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SKYLAB EXPERIENCE BULLETIN NO. 27

# PERSONNEL AND EQUIPMENT RESTRAINT AND MOBILITY AIDS (EVA)

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*National Aeronautics and Space Administration*

***LYNDON B. JOHNSON SPACE CENTER***

***Houston, Texas***

MAY 1975

# MAN-MACHINE ENGINEERING DATA APPLICATIONS OF SKYLAB EXPERIMENTS M487/M516

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This document is the twenty-seventh in a series of releases which are intended to make available to NASA and contractor personnel those results from the Skylab Man-Machine Engineering Experiments which have design and requirements relevance to current projects and programs.

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May 1975

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# EVA RESTRAINT SYSTEMS


## SUMMARY

Probably the most significant finding of the Skylab EVA operations was to confirm that man could accomplish significant and important tasks during EVA. The program would have been a near failure rather than a resounding success had the SL-2 crewmen not been able to free the jammed solar panel. Even though adequate personnel restraints were non-existent in the area in which the work had to be accomplished, the crewmen were able, through innovative techniques, to restrain themselves sufficiently to do the required tasks. Portable handholds and foot restraints would have aided such unplanned maintenance tasks.

The pre-planned tasks, performed at work stations designed to facilitate those tasks, were easily and routinely accomplished.

The majority of the EVA equipment worked rather well; the one item that could easily be omitted on future flights would be the clothesline. It worked, but not as efficiently as the extendible booms and was little better than having the crewmen physically transport equipment using their wrist tethers. EVA mobility was quite easy along the handrails. The double handrails were "like driving on the freeway."

Temporary equipment restraints received mixed reactions from the crewmen. Snaps were considered difficult to operate; gray tape was liked by some and disliked by others, while velcro apparently did well in those locations where it was used.

## PRE-SKYLAB EXPERIENCE

The Mercury Program had no EVA tasks to accomplish during any of the missions, so there was no EVA experience or equipment.

The Gemini Program initiated the first EVA activity in the space program. One of the foremost conclusions obtained was that man's capability to perform EVA work in zero-g was comparable to his 1-g capability if he had the proper restraint provisions.

Several kinds of foot restraints were devised and used with varying degrees of success on the Gemini missions. The analysis of the problems encountered in the use of the earlier Gemini efforts resulted in the following requirements for EVA foot restraints:

a. Motion must be restrained in all six degrees of freedom.

b. The foot restraints must position the EVA crewman for convenient access to the intended work task.

c. Release of the feet must not depend on the action of any moving mechanism.

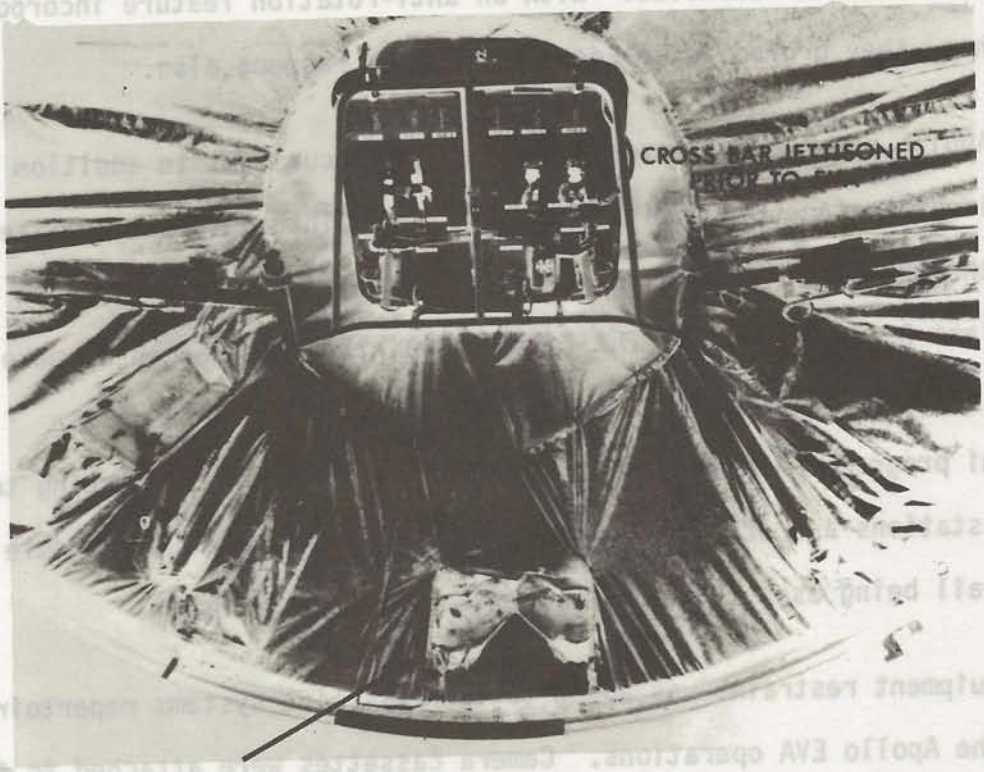
Molded fiberglass foot restraints meeting these requirements were designed for the Gemini XI and XII spacecraft. They were custom fitted to each user for each flight and were mounted on a platform attached to the inside surface of the spacecraft adapter equipment section. The flight crew of Gemini XII used and evaluated these

foot restraints and found them completely adequate for all tasks attempted.

Figure 1 shows a Gemini work station with the foot restraints near the bottom of the picture. Handrails are installed around the work area itself.

As with the foot restraints, several types and kinds of handrails were developed during the Gemini program. These included rectangular handrails, large cylindrical handbars, small cylindrical handrails, telescoping handrails, fixed handholds and portable handholds. The most useable handrail for pressure suited EVA use evolved to the rectangular handrail 3.2 cm (1.25 in) by 1.25 cm (0.5 in) in size. The rectangular cross section offered more resistance to rotation for a given hand force and allowed better control of body attitude. It was determined that handrails were a completely adequate mobility aid for translation.

Tether devices were developed and used during the Gemini program for personal restraints. The EVA crewmen found that tethers attached slightly below the waist at both sides and extended to the vehicle approximately four feet apart provided adequate restraint for small torquing tasks, minimized the effort required in controlling body position and eliminated the possibility of drifting away if the hands or tools slipped.




Gemini XII EVA Work Area

Figure 1

Pip-pin devices provided excellent portable tie-down points for the tethers. The exterior of the spacecraft had numerous receptacles installed in various locations about the exterior of the vehicle. In addition to providing a good tether attach point, the pip-pins were utilized as handholds. With an anti-rotation feature incorporated in them, they proved to be adequate in this respect also.

The Apollo program had several orbital EVA excursions in addition to the lunar surface EVA activities. The restraint equipment utilized for the orbital EVA operations was quite similar to that flown on the last Gemini mission. The foot restraints were changed to make them adjustable rather than the custom fitted restraints of the Gemini program. Rectangular handrails were used for translating to work stations and at the worksites. Figure 2 shows a Lunar Module Handrail being used in orbit during the Apollo IX mission.

An equipment restraint was added to the restraint systems repertoire for the Apollo EVA operations. Camera cassettes were attached to the crewmen by wrist tethers for transporting them from the Service Module back to the Command Module.

## SKYLAB DESIGN

A number of mobility and restraint devices for both the crewmen and their equipment were developed for the Skylab EVA operations. The majority of these were concentrated near and between the work stations.

Rectangular Handrails on LM in Use

Figure 2

## EVA Work Stations

The primary EVA tasks on Skylab were to have been concerned with film replacement on the Apollo Telescope Mount (ATM). To support these tasks, five EVA work stations were provided.

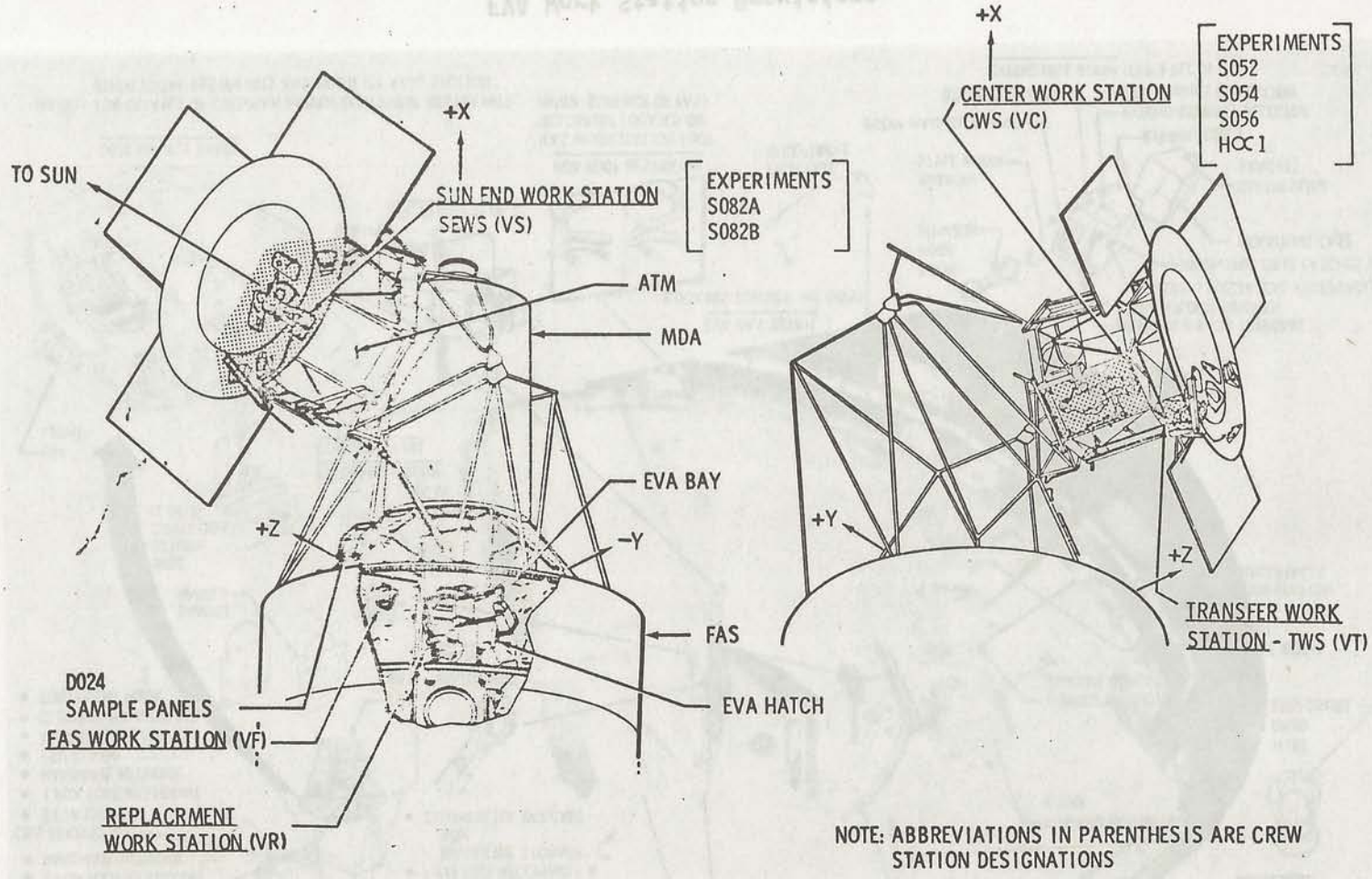
The main support work station, the Fixed Airlock Shroud Station (FAS Station), was located in the EVA bay beside the Airlock Module. A replacement work station was also located here as a worksite for contingency EVA procedures in case of hardware failures.

Three work stations were located on the ATM. These were designated as the center work station, the transfer work station and the sun end work station. These were the areas in which ATM camera and/or film handling, recovering and reloading were accomplished. Figure 3 shows the work station locations and Figure 4 shows the work station provisions.

The work stations were equipped with lighting provisions, handrails, PGA foot restraints, LSU clamps and equipment hooks, all described in the following paragraphs. Figure 5 shows the sun end work station and its provisions.

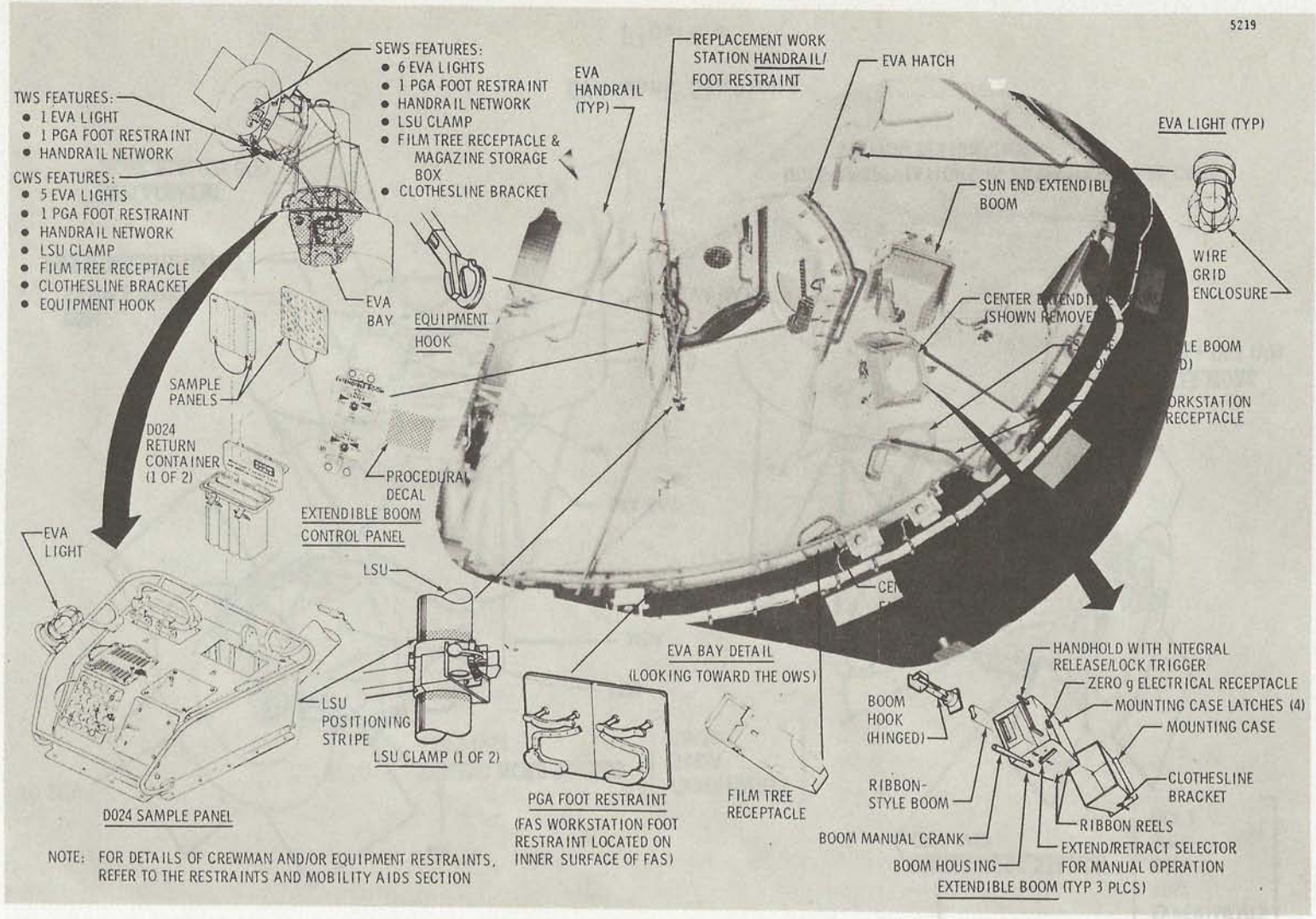
## Handrails

Handrails were located on the Airlock Module (AM) in the bay area outside the EVA hatch, the Fixed Airlock Shroud (FAS) area enclosing



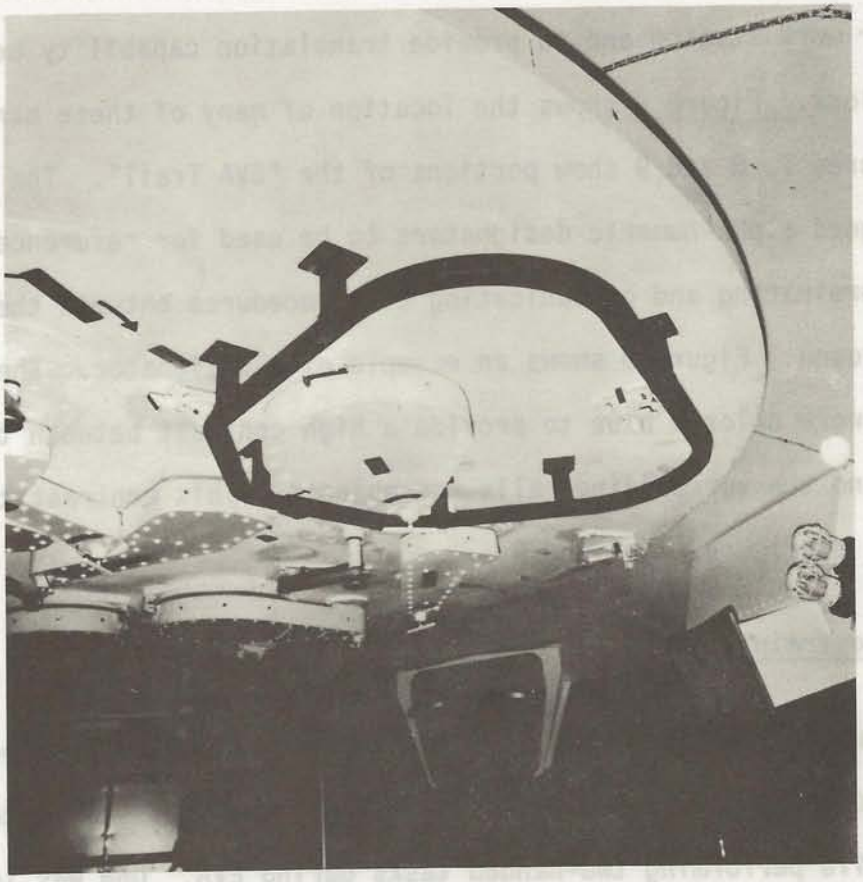

EVA Work Stations

Figure 3




EVA Work Station Provisions

Figure 4



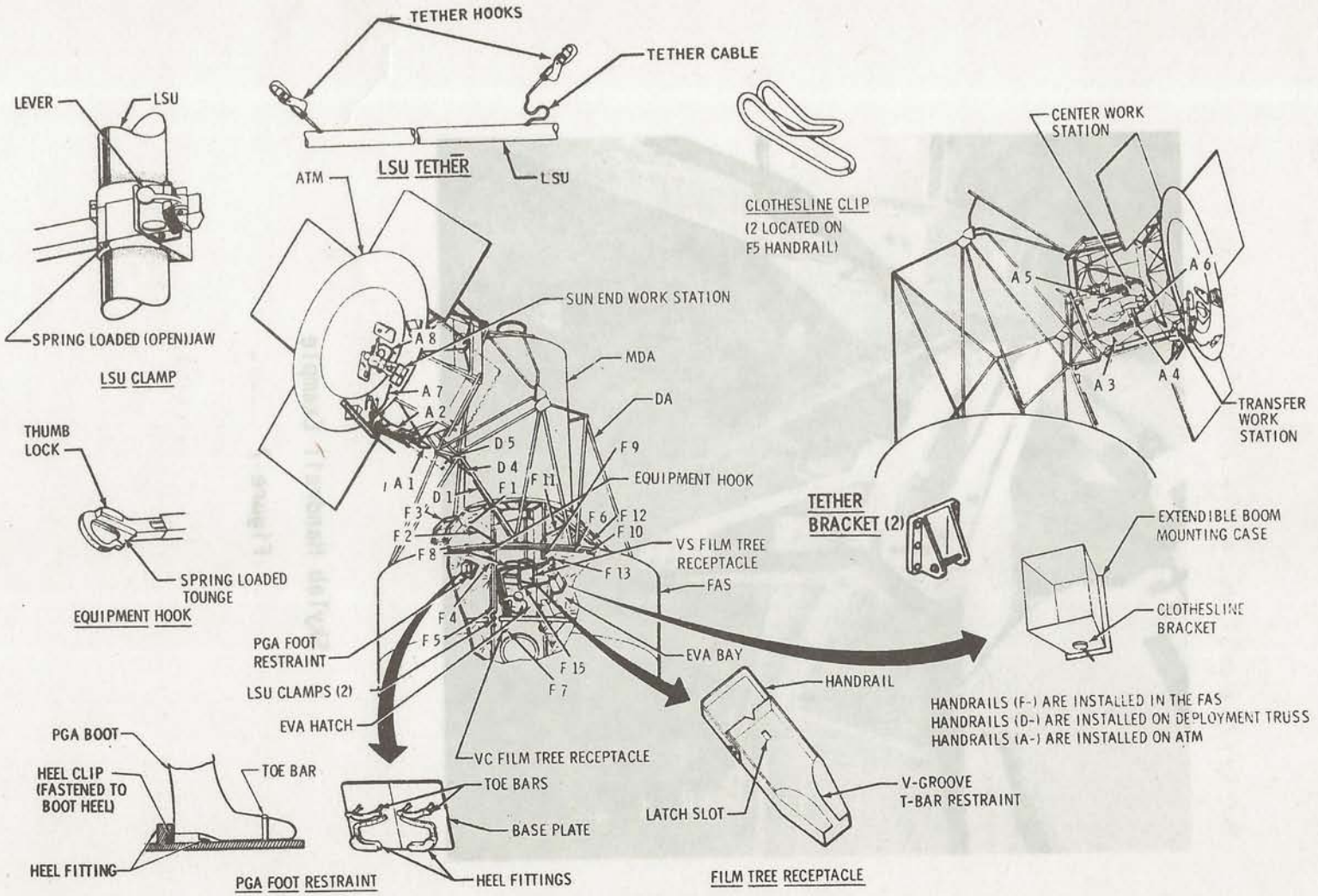
Sun End Work Station

Figure 5

an EVA work station, the Deployment Assembly (DA) route leading to the ATM work stations (the so-called "EVA Trail") and the ATM work stations themselves. These handrails were to be utilized by the crewmen to facilitate transfer through the EVA hatch, to restrain themselves at a particular work station and to provide translation capability between work stations. Figure 6 shows the location of many of these handrails while Figures 7, 8 and 9 show portions of the "EVA Trail". The handrails were assigned alpha-numeric designators to be used for reference purposes during coordinating and communicating EVA procedures between the crewmen and the ground. Figure 9 shows an example of a designator. The handrails were colored blue to provide a high contrast between the handrail and the surrounding walls and objects. This contrast can be noticed on Figures 7, 8 and 9.

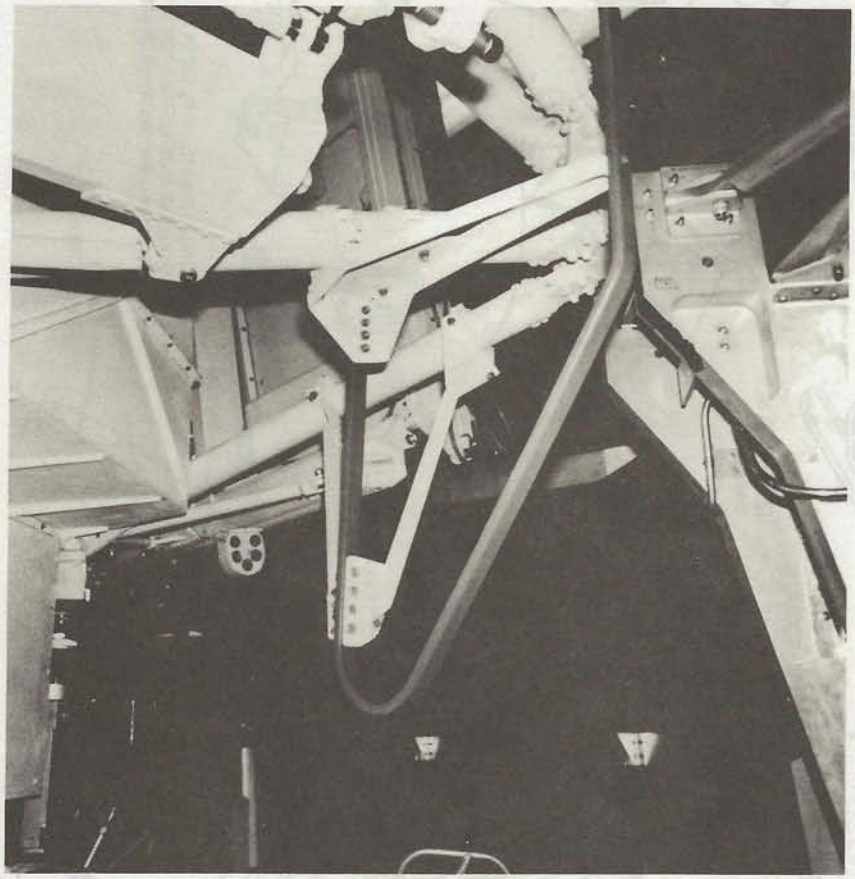
PGA Foot Restraints

Four pressure garment assembly (PGA) foot restraints were located on the exterior of the Skylab cluster to restrain the pressure suited crewmen while performing two-handed tasks during EVA. One was located at each of the work stations, the FAS work station, center work station, transfer work station, and the sun end work station. A portable PGA foot restraint was also provided. The foot restraint accepted and retained the PGA boots through the use of a toe-bar and a heel fitting which engaged the heelclips on the PGA boots. This provided rigid PGA foot restraint. Figure 10 shows the portable PGA foot restraint, and the sun end foot restraint can be seen on Figure 5.



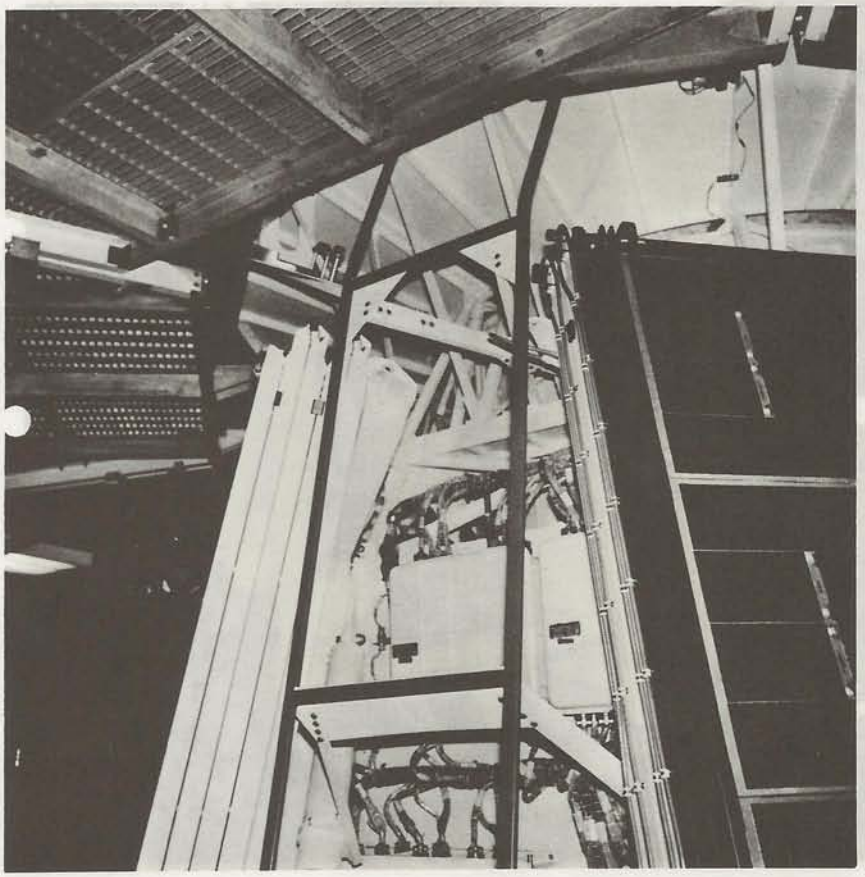

Skylab EVA Restraint Aids

Figure 6



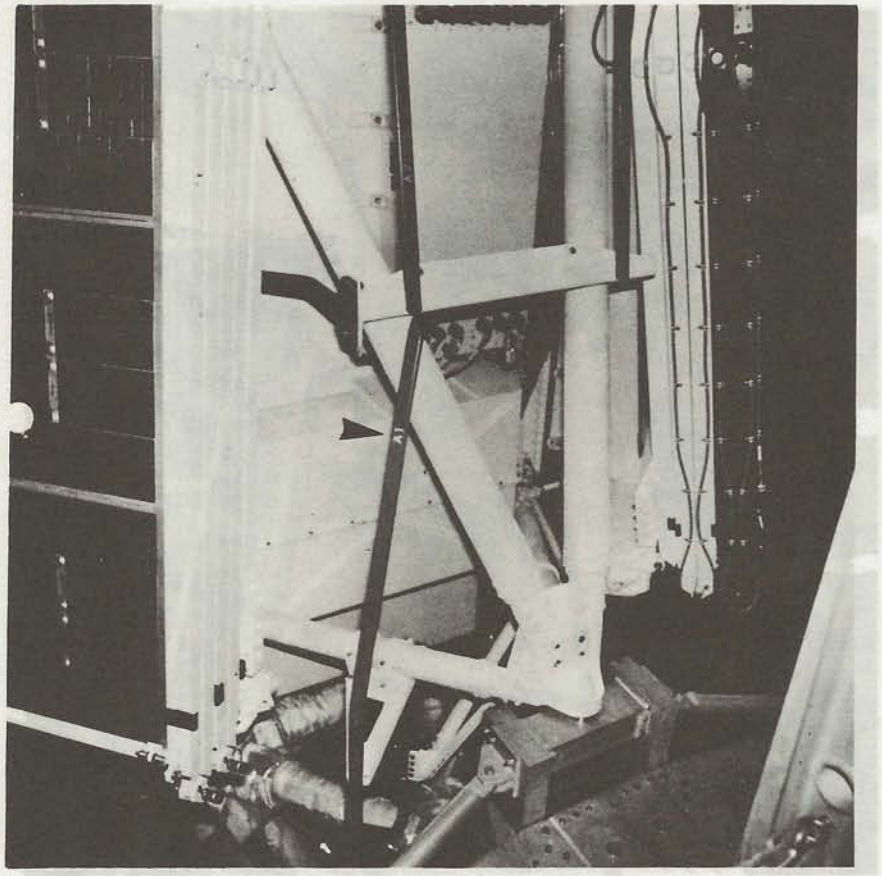
Skylab Handrail Example

Figure 7

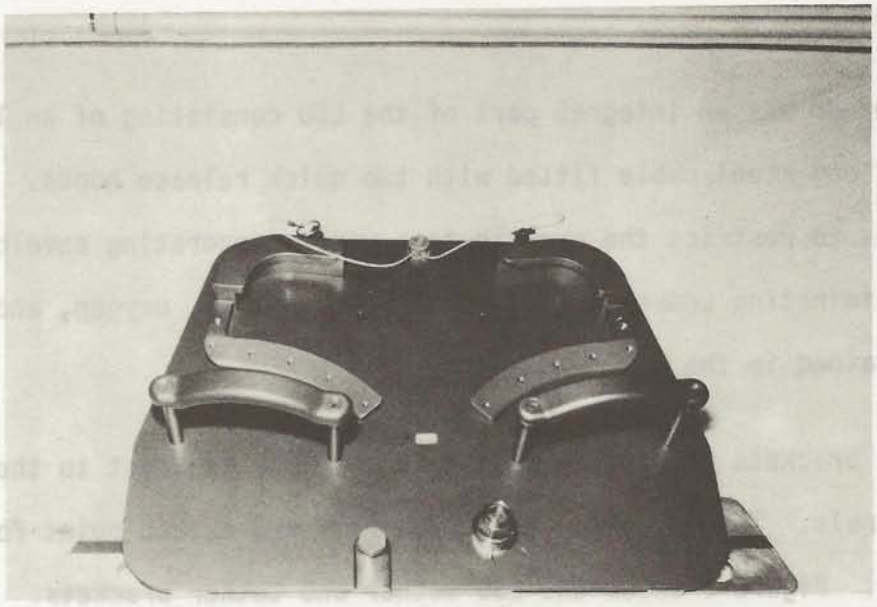


Skylab Handrail Example

Figure 8



Skylab Handrail Example
Figure 9



Portable PGA Foot Restraint

Figure 10

Tethers

Two different types of tethering devices were utilized; one for the crewmen and one for the equipment. The personal tether system consisted of the Life Support Umbilical (LSU) tether, the tether bracket and the LSU clamps.

