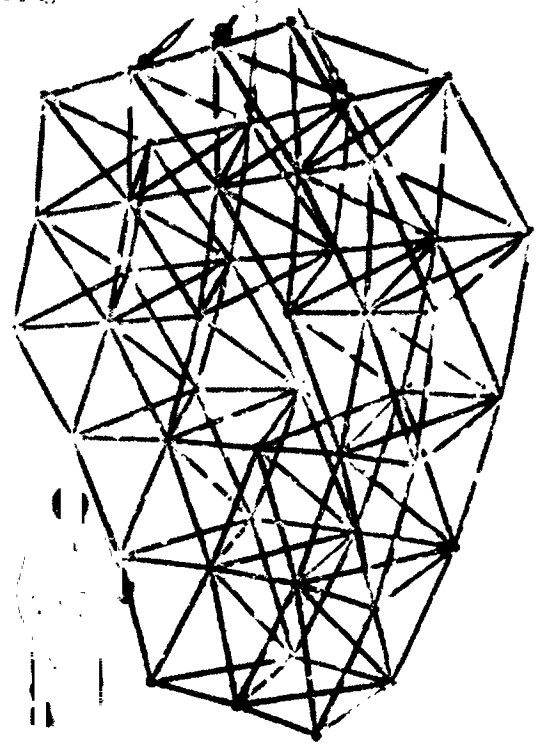
No Electronics

* *Primarily because of added integration complexity associated with the panels*

The joints that will be used for the *PROBE* truss are similar to the Space Station Freedom baseline joint, although scaled down to be compatible with one-inch diameter truss members. These joints are well developed and have already been used to assemble at Langley a precision parabolic truss consisting of 150 graphite-epoxy struts one inch in diameter. The core struts are nominally 0.8 meters in length. The front and back face struts are of various lengths to produce the parabolic curvature.

