NASA CONTRACTOR
REPORT

NASA CR-61386

SKYLAB EXPERIMENT PERFORMANCE EVALUATION MANUAL

Appendix D: Experiment M487 Habitability/Crew Quarters (MSFC)

By K. S. Purushotham
Teledyne Brown Engineering Company
Huntsville, Alabama

January 1973

Prepared for

NASA-GEORGE C. MARSHALL SPACE FLIGHT CENTER
Marshall Space Flight Center, Alabama 35812

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16. ABSTRACT

This appendix contains a series of analyses for Experiment M487, Habitability/Crew Quarters (MSFC), to be used for evaluating the performance of the Skylab corollary experiments under preflight, inflight, and post-flight conditions. Experiment contingency plan workaround procedure and malfunction analyses are presented in order to assist in making the experiment operationally successful.

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APPENDIX D.

EXPERIMENT M-487, HABITABILITY/CREW QUARTERS (MSFC)

Prepared By:

K. S. Purushotham

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DEFINITION OF SYMBOLS

AM	Airlock Module
CM	Command Module
DAC	Data Acquisition Camera
FBD	Functional Block Diagram
FO	Functional Objective
M/C	Mixing Chamber
OWS	Orbital Workshop
PDCS	Power Distribution Control System
PI	Principal Investigator
P_f	Probability of failure
P_{f_t}	Total probability of failure
P_s	Probability of success
TCS	Temperature Control System
VCS	Ventilation Control System

SECTION I.

EXPERIMENT M-487, HABITABILITY/CREW QUARTERS PRE-FLIGHT OPERATIONS EVALUATION ANALYSIS

TABLE D-I. EXPERIMENT M-487, HABITABILITY/CREW QUARTERS PRE-FLIGHT OPERATION EVALUATION ANALYSIS (Sheet 1 of 9)

FUNCTIONAL BLOCK NUMBER AND TITLE	EXPECTED RANGE AND DIMENSION OF VARIABLES			CRITICALITY CATEGORY NUMBER*	REMARKS
	MIN.	NOM.	MAX.		
3.0 Analyze and predict facet performance profile for Skylab Experiment M-487, Habitability/ Crew Quarters.				N/A	Refer to functional item 3.1.
3.1 Make explicit statements about objectives in qualitative and quantitative terms.				N/A	Refer to functional item 3.1.1.
3.1.1 Specify the time required for M-487 tasks to be performed.					Experiment M-487 is performed on SL-1/SL-2, SL-3, and SL-4 missions. M-487 will evaluate and report habitability features of the Orbital Workshop (OWS) and will assess the man-machine relationship under zero-g conditions in relatively confined areas. The experiment provides equipment necessary to measure the habitability features subjectively and objectively. The data collected will be used to evaluate OWS/crew interfaces and will form a basis for verifying habitability criteria and establishing requirements for future advanced spacecraft. To avoid impact on the mission timeline, the habitability data collection will be integrated into the crewman's daily routine. Reference 1.
3.1.2 Specify the types of criteria that are to be maximized or minimized.				N/A	The Functional Objectives (FO's) of Experiment M-487 Habitability/Crew Quarters are: • FO-1 --Obtain motion picture and objective and subjective data on the OWS internal architecture during Skylab missions. • FO-2 --Obtain motion picture and objective and subjective data on the OWS internal architecture. • FO-3 --Obtain motion picture and objective and subjective data on the adequacy of OWS mobility aids and restraints. • FO-4 --Obtain motion picture and objective and subjective data on the use and adequacy of food and water. • FO-5 --Obtain motion picture and objective and subjective data on garments and personal accouterments.

*Criticality Category Number Definition:

- Category I--Experiment and equipment whose failure could adversely affect crew safety.
- Category II--Experiment and equipment whose failure could result in not achieving a primary mission objective, but does not adversely affect crew safety.
- Category IIIa--Experiment and equipment whose failure could result in not achieving a secondary mission objective, but which does not adversely affect crew safety or preclude the achievement of any primary mission objective.
- Category IIIb--Experiment and equipment whose failure could not result in a loss of primary or secondary mission objective and does not adversely affect crew safety.

