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SKYLAB EXPERIENCE BULLETIN NO. 18

EVALUATION OF SKYLAB IVA ARCHITECTURE

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National Aeronautics and Space Administration

LYNDON B. JOHNSON SPACE CENTER

Houston, Texas

DECEMBER 1975

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

BULLETIN NO. 18

EVALUATION OF SKYLAB IVA ARCHITECTURE

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

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SKYLAB IVA ARCHITECTURE

SUMMARY

The Skylab crewmen had few complaints concerning the interior architecture of the OWS. Sufficient volume was available in most areas to permit freedom of movement and adequate access to the necessary equipment.

Probably the most prevalent complaint concerned encroachments into specific traffic paths. The lack of access by the Science Pilot to the food preparation area when the other crewmen were positioned at the wardroom table was noted by all the crewmen. Other, more minor encroachments, either by crewmen at work stations or equipment undesirably mounted, caused some traffic bottlenecks.

One of the more significant architectural findings was that of orientation of equipment within a room. The Skylab crewmen were able to operate equipment easily from any orientation. They quickly established their own coordinate system in which the location of their feet signified "down".

However, they also found that a room with the equipment oriented as if in earth's gravity was much easier to orient themselves in. The "zero-g" orientation of the MDA caused personnel orientation problems which were somewhat time consuming.

The one most prevalent crew comment concerning an architectural aspect of Skylab was directed toward the windows, which provided their single most important off-duty activity. They never tired of watching the earth go past beneath them, and they were unanimous in their desire to have "more and bigger windows".

PRE-SKYLAB EXPERIENCE

The Mercury capsule had just enough volume for the crewman to sit in his couch and reach his instruments. Architecture really doesn't apply in such a confined environment. The Gemini capsule had a similar environment but with two men on board. Any extensive movement by the crewmen took place only on EVA operations.

The Apollo Command Module had a bit more volume for the crewmen to move about in, but it was still a one-room cabin wherein all of the mission operations as well as the crewmen's personal functions were performed. It was adequate from an operational viewpoint, but not very habitable for long missions. The Apollo Lunar Module can be characterized in the same manner.

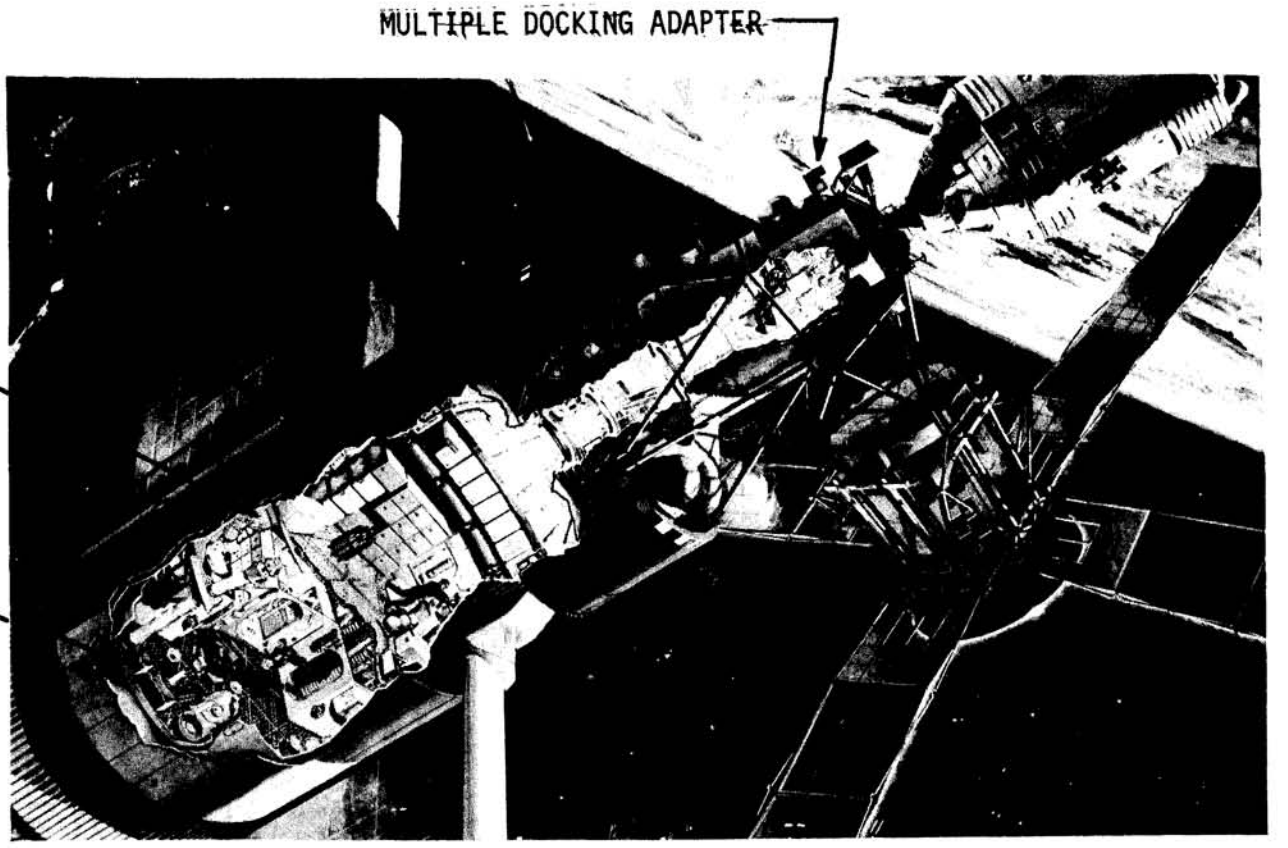
SKYLAB DESIGN

The interior of Skylab was made up of several individual compartments and modules. These included the Multiple Docking Adapter (MDA), the Airlock Module (AM) (discussed in Skylab Experience Bulletin #2), the forward/dome compartment, and the crew quarters/experiment deck. Figure 1 shows an artist's rendition of the Skylab assembled modules.

The crew quarters/experiment deck, shown in Figure 2, included the experiment compartment, the sleep compartment (discussed in Skylab Experience Bulletin #3), the Waste Management Compartment (WMC), and the wardroom.

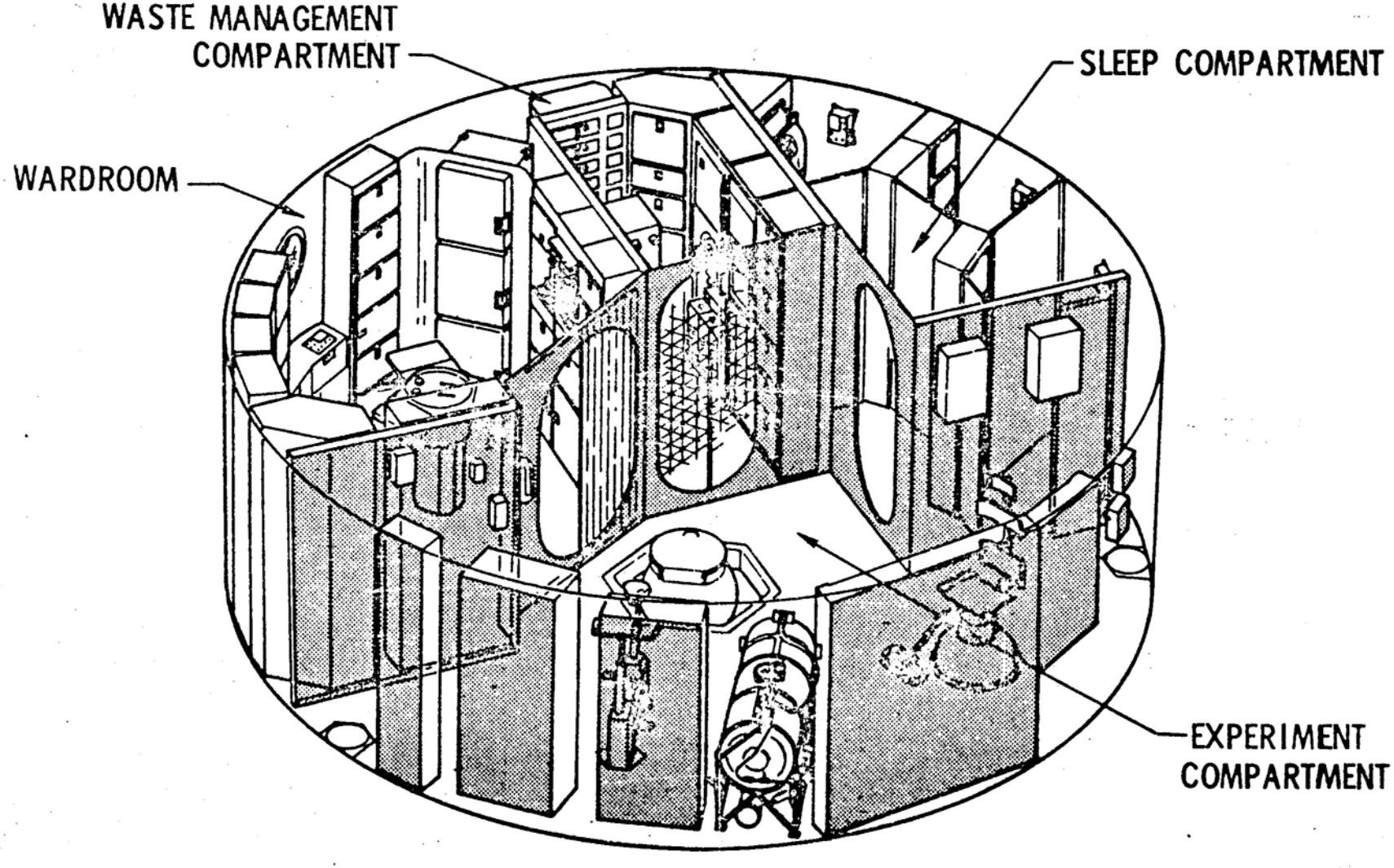
Multiple Docking Adapter

The MDA was the initial point of entry into the Skylab. It contained the docking port for the Apollo Command Module. It was designed as an open cylinder, 5.2 meters (17 feet) long and 3.1 meters (10 feet in diameter, and enclosed approximately 32.3 cubic meters (1140 cubic feet) of volume. This volume was well filled with experiments and associated



SKYLAB ORBITAL ASSEMBLY

FIGURE 1



CREW QUARTERS/EXPERIMENT DECK

FIGURE 2

support equipment. Figures 3 and 4 show the internal arrangement of the MDA. Experimental and operational hardware was installed around the walls of the MDA more or less randomly without regard to adhering to any specific architectural pattern.

Forward Compartment

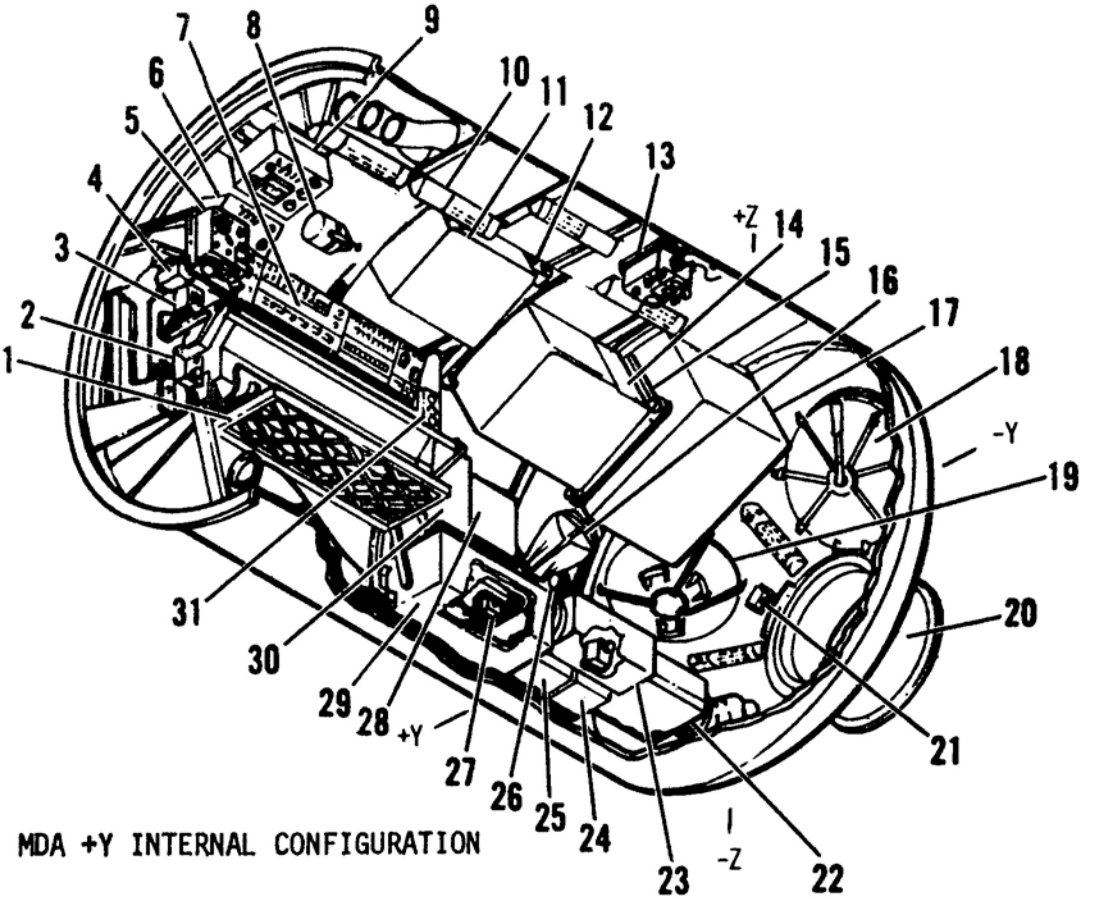
The forward compartment of the OWS consisted of the forward portion of the S-IVB stage of the Saturn rocket. Figure 5 shows its location and an interior photograph of its layout made in the one-g trainer.

It was a cylinder approximately 6.7 meters (22 feet) in diameter and nearly 3 meters (9.7 feet) high topped with a half circle dome for a total height of 6.7 meters (21 feet). This volume had a large number of storage units and experiment equipment items installed around the walls and located on the floor as seen in Figure 5. However, it retained sufficient open volume in the center to provide an area in which to perform free flying maneuvering unit experiments.

Experiment Compartment

The experiment compartment interfaced with the crew quarters through the installation of partitions. It was the control center of the Skylab in addition to being utilized for many of the Skylab experiments. Figure 6 shows the experiment compartment. The necessary control equipment, stowage lockers, experiments, and their associated equipment were located in the experiment compartment.

It covered approximately 12.5 square meters (135 square feet) of floor area and, with its 198 cm (78 in.) ceiling height, enclosed approximately 25 cubic meters (875 cubic feet) of volume. It had a standard one-g orientation with the triangle grid on the floor for restraint and a lighting system mounted in the ceiling.

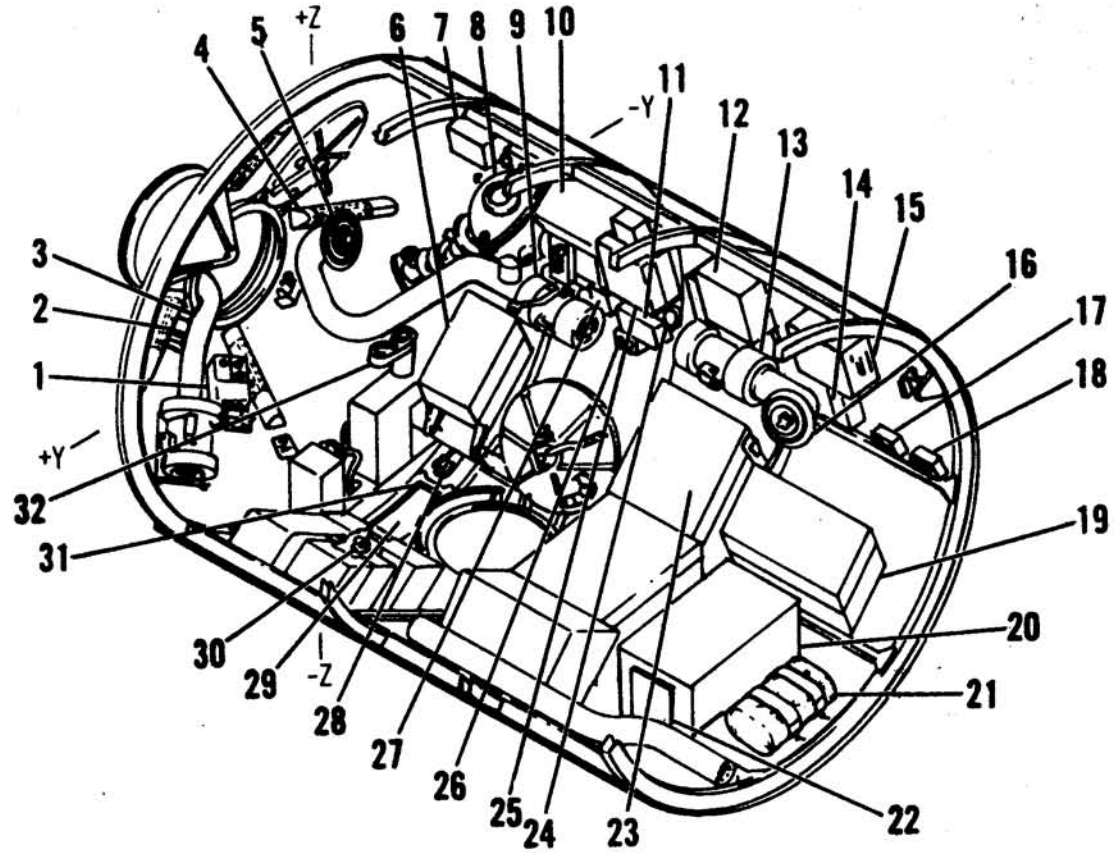


1	ATM C&D FOOT RESTRAINT	17	CONTAINER M124
2	UTILITY OUTLET 2	18	STOWED AXIAL HATCH
3	TV INPUT STATION	19	STOWED DROGUE
4	VIDEO SWITCH	20	AXIAL TUNNEL
5	SPEAKER INTERCOM ASSY	21	INTERIOR LIGHTS SWITCH
6	RADIO NOISE BURST MONITOR PANEL	22	EREP C&D PANEL
7	ATM C&D PANEL	23	S190 STOWAGE CONTAINER
8	FIRE EXTINGUISHER	24	S192 ELECTRONICS ASSY
9	RADIO NOISE BURST MONITOR PANEL	25	EREP TAPE RECORDER
10	AFT EMERGENCY LIGHT	26	VENT PANEL
11	CONTAINER M157	27	UTILITY OUTLET 1
12	HIGH POWER ACCESSORY OUTLET 1	28	CONTAINER M125
13	SPEAKER INTERCOM ASSEMBLY	29	CONTAINER M143
14	CONTAINER M141	30	CONTAINER M126
15	STOWED S190 WINDOW PROTECTOR	31	DIGITAL ADDRESS SYSTEM
16	STOWED PROBE		

MULTIPLE DOCKING ADAPTER

+Y HALF INTERNAL CONFIGURATION

FIGURE 3



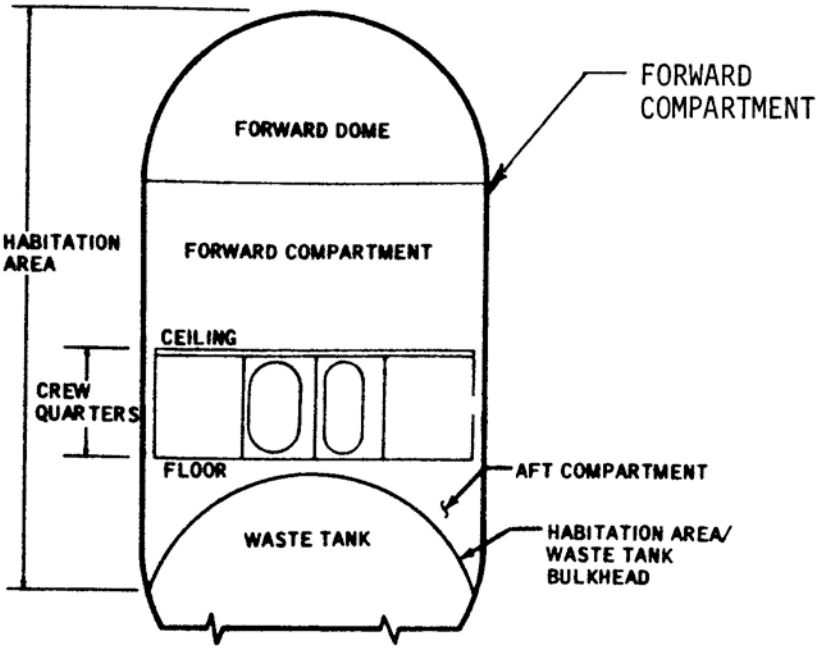
MDA -Y INTERNAL CONFIGURATION

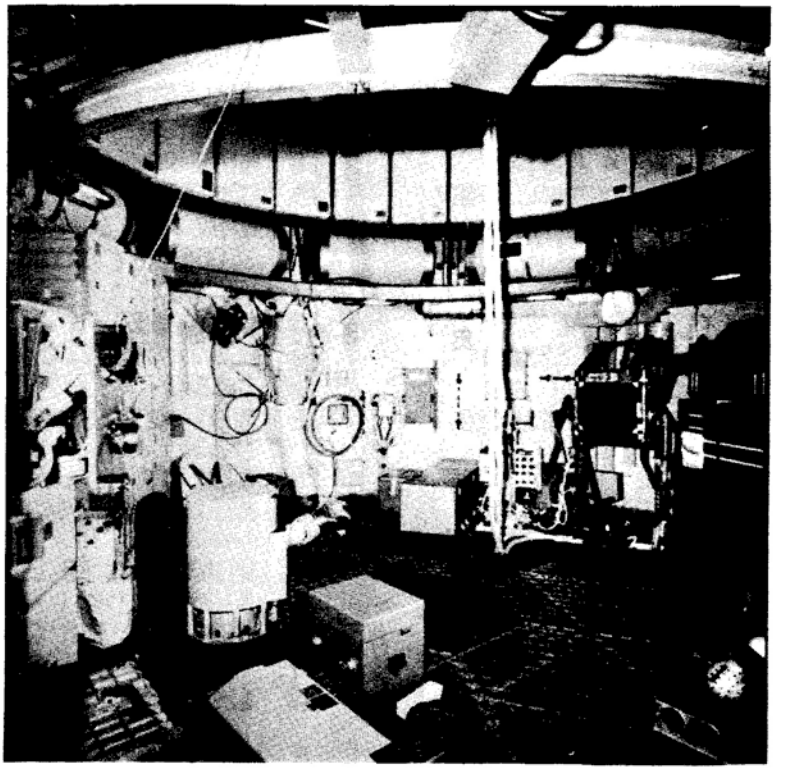
1 SPEAKER INTERCOM ASSY
2 WINDOW HEATER CONTROL PANEL
3 DEPLOYED CSM/MDA INTERCHANGE DUCT
4 FORWARD LIGHT
5 AIR DIFFUSER 1
6 S190A MULTISPECTRAL CAMERAS
7 M479 FLAMMABILITY SPECIMEN CONT (M122)
8 M512 MATERIALS PROCESSING FACILITY
9 MDA AREA FAN 1
10 M512 CONTROL PANEL
11 M555 CRYSTAL SAMPLE CONT (M132)
12 S082B FILM CANISTER, FWD
13 MDA AREA FAN 2
14 VS TREE (M170)
15 S082A FILM CANISTER, AFT
16 AIR DIFFUSER 2
17 UTILITY OUTLET 4
18 HIGH POWER ACCESSORY OUTLET 2
19 CONTAINER M168
20 S192 MULTISPECTRAL SCANNER
21 SECONDARY OXYGEN PACK (M165)
22 VC TREE
23 CONTAINER M152
24 M554 COMPOSITE CASTING CONT (M134)
25 M551 METALS MELTING ACCESSORIES (M136)
26 UTILITY OUTLET 2
27 M552 EXOTHERMIC BRAZING CONT (M120)
28 WINDOW COVER LATCH
29 S190 WINDOW
30 WINDOW COVER CRANK
31 INSTALLED S190 WINDOW PROTECTOR
32 EREP VIEWFINDER TRACKER

MULTIPLE DOCKING ADAPTER

-Y INTERNAL CONFIGURATION

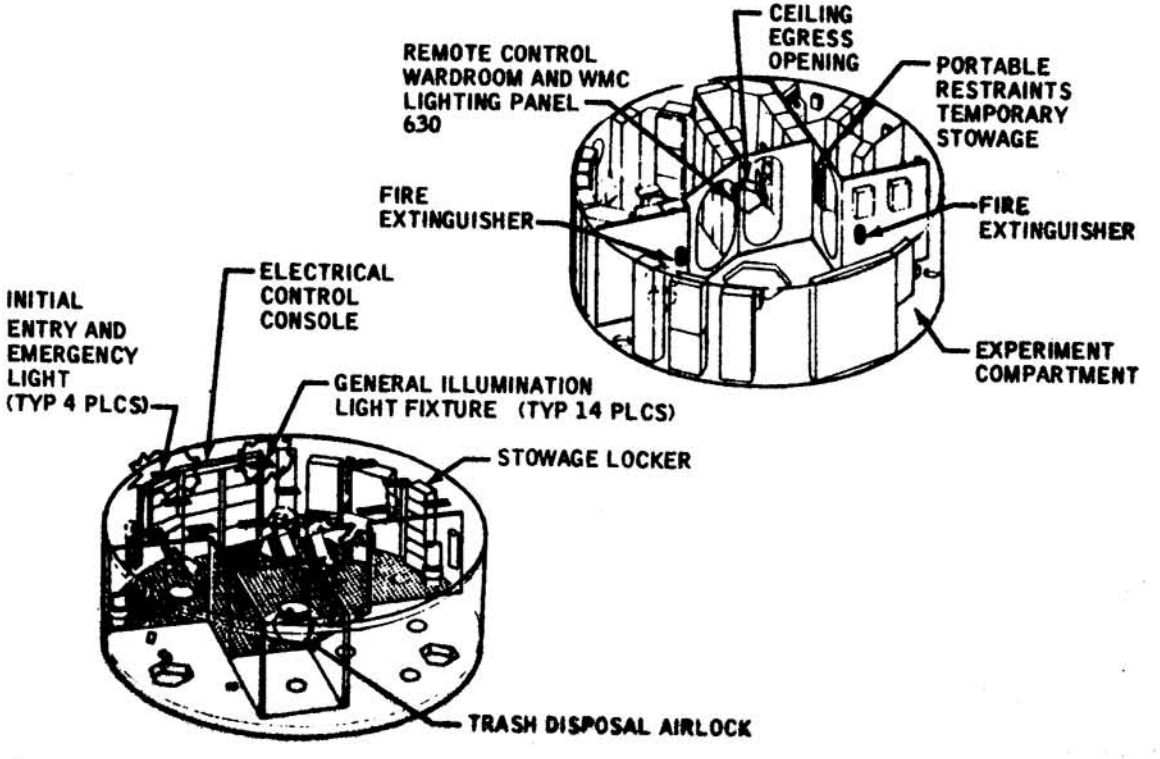
FIGURE 4





FORWARD COMPARTMENT

FIGURE 5



EXPERIMENT COMPARTMENT

FIGURE 6

Wardroom

The wardroom was located adjacent to the experiment compartment and served as the crew's dining area, off-duty leisure area, and as a location for certain experiments.

Figure 7 shows the interior arrangement of the wardroom. The food table was located near the entrance of the wardroom and the walls were lined with storage lockers.

The wardroom had a 198 cm (78 in.) ceiling height and a floor area of approximately 7.3 square meters (78.3 square feet). This gave a volume of 14.5 cubic meters (508 cubic feet).

Waste Management Compartment

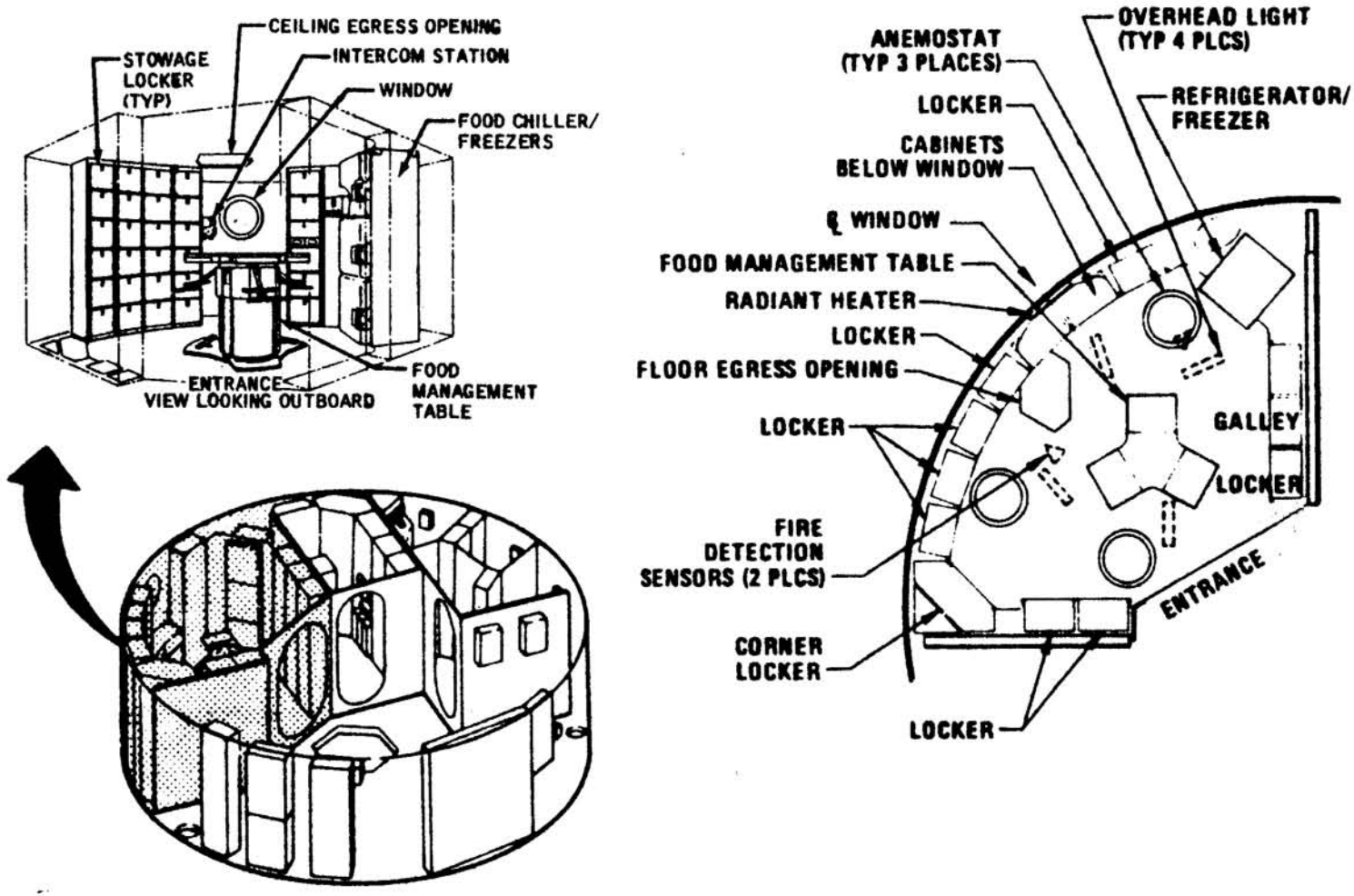
The Waste Management Compartment (WMC) contained the personal hygiene equipment and the supplies and supporting equipment necessary for body waste management on the Skylab.

The volume was totally enclosed with aluminum sheet to isolate the odors and any spills that may have occurred. The door was a telephone booth type which permitted privacy for the crewman.

Figure 8 shows the WMC layout. The room had nearly 3 square meters (32 square feet) of floor area and a 198 cm (78 in.) ceiling height for a total volume of 6 cubic meters (207 cubic feet).

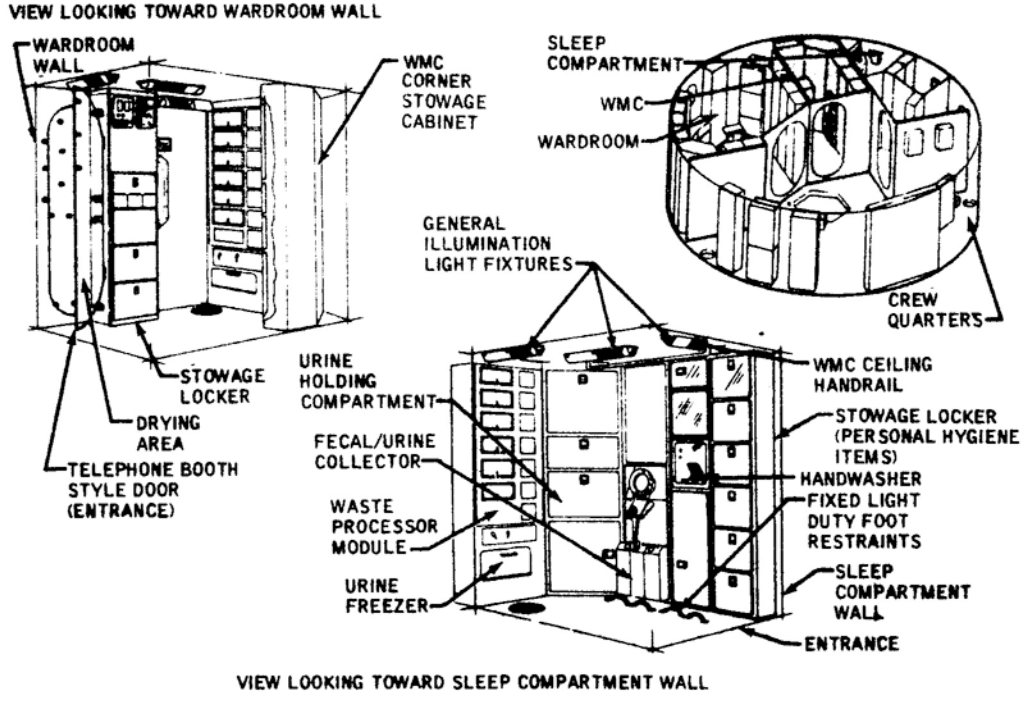
SKYLAB EXPERIENCE

The inflight air-to-ground and onboard recorded crew comments, the postflight debriefings, and numerous film clips and still photos have been studied and analyzed to ascertain how well the interior architecture of the Skylab permitted the crews to perform their functions. The results of these analyses are presented in the following paragraphs.



WARDROOM COMPARTMENT

FIGURE 7



WASTE MANAGEMENT COMPARTMENT

FIGURE 8

Compartment Arrangement

In general, the crews were quite well satisfied with the interior arrangement of the OWS. There was some concern with the airlock separating the living and work areas from the reentry spacecraft; it was felt that for future space stations the living/sleeping facilities should be closer to the reentry spacecraft.

One of the general complaints concerning the OWS concerned the electrical power system arrangement. Many of the crewmen voiced a need for more high power outlets located in the areas where they were to be used. Apparently, many power cables or extension cords were strung about the spacecraft and were somewhat confusing, a big nuisance to move from one point to another, and cluttered the interior volume of the spacecraft in some areas.

The following appendix pages contain the pertinent general arrangement comments:

A-9	A-24
A-10	A-25
	A-26

Multiple Docking Adapter - Some controversy is apparent in the crew's comments concerning the MDA. Some of the crewmen felt that arranging the equipment on the walls was an efficient use of the volume. However, some problems were readily apparent.

The arrangement of the equipment was considered "hodge-podge" by most of the crewmen. It appeared to be just "stuck in" and created problems in finding equipment and stowage locations.

Orientation of oneself was difficult to arrive at and maintain unless the crewmen entered the area with the same body orientation all of the time.

A different entry orientation created a completely different volume orientation for the crewman and would cause him to have to expend some time locating himself.

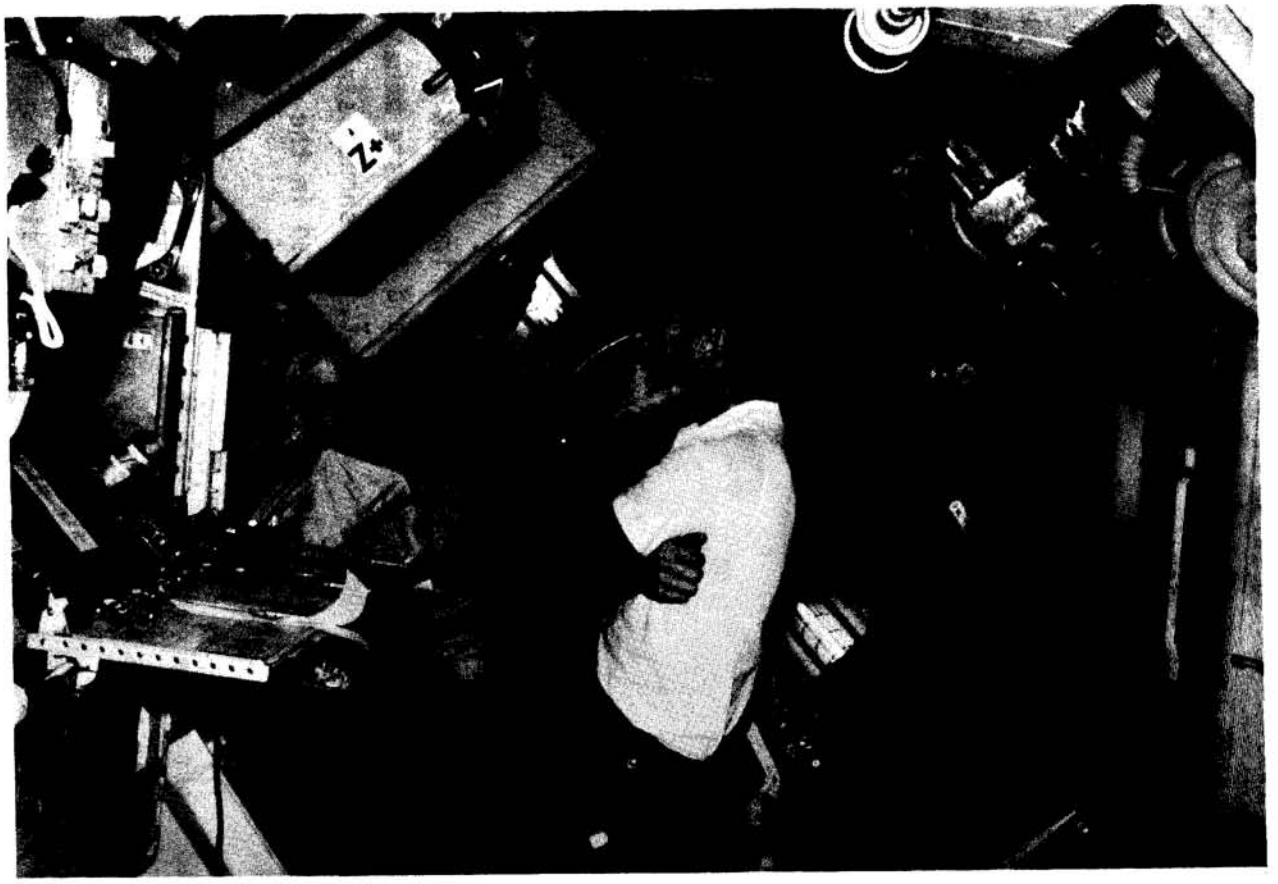
The "hodge-podge" arrangement also created some traffic problems. When one or two crewmen were working in the MDA, it was quite difficult for the third crewman to get through the volume. Figure 9 shows one crewman at the ATM panel and gives an indication of the lack of volume for moving past his work station.

Also, inadvertent bumping of equipment by the crewmen while translating through the MDA was quite common and somewhat hazardous to the equipment. This type of layout, which placed a major control panel in a frequently used traffic path, should be avoided in future designs.

Another problem with the arrangement was the lack of foot restraints. Two work locations had their own built-in foot restraints, but other locations were lacking foot restraints.

The following appendix reference pages contain the pertinent comments concerning the MDA:

A-1	A-29
A-3	A-33
A-5	A-35
A-7	A-38
A-16	A-39
A-20	A-45
A-21	A-46
A-22	A-48
A-23	A-52
A-24	A-59
A-28	A-61



MULTIPLE DOCKING ADAPTER

FIGURE 9

Forward Compartment - Generally, the crewmen felt that the forward compartment was adequately arranged for the experiments that had to be performed there. It was a large open volume, but some of the experiments required that. It also tended to serve as something of a gymnasium, providing a sufficiently large open volume to permit extensive personal experiments with body motion in zero-g.

