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CHAPTER 17

HABITABILITY/CREW QUARTERS – EXPERIMENT M487

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A spacecraft represents a unique and, in many respects, a different environment in which to live for any extended period of time. For a long term mission, considerable attention must be given to the habitability characteristics of the vehicle. The difficulties and discomforts endured during Gemini and Apollo flights must be eliminated before interplanetary flight can be undertaken. However, habitability data collected for earthbound stations may not be adequate as a basis for the design of future space vehicles. For example, crewmen have noted that the Apollo Command Module, which is relatively cramped during 1 g tests, assumes a more spacious character in zero gravity when movements can be made freely in three dimensions.

The need for habitability data relating specifically to space vehicles is well recognized and plans have been made to use the Skylab Program to provide a fund of meaningful information on a number of habitability variables. Skylab Experiment M487, Habitability/Crew Quarters, is designed to provide an operational evaluation of the Skylab habitat by gathering data regarding the manner in which crewmen carry out their daily living and working routines during the missions.

The success of the Skylab habitability experiment will depend, in large measure, on the adequacy of the data collection instruments and the manner in which they are used. For this reason, the M487 experiment was included in the SMEAT Program. To gain realistic experience in handling the M487 protocols, the four M487 objectives to be met in SMEAT were:

1. To obtain use-efficiency and use-time information for the environmental measuring instruments.
2. To obtain crew evaluations of the various subjective data formats and the times involved in their use.
3. To evaluate the communications disciplines associated with complete dependence upon voice recorded data.
4. To evaluate flight scheduling and timeline requirements for the experiment.

The evaluation of the SMEAT chamber as a habitat was not an objective of this experiment; however, useful habitability data were collected during the test that are applicable to the Skylab Program.

In keeping with the intent of M487 in SMEAT, only those results which reflect directly on the conduct of the flight experiment are included in this report. SMEAT habitability assessment data, such as the environmental measurements obtained with the M487 instruments, are not presented or discussed.

Test Hardware

The hardware employed by M487 can be categorized into two major groups: environmental measuring instruments and subjective evaluation formats. The instruments are further classified as experiment equipment and supporting equipment. Three different subjective formats were used during SMEAT: a rating form, a debriefing questionnaire, and an environmental evaluation scale.

Instruments

The M487 hardware has become something of a test case in an attempt to procure "off-the-shelf" items, conduct a minimum qualification-test program,

and certify flight readiness. The Development Center (Marshall Space Flight Center) for the M487 experiment chose to conduct this type of procurement since the hardware requirement for the experiment was quite simple and straightforward: to provide a small assortment of measuring devices useful in obtaining quantitative data to supplement the crewmen's subjective impressions of various habitability related parameters.

Experiment Equipment. The experiment equipment includes:

1. Velometer
2. Sound Level Meter
3. Frequency Analyzer
4. Thermometers (for ambient atmosphere)
5. Thermometers (for surface temperatures)
6. Force Gauge
7. Tape Measure
8. Equipment Container

Supporting Equipment. The instruments contained within the Skylab onboard inventory to be jointly used by M487 include:

1. CO_2/Dewpoint Monitor
2. One Degree Automatic Spotmeter
3. Photographic Equipment and Accessories

An equipment container was developed to house the M487 peculiar equipment. This unit, which resembles the Skylab tool kit, is a compact self-contained module with three slide-out drawers. The instruments are shock mounted in cutouts recessed into closed cell Mozite inserts within each drawer. The container is designed to fit into a standard Skylab stowage locker, as depicted in Figure 17-1. In the SMEAT chamber, the M487 equipment container was located in stowage locker 703 within the wardroom.

The experiment equipment used in the SMEAT Program was the qualification-test hardware. This hardware was of flight configuration except for two late changes which were identified at the M487 Critical Design Review held on June 1, 1972. The first was a redesigned drawer latch (welded instead of bonded) which will be more reliable under multiple uses, and the second was the incorporation of finger cutouts in the Mozite to facilitate instrument removal and replacement.