TABLE D-I. EXPERIMENT M-487, HABITABILITY/CREW QUARTERS PRE-FLIGHT OPERATION EVALUATION ANALYSIS (Sheet 2 of 9)

FUNCTIONAL BLOCK NUMBER AND TITLE	EXPECTED RANGE AND DIMENSION OF VARIABLES			CRITICALITY CATEGORY NUMBER	REMARKS
	MIN.	NOM.	MAX.		
3.1.2 (Concluded)					• FO-6 --Obtain motion picture and objective and subjective data on personal hygiene. • FO-7 --Obtain motion picture and objective and subjective data on OWS housekeeping tasks. • FO-8 --Obtain motion picture and objective and subjective data on communication within the OWS. • FO-9 --Obtain motion picture and subjective data on the adequacy of the OWS off-duty activity provisions. References 2, 3, and 4.
3.1.3 Specify the percentage of acceptable max./min. for each objective.				N/A	It is subjectively estimated that the accomplishment of the following would provide a minimum acceptable amount of experiment data:
	7.5%	11.25%	15%		• FO-1: Obtain subjective data on OWS environment. This constitutes 50 percent of the total desired data of FO-1 or 50 percent x 15 percent = 7.5 percent of the total objective.
	3.33%	6.66%	10%		• FO-2: Obtain subjective data on the internal architecture. This constitutes 33 1/3 percent of the desired data of FO-2 or 33 1/3 percent x 10 percent = 3 1/3 percent of the total objective.
	3.33%	6.66%	10%		• FO-3: Obtain subjective data on the adequacy of OWS mobility aids and restraints. This constitutes 33 percent of the desired data or 33 1/3 percent x 10 percent = 33 1/3 percent of the total objective.
	3.33%	6.66%	10%		• FO-4: Obtain subjective data on the adequacy of food and water provisions. This constitutes 33 1/3 percent of the desired data of FO-4 or 33 1/3 percent x 10 percent = 3 1/3 percent of the total objective.
	3.33%	6.66%	10%		• FO-5: Obtain subjective data on garments and personal accouterments. This constitutes 33 1/3 percent of the desired data of FO-5, or 33 1/3 percent x 10 percent = 3 1/3 percent of the total objective.
	5%	10%	15%		• FO-6: Obtain subjective data on personal hygiene. This constitutes 33 1/3 percent of the desired data of FO-6, or 33 1/3 percent x 15 percent = 5 percent of the total objective.

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TABLE D-I. EXPERIMENT M-487, HABITABILITY/CREW QUARTERS PRE-FLIGHT OPERATION EVALUATION ANALYSIS (Sheet 3 of 9)

FUNCTIONAL BLOCK NUMBER AND TITLE	EXPECTED RANGE AND DIMENSION OF VARIABLES			CRITICALITY CATEGORY NUMBER	REMARKS
	MIN.	NOM.	MAX.		
3.1.3 (Concluded)	3.33%	6.66%	10%		• FO-7: Obtain subjective data on OWS housekeeping activities. This constitutes 33 1/3 percent of the desired data of FO-7 or 33 1/3 percent x 10 percent = 3 1/3 percent of the total objective.
	3.33%	6.66%	10%		• FO-8: Obtain subjective data on the OWS internal communications. This constitutes 33 1/3 percent of the desired data of FO-8, or 33 1/3 percent x 10 percent = 3 1/3 percent of the total objective.
	10%	10%	10%		• FO-9: Obtain subjective data on the adequacy of OWS off duty activity provisions. This constitutes 100 percent of the desired data of FO-8 or 100 percent x 10 percent = 10 percent of the total objective.
	42.48 %	71.21%	100%		Total percentage of acceptable max. /min.
3.1.4 Specify the experiment constraints: • Musts • Must Nots • Wants • Don't Wants.				N/A	• Musts --Subjective crew comments concerning the habitability of the OWS must be recorded with respect to the following parameters: -Dimensional characteristics of OWS systems equipment -Location and adequacy of mobility aids and restraints -Air: temperatures, velocities, and humidity -Touch temperatures of OWS systems equipment during handling operations -Adequacy of internal illumination -Internal noise level of the OWS -Adequacy and suitability of clothing -Presence of any obnoxious odors within the OWS -Adequacy of internal communications. --Measurements of environmental features must be made with hardware, which includes measuring air velocity, sound level, and air or surface temperature. These measurements must be recorded by the crew and related to the crew comfort for the following OWS compartments: -Sleeping -Wardroom -Waste Management -Experiment -Forward compartment. --Motion pictures of various crew activities are required to aid in evaluation of crew/OWS interfaces. The motion picture will be taken with a 16mm Data Acquisition Camera (DAC) using 16 mm Ektachrome SO-168 color film (three cassettes will be provided, each containing 400 ft of film). • Must Nots --N/A