PRECISION PARABOLIC TRUSS HARDWARE

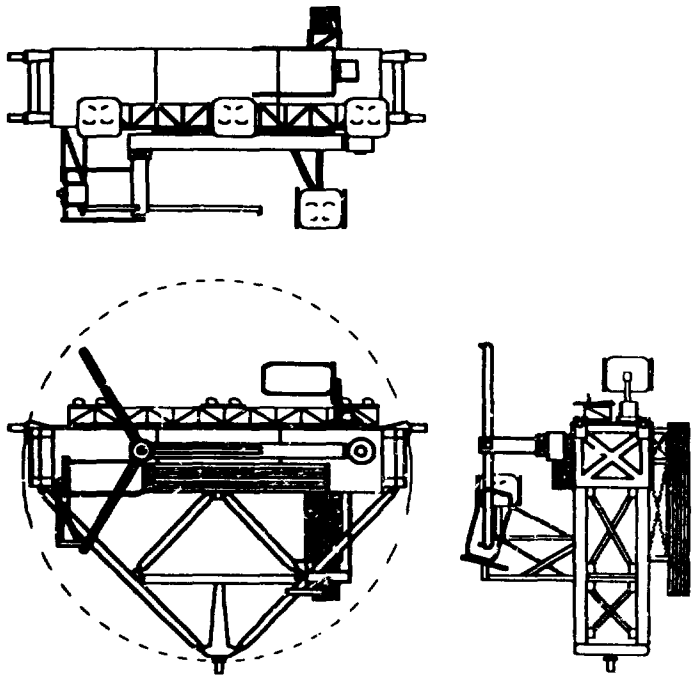




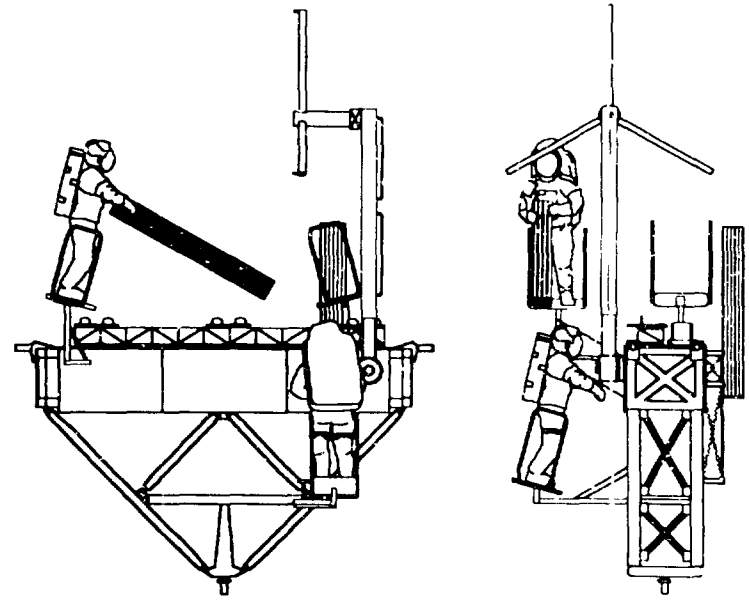
The ***PROBE*** assembly fixture, foot restraints, and strut and node canisters will be supported during launch and reentry on a Mission Particular Equipment Support Structure (MPESS), a standard Shuttle carrier pallet. The panel canister may also be attached to the MPESS or at another location in the cargo bay which is accessible to the RMS. Deployment of the assembly fixture and all other hardware setup required to prepare the worksite for assembly of the reflector will be performed by the EVA astronauts.

WORKSITE

STOWED CONFIGURATION



MANUAL SETUP



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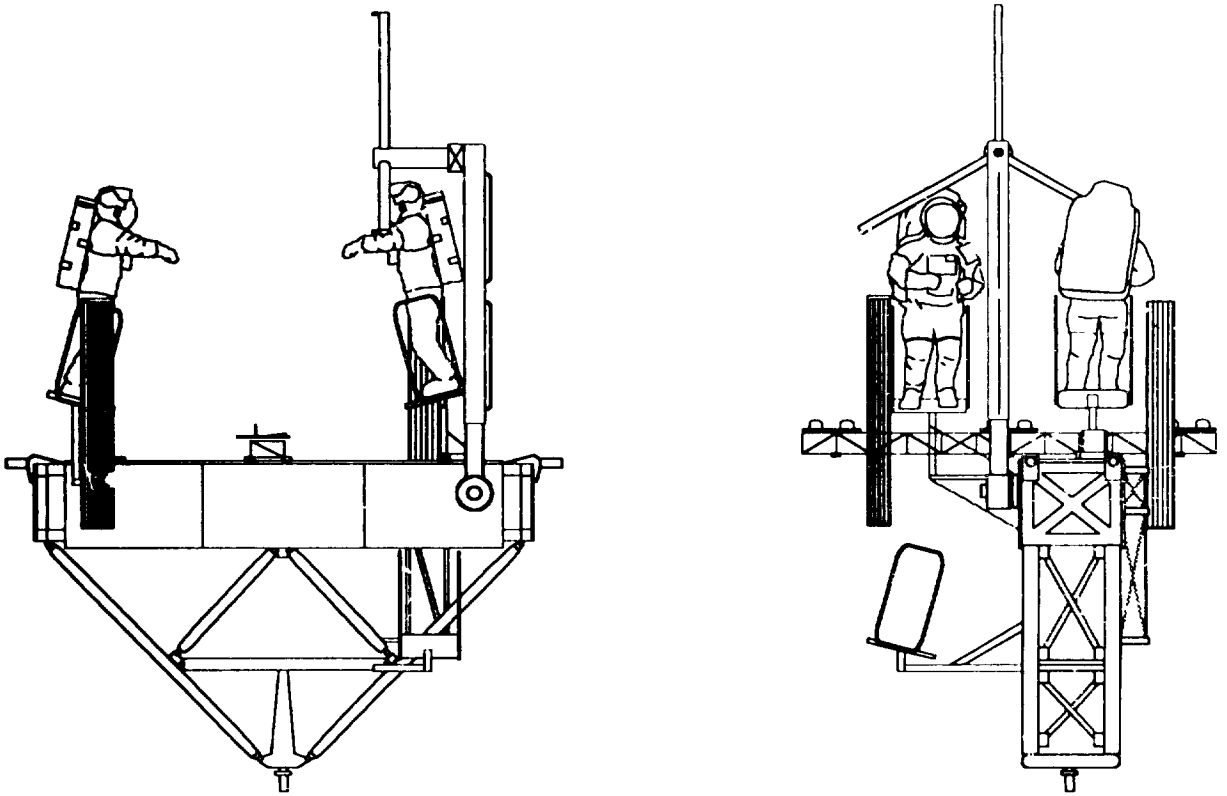
Based on the *ACCESS* experimental results, it is estimated that the worksite can be prepared for assembly within 23 minutes following the astronauts exit from the airlock.