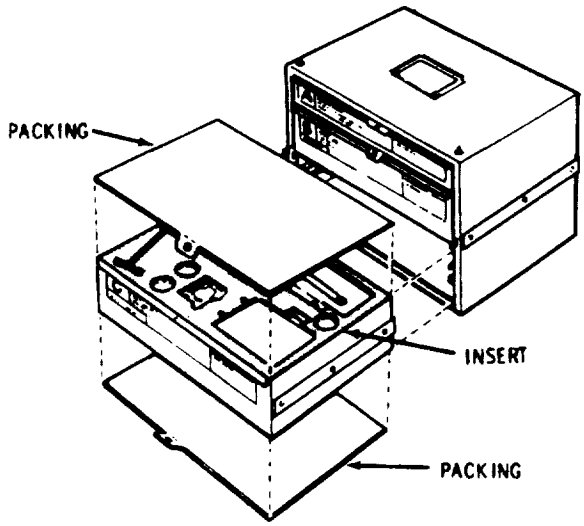

Figure 17-1. M487 Instrument Kit.

Subjective Formats

Although not hardware, the subjective formats are included in this section because a major effort went into their development and they do represent separate stowage items requiring unique timeline scheduling for their use. All the various subjective formats were flight configured and contained many zero g related items that were obviously not ratable by the SMEAT crew. These items were not used during SMEAT.

Rating Forms. The Subjective Rating Form used by the SMEAT crew was a "cue card" containing generalized compartment design information on one side and equipment adequacy information on the other side. Figure 17-2 shows the form used for general compartment evaluations. Items on each side of the card were alphanumerically coded to facilitate inflight voice recording of the evaluation data. In preparing the "cue card," a section was inadvertently omitted which called for evaluating certain items of equipment in terms of their frequency of use rather than in terms of an absolute assessment of their

STATE NAME & DATE

STATE CODE, THEN NUMERICAL RATING FOR EACH ITEM TO BE RATED (either by row or column).

EXPLANATORY COMMENTS ENCOURAGED, ESPECIALLY FOR RATINGS OF 3, 4, OR 5.

SUBJECTIVE RATING SCALE
DEFINITION

RATING

1 EXCELLENT: Improvements matter of individual crewman preference.

2 VERY GOOD: Minor improvements possible, but not really necessary.

3 ADEQUATE: Some shortcomings found and a few improvements would be desirable.

4 POOR: Shortcomings found and improvements are necessary.

5 UNACCEPTABLE: Gross shortcomings found and improvements are mandatory.

PARAMETER TO BE RATED	EXPMT	FWD/DOME*	AIRLOCK	MDA/STS	WARDROOM	HEAD	SLEEP
Compartment general arrangement and orientation	EA	FA	AA	MA	WA	HA	SA
Volume of compartment	EB	FB	AB	MB	WB	HB	SB
Ceiling/floor proximity	EC				WC	HC	SC
Compt ingress/egress provisions	ED	FD	AD	MD	WD	HD	SD
Trash collections provisions	EE	FE	AE	ME	WE	HE	SE
Stowage volume and access	EF	FF	AF	MF	WF	HF	SF
Temporary equipment restraints	EG	FG	AG	MG	WG	HG	SG
Personnel mobility aids	EH	FH	AH	MH	WH	HH	SH
Personnel restraint devices	EI	FI	AI	MI			

*Use FWD/DOME column for 2nd Deck evaluation.

Figure 17-2. Subjective rating for general compartment accommodations.

design adequacy. This form was included in the checklist and was used concurrently with the rating scale. Figure 17-3 shows the use frequency rating form.

Debriefing Questionnaires. In order to stimulate group discussion among crewmen concerning various aspects of Skylab habitability, a set of questions was prepared for use as part of the regular off-duty day debriefing. The questions were designed to gather a more comprehensive assessment of certain aspects of habitability which were not readily amenable to the rating scale form of evaluation. The rating scales were designed to elicit individual evaluations, while the questions were intended to create a discussion atmosphere which would allow a free exchange of ideas between the crewmen and thus possibly prompt a more detailed evaluation of design inadequacies and potential corrective actions. A sample of the questions used is shown in Table 17-1.

Environmental Scales. The environmental scales were designed for use in conjunction with the instrument surveys of the environment. These scales were intended to gather the crewmen's subjective evaluations of the environment for correlation with the quantitative measurements obtained from the instruments. Figure 17-4 shows the environmental scales.

