

SKYLAB EXPERIENCE BULLETIN NO. 2

ARCHITECTURAL EVALUATION FOR AIRLOCK

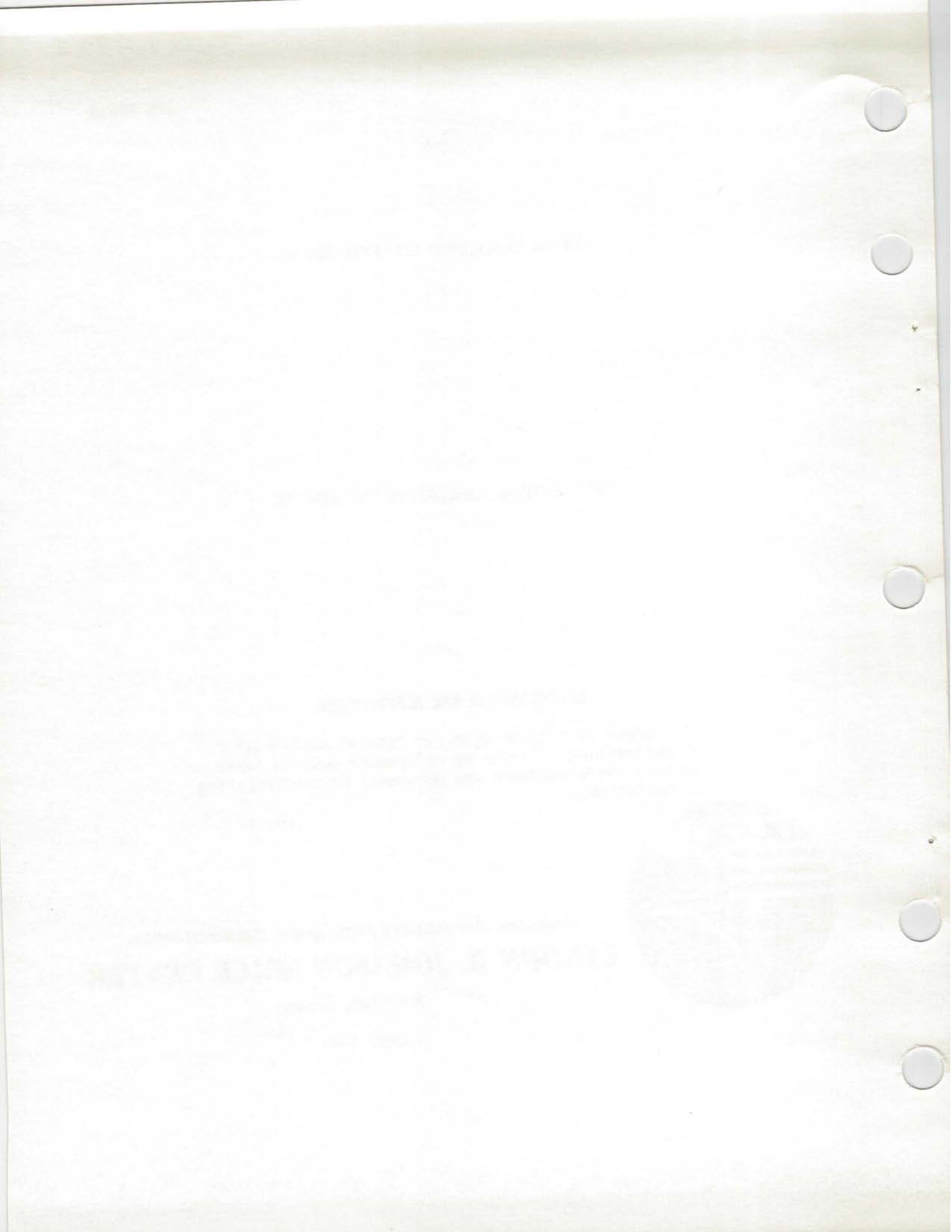
DISTRIBUTION AND REFERENCING

This paper is not suitable for general distribution or referencing. It may be referenced only in other working correspondence and documents by participating organizations.



National Aeronautics and Space Administration
LYNDON B. JOHNSON SPACE CENTER
Houston, Texas

JUNE 1974



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

BULLETIN NO. 2

ARCHITECTURAL REQUIREMENTS FOR AIRLOCK

This document is the second in a series of releases which are intended to make available to NASA and contractor personnel those results from the Skylab Man-Machine Engineering Experiments which have design and requirements relevance to current projects and programs. This method of data distribution has been instituted as a convenient way to provide early access to Skylab experience and is intended as an interim measure, to be followed up by a thorough experiment report six to nine months after receipt of all Skylab flight data.

PREPARED BY: Maguel Baltan

REVIEWED AND APPROVED BY:

Robert L. Bond

Robert L. Bond
Head, Man-Machine
Engineering Section

G. C. Franklin

G. C. Franklin
Chief, Crew Station
Design Branch

C. C. Johnson

C. C. Johnson
Chief, Spacecraft
Design Division

June 1974

ARCHITECTURAL REQUIREMENTS FOR AIRLOCK

SUMMARY

The size of the EVA airlock [1.65 meters diameter (65 inches) by 2.15 meters (80 inches) long] for the Skylab orbital assembly was apparently just adequate for use by two pressure suited crewmen during EVA operation. The volume became extremely marginal when the equipment used during EVA was restrained within the airlock.

There was a constant danger of damaging the EVA equipment during airlock operations from three sources: (1) the lack of foot restraints for the crewmen; (2) the lack of adequate temporary equipment restraints for the EVA equipment; and (3) the lack of sufficient volume to locate the EVA equipment outside the crewmen's immediate functioning envelope.

The physical location of the airlock created three general problems. The first was the potential safety hazard created by separating two living/working areas by an airlock. A failure in any of three hatches could have caused the entire mission to be aborted. The second was the actual impedance of the IVA traffic caused by channeling it through two hatches and the tunnel.

The third problem was the inordinate amount of time required to prepare for and secure from an EVA operation. Since very little stowage volume was available near the airlock, the EVA equipment was scattered about the orbital assembly. Thus, prior to an EVA operation, the equipment had to be gathered up, rigged for the operation and temporarily stowed within the airlock.

After the EVA operation, the equipment had to be unrigged and returned to its permanent stowage location. Locating the airlock as an appendage to the spacecraft living/working areas and providing EVA equipment stowage within or very near the airlock could have alleviated most of these problems.

PRE-SKYLAB EXPERIENCE

No NASA manned program prior to Skylab had used a dedicated airlock as an exit/entry path for EVA operations. In all previous programs the entire spacecraft had been depressurized in order to allow egress to the vacuum environment.

The Gemini EVA excursions were experimental in nature and the spacecraft itself served as the airlock compartment. Stowage and available volume were items of extreme importance since EVA prep and post activities had to be conducted in the same small cockpit [2.5 cubic meters (88 cu. ft.)] used for all other mission operations and crew personal needs.