WORKSITE READY TO BEGIN ASSEMBLY

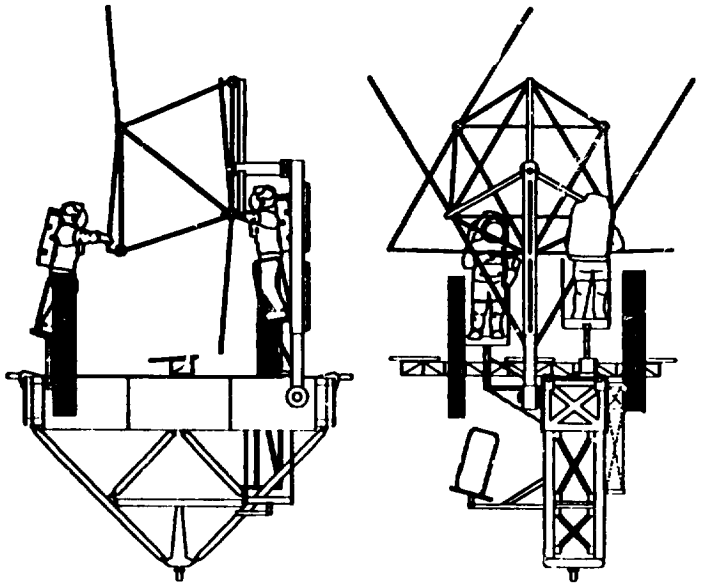
00:23:00



Working from fixed foot restraints the astronauts assemble a segment of the truss on the turnstile. A node/strut numbering scheme has been developed which requires no special training or written instructions. (The time estimates appearing herein are not generated from computer simulations, but based on experimental results obtained from the *ACCESS* experiment and from neutral buoyancy experience in assembling truss structures consisting of similar size components).