TABLE D-1. EXPERIMENT M-487, HABITABILITY/CREW QUARTERS PRE-FLIGHT OPERATION EVALUATION ANALYSIS (Sheet 4 of 9)

FUNCTIONAL BLOCK NUMBER AND TITLE	EXPECTED RANGE AND DIMENSION OF VARIABLES			CRITICALITY CATEGORY NUMBER	REMARKS
	MIN.	NOM.	MAX.		
3.1.4 (Concluded)					• Wants --It is desirable to gather periodic measurements at an early point, at mid-point, and at a late point in the mission to establish trend data. • Don't Wants --N/A References 1 and 5.
3.1.5 Specify the experiment operational tolerances: • Musts • Must Nots • Wants • Don't Wants.				N/A	Refer to functional item 3.1.4. Specific tolerances for each functional item are TBD.
3.2 Define the decision rules for each experiment objective.				N/A	If the experiment is aborted, the probability of success (P_s) is equal to 0.0. If the experiment is compromised and minimum information is salvaged, $P_s = 0.1 \rightarrow 0.5$; if the maximum information is salvaged, $P_s = 0.5 \rightarrow 0.9$. If the experiment is completed as scheduled, P_s = 1.0.
3.3 Specify the experiment priority number (numerical statement) for a given Skylab flight designation.				N/A	Experiment M-487 is scheduled for SL-1/SL-2, SL-3, and SL-4 missions. The priority number is 450. References 1 and 6.
3.4 Briefly describe and list the major subsystems for Experiment M-487.				N/A	Refer to functional items 3.4.1 and 3.4.2.
3.4.1 Describe the major functions.					Experiment M-487 is designed to measure, evaluate, and report habitability features of the crew quarters and work areas of the OWS in engineering terms useful to the design of future manned spacecraft. Experiment M-487 provides the crewman with procedures and equipment necessary to measure and record his observations, and to evaluate the following elements:

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TABLE D-I. EXPERIMENT M-487, HABITABILITY/CREW QUARTERS PRE-FLIGHT OPERATION EVALUATION ANALYSIS (Sheet 5 of 9)

FUNCTIONAL BLOCK NUMBER AND TITLE	EXPECTED RANGE AND DIMENSION OF VARIABLES			CRITICALITY CATEGORY NUMBER	REMARKS
	MIN.	NOM.	MAX.		
3.4.1 (Concluded)					• Personal Hygiene • Food and Water • Garment and Personal Accouterments • Architecture • Mobility and Restraints • Off-Duty Activities • Environment • Communications. Reference 1.
3.4.2 List the major components.					The major components involved in Experiment M-487 are: • Velometer • Sound Level Meter • Thermometers • Surface Temperature Sensor (Digital Thermometer) • Frequency Analyzer • Spring Scale • Measuring Tape • Spare Batteries. All of the above equipment is considered off-the-shelf hardware. References 1 and 7.
3.5 *Define the M-487 experiment/carrier subsystem interfaces:* • Physical --Mechanical --Electrical --Communication and Data --Support				N/A	A Functional Block Diagram (FBD) is submitted as Figure D-1 and is used as a subsystem component listing. Critical subsystems will be identified and evaluated for failure, and correlated to possible experiment/carrier interface problems.

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TABLE D-I. EXPERIMENT M-487, HABITABILITY/CREW QUARTERS PRE-FLIGHT OPERATION EVALUATION ANALYSIS (Sheet 6 of 9)

FUNCTIONAL BLOCK NUMBER AND TITLE	EXPECTED RANGE AND DIMENSION OF VARIABLES			CRITICALITY CATEGORY NUMBER	REMARKS
	MIN.	NOM.	MAX.		
3.5 (Concluded) • Environmental --Natural and Induced --Contamination • Operational --Pointing and Control --Crew Safety --Sequence --Operability.					
3.5.1 Specify the total probability of failure (Pf_t) for the velometer.		0.1		IIIb	The velometer provides the means to measure air velocity within the OWS. The instrument has a metal probe attached to it, and can be installed in ducts, lines, pipes or be hand-held. This instrument operates on the principles of a thermocouple. The sensing elements in the probes are bi-metallic strips. A low voltage ac bridge circuit heats the bimetallic strips. Any change in airflow causes a change in temperature of the bimetallic strips, resulting in a low Vdc output from the thermocouples. These changes are indicated on the dial as changes in velocity. The range of this instrument is 0 to 100 rpm and it requires 3 Vdc to operate. The probability of failure (P_f) of the velometer is very small. If this should fail, the following situation could occur: • Electrical --The fine thermocouple element can break and result in loss of usage of the experiment. The following indication could be used to determine the failure of the velometer: • Zero deflection of the velometer scale is an indication of a failure in the instrument. • Repeated measurement in the same location could be used to indicate any faulty operation of the instrument. Reference 7.
3.5.2 Specify the Pf_t for Sound Level Meter.		0.1		IIIb	The sound level meter is used to measure the intensity of workshop ambient, periodic, and random noises. The sound level meter is powered by three 1.5 Vdc flashlight batteries. The instrument consists of: condenser, microphone and source follower, input amplifier with input attenuator, weighting network, output amplifier with output attenuators, meter rectifier and indicating meter, and batteries. The meter scale is graduated ± 10 dB. The range is 32 to 140 dB within a frequency range of 50 to 10,000 Hz, and the accuracy is ± 2 dB up to 5,000 Hz and ± 5 dB up to 10,000 Hz. The instrument is operated by three batteries of 1.5 Vdc each.