Table 17-1

Inflight Debriefing Questions
Used for Day-9 in SMEAT Mission

1. What particular aspects of the O/A seem well designed and arranged for living and working in zero-g?

   What aspects are deficient, and how?

2. Which restraint device offered the most assistance in performing tasks; which the least? What recommendations do you have for improvements?

3. What visibility problems have been created by shadowing within the O/A? What areas, or activities, are most affected? How practical is portable supplemental lighting?

4. How effective is non-equipment-assisted verbal communication throughout the O/A?

5. How satisfactory are the food management and dining accommodations? How well does the food adhere to the utensils when eating? Would a closer tray-to-mouth proximity be desirable?

6. In what ways has zero-g been helpful; in what ways a hinderance?

Test Methods

Since the prime purpose for incorporating M487 into the SMEAT Program was to gain experience with all aspects of the experiment protocol, a dedicated effort was made to follow the anticipated Skylab flight procedures and schedules.

Instruments

The M487 experiment and supporting equipment was scheduled for periodic use throughout the SMEAT Program, with each crewman having at least two opportunities to operate each instrument. The instruments are categorized into scheduled use items and discretionary use items for inflight application, but all instruments except the tape measure were scheduled for use during the SMEAT Program. Scheduled inflight items are the velometer, the sound level meter and frequency analyzer, and the temperature measuring devices. Discretionary inflight use items are the force gauge, the spotmeter, and the tape measure. Environmental surveys were scheduled on SMEAT mission days 10, 23, 38, and 55, and required the use of each scheduled instrument in each compartment within the SMEAT chamber. The instruments scheduled for use on these days were divided among the crewmen in order to share the workload and to gain opportunities for use experience. The data were voice recorded in order to avoid as much onboard logging as possible, although the crew found it more convenient to log the instrument measurements as they were made and then read them into the recorder all at one time.

Subjective Formats

The use of the subjective formats was scheduled into the timeline in accordance with anticipated Skylab flight use schedules.

Rating Forms. The initial SMEAT timeline called for five uses per man of the rating form. Three objectives defined this schedule: first, to determine reliably exactly how much time was required to use the forms; second, to determine whether or not the form would become more of an irritant than a data source because of repeated use; and third, to identify any attitude shifts toward the items being rated as a function of their prolonged use. Supplementing the assigned ratings with explanatory comments was considered essential for proper interpretation of the ratings, especially for those items rated at midscale or lower.

Debriefing Questionnaires. The debriefing questionnaires were designed specifically for the three off-duty day debriefings scheduled for the SL-2 mission and were used intact for SMEAT. A fourth set of questions was also developed which addressed the experimental protocol rather than habitability assessment per se. The questionnaire uses were scheduled for mission days 11, 19, 32, and 47.

Environmental Scales. The environmental scales were included as a page in the M487 checklist which contained the instrument use procedures. The timeline called for the use of this form by each crewman during each scheduled environmental measurement day.

Ad Hoc Comments. During Skylab flight, Experiment M487 will be limited in its ability to make the timeline impositions required to fully document crew responses to all aspects of habitability. Those items

INSTRUCTIONS:

USING THE FOLLOWING 5- POINT SCALE, VOICE RECORD YOUR USE FREQUENCY OF THE ITEMS LISTED BELOW.

RATING	USE FREQUENCY
1 (very often)	Daily - or every available opportunity
2 (often)	Every day or two
3 (average)	About once a week
4 (seldom)	Infrequently - once every two or three weeks
5 (never)	Not at all - (define whether item is ill designed and difficult to use or found to be unnecessary)

EXPLANATORY COMMENTS ARE ENCOURAGED.

CLOTHING ITEMS

A. Jacket
B. IV boots
C. IV gloves
D. Bump hat

SLEEP COMPARTMENT ITEMS

E. Pillow
F. Blankets
G. Light baffle
H. Privacy curtain

SUPPORT ITEMS

I. Penlights
J. Scissors
K. Tool caddy
L. Portable fan

OFF-DUTY ITEMS

M. Tape player
N. Headset
O. Microphone
P. Playing cards
Q. Books - (pleasure)
R. Hand exerciser
S. Hand balls
T. Darts & board
U. Exer-gym
V. Binoculars
W. Windows (W/R - STS)
*X. Chess game
*Y. Course material
*Z. Manual dexterity kit

State the letter designator of the item and your rating of that item.