ASSEMBLY SEQUENCE

Install Struts & Nodes



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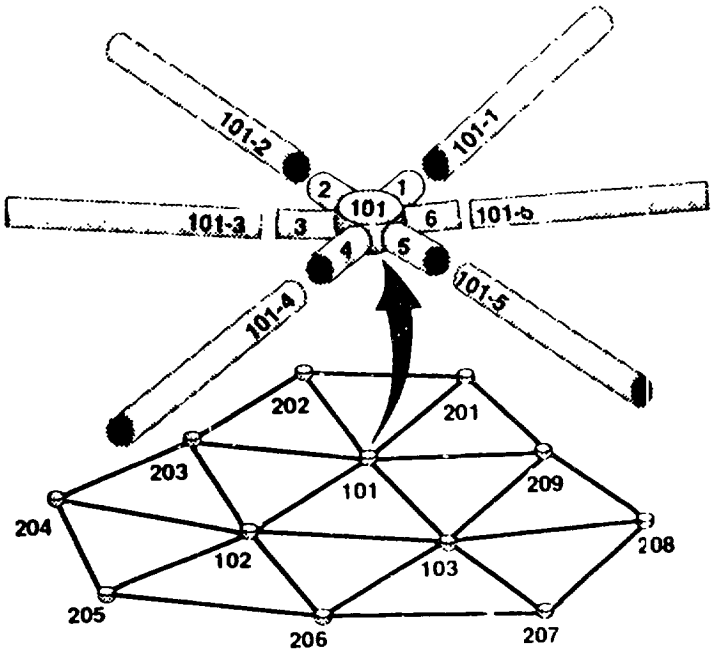
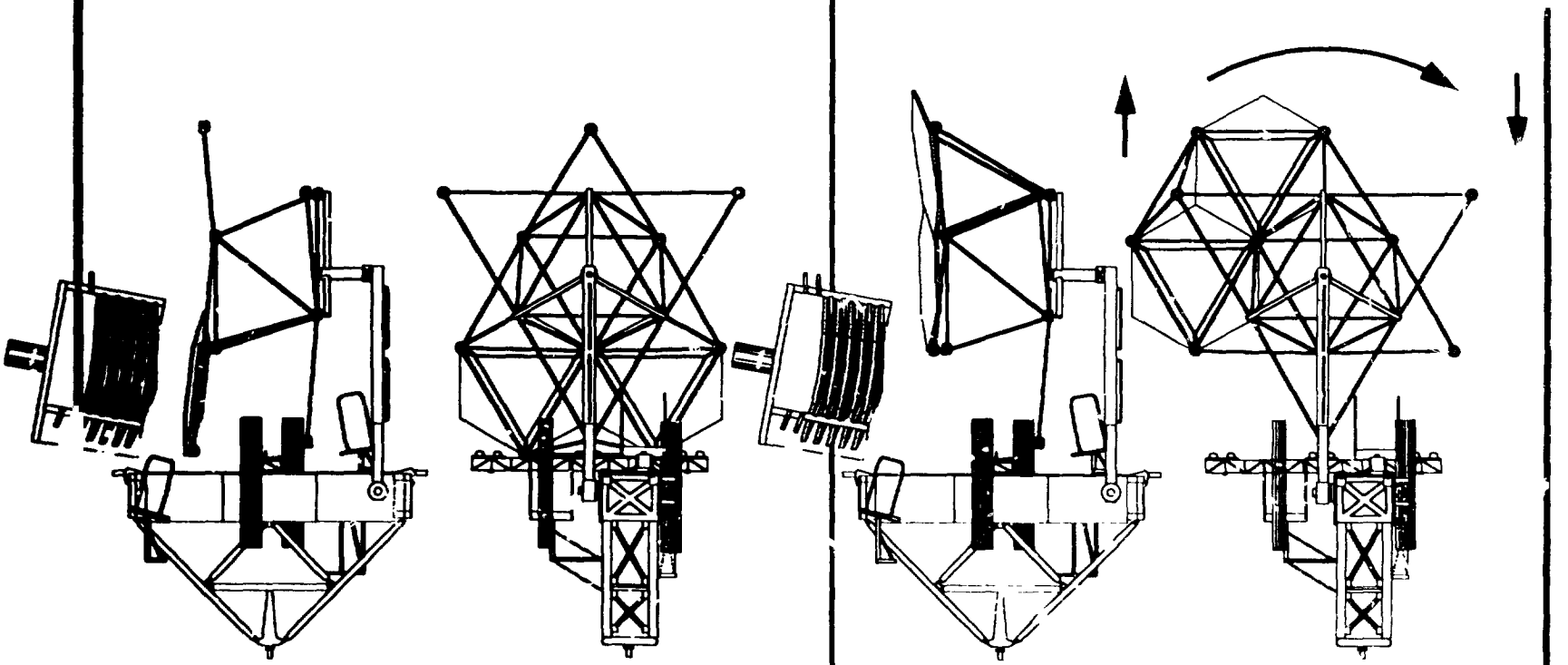


The RMS will be used to maneuver the panel canister close to the concave surface of the truss. The astronauts working from foot restraints attached to a truss-like catwalk on top of the MPESS will manually remove a panel from the canister, attach it to the truss, and install the additional struts required to stabilize the panel. Two panels will be attached between 120° rotations of the turnstile. A total of six panels will be attached in this manner.