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TABLE D-I. EXPERIMENT M-487, HABITABILITY/CREW QUARTERS PRE-FLIGHT OPERATION EVALUATION ANALYSIS (Sheet 7 of 9)

FUNCTIONAL BLOCK NUMBER AND TITLE	EXPECTED RANGE AND DIMENSION OF VARIABLES			CRITICALITY CATEGORY NUMBER	REMARKS
	MIN.	NOM.	MAX.		
3. 5. 2 (Concluded)					The P_f for the sound level meter is very small. If this should fail, the following situation could occur: • Electrical --If a failure occurs in the circuitry of the sound level meter, it would be impossible to obtain accurate measurements. The following indication could be used to determine the failure of sound level meter: • No deflection of the pointer on the scale. • Repeated measurements in the same locations can be used to determine any erratic operation of the instrument. Reference 7.
3. 5. 3 Specify the P_{f_t} for the frequency analyzer.		0. 1		IIIb	The frequency analyzer is used in conjunction with the sound level meter to determine the spectral distribution of the noise within the workshop. The P_f for the frequency analyzer is very small. If this should fail, the following situation could occur: • Electrical --Refer to functional item 3. 5. 2. The following indication could be used to determine the failure of Fequency Analyzer: • Refer to functional item 3. 5. 2. Reference 7.
3. 5. 4 Specify the P_{f_t} for the surface temperature sensor. (digital type).		-0. 1		IIIb	The surface temperature sensor (digital type) is a direct reading electronic unit and has a sensitive probe that senses the temperature of the surface under investigation. The sensor has a range of ± 200 °F. The unit is battery operated and the voltage of the battery is TBD. The P_f for the surface temperature sensor is very small. If it should fail, the following could occur: • Electrical --Failure of the electronic components could result in inconsistent temperature readouts. The following indication can be used to determine the failure of the temperature sensor:

TABLE D-I. EXPERIMENT M-487, HABITABILITY/CREW QUARTERS PRE-FLIGHT OPERATION EVALUATION ANALYSIS (Sheet 8 of 9)

FUNCTIONAL BLOCK NUMBER AND TITLE	EXPECTED RANGE AND DIMENSION OF VARIABLES			CRITICALITY CATEGORY NUMBER	REMARKS
	MIN.	NOM.	MAX.		
3.5.4 (Concluded)					• Inconsistent readings of the sensor could be verified by comparing the readings obtained from the second temperature sensor. Reference 7.
3.5.5 Specify the P_{f_t} for the ambient thermometers.		nil		IIIb	The thermometers provide the means of measuring ambient temperatures. They have a temperature range of -40 to 160 °F with an accuracy of ± 1 percent of full scale. There are two ambient thermometers provided for the experiment. In the event one of the thermometers fails, the other one can be used. These thermometers can be immersed in gasses or liquids. The Pf for the thermometer is considered to be remote. If the thermometer should fail, the following situation could occur: • Mechanical --Failure of the sensing elements of the ambient thermometer can result in faulty temperature indications. The following indication can be used to determine the failure of the ambient thermometer. • Obtain repeated readings in the same location. Any inconsistent reading could be used as an indication of a failure of the instrument. Reference 7.
3.5.6 Specify the P_{f_t} for the spring scale.		nil		IIIb	Spring scales are used to measure the forces required to open or close the drawers and panels. The seal is a push pull type gage that has a range of 1 to 50 lb or 1 to 25 kg, and an accuracy of 0.5 percent of full scale. The P_f for the spring seals is considered to be remote. If this should fail, the following situation could occur: • Mechanical --Failure of the components such as spring or friction clutch would result in obtaining inaccurate readings. The following indications could be used to determine the failure of the spring scale. • Obtain repeated readings by pushing and pulling the scale through a constant distance. The resulting readings should be identical. If not, it is an indication of a faulty instrument. Reference 7.