NOTE - ASTERISKED ITEMS (*) APPLY ONLY TO SMEAT AND WILL NOT APPEAR ON THE FLIGHT FORM.

Figure 17-3. Evaluation form for equipment use frequency.

deemed most important for evaluating Skylab habitability have been included in the various M487 data sources specifically developed to support the experiment. However, it is anticipated that additional data will be available during the missions in the form of ad hoc comments offered by the crew as they conduct their routine communications between the spacecraft and mission control. In order to assess the quantity and quality of data available through this means, the daily SMEAT reports were reviewed and random samples were taken of routine communications, which will be transcribed for Skylab, but were not for the SMEAT Program.

Results and Discussion

The results and discussion presented in this section are limited to only those data obtained during the SMEAT Program which impact the Skylab M487 protocol. Therefore, only representative examples of data actually gathered are presented. Complete transcripts of the debriefing questionnaires and the environmental measurement data are available through the M487 Principal Investigator.

Instruments

The two most significant outputs of the instrument uses were:

INSTRUCTIONS:

VOICE RECORD YOUR IMPRESSIONS OF THE FOLLOWING ENVIRONMENTAL PARAMETERS IN EACH COMPARTMENT THROUGHOUT THE ORBITAL ASSEMBLY. IDENTIFY YOURSELF, THE COMPARTMENT, THE DATE, AND THE TIME. ALSO IDENTIFY ANY ITEMS ON WHICH YOU CHOOSE TO MAKE SURFACE TEMPERATURE MEASUREMENTS. EXPLANATORY COMMENTS ARE ENCOURAGED.

PARAMETER \ RATING	A	B	C	D	E
1. ILLUMINATION	EXCESSIVELY BRIGHT	BRIGHT	ADEQUATE	DIM	EXCESSIVELY DIM
2. AIR TEMPERATURE	UNCOMFORTABLY HOT	COMFORTABLY WARM	COMFORTABLE, NEITHER WARM NOR COOL	COMFORTABLY COOL	UNCOMFORTABLY COLD
3. HUMIDITY	UNCOMFORTABLY DRY	DRY	COMFORTABLE, NEITHER DRY NOR DAMP	DAMP	UNCOMFORTABLY DAMP
4. AIR FLOW	UNCOMFORTABLY DRAFTY	DRAFTY	COMFORTABLE, NEITHER DRAFTY NOR STILL	STILL	UNCOMFORTABLY STILL
5. NOISE	ANNOYING CONTINUOUS NOISE	ACCEPTABLE CONTINUOUS NOISE	NO DISTURBANCE	ACCEPTABLE INTERMITTENT NOISE	ANNOYING INTERMITTENT NOISE

READ THE NUMBER OF THE PARAMETER FOLLOWED BY THE LETTER RATING YOU ASSESS FOR THAT PARAMETER.

Figure 17-4 Evaluation form for environmental features.

1. The determination of actual time required to conduct a survey.
2. The verification of operating procedures and reporting formats.

To use any of the units included in the scheduled surveys required about 30 minutes of a crewman's time from instrument unstowage to stowage and voice recording of the data. The one exception was the sound level meter/frequency analyzer combination, which took approximately 45 minutes because of the requirement to step successively through eleven different frequency bands rather than making a single reading per compartment (as was required with the other instruments). The initial use of the sound meter and the velometer required an additional fifteen minutes for battery loading and instrument assembly. Skylab flight timelines for instrument uses will be scheduled for no less than 45 minutes.

The SMEAT crewmen found the M487 instrument surveys to be more efficient if the use times during the day were staggered. This eliminated the potential congestion of two crewmen concurrently taking different measurements in the same area. It also reduced the use constraints on voice recording time by spreading out the data retrieval cycle. The crewmen suggested that instrument use efficiency would be enhanced if they were allowed to specialize in the use of one or two instruments rather than requiring all to be proficient with the entire inventory. Both suggestions will be incorporated in the plans for flight use of the M487 experiment and supporting equipment.