The LSU tether was an integral part of the LSU consisting of an 18.3 meter (60 foot) long steel cable fitted with two quick release hooks. Its purpose was to restrict the crewman to a maximum operating envelope as well as eliminating undue stresses on the electrical, oxygen, and water lines contained in the LSU.

Two tether brackets were installed in the airlock adjacent to the EVA control panels. They provided the spacecraft end attach point for the LSU tether. Figure 6 shows the LSU tether and tether brackets.

Two LSU clamps were located in the EVA bay adjacent to the EVA hatch to facilitate life support umbilical management during EVA while one clamp was located at each ATM work station. The clamp was made with two jaws: one fixed and the other movable. The movable jaw was spring loaded and contained a lever to override the spring when LSU retention was desired; when the clamp was not in use, the spring maintained the movable jaw in the open position for easy insertion of the umbilical. In the event that the LSU experienced side loads due to a crewman's activity, the spring-loaded jaw was supposed to open

to free the LSU to prevent possible LSU damage. Figure 6 has a picture of the LSU clamp.

The equipment tether utilized on Skylab was a wrist tether used to attach items of equipment to the crewman's wrist for transport and retention during EVA. The tether was a PBI material strap, 25 cm (10 inches) long with a trigger snap hook at one end to attach to a ring at the crewman's wrist and a larger hook at the other to attach items of equipment. Figure 11 shows the attach ring on a crewman's PGA and Figure 12 shows an EVA wrist tether.

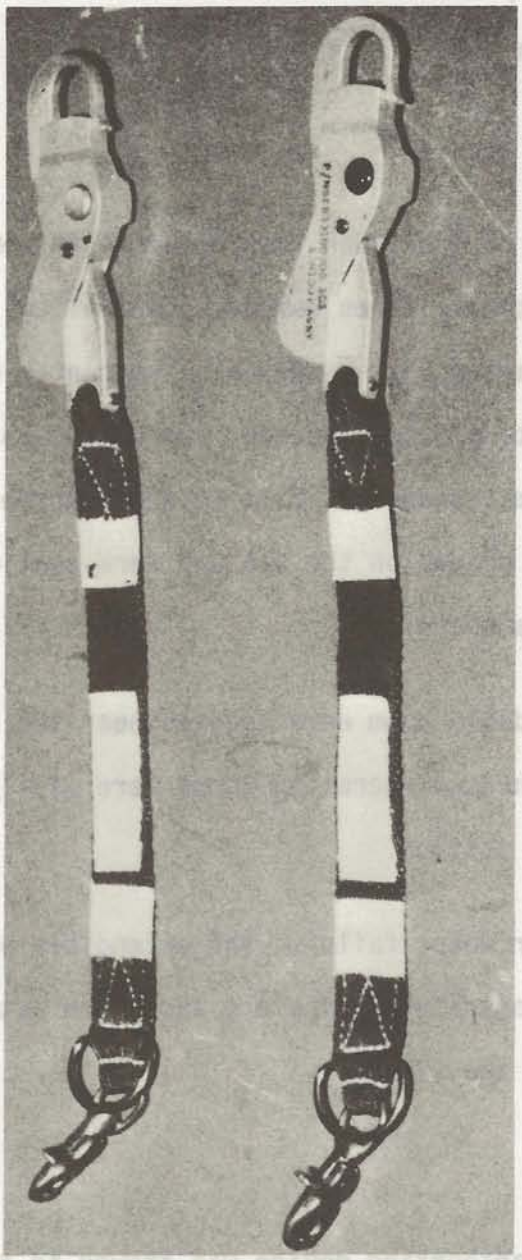
Film Trees

The film provisions for the ATM camera resupply were divided into center work station film provisions and sun end work station film provisions. All of the film destined for a particular work station was grouped together and restrained in a single, portable device called a film tree. It contained mounting provisions for film cassettes and cameras for convenient restraint and access during the EVA transfer from the film vaults to the ATM. The base of the film tree contained a T-bar and latch to facilitate mounting and positive engagement of the film tree into a film tree receptacle. One film tree was provided for each of the two work stations on the ATM.

Film tree receptacles were located in the EVA bay and at the ATM work stations to provide positive restraint for the film trees during the

Wrist Tether Attach Ring

Figure 11



Wrist Tethers

Figure 12

EVA. As shown on Figure 13, the receptacle contained a V-groove for restraint of the film tree's T-bar and a slot to engage the film tree's latch. Each film tree receptacle contained a handrail for use by the crewman to aid in installing the film tree.

Extendible Boom

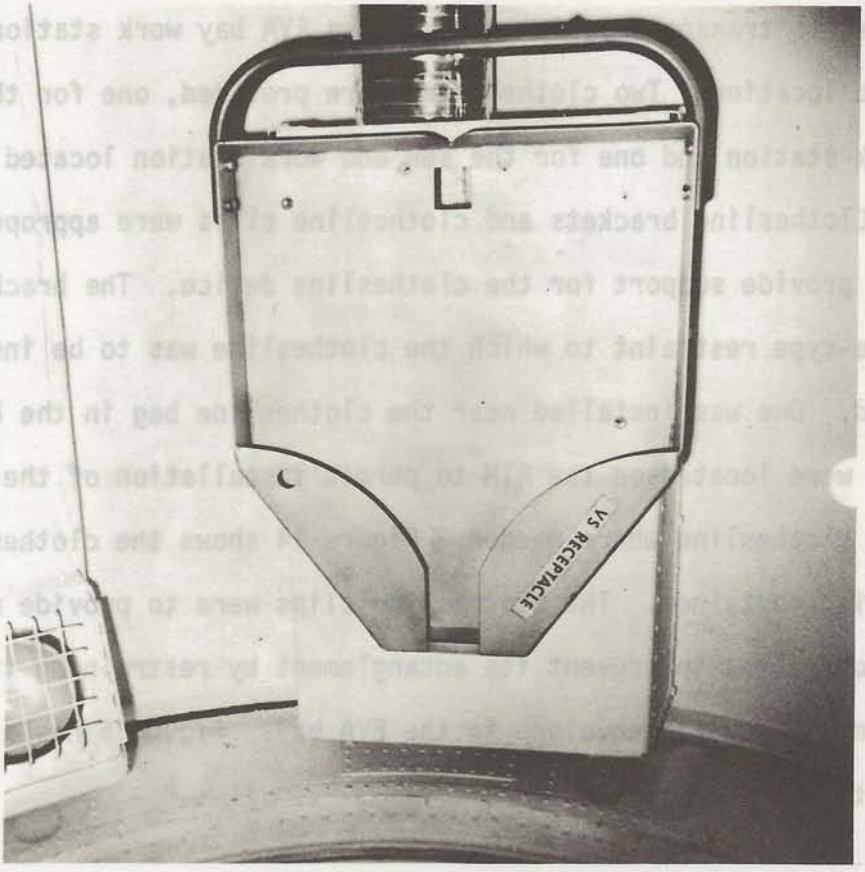
To aid in transferring ATM film between the FAS work station and the center or sun end work stations, three remotely controlled, motorized extendible booms were installed on the Skylab. The center extendible boom transported the film to a point adjacent the center work station. The sun end extendible boom transported film to the transfer work station, from which it was placed on the sun end work station. The third extendible boom was a spare.

The controls for the extendible boom were located near the EVA hatch opening in the EVA bay. The two operating booms were easily loaded or unloaded from the FAS work station.

In case of power failure or motor failure, the extendible booms were capable of being manually operated. Figure 4 shows the extendible booms in their location in the EVA bay.

Clothesline

A clothesline equipment transporting device was stowed in a clothesline bag located adjacent to the sun end and center extendible boom mounting




Film Tree Receptacle

Figure 13

cases. It was to be utilized as a backup to the extendible boom. For use, it was to be removed from its mounting bag, transported to the particular work station where it was needed, and installed. It could then be used to transport equipment from the EVA bay work station to the desired location. Two clotheslines were provided, one for the center work station and one for the sun end work station located on the ATM. Clothesline brackets and clothesline clips were appropriately located to provide support for the clothesline device. The brackets were an eye-type restraint to which the clothesline was to be installed when needed. One was installed near the clothesline bag in the EVA bay, two others were located on the ATM to permit installation of the other end of the clothesline where needed. Figure 14 shows the clothesline folded in its container. The clothesline clips were to provide restraints for the clothesline to prevent its entanglement by restraining it outside the crewman's operating envelope in the EVA bay. Figure 6 has a picture of the clothesline clip.

## SKYLAB EXPERIENCE

The data pertaining to the Skylab EVA mobility and restraint equipment has been compiled from the Skylab air-to-ground transcripts, post-flight debriefings, inflight motion pictures, still photographs, and a post-program questionnaire. This data has been evaluated to determine what, if any, problems with mobility and restraint equipment arose for the crewmen during their EVA operations.

Clothesline in its Container

Figure 14

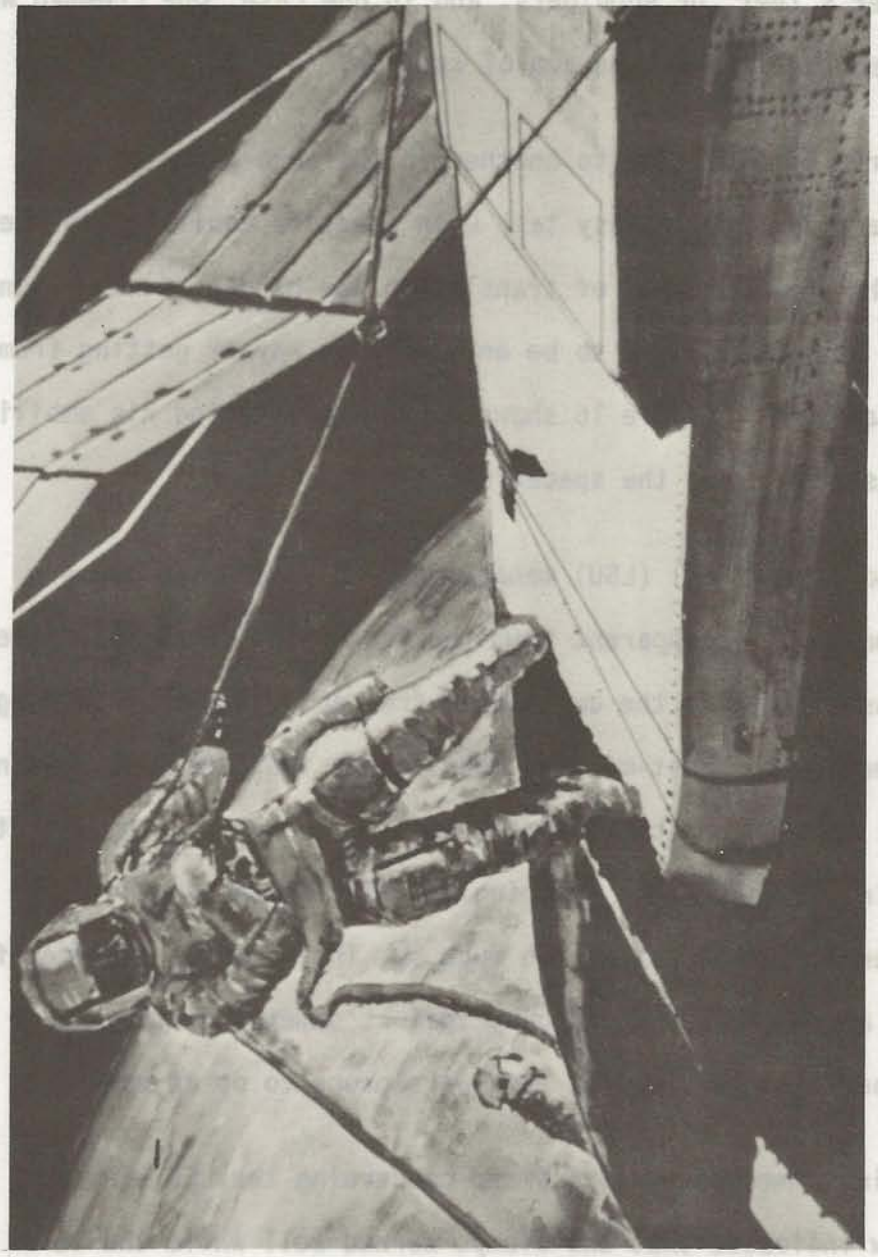
General Restraint and Mobility

The Skylab crewmen were nearly unanimous on two major topics. The first was that any of the pre-planned tasks such as the film changeout on the ATM were quite easy and created no problems. The necessary work restraints were readily available and the translation aids were quite adequate. As long as the proper restraints were available, any task was easily accomplished.

The second unanimous topic was that EVA tasks that had not been pre-planned were much more difficult to accomplish. The primary reason was the lack of restraints to permit the crewmen to adequately stabilize themselves to do work. Another reason was the lack of mobility aids to aid the crewmen in translating to the worksites.

The extreme example of an unplanned EVA task is, of course, the freeing of the solar panel wing from its jammed position early during Skylab 2. Obviously, such a task could not be pre-planned. The transcripts of that particular task are replete with the problems the crewmen had in translating and working without adequate restraints. The task was not impossible; it was, however, made extremely difficult because of the lack of restraints.

Various innovative restraint methods were utilized by the crewmen to aid in accomplishing their tasks. Figure 15 shows an artist's rendition of an unrestrained crewman using a rope rigged pry-bar to help in freeing the solar panel.



Artist's Rendition of SAS Deployment Personnel Restraint

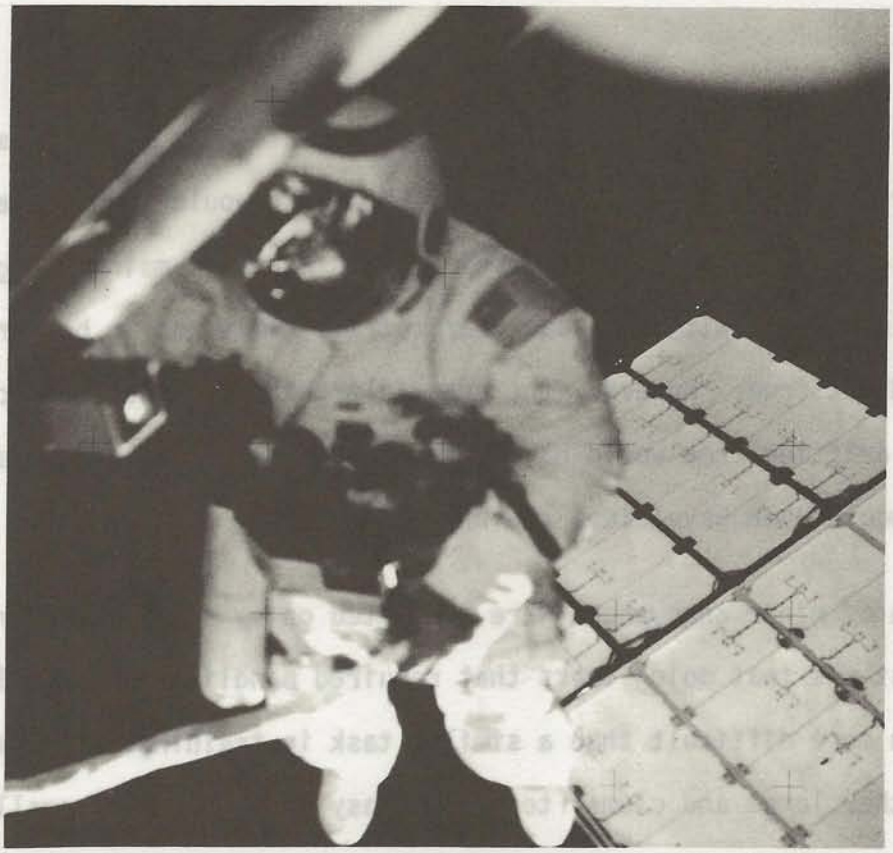
Figure 15

Several tasks were successfully accomplished only when the crewman doing the task was held in position by his EVA partner. They would hold each other's feet, or shoulders, and in one case, one crewman was held "like a sausage" under the arm of another.

Translation from one location to another in the zero-g environment proved to be a delightfully easy task when adequate mobility aids were available. The common method of translation was hand-over-hand along the handrails and this proved to be an excellent way of getting from one point to another. Figure 16 shows a crewman managing his umbilical while he translates along the spacecraft.

The Life Support Umbilical (LSU) management was an area of concern for the crewmen. It is apparent from the transcripts that they were very conscious of keeping the umbilicals free and clear from getting tangled. However, the post-mission debriefings indicate that getting the umbilical tangled was considered less of a problem during flight than it was in the Water Tank training facility on the ground. The umbilicals were somewhat stiff (too much so, in the words of some of the crewmen) and when they would bump against something, they would rebound, rather than tangling as they were prone to do on earth.

Two conflicting comments were recorded concerning the LSU clamps. The SL 3 crew indicated that the clamps worked well while the SL 4 crew indicated that the clamps were too small and tended to close



EVA Translation

Figure 16

prematurely. Since the LSU clamp was designed and built such that one jaw was spring loaded open to receive the LSU, it would appear that at least one clamp had a spring failure that occasioned the SL 4 crew's comments.

One area discussed by the SL 4 crew was that allowing themselves to drift free of the vehicle while doing EVA tasks would have presented no problem. Apparently, their training had stressed maintaining themselves in contact with the spacecraft at all times and to be very careful not to drift free. However, the crew felt that with the umbilical tether, drifting free would have presented no problems, and in some cases, would even have aided their EVA tasks.

A couple of minor annoyances were commented on by some of the crewmen. The first was that doing tasks that required handling many small items was much more difficult than a similar task in training. The EVA gloves were rather large and clumsy to permit easy manipulator of small objects. Further, the lack of acceptable restraints for these small items compounded the problem.

Another related problem commented on by the SL 3 crew was that their fingers got very sore and their hands tired badly by the end of their EVA tasks.

The following references contain the general comments discussed in this section.

| Reference | Appendix Page Number |
|---|---|
| 1 | A-2 |
| 2 | A-11 |
| 4 | A-16 |
| 5 | A-20 |
| 7 | A-23 |
| 11 | A-29 |
| 12 | A-30 |
| 13 | A-33 |
| 14 | A-28 |
| 18 | A-47 |
| 21 | A-52 |
| 23 | A-65 |
| 24 | A-79 |
| 25 | A-84 |
| 28 | A-95 |
| 29 | A-98 |
| 31 | A-102 |
| 32 | A-103 |
| 33 | A-106 |
| 35 | A-112 |
| 36 | A-117 |

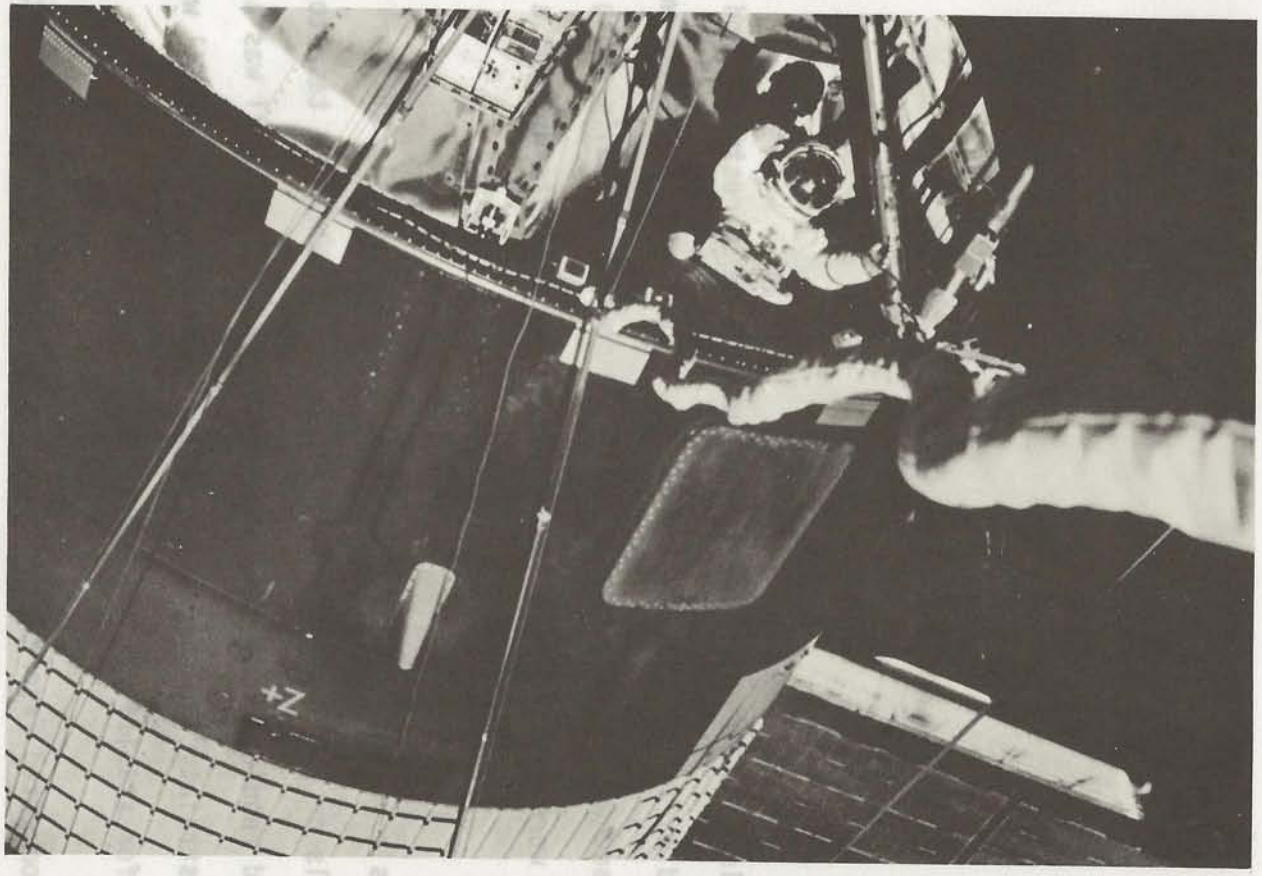
Work Stations

The work stations apparently served their designed function quite well. The FAS station was the only one mentioned much and it was considered "super". The crewmen were able to reach everything necessary without problem.

Most of the comments concerned the use of the foot restraints. This usage ranged from using them as intended, through using only one restraint, to using them as little as possible. One crewman functioned free from the restraint as much as possible so that he could see more of the OWS outside of the FAS. Figure 17 gives an indication of this mode.

The SL-4 crew commented that one of the foot restraints in the FAS work station was difficult to get into and didn't hold too well. They further commented, however, that it was probably due to the body orientation and direction of force application required by some particular task.

The only complaint concerning the FAS work station was brought about by the last EVA of the SL-4 mission. The crewmen commented that it got quite crowded with two crewmen, two clotheslines operating, the umbilical and an excess of extra gear. Apparently much of these tasks was somewhat "ad-lib" and not pre-planned. It was difficult for the crewmen to keep things from getting tangled.




Crewman at FAS Work Station

Figure 17

The following references contain comments concerning the work stations:

| Reference | Appendix Page Number |
|---|---|
| 1 | A-1 |
| 8 | A-24 |
| 10 | A-27 |
| 21 | A-54 |
| 35 | A-114 |
| 36 | A-120 |

Handrails

The handrails were an extremely useful multi-purpose restraint and mobility aid during Skylab EVA operations. The single handrails were considered adequate by the crewmen, but the double handrails along the "EVA Trail" were described as "super, superior, and like driving a freeway."

When used as a restraint, the handrails were functionally similar to the handrails on the interior of the spacecraft. When the task to be accomplished required only one hand to perform, the handrail was an adequate restraint; for two-handed tasks, obviously the handrail was inadequate for stability.

The crews commented favorably on the high color contrast between the handrails and the surrounding hardware. It made the handrails much easier to see, even though the blue color faded badly from exposure to the sun.

One comment was offered concerning the alpha-numeric numbering system. It worked well as a locator, but the numbers could have been larger and easier to see.

The only real complaint that the crewmen had concerning the handrails was lack of complete uniformity in their geometry. Apparently, there was just enough difference in size to permit some of the camera mounts to fit sloppily and jiggle on some of the handrails while on other handrails, the camera mount was difficult to lock into place.

The following references contain comments concerning the handrails:

| Reference | Appendix Page Number |
|---|---|
| 1 | A-7 |
| 4 | A-18 |
| 6 | A-22 |
| 9 | A-25 |
| 12 | A-30 |
| 13 | A-33 |
| 14 | A-34 |
| 19 | A-49 |
| 21 | A-56 |
| 35 | A-114 |
| 36 | A-124 |

Foot Restraints

The foot restraints proved to be an excellent type of personnel restraint for EVA tasks. The crewmen were unanimous in their comments that with adequate foot restraints, any desired EVA task could be readily accomplished. The work station foot restraints enabled the crewmen to perform their pre-planned tasks quickly and with relative ease.

The major foot restraint problem was the lack of adequate foot restraints to accomplish the unplanned maintenance tasks that arose. The crewmen feel that a good case can be presented for having some type of portable foot restraints that can be attached at nearly any location on the exterior of the vehicle. The SL-4 crew did use a portable PGA foot restraint for one of their repair tasks. The crewman commented that "That was a life saver. I couldn't have completed that EVA by myself." There were many instances of unscheduled tasks that were difficult to accomplish due to the lack of foot restraints.

The use of the foot restraint varied with the crewmen using them. At the FAS work station, in particular the crewmen utilized the foot restraints in various ways. Some of the tasks were accomplished while restraining only one foot to permit the crewmen a greater reach envelope, while at least one crewman used the foot restraints as little as possible. He preferred getting out of the restraints so he could have a better view of the exterior of the spacecraft.

A couple of minor complaints were voiced by various crewmen. The restraints apparently had a very close fit tolerance, which in some instances made the restraints somewhat difficult to get into and out of. Another problem, possibly due to the fit tolerance, was that the restraints occasionally released the user inadvertently. However, this also could have been caused by the orientation and direction of force that the user had to apply for a specific task.

One very interesting comment concerning foot restraint use was that "you need something to hang onto about waist level to get into foot restraints." Such a handhold provides the necessary stability to permit a crewman to shove his feet into foot restraints.

The following references contain comments concerning the foot restraints:

| Reference | Appendix Page Number |
|---|---|
| 1 | A-7 |
| 4 | A-16 |
| 10 | A-26 |
| 12 | A-31 |
| 13 | A-33 |
| 14 | A-35 |
| 15 | A-43 |
| 16 | A-45 |

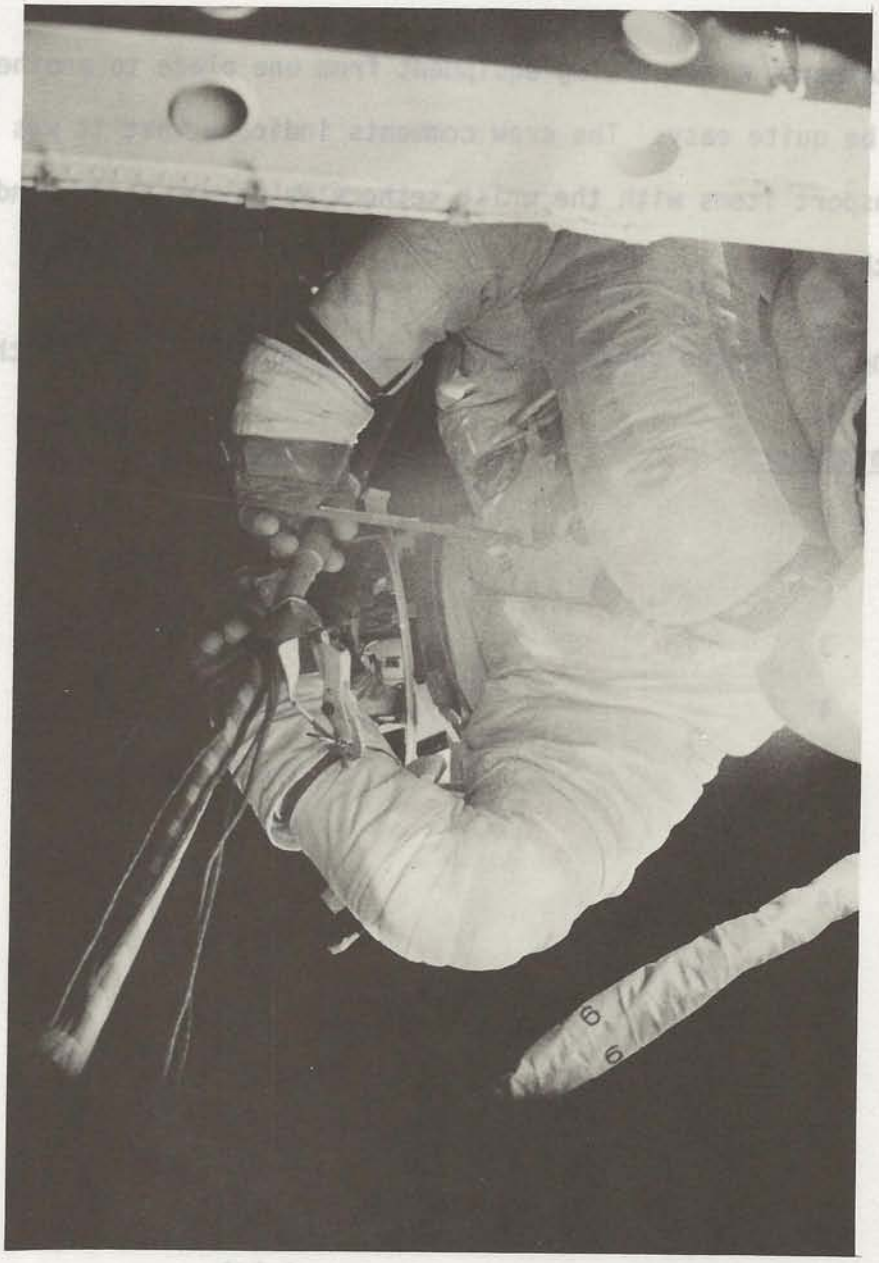
| Reference (cont) | Appendix Page Number |
|---|---|
| 18 | A-48 |
| 20 | A-51 |
| 21 | A-54 |
| 23 | A-68 |
| 24 | A-81 |
| 25 | A-83 |
| 33 | A-106 |
| 35 | A-110 |
| 36 | A-119 |

Tethers

Skylab crews utilized tethers both as equipment restraints and as personnel restraints. Figure 18 shows both types being utilized.