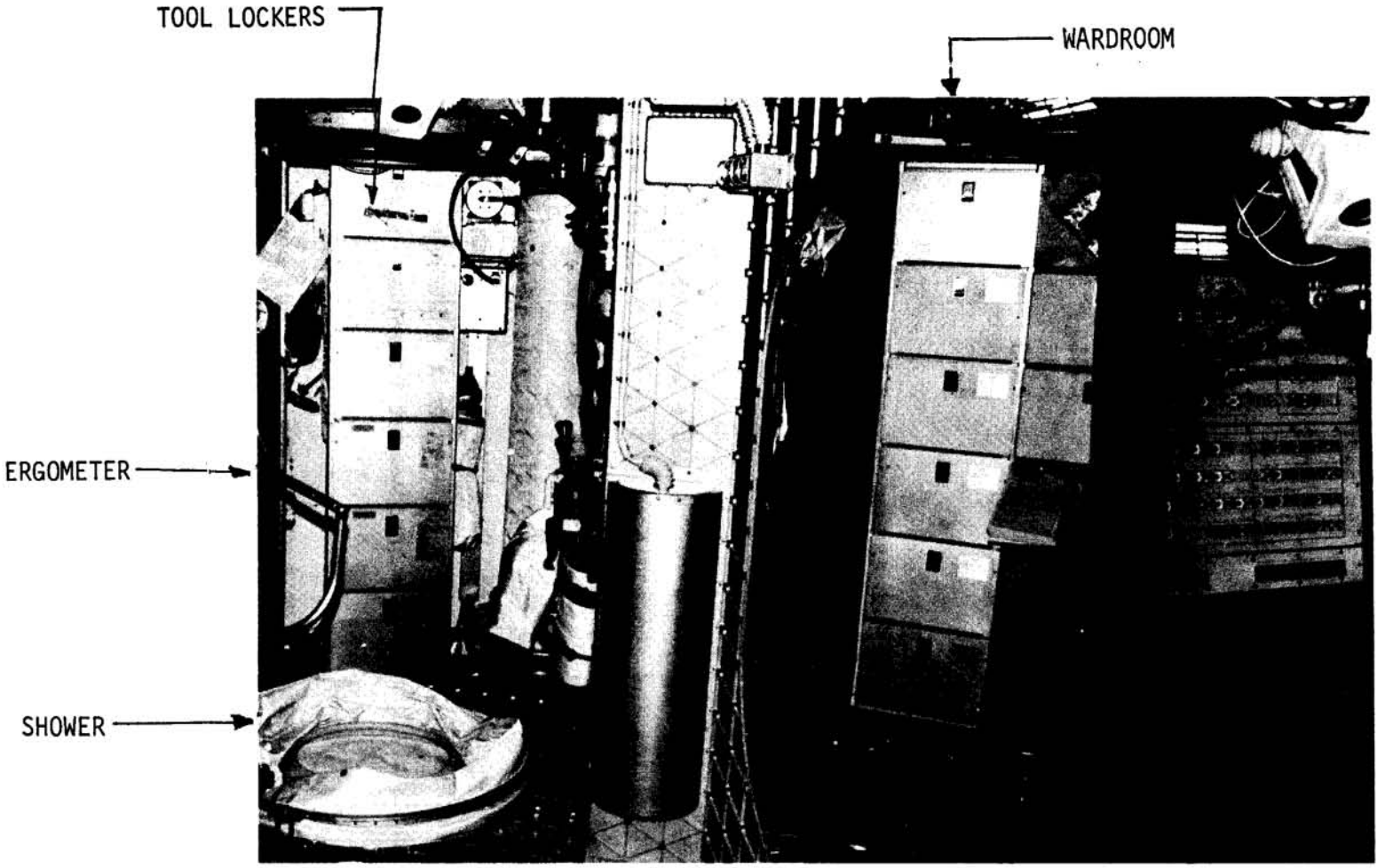
Several of the cremen felt that the walls of the forward compartment could have been better utilized. They felt that experiments could have been mounted on the walls to provide a more efficient use of the total volume. They also felt that had foot restraints been provided on the walls, more effective work could have been accomplished there.

The following appendix reference pages contain the relevant crew comments concerning the forward dome area:

A-3	A-15
A-4	A-19
A-5	A-33
A-7	A-35
A-14	A-48

Experiment Compartment - The experiment compartment was the 198 cm (78 in.) ceiling height volume on the crew quarters/experiment deck of the workshop excluding the sleep stations, wardroom, and the waste management station. Much of the medical experiment equipment, the shower stall, and some of the physical exercise equipment were located in the experiment compartment.

The crewmen moved about quite easily within the experiment compartment. The few adverse comments made by the crewmen concerned the crowded conditions that insued when the shower was added as an afterthought. This created a clutter in a corner that was frequently used since the tool kits were located in the same area. Figure 10 shows a portion of this corner. The tool stowage was in the bottom lockers of the bank on the



CORNER OF EXPERIMENT COMPARTMENT

FIGURE 10

left in the photograph. The shower and the ergometer handles can be seen in front of the tool lockers. The partition between the experiment compartment and the wardroom is located in the center of the picture, and the tight corner created is evident.

The following appendix references contain the pertinent experiment compartment comments:

A-2
A-3
A-4
A-6
A-13
A-14
A-18
A-31
A-34
A-35
A-36
A-37

Wardroom - In general, the Skylab crewmen liked the wardroom and felt that it was in a good centralized location. The window, especially, was highly appreciated.

The major crew interference problem was commented on by all the crewmen. The SPT's eating station at the wardroom table was extremely inconvenient to the food preparation and stowage area and to the trash stowage location. The SPT had to "crawl over the others to get to his food."

Part of the problem was due to the operational mode of having each crewman prepare his own meals and clean up after himself. However, since this mode of operation will probably be used on the Shuttle, care should be taken with the Shuttle mid-deck arrangement to prevent such inconveniences.

The following appendix references contain the pertinent wardroom comments:

A-2
A-4
A-5
A-6
A-8
A-9
A-10
A-11
A-12
A-16
A-17
A-18
A-31
A-34
A-36
A-49
A-50
A-75
A-87

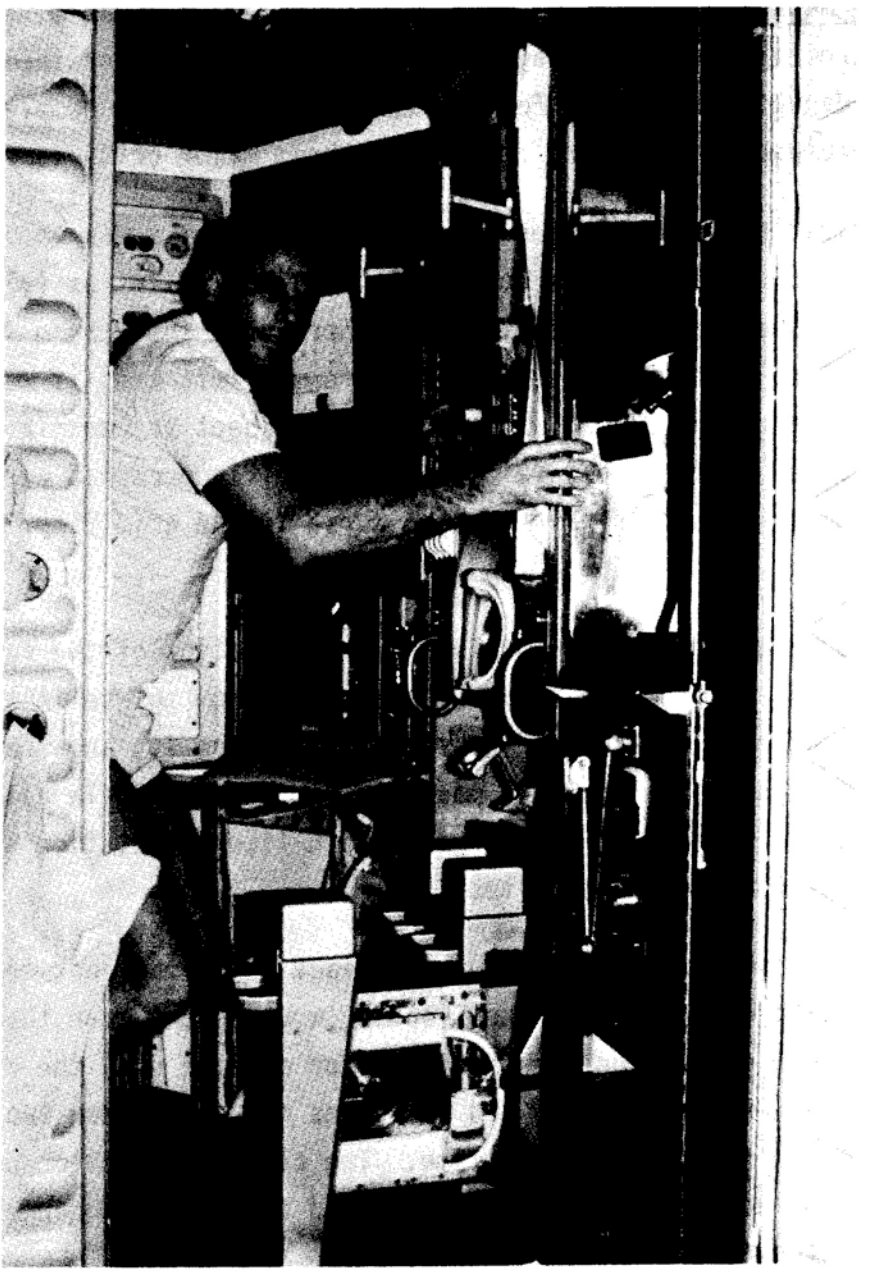
Waste Management Compartment - The Skylab crewmen had mixed emotions concerning the waste management compartment. Most of them felt that it was adequately arranged for one-man use and had few complaints about the equipment. However, there were three major criticisms.

The first and probably most significant criticism was the lack of restraints. This has been covered in previous bulletins (#7, #9, and #10) and will not be gone into in detail here, but the reason for the lack of restraints should be covered. The crewmen felt that it was a mistake to cover the triangle grid with an aluminum sheet to contain anticipated spills and odors. They felt that what spills occurred were easily cleaned up and would have been no worse if the grid floor had been left uncovered.

Some of the crewmen did not like the orientation of the fecal collector on the wall. It was not easy for some of them to use in that position; it forced them to look at the floor when using it; and the lighting was inadequate and in the wrong position for reading while using the fecal collector. They felt that a more earth-like orientation would have alleviated all of these situations.

The third general criticism was the lack of privacy between the waste collection equipment and the cleaning equipment. Even though the waste management compartment was designed for one-man use, the crew's time was scheduled extremely tight and occasions did arise when two crewmen needed to use the head at the same time. The close interaction between the waste collection equipment location and the washup equipment location was distasteful at these times.

Figure 11 shows the fecal collector on the wall and the proximity between the waste collection equipment and the personal hygiene equipment.



WASTE MANAGEMENT COMPARTMENT

FIGURE 11

The following appendix references contain the pertinent crew comments concerning the waste management compartment:

A-4	A-30
A-12	A-32
A-13	A-34
A-18	A-36
A-27	A-43
	A-44

Compartment Orientation

Skylab provided a unique set of circumstances to help determine what differences, if any, occur between a "one-g orientation" and a "zero-g orientation." The interior volume was quite large and permitted the crewmen to move about it and assume functional positions at work stations in any fashion they desired. Since two distinct design orientations were included, it was easy to differentiate between the ease and crew acceptability of operating in a one-g oriented area as opposed to a zero-g oriented area.

MDA - The MDA was Skylab's zero-g oriented area. It was a cylindrical volume that had the various experiments with their associated lighting and restraint systems and stowage units mounted in various locations around the walls in unspecific orientations with respect to each other.

The crewmen's reactions to the MDA's zero-g orientation were mixed. Some of them were vociferous in disliking the lack of a "visual gravity vector," while others thought that it was good. Those that liked it thought that it was a more efficient use of volume than a one-g orientation could have presented. Those that disliked it felt that it was too confusing to orient themselves and that it was difficult to establish traffic patterns through the area without bumping equipment and each other.

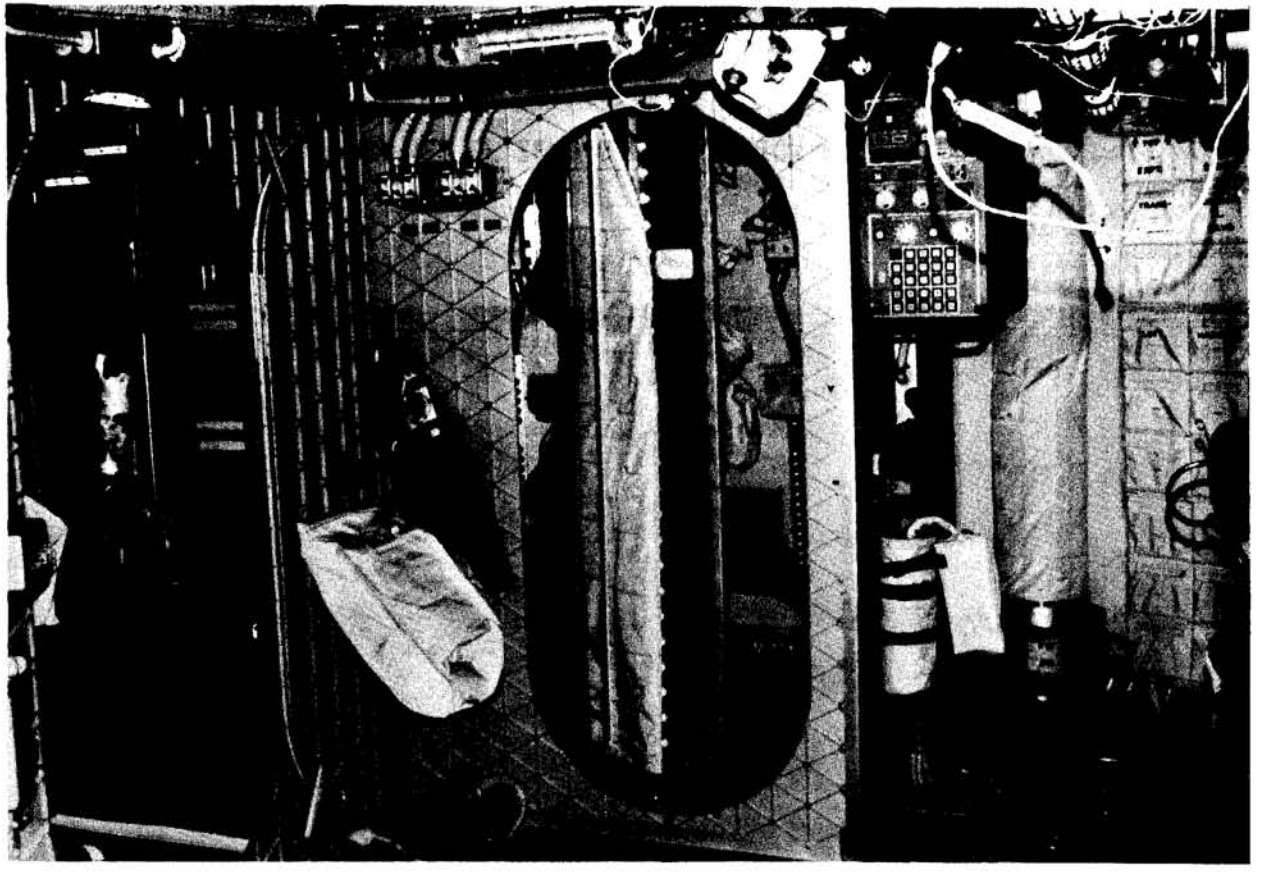
All of the crewmen, even those that liked the MDA, agreed that the rather hodge-podge equipment orientation was confusing and created difficulty in finding the various stowage lockers or equipment locations. It was felt that a more efficient orientation could have alleviated this situation.

OWS - The entire OWS was laid out in a one-g orientation, with some of the individual compartments being more definite in their adherence to this scheme than others.

The lower deck was a 198 cm (78 in.) ceiling height volume with foot restraints and equipment mounted on the floor and lighting mounted on the ceiling. It had a standard one-g orientation for all of the experiments, and the hatches and doorways were configured to be entered by the crewmen in a vertical position. Figure 12 shows the doors on the lower deck. This orientation was quite satisfactory to the crewmen. They had little difficulty in finding locations within the volume. They were able to move through it in an upright orientation with respect to the equipment, which enabled them to arrive at their destination properly oriented to attach themselves to the foot restraints and readily perform their necessary tasks. The one-g orientation permitted much easier training on the ground also, and had a positive transfer of training effect once the crewmen reached orbit. No such positive transfer effect was noted for the zero-g oriented MDA.

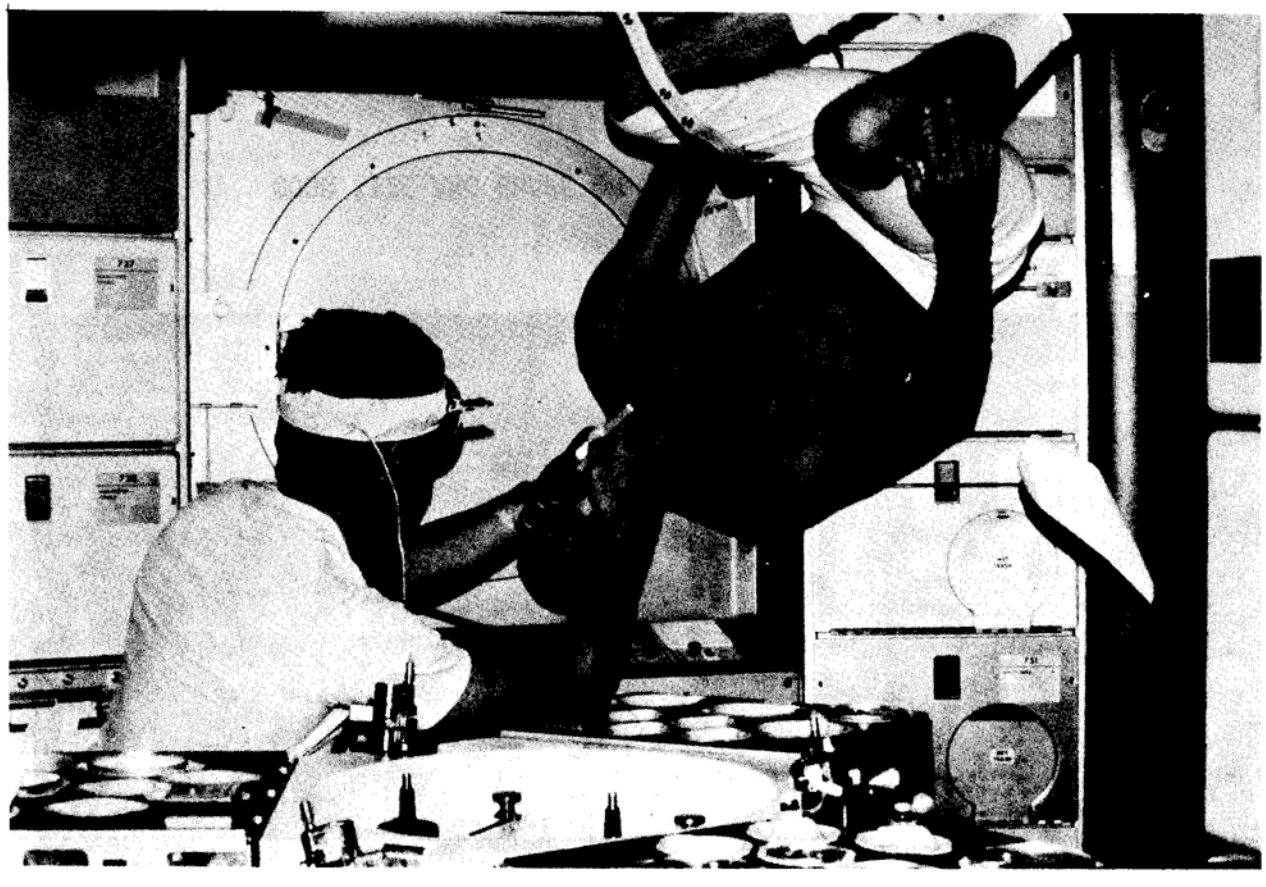
General Observations - The crewmen determined that an IVA coordinate system in space operations was established with the man himself as the determinate. Basically, where his feet were was down and the rest of the environment was perceived accordingly. The individual orientation was strictly visual, with the other body proprioceptors not receiving impulses. When doing a task or translating through the spacecraft, the crewman established a local orientation based on himself and proceeded without difficulty. Figure 13 shows an interesting use of orientation in zero-g to facilitate a task.

The crewmen were generally agreed that a specific "one-g orientation" or "zero-g orientation" arrangement was not significant as a design goal. The most efficient use of volume, considering equipment usage and traffic patterns, should be the prime consideration rather than a specific orientation scheme.



DOOR SIZE AND SHAPE ON OWS LOWER DECK

FIGURE 12



CREW USE OF ZERO-G ORIENTATION FREEDOM

FIGURE 13

All of the necessary equipment, restraints, lighting, etc. to accomplish any given task should be arranged to a local orientation or local vertical to aid in accomplishing that task. However, this one particular task needs no specific orientation with respect to any other task, if traffic patterns and use volume are properly considered in the overall arrangement.

To summarize the IVA orientation comments, it can be said that a one-g volume orientation is preferable to a poorly arranged zero-g volume orientation. The one-g orientation is easier to train in, is more familiar to the user, and tends to be less confusing. An individual task must have all of the necessary supporting equipment such as restraints, lighting, etc. arranged to a local vertical with respect only to itself. However, that particular task need not be oriented in any specific way to any other work station in the area, since the crewman creates his local orientation visually.

The following references taken from the Skylab Man-Machine Data Master Catalog File contain the pertinent comments concerning the IVA orientation:

A-7
A-20
A-21
A-22
A-23
A-28
A-29
A-51
A-52
A-53
A-54
A-55
A-56
A-57
A-58
A-59
A-60
A-61
A-62
A-63
A-64
A-65
A-66
A-67
A-68
A-69
A-70
A-71
A-72
A-73
A-74
A-104
A-105
A-106
A-107
A-108
A-109
A-110
A-111
A-112
A-113
A-114
A-115

Compartment Volume

The Skylab crewmen had few adverse comments concerning the actual volume of any of the various compartments within Skylab except for the airlock, which has been covered in a previous Skylab Experience Bulletin.

The few adverse comments about the wardroom and the waste management compartment were more concerned with the arrangement of the equipment and the traffic paths than the actual volume itself.

Only one comment concerning the floor-to-ceiling proximity was noted and that pertained to the sleep compartment. Again, the sleep compartment has been covered in another Skylab Experience Bulletin.

It seems obvious that the various compartments aboard Skylab had sufficient volume to permit the crewmen to accomplish their assigned tasks.

The following appendix pages contain comments pertinent to the spacecraft volume:

A-12	A-83
A-76	A-84
A-77	A-85
A-78	A-86
A-79	A-87
A-80	A-89
A-81	A-90
A-82	A-91

Passageways and Traffic Paths

Some of the traffic path problems were covered in Skylab Experience Bulletin No. 1. The problems of inadvertent switch operation, bumping equipment, and the crewmen bumping themselves were thoroughly discussed. This section will address the traffic path bottlenecks and more specific traffic path problems.

One of the traffic problems was in the wardroom. As has already been discussed in the section on compartment arrangement, one of the crewmen (the SPT) couldn't reach the food preparation area without "climbing over either the CDR or the PLT." This was commented on by every Skylab crew. In addition to the food bottleneck, one of the crewmen commented that it was difficult to get into the wardroom if the SPT and CDR were positioned at the wardroom table.

The MDA was pointed out as being something of a traffic problem area. If two crewmen were working at experiments in the MDA, the third crewman had difficulty in getting past them. Figure 9 shows one man working at the ATM panel and indicates the proximity of the walls behind him.

The OWS lower deck had only one area that caused some traffic problems. The corner in which the shower was located also held the tool kit stowage lockers, and the bicycle ergometer was nearby. Thus, on occasion, two or more crewmen would be working in the area (particularly on the bicycle) and the third would need to get to the tools. Apparently, it was quite crowded for this kind of activity.

The Waste Management Compartment was considered something of a bottleneck. If one man was using the washing equipment, a second man had difficulty in getting past to use the waste management equipment. There were times when two men needed to use the WMC simultaneously.

One good design feature commented on by the crewmen was the large "ship-type" doorways on the OWS lower deck. Since the crewmen translated about this deck primarily in an erect position, the large doorways enabled them to enter and leave the various compartments quite readily. Round hatches would have been much less satisfactory.

In general, there were few bottlenecks or inconveniences in the IVA traffic patterns onboard the Skylab. The four areas discussed here were the main

problems and, in retrospect, were not extremely bad. However, in future spacecraft, such negative features as the Skylab wardroom food retrieval situation should be avoided.

The following appendix pages contain crew comments concerning the traffic patterns:

A-1	A-20	A-49
A-2	A-29	A-88
A-4	A-34	A-98
A-5	A-35	A-99
A-8	A-36	A-100
A-10	A-43	A-101
A-11	A-44	A-102
A-17	A-48	A-103
		A-139

Stowage

Equipment and expendable item stowage on Skylab brought forth many comments by the crewmen; some favorable and some critical.

The sleep station stowage was commented on. The crewmen felt that they needed a more adequate space for personal stowage. What was wanted was a storage location for the small items that were removed from their pockets at night.

Along with the lack of personal stowage was the lack of a place to retain clothing at night. The crewmen needed a place to secure the clothing they removed when retiring. Sticking them behind a comm box was a common practice but doesn't seem quite adequate as a standard operational procedure.

One general stowage complaint was that of complexity. Some of the crewmen felt that they had far too many items that were stowed within a beta cloth bag which was either stowed within another bag or placed in a stowage locker. This appeared to be unnecessary and took additional time to unpack or repack.

One general stowage item brought out by one of the crewmen was the need for "soft" stowage. He described it as a stowage location that would accept irregularly shaped items that had not been considered in the initial stowage planning.

The crewmen also found the locker numbering system and the labeling system were somewhat confusing and misleading. The MDA lockers were particularly bad in this respect.

The following appendix pages contain general comments relative to the stowage:

A-28	A-164
A-147	A-166
A-148	A-167
A-149	A-169
A-153	A-170
A-154	A-185
	A-189

Stowage Location - There was sufficient stowage volume in Skylab to handle the necessary items, however, the crewmen commented that it would have made their on-orbit operations much easier if all of a similar item had been stowed in one location. Three specific items were mentioned as causing a problem.

The trash bags were apparently stowed in at least four locations. Thus, when the bags in the most used location were used up, the crewmen had to either transfer some from elsewhere, or go to one of the other locations to obtain them. This apparently caused a certain amount of wasted effort and loss of time during the day-to-day operations. It certainly complicated the stowage lists and inventory procedures.

The food stowage also created problems. Food was stowed in the wardroom and in the forward compartment. Then, as the wardroom supplies were used, it was transferred from the forward compartment to the wardroom. This

again required valuable time to accomplish, created inventory and menu problems and complicated the stowage lists. The crewmen commented that "clothes and towels were stowed in the wardroom instead of food."

A third area of concern was the tools. The crewmen felt that the tools were scattered into too many drawers in too many locations to be easily used. They were also jammed tightly into the mosite inserts which, in some cases, didn't hold them well. Had the tools been in one location, the crewmen felt that it would have been much easier to remember where they were and to locate the desired tool. Since translation from one point to another was quite easy, it would have been no problem to go to one centralized location to obtain the desired tools.

The following appendix pages address the problems of scattered stowage locations:

A-38	A-152
A-145	A-153
A-146	A-160
A-148	A-163
A-151	A-171

Stowage Locker Doors and Latches - The crewmen had many comments concerning some of the locker doors and the latches that held them shut. The doors to the film vault in the forward compartment were apparently the worst offenders.

The film vault had two heavy doors (for film protection) that hinged at the center of the vault. To pull out the stowage drawers behind the door, each door had to be opened 180 degrees. Thus, only one side of the film vault could be used at a time. Moving equipment or film from one side to the other was an extremely frustrating and time consuming procedure. The crews further did not like the butterfly clamp fastener on the door. It was not always easily operated with one hand and would sometimes flop into the closed position when the door was open.

Other comments were made concerning doors. Apparently the doors in some of the MDA stowage units were difficult to open. Also, the crewmen commented that the springs were too weak on the wipe and tissue container doors and the trash storage doors.

Some of the fasteners and door latches were not liked by the majority of the crewmen. One of the more controversial was the calfax fastener. One of the earlier crewmen liked the calfax fastener very well when it could be aligned in its holes properly. However, toward the end of the third mission, some of the calfax fasteners were beginning to break. Another problem commented on by many of the crewmen was that the hole alignment was critical. On those installations where the hole alignment was not perfect, the calfax fasteners were frustrating to work with. The majority consensus was that the calfax fasteners were not very good for use in spacecraft.

Another fastener that was disliked by all of the crewmen was the dial latch. It was difficult and frustrating to operate and considered too fragile to last.

Two kinds of latches were mentioned by the crewmen as being satisfactory and easy to operate. One was on a big locker in the MDA. It "just had two big pieces of metal that closed over each other, and you ran a pip pin through them. Super simple."

The other was the magnetic latch. These were used on some EVA doors and apparently worked very well. The crewmen commented that if they didn't cause problems with the electronics, magnetic latches would be very good.

One final comment on doors was mentioned by several of the crewmen. Apparently, those doors that had friction in the hinges were well liked. The friction held the doors in whatever position the crewmen left them and, at times, eliminated the need for latches. It was felt that such a a feature would be good to use on future spacecraft locker doors.

The following appendix pages contain comments relative to the doors and fasteners:

A-116	A-127	A-138
A-117	A-128	A-143
A-118	A-129	A-156
A-119	A-130	A-158
A-120	A-131	A-162
A-121	A-132	A-163
A-122	A-133	A-192
A-123	A-134	A-193
A-124	A-135	A-196
A-125	A-136	A-199
A-126	A-137	A-200

Stowage Locker Drawers - The preceding section addressed the locker door and fastener problems. This section is concerned with the stowage drawers.

The crewmen had a number of problems with the drawers and equipment stored within them. These problems appear to be caused by the equipment retention devices, or the lack of retention devices.

Some of the retention devices caused problems by being too tight or too loose. The mosite inserts for the tools didn't do too well. Some of the smaller tools didn't hold well in their insert.

At least one of the retention devices was too complicated. The crews indicated that the leg bands for the M092 experiment were inconvenient, hard to stow, and got tangled easily.

Some of the retention devices failed. One crew comment indicated that the teflon cassette inserts in drawer B of the film vault were coming out and sliding to the back of the drawer.

Most of the drawer problems were caused by a lack of retention devices. One of the storage lockers in the sleep station was utilized by the crewmen as a personal stowage drawer. They commented that the locker needed retention devices--that the "stuff just floats around in there."

One of the most complained about drawers was the camera stowage drawer in the film vault. The cameras were unrestrained in the drawer and "banged around a lot." Another part of the same problem was that occasionally an item stowed in the drawer would float up and jam against the drawer above. This would prevent the drawer from opening and cause a frustrating delay in utilizing some item from that drawer.

Even when the drawer was easily opened, it was a problem. The unrestrained items had to be caught before they floated away. The crewmen indicated that, if nothing else, a cover for these types of drawers would alleviate some of the problems.

The following appendix pages contain crew comments concerning the stowage locker drawers:

A-127
A-128
A-140
A-141
A-142
A-143
A-144
A-147
A-148
A-150
A-155
A-157
A-158
A-159
A-160
A-165
A-167
A-168
A-169
A-184

Temporary Stowage - One major area of accessible stowage concern was the lack of stowage or restraint for the hand held cameras at the wardroom window. Since the regular stowage location at the film vault was too far for quick access to the cameras, the crewmen devised tie straps, etc. around the window to keep the cameras handy for use.

An additional temporary restraint item that the crewmen recommended was the use of bungee cords on all stowage locker doors. This would provide needed temporary restraint for items being retrieved from stowage and permit the crewman to keep his hands free for use.

The lack of temporary stowage provisions at nearly all locations in the spacecraft caused problems for all the crews. It was quite time consuming to have to search out a place to stow items temporarily while doing a task.

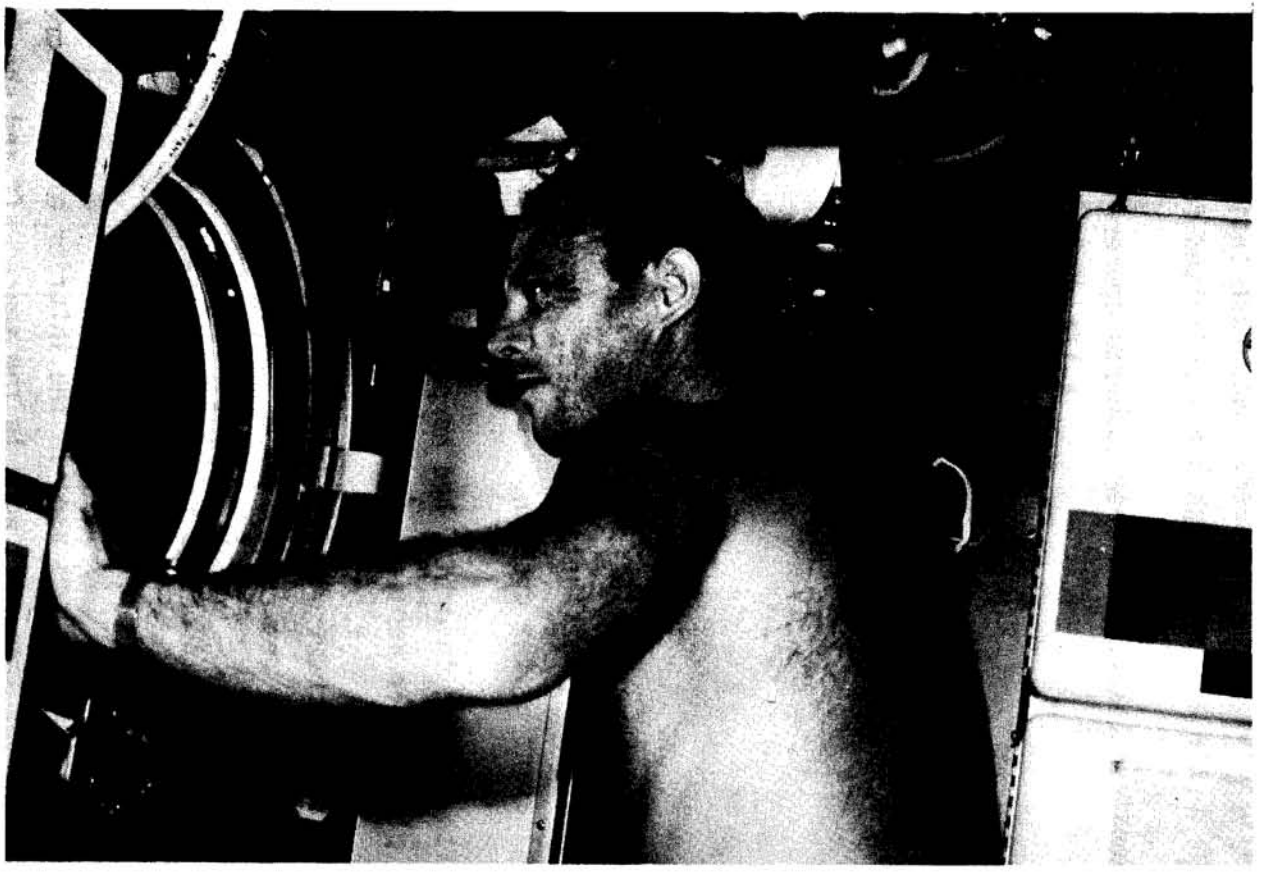
The following appendix pages have crew comments pertaining to temporary stowage:

A-40
A-41
A-42
A-43
A-145
A-146
A-151
A-152
A-161
A-166
A-184
A-185
A-186
A-187
A-188
A-189
A-190

Windows

The Skylab crewmen were unanimous in their praise for the windows. Not only were the windows used a great deal for photography and experiments, they were the prime off-duty activity for the crewmen. Their comments ranged from, "The wardroom window is outstanding. Its size is very good." to "...I think we do need more windows in the spacecraft. I think they need to be larger or at least domed out..." Figure 14 shows a crewman using the wardroom window.

However, there were some problems--the main one was the viewing angle around the window. In order to recognize the earth terrain beneath them, the crewmen would have to orient themselves properly with respect to that terrain. Thus, they were in such positions as stretched out along the ceiling of the wardroom looking out of the window or cramped up at the side trying to achieve the proper orientation, as well as fastened in the foot restraints in the standard position to see out. Their comments indicated that the window should have a sufficiently clear area around it to permit any body position for viewing.



WARDROOM WINDOW USE

FIGURE 14

Some minor problems also occurred. The wardroom window fogged up between the panes of glass occasionally and the shutters on the STS windows were difficult to crank open or shut. However, these were insignificant problems in comparison to the extremely high praise elicited for the windows.

The following appendix pages contain crew comments concerning the windows:

A-21
A-45
A-46
A-47
A-69
A-87
A-88
A-172
A-173
A-174
A-175
A-176
A-177
A-178
A-179
A-180
A-181
A-182
A-183

Color

The colors used in Skylab were selected primarily for their safety qualifications rather than for any aesthetic qualities. However, they were not considered unpleasant by the crewmen.

The first crew, with 28 days in orbit, had no particular feelings about the color, either pleasant or unpleasant.

At least one of the second crew, with 56 days in orbit, indicated that the color scheme was not too desirable.

The third crew, with 84 days in orbit, got tired of the color scheme and wished for more variations.

Thus it would appear that the colors used in the interior of a spacecraft should be pleasant to those that will work in the spacecraft and should have enough variation to prevent them from becoming boring. However, the length of time spent on orbit appears to be one of the determining factors in whether or not the color scheme becomes noticeable.

The following appendix pages contain the crew comments concerning the spacecraft color scheme:

A-92	A-95
A-93	A-96
A-94	A-97

Standardization

The crewmen were asked whether or not standardization of various items such as latches and fasteners would be advisable. Their answers present a rather potent answer as to why such standardization would be beneficial to a future spacecraft. They were usually quick to point out that a major research and design effort to develop the ultimate item--whether it be a fastener, an electrical connector, or a bungee cord--was not necessary. However, an effort to reduce the numbers of kinds of "widgets" doing the same task would be quite worth while.

As an example, there were several different types of door latches and stowage locker latches utilized on Skylab. Some of these worked very well, some functioned fairly well, and some were extremely disliked by all of the crewmen. It appears obvious that a careful selection of one type of latch could alleviate many of the problems described in one of the previous sections.

Standardization as much as possible of the small, every day fastening devices, even nuts and bolts, could reduce the different tools required for maintenance, reduce the maintenance training requirements, and reduce some of the operational frustrations encountered by the Skylab crewmen.

The following appendix pages contain pertinent crew comments concerning standardization:

A-118
A-122
A-123
A-128
A-133
A-134
A-191
A-192
A-193
A-194
A-195
A-196
A-197
A-198
A-199
A-200
A-201
A-202
A-203

CONCLUSIONS AND RECOMMENDATIONS

1. The Skylab crews had few complaints about the arrangement of the various compartments aboard their spacecraft. They would have liked power outlets in more usable locations to reduce the clutter of extension cords, but this has been covered in detail in Experience Bulletin No. 15.

2. Orientation of equipment within a given volume was somewhat controversial. Some of the crewmen thought that mounting the equipment on the walls, as exemplified by the MDA, was an efficient use of volume. However, most of them felt that arrangement to be rather hodge-podge and felt that it was difficult to orient themselves to a particular item when entering such an area. Entering the MDA in a different orientation on different occasions insured that they would have to spend a short time orienting themselves with the equipment. This could be critical in an emergency situation.

3. One of the more prevalent complaints was that of men and/or equipment encroaching into the traffic paths. One example was the wardroom. The SPT on all three crews had difficulty in getting to the food stowage area if the two other crewmen were seated at the wardroom table. Another good example was the MDA. If one or more crewmen were working at the work stations, the third crewman had difficulty in getting past them. The layout of future spacecraft should take into account crew traffic patterns and insure that major obstacles and bottlenecks are not imposed by design features.

4. The large doorways between compartments on the OWS lower deck were a good feature. They permitted the crewmen to remain in a vertical body position when moving between compartments, thus maintaining their orientation with the local surrounding hardware. This feature

seems worth retaining in future designs, especially if they are one-g oriented.

5. The stowage on Skylab was adequate for the missions but had some problems. One of the major problems was that of scattered stowage of like items.

   The food was stowed in the wardroom and in the forward compartment. As the food was used in the wardroom, it was replaced from the forward compartment stowage. This procedure took time that might have been better utilized on experiments. It also complicated the inventory keeping procedures.

   Similar problems were encountered with the trash bag stowage in that approximately four stowage locations for these items were utilized. This again caused time-consuming delays in obtaining trash bags. As one stowage location emptied, the crewmen would have to remember where others were and go to a different location. It became quite frustrating on the longer missions.

   The tool stowage also was discussed as being separated too much. It would have been more convenient to have all of the tools in one location and packaged to be more readily identifiable as to where all the tools of one type were stowed.

   Consolidation of like items in future vehicles will save crew time and ease inventory control.

6. Another area of frustration for the crewmen was the labeling and numbering of the stowage lockers. The lettering on the labels was usually too small to be easily read, particularly from a distance, and the locker numbering system was somewhat confusing to the crewmen.

It was difficult to learn the system. A simpler numbering system should be considered for lockers in future spacecraft and the labels should be large and easily read.

7. One of the minor but frustrating stowage problems occurred in the sleep station. The crewmen had inadequate stowage for "pocket items." Those small items that were accumulated during the day's operations were insignificant in themselves, but a number of them created a frustrating problem of stowage. In the same vein, inadequate overnight retention of clothing removed at bedtime was a problem. These problems should be considered in the design of sleep stations in future spacecraft.

8. Some of the stowage locker doors and latches were not well received by the crewmen. The film vault door was apparently an offender. It was unhandy and inconvenient to handle, particularly when transferring items from one side to the other. Of the various latches and fasteners in the spacecraft, the dial latches were unanimously disliked by the crewmen and the calfax fasteners were a close second. Both were unnecessarily complex to work with and the calfax had an added disadvantage in that it required perfect hole alignment to be usable at all.

   The crewmen felt that the few magnetic latches on some of the EVA doors were preferable to any of the other latches on the spacecraft. They also felt that friction in the door hinges would facilitate their functioning by holding the door in any location that the crewmen placed it.

   Future spacecraft can benefit operationally by considering magnetic door latches (where the EMI would not be a factor) and insuring that the doors have a small amount of friction in the hinges.

9. One of the frustrating problems that the crewmen had was the lack of retention devices in some of the stowage drawers. When items were newly placed in drawers, without being restrained, they would, on occasion, float up and jam the drawer above. Also, the bumping of items against each other as the drawers were operated was hard on the equipment. A further problem was that of all the items in a drawer floating out when the drawer was opened. This tended to be a time wasting complication that should be avoided. Those drawers that did have item restraints caused no problems and protected the equipment well. Future spacecraft stowage design should seriously consider these results and design simple item restraints in all stowage drawers.