Although considerably larger than the Gemini spacecraft [8.5 cubic meters (300 cu. ft.) for the Command Module and 6.0 cubic meters (220 cu. ft.) for the Lunar Module], the Apollo vehicles continued to be completely depressurized to support EVA operations. The Lunar Module was arranged to support the lunar excursions, and the majority of the equipment utilized during EVA was stowed on the exterior of the LM and thus remained in the environment in which it was used. Relatively few items were transferred to the LM for return to Earth. Since preparation for EVA was a prime function of the mission, the cabin was designed and stowed to support this activity.

Skylab considered EVA to be an operational adjunct to the main experimental operations, thus the time expended on pre- and post-EVA

operations became important because it was time that could have been used for experiment operations.

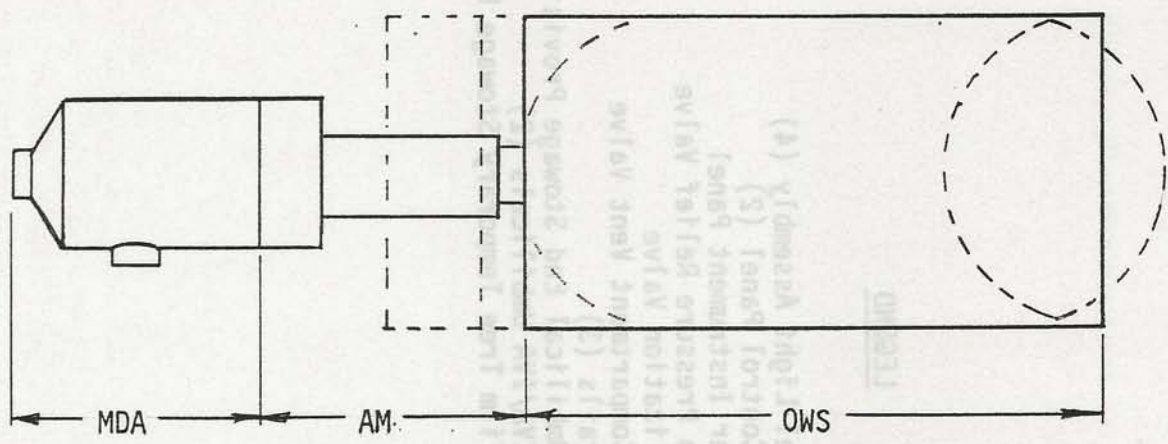
SKYLAB DESIGN

The Skylab Airlock Module (AM) (Figure 1) was located between the Multiple Docking Adapter (MDA) and the Orbital Workshop (OWS) and contained systems for environmental control, instrumentation, electrical power, communications, and operational management for the orbital assembly. It also provided a lock compartment, hatch and support systems for extravehicular activities. This bulletin is concerned with the lock compartment and hatches (Figure 2).

The lock compartment served two functions for Skylab. It was the connecting link between the OWS and the MDA and served as the airlock which was used for EVA activities.

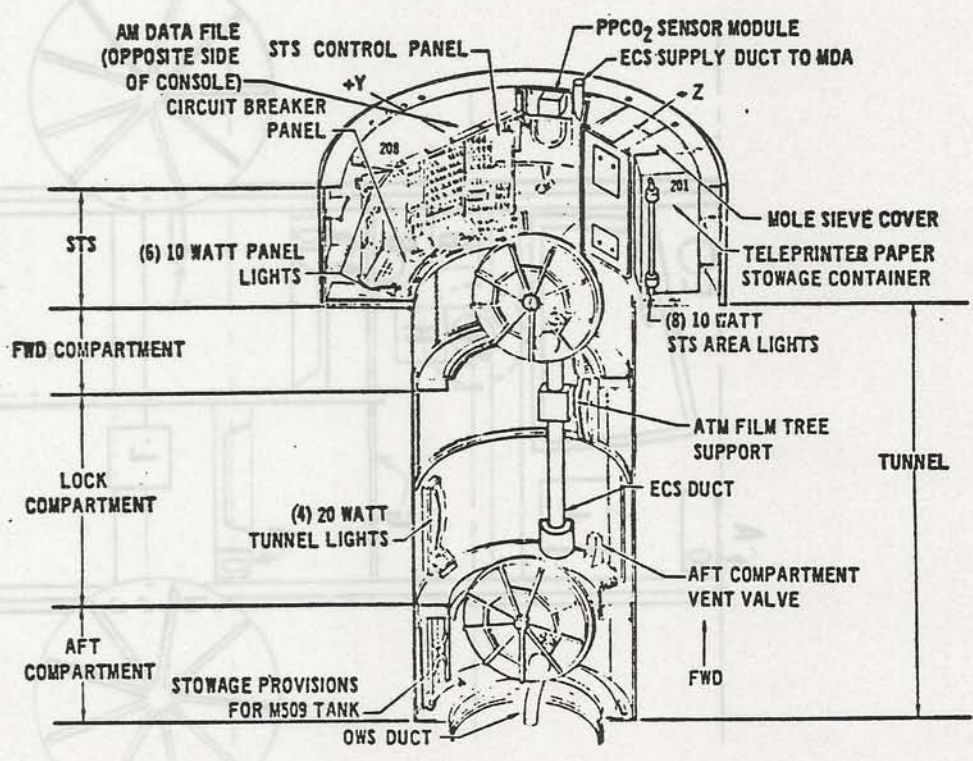
The lock compartment measured 1.65 meters (65 inches) in diameter and 2.15 meters (80 inches) in length. It included a crew hatch for ingress/egress during EVA and contained a volume of 4.35 cubic meters (154 cu. ft.). Figure 3 shows an unwrapped view of the lock compartment and the equipment stowed in it.

The two lock compartment internal hatches, (Figure 4) were used to seal off the lock compartment from the rest of the Skylab during EVA. They were circular machinings 1.25 meters (49.5 inches) in diameter with stiffeners attached radially. A 21.8 centimeter (8.5 inch) diameter



