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SKYLAB EXPERIENCE BULLETIN NO. 7

AN OVERVIEW OF IVA PERSONAL RESTRAINT SYSTEMS

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National Aeronautics and Space Administration

LYNDON B. JOHNSON SPACE CENTER

Houston, Texas

OCTOBER 1974

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

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This document is the 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. This method of data distribution has been instituted as a convenient way to provide early access to Skylab experience and is intended as an interim measure, to be followed up by a thorough experiment report six to nine months after receipt of all Skylab flight data.

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TABLE OF CONTENTS

TABLE OF CONTENTS

AN OVERVIEW OF IVA PERSONNEL RESTRAINT SYSTEMS

INTRODUCTION

Due to the vast amount of reference data available and the myriad types of personnel restraints utilized on Skylab, the Skylab experience reporting for personnel IVA restraint and mobility aids will be presented in four documents.

Skylab Bulletin #7 will approach the personnel restraints as a total system and present a general overview of the zero-g restraint requirements.

Skylab Bulletin #9 will cover the specific Skylab foot restraints and address the design requirements for foot restraints.

Skylab Bulletin #10 will cover the various body restraints used on Skylab. Such items as the ATM chair, the rotating litter chair, and various lap belts will be discussed. The need for such restraints and their design requirements will be outlined.

Skylab Bulletin #11 will cover the various mobility aids used on Skylab. Their use, adaptability, need and location requirements, and the design requirements for future mobility aids will be covered. This reporting format should result in a more easily useable set of personnel restraint and mobility aid data.

SUMMARY

The Skylab crewmen had little difficulty in learning how to use the IVA personnel restraints. After several days exposure, zero-g became a quite natural environment. The major problems that arose were due to poor restraints or a lack of restraints where they were needed.

It becomes apparent from analyzing the transcripts, that there are more similarities than differences in performing tasks in earth's gravity and in zero-g. Tasks requiring extreme stability on earth still require extreme stability in earth orbit. Using high powered binoculars or instruments such as a sextant are much easier on earth if the operator is able to rest his elbows on a solid, stable surface, giving himself, in essence, three or four point support. So it is in zero-g. Tasks that require a high degree of stability are made much easier with a three point restraint system.

The techniques of reacting or transferring forces in zero-g are very similar to reacting or transferring forces on earth. Man uses his arms and legs to complete a force couple in zero-g much the same as he does on earth. The major differences occur in how the man is restrained. On earth, he has gravity holding his feet to the floor. In zero-g he must have restraints for that purpose.

The Skylab crewmen utilized three general methods of restraint. These included the grid and triangle shoe foot restraint, gripping any available object with their knees or legs, and rigging tie-down straps for their

feet or legs. All of these methods had one common feature. They permitted the crewman to use both hands to perform the desired task. Of the three methods, good foot restraints were much preferred. The crews were unanimous in desiring a good foot restraint system installed all over the vehicle.

For less precise, or one-handed tasks, the crewmen utilized handholds to provide themselves with sufficient stability. Some tasks such as donning or doffing clothing were performed without any restraint at all.

To provide the crewmen with good foot restraints, the natural zero-g body position must be determined and analyzed in conjunction with the work surface-foot restraint relationship. Too many tasks aboard Skylab caused extreme muscle tension, resulting in fatigue due primarily to the crewmen being forced into body positions that were difficult to maintain in zero-g.

PRE-SKYLAB EXPERIENCE

The personnel restraint requirements of the Mercury and Gemini flights were comparatively simple. Neither spacecraft had sufficient volume for the crewmen to move around out of the couches, so the only IVA restraints required were the couch restraints. Since these were primarily designed for launch and reentry restraint, they played a very minor role in on-orbit operations.

The Apollo program had personnel restraint requirements similar to the Mercury and Gemini programs. The spacecraft was large enough to permit movement out of the couches and more volume could be gained in the Command Module by folding and stowing the center couch, but at no time were the crewmen out of reach of structural support to hang on to. Further, the experimental programs conducted within the Apollo spacecraft were not as elaborate as those conducted aboard Skylab and did not require specific personnel restraints. The Lunar Module (LM) had velcro patches on the floor and the astronauts' shoes for foot restraints, and a pulley system holding the astronauts' body to the floor. These were used during the LM's flight phases, with the 1/6-g field serving as a restraint during the lunar surface stay. The velcro patches proved to be inadequate as foot restraints, since the engagement forces were greater than the disengagement forces. But, they provided a needed friction surface on the deck of the LM.

SKYLAB DESIGN

For the first time in the manned space program, the Skylab OWS was large enough to require personnel restraint and mobility aids for the on-orbit IVA operations.

Not only was the vehicle large enough to permit crewmen to "get stranded out of reach of a structural member", but numerous experiments required a high degree of stability for the operators.

Various kinds of personnel restraints were devised and utilized on Skylab. Four different foot restraints including the triangle grid and at least five different types of body restraints were employed. These will be described in subsequent bulletins pertaining to the specific restraints. It is the intent of this document to present the more general restraint requirements determined from the Skylab experience.

SKYLAB EXPERIENCE

The pertinent in-flight air-to-ground transmissions and post mission debriefings have been organized and analyzed along with in-flight films and TV coverage to determine how the existing Skylab personnel restraints were utilized and to ascertain what problems, if any, the crewmen had in restraining themselves for zero-g operations.

Learning Process

In general, the Skylab crewmen had few problems in learning how to utilize the available personnel restraints or in devising them in those areas where restraints did not exist. Some of the crew comments from very early in the missions (day 4 or 5) indicate that the learning process is not automatic, but it soon became easier. It was reported in reference 21 that "...after about 10 days, we began to feel that zero-g was as natural

as walking down the street. And occasionally it poses a nuisance, particularly in the MDA where you don't have a place to fasten yourself down the way you'd like to."

In those locations where proper restraints were available, tasks were accomplished as readily in zero-g as in a one-g environment. In fact, some of the tasks appeared to be easier in zero-g because the legs could be used for more than just providing standing support. Also, the crewmen could arrange their bodies in an orientation better suited to the immediate task.

The following references indicate the learning process.

Reference	Appendix Page Number
1	1
21	45
24	49
27	54
29	59
41	92
43	97

Restraint Methods

The Skylab crewmen developed four general restraint methods, depending on the task and its location.

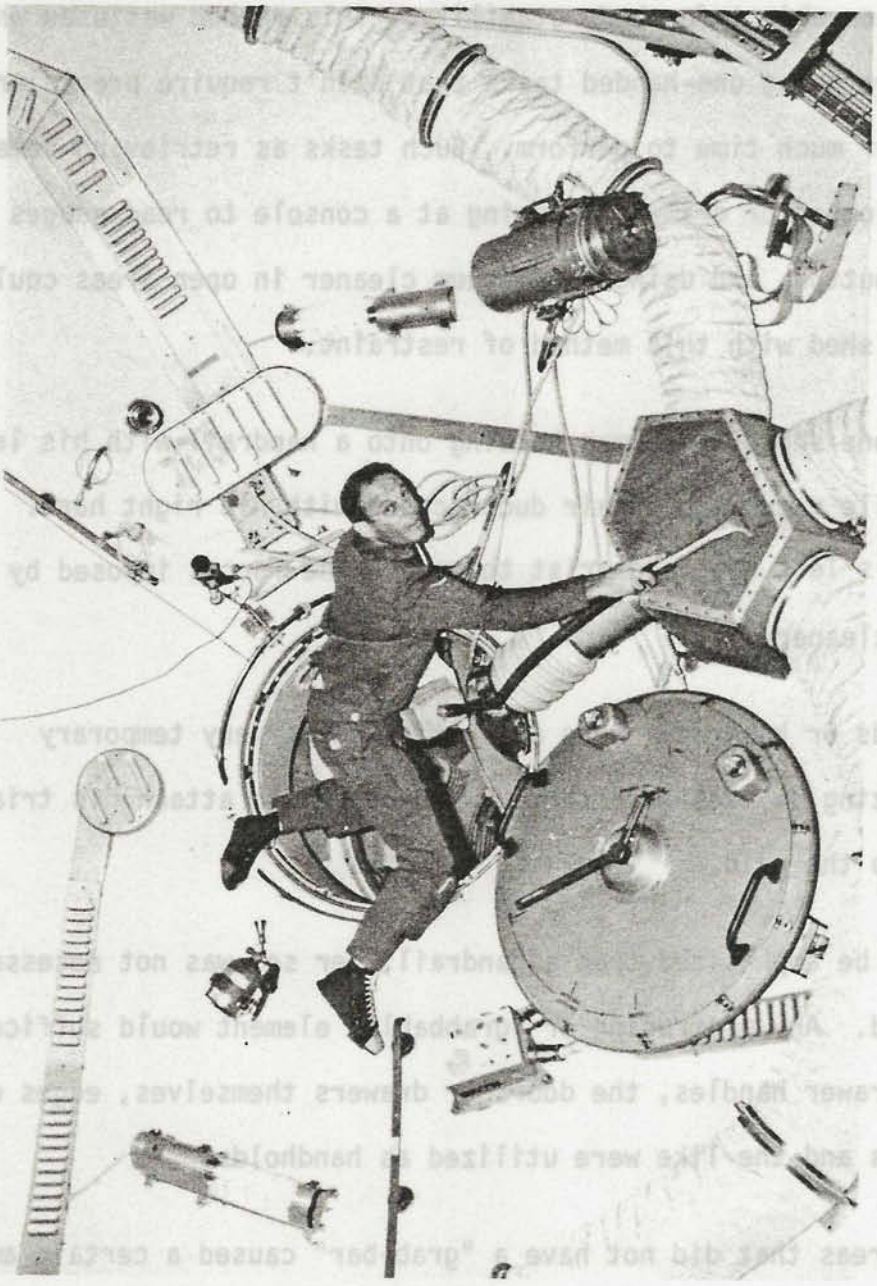
1. Handholds - The crewmen would use one hand to hold on to any available handhold, sometimes pressing one foot against the floor or another object for body stability. This method was used when they were doing one-handed tasks that didn't require precision, force, or much time to perform. Such tasks as retrieving something from a locker or drawer, stopping at a console to read gauges or push a button, and using the vacuum cleaner in open areas could be accomplished with this method of restraint.

   Figure one shows a crewman holding onto a handrail with his left hand while vacuuming an air duct screen with his right hand. He is using his left hand and wrist to remove the forces imposed by the vacuum cleaner.

   Handholds or handrails were also utilized as very temporary stabilizing devices when the crewman needed to attach his triangle shoes to the grid.

   It must be emphasized that a handrail, per se, was not necessarily required. Any protruding or "grabbable" element would suffice. Thus, drawer handles, the doors or drawers themselves, edges of consoles and the like were utilized as handholds.

   Those areas that did not have a "grab-bar" caused a certain amount of difficulty. The area around the film vault and the food lockers was specifically mentioned as having no place to hang onto while



Handhold Stability

Figure 1

the crewmen were attaching their triangle shoes into the grid. The following references address the use of and the need for handholds.

Reference	Appendix Page Number
3	3
4	4
5	7
7	12
11	22
12	27
13	28
15	36
17	38

2. Legholds - The crewmen would grip a stationary object between their feet, or knees, or wrap their legs around whatever was available. This method would be utilized on short, simple tasks that required two hands to accomplish but did not take too long or require much force. It was also used in some areas where foot restraints were not available.

This method of restraint enabled the crewmen to accomplish much more than handrails alone would have permitted. When the task was short-lived or required little force exertion, stabilizing themselves by gripping with their knees was satisfactory. Further, when the crewmen could wrap their legs around a stationary object they were much

better stabilized and had both hands free to accomplish tasks. This permitted them to use different, apparently stronger muscles and was less tiring than just gripping with their knees.

Figure two shows a crewman gripping an EVA suit with his legs to work on the helmet or neck ring. It appears to be much more convenient than foot restraints would have been.

Figure three shows a crewman working on the LBNP device. Instead of using his triangle shoes in the grid, he has chosen to wrap his legs around a portion of the LBNP device. This presumably permits him better access to the work than a hard-to-maintain crouching position would have permitted. The LBNP device was mounted on the grid floor in the foreward compartment and triangle grid was available had he chosen to use it.

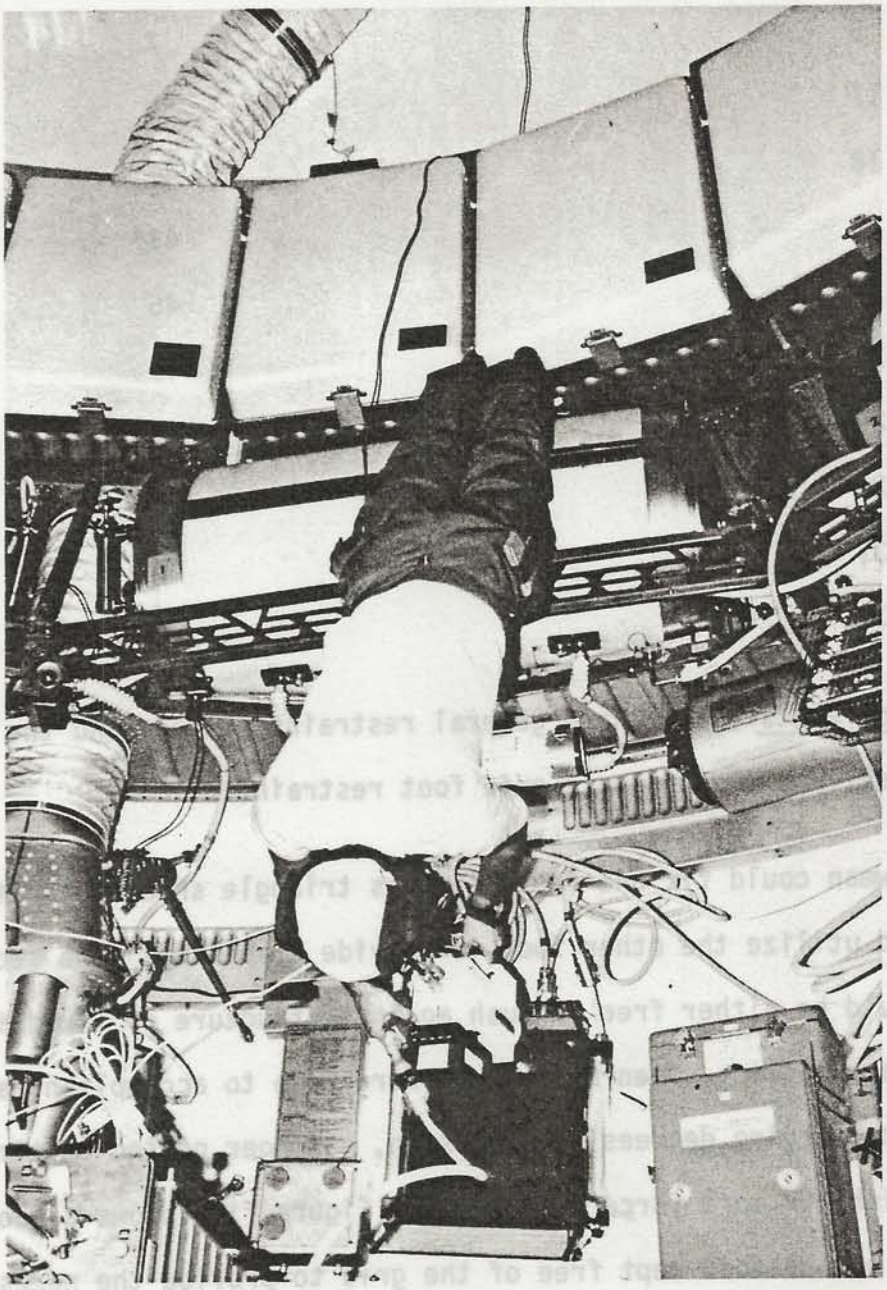
The crewmen would also jam their feet into available crevices such as openings between items of equipment.

Figure four shows a crewman with his feet wedged between a water tank and a dome locker support. He is oriented upside down with respect to the foreward compartment, but this simply illustrates the versatility available in zero-g if suitable restraints are provided or can be improvised.

The following references indicate the usefulness of leghold type restraints.

Leghold Restraints
Figure 2

Leghold Restraints
Figure 3



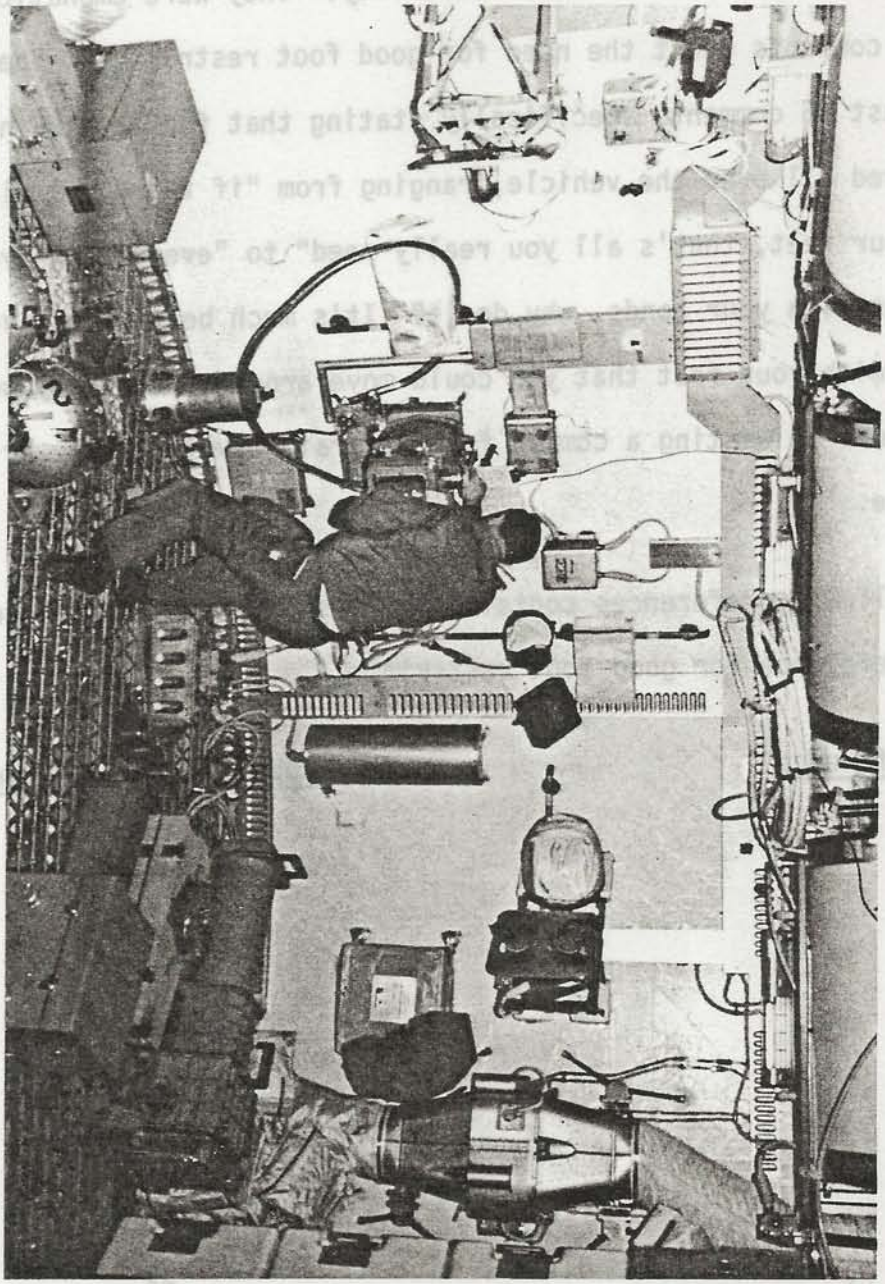
Foot Wedging for Restraint

Figure 4

Reference	Appendix Page Number
3	3
5	7
17	38
18	41
20	43
21	45
23	48
24	49
25	51
31	63
39	79

3. Foot Restraints - The third general restraint method, and the one most used, was the triangle grid foot restraint.

The crewman could fix one foot with its triangle shoe to the triangle grid and utilize the other foot to provide stability. The second foot would be either free to push against structure or fixed into the triangle grid. Then both hands were free to accomplish tasks requiring varying degrees of precision, a longer period of time to accomplish, or more force than usual. Figure five shows a good example of one foot kept free of the grid to provide the necessary stability.



Grid and Triangle Shoe Restraint

Figure 5

The crewmen quickly learned that good foot restraints were the most useable and provided the most stability. They were emphatic in their comments about the need for good foot restraints. There were at least 25 comments specifically stating that foot restraints were required all over the vehicle, ranging from "if there's a place to put your feet, that's all you really need" to "even though you can hold on with your hands, why do it? It's much better to have something with your feet that you could move around on." They were unanimous in wanting a common foot restraint system all over the vehicle.

The following references contain comments directed toward the need and preference for good foot restraints.

Reference	Appendix Page Number
3	3
4	4
5	7
8	13
10	19
11	22
12	27
13	28
14	34
17	38
20	43

Reference	Appendix Page Number
21	45
22	47
24	49
25	51
26	52
27	54
31	63
39	79
40	87

4. Innovative Restraints - When no restraints were available, the crewmen improvised useable restraints. Various combinations of straps to tie their feet and legs down were devised to permit them to accomplish the necessary tasks. However, this restraint mode was not too satisfactory. It appeared to be quite time consuming and rather inefficient to have to determine what restraints were needed and then find materials and methods to devise those restraints. Further, the unaccustomed pressure on their legs or ankles was, at times, painful. It cannot be argued that the "make-do" methods were unsuccessful, but they were not nearly as efficient as good foot restraints would have been.

   The following references are concerned with the various innovative restraints.

Reference	Appendix Page Number
4	4
9	14
26	52
27	54
28	58
36	72
38	75
39	79
42	93
43	97

Body Position and Orientation

The Skylab crewmen made numerous comments and observations concerning the unexpected ways they used their body muscles and the results of that unexpected usage. As an example, their leg muscles, used on earth primarily in compression or for pushing, were used in zero-g primarily in tension or for holding. This unaccustomed usage created muscle soreness and stiffness until the crewmen became used to it.

Their abdominal muscles also were worked in zero-g. The crewmen, even though they were in excellent physical condition, complained of stomach muscle soreness early in the missions. Analysis of the transcripts and films indicate that this was probably due to the work stations and restraint systems being improperly established for the natural zero-g

body posture. The commander of SL-4 provided a good verbal description of the zero-g body position in one of the post-flight debriefings.

> "Yes. See the thing is your natural posture is essentially---standing is just very slightly bowed, with your back hunched just a little bit, your legs flexed just a little bit."

However, certain work stations were designed for an almost-seated earth gravity body position. Thus, the crewmen had to exert muscular tension, primarily in their stomach muscles, to maintain body position at these work stations. For longer term tasks, this caused muscular fatigue.

One of the tasks commented on as being quite difficult was experiment T-002 which was taking star sightings from the wardroom window with a sextant. The two crewmen who performed this experiment both complained of fatigue while doing the task. The body position required at the window was maintainable only with extreme muscular tension. The relationship between the foot restraints and the wardroom window was, apparently, improperly established for this task. The SL-4 crewman commented that in one-g, the crouch or position that had to be maintained would have been fairly easy. In zero-g, it was extremely difficult.

The tasks required of crewmen in zero-g must be analyzed in terms of the zero-g natural body position to determine the proper relationship between the restraint system and the task itself. A Skylab experience bulletin is being prepared specifically on the zero-g natural body position.