TABLE D-I. EXPERIMENT M-487, HABITABILITY/CREW QUARTERS PRE-FLIGHT OPERATION EVALUATION ANALYSIS (Sheet 9 of 9)

FUNCTIONAL BLOCK NUMBER AND TITLE	EXPECTED RANGE AND DIMENSION OF VARIABLES			CRITICALITY CATEGORY NUMBER	REMARKS
	MIN.	NOM.	MAX.		
3.5.7 Describe the functions of the measuring tape.				N/A	The measuring tape is 10 ft long and provides a means for measuring distances to evaluate pertinent sizes and locations. Reference TBS.
3.5.8 Describe the functions of the batteries.					Twenty D size batteries will be provided as spares for experiment equipment. The specifications are as follows: • Nominal voltage (1.5 Vdc) • Rated capacity (10,000 mA hr) • Weight (5 oz) • Volume (3.20 in^3). Reference 7.
3.5.9 Describe the equipment container.				N/A	The equipment container is required for stowage of experiment hardware. It has three drawers and its volume in in^3 is 11.2 by 15.8 by 9.7. Reference 7.
3.5.10 Describe the functions of the DAC.				N/A	The DAC is used for photographing M-487 activities. Film sequences will be recorded by using the following support equipment: • 16 mm film cassettes (3) (400 ft) • 10mm and 5mm lenses • Power cable, remote cable, and camera mount. Reference 7.
3.5.11 Describe the functions of the CO_2 humidity sensor.					Measures the CO_2 and humidity level in the OWS. Reference 1.