SKYLAB ORBITAL ASSEMBLY

FIGURE 1

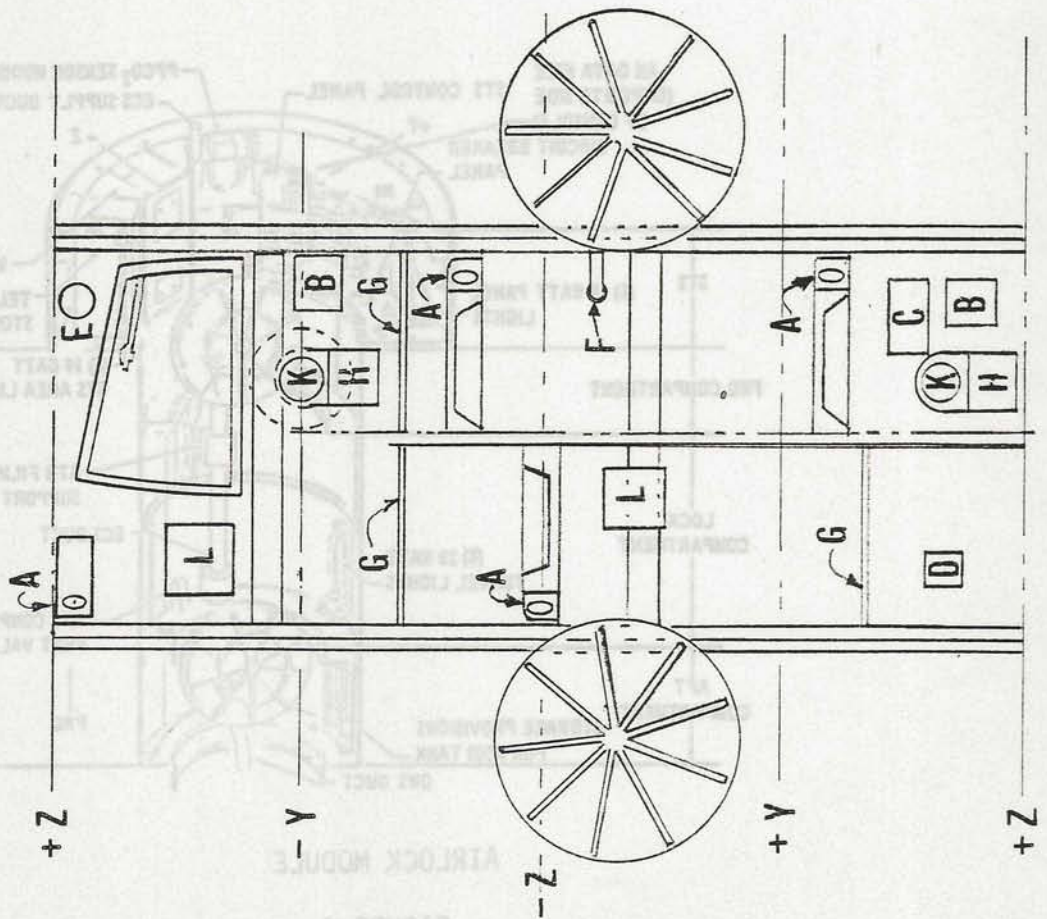


AIRLOCK MODULE

FIGURE 2

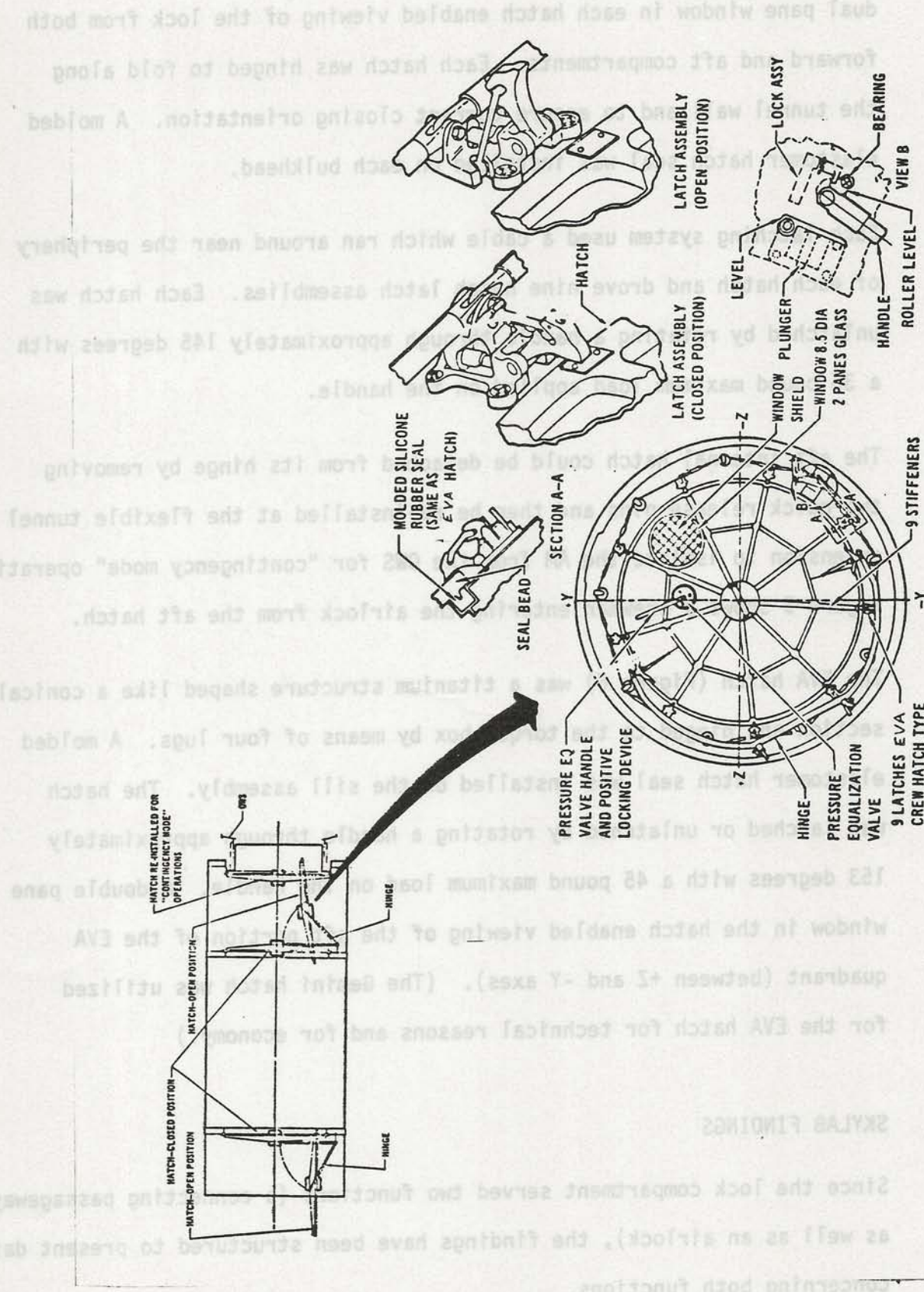
LEGEND

- A. Tunnel Light Assembly (4)
- B. EVA Control Panel (2)
- C. Center Instrument Panel
- D. Cabin Pressure Relief Valve
- E. Equalization Valve
- F. Aft Compartment Vent Valve
- G. Handrails (3)
- H. EVA Umbilical End Stowage Provisions (2)
- K. GFE EVA/IVA Umbilicals (2)
- L. ATM Film Tree Temporary Stowage Provisions (2)



LOCK COMPARTMENT

FIGURE 3



LOCK COMPARTMENT HATCH

FIGURE 4

dual pane window in each hatch enabled viewing of the lock from both forward and aft compartments. Each hatch was hinged to fold along the tunnel wall and to ensure correct closing orientation. A molded elastomer hatch seal was installed on each bulkhead.