10. Another stowage problem was that of temporary stowage of items. The crewmen felt the need for something similar to bungee cords located on each locker door to provide them with a place to restrain items while getting additional items from the lockers. Such temporary equipment stowage restraints were necessary at many locations around the Skylab. The crewmen had some extra bungee cords, but could have used many more. This subject was treated in some detail in Skylab Experience Bulletin No. 12.

11. Another problem arose from the "zero-g" orientation. Each work station required its own set of foot restraints. This was not a problem on the "earth-like" orientation of the OWS lower deck with its grid floor available throughout the area.

    Aside from the two areas mentions, conclusion 2 and this one, the orientation of equipment for orbital operations was insignificant. The crewmen had no difficulty in performing their tasks utilizing whatever position was most helpful to them. This can be reflected in future designs by simply being sure that each specific work station is self oriented with respect to its own support equipment, but not necessarily with respect to any other work station.

12. The windows were enthusiastically acclaimed by the crewmen for off-duty activity. Not only were they good for experimental photography, but they were also good for just viewing. The crewmen commented that they needed enough free space around the windows to be able to look out at any orientation to the passing scene on earth below. Applying these results will call for more attention to be given to numbers of windows and access to them in future spacecraft. Insuring that sufficient different window locations are available to always provide a view of the earth is also an important consideration.

13. The interior color of the spacecraft, the various equipment, and the crew's clothing were quite similar in hue and could tend to get boring. However, the first two crews had no adverse comments concerning the color. The third crew, with a longer period of time in orbit, all commented that the color was indeed boring and that they would have liked more variation. Future applications of this information should probably cue the color variety to two things: acceptable coatings (safety-wise) and anticipated time in orbit

14. One of the specific questions asked of the crewmen considered the desireability of standardization of various operational items such as door latches, fasteners, and electrical connectors. The consensus of the crewmen was the standardization of these mundane items was indeed desireable to simplify operational and maintenance procedures and to reduce the number and types of tools required for those procedures. The standardization need not be complex, in fact, the crewmen indicated that "off-the-shelf" type hardware should be considered. It would appear that standardizing much of mundane hardware such as door latches, electrical connections, nuts and bolts, and such items would be a worthwhile effort on future spacecraft.

Raw Data Appendix

All of the data pages are taken from the Skylab Man-Machine Data Master Catalog File. The data source is shown at each reference.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-II
FOR: A. ARCHITECTURE
1. Compartment Arrangement

MISSION DAY: 11 DAY OF YEAR: 155 (CONTINUED)
MISSION TIME: 22:26:45 GMT

NOTE: M487-2A

CDR: equipment on and off the EREP cameras that you need to work on remaining affixed to it in some manner not necessarily the same orientation; you have to move around on it. But it turns out to be an excellent thing. As far as the other things and all that, I'll let the other guys make comments on it.

MISSION TIME: 22:29:17 GMT

NOTE: M487-2A

SPT: My comments on the MDA as a whole are that it's a - it's an - it's an efficient way to arrange equipment, but the size of the MDA, which is very good for hanging onto things, is not too good for traffic. If two people are working there, sometimes the third guy can't get by.

MISSION TIME: 22:35:53 GMT

NOTE: M487-2A

CDR: Yes, let's talk about those things. The triangle wedge is ... lock yourself in, except it looks like you could lock yourself almost anywhere and that's not true at all. ... locked in something like that. ... ergometer to shower. ... airlock you try it. Yes.

PLT: If you wear the foot restraint instead of the triangles there are ...

MISSION TIME: 22:36:46 GMT

NOTE: M487-2A

PLT: The triangle is a good idea. It's just that you need something to stick your feet in.

(CONTINUED ON NEXT PAGE)

SKYLAB MAN-MACHINE DATA FROM MISSION SL-II
FOR: A. ARCHITECTURE
1. Compartment Arrangement

MISSION DAY: 11 DAY OF YEAR: 155 (CONTINUED)
MISSION TIME: 22:36:46 GMT

NOTE: M487-2A

PLT: 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. ... the shower and it'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 - that anybody's had. We've been into that many times since activation for a lot of different reasons.

MISSION TIME: 22:45:54 GMT

NOTE: M487-2A

SPT: Following that layout I think - I think it's a bad idea to have the head right next to the sleeping compartment, especially with the layout we have, with the urine separators and the blower in the common bulkhead between the two. If somebody gets up at night and has to go to the bathroom, and you turn on the separator and the blower, and it's - you tend to wake up people that are sleeping.

*****

MISSION DAY: 15 DAY OF YEAR: 159
MISSION TIME: 21:14:41 GMT

NOTE: M487-3B Wardroom Compartment

CDR: The general arrangement and the orientation of the compartment are basically very good.

MISSION TIME: 21:18:32 GMT

NOTE: M487-3B Waste Management Compartment

CDR: The waste management compartment is very good. General arrangements and orientation of the
(CONTINUED ON NEXT PAGE)

SKYLAB MAN-MACHINE DATA FROM MISSION SL-II
FOR: A. ARCHITECTURE
1. Compartment Arrangement

MISSION DAY: 15 DAY OF YEAR: 159 (CONTINUED)
MISSION TIME: 21:18:32 GMT

NOTE: M487-3B Waste Management Compartment

CDR: compartment are fairly good, and the location of the compartment next to the sleep compartment is not good because the blower runs and you can hear in the sleep compartments and so forth. So, it is just the location.

NOTE: M487-3B Sleep Compartment

CDR: I find my sleep compartment quite adequate.

NOTE: M487-3B Experiment Compartment

CDR: Experiment compartment ... arrangement and - of the experiment compartment is fine. We're a little crowded over the area where the shower is, because the shower is an afterthought to us. If the shower wasn't there, I think everything would be just fine.

NOTE: M487-3B Forward/Dome Compartment

CDR: Forward experiments and ... compartment, the general arrangement, orientation of the compartment are fine. ... made out of a tank, I'm sure ... better - the - we certainly use ... and do an M509 ... and things like that, but it is a great place to move around in.

NOTE: M487-3B Airlock Compartment

CDR: The general arrangement is adequate.

NOTE: M487-3B MDA/STS Compartment

CDR: The MDA and the STS. The general arrangement and orientation of the compartment I think could be a little bit better. Again ... around the cylinder, probably not the greatest orientation in the whole world, but it really had led us into too many serious problems. ... the compartment is certainly adequate.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-II
FOR: A. ARCHITECTURE
1. Compartment Arrangement

MISSION DAY: 15 DAY OF YEAR: 159 (CONTINUED)
MISSION TIME: 21:33:41 GMT

NOTE: M487-3B Wardroom Compartment

SPT: The wardroom: general arrangement is pretty good. I have some nit picks, being the SPT, that I do not have a handy place to put food trash - with a switch of my side of the vehicle - of the room. What we're doing is hanging a disposal bag on the stanch, between my seat and the door. Which serves and also serves for the food and shower bag and whatever else is around. There is - there do tend to be some bottlenecks in the food area in both obtaining one's food and disposing of cans. However, I think it was a good job for the amount of room involved.

NOTE: M487-3B Waste Management Compartment

SPT: Waste management compartment turns out to be a pretty good size and pretty well arranged.

NOTE: M487-3B Sleep Compartment

SPT: The sleep compartment arrangement and orientation are okay.

NOTE: M487-3B Experiment Compartment

SPT: Experiment compartment general arrangement and orientation is okay, except that, at the two corners where things get awfully crowded between the shower, the centrifuge, and the tool kits, our temporary stowage for the vacuum cleaner and stowage is crowded in that corner. In the other corner, it's not quite so bad, but M131 pretty well sweeps that area clear, and makes ... for stowage of other gear. Aside from that, we did well.

NOTE: M487-3B Forward/Dome Compartment

SPT: Forward dome panel arrangement and orientation is okay. Just figuring is one way you can put more

(CONTINUED ON NEXT PAGE)

SKYLAB MAN-MACHINE DATA FROM MISSION SL-II
FOR: A. ARCHITECTURE
1. Compartment Arrangement

MISSION DAY: 15 DAY OF YEAR: 159 (CONTINUED)
MISSION TIME: 21:33:41 GMT

NOTE: M487-3B Forward/Dome Compartment

SPT: things around the wall with a little triangle here and there, a few handholds beside them and you don't have to worry about the up/down arrangements. We may actually have underutilized the walls of that compartment a little bit. This is for future reference.

NOTE: M487-3B Airlock Compartment

SPT: The airlock is a fine tunnel. And for a tunnel and an airlock, its size and dimensions are pretty good because when you're EVA with the hatch open you always have something to bear against and I wouldn't want it a whole lot bigger. A little longer, maybe, because we always have trouble getting things in.

NOTE: M487-3B MDA/STS Compartment

SPT: In the MDA/STS, general arrangement is reasonably good except for a couple of things. The M200 circuit breaker panels have always been a pain in the neck and in zero-g, they continue to be a pain in the neck, orientation at right angles to everything else. And on down. The bottleneck of the MDA is the STS, where the control and display panels are. It's not compatible to have a guy working there and a guy working in the ATM. And the guy at the STS blocks the hatch.

MISSION TIME: 23:47:56 GMT

NOTE: M487-3B Wardroom Compartment

PLT: General arrangement and orientation is -- was adequate, I guess. That is, it's adequate from an arrangement standpoint. It's good for an orientation, it's in a good place. It's centrally located - that's kind of the area down there. The arrangement is too close - the eating table is too close to the

(CONTINUED ON NEXT PAGE)

SKYLAB MAN-MACHINE DATA FROM MISSION SL-II
FOR: A. ARCHITECTURE
1. Compartment Arrangement

MISSION DAY: 15 DAY OF YEAR: 159 (CONTINUED)
MISSION TIME: 23:47:56 GMT

NOTE: M487-3B Wardroom Compartment

PLT: wall. It's handy to be close when you're trying to reach into food drawers and such, but the SPT can't eat two food drawers directly anyway. If you hang getting trash bags on the walk, which is a requirement, then they get in the way. Other than that it's pretty good, it just needs to be a little bigger and I guess that's the point. Which is the next one. I'm confused, let me think about it. Oh, on arrangement thing, I'd say that the eating table is pushed too far back to the refrigerator and the replan down there.

NOTE: M487-3B Waste Management Compartment

PLT: The waste management compartment in general arrangement and orientation I think is generally - is good. I take that back, it's very good.

NOTE: M487-3B Sleep Compartment

PLT: Sleep compartment general arrangement and orientation. I guess I'm unique compared to my two compatriots in that I was not able to sleep well on a wall. Apparently, I have personal mental problem, I guess, but I've not slept in there since about the fourth night. We moved in the workshop, I slept in the forward workshop compartment.

NOTE: M487-3B Experiment Compartment

PLT: Experiment compartment. General arrangement it's a - let me think on this a minute. Somebody think they'd do better - someone else would do better - I think, evaluating when you're not used to it. We've been training in this thing for a year and a half, some things you come to accept. I guess I got no comments to make, no suggestions, so I'd have to give that a very good then.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-II
FOR: A. ARCHITECTURE
1. Compartment Arrangement

MISSION DAY: 15 DAY OF YEAR: 159 (CONTINUED)
MISSION TIME: 23:47:56 GMT

NOTE: M487-3B Forward/Dome Compartment

PLT: And the forward and dome areas, I don't know what you really - what were you really should be answering a general arrangement and orientation; it's all one-g vertical. Which is the way you are used to in general arrangement. It's all right. The compartments of which you have to work is very good that we put that the film vault on the grid floor because the work at the film vault drawers are heavy, you pull those drawers in and out, they work hard, they're difficult to move. All I'm doing is pointing out the fact that you have to have a place to stabilize your feet and we usually have the triangular shoes and that means we use the grid.

NOTE: M487-3B Airlock Compartment

PLT: The airlock is kind of nothing but a patsy ... We haven't used that as a working compartment except for EVA. So general arrangement orientation, we have ... good.

NOTE: M487-3B MDA/STS Compartment

PLT: Now, on the MDA, STS. General aids and orientation. Again it's a cylinder it's things are just a little stuck against the wall. Orientation is all right, I've come to learn to accept it during training. General arrangement is kind of helpless guilt and hodgepodge. I have not constructive comments to make I'd appreciate all your stuff put in here kind of helps. It's not good, you come in here and things are - you have trouble finding things in here, you come in zero-g and I think complete that MDA orientation on the ATM.

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-II
FOR: A. ARCHITECTURE
1. Compartment Arrangement

TECHNICAL CREW DEBRIEFING
14.0 In-Flight Experiments
14.1 Medical Experiments

KERWIN: I guess we ought to mention that in the future the wardroom should be so arranged that an individual's food stowage is convenient to his seat and place in the wardroom rather than everybody having to climb over each other in order to get to one locker.

18.0 Flight Equipment
18.2 SWS

CONRAD: The flight equipment in the crew compartment configuration. The beds worked great. Everybody had enough room for their gear. There was enough Velcro around. We would set the duty timer up for the alarm clock, and I'd Velcro mine at the dosimeter place. It would stick right on there. I know you had a lot of gear laid out in your room. Everybody fixed up their sleep compartment the way they wanted them. We had adequate places to hold the clothes.

*****

SWS SYSTEMS DEBRIEFING
PAGE 99

SPEAKER: Were controls and wipes accessible in the seated position? Everything all right? Anything you'd like to see on the future design, you know, could be in a better place?

CDR: No, you could reach all that stuff while you were on the seat and that was fine.

PAGE 113

SPEAKER: You, earlier on in the, when we were talking about trash bags you said that you had moved some of the small bags around some way.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
1. Compartment Arrangement

MISSION DAY: 13 DAY OF YEAR: 221
MISSION TIME: (222)02:07:19 GMT

NOTE: M487-2A

PLT: I think there are, uh, some other things that are well designed in the spacecraft. I think the general, uh, wardroom, uh, eating arrangement, uh, the way that the food is reconstituted, and so forth, and the table in the center works very well, and the water gun works good. I have no complaint about the way the food gets heated, the tray. I think that's good. And the layout of the pantry is also good. And it's a super idea to have the freezer in the pantry there because the frozen food is kind of the highlight of the day. I think another great design is the, uh, uh, the waste management system. It's, uh, essentially a no mess operation. And, uh, the only thing that takes a little time - It takes 30 seconds to have a bowel movement and about 10 to 15 more minutes to log all the data and, uh, snap the, uh, new bag in place. So that, uh, installation of the new bag could be designed in a more efficient manner. One of the systems that does bug me on the spacecraft is the video tape recorder. Any time you want to video tape something you have to go and turn on the recorder that, uh, you have to go and turn on the recorder which is way up in the MDA. So that, uh, when you've got various scenes that you want to take down in the workshop, you've got to work from clear up in the MDA to get them on the tape. And when you want to turn them off, you've got to go back up there and turn them off. There ought to be a switch down here somewhere where you can - down in the wardroom area where you could, uh turn the video tape recorder off.

MISSION TIME: (222)02:40:56 GMT

NOTE: M487-2A

CDR: Okay, we got too many jacks, power cables and TV power cables strung around the workshop. We got - and we got to have - we got to have those things

(CONTINUED ON NEXT PAGE)

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
1. Compartment Arrangement

MISSION DAY: 13 DAY OF YEAR: 221 (CONTINUED)
MISSION TIME: (222)02:40:56 GMT

NOTE: M487-2A

CDR: built into the wiring some place so that they could reflect directly in the way they reflected other appliances and things. ... the wire around it ... want to do that or a tape recorder or a TV camera or a blower. Looking around the worshop ... 6 foot, 12 foot cable ... after the workshop had already been configured ... There was no way to think of everything and you want flexibility, so need to make sure the cords themselves have some sort of adhering quality.

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MISSION DAY: 15 DAY OF YEAR: 223
MISSION TIME: 23:41:29 GMT

NOTE: M487-3A

PLT: Uh, one thing I mentioned the other night and it bugs me, is that ... the whole spacecraft's clear up there and when you want to do a ..., why, uh, you got to go clear up there to turn the switch on and off, and you waste time and tape by doing that. Making a lot of trips between the experiment compartment and APR just to get the rascal going. It would be nice to have a switch down here for that purpose.

*****

MISSION DAY: 21 DAY OF YEAR: 229
MISSION TIME: 19:53:53 GMT

NOTE: M487-3B Wardroom Compartment

SPT: Wardroom. The general arrangement is fair. It would be more convenient if the food trays were where each of the three people could get 'em. The SPT had to crawl over the other two every time he gets ... to

(CONTINUED ON NEXT PAGE)

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
1. Compartment Arrangement

MISSION DAY: 21 DAY OF YEAR: 229 (CONTINUED)
MISSION TIME: 19:53:53 GMT

NOTE: M487-3B Wardroom Compartment

SPT: prepare a meal. Also, there's no convenient place to store out menus where they can be seen. No convenient place to store out silverware, although they're within reach. That little plastic holder with the vile snapover is not a good arrangement for silverware.

MISSION TIME: 22:04:36 GMT

NOTE: M487-3B Wardroom Compartment

CDR: Under wardroom, general arrangement and orientation of compartment; I think it's good. Uh - I think the fact that we've got the wardroom on the minus Z, where we can have the best window in the place. And the minus Z, in the solar inertial air - spacecraft, uh, during the daylight hours, looks down at the Earth, it's one of the wiser things to do. Now, we do need, uh, a bigger window. That window's marginal in size, and should be much larger. Of course, there should be several more windows of equal size, throughout the spacecraft. Operating inside this little can just doesn't quite hack it. We have the - uh, the ability now to, uh, camp a little more weight, and we, I think one the things to put them in, is - is - is very safe windows, and uh, we can use them in uh, not only good experiments, we got T002 out there, a lot of handheld photography, but just uh, to relax these things. Uh, some of those things about the orientation of the room, it needs a desk in it. Wardroom seems to be the place where uh, we get all the paper and dispense it. Right now we've got a little clipboard on the wall and we plant our feet in the floor, but need some sort of permanent desk with some spare clip things that would allow you to - do your paper work. A lot of it comes up in a space station, and uh, you need a permanent place to file things, to hold things, and to sit and

(CONTINUED ON NEXT PAGE)

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
1. Compartment Arrangement

MISSION DAY: 21 DAY OF YEAR: 229 (CONTINUED)
MISSION TIME: 22:04:36 GMT

NOTE: M487-3B Wardroom Compartment

CDR: correct items, scotch tape dispensers built in, things of that nature. Food compartment's okay. It could be a little bit easier, I don't think it gets the food hot - the food trays get the food quite hot enough. And the restraints are a little bit more flexible than they need to be. I'd like to be able to go in there and hook on to something, and it just stay. The water gun idea, one for each person is good, the water gun tip can be improved, I think you could knock your teeth out, if you're not careful. It takes a few days to be very careful about it, but the main thing is, the individual water guns were - if you measured water taking a drink, you don't have to worry about what other people are doing are okay. It's a little bit small for getting to the refrigerator. Waste disposal now, is fairly easy with the change in the doors so that everybody's got a trash bag. Do - do - ability - The way your knife, fork and food is stored, the fact that all the spices are all over in one place, the pills are over in one place, all that's a little bit difficult.

MISSION TIME: 22:13:59 GMT

NOTE: M487-3B Waste Management Compartment

CDR: Let's take the waste management compartment. General arrangement orientation, poor, too small. The reason it's too small is, only one person can really operate in there at once. Also, there's no privacy, if a guy wants to shave, and the other guy wants to urinate, you can do it, but - but it would have been much nicer if we'd have somehow closed off the waste area, from the washing uh, clean up mirror shaving area, wouldn't - wouldn't have been difficult at all, we could have had a shag lining door, or something. But that's - I think that's a critical thing. Nobody likes to have it all hanging out while the next guy

(CONTINUED ON NEXT PAGE)

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
1. Compartment Arrangement

MISSION DAY: 21 DAY OF YEAR: 229 (CONTINUED)
MISSION TIME: 22:13:59 GMT

NOTE: M487-3B Waste Management Compartment

CDR: is shaving, as a result when people go in there, they close the door, and then that keeps you from going in just to even get a towel, or maybe you just want to go in there to see if something - what's in your eye. So I give that volume a poor and general arrangement and orientation is poor.

MISSION TIME: 22:18:34 GMT

NOTE: M487-3B Sleep Compartment

CDR: Sleep compartment, general arrangement, it's okay. Needs to be much more soundproof, it's very light-proof. Needs to have a door on it that when you close it's soundproof and gives real privacy. Needs to have an area to hang your clothes. You use a lot of clothes in this business, you use clothes for when it's cold in the MDA, when it's hot here, you got your gym clothes for exercise, and you got your sleep clothes. About the only way you could put them where they could dry out and get some air, is kind of out blowing in the breeze on those little uh, re - those little rubber restraints, which are great. And that's bad, it'd be nice if you had a - something like a closet that you could open the doors, put - hang those things in there and the breeze would blow through and keep them dry and cool, yet they wouldn't be out blowing in the breeze. Uh, I think that's about it.

MISSION TIME: 22:21:32 GMT

NOTE: M487-3B Experiment Compartment

CDR: Experiment compartment crowded, could be better, needs more lighting. Just a little crowded, I think you could do the things in there, that we want to do, but you really don't have a lot of extra room, if one

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
1. Compartment Arrangement

MISSION DAY: 21 DAY OF YEAR: 229 (CONTINUED)
MISSION TIME: 22:21:32 GMT

NOTE: M487-3B Experiment Compartment

CDR: person's riding the bike, and the other fellow is monitoring near the equipment that's so monitored has to be careful he doesn't get kicked as he pedals the bike. It just needs to be larger to do the sorts of work we're doing. I guess I'd have to say it's adequate but that's about it. General arrangement's good, best - best you could do, I think, with this.

MISSION TIME: 22:24:02 GMT

NOTE: M487-3B Forward/Dome Compartment

CDR: Experiments are random, all over the place. It sure'd be nice if we could have them stashed in some sort of order in an experiment wall or cabinet, like you'd have in a lab in school. You wouldn't just have things stashed all over it, then you could have the floor free to do the experiment. It'd be nice if this area and the other areas were all one in the same. With everything stowed somewhere on the wall, except the things that had to be permanently mounted, like the ergometer or the LBNP, and then that's notched by the floor space. And then when you needed something, you could go get it. One of the problems we have is, the numbering system is logical as it could be, but there's just so many different places, cabinets on all sides of the room in different places. There was somebody ... on the floor, for example, I'm looking right now at a cabinet S190B Earth terrain camera, stowage region called F-573 on one wall is 552, on the other wall it's 524, so if somebody should go to 524, he don't know whether to look on the floor, look on the wall, and it becomes just a real experiment. Things ought to be more essentially located with a numbering system that immediately tells you where things are. This would probably do it - probably all the 70's are on the floor, or something like that. No it isn't because

(CONTINUED ON NEXT PAGE)

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
1. Compartment Arrangement

MISSION DAY: 21 DAY OF YEAR: 229 (CONTINUED)
MISSION TIME: 22:24:02 GMT

NOTE: M487-3B Forward/Dome Compartment

CDR: here's one on the floor called 594, but probably all over - In any event, it's important that we do something about volume; got plenty of volume. If you're gonna do things like evaluate the maneuvering, you're gonna need more. One of the funny designs we got here is, and we live in one end and our so called safety hatch is at the other end, the command module. That isn't the way it ought to be. The experiment compartment ought to be the farthest from the come home module. Sleep compartment ought to be next to it, and everything 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.

MISSION TIME: 22:27:11 GMT

NOTE: M487-3B Airlock Compartment

CDR: 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 and secure yourself by the seat, 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 and tricks or what you have to do. As it is, two of you get in there and float around, bang into one another. One guy flats 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 you can restrain something, being protected where you won't get bumped,

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
1. Compartment Arrangement

MISSION DAY: 21 DAY OF YEAR: 229 (CONTINUED)
MISSION TIME: 22:27:11 GMT

NOTE: M487-3B Airlock Compartment

CDR: where you'll be nice and stable, and you can get to all the items you need to get to without floating to them.

MISSION TIME: 22:29:45 GMT

NOTE: M487-3B MDA/STS Compartment

CDR: It's much better to have rooms like down in the workshop where you got a floor and you got cabinets, uh 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. 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 the thing of the future. But right now my feeling would be that you want to stick to something that you could think of a similar nature in the same place. Puts all the stowage in one 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 gotta 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.

*****

MISSION DAY: 22 DAY OF YEAR: 230
MISSION TIME: 16:26:05 GMT

NOTE: M487-3B Wardroom Compartment

SPT: Now on to guide number 2, having to do with the parameters of the wardroom. I mentioned just briefly all
(CONTINUED ON NEXT PAGE)

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
1. Compartment Arrangement

MISSION DAY: 22 DAY OF YEAR: 230 (CONTINUED)
MISSION TIME: 16:26:05 GMT

NOTE: M487-3B Wardroom Compartment

SPT: sorts of ... again today. Now SPT's stuff is over there between the PLT and CDR. He has to transfer across them or around them to or something every time he gets his food out. It would be a lot simpler if he had the place where he eats. Uh, of course you all need one place to dispose of it, and there's no way to get around that.

MISSION TIME: 16:27:59 GMT

NOTE: M487-3B Experiment Compartment

SPT: Experiment compartment rates with pretty good.

MISSION TIME: 16:28:04 GMT

NOTE: M487-3B Forward/Dome Compartment

SPT: Forward area dome - it's obviously not arranged for anything in particular. It's just a big volume. If you're gonna do flyaround exercises, why you need that volume. If you were going to do experiments or something like that, for the most part, why it's very inefficiently arranged. There's no reason to have that big volume. It's fun from the standpoint of acrobatics. It allows you a little room to do tumbling, flips, rolls, and dives and so forth, but it's not functional from the standpoint of making good use of the volume.

MISSION TIME: 16:28:32 GMT

NOTE: M487-3B Airlock Compartment

SPT: The airlock is arranged satisfactorily - no complaints.

*****

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
1. Compartment Arrangement

MISSION DAY: 24 DAY OF YEAR: 232
MISSION TIME: 14:48:59 GMT

NOTE: M487-3B Wardroom Compartment

PLT: General arrangement and orientation of the compartment. Starting with the wardroom. I like the wardroom fairly well, except for - I don't like the pantry area. I notice that every time Owen wants to get his shower he has to stumble over Al or myself to get to it, cause it's directly across the table. His food should have been stowed over where he could reach it. Would have been much more handy for everybody.

MISSION TIME: 14:49:25 GMT

NOTE: M487-3B Waste Management Compartment

PLT: The waste management compartment - uh - general arrangement seems to be satisfactory. The john on the wall is okay - uh - setup. The urinal drawers work well. Uh - the one that I - uh - had to pull out and the one Al pulls out, though - uh - conflict with the foot restraints. I think we discussed that before.

NOTE: M487-3B Sleep Compartment

PLT: The sleep compartments seem to be arranged satisfactory. I've got no complaints about that. I sleep well every night. And, - uh - able to keep all my gear in here with minimal difficulty.

NOTE: M487-3B Experiment Compartment

PLT: Experiment compartment arrangement seems to be okay. Uh - it's kind of crowded in between the ergometer and the - uh - and the - uh - ESS panel. A - uh - sure is a crowded area when you get the shower erected but - uh - we know that wasn't originally planned to be in there, and I think it was a good location for it - uh - uh - as an afterthought. I guess that's all I can think of on the - uh - experiment compartment.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
1. Compartment Arrangement

MISSION DAY: 24 DAY OF YEAR: 232 (CONTINUED)
MISSION TIME: 14:51:28 GMT

NOTE: M487-3B Forward/Dome Compartment

PLT: Forward doom - dome area seems - uh - generally be arranged - uh - satisfactory and adequately. Uh - I've got no major complaints about the arrangement in there. One thing about the lower are that the - uh - poor arrangement is the - uh - the fact that the - uh - the pan is right next to the sleep compartment. And - uh - it's not that fact so much as the fact that when - uh - anybody goes in there to - uh - turn on the blower and use the - uh - waste management system at night, it wakes everybody else up. And that - uh - thing makes a fair amount of noise that - uh - and - uh - tends to wake you up when somebody goes in there and uses it.

MISSION TIME: 14:52:10 GMT

NOTE: M487-3B Airlock Compartment

PLT: The - uh - airlock itself. Uh - it's arrangement is - uh - seems to be satisfactory. Uh - during the EVAs, why - uh - tend to float around in there and - uh - grab on to whatever you can grab on to. Uh, there's usually other items and articles floating around in there, too, and you seem to kick 'em and bump 'em. And they're hanging on tethers and getting wrapped up in your legs and wrapped up in one another. And - uh - so, it's - uh - it's kind of a - uh - bowl of spaghetti during EVA but - uh - we've been able to manage with it all right. But I'm sure there are some improvements that can be made to - uh - to store equipment better in airlock areas and - uh - keep it from dangling all over and provide places for people to hold on to.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
1. Compartment Arrangement

MISSION DAY: 24 DAY OF YEAR: 232 (CONTINUED)
MISSION TIME: 14:52:56 GMT

NOTE: M487-3B MDA/STS Compartment

PLT: MDA/STS area is - uh - arranged in a pretty hodge-podge fashion. It's - uh - looks more like a boiler room than a spacecraft. Next time we build something like that we ought to make it so - uh - things are ... in better and there's not so many nooks and things for stuff to get lost into, so many head knockers and sharp objects - uh - sticking out from - uh - lack of - uh - things to grab on to and to fasten yourself down to. The - uh - the only arrangement of the - uh - MDA is probably - uh - more hodgepodge than - uh - any other area in the spacecraft, in my opinion. I - uh - in - uh - going from the - uh - airlock to the command module, uh - seems like the - uh - orientation that you go through there - that I go through there anyway, always winds me up - uh - uh - ... motion ... motion directly at the - uh - little table that's on the ATM. I've always got to - uh - grab a hold of it or rotate out of the way in order to miss it. Easy to kick the ATM - uh - panel when you're going by. And - uh - so our arrangement in the MDA - uh - could have been better somehow.

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MISSION DAY: 36 DAY OF YEAR: 244
MISSION TIME: 21:21:21 GMT

NOTE: M487-2C

SPT: On question number 1, preferable floor/ceiling or open cylindrical? It is a question of how much space is available. In other words, is volume - is a problem, or - uh - you can have all the volume you want. And secondly, what's the function to be performed. As far as a place to eat is concerned, or a new experiment. For the most part, say like a medical experiment, the floor/ceiling is perfectly satisfactory. For some of the others, like the maneuvering
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SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
1. Compartment Arrangement

MISSION DAY: 36 DAY OF YEAR: 244 (CONTINUED)
MISSION TIME: 21:21:21 GMT

NOTE: M487-2C

SPT: unit, you need a larger volume. There are some of those things that are probably not in - in the correct volume. And we've mentioned one of these the other day, like the window to look outside. That's in floor to ceiling, where it would have been better the more open arrangement so that you can orient your body - uh - appropriate to the horizon or the task that you're watching would be outside the window. So, it's either - is satisfactory, and depends upon what the volume available is, and what's the function that you're trying to perform is.

MISSION TIME: (245)00:34:25 GMT

NOTE: M487-2C

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 pre-

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
1. Compartment Arrangement

MISSION DAY: 36 DAY OF YEAR: 244 (CONTINUED)
MISSION TIME: (245)00:34:25 GMT

NOTE: M487-2C

CDR: flight and post flight, 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 ...

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MISSION DAY: 37 DAY OF YEAR: 245
MISSION TIME: 22:31:21 GMT

NOTE: M487-2C

PLT: Which is preferable, the floor/ceiling orientation or the open cylindrical arrangement of the MDA/STS? How do the tasks to be performed influence your preference of orientation? The - uh - floor/ceiling arrangement of the OWS is much preferable to that of the MDA. Everything is arranged much better, and I think you are able to make more efficient use of space. You don't have all the nooks and crannies to - uh - uh - weird orientation - uh - in the workshop than you do in the MDA. One sensation I noticed when we got to the MDA is that if I don't enter in the same attitude every time that I don't know where anything is. As soon as I get 90 degrees off on my entry orientation, I have to hunt around for things. So, it's - uh - very disadvantageous from that standpoint. It's - it's not a - it's not a - uh - vertigo-type feeling or - uh - sensation such as that. It's just a matter of not knowing where the things are that you want to get to.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
1. Compartment Arrangement

MISSION DAY: 37 DAY OF YEAR: 245 (CONTINUED)
MISSION TIME: 22:32:49 GMT

NOTE: M487-2C

PLT: So if you - uh - enter the MDA from the wrong - or from an unusual attitude, either from the command module and/or from the - uh - airlock end, you have to really hunt around to find out where things are. The - uh - general layout of things in the MDA also - uh - because of it's political (?) layout has to be approved also. For example - uh - uh - the STS area is - uh - or the - uh - STS panels are a real crowded place to work in when there's a guy up there working on the ATM and - uh - when you want to get in one of those - uh - windows to look out, why it's very difficult to do that. You - uh - there are things in the way everywhere in the ATM, although there are some few things - anything to grab onto. The orientation of the MDA - uh - that style of orientation is one I'd stay away from in the future. I prefer to make it - uh - modular, as you have it in the workshop where, although there is no up or down gravity-wise, there is up and down visual-wise. And it's the way you're accustomed to working in training. Also in training, the MDA layout is a very difficult layout to train in. It has to be rolled around and you can't reach things and - uh - you have to walk all over experiments and - uh - things that shouldn't be stepped on and so forth. And training-wise, it's - uh - also much inferior to - uh - uh - the layout - the layout like the MDA is much superior to one like the workshop where everything is oriented to one gravity.

MISSION TIME: 23:36:14 GMT

NOTE: M487-2C

PLT: I think for the next Skylab crew, there isn't a heck of a lot of things that we can do to improve the habitability. Uh - habitability ... and the - uh - floor plan and the - uh - other things like noise and

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
1. Compartment Arrangement

SWS SYSTEMS DEBRIEFING
PAGE 49

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 it's just all kind of a hodgepodge, you know. I didn't like the arrangement at all. I much preferred that in the crew quarters experiment area.

PAGE 79-80

CDR: What are you going to do about all these extension cords and things in shuttle? We had extension cords all over the place for the lights and the comm. There was all sorts of cables all over there. Same thing for the cameras. And then there was remote cables for the cameras. We had more stuff strung all over that workshop. I don't know how you're going to lick that for shuttle. It's messy, but you can't predict ahead where you are going to need all these things. Have you guys given any thought to that? Same way with the space station. Only way I guess you could somehow eliminate it is to have more electrical plugs, but you still need extension cords, even with electrical plugs.

PLT: Yeah, you always got to make one long enough to reach the furthest away, so that means that the close one, you got to coil it all up, or ----- Al's right, there's a lot of spaghetti all over.

SPEAKER: What about that scheme they use, that automatic windup type.

CDR: I think that would be great. I wish we would have had those on all our cables, where it reels

(CONTINUED ON NEXT PAGE)

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
1. Compartment Arrangement

SWS SYSTEMS DEBRIEFING (CONTINUED)
PAGE 79-80

CDR: out, it's kind of stashed on the walls, it's part of the plug. You run over here, and if you want to plug your unit in, you grab the plug and I think that would have been fantastic.

SPT: The only thing about those kind of things, is they are something else to break.

CDR: You're not kidding.

SPEAKER: You get it all reeled up inside there and you then have to take it apart to use it (chuckle).

CDR: There must be something better than what we did, that's not too complicated, although I don't know what it is. Can't use sash weights, that's for sure.

SPEAKER: Did you happen to get any pictures of any typical spaghetti situation?

SPT: Must have.

PLT: I'm sure it will be apparent in any of the film.

PAGE 115

SPEAKER: Assess the utility outlet adequacy, accessibility number, and location. Were there sufficient utility outlets in the OWS?

SPT: I thought it was marginal on the number of utility outlets available. We ended up having several places we liked to put the portable tape recorder and we were always having trouble making sure, disconnecting the tape recorder, plugging in a connection to DAC or something like that. So I thought is was sort or marginal. We should have had -----

SPEAKER: That would be the low power outlet then?

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
1. Compartment Arrangement

SWS SYSTEMS DEBRIEFING (CONTINUED)
PAGE 115

SPT: Low power outlet.

SPEAKER: Down in the wardroom area?

SPT: In the experiment area.

SPEAKER: In the experiment area?

SPT: Yes.

PLT: We never used the on in the head as I remember, we never. There's four plugs down there. Never used. There aren't enough high power outlets in the MDA, because we started using them up with other pieces of equipment.

SPT: I think we could use a couple more in the experiment area and a couple more in the MDA.

SPEAKER: Like at home, never enough.

PLT: Never enough in the right place. One of the big pains of operating up there was to have to turn around for a place to plug your utility plug in. When you want to go back, you had to unplug the VCR and use the long extension cord that's strung in all the way from the workshop. That's one thing you don't like to spend your time doing is hunting around for a cable and then finding a place to plug it in. You want to go do your job and get it over with. The rest is a waste of time.

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COROLLARY EXPERIMENTS DEBRIEFING
PAGE 12-13

QUERY: Al, you had mentioned the need for a different set of restraints located in different places in
(CONTINUED ON NEXT PAGE)

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
1. Compartment Arrangement

COROLLARY EXPERIMENTS DEBRIEFING (CONTINUED)
PAGE 12-13

QUERY: the waste management compartment, and you had some remarks concerning the use of the fecal containment system. Will you elaborate on that?

BEAN: My comment was that we should not have tried to put the restraints on the floor; that made it inconvenient to remove the drawers. We needed to find another place for them, such as the wall or the ceiling. We should have realized that we didn't need to have defined, closed-off head area, with the smooth walls and such. Urine spills presented no more problem than water spills somewhere else. We should have made the floor in that place with a plain grid. When we do design some sort of waste compartment for Shuttle, we should make it like any other compartment, without closing it off. The fan in there was a good thing. It allowed you to cut your fingernails and hair, which would go up and catch in the fan. A more powerful one, and one that could be pulled down a little bit might be better. The wall position of the fecal device was inconvenient because of our tendency toward vertical orientation. It should be positioned for sitting down. You have to sit on it with your knees way up in the air and your toes under and behind the urine cabinets; you have to look right down at the floor. Although it worked well, a more earthlike position would be better. Also, the lighting is not adequate to read by while you sit there.

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
1. Compartment Arrangement

MISSION DAY: 13 DAY OF YEAR: 332
MISSION TIME: 17:25:35 GMT

NOTE: M487-2A

PLT: PLT at 17:25, completion of M487-2 Alfa. Question 1: What particular aspects of the orbital assembly seemed well designed and arranged for living and working in zero-g? What aspects are deficient and how? I think possibly the best aspect in the arrangement is the OWS aft compartment. The height is proper, it enables you to move about with some - at least a degree of assurance of control; there's a lot of grid floor space available for foot restraints, although the work around the wardroom table is difficult. It'd been better off, I think, if they'd have left off the - the brown sort of pedestal or one-inch thick border around the food preparation table - would have been better left off because it robs us of a lot of foot restraint and the strap restraints aren't any good anyway. So I think that probably the aft compartment is pretty good. The rest of the spacecraft is very poor for working because of eight volume of arrangement or lack of foot restraints.

MISSION TIME: 17:34:42 GMT

NOTE: M487-2A

PLT: Now let's go to the - the MDA, I want to make this comment before I forget it. I think the layout of the MDA, the numbering of the lockers and stowage locations is very confusing, and also the locatability of items, locker and stowage locations in the MDA is very bad. We've got to come up with a better system than in locating the lockers; it's hard to move around the MDA, it's hard to work in the MDA, hard to find things. There are very, very few restraints, there are no - no foot restraints other than the one under the ATM and the one that's movable for EREP and for the ... processing facility.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
1. Compartment Arrangement

MISSION DAY: 13 DAY OF YEAR: 332 (CONTINUED)
MISSION TIME: 17:35:21 GMT

NOTE: M487-2A

PLT: However, not only does it make it difficult to do jobs in the MDA, but it is also causing us a lot of problems in that the rate gyro package which, to be sure was an add-on item and a contingency contains the installation, but nevertheless because of our inflexible - our lack of positive positioning in the MDA, we've kicked the rate gyros a couple of times and caused the things to go into coarse gain which can cause control problems. All I'm saying is not only is it a convenient device, but it can also cause you operational problems, so it's not just a pitch for greater maneuverability and greater ease in operating in it, but it can also lead directly to very serious operational problems.

MISSION TIME: 23:42:30 GMT

NOTE: M487-2A

SPT: SPT at 23:42.

SC: Subject is M487-2A. And I'll be giving my comments now, the CDR will be coming in a little later tonight. First question: What particular aspect, of the O/A seem well designed and arranged for living and working in zero-g? I'd say probably the best part is the MDA. That's because we've made - well - good use of the wall. I think the lower compartments, that is the experiment compartment, and the other quarters in the lower floor of the OWS are okay, however, the upper compartment could certainly be much better in that the walls are not utilized for anything, strictly a one-g design. The bottom experiment compartment is also a one-g design, but because of the height, you probably gain more by working on the floor than you do on the walls. I think the whole OWS has been a one-g design. It's been that because of well - for many reasons,

(CONTINUED ON NEXT PAGE)

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
1. Compartment Arrangement

MISSION DAY: 13 DAY OF YEAR: 332 (CONTINUED)
MISSION TIME: (333)03:13:31 GMT

NOTE: M487-2A

CDR: very pleasantly surprised ... the first time in using both systems I found 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 grid work 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 and so we 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 to lock your feet here or there and get yourself into 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.

MISSION TIME: (333)03:15:19 GMT

NOTE: M487-2A

CDR: You've also got to weigh the CC's put in a new bag, mark the CC's label, get it into the oven and so 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 mirrors, I think - we could have done a better job

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
1. Compartment Arrangement

MISSION DAY: 13 DAY OF YEAR: 332 (CONTINUED)
MISSION TIME: (333)03:17:04 GMT

NOTE: M487-2A

CDR: that would have held the universal foot restraints might have been a very valuable thing in there. So that the - each man could lock them into the airlock module much the same as we lock VS and VC3 and then the crewmen can go in there and lock his feet in and be stable and be much more efficient in the way he works in the airlock module. In the MDA I think the EREP foot restraints and the ATM foot restraints are very good. Unfortunately, I think, we need a few more. I think we could use a few more handholds in there too. It would seem to me that the handholds could be placed kind of randomly in there, but no handholds more than 4 feet from another handhold.