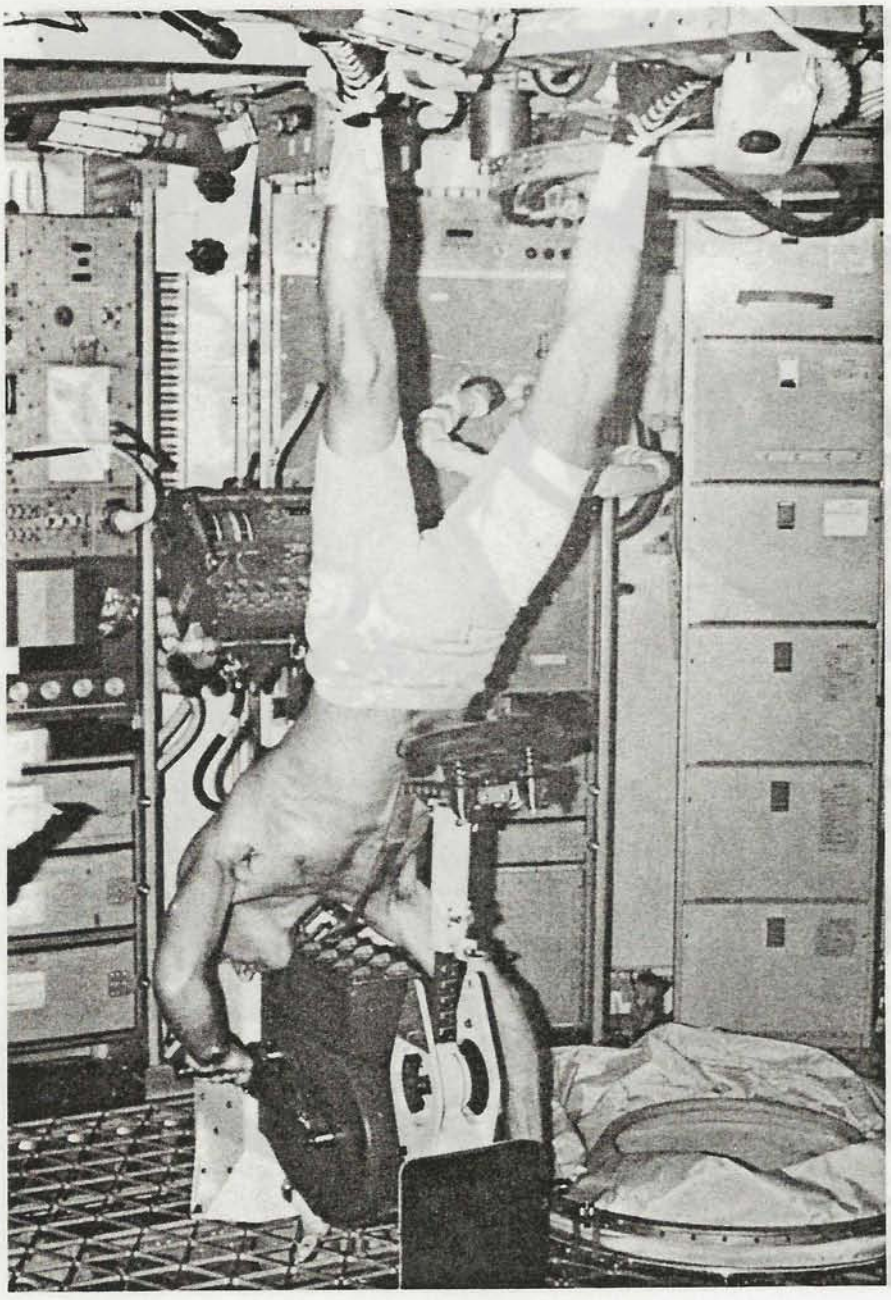
Another easy earth gravity body position that caused some difficulty in zero-g was the full crouch or squat. The Skylab crewmen reported that pulling the legs up against the body was difficult to do and more difficult to maintain. The simple (on earth) task of tying one's shoe laces was much more difficult in zero-g. Apparently the strong thigh muscles are too springy to work against easily.

Figure six shows a crewman operating the ATM panel. The body position indicates a large amount of crouching, which requires a great deal of muscle tension.

In general, the Skylab crewmen felt that the interior orientation of the vehicle influenced the restraint system and requirements considerably. The "one-g orientation" of the experiment deck with its floor and ceiling in close proximity (2 meters or 6.5 feet), both filled with triangular grid, simplified the mobility within the deck and increased the restraints available to the crewmen. It was readily available as a mobility aid and provided sufficient triangles for foot restraints at nearly all the places where they were necessary. The flexibility thus attained rated very high with the crewmen. Figure seven shows a crewman utilizing the ceiling to push against with his feet to hold himself in the proper position to exercise his arms and shoulders on the ergometer. The other architectural extreme in Skylab was the MDA, which was an open cylinder with equipment located circumferentially around the wall. Few foot restraints were provided except at specialized locations, specifically

Crouched Body Position

Figure 6



"Upside-down" Orientation

Figure 7

at the ATM panel, metals processing facility/vacuum chamber, and one of the two EREP stations.

The ATM foot restraint platform provided an excellent restraint for operating the panel, but was not a useful personnel restraint for other MDA tasks. The triangle grid platform at the processing facility was not completely useable. Its location was such that the crewmen, when established in the proper body position to use the facility, could use only one foot attached in the grid. Thus, there was very little flexibility for changing body position at that location. The crewmen were unanimous in their desire for more foot restraints in more locations in the MDA.

The following references contain comments relating to the need for the proper restraint-work area relationship and the orientation problems.

Reference	Appendix Page Number
2	2
5	7
6	10
9	14
20	43
24	49
30	62
31	63
32	65
33	68

Reference	Appendix Page Number
35	71
36	72
37	74
38	75
40	87
42	93
43	97

Restraint Requirements in Very Small Rooms

One of the restraint related topics addressed by the crewmen in the Skylab transcripts is whether or not a very small room required personnel restraints. The sleeping compartments, the airlock, and the waste management compartment (WMC) were quite small, with the walls and ceiling in rather close proximity, and there were some differences of opinion concerning the need for restraints in these rooms.

The sleeping quarters were the smallest single rooms on the OWS. The smallest was 0.7 meters (28 inches) by 0.96 meters (38 inches) by 1.98 meters (78 inches). The largest was 0.73 meters (29 inches) by 1.22 meters (48 inches) by 1.98 meters (78 inches). Thus, the crewmen were always very close to a structural support to push against. The crew comments were unanimous in saying that no personnel restraints were required in the sleep compartments (other than the sleep restraints, of course). The compartments were small enough that the walls, ceiling,

and floor sufficiently contained the crewmen to permit them to do the necessary tasks without restraints.

However, it must be remembered that the sleep compartments had a triangle grid floor and ceiling which could have been utilized had the need arisen. It is entirely possible that occasions did arise and that the triangle grid restraints were unconsciously used. Further, the necessary tasks completed in the sleep compartment were quite simple and did not require precision or great force.

As discussed earlier the retrieval of items from storage did not usually require foot restraints. Hanging on to the locker door ordinarily provided sufficient stability. Some of the onboard films show crewmen dressing and undressing while totally unrestrained. At last we have men that put their pants on both legs at a time.

The airlock module, 1.55 meters (65 inches) in diameter and 2.15 meters (80 inches) in length, was one of the more controversial areas with regards to foot restraints. All three Skylab crews commented about foot restraints, but some of the men did not feel a need for them (ref. Bulletin No. 2).

The airlock served as a tunnel between the forward compartment and the MDA. When being used strictly as a passageway, no restraints were necessary. However, the crewmen that used it during EVA, or had to perform other tasks such as the coolant loop checkout on SL-4, were nearly unanimous in declaring the need for foot restraints. It appears

that foot restraints are required to support tasks requiring the crewmen to maintain stability.

The waste management compartment received the majority of the crew comments about foot restraints in a small room. The compartment was 1.27 meters (50 inches) by 2.36 meters (93 inches) by 1.98 meters (78 inches) in size, but had a clear area of only 0.96 meters (38 inches) by 1.93 meters (76 inches) by 1.98 meters (78 inches) due to installed equipment. The triangle grid that was installed all over the floor and ceiling on the experiment deck was covered in the WMC to provide an odor barrier and cleanliness protection for the rest of the spacecraft. This resulted in a total lack of foot restraints except for the cloth toe straps in front of the urine collector and wash station. These toe straps were apparently extremely difficult to use with the triangle shoes.

The commander of SL-2 felt that the room was small enough that the lack of foot restraints did not create a problem. He was able to bounce off the walls slowly enough to not upset his stability completely. However, the two following crews were unanimous in their comments. They wanted good foot restraints very badly. Obviously, they were able to complete their missions, but the lack of good foot restraints gave rise to many complaints.

Figure eight shows a crewman bracing himself between two walls to provide him with the necessary restraint to shave. It obviously worked, but was not totally satisfactory.

Restraint Mode in the WMC

Figure 8

In analyzing the transcripts and films concerning the need for foot restraints in a small enclosure, it appears that the need was task related. As long as the task was extremely simple or require no precision, bouncing about in a small room was no problem. When the tasks required some precision, or were concerned with handling potentially unclean products such as filled urine or fecal containers, the crewmen wanted and needed good foot restraints for stabilization.

The following references contain comments concerning the need for restraints in small enclosures.

Reference	Appendix Page Number
9	14
13	28
14	34
16	37
17	38
21	45
29	59
30	62
34	70
39	79
42	93
43	97

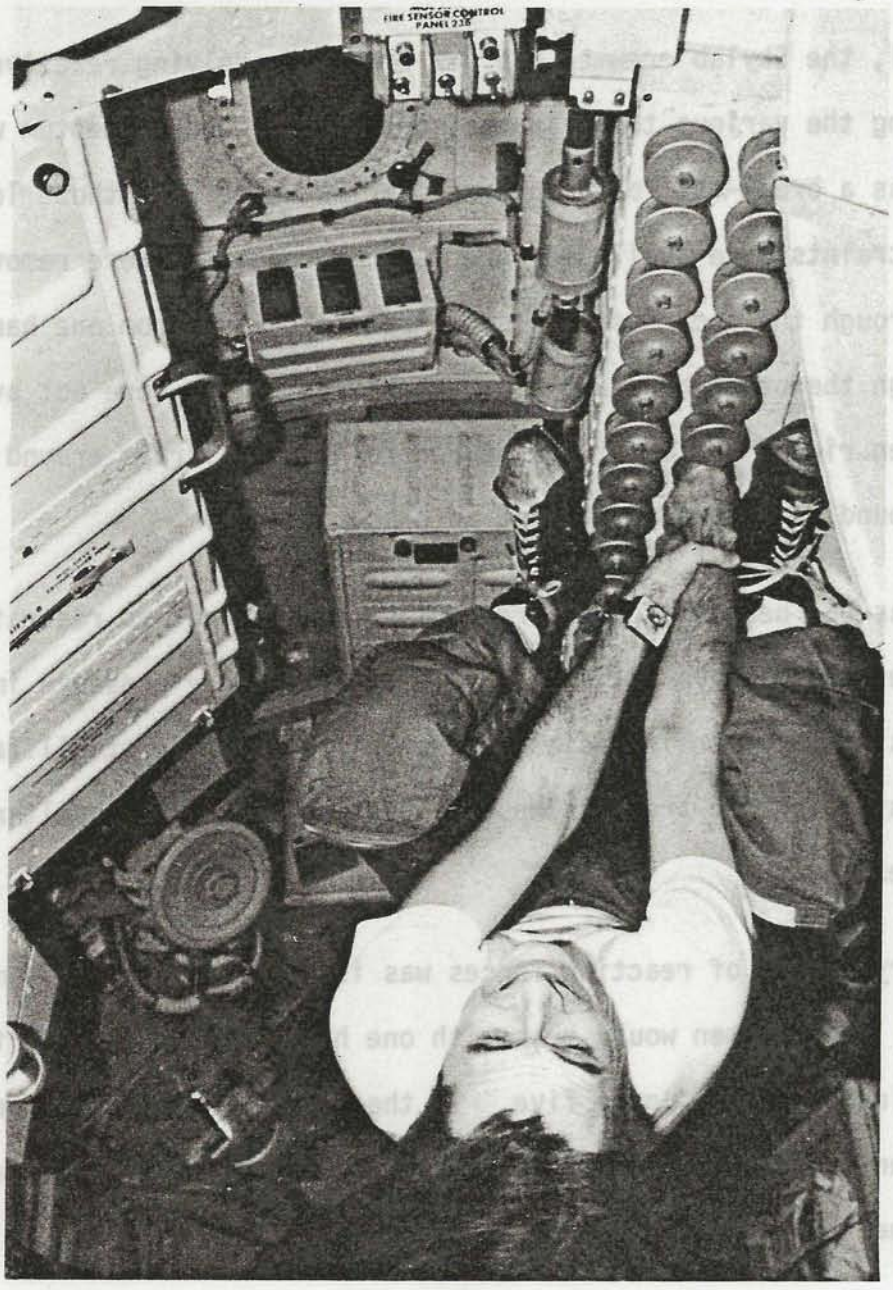
Reacting Forces and Extreme Stability Requirements

In general, the Skylab crewmen had few problems applying reactive forces while using the various tools in the spacecraft. Body momentum was utilized as a break-out force in numerous instances. At those locations where restraints were available, the various reactions were removed either through the foot restraints or isometrically, from one hand and arm through the other hand and arm. Where restraints were not available, the crewmen rigged various types of restraint with straps around their legs or found structure sufficient to brace against.

However, as has been indicated previously, the innovative restraint systems were not always satisfactory. Too often, the pressure imposed on various parts of their bodies became painful, or the stabilization was not sufficient to prevent "knuckle-busting" with its resultant cuts and bruises.

The primary method of reacting forces was isometric, much the same as on earth. The crewmen would push with one hand while pulling with the other as indicated in figure five. If the task required more force, the crewmen would push with one or two legs and pull with their arms. Figure nine shows this method of reacting forces.

There were some tasks that absolutely required good restraints for their successful accomplishment. For instance, all photography, whether motion pictures, TV, or still photos, required the crewman to be stable. Reference 10 presents a good discussion on the difficulty of trying to



Force Reacting Method

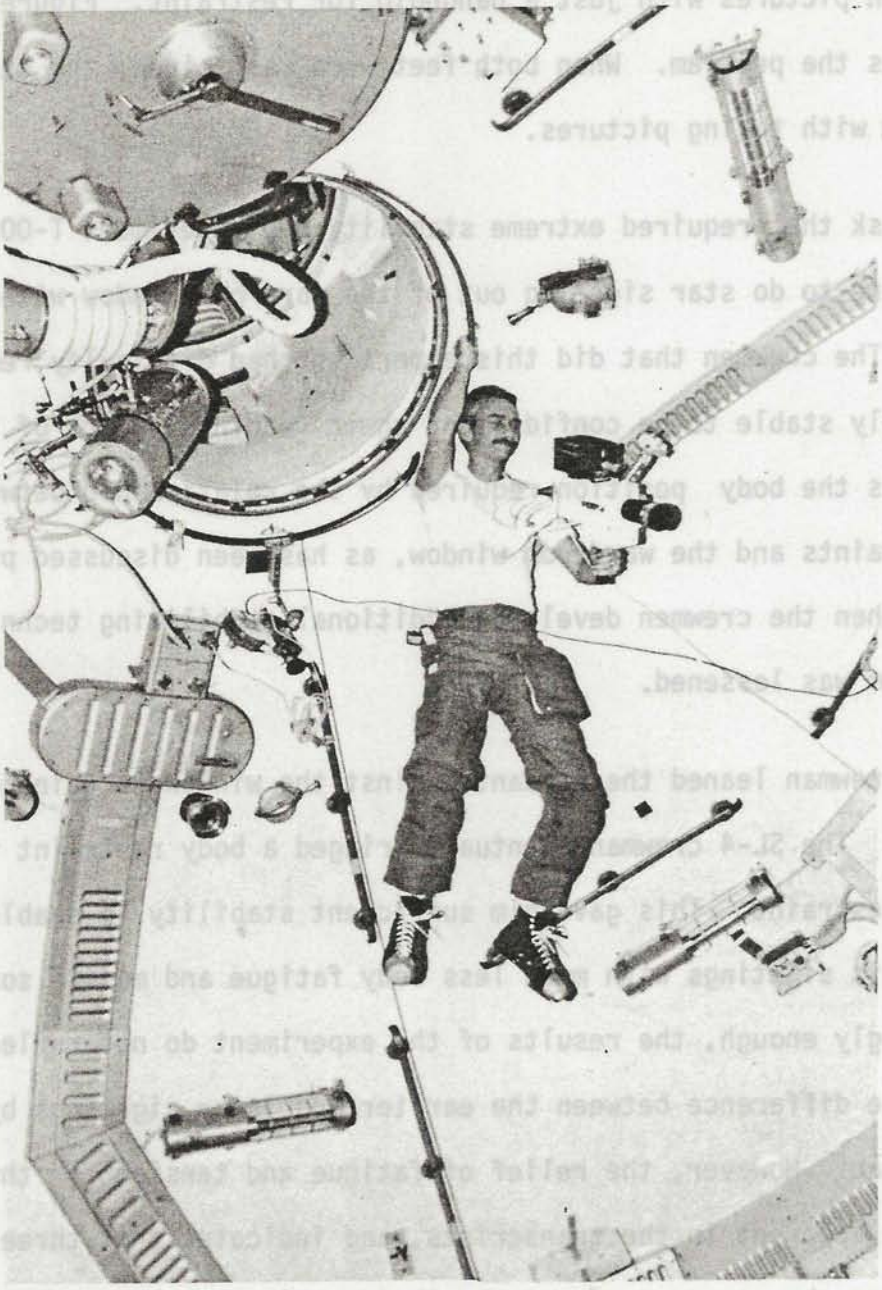
Figure 9

take motion pictures with just a handhold for restraint. Figure ten illustrates the problem. When both feet were restrained, the crews had no problem with taking pictures.

Another task that required extreme stability was experiment T-002. The crewmen were to do star sighting out of the wardroom window with a sextant. The crewmen that did this experiment had difficulty remaining sufficiently stable to be confident of their readings. Part of the problem was the body position required by the relationship between the foot restraints and the wardroom window, as has been discussed previously. However, when the crewmen developed additional stabilizing techniques, the problem was lessened.

The SL-3 crewman leaned the sextant against the window to gain additional stability. The SL-4 crewman eventually rigged a body restraint to assist the foot restraint. This gave him sufficient stability to enable him to complete his sightings with much less body fatigue and muscle soreness. Interestingly enough, the results of the experiment do not reflect an appreciable difference between the earlier and later sightings by the SL-4 crewman. However, the relief of fatigue and tension for the crewman is readily apparent in the transcripts, and indicates that three point restraint may be necessary for tasks that require extreme stability.

The following references contain crew comments concerning the use of tools and delicate instruments.



One-handed Restraint Problems

Figure 10

Reference	Appendix Page Number
9	14
10	19
13	28
19	42
27	54
32	65
35	71
36	72
37	74
38	75
39	79
40	87

CONCLUSIONS AND RECOMMENDATIONS

1. Learning to use personnel restraints in zero-g created no problems for the Skylab crews. When the proper restraints were available, all task requirements were readily accomplished.

2. Handrails were used as stability aids as well as for mobility aids. They were used for restraint to accomplish one-handed, non-precision tasks and to provide the momentary stability needed for the crewmen to attach themselves to the triangle grid. It must be emphasized that handrails, per se, were not required; any graspable object would suffice.

3. The crewmen would grip any available object with their feet or knees, or wrap their legs around it to provide themselves with temporary restraint when necessary. Thus, the equipment installed in a spacecraft must be designed to accept the impacts and forces imposed by the crewmen using it as a restraint.

4. Good foot restraints were much preferred over all other types of personnel restraints. The Skylab crewmen unanimously voiced a need for an efficient foot restraint system installed all over the vehicle. A common system throughout would have provided the required flexibility to support the unscheduled tasks that frequently arose.

5. When necessary, the crewmen invented restraints to enable them to perform their required tasks. These innovative restraints were

extremely inefficient in terms of time and difficult to use as compared to good, readily available foot restraints.

6. The restraint-work surface relationship must be determined along with the natural zero-g body position to enable the crewmen to accomplish their tasks with less muscle tension and fatigue. When restraints are emplaced for a given task, care must be taken not to force the crewman into a body position that is difficult to maintain.

7. One-g orientation, with a ceiling in close proximity (2 meters) to the floor, and with foot restraints covering the floor and ceiling permitted great restraint flexibility and easy mobility. The MDA, with its random orientation and specific foot restraints in few locations, was more difficult to work and move around in than was the experiment deck of the OWS.

8. Foot restraints are necessary for tasks requiring precision or stability, even in very small rooms. When tasks requiring extreme precision were done, a third restraint such as a body belt in conjunction with the foot restraints was helpful.

9. Basically, reaction forces were removed in zero-g much the same way as they are removed in one-g. When foot restraints were available, the forces were reacted against them. When larger forces were necessary and structure was available, the forces were reacted with one arm pushing and the other arm pulling. A variation of this was to push with one leg while pulling with the arms.

RAW DATA APPENDIX

REFERENCE	SOURCE	PAGE
24	SL-3 Dump Tape 259-05	49
25	SL-3 Technical Debriefing, JSC-08472B	51
26	SL-3 Systems Debriefing	52
27	SL-4 Dump Tape 332-08	54
28	SL-4 Dump Tape 332-09	58
29	SL-4 Dump Tape 333-02	59
30	SL-4 Dump Tape 344-06	62
31	SL-4 Dump Tape 365-07	63
32	SL-4 Dump Tape 365-09	65
33	SL-4 Dump Tape 365-10	68
34	SL-4 Dump Tape 003-01	70
35	SL-4 Dump Tape 007-02	71
36	SL-4 Dump Tape 010-03	72
37	SL-4 Dump Tape 010-05	74
38	SL-4 Dump Tape 014-02	75
39	SL-4 Dump Tape 022-03	79
40	SL-4 Dump Tape 022-06	87
41	SL-4 M-487 Experiments Debriefing	92
42	SL-4 Technical Debriefing, JSC-08809	93
43	SL-4 Systems Debriefing, JSC-08833	97

CDR Hank, unfortunately I got every message but 313 and 314. And - I've got 315 - 413, 414-B - 411-A. Send me 314 again, and then I think we'll be all right.

CC Okay. Would you like to have accounting of what you should have up there?

14 00 57 CDR No, don't confuse me. I'm confused enough now. (Laughter) Starting tonight, we've got to get organized on that. These message numbers don't make sense to me, anyhow. And I always sit here and scratch stuff in one spot.

CC Okay. We're - we're looking at that too, Pete. We think there's got to be a better way here. We're - we're also concerned that we don't have a way to check to make sure the messages are getting up. We send them, and we're not sure you're getting them all, and especially since you've been having a few problems with the teleprinter.

14 01 33 CC We will send you 314 again.

CDR Okay.

14 01 51 CDR Yes. It's taking us awhile to get the hang of things. I'd say, this morning with the M110 and everything, it probably took us 45 minutes to an hour longer. But we're finding out things that are costing us time. Number 1, Rusty loses his bet to me. The water system does, in fact, have gas in it. And if you go to 7-1/2 ounces of water in a coffee thing and it won't handle it, you've got to let air out and mess around with it. So food handling, I think, it is taking us a little longer than normal right now than on the ground, and I don't think that's to be unexpected. I think we're getting a little bit better hang on it, as we get better organized. We all had to refresh our memories today as we went through all the waste management stuff exchanging filters, I mean changing urine bags and so forth. So, I think we've got some learning curves to go yet, here in zero-g. There are places that not having restraint is kind of bothering us a little bit. As an example, we're all using triangle shoes and it doesn't work too well with those straps in the waste management

CC For Dr. Kerwin. Why were you the only crewmember who didn't swear when the first docking attempt failed?

SPT I was too stupid to realize the serious implications of our problem.

CC This one's for anyone. Have you had any trouble with the toilet facilities?

SPT No. We - took us a while to figure out how you've really got to work out a super-dooper system in the workshop. But that was a little mechanical problem. We got that squared away and we've had no problem.

CC For Commander Conrad. For listeners around the world, could you tell us some benefits that Skylab will bring to mankind?