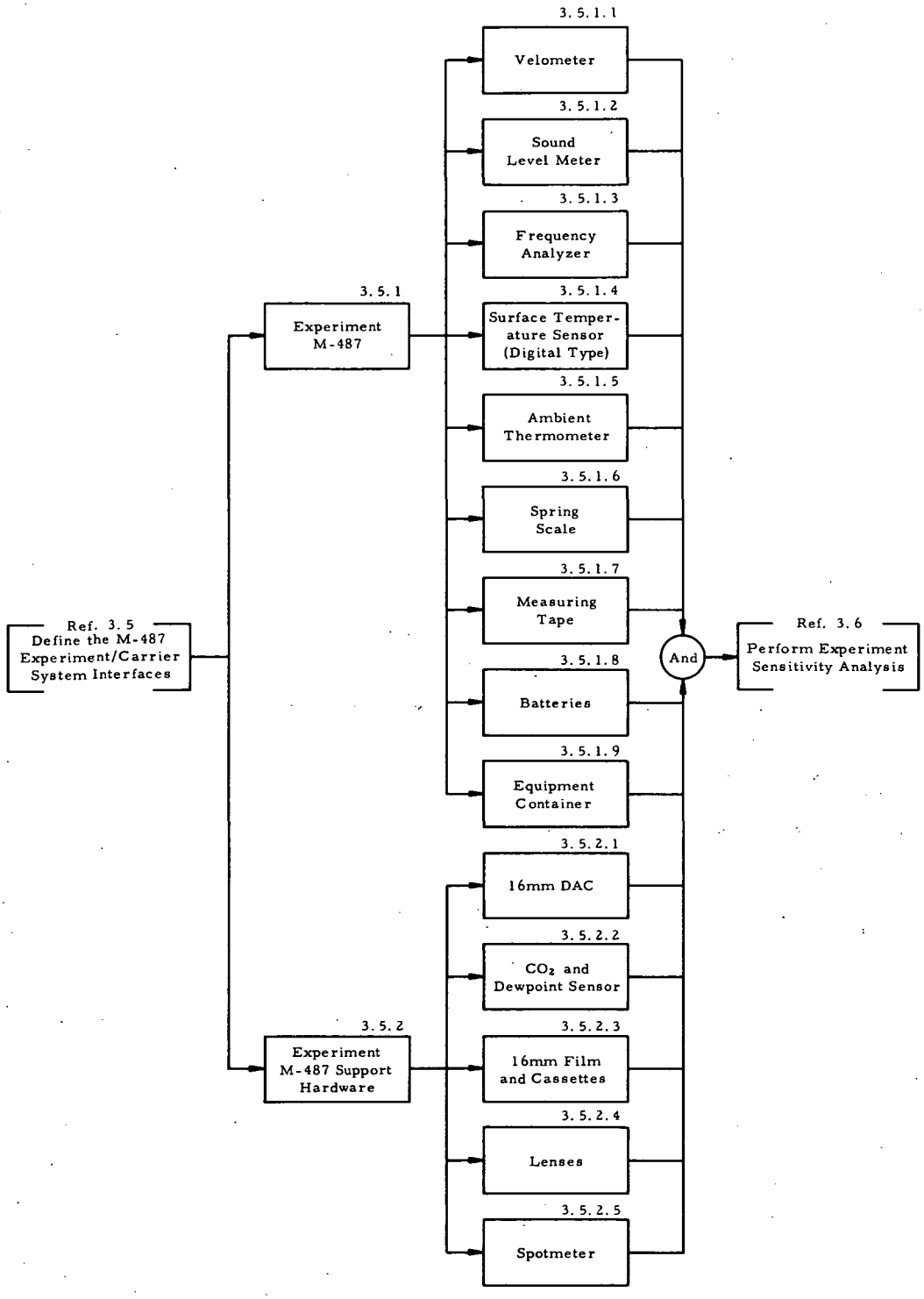
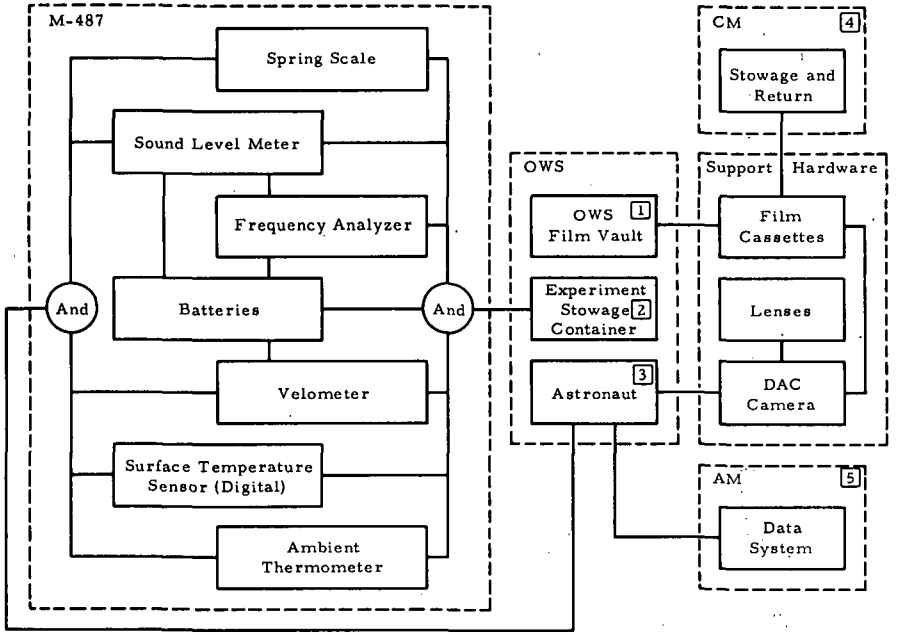


FIGURE D-1. EXPERIMENT M-487, HABITABILITY / CREW QUARTERS FUNCTIONAL BLOCK DIAGRAM

SECTION II.

EXPERIMENT M-487, HABITABILITY/CREW QUARTERS INTERFACE BLOCK DIAGRAM

FIGURE D-2. EXPERIMENT M-487, HABITABILITY / CREW QUARTERS INTERFACE BLOCK DIAGRAM AND DEFINITION



Code	Data Source	Remarks
1	Crew	There is a mechanical interface between the film cassettes and the OWS film vault. The film cassettes are stowed in the OWS film vault during launch.
2	Crew	There is a mechanical interface between the equipment container and each of the following: Velometer, Sound Level Meter, Frequency Analyzer, Surface Temperature Sensor, Ambient Thermometers, Spring Scale, Measuring Tape, and Spare Batteries. The Experiment M-487 hardware is stowed in the container during launch and when the experiment is not in operation.
3	Crew	There is an operability interface between the astronaut and each of the following: Velometer, Sound Level Meter, Frequency Analyzer, Surface Temperature Sensor, Ambient Thermometer, and Spring Scale. The astronaut will hand hold the instruments to obtain various measurements concerning crew habitability.
4	Crew	There is a mechanical interface between the film cassettes and the Command Module (CM). The exposed 16mm DAC film cassettes are stowed in the CM at the end of each mission for return to earth.
5	Crew	There is a communication interface between the astronaut and Airlock Module (AM) data system. Crew comments and experiment data are transmitted either from astronaut head communication set or OWS communication box to the AM data recording system and then dumped to the ground.