MISSION TIME: (333)03:18:40 GMT

NOTE: M487-2A

CDR: And a handhold could be designed in such a manner that a leg can be - or a knee - the back of a knee or something like that - could be hooked into it. And that way the hold - the restraint - could be both a foot restraint or a leg restraint and a hand restraint.

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MISSION DAY: 37 DAY OF YEAR: 356
MISSION TIME: 17:01:09 GMT

NOTE: M487-3B Wardroom Compartment

CDR: Okay, you're interested in the general arrangement and orientation of the compartment. I would say that the arrangement and orientation of the compartment is excellent, or very good. The table is well located, relative to the lockers, and each man, within, his arm's reach has got light available to

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
1. Compartment Arrangement

MISSION DAY: 37 DAY OF YEAR: 356 (CONTINUED)
MISSION TIME: 17:01:09 GMT

NOTE: M487-3B Wardroom Compartment

CDR: him, plus his locker with his G-utensils in it, and, the fact that it's oriented with a window that looks out toward the earth, I think, is very, very good. And all and all I think the arrangement is excellent.

MISSION TIME: 17:05:11 GMT

NOTE: M487-3B Waste Management Compartment

CDR: Waste management compartment, general arrangement and orientation in the compartment, - I guess, I have no complaints, I call that very good.

MISSION TIME: 17:08:02 GMT

NOTE: M487-3B Sleep Compartment

CDR: Sleep compartment, general arrangement. They're fine for sleeping, there's not much of a place to go hide and be by yourself, unless you're going to get into your bed, because there's no place to anchor yourself or really put yourself unless you're in bed.

MISSION TIME: 17:10:18 GMT

NOTE: M487-3B Experiment Compartment

CDR: Experiment compartment, general arrangement and orientation. I think that's fine, the chair's kind of off in the corner and out of the way where I would really put it.

MISSION TIME: 17:10:59 GMT

NOTE: M487-3B Experiment Compartment

CDR: I have no complaint about the arrangement and orientation of that compartment.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
1. Compartment Arrangement

MISSION DAY: 37 DAY OF YEAR: 356 (CONTINUED)
MISSION TIME: 17:12:43 GMT

NOTE: M487-3B Forward/Dome Compartment

CDR: The forward dome compartment, general arrangement, I have no quarrel with the general arrangement of the dome area, forward compartment area.

MISSION TIME: 17:13:01 GMT

NOTE: M487-3B Forward/Dome Compartment

CDR: I have already talked about the dome lockers and their arrangement, I think that's quite excellent.

MISSION TIME: 17:15:11 GMT

NOTE: M487-3B Airlock Compartment

CDR: Airlock compartment, general arrangement and orientation ... well there can't be much said about that. A tube is a tube is a tube, and you have to put a few panels in there for the EVA systems and it's all in there and you just can't say much about it.

MISSION TIME: 17:15:30 GMT

NOTE: M487-3B Airlock Compartment

CDR: It's acceptable.

MISSION TIME: 17:17:34 GMT

NOTE: M487-3B MDA/STS Compartment

CDR: Okay, MDA/STS, general arrangement and orientation of compartment, I would say given the size and volume you got to work with, it's rather well-oriented and arranged and compactly done so.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
1. Compartment Arrangement

MISSION DAY: 37 DAY OF YEAR: 356 (CONTINUED)
MISSION TIME: 19:09:30 GMT

NOTE: M487-3B Wardroom Compartment

PLT: Okay, I guess I have no particular objection. Like if the window was accessible from more angles. We find ourselves thrusting ourselves against the ceiling to look out. Nothing against the wardroom; the window just happens to be in there.

MISSION TIME: 19:15:11 GMT

NOTE: M487-3B Waste Management Compartment

PLT: WMC: general arrangement and orientation. I've already beat that one to death too. I don't like the way you have to hold your legs out straight when you take a crap. It's not a natural posture and it's just - it's irritating to have to consciously hold your legs out while you are straining to defecate. If you have to strain; a lot of times you don't, of course. But, anyway, it also prevents you from seating your posterior well on the waste management crapper.

MISSION TIME: 19:19:23 GMT

NOTE: M487-3B Sleep Compartment

PLT: Sleep compartment: general arrangement okay.

MISSION TIME: 19:21:01 GMT

NOTE: M487-3B Experiment Compartment

PLT: Experiment compartment: general arrangement and orientation of compartment. Well, that's sort of a hodgepodge. Hard to get back into that one corner over there where the tools are kept, because we have to get back there quite often. And when anybody's riding the bicycle, you're taking a chance of hurting them or you when you go sliding past them, cause

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
1. Compartment Arrangement

MISSION DAY: 37 DAY OF YEAR: 356 (CONTINUED)
MISSION TIME: 19:21:01 GMT

NOTE: M487-3B Experiment Compartment

PLT: they'll be pumping on the bike. That ought to have a special volume all its own, because it does occupy that, tied it up. And there is a small safety problem there when you start trying to go by somebody with a - the bike, while they're operating the bike. The corner over there where the - it was 131 chair; well, that's a good place for the 131 chair. It's sort of out of the way, and sort of useless area in there, anyway.

MISSION TIME: 19:24:08 GMT

NOTE: M487-3B Forward/Dome Compartment

PLT: Forward/dome area; don't do too much up there except vacuum. General arrangement and orientation, fine. The handholds are great; we don't use them a whole lot, but they're good for moving around when you need to.

MISSION TIME: 19:29:56 GMT

NOTE: M487-3B MDA/STS Compartment

PLT: MDA/STS, arrangement and orientation of compartment: well, all I gotta say is, if you want a very good example of how not to design - how not to design and arrange a compartment, the MDA is the best example, and STS is right on its heel. Boy, both of those are so lousy, I don't even want to talk about it until I get back down to ground, because every time I think about how stupid the layout is in there, I get all upset.

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
1. Compartment Arrangement

MISSION DAY: 41 DAY OF YEAR: 360
MISSION TIME: (361)04:17:29 GMT

NOTE: M487-3B Wardroom Compartment

SPT: SPT at 04:17; M487-3B. Wardroom: general arrangement's pretty good. Again, on the arrangement, I find that the SPT to get to the food, or to the place for stowage of used cans, or to the can crusher, or to the food freezer, has to crawl over the CDR or the PLT and I think from the standpoint the arrangement of the room could be a little bit better. I think it ought to be worked out so that all three have accessibility to the items required during a meal, as well as immediately before and immediately after.

MISSION TIME: (361)04:19:49 GMT

NOTE: M487-3B Waste Management Compartment

SPT: General arrangement: functionally is good; it works well.

MISSION TIME: (361)04:23:25 GMT

NOTE: M487-3B Sleep Compartment

SPT: Okay, the sleep compartments, general arrangement and orientation of compartments. General arrangement: I would like to have it so that the SPT doesn't have to go trudging by two other guys on the way out in the middle of the night and wake 'em up. I think that the arrangement ought to be such that three guys could have access to the sleep compartments without having to go through, or immediately adjacent to the other two.

MISSION TIME: (361)04:26:03 GMT

NOTE: M487-3B Experiment Compartment

SPT: Experiment compartment, general arrangement and orientation of compartment: okay, here I would like to
(CONTINUED ON NEXT PAGE)

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
1. Compartment Arrangement

MISSION DAY: 41 DAY OF YEAR: 360 (CONTINUED)
MISSION TIME: (361)04:26:03 GMT

NOTE: M487-3B Experiment Compartment

SPT: see us start using walls a little bit more. We've just got bare open spaces on walls. I don't know why we can't use equipment. It's really a one-g device ... to use in one-g. That's one feature I do like about the MDA, is that at least they managed, it seems, to use up all the walls. The walls are the working area.

MISSION TIME: (361)04:26:35 GMT

NOTE: M487-3B Experiment Compartment

SPT: I said this whole OWS is essentially made for - made for working, for training in one-g.

MISSION TIME: (361)04:36:32 GMT

NOTE: M487-3B Airlock Compartment

SPT: General arrangement and orientation of the compartment for EVA nonequipment. Volume - well, I think it could be a little bit larger. Run into a few instances where we had tough times planning for an EVA, and stowing of gear just because we don't have enough room in there. I'm afraid one of these days we're gonna kick one of those pie - delicate pieces of gear while we're in there and really mess it up. I think the volume could at least be 50 per - should be at least 50 percent larger for that kind of operation. Getting yourself in there with all that umbilical and - in a situation which may require that you have a volume available to you for crew safety, I don't think it could - it could - a good design in terms of volume; you just flat need more.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
1. Compartment Arrangement

MISSION DAY: 41 DAY OF YEAR: 360 (CONTINUED)
MISSION TIME: (361)04:37:43 GMT

NOTE: M487-3B Airlock Compartment

SPT: Again though, I will make an EVA hatch here - the general location of it though. I would make it an appendage, if you will, an appendage coming off of the main spacecraft rather than as a - something you had to pass through. I think it would make it a heck of a lot easier for the pre-EVA and translating from one place to another. You wouldn't have all the EVA gear in your way. We can set up the EVA gear and leave it there from one EVA to the next. And there - it ought to be like a T just have it coming off at right angles, if you will, to the central shaft of the spacecraft ... whatever it is you shouldn't have that in the major flow.

MISSION TIME: (361)04:41:07 GMT

NOTE: M487-3B MDA/STS Compartment

SPT: And on to the MDA/STS. Now let me say - now there's one thing I do like about it. General arrangement and orientation of compartment. Some people, I guess, do knock it but I kind of like having the walls and working space. However, I'd find that when we've got stowage and working volume walls just kind of throwing in there into hodgepodge. I think we ought to try to centralize stowage, or at least put it all in one location. They may have had to do it that way because of weight coming up short. But functionally, it sure would be a heck of a lot easier if we had all those big stowage lockers all together, and well labeled.

*****

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
1. Compartment Arrangement

MISSION DAY: 46 DAY OF YEAR: 365
MISSION TIME: 18:04:57 GMT

NOTE: M487-2C

CDR: Okay. How adequate are the restraints and mobility aids throughout the orbital assembly? Okay. I guess this is a rehash. I've already covered this ground sometime 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 four feet which is an easy reach distance. And I think that's still true. I think we need more of the grid work 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 elephant trunk that goes over the sill into the command module down through the tunnel, the AID.

MISSION TIME: 18:06:16 GMT

NOTE: M487-2C

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 and used those things, the more I think I better just keep my mouth shut. I think that the restraints in the dome are probably about right, and they probably shouldn't either be increased or just - decreased. Okay, I think I pretty well covered that. I think the restraint system in the MDA/STS really needs work.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
1. Compartment Arrangement

MISSION DAY: 46 DAY OF YEAR: 365 (CONTINUED)
MISSION TIME: 18:15:17 GMT

NOTE: M487-2C

CDR: In terms of your zero-g living, this is question five, and working experiences during this mission, what specific habitability improvements would you recommend for the next Skylab crew, or for future programs? I should have reviewed this thing before I came up. On tape my mind is kind of a blank on this one. There's a lot of things that could be improved for future Skylab crews and for future missions that we would kind of - well, I think we would probably need almost different layout or architecture of the area. Let me skip that and try to get back to it at another time.

MISSION TIME: 21:39:44 GMT

NOTE: M487-2C

PLT: How adequate are the restraints and mobility aids throughout the orbital assembly? Are more needed? Where? Are some unnecessary? Which ones? They're still not adequate around, I mean I still trash all over the place. At the film locker I don't have places to stow paper. Again I get on this thing of stowing small items in high traffic areas.

MISSION TIME: 21:40:07 GMT

NOTE: M487-2C

PLT: When you're doing a lot of work in the film vault, or M509 or at the SAL, you need beaucoup places to stick little pieces of paper under clips and velcro patches and peg board, hold patterns to stick stuff in and it is just completely underdesigned and that we just need, much much more of that sort of thing.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
1. Compartment Arrangement

MISSION DAY: 46 DAY OF YEAR: 365 (CONTINUED)
MISSION TIME: 21:40:32 GMT

NOTE: M487-2C

PLT: Are more needed? Yet I again think one has to look very carefully what you are going to do but in any case you are going to be handling papers and you are going to be handling multiple pieces of hardware of various sizes and one needs a way to stow that stuff temporarily while you're working at it. Particularly around the film vault, cameras, film packs, cassette, filters, ring sights, lens, batteries, photo - you name it skotmic heads. We're always cycling these things around the transporters, the film cassettes, ... transporters, taking them off and putting them on, - putting them, in stowing and taking them out and handling them and doing a five ball juggling contest there, in zero-g.

MISSION TIME: 21:41:14 GMT

NOTE: M487-2C

SPT: It was just - I would say that as far as restraints from handling the equipment that the orbital assembly is totally inadequate. I don't think we were smart enough - I - that is not meant to be destructive criticism that is meant to be a positive comment. Are more needed? Obviously, yes. Well of course the MDA and STS I took apart the other day, I think that both very very bad - bad. I don't want to kick a dead horse. Are some unnecessary? I can't think of any restraints that are unnecessary, you can let me talk about the ergometer.

MISSION TIME: 21:41:46 GMT

NOTE: M487-2C

PLT: We took the seat of, but there were other restraints that were necessary. The M131 chair is a good example of how you can screw up a design on restraint:

(CONTINUED ON NEXT PAGE)

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
1. Compartment Arrangement

MISSION DAY: 46 DAY OF YEAR: 365 (CONTINUED)
MISSION TIME: 21:41:14 GMT

NOTE: M487-2C

PLT: the belt didn't even hold you in there, it didn't, it had to be modified and still difficult to tie it down. And again that was just a case of no one in the world was smart enough to know how to put a - you know how to design a belt, but again that is not meant to be hypercritical of that piece of equipment.

MISSION TIME: 21:42:13 GMT

NOTE: M487-2C

SPT: When you lie down on that chair, the same thing. Any time you have to assume a certain posture, a sitting posture you are in trouble and you have to force to hold you there. And I also have pointed this out that in the john is the same way the toilet. You know you need something to be sort of chin high - we talked about that before.

MISSION TIME: 21:42:38 GMT

NOTE: M487-2C

PLT: I think that the people that have flown on Skylab should be in a either unique position to at least describe or assess requirements for a given task in future designs. Right now I just - it's very difficult to state anything other than very vague general principle and when you go - if you have a place at the work station or if you have a high traffic area for work you're going to need lots of restraints.

MISSION TIME: 21:43:04 GMT

NOTE: M487-2C

PLT: You need general volume restraints for all these small articles and you need restraints for pieces of

(CONTINUED ON NEXT PAGE)

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
1. Compartment Arrangement

MISSION DAY: 46 DAY OF YEAR: 365 (CONTINUED)
MISSION TIME: 21:43:04 GMT

NOTE: M487-2C

PLT: paper and documents big thick checklists as well as thin pieces of teleprinter paper and you also need restraints for your bod. You need restraint items so that you can work on them, that is velcro them out in the open. You need the restraint items just for temporary stowage.

MISSION TIME: 21:43:30 GMT

NOTE: M487-2C

PLT: I use a large bag with a plastic overlapping slit in the front so that you can stick things in there and then reach in there and get them out easy. It needs to be transparent because if you just give me a bag I can reach in there - item I want I throw it out and 15 other things go along with it.

MISSION TIME: 21:43:42 GMT

NOTE: M487-2C

PLT: I need to be able to reach in there and visually nab the item I'm after. And not pull a lot of other things out with it. If I could that things need talked after we get back on the ground and I think these are excellent questions.

MISSION TIME: 21:57:48 GMT

NOTE: M487-2C

PLT: What specific habitability improvements - I'm going to think about that one some more because I know - gosh, the things like traffic flow in the head. A guy that's in the head right now, shaving, completely block the entrance. The other guy could go in there and urinate if he wanted - you know there

(CONTINUED ON NEXT PAGE)

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
1. Compartment Arrangement

MISSION DAY: 46 DAY OF YEAR: 365 (CONTINUED)
MISSION TIME: 21:57:48 GMT

NOTE: M487-2C

PLT: would be no impact there. I think we have a way to go as far as architectural layout habitability. Traffic flow through the airlock - I've already mentioned in a previous debriefing - that there's too much traffic through that airlock. Airlock ought to be located some place else. At least if they're - if they're going to be located there it ought to be bigger.

MISSION TIME: 22:01:40 GMT

NOTE: M487-2C

PLT: Waste management and clean-up chores. Again water spatter is a big problem there. I've already mentioned having lots of tissue or certain types of blotting devices for handling the problems that occur - peculiar problems that occur in the waste management area. But I think in future spacecrafts you ought to be able to have one place for washing your hands and shaving and that sort of thing, and another place for going to the bathroom and taking care of the bodily functions. It's - I think it's preferable from a hygiene standpoint and I think it's also preferable from a traffic flow standpoint.

MISSION TIME: 22:02:12 GMT

NOTE: M487-2C

PLT: I think that the - you ought to have a place to wash your hands and a place where you defecate and urinate, but you also ought to have a separate place for shaving and taking care of routine primping and cleaning up.

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
1. Compartment Arrangement

MISSION DAY: 48 DAY OF YEAR: 002 (CONTINUED)
MISSION TIME: (003)02:55:26 GMT

NOTE: M487-2C

SPT: Something like that would be very useful for working out around here. Even though we do much more exercise than we usually do at home, we don't have any gear designed for it up here.

*****

MISSION DAY: 53 DAY OF YEAR: 007
MISSION TIME: 23:34:30 GMT

NOTE: M487-2C

CDR: In the area of sleep compartments, I've mentioned the - the desk arrangement, stowage arrangements, there just - it's just really nil in there, and they really ought to be improved. One specific thing that came to my mind today, and that is that we've got one locker there with three cubbyholes in it for wipes, and tissues, and all that stuff and man, you just don't use wipes and tissues in your sleep compartment very much. And seems to me that you could very well of gotten by with one cubbyhole and used that other space for something a lot more useful.

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MISSION DAY: 59 DAY OF YEAR: 013
MISSION TIME: 20:09:04 GMT

NOTE: T002

PLT: MARK. 37441. Oh boy, it's getting light. Take all my time getting set up. The only thing I can get. Okay, MDA just wasn't made for human beings to work in. Made to ... place to ... ... I'm doing is I'm trying the 190 window on for size. I see I'm probably getting some stars that I wasn't able to get in the wardroom window. It's really a great place but
(CONTINUED ON NEXT PAGE)

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
1. Compartment Arrangement

MISSION DAY: 59 DAY OF YEAR: 013 (CONTINUED)
MISSION TIME: 20:09:04 GMT

NOTE: T002

PLT: I'm going to have to make some body restraints so I can get in here and hold myself down. There are no - there are very few foot restraints or body restraints in the MDA. And it looks like I've let this opportunity go by so I'll make one more attempt here to get Regulus and Procyon. Stand by.

MISSION TIME: (014)02:44:43 GMT

PLT: PLT; time is 02:45, responding to general message to 6057 Alfa, M487 question. M487 ... obtain information pertaining to use maintain body position at wardroom window while performing T002. PLT regarding ... the use of what he felt to maintain body position while doing T002. Do you attribute problems in design inadequacy such as window-to-floor grid height or grid opening availability for foot restraints in front of window, question mark. 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 per distance was 5½ 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.

MISSION TIME: (014)02:46:14 GMT

PLT: Now, that's a matter of fact not all the answer to that. Talk more about that because there is a problem in floor - window-to-floor grid height here, in that, when I have my feet in the triangles, my eye

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
1. Compartment Arrangement

MISSION DAY: 59 DAY OF YEAR: 013 (CONTINUED)
MISSION TIME: (014)02:46:14 GMT

PLT: height is up near the top of the window, and I'm also displaced back away from the 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 1-g situation this probably would not be a particularly awkward posture. 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. And that is the tension that I think is - was actually spotlighting 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 and 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 strutch (?) beams and partial openings of the little triangle grids.

MISSION TIME: (014)02:47:51 GMT

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 1-g tension muscles to get your eye - get the instrument in a favorable position.

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

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
1. Compartment Arrangement

TECHNICAL CREW DEBRIEFING (CONTINUED)
12.0 Saturn Workshop Systems Operations
12.4 Crew Systems

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.

CARR: Yes. Another item that we discussed in a group and haven't put on tape yet is the idea that crew quarters ought to be more spread out. The three crew areas were so close together that if a crewman did have a loose bed and did do any thrashing at night, he bothered the other two crewmen. If a fellow wanted to stay up late and read or listen to music or do something like that, he had to be very careful not to disturb the others. Or if someone woke up early in the morning, he had to be very, very careful not to disturb the others. In future spacecraft design, the crew quarters ought to be separated as much as possible to give a person the opportunity to move around in his quarters and do things that he wants to do without constant concern about disturbing other people.

POGUE: Also, the individual quarters ought to be away from the traffic flow to the head because that can cause a lot of noise too.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
1. Compartment Arrangement

TECHNICAL CREW DEBRIEFING (CONTINUED)
12.0 Saturn Workshop Systems Operations
12.4 Crew Systems

CARR: We talked about the idea of having a personal stowage and a personal desk and the personalizing of the crew quarters, and I think that's important. In future space flight, when man starts staying up for long periods of time, each crewman should have a place to call his own. It's got to be a place that can be modified in the way any individual desires. We should start thinking about that right now and plan for it.

14.0 Inflight Experiments
14.4 Individual Experiments

CARR: I want to mention the food arrangement. Ed had to climb over the table to reach his food. I had the best position: next to the window and the food. Bill had a good position, but the food was not accessible from all positions at the table.

GIBSON: The room was designed for one-g. Things could have been located overhead or on the walls rather than in the center. That was true throughout the orbital workshop. We did not use the walls or floors as much as we should have.

CARR: The Donning Station: It was fairly well laid out. It's bad that it was stuffed between the T020 and the film vault and up against the wall, because it was difficult for the observer to perform his function around the donning station while the other crewman was strapped in. It was crowded and we had an accessibility problem.

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
1. Compartment Arrangement

SWS SYSTEMS DEBRIEFING
PAGE 435

CARR: ..... One other thing that we recommended too from an architectural standpoint is that the sleep compartments be spread around the workshop, so one guy thrashing around in his bunk doesn't disturb the other guy. If you're just a thin aluminum wall away, it can get pretty noisy and bothersome.

*****

EREP DEBRIEFING
PAGE 68-69

QUERY: We may have drawn this conclusion based more upon the ease of arranging restraints in the panel as opposed to having many different places we'd have that one type of restraint, at least in a small compartment like the wardroom.

CARR: Yes. The main purpose of the wardroom was for eating, and you might as well have everything arranged relative to the table. You concentrate on the way the table is going to be arranged and you don't worry about the rest of the workshop. Then all the lockers, the floor foot restraints, and everything should be arranged relative to the table because that's your main activity in there. Bill had a good point on the wardroom window. We should have arranged the area around the wardroom window for 360° rotation, because depending on your orbital parameters, you're going to want to look out the wardroom window with your feet in a different direction because you're more comfortable.

*****

SKYLAB MAN-MACHINE DATA FROM MISSION SL-II
FOR: A. ARCHITECTURE
2. Compartment Orientation

MISSION DAY: 4 DAY OF YEAR: 148
MISSION TIME: 17:07 GMT

SPT: -- You do have a sense of up and down. And you can change it in 2 seconds wherever it's convenient to you. If you go from one module into the other and you're upside down, you say to your brain, "Brain, I want that way to be up." And your Brain says, "Okay, then that way is up." And if you want to rotate 90 degrees and work that way, your brain will follow you. I don't think it is vestibular at all. I think it's strictly eyeballs and brain. And it's remarkably efficient.

*****

MISSION DAY: 11 DAY OF YEAR: 155
MISSION TIME: 22:36:46 GMT

NOTE: M487-2A

PLT: The whole experiment compartment is kind of one-g oriented and a lot of people have 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, ... nomenclature upside down." We don't do that. 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 slope. But once you get there and you want to be stabilized by the legs or the thighs or or the feet some place where you can do the job.

*****

MISSION DAY: 14 DAY OF YEAR: 158
MISSION TIME: 15:08:14 GMT

SPT: Up here and down there, Pete. It looks like over to me.

CDR: That right? It looks to me like I'm looking down. That's because Pete is looking ...

SKYLAB MAN-MACHINE DATA FROM MISSION SL-II
FOR: A. ARCHITECTURE
2. Compartment Orientation

MISSION DAY: 15 DAY OF YEAR: 159 (CONTINUED)
MISSION TIME: 21:14:41 GMT

NOTE: M487-3B Sleep Compartment

CDR: I find my sleep compartment quite adequate. --- Don't mind my head hanging on the wall.

NOTE: M487-3B Forward/Dome Compartment

CDR: Forward experiments and --- compartment, the general arrangement, orientation of the compartment are fine. --- made out of tank, I'm sure --- better - the - we certainly use --- and do an M509 --- and things like that, but it is a great place to move around in.

NOTE: M487-3B MDA/STS Compartment

CDR: The MDA and the STS. The general arrangement and orientation of the compartment I think could be a little bit better. Again --- around the cylinder, probably not the greatest orientation in the whole world, but it really had led us into too many serious problems. The compartment is certainly adequate.

MISSION TIME: 21:33:41 GMT

NOTE: M487-3B Sleep Compartment

SPT: The sleep compartment arrangement and orientation are okay.

NOTE: M487-3B Experiment Compartment

SPT: Experiment compartment general arrangement and orientation is okay.

NOTE: M487-3B Forward/Dome Compartment

SPT: Forward dome panel arrangement and orientation is okay. Just figuring is one way you can put more things around the wall with a little triangle here and there, a few handholds beside them and you don't

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-II
FOR: A. ARCHITECTURE
2. Compartment Orientation

MISSION DAY: 15 DAY OF YEAR: 159 (CONTINUED)
MISSION TIME: 23:47:56 GMT

NOTE: M487-3B Forward/Dome Compartment

PLT: And the forward and dome areas, I don't know what you really should be answering a general arrangement and orientation; it's all one-g vertical. Which is the way you are used to in general arrangement. It's all right.

NOTE: M487-3B Airlock Compartment

PLT: The airlock is kind of nothing but a patsy ... We haven't used that as a working compartment except for EVA. So general arrangement orientation, we have ... good.

NOTE: M487-3B MDA/STS Compartment

PLT: Now, on the MDA, STS. General aids and orientation. Again it's a cylinder it's things are just a little stuck against the wall. Orientation is all right, I've come to learn to accept it during training.

*****

MISSION DAY: 18 DAY OF YEAR: 162
MISSION TIME: 19:01:46 GMT

CDR: We've also gotten to where we can turn the vehicle right side up or upside down, depending on how we want to do it. If you want to stand on the ceiling for a while, after a while everything looks perfectly natural that way.

*****

SKYLAB MAN-MACHINE DATA FROM MISSION SL-II
FOR: A. ARCHITECTURE
2. Compartment Orientation

SWS SYSTEMS DEBRIEFING
PAGE 120-121

SP: Right. How about the philosophy of floor orientation versus the complete radial orientation of the type which is in the forward compartment or work area.

CDR: Well, I think there are things which lend themselves to being oriented on the floor and then we had them, you know, like the LBNP the bicycle and you maintain a sense of up and down. Panels like EREP and everything, they were perfectly suitable mounted on a radial orientation. The only thing I felt interfered on occasion there were times when we were working the orientation backwards where things on the ceiling interfered with us because we were trying to put our feet up there like pedaling the bicycle with your arms and a few things like that and along with that there were occasions that I would have liked to have the capability to switch the lighting to the floor or say to a wall, depending what my orientation was and again, I think in future designs, you can mix all these things up depending on the kind of tasks that you are tying to do and you might have, I mean some things lend themselves to the radial thing and I thought it was pretty well integrated in the vehicle, really. And I think it is a consideration that you got to do a lot of training on the ground for these things and there was no doubt about it, it was more difficult to train in the MDA on the ground than it was in the workshop, and yet it was very easy to adapt to using the benefits of the radial mounting in the MDA once we got into flight.

SP: OK.

PLT: I had a little more problem in the MDA, I think, remembering where some things were.

CDR: Yeah, had to look around.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-II
FOR: A. ARCHITECTURE
2. Compartment Orientation

COROLLARY EXPERIMENTS DEBRIEFING (CONTINUED)
PAGE 36-41

SPEAKER: lights are where they should be. In looking from your transcripts and from the TV shots, you adopted a mode of locomotion that accommodated that orientation. That is, there appeared not to be a completely haphazard three-dimensional movement. By and large, it moved almost nominal to the principal axis as opposed to this way. Did you do that as a matter of convenience, or did you just readily adapt to that form of locomotion, and was it convenient? Or was it a chore to have to live in a one-g oriented architecture?

KERWIN: I would say that it was unconscious and convenient to do that, not a chore. If you specifically tried to design the vehicle to completely break up the one-g habit patterns, you'd be reinventing the wheel in many cases, and you might not like the lighting, for instance, and you might not like the work arrangements at work stations where you have to settle in for periods of time. I thought many times during the mission that having the nomenclature run from floor to ceiling and the foot restraints on the floor - on the ceiling, too, was perfectly acceptable. It was obvious to us that in a larger enclosure, you can have more than one orientation simultaneously in the same space. You can have one experiment bolted to this wall and oriented so that toward the wall is down. At the same time on the ceiling or the other wall you can have another little mini-orientation or mini-world going on. But in the experiment compartment, we translated that way unconsciously. Paul mentioned during the mission that we were lucky we hadn't gone to little holes for doors instead of large openings, because we didn't translate that way. It would have been inconvenient to do so.

WEITZ: Because it's an attitude change that would have been forced by round holes instead of doors,

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-II
FOR: A. ARCHITECTURE
2. Compartment Orientation

COROLLARY EXPERIMENTS DEBRIEFING (CONTINUED)
PAGE 36-41

WEITZ: because everything was up. If you went from point A to point B, what you're doing at A, your head was along the plus X-axis, and when you got to B, your head was along the plus X-axis. So, it was mainly just to keep from making an unnecessary attitude change, and we did kind of do that skating around vertically. But we did very definitely do attitude changing, depending on where we wanted to go as we thought things out. And I particularly think of the movies that I've seen or the TV like in the wardroom. The only reason we were moving around in the wardroom in the one-g orientation was because the wardroom was built that way. It was easier to hold onto the tables and go around in the sitting attitude as you moved around just because the heater trays were sticking out. It really makes very little difference. I think Joe's got a good point. However you can conveniently locate experiments to do things, their orientation to something else or to the floor and ceiling is immaterial.

SPEAKER: Does the proximity to these other things matter, do you think? I mean, if you had one experiment that was oriented this way and another one right next to it that was canted 60 or 70 degrees, or something like that, would that get to you?

KERWIN: As long as you had room to move and operate. As long as you didn't have operator interference between the two. The visual interference I don't think would be significant at all.

WEITZ: No.

CONRAD: There's a lot of things you don't see in the movies. You're taking movies of us performing specific tasks. There were many occasions I can think of, like the hatch that goes through to the wardroom. Many times a guy would be up there

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-II
FOR: A. ARCHITECTURE
2. Compartment Orientation

COROLLARY EXPERIMENTS DEBRIEFING (CONTINUED)
PAGE 36-41

CONRAD: working on a scientific airlock experiment and he would stick his head down through that thing and the other guys would be down there eating and he'd spend 10 minutes shooting the breeze with your buddy who's eating or doing something down there 180 degrees out from one another and it didn't give you the appearance that he was upside down. You were in zero-g and so it's normal. So, you were facing each other 180 degrees out.

SPEAKER: Do you think that we are compromising the effectiveness of the spacecraft by, when having no other reason to, we just follow one-g architecture? Are we missing a big bet?

CONRAD: Well, I'm going to disagree. I'm going to say yes, because we had one discussion about lighting. We would have liked to have had 360-degree lighting that we could have changed depending on what it was we were doing and we discussed how nice it would be if we had lighting in the floor and the walls and the ceiling that was flush and that we could set it depending on what we were doing. And for that reason, I still say that to optimize the space utilization you don't have to follow the one-g.

KERWIN: Yes, I agree with that, and I said no to your phrase, "having no other reason to do so." If you have a good reason to do so and if that reason is space utilization, press on.

WEITZ: Yes. Right.

CONRAD: For instance, like working the bicycle in the arm mode, we concluded that if we had it to do all over again, we would clear all the junk off the ceiling around there because it was interfering with us putting our feet up there.

*****

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
2. Compartment Orientation

MISSION DAY: 21 DAY OF YEAR: 229
MISSION TIME: 22:04:36 GMT

NOTE: M487-3B Wardroom Compartment

CDR: It's a little bit small for getting to the refrig.

NOTE: M487-3B Waste Management Compartment

CDR: Too small. The reason it's too small is, only one person can really operate in there at once. I give that volume a poor.

CDR: Also when you're on the fecal device, and your head's over, you tend to be close to the ceiling which is troublesome, but mostly, it blocks out all your light, so if you want to read on the job, you're gonna have to do it with your book in the dark almost. It'd have been much better if we'd have made that thing set vertical and not tried to save space and all that stuff. Could have put it over there in the corner.

NOTE: M487-3B Experiment Compartment

CDR: Uh, there's been some thought about mounting some on the floor, and some on the walls, some on the seat, this doesn't work out. You tend to orient yourself when you're in a room, even though you're in 0-g, and when you orient yourself, you should find yourself in an attitude that everything's about the same; you don't like something up, something under ... You like things to be orderly like they always are on Earth. Now, if you want to put everything on the ceiling and the floor you sure handle that. It's just we don't want half and half.

NOTE: M487-3B MDA/STS Compartment

CDR: MDA/STS. General arrangements - a little bit small. Trouble with the MDA is, it's not oriented like a room. So one guy goes by and he faces one way, and he hits the other guy in the back of the head, who's

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
2. Compartment Orientation

MISSION DAY: 37 DAY OF YEAR: 245 (CONTINUED)
MISSION TIME: 22:31:21 GMT

NOTE: M487-2C

PLT: The orientation of the MDA - that style of orientation is one I'd stay away from in the future. I prefer to make it modular, as you have it in the workshop where, although there is no up or down gravity-wise, there is up and down visual-wise. And it's the way you're accustomed to working in training.

And so although moving around the workshop you don't necessarily retain the vertical orientation that you would in one gravity. Still in all, think they're arranged more neatly and know where things are so that when you do get in the one-gravity orientation, you don't have to hunt around for things and all the writing is in the proper orientation and so forth. So the workshop orientation was preferable to that of the MDA. Obviously the task to be performed do influence your preference of orientation because you won't want to look at the ATM panel upside down. You got to look at it the way the writing is. Same way with all the other panels. You got to face them the way you did in training. And it's not vertigo-producing sensation to operate in different orientations in the MDA but it's simply less desirable than the way we operate in the workshop.

*****

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
2. Compartment Orientation

TECHNICAL CREW DEBRIEFING
15.0 Training

BEAN: Any time I entered the MDA compartment, I'd rotate so that I was essentially head up in respect to the ATM panel. Then I knew where everything was located. If I went in there and didn't do that, it was kind of mystifying where all the objects were. So you got to where you would roll a certain direction as you went in the MDA and then the same thing occurred when you returned to the OWS. If you rolled a certain direction as you went through the lock compartment, then you come out through the overhead hatch, and you knew whether to break right or left or forward or backwards to end up over near the dome lockers or wherever you wanted to go. Otherwise, sometimes you end up in a part of the compartment where you didn't want to be.

LOUSMA: I know often when you'd come back in the OWS, you'd stop and look to see where the minus Z SAL was or wherever you wanted to go you just didn't automatically come through the hatch and zig in one direction or the other unless you came through at the same orientation all the time.

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SWS SYSTEMS DEBRIEFING
PAGE 49-51

SPEAKER: 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 is 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.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
2. Compartment Orientation

SWS SYSTEMS DEBRIEFING (CONTINUED)
PAGE 49-51

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 it's just all kind of a hodgepodge, 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 - every place. 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.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
2. Compartment Orientation

SWS SYSTEMS DEBRIEFING (CONTINUED)
PAGE 49-51

SPEAKER: Well, let me ---

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, halfway 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; any time 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 day-dream 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 let's see, there's the gold

(CONTINUED ON NEXT PAGE)

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
2. Compartment Orientation

SWS SYSTEMS DEBRIEFING (CONTINUED)
PAGE 49-51

PLT: 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 though it's not necessary to be built that way, it's just more organized.

CDR: It's conceivable 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 lay-outs we've got in fomecor. Maybe, further pursue this point of how you best lay out a fourteen foot or a twelve foot diameter vehicle.

CDR: OK. Remember the most important thing, to my mind, is that you've got to be able to secure yourself with your feet in range of everything, somewhere. That's the number one thing to be able to do. Sorta like here. In order to work here, you've got to be able to stand or sit and work on something. Same thing up there, it doesn't go away, once you can find those places everywhere, you've got it made.

PLT: I remember when the MDA was layed out, there were a lot of other factors that enter design besides ease of working in there. But I hope that, if possible, we can avoid those kind of requirements in the future.

SPEAKER: OK. Very good, appreciate it.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
2. Compartment Orientation

SWS SYSTEMS DEBRIEFING (CONTINUED)
PAGE 56

SPEAKER: How about floor orientation versus radial orientation. I think you've covered that pretty much in your discussion of the MDA.

CDR: Floor is much better.

PAGE 124-127

PLT: I thought the whole waste management system was a well designed system.

CDR: Uh huh! The only thing I did not like about it --- two things I didn't like about it. I think we ought to think about for Shuttle. I didn't particularly like being positioned perpendicular to the floor, even though it was 0-g, I thought, you still had an orientation in there, I thought it would have been much better to sit erect. That and the lighting too. When you got down there like that, if you wanted to read a book, that was bad. It caused a shadow looking down at the floor. So I think if we could have corrected it, it would have been nice and the other thing was the fact that you could not, when you sat on the seat, you always had to sit on the seat with your knees up high. It wasn't like the thing on the floor where you could sit there and make your legs perpendicular to your body. So you always felt like you were sort of clamped up in the position I am in right now on that fecal seat.

SPEAKER: Leaning against a tree like?

CDR: Well sort of. It didn't seem like it was as natural as it could have been. It didn't seem to be prohibitive of anything. Just wasn't as comfortable as in a normal airplane.

SPT: You had to assume the hunter's emergency position.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
2. Compartment Orientation

MISSION DAY: 4 DAY OF YEAR: 323
MISSION TIME: (324)00:02:27 GMT

SPT: One interesting thing I've noticed in the effect of zero-g, well, it's really an effect of body orientation on the room you happen to be entering, that I can move in to a given room sideways or upside down and not recognize it, or I would recognize it, but I would not feel at home in it. But as soon as my body would rotate to the 1-g attitude, that's the attitude which I had in working with - in the trainers for well over a year now. Then all of a sudden my mind would flash and say, "yes I know where I am," but until that time, why it would look like something entirely different than what I had been working in. It's as though your mind won't recognize the situation you're in until it sees it pretty much in the old standard way, and as soon as you get pretty close to the right orientation, then all of a sudden zap, you get these transformations made in your mind that tells you exactly where you are. I noticed this effect especially in traveling from up in the MDA through the OWS, forward area and finally coming down into the experiment compartment of the lower deck. When I come in there, everything looks sideways, and not until I rotate and put myself in the same attitude as I do in the one-g trainer do I really recognize and feel familiar.

*****

MISSION DAY: 9 DAY OF YEAR: 328
MISSION TIME: (329)05:09:23 GMT

SPT: Subject of general interest to the M131 folks. The feeling of orientation, persists, which I mentioned once before, and that is, if you're in the 1-g orientation in any of the structures we were working in especially in the OWS, and in the command module, everything seems pretty familiar, and you can ... yourself that you're in the Skylab itself as opposed to the trainer. However, if you spend any deal of time at all in a different body orientation -

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
2. Compartment Orientation

MISSION DAY: 9 DAY OF YEAR: 328 (CONTINUED)
MISSION TIME: (329)05:09:23 GMT

SPT: sideways, upside down - especially in one of the rooms in the experiment compartment or in the ward-room, you find that it is not as familiar to you as it is in the other. It's quite a noticeable difference. And then when you start rotating back to the 1-g attitude, just all of a sudden the location of around oh, 50 to 30 degrees or so, your mind all of a sudden says, "Yeah, that's familiar I've seen that before." And just sort of clicks. There's nothing in anyway disturbing about it. It's just kind of an interesting phenomenon. I just notice that there is a sharp transition in my mind when I grow close to 1-g orientation after being some other orientation for a good period of time, maybe up to a minute or so.

*****

MISSION DAY: 20 DAY OF YEAR: 339
MISSION TIME: (340)04:11:57 GMT

SPT: Subject for M131 and spacial orientation judgement. Okay, I think I've talked once about phenomena of your mind all of a sudden snapping to recognition of a one-g orientation or a one-g situation. Briefly what I learned to believe was that you are in the OWS if you are upside down sideways, you recognize everything but it doesn't seem familiar until you almost like get yourself relatively close to a working orientation say within 30, 40, 50 degrees. Then all of a sudden you might recognize it, something you're very familiar with. In the MDA there are some other interesting sensations. One is, if you're looking out of the - one of the hatch windows, or one of the MTS windows or looking out of the EREP window. You find when you come back - move your head back inside and look down the axis of the MDA and toward the OWS, you feel that you're looking down a long tube. I mean down that is a long tube which - which there is a bottom and it is in a one-g sense a down. You

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
2. Compartment Orientation

MISSION DAY: 20 DAY OF YEAR: 339 (CONTINUED)
MISSION TIME: (340)04:11:57 GMT

SPT: know of course that you're not going to fall down it. But you have a sensation that it is down. When you take both ends of the - away from the window and into the MDA a little bit, then all of a sudden old familia come into being and then when you look along the axis toward the OWS it's no longer down, but is across. There's another distance with no real direction associated with it except maybe a very neutral across. In working on the walls in the OWS, I find that it's kind of interesting and I'll give you this just for the interesting sensation. I'll work upside down or sideways and I no longer feel that I am in a one-g environment for which I am very familiar with in Houston. But that I actually am in a three dimensional zero-g space station. When I'm oriented in a one-g orientation with my feet in triangle I feel I'm floating but it's still a one-g. - in a one-g situation, but if I change my attitude, I all of a sudden go transition. It's kind of interesting and I've had a lot of fun with it. What surprises me is that even after - took about 3 weeks ago, that's still pushing it, apparently familiarity with the - that we acquired in the one-g trainer in Houston there really stuck with us.