CDR Well, the first thing that's obvious to me, is that man can work up here. And, surprisingly enough, in the workshop, we are doing what I consider a lot more physical task - that is exercising our muscles than I thought we would. Which has been one of the problems that I thought we might have. And, as you might expect, I think, all of us are a little stiff from using muscles that we didn't expect to use, and that we don't use on the ground to hold ourselves in a proper way to use the tools and everything. There's no doubt in my mind that all the Earth resources type things that we've talked about are going to work. I've just been eyeballing out the window here at 237 nautical miles, and we do pretty good with the Mark-1 eyeball. I think with our sensors, that we'll be able to do the tasks that we set out to do, especially the visual tracking and - Of course, we haven't been able to fire up the solar telescope yet, but I have understanding from the ground checkout, that it all appears to be in good order. And I'm sure that we're going to bring good data back from that. So, I, - I'm looking forward to a successful flight of Skylab of 28 days. I think we overcame our problems, and I think we will improve on what we have if we get that other solar panel out. Right now, we're in good shape, I think, to

Reference 3

Final
Dump Tape 151-09
Time: 18:33:24 to 20:04:08
Page 1 of 5

18 33 24 SPT Contamination observation on window - STS window 4. The window itself is clean. However, it has several linty particles on the outside. These come from the fact that on all STS windows, which I neglected to mention before, this is one of the most noticeable looking into the Sun, is that as you open and close the window cover, it rubs over that silver foil insulation and frays it. And the backing material appears to be some kind of cloth, and that causes linting.

19 13 14 PLT Hello, B channel. This is the PLT with the M487-3 Alfa. Going to page 3-3 on restraints and mobility aids. The fireman's pole we have not used yet because we have not needed it. The OWS dome and wall handrails have, on occasion, been of some use primarily for stability. They are not used for transiting the dome or forward areas. We do that by point-to-point translations free floating. Same thing with the STS handrails and the MDA. We've generally found that you just move about this vehicle by, as I say, just pushing off and translating from point to point. You use these handrails, but you use whatever is available; a surface - The mol sieve surface, the back of the ATM chair; whatever you need just to give yourself a little tweaks to keep yourself trimmed up. The handrails are not needed for translation. Handholds and handrails are needed for stability. And on occasion, for example, yesterday when I vacuum cleaned the plenum inlet screen at the top of the dome, I found the ducts themselves very handy for footholds. I'd wrap my legs around them and use that to stablize myself while I was vacuuming the screen. The triangular shoes in the grid have come in very handy. The mode we've gotten into usually, most of the time, is you only hook in one shoe. Consequently, we've been trying off and on, we'll comment on it later, on two triangles as opposed to one triangle and one mushroom.

19 15 03 PLT The water tank foot platform has been used on occasion when working in a dome locker. I think it's been necessary and useful. Again, the usual use for myself has been to hook one foot in one of the triangular cutouts.

19 15 21 PLT The ATM foot platform has been used so far only to hold the captain's chair. We have been using the captain's chair almost exclusively at the ATM.

Reference 4

Final
Dump Tape 154-03
Time: 13:44:09 to 14:18:19
Page 1 of 7

13 44 09 CDR Hello, friendly tape recorder; this is the CDR on S183. The time is 13:44; it's that sequence number 1, has been initiated on star field number 252 on plate 006.

13 45 45 SPT Okay, friendly B channel; this is the SPT at 13:45 with an M487-3A, subjective evaluation of the following equipment items. The OWS fireman's pole has not been used. I believe, that if it were in place, it would be a handy helper for - moving rapidly down the workshop and for carrying large objects with one hand; however, the strap, while it probably doesn't do as good a job - satisfactory job - and we don't have any present intentions of rigging the fireman's pole. Okay, the OWS dome and wall handrails, again, are adequate for their jobs, maybe even give them a very good. Their job is not to hand-over-hand it - you never hand-over-hand it around that place, unless you've got a lot of equipment in your hand and are carrying a large package, for instance, that you want to make sure you don't get loose. You ordinarily fly from one location to the next, and all you need when you get there is something to grab onto, and the handrails are perfectly satisfactory for that. I think the handrails in the STS, are very good. Once again, they're not for hand-over-handing. They're for steadying oneself at work stations, stopping when you come flying through the hatch. You want a handrail to grab to torque yourself around on to get into position to look at a panel. Having the panels circum - the handrails circumferentially around the various panels is a very good thing.

13 47 53 SPT Triangular shoes. We all wear the triangular shoes most of the time. They're not at all necessary for translation or walking. And, of course, we never use them in that mode. They're extremely handy for keeping oneself steady at a work station while doing a job, leaving both hands free. We have several kinds of mushrooms and buttons for the shoes up here. My personal preference now, the way I'm going, is to wear the large mushroom on my right foot and the triangle on my left foot. The

triangle is quite helpful when you want to concentrate on something else for a few too many minutes - want to lock yourself in and stay locked. However, it's a lot of trouble getting it in, and a little trouble getting it out. With two triangles on my shoe, it drives me up the wall, because it takes me 30 to 45 seconds to get locked in at a spot, which is a waste of time. Between the mushrooms, I've evaluated the medium and the large. I thought the medium mushrooms were adequate, but they were too easy to slip out with, and you had to concentrate too much on keeping your foot pressed against one corner of the triangle so that the mushroom wouldn't pop out. With the large mushroom - this is not nearly so bad. They're fairly easy to slip in and they hold very well. Sometimes they're a little trouble getting out of. Trying to get it out in a hurry, you have to sometimes look down and figure out which direction you have to go. I think, for that reason, Paul prefers small ones. I prefer big ones. In summary, triangle shoes are mandatory. If I had to make an improvement, I would have loaded two pairs of shoes on board for each crewman, so that I might leave the triangles in one of them to ride the bike with and put mushrooms in the other.

13 49 55 SPT

The water tank foot platform is handy but not required. If you're working at a dome locker for a period of time, it is very pleasant to be able to stick one foot into a mushroom or a triangle into one of the holes in the - in the foot platform. So, if you're just going there to get loose item of equipment, you can steady yourself on your hands, then open the locker, steady yourself with your hands again, reach in and get what you want, and steady yourself again, and close the locker on the way down. The portable EREP foot platform, I have not used. The portable PGA foot restraint, we have not yet used. The portable handholds have not been used. The portable tether hooks, I am currently using to try and rig ropes with handles to hold myself down on the bicycle seat while peddling the bike. The portable tether hooks hook you to the floor grid and the ropes are attached to them, and

various locations can be selected either forward or aft, of the - of the pedals to try and find the right axis along which to exert the force. The big difficulty here is that we didn't think, when we put all the extra junk in the experiment compartment, how handy those triangles were going to be.

13 51 23 SPT And on the right-hand side of the bicycle there is virtually no open grid work or holes between triangles to put things in. The shower is much too close to the bicycle. Okay, portable equipment, these three: The straps are extremely useful. The short straps, I haven't used too much. They are really too short to tie things to. But the long straps and the equipment straps are extremely useful. I have right now, the entertainment tape recorder strapped to the radio noise burst monitor here - monitor here at the ATM panel. Bungees we find very useful, particularly down in the wardroom and so on for temporary restraint of cameras and checklists. Smaller things than that, such as pads, the bungees are not adequate for me, because they - the pads slip out and makes it too flat or too smooth. But anything that's got hooks on it, like a camera, works out very well under a bungee.

13 52 29 SPT The - One item of equipment that is a pain in the neck, and it's not useful at all, are the large clipboards that snap in the standard snap pattern. Everytime you touch one of those things, they come flying off. On the other hand, it's a major operation to get them back on the snap. And we just made a bad mistake by assuming that we could snap something to a flat wall, especially something with any standoff, such as these clipboards have, and then exert any force against it. The ATM seat is very useful, although you don't really sit in it, obviously. You have to push the seat belt down pretty tight ah - if you want your back to be supported. I find it useful because it gives you a body-centered restraint from which you can work against. You can reach the whole ATM panel,

Final
Dump Tape 155-12
Time: 22:15:45 to 22:52:28
Page 3 of 11

22 31 24 PLT Anything else on the MDA? Press on to the airlock. We really haven't done anything in the airlock yet. Yes. Yes. Okay. So now we're into the dome area. Okay. I suppose I've probably done as much up in the dome there - well, Joe, you hung the portable fan. I cleaned the ... screens twice. Pete and I hung the condensate tank and I must say that those leg restraints that are bolted onto the lockers work quite well for maneuvering that. Yes, me, too. That was really a piece of cake. We thought it was going to be a great big blimit to handle up there and maneuver into place, and it really went well. Even though it was 130 degrees in there at the time. I tell you, my primary restraint when I've been working at the inlet screens has been to just kind of wrap my - not wrap them around but clamp - a duct - a soft fabric part of a duct betweem my legs and stabilize myself that way. Otherwise, there are plenty of handholds. I got no problem on the dome. Joe, you got anything about that fan?

PLT No, it was no problem. It's easier to work by the ... in the dome locker region than it is up where the fan is, because you're right. What you need is not handholds up there. Handholds are strictly for translation. You don't need them for translation. You push off and get there. You need them to grab onto. What you need for working up there are legholds, like the soft part of the duct - like the knee knockers on the film lockers or like the water ring where you can stick a foot in. Something to restrain your body so you can work with your hands. All the handrails ... Yes. The other thing about - those are the ... good side ... The one thing ... you can move around, bend your body back and forth, do your exercising, get a little sensation of largeness. The other thing, it would be an ideal kind of enclosure around which to situate experiments and things to operate, with plenty of ... in the middle.

22 33 41 CDR Yes, I think - I think the thing that's turned out about - the whole upper experiments area is the fact that it is so easy to operate. I think we were all worried before we started out on the flight that it

was going to be so big that we were going to get, you know, all this stuff that we have in there ... the best way to have it. ... a airlock, to go to a dome locker ... just take aim at wherever it is you want to go and take off. You can get pretty close. Every day longer that we're up here the better we get at that sort of thing. I know that over the - the line to the SAL - the SAL power cables ... and the SAL instrumentation cables are stowed in the dome locker, and it's nothing to just give yourself a little shove with your feet and you are right straight up in front of it ... in there and work in those lockers - the lockers that have the heavy gear in them. ... down in them ... equipment ... are well placed ... for ... people that I had no trouble working on any of the EREP experiments.

22 35 02 SPT Another thing about that water ring, foot restraint, or whatever we call it is that I had a couple of tasks to do like stringing the water tank hoses and my favorite one - the portable water tank and a couple of other things, and again I - you can't hook your feet in them when you're working on it. And I just laid along horizontal or parallel to it and again clasped it with my legs, because you really don't want to sacrifice that hand for stability. You want to be able to maintain your stability with your feet. ... we better - we better move on.

22 35 53 CDR Yes, ... let's talk about those things. The triangle wedge is a great way to lock yourself in except it looks like you could lock yourself almost anywhere and that's not really true at all. ... looking for places to lock in that we're working at especially ... equipment-like ... to get the heaters ... down here, something like that. ... all I can see just to find a place to lock it - the right side of the bicycle - they ... ergometer to shower. ... to try it. Yes. And, well, I ... to try it.

SPT ... if you wear the button instead of the triangles then there are more places to - You're not quite as constrained as ...

Final
Dump Tape 153-12
Time: 22:15:45 to 22:52:28
Page 5 of 11

22 36 46 PLT I think the ~~high~~-angle grid invention is a good idea - - TRI

CDR Oh, yes. Yes.

PLT - - because you need something to stick your feet in. And this - the whole experiment compartment is kind of one-g oriented, and a lot of people have always said, "Aw, you don't need that. You'd rather - you know, you'll be hanging from the ceiling. You'll be hanging from the sides. We can make the nomenclature upside down." We don't do that. We, at least I, operate in here pretty much in the same body position as I did in training. How you get from one place to another is grossly different. You push off the float. But once you get there, you want to be stabilized by the legs or the thighs and the feet someplace where you can do the job. Yes, Pete mentioned there's one corner of the experiment there. It is so crowded and cluttered that I can hardly believe it. The one where the shower is. Between the centrifuge, the shower - and, that's a busy place. Fortunately, you don't have to step over the shower to get to the tool kit and that tool kit is the best idea that - anybody's had. We've been into that many times since activation for a lot of different reasons. One other comment, when you translate to a surface, it's good to have something like the blue handrails on the surface to grab hold of and torque your body or stop a pitch rate of whatever you're having. If it's a flat surface, you tend to do some scrambling around. In the wardroom, I noticed that the edges of the locker stanchion are recessed so that you can grab them with your fingers. That's a good idea on somebody's part. So much for that question. How about - you want to say anything about the compartment - the head - What are we talking about? Yes. We got carried away on that. Okay. Yes.

SC ...

PLT Which restraint device offered the most assistance in performing tasks; which the least? If you want to pick out one device, in my particular case, I would

CDR Okay, we just had a - a first here. Paul fired one from the experiments compartment down off the top of the trash airlock and it returned all the way to where, Paul, the command module? Made it all the way to the command module.

CC Is that that miserable little sponge ball that has very little elasticity at all?

CDR Oh, no, no, this is a blue rubber ball, regular rubber ball.

CC Copy.

CC One last question, Pete. When you apply force to a body - your body. Do you get into much trouble with rolls and that sort of thing? Or do you pretty well sense where the center of gravity is?

CDR No, you sense real easy where it is. I - I mean we're not perfect because - mainly because of the kind of things that you're taking off from. But you - you have a pretty good idea how you want to take off. So you may not be able to push off the particular object just in the right manner, but we - we've gotten pretty good. I think the M151 movies and stuff will show you a lot more than the television did about how well we get around. But we've - we've really adapted. I - I'm really convinced that the first day back we're going to leap out of bed and land right on our heads.

CC Yes, we've got a football helmet set aside for you on that one, Pete.

CDR ... Be helpful.

CDR Are you still there, Bill?

CC Yes, we're still here; we've got about a minute and a half.

CDR One of the other things that I've noticed is - is that in holding ourselves while we're out here and doing our tasks, we really use our stomach muscles. It's - it's really interesting. I - I - The first 3 or 4 days that we were up here, we kept finding ourselves just really holding our - our stomachs to hold the right position. And you use your stomach muscles more than anything else, I think, in - in holding wherever you are, and working on it, whatever it is that you're working on.

Final
TAG Tape 163-01
Time: 01:41:05 to 01:55:05
Page 8 of 8

01 54 39 CC Yes, there's some pretty good physiological reasons for that, because normally all of the vertebral muscles are on the back side to take care of center gravity on Earth. And you really don't have much required on Earth. But, we're going LOS here in about 45 seconds, and at Honeysuckle we'll be AOS at 1 - at 02:29.

01 55 05 CDR Okay.

END OF TAPE

PLT Oh, so do I. Talking about wall openings, only through a window down here.

CDR Yes. Well, wall openings - it all depends on where I am or where I'm going. I'd like to ... a lot around here.

SPT I'd like to give one other comment ... eating and waste management ... four hours a day possibly ... medical requirements. ... still cost a lot of time and electrical and ...

CDR Seven: "How satisfactory is the frequency of change of bedding and clothing?" I think it's been satisfactory on the flight. I would have preferred a few more - certain items of clothing. ...

PLT Yes, that's - I agree with you.

14 08 34 CDR Okay. That's the of 487-2 Charlie.

14 08 39 PLT Yea!

14 09 16 PLT Hello, tape recorder. Here's the PLT with the rest of his M487-4 Charlie, which is the subjective evaluation guide 1. I just realized that I was remiss, negligent in not filling out for you verbally before. On the equipment items: the fireman's pole we have now put up and - as we just finished debriefing on this round table discussion 2 Charlie, or whatever it is. A. Mobility aids: From the dome duty experiments area is handy. We were formerly using the strap. We put the fireman's pole up just to try it, and due to its rigidity, I personally prefer it, because you can just grab a hold of it, and you can change directions using the fireman's pole far better than you could with the relatively slack strap. The handrails: we still don't use them, the same as the STS handrails and the MDA and mobility aids. We use them all as stability aid when you're working in the area, but not as mobility aids. Triangular shoes in the grid I still think are good. That goes for the water tank foot platform. ATM foot platform we only use now as a base for the Captain's chair. And even though I don't strap myself into the Captain's chair, I do kind of half sit, half lie at it with my toes hooked over the

CONRAD (CONT'D) for 28 days was adequate. The only thing I would like to add was more socks and maybe a few more shorts.

WEITZ I had a change of shorts for every other day, which was good enough for me.

CONRAD When we changed our shorts, we kept the used ones to exercise in. Those sweaty shorts we would throw away. We got 2 days of normal wear out of them, then we would wear them for 2 days for exercise. We put the fresh ones on for working. That worked very well.

WEITZ In moving around the vehicle and stabilizing yourself you use your toes a lot. You drag your feet over the grid, you stick your toes down in the grid, you hook your toes under things. We mentioned it, we have some pictures of it, we wore out the toes on both shoes, both the triangle shoes (the ankle-high shoes) and the gold boots.

KERWIN I wound up not using my slippers at all. I used my triangle shoes from morning until night. I would change from the triangles for the bicycle to the little mushrooms for general moving around and working. My general comment is that it serves as a restraint system. Wherever you stop to do a job, you want your feet restrained. I'm awfully glad we had the triangle shoes and the triangle grid all over the floor.

PLT: I had the idea that I had to, maybe it's because your knees are relatively high, I had the idea that you really had to get yourself forward this way. That the seat was from wher you wound up with your feet--I think I would have liked the seat to have been higher on the wall and tilted this way a little more.

CDR: Yeah, I, there was, I'm wondering when you get a guy like Jack Lousma on that thing, it it he's really got enough room to get it all sorted out when he gets his feet jammed down in there and everything, because he may be - you almost had the feeling even as small as I am that I was a little crowded in getting in the right position. Paul is right, you hadto pull your body further forward than just perpendicular to the wall and when you did that, your feet were down in the slots you know, in back of the uring drawers and you had the feeling that maybe if they had been a little deeper and you could have gotten your legs down better or you cocked the seat back, I, there was let me tell you I, I gave you the supreme sacrifice, so there are some M-487 movies of your old dad on there operating the system, so--

PLT: W th a towel around his head

CDR: I, I really for analysing the design and what we are trying to say, I think if you'd look at those movies, you'll still become apparent to you what we are talking about. I think it will be of help the next time you put one of those things together.

SP: Well, was there an attempt to kind of get you into a squat position, that's reported to be the best position to be in I was wondering---

PLT: Yeah, I know, but what you really had to do, it took two hands there and a fair amount of force to hold you in that position the squat position is fine but is is a little too accensuated.

SP: Ok

CDR: It's a good thing you had a good, I had a feeling that I was glad the handholds were anchored as good as they were anchored or I Would have pulled them right out of the wall.

PLT: Yes, I used the belt all the time

CDR: Yes I did too and just as tight as I could get it.

SP: Probably the squatting position with one-g you got one-g helping against the springier thighs, where as up there it's tending to go back.

CDR: You got to do it with your arms

SP: In connection with that belt, in the M-487 briefings, I think there was a discussion of the belt and the necessity for the belt. You feel that the belt needs any changing--we made up another one to go up there. Do you--

CDR: No, it, it, I, there was some confusion between there was some confusion over in the Project Office between--they picked up the discussions between the M-131 belt and they said any belt that's got velcro on it, the guys don't think it's satisfactory and that's , is not satisfactory and that's wrong because the M-131 belt was just two pieces of velcro like this and you apply a load and it just pulled apart. Your belt goes thru a loop and covers around that velcro, I had the decided feeling that there was no way I could have pulled that belt apart.

PLT: Of course you had a lot of contact area

CDR: Yeah, you had a lot of contact and that belt worked fine in and and Program Office confused that and I think turned you guys on, on fixing up the Waste Management belt based on the M-131 belt and they are not comparable belts.

SP: I think in Joe's M-487 tape, there is a discussion that the ATM chair belt would be a better fecal collector belt and that might be where some of it came.

CDR: I found that the other foot restraint, had we had the softer strap on it, that is great either with two feet or one foot. You know, and you could put one foot in just one of them and that gives you a nice anchor because you can push your toes against the little grid-work you had and everything. And what the guys have come up with, with the metal thing and the softer cloth, I think is goint to make that work fine. The only problem still is going to be the fact that you'll have to remove it and lay it over to get the urine drawer out. In fact I don't see anyway around that problem. You know. I Think if you are goint to design it again all you'd had to have done is to recess those foot restraints about an inch and a half down in the floor and then you'd been able to pull the drawers in and out, but the drawers evolved from a different thing and we were stuck with what we had but if we are going to do it in the future all you have to do is to drop anything like that an inch and a half into the floor if you got to pull the drawer over it and it's goint to clear.

SP: It's an advantage to have the capability to get just one foot in?

CDR: Yeah, that's fine, you know. Or waste management compartment was small enought so the free floating business was relatively easy to do. You weren't you wer just kind of-you could get yourself stable in there free-floating and you weren't going anywhere. The little bit of torque you had on your body anyhow-you might drift towards the ceiling or a wall but you only had a few inches to go.

SP: I think we have answered pretty much this one and we've covered this.

SP: Dick , I'd like to ask you a question if I may.

SP: Ok, Al

SPT: Yeah, they didn't seem to be able to do the job they were designed for.

CDR: I'm not sure you didn't have a defective, however they're made, casting or something because it broke twice, both on the same side and I have the feeling it was just defective, had air bubbles in the casting or something.

SPT: I think that every pair of those is broken now.

SPEAKER: Yeah

CDR: Well maybe it was just too small a set of dykes for the wire you were trying to cut then.

SPEAKER: Right.

PLT. No, these are the tool guys; the wire was too big. (Laughter)

CDR: Excuse me.

SPEAKER: (Laughter) We wanted bigger ones, but you know, the weight problem.

PLT: Oh, OK.

SPEAKER: Were there any instances where reaction forces presented a problem in using the tools?

CDR: I think it was quite to the contrary. I think that we found that body momentum and so forth and just a little bit of restraint was more than adequate to break anything loose. I think the thing we worked over the hardest was getting the nuts and bolts that we wanted, because those were put in there with the idea that they weren't going to be taken out and they were lock tight nuts and we really threshed around getting those out. But that's probably the highest torques we ran into.

PLT: I had my feet in the grid for that so it was no problem.

SPEAKER: With respect to that, were there any body restraint problems at any task location. Apparently not from what you've said.

CDR: No, you essentially invented something on the spot, if you needed it. Mainly just body positioning to get a wedge or, you know, a place that you could push against to apply force to whatever you're trying to work on.

SPEAKER: OK. This was for any maintenance task, is what the question was referring to, so you didn't have any problem in any maintenance areas.

SPEAKER: I think you commented somewhat on this before--the lack of standardization of fasteners causing confusion and

CADWELL (CONT'D)	noticed, Paul, when you were using the camera, it appeared that you were having some difficulty with the restraint, some difficulty of aiming the camera.
WEITZ	Which camera?
CADWELL	The TV camera. It seemed to be responding to your motions.
WEITZ	Is that during the chores?
SPEAKER	Out of the window during the EVA.
CADWELL	Out the window during EVA. Now, there's a lot of reasons that could be, but one of them could be just that you were poorly restrained at the time.
WEITZ	Yes, it was. I was doing a fair amount of thrashing, but there were contributing factors to that. One, that's when we were having the coolant loop problems, and I'd have to talk to the ground. I soon went to the mode of using the umbilical, and I was talking hot mike to these guys on the CCU RAD because I wasn't plugged into my umbilical; and therefore, I had to do that. A lack of restraint in there did contribute, but I had carried a pair of foot restraints up there. I didn't use them.
KERWIN	I had trouble with that camera during the second EVA, too. Because you're in the hustle mode, you can't take time

KERWIN (CONT'D) to settle down and restrain yourself, you've got that monitor, and the STS windows are so small that you can't point the TV camera and mount the monitor on. So that's laying off on its own string and you're trying to see what's on the monitor and it's unsatisfactory.

CADWELL So it was not just a matter that you lacked the restraint.

KERWIN For something delicate like pointing the TV camera, hanging on to one other thing with one hand isn't satisfactory, because your feet tend to move out on you, and then you've got to move the arm and the TV camera moves around.

CADWELL That's good information, because we're looking for a threshold air restraint system. It's clear that we're adequate in some places, and it's clear that we're completely inadequate in others and then we're looking for this, and how to tell when we have an adequate system or inadequate.

CONRAD Where do you say it was clear that it was inadequate?

CADWELL Well, for instance, it was inadequate in the head, waste management compartment, apparently through poor detail design on the foot restraint.

CONRAD The foot restraints themselves were located in an excellent place in the waste management compartment, but it was purely a function of that material. But that kind of restraint works very well for doing those kind of tasks in there.

CADWELL Right. No disagreement.