The personnel chest tethers were invaluable as restraints during some of the EVA tasks located in areas where foot restraints were not available. The SL-2 crew comments recorded during the task of freeing the jammed solar panel beam indicate that they probably could not have accomplished that task had a chest tether not been used by one of the crewmen.

The wrist tethers were utilized as equipment tethers rather extensively. The SL-4 crew commented that they were "worth their weight in gold" and that they could have used more. However, it appears that too many tethers



Tethers, Personnel and Equipment

Figure 18

could get in the way at times. Reference 27 indicated that there were too many things flapping about on tethers during one of the EVA tasks.

With wrist tethers, transporting equipment from one place to another appeared to be quite easy. The crew comments indicate that it was as easy to transport items with the wrist tethers as it was to rig and use the clothesline.

The following references contain comments pertinent to the EVA tethers:

| Reference | Appendix Page Number |
|---|---|
| 1 | A-3 |
| 2 | A-11 |
| 3 | A-15 |
| 4 | A-19 |
| 5 | A-20 |
| 12 | A-31 |
| 14 | A-38 |
| 22 | A-61 |
| 23 | A-64 |
| 24 | A-79 |
| 25 | A-89 |
| 27 | A-93 |
| 31 | A-101 |

| Reference | Appendix Page Number |
|---|---|
| 32 | A-103 |
| 35 | A-116 |
| 36 | A-133 |

Extendible Boom and Film Trees

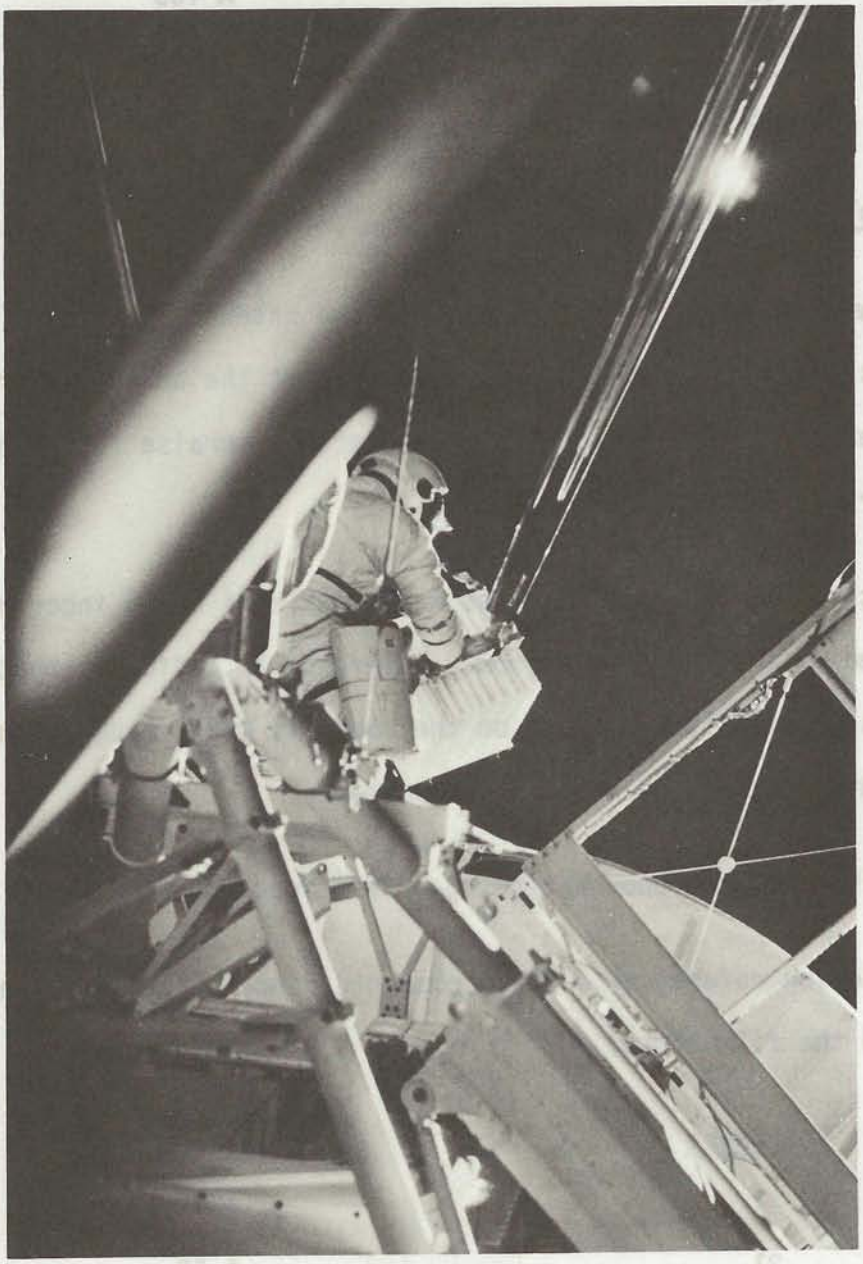
The crewmen had nothing but praise for the extendible booms. The few comments that the crewmen made indicated that the booms performed their tasks perfectly. The film trees also received praise for being good transporting devices.

Apparently, one of the film trees was capable of being incorrectly installed on the end of the boom. Reference 25 indicates that if the tree was incorectly installed on the boom, it would hang up on one of the light fixtures and stall the boom motor.

Figure 19 shows the boom extending a film tree to a crewman.

The following references contain comments concerning the extendible boom and the film trees:

| Reference | Appendix Page Number |
|---|---|
| 1 | A-1 |
| 21 | A-55 |
| 22 | A-61 |
| 35 | A-113 |
| 36 | A-121 |



Extendible Boom Operation

Figure 19

## Clothesline

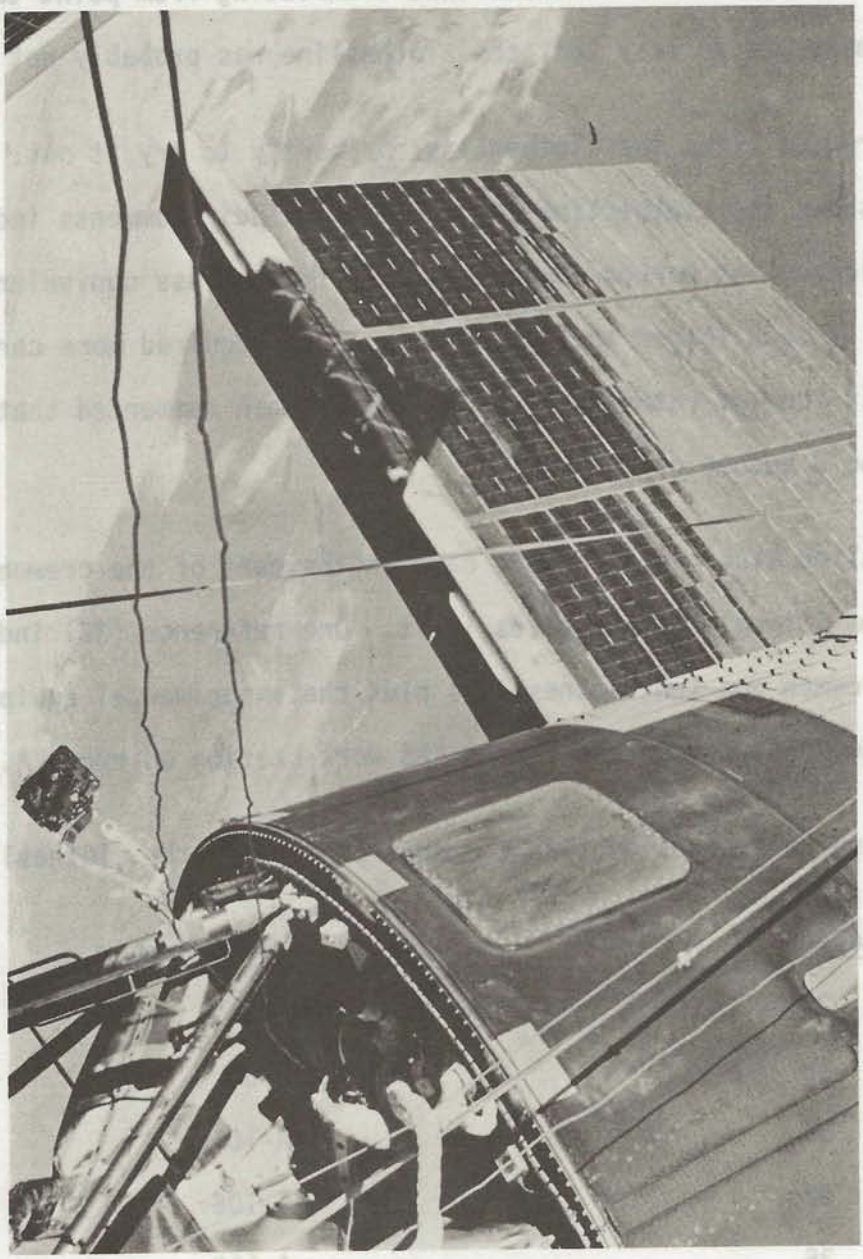
The SL-2 and SL-3 crews did not use the clothesline for any of their tasks. It was a backup system for the extendible booms and was not required. The SL-3 crew commented that translating from point to point with equipment was so easy that the clothesline was probably not needed.

The SL-4 crew utilized the clothesline, primarily to try it out. Figure 20 shows the clothesline in operation. Their comments indicated that the clothesline worked adequately, but it was less convenient than the boom. It took longer to rig and to use and required more care to operate. It tangled rather easily and one crewman commented that the tangling could become dangerous.

The clothesline also required more care on the part of the crewmen to keep from intangling themselves in it. One reference (35) indicated that two crewmen and two clotheslines plus the experimental equipment created a good bit of clutter in the FAS work station on one EVA.

The following references contain comments concerning the clothesline:

| Reference | Appendix Page Number |
|---|---|
| 21 | A-55 |
| 22 | A-61 |
| 31 | A-101 |
| 32 | A-105 |
| 35 | A-113 |
| 36 | A-127 |



Clothesline in Use

Figure 20

Temporary Equipment Restraints

Several types of equipment restraints other than tethers were utilized on the Skylab EVA operations. The gray tape, used so much on IVA tasks, was also utilized on EVA restraint tasks. The crew comments ranged from "it really grabs out here" to "it doesn't stick very well when its cold". It appears that gray tape has a limited use for EVA temporary equipment restraint.

Velcro was utilized some for EVA tasks. Apparently it worked well where it was used. One crew commented that it held much better in a vacuum than it did during the underwater training exercises on earth.

Snaps caused some problems during IVA usage and those problems were multiplied during EVA usage. They were difficult to align, (presumably because the EVA gloves were so large) and they were hard to get snapped together. The SL-4 crew commented that they really needed a foot restraint to maintain position and stability to mate a male and female snap together. They further recommended that the particular type of snap used on Skylab not be used again, if possible.

The following references contain comments pertaining to gray tape, velcro, or snaps as restraints used during EVA operations.

| Reference | Appendix Page Number |
|---|---|
| 4 | A-18 |
| 11 | A-28 |

| Reference | Appendix Page Number |
|---|---|
| 17 | A-46 |
| 23 | A-64 |
| 25 | A-88 |
| 26 | A-91 |
| 30 | A-100 |
| 34 | A-107 |
| 35 | A-109 |
| 36 | A-128 |

## CONCLUSIONS AND RECOMMENDATIONS

1. EVA restraint problems are similar to those of IVA. The crewmen, when adequately restrained, could perform any desired EVA task.

2. EVA translation differed from IVA translation in that the crewmen did not free-float from point to point, but rather translated hand over hand along the handrails. The single handrails provided good mobility aids and the double handrails provided excellent mobility aids for translation. Those areas without handrails proved difficult to translate through.

3. The umbilical tether provided an adequate safety line for the crewmen. It did have some tangling problems, but apparently not as great as in the water tank training exercises. Some of the crewmen felt that with the umbilical tether, drifting free from the spacecraft while performing tasks would not create problems and, in some cases, make certain tasks easier.

4. The work stations with their restraints, lighting and pre-planning for EVA tasks were quite easy to work from and enabled the crewmen to complete the assigned tasks quite easily and quickly.

5. The handrails were invaluable. The high color contrast, even though it faded, made them easier to see and utilize. The alpha numeric designators made differentiation between the handrails

possible, but should have had larger numbers and letters for quicker and easier spotting. The crewmen should not have to waste time looking for small numbers.

6. The handrails apparently had sufficient differences in cross sectional geometry to cause difficulty in attaching some of the portable equipment mounts. Some of the handrails permitted a loose fit, while others were difficult to clamp around. Equipment mounts should be capable of functioning well throughout the tolerance range of the handrails.

7. The foot restraints were the most useful personnel restraint devices for EVA work as well as for IVA work.

8. Portable handrails and foot restraints should be available for use when permanent restraint and mobility facilities are unavailable. Such devices will greatly facilitate the completion of unplanned maintenance tasks.

9. Personnel chest tethers enabled the crewmen to complete their more difficult, unplanned maintenance tasks in areas without adequate restraints. However, the success ratio was considered marginal.

10. Wrist tethers for transporting and restraining equipment were very useful.

11. The extendible booms performed their designated tasks extremely well, but it should not be possible to incorrectly install the attachments.

12. The clothesline transported equipment adequately, but was much more time consuming to use than the extendible boom. Further, one crewman indicated that the propensity of the clothesline for tangling could create a dangerous situation. The clothesline was not significantly better at transporting equipment than having a crewman carry the equipment on his wrist tethers.

13. Gray tape is somewhat controversial as a temporary equipment restraint. It was used somewhat extensively, but some of the crewmen felt it was quite temperature sensitive and didn't like it.

14. The velcro used for EVA equipment restraints appeared to work rather well.

15. Few snaps were used for EVA restraints. Those that were used were difficult to mate and snap together. The crewmen didn't recommend snaps for further EVA use.

11. The extendible booms performed their designated tasks extremely well, but it should not be possible to incorrectly install the attachments.

12. The clothesline transported equipment adequately, but was much more time consuming to use than the extendible boom. Further, one crewman indicated that the propensity of the clothesline for tangling could create a dangerous situation. The clothesline was not significantly better at transporting equipment than having a crewman carry the equipment on his wrist tethers.

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14. The velcro used for EVA equipment restraints appeared to work rather well.

15. Few snaps were used for EVA restraints. Those that were used were difficult to mate and snap together. The crewmen didn't recommend snaps for further EVA use.

RAW DATA APPENDIX

| Reference | Source | Page |
|---|---|---|
| 22 | SL-3 SWS Debriefing | A-61 |
| 23 | SL-4 Dump Tape 326-06 | A-64 |
| 24 | SL-4 TAG Tape 326-09 | A-79 |
| 25 | SL-4 Dump Tape 326-10 | A-83 |
| 26 | SL-4 Dump Tape 326-13 | A-91 |
| 27 | SL-4 Dump Tape 359-10 | A-93 |
| 28 | SL-4 Dump Tape 359-13 | A-95 |
| 29 | SL-4 TAG Tape 363-08 | A-98 |
| 30 | SL-4 TAG Tape 033-11 | A-100 |
| 31 | SL-4 TAG Tape 034-07 | A-101 |
| 32 | SL-4 TAG Tape 034-09 | A-103 |
| 33 | Catalog Index E-1 | A-106 |
| 34 | Catalog Index E-3 | A-107 |
| 35 | SL-4 Technical Debriefing, JSC-08809 | A-109 |
| 36 | SL-4 SWS Debriefing | A-117 |

CDR-EVA S082 went in there just out of sight. It's so much simpler than the water tank, it's unbelievable.

CC Roger. That's good news.

CDR-EVA This whole FAS station works just fine. And I will probably configure it for our next EVA before I come back in.

CC Okay, that sounds swinging.

CDR-EVA I'm going to check out all the booms and everything else. I figured you guys might have something else up your sleeve; so I'm trying to stay in front of you.

CC Sometimes that's hard to go, since we don't know which direction we're moving.

CDR-EVA That's all right. We're covering that ...

16 26 26 CDR-EVA Yes, it's sticking out, isn't it?

SPT-EVA Isn't it, though.

PLT I can see it, too.

SPT-EVA Let me kind of stand back here and see if I can work that way. Yes, there is clearance.

CDR-EVA That's the way I remembered it. Gosh darn, there's a lot of solar panels further down though, isn't there?

SPT-EVA Oh, yes.

CDR-EVA You're in good shape there, Joe. Can you put your - pull your feet down?

SPT-EVA Hard to tell. No, I don't want to pull my feet down right now.

CDR-EVA Okay.

16 26 54 CC Skylab, Houston. We've got you for about 17 minutes coming over the States.

CDR-EVA I'll tell you when you're on it.

16 28 06 PLT Houston, I'm going to try to get to the command module with the TV and - so you can look at the sail.

CDR-EVA All right. Now wait - -

CC Okay. Now we've got a way to get you some comm here, P. J. I mean ...

CDR-EVA Joe?

SPT-EVA Yes?

CDR-EVA You're battling the tether.

PLT No, let's let that go.

SPT-EVA I know I am. I'm going to have to untether.

CDR-EVA Let's come back in here. Let's come back in here. Just take it easy, and let me help you.

SPT-EVA I'm going to have to untether it, Pete.

CDR-EVA Now that's my - tethered around my feet. Right?

SPT-EVA Yes.

CDR-EVA Let me turn around.

SPT-EVA Okay, now it's loose.

CDR-EVA Where's my tether?

SPT-EVA Cripe. It's all right. It goes in front of your feet, but it goes straight back into the airlock. You're all right.

CDR-EVA Yes. Let me see if I can help you. Now. You should just - ease it over towards me. All right, wait.

SPT-EVA Don't - -

CDR-EVA No, the trouble is, I have to get it a different way. All right. I got it off. It's this whole thing holding the pole. Now just send it back towards me. Can you do that?

SPT-EVA What, the pole?

CDR-EVA Yes.

SPT-EVA No, I don't want to do that, I don't want to do that, I don't think. Let's - Why don't you help me ... while I have it on?

CDR-EVA Joe, you've got to have it tethered, and I'll let it slide out - it can slide out. Let's not lose - -

SPT-EVA Tethered to what?

CDR-EVA The pole. Let me get it in front of the rope.

SPT-EVA What are you going to tether the pole to? Oh, yourself, huh?

CDR-EVA No. Now you - -

SPT-EVA Oh, the BET.

CDR-EVA I just - no, darn it. I'll tell you what I want to do. Back - -

SPT-EVA What is that tether you've got on there?

CDR-EVA That's the pole tether. Now, you should just stay with me a minute. Come back with the pole. I'll tell you what we're going to do. We're going to get in the right configuration - -

SPT-EVA We were in the right configuration.

CDR-EVA No, we weren't. We were too short. You couldn't slide your pole back. See? Now the tether will go as far up the pole as you want it to. Did you retether it? You follow me?

| | | |
|---|---|---|
| | SPT-EVA | Whew! |
| | CDR-EVA | I'll tether it for you. Hold still. If I can coord - . Can you hold the pole? |
| | SPT-EVA | I've got the pole. |
| | CDR-EVA | Okay. I'm going to hold on to the pole and translate to the tether point. There. Okay. |
| | SPT-EVA | Be sure and lock it. It'll come apart in a second and then out. Okay, it's locked. |
| | CDR-EVA | It's locked. Let me get back to my - I need to get back. Push me back just so I can get ... |
| | SPT-EVA | Wait a minute. |
| | CDR-EVA | I'm on my way. That's a boy. |
| | SPT-EVA | Okay. |
| | CDR-EVA | Got it. Now you're in business. Okay? |
| | SPT-EVA | Okay. That might even help, if I reluctantly have to confess. |
| | CDR-EVA | All right. Now just turn the pole nice, freeze, and let her ... |
| | SPT-EVA | I'll tell you, holding that on there is going to be a chore. Goldang it. Wait a minute. |
| 16 31 01 | PLT | Do you see the corner of the sail, Houston? |
| | CC | Say again, P. J. |
| | PLT | Can you see the corner of the sail, the orange corner? |
| | MCC | Stand by. I think we can psych it out. We do have a good picture. |
| | CDR-EVA | All right, let me - Come back a little. Now we got to go forward. |

SPT-EVA Oh, that's it. Now come up.

SPT-EVA Just take your time:

16 32 38 MCC Okay, we've got it, P. J.

CDR-EVA Could you hold one foot -

SPT-EVA Yes, you try it. You that stable? If you could hold one foot, man, I could use both hands on this.

CDR-EVA Wait.

SPT-EVA Oh!

CDR-EVA Let me hang on. All right. How's that?

SPT-EVA That's pretty good. Now to get up under the rubble there. Wait a minute. Make this come foward.

16 33 35 PLT Tell me when you've got enough of the sail, Houston. I'll go back into the MDA.

MCC We've got enough. Thank you very much.

PLT Okay.

CDR-EVA Tired?

SPT-EVA I'm not tired. I'm a little frustrated because I have no place to secure myself here.

SPT-EVA Houston, I've got a suggestion.

MCC Okay, we're reading you. Understand you're having trouble in maintaining your position in order to hook it on the strap. Can you give us a little more detail? We're hearing a lot of the conversation but we haven't got a very good picture of it.

CDR-EVA Well, let's just cool it until we get done. We're working the problem. Bunch of wires in the way. Gosh, that prevented you from getting it that time.

SPT-EVA Un huh?

CDR-EVA Trying to let it go, you know.

CDR-EVA That's it. You've got it right there. Pull back.

SPT-EVA Can you by any possible means - -

CDR-EVA Oh, it came off.

SPT-EVA I know it, but can you get hold of that gray rope?

CDR-EVA Gray rope?

SPT-EVA The rope we marked.

CDR-EVA Oh.

CDR-EVA Yes.

SPT-EVA Wait a minute.

CDR-EVA I'm going to have to - Well, unfortunately, I've got myself tethered to the BET - to the deal right at the moment. Take a rest. Okay. I've got the - -

SPT-EVA You're pulling me around.

CDR-EVA I've got the pole.

CDR-EVA Take it easy.

SPT-EVA Okay, now. Yes the thing is - Listen, help in unhooking that rope back there.

CDR-EVA Hey, how about - Could you - -

SPT-EVA Unhook it from the cleat. I want you in a position to pull on the right rope while I'm holding it in place. Because I can't do both.

CDR-EVA Okay.

SPT-EVA Okay.

CDR-EVA Just a second.

SPT-EVA That would be the deal.

CDR-EVA Okay, I've got the right rope.

SPT-EVA That's the one.

16 36 16 MCC Joe, just for your information, we operated on the opposite side of the discone from the one you're operating on. That is, we operated from the right hand side of the discone. That may help you if you need more pole.

CDR-EVA It's not a question of ... pole -

SPT-EVA It's not a question - I've got more than enough pole, Rusty. It's a question of keeping my feet from flying away so that I can not only reach the thing, but hold it there.

MCC Okay, the only thing I can say that in the water tank we stood up almost parallel with the discone with our feet down by the base, and used the discone as a handhold. That helped us. You might want to try that.

SPT-EVA Yes, I'm doing that. It's not a handhold I need, Rusty. It's a foothold.

MCC Right. We put our feet right at the base of the discone and you only have to - -

SPT-EVA That's where they are, Rusty.

MCC Okay.

SPT-EVA It's easy to get it in touch, but it's impossible to get it to stay there. Not impossible. Just take it easy.

SPT-EVA Just takes a little longer.

CDR-EVA I may speed things up.

CDR-EVA I'm not in too bad a shape to steer this pole myself. Keep - Here. Now I got a hand on that son of a gun, myself, to steady it. How's that? I can steady it -

SPT-EVA ...

CDR-EVA - - left/right. Now tell me where you want to go with it. First, you do the fore/aft and let me do the left/right. Got to steer me because I can't see.

SPT-EVA Yes, wait a minute. I got a little torque on my body that's holding that from coming the way it wants to.

CDR-EVA Well, that may be me.

SPT-EVA No, it isn't you.

16 43 15 CDR-EVA I tell you, Rusty, it looks like if we ever get it on the strap, we got it made. Because I can see the rest of the meteorite panel, and most of it's underneath and looks relatively clear.

MCC Okay. If you can hook on anything at all out there --

SPT-EVA I understand --

CDR-EVA Yes, yes, it's not oriented to do that. We understand.

16 43 34 MCC Okay, and for your information, we're about 30 seconds from LOS. And you got 26-1/2 minutes of day left. And we're going to pick you up at Vanguard at 54; that'll be after dark.

CDR-EVA Where you going, Joe?

SPT-EVA I can't stabilize myself on this side. I just can't do it.

CDR-EVA Yes. Rest. I'll tell you what, Joe. Where's your umbilical with respect to mine? I see it.

CDR ... Wait.

SPT-EVA Let me try straddling it like this.

CDR-EVA Wait. We're getting umbilicals and everything else all twisted up here.

| | | |
|---|---|---|
| | SPT-EVA | Wait a minute; this may do it. Right here. |
| | CDR-EVA | Okay. You want the pole? |
| | SPT-EVA | I got the pole. |
| | CDR-EVA | Okay. You want me to still pull? With full strength? |
| | SPT-EVA | Uh huh. |
| | CDR-EVA | All right, let me get in a position where I can do that. I don't know. |
| 16 53 48 | SPT-EVA | That okay. There. Now. |
| | CDR-EVA | Now where are you? |
| | SPT-EVA | ... what I've done. |
| | CDR | Huh? |
| | SPT-EVA | Okay. Well, our umbilicals are free of each other. |
| | CDR-EVA | Look, now - now - I want you to get back. If I go out, where's my umbilical with reapect to yours? |
| | SPT-EVA | Inside of it; right where it ought to be. |
| | CDR-EVA | All right. So I can go under, right? |
| | SPT-EVA | Yes, sir. |
| | CDR-EVA | Right now? |
| | SPT-EVA | Yes, Paul. [sic] |
| 16 54 17 | MCC | Skylab, Houston; we've got you through Vanguard here. Sounds like you got it hooked on somewhere. |
| | CDR-EVA | Yes we do, and now all we're trying to do is straighten out the umbilical mess before I go out. |
| | MCC | Great. |
| | CDR-EVA | I don't believe we'll have to move the cutter. We got it in about the thinnest spot. All right, you ready? |

SPT-EVA Yes.

CDR-EVA All right, now. I've got to go - let me get oriented on this pole right. I got to go --

SPT-EVA Now you want to go with your feet out that way, don't you?

CDR-EVA Yes, and I want you to grab a hold of the pole now to stabilize it.

SPT-EVA All right.

CDR-EVA Got it? On my way.

SPT-EVA You bet.

CDR-EVA Bye.

SPT-EVA Good bye.

16 54 56 MCC And, Paul, the messages are in the teleprinter if you want to give them guidance.

CDR-EVA Okay, you may have to feed some of my umbilical out. You may have to tip my - -

SPT-EVA Oh, boy.

CDR-EVA ... Rusty.

SPT-EVA Wait a minute. However you fastened this rope, it sure is in there tight.

CDR-EVA It's all right; just let it come out.

SPT-EVA Okay, it's coming out now.

CDR-EVA Let it come over the end first. Let it come over the end. Don't pull it all loose; over the end. That's it, mushroom. That a boy. Bye.

SPT-EVA Take your time; I want to feed this rope behind you.

CDR-EVA Yes. And - -

SPT-EVA Okay.

| | |
|---|---|
| MCC | Okay. And we would like for you to leave it in the dump procedure, that is. We'd like you to leave it in a vacuum - - |
| SPT-EVA | Whoops. |
| MCC | - - on that side. |
| PLT | That's how it was when the light came on. |
| MCC | Okay. Thank you. |
| CDR-EVA | Yes. Joe, hold it just a minute. |
| SPT-EVA | Yes. |
| CDR-EVA | While I get these. I don't know whose umbilical is whose, here. |
| SPT-EVA | I'm trying to get down and help you. And I'm hung by the fact that I'm still tethered (laughter) to the pin. |
| CDR-EVA | Okay. |
| SPT-EVA | So I think I'd like to get this - - |
| CDR-EVA | All right, now I'm going. |
| SPT-EVA | - - like to get this pole going in some direction or other. |
| CDR-EVA | All right. Now, I've got mine all down here, and putting it away. Okay, with that. Now, where is it? |
| SPT-EVA | What? |
| CDR-EVA | Oh, I'm just looking for my umbilical. |
| SPT-EVA | Oh. Easier to track another guy's umbilical than it is your own, you know it? |
| CDR-EVA | Yes. But unfortunately, I've got yours down here, too. And I don't know why. |
| SPT-EVA | Just come along with - |

| | | |
|---|---|---|
| | CDR-EVA | Huh? |
| | SPT-EVA | It must have come along with you when you went down. |
| | CDR-EVA | Well, it's hooked in me somehow; it's behind my PCU, or something. |
| | CDR-EVA | Oh, no, it isn't. Wait a minute. I see it. |
| 18 08 35 | CDR-EVA | All right, that's yours. Now all I need to do is come over my head with it. I can't believe it. We've got them in, without being tangled. |
| | SPT-EVA | (Laughter). |
| | SPT-EVA | It's due to 100-percent skill, and zero percent luck, right? |
| | CDR-EVA | Yes. Okay. Now. I'm ready for you. All right - - |
| | SPT-EVA | I'm coming. |
| | CDR-EVA | - - hand me the pole. |
| | SPT-EVA | I'll get it a more favorable location momentarily. I'm trying to manage - - |
| | CDR-EVA | You're flailing around with it. |
| | SPT-EVA | I know it. Ah, yes. |
| 18 09 21 | MCC | Joe, this is Houston. If you've got a look at it, was the inboard panel clear of debris? Or is - - |
| | CDR-EVA | Yes - - |
| | MCC | - - it hanging up on it? |
| | CDR-EVA | - - yes. |
| | MCC | Okay. Thank you. |
| | CDR-EVA | Best I can tell. |
| | SPT-EVA | It's been that way - - |
| | CDR-EVA | Always been that way. |

MCC Say again.