ATTACHMENT OF PANELS



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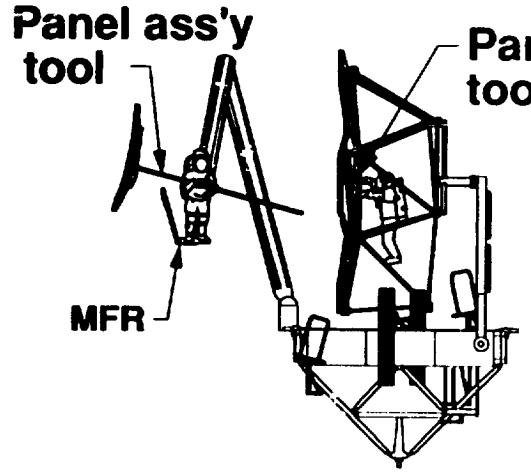
Following assembly, servicing will be demonstrated by installation and removal of a single panel in the center of the reflector. Again, the RMS will be used with an astronaut positioned in the Manipulator Foot Restraint (MFR) to act as a grapple. Two special tools used in this operation are the panel assembly tool and panel assembly tool guide.

SERVICING DEMONSTRATION



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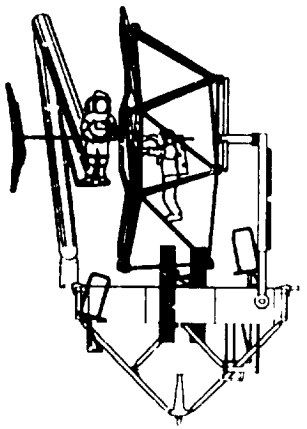

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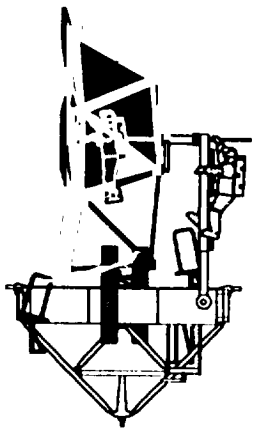

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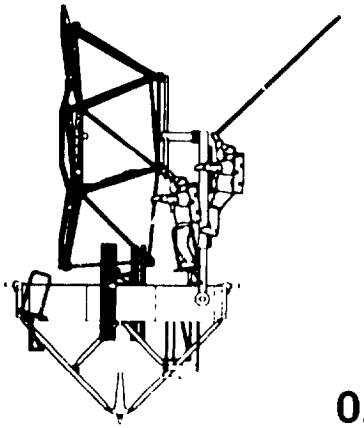

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The complete flight experiment can be completed in one EVA day. The major tasks and estimated time for completion are presented in Table 1, and a summary for the reflector components is presented in Table 2.

PROBE SUMMARY

TABLE 1

TASK	TIME
Worksite Prep	00:23:00
Assembly	01:29:00
Servicing	
Panel Installation	00:25:00
Panel Removal	00:25:00
Disassembly & Stowage	01:29:00
Stow Worksite	00:23:00
Total	04:34:00

TABLE 2

Truss	
No. of struts	51
No. of nodes	18
Mass	93 lbm
Max dimension	19.7 ft
Reflector surface	
No. of panels	7
Area	261 ft^2
Mass	533 lbm
Max dimension	19.7 ft

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An aluminum planer truss mockup has been fabricated and assembled in the laboratory as an aid to developing the on-orbit assembly procedure for *PROBE*. Three low-fidelity flat panels are also being used in this on-going study.