One of the more interesting results of the M487 instruments' presence in the chamber was their discretionary use to supplement subjective impressions and to quantify data items for interested

Table 17-2

Subjective Rating Data for Generalized Compartment Design

Compartment	Day	Crewman	Design Feature/Accommodation A	B	C	D	E	F	G	H	I
EXPT	6	CDR	3	3	3	3	3	3	3	3	3
	4	PLT	3	3	2	2	4	3	2		
	8	SPT	3	3	3	3	3.5	3	4		
WARD-ROOM	6	C	3	4	3	2	4	3	3	3	
	4	P	4	3	2	2	3.5	3			
	8	S	3.6	3.5	3.5	3.5	3.5	3			
WMC	6	C	3	4	3	2	3	3	3	3	
	4	P	3	3	2	2	2				
	8	S	4	4	3	3.5	3.5	4			
SLEEP	6	C	3	3	3	2	3	3	3	3	
	4	P	3	3	2	2	2	2.5			
	8	S	3.5	3.5	3.5	3.5	3.5	4			
SECOND DECK	6	C	4	4	3	3	3	3	3	3	3
	4	P	4	3		3	2	3	3		
	8	S	3.5	3.5		3.5	3.5	3.5			

Note: 1 = Excellent, 5 = Unacceptable; see Figure 2 for complete definition of ratings.

Table 17-3

Frequency of Use for In-chamber Equipment Items

Crewman	Day	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
CDR	6	4							1	3	2	3	2	1	1	5	5	2	5	5	5	3			2	1	1
SPT	8	2	1			1			4	1	2	1	1	2	1	1	5	1	5	5	5	5			5	1	5

Note: See Figure 3 for list of equipment items.

parties who had no onboard hardware for such purposes. An example was the use of both types of temperature sensors to determine the most acceptable water temperature for the shower. Such discretionary uses of the instruments, either at crew option or ground request, will be their primary inflight use mode.

Subjective Formats

Representative results are covered in this section for the various subjective formats used, and the related discussion will address any protocol changes.

Rating Forms. The first use of the rating forms revealed several operational difficulties. First, to complete both sides of the cue card took about fifteen to twenty minutes, which was nearly twice the time that had been anticipated. Second, some problems were encountered in interpreting the voice data. These difficulties were associated with the listener confusing the alphanumeric designations. Finally, and most importantly, there was less than wholehearted crew acceptance of the forms as useful data tools. The major complaint was that the forms were too mechanical and constrained the crew's attempts at subjective evaluation.

Table 17-4
Subjective Rating Data for Equipment Items

Equipment Item	Crewman								
	CDR			PLT			SPT		
	Parameter			Parameter			Parameter		
	A	B	C	A	B	C	A	B	C
OWS fireman's pole				2	3	3			
OWS dome and wall handrail	3	2	3						
Triangular shoes/grid	3	3	2	2		3			
Trash airlock	3	4	3	2	3.5	3.5			
Wardroom table (eating station)	2	2	2	2	2	3	3	3.5	3.5
Wardroom table (non-eating uses)	2	2	2	2	2	3	3	3.5	3.5
Water dispenser (food)	2	2	2	2	2	2	2.5	3.5	2.5
Drinking water dispenser	3	3	3	2	3	3	2.5	3.5	3.5
Food tray	2	2	2	3	3	3	3	3	3.5
Food cans	3	3	3	3	3	2	4.5	3.5	4
Drinking containers	4	4	4	2	2.5	2.5	4	3.5	4
Seasoning dispensers	3	3	3	3	3	2			
Eating utensils	4	3	4	3	3	2	3.5	3.5	3.5
Fecal collection equipment	3	4	3	3	3	2			
Urine collection equipment	3	4	3	2	3	2	4	4	4
Hand washer	3	3	3	3	2	3			
Drying stations	2	2	2						
Whole body shower							3.5	3.5	3.5
Sleep restraint	3	3	3		3	3			

Note: 1 = Excellent, 5 = Unacceptable; see Figure 2 for complete definition of ratings.

A compilation of the data retrieved from the first use of the rating forms is shown in Tables 17-2, 17-3, and 17-4. A short set of comments was offered in support of the actual ratings. They are not presented in this report.

Following the crew's first use of the "cue card," the card was reconfigured in an attempt to increase crew acceptance, since it was still considered to be a worthwhile evaluation instrument. A copy of the revised form was passed into the chamber for crew evaluation. It was evaluated as no better than the first edition and the use of the subjective rating form was discontinued for the remainder of the SMEAT Program.