CDR-EVA Oh, we're talking to ourselves, Houston.

SPT-EVA Wait a minute - yes. I need to stop right here, untether from the pin, and get myself toward it.

CDR-EVA All right; take your time.

SPT-EVA Yes.

CDR-EVA Got the main job done.

18 10 04 MCC And, Joe, if you get a chance before you leave the area, did you look at the connector on the top of the AUX tunnel to see if there is any obvious debris around it?

CDR-EVA No, it's clean - -

SPT-EVA ... connector.

CDR-EVA It's clean.

SPT-EVA On top - -

MCC Thank you.

SPT-EVA - - of the AUX tunnel, I cannot see from where I am right here.

CDR-EVA There - there isn't anything out there but that old piece of meteoroid shield that was underneath the wing.

SPT-EVA That sure is what it looks like.

CDR-EVA Ed, you got - -

SPT-EVA From an angle I can get on it, it's completely clean. You're right, Pete.

CDR-EVA You guys called it pretty well. It's - When I cut the strap it was under tension and it went about 2 feet. And it stopped; and then I had to break the - the - -

SPT-EVA Oh, look at that.

CDR-EVA - - whatchacallit. Look at what?

SPT-EVA Oh, my foolish 6-foot tether here. It's more of a hindrance than a help, all of a sudden. As a matter of fact, it you'll, well - I'd like to stuff it away some place. Not quite sure what to do with it.

18 11 34 SPT All right.

CDR-EVA What you doing? I'm holding on to the pole.

SPT-EVA You're holding on to it?

CDR-EVA Yes.

SPT-EVA Oh. Is it in a good position for you?

CDR-EVA Yes. Want me to get rid of it for you?

SPT-EVA Well, let's - let's bring it on down.

CDR-EVA Okay. Keep coming.

SPT-EVA I have to roll it here.

CDR-EVA Okay.

SPT-EVA To get the blades in the right configuration to get by this pole.

CDR-EVA Yes.

SPT-EVA Okay. Coming?

CDR-EVA It's coming.

SPT-EVA Keep her coming. You've got it now. It's out of my hands.

CDR-EVA I got it.

18 12 07 MCC Okay, EV-1 and 2. We're seeing a fairly high DELTA-T on the gas temperatures going through. We'd like you to, if you can, to go ahead and increase your water cooling.

| | | |
|---|---|---|
| | MCC | You got the job done. We don't care. |
| | CDR | Well, we got the job done only for one reason, and that's because Joe asked for the end of the double and long tether up to get himself anchored. If he hadn't been able to anchor himself, we wouldn't have been able to do it. And I think the difference is that the ... in the water between the pole and you, in hanging on, made the difference. Because I bet you he splashed around and splashed around ... |
| 21 15 30 | CC | Skylab, Houston; we're AOS Hawaii for the next 9 minutes, and we should be dumping a data recorder at this pass. |
| | CDR | Hello, Crip. Roger. |
| | CC | Rusty gave it back to me. |
| | CDR | Hurray! Maybe we won't get so many changes. |
| | PLT | Hey, Crip, I'd like to do something about these mol sieves soon. I mean the status right now is that our outlet temperature's come up. Apparently it was frozen. We did have the line blocked in there due to freezing. I just went up and ran both the primary and secondary fans on mol seive A, and it runs all right. However, the present configuration is, as you probably know, - is that most mol seives are shut down right now. Both fans are off. |
| | CC | You got both - both fans off? |
| | PLT | Fans are off and both mol seives. |
| | CC | Roger. But you did try the one and A? |
| | PLT | That's right. And the seive flow light does not come on anymore, and it doesn't make that noise anymore. As Pete said, I think it was the fan stalling out as they were flowing into the - into a blocked pipe. |
| | CC | Stand by 1 on that, Paul. |

| | | |
|---|---|---|
| | CDR-EVA | Yes, look at it. It comes over my shoulder, right? Where's that - where's - where's this coming from over my thumb? This one. |
| 16 00 11 | SPT-EVA | Goes over your shoulder, but where it goes from there I cannot tell. |
| | CDR-EVA | Oh, it's got to go to my suit. And this one is through the loop. Darn it! |
| | SPT-EVA | Well, wait a minute. Let's see - |
| | CDR-EVA | I'll tell you what I'm going to do. |
| | SPT-EVA | You're going to have to move yourself through a loop, I think. |
| | CDR-EVA | I'm going to have to go through this loop - - |
| | SPT-EVA | Yes. |
| | CDR-EVA | - - right here. |
| | CDR-EVA | All right, now. Push that over me. Wait. Wait, one second. |
| | SPT-EVA | All right. |
| 16 00 50 | SPT-EVA | Wait a minute. I lost it for a minute there. Okay. |
| | CDR-EVA | Okay. Yes. Let me tell you something about these foot restraints. You can take those foot plates out of there. |
| | SPT-EVA | How's that? |
| | CDR-EVA | Huh? It's - it's real easy for a fellow to get himself hung up in them. Man, my - my left shoe hardly comes out of that thing. All right, now where am I? They're all behind me now? |
| | SPT-EVA | Yes, it looks like it. |
| | CDR-EVA | I'm not sure what I got, yet. |

| | | |
|---|---|---|
| | SPT-EVA | Yes, I just hope by screwing around, we haven't made a loop where there was none before. |
| 16 01 42 | CDR-EVA | Well, I tell you what - |
| | SPT-EVA | ... there was an apparent loop. |
| | CDR-EVA | Huh? |
| | CDR-EVA | Mine's over my shoulder now. Is this mine? |
| | SPT-EVA | Yes. |
| | CDR-EVA | Trying to figure out where it goes. |
| | SPT-EVA | Goes right over, around your back and into your PCU. |
| | CDR-EVA | No, where it goes from there - goes down into here. |
| | SPT-EVA | Yes, that's the next end of it. |
| | CDR-EVA | Well, here, let me get it down. Get it. |
| | MCC | Okay, Skylab. Houston again over Guam for about 8-1/2 minutes. |
| | CDR-EVA | Okay. |
| | SPT-EVA | Roger. |
| 16 03 01 | CDR-EVA | I tell you. I'm going to get worn out doing the things that require you to get there. Do it. Well, that's a big snarl down there. I hope it all comes out right. |
| | SPT-EVA | Now, I suggest you take that loop in your hand, and put it up over your head. |
| | CDR-EVA | Why did we do that? |
| | SPT-EVA | Well - |
| | CDR-EVA | Huh? |
| | SPT-EVA | I'm just checking it. |

| | | |
|---|---|---|
| | CDR-EVA | Yes, it is. |
| | SPT-EVA | Okay? |
| | CDR-EVA | Go ahead. |
| | SPT-EVA | I am on my way. |
| | CDR-EVA | Handholds are pretty good, huh? |
| | SPT-EVA | So far. Up to here they're super good. Now from here to get to the pin, ... I can almost reach it. I - In fact, I can see the pin, so let me hold right here and undo the gray tape (laughter). Try and get that. Getting myself pinned here. I am pinned, but I'm not locked yet. |
| | PLT | Hey, Pete, what's the speed on that Hasselblad film - 64? |
| 16 14 10 | CDR-EVA | That's - well - Yes, I guess so, ASA-64. It's TV this pass, if they want it. |
| | SPT-EVA | Dag nab it! |
| | CDR-EVA | What's the matter? |
| | SPT-EVA | I can't get the lock locked on that Apollo tether pin. |
| | CDR-EVA | Is there something wrong with it, or - |
| | SPT-EVA | I don't know yet. Well, I got it. |
| | CDR-EVA | What in heaven's name is - |
| | SPT-EVA | It's a little crochety on the - Now I've got to go to the A-frame, huh? |
| | CDR-EVA | Yes. |
| | SPT-EVA | And up the A-frame. Hmm. I can't go up the A-frame more than the length of my tether. |
| | CDR-EVA | Well, let me see if I can see you. That's the big problem. |

| | | |
|---|---|---|
| | SPT-EVA | Just a minute now. Thanks to my friendly handhold. |
| | CDR-EVA | There - there went some gray tape. |
| | SPT-EVA | That's all right. That's gray tape off my - |
| | CDR-EVA | Shoot! |
| | SPT-EVA | What? |
| | CDR-EVA | See the holes in the discone antenna for ... |
| | SPT-EVA | Ah-hah! I can see four holes down. |
| | SPT-EVA | All right. Well, I'm about to go to that point. That's exactly where I'm going to go is up that - up that beam. |
| 16 15 50 | PLT | Joe? |
| | SPT-EVA | Yes? |
| | PLT | Your chest tether is between the SOP and your leg there. |
| | SPT-EVA | Thank you. Now let me see - Oh, yes. |
| | PLT | No, it's all right. There you go. |
| | SPT-EVA | Okay? |
| | SPT-EVA | Tell you what. I'm going to make a 180 here. |
| | CDR-EVA | I see you know. |
| | SPT-EVA | I want my umbilical behind my back, I think. |
| | CDR-EVA | Yes. |
| | SPT-EVA | Like that. |
| | CDR-EVA | All right. I see you fine. |
| 16 16 17 | SPT-EVA | That's as far as I can go; my tether won't let me go any farther. |

| | | |
|---|---|---|
| | CDR-EVA | Already did. |
| | SPT-EVA | We're already into the bathroom. (laughter). Very convenient. |
| 17 39 10 | PLT | Do you read me on this mike? |
| | CDR-EVA | Loud and clear. |
| | PLT | Great. I got more darn cords, cables, crap around in here. |
| | CDR-EVA | It'll take us a whole day, day and a half to clean up, another day to get organized. |
| | CDR-EVA | I tell you, Joe, you were really using the old head-a-rooney there, doubling up your tether. |
| | SPT-EVA | Listen, without that I never would have made it. The BET would flip every time I exerted any torque. |
| | CDR-EVA | Oh, yes, you were one-arm - - |
| | SPT-EVA | Yes. |
| | CDR-EVA | - - flailing. |
| 17 39 57 | SPT-EVA | Yes, I was bad - was bad. We should of thought of it before. And It's a little lesson that a foot crotch cutter, which is essentially what I had - - |
| | CDR-EVA | That's right, well - - |
| | SPT-EVA | It's a useful device in that situation - - |
| | CDR-EVA | - - that's why I asked you, you know, because it looked to me like that would have been an ideal way to get up here. We could have gone ahead and rigged that thing so it could have been a crotch tether. We could have done it real easy. |
| | SPT-EVA | We could have done it, yes. You should have done it beforehand. Well, I was lucky, it was the right length when doubled. |
| | CDR-EVA | Yes. |
| | SPT-EVA | It was just perfect. |

| | | |
|---|---|---|
| | CDR-EVA | When I disconnect from the pole tether, Joe - |
| | PLT | Yes. |
| 17 40 55 | CDR-EVA | I will have my other tether on the BET and I will disconnect at my wrist so that the long tether stays with the pole. We'll get - - |
| | SPT-EVA | You'll have your other tether on the BET? |
| | CDR-EVA | Yes. |
| | SPT-EVA | Your wrist tether? |
| | CDR-EVA | My wrist tether on the BET. |
| | SPT-EVA | Okay. |
| 17 41 20 | CDR-EVA | Sounds loud and clear down there. |
| | CDR-EVA | P. J., you got your maps - orbital maps up there? |
| | PLT | Yes. |
| | SPT-EVA | I almost can't see the ground anymore. |
| | CDR-EVA | Well, that's good, that means we're coming out daylight pass. Where do we cross the states? We got a long stateside pass, again? |
| | PLT | Got my hands full of tape! |
| | CDR-EVA | Okay. |
| | SPT-EVA | Turn this way a little so I can see sunrise. Out of China, cross the bay, kinda. Upside down, but that's all right. |
| 17 42 10 | SPT-EVA | It's starting to get blue. |
| | CDR-EVA | Good show. |
| | PLT | We had kind of a long pass. We go - kind of right down the length of California. We're descending down the west coast and down along the west coast of Mexico. We got Goldstone intersection. |

PLT Okay. Oh, you take that off and stow it.

CDR-EVA That's what I'm doing.

SPT-EVA There's nothing hanging that inboard panel up, Pete. I can see it from here, and there's nothing but black underneath it.

CDR-EVA That's beautiful.

18 42 56 SPT-EVA There's a good 2 feet of clearance.

CDR-EVA Okay.

SPT-EVA Those panels ought to come out.

CDR-EVA All right, Joe; any time your're ready.

SPT-EVA Okay, I'm coming. These double handrails are the way to go. This is first class.

PLT Okay, you got the Sun end boom fully retracted and the hook folded?

CDR-EVA Yes.

PLT Okay, I guess you don't want to pick up the 024 while you're out there, huh?

SPT-EVA (Laughter) Wouldn't mind; get it all done. One at a time. It's getting dark!

PLT Well, heck. You just come back and get in, Joe.

SPT-EVA Yes. Okay. Tending my umbilical nicely.

PLT What are - what are you doing with it, Pete? Are you twisting it in behind you?

SPT-EVA Yes, that's what he's doing.

PLT Is is working all right?

SPT-EVA Beautiful. Sure looks all right.

18 44 02 PLT Okay, and the EVA clock says 3 hours and 20 minutes.

CC Okay. It won't be until Canaries, as I say, and that's still awhile away at 14.

PLT All right.

CC Have you got a minute to chat with us now?

PLT Yes, go ahead.

CC Okay. I guess it would be better for the CDR, SPT. We been reading over this dump tape on the SAS deployment, and I guess some of us were - had the question as to what really happened there when you - when you finally cut through that bolt. That sort of looks like the pole and everybody kind of went - went for a good ride. I guess we'd like to get a little more elaboration on what sort of dynamics you went through there, with the umbilicals and all.

CDR Well, I couldn't really see my umbilical, Hank. What I did, when the pulling on the BET, when the - when the tape broke, I took off upward, but I was tethered to the BET, and I had both hands on it; and of course, it went slack. And so, all I started doing was hauling myself toward the A-frame. And Joe was hanging on to the BET, too. And I - I don't know where he went. (Laughter)

SPT Let me tell you first about Pete's umbilical. It really was no problem because his - his umbilical was stiff enough - stiff enough, intending to take a set up there, and all the time he was working out on the beam it was trailing to his left and behind him in a big arc around the corner and away from the SAS beam. So, it - it never gave me a moment's trouble. When he bounced up, it just bounced up along with him. I was under the - under the - the BET further back, in fact, right at the corner of the FAS, heaving like a mule, and when it went slack, I just went up in the air a few feet and did a right roll of 360 degrees, and finally scrambled down onto the - the truss work there - slowly.

against a small field in tomorrow's Belmont Stakes. The record smashing thoroughbred is favored to win the hard-to-win race.

CC Okay, the latest score on Houston is Astros ahead 4 to 3 in the ninth, and it's not over yet. Yesterday's scores, let's see - I believe we had a Dodger fan and a Cub fan and - onboard here, and they played each other. And the Dodgers came out on top, 4 to nothing.

PLT You don't have to give those scores.

CDR What place the Astros in?

CC Okay, Astros are 6-1/2 out now. And Chris just tells me that the Cubs won tonight 6 to 5.

02 57 49 PLT How are the Cubs doing in the NL East?

CC Okay, they're 5-1/2 out in front of Pittsburg.

PLT Oh, isn't that nice?

MCC And for the CDR's information, we - I want to relay greetings and so on. And I think that's all the news for tonight. See you around, Henry.

CC Good bye, Rusty.

02 58 16 CDR Say, Rusty, did you get my last comment about the damping in the water tank? That would be the biggest thing that I could see is the difference out there.

MCC Yes. Okay, I got that, Pete. Thanks.

CDR Okay, the other thing is - is that EVA station - the FAS station - is super. It's so much - it's so easy to work in there, it's unbelievable. You guys did great work designing it.

MCC You mean even for a little guy, you can reach all those things, huh?

CDR Even for a little guy; I didn't complain about you one time.

| | | |
|---|---|---|
| | CDR-EVA | All righty? |
| | PLT-EVA | Hold it in your teeth, now. |
| | CDR-EVA | Well, I'm trying to. |
| | CDR-EVA | Okay, now. Let me see if I can't get out of here. |
| | CDR-EVA | Okay. |
| 12 10 50 | CDR-EVA | Now here I come. These handrails are superior. This is so good, I can't believe it. Too bad we don't have these all the way in, because this is the way to go. |
| | PLT-EVA | The doubles? Yes, aren't they neat? |
| | CDR-EVA | Now, they want the cap con [?] out, right? |
| | PLT-EVA | Oh, I like this. |
| | CDR-EVA | I think what you got to do is just take your time. |
| 12 11 47 | PLT-EVA | Umbilical management is really no sweat, I think. |
| | SPT | No, I didn't think so either - particularly. |
| | PLT-EVA | Man, did this suit just bite me, on the inside of the elbow. |
| | SPT | (Laughter) |
| 12 12 01 | CDR-EVA | Wow. |
| | PLT-EVA | What's the matter, are you lost? |
| 12 12 05 | CDR-EVA | No, I'm just trying to figure out how to approach this. |
| | PLT-EVA | I guess I can turn this DAC off now. |
| | SPT | How would you ... the problem in the water? |
| | CDR-EVA | No, no, I'm talking about putting this thing on. |

CONRAD D024? No!

SPEAKER Did anything unusual happen during the retrieval EVA? Did everything go smoothly there? Nothing unusual?

CONRAD Yes. It was as hard to do up there as it was in the water tank.

SPEAKER You had to hang on with one hand.

CONRAD Yes.

SPEAKER There was some comment during the second EVA about whether or not the white light on the D024 support was on. It should be illuminated when either the AM EVA light switch on the panel 316 in the lock compartment or the DOCKING light switch on 207 panel in the STS is ON. We were just wondering, was the illumination observed that would confirm that the light was operable?

CONRAD It was down here during the day time.

SPEAKER Could you be specific on what sort of restraints, stability/mobility aids, would have been useful?

CONRAD Yes. Barefoot restraints down there, just like we had every place else, so you could just lock your feet in and work with two hands.

SPEAKER Don't you have heel plates there?

CONRAD Yes. Standard foot restraints. Even one. Anything.

WEITZ Anything, if you're in a bind for room, because my normal mode in the FAS was only one foot in there anyway, which gives you more room to move about. Then if you're in a place where you're room limited, even one foot restraint is enough.

SPEAKER Were any pictures taken of DO24?

CONRAD No, sir. We never had any requirement to.

SPEAKER When the detector package for S009 was observed to be stalled between the OPEN and CLOSE positions, was the motor making a noise or was it silent?

WEITZ No. It was silent at that time.

SPEAKER The reason the motor can stall in the latched position in which nothing's moving, it's just drawing current but nothing's wearing. If it's not quite latched, it keeps trying to latch and chatters. This could wear out the ratchets. When you performed the malfunction procedure, there was one part of that, rather a critical step, when the bearing latches were moving to the full OPEN position. If they traveled all the way to the

CATALOG INDEX E-1 PAGE 10

SKYLAB MAN-MACHINE DATA FROM MISSION SL-II
FOR: E. EVA-SUITED ACTIVITIES
1. EVA Maintenance

ATM EXPERIMENTS DEBRIEFING (CONTINUED)
PAGE 46-47

KERWIN: The follow-on crew suggested that they might put gray tape over that door when they were done with it. I don't know what anybody thinks about that. It might give you a little warmer feeling that the door wouldn't come open.

CONRAD: Well, I had a very warm feeling about those magnets. I had to put a real healthy pull on the door just to get it open off the magnets. I wouldn't be concerned about it. The reason I say that is that I noticed, on the other portions of our EVA when we were using gray tape out there, it really grabs once it's put out in the vacuum. I just think you'd make things more difficult, and I feel those magnetic latches are perfectly adequate.

PAGE 49-50

CONRAD: Let me just say one thing about that. I gather Owen has some hesitancy to bring it up, but I wasn't going to argue with you guys in flight because I don't believe in that. I really felt you made the wrong decision in pulling the pin. I'd sure like to see you let them on their first EVA, because they got all the time in the world. I realize there's a clocking problem on that pin, but if you could take the time with them to do a little training, the guy could sit out there after he puts the pin back in and you could run that door as much as you want to. My personal opinion for them and for operations is that it would sure help them if they could get that door back into operation. I understand there's another way to the operate and the ready light going. Either way, to your satisfaction, if we could give them an operate/ready light situation it sure makes running the building blocks a lot easier.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-II
FOR: E. EVA-SUITED ACTIVITIES
1. EVA Maintenance

ATM EXPERIMENTS DEBRIEFING (CONTINUED)
PAGE 51-52

KEATHLEY: Were there any difficulties encountered in operating the EVA rotational control panel from outside? Did the canister work as advertised and were the speeds okay?

CONRAD: There were no difficulties whatsoever. We got all the lights where they're supposed to be on the front end.

KEATHLEY: Were the talkbacks visible?

CONRAD: They sure were. The magazine went in and out easier than any I've done before. The actual flight articles worked very well. All camera magazines, for that matter.

PAGE 54-56

KEATHLEY: The next question concerns the cleaning of the disk on the S052. There's a piece of string there for your reference. Is this perhaps what was on the D-1 disk when you cleaned it? Can you make some comments about the size, and where did the piece go?

CONRAD: I would say no to this, because this looks like it's waxed or has some kind of coating on it. I had the impression that it looked like a very small piece of cotton or Beta cloth thread and that it was not from string but possibly from a fabric edge that had been cut. I didn't see it go. I could see it when I looked in there, but my hand is pretty big with the EV-gloves on, and I didn't see it go. I guess my general comment still pertains. I really have the feeling that we ought to see, from the data, if you could reconstruct whether we had just rolled the canister at the high rate whenever you happened to see contamination going by the coronagraph. I had the decided impression, after being out

(CONTINUED ON NEXT PAGE)

SKYLAB MAN-MACHINE DATA FROM MISSION SL-II
FOR: E. EVA-SUITED ACTIVITIES
3. Restraint Use

TECHNICAL CREW DEBRIEFING
6.0 Anomalies and Unusual Activities

CONRAD: The other thing was some of the EVA gear. Maybe I'm a little finicky, but I came up with some better ways of putting it together than the way they did from the ground. We worked with a lot of the throw-away stuff inventing better ways to make tethers for hammers and tape lens brushes and all the things we carted out on the EVA.

7.0 On-Orbit Days
7.6 Mission Days 12, 13, 14

CONRAD: However, doing the last EVA with all three of us on one loop, they thought I was probably stowing a little heat towards the end. The only reason was that I got hot doing the add-on tasks which are the most difficult ones to do. Putting that piece of JSC sail around that strut was a real Dick Gordon-type operation. I was really flailing away out there trying to hold on until Paul came down and put his feet on my shoulders. Then I could hold on with my legs and I finally got that sail cloth on. That's when they called and said I was storing heat.

14.0 In-Flight Experiments
14.4 Individual Experiments

CONRAD: D024 was done on the EVA, and the retrieval of the panels and stowing them in the container went per checklist. My only comment is because there are no foot restraints down there, it was something that I just had to take my time doing. I spent most of my time hanging on with my left hand to the little guardrail around the D024 assembly, just moving slowly, performing all operations with my right hand, and using my left hand to hold my body and stabilize myself. That just takes time, because you've got to move slowly, so you don't get out of shape. I don't believe that I touched

(CONTINUED ON NEXT PAGE)

SKYLAB MAN-MACHINE DATA FROM MISSION SL-II
FOR: E. EVA-SUITED ACTIVITIES
3. Restraint Use

TECHNICAL CREW DEBRIEFING (CONTINUED)
14.0 In-Flight Experiments
14.4 Individual Experiments

CONRAD: any of the panels in any of the places that would cause any problem with the experiment. I was able to pull the panels off and transfer them to the return container in a proper manner. The big butterflies on the return container made it simple to open and close.

15.0 Training

CONRAD: If you can do it in the neutral buoyancy facility, it works. But there's one place in neutral buoyancy that's the same as the airplane where you have to be careful. In every one of these places where we did not have good foot restraint, I think you can be misled when you can do it in the neutral buoyancy facility, but you can't do it in-flight due to damping in the water. Wrapping the cloth around the strut they wanted was the highest workload I had in the EVA. Changing film out and doing DO24 was another difficult task because we didn't have adequate restraint. It was a difficult task in the water tank; it was even more difficult inflight. It was the same thing with hooking up the BET. I have the feeling that the water helped a little bit, because we were very poorly tethered out on that SAS beam, and there was a little bit of luck in both Joe and I getting that job done. We were very marginal on completing it.

16.0 EMU Systems

CONRAD: The foot restraints were excellent. I used every station, i.e., the FAS foot restraints, the VC foot restraints, the VS, and over the side. All four foot restraints worked well. I had the Owen Garriott fix on my boots to make it easier. It's really not necessary in zero-g. One other comment on the foot restraints. I noticed when I moved

(CONTINUED ON NEXT PAGE)

SKYLAB MAN-MACHINE DATA FROM MISSION SL-II
FOR: E. EVA-SUITED ACTIVITIES
3. Restraint Use

TECHNICAL CREW DEBRIEFING (CONTINUED)
16.0 EMU Systems

CONRAD: both my heels outward into the foot restraints, that there was a very definite bite. It took hold. It took a very definite bang inboard of my heel to get them unlocked out of there. They had no tendency to slip out whatsoever. It's a very nice tight fit.

*****

SWS SYSTEMS DEBRIEFING
PAGE 26-28

SPEAKER: OK. Next one is kind of a loaded question but it has to do with mobility. In light of your experience on Skylab, with respect to the need to move about on the exterior of the vehicle in an unplanned mode, do you recommend incorporation of a universal type portable mobility aid like handholds or little portable gimmicks that you would carry along? This is advanced planning.

CDR: Yeah, I'd-- There's no doubt in my mind--there's no way you can think of what happened to the OWS happening and preplan that. In the first place, had you preplanned it, all that stuff would have been gone anyhow, cause it would have all been mounted in the meteoroid shield, right. So you get down to the meteoroid shield, which you never planned on leaving. But, I think, in future design the message is that if you know that you may have to go someplace and perform any kind of a task, like changing out black boxes that are exterior equipment or anything, as long as you preplan this, these are relatively simple tasks, and the EVA operation speaks for itself on changing film out. That was well thought out, it was exercised by all parties and it was a very smooth operation. But anytime you are going to ask a guy to go do something that we haven't tried, and you don't give him proper restraint EVA he is going to have trouble.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-II
FOR: E. EVA-SUITED ACTIVITIES
4. Mobility

TECHNICAL CREW DEBRIEFING
17.0 EVA
17.1 EVA Operations

WEITZ: Handrails. From the one trip I made out there, a single handrail is a perfectly feasible way to get someplace. You have to go a little slower because you're keeping your body straight through your wrists. The double handrail is like driving the interstate highway.

CONRAD: The double handrail was neat.

WEITZ: Yes, that's the way to go.

CONRAD: It's was much easier to transition off that handrail into the foot restraints over the Sun end station than in the water tank. You need something to hang on to about waist level to get into foot restraints.

LSU management worked well. You can see them well enough and work them either in the FAS or outside. We never did get them tangled as we had done many times in the water tank.

WEITZ: There's a lot of stiffness to those things to keep them from wrapping around each other.

*****

PLT: It's relatively unimportant really, I think, Dick.

CDR: Yeah, but we do appreciate the fact that that worked well, that they were a different color. I think that we appreciated that outside too. You know, not just inside.

PLT: Yeah

SPEAKER: OK. Next one is kind of a loaded question but it has to do with mobility. In light of your experience on Skylab, with respect to the need to move about on the exterior of the vehicle in an unplanned mode, do you recommend incorporation of a universal type portable mobility aid like handholds or little portable gimmicks that you would carry along? This is advanced planning.

CDR: Yeah, I'd-- There's no doubt in my mind--there's no way you can think of what happended to the OWS happening and pre-plan that. In the first place, had you preplanned it, all that stuff would have been gone anyhow, cause it would have all been mounted in the meteoroid shield, right. So you get down to the meteoroid shield, which you never planned on leaving. But, I think, in future design the message is that if you know that you may have to go someplace and perform any kind of a task, like changing out black boxes that are exterior equipment or anything, as long as you preplan this, these are relatively simple tasks, and the EVA operation speaks for itself on changing film out. That was well thought out,

it was exercised by all parties and it was a very smooth operation. But anytime you are going to ask a guy to go do something that we haven't tried, and you don't give him proper restraint EVA he is going to have trouble.

SPT: Yeah, with handrails and foot restraints where required you can do anything.

CDR: Yeah

SPT: So that in a future vehicle, if you could design cleverly some little pop-up attach points to which you could affix a handrail and you could probably, you know, exact this thing with a foot pole or something like that if it was designed properly. Attach a handrail to it and it the required foot restraint somewhere, I'll bet you could easily devise a foot restraint bracket that would attach to a handrail.

CDR: I gather--

SPT: With that kind of preparation, you could do anything out there.

CDR: I gather that not everybody like Rusty and those guys knew whether the extra handrails were still on the MDA or not and I was damn happy to see those ones that got us up under the D.A. struts and everything.

SPEAKER: The longitudinal handrails?

CDR: Yeah, there were some on there and the comment from the ground, as I remember it was, they may be there and they may not, you know, and you can make it whether they are or they aren't, but there did happen to be those extra ones up there, which apparently you had them all over the vehicle, at one time and you removed some.