KERWIN Foot restraints are mandatory. We couldn't have done without the triangle shoes.

CADWELL I gather that there is still something to be desired in this combination of foot restraint and shoes. That is, the triangles worked after a fashion, the buttons worked after a fashion in the different restraints, but we should seek something a little better.

CONRAD There's two things that are overriding in my mind that I want to make sure that you appreciate. One of them is the fact that we did so well without restraint, and the less restraint you've got to provide, the more efficient in many respects a guy is going to be. Because there were times when I could have locked my triangles in the floor, but I would choose to use body momentum or some other way to accomplish it to frankly save the unpleasant task of having to go through the exercise of locking in, do a very

DAY 222 (AM)

222 02 04 37 PLT Okay, there we are. Let me put this ... Channel B, right?

CDR No, I put that on B, so you go on A.

PLT Oh, yes; right. Okay, this is M487-2A, day 222 at 02:00. It's crew debriefing, roundtable discussion. Question 1 is: What particular aspects of the orbital assembly seem well designed and arranged for living and working in zero g? What aspects are you changing and how? Huh! Anybody got an answer.

222 02 05 29 CDR I got a start. I think one of the best things that we have in the workshop are these triangular grid structures on the floors and ceilings. I don't think there's any way that you can tell before you fly just where you're going to need to position yourself to do different tasks. One, you can't think through everything just as planned; and two, plans change at the last minute. So it means that, really, all over the spacecraft, you have to position yourself from time to time to do work. Sometimes it's possible to use a handhold to do work. Sometimes it's possible just to float by and do it. Sometimes it's possible to get your buddy to hold on to. Most of the time, to do real constructive work, you've got to be stabilized, and these triangle shoes seem to be able to do the job real well. My only thought would be, on a future space station, that we ought to have a similar-type device. Now maybe there's an improvement - magnetic shoes or some sort of grippers or something. But we're going to need a device that can be used almost anywhere and have it accomplish the business of tethering the - the man, himself, so he can do a job. And certainly, the triangles are one of the best.

222 02 06 37 CDR Now there's one disadvantage to these. There's a lot of places where the triangles, themselves, are not useful because structure is - is taking up the place where the triangle goes. I would suggest, if we built another one just like Skylab, which, of course, we have no plans of doing, we could, somehow, offset the grid by the depth of the little triangle from the main ... beam. And you could do it with a little standoff - probably be just as

620

easy. You could have built - They could have built the I-beams that way or put a number of washers. That way every place that you went, you could put your triangle down. This would mean time savings and, certainly, that's what the name of the game is. So that would be - one thing - one of my first thoughts. How about yours?

222 02 07 19 SPT I second the motion that we need to stabilize ourselves. I'm not as happy with the triangle shoes as I think I'd ought to be, however. They do work well enough. They hold you where you need it and, without it, we'd be in a heck of a lot worse shape. But I think we had ought to work hard on something like a magnetic device that you could tether yourself to even more easily than the triangle shoes.

222 02 07 37 SPT Now going on to other things in there. We ought to have some other thoughts. The - Oh, for example, the mineral supplements down here in the food. The mineral supplements in ... are a sorry mess. They come in very tight packages. They are arranged in a locker so that it's almost impossible to get them slid in without catching on the little, thin metal plates that cannot be seen. And when they do catch on those little metal plates, they normally tear off some of the mineral supplements that go with them. Now these things should ought to be in some sort of an easily-dispensed - device so that we could just meter them out - one, two, three, or four out of little spigots or something like that. So a complete redesign of - of ways to take pills and things like that - vitamins and so forth - had ought to be redesigned.

222 02 08 28 SPT As far as the food is concerned, some of the cans don't fit the size of the slots. There'd ought to be better control on the position. I had to put napkins around some of my small cans to make them fit into the slots so that they don't all float out and get lost. They should have been done better. Most of the wet - wetpacks - I suppose they are satisfactory by Apollo standards, but they're not very satisfactory by Earth-based or even Skylab standards. Too many of the food packages - When

626

here that you can see anything out of that's worth looking at. And I think we need to have more of them, because we sure cover a lot of ground and a lot of interesting features on the ground, not too scenicwise, but geologically; and then the weather - in the area of weather.

222 02 18 56 PLT And if we could see more in the different directions, I think it would be a great asset to collecting data as well as providing something to do that's enjoyable. So the one window is really not enough, and if we could have some more windows somewhere, we need to have them. What else is ...?

222 02 19 19 SPT Yes, I was going to comment on the coloring. It may be a little different viewpoint than Al just had, but it seems to me that the color arrangement that we've got in here might very well have been designed by a Navy supply department or something with about as little imagination as anybody I can imagine! All we've got in here are about two tones of brown, and that's it for the whole blinking spacecraft interior.

PLT Yes.

SPT Yes, with ...

CDR ... got a ...

222 02 19 42 SPT And it would seem to me that a better study by an interior decorator, not only of our instrument panels, which are equally bad if not worse, but also just the interior decoration of our living quarters would make it a much more pleasant environment - some pastels and some other things that certainly help make it better. The other thing that I think that - I would feel would be helpful is, as I see ourselves move around through the spacecraft, 85 percent of our motion is by arm. We pull ourselves everywhere are going - we're - everywhere we go. The exception here being when we jump off from one side of the dome to the other.

We spring forward, of course, from the hatch opening between the trash airlock and the MDA hatch, and we do that with our legs and arms. But, basically, we move around with our arms. There are essentially no handholds around anywhere. There are a few over on our electrical panel, which we can use occasionally to stabilize ourselves.

222 02 21 37 SPT But we really tie ourselves into our feet whenever we go in front of the electrical panel. So as far as practical handholds, there is very close to zero around the whole spacecraft. I guess that's our principal means of locomotion. So I just think we had ought to have a better arrangement of handholds the way they do for EVA to get around inside the spacecraft. And I've thought about where they should go, some place so that they don't stick out and reduce the amount of volume available for moving but still are accessible to the hands. I think that would be a significant design improvement.

222 02 21 07 CDR Owen, are you trying to say that we - We have handholds around expanses where we thought we were going to work. You're suggesting that we ought to have handholds positioned in traffic areas - -

SPT Yes.

CDR - - to use to pull and direct and remaneuver. Yes - not in so much for - for stabilization for work but to get from one place to another, sort of a switch-off/pull-off thing.

222 02 21 27 SPT Yes, because once we get to the place where we're going to work, we than want to tie our feet in so that we can use our hands to do the work. We don't need the handholds there. Like this example that I just gave at the electrical panel 613 and so on - five handholds, but we don't need them there.

PLT Yes, I think ...

628

222 02 21 45 CDR Wait, wait. One other thing. We got handholds up here on the dome. And we put them there so a guy could come in and sort of follow those handles and get down to the floor. Well, we know now that nobody ever follows handholds around. They shoot up in the air to the next spot, and the only time that they need to grab by their hands is when they're going through small openings like doors or openings in the ceilings or things like that. And that's where the handholds should be and not against walls where nothing's going on or where you've got - nothing to do. Because like Owen points out, you want to stabilize yourself some other way, and that some other way is usually with your feet. It's more desirable, and it frees your hands to work. Here you are, Jack. Why don't we move on to the next one.

222 02 22 28 PLT Okay, one of the other questions that we ought to discuss is the the effectiveness of - of verbal communications throughout the workshop without the use of the intercom box. And we find it isn't very good because you have to holler pretty loud to be heard even from the lower crew quarters area up into the dome. And, - -

CDR ... the door.

222 02 22 51 PLT And sound does not - Voices don't transmit up through the airlock at all. We have to use the intercom box to talk to anybody in the MDA. It's not because of the external noise within the spacecraft either. The spacecraft is relatively quiet, more so than I had thought it would be with - even with fans and other electrical equipment running. It is very quiet and - and, - even when our - we burnt the rod, I didn't notice that there were any loud noises which I was not used to. So verbal communications throughout the assembly without the use of sound equipment is not very good.

222 02 23 28 PLT The intercom boxes must be used and - and on that score you probably have already heard that they keep

opening, near the ceiling in the experiment compartment or the floor in the forward compartment would be perfect. It would allow you to grab them and zip in. Presently, we're just using the edge of the hatch, which works okay. But it's perhaps conceivable that, if we didn't have this triangular grid where our fingers grab real good, we would be at a loss there.

223 14 34 35 CDR

Having handholds at workstations are a little bit wasteful, mainly because it turns out that, when you go to a workstation, you want to anchor your feet and do some work there. Now if you're coming up to a squawk box, such as I'm holding onto right now, you definitely need - definitely need these little bitty - standoff switch guards and handholds to react your forces against. So they're useful things and very good to have, but you certainly don't need a handhold near this box, if I were - And the handholds running around the dome that essentially we thought would lead you hand over hand down the dome are never used sometimes people fly up in the dome to do something and they grab one, but it's not needed. We should not have put them there. Definitely should not use handholds as a pathway. The technique for moving in the space station is more of a flyaround where you're at one position, you fly to the next and fly to the next. So that would be my comment there.

223 14 35 34 CDR

STS handrails. They're good things, the reason being you don't do any work in the STS. You merely stop there and read some gages and the like. You don't need to put your feet in anything firm, and that's exactly what they allow you to do. Now there may be a - an excess of those handrails, but they're not noticeable, like most excess.

223 14 35 57 CDR

MDA handholds and handrails. There are not a lot of them there. I'll have to look at them later and give you an evaluation of them but I can't say that I've used very many of them. There's plenty of objects and boxes and small containers - EREP - that allow you to use them as sort of handholds when you need to.

223 14 36 20 CDR

Triangular shoe cleats and grids - excellent. Those are excellent things. The only suggestion I could make would someone try to come up with a triangular

Reference 13

Final Dump Tape 223-08/D-163
Time: 223:23:05 to 223:23:45
Page 1 of 13

223 23 06 21 PLT Okay, space fans; this is Jack, channel A. The subject is T002, visual navigation sightings for Bob Nute and Bob Randle. Just took my second set of star-to-star sightings, run number 2 of day 223, from approximately 22:30 to 23:00 GMT. At the beginning of the run, the temperature was 71; diopter, minus 1.25. The stars are Formalhaut and Enif. The first of five zero-bias settings as follows: 0.005, 0.001, 0.001, 0.005, 0.003. Now the 10 star-to-star sightings are as follows: 43.276, 43.267, 43.271, 43.271, 43.271 43.271, 43.277, 43.271, 43.271, 43.271. Temperature at end of run, 75 degrees. You notice there are a number of readings all the same there. That was done each time by separating the stars and then projecting the line of sight, so that I could get the stars lined up again and now they're coming out pretty consistent. It turns out that you can't hold the - the instrument - sextant steady all the time. It still wiggles around and the stars appear as snakes - kind of snaking around on there but it's - apparently - (cough) apparently we can line up the stars well enough to get some pretty good readings. I lean the front of the sextant up against the window and view out - pretty much out of the center of the window. That'll be all the runs for today. I can't think of any more to add to this conversation at the present time. We'll try to get some more in the near future.

223 23 09 31 PLT Good night.

223 23 10 16 PLT Hello, space fans; this is Jack, on channel A. The subject is M487-3 and probably my friend and professional golfer, Robert Bond, whould like this information. This is subjective evaluation guide number 1.

223 23 10 39 PLT First subject is work restraints and mobility aids. The workshop fireman's pole I rated excellent, at the time that you need it. We used it when we first came here and we use it - we could use it to handle large loads, but just from my - Getting from the workshop hatch down to the hole on the dect it's not necessary. We don't have it up any more. We don't use it and - However, I think it was used to good advantage the first few days while we were here,

getting accustomed to floating around and in transporting mainly the larger packages we had to transport.

223 23 11 32 PLT The workshop dome and wall handrails, I guess they're okay, but we don't ever use them much. We just float between hatches. Seldom use the handrail unless we - seldom do we need to go there. The only time we need to go there is to put something in the workshop hatch or possibly do a little vacuum cleaning. But normally there's no need to be in between the dome lockers and the hatch. So the workshop dome and wall handle - handrails really aren't used very much. STS handrails are those I presume in front of the EPS/ECS control panel. Oh, they're used when we're there to stabilize ourselves. But they are not used for mobility. They're adequate; there's probably more of them there than we need.

223 23 12 30 PLT MDA handholds and handrails; there aren't many handholds and handrails in the MDA. Probably could use some, not necessarily for hanging onto things, or getting in a stable position, but more in getting from one end of the MDA, from the STS down to the command module. I know that when I go in there I tend to use the handrails in the airlock very much in - in mobility from one end of the airlock to the other. Then I kind of float over to the ATM, grab on to the - the writing board there on the ATM, and then grab whatever else happens to be sticking out or available. So there aren't many good - handhold - handrails in the ATM.

223 23 13 28 PLT Triangular shoe cleats and grid. I gave them a very good; I think it's been a definite advantage to have grid in as many places as possible, because you never know where you need to stand or where you need to anchor yourself and you certainly can use the grid we've got to good advantage when ... and ... The triangle shoes, I wear - they - one on each foot all the time, except when I'm sleeping, of course. I found them very handy. I've noticed that they tend to - perhaps I have them too loose. That's the way I like them, but whatever position they are, they tend to come out of the grid in the locked position;

frequently have to reach down and twist them around to line them up so they'll go in the next time.

223 23 14 26 PLT But the triangle shoe cleats are great and I haven't used the conical shoe cleats at all. I haven't tried them. I might mention that one place you really need some handholds is right around the film vault. There's nothing there to hang on to. That film vault is just a big square object and you just can't grab on. You don't have any triangular shoes on and you're pretty much out of luck in that film-vault area. Frequently go up there with our socks on late at night and put cameras away early in the morning, before you get your triangle shoes on, and it's a real unhandy place to be without handholds or - or foot restraints.

223 23 15 13 PLT Portable PGA foot restraints - correction - ATM foot platform is very good. I use it all the time when I'm at the ATM, but don't use the chair. And I always have myself anchored by one foot at the ATM.

223 23 15 31 PLT Portable PGA foot restraints are - I tried forgetting this. I'd rate them excellent. The extra little pins that were put in there to keep the feet in there, the PGAs down there by themselves were a very good position. And the portable foot restraints worked very well in suiting up, and they also worked very well on the EVA the other day when we carried a set outdoors to put up the sail.

223 23 16 03 PLT Portable handholds. I haven't used any of them yet. Portable equipment restraints, tethers, bungees, universal mounts and so forth I would rate them as adequate to very good. The tethers - they're really not used very much except for the tether that we strap onto the arm of the suit to use for EVA. Be nice if there was a way to fasten the EVA tether down to your arm with some sort of elastic or something. One wasn't any use because otherwise it flops around and catches on things. The bungees we've got, we've used them all. We've got them all over. I don't like the ones with the sharp hooks on them because there's

a good possibility that they could get loose and zap you in the eye. I like the ones that come in the command module much better. The ones that were with the workshop are - could be dangerous type of bungee. And I am always very cautious when I use them. I prefer not to be around them. We've got them mounted all over, particularly on the front of the lockers in the wardroom to hold down anything - checklist, maps, camera, flight plan, food bundles, extra drinks, that is. Just anything that you might want to hold down. My suggestion there is the next time we go around we ought to build some bungees right in a lot of places like that so we can hold things down without having to get portable bungees. Obviously we're going to need them, so we ought to have them built right on the doors. Universal mounts are - the only thing I don't like about universal mounts is that the blocking - lock and lever is not over center. It should be further over center.

223 23 18 12 PLT ATM seat/backrest restraint, I haven't used. I don't think anybody has except for maybe right at first. We find it just as convenient to strap - or to fix ourselves at the ATM with our feet. So, we're not using the ATM seat/backrest restraint.

223 23 18 28 PLT Waste management/hygiene equipment is the next subject. Fecal collection equipment; I rate that very good to excellent. The only drawback to the fecal collection business is that it's too much of a nuisance to fill a new bag. There should be a better way of fastening a bag on there - a lot quicker. It takes you about 30 seconds to relieve yourself fecalwise and about 10 minutes to take care of all the logging and putting the thing in the heater and taking the one in there out, securing that and then putting a new fecal collection bag in.

223 23 19 12 PLT Urine collection equipment works very well, also. Don't - Haven't had any spills; blowers all work good. It's a - just a great system. It's no fuss, no muss. There's some way we could save time in taking samples and changing bags and so forth, that'd be a plus for that system but as it is, it's pretty good.

223 23 19 36 PLT The handwasher is - is - used frequently. It seems to work all right. Usually when you get some water out of it get it on your hands, why a few drops will splatter around and they go where they may, mostly in to the back of the stainless sink area, and they just collect on the wall. The hand washer is a good deal; if you get soap on your hands you can't very well rinse it off because you can't get that much water on there. So you wind up washing you hands with a little bit of soap and then put a little more water on there, which makes a little more suds; then you wipe it off with a towel.

223 23 20 21 PLT Fecal/urine collector lapstrap and handholds. First day or two I used the lap - lapstrap, and it was very handy. I don't use it anymore. I do use the handholds. They're in a good location and I use the footholds on the fecal collection position as well. Most for stabilization. Triangular shoes fit quite well-not to be confused with the foot restraints on the floor.

223 23 20 53 PLT WMC handwasher handrail. I guess I've used that periodically but mostly when you are in there, well, you use the foot restraints, no place to hold your hand. What you're doing in there most of the time is working with your hands. There's no - there's no extra hands to grab onto things. What you need is good foot restraints.

223 23 21 12 PLT WMC ceiling handrail. I haven't even noticed. Maybe I've used it and maybe I haven't. I don't know. You sure don't need it to get in and out.

223 23 21 21 PLT WMC light-duty foot restraints. I guess they're okay for bare-footed operations. But most the time, you're not in there barefooted. You're in there with your triangle shoes and that's a very inefficient setup in there. There ought to be some triangle cutouts in that floor like there are around the wardroom table, so you can fasten yourself down. Particularly true over in the SMMD area and over by the fecal dryer area. You need some foot restraints over there. You're just floating and struggling there all the time. And sort of wed - I sort of wedge myself in between the wall - the two walls, with my feet and

my elbows up against the other wall. The foot restraints in there are almost nonexistent with triangle shoes. Little wider or new straps - installed to use with the triangle shoes really don't do the job either because the triangle foot's on that floor and your toe comes out real easy. The foot restraints often get in the way of yanking out the urine drawers to the point of frustration sometimes and pinching fingers other times. So foot restraints for triangle shoes in the wardroom or waste management compartment are unacceptable.

223 23 22 55 PLT Drying stations work very well. I give them an excellent.

223 23 23 01 PLT The shower I haven't had a chance to use yet; just haven't had time.

223 23 23 05 PLT Personal hygiene kit. I like that hygiene kit. I've used toothpaste, toothbrush, comb, the dental floss, the safety razor, the shaving cream. I've used the shaving lotion every day. The shaving lotion that we brought up, Old Spice, I like very much and use it every day. And I used primarily the windup shaver to shave with; although it's - has certain deficiencies, too. If you ever let any of your whiskers grow out a little bit long or you miss some, why they're going to keep on growing because that windup shaver doesn't catch anything but real short whiskers. So at - I've still got the same head I put on when we got here. It's been 2 weeks, now; it's still working pretty good. And every once in a while you've got to clean it out using the overhead ventilator and - and the windup shaver is working very well. Well, once a week I use a safety razor and the shaving cream to get all those extra, longer whiskers near the sideburns that the - the mechanical shaver can't get. One thing that's not on here is the vent overhead in the waste management compartment. It's very good for collecting things. It collects most everything up there, and if you ever want to hang onto a checklist or anything, why you just put it up there and it'll stay there. All the junk stays up there very well until we vacuum it off. We leave it on all the

else in between. There just is no reason to separate yourself so far from safety, in the event of a - of failure - big failure of some sort.

229 22 26 31 CDR Temporary equipment restraints: There aren't too may, except the floor and ceiling. They're not adequate, I don't think.

CDR Personnel restraint devices: Nothing except the floor/ceiling. I'd recommend a little bit more in the way of restraints and mobility aids.

CDR Thermal comfort: Satisfactory.

CDR Noise level: Okay.

CDR Illumination: Poor.

CREW ...

CDR 30-minute time limit!

CREW ...

229 22 27 11 CDR He didn't say. Airlock, general arrangement, orientation of compartment: Not big enough. It's tubular when you'd really like it square like a room. You have to lay sideways in it. And as you lay sideways in it, you kick things. You don't have any good restraints. What ought to be in there is some way to go in that lock compartment, secure yourself by the feet - some sort of foot restraint - have your equipment all mounted around you, and that foot restraint be in such a position that you could open the hatch, and do all the other hatch and maneuvering ... that you have to do.

229 22 27 42 CDR As it is, two of you get in there and float around, bang into one another. One guy floats up and down, tries to get cockeyed, brace his feet to do this, tries to stay out of the way of the cameras that are mounted on the wall. It just - it's sure a makeshift operation. You need something with a nice floor, a nice way that you can restrain something, be protected, where you won't get bumped, where you'll be nice and stable, and you can get

head, whose facing the other way who's looking at an experiment and doing just the opposite. Also by having circular rooms, you end up having a problem knowing where different cabinets and things are stowed. It's much better to have rooms, like down in the workshop where you got a floor and you got cabinets; you got certain places to put certain things, and it just seems to work better. Now, this is certainly acceptable for what we're doing.

229 22 30 22 CDR We don't have any trouble in there except bumping into each other unless things accidentally slide into spots and maybe, who knows, maybe that's a thing of the future. But right now, my feeling would be that you want to stick to something that you put - things of a similar nature in the same place: Puts all the stowage against one wall; puts all this against the other wall; puts all the equipment in a little corner. In other words, it gets everything in a spot where it can be useful and not have to try to hunt it. Now if we have to find something in a stowage box in the MDA, someone says get it out of M-323. Good luck! Because you've got to hunt around until you find M-323 and it's just more difficult than if you had a nice stowage wall like these food lockers are. You ought to try to get things like that in every compartment.

229 22 31 16 CDR Ingress/egress provisions: They're okay for the size room. But, once again, you're stuck with a single access down to the workshop and a single access back into the OWS. I mean back into the command module.

CDR Temporary equipment restraints: Nothing there; poor - especially poor. Ought to be springs on top of every one of those boxes, ought to be multiple restraints and things so that the people could hold on. It - it's poor. Mobility aids: In the form of special ones; poor also. There're handles on top of boxes - boxes themselves. One of the nice things is the restraint used for the EREP C&B. There ought to be a similar thing for the - for the VTS. Even though you can hold on with your hands, why do it? It's much better to have something with your feet that you could move around on.

231 21 27 18 PLT MARK. Cameras off. Okay, that's got two successful translation maneuvers. Okay, now let me look in the book and see what's next.

CDR ... translation ...

PLT Yes.

231 21 27 35 PLT Okay, and the pressure is 1500. Okay, now facing the forward - forward in this area. Has to go back to his translation. It's over here by -

CDR ... the same place. It always starts here and goes to - -

PLT Oops! That is right. You're correct. MMD.

CDR ...

PLT Yes, okay. Then you rotate to - I thought you said you wanted to go over there. You grab on to that because I'm floating. One gripe I got about this food locker here; there's nothing to hang on to. Got to remember to put that in the habitability. If Lou Ramon will pass that along to the habitability guys. There's nothing to grab on to in the food locker or the film vault area. ..., I don't want to do that. Okay, I'm going to position your feet toward the plus- or minus-Z SAL and then you're going to pitch - pitch up and thrust downward. Pitch up, thrust down, and pitch down. Okay, I'd say your feet are pretty well pointed. How do you like that? Okay, let's get the cameras on.

231 21 29 22 PLT MARK. Cameras on. This is number 1. Okay, let me stabilize you again. Okay, let go. Let go and let me - stabilize you.