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MISSION DAY: 46 DAY OF YEAR: 365
MISSION TIME: 18:02:23 GMT

NOTE: M487-2C

CDR: 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 - well, there is two good reasons for that: number 1 is - that's kind of the way we're oriented in life on the Earth, and I think it's good to bring some of that orientation with you. It helps quite a bit.

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
2. Compartment Orientation

MISSION DAY: 46 DAY OF YEAR: 365
MISSION TIME: 18:02:23 GMT

NOTE: M487-2C

CDR: How do the tasks to be performed influence your preference of orientation? Well, I don't know if the tasks necessary [sic] influence my preference more than just 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 grid-work floor and ceiling helps quite a bit. So, not necessarily the tasks influence my preference for the orientation, more than the opportunities or the availability of the - of person and equipment restraint.

MISSION TIME: 21:34:38 GMT

NOTE: M487-2C

PLT: Which is preferable, the floor ceiling orientation of the OWS, or the open cylindrical arrangement of the MDA/STS? Insofar as the experience in this endeavor I would say that the OWS floor/ceiling arrangement is much preferable. But I think that has to be modified with the fact by the fact that I think the numbering and the restraint provision, the numbering system in the restraint provisions of the MDA/STS are very poor. So I think rather then directing the contrast between a physical arrangement floor/ceiling rather that against versus cylindrical, we'll have to bear in mind the fact that the MDA/STS are very poorly numbered and have pretty poor foot restraints.

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
2. Compartment Orientation

MISSION DAY: 46 DAY OF YEAR: 365 (CONTINUED)
MISSION TIME: 21:34:38 GMT

NOTE: M487-2C

PLT: How do the tasks to be performed influence your preference of orientation? The task definitely influences 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. So you naturally try to get in the right position to do that with a minimum of physical damage to your hand. 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 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 starts in the sextant. The vertical - the plane of symmetern, the sextant that to pass through two stars. If listening you have to move your head. Well the two stars weren't picked so at then were perpendicularly to the floor of the wardroom, so I had - it was a very awkward posture, and I finally ended up after I did that other two start I picked two other - 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 a conflict with the vivid arrangement of the floor/ceilings in the wardroom. I think that there are a lot - if one had to look very very closely it was a task that had to be performed to see whether or not you have designed a task to fit the floor or whether you have to modify the physical - the physical arrangement to fit the task. That is a very important point and should not be taken lightly. It's a good question.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
2. Compartment Orientation

MISSION DAY: 46 DAY OF YEAR: 365 (CONTINUED)
MISSION TIME: 21:53:22 GMT

NOTE: M487-2C

PLT: Habitability - by the way - I know one, you know, philosophical approach to habitability is that there seems to be - and I've heard other crews mention this too - there seems to be a preferred up and down orientation in volume. I mean you get used to working them that way. I mean we always walk across, or go across the floor, upright. ... I suppose we go upside down occasionally; but mainly people put themselves in a one-g upright position to do tasks.

*****

MISSION DAY: 48 DAY OF YEAR: 002
MISSION TIME: (003)02:42:00 GMT

NOTE: M487-2C

SPT: Which is preferable, the floor/ceiling orientation of the OWS or the open cylindrical arrangement of the MDA/STS? Gee, I like the MDA/STS. I like that arrangement. I think they got more room to work in. I think it gives you more area and more flexibility in the way in which you lay things up.

How do the tasks to be performed influence your preference of orientation? Well, most of your tasks are concerned with just you and the equipment right in front of you. So almost all the tasks do not make any difference. I think in the overall layout though it does. Tasks - I'm trying to think of any tasks which would be performed where that would make a difference. If you had something which required a straight flat plane like a floor, for example, that might be a consideration. But right now, we don't have any such place in the whole OWS. The floor down here is so butchered up with things laying on it, that for all practical purposes, it might just as well not be flat.

*****

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
2. Compartment Orientation

TECHNICAL CREW DEBRIEFING
5.0 Workshop Activation and CSM Powerdown

CARR: MDA/STS Entry: When I threw the MDA hatch open and looked inside, there was no sense of disorientation. I felt at home; I know where I was; I had been there before; and I was glad to be there.

GIBSON: You and I went down there. You went first, and there was no problem. Things were written out so that we went slowly in a holding fashion. I saw no reason why we shouldn't go in, turn the lights on, and get the whole thing operating. This was opposed to the piecemeal holding fashion in which it was set up.

CARR: ..... AM/Dome Entry: I remember sticking my head through the hole and looking down in the area and not being surprised at what I saw; nor was I disoriented.

14.0 Inflight Experiments
14.4 Individual Experiments

GIBSON: The concept of walls and floors is not applicable to zero-g.

CARR: I would have been disoriented without wall/floor/ceiling orientation.

POGUE: I don't think it's a problem. There is no reason why we could not have used a ceiling for a food compartment.

CARR: We are one-g animals, and we do have a favored orientation when addressing a panel.

GIBSON: When you are addressing a panel this is true, but the whole workshop need not be a one-g structure. Floor/ceiling space could be utilized.

CARR: A compromise is necessary between one-g and zero-g space utilization.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
2. Compartment Orientation

TECHNICAL CREW DEBRIEFING (CONTINUED)
14.0 Inflight Experiments
14.4 Individual Experiments

POGUE: Orientation is necessary in a large area such as the MDA.

*****

EREP DEBRIEFING
PAGE 69-70

GIBSON: For a given task, all of the hardware ought to have the same orientation.

QUERY: Yes, I think we worded our conclusion very poorly.

GIBSON: If you make a room like our camera facility for Earth resources with a dome, have all of the camera restraints, and all of the maps and everything with the same local vertical.

CARR: Compared to wherever the guy is strapped.

GIBSON: If you have a camera facility right next to a medical facility, there is no reason they have to be at the same local vertical.

POGUE: Just don't let it mislead you, when we turned upside down in the experiment compartment, it really looked completely foreign to us. But we had lots of volume in the workshop area that could have been used but wasn't.

GIBSON: Yes, we could have put all kinds of equipment in the local verticals if we'd had them there on the walls, and never experienced any difficulties.

CARR: It is a problem to come into an area in an odd attitude and you do have to reorient yourself. We had the same trouble the other crews had going from the MDA to the command module. You went in upside down and you had to do a flip and then all

(CONTINUED ON NEXT PAGE)

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
2. Compartment Orientation

EREP DEBRIEFING (CONTINUED)
PAGE 69-70

CARR: of a sudden you were comfortable. We normally went in head first, going from the MDA into the workshop, but if we decided to go in feet first, we suddenly felt that we were very high and that we were going to fall and had to be careful. It's just because of using your feet as a visual reference to "down" and too far down is dangerous and you never forget it.

*****

EXPERIMENTS M487 & M516 CREW DEBRIEFING
PAGE 1-5

JOHNSON: One of the very important lessons we think we've learned about architecture is that an adherence to a one-gravity situation, architecturally, is not all bad. Although it may not fully exploit all you could do in zero gravity, it does have at least the convenience of orientation. The table is always here, the window is always there, and there's no question of which is up and down.

GIBSON: I wouldn't consider that's a real strong advantage. To me, the one-g structure was used so that you could easily test it and develop it on the ground. I don't think once you get into space that you should worry about the problem of recognition of where things are. I could find things in the MDA as well as I could find them in the OWS. You learn your way around rather rapidly, so I wouldn't use that as a major justification, only the people who are building and testing it have the strong input of making it one-g oriented. I personally prefer the other approach. Once you're in flight, I find it just as easy to look at something that's on a wall or what you might call the floor or ceiling.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
2. Compartment Orientation

EXPERIMENTS M487 & M516 CREW DEBRIEFING (CONTINUED)
PAGE 1-5

CARR: I think we all three agree that the way to orient your equipment is for the task you're going to use the equipment for. You could go to a station and work and orient yourself relative to that station and it doesn't matter where everything else is in your world. A case in point was the wardroom window. At certain beta angles, it was much more convenient to go to the wardroom window and flip upside down, put your feet up through that vent or escape hatch area there, and watch the Earth go by and take your pictures. If you looked away from the window and looked inside, you'd say, everybody's upside down, and then you'd go back and do your work. When you were finally finished at the window you'd just come back and rotate yourself back up. As Ed pointed out, when you're that far away from the floor, all of a sudden the new orientation just clicks right in and you are right side up again. It seemed to us to be more important that you orient the work station for the best use of the equipment and things, and not worry about whether or not it looks like a one-g and whether the crew is comfortable relative to the entire surroundings because when you're doing work in an area you focus on that area and you forget everything else.

POGUE: There is, locally, an up/down.

GIBSON: Yes, in the MDA, for example, we had three work stations, the ATM, the EREP, and the STS, and each one of those required a different body orientation. That was in no way confusing; it was very convenient.

QUERY: We may have drawn this conclusion based more upon the ease of arranging restraints in the panel as opposed to having different places we'd have that one type of restraint, at least in a small compartment like the wardroom.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
2. Compartment Orientation

EXPERIMENTS M487 & M516 CREW DEBRIEFING (CONTINUED)
PAGE 1-5

CARR: Yes. The main purpose of the wardroom was for eating, and you might as well have everything arranged relative to the table. You concentrate on the way the table is going to be arranged and you don't worry about the rest of the workshop. Then all the lockers, the floor, foot restraints, and everything should be arranged relative to the table because that's your main activity in there. Bill had a good point on the wardroom window. We should have arranged the area around the wardroom window for 360° rotation, because depending on your orbital parameters, you're going to want to look out the wardroom window with your feet in a different direction because you're more comfortable.

GIBSON: For a given task, all of the hardware ought to have the same orientation.

QUERY: Yes, I think we worded our conclusion very poorly.

GIBSON: If you make a room like our camera facility for Earth resources with a dome, have all of the camera restraints, and all of the maps and everything with the same local vertical.

CARR: Compared to wherever the guy is strapped.

GIBSON: If you have a camera facility right next to a medical facility, there is no reason they have to be at the same local vertical.

POGUE: Just don't let it mislead you, when we turned upside down in the experiment compartment, it really looked completely foreign to us. But we had lots of volume in the workshop area that could have been used but wasn't.

GIBSON: Yes, we could have put all kinds of equipment in the local verticals if we'd had them there on the walls, and never experienced any difficulties.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-II
FOR: A. ARCHITECTURE
3. Compartment Volume

MISSION DAY: 2 DAY OF YEAR: 146
MISSION TIME: 01:03:24 GET

SC: And we're on our way to the MDA. I wish I had a poloroid picture to send down to you guys from the inside of this command module with three suits, all that gear, a drogue, a probe, and a hatch, Joe, Paul, and Pete.

CC: Roger. I'd like to see that myself.

SC: It's unbelievable.

*****

MISSION DAY: 3 DAY OF YEAR: 147
MISSION TIME: 13:07 GMT

PLT: I didn't eat my snack last night either. I couldn't find it. We - I ate everything else except the asparagus which was already reported, Ed. We'll try and do better for you but we're using the menus out of the checklist, now and finding the food. But yesterday we were a little behind the power curve. But, until we get this food down in the pantry and can get organized in the wardroom, it's like three guys eating at the rush hour at Times Square, inside this command module.

*****

MISSION DAY: 11 DAY OF YEAR: 155
MISSION TIME: 22:30:26 GMT

NOTE: M487-2A

PLT: The only thing I have to say is the MDA is not as large in zero g as I thought it would be. You can really hang onto things and work diametrically easier than I thought we'd be able to.

*****

SKYLAB MAN-MACHINE DATA FROM MISSION SL-II
FOR: A. ARCHITECTURE
3. Compartment Volume

MISSION DAY: 15 DAY OF YEAR: 159
MISSION TIME: 21:14:41 GMT

NOTE: M487-3B Wardroom Compartment.

CDR: The volume of the wardroom is adequate.

NOTE: M487-3B Waste Management Compartment

CDR: The volume is fine.

NOTE: M487-3B Sleep Compartment

CDR: You don't need a large room.

NOTE: M487-3B Experiment Compartment

CDR: One other point, the volume of this compartment is quite inadequate. The ceiling has got ... of stuff ... We find we like exercising with the bicycle ergometer in the command module we have no place to put our feet up on the ... wire rugs, fire sensors, lights, and shower stuff's all in the way.

NOTE: M487-3B Airlock Compartment

CDR: The volume in the compartment is adequate.

MISSION TIME: 21:33:41 GMT

NOTE: M487-3B Wardroom Compartment

SPT: The volume as set is marginal.

NOTE: M487-3B Waste Management Compartment

SPT: Waste management compartment turns out to be a pretty good size and pretty well arranged. ---- get a bit of a bottleneck there at the door with one guy standing there putting on and taking off electrodes with the trash bag in place, covering people hygiene kits. That's the area that's too crowded. The deeper you go into the compartments the better things get.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-II
FOR: A. ARCHITECTURE
3. Compartment Volume

MISSION DAY: 15 DAY OF YEAR: 159 (CONTINUED)
MISSION TIME: 21:33:41 GMT

NOTE: M487-3B Sleep Compartment

SPT: The volume of the compartment is okay, except that a little more temporary stowage is required.

NOTE: M487-3B Forward/Dome Compartment

SPT: The volume is fine and we need a compartment this big to give you room to play around and move in.

NOTE: M487-3B Airlock Compartment

SPT: The airlock is a fine tunnel. And for a tunnel and an airlock its size and dimensions are pretty good because when you're EVA with the hatch open you always have something to bear against and I wouldn't want it a whole lot bigger. A little longer, maybe, because we always have trouble getting things in.

MISSION TIME: 23:47:56 GMT

NOTE: M487-3B Wardroom Compartment

PLT: It just needs to be a little bigger.

NOTE: M487-3B Waste Management Compartment

PLT: The volume is all right.

NOTE: M487-3B Sleep Compartment

PLT: The volume is good.

NOTE: M487-3B Experiment Compartment

PLT: Volume is all right.

NOTE: M487-3B Forward/Dome Compartment

PLT: Volume is quite adequate --- doesn't really apply.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-II
FOR: A. ARCHITECTURE
3. Compartment Volume

MISSION DAY: 15 DAY OF YEAR: 159 (CONTINUED)
MISSION TIME: 23:47:56 GMT

NOTE: M487-3B MDA/STS Compartment

PLT: The volume is very good, more than adequate. We've got plenty of room to move around in here. Actually more than we need, this one really hasn't to be this big anymore. However, we've not had enough problem working in here as I thought. I thought it would be large, and it had not turned out to be such. You can work on something in the middle of the volume, and still hook your toes/feet/legs or something else.

*****

SKYLAB MAN-MACHINE DATA FROM MISSION SL-II
FOR: A. ARCHITECTURE
3. Compartment Volume

SWS SYSTEMS DEBRIEFING
PAGE 119

SP: When you mentioned the compartment sizing in the waste management compartment sounded pretty good. How about any other work areas?

PLT: Well, again, floor to ceiling dimensions, I thought was marginal in the sleep compartment.

SP: You mentioned that the other day - as far as getting in and out of the bag?

PLT: No just while you sleep in there, but it didn't bother Joe apparently, he said only when he had the cap on and it will be interesting to see what Jack says, but now my mode was normally as I mentioned before, I didn't use any covers, so therefore my bedroll was rolled up at my feet as it were and I kind of had my feet on top of it, which may have raised me up higher but my head was very, very close to the light baffle. Now we got the light baffle infringing on the volume in there too. And it also put my head up higher on the pillow than I really wanted it. I'd like to have seen that thing 6 inches longer - the sleep restraint. And it could not have been without having a 6 inch higher compartment.

*****

COROLLARY EXPERIMENTS DEBRIEFING
PAGE 74

KERWIN: I can't say enough for how pleasant and convenient it was to work in that large volume of the forward compartment. If you have a choice in future design between a larger and smaller volume, use the big one.

*****

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
3. Compartment Volume

MISSION DAY: 21 DAY OF YEAR: 229
MISSION TIME: 22:18:34 GMT

NOTE: M487-3B Sleep Compartment

CDR: Volume of compartment seems adequate. It does need a little more, like I said, closet. But as far as where you want to sleep, it's okay.

NOTE: M487-3B Experiment Compartment

CDR: It just needs to be larger to do the sorts of work we're doing. I guess I'd have to it's adequate.

NOTE: M487-3B Airlock Compartment

CDR: Volume, not enough. Not big enough.

*****

MISSION DAY: 22 DAY OF YEAR: 230
MISSION TIME: 16:28:04 GMT

NOTE: M487-3B Forward/Dome Compartment

SPT: --- It's just a big volume. If you're gonna do fly-around exercises, why you need that volume. ---

*****

MISSION DAY: 24 DAY OF YEAR: 232
MISSION TIME: 14:54:10 GMT

NOTE: M487-3B

PLT: Volume of the compartments is adequate I think, except for possibly the airlock compartment. That could have been bigger. When you're sitting in there, why it gets pretty crowded with all that in there, too. And could use more room in the airlock. The rest of the compartments, the volume seems adequate. I wouldn't make sleep compartments any smaller than they are. I can't think of any, neither

(CONTINUED ON NEXT PAGE)

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
3. Compartment Volume

MISSION DAY: 24 DAY OF YEAR: 232 (CONTINUED)
MISSION TIME: 14:54:10 GMT

NOTE: M487-3B

PLT: the waste management, they shouldn't be smaller, neither should the wardroom. Going in the wardroom, you always have to scoot around the tables or over the top, if there's somebody in the way. And so you don't have that any smaller. The commander pretty much blocks the entrance to the right side of the wardroom when he's going in. The volume of the MDA is probably about right, but it's so cut up, it's hard to really evaluate the volume in there. The volume in my case, is unusable because its small sections of volume tucked down behind boxes and around boxes. And a lot of the volume in the MDA is not available for use.

*****

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
3. Compartment Volume

MISSION DAY: 37 DAY OF YEAR: 356
MISSION TIME: 17:02:02 GMT

NOTE: M487-3B Wardroom Compartment

CDR: The volume of the compartment is - is very good, I'd say, there's plenty of room, in fact, about all you need, and I don't think there's anything to be said about that.

NOTE: M487-3B Waste Management Compartment

CDR: Volume of the compartment, I think that's very good; it's quite adequate for the use.

NOTE: M487-3B Sleep Compartment

CDR: The volume of the compartment is just about right for that use.

NOTE: M487-3B Experiment Compartment

CDR: The volume is about right.

NOTE: M487-3B Forward/Dome Compartment

CDR: Volume of the compartment is more than adequate.

NOTE: M487-3B Airlock Compartment

CDR: The volume of the compartment is acceptable; it's - really would be nicer if the airlock could have been bigger. When - there's two guys in there with all their equipment and their suits, the volume does appear to be rather cramped. It's very tight in there.

CDR: It would be better I think to have it bigger, however having a bigger airlock means you've got to pump more air when you want to pressurize or depressurize it.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
3. Compartment Volume

MISSION DAY: 37 DAY OF YEAR: 356 (CONTINUED)
MISSION TIME: 17:02:02 GMT

NOTE: M487-3B MDA/STS Compartment

CDR: The volume is acceptable, adequate.

MISSION TIME: 19:10:57 GMT

NOTE: M487-3B Wardroom Compartment

PLT: Think it's sufficient in volume. The - we find our - we need more place to stow things on the surface. We find our - we - cameras, ... papers; our Flight Plan had to be cut into small pieces because they're - they come - they come up in bunches and they're all different ... and we need to cut it all up. And we need to have more places to stow small pieces of paper.

NOTE: M487-3B Waste Management Compartment

PLT: Size of the compartment. Well, it - it's plenty big enough as far as I'm concerned.

NOTE: M487-3B Sleep Compartment

PLT: Volume of the compartment, fine. I don't think that it needs to be a lot bigger than that.

NOTE: M487-3B Forward/Dome Compartment

PLT: Volume is great.

NOTE: M487-3B Airlock Compartment

PLT: Volume of compartment for ... Because of traffic through that thing, that's a lousy place to put an airlock. I think an airlock ought to be out of the main flow of traffic. But I know why it's there: because it's reasonably close to the - supposedly EVA work area. But we're - we have to go back and forth through that a hundred times a day almost,

(CONTINUED ON NEXT PAGE)

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
3. Compartment Volume

MISSION DAY: 37 DAY OF YEAR: 356 (CONTINUED)
MISSION TIME: 19:10:57 GMT

NOTE: M487-3B Airlock Compartment

PLT: and the fact that it's so small in diameter does cause a small problem. And also we've had to string equipment through there. Like ... - right now I have got a high power accessory cable connected up to the video tape recorder from the dome area. A high power outlet. Now, personally, I think that is a questionable procedure, but that's what the procedures call for and we've done it be - for the reason. So it's not just - I'm not just directing this against the ground from - from the procedure standpoint because we've done it ourselves. But I personally think that that's not the safest thing to do is to keep a cable through there all the time. And what - that has to do with the volume of the compartment and the location. The fact that it - it's an airlock, the volume is satisfactory for its designed function. But the fact that it's a tr - high traffic flow area makes the volume of the compartment - I'd say marginal. Now, don't get me wrong. I mean, it's not hard to get - get in and get through there and so forth, but I just question the wisdom of locating an airlock in that position relative to the major activity area. That is, between major activity areas and the workshop.

NOTE: M487-3B MDA/STS Compartment

PLT: The volume of the compartment is great.

*****

MISSION DAY: 41 DAY OF YEAR: 360
MISSION TIME: (361)04:17:29 GMT

NOTE: M487-3B Wardroom Compartment

SPT: I think the volume on the compartment could be slightly larger, although I think it's fairly adequate.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
3. Compartment Volume

MISSION DAY: 41 DAY OF YEAR: 360 (CONTINUED)
MISSION TIME: (361)04:17:29 GMT

NOTE: M487-3B Waste Management Compartment

SPT: WMC: thing is too small and cramped. Volume of the compartment: as I said, is too small.

NOTE: M487-3B Sleep Compartment

SPT: The compartment, itself, is too small. I think what we need in there are some locations where a person could sit down, or at least, if you will, sit as best he can in zero g and work. You need a small desk in there. You need better, more provisions for your personal equipment.

MISSION TIME: (361)04:44:09 GMT

NOTE: M487-3B MDA/STS Compartment

SPT: Volume of the compartment: It is okay for the job you have to do.

*****

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
3. Compartment Volume

SWS SYSTEMS DEBRIEFING
PAGE 432-437

QUERY: Could you give us a little information, a little more discussion on the comparisons of volumes between the sleep, the wardroom, the waste management compartment, experiment area, and the airlock? You know, just the - the adequacy and whether you felt that they were oversized or smaller; good the way they were.

POGUE: I was going to say that I thought the worst area was the wardroom. Although I liked the wardroom, there were a couple of things about that and all of them are architectural. Ed did not have access to his food trays, and he was always either coming around float - he always felt like he was an interloper. In other words, he had to come around behind me or Jer, over the top of the food table when, if we were all eating together, was a mess. And it - a lot of times, if you want to reach over and get another drink or something like that, it wasn't convenient.

CARR: It was very inconvenient for him. The size of the wardroom, I think, was reasonable for the purposes of having a place to eat.

POGUE: Ed's already made several points regarding use of floors and ceiling for additional stowage, which I thought were well taken. And, of course, this has nothing to do with the wardroom as such, and, of course, we were delighted to have the wardroom window, but it would have greatly enhanced the usability of the wardroom window had there been a large radial area clear around so that we could have - with our nose in the window - we could have put our feet around a 360 degree swath.

CARR: Because as beta angle changes, the horizon changes as it comes up and through the window, and it's most natural looking outside to look at your horizon this way, with sky up here and Earth down here.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
3. Compartment Volume

SWS SYSTEMS DEBRIEFING (CONTINUED)
PAGE 432-437

POGUE: You always move around to look that way.

CARR: You can ... yourself around in the window to get that. It looks more natural, and that way the Earth is either moving away from you or towards you this way.

POGUE: Strange thing, too, is that you'd recognize that there's, you know, an area, a land mass area down there until you moved around and got it so the top was up. You couldn't recognize it as easy even though the continent itself may be upside down.

CARR: Yes.

QUERY: That's interesting.

CARR: Waste management compartment: Traffic was the thing there. The use of the - the fecal and urine collector and somebody washing at the same time really wasn't compatible at all. And as far as using the urine collectors, I had no objection to somebody going in there to use the urine collector while I was washing. It didn't offend me at all; and when you got three guys living together that much, it doesn't bother you at all. But the thing was, it was inconvenient because the guy standing there trying to wash himself really had to paste himself against the wall for the guy to go behind him or in front of him to get over to the urine collector. So you had sort of a traffic problem there in the bathroom.

POGUE: That was architectural, too, because there was that pedestal, or that one column of equipment, stowage and the heater panel, and so forth there, the 800 series, was in the way.

CARR: That's the only thing I had in the waste management compartment as far as volume is concerned.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
3. Compartment Volume

SWS SYSTEMS DEBRIEFING (CONTINUED)
PAGE 432-437

CARR: Once you fill that thing up, you know, it was time to dump the trash. But the problem is there was no place to put the guy dumping the trash. There was no place to get leverage or anything like that. And I had to wedge myself into the well, which meant I had to displace three of the bags in order to get myself in there so that I could operate the levers and provide back forces or counterforces to the forces that I was putting on the levers. And so that - really the working arrangement around the trash airlock was not too steamy at all. As far as volume in the forward compartment, I guess on occasion there was too much volume. If you ever let yourself get loose, got distracted and you drifted out of a foot restraint and you didn't notice it, all of a sudden you're out there by yourself and you could do nothing about it. All the swimming and fluttering and flopping did you no good, and all you could do is swear and one of your buddies would come by and give you a shove and get you back to the wall. Otherwise you were doomed to stay there and free floating for 5 or so minutes until you finally got close to something to grab. And it happened to all of us at one time or another.

QUERY: How about the airlock/MDA area, any particular comments on volume there?

CARR: I don't think the volume was too bad. It was just the lack of proper restraint up there (airlock/MDA), proper ways to restrain yourself while you're working.

*****

SKYLAB MAN-MACHINE DATA FROM MISSION SL-II
FOR: A. ARCHITECTURE
4. Ceiling/Floor Proximity

MISSION DAY: 15 DAY OF YEAR: 159
MISSION TIME: 21:14:41 GMT

NOTE: M487-3B Wardroom Compartment

CDR: Ceiling/floor proximity are fine. There is no problem there.

NOTE: M487-3B MDA/STS Compartment

CDR: Ceiling/floor proximity: it doesn't really apply in there.

NOTE: M487-3B Airlock Compartment

CDR: Ceiling/floor proximity doesn't apply; it's really a cylinder.

MISSION TIME: 21:33:41 GMT

NOTE: M487-3B Wardroom Compartment

SPT: The ceiling/floor proximity is good.

NOTE: M487-3B Waste Management Compartment

SPT: The ceiling/floor proximity is okay as is the wall-to-wall proximity for doing such tasks as the shaking up the urine and also for defecation.

NOTE: M487-3B Sleep Compartment

SPT: Ceiling/floor proximity is okay. Don't make it any smaller. When I have M133 on my head tends to bump and scrape the ceiling with that cap on when I'm in bed.

NOTE: M487-3B Experiment Compartment

SPT: Ceiling/floor is okay.

NOTE: M487-3B Forward/Dome Compartment

SPT: Ceiling/floor proximity is okay.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-II
FOR: A. ARCHITECTURE
4. Ceiling/Floor Proximity

SWS SYSTEMS DEBRIEFING
PAGE 119

SP: We got some of this the other day, I believe could we get you to comment a little more perhaps about the floor to ceiling height that work out pretty good in the experiment area, wardroom thru there.

PLT: Yes, that was good, except that -- put you head up a little high on the bicycle ergometer. I thought, Joe did not complain but he used to like to brace his head against the top, he gray-taped a folded towel to the upper grid over the seat anyway and just pushed against it with his head.

CDR: It is on one of the wire bundle channels, flat, you know the flat channels.

PLT: Was it.

CDR: There is one that runs right over the top of the bike.

*****

COROLLARY EXPERIMENTS DEBRIEFING
PAGE 27

WEITZ: I'm not sure how well Jack is going to sleep in that sleep compartment. You're really be encroaching. Well, Joe's almost as tall.

KERWIN: I'm as tall as Jack, although I'm not as muscular. But the only time it bothered me was when I had the sleep cap on that extra inch did it. The top of the preamplifier would scrape against the ceiling as I turned my head. You are that close.

CONRAD: The difference there was that if I got down to where my feet were touching the floor, my head wasn't on the pillow.

*****

SKYLAB MAN-MACHINE DATA FROM MISSION SL-II
FOR: A. ARCHITECTURE
6. Color Scheme

SWS SYSTEMS DEBRIEFING
PAGE 25-26

SPEAKER: OK. We had a lot of back and forth on color, on the handrails. Did you give us an evaluation of the contrast between handrails and the background structure? Was the blue anodized color acceptable, or would it have been better some other color?

CDR: I think that was good and I think it was good that you had them a different color.

PLT: Yeah.

CDR: I think that worked well.

SPEAKER: OK. Blue, in other words, would be preferable over dark gray or ---

CDR: Yeah, I think so. Esthetically, the blue was very pretty (laughter).

SPEAKER: The message is the contrasting handrails the color is whatever is necessary.

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

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

PAGE 55

SPEAKER: How about a change in color for each experiment?

PLT: I really think that, you know, that's kind of hokey in some ways, but in other ways, man it's, for instance, on the EREP, C&D, on our list of 40 different readings. You know, the 10 for each of 4 meters there. And we color coded the gauge to

(CONTINUED ON NEXT PAGE)

SKYLAB MAN-MACHINE DATA FROM MISSION SL-II
FOR: A. ARCHITECTURE
6. Color Scheme

SWS SYSTEMS DEBRIEFING (CONTINUED)
PAGE 55

PLT: the, I guess I've been using the word gauge and not everybody understands the manner in which I've been using it. How do you define gauge, the right way? For the answer --- We color coded all the S192 meter readings were one color background, and all the 191 were another. I really think that the ATM panel could have benefited by having each experiment with a different background color.

PAGE 122-123

SP: The color scheme of the OWS, was it pretty good, I mean, would you go over that again?

PLT: What was it? Yeah, it didn't make me sick or anything, so.

SP: Various shades of beige.

PLT: No, the walls were green I guess the sides were that pale green weren't they? (laughter)

CDR: It was all right. We did not miss the seals of the 50 states of the U.S. on the lockers in the wardroom. Oh, I suppose that you could sport it up here and there. We, we of course did not send TV back to the ground of all our playmates of the years pinned up here and there. We always took them down before we did that.

SP: You want those to be portable?

CDR: I don't know, maybe you could have, just to change the scene, painted the sleep compartments different colors. There's no doubt about it, there are pleasing colors and not so pleasing colors although I'm not aware of that there was anything to displease me about the color of the vehicle and there is nothing that lit my candle so I

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-II
FOR: A. ARCHITECTURE
6. Color Scheme

SWS SYSTEMS DEBRIEFING (CONTINUED)
PAGE 122-123

CDR: I guess what I'm saying is that you were successful in the scheme you came up with, it didn't excite us one way or the other.

PLT: That's right, only from a general lighting standpoint, I had the idea that all our EREP boxes were made that MDA kind of dark instead as compared to the white film vaults.

CDR: Yeah.

PLT: And then a little touch of color like 192 is, I don't know gold, it's kind of nice.

SP: How about texture of things? Did all the metal around you bother you for 28 days?

PLT & CDR: No.

PLT: Living aboard ships for awhile does that to you.

CDR: Yeah, that's a good point, I mean I had the decided impression that I was adapting in a similar manner like making a cruise. Just that it was white and brown instead of all gray. Even the windows were round like portholes.

SP: Same reasons probably.

*****

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
6. Color Scheme

MISSION DAY: 13 DAY OF YEAR: 221
MISSION TIME: (222)02:12:25 GMT

NOTE: M487-2A

CDR: One of the things I think is good in here, ---, is the general use of colors and materials.

MISSION TIME: (222)02:19:19 GMT

NOTE: M487-2A

SPT: Yeah, 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 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 blunking spacecraft interior.

PLT: Yeah.

CREW: ...

SPT: And it would seem to me that a, uh, better study by an interior decorator, not only of our instrument panels which are equally as bad if not worse, but also just the interior decoration of our living quarters would make it a much more ... environment. The pastels and other things that, uh, certainly would make it better.

*****

MISSION DAY: 21 DAY OF YEAR: 229
MISSION TIME: 22:04:36 GMT

NOTE: M487-3B Wardroom Compartment

CDR: Color scheme's okay, could be a little different. It keeps clean even though we make a lot of mess in there. I would recommend that we use the

(CONTINUED ON NEXT PAGE)

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
6. Color Scheme

MISSION DAY: 21 DAY OF YEAR: 229 (CONTINUED)
MISSION TIME: 22:04:36 GMT

NOTE: M487-3B Wardroom Compartment

CDR: materials that we have even if it's several different colors.

*****

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
6. Color Scheme

SWS SYSTEMS DEBRIEFING
PAGE 418-419

QUERY: What changes in general acceptability of your surroundings did you notice over time? Any particular things?

CARR: Well, one of the things is color. We got tired of the colors up there. There wasn't much variation, and our clothing was all the same color, and the walls were all the same color. And it would've been, I think, good to have some color - a little more color up there. And of course, the submarine folks are learning that lesson or have learned it.

*****

SKYLAB MAN-MACHINE DATA FROM MISSION SL-II
FOR: A. ARCHITECTURE
9. Hatches/Doors

MISSION DAY: 9 DAY OF YEAR: 153
MISSION TIME: 13:00 GMT

PLT: What I can tell you about the doors is only that - in discussions before, I mentioned compression walking and about access panels and walls as it were. And some people opted for large round holes because you would be moving about head first. Well it's not so and, I don't know, I still feel there's a fair amount of the - the carry over of 1-g training in your attitude in here. But we finally translate from place to place essentially in an erect position; erect or semi-sitting. The doors are - are really just what you want, even in zero g.

CC: Copy that. The 1-g carry over works pretty well in zero g.

SC: Yep. Yeah, you don't go head first. You push off and if it's convenient you go head first; if it's convenient, you go feet first but most of the time we just move forward or laterally.

*****

MISSION DAY: 15 DAY OF YEAR: 159
MISSION TIME: 21:14:41 GMT

NOTE: M487-3B Wardroom Compartment

CDR: Ingress and egress are but it could be a little bit better. The PLT location ... if everybody is eating he has to either go over the top of the table or slide around the floor to get by the CDR or the SPT.

NOTE: M487-3B Waste Management Compartment

CDR: ... as far as ingress/egress is okay.

NOTE: M487-3B Experiment Compartment

CDR: There --- ingress/egress in the experiments compartment is no sweat.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-II
FOR: A. ARCHITECTURE
9. Hatches/Doors

MISSION DAY: 15 DAY OF YEAR: 159 (CONTINUED)
MISSION TIME: 21:33:41 GMT

NOTE: M487-3B Airlock Compartment

SPT: Ingress/egress is good.

NOTE: M487-3B MDA/STS Compartment

SPT: Ingress/egress is all right.

MISSION TIME: 23:47:56 GMT

NOTE: M487-3B Wardroom Compartment

PLT: HR, GF, provision not special are at the large door, which is good. As I mentioned previously in another comment to the ground, the large doors - the one-g type doors shape and in zero g because you don't move around hand free you move around in an a ... size is good. ... ... you move around and in a vertical position. You just push off and you go scooting around either in a vertical or say like sitting. Very good.

*****

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
9. Hatches/Doors

MISSION DAY: 21 DAY OF YEAR: 229
MISSION TIME: 22:13:59 GMT

NOTE: M487-3B Waste Management Compartment

CDR: Ingress/egress provision, awful tight, can't get by anybody if they're there. If anybody's in there and you want to go past him, you can't; should be wider.

NOTE: M487-3B Sleep Compartment

CDR: Ingress/egress provisions are good.

NOTE: M487-3B Experiment Compartment

CDR: Ingress/egress provisions, just the ceiling hatch, right in the middle, I think is not enough. We should have a small hatch over to the side, just as we do in the wardroom, and one sleep compartment. There's just a - just don't want to come down to one ingress/egress bun.

NOTE: M487-3B Forward/Dome Compartment

CDR: Ingress/egress provisions, I don't like the fact we've only got one hole leading back to safety when you're in the command module.

NOTE: M487-3B MDA/STS Compartment

CDR: Ingress/egress provision, they're okay for the size room, but what you get stuck with a single access down to the workshop and a single access back into the OWS, I mean back into the command module.

*****

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
9. Hatches/Doors

MISSION DAY: 22 DAY OF YEAR: 230
MISSION TIME: 16:27:43 GMT

NOTE: M487-3B Waste Management Compartment

SPT: Ingress/egress are okay.

*****

MISSION DAY: 24 DAY OF YEAR: 232
MISSION TIME: 14:56:28 GMT

NOTE: M487-3B MDA/STS Compartment

PLT: Ingress/egress provision, they're lousy in the MDA. Just grab whatever seems to be sticking out. More often than not it's the table, work table at the ATM. So ingress and egress in the MDA is not good. Come out of the command module, the only thing you can do, just about, is push off at the hatch and float, actually to the first thing you run into. And there's no hand over hand way to get around in the MDA to speak of. Putting in a little handrail the crew quarter's hatch, going through the hatch, to grab onto when you come down from the dome and fling yourself into the lower compartment. Been nice to have, but not required.

NOTE: M487-3B Waste Management Compartment

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 your feet in to. Your feet just slide all over the floor, you sort of bounce, ricochet from wall to wall. And you know the best way to restrain yourself in there is to put your knee up against the little handrail there and your back against the tissue wipe dispenser area and kind of wedge yourself 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 wall, in order to by

(CONTINUED ON NEXT PAGE)

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
9. Hatches/Doors

MISSION DAY: 24 DAY OF YEAR: 232 (CONTINUED)
MISSION TIME: 14:56:28 GMT

NOTE: M487-3B Waste Management Compartment

PLT: yourself. So, it's uh - getting in and out is all right but once you get in there - uh - it's anybody's guess as to how you're going to handle the situation.

NOTE: M487-3B Wardroom Compartment

PLT: 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 backs are pretty much up to the wall.

NOTE: M487-3B Forward/Dome Compartment

PLT: Egress/Ingress into the forward dome area is satisfactory. Coming from the airlock, of course, they push off. If, we had the ... ... why that'd be a perfect way to do it, but we no longer find it a necessary unit and undesirable to have it in the way.

NOTE: M487-3B Airlock Compartment

PLT: Ingress and egress out of the airlock are satisfactory. In fact, got a handrail to the airlock to take care of that problem.

*****

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
9. Hatches/Doors

MISSION DAY: 37 DAY OF YEAR: 356 (CONTINUED)
MISSION TIME: 19:10:57 GMT

NOTE: M487-3B Experiment Compartment

PLT: get a hold of something, you're going to grab; you're going to grab for the lightning hole or anything else. And this is what's happened; that's why that particular experiment's been possibly contaminated. Now, that - that - that's a consideration. You should not locate sensitive devices anywhere around a high traffic area because, man, a guy's going to - going to grab, and eventually he's going to get a hold of it.

NOTE: M487-3B Airlock Compartment

PLT: Ingress/egress, no problem. No, it's no problem. The hatches - I don't like the way those hatches are designed. I think they're totally out-to-lunch on that design. Those things too hard to move around. They bang into stuff; they gouge hunks out of - hunks of point out of material. And, in fact, it's - those are designed so bad, the factory put one of them in wrong, if you want to check the documentation on them. They had to change all the pictures. But they're not very good hatches, I don't think, because of the way they interfere with everything.

NOTE: M487-3B MDA/STS Compartment

PLT: Ingress/egress provisions, no problem.

*****

MISSION DAY: 41 DAY OF YEAR: 360
MISSION TIME: (361)04:20:57 GMT

NOTE: M487-3B Waste Management Compartment

SPT: Ingress/egress provisions: again, it's too hard if two guys want to be in there at the same time, they're really crawling all over each other. That's part of the accessibility.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
10. IVA Coordinate System

MISSION DAY: 51 DAY OF YEAR: 259
MISSION TIME: 14:19:35 GMT

NOTE: M487-2D

PLT: Okay. Let's see. Number 6 is have you noted a definite to establish an IVA coordinate system as a frame of reference and for locomoting and working on the various modules and compartments of flight Skylab? Well, I think you tend to orient yourself to the way you did in one g because that's the way everything is made. The writing is that way. Doors open that way and so forth. It's not uncomfortable to go upside down on something. We frequently do, just go upside down, whatever is most convenient. But generally, with all - your restraint devices one-g oriented, it's remained a tendency to operate that way up here, too. For example, I'm standing at this comm box, and it's oriented for one g where it's head height when I'm standing on the deck, it'd be pretty unusable if I tried to stand on the ... because it's only one foot from the ceiling. So it's just the way things are built to look like they were normal in one g requires that you use them in that manner, although it would be nothing difficult or undesirable to ... I would assume in any manner. I had noticed though that on the MDA is just a hodge podge of all different directions. And although it doesn't impede us in what we're doing, it seems like it's an inefficient way to go. So to have a hodge podge is not acceptable. It has to be well organized so that there's proper operating space for everybody and whatnot. And in so doing, if that best need is fulfilled what, it's orientation is not a problem nor - let's see now have I locomoting. I think, I probably when I go from the trash airlock up to the dome, I tend to face the sleep compartment when I push off. And therefore, I arrive at the same orientation right every time. But, when I push off from the dome area and come down to the workshop, I notice that usually I push off in the same orientation, it's a hard maneuver because the location of the hatch up there, I think, you tend to squeeze past where we have the

(CONTINUED ON NEXT PAGE)

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
10. IVA Coordinate System

MISSION DAY: 51 DAY OF YEAR: 259 (CONTINUED)
MISSION TIME: 14:19:35 GMT

NOTE: M487-2D

PLT: most room. If we had more handholds to push off on in the hatch it's just not worth doing. And by the same token of going up there, you tend to push off on an orientation where, when you get to the place you're going to, it's got the best handholds. And the hatch is just a big flat area and nobody wants to land on it, so, they always try to go, at least I do I guess, unconsciously now, head for the opposite side of the opening from where the opening from where the hatch is opened on. And so that requires that I push off in a certain orientation when I leave the crew compartment. And I've noticed that when I go through the airlock why, I usually can maintain the same orientation as I entered the airlock with from the workshop area. And this puts me in the same orientation about every time I hit the MDA. And I guess it's sort of half partial rotation to get over to the STS or the EREP stuff, and in order to get out of the way of the ATM panel. So, I have found that I tend to locate through the workshop in the same orientation going, and then another orientation which may or may not be the same coming back. And I tend to work in the area with respect to one-g, just because that's the way things are built. But frequently I do it otherwise, - usually slow sideways, or frequently approach things upside down, or whatever seems to be right at the time, I guess you might say.