--END OF TAPE--

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|---|---|
| SPEAKER | Would you recommend taking up some portable foot restraints, if we could get some devised? |
| PLT | At this point in time? For Skylab? |
| SPEAKER | Yeah |
| CDR | No. I don't think you got any reason to go any place now other than out to the ATM now, I guess they're talking about changing rate gyros or adding rate gyro packages or something. By golly, if you're going to do those kind of things, you had better think it out in the old water tank. You are going to have to do things like for the Marshall sail, you know, put foot restraints where a guy has to work. |
| SPT | Which would have worked beautifully, and will, if it gets used. |
| CDR | Yeah, that's right |
| SPEAKER | Reading the transcript, you get the impression that you could have used some with that thing you were doing out there that wasn't lying flat. |
| CDR | Oh, that's right. That's what the whole problem was. |
| SPT | I was wishing about that time that something we talked about in the 10 day period, that we'd found, and those were stick-on portable handrails of some kind. |
| SPEAKER | If you had a box of those, like 8 or 10 of those that could be stuck on any surface, you think that they would work out. |
| SPT | I'll bet that if we had failed to hook the hooders on we could have gotten down there to the action site by using portable handholds. I'll bet that if Pete had had portable handholds, one or two of them at that point, to place on the right hand side of the beam fairing he could have hooked up the other hook. |

SP: It's a flexible system

SP: I think we've got everything on the ATM chair from the other day. The manual pointing controller on the ATM, we had that retainer ring around there, did that work out well? Were there any comments on that?

CDR: Yes

SP: About height or is it good like it is or would you rather have it a different height or anything like that?

CDR: I, personally I liked it.

PLT: Yeah, it was good

SP: Did your pinky finger meet to lock around it?

CDR: Yeah

SP: Stability or anything?

CDR: Yeah

CDR: If you give a guy EVA adequate foot restraint put him properly in place, then he can perform any ~~kx~~ of the kind of tasks that you would like to do out there, which is either replace packages or change film out or anything and the thing that was so nice about EVA is that the water-tank allowed us to develop good procedures and all the stuff we worked on went the way it was supposed to.

SP: I know on the SAS beam one of the things we were afraid of was that we were going to be possible a little over optimistic because of drag and just how much optimistic we were otherwise.

CDR: Well, I can tell you Al, overly optimistic you, the two places we had trouble was getting Joe bolted down to get the pole on and we would have never gotten him there using your method. We had to tie his chest-tether tight, and fortunately we were able to do that or I don't believe he would have ever hooked that pole up. Because he failed away for 50 minutes the first daylight pass, or a good part of it.

CDR (cont'd) Ok, the second place where damping I'm sure was an influencing factor was me trying to get that bet-rope over my shoulder; because it acted like a bow and arrow--I was the arrow and that was the sting and every time I linked that thing up, my feet would shoot out from under me and would shoot out from under me and I would start down the side of, the tank and you know, I had to really jockey around to get up underneath of to where I could get it up on my shoulder and not have it squirt me back out because I had; I, I you know you can't walk and the surface was smooth and my feet would slip and I kept shooting out from under the rope every time I tried to pull it up, I'd, my feet would go out from under me. And those were the two places, those were the two places that's waht elicited my original comment before we went that I didn't thing our chances were as good as you guys thought they were because it was obvious, you know, we could see the pin to tether to, we could see the dipole, we could see the connectors, excuse me, on the discone we could see the connectors and it was obvious that it was going to be a difficult place to get anchored. Now, the only thing I feel ~~lead~~ good about as I was smart enough to poop-can the original tether on Joe and given him my wrist thther and had he gone out with that on in the first place and pulled himself down, we'd had the job done in the 50 minutes, it would have gone just like that, because as long as we had adequate restraint, those tasks weren't difficult.

SP: While you were in the suited mode, would you compare the zero-g masses versus the water? The reaction of mass in the water-tank, was it easier, harder, accelerations, decelerations, again this reflects to damping.

CDR: The damping, the viscosity of water, there's no way to get away from that.

SP: Yeah, right

CDR: You've got to move very slowly in the water. However, as long as you move slowly out there too you never get into any mass problems. You can move faster and I think it's a, it's like going from one-g to zero-g, you catch on very fast. In the water-tank you've got a good handle as to how it's going to act, you have the procedures down and it's just that much easier to do. If you can do it reasonably in the water tank, you can do it easier in zero-g and that's all based on giving the guy adequate restraint.

SP: Did you ever attempt to maneuver Joe on the end of the 25 foot rod, either inside or outside?

CDR: To maneuver Joe?

SP: Yeah, or he maneuver you?

CDR: He did me inside we tried that that night before we went out. He was not suited. He was maneuvering me--I was up at the cutters

SP: Right, how did it go?

CDR: J st smooth flow

SP: Yeah, did you ever assemble?

SP: Excuse me, he didn't have any big problems positioning you close to anything you wanted to be positioned to?

CDR: Yeah, if you get pole dynamics going, if you just stop whatever you're doing there's enough internal friction in a rod like that, that it is going to damp itself. It may take a while but it'll damp. Just stop what you are doing.

SP: Ok, we had played with this some in the water tank using the boom, let one man hold the boom housing, put a sencond subject out at the end of the boom at 25 or 30 feet and played him up and down the side of the OWS vehicle and we could do this very well and we just wondered if you had tried it.

SPEAKER: Whenever that is.

SPEAKER: Yeah. I believe we ought to get it before . . . storage guys start finding a place for it.

PLT: We didn't put that on tape, huh?

CDR: No, because it broke on, it was the one we took out of the MDA. What we were using it for was we were putting up the heat shield and we were getting it to break loose the big tank, the condensate tank?

PLT: I guess maybe so.

CDR: It was busted so we zipped down and got the other one and we said "We'll report that," and promptly forgot it forever.

SPEAKER: Somebody's handed me one last question. Pete, do you think you would need a wider assortment of hammers? (Laughter)

CDR: Surprisingly enough the only thing we used the hammer for was the CBRM.

PLT: Oh no! Joe used it trying to get his holes in.

CDR: Oh, that right (much laughter). I forgot.

SPEAKER: How did you carry the hammer out, by the way? Did you-- you sent it out on the boom, didn't you?

PLT: Yes

CDR: Came awful close to loosing the hammer, because we made the ring out of safety wire and there's a little gap in the clamp. When I reached up to grab the hammer, it just came off the end of the boom clamp.

PLT: Oh, is that right?

CDR: Yeah then I had it tethered with--I put my wrist tether around it and I guess I didn't lock it. I was flailing away out there and after a while I realized that the wrist tether was flailing off by itself in one direction and all I was doing was holding on to the hammer. I didn't lose it, but it was close.

SPEAKER: You struck that thing a number of times?

CDR: 8 or 9. Well, I figures I'd give her a few good ones and then have Joe check it, you know. I hit it 8 or 9 times and then said "check it" and it worked.

SPEAKER: In reference, going back to your discussions yesterday concerning the difficulty of talking, you know, just with other--communicating with each other orally, and we were saying at 4 or 5 feet you lost intelligibility at normal voice levels. Now what we are trying to do here is to say comparing the speaker outputs, the one of the speaker outputs to one of you talking to another. Was

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|---|---|---|
| | SPT-EVA | I'll put it wherever you like it. |
| | PLT-EVA | A little higher. Or about 6 inches toward me. |
| 218 19 24 39 | SPT-EVA | There you go. |
| | PLT-EVA | Oh, my gosh! It's in! |
| | CDR | Hey-hey! |
| | PLT-EVA | (Laughter) It's swinging back and forth out there. |
| | SPT-EVA | About a 4-second period, isn't it? No, you best don't - Yes. You don't ... |
| | PLT-EVA | I'd just leave it. |
| | SPT-EVA | Yes, just put a hand damper on it and that'll take the energy out better than anything. |
| 218 19 25 07 | CC | Skylab, we've got you over the Vanguard for 11 minutes. Reading you loud and clear. |
| | SPT-EVA | Okay, we just got the first 11-section pole out there, Story, and passed it on out to Jack. Maybe you can - no you're not - you don't have any video, of course. But the 11-section pole is now being clamped to the base plate and it's not oscillating too badly at all. It does oscillate with about a 4 - or 5-second period, really a slow one. And - oh, I'd say the amplitude at the moment - when I passed it out to Jack wasn't more than plus or minus 3 feet. So it's not too big an oscillation. |
| | PLT-EVA | It's stable right now. |
| | SPT-EVA | And it's already stabilized, Jack says. |
| | CC | Okay. Great. And you've made a lot faster progress since the last station than you made before. Are you doing something different? |
| 218 19 25 57 | SPT-EVA | Yes, as a matter of fact, I am. In order to get these rods out, I kick out of one foot restraint, my right one, prop it up against the F-4 handrail, then lean back and tug on it (chuckle) as hard as I can, keeping the rods away from the - rack so that the grommet doesn't drag. Then I have to |

twist it off through a - an elastic band, while bracing my foot against F-4. So it's sort of a complicated procedure, but apparently you do learn a li - little bit by trial and error.

CC Okay. Understand. Looking at the grommet on the TV, we thought we saw some grommets on the locking nuts? Are they on the cooar of the rod or on the locking nuts?

218 19 26 35 SPT-EVA Well, now, on the rods themselves, the grommets are right behind the locking nut.

CC Okay, that's - that's where they ought to be. And I guess you found the twisting motion helps retract the rod.

SPT-EVA Oh, yes, I've been through all that. The elastic bands are really something.

CC Okay. We've solved another problem. You beat us to it. If we can be of any further help, let us know.

SPT-EVA Okay, we'll let you, Story. I think the next rod will go a little bit faster, probably. Although what we're going to do is to - Jack's going to come back. And then we will turn this section of rods over, so that the next array is also facing upward to me so that I can see them as I pull them out. Otherwise, I'm afraid I'll drag more across the rack and could pull another - almost pull another grommet.

CC Copy.

PLT-EVA Holy cow! What are we over here, Al? Is this South America or what?

CC Affirmative.

218 19 27 41 PLT-EVA Boy, look at those mountains down there with the snow on them.

SPT-EVA Called the Andes?

PLT-EVA My green pole is pointed right down there at the Andes. Buenos disa, senores and senoritas. Well,

| | | |
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| | PLT-EVA | Yes. Wait until I get everything - - |
| | CDR | No, it's going to have to all be done. |
| | PLT-EVA | Right. |
| 218 19 59 20 | CDR | Ain't going to be any premature announcements. |
| | PLT-EVA | Okay - |
| | CDR | Just want to be ready. |
| | SPT-EVA | This one - - |
| | PLT-EVA | That sounded real good. |
| 218 19 59 27 | SPT-EVA | This one does not have the normal cap, Jack, so I'm going to have to take it apart, check it all. |
| | PLT-EVA | Okay. |
| 218 19 59 39 | CDR | Which foot did you take out the foot restraints for pulling out the poles, Jack - Owen? |
| 218 19 59 43 | SPT-EVA | I take the right one out for pulling out the poles; I take the left one out for making the poles. |
| | CDR | Okay. |
| 218 19 59 59 | SPT-EVA | The other activities require both out. |
| | CDR | We haven't got our medallions cast yet, and we're going to have them cast the back with this on there. |
| | PLT-EVA | That's good idea. |
| | CDR | You're darn right, boy. |
| | SPT | *** pole? |
| 218 20 00 37 | CDR | You bet. ATM will have - I mean the workshop will have one wing and the - and the sail out. This one right here. |
| 218 20 00 49 | PLT-EVA | Got to get this in line. |

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| | SPT-EVA | This tape may - might have gotten dry. Jack? |
| | PLT-EVA | Huh? |
| | SPT-EVA | I pulled the tape loose, you know, about 10 minutes ago before I went to stick it over these bolts, and it might have dried out. |
| | PLT-EVA | It won't stick? |
| | SPT-EVA | It doesn't want to stick very well. |
| | CDR | Probably cold out there, and it doesn't stick to that stuff when it's cold. Take - well, you can't stick it in your pocket. |
| 236 20 08 49 | SPT-EVA | Yes. I've got it stuck now, I think. |
| | PLT-EVA | I'll have to load it very gently. |
| | SPT-EVA | Yes. |
| | SPT-EVA | Very gently. |
| | PLT-EVA | Almost went to sleep. |
| 236 20 09 43 | PLT-EVA | We don't lose that glow in the sky over there, you know it? With the horizon. Stays light all the time. Guess it's just the right combinatioof - of orbital plane and daylight darkness, huh? |
| 236 20 10 08 | SPT-EVA | Yes, we're just about tipped up as close to perpendicular to the Sun as our plane can get. |
| | PLT-EVA | It's never - That blue crescent on the horizon towards the Sun area, has never - never left. |
| | CDR | And you can see how - how the ATM is - is looking almost right at the horizon. |
| | PLT-EVA | Yes, uh-huh. It's down through it a little bit, so - |
| | CDR | Barely through it. |
| | PLT-EVA | Yes. |

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| 236 18 42 01 | PLT-EVA | Okay. Owen came back and had to go around the top the sail instead. So, that's the way he's going now, and you can see him right there in front of the picture. He's heading out toward the Sun end of the solar telescopes. Hand over hand along the handrails, umbilical trailing behind. Now you see the rear view of an Oak - Okie, north end going south. Okay, now he's out to the Sun end. Let me give you a little umbilical there, O. |
| | SPT-EVA | Okay. |
| | PLT-EVA | All right. |
| 236 18 42 53 | SPT-EVA | Okay. I'm in the foot restraints. |
| | PLT-EVA | VTR is off. |
| | SPT-EVA | Okay. |
| | PLT-EVA | Let me fix this umbilical wherever it needs to be now. I'm - I'm kind of - ... (laughter). Hey, is that TV? You're pointed back then. |
| | SPT-EVA | Back up here? I see you over there now. |
| | CC | Skylab, this is Houston through Guam for 8-1/2 minutes. Out. |
| 236 18 43 41 | SPT-EVA | Okay, Bruce. We're about halfway through with the film exchange now. We've got all the further workstation exchanged. And we've got all the cameras - there checked out, and moved out to the Sun end now. We're just getting ready to work on the S149. |
| | CC | Roger. We copy you. And you've got about 2 minutes left on the VTR. And we'll probably be dumping the data voice tape recorder this site. Out. |
| | SPT-EVA | Okay. Let me get around here and do that. Okay, I'll go all the way closed and a little bit open, and when the Sun comes up, I'll adjust it. Okay. Now I'd like to ask Jack a question here. It looks like to me to get this 149 crank closed, you could |

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| | | not do it from these interim foot restraints. I had to kick out of those and get behind the experiment. Is that the way you did it, Jack? |
| | PLT-EVA | Yes. You might have to take one foot loose there, O., and reach around there. |
| | SPT-EVA | Yes. It looks to me like that's the better. Have to kick both loose. |
| 236 18 44 45 | CDR | And, Bruce, all the experiments that we excha - films that we transferred into the center workstation, the four of those, checked out okay. |
| | CC | Okay. We copy that, Al. |
| | PLT-EVA | Look at the thunderstorms on the horizon, Owen. |
| | SPT-EVA | Yes, I saw them. They're really amazing. |
| | PLT-EVA | Really fierce. Looks like the limb of the Sun with a bunch of prominences. |
| | SPT-EVA | That's right. There's a close analogy. Close comparison. |
| 236 18 45 10 | PLT-EVA | How are you doing there, O.? Can you work from that position? |
| | SPT-EVA | I'm going to have to scoot back a little bit more, yet, I think. |
| | SPT-EVA | Okay. Now I'm in a little bit better position, I think, to crank this little machine. |
| 236 18 45 35 | SPT-EVA | That was after I got a crank clamp closed. |
| | PLT-EVA | Few thunderstorms down there on the Earth. |
| | SPT-EVA | See them flashing away. |
| | PLT-EVA | The Sun's just about to come up. |
| | SPT-EVA | Might get our gold visar down, Jack. |
| | PLT-EVA | Good idea, Owen. |

| | | |
|---|---|---|
| | CC | And we'd like - - |
| | PLT | - - configure - - |
| | CC | - - a time for hatch opening, Jack. |
| 265 11 27 35 | PLT | Okay, I'll give you a mark when it happened. It was about 10 minutes ago, and it's going to be 9 minutes and 45 seconds; stand by - |
| 265 11 45 | PLT | MARK. 9 minutes and 45 seconds ago. |
| | SPT-EVA | Kick out of my shoes to get down here and see if that thing's running or not. Okay. Sometimes you can see it vibrate, but - |
| | CDR-EVA | Okay, looks nice and gold. |
| | SPT-EVA | Yes. |
| | CDR-EVA | Much better panorama out here, isn't it? |
| | PLT | Yes. |
| | SPT-EVA | Fasten it. |
| 265 11 28 23 | PLT | Let me know when you're ready, or when you are ready, Al, just egress and go down the VC. |
| | CDR-EVA | Okay. I'm waiting for the Big O. to - - |
| 265 11 28 30 | SPT-EVA | Okay, it's clicking. |
| | CDR-EVA | Clicking. O.'s going to pull out my umbilical, no doubt. |
| | SPT-EVA | Okay, let me get out of your way a little bit. |
| 265 11 28 53 | CDR-EVA | Blue hatch - I mean the blue handrails have turned turquoise on us. |
| | SPT-EVA | They sure look turquoise. |
| | CDR-EVA | Um-huh, they got sort of - everything has - - |
| 265 11 29 00 | SPT-EVA | Watch out! You - Okay, you're in the DAC with your right - right leg there. |

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|---|---|---|
| | CDR-EVA | How's my umbilical doing? |
| | SPT-EVA | Coming. |
| | CDR-EVA | You're outside; you're - |
| | SPT-EVA | Yes, you are. |
| 265 11 29 23 | CDR-EVA | Nice view. There's the old command module. |
| | CDR-EVA | Quads - Boy, is the side of that baby scorched! |
| | SPT-EVA | Ain't it, though. |
| | CDR-EVA | Back there just below United States, all that stuff is scorched, and the foil is kind of bent up. |
| 265 11 29 39 | PLT | I see you there, Al. Poking around. |
| 265 11 29 47 | CDR-EVA | Baby has been getting some heat. |
| | PLT | When you get there, just get in the foot restraints and hook your umbilical up there. |
| | CDR-EVA | All right, let's do that. |
| | CDR-EVA | Looks like a good place to visit over here. |
| 265 11 30 15 | PLT | Picking up the clamp about 9 feet. |
| | CDR-EVA | Sure can't get around here, compared to that water tank. |
| | PLT | Okay, Owen, clamp his umbilical at 31, thereabout. |
| 265 11 30 26 | SPT-EVA | Okay, it's in work. |
| 265 11 30 29 | CDR-EVA | Solar panels look nice and clean. I can see them back there - the one on the side of the workshop. |
| | CDR-EVA | I don't see that cable on there anymore that - that the SL-2 crew put on to pull it up. Have to look out the window. It looks like it may have departed. Maybe that's what I heard the other night. |

| | | |
|---|---|---|
| 265 14 45 46 | CC | Okay, did you have any trouble opening one of the 82 doors? |
| | CDR | Sure did. 82B doesn't want to open, and it didn't for Jack or Owen. Apparently, the seal in there is - swells up or something. I - I pulled and pulled and couldn't do it so I sort of got out of the foot restraint and got both hands on it and my knees on the front of the ATM canister there, not on any doors or anything, and gave it one good hard tug and it came open. |
| | CC | Okay, and did you bring that grommet in you were telling us about earlier? |
| 265 14 46 22 | CDR | No. The grom - when I tried to remove it, it - it slipped out and flew off. I attempted to do it, but muffed it. |
| | CC | Okay, you can take a note when you get to it. We'd like the serial number of the S056 camera you brought in. That's the one that's been hanging up on us this trip. |
| 265 14 46 43 | CDR | Okay, why don't you hold up; I'll get that for you right now. |
| | SPT | While he's checking that, Story, I don't get any displays on our monitor. Now I've got the - both H-alpha doors open. I've got the S053 door open and the WLC on, and I have both the H-alpha vidicons powered and the monitor powered. I wonder if you can give me a clue as to what switch, if any, I've overlooked. |
| | CC | Okay. |
| | CDR | Serial number 3. |
| | CC | Okay, Al. |
| 265 14 47 18 | CDR | The EVA went, not that you gen - generally very smooth. It just ground along and didn't have any problems either tethering or cooling or handling the equipment. I think you've got to be careful, though, with the small ones to keep your tethers |

## 16.0 EMU SYSTEMS

LOUSMA PGA Fit and Operations: I think I picked the right suit down there. I liked the fit of my suit very well. There were no adjustments that had to be made and I felt very comfortable in it. I noticed that, during the first EVA, my fingers got very sore. We did a lot of handwork and it was a long EVA and I noticed water down in the fingers and that they were sore and I got hangnails. They were sore maybe for a couple of days. I couldn't grip anything real hard with my fingers. All my fingertips were very tender.

LOUSMA I liked my suit very well. It was a good fit and was comfortable all the time.

BEAN I appreciated the extra effort of our suit monitor, the fellow in charge of keeping up with your equipment and knowing where it is at all times. I appreciate the effort that he went through to allow us to run our flight suits in the CMS towards the end so we could get some time on them. My only comment is that I think we ought to define our flight suits earlier, the one we're going to use, and then try to use them as much as we possibly can to try to get some time on them, particularly if you run into any of the chamber runs. Did you run the chamber with your flight suit?

LOUSMA I believe I did.

GARRIOTT I can't remember for sure.

LOUSMA I'm glad they took up the lining in the legs of my suit because it really made it a lot easier to don in zero g.

GARRIOTT I thought mine fit very well. I wouldn't have wanted to change any of the adjustments. My hands got very tired but that's not a problem with the suit fit. It's just the design of those EVA gloves. It's unfortunate that they can't be made any better. But my hands were just as tired and as beaten up as yours were, sort of darkened around the nails for 2 or 3 days; less so after the second EVA, and even less after the third EVA. The tiring thing about the whole EVA was your hands.

BEAN Biomed Instrumentation: No comments there.

LCG: My LCG leaked and I looked at it very closely and thought it was the seal in the suit, so I took the O-ring out and looked at it, lubricated it, and put it back. It didn't leak much, but every time I used it, which was twice, there would be maybe half a cup of water that was kind of splashed on the front of my suit and right near the area there. We brought the LCG back for check, but I don't hold much hopes that there's going to be a big leak. I suspect it's

LOUSMA Foot Restraints: I thought the EVA foot restraints were adequate for doing the job. Both the ones outdoors and inside pretty well fit my feet. What'd you think, Owen?

GARRIOTT I was the one who had the most problems in the water tank and I didn't notice any problems over here. Particularly in the FAS area, I had to kick in and out an awful lot to reach the thing that I needed to reach, back or front, or wherever. I managed to get in and out without any real difficulties.

LOUSMA Communications: Communications worked quite well. You might want to make sure that you turn the VOX sensitivity up to a point where you don't have to shout to be heard.

GARRIOTT I guess you adjusted it every time, didn't you?

LOUSMA Once in a while.

## 17.0 EXTRAVEHICULAR ACTIVITY

### 17.1 EVA OPERATIONS

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|---|---|
| GARRIOTT | Boom Operation: It boomed along just perfectly with no problems of any kind. I'll mention again about the NRL Sun-end tree. When you pass it back and forth, it's got to go with the foot toward the FAS or AIRLOCK, any way you want to describe it. Or else it will not pass or get over that light fixture. That was already called down. |
| LOUSMA | As EV-3 looking through the STS window on the Sun-end boom, I noticed some little regularly spaced marks on the side of the boom. It looked like maybe a drive mechanism was putting a little crease in it or put a mark on it. There is no reason to suspect it won't keep running just like it has in the past. The boom operation is good. |
| LOUSMA | Clothesline Operation: We didn't use it. I got the impression that you would shuttle a man back and forth with the packages instead of pulling out the clothesline if you had a boom problem. |
| LOUSMA | Handrails/Foot Restraints: I've got no question about that. I knew when I was working in the FAS and I wasn't required to be in a foot restraint. I like to get out of the foot restraint and kind of get myself up to the sitting position on the edge |

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| LOUSMA (CONT'D) | of the workshop to look at the view. Otherwise, you can only see the back of the ATM. From my waist up was above the circumference part of the edge of the workshop. You can look all over, you can look back there aft towards the sail and see the aft end of the workshop. It's a spectacular view. When you're inside, it feels like you're looking outside from a train window. But when you're outdoors, it makes you feel like you're sitting on the locomotive steaming down the track at a high rate of speed. It gives you a super feeling you don't have inside. That was my operation in the FAS in the foot restraints - as little as possible and out looking around as much as possible. I didn't see anything sharp that you could ding your suit on. I didn't see anything dangerous or likely to foul your suit on. |
| GARRIOTT | They were adequate handrails and worked good. |
| LOUSMA | LSU Management: That really wasn't too much of a problem. We just did it like the checklist said. It was easier to clamp that umbilical in zero g than it is in the water tank. |
| GARRIOTT | Those darn umbilicals are still too large. |
| BEAN | They are. That's funny. They kept saying they're going to be great. They never have been. They still clamped, worked. |

LOUSMA But not like they should.

BEAN I noticed that even in zero g every string didn't get tangled up, although it would swing around and interlace some. It never got in knots. That's helpful with the umbilical too. Zero g prevents things from dragging against one another and from making little knots. So, it can sort of swing behind you; it doesn't get into any trouble everytime it touches something. When it does, it immediately rebounds from it. It just stays out of the way. One of the nice things that occurs in zero g is that the umbilicals tend to mind themselves and not get into trouble.

LOUSMA Lighting: Lighting was more than adequate. Plenty of light to work by.

BEAN We didn't try to take any of those latches off.

GARRIOTT No, I did.

BEAN We had a problem one time. Somehow we had lighting everywhere except on the Sun end. Then we came over to ground, they did something, and then we had lighting on the Sun end thereafter. They never revealed exactly what went on. I guess if SL-4 doesn't have any lighting someplace, they should inform the ground. Maybe they have a command capability because thereafter it all seemed to work well.

GARRIOTT

It's that tree that goes to the Sun end. It must be placed on the Sun end boom in such a way that the foot is toward the MDA or ATM. In that direction, rather than away. Because if it's not toward the MDA and ATM, the tree will hit one of the light fixtures on the edge of the FAS and cannot get by it. It will stall the motor, as well as bang up the tree and the EVA light. So just make sure you put it on in the right orientation.

LOUSMA

Owen had put the poles together on the twin pole and shot it out in my direction and when it got long enough for me to hold onto, I'd hold it in my left hand and hold one of the ropes in my left hand and the other rope in my right hand, all the time watching the pole to make sure that it didn't rotate so that the rope twisted. Also checking each set of knurled knobs and grommets that went past, to make sure they were all inserted properly and that they were secure. When we got the one section of pole made, Owen passed it out to me, and I took about a minute or two to swing it the 90 degrees that was required to mount it into baseplate which I did with no problem; no difficulty in coning. Owen was watching the pole so that there was no problem with the oscillation. We felt that we could have gotten a good oscillation going if we wanted to, but we always moved it slow enough so that it didn't

LOUSMA (CONT'D) and pressed the poles down so that they were touching the workshop at the trailing edge and about 10 to 12 inches above the workshop at the leading edge. The only difference we notice is that one grommet came off. Another observation is that the sail coloration was starting to turn brown on the second EVA, and I don't know what its coloration was on the third EVA. That was the twin pole deployment. SL-4 will have to work around that thing when they are performing their EVAs.

17.5 EVA - GENERAL

LOUSMA The rest of the EVA came off pretty nominal. It took 6-1/2 hours on the first one and the only thing we noticed later was, after we got our gloves off, our fingers were pretty sore for a couple of days, right on the fingertips. This was due to all the action with them, I guess.

BEAN Do you have anything to say about the second EVA that was significantly different and might be useful.

GARRIOTT The only comment I could make is we hadn't practiced that one. We had good procedures sent up, they had been practice on the ground, we had time to think it through and understand it. I don't think it was easy for Jack to do it but it certainly wasn't that difficult. He just followed through the procedures very carefully and did the job. It gave me the feeling that

GARRIOTT (CONT'D) anything that you can do in the water tank in the way of simulating zero-g EVA work, we could sure learn to do in real life EVA probably easier. That's a good index.

LOUSMA The only comment I have on the EVA is don't let them rush you and don't get in a hurry. Don't get in a position where you might have to rush. Go up there and take your time. If you have a question, be sure to stop and think it over. If you get in a rush up there you are going to get into trouble. If you take your time and work methodically, you're going to do pretty well.

BEAN Let me make some comments about the third EVA and the cooling. I felt that the air cooling was certainly adequate. It would have been nicer to have water cooling, but all you have to do is work at a slightly reduced level and you will be just as happy as if you had water. The procedures to dump umbilicals and the PCUs were straightforward. I would recommend the one in the book using that water purge fitting, and use one of those big purge fittings like the wardroom. It allows more air to come in the hose and dumps that much faster. My feeling would be if you ended up with the ability to have water cooling it would probably be nice to have it. If it turns out you don't, it's nice to get in your suit without having the LCG on. It's also straightforward to be in your suit, not working hard, and have air cooling. Either way is good. You get lots of work done. You just have to work at a slower rate.

TAPE 3, SIDE 2

SPEAKER Let me just let him ask them. A couple of MDAC West people are going to be leaving and they had four questions that they'd like to ask if possible. Joe?

PEAKER Didn't he give them to you?

SPEAKER No.

SPEAKER Well, one of them was which position did you leave the trash lock in, in the vent or press position? Do you remember?

CDR Vent.

SPEAKER In vent.

CDR We wanted to leave it in press. ----

SPEAKER Yeah.

CDR Cause thats the way we'd run it for sixty days. But the word came up right at the last minute to leave it in vent.

PEAKER O.K.

PLT Yeah, we taped the handles too, I remember, didn't we?

SPEAKER Under EVA, we had the extendable booms, which you commented worked fine for the ATM film transfer, and, with the idea in mind that we were replacing good new cameras, as well as bringing the old ones back, how do you feel a hand-over-hand transfer would have been?

PLT Particularly the sun end, we talked about it while we were out there. And decided that if they failed it would probably be easier than the clothesline. To just clip it on your wrist with a tether to make sure you didn't drop it and just walk out with it and plug it into the, what do you call the receptacle for the tree.

SPEAKER Right.

PT Those are thoroughly protected, there shouldn't be any problem with them any. The only thing that you'd have to, from our experience, that we had looked at. You might have to look at an unprotected camera like the S052. You'd have to be a little more careful with the S052.

CDR Oh, but you could be very careful.