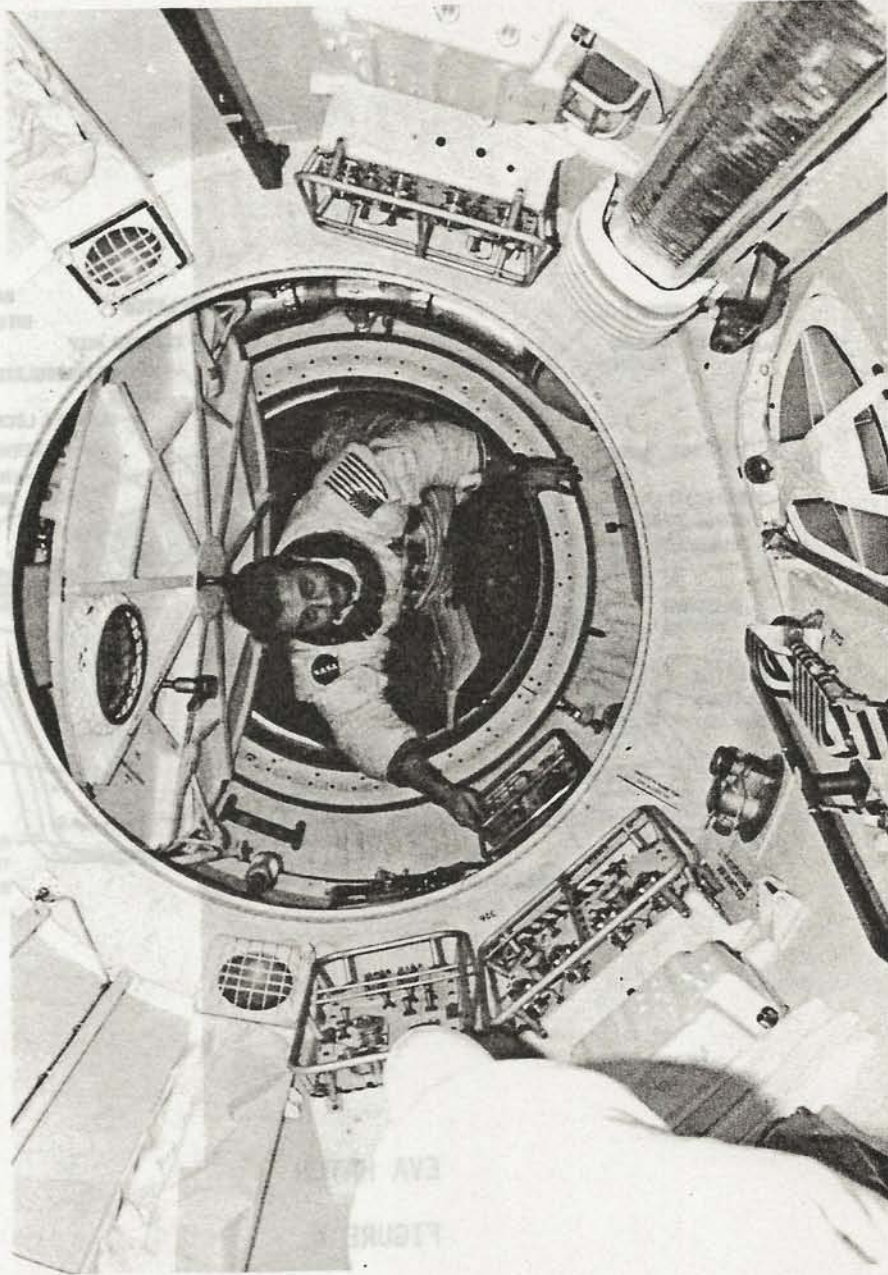
Each latching system used a cable which ran around near the periphery of each hatch and drove nine hatch latch assemblies. Each hatch was unlatched by rotating a handle through approximately 145 degrees with a 35 pound maximum load applied on the handle.

The aft internal hatch could be detached from its hinge by removing two quick release pins and then be re-installed at the flexible tunnel extension to isolate the AM from the OWS for "contingency mode" operations. Figure 5 shows a crewman entering the airlock from the aft hatch.

The EVA hatch (Figure 6) was a titanium structure shaped like a conical section and hinged to the torque box by means of four lugs. A molded elastomer hatch seal was installed on the sill assembly. The hatch was latched or unlatched by rotating a handle through approximately 153 degrees with a 45 pound maximum load on the handle. A double pane window in the hatch enabled viewing of the aft portion of the EVA quadrant (between +Z and -Y axes). (The Gemini hatch was utilized for the EVA hatch for technical reasons and for economy.)

SKYLAB FINDINGS

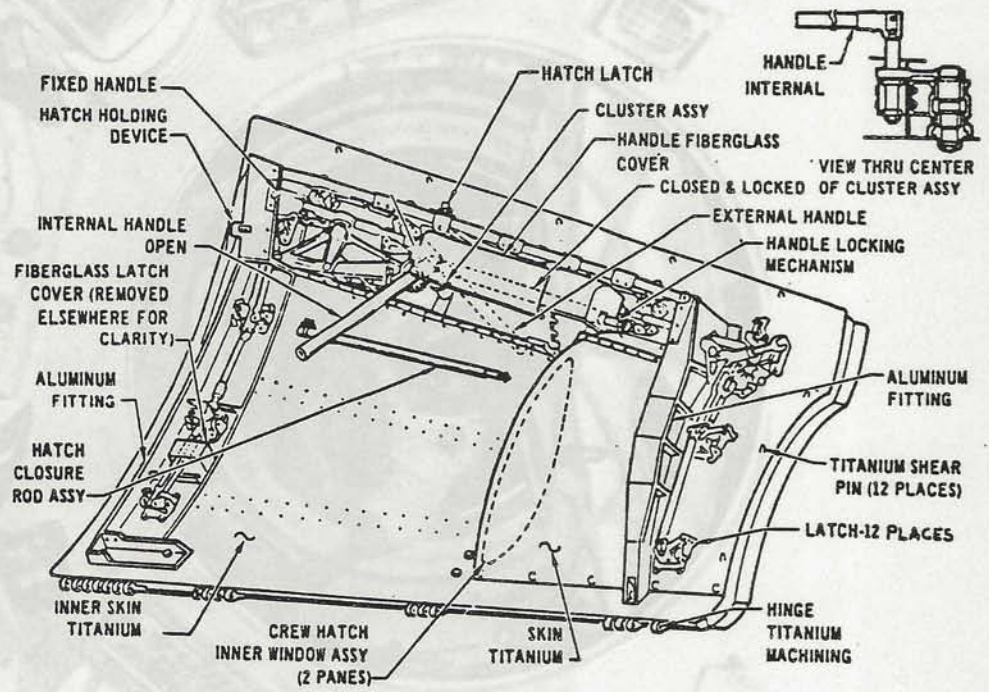
Since the lock compartment served two functions (a connecting passageway as well as an airlock), the findings have been structured to present data concerning both functions.