231 21 29 39 PLT MARK. He's pitching up; starting to pitch up, moving very slowly. I'd say his feet are pretty much pointed at the FMU. He's translated only about foot and a half. Now he's going toward the FMU. He's got himself a left roll going and a right yaw. He's actually moving up toward the water tank. Now he's bringing that down. Now he's pitching down. He's got a little right yaw in yet. Looks like in that translation he might have got a little attitude maneuver in there

232 14 57 26 PLT Getting in and out of the waste management compartment is sort of a stunt because once you get in there - getting in and out is okay, but getting in there is not too good because there's nothing to lock you feet into. Your feet just slide all over the floor; you sort of bounce and ricochet from wall to wall. And you know the best way to restrain yourself in there is to - in front of the sink to put your knee up against the little handrail there and your back against the tissue wipe dispenser area and kind of wedge yourself in there to do whatever is necessary. Other than that, you just drift around in there. And you have to wedge yourself with your feet and hands between the walls in order to stabilize yourself. So it's getting in and out is all right, but once you get in there it's anybody's guess as to how you're going to handle the situation. Getting in and out of the wardroom has been discussed. If the SPT and the Commander is seated, why the only way is to get over the table; there's no way to get around it. Their - their backs are pretty much up to the wall in there.

232 14 58 33 PLT Egress/ingress into the forward dome area is satisfactory. Coming from the airlock, of course, they - you just push off. If we had the fireman's pole mounted, why that'd be a perfect way to do it, but we no longer find it necessary to use it and undesirable to have it in the way. Ingress and egress out of the airlock are satisfactory. In fact, got a handrail to the airlock to take care of that problem.

232 14 59 01 PLT Trash collection provision. It's satisfactory in the wardroom. It's not satisfactory in the - there's no trash bags that we ever use in the experiment compartment. We always have to go over to waste management or into the - the wardroom to throw things away unless we put - fold the bag out and hang it on the wall which is what we typically do. The little trash bag deals in the sleep compartments are good. It takes a while to fill them up. I guess I've only used one so far. And the one in the head gets used a lot, but it's adequate. We never use the one in the forward dome because they're never near you, it seems like. There aren't any provisions in the airlock or in the MDA. You really

and I'd be interested in any comments you might have. First of all, I would like to know the amount of weight lost in pounds that corresponds to those two different BMMD readings, to the nearest 0.1 of a pound, please. And any other comments you might have about it would be appreciated.

232 18 38 53 SPT The message goes to Doctors Buchanan, Michel, Rummel, Mike Whittle, and anyone else interested in the exercise or water-balance studies.

232 18 39 11 SPT SPT, end of message.

232 18 40 08 SPT SPT again, on channel A. That last message, relative to exercise and weight loss should also go to Dr. Bill Thornton; Bill Thornton, also.

232 18 40 18 SPT End of addition.

232 18 51 24 PLT Okay, space fans. This is the PLT, on channel A, continuing M487-3 for Bob Bond; Subjective Evaluation Guide number 2. The subject is, continuing on, personnel mobility aids, I think the - there aren't very many personnel mobility aids in the wardroom. It's just - you sort of grab on to the table and ceiling to get around there. That seems to do the job pretty well; although we could have a handlebar here and there, which would help some. Waste management compartment, I think we've got adequate handholds around the sink area, but there are not enough handholds back in the fecal dryer area. Sleep compartment, you've got to use the ceiling to get in and out and that should be adequate in there. Experiment compartment, there aren't any handholds in there, but we do use the ceiling a lot and whatever's available. I think that the mobility aids there are adequate. The forward dome, we don't have the fireman's pole coming up any more. The handholds - there are no handholds around the food lockers and the film vault, where you need some, and we have an inadequacy in that area. We have a number of handrails in the upper dome which seldom get used because we're seldom in that area. In the airlock, we have adequate mobility aids; probably about the

best there is to - We spend very little time in the airlock itself. We're mostly in transit when we go through airlock, and the handrails there are used extensively. As I mentioned before, there are no suitable ones - mobility aids in the MDA. You just sort of grab whatever you can and - very inadequate mobility aids availability in the MD - STS.

232 18 53 27 PLT Personnel restraint devices - Stand by 1.

232 18 54 41 PLT Okay, here we go again on personnel restraint devices, M487. The best restraint devices we've got are the triangle shoes and the more of them you've got located around, the better we do. We have quite a bit of it down in the experiment compartment, and so that's the best restraint device there is. We're not using any tethers at all, except to - to hang on to things and go EVA. But then we're not hanging on to body, we're hanging on to equipment against the ri - rip tethers.

232 18 55 19 PLT So the best personnel restraint device we've had is the triangle shoes. I used the leg restraints, along with the triangle shoes or the toestraps in the wardroom. And I think they do a very good job. Personnel restraint devices not employed much in the sleep compartment. You just sort of drift in there, out without fastening yourself down. The worst place - one of the worst places is in the head. The restraint devices are inadequate there. You always hoist yourself between the walls to do the job, to - to restrain yourself. There should be some cutouts in the floor for your triangle shoes. The toestraps ate inadequate because they don't fit over the triangle shoes, even the lengthened ones. Even though you can get your feet under them why the bottoms of the triangle are so slippery that if you put any force at all, your feet slip out. So we have inadequate restraint devices in the head.

232 18 56 24 PLT The only one that's adequate is the handholds and the feet restraints that keep you down when you're on the - on the one-holer. The - it's a - in fact, a very annoying thing to go in there and try to

do your work, to - to change your urine drawer out, to change the fecal bags and weigh them and put them in the fecal dryer. You're just continually floating around there. You can't even hold yourself down to write something. You've got to wedge yourself against the wall in order to write on the little chart we've got in there. And it's a very inadequate, poorly designed from the restraint device standpoint. The airlock module doesn't have any personnel restraint devices and probably doesn't need any. The other place that the restraint devices are poor is in the MDA. We've got a good restraint device in front of the EREP and in front of the ATM panel with the triangle gridwork. However, any other place that you want to work, you got to wrap your legs around things.

232 18 57 36 PLT

If you want to take pictures of TV out the window, if you want to work on S192, or if you want to work on the - do the VTS or any other place you want to go in the MDA, there's just nothing to grab on to. You've got to find - find your - some place to wrap your legs around. And so MDA-wise, the restraint devices are something that has to be improved on also.

232 18 58 06 PLT

Thermal comfort. The temperature has been quite satisfactory in here. It was a little warm in the workshop when we first got here; the sail took care of that. It gets cool in the night when we're sleeping and most of the stuff is powered down. Wind up putting a little extra blanket over late in the mornings. The MDA is always quite cool, and it's uncomfortable to come up here, matter of fact, for me anyway, without any - or in my underwear, which is sometimes the way you work up here because you have to work up here just before you go to bed. And you come up here to get the pads and do some other things. So the MDA is a little cool but tolerable; in fact, sometimes a pleasant place to come when things get a little warm down in the workshop.

232 18 58 57 PLT

Whenever you get the high-intensity lights on down there or midafternoon while we're working, it seems to get a little warm down in the - the workshop area. The sleeping compartment does cool off at night near the ventilator the - the floor.

234 22 43 12 CC ... The probability of an aurora is high for the next couple of days. In fact, one was observed in Alaska ... - -

SPT I think that's a little bit too long. It seems to me like about 15 inches is as far out as we ought to come. Fifteen inches out from the window will bring optics out to just about the current level of the blue handle here.

234 22 43 35 SPT Now it sticks up further - It's possible for the telescope to come out further than that, but it seems to be undesirable unless there are very strong optical reasons for wanting it to be that long. I don't think it's desireable for it to be longer than about 15 inches and that would bring the eyepiece right out about parallel to this blue handle on panel 225, and that would seem to be about the optimum location.

234 22 44 05 SPT As far as foot restraints are concerned, let me tell you how my body is - my feet are located now. My feet really straddle aft light fixture number 4 - MDA light or MDA light number 4. As a matter of fact, that light doesn't work right now anyway. I don't know whether it's going to get fixed or not but at the moment that's where my feet are located. My left foot is down on the left side of it and goes all the way to one of these close-out covers above the ATM panel. And so it's possible that a foot restraint could be mounted right in there.

234 22 44 41 SPT I think it would be desirable if there was some sort of little shoe that you could put your foot into. Over on the right-hand side, my right foot just tucked in between a couple of these air duct pipes and I don't see any convenient place for a foot restraint over there. Quite truthfully, I don't think you'd have to have a foot restraint because I can brace myself with my legs and shoulders and arms right in here quite solidly. But it would be desirable if you could get one, to have at least one foot restraint. It would be above the RNBM number 2 and not in the way that my body is to - allow my body to be oriented as I'm presently describing it, with my head up towards the workshop end.

with this one. I assume this experiment will run on SL-4, and you probably ought to send up a couple of new batteries for the sight and just ver - reverify my lamp is in the off position and that's the way I found it when I was using the other battery in the off position. But yet it was somehow inoperative. I haven't checked it with a multimeter, but I assume the batteries are dead.

239 15 21 12 SPT So the Sun's coming up and that's essentially the end of this particular run. Got another run tonight and I'm going to request an extra run - set up after the late one tonight. And we'll see if there's any problem with getting that done. Okay, there is a little problem with orientation here. It takes a while to get used to switching hands in the middle of the operation so you can keep your feet locked into the pedestal here. But it is essential - essentially necessary to do that. Because you can't - you just don't have sufficient stability.

239 15 21 51 SPT Okay, I'm looking at a very bright horizon right now. Still see a very faint airglow. So I'm a little more pleased and optimistic now that we got some good pictures. And I think this is far better than any handheld photography and be awaiting any comments you may have as to how - how it appeared to run from the ground.

239 15 22 15 SPT SPT, end of recording on channel A. Information goes to the S063 PIs, Drs. Packer, Wally Teague, and Jack Lew.

239 15 22 26 SPT SPT out.

END OF TAPE

245 00 33 23 CDR Okay, this is the CDR.

CC Skylab, this is Houston. We're 1 minute and 30 seconds to LOS at Honeysuckle. Next station contact at 17 minutes through Hawaii at 00:48 for the evening status report. We will be standing by ready to copy you on AOS. The station following, Goldstone, is your med conference for the evening. Over.

245 00 33 48 CDR Okay, this is the CDR. I'm doing 487-2C, 487-2C. It's supposed to be a roundtable discussion but the general feeling has been that - that we end up listening and wasting two people's time. So we're running these roundtable discussions as individuals. We do a lot of talking on our own. We listen to the other guys usually. They're usually around when the other fellow's talking, and as a result, we get the benefit of this cross-pollination, but we don't have to just sit idle while the other fellow's talking.

245 00 34 25 CDR Question 1: Which is preferable, the floor/ceiling orientation of the OWS or the open cylindrical arrangement of the MDA/STS? In my opinion, the floor/ceiling is. It allows you to nail yourself down and work in front of an object. Whenever I think of the space station now, I think of the part that we're in right now, which is the experiment compartment. When you work, you got to anchor yourself down and it's convenient. It's much more convenient to have a grid floor like this and the ability to anchor yourself down than up in the MDA where you have to put in a false floor, as you notice, like in front of the ATM and in front of the EREP C and D. You have to put in a false floor. Everywhere else you're wrapping your feet around handrails or something. This is a much more reasonable arrangement and much more convenient. It is also more convenient during ground checkout and also for training. Crawling around the MDA in training time was a big pain. You're always tripping over. You couldn't get to all parts and - whereas the OWS, both the first and second floor were very convenient. But not only during flight, but preflight and postflight, I suspect will be much better with the floor

arrangement as we have it down here in the OWS, and the task performed, for the simple reason you can anchor yourself to work the job. It's more conventional, you're familiar with it and - Although it isn't that bad, it doesn't seem to offer any advantages, offhand, to the ...

245 00 35 52 CDR

2:2 How adequate are the restraints and mobility aids throughout the OA? We discussed those. The floor is the biggest mobility aid of all. By the way, in mobility aids, remember one thing. You don't pull on anything to get around much. You shoot from place to place to place and you can use corners and boxes and handles and all that to get there. Handrails at the openings would be nice. Those are useful mobility aids. The rest of them are restraints and by far, the best is something like the floor where you can lock in and work. The ceiling is excellent, too. Are some unnecessary? Sure, like the ones we designed in the dome so you crawl down them. The fireman's pole was different. We haven't had the thing in since about the first or second week because it's just more fun with it out. We just hold to the floor and dive to the ceiling. It's just much better. We like it that way. You can do flips and things ...

245 00 36 47 CDR

How often have environmental factors - noise ... At night sometimes they worry you, but after 3 or 4 days then you're - become accustomed to what they are. They don't worry you because they're loud. You just wonder if something's going wrong. After a while you know the ones that are bad and good, so you're okay. The temp has been good. I think if it were hot though, it would be terrible in here because the - the ... I've also noticed that when you get over near the sunny side up on the second deck where you're right next to the skin of the vehicle except for the insulation, you've got a lot of radiation heat. It's hotter to stand around here near the 509 and T20 area than it is anywhere else. It's definitely warmer. And I don't know if the thermometer measures it, but when you stand there, your face gets hotter and I'm sure it's the radiation off of that wall. Illumination doesn't allow you to reach in the head too great. Airflow is good. Little too much airflow in the head, but ... I'm going to

245 23 36 42 PLT For future programs, why, I recommend that you keep the noise makers away from the sleeping area like - that's one item that's - noise has been an interference. The noise of the urine separator's - blowers coming on during the night when somebody gets up to use the bathroom. Being right on the adjoining wall wakes everybody up. So that's a bad deal and you won't want to have that again.

245 23 37 11 PLT I think maybe you'd like to take some of the extra uses out of the - of the wardroom - out of the wardroom. Frequently there's something going on in here that prevents a guy's eating on time, or we have to darken it to look at the stars or something. Why, he can't come in here and eat. Or if he's running an experiment on the wardroom table, why, he can't come in here and eat. So I think maybe we ought to - have out-the-window viewing in a different place. And also some of the experiments, - perhaps the medical tasks that are performed in the wardroom, could better be formed - performed somewhere else. So at the moment, habitability-wise, I guess - I've got no more to add, although I'm sure I'll be able to think of something in the future.

245 23 38 11 PLT Question number 6: Discuss both the beneficial and the detrimental effects of zero-g on the following types of activities. Well, for the preface, my general remarks is just that, by and large, zero g is very comfortable to work in, and it becomes very natural after a while. And I think after about 10 days, why, we began to feel that zero g was as natural as walking down the street. And occasionally it poses a nuisance, particularly in the MDA where you don't have a place to fasten yourself down the way you'd like to. But if you have a place to fasten yourself down when you want to, there's no - I don't see detrimental effects to zero g. In fact, I think it's all an ad - an advantage because you don't have to fool along - around with labbers - ladders.

245 23 42 54 PLT Work - Let's see. Work activities requiring assistance from another crewman. Really, you very seldom need another crewman to move anything around. You can usually do it by yourself. Handling equipment, heavy loads like S073 is no problem here. Just one guy can do that with no problem at all. Or S183 - any of those things that we used two crewman for in one g, and it called on the checklist to use two guys here, are unnecessary. If we got one guy working on another one to, say, suit him up or something like that, you got to get him in his suit restraints - the foot restraint, and the other guy will have his legs wrapped around him somewhere, zipping him up. And so activities involving two crewman are less of a pain in the neck than they are in one g.

245 23 43 48 PLT Personal main - maintenance activities: personal hygiene, donning/doffing garments, and so forth. We found that it's easy to get your legs in a suit and that you can get it over your head, but that it's very difficult to get it zipped up compared to one g. That's one thing that's tougher, is to get your suit zipped up. Donning outer garments. I guess this is one of the few places in the world, and some of the few personnel in the world that are able to say with a straight face that this is the only environment in which you can put your pants on two legs at a time. And that's different than anybody else. So we're not like everybody else. We don't put our trousers on one leg at a time. We put them on two at a time. And it's quick!

245 23 44 41 PLT Okay, doffing garments: Its easy to get out of your suit - out of your - your spacesuits. Lot easier than in one g. But there are other things like personal hygiene that are no problem at all. The - You have trouble cleaning your razor, but I guess that's not so much a function of

Final Dump Tape 246-04/D-385
Page 4 of 11

246 15 16 40	CDR	Near as I can tell, we're properly configured.
	PLT	(Whistling)
246 15 18 16	PLT	Going to hit the coast at 23, roughly; 5 minutes - 5 minutes to the coast. I hear them trying to lockup over Vanguard. Is the fire alarm off? Nope, we better turn it off because it's going to whistle.
246 15 19 30	SPT	See how we're doing on Z-LV, Jack. We're almost there. We're there for practical purposes.
	PLT	Oh, a 22-minute maneuver. We ought to be there - just about there is right. We needed a foot restraint by the VTS.
	SPT	I know it. Just saying we could hold on there by our hands was not a good thought.
246 15 19 59	PLT	Well, when you got too many other things you want to do with your hands - you want to grab stuff, shuffle your papers, all that kind of thing.
	SPT	I'm suppose to go EREP start in about 40 seconds, Jack.
	PLT	Okay, old buddy. You'll be there and I'll be there. Another classic pass.
	CC	Absolutely, guys, we're looking forward to it. 9-1/2 minutes through the Vanguard.
	CDR	And they're listening.
	PLT	Let me - -
	CDR	There they are.
246 15 20 29	PLT	- - Give you a little tour of where we're going here today. We're coming up across South America from the South Atlantic. We're going to cross the coast at Santiago, Chile, go up over Asuncion, Paraguay, up over the capital city of Brazil, which is Brasilia, and then we'll leave the coast of South America at Fortaleza, Brazil. Up over the Cape Verde Islands, off the northwest coast of Africa, across Gibralter, northern Italy, and the EREP pass will be over.

location in. And then I'll fasten them to the wall or stick it up somehow so that it's within reach but not on my - on my waist. Some of the work sites we've used, other than those locations that the work needed to be done at, were - That is, some of the work sites we've used which are other than those at which your actual work is being performed have been on the food lockers, for example, a nice big flat surface. Put springs (?) on there and hold things down and work on them. Stand there on the grid, support yourself, so found the food lockers been a good place to work.

250 15 02 37 PLT

And I worked in the tape recorders there. Also at the top of the waste management vent filter cover is another reasonably good place to work until we have better ways to hold things down. But it's a nice flat surface and about desk height. Fasten yourself down next to it and go to work there. Other work that we - we've done has mostly all been done at the site where the job needed to be done. You just take what you get when you get there, figure out a way to wrap your legs around something and go to work on it, is about the only way to do it. But as far as performing tasks is concerned, there's not much difference in being able to do the job than there would be if you were at home.

250 15 03 17 PLT

Adequacy of lighting for work tasks: In some cases, okay and in most cases, it's not. In most cases, you want to inspect something or look at something closely or find out how the nuts and bolts come off in the preferential order and all that sort of thing, you got to get out a flashlight to take around.

250 15 03 38 PLT

Adequacy of onboard data package, toolwise. I guess I don't know what that means. As far as the housekeeping-type items where you replace components, I think the - the adequacy of onboard data has been very good. The housekeeping maintenance tasks and the systems checklists are - are very explanatory and - and if - if anything, they're conservative in telling you too many things as opposed to not telling you enough. So I think they're good. It's better to be on that side than any other way.

you can introduce a small amount of this radioactive material in it and then run around with a little sniffer, same as they do on ground, because it looks like that's going to be a continuing problem up here.

259 14 37 06 CDR

What postural adjustments have you had to make in order to accommodate task performance in zero g? Not too much. What major muscle groups do you employ in zero g? You employ your - your arms a little bit more, I guess, because a lot of times you're not in position to use your legs. Now when you are in a position to use your legs, then you'll use your legs differently. Mostly, on the ground, you use them in tension or - or just compression. Here, a lot of times you wrap them around something and squeeze down on them. A tank, or you wedge your feet in a door. Like right now I'm kind of floating up in my compartment, and to hold myself steady, I'm pushing back on one side of the door with my left he - heel, Achilles tendon, and I'm pushing forward with my right toe; and that keeps me nice and stable. Now on Earth, I'd just be standing on the floor. So you tend to use little, different tricks. Takes you a while to learn to grab in different ways. You tend to want to stand up upright, and after a while, you just look around for somewhere to put your feet. It may not be upright or upside down or just a better view, but a better visibility for what job you're doing. By the way, another thing you need in the way of the tool kit is you need a good light. You need - We already talked about workbench last time, but you need a good light that you can wear on your head. Now we have one over there that ought to have a little frosted glass on it; it would be adequate. I think it needs maybe a few more batteries, or it needs to be made so that it fits the entertainment kit batteries, so you don't just have one battery aboard. And then the tendency would be ... That's what you need.

259 14 38 40 CDR

Would you offer any design recommendation for future vehicles, based on these considerations? Yes. The main one is you got to have a floor everywhere that you can grip to somehow, like this triangle grid. Triangle grids have been great. They've been one of the nicest things here, and

it would have been really tough if we hadn't had it. And I'm just wondering - In this spacecraft, d do you want to triangle grid it, or you want to end up with some sort of magnetic shoes or some other technique. But you've got to have the ability to get your feet locked down. Up at the EREP panel, the C&D does have that ability. It's easy to work that. The - VTR does not have handholds, and so when you let go of the handholds to turn a map or something, the whole thing goes to pieces. So you've got to have your feet placed down, and that's probably the most important thing. Our large masses are far less difficult. They're more fun to handle, because you think - you realize how you'd - you'd have to do it on Earth. You tend to spin them and hold them in one hand and leave them floating, and it's great. It's one of the nicest things. Now large masses, I think, are easy to handle; no sweat there. Small masses, like screws and things, are difficult. I would think that we're going to have to come up with some device like a spring where you pick up in the coils of the spring, which might not be a bad idea. Or some sort of a bag where you can lay them out. We've been using tapes. That works fairly satisfactory, but it looks awful rudimentary. And something could be invented to hold things. We're thinking of screws and washers and the like, anything small. Anything bigger than a screwdriver is no sweat.

259 14 40 26 CDR Have you found you could accomplish maintenance tasks reasonably well? Reasonably, I'd say, ... well without having - without having a work space. You really do need a workbench with rubber - insulated boards with hookups, so you can power this equipment. Right now, we've got a probe, but nobody - It checks out great not under power, and everybody's been afraid to power it up because somebody's liable to get burned. Ridiculous. First of all, we could do it here with a vice. You need a workbench with a vice, some electrical power, some way to hold it. You got your volt - volt meter there and grippers from the experiments; so whatever is bolted, you take over and strap down to the table and work on it. Now you have to strap it to the floor, and you don't have any lights. You bring your flashlight. A lot of

BEAN I tried the double mushrooms and found them to be okay. They are easier to get into than triangles. The only trouble is that there is not a passive restraint, so if you start getting your mind on doing something at the same time you're being restrained and let your legs relax, which you intend to, at least I do, then a lot of times I'd float out. So I took them off after a couple of days use. I used the little mushrooms one day and the big ones the next. Generally, I like the big ones better than the little ones but I didn't like any of them relative to the triangles. I thought that the triangles could have been improved somehow, so that you could get them in the triangular spaces better, by providing more clearance between the triangle and the space available.

On a space station you've got to have some way to connect yourself to the floor. One of the nice things about the EREP C&D panel was that you could use your triangle shoes, so it gave you both hands free. One of the disadvantages of the VTS was that you didn't have any foot restraint and you were always trying to put your legs around something else or hold on with your hands which meant your hands weren't free to hold something else. I think maybe in future applications we ought to try to always have some sort of foot restraint at every station. That allows you to move your body and do work with your hands.

SPEAKER (Cont'd) we have got now, has essentially a horizontal floor going down the length of the spacecraft. Its anywhere from probably eighteen to twenty-five feet, depending on the payload. It's built in sections. Basically, I guess what I ask, is the floor that worthwhile, knowing the way you used it in the experiment compartment and on the second level of the workshop, versus an MDA type vehicle. Again, we're talking about a vehicle that probably two to four feet bigger in diameter, the MDA, I think is about ten, could you comment, can you extrapolate at all the utility of the grid, maybe not necessarily that grid, although it may be great. But just a uniform platform that you'd use to work off of versus a 360 degree vehicle like the MDA. Orientation doesn't really matter.

PLT Yeah, I have a very strong feeling about it. I don't know about Al, but I hope we never build another one like the MDA. I hope we build it more like the workshop, where things are oriented kind of like they are here. Not because you need to do it that way, but it just works out better if you do. The MDA everything was just ---you could live in there all right, but its just all kind of a hodge-podge, you know. I didn't like the arrangement at all. I much preferred that in the crew quarters experiment area.