PEAKER Well, that was the reason for talking about the sun end tree. Now, on the other tree, what we thought would be the easier way to transfer it, although it might not have had trouble when you got out

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| SPEAKER (cont'd) | there, was simply to take the whole tree down to the VC also. But then you've got the problem of how you handle the tree with four cameras on it. |
| PLT | Right |
| SPEAKER | I sorta really think we probably would have wanted to use the clothesline. |
| CDR | I think we probably would have used the clothesline in both applications because that was the plan ----- |
| SPEAKER | You're right. |
| CDR | Plus we would have rigged it up for the next guys. But re-thinking it we would have said forget the clothesline ------ |
| SPEAKER | If we were starting a year ago, or two years ago. |
| CDR | That's right. Get rid of the clothesline, if the boom fails well, we'll carry it down there. |
| PLT | Yeah, I think we mentioned that up there, as a matter of fact. |
| CDR | Yeah. |
| PLT | After it was all said and done, then. Hand-over-hand be the way to go. |
| CDR | Over-cautious. There's just one way we could have saved money. But, we're learning. |
| SPEAKER | Clotheslines are not too expensive, but, how about the design - (chuckle) |
| CDR | I think the booms are right. I think maybe we overdid it having the clothesline in addition to that. |
| SPEAKER | Would you still recommend a spare boom, though, in addition the two we have there, as opposed to going hand-over-hand, if one fails. |
| CDR | I would, cause you can get a spare boom pretty cheap. |
| PLT | So would I |

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| CDR | (In answer to many chuckles). Or maybe you can't. (Laughter) Sorry I said that. |
| SPEAKER | When you're looking at costs, which would you rather use, the clothesline or a boom? (Laughter) |
| PLT | Well, now that you've got the boom up there and you can replace it, thats the way to go. |
| SPEAKER | For future application, did we overdo it? The booms now, they worked great and made it nice and easy. Did we overdo it using something like that, that complicated? |
| SPT | No, I think we did the right thing, with going to the boom ---- |
| CDR | I do too, whether or not you need a spare, I don't know. |
| SPT | I agree with Al, though. If you bought two, you might as well buy the third. No telling how many NASA has really bought. One more on top of that or one less, I think its worth having the spare there. |
| SPEAKER | O.K. Do you have any comments on any of the detents, flags, hard stops, any of the feed back methods we provided in the ATM stuff? |
| SPT | You mean for how the cameras operated? |
| CDR | Or the door? |
| SPT | And the door? It was all pretty smooth, very nice. Just as advertised. And it was pretty clear when it was seated properly, and was working well. I guess there hasn't been a miss, a bad seating or anything like that yet with three exchanges. |
| CDR | Gives you the feeling you could probably have done without them, frankly. Particularly the one on the door, I thought, it didn't always tell you that the door was locked and in position. You could get the white flag before you finished locking it and you could get the white flag -- You also didn't know how much white flag you had to see to make it a real white flag. I think you could probably have eliminated all those things and got it done anyway. |
| PLT | It gave me a warmer feeling, though, to see that flag and know I've done it right and don't have to work on it anymore. |

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| | SPT-EVA | Actually have - in the shadowing there - the bolts on the 228. |
| | PLT-EVA | *** gassing. |
| | SPT-EVA | Okay, I've got that thing perfectly normal for the - perfectly parallel to the Sun's rays. |
| | CDR | Good show. |
| | SPT-EVA | Okay. |
| | CDR | Now D024. |
| | SPT-EVA | Let me get organized here. |
| | CDR | Go down and get yourself in position. |
| | SPT-EVA | Assume the po-si-ti-oń, monsieur. Okay, now there's a cuff tether on that thing, is there not? Go put that on my D-ring, please. |
| | PLT-EVA | *** off, is it? |
| 326 19 38 07 | SPT-EVA | Not all the way. But I know you can - I know from experience that you can't open that. |
| | PLT-EVA | Watch my feet. |
| | SPT-EVA | I'll watch them. Just press on. I'll - Okay, Jer. Go ahead and read. |
| | CDR | Okáy, there's a couple of pieces of tape on that container that you're supposed to take off. |
| | SPT-EVA | Okay. Where's the - where's that all to be put? |
| | CDR | It doesn't say where to put them, you know that? It just says, just remove the tape. |
| | SPT-EVA | Well, no. That's all right. I can remove the tape, but where do I put the other pieces, though? There's a couple of pieces of gray tape they got here holding the whole thing on. |
| | CDR | Yes, it says here - Let me read it to you. |

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| | SPT-EVA | Okay. |
| 326 19 39 01 | CDR | It says, Remove two pieces of tape from D024 container holding twinpole sail samples. And that's it. It says, Samples will be held to the D024 lid with tape. |
| | SPT-EVA | Yes, hold on. |
| | CDR | In parentheses. |
| | SPT-EVA | I think I've got it. Just let me - let me work it here. I tell you what, Bill, if you could hold my feet, I would not have to worry about steadily positioning myself and I could - - |
| | PLT-EVA | Let me turn the DAC off. |
| | SPt-EVA | Okay, get the DAC off. |
| | PLT-EVA | Fold it out of the way so I don't worry about it. |
| 326 19 39 33 | SPT-EVA | Okay, now if you'll just hold onto my feet. |
| | PLT-EVA | Okay. |
| | SPT-EVA | Just a second now. Hold on to the - I won't be putting any forces on it, so it shouldn't be - No, wait a minute. No, you don't have to come out; get back in the shoes. |
| | PLT-EVA | Well, I got one shoe in. |
| | SPT-EVA | Oh, okay. Okay. |
| | CDR | All right now, Ed. I'll read you the procedure here. It says, pull the twinpole sail samples, two of the, from the clear plastic and install them on the A side of D024 panel; disk panel, toward the Sun. |
| 326 19 40 02 | SPT-EVA | Well, with great skill and cunning, they left that gray tape on this - on this thing. |
| | SPT-EVA | Okay, now put me back down over there. |
| | SPT-EVA | A side, towards the Sun? |

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| | CDR | Right. |
| 326 19 40 44 | SPT-EVA | Now that's not going to be normal to the Sun. Let's see, we're going to make all our installations on the beam. Would you verify that? |
| | CDR | Yes, that's right. |
| | SPT-EVA | *** path to the world. One of them in. |
| | SPT-EVA | This is like handling flypaper. |
| | CDR | (Laughter) |
| | SPT-EVA | Okay. Now let me torque myself up this way, Bill, because I can't move my hands any more. Feet up towards the top. Let go a little bit. |
| | PLT-EVA | Let me get back in my restraint. |
| 326 19 41 56 | SPT-EVA | Okay. They're on there. It's not - I just got a slight overlap on the two of them, maybe about one-eighth of an inch leading up to zero. I'd say that maybe 1-percent overlap or so at the most between the two of them. Now let me take my pin here, which I had to pull out. Let's try to get that out of the way. |
| | PLT-EVA | All right. |
| | SPT-EVA | Now what am I supposed to do with the extra pieces that I've got here? |
| | CDR | Well, it doesn't say. Now that - that's the extra pieces of gray tape, right? |
| | SPT-EVA | Gray tape and - |
| 326 19 42 43 | SPT-EVA | Gray tape and the pieces of plastic which have come off to expose the sticky surface. |
| | CDR | They really adroitly avoided that question. I'd suggest - if you can, hand them to Bill and maybe he can hang onto them until one of you could get to a pocket - tuck them in a pocket. Tell you what, toss them back in the airlock, if you can, Bill. |

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| | PLT-EVA | Do they give you a - a focus distance? |
| | CDR | Infinity. |
| | PLT-EVA | Infinity. |
| 326 19 47 40 | CDR | If you're going to work close here, you can change it. |
| | PLT-EVA | I think with the wide-angle lens like - that's the reason I didn't. |
| | PLT-EVA | Okay, Jer, I'm extracting it, and I've got the wrist tether on and locked and I'm extracting. |
| | CDR | All right. |
| | PLT-EVA | Where do I put it? |
| 326 19 47 57 | CDR | All righty. it say [sic] here "Snap the strip panel to the B side nearest the container, handle toward the FAS work station, and remove the wrist tether. |
| | PLT-EVA | Okay, and I know they don't want my little finger-prints - |
| | CDR | We're coming up on sunset. |
| 326 19 48 50 | SPT-EVA | *** the same old problem - stabilizing your feet - stabilizing your body while you're trying to do a two-handed task - in restraints. |
| | SPT-EVA | Tell you what, Bill, can you pull - lean forward and stabilize my feet again? |
| | PLT-EVA | Okay. I'll turn the DAC off here. Just a second. |
| | SPT-EVA | Down. |
| 326 19 49 24 | SPT-EVA | Okay, I'm drifting away from that thing now. *** go. |
| | SPT-EVA | I need to get up further on it. |
| | PLT-EVA | Higher? |
| | SPT-EVA | Yes. |

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| | PLT-EVA | Okay. |
| 326 19 50 03 | SPT-EVA | Okay. Now the foot restaints. What I'm going to do, I'm going to eventually put a pip pin in this here, am I not, Jer? |
| | CDR | All right, let's see here. |
| | SPT-EVA | How's this? |
| 326 19 50 13 | CDR | Yes, that's right. |
| | SPT-EVA | Right. Okay, what I'm going to do is take the pip pin and put it through *** first. |
| | PLT-EVA | Is this all right, Ed? |
| | SPT-EVA | Yes, that's good. |
| 326 19 50 38 | CDR | Got 2 hours now, guys, 2 hours and 5 minutes. |
| | SPT-EVA | Okay, now let me bend down here a little bit so I can see what - |
| | PLT-EVA | I'm having to keep my eyes closed because I'm facing the Sun. Tell me which way you want me to move. |
| 326 19 50 52 | SPT-EVA | Okay. Now. Now I'm in business, I think. *** I did was putting the pip pin in first. There we go! |
| | CDR | Got it in? |
| | SPT-EVA | Yes. I thought that might work, and it did. Okay, I got it in there. |
| 326 19 51 07 | CDR | All right. Now it says put your tether on the disk panel and remove it from the container. |
| | SPT-EVA | Okay, this is the same exercise all over again. |
| | CDR | Right. |
| | SPT-EVA | *** you'll remind me before I leave here, I want to straighten these extra pip pin out for the other side so they're not shading that panel. |
| 326 19 51 29 | SPT-EVA | *** up at this angle, Bill? |

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| | PLT-EVA | Say again. |
| | SPT-EVA | I'm okay. Let me use mine. |
| | PLT-EVA | That Sun really heats up the - the tips of - |
| | SPT-EVA | Yes, I can feel things all the way to the glove as I've been handling them. |
| 326 19 52 10 | SPT-EVA | Okay. *** your work. Okay, Jer, I'm pulling out the disk panels now. |
| | CDR | Okay. |
| | PLT-EVA | Go now, Ed. |
| | SPT-EVA | Can you hold my feet so I'm stable? |
| 326 19 52 40 | PLT-EVA | Well, I can hold one foot - - |
| | SPT-EVA | Yes - - |
| | PLT-EVA | - - I will not be putting any forces on this. |
| | SPT-EVA | Whoops! I just - snapped free. Give me a second to restabilize myself. |
| 326 19 53 18 | SPT-EVA | Okay. Now, Bill, I want to move down, eye level with the panel here. |
| | PLT-EVA | *** reference to your body. |
| | SPT-EVA | Can you hold me now? |
| | PLT-EVA | I thought I was. |
| | SPT-EVA | *** time line for this one. |
| 326 19 54 44 | PLT-EVA | How are you reading me on VOX now, Jerry? |
| | CDR | Oh, you're still breaking up a bit. |
| | PLT-EVA | Okay. |
| | SPT-EVA | Can't say I didn't predict it. |
| | PLT-EVA | *** to push you out a little farther? |

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| | SPT-EVA | No, no. |
| | SPT-EVA | Got to aline these film - |
| 326 19 55 44 | PLT-EVA | Sure does take a lot of time for such a little bitty old experiment, doesn't it? |
| | SPT-EVA | *** it. I had that pin in there and I - |
| | SPT-EVA | *** front of me - - |
| | PLT-EVA | Can I help you any way? |
| 326 19 56 56 | SPT-EVA | No. Just hold on to me. I'm getting it lined up now. Okay, just hold on to me, Bill. You keep me stable, and I can do it. |
| | PLT-EVA | Okay, I'm holding hard. |
| | SPT-EVA | Other way. Tell you what, I'm going to change my wrist - my waist or my chest tether here to pull me down to that thing, because there's no way - Get out in front of me. |
| 326 19 58 16 | SPT-EVA | Okay. Now I think I stand a chance. You just stabilize - |
| | SPT-EVA | Tell you what, I'm going to tighten up on that tether a little bit more again - start ***ing. |
| 326 20 00 19 | CC | CDR, this is Houston through Carnarvon for 10 minutes, and when you have a moment, we would like to get the MPC ROLL switch to INHIBIT. We'll be dumping the data/voice here. Over. |
| | CDR | Okay, Houston. Right now, we're work - still working D024. It's kind of slow work. |
| | CC | Roger. We copy. |
| 326 20 01 27 | SPT-EVA | Frustrating work. |
| | CDR | ... |
| | CC | Roger. Out. |

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| | CDR | Sorry, Bruce. I was talking to Ed. I'm watching him try to - simple one-g task is infinitely difficult in zero g here. Kind of like - - |
| 326 20 01 48 | CC | We were just - - |
| | CDR | - - kind of like threading a needle - - |
| | CC | - - we were just - - |
| | CDR | - - with a boxing glove. |
| | CC | We were just sympathizing with your plight. |
| 326 20 02 49 | PLT-EVA | You trying to engage snap? Is that what it is? |
| | SPT-EVA | Yes. See, You're trying to engage snaps and I get this thing - thing completely lined up and - - |
| | PLT-EVA | *** don't know why anyone'd design anything like that. |
| | SPT-EVA | Well, see the thing was, this was made not for - - |
| 326 20 03 01 | PLT-EVA | I think it was made strictly for retrieval. |
| | SPT-EVA | Yes. ... - - |
| | PLT-EVA | ... |
| | SPT-EVA | Look, I'm going to give it one more go and then what we're going to do is go on inside and get that little extra piece of gray tape that we've got and we're going to tape the mother on here. |
| 326 20 03 19 | CDR | Can you just pip pin it without snapping it? |
| | SPT-EVA | I tried that, Jer, and the pip pin won't hold until it gets - |
| | CDR | Doggone it. That's too bad. |
| 326 20 03 29 | SPT-EVA | Hey, now wait a minute. Hey, all it needed was a little body inertia against it. |
| | CDR | You got it? |

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| | SPT-EVA | Hold on. Ah, hold on. Ah! I had it too. |
| 326 20 03 50 | PLT-EVA | Here, let me hold your leg. |
| | SPT-EVA | Okay. Press. |
| | PLT-EVA | Try not to kick me in the visor. That's okay. Your foot's clear now. |
| 326 20 03 57 | CC | CDR, this is Houston. All systems are looking good on board, and we show you about an hour ahead of your anticipated position in the EVA time line. |
| | CDR | Roger. Thank you. We are trying to catch up though, aren't we, gang? |
| | SPT-EVA | I tell you, these little snap holes don't look as though they're - they take these size snaps. I'll give them a go and then we're going to try and tape it on here. |
| 326 20 04 27 | SPT-EVA | Tell you what; we got that S1 - we got a whole roll of that tape in there in S149, don't we? |
| | PLT-EVA | 93, you mean? |
| | SPT-EVA | That's right, 1 - 193. That's right. |
| | PLT-EVA | Yes. You want me to get you a piece of tape? |
| | SPT-EVA | Go ... - - |
| 326 20 04 44 | PLT-EVA | You'll have to unroll that dang thing, though. |
| | SPT-EVA | Yes - - |
| | PLT-EVA | Make several passes. |
| | CDR | Yes. Yes, I know. How about a piece of that silver tape? Can you spare one of those? |
| | PLT-EVA | Yes, but I still have to unroll it. If he doesn't get it this time, we'll do that. |
| 326 20 04 50 | SPT-EVA | *** time on this. This is a real killer. *** another hour on that thing. |

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| | CC | Bill, we're GO for taping it from down here and there is tape in the pouch in the airlock with the scissors, next to 316. You don't have to unroll the S193 bag there. |
| | PLT-EVA | Okay. That's right. I took that out. I stowed that myself. The small roll of tape. |
| 326 20 05 52 | CDR | Okay. Now just hold on there, guys. Give - - |
| | PLT-EVA | I'll hold you once more here. |
| | CDR | Oh, you know what, though? I don't think that small roll of tape - I think we pulled it out for something. Didn't we? Ed, you remember when you said yesterday, "Well, just put the small roll of tape in there, we never use it anyway." And I said, "Yes, Ed, you are right. We will never use that tape." |
| 326 20 06 49 | SPT-EVA | Now don't make a move, anybody. Don't breathe. Ah, (laughter) oh. Hey, you know what I've - I think I've been snapping it all right the way they act. But the pip pin, for some reason, doesn't want to stay in there. |
| | PLT-EVA | Well, why don't you go ahead and get the tape and give it a whirl? |
| | CDR | Stand by, Ed. We've blown about 25 minutes on this thing now already. |
| 326 20 07 23 | SPT-EVA | Yes. - - |
| | CDR | ... |
| | SPT-EVA | - - ... at least four times. It's just not designed - Hey, I'll try that pouch. |
| | CDR | It is 316, Bill. It's right next to panel 316. That's the one. |
| 326 20 07 50 | SPT-EVA | Okay. I'll tell you, Bruce, I was able to get the strip ones on real well. But the disk ones, for some reason, I get it all lined up, push down and I feel it snap in there and then as soon as I just lightly touch the safety tether that's on it and |

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| | | try to remove my tether from it, it just falls right off again. I'm not sure whether the - we got an interface problem. It sure appeared that way to me. What would have been helpful is to have a - the pip pin which we put through the center so that it would snap without ever having to have the other snaps in there, so that we could just put the pip pin through and doesn't matter whether this thing floats a quarter of an inch off the plate at all. It's still going to be at the right angle. I'm afraid in this process, there's a couple of these things we shouldn't have touched. |
| 326 20 08 41 | CDR | That EVA - Does that silver tape not have a - - |
| | SPT-EVA | Make sure of it - - |
| | CDR | - - not have a - a tab on it? |
| 326 20 08 46 | CC | Say, did you verify that the assembly is cocked properly and the words are getting down here, you should be able to put the pip pin all the way through and hold it in place with just the pip pin, if you push hard enough on it. Over. |
| | SPT-EVA | Well, okay. Let me - I got a good chest tether up here, Bruce, which is right next to the work and - - |
| | PLT-EVA | Go. |
| 326 20 09 08 | SPT-EVA | - - Now would either of you guys answer something for me? On that pip pin, which I push in the center there, and release right in the center release, which releases the balls at the end. Now if I - - |
| 326 20 09 19 | CDR | Pull it easy, Bill |
| | SPT-EVA | - - if I push down on that, then let up real quick, will I expect to see that pip pin come roaring out back at me or should I try and push on the - the wider part around the - wider part around - - |
| | CC | I - - |
| | SPT-EVA | - - that releases - - |

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| | SPT-EVA | Negative. |
| | CDR | Okay. |
| | SPT-EVA | *** straightened out here, I'll be right with you. |
| 326 20 19 52 | SPT-EVA | Okay, now. I've got to get back up here and keep my umbilical free of 228. |
| | SPT-EVA | ... need a wrist tether there. |
| | SPT-EVA | That's both of them. Okay. Now let go. Okay, Jer; go ahead. |
| 326 20 20 25 | CDR | All right. It says, remove the wrist tether from the double handle and place it on the protective cover handle. And then remove the protective covers. |
| | SPT-EVA | Jer, let's hear that once again, please. |
| | CDR | It says, remove the wrist tether from the double handle and place it on the protective cover handle. Well, it's not on the double handle. |
| 326 20 21 07 | SPT-EVA | I know how Don wants it. |
| | CDR | Okay, just do it that way, then. |
| | SPT-EVA | If I could turn loose of that thing *** on here. |
| | CC | Roger. We're reading you loud and clear, Ed. |
| | CDR | You got two clips to remove. You place one of them on the D-2 handrail and - - |
| 326 20 21 38 | SPT-EVA | Stop. Hold on. |
| | CDR | Okay. |
| | SPT-EVA | That's a little - little ways downstream here. |
| | CC | Skylab, this is Houston. One minute until LOS. Next station contact in 16-1/2 minutes through Goldstone at 20:38. Out. |

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| 326 20 22 30 | SPT-EVA | Looks like it's on. Now I believe I can take that protective cover off. |
| | PLT-EVA | Okay. You - - |
| | SPT-EVA | That's on - - |
| | PLT-EVA | ... - - |
| | SPT-EVA | - - And I did not touch a fragile little bit of it. |
| | CDR | Very good. |
| | SPT-EVA | It looks good. |
| | PLT-EVA | I can see his test patch. |
| | CC | Roger, sounds good to us too. |
| 326 20 23 20 | CDR | Now, if you'll hand those - that cover to Bill, then I'll tell you where to put the clips and things. |
| | SPT-EVA | Okay, Bill. |
| | PLT-EVA | Just a minute. |
| | SPT-EVA | If you'll just hold onto that and I'll give you a wrist tether for it. |
| | SPT-EVA | Okay, why don't you tether that down there then? |
| 326 20 24 10 | SPT-EVA | Okay, Jerry, read on. |
| | CDR | Okay, it says, remove two clops installed on the old collector. You place one on the D-2 handrail - and then I'll tell you where to place the other one. |
| | SPT-EVA | Put them on the D-2 handrail. |
| | CDR | Right. |
| 326 20 24 32 | SPT-EVA | Seven - two. Friendly D-2. Got to remember that. |
| | CDR | Try to be careful not to scratch that visor any more. |
| | CDR | Looks like your umbilical's kind of hanging you up, Ed. |

| | | |
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| 326 20 25 10 | SPT-EVA | No, I'm - I'm just leaning around here trying to find D-2. |
| | CDR | Is D-2 over there on the other side? The other side of - from your left hand? Is that it? |
| | SPT-EVA | Here? |
| | CDR | Yes. |
| | CDR | Okay, watch out for your tether. It's going to drag over 230. Hey, you're up to your elbows in tethers aren't you? |
| | SPT-EVA | Yes. |
| 326 20 25 39 | CDR | I would take that waist tether that's flying free, if you can, and hook it onto something else there that - maybe the other part of the other tether or something. |
| | SPT-EVA | Yes, I think what I'm going to have to do is that, Jer, I'm going to have to - if I don't take these tethers off, I stand a chance of dragging them across there. |
| | CDR | That's right. Specially that waist tether. That's a real bother. |
| 326 20 26 05 | SPT-EVA | We'll need that later, but not right now. Okay, Bill, I need a little assistance. |
| | PLT-EVA | Okay, let me put the DAC up here. |
| | SPT-EVA | What I'm going to do is to take off these wrist tethers. How much film does it look like was left on there, Bill? Do you get to see - to look at it? |
| 326 20 26 35 | SPT-EVA | Okay, that one is on there. |
| | SPT-EVA | That one's on there. Now take my wrist - take my chest one off, if you can, and tether that somewhere. |
| | PLT-EVA | Okay. Just a sec. |

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| 326 20 27 13 | SPT-EVA | Okay. It's done, Jerry. |
| | CDR | Okay, looked like you had the right idea out there on the other side. |
| | SPT-EVA | Okay. Just read on, through I'm - I'm - I'm not too sure exactly what we're do want with them. |
| | CDR | All right. Now you - just take one - one clip and get it out of the way is all you're doing. Clip it on this - on the handrail somehwere. |
| 326 20 27 40 | SPT-EVA | Okay, we've done that. |
| | CDR | Okay, now the other clip, here's where it goes: Place the other clip on the new collector next to the spool with joint bracket away from the MDA, outboard. |
| | SPT-EVA | *** some other words after that too, isn't there? |
| | CDR | No, that's it. |
| 326 20 27 57 | SPT-EVA | Minus - antisolar directions? |
| | CDR | Minus-Z. |
| | SPT-EVA | All right. That's antisolar. Away from the MDA. |
| | SPT-EVA | Okay, now let's hear the other - the beginning words. |
| | CDR | All right, here we go: Place the other clip on the - on the new collector next to the spool joint bracket, minus-Z, away from the MDA, outboard. |
| 326 20 28 29 | SPT-EVA | I assume that means right close to there. Now let's - let me see. |
| | SPT-EVA | Ah, now that one doesn't slide all the way down does it? That's as far down as it goes. It shades but it doesn't touch. |
| | CDR | Is the Sun behind you now? |
| | SPT-EVA | Yes. |
| | CDR | Okay. |

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| | | Now, I got to get 35 feet umbilical up behind me in the aft section here. Let's feed that first. Watch - watch the gear - - |
| | PLT-EVA | I am. |
| | SPT-EVA | - - as I pull this stuff out. |
| | PLT-EVA | Just leave - let TO25 hang out there because - - |
| | SPT-EVA | Wait a minute. Take it easy. If it starts hanging up on anything, let me know. |
| | PLT-EVA | Okay, hold off just *** |
| | SPT-EVA | Okay. |
| | PLT-EVA | Okay, Ed. |
| | SPT-EVA | ... away. |
| | PLT-EVA | Just take it easy there. |
| | SPT-EVA | Okay. |
| | PLT-EVA | There you go. You've got it all out. |
| 326 20 45 34 | PLT-EVA | Well now, I have a tether for the jumper box. |
| | SPT-EVA | Well just a minute, I've got a EVA wrist tether here. What I'm trying to do right now is to roll down to clamp my LSU. |
| | PLT-EVA | Yes, I've got one too. Let me - |
| | SPT-EVA | Okay. Ready anytime you are Bill. Send her up. |
| 326 20 46 12 | PLT-EVA | Okay, now I'm going to bring it out and hold it without a tether. |
| | SPT-EVA | Look let me move in there a little bit for that kind of an operation. Okay, just come on over this way. There just stay where you are. Bring her out. I'll get it. Hold on to it - A different angle on it. |
| | SPT-EVA | There you go. Hold it - now hold it still. Okay let go. |

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| | PLT-EVA | Okay? |
| | SPT-EVA | Yes. |
| | PLT-EVA | Right there, Ed. |
| | SPT-EVA | Okay. |
| | PLT-EVA | Yes, that's in work. |
| | SPT-EVA | Oh, okay. That's - all right. We might be able to use that extra tether. Okay, now let's lock both of them. |
| 326 20 47 30 | PLT-EVA | Okay. That's complete. |
| | CDR | ... |
| | PLT-EVA | Okay. Stand by; it's in work. |
| | PLT-EVA | I've got to change wrist tethers here. It'll take a *** |
| | CDR | I'll tell you, Bill you've got to notice and experience when you get in the great outdoors there. You really relized you're up. In here, it still looks like a window until you get out there on that Sun end. |
| | PLT-EVA | Roger. And I'll go first, if I recall. |
| | SPT-EVA | Yes, you do. |
| | SPT-EVA | It's silver. It may be gold now. I think I see a gold wrapping around it. |
| | SPT-EVA | What are you doing there, Bill? |
| | PLT-EVA | I'm just trying to get the tether loose. |
| 326 20 49 19 | SPT-EVA | Okay, I'm looking at 3.63 and no lights. |
| | PLT-EVA | Okay, 3.65; no lights. |
| 326 20 50 23 | PLT-EVA | Okay, I'm coming out. |
| | SPT-EVA | Let me quide your feet. Okay. Get your bearings hear, Bill. And we've got your umbilical hose a |

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| | | little snagged here. It's around the front of you. Just a minute. That's your umbilical there. Okay, now just pick your left arm off. Yes, wait until you get on the hand rail. Step over here on F-15; bring your right hand over here. There you go. Okay, Bill, go ahead. |
| | PLT-EVA | Okay. |
| | SPT-EVA | Take it nice and slow, Bill. And watch that thing. It gets wrapped around very easily. |
| | PLT-EVA | Okay. |
| | SPT-EVA | Bill - Read on a little bit will you, Jer, so we can see what's coming up. Okay. |
| | CDR | ... Okay. |
| | SPT-EVA | Yes, that's good. You'll be able to see him over there, will you not? |
| | SPT-EVA | How's he doing? ... |
| | PLT-EVA | I'm here, but it doesn't look like the trainer. I - I can't - |
| | SPT | How's your umbilical, Bill? You need more? |
| | PLT-EVA | Oh, there it is. I - I can't tell. It's behind me. |
| 32620 52 59 | SPT-EVA | Is it tight? |
| | PLT-EVA | No; looks okay. |
| | SPT-EVA | Okay, now it's loose. I see it. |
| | PLT-EVA | Okay now, Jer, what you can do to help me is make this - help me get *** If you happen to check me make sure I have it pointed properly. |
| | CDR | Okay. |
| 326 20 54 18 | PLT-EVA | Doggone pin. I - I don't trust our pins. Okay. Yes, but the pin doesn't lock and it's just like it was in the doggone trainer. |

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| | PLT-EVA | Yes, there is but it - it works just like it did *** |
| | CC | PLT, Houston. We understand you are having trouble with the locking pin on the foot restraint mount? |
| | PLT-EVA | Yes, the little balls don't stick out far enough to keep the pin from drifting back out. I'm going to use a wrist tether. |
| | CC | Okay. You sure you've got the pip pin seated all the way home? |
| | PLT-EVA | It's way - sticking out on the other side, Bruce. |
| | CC | Okay, we copy. |
| | PLT-EVA | Yes, but it's - I can fix it here - Doggone. |
| 326 20 55 05 | CC | Okay, another suggestion is you've got plenty of tape with you. Whatever it looks like it'll hold it best to you all. Maybe you can put the pin through and then tape the pin in place or something. And we've got 30 seconds to LOS; next station contact is the Vanguard in port in 9-1/2 minutes. Out. |
| | PLT-EVA | Roger, Bruce. |
| | SPT-EVA | Take your time there, Bill, and think it through. |
| | PLT-EVA | I will. I - I - I have a solution. |
| 326 20 55 48 | PLT-EVA | Got it and - coming out. |
| 326 20 56 00 | SPT-EVA | Okay, I've got one little whifferdill on this LSU which I'd like to get out of here first. Make sure it doesn't get - okay. |

END OF TAPE

Final Dump Tape 326-10/D-66
Time: 326:20:54 to 326:22:27


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| 326 20 54 19 | CDR | All done? |
| | SPT-EVA | Make sure it's clear in. |
| | PLT-EVA | Man, I'm hard pressed for a pin. |
| 326 20 54 23 | CDR | What? |
| | PLT-EVA | Okay. |
| | CDR | Is it clear through? |
| | PLT-EVA | No, it's - the pin doesn't lock; it's just like it was in the doggone trainer. |
| | CDR | And there's no ball peen pin on it? |
| | PLT-EVA | Yes, there is, but it works just like it did. |
| 326 20 54 37 | CC | PLT, Houston. We understand you're having trouble with the locking pin on the foot restraint mount. |
| | PLT-EVA | Yes, the little balls don't stick out far enough to keep the pin from drifting back out. I'm going to use a wrist tether. |
| 326 20 54 50 | CC | Okay, you sure you got the pip pin seated all the way home? You got to - - |
| | PLT-EVA | It's way - it's sticking way out on the other side, Bruce. |
| | CDR | It looks like you got another hald inch of travel you could go. |
| | CC | Okay, we copy. |
| 326 20 54 59 | PLT-EVA | Yes, but it's - I can fix it here. |
| | CDR | All right. |
| | PLT-EVA | Gosh darn - - |
| | CDR | Do what you need to do. |
| 326 20 55 06 | CC | Another suggestion is you've got plenty of tape with you; whatever looks like will hold it best to you all. Maybe put the pin through and then |