LOCK COMPARTMENT

FIGURE 5

FIGURE 2
LOCK COMPONENT



EVA HATCH

FIGURE 6

Size

Five different Skylab crewmen commented on the size of the lock compartment. Two definitely wanted it larger, one thought that it was acceptable but cramped and would have preferred it larger, and two felt that it was properly sized. Of the two crewmen who rated the airlock as adequate in volume, one had not performed the EVA tasks prior to his evaluation of the compartment. The most prevalent complaint was insufficient stowage volume, both temporary and permanent, and how that fact hampered the EVA activities. Thus, the free volume of the AM seemed marginally acceptable for two suited crewmen, but was insufficient for them and the equipment used during EVA. The following references address the size of the airlock.

<u>Reference</u>	<u>Appendix Page Number</u>
2	4
5	13
6	15
7	16
8	19

Stowage

The three Skylab crews consistently offered derogatory comments concerning both permanent and temporary stowage provisions within the

airlock. These remarks ranged from "should be a little better thought out for EVA" through "it's a rat's nest during EVA."

Permanent stowage facilities within the airlock were insufficient. Most of the EVA equipment was stowed in other compartments, causing the crewmen to spend an inordinate amount of time retrieving and replacing items during pre- and post-EVA operations. This arrangement lengthened the timeline on EVA days and could have shortened the useful time available in the EVA environment by overextending the preparation period.

The temporary stowage provisions were also considered insufficient and often poorly designed for their purpose. One large bag with a zipper was difficult to use during hard suited operations because the zipper had no pull tab to simplify the interface with the pressurized glove. Snaps were also furnished, but likewise were difficult to use with the pressurized glove. Some of the velcro used was good, but apparently it was not of a consistent quality since some adhered well and some not at all. The crewmen used a great many wrist and waist tethers to temporarily secure tools and equipment in the airlock while performing the EVA operations. Many of them felt it was a makeshift operation.

The following references refer to stowage problems in the airlock.

<u>Reference</u>	<u>Appendix Page Number</u>
1	1
2	4

<u>Reference</u>	<u>Appendix Page Number</u>
3	7
4	10
5	13
7	16
8	19
9	21
10	23

Foot Restraints

Several comments were recorded concerning foot restraints, some of them directly and some indirectly. Of those comments directly related to foot restraints, only one crewman did not express a need for them. He braced himself against the hatch sill and the wall and did not feel a need for foot restraints. The other crewmen felt a definite need for foot restraints of some kind during the EVA prep and post tasks.

Some of the crewmen didn't comment directly on a need for foot restraints but they did express concern about their flailing around during the EVA prep and post operations. These concerns about injuring the equipment are interpreted as an indirect expression of the need for foot restraints.

The following references have comments concerning foot restraints.

<u>Page Number</u>	<u>References</u>	<u>Appendix Page Number</u>
7	2	4
10	3	7
13	5	13
16	7	16
19	9	21
21	10	23
23	11	24

Location

Very few comments were made about the location of the airlock, but they were all from the crew that spent the most time in orbit and doing EVA operations. The SL-4 crew was unanimous in believing that the airlock should be out of the mainstream of the IVA traffic and cited several reasons for this. First, the hatches in the tunnel impeded IVA traffic. Second, due to the lack of power outlets within the spacecraft, several power cables were passed through the lock compartment to provide power where it was needed. They had to be unriggered during pre- and post-EVA activities and this was another timeline impact. Third, from a safety standpoint, the separation of two living or working areas by an EVA airlock created a hazard. Had the outer hatch failed open, the mission would have had to have been aborted; had either of the two inner hatches failed closed, the mission would have had to be aborted, with the possibility of the EVA crewmen

being trapped and unable to make an IVA transfer to the Command Module. Fourth, the location of the airlock in the mainstream of traffic prohibited leaving EVA equipment set up and operational. Thus an inordinate amount of time was spent during pre- and post-EVA operations rigging and unrigging the equipment. The lack of stowage facilities for the EVA equipment can be attributed, at least in part, to the location of the airlock in the mainstream of the IVA traffic.

The following references contain comments concerning the location of the airlock.

<u>Reference</u>	<u>Appendix Page Number</u>
1	1
2	4
3	7
4	10

CONCLUSIONS/RECOMMENDATIONS

1. Size the airlock for the EVA function. The 1.65 meter (65 inch) diameter appears to be adequate for two men to perform EVA prep and post tasks. The 2.15 meter (80 inch) length appears to be marginally adequate, however, the length of the equipment that will be used in the EVA operations will have to be considered. This total volume leaves little or no room for the hardware to be deployed, retrieved, or functionally operated during an EVA.
2. Provide permanent stowage in the airlock for the equipment that will be used during EVA operations. Provide temporary equipment restraints within the airlock that can be operated by a pressure suited crewman.
3. Provide foot restraints in the airlock for use by a pressure suited crewman. Locate these foot restraints so that the crewman can, when restrained, reach the required equipment and hatches.
4. Locate the airlock as an appendage to the work area of the spacecraft, out of the main traffic flow within the spacecraft.

RAW DATA APPENDIX

<u>REFERENCE</u>	<u>SOURCE</u>	<u>PAGE</u>
1	SL-1/4 Dump Tape 356-06, page 11, 12, 13	1
2	SL-1/4 Dump Tape 361-03, page 1, 2, 3	4
3	SL-1/4 Technical Debriefing, page 26, 27, 28	7
4	SL-1/4 Systems Debriefing, page 391, 392	10
5	SL-1/2 Dump Tape 159-12, page 10, 11	13
6	SL-1/2 Dump Tape 159-13, page 5	15
7	SL-1/3 Dump Tape 229-13, page 11, 12, 13	16
8	SL-1/4 Dump Tape 356-05, page 16, 17	19
9	SL-1/3 Dump Tape 232-05, page 4, 5	21
10	SL-1/3 Dump Tape 232-05, page 13	23
11	SL-1/4 Dump Tape 333-02, page 9	24

Dump Tape 356-06
Page 11 of 17

356 19 25 40 PLT

The airlock: General arrangement and orientation of compartment: don't like the small size of the numbers on some of the panels. Hard to see some of the numbers, not nearly as bad as the MDA. 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 - 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, 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 because - 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 - the - 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 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.

356 19 27 23 PLT

Ceiling/floor proximity. Course you can move around there with no problem. 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. Trash collection provision. There's none in there and I'm not even sure there needs to be. 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 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.