CDR I agree with Jack one hundred percent. It seemed that we always -- the thing that was noticeable is to do any useful work and you didn't always plan the vehicle to know where useful work was going to be done--is you had to have your feet locked in, somehow. And the best thing that we ever put in that vehicle were those triangle grids. I really never thought they were going to be as useful as they are. But that thing allows you to go anywhere in the workshop and work. We had to put some up around the dome lockers, which we used a lot. I really didn't think those were going to be too useful. You got to lock your feet in if you are going to do useful work. You can't hold on with one hand and work. You certainly can't hold on and then work with two and come back. You got to get your feet locked down. The only thing, I think, is wrong with this--you got a floor here of some universal type. You need a floor that you can--you need some way to lock yourself in at unknown--everyplace. How's a guy going to work up here on that floor. That would be my only comment here. This floor's great as long as you are going to work within six feet of standing here. But I don't know how you are going to work up there on the dome.

SPEAKER Well, let me ------

TAPE 2, SIDE 2

CDR Have you thought about putting a floor in the middle? Are you going to put some sort of, kind of halfway floor up here, half way up, like you did the floor around the ring lockers?

PLT Floor on the wall there.

CDR So you got a floor like this and this so a guy can work this area from that floor and this area from this floor.

PLT You know that blue floor in the -- below the dome lockers was very useful; anytime you wanted to get into a dome locker you lock your feet in one of those triangles and you went to work. That was a good choice.

CDR Yeah, not only does this allow you to work, but it cuts down time. You get ready to go up there and do anything, you don't have to try to daydream up a way to hold yourself in position as you stand there thrashing around. You just float up there, headed that way, and you know that when you get there, you are going to put your feet in the floor here, or here, or here and that's it--go to work.

PLT The other thing about the MDA is, I shouldn't bad mouth the MDA I'm not meaning to do that. I just didn't like the layout of it, but the reason, besides what Al says, is that except unless you were in front of the ATM, or in front of the EREP C and D, there was no way to fasten yourself down. Unless you wrapped your legs around something. Also, it was difficult to find things in there unless you went in at the same orientation every time. If you didn't do that, you had to stop and say " well lets see, there's the gold box, I go from the gold box, the rate gyros have got to be up here. It was an orientation problem and I think you can work more efficiently in a known layout situation which is more common to the one you have trained in here on earth which is built to look like one-g. Even tho its not necessary to be built that way, its just more organized.

CDR Its conceiveable you could come in with a floor here and here and then work either side of the floor. We never found much problem in hanging upside down.

SPEAKER Let us go back and --------I think what we'd like to do after you get through with ever----- you've got to do now we'd like to show you some of the layouts we've got in fomecor. Maybe, further pursue this point of how you best layout a fourteen foot or a twelve foot diameter vehicle.

to use the mushroom shoes; I'm not reporting on them. The triangle shoes really take a beating. This has been reported by all crews, and I think it's, of course, that we've u - When you move around, you tend to sort of move with your hands and try to stabilize and stop your thrashing about with your feet. The shoes really take a beating, the backs and the toes. The fireman's pole's excellent. I - I use that all the time.

332 17 42 46 PLT

Okay, I think I've already covered item number 2 in my discussion of temporary stowage provision and small restraint. As far as body restraint, triangle shoes are excellent. I have found myself at times when there's no grid pattern - Like when I did the Coolanol servicing maintenance task, I actually took tethers, tethered my ankles to handholds on the mol sieve. Because as you maneuver with your hands, the rest of your body torques about. And you've got to have some - some way of restraining your feet because this is the one part of your body that - over which you do not have as much control as, of course, the arms and the upper body. As far as recommendation - as recommendations for improvement, I would say that the triangle shoes are very good, a little bit difficult to get in. If it could be made easier, that would be an improvement. The only way I can think of improving it is, where you don't have the permanently installed grid, that you should have some way of attaching, say, something like a fishnet webbing or something into which you could put your feet to restrict - restrain the lower part of the body while you torque about with the - with the upper body and the arms. If you had something like a fishnet that you could stretch around, - and I'm talking about one you can just poke your feet through and maybe entangle them in a couple of - of the lines so that you just have something to hold your body - lower body while you're - while you're working - it would help an awful lot.

332 17 44 46 PLT

I've already mentioned the way I tied my legs down to do the Coolanol servicing.

still get the splash and spatter problem, and in fact, getting all of the food out of the plastic bags and - Once you get it on the utensil, out of the bag, then it's no problem. One of the things that I would like to - that I find is difficult is fixing - is mixing the condiment in. And I find that I spray - I try to really spray it around and mix. Cut a big triangle out of the plastic container, hold it over the food, and spray the condiment in there, whether it's pepper or Tabasco sauce, which are the main condiments I use.

332 17 48 02 PLT Would a closer tray-to-mouth proximity have improved eating ease? The answer is, for me at least, affirmative; it would, and I find myself eating Japanese style quite often, getting my mouth down very close. And this just - it just minimizes the probability of getting - getting food loose, because you're - you got your mouth open right down next to the food and you can sort of shovel it in.

332 17 48 29 PLT What unanticipated problems have occurred in performing various activation, housekeeping, or experiment activities to date? Well, I guess they weren't really unanticipated, but movement around and restraining myself has caused me a little bit more of a problem than I thought. I've already mentioned the problem of stowage - temporary restraint and stowing of loose items, particularly when assembling equipment that has multi - a multiplicity of pieces. One of the things that has really caused me more trouble than anything else is the book and accounting on the film. One of the worst tasks I've ever performed is in the film transfer. I don't think it was too well - As far as the bookkeeping part of it, it was excellent. I mean there were no errors. There were no errors, and it was correct. However, as far as being well designed for the human factors and so forth and having some creative planning going into it, the film transfer represents a good example of how not to do it.

it up to thirty things. You got to get a DAC camera out in addition to the flight magazine and carrousel. And all in all, I just use it as a typical example of for what I con - what I consider to be, although not an extremely difficult, one which is a complex task of management of small pieces of equipment and hardware.

332 17 52 35 PLT

Now we got to do that - I got to do it one time, and yet when we got ready to do that experiment, we were scheduled a time line just as though we were completely precision and had done it hundreds of times. I'm not - I think we've said enough. I think the flight planners had a lot of stuff jammed down their throats, the FAO people. I don't want to be critical of them, but I do want to point out the problem. The question was asked, and I'm answering it. And I was extremely irritated with the time that we were given to perform these tasks the first time. And I can see what happened on the ground; I know that there are a lot of people involved. When you do that, there's no single individual who's at fault; it's just sort of - you get caught in the system. And so I want to make it very clear it's nothing personal. But the question has been asked, and I do want to emphasize my - my feelings about it.

332 17 53 23 PLT

Now there were a lot of housekeeping tasks that I had never done before, and again, the first time through required more time than was allotted. Some of the medical stuff that we got, the stereo photos we had never - That's right; the stereo photos we had never done. Some of the IR photos we had never done, and yet we were given, you know, like - just added on a couple of minutes here and there to do this sort of thing that's extremely difficult. What - I would like to give an example of what happens when you add on a task like the IR photos. And this is a case where we were given the task of taking IR photos of each other, and the instructions, although it sounded rather glib, were pretty difficult to follow.

332 17 54 10 PLT

Man lays down on the grid floor in front of the film locker. Another man was supposed to float up around the fireman's pole. And of course that's

ridiculous. You don't float when you're taking photographs. So what I - what I ended up doing was going up by - putting one triangle in by water tank 3 and sticking one leg back in between the water tanks. And what I did, I had activated water tank 3 and pressurized it, and I had - Then I kicked the valve OFF. Now I didn't know this until last night; we had some trouble with - started having trouble with the water tank. I still have not reported this to Ground. But I just would like to give this as a good example of what happens when you throw stuff on the last minute without having proper training on it.

332 17 54 53 PLT

And what I did - I actually could have damaged the pressurization valve to water tank 3. There I was, fat, dumb, and happy, one foot restrained and the other foot sticking back between the water tanks, and I kicked the valve off - PRESSURIZATION valve OFF, which started losing water pressure. And I didn't - I wasn't smart enough to figure this out until last night after we'd al - after Houston had already solved the problem. The question you asked here in the book is what unanticipated problems have occured in performing various activation housekeeping, or experiment activity to date, and that's the answer. That is - that is a kind of thing that happens when you start throwing things on at the last minute. And we're very - we're quite happy to do this, but we've got to have the time, the first time through, to get familiar with it. And also, you can expect glitches, like me kicking off that PRESSURIZATION valve on water tank 3.

332 17 55 42 PLT

Now I consider that to be my fault; I should have known better than that, because exactly what happens - This is a very good question you've asked, and I was just giving that as a good example of how not to fly a spacecraft and how not to schedule operations. Somebody thinks something up in an office, it sounds good, and the all of a sudden you find yourself trying to do it the first time, never having done it before, and it's - it's going to take probably four or five times as much time to do the task than the man who is needling the FAO types - "Have them do my experiment;

Final Dump Tape 332-09/D-136
Time: 332:19:39 to 332:21:37

332 19 39 05 PLT ... instructions - to take the pictures.

PLT The posture I assumed was with one of my triangle shoes in the blue restraint panel that is under - below the water tanks. And what I did, I put my left foot in one of the triangles, and my right foot I stuck back between the water tanks and maneuvered it around to hold my position.

332 19 39 44 PLT I'm fairly confident that what happened was that I moved that with my foot. And I guess this just points out once more the lack of wisdom in doing things in flight that you never trained for. We had never trained for that. All we did was we read - we read the procedures first time we got ready to take those IR photographs, and we're going through a learning curve on it. Probably wasted a lot of film - frames of film.

332 19 40 10 PLT And it was improper procedure simply because it was completely strange in trying to stabilize ourselves. But the main point I'm trying to make is that I am reasonably certain that I kicked the pressurization valve off on water tank 3 while I was maneuvering there taking those IR photos.

332 20 07 07 CDR This is the CDR at 20:02 Zulu reporting on handheld photography. The site assigned for 19:56:31 was HH140, a wheatfield in - around Asuncion, Argentina. On the lead-in to that particular site we passed over northern Chile and southern Peru. We did not get to look at fault zones which are called out in HH101-6, and HH106. However, in northern Chile we did notice great, huge dry lake beds, and we photographed one in particular that had a lot of very dark brown water in it. We are assuming that that's caused by mining - probably a mine pond. The location of the photograph was near Calama, Chile. The picture was a 55-millimeter Nikon picture; the setting was probably not correct, it was f/8.

332 20 08 34 CDR I think it should have been an f/11, but we had the camera set up for the wheatfields and just quickly snapped this one off on the spur of the moment. The following - that - That was frame

it would have been, I think, a lot better off with just more open grid.

333 03 11 32 CDR The sleep compartment. I think for the room that is available for those, I think the sleep compartments are well laid out. As you lay here in your bunk, everything is within reach - the radio, the lights, your locker - and I think that that's a good design situation. I think - Well, I just can't think of anything else to say there. I think maybe a little more work could have been done in the lockers to personalize them a little bit more. The lockers are really just the plain old sterile lockers that are available in all the rest of the area - your open areas or with straps in them for retaining bundles. I think one locker probably should have been - maybe the second or the third from the top; probably the second from the top - should have been designed to open out only horizontal and provide a writing surface, sort of a little desk, much like you find in the stateroom aboard a navy vessel - in - in the officer's stateroom. I think - You know, a Ben Franklin desk sort of think where you can pull down the door and it would stay horizontal. You could lay in your bed and write. And in the locker itself, would have been - I think it would have been good to have a bunch of little pigeon holes and various little ways of restraining pieces of personal equipment and things like that. Last but not least, on the lower deck is the - the waste management compartment. I think the equipment in there is very good. The pot and the urine collection devices, I think, are surprisingly easy to use, and they're very effective.

333 03 13 31 CDR I don't know how much better you can get those. Of course, I - I must admit that when I - before I got here, I had very grave reservations for the ability of these two systems to work well. And I must say I was very pleasantly surprised, oh, on the first time in using both systems. I found that - that they worked as well as advertised. The big problem, I would say, in the waste management compartment is lack of proper foot restraints. We kind of boxed ourselves in, literally speaking, when we put the sheath over the floor and - thereby

dealing ourselves out of the gridwork available for locking your seat down. And unfortunately, we didn't do much to remedy the situation once it was done. The designed foot restraints that are in front of the urinal and the pot interfered with the drawers; so we've had a lot of design modifications and a lot of fiddling around. And the final upshot of that is that we've ended up with nothing. And changing out a urine drawer in the morning is pure hell because you've got no way to lock yourself down to do the work that you need to do. And you're forever trying to jam yourself up against the wall or lock your feet here or there and get yourself in position so that you can do the urine sampling and the urine bag change op. The same goes for when you're finished using the commode, the fecal collector. You find yourself in a tough situation with a tough cleanup job left to do and no way to lock yourself down so that you can stabilize yourself and do the cleanup you need to do.

333 03 15 18 CDR You've also got to weight the feces, put in a new bag, mark the feces label, get it into the oven. And so then during the whole period of time, you're just ricocheting around in there with really not much of anything to lock into, nothing but a couple of handholds. That's the most serious problem in there. The - the mirrors, I think - We could have done a better job on the mirrors. I think there are better metal mirrors available than what we've got. Those are just too dull, too difficult to see yourself in. I think the water dispenser and the - the squeeze bag are very good pieces of equipment. Right offhand, I can't think of a - a better way to go about doing that. I think for those of us who shave with a razor, a blade razor, you need some way to clean it out. And I think that would be something that can very definitely be designed for future spacecraft - some sort of a little see-through compartment with a jet - water-jet nozzle inside of it that you can stick your razor in and seal it and then turn on the little sprayer and rotate your razor or - or squirt it and - and knock all the - the lather and the hair out of the razor so that it can be used again without wiping the blade. I think that -

I was making a point that in spite of all the training we've had, we were still surprised when we got here. There were quite a few reasons, and most of them were not equipment problems. There were some stowage problems. Things were not stowed where they were supposed to be stowed. We got ourselves into a mode of having to ask the Ground where everything was. In some cases, the Ground pointed out places - proper places where they were stowed, and in other cases, we just had to look for the things until we found them.

333 03 35 25 CDR

One of the most serious problems in activation was learning how to restrain ourselves, how to hold ourselves down in order to do a task. That's something that you could only learn, apparently, by experience. You could think about it and anticipate it all you want, but when you get up here in zero g, it's a whole new world. And you just got to learn to get used to it; and it takes time. So everything we did took two to three times as much time as we thought it would take. We fooled ourselves. We told the people on the ground before we left that we were going to take it slow and easy on activation, that we weren't going to pay any time - any attention to the time line, that we were going - not going to allow ourselves to be rushed. We got up here, and we let ourselves just get driven right into the ground. We - we hollered a lot about we were being rushed too much, but we did not, ourselves, slow down and say, "to hell with everything else": and do things just one after the other, like we said we were going to do.

333 03 36 28 CDR

I guess that's a psychological fact that I just didn't face up to on the ground when I felt that we could do it. Because we - we worked hard. We tried real hard to get things done. We made a lot of mistakes, and it was because we were rushing around and we were having difficulty getting ourselves properly anchored down to do the jobs we were doing. We - Also, I think another thing that caused a lot of the delays in activation was the fact that we were

It puts the Ground into a full-scale panic to even touch those things. So I guess I'd say that poor to adequate would be the rating I would give the handrails. And as far as the MDA and STS as a working area, as far as restraints are concerned, I'd say it's unacceptable. Real shortcomings all over the place, and the MDA is just a lousy place to work.

344 21 41 22 PLT

Triangular shoe cleats/grid: I would say very good to excellent. Conical shoe cleats/grid: I've not used yet. I want to get around to using those; I'm going to try to fit up my second pair of shoes with conical cleats and try them out. Water tank foot platform is excellent for working dome lockers. It's no - not much good for working water tanks. I'd say it's poor for working water tanks because of the crouching action that has to take place. By the way, a crouching action is very difficult in zero g; so if you design a foot restraint where there's - this posture requires a crouching action, then you're not helping us at all. In fact, it's a great hindrance to have to go into a crouch because you have to hold your abdomen very stiff and your leg muscles very stiff and you're at a constraint strain even putting on shoes. When you bend down to put on your shoes - If you bend down, it's difficult; if you pull one leg up at a time, it's not too bad to lace shoes.

344 21 42 22 PLT

Portable M512/479 foot platform: Not applicable except for its EREP purposes. So - And that's very good except it's very limited. It's only good for the C&D panel, and that's about it. The rest of the thrashing about for the C&D and the VTS operator is done without foot restraints and is difficult. The ATM foot platform is good. Portable PGA foot restraints: I did get to use them the time - Because I was - I had to use my PGA foot restraints for the EVA - foot restraints for the S193 maintenance. Portable handholds: Not used. Portable equipment restraints - tethers, bungees, universal mounts, et cetera: Tethers and bungees, in general, are - are - are very nice to use; however, the ones with the little, fine wire hooks on them are really bad. They - The wire comes out

Reference 31
Final Dump Tape 365-07/D-457
Time: 365:17:43 to 365:18:58
Page 1 of 15

365 17 44 10 PLT Okay, it's the PLT. The time is 44:10. And for PLATE 19, which is field 119, we have a ROTATION of 58.4, 058.4; TILT of 08.7. Standing by for 12:45 - excuse me 17:45. Okay, on 1 second ... the time in 1/60. Okay, I'm waiting to start. Stand by - 1260. Okay, 001262's good.

365 17 45 04 PLT MARK. Okay. Once again, that's frame - or PLATE 19, field 119, ROTATION 058.4, TILT 08.7, 000/000/1260. And I'll turn the recorder off while we're waiting.

TIME SKIP

365 18 02 23 CDR No, it's not time yet. It's still set for this morning. Okay, this is the CDR. The subject is M487-2 Charlie, crew debriefing. And some time during this conversation, we're going to get interrupted. And the PLT will be doing some S183 - putting some more data on tape. So don't be surprised to see this get interrupted. Number 1: Which is preferable, the floor/ceiling orientation of the workshop or the open cylindrical arrangement of the MDA/STS? I personally prefer the floor/ceiling. And the only reason is because of - of - Well, there is two good reasons for that: number 1 is, that's kind of the way we're orientated in life on the Earth, and I think it's good to bring some of that orientation with you. It helps quite a bit.

365 18 03 26 CDR How do the tasks to be performed influence your preference of orientation? Well, I don't know if the tasks necessary influence my preference more than just the - the naturalness of things as far as visual orientation are concerned. And also I think another influencing factor is the grid here. And really, that shouldn't have anything to do with it, but the grid aspect, the floor grid and ceiling grid aspect, certainly does make the floor/ceiling type of arrangement more preferable to the cylindrical arrangement in the MDA. It's

because - And the reason why is because you've got more flexibility and personal - personnel restraint and I think that's very important. And that is certainly something that I've mentioned before is definitely lacking in the MDA/STS; and I think the fact that we have this open gridwork floor and ceiling helps quite a bit. So not necessarily the tasks influenced my preference for the orientation, more than the opportunities or the availability of the - of person and equipment restraint. Bill, how much time you got?

PLT — Don't worry about it. I could get this read in a second very easily.

365 18 04 57 CDR — Okay. How adequate are the restraints and mobility aids throughout the orbital assembly? Okay. I guess this is a rehash. I've already - already covered this ground some time before. Restraints and mobility aids in the workshops area are very good. In the MDA, I think they're deficient. And where are they - are more needed? There are more needed in the MDA. I think I mentioned before that from any handhold where you have your hand, there should be another one within 4 feet, which is an easy reach distance. And I think that's still true. I think we need more of the gridwork sort of thing like the ATM C&D and the EREP C&D foot grid restraints. Those are very, very useful, and very versatile and very handy. And a few more of those throughout the MDA probably would have helped quite a bit more. I think the VTS operator needs some sort of foot restraints. The way it's working right now, you - we're wrapping our feet around the restraint system that holds the - the elephant trunk that goes over the sill into the command module down through the tunnel, the AID.

365 18 06 16 CDR — Are some of the mobility restraints that we have around here, mobility aids and restraints, unnecessary? I can't think of any that are unnecessary. I was going to say something about the dome, but the more I look at the dome the more - and the more I remember how many times I've been up there

CC ...

PLT Okay.

CC First two steps of step 10.

SPT Maybe zero zero zero.

CC No, the commands are 52014E and a 50002E ...

SPT Okay.

365 19 20 34 PLT Doggone awkward angle I have here. Your concern's with all wrong problems. The lighting - there's no problem. The concern is getting your body in the right posture to make the - the - You have to work for the sextant; the sextant does not work for you. You've got to turn sextant around at the right angle. That seems to be the - be the biggest - biggest stumbling block to the operation so far.

SPT A note on the drift compensation again. For this last nightside, I used a drift compensation ... 8 minutes ... we had yesterday ...

PLT Okay, that's what I've got to do.

SPT ... I had no change in the position of the comet. I also suspect that the ...

361 19 21 29 PLT There's no way to point. You don't have any way of pointing at a given star. I can see a star. How do I point the instrument at that star? It's just by - by guess and be golly. Yes, I did a better job in the daytime than I'm doing right now; I mean with lightup. I practiced in the last orbit, after it turned daylight. It looks like I'm going to lose the night before I ever get these two stars together. I'm sighting on Procyon. Okay, I'm assuming that's it. Let me see. Focus, focus, focus. Oh, knocking everything off the walls here. Sure don't like the instruments in zero g. Body position is the biggest irritation right now, getting the right body position. You have to work yourself around so that you got your body in the right position and line up. Okay, let's see.

You want the diopter setting and a temperature, I think. Okay. Temperature is 75 degrees, and let's see what the diopter is. Minus 1 - no, 2, add 5 - minus - guess that's minus 1.6, I don't know where the index is. There it is. Okay, minus 1.6.

365 19 23 27 PLT — Okay, now let's see if we can get you some readings. Boy, that sure doesn't look right.

365 19 23 56 CC — Skylab, Houston. We have 1 minute to LOS. See you over Carnarvon in about 30 minutes.

PLT — Okay, the first one is 38.585. (Music: Bluegrass) Believe I wouldn't bet anybody I got the right stars either. The thing is that the one I'm aiming on apparently - Well, I don't know; maybe. So, - Okay, let's try again here.

PLT — Okay, here we go. 38.573, number 2; number 3, 38.572; number 4, 38.577. What happened? There we go. Number 5, 38.588. (Music: "Blowing in the Wind")

365 19 27 26 PLT — Number 6, 38.588. Think we have a mechanical problem in the gears backlashing us, friction and friction and all that good stuff. 38.562, 38.564. Doggone. 38.572, 38.560, 38.555, 38.561, 38.565, 38.571, 38.571, 38.588, 38.572, 38.571, 38.550.

363 19 32 35 PLT — I think that the variation here is not doing - sighting it through the mechanical backlash. I was trying to turn it off the same amount coming in slowly from the same du - coming in from the same direction. 38.561. I was trying to use the same amount of offset each time, ~~but~~ - Thought I had it wired there a minute ago and I was getting the same readings. 38.572, 38.562.

365 19 34 07 PLT — Overshot. Overshoot again. 38.551, and I think that's a bad reading. Muscle cramp. I'm having - getting muscle cramps in arms and in my legs from trying to get my - hold my body in the right position to angle between the two stars. I think that all this overconcern about lighting and everything is just a burnt red herring. That's not the problem at all. The problem is getting to a body position so that you can hold a - the sextant

properly oriented between the two stars. Okay, I'll change my body position; let's see if I do any better. Making sure I've got Procyon there. Now let's - No, I sure don't. Have to go back to the floor. There's just no - no comfortable position for this particular operation. And not that that's a - not - not complaining; I'm just saying that that affects the - the results.

365 19 35 39 PLT Okay. Let's give you a few more here. 38.562, 38.573, 38.577, 38.577. Oh, let's throw that one out. Let's do that again. I just didn't - Okay, that's a good one, 38.563 - 4, 38.564. 38.566, 38.555, 38.562, 38.581, 38.562, 38.565, 38.572, 38.572, 38.565, 38.571, 38.565, 38.568. Okay, and I'm going to stop and I'm going to give you my zeros.