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| | | tape the pin in place or something. We got 30 seconds until LOS. Next station contact is the Vanguard in port in 9-1/2 minutes. Out. |
| | CDR | Roger, Bruce. |
| | SPT-EVA | You got it, Bill? Take your time there, Bill, and think it through. |
| | PLT-EVA | I will. I - I have a solution. |
| 326 20 55 38 | CDR | Yes, if you just get it tethered, you're in good shape. Its installation is very good. |
| | SPT-EVA | Got it? |
| 326 20 55 48 | PLT-EVA | Got it and - - |
| | SPT-EVA | Looks good. |
| | CDR | Okay - - |
| | PLT-EVA | Coming out. |
| | CDR | Now, Ed, you grab the FAS and manage your own LSU and come on down. |
| 326 20 55 59 | SPT-EVA | Okay. I've got one little whifferdill in this LSU, which I'd like to get out of here first. Make sure it's going to get - Okay. |
| | CDR | Bill, you want to go ahead and go to a position where you're ready to start working on the antenna. |
| 326 20 56 27 | PLT-EVA | Okay. That's where I'm getting now. |
| | CDR | Okay. |
| | CDR | Watch out for this window behind you here, so you don't want to kick it. |
| 326 20 56 44 | CDR | Say, it seems to me the best place for you to be working, Bill, is to be upside down from what you are right now - with your feet away from the restraints, so that as Ed manages your body, he's working with your shoulders rather than your waist or your hips. And he'll do a lot better job of restraining you that way. |

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| | SPT-EVA | Darn, this was originally silver, the way it says in the trainer. That's this vent line here. It sure isn't where the Sun gets to it. |
| 326 20 57 37 | PLT-EVA | I - I think my umbilical might be caught down there. |
| | CDR | Well, I'll tell you what. Wait until Ed gets down there and can see what's cooking. |
| | PLT-EVA | Okay. |
| | CDR | Just relax and let him get down. |
| | SPT-EVA | No, you got - you got lots of umbilical there. |
| 326 20 57 48 | PLT-EVA | Yes, but I think I went down - when I went down there to - |
| | SPT-EVA | Yes, okay. I can - I can pull out more umbilical. Is that what you need? |
| | PLT-EVA | No, no, I don't need any more. |
| | CDR | No, I don't think so. |
| 326 20 58 04 | SPT-EVA | Oh, okay. |
| 326 20 58 06 | CDR | Bill, your feet are going to be down in the wrong direction; they need to be pointed in the opposite direction. |
| | PLT-EVA | Jer, I can't turn around; that's why I was - |
| | CDR | Well, then just relax and wait until Ed gets there. |
| | PLT-EVA | That's what I'm doing. |
| 326 20 58 17 | SPT-EVA | Okay, coming down, William. |
| | CDR | Wait until Ed gets in the restraint. Then he's got all the leverage and he can maneuver you around. |
| | PLT-EVA | Roger. |

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| 326 20 58 31 | SPT-EVA | Okay, now let me - Bill? I guess what I do is slide right down between this box and you. |
| | PLT-EVA | Yes. |
| | SPT-EVA | Can you lean forward a little bit? |
| | CDR | Why it's Big Ed. |
| | SPT-EVA | There. Now - Now when I - - |
| | CDR | Tell me as soon as you get in the foot restraints, Ed. |
| | SPT-EVA | Yes. Stand by, there. |
| 326 20 59 25 | PLT-EVA | I don't have any below me. |
| | SPT-EVA | Okay. Now those foot restraints are locked. |
| | PLT-EVA | Yes. So go ahead and stick your little tootsies in there, Cinderella. |
| | SPT-EVA | All right, Jer, we'll go ... locked. |
| 326 20 59 48 | CDR | No, you're not there; you're not there. Roll the inside of your - your left foot in and then try it. You're cocked on the - |
| | SPT-EVA | Sure I'm not there? |
| | CDR | No, you're not there. |
| | SPT-EVA | Well, this is not the most stable little platform, is it? |
| | CDR | Roll down on your left arch. Push it down toward the plate. |
| 326 21 00 09 | SPT-EVA | Okay. It feels like it's in there, Jer. |
| | CDR | Well, you're in there part way, but you might slip out easy. Now that's good; perfect. |
| | SPT-EVA | Okay. |

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| | CDR | Now you're in solid. |
| | SPT-EVA | Okay. Now, read on. |
| | CDR | Okay. You're going to deploy - remove the jumper box and place it on the hook of the tool pouch. And - well, no, first of all, deploy the tool pouch. |
| 326 21 00 34 | SPT-EVA | This is a good idea. Now - - |
| | CDR | But you need to help deploy Bill, too, if necessary there. |
| | SPT-EVA | Well, Bill, tell you what; whay don't you just stop thrashing there? Just - just cool it a minute. |
| | PLT-EVA | I'm trying to get my bearings so that I can see the - I've already looked inside the pitch pot, and it looks clean. |
| | CDR | Okay. |
| 326 21 01 19 | SPT-EVA | Don't keep bumping your - |
| | PLT-EVA | There's the Sun down there. |
| | SPT-EVA | Take it easy and I'll have this thing deployed in no time, and I'll be holding onto you. Oops! |
| | CDR | I saw that jumper box floating away and the - and the lanyard was behind it. I couldn't see it, and I thought it was loose. |
| | SPT-EVA | Come on there. |
| 326 21 01 43 | CDR | Oh, what a mess. (Laughter) I'm straining my gut trying to help you, Ed. |
| | SPT-EVA | Well, hold on now; we're getting it. |
| 326 21 02 09 | CDR | Gently with that, Ed. You're liable to flip a tool out. |
| | SPT-EVA | Yes, I understand. Got to take this other one now and put that one around too. |

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| 326 21 02 32 | CDR | Bill, I think you'd be better off helping Ed get that tool box deployed. |
| | PLT-EVA | Okay. |
| | CDR | Hold it out for him so that loose end doesn't swing around, the one that's looking at you right in the face. Attaway. Be terrible to flip one of those tools off of there and see it go whistling off. |
| 326 21 02 55 | SPT-EVA | Okay, there's the Velcro on the left side, and I think we've got a pretty good feel now. Now I can take my wrist tether off this thing. Okay. Now *** there, Bill. Son of a gun. |
| 326 21 03 19 | CDR | There you go. Good show. Not - not too much; you're flipping it clear over. |
| | SPT-EVA | Yes, I know; I got to undo a little of it. |
| | CDR | Bill's got it and handing it to you. |
| 326 21 03 32 | SPT-EVA | Yes, I see it, but you see, there's a - |
| | CDR | There you go. |
| | SPT-EVA | Watch your feet there, Bill. There you go. That's what we needed. Now I in turn am going to hand something to you. This thing coming around here. Will you take that? |
| 326 21 03 50 | PLT-EVA | Just a sec. I got it. |
| | SPT-EVA | Okay, now pull on it. No, no; I don't mean there. I mean underneath here. |
| | CDR | There you go. There - got it. |
| 326 21 04 00 | SPT-EVA | Okay, now, just bring that up. Just lay it down, and I'll put it - okay, I got it. Now you just worry about yourself there. |
| 326 21 04 35 | SPT-EVA | Can't get the right side turned over to Velcro it. |
| | PLT-EVA | Ah, okay. |

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| | SPT-EVA | Hold onto that. I just got to make a 180 with this strap, here. |
| | PLT-EVA | (Laughter) Okay. |
| | CDR | Your left heel is about to kick the window, Bill. |
| | PLT | Okay, okay; if you hold it steady; I think I can wrap it. |
| 326 21 04 52 | CDR | Bill, your left heel's about to kick the window. |
| | SPT-EVA | Now let me put this one around here too. |
| | CDR | Okay, that looks good. Now you need to do the other end that good. The other end looks pretty loose. |
| | SPT-EVA | This - I've just been sliding along here, Jer; that's my problem. It's - it's on there; on my side I got good Velcro both ways. |
| | CDR | Okay. |
| | SPT-EVA | So I think we're okay. |
| | CDR | Very good; let's press on then. |
| 326 21 05 24 | CDR | Now you take the jumper box container and - from your wrist tether and place it on the hook of the tool pouch, Ed. |
| | SPT-EVA | Okay. Get that hook over here first. Tether off. |
| | SPT-EVA | Okay. |
| 326 21 05 58 | CC | Skylab, this is Houston through the Vanguard in port for 6 minutes. Over. |
| | SPT-EVA | I said hello, Bruce. We're just setting up shop here. We got the tools deployed and we're ready to move on. |
| | CDR | Okay, we're - - |
| | CC | Roger. For the - - |

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| | CDR | We're to inspect and the clean the pots. |
| 326 21 06 16 | SPT-EVA | Let me give you the little spatula, Bill. |
| | PLT-EVA | Okay. |
| 326 21 06 23 | CDR | Okay, it says inspect the pitch pot area of the gimbal and sweep out any debris that you might see. Using a motion - - |
| | CC | - - and periodically thereafter until we go back into the momentum dump scheme. Over. |
| 326 21 06 37 | SPT-EVA | Bruce, you didn't come through. Only the last half of your sentence came through. |
| | CC | Okay; I'll repeat again in a minute. |
| | SPT-EVA | Okay, you have got a wrist tether there, Bill? If you do not, take one of mine. |
| | PLT-EVA | No, I didn't. I used it to hold down the - - |
| | SPT-EVA | Oh. |
| | PLT-EVA | - - end that holds your foot restraint in. |
| | SPT-EVA | *** minute until I get the spatula back in here. But let me put it on my left wrist tether. And I'll give you my right. |
| 326 21 07 17 | CC | CDR, this is Houston; how do you read? |
| | PLT-EVA | Well, okay. |
| | SPT-EVA | Jer, you reading them? |
| 326 21 07 24 | CDR | Loud and clear. |
| | CC | Okay, would you, just on panel 207, INHIBIT the CMG SAT parameters. We expect you'll get a CMG SAT in 45 minutes to 1 hour and periodically thereafter until they get the momentum management scheme going again. Over. |
| | CDR | Okay. |

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| | SPT-EVA | Ever tried to straighten out fly paper? |
| | CDR | (Laughter) |
| 326 23 21 05 | CDR | Some of those bits of foil are actually reflecting enough light back to - so that I can see flashes against the back of you guys. |
| | SPT-EVA | Yes, I've noticed that. |
| | PLT-EVA | I've noticed that. |
| 326 23 21 13 | SPT-EVA | My gosh! I'll tell you, that sunlight - Oh, boy, that tape just doesn't want to stick, does it? |
| 326 23 21 19 | CDR | No, it's not very good tape at all. |
| | SPT-EVA | Anyway, we can get - - |
| | PLT-EVA | That's all right. |
| | SPT-EVA | Give me one more, and we can get it up here on the structure here. Okay. |
| | PLT-EVA | One more is all you got. |
| | SPT-EVA | Oh, I won't ask for more then. Here. |
| 326 23 21 41 | PLT-EVA | It sticks nicely to itself though. |
| | SPT-EVA | I tell you, I think that this stuff is a little bit cool. That's probably why. |
| | SPT-EVA | Got one tape. |
| 326 23 21 51 | PLT-EVA | Don't put - don't put the tape at - at the thermal control, Ed. That white square. |
| | SPT-EVA | Oh, okay, Well, let's see here. |
| | PLT-EVA | You - if you - that - if you could peel that one. |
| | SPT-EVA | I'll peel that one back. Both of them, completely free. |
| | PLT-EVA | That's good. That'll keep the thermal peop *** |

| | | |
|---|---|---|
| 326 23 22 34 | SPT-EVA | That - that's not going to stick. Hey, I'll tell you what, though. |
| | PLT-EVA | What can you do? |
| | SPT-EVA | The tape is so darn cold that it's just - |
| 326 23 22 59 | SPT-EVA | Okay, we got the Velcro on, and we've got it around the side there. As long as we don't disturb it while we're here, nothing else is ever going to happen to it. |
| 326 23 23 15 | CDR | You started to peel back the insulation, Bill? |
| 326 23 23 19 | PLT-EVA | Yes. |
| | CDR | Okay, we got two allen-head cap screws to get out. And those screws are not captives. |
| | SPT-EVA | We don't need them though, huh? |
| | CDR | No. |
| | SPT-EVA | Okay. |
| | PLT-EVA | Ed, could - do you - Could you hold on to me? |
| 326 23 23 34 | SPT-EVA | Yes. |
| | PLT-EVA | Put tension on me to stop because I pushed myself from this. |
| | SPT-EVA | No, let's see. See, I'd have to - I can't - - |
| | PLT-EVA | Okay. That's all right. |
| | SPT-EVA | I can't do everything for you because you're working normal to the forces I could put on you. |
| 326 23 23 44 | PLT-EVA | Yes. |
| 326 23 23 51 | SPT-EVA | Yes, that's it; put it down that way. |
| 326 23 24 06 | CDR | How you guys feeling? |
| | SPT-EVA | Great. |
| | PLT-EVA | Feeling fine; feel good. |

| | | |
|---|---|---|
| | CC | And we're a minute from LOS. About 25 minutes to Carnarvon, to 20:54. |
| | CDR-EVA | Okay, Ed, if you - if you will, read me the procedures on putting away T025; and I'll get that out of our way. |
| | SPT | Okay, let me dig back in here. Good Lord ... do all this stuff. Appears to be - Okay, Jer, you want to stow the T025 assembly and AM strap; extension boom handrail, next to 323. |
| | CDR-EVA | Next to 323. |
| | SPT | That's the extension boom. |
| | CDR-EVA | That's got to be 317 there. |
| | CDR-EVA | Okay. |
| | PLT-EVA | Floating out into deep space, that thing ... on. |
| 359 20 31 18 | PLT-EVA | What time outside, Ed? About 3-1/2 hours? |
| | SPT | Yes. Let's see. You went out at 16:54, and we're coming up on 20:30; so you're 3-3/4. Okay, Jer, I'll give you some other words on that. You tether the T025 assembly handle to the handrail in the ATM aft - the AM aft, next to 314. |
| | CDR-EVA | Okay. |
| | CDR-EVA | Next to 314? |
| | SPT | Yes. |
| | CDR-EVA | I'm going to need another tether for that. I'll use my wrist tether. |
| | SPT | Well, you may be needing the wrist tether later, Jer, when you start working the 54. |
| | CDR-EVA | Well, I'll see if I can't procure one somewhere else. |

| | | |
|---|---|---|
| 359 20 32 16 | PLT-EVA | Yes, we're running pretty short of those things, you know. I didn't tether the S149, but I did put it on a handrail, lock it, put it - the lock retaining bar in position; so it's pretty safe. |
| | SPT | Bill, did you look in that dome locker in the OWS, which had them? |
| | PLT-EVA | Did I do what? |
| | SPT | Before, when we were getting set, did you see all the ones that were in the dome locker in the OWS? |
| | PLT-EVA | That's what - that's the one's we're using. |
| | SPT | Oh, okay. Well, you know where the other one is if we really need it. |
| | PLT-EVA | I'm afraid it's going to stay there. |
| 359 20 32 58 | CDR-EVA | Okay, T025 is now tethered. |
| | SPT | Okay, we'll consider that done. Bill, I'll tell you what. We got the S020 to go, 201, and S054. And I really can't do much on any of them right now. |
| | PLT-EVA | Okay. Particulates keep coming out here and ricocheting off my helmet. I can't - - |
| | CDR-EVA | Yes. |
| | PLT-EVA | - - figure out where they're coming from. Like rice-sized grains. There just went another one. I think it's paint flaking off. In fact, it has a lot of surface dirt to it. There just went another one. |
| | CDR-EVA | You know, I could - It's no big - Let's see, Bill. Are we - Did we take 201 out and mount it? |
| 359 20 34 11 | SPT | You got a problem there, Bill - or Jer, in that - that these have to be pointed within 20 degrees of the Sun in the maneuvers itself - - |

| | | |
|---|---|---|
| | CDR-EVA | Okay, watch, can you just hold me like a big sausage under your arm? |
| | PLT-EVA | Yes, stand by. Okay. |
| 359 22 14 58 | CDR-EVA | You can go ahead and put your foot in the other foot plate if you want to. |
| | SPT | Is that the only shutter plate that's in there, Jer, or is there one in the camera? The camera has got its own, does it not? |
| | CDR-EVA | I think so. |
| | SPT | All right. So as long as that thing will open and stay open, we're still in business. |
| | CDR-EVA | Yes, if I can get it open. |
| | SPT | All right. |
| | CDR-EVA | Excuse me, Bill. I've got to come down. |
| | PLT-EVA | Okay. |
| | CDR-EVA | I can't see. I need to - |
| 359 22 15 33 | PLT-EVA | I held you too high, was that it? |
| 359 22 15 35 | CDR-EVA | Yes, I'm too high. Roll me over more on my right - right side toward you. |
| | PLT-EVA | Like so. |
| | CDR-EVA | A little more. All right. Now, just kind of put me in here. Good. |
| | CDR-EVa | There just isn't room. |
| | CDR-EVA | All right, now shove me in if you can. Any further. |
| | PLT-EVA | Just a second. |
| | PLT-EVA | How's that? |
| | CDR-EVA | That's better. |

| | | |
|---|---|---|
| | CDR-EVA | This is really murder. |
| | PLT-EVA | I bet it is. |
| 359 22 17 10 | SPT | Can I help you find anything inside here, Jer? |
| | CDR-EVA | Not that I know of, Ed. |
| | PLT-EVA | Can I hold the flashlight for you? |
| | CDR-EVA | Can - Can you hold it down low there? |
| | PLT-EVA | ... hand. Your arm. |
| | CDR-EVA | Do you have the knife - the blade of the screwdriver? |
| | PLT-EVA | Just a second. Let me get a good grip. |
| | CDR-EVA | I've got to rest my hand. |
| | PLT-EVA | Okay. |
| | CDR-EVA | We've got to turn that off, or we'll lose it. |
| | CDR-EVA | It's all our arm's length, Ed. |
| | SPT | Yes, I know. Rusty's got good long arms. |
| | CDR-EVA | Man, that's a very, very fragile shutter knife blade too, because I was really not pushing at all. |
| | CDR-EVA | Okay, Bill, can you try to shine it in there again? |
| | PLT-EVA | Okay, stand by. |
| 359 22 18 21 | SPT | You going to try to open it up again? |
| 359 22 18 23 | CDR-EVA | Yes. |
| | CDR-EVA | Right down on the plate there. Want to try to push that button back there. See if I was successful. No, it's jammed now. Shoot. |
| | SPT | Can you get lots of leverage on it? |
| | CDR-EVA | No, I can't get any leverage on it. |

| | | |
|---|---|---|
| | SPT | Can you see the deformation? |
| | CDR-EVA | Yes. |
| | CDR-EVA | It's - I bent it down about 20 degrees. |
| | CDR-EVA | Bill, put me down some now, please. Can you kind of roll my right arm in? Okay, hold me right there. |
| | PLT-EVA | Okay. |
| 359 22 19 52 | CDR-EVA | No. It's ruined for good now, Ed, I'm afraid. Doggone it. |
| | SPT | Is there any way of prying it from either side? |
| | CDR-EVA | No. |
| | CDR-EVA | It's bigger than the hole. |
| | SPT | Do you think - Well, we won't do it until ground comes up. Do you think if you could put the camera in, that might give it enough leverage to push those things down? |
| | CDR-EVA | No. See, they're on the other side of the plate. The shutter blades are on the other side of the plate, down in the - down in the telescope. |
| | CDR-EVA | I had no idea there was any possibility that they could spring back on me. |
| 359 22 20 47 | CDR-EVA | Bill, can you push me down and in again? Push me hard. Good. Hold me right there. |
| 359 22 20 58 | PLT-EVA | You have it - There's the rotation knob there. |
| | SPT | Yes, confirm that those things are all inhibited. |
| | CDR-EVA | Oh, golly, this - these shutter blades are like paper, they're so thin. |
| | CDR-EVA | I might just chop it out, I don't know. Let's wait for the ground and ask them. |

| | | |
|---|---|---|
| 363 18 07 39 | SPT-EVA | Start off with frame number 5 with our highest priority, which I believe is 5. |
| | CDR-EVA | Okay, Ed. I wonder, would it be any help for me to get in that - those restraints and hold you while you fiddly with the experiments? |
| | SPT-EVA | It may well, Jer. I was just thinking about that, because it looks as though I'm - even though I've grown a little, I'm still about a foot too short to make my head over there. |
| | CDR-EVA | Yes. Well, I could hold you like a sausage, a loaf of bread under my arm, you know, and you could just kind of go where you wanted. |
| | SPT-EVA | (Laughter) All right. We'll give it a go. Let me - - |
| | CDR-EVA | All right. |
| | SPT-EVA | Let me get out of the restraints here and get up at approximately the right position. |
| 363 18 08 31 | SPT-EVA | My, that blue is a pretty blue. |
| | SPT-EVA | Right now, Bill? |
| | SPT-EVA | Okay. And what - do you know what we're over? |
| | SPT-EVA | Oh, you don't have the slider out, do you? |
| | PLT | We're coming up over tip of Australia and headed for New Zealand. We'll be over New Zealand in 10 minutes. |
| | SPT-EVA | Okay. I was just looking at the thunderstorms here. I notice when one - one bolt goes off, it tends to propagate, and there's a whole chain of them then go off. |
| | CDR-EVA | Yes. |
| 363 18 09 37 | CDR-EVA | Purty, purty [sic]. |
| | SPT-EVA | That it is. |
| | CDR-EVA | How about an EMU check? |

SPT-EVA 3.6 and no lights for EV-1.

CDR-EVA 3.7, no lights, EV-2.

SPT-EVA Star that is that's rising right there. That's almost the same intensity as the comet, isn't it?

CDR-EVA Yes. It's a pretty bright star.

363 18 10 16 SPT-EVA Story, there's a star right above the horizon now, just about where the Sun's going to be coming up.

CDR-EVA Could that be Mercury?

SPT-EVA About 20 degrees - or - no, about 15 degrees right now, rising pretty fast. And it's about the same intensity visually as the comet. If anything, it might even be a tad dimmer.

CDR-EVA Could it be Mercury?

CC We're working on an answer to that, Skylab.

CDR-EVA I think it's about - only about 5 degrees up off there now. It's only one finger above the airglow.

SPT-EVA Okay, there's the Sun. Okay, let's start working on S022. I've got - -

CDR-EVA Okay.

SPT-EVA - - I think I need to get my - my head up here.

CDR-EVA All right. How's that?

SPT-EVA - ... I'll tell you what, I'm going to have to try and sight it in coarsely, without the - without using their sighter. Just trying to - -

CDR-EVA Okay.

SPT-EVA - - square that - -

CDR-EVA I got you by the knee, here.

363 18 11 25 SPT-EVA Okay, Jerry. Now let me go back down here.

end canister. And it's - it's held in with six screws, and you'll be taking that off. It's the one - there are four of them out there, and it's the one immediately to the left of the S082B film retrieval door.

CDR Yes, we've got a picture of the Sun end up here, and we just referred to it and located it. Those - -

MCC Okay.

CDR - - screws are - are for a blade screwdriver. Right?

MCC That's affirmative. Okay. We were just going to tell you about that photograph, and you've already seen it, so that's fine. Okay, during the prep, we mentioned preparing a universal mount to hold the Nikon camera. And wh - what we've done there is recommended some settings which will enable you to hold the - the handle on the universal mount and put you just about the right place to get your eye up to the - up to the viewing port. However, you all can play that any way you want. We found that that was about the best setting for us.

033 21 02 51 CDR Well, we'll sure give it a try, Rusty. And getting back to that zero-g cover again, we're not too in love with the tape up here that's used outside because as soon as it gets cold, it lets go. And I wonder if it might be wiser for us to take a PGA pocket out and strap it onto my arm or something and put that cover in the PGA pocket. And I just measured a pocket, and it's wide enough. It stretches to about 7 inches.

CC Okay, stand by.

033 21 03 52 MCC Okay, you've got a GO on that Jerry. And I think you - you certainly ought to locate it on you arm in such a way that you'll minimize snagging. And we'll leave that up to your judgment.

CDR Yes, we'll do a little experimenting and see if we can't work something up.

| | | |
|---|---|---|
| 034 17 18 18 | SPT-EVA | I hate to tell you this, but the clothesline from point to point described a perfect straight line through T025. |
| | CDR-EVA | Right. We're going to have to really be careful with that. |
| | SPT-EVA | Yes. |
| | PLT | Okay, now I'm going to read the DAC procedures here that Story said apply to our case. |
| | CDR/SPT-EVA | Okay. |
| | PLT | EV-1 - - |
| 034 17 18 39 | CC | Skylab, we're 30 seconds to LOS here; 12 minutes to Vanguard at 17:30. |
| | SPT-EVA | Roger, Story. |
| | PLT | 17:30. Okay, that's 11 minutes. |
| | PLT | Okay, EV-1, remove DAC and attach to VS clothesline hooks and lock. |
| | SPT-EVA | I think I will attach clothesline hook first. I'm going to leave this wrist tether on it, Jer. You may need it. |
| | CDR-EVA | Okay, good. |
| 034 17 19 00 | PLT | Go ahead and transfer the DAC to the VT. |
| | SPT-EVA | Tell you what else let's do, let's not hook the two clotheslines hooks together, or we're going to be hurting for slack to work around here. |
| | CDR-EVA | Yes. |
| 034 17 19 15 | CC | Skylab, we show you having plenty of time to realign T025 for the next window, if you need to. |
| | SPT-EVA | Okay, Roger, Story. |
| | CDR-EVA | If we're careful, we won't need to. |

| | | |
|---|---|---|
| | CC | You'll have the time. And going over the hill here; all your systems looking good. |
| | PLT | Thank you, Story. |
| 034 17 19 30 | CDR-EVA | Thank you, Story. Talk to you - |
| 034 17 29 34 | SPT-EVA | I'm not in the position to do that right now. |
| | CDR-EVA | Okay. There's 80 - about 78 percent of the film left. |
| | PLT | Oh, that's good. |
| | CDR-EVA | Tell me when you're ready, Ed. |
| | SPT-EVA | Yes, I will in a minute. |
| | CDR-EVA | Okay. |
| 034 17 30 18 | SPT-EVA | I want to get my own umbilical squared away here. |
| 034 17 30 21 | CC | Skylab, we're back with you through the Vanguard for 11 minutes. |
| | PLT/EVA | Roger, Story. |
| | SPT-EVA | Okay, I got your umbilical, Jerry. You're clear. Go ahead. |
| | CDR-EVA | Okay. |
| | PLT | And, Ed, just for planning on, we need to terminate S020 in about 3 minutes. |
| | SPT-EVA | All right, we'll just switch on to the next one. |
| 034 17 30 39 | PLT | Which is a 30-minute. The next priority is the 30-minute exposure, so we'll have to back-to-back it also. |
| | SPT-EVA | Story, would they like to pick up the next exposure which is shorter than our 30-minute and have it all in one sequence, or press on with the 30 which is going to have us break that one up too? |

| | | |
|---|---|---|
| | PLT | Okay, you did get a picture of the boom, right. |
| | CC | Beautiful, Ed. |
| | CDR-EVA | Yes, I got a picture of the boom. |
| | PLT | Good. |
| | CC | Understand you got the boom out already? |
| | CDR-EVA | Yes. |
| | SPT-EVA | Affirm. |
| | PLT | Roger. |
| 034 20 16 09 | CDR-EVA | You better start pulling in my umbilical, Ed. |
| | SPT-EVA | Uh - oh. Well, I better got down there where I can do it. Get my warm young, tender, pink, little bod down in there. You know, we've got a few pieces of gear hanging around here. |
| | CDR-EVA | We sure do. |
| | SPT-EVA | Along with ropes and tethers. Hey, this SOP was not moid - made to avoid hangups. Can you see me, Jer? |
| | CDR-EVA | Yes. |
| | SPT-EVA | Okay, what am - what am I hanging up on, this rope here? |
| | CDR-EVA | On the clothesline. |
| | SPT-EVA | And what part of me is hanging up? |
| | CDR-EVA | Your - the whole backside. Now try slipping down. Wait a minute. Wait a minute. Wait a minute. You're on the wrong side of it any way. You need to have it in front of you when you go down. |
| | SPT-EVA | Well, heck. The darn thing must have crossed under my feet. |
| | CDR-EVA | Yes. Because your unbilical is on this side of it. |

| | | |
|---|---|---|
| | SPT-EVA | Okay. |
| | CDR-EVA | If you go down that side of it, you just made a problem. |
| | CDR-EVA | A little bit further. Another - There you go; your left. Now you're free. |
| 034 20 17 27 | SPT-EVA | Okay, hey, I'm with it. Now I see it. Now I'm straightforward. If someone ever told me we'd be working in this environment 2 or 3 years ago I would have said they were crazy; no way. |
| | PLT | Okay, Ed, where are you right now? |
| | SPT-EVA | With my unbilicals tangled around my feet (laughter). |
| | CDR-EVA | Oh, dear. |
| | SPT-EVA | (Laughter) Just a minute I need a - - |
| | CDR-EVA | No, you're going the wrong - - |
| | SPT-EVA | No, I need a counterwhifferdill. |
| | CDR-EVA | Yes, but that's the wrong way, if you're going to go that way. There's the right way. |
| | PLT | I lost control, Story. |
| | CC | We copy. We know what that feels like. |
| | CDR/SPT-EVA | (Laughter) |
| | CC | Both the whifferdills and the control. |
| | CDR/SPT-EVA | (Laughter) |
| | CDR-EVA | Okay, put my umbilical in, monsieur, and I shall en - entre. |
| | SPT-EVA | Okay. |
| | PLT | Okay. |

| | | |
|---|---|---|
| | SPT-EVA | Go ahead. |
| 034 20 18 41 | PLT | I'm going to start reading. You can pay attention if you want or not. Verify - - |
| | CDR/SPT-EVA | (Laughter) |
| | PLT | What - whatever turns you on. Verify clotheslines are stowed properly and EVA area secured. So make sure you didn't leave anything out there. |
| | CDR-EVA | Yes. |
| | SPT-EVA | Yes, we got a little bit of doing there. |
| | SPT-EVA | We got a big, white blivet out here he's trying to get in right now. |
| | PLT | Okay. |
| | SPT-EVA | Okay. Come on over. ... blivet. Oops. Your - maybe you should be on the other side of it. You're getting it lined up. Okay, as you go in, grab that last little fist full of umbilical. Grab - Hold on. Your SOP is getting tangled in the clothesline. |
| | CDR-EVA | Oh, it sure is. |
| | SPT-EVA | Back - back out a little bit. |
| | CDR-EVA | Okay. |
| | SPT-EVA | Boy, you know, that's a trap that we've both fallen into more than once today. |
| | CDR-EVA | Yes, that - There's the disadvantage right there. |
| 034 20 19 33 | SPT-EVA | That's just made for it. So you're going to have to go out further, Jer. |
| | SPT-EVA | Yes, okay, now pull yourself over this way. Okay, there you go. Just a minute. Make sure to get my umbilical. Okay, go ahead. |
| | SPT-EVA | There you go. Why don't you just exchange that - put your hand on your wrist right here. |

CATALOG INDEX E-1 PAGE 47

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: E. EVA-SUITED ACTIVITIES
1. EVA Maintenance

EREP DEBRIEFING
PAGE 32-34

NOTE: S193 Microwave Rad/Scat/Altimeter

CARR: Would you describe how difficult the job of pinning the antenna was?