MISSION TIME: 14:41:18 GMT

NOTE: M487-2D

CDR: Have you noted a tendency to established an IVA coordinate system. Yes, because it goes just like you did on Earth. In fact, I think it end to hold the back up here, somewhat, to get generally move to a station that way. It allows you to reach things; it allows you to move into position. But it - you have

(CONTINUED ON NEXT PAGE)

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
10. IVA Coordinate System

MISSION DAY: 51 DAY OF YEAR: 259 (CONTINUED)
MISSION TIME: 14:41:18 GMT

NOTE: M487-2D

CDR: to remember and say, hey I could work out this thing the other way; it'd be easier. So you have to be careful or you fall into the trap of trying to always do it with that reference frame, whatever it is. It's hassled and then it allows you to orient yourself easily into space. The application you feel it should have: I think you should design it with a definite orientation in mind. Uh - because that makes everything uniform; it makes you, when you come - into a site, know how you got to operate, without having to figure it out. Now, if you get - let's say you're gonna go up and work on the water tank. When you get there, you spend a quite awhile flipping around to different places. And when you flip around, you'll find that sometimes you're working with your foot, in a switch that shouldn't be in. Uh, going up and looking out the STS window, we've turned off the switches up there two or three times. It's a ridiculous thing to do. There ought to be a way to operate at those windows where switches are out of the way, yet you have the ability to see out the windows in all directions you want to go. So, you ought have design with one orientation in mind that - but you, yourself be flexible enough to change, have things protect realizing that people may change.

MISSION TIME: 21:32:54 GMT

NOTE: M487-2D

SPT: Tendency to establish an IVA coordinate system as a frame for reference? The answer is yes. Going down here to the experiment area, wardroom, and sleep compartment. There's no question but what the orientation is the same as it was on the ground. Now we can reorient that coordinate system whenever we need to. But for most of our work, 95 percent, we all use the same coordinate systems. We've practiced, for

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
10. IVA Coordinate System

MISSION DAY: 51 DAY OF YEAR: 259 (CONTINUED)
MISSION TIME: 21:32:54 GMT

NOTE: M487-2D

SPT: example walking around on the overhead in the experiment area. And it gives a very strange sensation. You see brand new things. You just have no idea how floor - how cluttered up the ceiling, which is now the floor, has become. Wires and cables and everything else tumbling over. And it's really like a whole new room that you walk into. It's a fascinating new room. It's a pleasant physiological sensations just to see it with the lights underneath your feet and it's just an amazing sort of situation to find yourself in. But very definitely there has been a coordinate system established in these two areas. But now in the workshop and - it's not quite so clear. Going into the MDA, I frequently go in without any reference at all. But once I'm in there, then I orient myself principally to the ATM panel. So when you're going over to the EREP stuff, I'm sure that Jack and Al orient themselves in respect to that. If you're at the STS you just reorient to that direction. So you have all these reference systems. You do use them, but you just reorient them as necessary.

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
10. IVA Coordinate System

MISSION DAY: 68 DAY OF YEAR: 022
MISSION TIME: 12:36:34 GMT

NOTE: M487-2D

PLT: 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? Yes, verily, I have. And it may vary for the individual work station. 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 defuser section, I'm oriented to that devise. 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 you the PSS recharge station. When I look from either one of those to the other during a individual task, that other location doesn't occur to me. It's only when I get to that location and start doing that work that everything falls into reference for that particular task and work station.

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 off 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 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. But you do not - what is it - subjectively reorientate the volume relative to the

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
10. IVA Coordinate System

MISSION DAY: 68 DAY OF YEAR: 022 (CONTINUED)
MISSION TIME: 12:36:34 GMT

NOTE: M487-2D

PLT: given posture you have. You do not do that. The body - or the mind does not do that. Because that wardroom just looked completely different, and this, I think is - some of it has already been well documented by the other crewmen, so I won't go into more detail on that.

Discuss the application you feel that it should have in the design of future vehicles. I think it's rather obvious. I think that you cannot design an omni-directional system. In other words, I - you cannot design a volume which is going to look right to the crewman all the time, no matter what his attitude is. At the same time, it should im - implant the germ, at least, of the idea that when you are in a given a work area, things should be oriented relative to that work area - relative to the task performed at that point. And that you cannot depend - you can't say well, zero-g ain't gonna make no difference anyway; I'll just put it upside down here. Well that's not true because you - when you sit at - when you're standing here, say at the minus-Z SAL where I am right now, everything should look upright at that point. You do not assume some kind of emotional capability, or I guess the orientation capability in zero-g that one may think. Things do look upside down. Things do look upright and upside down relative to the present orientation of the individual. And it might - I've already I think I've already gone into great detail on how I think that you should label and number things. And I think that at least this - there's no big problem once you locate your hardware and you go to that piece of hardware, you orient yourself in a familiar direction to work at that station and press on from there.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
10. IVA Coordinate System

MISSION DAY: 68 DAY OF YEAR: 022 (CONTINUED)
MISSION TIME: 18:16:00 GMT

NOTE: M487-2D

CDR: 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. Yeah, 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, and about whether there was a definite relationship there, that would have affected us and it's the same relationship here. 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. The vehicle were - we are inclined in here to usually do our traveling with our bodies parallel to the X-axis of the vehicle. I might add that frequently, when I come through the dome, the dome hatch, feet first, I get the definite impression that I am in a high place 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 1 g. I think that you very definitely should have some sort of a coordinate system established or a coordinate system established or a coordinate system in mind when you design the spacecraft for the future because the disorientation that you suffer going from one module to the other when they're not compatible, is quite a bother really. Now the best example of that is going to and from the command module from the airlock module. 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

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
10. IVA Coordinate System

MISSION DAY: 68 DAY OF YEAR: 022 (CONTINUED)
MISSION TIME: 18:16:00 GMT

NOTE: M487-2D

CDR: picture where the couches are and mentally picture where the - the instrument panel is, and then I have to do sort of a 90 degree transform in order to get myself reoriented to the command module reference coordinate system. And that - you know, that's something that if you could avoid that's good, because - having to work between say two compartments, in a hurry, excuse me, if you got an orientation problem going from one compartment to the other, you're going to waste time, and or make mistakes - if you have a coordination problem, throw a switch in the wrong direction.

Right now is where I can get my licks in at the STS panel. As far as I'm concerned, the circuit breakers on the circuit breaker panel 200, 201, and 202, violate my sensibilities, that is my internal reference system. And I always have to think twice or three times before I throw a breaker and remember that throwing the breaker toward the - toward the panel is closing it - throwing it away is opening it. I have to think that out just about every time because the doggone circuit breakers go in I kind of think, in the wrong direction, but that depends on your point of view. The orientation of that panel is really kind of screwy. But anyway, those are sort of examples of the IVA coordinate system. The kind that screw you up. As far as locomotion is concerned, the frame of reference for locomotion, I don't think that's too much of a problem, but for working, I think it's a problem when you've got to reorientate yourself going from one compartment to the other.

MISSION TIME: 19:05:15 GMT

NOTE: M487-2D

SPT: Number 6. Have you noted definite tendency to
(CONTINUED ON NEXT PAGE)

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
10. IVA Coordinate System

MISSION DAY: 68 DAY OF YEAR: 022 (CONTINUED)
MISSION TIME: 19:05:15 GMT

NOTE: M487-2D

SPT: establish an IVA coordinate system as a frame of reference for locomoting and working within the various modules and compartments of Skylab? No, I don't think so. I think it depends upon what you're doing. By - if you're working that - the EREP, you got your own little coordinate system right in front of you; if you're working at the ATM, you got another one; if you're looking out the window, any of the STS windows, you got your own coordinate system; if you're working at the - the --

MISSION TIME: 19:49:29 GMT

NOTE: M487-2D

SPT: Okay. Coordinate system, IVA, question 6. Usually you don't have to worry yourself about an overall coordinate system, because you're only working at one place at one time. I cannot think of anything in the workshop or in the MDA which involves the use of both sides of the compartment simultaneously so that the relative conditions of - what you have on both sides of the compartment makes a difference. Here the distance between you and the work station whether it be - EREP, - ATM, - scientific airlock, front of a film vault, it's - one to one. So I think your choice of coordinates system, if you will, ... vehicle designs, really boils down to is efficient use of the volume that you have available. Where do you put surfaces in order to - make maximum utilization of the volume. By surface I mean walls and/or the total outside configuration of the space vehicle, cylinder ... versus sphere versus square. In that regard I think we have a reasonable - approach here in the initial thought. But that's as far as it goes. By that I mean, we have a large volume which I think you will - you will need for experiments like 509, T020, and just as a place where people can get away from any

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
10. IVA Coordinate System

MISSION DAY: 68 DAY OF YEAR: 022 (CONTINUED)
MISSION TIME: 19:49:29 GMT

NOTE: M487-2D

SPT: claustrophobia which they might get in small compartments - which I think could get on you after a long period of time. At least I feel that if I were pinned up in the MDA all the time, that is, for a months at a time, it would begin to feel pretty much like a cell as opposed to a - a work area. I think you do need a large volume for those reasons, and I'm sure there's many more. I guess the many more would include the different types of experiments which you would do, many of which you, - as we found on this mission, you can't predict years in advance. Many of them are inflight generated. They could not be generating unless you had the large volume. The other aspect which I think in general is good, is the general design of the MDA in which tried to utilize the walls of the cylinder in a zero g manner rather than a 1-g manner. The OWS is a 1-g vehicle and I think it's a waste a lot of wall space.

MISSION TIME: 19:53:46 GMT

NOTE: M487-2D

SPT: The MDA tried to use the wall space, which is good, but I think they do it in a - what I would consider a unorganized, confusing - manner. I would not - I would like to see a compartment about the same size as the OWS, maybe even longer - which has got work stations on the walls. By walls now, I mean the cylindrical walls - as opposed just to a place as a place - separate - used to separate ceiling from the floor. You'd have to build things, work platforms, work stations, so that in a given locale, you'd have your own local vertical. You own local vertical is perpendicular to the wall or the floor. In that sense, walls and floors are no longer distinguishable. I would like to see the area like the MDA which ought to be large in diameter. I think the OWS is probably

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
10. IVA Coordinate System

MISSION DAY: 68 DAY OF YEAR: 022 (CONTINUED)
MISSION TIME: 19:53:46 GMT

NOTE: M487-2D

SPT: there aren't many things that can go in there, except for stowage. And we have not yet been able to find things to stow over there, except the temporary stowage of T020. I'm getting out of subject coordinate systems, it depends how large you're gonna make this as to whether you really got to worry that problem too hard. If you're gonna come up with a vehicle which has got 40,000 cubic feet, a factor of four greater than what we have - a factor of three greater and you're gonna have many more compartments, then maybe you ought to think about aisles and passageways, if you will, tubes and that type of coordinate system. If you ever do that, you ought to make sure that you end up with a aisle or two which is a main thoroughfare in the same way as an aisle way is in a series of - or a hallway is in a series of offices. So that to get from one room to another, you do not have to go through another couple of rooms, but you go out into the major two or the hallway and go that exit - go to the other room. Functionally, that's what you do in one g and I think in zero g you should have the same functional requirement. Coordinate systems are kind of funny in the sense that, in the command module - it all goes back to the way we're trained. We got our own local vertical in the command module which is very hard to find when you first get in there now in zero g. That's laying on your back on a couch with the - with the gravity down towards your back. That's hard to - hard to find when you initially go in there. At least I always find it a little confusing. I shouldn't say confusing, but it just takes a little while to get myself oriented. MDA, because that thing was always rotated in the a different orientation in training, we never really established a local feeling of vertical there - feeling of local vertical. OWS, we do. 'Cause the way it was put together and the fact that it is a one-g design. I think coming through the upper dome - from

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
10. IVA Coordinate System

MISSION DAY: 68 DAY OF YEAR: 022 (CONTINUED)
MISSION TIME: 19:53:46 GMT

NOTE: M487-2D

SPT: the airlock into the upper dome is kind of an interesting sensation. Jerry and I were talking about this yesterday.

MISSION TIME: 20:01:17 GMT

NOTE: M487-2D

SPT: If you come through feet first and you look down, you feel that you're gonna fall. That's because of the one g ... image you still have in mind. For some reason if you can come whistling through head first, it doesn't seem to bother you. It really doesn't bother me the other way either, but I have this - you have the feeling of height which, rather than just dimension from one point to another, you all of a sudden - the term height comes into it - gravity gradient. I don't feel that till I come through that dome feet first. Much more so in the early part of the mission than now. Strangely enough, I also sometimes feel that up in the MDA when I am looking out of the EREP window with my body parallel to the X axis and my feet toward the OWS. I then look down toward my feet and all of a sudden I feel as though I'm looking down a long tube. And I mean down a long tube, not just along a tube, but down it. And there is a gravity gradient and if I step off the little platform, why I - I'm going to go whistling all the way on down. I think that's - ... real tough time trying to figure out where the heck I ever would come up with that sensation. And then I remembered all the testing which we've done down at the cape where that was the orientation that the whole vehicle was in. And in the MDA, even though we had a lot of hatches, and ladders, and all that good stuff in there, in the MDA when you look down in that manner it was really down. And I think that's where it has arisen. If we never had the one-g background in that

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-II
FOR: A. ARCHITECTURE
12. Locker Doors/Fasteners

TECHNICAL CREW DEBRIEFING
5.0 Workshop Activation & CSM Powerdown
5.2 Mission Day 3

CONRAD: Then we had AM/OWS VCS duct installation. The only comment I have on that is, the two center Calfaxes don't engage. You have to plug in at the OWS end and you have the four Calfaxes that hold the other end on the airlock module duct. The two support Calfaxes just don't fit - just like in the trainer. Yes it was fit-checked apparently at the Cape, but I think there's some normal distortion. It's no big deal, though; it works fine.

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SWS SYSTEMS DEBRIEFING
PAGE 24-25

SPEAKER: Do you have any comments on the fiber-glass stowage containers that are used in the airlock as far as being sufficiently rigid? Did you find any problems with the lids flexing or any problem like that?

PLT: Well, the only one that, I think, that we had problems, with and we've had problems with it in the simulator, in the trainer, is that 202 box. Isn't it 202? When you move the whole box, you know. It's got a cover on it plus it's got the two calfax so you can swing it down and get at the ATM C&D loop, right? And it's a real pistol to get it hooked back up just like it is in the trainer.

SPEAKER: Calfaxes don't align properly, is that it?

PLT: That's right.

CDR: Other than that, we didn't have any fit and function problems with any of those hatches that I can think of.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-II
FOR: A. ARCHITECTURE
12. Locker Doors/Fasteners

SWS SYSTEMS DEBRIEFING (CONTINUED)
PAGE 24-25

PLT: Well, how about the lids on the stowage spheres, they are fiber glass, right?

CDR: Stowage spheres? In the airlock?

PLT: The LSU stowage spheres.

CDR: The 310-311.

SPT: They are OK if they are not loaded by the connectors.

CDR: Yeah, it's the LSU's that are loading those things.

PAGE 52

SPEAKER: Were there any problems experienced with the operation of the film vault in any way? Latches, hinges, drawers sticking?

CDR: The doors were difficult to operate, because they had a tendency to want to be open about one inch. Therefore, they hung always on the little butterfly clamp. If you opened the butterfly clamp fully, you still had to lean against the door to pull the clamp off to open the door all the way, and like Paul says "It wasn't the world's greatest design, putting the hinge line down center. You know, to open those doors. And the other thing was you had to be damn careful where your toesies were or you would get them pretty well pinched under those doors.

PAGE 132-134

SPEAKER: I think you commented somewhat on this before --- the lack of standardization of fasteners causing confusion and problems. I think it was with respect to electrical connectors in particular, the

(CONTINUED ON NEXT PAGE)

SKYLAB MAN-MACHINE DATA FROM MISSION SL-II
FOR: A. ARCHITECTURE
12. Locker Doors/Fasteners

SWS SYSTEMS DEBRIEFING (CONTINUED)
PAGE 132-134

SPEAKER: zero-g connector and some of the other boxes. How about the other --- just the fasteners and so forth like that. Did that really bother you very much?

PLT: I don't think it really bothered.

CDR: Well, you've maybe gone out to your car and start to take it apart. You've got all kinds of fasteners on it and there's something. You probably have trouble psyching them all out because you don't usually go out to your car and take it apart. I guess we had enough training tasks that every time we cycled through the same one again, it was six weeks later. It was almost like a new task. In one sense, it's not a --- you know you can't tear up the whole world and spend zillions of dollars trying to invent universal fasteners and everything. I suspect this is something we are going to live with but when you can use the same kind, and keep the number to as few as possible, you're just making it easier to do, especially unscheduled maintenance or unscheduled tasks that you are not going to train on all the time. The other thing is that some of them were delicate. There is no doubt, you know, you really should know what it was you were doing when you operated those things or you would break them. Like the television input stations, the microdots. You know, put a microdot on the wrong way you could goof it up easily. And you're in a place, because you're up there, you're in a place you can't replace, it's not like, you know, I screwed that one up and you jump in the car and run to the local store and get another one.

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-II
FOR: A. ARCHITECTURE
12. Locker Doors/Fasteners

COROLLARY EXPERIMENTS DEBRIEFING
PAGE 75-76

SPEAKER: What did you do with the 190B lid, Joe?

KERWIN: 190B lid? I operated it per checklist. I snapped it with that little elastic snap strap when it was opened and just tucked that thing back in temporary closing.

SPEAKER: Did you use one or more snaps through the closed strap?

KERWIN: You mean of those dial latches? When I finally closed it up, I tried to get them on; I think I did. It's a very hard lid to close, however. You can get it articulated over center and down, but it was very hard to get some of those latches to mate. I really had to bounce on the lid, to snap the latch on. But it wasn't interference from the camera; it was always that way.

SPEAKER: In a sense it was a different lid from anything else you've had, being articulated the way it was. We're wondering if it was any problem?

KERWIN: No, the articulation of it wasn't necessarily a problem.

*****

EREP DEBRIEFING
PAGE 15

SPEAKER: Would you comment on the magazine loading, cassette handling, and film vault operation?

WEITZ: I meant to mention that yesterday. That's a bad design on that film vault, requiring that one door be closed before you can open the other. They should have opened it the other way or something. No appliance manufacturer would ever sell a freezer or refrigerator with two doors that opened that way, but we got one.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-II
FOR: A. ARCHITECTURE
12. Locker Doors/Fasteners

EREP DEBRIEFING (CONTINUED)
PAGE 92

SPEAKER: Were there any problems encountered with the cover removal or reinstallation of the C&D panel?

WEITZ: On the C&D panel? We removed it or reinstalled it.

KERWIN: The cover doesn't come off the C&D panel.

SPEAKER: Well, this meant opening and closing.

WEITZ: No. None of us like dial latches I think. Of all the fasteners in the vehicle, I think the least favored were the dial latches, right?

KERWIN: Well, I'm thinking S190B when you say that. They were a pain in the neck. The ones on the film vault aren't too swift either.

WEITZ: That's right.

PAGE 95-96

SPEAKER: Were there any particular problems encountered with the Calfax fasteners on the stowage containers?

WEITZ: No. Surprisingly our experience with the Calfax was that they were relatively trouble free. I didn't even have any of them come apart on me. Did you? You purposely took the rings off.

KERWIN: I purposely took the rings off. The ones on the 310 and 311 in the airlock were troublesome, but that was due to fit rather than function. They were troublesome.

WEITZ: The ones that were troublesome in the trainer were troublesome in flight. But generally speaking they performed better than I expected. The answer to this is no.

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
12. Locker Doors/Fasteners

TECHNICAL CREW DEBRIEFING
23.0 Human Factors
23.2 Flight

BEAN: There's one kind of latch I consider unacceptable on the spacecraft. That's the kind you use to hold down the lid on the EREP C&D, or the hold down lid on the S019 AMS and optical canister boxes. Those things don't have any friction in the hinges. You've got about four dial latches on each of those lids. You've got to make sure you hold all those dial latches. They are unacceptable. You got to make sure you hold them all down, otherwise you can't get the lid open.

GARRIOTT: You would be if you had friction at the hinge point.

LOUSMA: The message is don't make hinges without friction in the hinges. In this particular case, you get three down and there is still one latched and you try to open the lid and you can't, so you put that one down and another floats up. Continuous nuisance. Another thing that works kind of hard is the place where you repressurize the nitrogen bottles for the maneuvering unit experiments. The stowage location of the gas pressure hose works very hard. You got to really pull and tug and it's better to leave it off.

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SWS SYSTEMS DEBRIEFING
PAGE 8-9

CDR: A couple of lockers didn't close very well. One of them was the water testing, 505 locker. Yes it was. It works like it does over here in the trainer, the door won't close. So we had to hold it down with tape. And another was the

(CONTINUED ON NEXT PAGE)

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
12. Locker Doors/Fasteners

SWS SYSTEMS DEBRIEFING (CONTINUED)
PAGE 31

CDR: Jack has commented about the dial latches, you might want to ---.

PLT: Yeah, I ---, No, we were able to figure out how to use most of the fasteners. The ones I thought were unacceptable were the dial latches. Not because of the dial latch, but because there was no friction in the hinge. If you had a lid that was held down by four of those things, why you would get three of them down and the other one would still be hooked up. You would unhook that one, then another one would be hooked up. It was hard to get the lid open unless you were lucky. It wasn't quite that bad, but they should of had friction in the hinge.

SPEAKER: They do that here, much less up there.

CDR: Just thinking about this, it would be definitely desirable to pick some of those up there and try to get them as a standard for Shuttle. For anything built new, it would seem to me it ought to be quite easy to do, to put out a spec for anything new. My guess would be for anything that we buy off the shelf, we should not attempt to change almost any fastener or anything about it. We found that the vehicle, I thought it was, over-optimized as far as convenience to use. Almost anything we came up against up there, we could surmount it easily or we would, or it was designed to be simple, and it was simple. So from that thought, goes the thought that anything off the shelf, we ought to just take it. I don't think they could make it too unacceptable when you really get down to it, as far as fasteners, tiedowns, the way the lid opens, any of that.

SPEAKER: The uncommonality that would go along with that is just a nit, then.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
12. Locker Doors/Fasteners

SWS SYSTEMS DEBRIEFING (CONTINUED)
PAGE 31

CDR: That's a nothing. It's just like it is with your home tool kit. I mean, you got tools from all different makers, and the lids open backwards and some of them don't even have lids. We way over - we spent too much time and effort making these things simple. We ought to make them simple when we build them, but if we don't we ought to forget it. Just take it and stick it in the thing and go.

PAGE 63-66

SPEAKER: Which of the stowage latches or fasteners did you feel worked best? Do you have any ones that you would like to see carried on?

PLT: We have some we don't want carried on, like dial latches.

SPEAKER: Dial latches, we got that one.

CDR: I think maybe the way to answer that, rather than just trying off the cuff do it. If you've got two or three fasteners up for grabs for Shuttle, or a space station. I would think it would be worthwhile bringing them over and letting the guys that have flown and fooled with them pick out two or three. Cause I think you could get a pretty good agreement, by the way, plus it would eliminate the problem.

SPEAKER: How did the Calfax work?

SPT: Just what I was going to say. Don't you think we all agreed that the Calfax were great?

PLT: If you could find the hole, they were all right.

CDR: They're OK. I wouldn't say they are the best we had.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
12. Locker Doors/Fasteners

SWS SYSTEMS DEBRIEFING (CONTINUED)
PAGE 63-66

SPT: I thought that for things that didn't need to be firmly tied down, like the front of the metabolic analyzer, all the medical gear was in there, you just close the door and give it a half twist. It didn't have to be tight because you knew you were going to be getting in and out a lot, and no vibration at all. I thought the Calfax worked as well as anything we had for that kind of a ---

CDR: What I would have preferred to see on there, one, was nothing, cause the doors didn't come open anyhow, or the same thing we had on all the ward-room ---

PLT: Wardroom doors ---

CDR: Wardroom things. The little snaps, they snapped and then you pulled and it opened. I thought that those were good things. I thought that the mag-netic latches that were EVA, had some good forces, magnetic latches around there would have been excellent. We've overdone it. You don't need a all those tiedowns. For example, on --- and I know it's launch in some cases - but maybe what we should have done for launch was put a band around it with a screw on the top and screw it tight. Then the minute we got to orbit, undo this metal band, or cut the metal band like you do on stuff that's shipped to you and then throw it away. The rest of it is just a magnetic latch or a snap latch, or something like that. To have six dial latches on something like the S019 is a waste of time and money and weight. We could have just strapped that thing in there and then cut the strap and thrown it away or untied a nylon bungee and throw it away.

PLT: If you had nice friction in the hinge, you didn't need any kind of latch at all.

CDR: That's right.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
12. Locker Doors/Fasteners

SWS SYSTEMS DEBRIEFING (CONTINUED)
PAGE 63-66

SPEAKER: How was the friction in most of the hinges on the doors?

CDR: Too low.

PLT: Too low.

SPEAKER: What about the film vaults in the MDA? Same thing, still too low?

PLT: There was no friction, I don't think, in the film vault doors. At least, when you started them swinging, if you didn't stop them, they'd go clanking against the other one.

SPEAKER: --- the MDA?

CDR: That was in the MDA.

PLT: I think Owen probably got in that one more than anybody else.

CDR: I thought they were OK, by the way.

SPEAKER: I think a little magnetic latch would have been all that was required, instead of these pip pins.

CDR: Yes.

SPEAKER: Oh, OK.

SPEAKER: Those pip pins that were used on most of the MDA film vaults.

SPEAKER: Right.

CDR: Use a couple for launch, taken them out and throw them away, and that'd be the end of it.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
12. Locker Doors/Fasteners

MISSION DAY: 9 DAY OF YEAR: 328
MISSION TIME: 19:53:43 GMT

PLT: PLT reporting a jammed GM transporter number 6. I had to take the transporter apart and build it again inside the transporter. Also I'd like to comment on the efficacy of the film vault in so far as restraining or retaining or holding the items that are placed into them. There are a couple of - I can pick out three what I consider to be major design error on the design of the film vault. One is the total lack of engineering mass harmony between the bulky, heavy, massive doors and the tiny useless dial latch that's used to hold them closed. The dial latch is continually coming loose; you can slam the left side of the film vault and the right side will come open, which is a hazard to the film. So the two dial latches were very, very poor choice in so far as the latch to hold the doors closed and jeopardized the storage of the film. One of them is broken; the one on the right side is broken and it's been taped in repair. And this is the one that continually flies open when you close the left side. Unless you notice it, you can walk off and leave the right film door ajar. It has been seen to swing open as far as a foot and a half. By the way, during activation that door was found open, so the film that was in drawers B through L may have been exposed to considerable radiation, and as I say, this is due to a - what I consider to be an inexcusable design error in using the dial latch to hold those doors closed.

*****

MISSION DAY: 10 DAY OF YEAR: 329
MISSION TIME: (330)02:56 GMT

CC: Bill, while the EREP people are working over your EREP comments, I got a bunch of other questions for you here. On the film vault, could you verify that it was the right door that was open, and give us an estimate of how far that door was open, that you found on the activation.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
12. Locker Doors/Fasteners

MISSION DAY: 11 DAY OF YEAR: 330
MISSION TIME: (331)03:59 GMT

CC: side. That's one possible fix to the right side. Another fix you can apply to either side is to go to E623, 2 Alfa and pull out three inch piles of sticky back Velcro put those on either - both sides of the opening of the door. And then cut about 6 inches of Velcro hook off of that and use that as a latch.

*****

MISSION DAY: 13 DAY OF YEAR: 332
MISSION TIME: 17:34:01 GMT

NOTE: M487-2A

PLT: Now the closing of the doors on our lockers in the wardroom the wardroom and the sleep compartment type and the tool container type drawers. Now these are the lockers that have the 700 numbers on them and the 600 numbers on them and the 900 numbers. Those things are very, very poorly designed in that they - you don't get a positive latch, and sometimes they stick and sometimes they - even the slightest thing jammed in the side of them, of course, they're difficult. I think the thing is just a little - the latch is just too delicately designed. They also fail; we've had several that - I have one in my lock compartment that I can't use.

MISSION TIME: (333)03:37:27 GMT

NOTE: M487-2A

CDR: I think up here in the - I'm sitting in the forward compartment of the workshop at the moment, and I'm looking at the safe - the film vault. Now that thing has got deep drawers and deep doors and a neat restraining system outside. But I wouldn't give you 2 cents for the latches that hold the doors, and I would give you less for the restraint provisions

(CONTINUED ON NEXT PAGE)

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
12. Locker Doors/Fasteners

MISSION DAY: 13 DAY OF YEAR: 332 (CONTINUED)
MISSION TIME: (333)03:37:27 GMT

NOTE: M487-2A

CDR: inside the drawers where you got to put cameras and odd-size film magazines.

*****

MISSION DAY: 68 DAY OF YEAR: 022
MISSION TIME: 12:42:31 GMT

NOTE: M487-2D

PLT: And as far as dial latches are concerned, I think they're terrible. They don't work a lot of times; they - the little things - the dial latches on the S019 equipment, on the film vault door, and the S063 vault 512, I think it is: all around those things have - they - they're just a lot of trouble. I don't particularly like them. And I just - I guess that I shouldn't criticize something without - without making some suggestions for something better, but we're probably going to live with those for a-while. I don't like them. And also the little dial latches that hold the hoses for the OWS water system: I don't know. I'm at a loss to suggest a better system, but I think the idea of standardizing those things is great.

MISSION TIME: 13:48:44 GMT

NOTE: M487-2D

PLT: Some of the latches - I was mentioning dial latches, the type of dial latches that's on the film vault, the water purification compartment container, the T025 and various other pieces around and how those - the S019. Those things you undo them and they flop back. And then by the time you get ready to open the door the thing has bounced back and re-engaged itself. That's one thing that's sort of an irritation

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
12. Locker Doors/Fasteners

MISSION DAY: 68 DAY OF YEAR: 022 (CONTINUED)
MISSION TIME: 13:48:44 GMT

NOTE: M487-2D

PLT: to keep pushing the things out of the way. Another is that they seem to get out of adjustment. And this is not so bad on the type that's used on the S019 film vault, although we have had an awful lot of trouble with the ones on the film vault. I don't know why, I just don't particularly like those. And I don't like the little ... the ones that have the - it's sort of like a wing nut only they're a dial-like type thing. You always seem to be just short of getting far enough with the thing because there's a limitation in the wrist-twist motion in movement. Instead of moving (?) it, you keep going with the wrist. The Calfax are other headaches. The little washer on the opposite end is always coming off. Awfully hard to line the things up. I think that's not the fault of the dial latch. I think it was mismatch of hardware. But the access for the water --- The - let's see what was I going to say - access for the mol sieve compartment for water - the water reservoir for the ATM. That compartment is very poorly aligned and the Calfax is very difficult to get in position. OWS heat exchanger access: one of them, we never could put in.

One of the other things that I dislike very intensely about the little wing nut dial latches, the type that are used for retaining the OWS water system ... that they're too small. They end up hurting your fingers. In the event - it seemed like they were a little bit more than - well, first off, you could - you go past the engagement point, it looks to me like. You could continue - if you twist it too hard, you would release it again. Either that or I wasn't in just the right position to start with. Anyway, that's enough on those. And Calfax didn't appear really to do the job. The OWS heat exchanger cover: one Calfax we could never get tightened down. The ATM water reservoir access: we never got that compartment

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
12. Locker Doors/Fasteners

MISSION DAY: 68 DAY OF YEAR: 022 (CONTINUED)
MISSION TIME: 13:48:44 GMT

NOTE: M487-2D

PLT: installed. I got it once; I got it in one time, I think. We used ... tape after that so the Calfax were virtually useless. As I say - and I don't know if it was the fault of the Calfax or it was the alignment of the hardware. But the Calfax require - they were it was on the end of a rod ... the fastener part of the Calfax. The little engagement part was on the long end of a rod which extended back through the water - the ATM waste reservoir access compartment which was actually another stowage container. The whole thing hinged out. And so the problem was that there is the Calfax engagement bit, or whatever it is, was on the end of that long rod. And, of course, if the compartment itself was not aligned perfectly at the interface, then you couldn't get the Calfax engaged.

MISSION TIME: 18:22:37 GMT

NOTE: M487-2D

CDR: Two things about the dial latch that are a bother: number 1, like for instance, the film vault door. You got that little bitty dial latch holding that big heavy door, and when you're closing that big heavy door, if the dial latch manages to float - that is, up against the door, and you close the doors, it is quite frequent that latch will be between the door and what you're closing it on and you bend the dial latch or you jam it on the opposite surface and cause it to shift its position on its mounting screws and then you have a dickens of a time getting the dial latch hooked over its little plate. That's a real bother. Another thing is the dial latches on a lot of these boxes, they they float. They need to have friction in the lower hinge. Because you undo one dial latch and then you move to the next dial latch and undo that and the one you just undid may float

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
12. Locker Doors/Fasteners

MISSION DAY: 68 DAY OF YEAR: 022 (CONTINUED)
MISSION TIME: 18:22:37 GMT

NOTE: M487-2D

CDR: back and re - rehook itself. And you think you got all 2 or 3 or 4 dial latches undone, and you pull up on the handle on the door that you're trying to close and nothing happens. Then you got to go back very carefully, get them all off, make sure they're all off before you can open the one that you want to get to. And that's a time consumer - that's a real waste. I think I mentioned that to you in an earlier briefing when I was howling about the film vault and I still feel just as emotional about that dang thing. We really let a bad one get by when we didn't force the issue and require that retention in the drawers be taken care of and a decent latching system be used on the doors.

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
12. Locker Doors/Fasteners

TECHNICAL CREW DEBRIEFING
5.0 Workshop Activation and CSM Powerdown

CARR: We had trouble with the workshop airlock module. We always had trouble winding up those Calfax.

POGUE: That's right. At the end of the fourth EVA, I learned the easiest way to do it. There was no easy way; only a best way.

11.0 Command Module Systems Operations
11.8 Mechanical

CARR: I sure liked the pip pins we used in the command module. It sure beats the other fasteners that are available elsewhere in the workshop.

12.0 Saturn Workshop Systems Operations
12.4 Crew Systems

POGUE: Calfax fasteners are a root factor in maintenance because we were always undoing Calfaxes during routine maintenance. Some of the Calfaxes had a square fitting inside, some of them had a hex fitting, and some had no fittings. I don't like Calfaxes because the single point failure in the Calfax is a tiny washer on the other side of the business end of the Calfax. These things were always coming off and causing us problems. We were losing them. Unless that problem can be corrected, I think Calfaxes are bad things to have in a spacecraft. Also, they were poor to fit. We had a couple of places in the spacecraft where we never did get the pieces of hardware to fit properly. One of them was the ATM access to the coolant loop reservoir, panel 202.

GIBSON: We used tape to hold that thing in place.

POGUE: The other one was the cover for the OWS heat exchanger panes. My fingers were usually sore for 2 or 3 hours after I did that one. There's no reason for this to be that difficult. You should

(CONTINUED ON NEXT PAGE)

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
12. Locker Doors/Fasteners

TECHNICAL CREW DEBRIEFING (CONTINUED)
12.0 Saturn Workshop Systems Operations
12.4 Crew Systems

POGUE: be able to close a door with minimum effort if there's a fitting or a fastener on it. This was not true, and we had trouble with Calfaxes all around the spacecraft. You ought to be consistent. If some of them are square tool receptacles in the center of the Calfax for freeing a stubborn Calfax, then they all ought to be square or they all ought to be hex.

POGUE: Cam locks, the little wing nut in the water system and several other places, were difficult to operate. They were stubborn and an irritation to work with. You'd turn a cam lock wing nut with your fingers as far as you could turn your hand, and it always seemed like you ought to turn it another 10 degrees to get the thing to lock. You always ended up trying 2 or 3 times before you got the cam lock to engage properly. The idea looks good, but in practice, it turned out that they were an irritation to work with.

CARR: You should avoid mixing different kinds of fasteners, cam locks, Calfax, and that sort of stuff; it is undesirable. Standardization is a watchword for the future because it does simplify maintenance and procedures.

GIBSON: That's true. Even if you end up with one that does have some idiosyncrasies to it, you become accustomed to it and learn how to replace it rapidly. The way it was, we had so many different kinds of locks that when one malfunctioned, we couldn't have many replacements for it.

CARR: The idea of using those little cam locks to hold the big heavy doors of the film vault closed is ridiculous.

GIBSON: We needed something that was rapid, easy to use, but yet did the job. Those fell short of it.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
12. Locker Doors/Fasteners

TECHNICAL CREW DEBRIEFING (CONTINUED)
12.0 Saturn Workshop Systems Operations
12.4 Crew Systems

POGUE: The comments we've been making about cam locks applied to the dial latches, too. The dial latches had a very irritating feature in that, if the compartment had several dial latches, you'd open all the dial latches and as you'd start to pull the door open, the dial latches would flip back over and catch again. You had to open them all up and hold them in position.

GIBSON: I had that problem on the ETC box where we had seven or eight dial latches. I usually ended up closing down one or two, but some of the other ones would become engaged anyway from time to time. It was a juggling act to open that box.

CARR: I think hinge friction on that thing would have solved the problem, where you'd have to physically move it away and it would stay where you put it.

GIBSON: That's right.

CARR: One area we got bit by was the film vault door being so heavy; the time that you banged Bill's foot with that door. That's a heavy door. You have the danger of locking your foot in within the envelope of that door, or doing it yourself, moving the door and not realizing there's a foot in the way. When you have the foot locked and the door's moving with all the inertia it has, it is dangerous. I'm surprised we didn't hurt somebody with that.

14.0 Inflight Experiments
14.3 EREP Experiments

POGUE: Fly the red flag on camera shields. Those little fasteners were terrible. They were always snapping shut when you wanted them to stay open. They were always difficult to close and to move from

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
12. Locker Doors/Fasteners

SWS SYSTEMS DEBRIEFING (CONTINUED)
PAGE 305-307

CARR: - on the lever - on the handle in order to unlatch the door.

QUERY: Okay, now one other thing on that, on the freezer I guess there was a piece of metal foil tape, you know, like so wide, that went around the freezer itself that the rubber seal stood against. Did you notice that previous crews cleaned this freezer or anything? That thing wasn't meant to be cleaned as you know. Did you see any apparent mechanical degradation of that foil? Was it torn, anything like that that might accelerate an ice problem?

CARR: Yes.

POGUE: Very definitely.

CARR: And we did our bit on it, too.

POGUE: That's right. We sure didn't help it any. And I would suggest that in future systems you have removable ones, replaceable ones. Either that or get a hot - have a frostfree or self-defrosting or something, because that was a real problem. It's hard to get to, too. I think we've already mentioned that little inner door there; that really presented a problem.

PAGE 403-405

QUERY: On the various latches and fasteners that we had inside, did you see any particular ones that you'd like to flag as really good or really bad? You mentioned the dial latches and the Calfax in the tech debriefing ...

CARR: The dial latches were just too doggone fragile. The Calfax were too fragile, too; you kept losing those little bitty washers, the grip washers, on - that retain it - the canister.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
12. Locker Doors/Fasteners

SWS SYSTEMS DEBRIEFING (CONTINUED)
PAGE 403-405

POGUE: Not only that, but the alignment of a Calfax is extraordinarily critical. There were - the heat exchanger vane - OWS heat-exchanger-vane cover panel, I think, had four Calfax on it and then one hinged panel - one hinge line. There was one Calfax that - I don't know if any of us ever got that one in. And there was only one order of tightening which would work in attaching that cover, which - and I can't see that it's much different than it was when it left the factory. There was another area - this has nothing to do with EVA, but the ATM coolant reservoir, we never could get those to work; they flat - we just couldn't do it. But I didn't like the dial latches for that reason.

QUERY: The Calfax is supposed to have 1/16 of an inch of slop around. And we noticed that most of the complaints are around that little ring that carried them on ---

CARR: Uh-huh.

QUERY: --- because it seemed to come off.

POGUE: Cam locks also gave us fits.

CARR: The most handy doors to open and close were those big lockers in the MDA that just had a - two big pieces of metal that closed over each other, and you ran a pip pin through them. Super simple.

QUERY: The film vaults.

CARR: Yeah. I don't know why you didn't have that on the film vault down in the workshop or nothing but just a plain old bar-over-the-hook gate latch to hold it shut. But those little Calfax, it - it ever swung closed while you were swinging the doors closed. And you'd hit it. It got inside ---

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
12. Locker Doors/Fasteners

SWS SYSTEMS DEBRIEFING (CONTINUED)
PAGE 403-405

POGUE: Fit tight.

CARR: It just bent it. And then you'd have to straighten it out, loosen the screws that hold it, and readjust the whole thing.

QUERY: Okay. How about the - Let's see. Internally - we didn't have any magnetic latches internally, really; we had some on the outside, on the ATM doors. The ---

CARR: Yeah, if it doesn't screw up your instrumentation, those magnetic latches are a very good way of latching.

PAGE 415-417

QUERY: Okay. Were the friction and detent provisions on the stowage container doors and the hatches and all satisfactory?

POGUE: No. The M131 door, the latch on that thing gave us trouble. In fact, I don't think I ever got that thing latched. We always pushed it up there in position. The T025 - When you have the cam lock latches on four or I guess three sides of the door, almost always one of them is out of view. And the thing has so little friction in the cam-like hinges - the cam-lock hinges - that they would flip back and reattach themselves after you thought you had unfastened them.

CARR: These were the dial latches.