356 19 28 38 PLT

Stowage volume and access; my previous comment applies to the - this. Okay. Temporary equipment restraints. Well, in the - in the EVA position - you've got a big zipper bag in there for use in EVA and there's not even a zipper pull tab on it, I don't think. That's really bad planning. It's hard to do that with - with gloves on and hard suits. I went back in there to try to get something hard suit; I forget what it was, a pair of scissors,

Dump Tape 356-06
Page 13 of 17

I think. And that was a real pushing and shoving contest to try to get that bag open. Anything that's designed for stowage in a EV - in an airlock ought to be designed for EVA use. Because it'll eventually be - end up used for that. We do not have enough places to locate equipment around in the - in the airlock for EVA use. It's always make do - make do with straps and tethers and tape and that sort of thing. An airlock ought to be very, very flexibly designed with - with an idea toward equipment that you haven't even seen yet and can't even envision. It ought to cover a complete spectrum of size and delicacy. In other words, there ought to - you ought to - you ought to have some way of - of restraining large items, long items, big items, round items, small and rather fragile items.

356 19 29 56 PLT

Personnel mobility aids they're all right. I think the - the airlock hatch required too much force to put the pole into position that holds it open. But that's - that's too late, way too late now. Each EVA task, thought by - just by nature to be very easy, but that is a problem in the airlock. Thermal comfort, no big deal; noise level, fairly high up there; elimination, no problems. 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 it's 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 everytime I think about how stupid the layout is in there, I get all upset. You can't even find the numbers on panels. They refer to numbers that are not even in there. Just the other day, yesterday, in fact I was doing 557, and I was directed to the battery vent valve, number - panel or location number so-an-so. That's another thing,

USE THIS SIDE OF THIS SHEET ONLY

1 361 04 36 32 SPT

2 - photography or for better vision,
3 for one reason or another. I think
4 they can do it in the airlock. Well,
5 what can you say about it? An airlock
6 is an airlock. The tube - the tube
7 is a tube. There's not much else you
8 can do with it.

9 SPT

10 General arrangement and orientation of
11 the compartment for EVA nonequipment.
12 Volume - Well, I think it could be a
13 little bit larger. Run into a few
14 instances where we had though times
15 planning for an EVA, and - and stowing
16 of gear just because we don't have
17 enough room in there. I'm afraid one
18 of these days we're gonna kick one
19 of those pie - delicate pieces of
20 gear while we're in ther and really
21 mess it up. I think the volume
22 could at least be 50 per - should be
23 at least 50 percent larger for
24 that kind of operation. Getting
25 yourself in there with all that
26 umbilical and - in a situation which
27 may require that you have a volume
28 available to you for crew safety, I
29 don't think it could - it could -
30 a good design in terms of volume; you
31 just flat need more.

32 361 04 37 43 SPT

33 Ceiling/floor proximity - Yeah that's
34 not applicable. Ingress/egress provisions -
35 Great, one ... the other. TRash
36 collection provisions. There are none,
37 but you don't need it in there. You're
38 always passing through whenever you'd be
39 in the mode of making or generating trash.

40 SPT

41 Stowage volume and access. I think we need
42 a little more stowage volume for EVA. And
43 that fits in with the whole - Well, the
44 question of volume.
45
46
47
48

Noise

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48

SPT

Temporary equipment restraints - Not needed, except for EVA. Personnel mobility aids - not needed. Personnel restraint devices. Not - Well, I would think maybe for EVA, we could do something there. I think if we get - had ourselves a pair of heel clips in there. which could be - which could be put in various locations for a given EVA, set up ahead of time. it might ake it a little easier to work.

SPT

Thermal comfort - fine. Noise level, - ... We got the problems with the pumps in there that's way too high see have the ATM coolant pump which s - ATM and EREP coolant pump which is acting up. I think if we're gonna have gear like that around there, we sould not have it so close to the walls, and where the vibration and sound can be transmitted so easily. That leaves the MDA which will be discussed next as a noise source. But that certainly is - certainly is real generator of noise and I think in future planning we ought to take into account malfunctions of that kind and try to keep all the potential noise sources away from bare metal - being right up against bare metal walls which act like a vibrator - accoustical can. Illumination :s - is adequate for EVA. If we had to spent any other time there for something else - I guess it is pretty good. I - I really can't complain about it. It's ... I've ever been in I've never had any problems with. Again though, I will make a EVA hatch here - the general location of it though. I would making 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 - 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

USE THIS SIDE OF THIS SHEET ONLY

AIRLOCK OUT
OF MAJOR FLOW



USE THIS SIDE OF THIS SHEET ONLY

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48

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.

361 04 41 07 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 - 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. I don't see anything here that gets me to that question of labeling. And let me talk about that. The MDA/STS is one of the biggest mysteries of the world when you go in there to find a panel. The 200 series, I think I can find. But I'll tell you. sometimes they have - I've been on so many wild geese chases in that place, both in training and in flight. I wasted more time because some guy had given me a panel number which no way related to the panel numbers which should be adjacent to it. On 243; is nowhere near 245. I will never be able to guess - Some panels are closed inside something, with no - nothing on the exterior that's immediately obvious to you unless you search every square inch of the spacecraft that - the panel really is on the inside of another enclosure. I think that thing

GIBSON (CONT'D) do have a single point failure in the composite disconnect, in that you can take a rope with two motions, both of them being in the same direction, and pull your disconnect off. That nearly happened during the last EVA; EVA 4.

CARR Closed Chill Water System: That was a great system even though we had a few problems of leakage on EVA 2 and EVA 4. The system itself is an excellent system and it certainly is a boon to crewman outside under a heavy work load. It really keeps the body temperature down.

POGUE We had a continuing problem, apparently a design or manufacturing problem with the loop, and that was the liquid gas separators leaking. This caused problems on earlier missions by introducing gas down in the condensate system. There was a couple of things that were done right toward the end of our mission, trying to troubleshoot, that I didn't quite understand. More design work must be done on tolerances and QD's and gas liquid interfaces and that sort of thing. The system itself is great. I would hate to do a hard EVA knowing from the start that I was only going to have gas cooling.

GOOD

CARR Lock Compartment: We were stuck with the lock compartment just because of the nature of the beast. In the future, if we're going to have use a lock compartment concept for going EVA, that the

CARR
(CONT'D)

lock compartment should not be in the middle of the workshop or the vehicle. It should not separate two living areas when depressurized. It should be on the end somewhere so that if it were to fail open or depressurize, that it would not render the rest of the workshop untenable, essentially, for any period of time. 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 experienced. A lock compartment on the end of a vehicle could be prepacked, premission. It could have good stowage provisions for all the things such as scissors and tape, and all of your EVA equipment could be stored there. It would certainly cut down on the overhead time presently required in the EVA.

POGUE

You're right, that is a very heavy traffic area. And, of course, you stood the chance of damaging the equipment.