GIBSON: That was a very difficult EVA because it required a lot of work with the fingers on very small objects, an endeavor which was not accomplished as easily as it was in training. We almost got completely hung up in trying to take off the junction box, the removal of which would have allowed us to put on the other connector. There was a lip that hung over the screws we were trying to get on. We couldn't get a straight shot at them. We had to work from all angles with many pushes with the Dixie screwdriver. That took probably 20 or 30 minutes.

POGUE: It would have been an impossible task had we not had the foot restraint. Every time I pushed on it, I pushed myself away. Also, he was holding on to me and was torquing me sideways. I finally had to give the screwdriver to him. It was very laborious. I think we ended up using a manual screwdriver for the final portion of that rather than the Dixie screwdriver. The accomplishment rate per unit time was very low. The actual task of pinning the antenna was not that difficult. Taking the pyro fitting off was the biggest problem.

CARR: The torques on those nuts that you had to take out were higher than expected. It took a lot of force, but once you got them loose, they came out.

POGUE: Once I left the pin in position, there was no problem. We got the antenna to the right position, so that we could see it through the hole after we took the pyro fitting off. It was a little bit of work, but not too much.

(CONTINUED ON NEXT PAGE)

CATALOG INDEX E-3 PAGE 116

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: E. EVA-SUITED ACTIVITIES
3. Restraint Use

SWS SYSTEMS DEBRIEFING (CONTINUED)
PAGE 395-397

CARR: The loose items - The tool caddy problem is a problem, and I guess it always will be. When I was trying to take the zero-g fixture cover off on the last EVA and I was prying, I had the gray tape on it as we'd - it said to do. But you know, gray tape when it gets hot or cold doesn't stick. And they forgot to tell me that under the zero-g fixture was a 2-inch block of some phenolic material that went on down; it was a plug. And I was busy prying, and I couldn't figure out why that cover wouldn't come off. And all of a sudden - pop - off it went; and I caught it in mid-air, and it was on its way. And I was just thankful I was able to catch it, because I would have had to go find another cover and start all over again if I had lost it. Just those handy little restraint things - tool restraints.

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COROLLARY EXPERIMENTS DEBRIEFING
PAGE 1-3

NOTE: D024 Thermal Control Coatings

QUERY: Are snap type restraints acceptable for EVA operations or should they be disregarded for future EVA applications?

GIBSON: I wouldn't want to say across the board they ought to be disregarded, but for that type of application it would have been much easier to use a softer type restraint. There was no reason to have that type of a rigid, hard mounting. We could have done just as well with a couple of pip pins which could have rotated in and held it almost as firmly.

CARR: Possibly the sort of grommet and post type of fastener that you use on boat tops where you have

(CONTINUED ON NEXT PAGE)

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: E. EVA-SUITED ACTIVITIES
3. Restraint Use

COROLLARY EXPERIMENTS DEBRIEFING (CONTINUED)
PAGE 1-3

NOTE: D024 Thermal Control Coatings

| | |
|---|---|
| CARR: | a post sticking out with a little wire on the side and what you have has a grommet in it and you just push it through. One of the big things is being able to see and line them up. When I was inside and they were outside, Ed was having the biggest part of his problem lining that snap up so that he could push it and get it to snap and it was almost impossible. When you have that sort of application, you should stay away from snaps, I think. |
| QUERY: | Thank you. Would alignment marks or the larger snaps be more acceptable? |
| GIBSON: | No, I wouldn't want to use snaps, but alignment marks certainly would have helped. All we really needed was to have a center post which you could slip it over and you could see through a hole in the center where to put it, and we didn't have to have any alignment like this. All you wanted was to have it normal to the surface it was on, parallel to the surface in that case. Knowing what you wanted, I tried doing it for 10 minutes trying not to touch any of the pieces of sample, and finally I got my thumb on a couple of them. I apologize for that, but it was either that or try tape which I knew was less acceptable because of outgassing and sunlight and tape was hard to work with. So it was either touch a few samples or not get it done at all. |

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## 14.4 Individual Experiments

GIBSON D024: Our first problem was putting the samples out during the EVA. By way of apology and explanation, we predicted beforehand that attaching those panels with snaps designed for another purpose would cause difficulties, and we were correct. The voice tapes document the amount of time and effort that went into making that work. Some of the disks were smudged by the EVA gloves, because, rather than tape the experiment, a method which seemed unreliable, we struggled through and put it on with the snaps. However, a couple of panels were affected.

CARR In summary, the time required to install the D024 during EVA was much too long. The time allotted was not commensurate with the equipment. That was poor system design.

GIBSON This experiment was never intended for EVA installation.

POGUE M518: The M518 was extremely simple in design. With the exception of making electrical connections, it presented no difficulties. My only complaint is that the M518 control box was positioned on top of another box so that numbers and nomenclature were hidden.

CARR The furnace and all the equipment that went in there was very well designed.

POGUE It's awkward working suited inside the spacecraft without helmet and gloves. I tried to do fairly precise work on the DACs and ATM panel without foot restraints. When you have one suited man working inside, you want to consider certain provisions for him.

CARR I remember wishing I had triangles on the bottom of my shoes.

POGUE I always felt very uncomfortable moving around suited in the command module with the hand controllers up there.

CARR Connectors and Controls: The regulator control on the left-hand side for the integrity check was difficult to turn off and get back on. That's an off-nominal mode of operation, and it should be very difficult to turn off and easy to turn on. That's, essentially, the way we had it.

CARR Foot Restraints: I didn't find any problem with the EVA foot restraints. There was a tendency to drift out if you weren't properly seated into them. But if you put in a foot restraint for every way you were going to position yourself, you'd be up to your elbows in foot restraints.

I'd say they were adequate, outside, for the most part. There were areas when we wished we had had better foot restraints.

GIBSON | For some reason, maybe it was body geometry, the left-foot restraint in the FAS workstation always seemed a little difficult to get into and stay in.

POGUE | I had trouble with the right one.

CARR | Maybe it was the right.

POGUE | It did that in the neutral buoyancy trainer at Marshall and in flight.

CARR | Perhaps it's the direction that you lean to do your work. It must have naturally unhooked your heels. We probably could have relocated that restraint some way.

GIBSON | Overall, I think those foot restraints were quite satisfactory. They made the EVA very easy.

CARR | On the S193 EVA, you tucked your foot restraint under your arm, and went over and installed it.

POGUE | That was a lifesaver. I couldn't have completed that EVA by myself.

GIBSON | I didn't think I'd be able to work on S193 in the foot restraint, but I did.

## 17.0 EVA

### 17.1 EVA Operations

GIBSON | Translation techniques - are very straightforward. I think we worried that one a little bit too much in the design of the system. It's so easy to get from one place to the other out there. It doesn't matter whether you're going backward, sideways, or what. There's no problem translating yourself. Translating yourself with something tied onto your wrist is also very easy. All you need is one hand and maybe one foot to stabilize yourself and you can work your way along almost anywhere, if you go slow enough.

CARR | There's one area that the folks in training imbedded into us and that was an innate fear of allowing yourself to get free and drift away from the vehicle. It caused us to restrict our operations a little bit and when I think back about it, I really don't understand why in the dickens we worried so much abou that. What's wrong with it? You lose time, but there's really nothing wrong with losing your grip on the vehicle and drifting out so your buddy has to haul you in. I guess that's the big disadvantage. For some reason, I had a psychological hangup about allowing myself to drift free of the vehicle and I used a lot of energy on occasions to make sure that didn't happen.

GIBSON | In no way is it a safety item, it's strictly time. We all felt that you'd lose a lot of time getting regrouped and pulled back in. I don't think there is any problem with safety here.

CARR | I somehow became hung up on the safety aspects of it. It would have been neat out there on the Sun end, when I had that camera in my hand, if I could have just kicked free and floated out there, taken the pictures and then had Ed reel me in like a fish and send me out again.

GIBSON | After handling umbilicals and each other out there, that would have been no problem as long as when he kicked free he didn't start out with any large velocity. No matter what he clanged into, the side of the OWS or whatever, it would have been no problem.

CARR | Boom operation - The booms just worked like champs. We found them to be superior to the clothesline operation because you didn't have the tangle, the intertwining problem, that you had with the clothesline. I think our modes of operation were the right way to go. The boom is the prime mode and the clothesline is the backup mode if the boom fails. The clothesline mode is a good mode of operation. It's quite usable but it takes more time and it's a little more trouble.

GIBSON | The third method we had was just a straight, manual translation; tying your film casettes on your wrists and going. That I felt

GIBSON (CONT'D) was also feasible. So we really had three ways of going. If we had done that, it would have taken a little more time, not too much effort, but it could have been done.

CARR On the last EVA, a lot of people were worried about having to make too many trips out to the VC foot restraints and back. The most desirable method of operating T025 was a two-man operation. It was no trouble at all to whistle out of the VC foot restraints, go back to the VF station, and do the work. Going from one point to another with the handrail system we had was very easy and we didn't mind making an extra trip.

GIBSON Talking about clotheslines gets into what we encountered during the last EVA. That was the amount of clutter we had in the FAS workstation in the way of clotheslines. We had two clotheslines out in the stem. We had all the ATM film which was stowed back there which we had retrieved. WE had S020 out and T025, and a DAC out there and/or a Nikon, and two people up in that area working. I found it really did get crowded. We were able to get it all sorted out. I believe that's a higher level of mechanical and geometric complexity than you should put into an EVA. Also, that's when I got the rope from the clothesline hooked into my PCU.

CARR LSU management - I didn't see any significant difference between that and underwater.

GIBSON | It didn't damp quite as fast, but it was no problem in management.

POGUE | The only problem we had was that if you became entangled, it was like a dog-leash problem.

GIBSON | When we were out on the first EVA Bill and I really got tangled up. Bill became tangled in my umbilical. All we did was have Bill stay still, I figured out what the problem was, gave him some directions, and he maneuvered himself out of it with no problem.

POGUE | It was a lot simpler than I thought it would be. Especially after coming back from that 193 area and having been out there digging around.

GIBSON | Once you see the problem coming up, you have to stop and take care of it.

CARR Lighting - I thought lighting was more than adequate.

GIBSON The only problem that Bill and I encoutered in lighting was working the 193, when we were using flashlights at night. We had a tough time holding them. We needed a flashlight which could have been mounted on a rail, which could have had a gimbal or a ball joint on it so we could have pointed it at our workstation. Then we both could have worked on it.

CARR A battle lantern would have been a very good thing to have.

POGUE That's a good thing to have. We should have the exterior of the spacecraft well lighted from at least two directions to avoid shadowing. We thought we would never do an EVA in that area, but sure enough, we did. In the future, you cannot count on doing EVAs in just certain areas outside the spacecraft and lights should be provided.

CARR One-handed versus two-handed Operation - Two hands are better than one.

GIBSON It depends on what you're doing. If you are restraining yourself, one hand is more than adequate. If you're trying to accomplish work two hands are better.

CARR Waist and wrist tethers are worth their weight in gold. I think we could have used six extra tethers any time we were out there.

GIBSON When I was trying to get D024 put in, although I had the tether the proper length, it would loosen up on me and increase in legnth as I was working. I don't know how we can avoid that. Maybe we could have the retainer mechanism spring loaded rather than work only against the tension in the rope.

CARR (CONT'D) with me, I had a good fit around the chest, so I had good trunk mobility, I felt. I wasn't rattling around in my suit.

QUERY One final question. Do you believe that separate mobile legs on the EV suit are necessary for working EVA; that is, except for foot restraints, an attachment for the separate legs used during EVA?

CARR Separate mobile legs? In other words - -

QUERY Yes. Like - like we've got.

CARR Yes. In other words, the other choice is ... - -

QUERY As opposed to just a ...

QUERY A mummy-log-type thing.

MS ...

CARR Oh, heavens, yes.

(Laughter)

CARR I wrapped my legs around things and I straddled things out out there to hold on, especially on that EVA where I was taking those movies. I was doing all sorts of things then.

POGUE Not to mention all the body English you use. You use inertia of the legs a lot of times to torque yourself around, you don't even realize unless you're using them.

CARR Yes.

POGUE Man, don't ever let anybody ... for that.

QUERY (Laughter)

QUERY Legs then - legs then definitely do have a use in a ... - -

CARR Oh, yes. Yes.

QUERY Right.

CARR I did a lot of straddling, where I'd wrap my legs around something, then let go with my hands.

QUERY ... Do you have any more? That's all we have. Thank you.

CARR Okay.

QUERY On EVA, in the lock compartment, did you feel the ventdown rate in the manual valve control that you have is satisfactory? Any comments at all on that?

CARR Yes, I think so. I think that we - we wasted some time. It took - took a little - sometimes, I felt like it took too much time to vent down. The - Actually, the repress was the thing that I felt took too much time. The

CARR (CONT'D)

venting down - I was kind of grateful that it went slow, because I - I had to work hard to keep my ears clear due to the congestion - the blood engorgement of my tissue in my membrane - in the nasal and ear areas. But I think we could probably go with bigger - bigger valves with more controllability, so that if everybody was clear and could do it, you'd go ahead and open it wide and do it fast, instead of wasting so much time just laying there while it, you know, dribbles out through a little valve. Of course, I think you'd probably - the bigger your valve, then you'd have to go more towards the - the screen routine that we had where you had one screen that worked for a while and then you'd remove it when the ice built up to a given level and go to the next screen.

QUERY

Okay.

POGUE

... a good fix.

QUERY

Do you feel that the foot restraints, such as we had for ATM, are adequate for the type of tasks that we had there, or do you feel that there might be some tasks where you might need additional restraints beside the foot restraints, such as a waist restraint or anything like that? Can you think of anything where the foot restraints wouldn't do - -

CARR

No, the places where we used the foot restraints - they'd had enough work done on them so that they were in the right place. There was one restraint in the FAS that bothered both Bill and Ed. Their foot kept coming out of it.

POGUE

I think it was my right one that kept coming out.

CARR

It seemed to me Ed was having trouble with - -

POGUE

I don't think that was as much a function of the foot restraint as it was of the individual body posture that resulted from trying to move yourself to face the task at hand. I think that maybe a little bit more work can be done with those foot restraints, but I don't know what. I can't suggest it. It seems like that it's such - it's a very, very close tolerance thing. I had trouble in the water tank at Marshall with that foot, and I had trouble with the same foot in flight. It's just exactly the same.

CARR

It was really pretty much the same for me too, in the ones that I fooled with. The water tank was pretty much the same as in flight. I didn't have much trouble because I didn't have any - any work - much work to do in the FAS area.

| | |
|---|---|
| QUERY | The FAS area had much more of a reach envelope requirement - - |
| CARR | Yes. |
| QUERY | - - more than we intended because of the additional stuff that we were taking out too. I know Ed mentioned in the technical debriefing that the methods of transferring of equipment - why, we had the booms; we had the clotheslines; and we also had manual transfer. Do you feel that the manual transfer is a good method, and do you feel that it's satisfactory for something like, say, the S052 camera or 54 camera, one or the other cameras like that? |
| CARR | Sure. |
| QUERY | ... be okay? |
| CARR | Yes, I think it's okay as a backup. I think - I think the boom was a - is a very good piece of equipment. It was very handy, and we could move gear from one place to another very quickly and smartly. |
| POGUE | But I think in moving the foot restraint around for the 193 repair - that was a good test of that particular task. |
| CARR | Yes. |

QUERY — Yes, for - for equipment like that there's no problem of damage - when you have lenses and things like that on camera - I guess that's one of the reasons we went to those, and do you feel that you'd be able to work with fairly sensitive equipment without some kind of a separation of the crew transfer and the equipment transfer ...?

POGUE — As long as we had a good palpate for it, or something like that.

QUERY — Okay.

POGUE — I'd be - I'd be more concerned about ... antennas and stuff like that.

CARR — Yes.

CARR — We were - we were very pleasantly surprised by our mobility along the EVA trail, the fact that we could move so quickly from one place to another. I could make it from the center workstation into the FAS in less than a minute, just really hustling right along, and once we got rid of the buoyancy problem like we had in the buoyancy trainer, it was really very, very easy to do.

CARR (CONT'D)

with the water. And we fought it all the time, and we knew it was going to bother us. And it was such a pleasure not to sweat buoyancy up there, that it made our mobility much better. You could move along the EVA trails just hustling - hand over hand, just like this. And you felt very comfortable doing it. You know, you hit the straightaway once you get beyond the twin pole sail; it was nothing just to whistle right on out there. And you remember all the trouble I had getting into the transfer workstation? It was nothing; you just swing right down and, clunk, your feet went in. And once you just got rid of the buoyancy problem, it was just a piece of cake.

QUERY

Okay. On lighting, could you comment on the - I think that we've got pretty good comments from you on the lighting at the workstations, how about the S193 area? And if you have any comments on the workstations, any additional ones, fine.

POGUE

The lighting was completely adequate. On the day - when the dayside - of course, that was supposedly on the shadowed portion, but plenty of lights. No problem at all. And at night, we even played with the flashlights trying to find this Mylar that supposedly jammed in this ... and

CARR (CONT'D) in your garage to put on the car. And you go out and you mount the light somewhere, and you plug it in.

POGUE There's only one thing about that - and remember that there are - you could always get yourself in a position, suited, where you're looking into the light. That's why you're always going to have a need for an auxiliary portable light.

QUERY Do you have any comments on handrails, handholds, any reach envelopes that we had, other than you mentioned, that probably because of some reach, you had some trouble with putting one foot in the FAS? Any other comments on general reach on the nominal EVA area?

POGUE Yeah, I have. The - You tried to standardize the geometry of the handhold. I don't think that was quite achieved. It looked to me like there was variations in the size of the handhold. That's noble target - noble goal; I think that's good. It screwed us up using the - the camera mounts. Some of the times it would make it flop around and jiggle. And sometimes you couldn't get the lock closed. That's a

POGUE (CONT'D)

whole other area to talk about. There was one other thing. Oh, please give us great big numbers on the handholds. You're talking about F-7 and all that. You're looking all over; it takes 15 minutes to find F-7, for crying out loud.

CARR

We could never remember where they were. We'd always have to go look for the number.

POGUE

Great big numbers, for people that are over 40. No, it's just - there's just no sense, I mean, you got all that space there, why not put great big number there and put one, instead of putting that little tiny?

CARR

No sense in wasting time looking for a handrail, when you're outside. That time's too valuable.

POGUE

And another - another case finding it, the paint fades. It's got to be a very high contrast thing.

QUERY

Which handrails faded?

CARR

Everything out in the direct Sun, faded. Turned more toward green.

POGUE

Yeah.

MS

...

QUERY Some of them were anodized. And - -

CARR Well, even the anodized ones turned toward a green.

POGUE Sure did.

QUERY Yes. They - they should lighten. We expected that they would probably lighten some.

CARR They sure did.

QUERY Because of the fact they were anodized.

CARR And if they're aluminum that was unanodized or it was anodized so that it still had a satin finish, it turned more toward a yellow. And that - that all stands to reason; you take blue and add yellow, and it goes toward a green. And if it's unpainted or untinted, it will go toward a yellow.

QUERY Do you feel you needed - that you lost contrast in the handrails and that that was not a good -

CARR Well, as far as finding the handrail, it was - there was no problem there. But seeing the number, the little F-7 or the F-5 or something on the handrail, was difficult. But the handrails we had, I thought were perfectly adequate. The EVA trail was excellent; we just - no problems

CARR (CONT'D)

with that whatsoever. The trouble is, the EVA trail didn't go far enough; and when we had to go around to 193, that was a different ball game. And the guys that went down and pulled that wing out - -

POGUE

Another thing that you might think about, Dick: you know that foot mount that I took down there for that 193. I - I watched Jer and Ed work in training, working the - Was it DO24? And this - there's a good argument to be made for being able to take the foot restraint and putting it around on trussworks and so forth. In other words, have some kind of universal mounting capability for a foot restraint, because watching them work on - on that particular one was just - You know, you'd just sit there, and it - you'd get a - build up a frustration case yourself, just watching the other guy. That's such a poor purchase on - in the area.

QUERY

Okay. I think we've covered the clotheslines versus film-transfer booms in the tech debrief pretty well unless you have any other comments. You did get some entanglement which was - -

CARR

Which can be dangerous, and that's - -

QUERY

- - what we were worried about.

CARR — - - the biggest disadvantage of the clothesline. It's not only a nuisance, but it can be dangerous.

QUERY — You mentioned that you did have that sticking problem with the pin on the Sun-end clothesline boom when you handed ... - -

CARR — Yes. It wasn't as bad as I had in the water, but my first yank, I said, "Aw, heck, here we go again, just like - This thing's just like the simulator." And then I got the other hand over there. And because I had no buoyancy problem, I was able to better position myself. And when I heaved a little harder on it, it popped right out. But positioning helped a great deal there.

QUERY — There was some comment, and I think it was Ed that had some problem with the Velcro on the clothesline stowage box. Do you know anything about that, Jer?

CARR — Oh, it was tough. He really had to pull on that. That was about all there was to it. He just - -

QUERY — Yes. Just -

CARR — You know, you get that old sloppy Velcro under water, and it gets real loosey-goosey and it comes right off. And up there the Velcro was holding the way it was designed, and he had to really yank on it.

POGUE | Yes. I've got a comment to make on those umbilical clamps. I - I didn't - never did like those in the water tank. I didn't like them up there.

CARR | They weren't any better up there.

POGUE | You know, it's just like you - they'd come up slightly underdesigned - in size, geometry. And they'd just say, well, if they've got them, use them. That's - that's the impression I always got. The thing that - You'd open it up and get ready to put the hose in position, and the thing would slide back down on its own, you know. It was always a bit of an irritation to work it.

CARR | Might have been better to go with a clamp - like you have the clothesline clamps up there, those clothesline hooks for pulling them tight. Just that sort of a broom-clip thing might have been just as good for the umbilicals. You never put that much strain on it - to hurt anything.

POGUE | You'd want it to pull out, anyway.

CARR | Yes.

POGUE | Either that - What is it, a cleat? Is that a thing that's used on a ship or a boat?

QUERY Yes. That would get pretty big if you have an umbilical of any great amount.

CARR Yes.

QUERY With any radius in it.

CARR It looks like one time there was a clamp on the S230 experiment up there that was placed in a position to shadow - to shadow the collection foil and to give them a little sort of a calibration of shadow. And it appears that our umbilical at one time or another went by there and flipped that thing off, and we never saw it go. And it looks like it must have happened on EVA-3 because we have photographs of the clip in place and then when I went out to retrieve the clip, it wasn't there on the next EVA.

QUERY On the - Do you have any way that you think that EVA prep and post times would be reduced at all? That's really kind of -

CARR Oh, yes. Yes. By designing a spacecraft that - that is better designed for EVA, you can - you can cut that prep and post down a lot. We spent an awful lot of time putting tinker toys and erector sets together and lashing them down the airlock module and then after the thing was

QUERY — - - so you didn't really need quite all the amount of flaring that we put on the - on the 82A and B cameras, perhaps, and in the canisters.

CARR — Yeah, that's right. But I tell you, it's easier to - to design your stuff with a good lead-in and flare and all that in the beginning than it is to find out it's a little too snug and you're going to have to redesign it later.

QUERY — And I guess Ed was the only person that used the replacement workstation foot restraint, when he went up and got the clotheslines. And maybe we can catch him later and just see how that compared and what he thought of that typical - that particular method of restraining the feet.

CARR — Oh, yeah. Well, he put one foot in it, and it came out again in a little while.

QUERY — Yeah.

CARR — Of course, I was right there, right next to his foot, watching it. It was no big thing; you really didn't need it. When his foot came out, he didn't worry about re-reinserting his foot; he just kept on working with the clothesline and got - got it out.

QUERY — So it wasn't very positive, and it came back in. You mentioned that there were hot spots and you feel different

hot spots. Were any of - Did you notice any of those on handrails or any of the - like the tree or anything like that?

CARR No. For the most part, it was on white, white places that were reflecting the heat. I wouldn't even call them hot spots; they were warm spots, really.

QUERY On stowage and - and hardware restraints. Can you comment on any problems that you had with stowage containers, if any? Any that stick out in your mind at all?

CARR No, most of the trees and things worked; the trees and the pallets and everything worked.

QUERY We're moving now inside, too; so - out of the EVA area.

CARR Okay. Inside it was just a mess, a general mess. And of course, by properly designing an EVA area, you can - you can design a lot of these messes out so that you don't have all that foolishness going on. But we would do a real neat job of lashing down T025 or something like that. And then on one case we used it - a pip pin with a chain on it; wrapped it around a piece of equipment and then stuck it back in its hole, forgetting the fact that a guy with a big gloved hand was going to have a hard time working that pip pin. And that almost caused

CARR
(CONT'D)

us to have to omit doing an experiment. The ad lib stuff, I guess, was the more dangerous of anything. We were thankful we had plenty of wrist tethers because the tools we were carting around out there, I was always afraid I was going to lose one. And when I was doing the S054 camera fix, it was a real pain in the neck not having a good place to retain those tools, because I would have the flashlight mirror flopping from this wrist and I'd have the screwdriver in my hand, trying to do the thing with the screwdriver when I was levering the filter wheel along. And I would have this other thing hanging on my wrist. It was very helpful to have Bill there holding me while I was doing that. The loose items - The tool caddy problem is a problem, and I guess it always will be. When I was trying to take the zero-g fixture cover off on the last EVA and I was prying, I had the gray tape on it as we'd - it said to do. But you know, gray tape when it gets hot or cold doesn't stick. And they forgot to tell me that under the zero-g fixture was a 2-inch block of some phenolic material that went on down; it was a plug. And I was busy prying, and I couldn't figure out why that cover wouldn't come off. And all of a sudden - pop - off it went; and I caught it in mid-air, and it was on its way. And I was just thankful

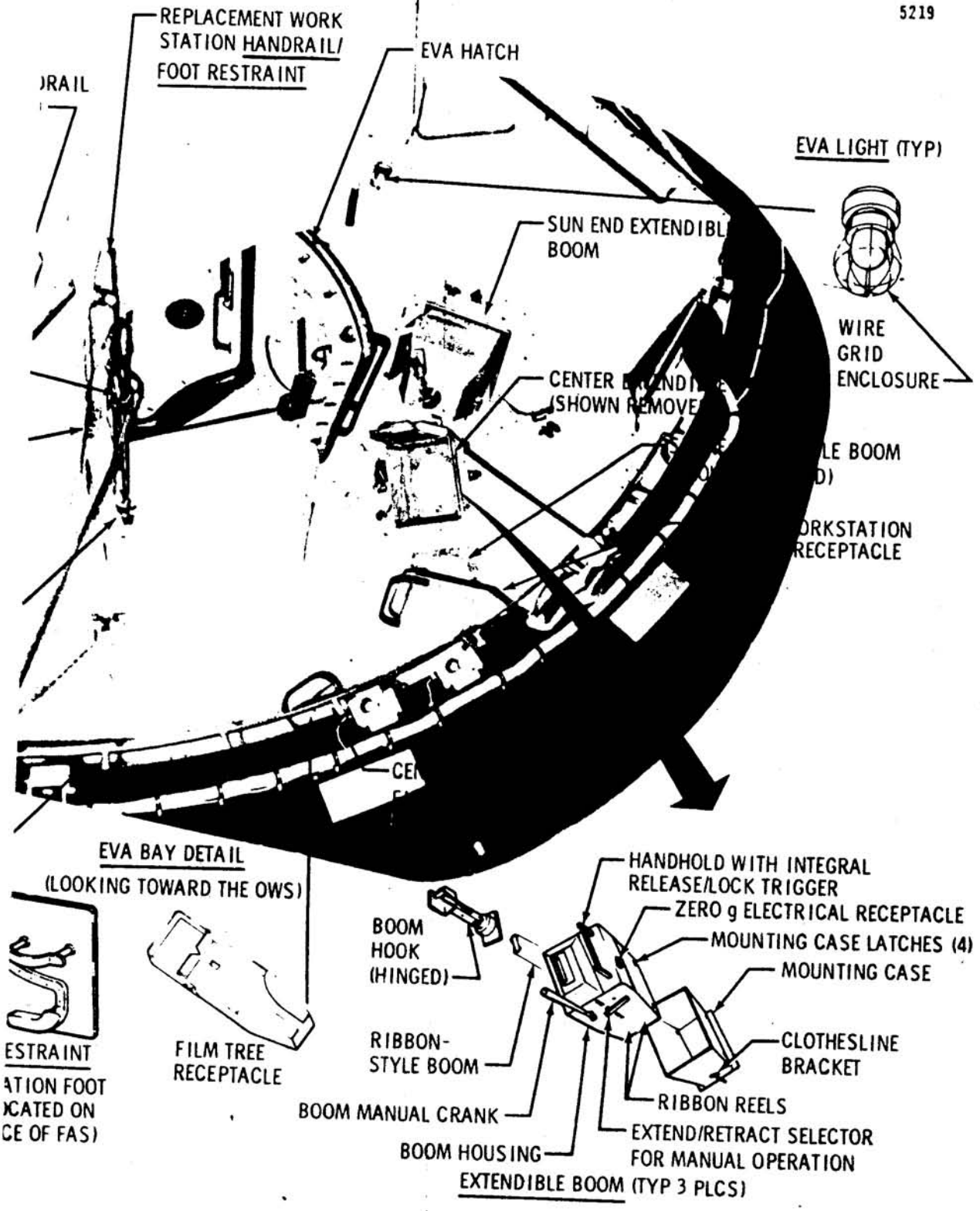


Figure 2.5.7-3 EVA Workstation Provisions



* U.S. GOVERNMENT PRINTING OFFICE: 1972—559-011/1659