Subsequent use of the reconfigured form in a recent Skylab crew training exercise which simulated several days of the SL-2 mission revealed rather similar crew reactions, although all parties agreed that the data which the form was designed to retrieve were indeed worthwhile.

As a result of these experiences, the cue card has now been abandoned for Skylab inflight application. However, the individual segments of the revised card

are now being expanded and incorporated into the M487 checklist, with a two-page format being used to present use instructions and evaluation criteria on one page and the items to be evaluated on the facing page. This scheme will be baselined as the SL-2 subjective evaluation format.

The scheduling of the subjective evaluations will also be modified as a result of the SMEAT experience. The equipment evaluations will be made twice, once yearly and once late in the mission; the compartment accommodations will be evaluated once about midmission; and the equipment use frequency will be recorded once, late in the mission.

Debriefing Questionnaires. The debriefing questionnaires had a high degree of crew acceptability. Each scheduled use was completed, and, on occasion, an extra question or two was added to the list to cover some specific item of interest that had arisen since the previous debriefing. A representative excerpt is provided here to indicate the quality of data that this method of retrieval elicited.

"Mission Day 11 Debriefing"

Question #5 - How satisfactory are the food management and dining accommodations? How well does the food adhere to the utensils when eating? Would a closer tray-to-mouth proximity be desirable?

Answers -

SPT - The food system is surprisingly good. The trays heat well--the water dispensers work well--the total activity required to prepare, consume, and clean up after a meal is something of a nuisance but no big problem.

PLT - Trash accumulation associated with dining is the biggest problem. The manipulations of prep and post are a pain, but necessary. Forty to fifty pieces of trash are generated per meal and their constant management is the main drawback to the food system. The utensils are too small to handle comfortably.

CDR - Agree with trash comments. Each guy should handle his own residue rather than constantly passing items to a single trash manager. For SMEAT we are dumping most trash into a large food can which is placed in the middle of the wardroom table. If this scheme is used for flight, a restraint will be required. The pantry system seems well organized. It takes about 40 minutes to prep-eat-and set up for the next meal. The wardroom table is well laid out to cope with this job. We like the table arrangement of facing each other because it lends itself to a nice social atmosphere in conjunction with eating. Also a good place for group discussion and timeline planning activity. The zero g aspects of this question can't be addressed very well.

Environmental Scales. The environmental rating scales were intended for use each time an instrument survey was made in order to obtain subjective data to correlate with the quantitative data. However, some interpretation problems were associated with their use. Seemingly, all possible combinations of use were found:

1. Rating each parameter for each compartment (as was intended).
2. Rating only the parameter associated with the instrument that particular crewman was using.
3. Announcing an overall chamber rating for each parameter, integrated over all compartments.

Due to the confusion which the scales seemed to generate, and due to the logistic difficulty of acquiring scale ratings in close proximity with instrument readings, the environmental scales will not be used inflight.

To salvage the subjective environmental data during flight two changes will be made in the M487 protocol. First, three environmental parameters (noise level, thermal comfort, and illumination) will be added to the subjective evaluation form under the compartment accommodations section. Second, there will be an environmental assessment question added to each debriefing session.

Ad Hoc Comments

One of the most beneficial data sources was the communication interchanges between the crew and the capcom. Numerous items of interest to M487 were either specifically discussed in response to questions or unsolicitedly offered during the

debriefing. Since most of this type of information was problem oriented, it is discussed in more detail in the following section. This type of data source is expected to provide a major source of habitability assessment data during the Skylab flights.

Problems

The items covered in this section relate primarily to the Discrepancy Reports (DR's) initiated against M487 during the course of the SMEAT Program. Those difficulties that M487 encountered with respect to protocol have been addressed in previous sections.

M487 Discrepancy Reports

The DR's initiated against M487 are listed in numerical order with a statement of the problem and the solution.

Problem - The probe portion of the M487 digital thermometer became inoperative.

Solution - The inoperative probe was removed from the chamber and a replacement unit was passed into the crew. The replacement unit was a new configuration which corrected an electronic open circuit inherent in the manufacturing process for the probe sensor tip. The new configuration will be used onboard Skylab.

Problem - One of the ambient thermometers (S/N 002) appeared to be reading 10°F low.