GIBSON

There should be a better way to stow those items which you're going to take EVA. The way we were set up, they were just hanging bare off the wall, and when you got in there with all your equipment, you found yourself thrashing around, kicking the end of Nikon cameras on a TO25, or kicking a DAC or a whole multitude of other things which were lined up in there. All the gear was thrown in there with the crewmen and you were left to flail around. I don't think that's an adequate way to go. The gear

GIBSON
(CONT'D)

should be stowed off on one side so it can be reached EVA but is out of your general working path while you are trying to get in and out of the lock.

Refrigeration, Food and Urine Freezing: The problem that we did have was the way which the urine icicles froze. We had those freezing at a higher attitude above the drawer than desired, and that system needs another look at it, if anything like that will be used in the future.

On the - Do you have any way that you think that EVA prep and post times would be reduced at all? That's really kind of -
Dr. Yes. Yes. By designing a spacecraft that is better designed for EVA, you can cut that prep and post down a lot. We spent an awful lot of time putting the stinker tape and erector sets together and jacking them down the airlock module and then after the thing was

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

CARR Yes.

QUERY With any radius in it.

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

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

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

CARR
(CONT'D)

over, taking them apart and putting them away. And in our tech debrief, we discussed the idea that the EVA lock should not be between two living areas. You should not isolate two living areas. It should be on the end somewhere. And it should be located in such a manner, designed in such a manner, that the stuff that you're going to use on EVA is stowed in it, with lockers and things right in there, so that you don't have to be taking things apart and putting them together and stowing them in a high-traffic area.

POGUE

Reconfiguring ECS ducts, taking that elephant trunk out, putting it back in, and all that other nonsense; all that took time.

CARR

Yes. The suits - There's a lot overhead in suit prep.

POGUE

Stowage was the ... - -

CARR

And stowage of suits. There's no good stowage area for the suits. You know, that - that game we had to play of moving the suits up into the MDA and stowing it underneath the foot restraints for the ATM panel in little nooks and crannies was not too terribly sterling. All that overhead time is just costly to you. The - That was really the main thing; we spent so much time putting things together and prepping them that -

POGUE

I guess that - No. I was going to say that traffic - you know, getting ready, going to the sleep compartment, coming up, getting radiation dosimeter, and all that - I suppose there's no way to avoid a lot of that. But there's - just relocating the airlock would have eliminated a lot of the wasted time.

QUERY

Okay. The S082A and B overcans, the big jerry cans, didn't have a lot of lead-in on the guides; they were a fairly close fit, whereas the S082A and B cameras in the canister had quite a bit of lead-in. Could you comment at all on - on differences or any difficulties in inserting the cameras into the 82A and B?

CARR

There was no problem. I know in the procedures we always had a little comment in there about making sure they were flush before you tried to close the door, and that just never - never reared up. It was always straightforward; they'd just slide right in and you - they'd be flush and you could lock it up. No problem.

QUERY

Visibility was good both places, and - -

CARR

Yeah.

Skylab Dump Tape 159-12

Time: 2108 to 2240

6-9-73

Page 10 of 15

Reference 5

and makes it ... for stowage of other gear. Aside from that, we did well. Ceiling/floor is okay. Ingress/egress is not applicable. Trash collection, we don't collect trash in that compartment. Stowage volume is all right. Temporary equipment restraints, have trouble finding places to put the checklist still. What we need is a mini camera mount that doesn't stick down in the compartment so far, and which could be placed in more different places. Personnel mobility aids not required. Restraining devices not required: the triangle does the trick. Thermal comfort okay. Noise level okay. Illumination on the low side. 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 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. The volume is fine and we need a compartment this big to give you room to play around and move in. Ceiling/floor proximity is okay. Ingress/egress is okay. Trash collection, we don't collect trash upstairs. Stowage volume is fine, and access to the dome lockers is fine. Temporary equipment restraints, don't seem to be needed, except in the suit doning areas where we could use some more. Personnel mobility aids, not required. Restraint devices adequate. Thermal, noise, and illumination, the first two okay, the illumination is a little low. The air lock is a - a fine tunnel. And for a tunnel and an air lock, its size and dimensions are pretty good because when you're EVA with the hatch open you always have something to bare against

and I wouldn't want it a whole lot bigger. A little longer, maybe, because we always have trouble getting things in. Okay, ceiling/floor proximity is good. Ingress/egress is good. We don't collect trash in there. Stowage volume, we should have a little more, a little better thought-out stowage for EVA. Equipment, the zipper pockets aren't very useful because you can't get anything in them and then close the zipper. The zippers aren't easy to handle in the pressurized glove. Keep in mind that Velcro is - would be great if we had the right kind. Snaps are also no good in the pressurized glove. Much of the Velcro aboard the ship is no good because it doesn't hold well enough. Okay, personnel mobility aids, not required. Restraining devices, not really required. We talked at one time about having shoes in the air lock, and shoes are a great thing in a pressurized suit. We just don't happen to need them in a compartment this size. Comfort, noise level, and illumination are not applicable. 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. Ceiling/floor proximity is all right. Ingress/egress is all right. Trash collection, don't seem to need one in the MDA. We don't have any that I can think of. Stowage volume and access, okay. Equipment restraints, okay. Mobility aids, not required. Restraint devices, the two

Skylab Dump Tape 159-13

Time: 2245-0020

6-8-73

Page 5 of 6

really used them as we debriefed earlier, as handrails, as mobility aids we use them more as safety devices. Restraint devices are very good. Thermal comfort is very good, noise level is very good, illumination is a little bit dim. And I give that adequate but we could certainly use some

more light. 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, the ... proximity is ..., the cylinder diameter is good. When you work in there you can't expect to press up and put your shoulders against one side and your feet against the other side and stabilize yourself quite well. ... we discussed doesn't apply, trash doesn't apply, stowage volume doesn't apply, temporary equipment restraints I haven't really had the occasion to use them in there, the other two people can give you a better handrog ... exercise. Mobility aids doesn't apply, restraint devices doesn't apply. Thermal comfort doesn't really apply, noise level is all right, illumination is very good in there because they have got, 20 - I think 25 watts of volts in the walls of the painted white, and that is the one place we have excellent illumination. 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 complet that MDA orientation on the ATM. The volume is very good, more than adequate. We've got plenty of room to move around in here. Actually more

bering 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 here's one on the floor called 594, but probably all over - In any event, it's important that we ah, do something about volume; got plenty of volume. If your gonna do things like ah, evaluate the maneuvering, you - you're gonna need more. Ceiling/floor proximity, good. 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. One of the funny designs we got here is, and we live in one end and our so call safety hatch is at the oether end, the command module. That isn't the way it ought to be. The experiment compartment ought to be the farther from the come home module. Sleet compartment ought to be next to it, and ah, everything else in between, there just is no reason to separate yourself so far from ah, safety, in the event of a - of failure - big failure of some sort. Ah, temporary equipment restraints, there aren't too many, except the floor and ceiling. Ah, they're not adequate, I don't think. Ah, personal restraint devices, nothing except ah, ah, the floor and ceiling. I'd recommend ah, a little bit more in the way of restraints, and ah, mobility aids. Thermal comfort, satisfactory. Noise level, okay. Illumination, poor.