SECTION III.

EXPERIMENT M-487, HABITABILITY/CREW QUARTERS SYSTEM DIAGRAM

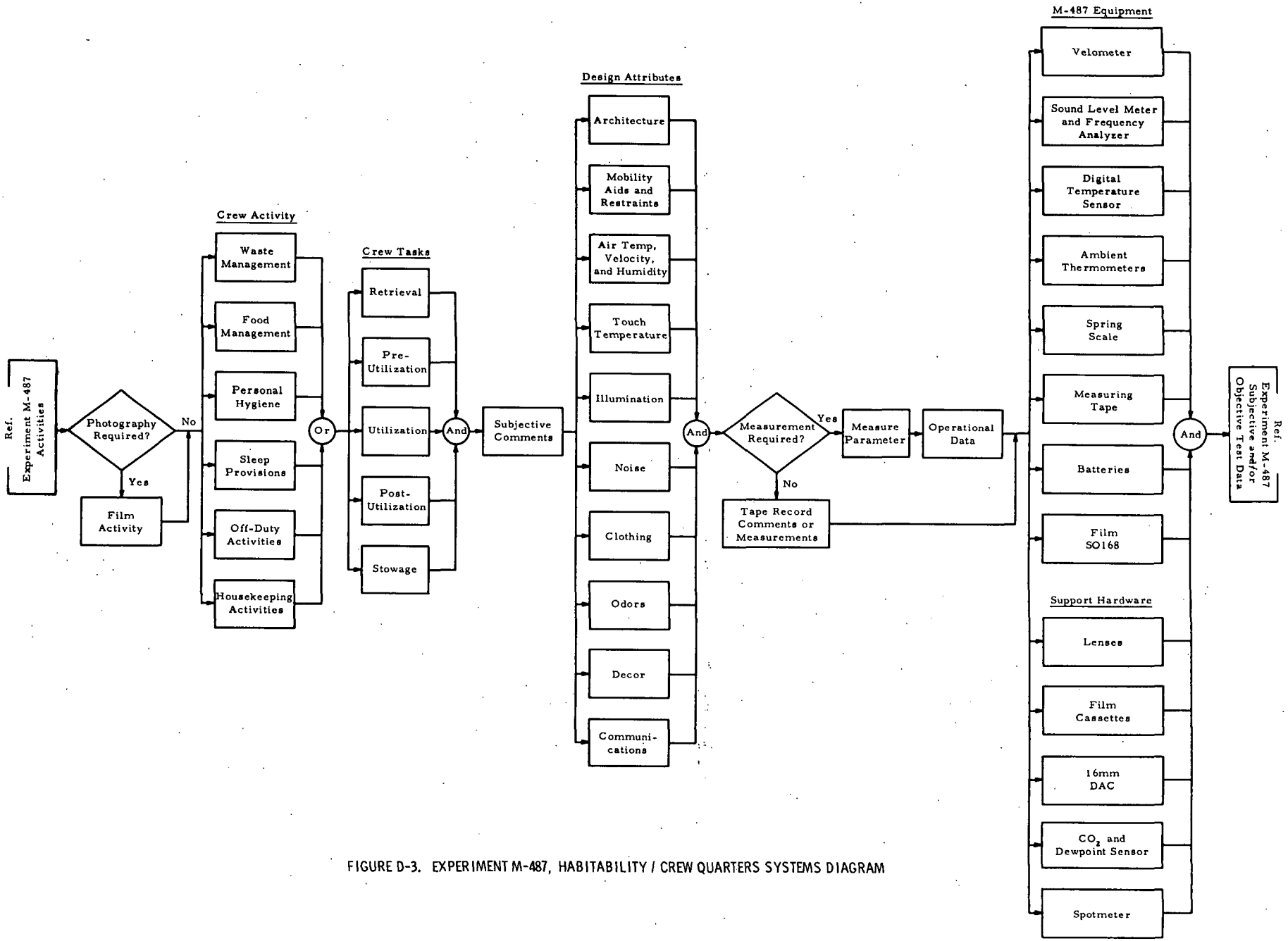


FIGURE D-3. EXPERIMENT M-487, HABITABILITY / CREW QUARTERS SYSTEMS DIAGRAM

SECTION IV.