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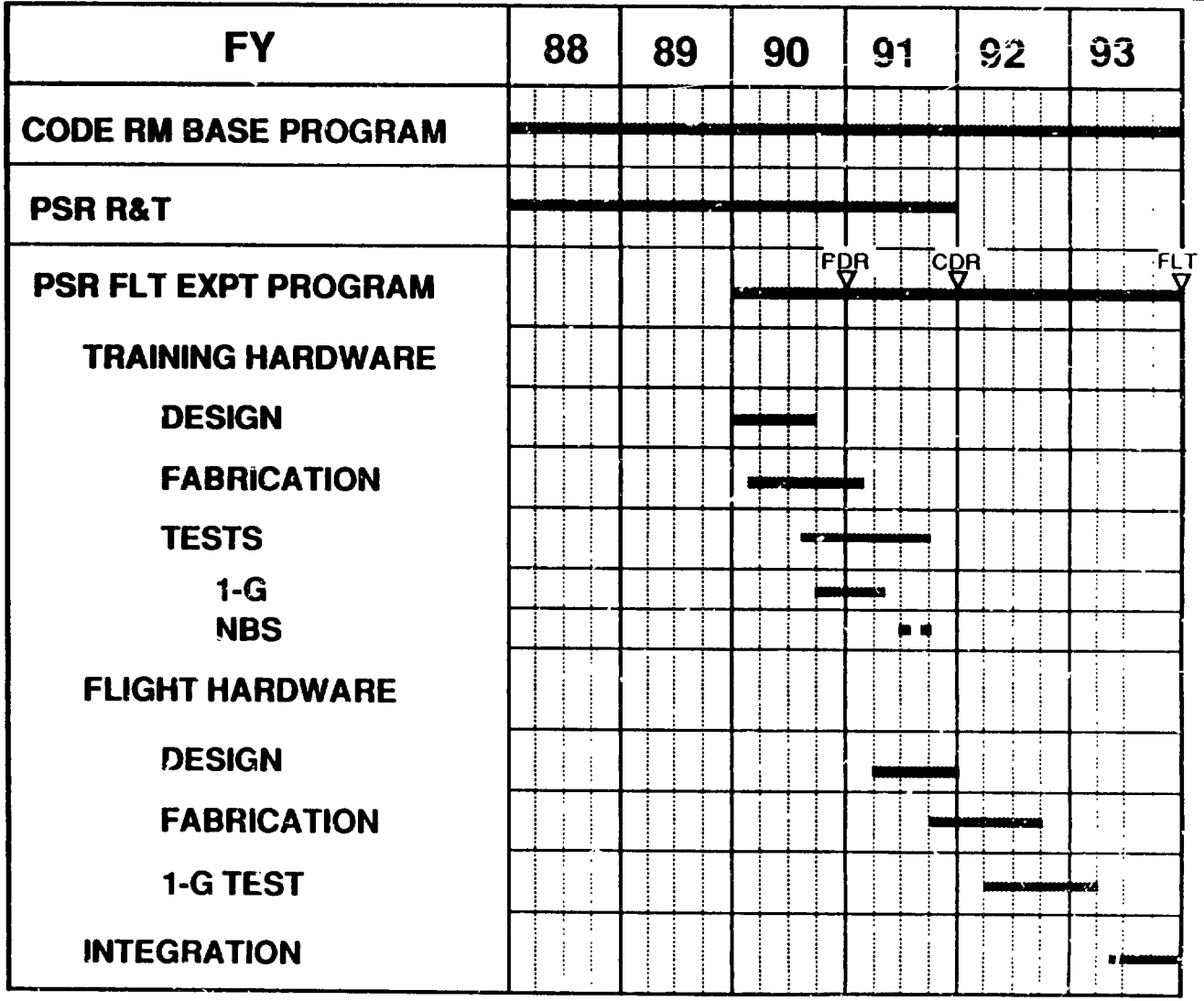
Pending notification of ***PROBE*** go-ahead, plans have been made under base R&T to assemble a parabolic truss and attach reflector surface panel mockups in neutral buoyancy tests.

SCHEDULE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PSR R&T
PSR FLT EXPT PROGRAM
PDR
CDR
FLT
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DESIGN
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TESTS
1-G
NBS
FLIGHT HARDWARE
DESIGN
FABRICATION
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