POGUE: I'm sorry, dial latches.

QUERY: The dial latch problems - we got that.

CARR: Should have put friction in the hinge.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
12. Locker Doors/Fasteners

SWS SYSTEMS DEBRIEFING (CONTINUED)
PAGE 415-417

QUERY: How about the friction in the - for the MDA film vault doors, the friction on those? They're pretty good?

POGUE: Yes.

CARR: Yes.

POGUE: No problem on that.

CARR: They'd stay where you left them.

*****

EREP DEBRIEFING
PAGE 12

NOTE: S190A

POGUE: The covers were poorly designed. The slip pins were continually causing us problems. When we wanted them in they'd stay out and when we wanted them to stay out, they'd pop in. They were always in our way.

*****

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
14. Passageways

TECHNICAL CREW DEBRIEFING
11.0 Command Module Systems Operations
11.8 Mechanical

CARR: Tunnel: I had no problems with the tunnel with the probe, drogue, and everything; the tunnel is nice and smooth. There aren't many projections in there to bother you. The only time I felt a lack of lighting was at the point where the probe and drogue were in and I was trying to put the hatch in, then the tunnel lights were useless. In this particular tunnel, if you could retrofit the command and service module, you could probably put some more tunnel lights in the area toward the vehicle from the hatch so that when you're putting in the hatch, you've got some light, too.

12.0 Saturn Workshop Systems Operations
12.4 Crew Systems

GIBSON: I think the traffic pattern that we had was not very good. In a building here on the ground, you have a hallway with rooms going off on either side. Up there, essentially, we had rooms with the hallway going just about right through the rooms. If I went out to the head in the middle of the night, I went through their sleep compartments, and I don't think that was proper. I think you ought to construct all the rooms in the vehicle off of a hallway.

*****

SKYLAB MAN-MACHINE DATA FROM MISSION SL-II
FOR: A. ARCHITECTURE
16. Storage Volume/Access

MISSION DAY: 15 DAY OF YEAR: 159 (CONTINUED)
MISSION TIME: 23:47:56 GMT

NOTE: M487-3B Forward/Dome Compartment

PLT: always find something to grab hold of and hook a hand on for all the longer you have to be in one of those F523.

NOTE: M487-3B Airlock Compartment

PLT: Stowage volume doesn't apply.

*****

MISSION DAY: 19 DAY OF YEAR: 163
MISSION TIME: 14:06:24 GMT

PLT: This note is for the stowage and configuration people. And the M487 people may also be interested in it. N - On the inside of the door to locker W742 was a Beta cloth pouch that held extra pens, pencils, and markers. This thing was always in the way. It interfered with proper closing of the door and consequently was getting pretty well beat up on the top. Now that - because that is the flight data file locker that is most used. Therefore, to get around it, this pouch has been moved from 742 to W743.

*****

MISSION DAY: 20 DAY OF YEAR: 164
MISSION TIME: 15:17:50 GMT

PLT: This is the PLT with a short note for the configuration and the photo people. The teflon inserts that go in drawer B - drawer Bravo, to hold the cassettes are continually coming out be moving toward the aft end of the drawer. This was hopefully alleviated today by putting a strip of gray tape along the underside of the drawer such that the inserts cannot move aft. That's all.

*****

SKYLAB MAN-MACHINE DATA FROM MISSION SL-II
FOR: A. ARCHITECTURE
16. Storage Volume/Access

MISSION DAY: 27 DAY OF YEAR: 171
MISSION TIME: 09:52 GMT

CDR: Take a note to talk to me when I get back about locker A-8 and all the cushions in it, where they're supposed to go, and for the back part of A-8 H Alpha 1, S056, 52 and (garble) 54 and all that business. It's kinda goofed up.

CC: Okay, will do, Pete.

CDR: (Garble) the lockers and the straps don't match is what I'm trying to say. And I've been puzzling over it for a long time, and I think I'm right.

CDR: Hey Hank, CDR.

CC: Go ahead.

CDR: I faded out. They put the S056 cushion where the H Alpha 1 cushion should have been and vice versa. Now once I got that sorted out, it all makes sense.

CC: Okay, copy.

CDR: The reason that happened is both cushions look to me like they're almost identical. And they have three black alignment marks to line up with three white alignment marks in each place, and they're interchangeable. And somebody just got them in backwards.

CC: Okay. You think it's gonna work all right once you got it reconfigured there?

CDR: Now that I got the cushions sorted out, it all matches up with the drawings on 3-5, and everything is super.

*****

SKYLAB MAN-MACHINE DATA FROM MISSION SL-II
FOR: A. ARCHITECTURE
16. Storage Volume/Access

TECHNICAL CREW DEBRIEFING
14.0 In-Flight Experiments
14.1 Medical Experiments

KERWIN: M092. Stowage: we could cover that for 92, 93, and 171 also. The leg bands had rather complicated stowage inserts. They were not convenient to use and tended to get the line tangled up. In some cases it was hard to close the drawer after you put the leg bands back. The rest of the stowage for those experiments was okay.

*****

SWS SYSTEMS DEBRIEFING
PAGE 12

PLT: I got a question. What do you guys pack those clothing modules with, the same ram you pack the main chutes with? (laughter)

PLT: Man, I pulled that first pile of stuff out ---

CDR: Pulling the first one out with a lot with it, you'd never get it back in again. You gotta get to about day 14 before you can handle anything in there.

SPEAKER: Was that a real problem?

PLT: No, except like Pete said - I tried to pull one set of skivvies out and got the whole section out. I wound up with clothes in two lockers for about half - fourteen days.

CDR: Either that, or if you pull a pair of socks out they grow to about size 98 (laughter) as you're pulling them out and holding everything else in.

PAGE 118

SP: Were there any mechanisms or stowage locations that had an accessibility problem?

SKYLAB MAN-MACHINE DATA FROM MISSION SL-II
FOR: A. ARCHITECTURE
16. Storage Volume/Access

SWS SYSTEMS DEBRIEFING (CONTINUED)
PAGE 118

PLT: Yeah, film vault.

SP: OWS film vault?

PLT: Yes, because of the way the doors open. You had to have one closed to get the other one open.

CDR: Plus this moving I you know, they have those cam-locks on them and the doors always had a tendency to be open a little bit and they were always against the cam-locks and you had to push to get the dial latches or whatever, to get them open.

SP: OK, the rest of those have been answered. Was there any bumping that you noticed, particularly head, elbows or otherwise due to the cluster lay-out and installation?

PLT: No.

*****

EREP DEBRIEFING
PAGE 15

WEITZ: Film vault operation: this is from an EREP point of view, pretty straightforward. The magazine drawers all worked normally; they came in and out easily. The teflon inserts in drawer E worked as advertised. The inserts in the drawers K and L worked fine. Everything was nominal.

PAGE 96-97

SPEAKER: Were there any particular problems encountered with the accessibility, removal, or reinstallation of the stowage items such as the optical adapter, the TV optical adapter, the gloves, the filter, film tape, and so forth?

SKYLAB MAN-MACHINE DATA FROM MISSION SL-II
FOR: A. ARCHITECTURE
16. Storage Volume/Access

EREP DEBRIEFING (CONTINUED)
PAGE 96-97

WEITZ: Generally speaking, I didn't like the arrangement of the lid on the upper lid, the one that fit over the desiccants. We always had to get down under it to get out what you wanted because it didn't open up far enough. The desiccants themselves were difficult to restow. The holes in the mosite were large enough that they wouldn't hold the desiccants by themselves, which I can understand. But, once you cut open one of those bags, then it was too big to put the desiccants back in. What you end up doing, is taking the desiccant out, cutting the bag in half, and sticking half of it back in the hole, and throwing the other half away. That's part of our overall problem with mosite. Someone asked me about mosite. Generally, we had no big problems with mosite and I don't know why whether it's because it finished outgassing and didn't expand anymore or whether we properly applied our altitude chamber experience and got it so it works right. But the fit of the tools in the drawers was good, the CCUs and their container. I never got into the 151 container where the lightweight CCUs were.

KERWIN: I went in there maybe once and got some out and there was no difficulty. The only difficulty with mosite, I remember, was some of the smaller tools in the experiment compartment tool kit, the skinny Allen wrenches were too small. They weren't properly secured and they floated out every time you opened the drawer so we put gray tape over them. Most of them fit very well.

*****

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
16. Storage Volume/Access

MISSION DAY: 21 DAY OF YEAR: 229
MISSION TIME: 22:04:36 GMT

NOTE: M487-3B Wardroom Compartment

CDR: Stowage is good. We got a lot things stowed in there that we don't use very often, like clothes, towels, and like I think maybe ah, if we could somehow stow that food there, moved it from one side of the room to the other, instead of moving from upstairs to downstairs.

NOTE: M487-3B Waste Management Compartment

CDR: Stowage volume, not near enough in there, all these things that are in use are stowed there, any time you want anything else, you have to get it, from somewhere else, and move it down there in a small basis. You can only have about four or five towels in there at once; you use one a day. Another feature that would be nice - no real good stowage for - you open it - open the door and then there's your dop kit, then you got to open four flaps on your dop kit to get anything. There should have been some good stowage there for shaving cream, shaver, and all that. Now, you can make it because there's female velcro in there and you put a male velcro on your equipment, which I did. But still it would have been better to have spring bungee things inside some of those compartments, and called them the cabinet for your personal equipment and just put it in there, instead of in a bag that's in the near 2.

NOTE: M487-3B Sleep Compartment

CDR: Stowage volume and access, you got lots of stowage in there, and most of your personal equipment

NOTE: M487-3B Experiment Compartment

CDR: Stowage and access, needs a little more stowage volume, we've got tools in there and trash bags and all that, it would be nice to collect all the trash bags

(CONTINUED ON NEXT PAGE)

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
16. Storage Volume/Access

MISSION DAY: 21 DAY OF YEAR: 229 (CONTINUED)
MISSION TIME: 22:04:36 GMT

NOTE: M487-3B Experiment Compartment

CDR: in one place, it's easy to find them, now they're kind of throwed here and there and if you want a trash bag, you gotta remember where they are, if you want it, and there's about four places, when one runs out you got to remember that next time. You're not the fellow that ran it out, so you don't remember it and he does, so it takes three different people traveling there once to find out it's empty.

NOTE: M487-3B Airlock Compartment

CDR: I think there's need not for trash collection provision but stowage provision that you can use EVA. Now we sit here and ... not because the handrails are tied to the handrails with straps, now that's a pretty poor way to do. We had some nice pocket springs and ah, restraints built in, where we could snap the stuff, or catch the stuff, and not have to put tethers and things all over them, unless you really needed them outside, it'd be much better, and it'd also be more organized, also you would ticket and then center it. There's just a lot that needs to be done to that lock compartment to make it type that you'd really want to use. Now I'd have to say that it's okay to do our job, but we're trying to get improvements here and I would say as a result of that thought, that it just, it just needs a shape redesign and a whole concept redesign. Stowage volume, we just talked about.

*****

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
16. Storage Volume/Access

MISSION DAY: 22 DAY OF YEAR: 230
MISSION TIME: 16:27:56 GMT

NOTE: M487-3B Sleep Compartment

SPT: Sleep, trash collect - sleep compartment - all that looks reasonably good. However, all the stuff that you need to have stowed, you need to have little compartments or cubbyholes or things for it. It's a nice job packing all that amount of clothes into that little tiny spot, but every time you pull out one, why you pull out a whole fist full. We need to have a spot where we could stow things. There's that one big locker up at the top that's got velcro around the sides, but I think it would be better if it were divided it into four - four smaller compartments or at least two or three compartments so that various things could be put inside them. And we also need to have, velcro tied to those things that need to go into them. For example - no - for example, that can of 133 equipment with the large syringe and needle and stuff. All that stuff is floating around in there, and I've had to just tape it down. It should have had some velcro attached so that you could put the stuff where it went - where it - where it belongs.

*****

MISSION DAY: 24 DAY OF YEAR: 232
MISSION TIME: 15:01:05 GMT

NOTE: M487-3B Sleep Compartment

PLT: Okay, storage volume and access. We're limited on storage volume in the sleep compartment. We could have used a little more storage volume for odds and ends that finally come your way, as far as clothes and shoes and biomed stuff and the tool caddy and all that. Cause you want to stow your personal tapes, and the music tapes, and a book or two and there's no good storage for the tapes in the sleep compartment which is where everybody stows their's cause they got extras in the ... now that the wardroom tape

(CONTINUED ON NEXT PAGE)

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
16. Storage Volume/Access

MISSION DAY: 24 DAY OF YEAR: 232 (CONTINUED)
MISSION TIME: 15:01:05 GMT

NOTE: M487-3B Sleep Compartment

PLT: recorder's broke, why there's no sense in having your tapes in there. The tapes just drift around in the locker. Should we slam the door, you could break one very easily. And you can never can find the one you want unless you go through all 18 of them. What you need is some little thing you can install in the locker in the sleep compartment to keep your tapes in, so that you can get at them and also, so you can know what they are. I was thinking of us having a catalog for each guy to use independently in the sleep compartment so you know just what's on each tape and grab the one that he wants. Or have some better way of marking them. The tapes come up and they're unmarked. Except for the ones that were launched, the others are unmarked. They just come in a cassette 1, 2, or 3 indications so there's no way of knowing what's on them unless you go through every-one of them. You can't file them like you would at home in a cabinet, and just look at the pages of them, like you would at a book to see what the title is. You got to go through the whole stash. So my suggestion is that you figure out some way to contain all these tapes and some way to mark them on the outside so that you know what they are, without having to go through the whole heap and have them float all over and then they float out of the compartment. You find 1 or 2 that drift, during the day, somewhere around the workshop. The rest of the stow ... like we said, we could use more stowage are in the sleep compartment. They're lockers that we do have in here that we're not using, are full of trash bags or some other thing like that, that you don't use very many of. And so you just don't empty those lockers, they're not available for personal use. There is no good way to stow your clothes at night. You can't stow everything on these little rubber towel holders because it floats all over and it just kinda gets in your face and everywhere. And so you need somewhere

(CONTINUED ON NEXT PAGE)

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
16. Storage Volume/Access

MISSION DAY: 24 DAY OF YEAR: 232 (CONTINUED)
MISSION TIME: 15:01:05 GMT

NOTE: M487-3B Sleep Compartment

PLT: to stow your clothes. It would be nice to have a locker to dump those clothes into. And normally, what I do, is I roll up my shirt and stick it behind the SIA and the light, wedge it in there. And my trousers, I roll them up, throw them in the trash compartment. And then I got T-shirt a pair of skivvies, I usually stick in the towel holder and they float around. And the shoes I still got a back down here with extra clothes in it that we brought up and I got that bunched into the deck and out of the way of the vent so I get some fresh air and I usually stick my shoes down there wedged in somewhere. But really not enough stowage area in the sleep compartment. Looks like we got enough over there in the wardroom. We're regularly using towels and things outa there. And some of those lockers could be used for other things. I've stowed the T002 in one of those lockers instead of folding it up every time and putting it back where it belongs, so, I take an empty locker and I stuff it in there. Now there aren't too many storage provisions are required in the pad area. The compartment where you keep the used fecal bags is a little too small. It should be emptying that thing all the time, seems like it's always full. And so that could have been a bigger area. Everything else.

NOTE: M487-3B Experiment Compartment

PLT: In the experiment compartment, you don't stow much extra stuff there either, and stowage volume that we do have appears adequate. The area will get things outa there all right when you need them. Up in the forward dome we started to use that extra stowage space up there. That's stowage seems to be adequate. The extra things we brought up however, are stowed somewhere on the wall or tied to this, that, and the other thing. And we don't really have a place to put them like extra ... and that kind of stuff is a kind

(CONTINUED ON NEXT PAGE)

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
16. Storage Volume/Access

TECHNICAL CREW DEBRIEFING
8.0 CSM Powerup and Workshop Deactivation

BEAN: When you get full urine containers in the waste management compartment, if they don't fit in the freezers flat on the floor, you have to sort of cock them up a little bit to get them to fit in. But it's no trouble.

12.0 Saturn Workshop Systems Operations
12.4 Crew Systems

LOUSMA: Stowage: I thought one of the places that had some good stowage and some bad stowage was the film vault. Some of it was very good, some of it was lousy. For example; the upper right drawer where you keep the handheld cameras. We had to improvise some straps in there, otherwise there were three or four camera and associated other items floating around every time you opened or closed the door. They bang against either end and against each other. That's not too good for Nikons and other precision instruments. That stowage certainly should be better. I don't know whether it's worth trying to take up some inserts to improve it or not. The other one was the S019, where we had one more film canister than we really had places to keep it. So every time you opened the drawer above it you could not close it without reaching down behind and pushing S019 back in its position or taping it.

17.0 EVA
17.3 EVA Post Procedures

BEAN: Some of those long, thin bologna like desiccants won't allow you to close the fecal drawer. If you don't have anything in the fecal dryer, and you close the door, that little black metal plate that the fecal would stand on sort of moves up, pressing near the top vent inside the drawer. Then, when the door closes, you will hear a slight vacuum sound, as the vacuum is pulled on the door,

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SKYLAB MAN-MACHINE DATA FROM MISSSION SL-III
FOR: A. ARCHITECTURE
16. Storage Volume/Access

TECHNICAL CREW DEBRIEFING (CONTINUED)
17.0 EVA
17.3 EVA Post Procedures

BEAN: sacks will be the ones we used and will be acceptable.

*****

SWS SYSTEMS DEBRIEFING
PAGE 7-8

SPEAKER: Beta cloth, the various fabrics on the MDA - webbing, straps, storage bags, table covers, etc. Did you have any indication of fraying or abrading of that material?

CDR: A lot of it. It was an incredible amount of beta cloth bags up there. I hope that on Shuttle we can do away with some of those bags. There must be 500 lbs of bags up there.

SPEAKER: Everything comes and goes in a bag.

CDR: I like the ones for the flashlights. To get at the flashlights you open a door. You pull out, you open a couple of beta cloth flaps then you pull out this beta cloth container that had two-fold locks and then when you do, the flashlights are in there --- completely overweight operation.

SPEAKER: But the bags themselves are OK and did not cause any problems?

CDR: Great problems - (laughter).

PAGE 32-34

SPEAKER: Were they conveniently located?

CDR: They were conveniently located, but I thought that they lacked a lot of trying to put all the tools in these two drawers. It would have been

(CONTINUED ON NEXT PAGE)

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
16. Storage Volume/Access

SWS SYSTEMS DEBRIEFING (CONTINUED)
PAGE 32-34

CDR: much better to get a little bit more room, and then have all the screwdrivers in one area; all the wrenches in one area; all the torque things in one place. For example, let's take Allen wrenches. We had Allen wrenches in about three different drawers. So if you came to do an Allen wrench job, you had to look through three drawers to find a wrench, the device, then maybe in the third drawer, some other drawer was the ratchet handle, and in a different drawer was the spin handle. So you had a little learning to do each time and you had to kind of hunt around for it. It would have been much better to say, "anything that goes with this ratchet handle is going to be in these three drawers, even though we're going to waste some space. Then the guy says "I need something that works with the ratchet handle." he goes to those drawers, opens them up, gets his gear together and goes. And that's kind of how you do it at home. You don't try to make every drawer filled, even if you have to shove in something that has nothing to do with what you're doing. That, to me, was the problem. I know it must have been with everyone else. Because you'd go over to the tool drawers, you'd pull out about four drawers before you'd find the drawer you wanted. Then you'd get the thing and go on. When you came to put them up, it would be the same sort of thing. You don't do that at home. I just open the drawer and it's just always in that drawer.

PLT: I thought I was dumb or something, because I never did learn what drawer to get in. And the writing was underneath that little lip. You're always looking down on it, you can't see the writing unless you look under like this. I was always pulling, like Al said, all the drawers out to find what you want to get.

CATALOG INDEX A-16

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
16. Storage Volume/Access

SWS SYSTEMS DEBRIEFING (CONTINUED)
PAGE 32-34

SPEAKER: There were a lot of, there were a number of tools put in that tool kit in the MDA because it was expected that that was where the work was doing. But, basically, what you're saying is that that was really not as important as having all the tools of a particular type in the same place. You would rather have them that way, than have them by a use location.

CDR: That's the most important thing. Because we never used the MDA tools unless the other tools didn't work, or somebody had them, or something. You always - just like you - you always go out to the garage, there's your tool box, you grab the tool, go back in and work on the thing. You don't hunt the one that's somewhere else, maybe stashed around.

PAGE 61-62

SPEAKER: On stowage and hardware restraints, did you experience any problems with any of the stowage restraints that you would like to comment on? Any particular things that you can identify?

CDR: Too complicated. Once more, we've overdone it. Spent too much money, etc. A lot of it is our office's fault, by the way, so we're not casting stones at Marshall or anybody else. A lot of it is our own doing. But, for example, the way we stowed the filters for the Waste Management Compartment, odor filters. You ended up having to take a tool up there to release them. It looked like a cheap, simple, structurally good way, seemed okay. Some of the things like the restraint for the tapes? It was okay too, except somehow it had marmon clamps, it had little levers so you could do it without tools. It was better. The one without tools was better, but if we paid a penny more for it, we cheated ourselves.
(CONTINUED ON NEXT PAGE)

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
16. Storage Volume/Access

SWS SYSTEMS DEBRIEFING (CONTINUED)
PAGE 61-62

CDR: We should have had them mounted in there the cheapest possible way because they were only used once, then go get a tool, unscrew them and take them out of there. We over-optimized a lot of this stowage. We used it once and we had folding hinges. All this fancy stuff. It was nice, but I don't think we want to do it. Also, there was a lot of padding in there, and a lot of bags within bags it would be nice to eliminate. Stowage was overdone. One of the nice things about coming home, or launching the command module this time was all those brackets and fittings and everything that was in there to put every little piece in its place that someone said you had to have to make it work right, we'd just end up with more stuff that wouldn't fit on them. So you essentially opened the door, shoved the stuff around in there and closed the door. It worked great; the thing didn't sink; none of the stuff got broken; and it was just great. That's just the way it had ought to be and all this. We had pockets for things and we really didn't need them. We got to get cheaper. How they going to do the Shuttle boxes?

SPEAKER: I guess there's a lot of work on that right now. I'm not sure.

CDR: I hope they have it where you open the door and it's either stuck in there with velcro or you just open it, throw it in and close the door.

PLT: Yeah, that's right.

SPEAKER: We are starting out with the same philosophy.

CDR: Think of the money you could save; the weight you could save. We had more weights in beta cloth bags than we oft times had in items. The example I used the other day was these flashlights. The

(CONTINUED ON NEXT PAGE)

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
16. Storage Volume/Access

SWS SYSTEMS DEBRIEFING (CONTINUED)
PAGE 61-62

CDR: flashlights we, if you wanted to go get a little flashlight, you opened the locker, then there was beta cloth couple of flaps you moved -- then you pulled out this beta cloth bag this big. Then you opened the flaps on this beta cloth bag and inside were these little flashlights, neatly stowed. The weight was tripled, cost.

*****

COROLLARY EXPERIMENTS DEBRIEFING
PAGE 24-25

QUERY: Did you have any difficulty in removing things that were stowed in Mosite?

LOUSMA: Yes, the one in the kit in the wardroom. They were stuffed down too tight and too deep.

GARRIOTT: And the temperature probe, the long scale.

BEAN: We did recommend that in all future tool kits you eliminate all Mosite beds, and have more space so that all tools that do same task are near each other. You should try to contain it in there with more velcro per tool and velcro on the kit itself. If we'd had that, it would have been superior to what we had. Another possbility is to use the Mosite with a lot of clearance around it then put velcro on the tool and in the little slots.

GARRIOTT: Some of the tools were loose in the tool kit.

BEAN: Yes. Things that we had nailed down by velcro were in good shape, particularly if they were in a drawer or something.

*****

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
16. Storage Volume/Access

MISSION DAY: 2 DAY OF YEAR: 321
MISSION TIME: 15:08:20 GMT

PLT: This stowage is killing me. Takes you 15 minutes to a half hour to get the stowage out of the way so you can throw one switch. I've got to get stuff out of the way, so I can open panels and everything. Man alive, this is really too much. I have to move 50 gullion things, to get one ---. I can't get the panels and things - like - took me 30 minutes to get to the LiOH canisters out. Cause I couldn't get to the grounding strap. And I never did carry anything back into A-6. I finally had to leave one piece out.

*****

MISSION DAY: 13 DAY OF YEAR: 332
MISSION TIME: 17:29:01 GMT

NOTE: M487-2A

PLT: Another one of the problem areas in the workshop is the abominably poor design of drawers and doors. I just can't believe how lousy the drawers rungs are. We get an awful lot of chatter - friction chatter in the film vault and it's just inexcusable, I would imagine; especially you'd think in zero g it'd be better. But we thrash and bounce and thump about our expensive camera because the drawer won't close properly. It seems to me to be inexcusable that we would spend money building something like the film vault and then put a dime store latch on the two film vault doors and then when we're activating the workshop, find one of the doors hanging open. Now I don't know if we jarred the door open or it had been open ever since a vibration or something shook it loose after deactivation from the previous mission. Also the film vault itself is very, very poorly designed for containing items. They're either too loose, too tight, can't get them out, breaking your fingernails off trying to get a magazine out; or there's no provision at all for holding things.
(CONTINUED ON NEXT PAGE)

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
16. Storage Volume/Access

MISSION DAY: 13 DAY OF YEAR: 332 (CONTINUED)
MISSION TIME: 17:29:01 GMT

NOTE: M487-2A

PLT: Cameras, there seems to me to be a need for some way of devising slots of movable partitions in a drawer to allow for varying volumes, because we have no way - I'd have to take a urine bag container, take the cardboard from it, and cut it up to make partitions for our film drawer. The straps are dull - no you can use velcro straps and they were in there, but there were not enough to handle all the equipment we have now. But a simple thing like drawers and doors has really impressed me as being very poorly designed. Now without going into detail, another area where the drawers are poorly designed is the tool boxes and the tool box compartment. And this applies back to the film vault. There are no partitions top and bottom between drawers; the bottom of the drawer above serves as a partition, and when it's pulled out, the item in the bottom - in the drawer below drifts free. It can get in the way of the drawer above, and when you get ready to close it - of course, you don't know this - but when you get ready to close it, then you close it on the item. Now if it's a nonfragile item, you have not lost anything. But it has caused you difficulty in that you're going to pull the drawer out, restow the item in a drawer below, which testifies to the fact that we have poor restraint capability. And the Mosite is not the greatest thing, since peanut butter as far as stowing loose items. Large items have 95, 98 percent of friction surface holding them and then it takes about a 100 pounds of pressure to pull them out. Small items have about, oh, 10 percent of a surface with friction contact with the Mosite and they drift free. Then we've got a complete spectrum of more or less resistance to pulling or drifting free of items that are stowed in cutouts. We've got a long way to go for making just simple cutouts for an individual piece of equipment. Back to the tool drawers. They slide freely but they also slide out, and I've pulled them

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
16. Storage Volume/Access

MISSION DAY: 13 DAY OF YEAR: 332 (CONTINUED)
MISSION TIME: 17:29:01 GMT

NOTE: M487-2A

PLT: out a couple of times. We talked about this before even when we're talking about M487. I don't like the idea of a drawer pulling free without having to take some action on my part. Also, it'd be nice if the drawer pulled completely out if you do have the restraint device as the drawers in the film vault do. They pull out; you can pull them all the way out of the container. Back to the film vault for a minute, something else I just recalled. The film vault doors open against each other in such a manner you can only open one at a time. Also, the thing has to be opened a full 180 degrees before you can pull the drawers free, I think that's a poor design. I know it probably was meant that way to save space between the two columns of drawers. In other words, they did not want to waste that volume in there. But in any event it does restrict your operation lead; you have to close one door and then the other. A lot of times you're transferring things from one side of the film stowage vault to the other, and this causes difficulty. Back to the film vault, and the trouble it's caused with items drifting free. I have jammed drawers into the S019 optical - I guess it's container couple of times, and it was completely inadvertent, I had no idea that the thing had drifted free, but one of those S019 magazines is not restrained. Anyway, I just can't overemphasize the fact that that film vault is just very, very poorly designed for restraining very, very delicate pieces of equipment.

MISSION TIME: (333)03:37:27 GMT

NOTE: M487-2A

CDR: Now the restraint provisions for 35-millimeter, and 16-millimeter, and 70-millimeter cassettes is neat. They're all very nice and neat and orderly and things slip in and slip out and are nicely labeled, and

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
16. Storage Volume/Access

MISSION DAY: 13 DAY OF YEAR: 332 (CONTINUED)
MISSION TIME: (333)03:37:27 GMT

NOTE: M487-2A

CDR: everything is in good shape. But we got a few drawers in there in which we have to keep Nikons and things like that. And there was just no restraint flexibility designed into these drawers. And you end up just putting things in the drawer, letting them float around and bump into each other, and every time you open the drawer, watch the goodies fly out in your face. Bill Pogue has spent many, many man-hours up here slaving over this vault, with cardboard, and knife, and scissors, and tape, and he is busy - has done a real fine job of fashioning the partitions in some of the drawers in order to hold down some of the Nikons and some of the other pieces of equipment.

I think that in future design of film vaults and camera-retentions facilities, that we should really give a lot of attention to flexibility of hold-down capability. Maybe what we need is some hold downs like the ones we're used - using the SMMD; that is, flexible rubber of teflon curtains that latch down and you could put a camera under the curtain and just bring the top over and latch it down and you've got a restraint. That might be just the thing you need in a drawer for odd-shaped Nikon cameras with flash attachments and all sorts of funny lenses on them. Stowage in the spacecraft, although there's lots of lockers, ring lockers, dome lockers, wardroom lockers all over the place, those facilities are very nice. The problem we have is the man. And that is learning to put things back where we got them and the other man problem is to keep track of these things on the ground so that when one crew comes up, you can generate a storage list that's readable and understandable. The stowage list this time I just don't think was quite adequate. We have made a few inputs on how it ought to be formated and the folks down there did the best they could, I think. Maybe they could have done more in giving us a better stowage book,

(CONTINUED ON NEXT PAGE)

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
16. Storage Volume/Access

MISSION DAY: 13 DAY OF YEAR: 332 (CONTINUED)
MISSION TIME: (333)03:37:27 GMT

NOTE: M487-2A

CDR: but on more than one occasion, we have looked up an item - for instance, disposal bags, or urine disposal bags, and found out, oh gee whiz, there's 56 of those rascals E-699. Well, I don't give a damn how many are down in the trash airlock that the crew's ahead of us threw down the crash - trash airlock. What I want to know is, where are the ones that are assigned for my mission. And I find it very, very difficult to sort the wheat from the chaff when these stowage books slavishly keeps track of everything that's down in the trash airlock. That is of no interest whatsoever to the crew that's onboard and should never have been put in the stowage book.

*****

MISSION DAY: 37 DAY OF YEAR: 356
MISSION TIME: 17:02:52 GMT

NOTE: M487-3B Wardroom Compartment

CDR: Stowage volume and access is excellent, there's lots of room, and as more and more clothing is being used up, and lockers are being emptied out, we're moving more and more bulk volume food, overage food down into the lockers near the tables, so we don't have to spend as much time transferring from the wardroom up to the food lockers, into forward compartments. Access is very good in all these stowage areas, these lockers in the wardrobe.

NOTE: M487-3B Sleep Compartment

CDR: Stowage volume and access, well I've already discussed that earlier; I think we're a little light on personal item stowage volume; I think a little Ben Franklin type desk top or something for the second from the top, a locker would have been very nice,

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
16. Storage Volume/Access

MISSION DAY: 37 DAY OF YEAR: 356 (CONTINUED)
MISSION TIME: 17:02:52 GMT

NOTE: M487-3B Sleep Compartment

CDR: because you could lay in bed and reach that and write or read or something like that, that would have been very nice. It would have been nice if that locker was - was provisioned with ways to restrain small articles that you would want to keep in there, personal articles. Temporary equipment restraints again, we're in wide use of snaps, velcro and - and springs, bungees in order to anchor your personal equipment down.

NOTE: M487-3B Experiment Compartment

CDR: Stowage volume and access no problem there.

NOTE: M487-3B Forward/Dome Compartment

CDR: Stowage volume and access, no problem there, there's lots of volume and access for stowage, and the dome lockers are very good.

NOTE: M487-3B Airlock Compartment

CDR: Stowage volume and access is NA, not applicable.

MISSION TIME: 19:12:43 GMT

NOTE: M487-3B Wardroom Compartment

PLT: Stowage volume and access. There's not too much of a problem there. The mixed purpose of the stowage has been the big concern as far as I - I have there. For the - for the window you need a place to stow a camera and extra lenses and filters and that sort of thing without spattering them all up with food spills. This is a problem; we've spattered the window up; of course, there's the window cover, but we occasionally do take that out. And we have to have the - out the window - and we have to have it - the window cover

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
16. Storage Volume/Access

MISSION DAY: 37 DAY OF YEAR: 356 (CONTINUED)
MISSION TIME: 19:12:43 GMT

NOTE: M487-3B Wardroom Compartment

PLT: over. Food spills are a major concern when you start locating anything in an area where you're eating.

NOTE: M487-3B Waste Management Compartment

PLT: Stowage volume and access. Well, we got enough urine bags and all that, and so forth.

NOTE: M487-3B Sleep Compartment

PLT: Stowage volume and access. Okay, once again, the door on these lockers are really bad designs and another thing that I've meant to - to - to gripe is the - the little doors on the wipe and tissue containers. Those aren't - don't have a strong enough spring in them. And the trash - the dry trash doors and the wet trash doors don't have strong enough springs on them, because they - they stay open and you find yourself snagging on them while they're in the open position. As I say, all these doors, drawers, and everything else are just really very poorly designed. They don't do the job. They're just - they don't latch, they pop open when you don't want them to, and then they - they just are not satisfactory.

NOTE: M487-3B Forward/Dome Compartment

PLT: Stowage volume, there's no stowage up there.

NOTE: M487-3B Airlock Compartment

PLT: Stowage volume; there is no stowage in there other than the umbilical hoses. And those caps on those umbilicals are too darned hard to put on when you got - they've been connected. I think that's an unsatisfactory arrangement. I think that you stand

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
16. Storage Volume/Access

MISSION DAY: 37 DAY OF YEAR: 356 (CONTINUED)
MISSION TIME: 19:12:43 GMT

NOTE: M487-3B Airlock Compartment

PLT: to damage the umbilical hose with the force that's required to put that thing back on. And I think that ought to be taken a look at by ground safety as well as the safety people themselves. It's just - you - you bang - you really have to push on that thing. And there's no reason and - any operation involving delicate EVA hardware; there's just no excuse for it to - being that hard to work.

NOTE: M487-3B MDA/STS Compartment

PLT: Stowage volume and access, stowage volume is, I believe, adequate - fairly adequate as far as the volume; and access is terrible because some of those doggoned doors are really hard to open. The pins are hard to get out; and they're hard to get back in. And I realize that these things are mapped to be made like a mansoleum vault because of the film protection, but that does not mean they need to be hard to operate.

*****

MISSION DAY: 41 DAY OF YEAR: 360
MISSION TIME: (361)04:18:35 GMT

NOTE: M487-3B Wardroom Compartment

SPT: Stowage volume and ex - access. I would like to keep in the wardroom those things which are used - to be used in the wardroom, like most of the food. For example, down here we have to go on up and try and pull most of the food out of the - the lockers. And frequently it's falling out down here, and especially now that we're working where third day we have to go shopping and find all of the overage food. We gradually moved it all down here, but we've had things like ED experiments to showers to flies to clothing

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
16. Storage Volume/Access

MISSION DAY: 41 DAY OF YEAR: 360 (CONTINUED)
MISSION TIME: (361)04:18:35 GMT

NOTE: M487-3B Wardroom Compartment

SPT: modules. Just everything has ended up in here, instead of - just a haven of anything they can't fit elsewhere. And I don't think that's right. We ought to put things in here which are directly used for the food. You ought to have to have the pantry right down here.

NOTE: M487-3B Waste Management Compartment

SPT: Stowage volume and access: that's no good - pretty poor. I think it would be much easier if we had more - make the thing larger and put some more lockers around here where we could store more towels, more washclothes, urine disposal bags. Each guy have his own cupboard for - for his own personal belonging. I think that's way under - under supplied and ... related to personal items, your Dopp kit and else you'd like to keep in there

NOTE: M487-3B Sleep Compartment

SPT: I intend to take and restow lots of things, take the trash bags out of there, which have no place in the sleep compartment, a whole host of other things and try to make a little more provision for some of the things I'd like to have immediately accessible to me. Stowage volume and access: I've just discussed again that is poor, in that stowage volume for personal items is negligible. Access to them: I would just as soon use a few more walls for that.

NOTE: M487-3B Airlock Compartment

SPT: Stowage volume and access. I think we need a little more stowage volume for EVA. And that fits in with the whole - Well, the question of volume.

*****

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
16. Storage Volume/Access

TECHNICAL CREW DEBRIEFING
5.0 Workshop Activation and CSM Powerdown

POGUE: There is something else I wanted to point out. We had several drawers that I think contained EREP cassette containers. You would put the EREP cassette container in a teflon receptacle and close the drawer. Then you would open the drawer above it and close the drawer above it and it wouldn't close. The cassette container had floated freely from the container in the drawer below and gone up into the space behind the drawer above. So you would have to open the drawer below and reestablish all the configuration and close them fast enough to prevent the stuff from floating free again. It was a complete mess.

CARR: I would add that we as a group bungled that one. I don't know why in the world we ever talked ourselves into thinking it was perfectly okay to put cameras in a drawer loosely and close the drawer, hoping everything would be okay. Drawer G in the film vault was probably one of the most aggravating drawers we had. Every time you opened that son of a gun you got three or four Nikons floating up, plus photomic heads, filters, E12 adapters and all that sort of stuff. There was no excuse for that. Why we stood by passively and let that go by, I just don't understand. We all know better than to allow stowage in zero g to be unrestrained, but we did it and we certainly did pay the price for it. As Bill said, there were other drawers also where items floated up and jammed. Frankly I'm surprised we didn't damage more film cassettes and expose more film just because we jammed things into drawers.

12.0 Saturn Workshop Systems Operations
12.3 Environmental Control System

CARR: The lock compartment ought to also be designed strictly for EVA stowage so that we don't have to go through the EVA prep exercises that we

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
16. Storage Volume/Access

TECHNICAL CREW DEBRIEFING (CONTINUED)
12.0 Saturn Workshop Systems Operations
12.3 Environmental Control System

GIBSON: That was a good point. Concerning the packaging, by putting cubes or squares or rectangles or cross sections, we could have gained about 50 percent more food that what we had in there.

CARR: ... If you need a chiller for IMSS equipment, there should be a separate IMSS chiller. The food chiller should be left strictly for the food.

GIBSON: We had so many things mixed in there, from penicillin to cans to heat sinks and all those should have been in a different chiller.

12.0 Saturn Workshop Systems Operations
12.4 Crew Systems

GIBSON: Personal Stowage: I found no reason why we should have had a whole multitude of trash bags and other gear stowed in what should have been a crewman's personal stowage location.

POGUE: Even the sleeping bags didn't need to be in there.

GIBSON: That whole area for each crewman should have been opened up to his own personal stowage and not those of the ship. I think we had enough other dome lockers and locations around that we could have taken care of all those other good things that we had to stow in sleep compartments. I would like to have seen something also with smaller compartments that you could open. When you opened a large locker, you opened yourself up to everything that happened to be in there. In terms of personal stowage, you ended up with a host of many small things, with pencils, pens, eye glasses, and who knows what else in there. Every time you opened up one of the lockers, it all came out at you. I think we could have done a much better job in designing that. One thing we do need is a soft

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
16. Storage Volume/Access

TECHNICAL CREW DEBRIEFING (CONTINUED)
12.0 Saturn Workshop Systems Operations
12.4 Crew Systems

GIBSON: stowage, for film and all kinds of small things. The configuration of these small items cannot be predicted. The stowage needs to be something like a very soft foam that will grip whatever is put against it and that will be very flexible. Something like that would have helped our film stowage, all the personal stowage, and every small item that you cannot predict ahead of time what it's configuration will be.

CARR: Regarding stowage in general, I thought the stowage in the whole spacecraft, generally, was good. We have already pointed out some very definite problem areas. The most glaring example of a stowage problem was the film vault. That's been thoroughly kicked and I don't think there is any need to jump into that one anymore. As we used equipment, particularly in the wardroom areas, stowage lockers opened up and we found them to be very handy for stowing items.

14.0 Inflight Experiments
14.1 Medical Experiments

CARR: M171 Metabolic Activity: No problem with the stowage.

POGUE: The drawers ought to be separated for zero g. It should not be possible for an item to float loose and jam the drawer above it.

*****

SWS SYSTEMS DEBRIEFING
PAGE 27-28

QUERY: Okay, could you speculate on what might have caused the damage to the overwrap of the LiOH element which was rejected. You know you changed out the ---

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
16. Storage Volume/Access

SWS SYSTEMS DEBRIEFING (CONTINUED)
PAGE 27-28

CARR: Those two canisters were just rattling around loose in A-6, and we were putting pieces of equipment in there and taking them out all through the mission. And I think we just bumped it and scarred it. What we did was we pushed the plastic up against something sharp or hard inside. We just ended up lacerating it. And I wasn't sure - Well, the fact that the plastic was puffed out instead of sucked in tight like most of the canisters was enough for me to think about it. And I went over and looked in that locker 151 or whatever the locker number is. There was a thousand canisters in there and so I just picked a nice looking one and took it. I had so many things to choose from that I didn't worry about it. But I think all we did was - let's see, the Dewar cooler S192 was in there and it's got lots of sharp protrusinos on it. That was rather rattling around in A-6 with these two LiOH canisters. And the S009 was in there just floating around. So every time you'd open that locker to get something, you'd bump those things. You know they play pinball machine for the next 2 hours, bumping into each other, and so I think that's the reason.