365 19 43 13 PLT Okay, I got sirius; it's in a comfortable position; I going to use it. 000.3 - 29, 000.25, 00027, 000.31. Shucks. That came from the wrong direction 000.28, 000.26, 000.32. Looks like I overshot on that thing. You might throw that one out. Yes. 000.31; that's a good one; was a good one. 000.30, 000.32, 000.32, 000.32, 000.37. The longer I do these, the bigger the numbers get. 000.32, 000.34.

365 19 47 35 PLT Okay, give you 15 between the Rigel and Sirius, since I'm comfortable. That looks to me - I'm going to estimate about, oh, 21 degrees; see how close I get on that. 20 degrees; let's see what it looks like. Okay, Sirius, come in there, boy.

PLT Come on. This can't be that hard to find. Let's see. The big problem is that I'm holding the thing in my hand; the strap's in the wrong angle for pointing it. Ought to have some way of subjectively pointing at the stars. One of the problems - Okay, that should be it.

365 19 50 04 CC Skylab, Houston. With you through Carnarvon for the next - for the next 9 minutes.

PLT Straight out there all by itself. Should be brighter than that. Well, perhaps not.

SPT Roger, Houston.

365 21 27 26 PLT PLT out.

365 21 34 17 PLT This is PLT. The time is 14135 - ... 135. The rate gyro pack temperature: X-ray 5, 97; X-ray 6, 93; Yankee 5, 96; Yankee 6, 96; Zulu 5, 96; Zulu 6, 96.

365 21 34 37 PLT PLT out.

365 21 36 06 PLT Okay, it's the PLT. M487-2 Charlie. M487-2 Charlie, time is 21:36, page 2-5 Eval Checklist. Voice record the debriefing. Which is preferable, the floor/ceiling orientation of the OWS, or the open cylindrical arrangement of the MDA/STS? In so far as the experience gained in this endeavor, I would say that the OWS floor/ceiling arrangement is much preferable. But I think that has to be modified with fact-by the fact that I think the - the numbering and the restraint provisions, - the numbering system and the restraint provisions of the MDA/STS are very poor. So I think rather than directing the contrast between a physical arrangement floor/ceiling, rather than against - versus cylindrical, one would have to bear in mind the fact that the MDA and STS are very poorly numbered and have pretty poor - poor foot restraints.

365 21 37 43 PLT How do the task to be performed influence your preference of orientation?

PLT The tasks definitely influence the performance - or preference of orientation, mainly because of the way things turn. Take for instance the crank handle on the STS windows; it takes about 45 or 50 pounds of force to move the crank. And you definitely prefer an orientation for that because there are no foot restraints and there are no hand restraints and also it's a knuckle-busting operation.

365 21 38 11 PLT So you naturally try to get in the right position to do that with a minimum of physical damage to your hands. Also, by looking out the window you find yourself orienting - orienting with the horizon or with a certain angle in order to read a map properly or in order to get the best angle.

		The - I just did a T002, which was a very good example, where I kept wanting to - I had to move the sextant a certain way in order to get two stars in the sextant. The vertical - the plane of symmetry of the sextant had to pass through the two stars. This means you have to move your head.
	PLT	Well, the two stars weren't picked so that they were perpendicular to the floor of the wardroom, so I had - it was a very awkward posture. And I finally ended up after I did the - those two stars, I picked two others - two other star pairs that - and did them to see if it was influencing - adversely influencing. But there's a case where you need to do something oriented to a certain special operation, in this case two, stars, and it was - it conflicted with the rigid arrangement of the - the floorceiling in the wardroom.
365 21 39 20	PLT	I think that there are a lot of - if one has to - very - look very, very closely at - at the task that had to be performed and see whether or not you have designed the task to fit the floor, or whether you have to modify the physical - the the physical arrangement to fit the - the task. That's a very important point and should not be taken lightly.
	PLT	It's a good question.
	PLT	How adequate are the restraints and the mobility aids throughout the orbital assembly? Are more needed? Where? And some necess - unnecessary? Which ones? They're still not adequate around - I mean, I still thrash all over the place. At the film locker I don't have places to stow papers. Again, I've hit on this thing of stowing small items in high traffic areas.
365 21 40 07	PLT	Where you're doing a lot of work, in the film vault, or when - M509 or at the SAL, you need beaucoup places to stick little pieces of paper under clips and Velcro patches and peg board hole patterns to stick stuff in. And it is just completely under designed in that respect. We just need much, much, much, much, much, much more of that - that sort of thing.

getting the camera out. Let the fil - let the camera stay right where it is, float, get the new filter out and put it on; put the window on it - or put the window on the - the SAL, then put the whole thing on. And you can do that real quick.

SPT It's amazing. You would think the things up here which you know on the ground weigh an awful lot would feel more massive, but they don't. Even like, you know, another - another body, if you push him around, 180 pounds, or I guess both ... Jerry and Bill, 150 pounds - very light, very easy to move.

003 03 01 18 SPT Personal maintenance activities: personal hygiene, donning/doffing, so forth. Well, certainly the personal hygiene has been complicated by zero g; there's no doubt about that. It's just that one g is - I think that's plainly obvious there.

Donning/doffing garments: No problem. I find it just as easy in one g as zero g. Probably you do need a room that's something kind of like my sleeping compartment, a little larger. But you don't need it much larger. I find when I'm putting on things, for example, I'm usually bounding around inside there like a ping-pong ball. But the room is small enough, and you're - you're bouncing slow enough that it doesn't seem to be a problem.

003 03 02 37 SPT Waste management and cleanup chores. Waste management and cleanup chores: No problem. In terms of cleanup, I think the waste management itself is big - the big thing, urine. Although I think the urine - the urine system is okay. It's very quick. I think it's just about easy as zero g. Taking care of the bags and cleaning up the - the urine drawer and doing all of the associated things with the experiment first thing in the morning - the measuring, taking samples, dumping, that's just - and putting the new bag in - that - that just takes an awful lot of time. Just a lot of small - small items, packed, one stacked up after the other, just all take time. And I think if you got rid of the experiment and you were able to just flush the stuff right overboard, there'd be no problem.

if you just reach down there and very carelessly move the eyepiece for a particular alignment, you've just destroyed the focus that you may have worked several minutes on.

007 02 22 02 PLT — The command module optics are very, very difficult to adjust and just - people that have worked with them - with the command module sextant and telescope for 5 years still get screwed up with it. It's just a simple little mec - mechanical device that just works all wrong. And you've got something like that working for you here, the way this cup adjusts on the focus. I think that - I don't know how to do it, but that's the problem. And I think that that ought to be corrected; the fact that you ought to be able to adjust this cup without [illegible] changing the focus.

007 02 22 46 PLT — Okay, that's real good. Now let me record the diopters here. I can - I can record this. I got real good focus now. I start screwing around with this - minus 1.5. Now that's about what I normally get. Okay, now, I'm going to take a zero - zero bias on Sirius. And then if I start setting up for Procyon and Rigel, I twist the eye of the cup, I destroy my focus. That's my point.

007 02 23 32 PLT — Okay, 00027.

007 02 23 55 PLT — 00034. I still say - I don't care about twisting this eyepiece or anything else. I still say body posture is one of your big problems. I need to have something to lean against. It has to be a prepared station in order to use this thing to the maximum advantage. Just putting your feet on the floor is not good. You ought to be able to lean against something and prep - and in addition to that, you ought to be able to put the instrument against something to steady it. I think you'd get highly repeatable results.

007 02 24 44 PLT — 00021.

007 02 25 03 PLT — 00022.

007 02 25 18 PLT — 00020. The focus seems to have shifted or my eye has.

010 16 06 17	PLT	MARK. 60211.
	PLT	Stand by.
	PLT	Having trouble seeing that star against the Moon.
010 16 07 18	PLT	MARK. 60151.
010 16 17 50	PLT	MARK. 60110.
	PLT	Stand by -
010 16 08 44	PLT	MARK. 60060.
010 16 09 13	PLT	MARK. 60027.
010 16 09 38	PLT	MARK. 60006.
010 16 10 01	PLT	MARK. 60011.
010 16 11 08	PLT	MARK. 6 - 59926. It's getting light. Probably do one more mark.
010 16 11 31	PLT	MARK. 59889.
010 16 12 12	PLT	MARK. 59856. I think I'll keep on going here until I lose it.
010 16 12 36	PLT	MARK. 59839.
	CDR	Houston, CDR.
	PLT	I've lost it.
010 16 13 25	PLT	Okay, now. Those marks were much easier to take. What I did, I make a - made a belt out of a long strap. And then I hooked it over the - mount for the bar for S90 - S063. The point is - and I don't know if there is anything in particular to do with that - I held myself over to the window and with my feet in the triangle shoes. There's only a certain number of triangles I get my shoes in down here. And I was having to lean forward and stretch my abdominal muscles to hold myself in position to make the mark.
010 16 13 59	PLT	By making this belt and pulling myself over toward the window, I was able to lean the instrument

		against the window, and I think, make the marks much more accurately. But whether they're more accurate or not is - is subject to question. However, I will say this, that it's much less fatiguing to do it.
010 16 14 19	PLT	And this emphasizes one of my previous comments in that body posture is a very, very important thing in making the mark, in being able to make them in - with some degree of comfort. I noticed that much, much, much less jitter of the star, as I was taking the marks on the limb, and much - And while I was taking the null bias, it was much easier because the - there wasn't the jiggling, continuous jiggling.
010 16 14 45	PLT	So I guess what I'm saying was the two-point foot restraint; that is, having both feet nailed down to the floor and then having your body - the upper torso of the body more or less fixed - And the way I fixed it was just pull my - my waist over toward the window with a belt which is looped around a fixture. And then by pressing the instrument slightly against the window, just resting it on the window, I was able to - to get a very, very stable platform, much more stable than the previous. The previous, the thing was just jiggling around, and I was just sort of averaging out the position.
010 16 15 24	PLT	Okay, temperature on the instruments is 73 degrees now. And that was done, by the way, with filter 1.0 in. And it was much - a bit more difficult to get Aldebaran on the limb than with a filter 1.6.
	PLT	And the next orbit I'll try to get both of them. PLT out.
010 16 15 50	PLT	PLT again on the T002. I didn't give you the null bias. I started at 15:40, 68 degrees was the temperature, 1.6, the diopter. Your series for the null bias: 00038, 00035, 00033, 00034, 00035.
010 16 16 11	PLT	PLT out.

TIME SKIP

Reference 37

Final Dump Tape 010-05/D-557
Time: 010:18:41 to 010:19:36

010 18 41 21	PLT	Okay, it's the PLT. The time is 18:41. I shall endeavor to get the last comb - filter combination on Aldebaran to the Moon. And that will be with filter 2.6. And I'll do a quick null bias.
	PLT	Okay, picked up my belt here.
	PLT	Temperature is 70; diopter, minus 1.6. I'm setting it there. And as usual, the comm cable is right in the way. The comm equipment's something else.
	PLT	Dang! More trouble than it's worth.
	PLT	No filter - Sirius.
010 18 44 52	PLT	MARK. 00039 - No, make it 40 - 00040.
010 18 45 15	PLT	MARK. 00039.
010 18 45 30	PLT	MARK. 00040.
010 18 45 45	PLT	MARK. 00040. Boy, this belt really helps. Stand by -
010 18 46 06	PLT	MARK. 00040.
010 18 46 19	PLT	MARK. 00040. Okay, now we shall get Aldebaran and the Moon.
	PLT	Okay, now let's see if we can do it. Okay, got to go over to my left just a little and undo my belt one notch. Gee, I can't overemphasize the importance of body restraint. We're using this - getting good results out of this instrument, at least, in de - decreasing the fatigue. It really kills you. Yes, a couple or 3 inches difference in foot position also makes a difference. You ought to be able to move your feet around. So the important thing is to have your body position correct and your head in the right position to look out the Astrodome window or whatever it is you're using. Okay, going to put in both filters. Make sure they're in and - in other words - Okay, that's 2.6. We call that the neutral density.
	PLT	Okay, stand by -

SPT The bubbles tend to move in the direction away - they tend to stay away from the disk which is the forcing function or which is moving the fluid. And now they're ... There they're just clinging on to it for all they can.

014 02 29 53 SPT Okay, enough of bubbles.

CDR ...

014 02 40 50 SPT Yes, I did, Jer. Okay, here we are. We are going to try this now with a little bit of ice in the center. This is an untried or unproven technique here. We have a rod of frozen ice there in the center. And we'll see if we can get some water around it, without melting it all.

014 02 41 46 SPT Okay, it's far below the desirable amount, but let's go ahead and give it a whirl, so to speak; the rotation in the same direction, both rods.

SPT Okay, there you see the ice tends to act in the same way as the bubbles did. Ice, being a little bit less dense than water, will also tend to move in the opposite direction in which the water is forced. This case, centrifugal force is causing the motion. And I'd like to keep this probably about the same rate; not - not as predictable as you'd like. Get these fellows together here. They just touched one of these off-axes. Okay. There we go. Now let's try this again. They're staying pretty much all together, relatively straightforward flow. It tended to remain right there in the center. And I think that's about all we can ask of this one.

014 02 43 30 SPT It did show it, although it was not a steady state.

014 02 44 43 PLT PLT, time is 02:45. Okay, responding to general message 6057 Alfa, M487 question. M487 is interested in obtaining information of the technique used in maintaining body position at the wardroom window while performing T002. PLT, in regards to your use of waist belt to maintain body position while doing T002, do you attribute problem to any design inadequacy such as window-to-floor grid height or grid opening availability for foot restraint in front of window? I think in the previous

M487 briefing that I thought all windows should have a circular area around them which would enable you to look out the window with your head in any clock position around the window. This would mean for a person whose eye-to-toe height or distance was 5-1/2 to 6 feet. Then there should be an area around that window clear for that distance, at least an envelope available. Now, that doesn't mean something can't be located in there, but you should be able to torque your body all around because there are re - times when you do want to preferentially orient your eyeball-to-eyeball plane, as it were, to better view the subject, or to take a picture which will later make more sense.

014 02 46 14 PLT

Now that's not - that's not all the answer to that. Talk more about that because there - there is a problem in floor - window-to-floor grid height here, in that when I have my feet in the triangles, my eye height is up near the top of the window. And I'm also displaced back away from thy window about a foot and a half. This means I have to crouch down and lean forward in order to make the sightings. This means my body is in a perpetual state of tension, and I'm fighting the body's natural tendency to erect itself in zero gravity. In a one-g situation, this probably would not be a particularly awkward posture, the - the - a slight crouch over. Up here, it requires quite a lot of effort because most of the muscles in the body - upper - upper torso muscles, are designed to fight gravity. So, you actually have to exert against those muscles when you lean over or lean forward.

014 02 47 15 PLT

And that is the tension that I think is - was actually spoiling a lot of my observations. I know it was making me - it was fatiguing me; put it that way. So the answer to the question, do you attribute problem to any design inadequacy such as windows-to-floor grid height, I'd say definite affirmative. Now grid opening availability is a problem in that the - if you'll go into the trainer, you'll - you'll find that although there are lots of triangles, you can't get your feet in just all of the triangles there because of struts, beams, and partial openings of the - the little triangle grids.

	PLT	So you only have a few to select from. That's another problem. But the main problem is the one I mentioned earlier, and that is, your - you have to strain against the one - g tensor muscles to get your eye - get the instrument in a favorable position.
014 02 48 14	PLT	Now sighting angle requirement is another thing. Now that can also lead to the - You're leaning over to one side or to the other, or trying to get high or low around the window. In any event, all of these things work together to fight the operator. The operator is fighting himself continually. In other words, it's very easy to find an optimum eye instrument position. It's very difficult a lot of times to hold that orientation. Now I've also noticed that when I hold the instrument - when I - when I clock the instrument around in order to get the proper - see - in order in order to get the proper angle - mirror angle; that is, to bring the - the plane of rotation of the mirror along st - the line of sight between the two stars or whatever it is, that I find it much more difficult to make the observations when I'm holding that thing at 90 degrees.
014 02 49 13	PLT	Now I think that that is - since that is more difficult for me personally to do, I think the posture problem aggravates that. However, that's another problem all by itself. Okay, the belt I was talking about are three long straps. I used two long straps to more or less make a - a waist belt with a sort of a pigtail, with three or four snaps snapped together in a pattern. And then I have another belt with another long strap attached to that pigtail which is looped around - It's snapped on the other side of the pigtail, or to itself, depending on what length I require. That length varies depending upon the stars I'm using and the - the particular angle at which I want to look out the window.
014 02 49 59	PLT	I make a loop out of that third strap and hook it over the mount for the S063 mounting rail at the bottom of the wardroom window. There's a fixture there that holds the electric Nikon - bar. I - I guess there's - there's one at the top of the

	window, and there's one at the bottom of the window. And there's a bar fits in there for the S063 Nikon. And the lower one sort of stands up a couple of inches, and makes it about - it's about 3 inches wide. So I just fit the loop up over that, and then I draw the belt up to give me the proper tension to pull my body forward so that I - my head is then held in the correct position to make the sighting. And I also can look - can fix it so that it holds me and the instrument against the window. And I find that this is an extremely stabilizing situation, and I can make much better and much more repeatable sightings using this technique.
014 02 51 00 PLT	Okay, and that sort of halfway answers number 3: An explanation of how you use the belt along with the foot restraint location would be appreciated. Okay. The - There're only a few foot locations to use and - I tell you, I'm not completely conscious of the ones that I use other than the fact that I look down and I try to put them in the right ones. But there are a limited number. If you look in the trainer, you'll see that there are only a few of them where you can - where you can get your feet in them. What you'd like to do is have your feet as close to the wall as possible, as we do to the bulkheads next to the window. And you can't do that. So this again aggravates the situation in holding your body back away from the window.
014 02 51 40 PLT	I can't overemphasize the influence I think body posture and postural stability has on the accuracy that you're able to get with a - with the hand-held instrument like this. And I think that - I wasn't meaning to carp. I was trying to point out what I thought was a very valuable point in that you've got to have help in holding your body in the right position in - in stabilizing the - the - the eye and the instrument at the right position in the window. And if you can accomplish that and you don't have to worry and concentrate on that, then you can do a much, much better job of making the sightings.

By the way, we have mentioned that from time to time; I've found it an excellent place to - to work. Now, the diffuser section itself, is a - a pretty large area and really serves the - the purpose for holding down pieces of paper and using small screws.

CC ... AOS at Honeysuckle for a very short pass. ...

022 12 15 54 PLT I haven't answer that question number 1 too well, because I - I know that I at time - from time to time, I've thought of better, you know, tools that I'd like to have and the effectiveness of the given tools and - I'd like to come back to that, if I think of any thing else.

PLT Number 2, what postural adjustments you have to make in order to accommodate task performance in zero g? Numerous. Taking stuff out of the dome lockers. You may think, well, that wouldn't be too bad because you've got that blue ring. Well, it's not true because most - a lot of times in order to get to the equipment that's located under the lid, you have to come out of the - the blue ring foot restraints and work op - in the open. And there, in the airlock is hard to work because there are no foot restraints. The STS and the MDA are very difficult locations in which to work with tools because of the great lack of foot restraints and body restraints. And this means that you end up use - using your body against whatever things - whatever pieces of hardware are available. And I have experienced numerous cuts and bruises and so forth in trying to stabilize myself while I'm working with tools or just with installations.

022 12 17 15 PLT I'd like to go back and say that in particular - this is question 1 again. It just occurred to me that a vacuum - the vacuum cleaner, I'd call a tool, because it's used in so many ways. Doggone, it just still doesn't have enough suck is all it amounts to. That's the - the vacuum just is not strong enough to do a lot of the things we'd like to do. In particular, I'd like to mention the OWS heat exchanger fans in the aft airlock compartment and the associated heat exchanger vanes, fins - vanes and fin area; there is a little

radiator heat exchanger itself. We've been trying to - to vacuum that thing now, but the - the manufacturer very thoughtlessly neglected to put filter in front of those heat exchangers, and so the heat changer vans and fins themselves act as a filter and then over a period of time trapped an awful lot of lint, what appeared to be lint and fine particulants. And it requires that we go up there several times - Oh, during the mission, it's about every third or fourth day and vacuum those, and we don't have a suitable vacuum tool for it.

022 12 18 25 PLT

I tried to - I - I - I've made one up in order to get down in there, but the hose itself, the - the metal part of the vacuum cleaner is too large to fit by the OWS flapper valve that leads down to the heat exchanger. And what I'm leading up to is saying is that maybe we ought to give it a little bit more thought to more flexibility in our attachments on the vacuum cleaner. And also the fact that the vacuum cleaner itself turns into a maintenance device, rather than just a cleanliness device. It's certainly satisfactory for cleaning off the diffuser and doing routine vacuuming in zero g, but that thing is asked to do - fill many, many, many more roles than - than it was orgininally designed for. And I assume that the same thing is going to hold true of a vacuum cleaner in Shuttle. And I think we ought to have a lot more vacuuming capability. In other words, they ought to have a lot more power to it. And I know you've got problems because it's already on high power, and I don't know what the answer is. But that - that thing - that thing does turn out to be a maintenance tool, and that's the point I'm trying to make. And I think that we ought to have more flexibility in the attachments, and it ought to be a stronger vacuum.

022 12 19 38 PLT

What major muscle groups do you employ in zero g as opposed to one g? Well, of course, you use your arms and shoulders more, but what you do is you end up trying to use your legs as primary stabilizing devices and wrapping them around whatever is available in order to stabilize yourself and give yourself a - a work position which is

satisfactory for the job at hand. And also, you - you end up an awful lot using your arms and - and your legs to wedge into places and it's a very - Well, sometimes it's painful. It's certainly not the - the way that you would - a good human factors, time and motion man would just throw up his hands if he saw a lot of things that we have to do in order to perform the tasks that are more or less routine.

022 12 20 27 PLT

What major muscle groups - okay. Would you offer any design recommendation for future vehicles based upon these considerations? Yes, I would. And they fall into the following catagories: (1) good work station for each area where there's equipment located. I don't care if it's designed to put 10 billion hours of trouble-free operations, it may break down after 10 hours. And we end up replacing, modifying, patching, taping, and everything else, these - these pieces of equipment. If you - if you have a piece of equipment that's accessible, inside or outside of the spacecraft, unless it's got weld beads closing in half-inch steel armor plate around it, then that son-of-a-gun may be - has to be - you may be asked to work on that thing. And now, inside and outside the spacecraft, there ought to be at least mounts or provisions for crew restraints, feet and hands. Remember, just give you foot restraints a lot of times is not enough, if the guy can't hold onto anything else, because he may have to hold on with one hand and pull with the other. Now the stepping stone of proper cr - the proper provision for crew restraints, and handholds, footholds, whatnot throughout the spacecraft at any area where maintenance activity could be envisioned to take place, replacement of modules or modification of modules or any other thing.

022 12 22 02 PLT

So, the second general area is that - and it's sort of a continuation of the first is that every time there's a - whoops - place where it's considered or envisioned that a tool could be used, consideration - I think you should have an opposition point of application of force. If you're going to undo a screw - if you're going to unscrew a screw in a screw at point A, then radially out from the axis of rotation of that screw at several inches, say 6

to 12 or 15, there ought to be a location where you can grab ahold of something and hold. Say, if you're going to unscrew it with your right hand, there's a place there foryou to hold with your left to offset the torque; if you're going to have to push on something. Now we've - A good example of a really lousy design, as far as I'm concerned, is the recharge station for the PSS in the aft airlock compartment. Oh, we end up thrusting our back against the - all kinds of hardware and hatches and everything else trying to get the recharge um - umbilical hose on and off the - the bottle connection. Now this is one of the worst connections, I think, for - for a QD that I have ever seen. The point that I'm trying to make is that there is really no suitable opposition - point of opposition - application of opposition force to accommodate that action. If you go look at that particular taks, I think you will see what I'm talking about. But I mean, there are things there to grab on to but there should be - you also can - can hurt yourself in there. There are all kinds of sharp pieces of hardware and so forth. It's almost a ground safety problem. But that - that's one example of a task where you really don't have a suitable opposition point, and you're pushing and pulling at the same time, of course, on the thing, too.

022 12 23 54 PLT So proper crew restraint, and - in order to anchor the body and also proper location of and provision of opposition force application point for - tool force application; that is, one opposite for tool force application. And it doesn't have to necessarily be a tool either, as I said; constitutes an action which requires a - an opposition force.