Solution - The defective instrument was removed from the chamber and a calibration test was conducted. The test revealed that the unit was indeed reading from 8 to 10° low throughout its entire range. No visible damage could be detected and no obvious reason could be found for the anomaly, although it was suspected that a lateral impact to the stem caused the problem. The thermometer was put into bonded storage until the end of the SMEAT Program and then returned for failure analysis. No results are available as of the writing of this report. However, the M487 checklist will include a note on precautions to be followed when handling and transporting the ambient thermometers.

Problem - Exactly the same as the previous item.

Solution - The same procedure was followed for the second ambient thermometer failure, and the outcome was precisely the same. Pending some reassurance from the failure analysis that this anomaly can be corrected in the flight units, the prime instrument for inflight ambient temperature measurements will be the onboard CO_2 dewpoint monitor.

Problem - The M487 instruments are stowed in Mozite inserts (configured to instrument dimensions) within the equipment container, and the fit is tight enough to make instrument retrieval difficult.

Solution - The Mozite problem is one of universal application to Skylab since numerous stowage areas onboard make use of this material for shock mounting. The material has been tested under a variety of pressures and seems to contract markedly during the 26 psi launch environment and expand when the pressure falls to the 5.0 psi seen in orbit. The M487 stowage scheme has been modified to include finger cutouts around the instruments to facilitate their removal and replacement in the kit. This modification was independent of the difficulties induced by the spacecraft pressure environment since the M487 Mozite was evaluated as too tight a fit even at ambient sea level pressure.

Problem - The one-degree spotmeter is not an incident light-reading device and needs a reflective surface to be used as an ambient illumination survey device.

Solution - A standard 89.5 percent reflective card was stowed in the chamber for use with the spotmeter during the SMEAT Program, and a similar card will be included as a blank page (approximately identified) in the M487 checklist for use during Skylab flights.

Habitability Related Items

In support of the M487 request to receive transcripts of all Skylab inflight communications, and to support the earlier remarks regarding the value of the ad hoc comments during the SMEAT Program,

the following examples of significant habitability related items (retrieved via this means) are provided:

Urine spills
Wipes quantity and quality
Housekeeping procedures
Beverage container leaks
Vacuum cleaner difficulties
Can crusher procedures and problems
Fecal bag handling and sealing
Hygiene period rescheduling
Use of Command Module spoon as Orbital Workshop eating utensil
Lint and dust collection
Clothing preferences

Detailed discussion of the items in this list can be found in other sections of this report.

One last comment is offered in support of habitability as an entity as opposed to habitability when constrained by outside influences, such as biomedical data considerations. Were it not for the requirements to collect urine and fecal samples, the waste management facilities could have been designed to avoid many of the problems observed in SMEAT and anticipated in Skylab by simply treating these items as disposable. A systematic review of the entire habitat might reveal other areas where habitability has been compromised because of experimental or operational constraints.

Flight Impact

Three major areas of flight impact emerged from the M487 experience in the SMEAT Program:

1. Reconfiguration of portions of the subjective data package.
2. Scheduling implications.
3. Instrument use philosophy.

As previously discussed, the "cue card" rating format has been abandoned in favor of a less rigid evaluation scheme with greater emphasis on supporting commentary and less emphasis on the assignment of unique scalar values. The subjective approach to the environmental data has been reoriented to allow more freedom for the crewmen to discuss their impressions rather than forcing scalar choices.

Based upon the SMEAT experience in scheduling unique timeline periods to accomplish the various portions of M487, and the actual times required for performance, inflight use of all data sources except the debriefing questionnaires has been reduced. More freedom has also been granted the flight planners in scheduling the various M487 data sessions into the timeline. Since many of the M487 data acquisition items have minimal time requirements, and are not uniquely constrained by orbital position or time of day, they may be conveniently scheduled as timeline activities when a small time period is available.

The periodic instrument surveys are time-consuming and somewhat redundant in purpose unless there has been a change of some significance in the onboard environment. The current philosophy is to obtain an early survey for baseline purposes and rely upon the crewmen to detect and report changes in their impressions of the various Skylab environmental elements. The measuring instruments will serve as discretionary devices available to verify subjective impressions, quantify anomalies, or assist mission control in troubleshooting as necessary.