PAGE 341

POGUE: Along that line, another thing too, with these cable caddies and all, there should be central repository for placing and stowing these things. You know, like you'd have one locker dedicated for all these cable caddies and so forth. It was a little bit of a management problem, in that you didn't know who had had it last and he had left it - where he had left it and so forth. We had a sort of a system, but it was not designed into it. That should be designed into it, a locker or something like that.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
16. Storage Volume/Access

SWS SYSTEMS DEBRIEFING (CONTINUED)
PAGE 401-403

QUERY: Yeah, the lanyard would have done the ---

POGUE: Yeah. There was no need for them to ---

QUERY: Everybody was afraid you might lose the ends down in there and you'd ---

POGUE: Ahhhh.

CARR: And a lanyard would have been good - a nice strong lanyard.

QUERY: And I'm sure that we overdid the Calfax and had too many on there, too.

CARR: Yeah.

PAGE 410-413

CARR: The stowage in general - The biggest single problem with stowage is retention in the zero-g situation. We need to do a lot of thinking and get some inventiveness brought to play here on how to retain things - little things. Of course, the film vault is a prime example of that. But some of those big film vaults up in the MDA were just great big empty boxes, and it got to the point where you just pushed something in there and closed the door real quick. And then you knew the next time you had to open the door, you had to be on your guard. And little things that we put in there, we would stick tape on them and tape them to the door because we knew that we were liable to lose them. In our sleep compartments there was no stowage for personal items. And there was no place to write or have your own little desk or to keep little things that you wanted to have. And there was no personal place. A Ben Franklin desk sort of thing would have been - could have been very easily designed into one of the lockers, you know, where you pull

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
16. Storage Volume/Access

SWS SYSTEMS DEBRIEFING (CONTINUED)
PAGE 410-413

CARR: the locker door down. Instead of having the locker door go all the way down, just have it come down part way and stay level so you could use it for a writing surface. And have a module of something you could put in there with lots of little pigeonholes and cubbyholes to put small things that you might want to keep, because you gather things over a period of time. Like I had a couple of spare triangles in mine, and I had a little lanyard with a dog leash clip on one end and a ring on the other one. And I wanted to keep that because I wanted to have it when I was ready to come back and put it in the command module. And I had some items of a personal nature that I wanted to keep, and all I had was big open locker. And every time I opened that, I had to watch it because I had an airflow coming up from the floor. And as soon as I opened that locker, I'd get a venturi effect in the locker; and all the small things would start coming out at me and - just because of the airflow that moved through the area. And I kept a logbook in there so that I could write notes. And anything that's small like that is just going to start coming out at you. And after awhile, when you get a lot of stuff in there, you dread opening it, because you know you're going to have to fight it to the death in order to keep everything in and get the door closed back up again. I think all three of us ended up going into the tissue dispensers in those areas and removing the tissue boxes and cutting the spring out and using that little flapper door as a real handy way to get in and keep things in the small tissue dispenser areas. And I ended up just maintaining one tissue dispenser, and I cut the springs out of the other two so that I had little pigeonholes to put personal items that I wanted to be able to get to - like the Swiss army knife and pieces of paper, things that I wanted to keep from the teleprinter - teleprinter pads and things like that. I think in the area of stowage that any habitable

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
16. Storage Volume/Access

SWS SYSTEMS DEBRIEFING (CONTINUED)
PAGE 410-413

CARR: area, place where you got - that's your own, your own bedroom, there ought to be some sort of a personal area there where you can keep your personal items and do your writing and your reading and keep your pencils and all that sort of thing. Just like you do, say, aboard ship, where you have a little stateroom. And in the - most all staterooms in a ship have got a little built-in desk.

PAGE 459-460

QUERY: Tool kits and spares conveniently located?

CARR: No, I don't think so. I thought the tool kit, if we had located them more centrally, I think it would have been better off. I think they were kind of down in one end of the workshop.

POGUE: Yes, I guess it would have been best ---

CARR: It would have been better if we could have had them up in the dome somewhere, maybe all that big wall space in the dome, part of that could have been used for a tool box.

POGUE: Yes, that was all wasted.

CARR: And you could have spread the tools out more instead of having to concentrate them so tightly.

POGUE: No reason why you couldn't had a pegboard just like you do in your own garage, or tool or workroom. We had them all spread out - with a lot of visibility because getting them in and out - putting them in and out of the drawers was a mess. I've already debriefed the drawers, too.

QUERY: Right.

POGUE: And restraint.

*****

SKYLAB MAN-MACHINE DATA FROM MISSION SL-II
FOR: A. ARCHITECTURE
19. Windows

MISSION DAY: 2 DAY OF YEAR: 146 (CONTINUED)
MISSION TIME: 1:15:32 GET

CC: I'm sorry, I couldn't copy there. Did you say we were about 10 degrees off?

PLT: We are more than 10 degrees off. It's hard to estimate, but it's a plus Y and a plus X rotation. We are not going to touch it this time. We're going to let you guys fool with it. We'd like to get in solar inertial once so we'd know what it looked like and if we get off we can get ourselves back on.

*****

MISSION DAY: 4 DAY OF YEAR: 148
MISSION TIME: 12:37 GMT

SC: If it weren't for the fact that we had such a spectacular view out of the wardroom window, which we didn't open until yesterday evening late, I'd think we were back in Houston simming.

CC: Roger. Copy.

SC: And right now we're over Italy, and weather is spectacularly clear. We can see just about all of Italy from one end to the other, all clear across the Mediterranean. Going over some ground I've never seen before.

*****

MISSION DAY: 15 DAY OF YEAR: 159
MISSION TIME: 21:33:41 GMT

NOTE: M487-3B Wardroom Compartment

SPT: The wardroom window is outstanding. It's size is very good. Certainly let's not make them any smaller. Its field of view is also excellent. I understand that's partly coincidence, on account of the meteorite shield being missing. I think it would of been a shame if we have had the smaller field of view.

*****

SKYLAB MAN-MACHINE DATA FROM MISSION SL-II
FOR: A. ARCHITECTURE
19. Windows

MISSION DAY: 22 DAY OF YEAR: 166
MISSION TIME: 08:27 GMT

CC: Skylab, Houston. We'd like to verify this wardroom window got fogged up. The fogging is between the panes, isn't it?

PLT: It's on the inside of the outer pane.

CC: Roger. The next time one of you is in the wardroom, if you're not there we'd like for you to open the vent valve, panel 704.

*****

MISSION DAY: 23 DAY OF YEAR: 167
MISSION TIME: 11:24:51 GMT

NOTE: M487-3C

PLT: And the off-duty windows, the only thing I can say about that is, there are not enough of them looking in the right direction and they are not large enough. The wardroom window is nice and large, however, now we are at high beta angle it's looking out at the southern horizon. We cannot see below us out of that window anymore and besides that window has a big ice spot in it now, as you are probably aware. And we need - we ought to have bigger and more - more windows like the wardroom window in the workshop. STS windows are - they're very good, however they are obstructed very much by external structures to the vehicle.

MISSION TIME: 12:31:37 GMT

NOTE: M487-3C

CDR: I wish we had more windows that covered more of the outside. It turns out the high Beta angle we're at now, our one --- window is looking mostly at the horizon and the sky.

*****

SKYLAB MAN-MACHINE DATA FROM MISSION SL-II
FOR: A. ARCHITECTURE
19. Windows

TECHNICAL CREW DEBRIEFING
14.0 In-Flight Experiments
14.2 ATM Experiments

KERWIN: You wind up leaving a window or two open up there because you want to see out from time to time. When something is coming in the window and bouncing off the mol sieve, it's very bright near the ATM console.

*****

SWS SYSTEMS DEBRIEFING
PAGE 23-24

SPEAKER: Do you have any comments regarding the vulnerability of any of the windows, as far as accidental impact, from any means, transfer or cleats on your shoes, or anything like that?

PLT: The STS windows are pretty invulnerable.

CDR: Pretty buried. You know, they got MOL sieves around them, and teleprinter paper boxes or whatever all that stuff was.

PAGE 122

SP: Would you rather have, if you're getting the tradeoffs on windows, I think we got the message that more and bigger windows, but if you got a choice of larger quantity of smaller windows versus a couple of big windows, which do you think you'd rather see?

PLT: I would rather have more small windows.

CDR: You mean to give you more viewing?

SP: Viewing angles.

CDR: Viewing angles? Yeah, I, we figured out we were going to see more out of the wardroom window as

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-II
FOR: A. ARCHITECTURE
19. Windows

SWS SYSTEMS DEBRIEFING (CONTINUED)
PAGE 122

CDR: the beta angle went up, it turned out we psyched that one out.

PLT: That's right, we had it completely backwards.

CDR: Getting further and further away rather than the window looking more and more at the earth.

*****

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
19. Windows

MISSION DAY: 13 DAY OF YEAR: 221
MISSION TIME: (222)02:18:29 GMT

NOTE: M487-2A

PLT: One of the things that we've enjoyed the most of all has been the, uh, ... the window. There's only one of them 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 scenic wise, but geologically, and the weather - in the area of weather, 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 for ... enjoyment. So the one window is really not enough, and if we could have some more windows somewhere, we need to have them.

MISSION TIME: (222)02:23:28 GMT

NOTE: M487-2A

PLT: And back to the window business again. I know that Owen's been trying to look out the window to see ... going underneath the spacecraft, but it ... over the edge of the window and I can't see it. If I had another window 90 degrees on the other side, why, I'd be much more able to look around than I am now.

*****

MISSION DAY: 18 DAY OF YEAR: 226
MISSION TIME: 17:31:16 GMT

PLT: And one thing I noticed about - some interesting observation of the window. I turn my flashlight on or put anything in front of the window, you get four reflections, one from each side of each pane. The foremost reflection is a brass color even by flashlight. Turn on the flashlight - the guy turning on the flashlight, the color of the flashlight is brass, the first reflection is a brass color. Second

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
19. Windows

MISSION DAY: 18 DAY OF YEAR: 226 (CONTINUED)
MISSION TIME: 17:31:16 GMT

PLT: reflection is a burnt orange. Third reflection is lavender or very pale purple. Then the fourth reflection again is brass, with a little deeper hue than the first brass reflection.

*****

MISSION DAY: 37 DAY OF YEAR: 245
MISSION TIME: 23:00:21 GMT

NOTE: M487-2C

PLT: I remember way - I remember way back one time early in the program when they thought of having no windows at all because you really didn't have a need to look out but that's wrong. We've got lots of out-the-window photography to do. We've got lots of out-the-window viewing to do and we got the stars to look at with various instruments.... and so forth.

*****

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
19. Windows

TECHNICAL CREW DEBRIEFING
14.0 Inflight Experiments
14.4 Individual Experiments

LOUSMA: As it turns out you can't see as much out that wardroom window as you would think you might be able to, because of the angles involved in looking around the sill. Whatever you look at has to be directly out the window.

18.0 Flight Equipment
18.2 SWS

BEAN: Wardroom window coupling for moisture removal: I'll discuss that one. We used the fitting which is still present on the wardroom window. We pulled the vacuum on it and it works dandy. It cleans out almost all the spot that's right in the middle of the window. During the next week or so it'll slowly get moisture in it again. It needed another pumpdown. We felt that maybe the moisture is coming in through that other fitting that is finger tight. It might be of interest to see if you can put some more torque on that fitting and if you can try to tighten it down a little bit more. Maybe it would be more desirable to pull it out, inspect it and then put it back in. If that can't be fixed, putting the vacuum on that window every couple of weeks is not unduly prohibitive or time consuming. It should be done to keep the wardroom window in pretty good shape.

*****

SWS SYSTEMS DEBRIEFING
PAGE 11-12

SPEAKER: You made another comment about how you wish you had more windows, bigger windows, bubble windows, windows you could sit around yourself and see outside. But what we are trying to find out is the procedure which you evacuated this window you

(CONTINUED ON NEXT PAGE)

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
19. Windows

SWS SYSTEMS DEBRIEFING (CONTINUED)
PAGE 11-12

SPEAKER: made mention in your previous debriefing that you had to do it about once a week and prior to each evacuation did you take and tighten by hand the little vent valve which you had mentioned you were afraid you might twist off.

CDR: I tightened it one time using --- I don't know whether I used the pliers or what because it's just a zoned knob it's not a hex head or anything like that. It's just a little bit better than finger tight. That was the only time as far as I know anybody touched it.

PLT: I did try it a time or two and it seemed to be tight and so I didn't fool with it anymore. But to evaluate it just wasn't a vacuum line down from the SAL. Down to the window and plug it in and you can actually watch it. Any condensation there would disappear. Or you can even see it pump down and there might still be a small residual that you'd want to leave the vacuum line for another ten or fifteen minutes or so to make sure every last bit was out but it disappeared rapidly enough that you could see 90 percent of it disappear within I'd say 30 seconds

SPEAKER: Does this moisture appear that quickly when you backfill it with the desiccated air?

CDR: No. It did not. It looked pretty good when we backfilled it. I'd say that it accumulated moisture about as fast backfilled with the supposedly dry desiccant air as when you tried to leave it at vacuum. About the same time which was --- it would show up in about three or four days and you would notice it. In about two weeks it would have good condensation on it where you would want to pull it out again.

SPEAKER: So this was not a real time condensation problem with the desiccated backfill?

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
19. Windows

SWS SYSTEMS DEBRIEFING (CONTINUED)
PAGE 70

SPEAKER: In the STS, did you notice any change at all in the forces required to open or close the STS window covers?

PLT: Seems like they were always hard, but they're hard enough so that you never noticed any difference.

SPEAKER: Uniformly hard (chuckle).

CDR: They were unsatisfactorily hard all the time would be my comment.

*****

COROLLARY EXPERIMENTS DEBRIEFING
PAGE 94-95

QUERY: Was the actual vent valve on the wardroom windows ever checked for tightness? Was it ever tightened?

GARRIOTT: This is the one that screws down?

QUERY: Yes.

GARRIOTT: Yes, it is right. Wasn't it purged?

QUERY: Yes.

*****

EREP DEBRIEFING
PAGE 70-71

NOTE: C&D Panel Operations

LOUSMA: That sounds like a very good idea because one of the things that we were suggesting for out the wardroom window was a better tracking system or a way to know how big things were by using a sight.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
19. Windows

MISSION DAY: 46 DAY OF YEAR: 365
MISSION TIME: 21:51:08 GMT

NOTE: M487-2C

PLT: Working experience - what specific habitability improvements would you recommend for the next Skylab crew for future programs. I'll think about that one for a minute but I think we do need more windows in the spacecraft. I think they need to be larger or at least domed out so you can see more of the - of the area. That has nothing particularly to do with habitability.

MISSION TIME: 22:03:00 GMT

NOTE: M487-2C

PLT: Windows are another thing that you have to be careful for because you just get carried away with the ability to move rapidly in zero g.

*****

MISSION DAY: 79 DAY OF YEAR: 033
MISSION TIME: 19:22 GMT

CDR: By the way, Dick, somebody asked about a week ago for comments on the wardroom window - if there'd been any indications of any micrometeorite impacts or anything like that. The windows are quite smooth. There are no indications of any pits or anything in them at all. About the only problem we have with it is our little ice thing forms about once every two weeks. And there's some sort of a deposit on it on the outside that - it kind of looks like water stains, the sort of thing that when you wash a car window but don't get it clean - rinsed off clean.

*****

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
19. Windows

TECHNICAL CREW DEBRIEFING
12.0 Saturn Workshop Systems Operations
12.4 Crew Systems

POGUE: Another crew safety item is the handle cranks for the STS windows. You could guillotine a finger right off with those if you weren't watching it. Boy, that was a very bad design.

CARR: You had very, very poor mechanical advantage, so you ended up leaning into that handle to turn it hard, and there wasn't finger clearance all the way for full throw of that crank. You could really loose a finger or a bone there very easily.

GIBSON: I think that was also a poor design from the operator's standpoint of having to open and close those windows a large number of times, and the amount of force that was required. To take good photographs of comets and a whole host of other things, having to open and close those windows frequently. I suspect I did it 6 to 12 times a day or so, being up in that airlock a lot. And it was a chore every time.

14.0 Inflight Experiments
14.3 EREP Experiments

GIBSON: I think in future operations, though, this type of observation would yield more useful data if the spacecraft had a built-in dome, much like a bomber's, where the gunner sits in a hemisphere. This would allow you to get an almost complete 180 view of the whole earth as you went over.

*****

SWS SYSTEMS DEBRIEFING
PAGE 253-254

QUERY: Did you keep the STS window covers on mostly or ---

CARR: Most of the time, yes.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
19. Windows

SWS SYSTEMS DEBRIEFING (CONTINUED)
PAGE 253-254

GIBSON: Most of the time - the outside.

CARR: That's a mechanical thing for the mechanical folks, and that's those windows on the - the covers on the STS windows were a great pain in the neck, because they were so hard to open. You had so little mechanical advantage on the crank you had to turn, and there were so many things close to that - the crank throw that you were just asking for broken fingers. We were always banging our knuckles up trying to open and close those doggone STS windows.

POGUE: One of them in particular you could actually guillotine a finger to death.

CARR: There was lots of profanity used on those windows.

*****

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
21. Temporary Storage Provisions

MISSION DAY: 13 DAY OF YEAR: 221
MISSION TIME: (222)02:17:10 GMT

NOTE: M487-2A

CDR: Let's talk a few seconds about the camera equipment and how we, found it. We got the cameras stuck in some drawers up here, and they're kind of banging around loose unless we come up with a homemade strap.

Well, anyhow, down here by the window where you take pictures, we got them hung on strings and all that sort of thing. It seems to me that we could do a little bit better about understanding equipment we're going to use operationally in flight and then try to have something permanent setup where we - we have something permanent, in a way. For the - for the 16-millimeter camera on the EREP. And that's a good way. We ought to have some permanent installations where we can stash these cameras by the ... stations, and ... instead of having to carry them over to the ... built a little box right by the window where you can lay ... it in. We can throw the things in there and then we can get them out instead of having to take them around.

*****

MISSION DAY: 45 DAY OF YEAR: 253
MISSION TIME: (254)01:49:57 GMT

CDR: You're now looking at the vacuum cleaner over there in the corner, we just leave it hanging there. It's quite quick to get it out and use it, get a bag and to put in it. We just put a new bag in every time we use it. It gives us good suction; as good as it can get.

MISSION TIME: (254)01:58:20 GMT

CDR: We got IMS out. As you can see, we just got the cans inside our chiller. So that's one good deal. Now you'll notice we got some of those little inserts of

(CONTINUED ON NEXT PAGE)

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
21. Temporary Storage Provisions

TECHNICAL CREW DEBRIEFING
12.0 Saturn Workshop Systems Operations
12.4 Crew Systems

BEAN: The stowage provisions were adequate to hold whatever you had. It would have been nice to have some place a little bit larger to hang up your clothes that you wore during the day so that you wouldn't have to just leave them floating around at night. It worked out okay. Instead of putting my clothes in my compartment at night I hung them out there on the 131 control box.

14.0 Inflight Experiments
14.3 EREP Experiments

LOUSMA: Equipment Racks: We only had one equipment rack, where you hang the S190 film when you bring it up. That seems to work satisfactory.

*****

SWS SYSTEMS DEBRIEFING
PAGE 66-67

SPEAKER: Temporary stowage location. Where you had temporary stowage bags, for example, things like that. Were the layouts reasonable, or did you want them other places, or did you have ones that you just never used, some place that you'd like to have special temporary stowage location.

CDR: Owen's idea of putting, you know these springs we always had on doors, in the front so you could shove things under them. He indicated, Owen mentioned one day, he said, you know we ought to build doors, almost every door in the spacecraft ought to have a spring on it or in it or somewhere. So all the flat surfaces have an ability to receive something you want to set down for a few minutes. That ought to just be part of a door. Couldn't agree with him more. So as far as, that would be one temporary stowage scheme

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
21. Temporary Storage Provisions

SWS SYSTEMS DEBRIEFING (CONTINUED)
PAGE 66-67

CDR: that would not bother anybody, would add some weight to the spacecraft, but it would sure be all over the place, useful. It might solve almost all your temporary stowage problems just with one simple device.

SPEAKER: You talking about bungee type springs?

CDR: Yes.

SPEAKER: Screen-door things?

CDR: Yea - on every _____ much the same as we can put anything down here on a horizontal surface and forget it. So we don't need hardly any restraints in this room. All we got to do is set something down. Put a spring on every horizontal surface in that spacecraft, you don't need much else. You can always stick it under the spring. Or if you don't want to, you can carry it down and throw it into a locker. And then eliminate all of these problems. We could find, you know, we could get a special holder that would hold this here, and that one there, we can always lay it down horizontal. With these springs all over the place, you've got built-in restraints. Simple, straightforward and fits everything.

SPT: We ended up with two or three of these apiece in the wardroom, but we didn't have enough springs or time to go putting them around everywhere.

CDR: Lot of places don't have places, like those big lockers in the MDA. Film lockers had snaps on it, we tended to put springs up there. They were always useful. We never had too many springs around.

PLT: That's right.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
21. Temporary Storage Provisions

SWS SYSTEMS DEBRIEFING (CONTINUED)
PAGE 69-70

SPEAKER: In the FTS, ---

CDR: One other thing about, let me go to this temporary stowage thing one second. A lot of times it's difficult to determine prior to flight exactly when you want this temporary stowage business. I think if you ended up having a spring on every horizontal surface, you'd have it ninety percent whipped. OK. But there are other things that are going to come up. For example, we very much wanted to have a way to restrain our food in the chiller. Because we had three or four drinks, plus maybe our peaches and one butterscotch pudding and all that sort of thing. It was all floating, free in there, plus we had the IMSS in there. In all, it was big fiasco in there. Same thing inside our spice locker, cause we had not foreseen that we'd have spices. Same thing in our own personal lockers. You couldn't predict what you'd have in there. But we had nothing that would give us the ability to put restraints in these places realistically. For example, the thing that had been daydreamed up was a round piece of metal like this with a snap on it. You would take that round piece of metal that had adhesive on it and stick it to the wall and then stick something to that snap. Great idea. It would sometimes work outside if you had the right surface. But, for example, it wouldn't work inside the chiller at all. It was too cold. You'd put one there and three days later it would come loose.

SPEAKER: Condensation would break the seal.

CDR: Yea, so somehow we need, in future applications, the ability to get snaps on in positions on flat surfaces with an adhesive that really works. Even if we have to take up two bottle adhesives. I mean, I can get that and do it in my house, I

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
21. Temporary Storage Provisions

SWS SYSTEMS DEBRIEFING (CONTINUED)
PAGE 69-70

CDR: can do it on the side of my car if I want, but we just could never do it to the spacecraft. Those things just didn't hack it. That would be extremely desirable. Those springs and the ability to put these little snaps, if you would put two of the, you'd have a spring in position, or you could leave the snap and put a clip, like we had, those different clips. I think you'd have this stowage problem whipped very easily.

SPEAKER: Al, there were two snaps inside that chiller on the left side ---

CDR: We used them. We needed more. Those were great.

SPEAKER: OK.

PLT: Just like that ---

SPEAKER: Rib cages?

CDR: Yea, we needed about five rib cages to do the job.

SPEAKER: OK. You had more quantity than we envisioned, then.

CDR: That's right, and I think that we can't always envision --- If we could have put three more in there, just like that, --- we did it a couple of times, they'd last three of four days and then float out --- we would of had it made. But we just couldn't get them in there. We thought "I'll bet Frigidaire has got some tape; we could have taped them in there; they probably have some glue, you could stick it on one of these and it would stay forever. Cause they must have that application, they do it every week on their equipment.

*****

SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
21. Temporary Storage Provisions

COROLLARY EXPERIMENTS DEBRIEFING
PAGE 21

NOTE: Garments

BEAN: You didn't have any place to put them at night, so you stuck them on the walls.

GARRIOTT: I always stuck mine behind the comm box on the cables.

*****

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
21. Temporary Storage Provisions

MISSION DAY: 13 DAY OF YEAR: 332
MISSION TIME: 17:25:35 GMT

NOTE: M487-2A

PLT: The one thing that is lacking throughout the spacecraft is the provision of temporary stowage restraint of equipment. You find yourself trying to manage a half dozen pieces of equipment and at a given location or work location. I'm concerned right now about the film vault, but it equally applies when you're setting up say, a 183 S019 earth terrain camera, or anything in one of the SALS. You find yourself with pieces of paper, hardware, trying to read checklists or cue cards. Yes, you can clip them, but there are no clips; it all has to be manually done. The velcro is unsuitable in many cases because it's not in the right places and it isn't easily movable. Anyway, temporary restraints and attachments at all work locations seems to me to be highly desirable and what I'm talking about is just a sort of flexible versatile volume to contain things, like, for instance, something the size of a temporary stowage bag with an overlapping flap, transparent flap on the front in which you can just put things temporarily while you're working with equipment. When you have to get equipment, you have to either install it or you have to take time out; and when I say time, I mean like on the order of 2 to 5 minutes when assembling and disassembling pieces of hardware. A lot of the time is consumed in hunting up and getting checklists or cue cards, putting them in the right position, and then going and finding them after they get loose and float free. We find ourselves wasting an awful lot of time finding this equipment and hunting for pieces of equipment that have floated free; anything from hardware to procedures books. Now that's one of the problems.

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
25. Standardization

MISSION DAY: 51 DAY OF YEAR: 259
MISSION TIME: 14:24:19 GMT

NOTE: M487-2D

PLT: Question 7: What is your opinion concerning the advisability of exerting design influence to standardized the multiple types of snaps, latches, retainers, restraints, doors, that you have been conformed with aboard Skylab? Well, I know one thing that we seem to have a lot of different kinds of is connectors, flex-hoses and air lines, and selectable connectors, and that kind of thing. Some of 'em you gotta push before you rotate and some you got to rotate before you push and some of - 'em are a real mystery. I guess the one that is the greatest mystery of all is the quarter connector in the PCU for example. The dust covering goes on it. You never know whether to push or pull or turn or what if you just sort of stand there and figure it out for awhile, and finally, you learn it. Most of 'em are pretty well standardized, but I think it would be a definite advantage to try to standardize as much as possible. Although several different kinds of connections are not objectionable, as long as they're not a Chinese puzzle to figure out. I've complained before about the safety hazard on the spring bungees that we've got. The ones with that come up on the command module, with the command module bungees are okay. They're good. They don't have sharp hook on 'em - the wire hook. But the other ones that came in the workshop have a wire hook on 'em. And not only is that a sharp hook and if somebody gets in the eye why, it's all over, but they're weak, and they're starting to straighten out like a straightened out fishhook, and they don't hook so well behind on the doors anymore, or whatever you put 'em on. And when you put something under 'em, they're tending more to come off now. And it's much easier to get snapped in the eye with one of those sharp things now than it used to be. So, if I were doing it, I'd get rid of all of 'em and replace 'em with something else that's safer even for Jerry's mission. Let's see, other

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
25. Standardization

MISSION DAY: 51 DAY OF YEAR: 259 (CONTINUED)
MISSION TIME: 14:24:19 GMT

NOTE: M487-2D

PLT: multiple types of latches. I've noticed that lots of the Calfax, the rotary ones come out real easy. And I guess probably there's four or five of them that have come out; that little retainer ring's come out and they're just useless after that. Multiple restraints: we really don't have a lot of multiple restraints, I don't think. So that's not a bother. There are different kind of door. We always use the phone booth type door on the head when we go in and that seems to be a good one. We hardly ever use the door on the wardroom, except to shut off the lights for T002, whenever we're looking out the window and want it dark there. But, we don't use that door otherwise, this open door is better, and the one in the sleep compartment is the same way. We usually put our little velcro or our little Beta cloth or dividers up at night just to keep the light out and so forth. And they seem to work just fine, and so does the door on the waste management compartment. So it's not objectionable to have different kinds of doors as long as they do the jobs that they are trying to do. So multiple things don't bother me much. I noticed that the Calfax-type latches that we have on the film vault and the food trays are not as good as they ought to be. There ought to be some better kind of device to hold those things shut. They also are used to hold down a variety of other things; covers one of 'em. For example, the EREP panel cover's held down with those kind of things and so are the container boxes for S019 equipment. And they're a nuisance. The reason they're a nuisance is because they don't have a friction hinge, and when you get one down to and you're about to fasten it - there's four of them on one of those covers, you go to open the cover while the other one is up when it's hooked, and when we get that one down there - the others - another one is gone up and is hooking over the latch. You just gotta of go around pushing all

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
25. Standardization

MISSION DAY: 51 DAY OF YEAR: 259 (CONTINUED)
MISSION TIME: 14:24:19 GMT

NOTE: M487-2D

PLT: those latches down and hoping that they stay down before you get a cover open, and they're a doggone nuisance. If you don't have a friction hinge, a latch and a door and something like that, why, it's an unusable piece of equipment for zero-g. So, those kind of latches I don't think too much of. And I mentioned the Calfax problem of having poor retainer rings. Plus the Calfax are difficult to adjust. For example, on the covers for the mol sieve. You're lucky if you can get two of them in there. They just don't line up good, or if you do get 'em lined up, you gotta push extra hard to start, or to initiate. And they do the job once you get 'em in, but you gotta hunt around for a spot and you gotta push hard to find the right hole, and then crank. And sometimes it'll ratchet close, and sometimes it just won't take. So you have them on the mol sieve covers and you only use one or two of 'em because they're just such a nuisance to have to run around the lab to hold.

MISSION TIME: 14:43:11 GMT

NOTE: M487-2D

CDR: What is your opinion concerning the advisability of exerting design influence to standardize the multiple type of snaps? Every snap ought to be the same. I agree with that. Latches: as good as possible. Retainers: I don't think you ought to do it after the thing is built except in areas where - like trash bags and utility bags, things like that. These little holders for clothes. All of that ought to be standardized and not try to assess something better than we got. Springs on the door, they ought to be standardized. A lot of that ought to be standardized. But once a piece - once you go buy a piece of gear, you shouldn't change it over. You should try to take

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
25. Standardization

MISSION DAY: 51 DAY OF YEAR: 259 (CONTINUED)
MISSION TIME: 14:43:11 GMT

NOTE: M487-2D

CDR: it like it is, cause we do have a lot of flexibility. We haven't - one thing I've noticed is we overkill the personal problems. We work with a lot less human engineering than we have pass. Now we could do away with almost everything we have and still survive up here which gives me the feeling we spent a lot of money to get these things standardized to just perfect. I suspicion what we ought to do next time is factor that. Let's pot out some specs to begin with for all experiments. Before I had to say, excuse me, pass me this and this and here's where you get them. If we get if off-the-shelf item, take it like it is. But have the specs in plenty of time to give the other correct. One of the biggest complaints I've about stowage around here, is we got all this stowage so neatly placed to waste. Particularly in the command module. You got straps, bags, and bags. Ridiculous. All we ought to have is down in little compartments. You open the compartments, stuff your thing in there, just a little tab of velcro will keep it in. Like these spring on the front of the box that houses the flight data file. We got those. We talk about springs now, that sort of thing. Now, one of those springs broke and we like it better without the spring. The stuff doesn't come out of there. You just keep it in there. Now if you're talking about little nuts and bolts, it's 50 individual items you're going to have to hold them in some way. But the best way to hold them in there is just get them like they are, put a little tab of velcro on it and a little tab of velcro nearby, just snap it in. Get rid of all the bags. You got too much bags. ... the bags by the thousands of them. Every time you open the drawer, the door down in the bottom shelf, next you open the Beta cloth flap, pull out a bag, and in this bag are a bunch of flashlight and little holders. Would it been better to take those little flashlight holders, if you want to put

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-III
FOR: A. ARCHITECTURE
25. Standardization

MISSION DAY: 51 DAY OF YEAR: 259 (CONTINUED)
MISSION TIME: 14:43:11 GMT

NOTE: M487-2D

CDR: them in holders, fold them up and just shove it in the door there, with a little piece of velcro to hold it down. You pull it out and open it up. And we found that to be much simpler.

MISSION TIME: 21:35:07 GMT

NOTE: M487-2D

SPT: Opinion concerning the advisability of exerting design influence to standardize - to type of snaps. Yes I think it is definitely a design advisable feature. We finally got them all learned, I think, and know what fits to what. But there's no reason to have as many kinds scattered around as we do. And I think a lot of thought ought to go into just what this standard ought to be. And then settle on a few. One standard for all fittings, of course, isn't going to work. But a lot of things like these ... ought to be kicked out, thrown away. It ought to be arranged so they don't come undone in zero g. Now the Calfaxes work very nicely. I think Calfax are gone up in my estimation, was high already. ... have gone further down. They were low already. And that sort of thing. We had ought to standardize and throw out the bad ones.

*****

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARHCITECTURE
25. Standardization

MISSION DAY: 68 DAY OF YEAR: 022
MISSION TIME: 12:40:30 GMT

NOTE: M487-2D

PLT: What is your opinion concerning the advisability of exerting design influence to standardize for future vehicles the multiple types of snaps, latches and retainers, restraints, doors, et cetera, that you have been confronted with aboard Skylab? Well, I think that there ought to be a lot of standardization, and I think a good step in the right direction is standardized snap patterns. And I think that the grid pattern on the floor is a good idea, and the way we've used handholds and universal mounts. I think that some - ought to be more of that, and I think there ought to be something like a pegboard pattern all around the spacecraft. In other words, where we see walls here in the OWS, ought to be a pegboard pattern. Now I don't say it would have to be brown like it the pegboard things that you buy, cause it - you know it could be just the same color as we have here. But if you stand-off surface, fairly sturdy, with something like a pegboard pattern, that'd give you a lot more flexibility. I've found that a lot of times the - the hex pattern we have here, the 60-degree limited - limit in capability, is - doesn't - doesn't give you quite the flexibility you would like to have. The pegboard pattern is not going to give you a whole lot more, probably, but they could - at least you can lotate - locate the thing, as far as position is concerned, with a little more fineness in selectivity. I still find different size snaps around the spacecraft. Generally speaking it's pretty good, but I haven't counted them. And we do find that here and there we well occasionally get a snap that does not fit, too small or too large. Again, snaps - in order to use snaps, you ought to have something - something that's behind - some way to get your finger behind the snap in order to put another snap on, because that - that turns out to be quite a chore sometimes. And as far as dial latches are concerned, I think they're terrible. They don't

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
25. Standardization

MISSION DAY: 68 DAY OF YEAR: 022 (CONTINUED)
MISSION TIME: 12:40:30 GMT

NOTE: M487-2D

PLT: work a lot of times; they - the little things - the dial latches on the S019 equipment, on the film vault door, and the S063 vault 512, I think it is: all around those things have they're just a lot of trouble. I don't particularly like them. And I guess that I shouldn't criticize something without making some suggestions for something better, but we're probably going to live with those for awhile. I don't like them. And also the little dial latches that hold the hoses for the OWS water system; I don't know. I'm at a loss to suggest a better system, but I think the idea of standardizing those things is great. I also feel like there ought to be an easy way to replace them. We found that the ones on the film vault caused us a lot of problems. I think you ought to be able to replace them very easily. I tell you, the thing that looks like a ring nut fasteners, only they're dial latches, that hold the OWS water system hoses. Those things are hard to get in position, and it's hard to know when you have them engaged properly. And then also it seems like you always have to turn them just a little further than your wrist wants to go.

MISSION TIME: 14:07:27 GMT

NOTE: M487-2D

PLT: The OWS aft - The OWS dome hatch has a very peculiar sequencing to its operation. And I think it was one of the problems that we had with it during prep for EVA is that the first time the crewman works that thing, he usually gets all mystified because it works different from the others, which another point in favor of standardization. That is, that all hatches ought to work the same.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
25. Standardization

MISSION DAY: 68 DAY OF YEAR: 022 (CONTINUED)
MISSION TIME: 14:07:27 GMT

NOTE: M487-2D

PLT: Still trying to - to give you more comments on standardization of fasteners and sort of thing. I think I already mentioned earlier that it would be nice if you had sort of standard size bolts; you know, like if there wasn't 50 jillion different sizes of threads and nuts and so forth. It would be awfully nice if you could come up with - standardize, even if you - if you erred slightly in overdesign; that is, overkilling the problem on bolt sizes for some particular purpose. It'd sure make it an awful lot easier to know that you didn't have to worry about some offsize thing. And another question that's sort of reared its ugly head here is the conversion to the metric system, and should we start giving attention now to changing our way of thinking in order to switch over to the metric system. Because this is gonna really square wave the whole system. Now, remember we're gonna be cooperating with the Germans and I guess the French - Europeans, say western Europeans, on a lot of the space lab work in the Shuttle. You can guarantee that they're not gonna switch over to - to foot and inches. So we're going to have to face that problem, and I think that fasteners are gonna fall in that category. And we ought to give serious consideration to open negotiations with those people at an early possible date to arrive on some size compatibilities, dimensional compatibilities, what I'm thinking of is - well, sure, I mean, we decided that we would have a fastener, a snap fastener that's 5 millimeters across, then, fine; that's great. But what I'm talking about is that we ought to, insofar as the compatibility is concerned, decide on size limitation for design criteria and so forth, that we could move one way or the other or they could move one way or the other in millimeters to make sure that we didn't violate any design constraints for structural problems. But at least that wouldn't be a problem to worry about. But I think conversion to the

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
25. Standardization

MISSION DAY: 68 DAY OF YEAR: 022 (CONTINUED)
MISSION TIME: 14:07:27 GMT

NOTE: M487-2D

PLT: metric system oughta - ought to be really be considered in designing an awful lot of our fixtures. I think that on the spacecraft itself, like connections in the plumbing and so forth that are never accessible except on the ground, we can handle that problem on the ground. When you're in the - in flight is no time to start worrying whether you're metric or inches. And working on foreign cars and so forth, of course, you'd - you see this problem crop up. It can really square wave you.

MISSION TIME: 18:22:12 GMT

NOTE: M487-2D

CDR: What's your opinion concerning the advisability of exerting design influence to standardize the multiple types of soap snaps, latches, retainers, restraints, doors, that you've been confronted with aboard Skylab? I think all these types of retainers ought to be standardized as much as - is feasible. I recognize the fact that for some uses, you can't use the same restraints system or snap or latch system that you used in another, but I really don't like the dial latch at all. I think that thing is a bummer. Particularly if you're going to move heavy things.

MISSION TIME: 20:06:02 GMT

NOTE: M487-2D

SPT: Okay, what is your opinion concerning the advisability of exerting design influence to standardize the multiple types of snaps, latches, retainers, restraints, doors, et cetera you have confronted, or not confronted in Skylab? I think that's an excellent idea and I wish it had been done for Skylab and we had come up with something better than dial latches and these

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
25. Standardization

MISSION DAY: 68 DAY OF YEAR: 022 (CONTINUED)
MISSION TIME: 20:06:02 GMT

NOTE: M487-2D

SPT: other goose fasteners. Dial latches, the problem with those is just too ... slippery. I think they're poorly made. They're cheap. They get too easily bent. Film door is a per - perfect example. They're, I find, always sticking, always binding in the open position. And they put much more force than is ever required to hold something closed in zero g. It's strictly a lift-off vibration type lock which has no business being your only means of holding something down in zero g. I think the darn things ought to be just flat removed. Find another way of holding something down for launch then remove it when you're up here and call for the flexible, easy zero-g restraints. The trouble with the goose fasteners, getting everything perfectly aligned in order to make them start clutching in there. If you don't you're just lost. You're just turning something and nothing's happening. We put in a tape recorder the other day - two days ago. Jerry and I were doing it, and we had one heck of a time trying to get all those holes - four holes lined up so you get all four of those little fellows screwing down there. There's no reason it should have been that hard. All we were trying to do is hold something down against a ... I'd like to see some standardization and I'd like to see something a little better than what we've got now in the way of these fasteners or dial latches. Something easy, simple, light, not complicated, and won't get dinged or busted easy. Again, I'm not the design engineer. This is the kind of thing that doesn't have to hold 40,000 kilopounds worth of agressive torque and strain for liftoff and all those kind of good things. And it's got to do is hold something together in zero g ... And I'm almost thinking something with the ease of velcro tab. But they tend to wear out. And they're also not quite as quick and convenient to attach unless they're placed perfectly correctly and I'm not sure that would always be done properly.

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
25. Standardization

MISSION DAY: 68 DAY OF YEAR: 022 (CONTINUED)
MISSION TIME: 20:06:02 GMT

NOTE: M487-2D

SPT: But the ... latches we've got on all these compartments are overdesigned for zero g, of course, they're made for liftoff. They have far more spring force than they need and there require forcing them closed sometimes in order to make the latches catch. That shouldn't be. I'm all for standardizing; coming up with something that's cheap and easy. I ... pay through the nose for some new super improved dogtrap. Do it simple.

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SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
25. Standardization

TECHNICAL CREW DEBRIEFING
12.0 Saturn Workshop Systems Operations
12.4 Crew Systems

POGUE: An area that would help more and could be corrected by proper early design consideration is the area of tools and fittings. We had many different sizes of screwheads and different sizes of hex tools that were required to service these things. What I would like to see in a spacecraft is a minimum number of graduated sizes of fittings.

CARR: Good point.

CARR: You should avoid mixing different kinds of fasteners, cam locks, Calfax, and that sort of stuff; it is undesirable. Standardization is a watchword for the future because it does simplify maintenance and procedures.

GIBSON: That's true. Even if you end up with one that does have some idiosyncrasies to it, you become accustomed to it and learn how to replace it rapidly. The way it was, we had so many different kinds of locks that when one malfunctioned, we couldn't have many replacements for it.

CARR: Maintenace can also be greatly simplified by standardizing sizes of nuts, Allen head screws, Phillips head screws, and all that sort of thing. As a mechanical engineer, I understand how you want to design your bolt holes and bolt sizes to the strength that it's going to be, because it is not efficient to overdo it. But on the other hand, you've got to think about the operator, too. And in this case, I think operations may well overshadow the design efficiency.

POGUE: We always wanted to use off-the-shelf hardware where we could. I agree with that, because that saves NASA money. But someone ought to look at the area of adapting existing fastener screws, bolts, what have you, to a standard size. Every fastener you can make captive ought to be captive.

SKYLAB MAN-MACHINE DATA FROM MISSION SL-IV
FOR: A. ARCHITECTURE
25. Standardization

TECHNICAL CREW DEBRIEFING (CONTINUED)
12.0 Saturn Workshop Systems Operations
12.4 Crew Systems

CARR: Right.

POGUE: Just because you used a piece of off-the-shelf hardware to save money does not excuse us from adapting that to space purposes; that is, putting standardized fasteners on to replace existing fasteners or putting a false head on them that receives the tools that you have.

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