PLT Okay, would you offer any design recommendations - Okay, ... trying to think of any more. Another thing, by the way, that turns out to be a real frustrating business is - is applying the clipboard that we have. It has a double snap on it - it has two snaps. That thing is very hard to put on. It's really amazing, and the snaps that are on handholds are great to use because you can put one finger behind the handhold and the other finger in front and push them together with your two fingers. Now that - that consitutes an

the work bench at the - earlier and that's - that's a - this is a specialization of that. And what I had an id - in mind was a general work bench, say, located near or above our diffuser, something that is similar to what we have had, but the diffuser section or perhaps even one that was specially designed which could, say, have a couple of vacuum cleaners hooked up to it or something like that. And we'd turn on just as is - is - as - as the need arose. For instance, like me - we have a vacuum cleaner in - incorporated in our shower system and there's no reason why you couldn't have just a - especially, if the volume did not cost you all that much. What I've been envisioning is a workstation flat surface with a C, with - like a vise or you know, and a few ancillary - pieces of ancillary equipment. And then you turn the - the vacuum on - this thing would be the diffuser section, maybe located underneath this thing or incorporated as a part of the surface or something like that and - and you use it to - to restrain items while you work on them. But - but dedicated maintenance station idea is - is excellent because it - we - it would focus your attention on the task when you design it and also would probably give you the - give you a stowage location for special tools for that so you'd have to go and - and search them out every time. And also, yes, I think it would lead to better - better management in housekeeping regarding those tools. I think we've been pretty good about that, but occasionally we do lose a tool and then find it.

022 12 31 06 PLT

But it's always that gnawing fear that you know, golly, you just sort of loose track of the thing. You'll get a tool to do the job and then maybe you put it in your pocket, like I said we did, and if you - sometimes if you do, you forget, and you don't put the thing back for a while.

022 12 31 24 PLT

What is your prime method of removing reactive forces when you must exert linear push or pull forces during a task? Okay, the prime method is body english and agonizing pain. The - the MDA and the STS are two area - and also the airlock - where it's really to - One of the - one of the tasks I was thinking of - it just - just occurred to me was the replacement of the umbilical stowage

container cover. Now that - that cover is not very well designed because it won't even receive all the receptacles that are located in it. I mean, you can't attach all the pieces that are supposed to attach to the Fittings in there and get that - they won't even - you can't even get them in there, I don't think. I think maybe a factory man might with a couple of Stillson wrenches and large pair of pliers, twisting and bending and deforming but anyway. That - There - When you start to put those back in, that - that turns out to be quite a - an un - unsatisfactory chore. And there's nothing to push against except put your feet on the opposite side of the airlock and push - put your shoulder or whatever else against it and get to - try to get the thing in there. So what you end up doing is really lo - looking all around and seeing what you can wrap your legs around, arms around, put your shoulder against, put your back against, put your feet against, that sort of thing and then if you can't, you start thinking about something else.

022 12 32 55 PLT

Now when I did the repair of the primary coolant loop early in the mission, I was working in an area that hadn't - in the - Let's see, the STS - MDA, MDA - Was it MDA or ST - yes, I guess, it just - guess - it's just the STS.

022 12 33 21 PLT

I was working in the area there around the mol sieves where there were no foot restraints and poor lighting. By the way, that's another thing, too. There ought to be a way of getting adequate lighting around. Now we do have portable lights and all that sort of thing, but that - I think in addition to that that ought to be a prime consideration of all envelopes working in the working area, lighting and, of course, permanent lighting would be better, if you have, if you have - do have permanent lighting. Okay, go back to working on primary tool that no - no footholds - foot r - straints in - and all you have in the area there are the handholds that run around the mol sieves in the STS. What I need - what I did was I took some long straps and I snapped them around my legs and from my legs around - through just about my

calf and ankle area. I strapped my feet, my legs to the handholds by putting - by looping the long straps around the handholds. One of the reasons I did this is I was - they wanted this coverage on television. Well, I didn't want to look like an imbecile on the television, so I very - gave a lot of careful thought which was a good deal because I did the job better. But I wrapped the straps around my legs and wrap - then wrapped both the straps around the handholds and this anchored my legs and permitted me to use my hands without having to worry about my hands torquing the rest of my body. That was the primary point there.

022 12 34 51 PLT

Otherwise it's a - it's really a - a big guessing game for removing the torques, and a lot of the times what you end up doing and this is - I assume I ought to be ashamed to admit this but as - as the designers ought to be equally ashamed in providing us with a - a system where you have to use this, is to - it'd be to use lag forces and the inertia of the body in order to take out some of the torque. In other words, if I'm getting ready to unscrew a screw I - I go ahead and give the thing a big pull or twist and so forth and then let my body go ahead and torque. And then I wait until our thing is stable around and - stabilizing again and then I give it another twist.

022 12 35 28 PLT

And so you're just sort of using the inertia of your - of you body, free floating there as a temporary, short-term opposition for - to - to cancel the reactive force. And, of course, you've got to get yourself back under control. Our working - working in the lids at the dome ring lockers is that way a lot, and undoing some of the Calfaxes on some of the equipment. One, if you're getting the PCU out. When we had trouble on the - I guess it was the second EVA, Jerry's PCU started leaking and we had to get the spare PCU out. And I got up there and I had to use a - the ratchet - ratchet handle plus an extension and some - some tool fittings on the end of the extension; I think it was a 7/16 deep socket; I don't know. Anyway that was a - that was a good example of question number 5 - question 5 here, in that I was sort of

thrashing myself back from one side of the locker to the other as I was a ratcheting those things; they were real tight.

022 12 36 34 PLT Have you - number 6: Have you noted a definite tendency to establish an IVA coordinate system as a frame of reference for locomoting and working within the various modules and compartments of Skylab? Yea, verily, I have. And it may vary for the individual workstation. And when I'm facing the minus Z-SAL, I'm minus-Z-SAL oriented. When I'm facing the film locker I'm film-locker oriented, or when I'm facing some other area, like when I'm vacuuming the diffusers section, I'm orientated to that device. When I'm looking in the OWS heat exchanger areas, I'm located there; I've got a different orientation when I turn around and view the PSS recharge station. When I look from either one of those to the other during a individual task, that other - that other location doesn't - doesn't occur to me. It's only when I get to that location and start doing that work that every thing falls into reference for that particular task and workstation.

022 12 37 36 PLT That's a - that's an awfully good question and I've found that that's a phenomenon I did not know exists. Now yesterday I was cleaning the freezers and I found - this was in the wardroom, getting the ice off - chipping the ice of the - around the doors and so forth. We do this about - I think about once a week. And it turned out to be very, very useful to turn myself upside down with my feet on the ceiling, on the wardroom, as it were, and with my head down towards the grid floor of the wardroom. And while - as long as I was doing that and working on those freezers, everything seemed great; in other words, it just seemed very very reasonable. As soon as I diverted my attention - I finished and I diverted my attention back into the wardroom I looked around and everything looked all weird because I was upside down. Just like turning yourself on your - standing on your hands in a room in one g.

CC Of information for the CDR - -

CDR Stand by.

CC We are noticing that since you started the first of the Z-LV - -

022 18 08 46 CDR Okay, the muscle groups that you use the most in postural positioning is your stomach muscles, I think. For the most part, any pushing, shoving, hauling, anything like that that you do, you use the normal sets of muscles. But I think, for most little work jobs we do where you want to be anchored, you - you're always in sort of a crouch; sort of knees flexed, butt down a little bit, shoulders rounded a little bit - just, you know, kind of down a little bit toward being in a crouch. And, of course, in one g, in something like that, you'd be standing up straight with your knees locked or something like that.

022 18 09 38 CDR Based on the considerations, I would suggest that things like tool benches, work benches, be chest high; that is, where you don't have to go into a crouch to work, and you can anchor your feet and work with your muscles relaxed - relaxed instead of pulled up a little bit. Because it'll certainly make you feel a whole lot more rested when you've finished your job. That's essentially it. If your - Tool retention, again, is something that's got to be solved. And I don't have any good answer for you on that. Velcro on them - this doggone fluorocarbon Velcro that we've got is certainly not all that good. It's - it's a rather weak Velcro, and it doesn't hang on as well as it should. But we certainly need something like the coo - tool caddy only something more efficient.

022 18 10 46 CDR The previous Skylab crew observed that handling large masses was far less difficult than multiple items. Very definitely I would agree with their assessment. Large masses are extremely easy to handle. For instance, the S183, PSSs the portable water tank, just about any large mass. For that matter, even the M509 and the T020 are quite easy to handle. They're a lot less bother than - than a bunch of small masses, and that - that is very true.

022 18 14 24 CDR Okay, improvised work sites are really kind of a pain. You get a task that re - that requires a work site and you spend more doggone time improvising a work site than you do actually doing the chore, quite frequently. So I - I really do think a dedicated maintenance station would be good. You ought to have lots of good retention features there. In line maintenance tasks - or on line, I should say, are really no great problem with the right kind of tool, right kind of wrenches and screwdrivers, and things like that. They really aren't too terribly tough.

022 18 15 13 CDR What's your prime method of removing reactive forces when you must exert linear push or pull forces during a task? Well, essentially, I try to line the push and pull forces up with the vertical - or the - the longitudinal axis of my body, and - if it's just a very, heavy force. If it's not a very heavy force, I'll do it laterally by placing one hand, you know, against what I'm going to pull, for instance, and then essentially push with one hand and pull with the other. But I think the prime method of removing reactive forces depends on how thick the reactive force is. You know, how big a force is require.

022 18 16 04 CDR Removing torques: The same thing. In any case, you had darn well better have your feet anchored if you can't use the other hand to remove the force, because if you don't either, linear or torque forces are just going to swing you around and you'll get nothing done on them. Cases in point are things like going up and - and connecting power cables, either high or low accessory power cables, or water tank hoses, or gas hoses, or something like that. If you go put a hose in your hand and try to push it into a receptacle, you're going to go the other way, and everything else will stay where you put it, you know. And you - you've gone and nothing's happened.

CDR Removing torques: Again, the opposite hand is usu - usually good. Or if you can anchor your feet, you can remove the torques with your body - with your feet. So you know, there's a definite tendency to establish an IVA coordinate system as

a frame of reference for locomot - locomoting and working within various modules. Yes, I - I guess what you mean by an IVA coordinate system - that kind of refers back to the question in your last debriefing guide, and that had to do with the floor/ceiling relation and all that sort of thing, about whether there was definite relationship there that would have affected us. And it's the same relationship here.

022 18 17 51 CDR Case at point is coming through the dome down to the experiment compartment. We all either go head first or feet first. We never go, you know, sideways; that is to say, with our long axis perpendicular to the X-axis of the vehicle. We're - we are inclined in here to usually do our traveling with our bodies parallel to the X-axis of the vehicle.

022 18 18 21 CDR I might add that frequently, when I come through the dome - the dome hatch, feet first, I get the definite impression that I'm in a high place or going down to a low place and that I could fall and hurt myself. You know, you get - you get that feeling of being up high and looking down. However, if you turn around and come in head first, you don't get that feeling at all. Everything seems to kind of relate okay in zero g, so that's kind of a peculiar thing we carry over with us from one g.

CDR I think that you very definitely should have some sort of a coordinate system established or a coordinate system in mind when you design the spacecraft for - for the future, because the disorientation that you suffer going from one module to the other when they're not compatible is - is quite a bother, really. Now the best example of that is - is going to and from the command module from the airlock module.

022 18 19 31 CDR I get, you know, a coordinate system embedded in my mind and I whistle down the tunnel and into the command module and, zingy, all of a sudden, it's upside down. And I have to turn around and picture where the couches are and mentally picture where the instrument panel is, and then I have to

bit too large for one size screwdriver and too small for the other. And you got to put a lot of force on those screws and a lot of pressure. And I find it would have been useful to have a screwdriver which fit, and we didn't have it.

022 18 53 49 SPT Two of them that - that are in there - No I can't I've usually been able to make almost anything - I can get almost anything I need to get done in one way or another. I find the Swiss army knife is an exceptionally useful tool in itself. The postural adjustment is question number 2. What postural adjustment have you had to make in order to accommodate task performance in zero g? First one is at the ATM panel, I wish that the flooring was a little bit lower there. I find myself having to continually bend over; was much worse at the beginning of the mission when I was used to the simulator. Now, I'm used to working a little higher eye level on the ATM panel, but I still find myself bending over and that is somewhat of a problem.

022 18 54 31 SPT What major muscle groups - Anywhere else, anywhere else. About the only place that I'm really working most of the time - well, also when I'm doing some of these TV-IOX series, I've got the television camera mounted on the floor and the lights and everything else, and if I'm bending down there all the time, it's a little bit harder than one g because you don't have the gravity holding you down. So I find myself with my legs and my back getting tired.

SPT What major muscle groups do you employ in zero g as opposed to one g? Most of the time you don't employ many muscle groups in zero g except for the fact of trying to bend over and get something and stay - and stay bent over. You're going to be at an ATM panel or - or close to the floor, as I just mentioned. And there you're - you're using you - your stomach muscles too, I guess, as a traction to hold you down forward; and you're also using your leg muscles.

022 18 55 31 SPT Would - would you offer any design recommendations for future vehicles based upon these considerations?

SPT

What is your prime method of removing reactive forces when you must exert linear push or pull forces during a task? Removing torques? Removing reactive forces: Hmm. Let's see, F equal MA [?]. I'll tell you, Bob, baby, I just - I think I understand what you're asking there. Let me kind of talk around the subject; I hope I hit your - what you're asking.

022 19 03 25 SPT

When you push on something during a task and you either have it braced between hands or you brace yourself with triangle grids and a hand on the handrail and the object on a wall if you have to, although most of the time we don't have forces that require anything like that - Most of the stuff we do is - is all internal though; isometric, if you will. You're - You're pushing one hand against the other a good part of the time, or pulling. Torques: We really don't have any high torques - well I guess those screws, for example - of course, now that's all - all I've never had to work anything fixed that I was not holding my hand that I can think of. Oh, I guess I have. I guess what you do is just brace your body up against something. What the heck am I trying to think of - I've done that. Up in the MDA there was some darn bolts out, a long time ago in the beginning of the mission.

022 19 04 35 SPT

Then really, what you do is just get your - oh, I know; another good example is opening up the windows in the MDA. Those windows are the highest torqued windows I've ever seen. Those - turning the cranks on those things. There, what you do is just wedge your body in a position where you can hold yourself down towards the window and then torque so that your legs or your hips or something else are reacting against something in the immediate vicinity. And you can then open or close the window. Now that's all improvised. If you ever needed a workstation, it's right there, to open up those darn windows.

022 19 05 15 SPT

Number 6: Have you noted definite tendency to establish an IVA coordinate system as a frame of reference for locomoting and working within the various modules and compartments of Skylab? No,

CARR Yes, if I took a pencil and wanted to write on that, I'd have to take my hand and hold myself to it in order to write, otherwise I'd just push myself away.

QUERY I don't know why we have such a hard time observing Newton's laws. I'm going to jump to mobility and restraint. We had some other questions on the environment, but while we're talking of Mr. Newton; I'll just go ahead.

We noticed that given the proper restraint you performed a task just about as well in zero gravity as you would have probably would have in one g.

CARR Yes, once you get used to walking in and getting yourself positioned, that was very easy.

GIBSON There are some tasks you can actually do quicker if you make use of zero g if you've got fairly massive objects. Putting the Earth terrain camera away and getting that assembled is a good example.

CARR That's an important observation, the larger the inertia of the body, the easier it is to work with in zero g.

QUERY A number of small articles were much more difficult to deal with?

CARR Right.

POGUE (CONT'D) none for the VTS operator. The one for the material processing facility I didn't use on the M518 sequence.

CARR For 487 I used the one triangle in the upper left-hand corner, because that was the closest one. It was poorly placed for the furnace work.

GIBSON I always wished that the ATM foot restraint were lower. We all found that we were hunched over when we started operating the ATM. We got a little better as we got used to having a higher head position relative to the panel but we always seemed too high on the panel. I would much rather have that thing gone down about 6 to 10 inches.

POGUE You tend to get a cramp in your abdomen from tensing, because all the work stations were set up for normal one-g work. Your body tends to hold itself erect, and even slightly arching the back, so you are always held away from your workstation. I thought the aids around the MDA and STS were very poor. It was very difficult to do some of the tasks which were required. In fact I put up long straps, and ended up tying my ankles to single handholds, in order to have a good stable body position for doing some of the early work in the Coolanol servicing loop in particular and for some of the EREP instruments' calibrations.

CARR There was just no way for restraining the cameraman for the television work in the MDA. In the airlock module, we just had a few handholds, but not much work is done in the airlock module.

POGUE The aft airlock was the big one. We had to charge the PSS and we had to vacuum the OWS heat exchanger vanes and remove the cover and replace it. Those were two tasks I felt were very poorly helped because of the absence of restraints. You just had to wedge yourself in and use body english, to hold yourself in position.

CARR Now in the forward compartment area, I was in general very pleased with the restraints and mobility. Of course, the grid floor is the greatest part. I found the grid ring around the bottom of the water tanks to be very useful. I was never at a loss for foot restraints while I was trying to get into any locker.

GIBSON I found that the walls of the OWS were not really used as much as they should have been. I would have liked to have seen not just the one-g design in that total structure, but a three-dimensional design which would have put restraints in the walls. In that sense, I like the MDA because we did use all the walls all the way around, although the restraints there were poor. In the OWS, I would much rather have seen a lot of the dome wall used, as well as down in the forward compartment.

CARR There was a lot of blank area up in the dome that could have been used.

GIBSON I would have liked to seen triangle grid up in all those areas; we could have done a lot of useful work there.

POGUE You mentioned it earlier, Ed, that the work over there by the food lockers was very difficult because so much of the triangle grid was occupied by hardware installation. There were really very few places where you could put a foot triangle.

CARR Let's have comments on the aft compartment.

POGUE The head was probably the worst.

CARR That was absolutely impossible, but the experiment compartment really was generally pretty good. There weren't many places where you needed to put your feet that you couldn't find a couple of triangles to lock yourself in. The proximity of the overhead, the ceiling, I thought was good because you could reach out and hold on with your hands, if you wanted to, or if you needed to lock a foot in the ceiling, you could do that. I think the experiment compartment was by far the best place to be, as far restraints were concerned. The waste management compartment was terrible.

GIBSON You were just like a ping pong ball inside of a little cup; you bounced around in there. You never really restrained yourself. You just ricocheted off the walls.

CARR Of all places, where body wastes are handled is no place to be unable to control body position. That was just absolutely ridiculous. The folks who designed that did a nice job of making sure that all the smells were retained, and that you had privacy. Unfortunately, when they did that, they eliminated all opportunities to properly restrain yourself.

POGUE The restraints that were in there got in the way when the urine drawers were pulled out. They weren't very good for really holding your feet in.

GIBSON We should have, at the minimum, had a triangle grid on the floor.

CARR In the wardroom, until we took the floors that go with the pedestal out, I considered that to be pretty much unsatisfactory, too, because for the most part we refused to use the foot restraints that were there. We would stand to the side of them or we would lock ourselves in somewhere else to eat. Once we finally found the time to get in there and take those floors out and get rid of them, the wardroom became much easier to get around in and lock yourself down. But there still was a pretty

Reference 43

POGUE Because it - Boy, it was really giving me fits. I had my legs strapped to handholds and everything to get the right force.

QUERY That's probably why you commented on the lack of restraint in the airlock module and having to tie yourself to the airlock ... - -

POGUE Yes, I remember pausing quite a few times to reflect on that.

MS (Laughter)

QUERY Because we - nobody else has commented about the lack of restraint in the airlock.

MS (Laughter)

QUERY We forgot about that Coolanol servicing.

CARR Tools in general, I can - I'll just - we made a lot of comments in the tech debriefing on what we thought we should have had in the way of tools. We asked for a soldering iron a long time ago and didn't get it - a soldering gun.

POGUE Files.

CARR It might have been better because it requires that you get the finger in the - in between the wickets to throw a switch; whereas, if you bump it with a foot or something, it will protect it. But you've got an engineering tradeoff there because a whole bunch of wickets are such much heavier and space - use up a lot more space than just a bar across the top.

QUERY True. You commented in the debriefings on the ATM foot restraint position and the fact that it generally was too high for all of you by about 8 or 10 inches. Did you move the ATM foot restraint from its position and what position did you use?

CARR It was all the way down, as far down as it could get.

QUERY It was all the way down?

CARR Yes. See the thing is your natural posture is essentially - standing is just very slightly bowed, with your back hunched just a little bit, your legs flexed just a little bit. And what we ended up with was the eye level right at the top of the panel instead of where we had had all of our training where you're sitting in a chair and you're looking at the panel like this. You had to look at it like that. And the same thing in the food area too. You're not sitting

CARR (CONT'D) down, and so we shouldn't have put the food tables at the sitting down, chest level sort of thing. We should have recognized that people are eating standing up. And so the upshot was that at the food table and at the ATM panel, you had to hunch down in order to get a decent level and --

POGUE Tense your abdomen.

CARR Yes, but your abdomen and your muscles tensed up and you just got tired of it. What we need to do is remember postural situation up there and the fact that it is quite natural to be standing up, so you might as well get all of your work surfaces and everything, your eating surfaces up here.

POGUE And the thigh restraint didn't help that any?

CARR Yes.

QUERY That's one thing, which crewman's restraint methods worked best and worst? Did you have any?

POGUE Triangle shoes.

CARR Oh, they were by far the best, yes. It took a little while to get that eye that you need so that you could come right down and put your foot in a triangle and snap it. You know, the first few weeks it was put your foot

CARR (CONT'D) down and fiddle around with your foot until you finally got it to drop in the triangle and then lock it. But you get an eye for it later on. You got to the point where 50 percent of the time you could float free right down the floor and hit the triangle and lock yourself in without ever having to grab something and make sure you didn't - And the other 50 percent of the time you missed the triangle and propelled yourself back up.

POGUE Yes, and if you have both hands full, you're off and running again; couldn't grab anything.

QUERY Do you have one that you selected the candidate as being the one that we shouldn't look at anymore?

CARR Restraint?

QUERY Yes, restraint types.

POGUE Straps. Those foot straps are no good.

CARR Yes, in the waste management compartment. Also don't ever cover up triangles for another kind of foot restraints.

POGUE Yes. The waste management compartment is the worst in the whole vehicle. I think that's even worse than the MDA/STS, if it could be.

CARR And the floor, you know the plates you had on the floor around the food pedestal? Once we got rid of those things, we probably quadrupled the number of triangles that were available to us to anchor ourselves in. And we still didn't have very many because of those intercostal beams that are in there that blocked off the triangles.

QUERY Bill, you mentioned that the M512 foot restraint was a little bit off for some of your work with the furnace, that you had just used one triangle I believe, and you felt the body position was a little wrong.

POGUE Yes; now Jerry, I think, used it all right.

CARR No, I had the same problem though; all I could anchor was my right foot. The other one was off - -

POGUE Okay. I ended up not even using it for the 516, because the 516 work was so limited. Now the flammability, that was another matter entirely, because that required the continual presence there at the panel, and Jer spent several hours doing that. So on 516, it wasn't even worth the problem.

CARR The work chamber, the furnace chamber was here. And the floor started here at my right foot and went off that way. So I could anchor - The most comfortable thing was to

CARR (CONT'D) anchor my foot in the forward left-hand corner, and then the rest of me was hanging out over the end, and I was working with one foot restraint. We just didn't have it in the right place, that's all.

QUERY Apparently they - when it was originally planned, it was organized for - -

CARR The C&D panel.

QUERY And for the activity back there in the back and the preparation and not actually for ...

POGUE Oh, for all that stowage and everything.

CARR Yes.

QUERY Yes. For handling all the other stuff. And maybe that is why, because of the particular type of experiments that were flown on your mission, we didn't have any comment about it on either of the other two missions.

POGUE You know, thinking out loud and not trying to redesign, but, I guess, really suggesting it; you could have something like that foot restraint there, but where you had different levels of the triangles that would telescope and slide out, giving you a longer - which could be rigidized by tethers, maybe. But the idea was excellent. The triangle - when