CREW ...

CDR 30 minute time limit!

CREW ...

229 22 27 11 CDR

He didn't say. Airlock, general arrangement orientation of compartment, not big enough. It's tubular when you'd really like it square like a room, you

have to lay sideways in it, and as you lay sideways in it, you kick things. You don't have any good restraints. What ought to be in there, is some way to go in that lock compartment 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, trys 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 make shift operation. You need something, with a nice floor, a nice ah, way you can restraint something, being protected where you won't get bumped, where you'll be nice and stable, and you can get to all the items you need to get to without floating to them. Volume, not enough. Ceiling/floor proximity, there ain't no ceiling/floor, it's a round tube and you're generally laying from hatch to hatch, it's not the way it ought to be built. Ah, trash collection, no provision, I don't - 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. Temporary equipment restraint, not good enough, poor, the only thing there is poles. As far as mobility aids they've got em'. Good mobility aids, you can get around in there, hold the sides, hold the handrails when you want to leave something in there for just a minute, it's hard to find it. Thermal comfort's okay, noise level, okay, illumination, so so.

229 22 29 45 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, whose facing the other way who's looking at an experiment and doing just the opposite. Also by having circular rooms, you end up having a problem knowing where that the cabinet things are stowed. 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 uh 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 uh be useful and not have to try to hunt it. Now if we have to find something in a stowage box in the MDA,

Dump Tape 356-05
Page 16 of 19

356 17 14 17 CDR

I think probably a few snap patterns under the dome area would be handy. We could put some - some equipment up there. Personal mobility aids, the fireman's pole we used the first part of the mission until we got our bearings; we got rid of it. The - we haven't even tried to use the strap.

356 17 14 43 CDR

In this compartment it's a matter of deciding where you want to go, aiming yourself in that direction, pushing off and coasting. I don't think you really need many mobility aids in here. Personal restraint devices, the good old grid; no sweat. Thermal comfort is quite comfortable in this compartment as well, the noise level is just a little bit noisier than the experiment compartment because we're a little bit closer to the noise of the MDA.

356 17 15 11 CDR

Illumination in the forward compartment is excellent. Airlock compartment, general area - 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.

356 17 15 30 CDR

It's - It's acceptable. 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.

356 17 15 51 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. Ingress/egress provisions, no prob-

Dump Tape 356-05
Page 17 of 19

lems with it. The gemini hatch is a fine external exterior hatch and the hatches on each end of the airlock are of adequate size. Stowage volume and access is NA, not applicable. Temporary equipment restraints, snap patterns and delco are about all that are in there.

356 17 16 30 CDR

And we use - make extensive use of wrist tethers and waist tethers for the EVA situation. Personnel mobility aids, there are none in there. Restraint devices, little or none, some hand rails and that is about it and there really isn't much you can do about that either.

356 17 16 53 CDR

Thermal comfort, it begins to get cold when you move from the dome to the airlock toward the MDA. Noise level; it is extremely noisy in the airlock. The airlock pumps - the water glycol pump - correction, not water glycol, coolanol pump and the - the primary coolant, secondary cooler loop, also, the ATM coolant pump, are very noisy. Illumination in the airlock is fine. You can set it negative or dim and it's quite adequate.

356 17 17 34 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; the volume is acceptable, adequate. Ingress, ceiling to floor proximity, well, you know that's not applicable in there really. Ingress/egress provisions, one whole in each end is quite adequate. Trash collection provision, there's none up there and there really ought to be at least two areas for trash collection, one around the EREP area and one over next to the ATM.

against the ceiling. Blocks out the light all right, but doesn't let any air through it. I - uh - keep my - uh - little - uh - curtain half way open in the evening - at night, to prevent - permit - permit ventilation - uh - through the compartment. The air coming up through the - uh - vent duct in the floor - uh - flows fairly rapidly. It's uncomfortable to have it pointed at you. You have to have it pointed away and - uh - otherwise, it - uh - it's too drafty. Experiment compartment - uh - arrangement uh - 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 after thought. I guess that's all I can think of on the - uh - experiment compartment.

232 14 51 28 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.

232 14 52 10 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 - grap 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.

232 14 52 56 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 grap on to and to fasten yourself down to. The - uh - the only arrangement of the - uh - MDA is probably - uh - more hodge podge than - uh - any other area in the space craft, 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.

yourself to something to get in there. There's just not - no way to hold yourself down unless you wrap your legs around something. And - uh - uh - haven't actually had too much occasion to get things out of stowage in the MDA. Uh - but - uh - here again, all the stowage is arranged in real hodgepodge fashion and - uh - lighting is all different directions and - uh - when you go up there you really got to look around to find out where you are before you can find what you're looking for. Uh - depends on the orientation, you hit the MDA at - as to where you think you are. Seems like everytime I go up there still - uh - unless I enter it the same way everytime - uh - I'm always a little confused as to whether to go right or left to - uh - to find what I'm looking for. And I always gotta go in there and find - uh - EREP stuff and uh - and then I can locate myself with respect to that, or with respect to the ATM panel.

232 15 08 17 PLT

Uh - there's not much stowage - uh - volume in the airlock and there ain't a whole lot required in there - uh - except for the stuff that we take out EVA, we naturally have a place to put it instead of hooking on to everything; so its in the way of your feet, kicking it around and banging on tethers, and - uh - getting wrapped up in your legs and - uh - your umbilical and wrapping itself around other articles that are also fastened to the tether. It's a big - uh - rat nest in there during EVA, as far as stowage is concerned. Temporary equipment restraints - uh - we should've had more spring bungees and we shouldn't have had those sharp wires on them cause those are eye catchers. We found that - uh - with time and use that those bungees, those little wire hooks and - the ones from the command module are real good, but the ones that were built with the

Dump Tape 333-02
Page 9 of 17

I think that would be something that can very definitely be designed for future spacecraft. Some sort of a little see-through compartment with a jet - water jet nozzle inside of it that you can stick your razor in and seal it and then turn on the little sprayer and rotate your razor or squirt it and knock all the lather and all the hair out of the razor so that it can be used again without wiping the blade. I think that - that all of the - the items that are in the hygiene kit I think we'll probably get a chance to hit later, so I'll drop that for now and hope that I'll get a chance to brief - debrief on that at some later time.

333 03 17 04 CDR

Getting back to restraint devices and handholds and the like are pretty hard to give them a good bill of health to the workshop section. Moving

on up into the airlock module of the STS and the MDA. We begin to find that the handles become few and far between, or leg correction - foot restraints become very few and far between. There really isn't much requirement in the airlock module for foot restraints during the non-EVA situation. But it would give a thrashing around there in an EVA situation. It certainly would be helpful if you could lock yourself into some sort of a position. I suspect that some sort of a bracket 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