EXPERIMENT M-487, HABITABILITY/CREW QUARTERS DATA REQUIREMENTS SUMMARY

TABLE D-II. EXPERIMENT M-487, HABITABILITY / CREW QUARTERS DATA REQUIREMENTS SUMMARY

Measurement Name	Range and Dimension of Variable	Measurement Number	Telemetry Assignment Channel	Data Return	Data Time	Remarks
• Astronaut Voice Comments and Recording:						
--Dimensional characteristics of OWS equipment	N/A	N/A	N/A	Intermittent	Real/All	
--Mobility aids and restraints	N/A	N/A	N/A	Intermittent	Real/All	
--Air Temperature	25 to 125 °F	N/A	N/A	Intermittent	Real/All	
--Air Velocity	0 to 100 ft/min	N/A	N/A	Intermittent	Real/All	
--Humidity	TBD	N/A	N/A	Intermittent	Real/All	
--Touch Temperature	0 to 200 °F	N/A	N/A	Intermittent	Real/All	
--Illumination	TBD	N/A	N/A	Intermittent	Real/All	
--Noise Levels	30 to 140 dB	N/A	N/A	Intermittent	Real/All	
• Temperature, Ventilation Control System (VCS), Wardroom Inlet Gas	40 to 100 °F	C 7144-438	WP1A150A52LQ21	Continuous	All	
• Temperature, VCS, Experiment Compartment Inlet Gas	40 to 100 °F	C 7255-438	WP1B104A14LB04	Continuous	All	
• Temperature, VCS, Sleep Compartment Inlet Gas	40 to 100 °F	C 7256-438	WP1A050A43LM18	Continuous	All	
• Temperature, VCS, Mixing Chamber (M/C) Inlet Gas	40 to 100 °F	C 7254-436	WP1B104A10LB03	Continuous	All	
• Temperature, Thermal Control System (TCS), Wardroom Ceiling	0 to 120 °F	C 7123-437	WP1A150A48LQ20	Continuous	All	
• Temperature, TCS, Sleep Compartment Ceiling	0 to 120 °F	C 7032-437	WP1A150A40LQ18	Continuous	All	
• Temperature, TCS, Experiment Compartment Ceiling	0 to 120 °F	C 7122-437	WP1A050A23LM13	Continuous	All	
• Temperature, TCS, Sleep Compartment Wall	0 to 120 °F	C 7094-441	WP1A010A35LM16	Continuous	All	
• Temperature, TCS, Wardroom Stowage Locker	0 to 120 °F	C 7033-463	WP1A150A32LQ16	Continuous	All	
• Temperature, TCS, Wardroom Wall No. 1	0 to 120 °F	C 7059-443	WP1B150A30LQ08	Continuous	All	
• Temperature, TCS, Experiment Compartment Ceiling	0 to 120 °F	C 7040-437	WP1A150A20LQ13	Continuous	All	
• Logbook	N/A	N/A	N/A	N/A	N/A	

SECTION V.

EXPERIMENT M-487, HABITABILITY/CREW QUARTERS DATA REQUEST FORMS

Page 1 of ____

DATA REQUEST FORM Skylab Program	DRF Control No.	Date
	Exp/Sys No. ASTN-SD/OWS/EXP-068	Revision

Mission	Period of Interest	Op. Need Date	Rev Date
SL	FLT		

Request Contact	Data Recipient	Date Req
Name Organization Phone	Name: Mr. W. R. Bock Address: S&E-ASTN-SDF Phone: MSFC, Alabama 35812 205-453-3810	Qty

Reference Documents

MRD Content

Detailed Requirements:

Experiment Crew Logs

Provide one copy of the crew logs taken during operation of experiments M487 and M516

Comments & Explanations

Originator	Integrator
Name: W. R. Bock Organization: MSFC/S&E-ASTN-SDF Phone: 205-453-3810 Signature: [signature] Date: 3-22-72	Name: J. R. Riquelmy Organization: S&E-ASTN-SDF Phone: 205-453-3810 Signature: [signature] Date: 3-22-72
Request Approval	**Implementing Agency**
Name Organization Phone Signature Date	Name Organization Phone Signature Date

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DATA REQUEST FORM Skylab Program	DRF Control No.	Date
	Exp/Sys No. ASTN-SDI/OWS/M-487	Revision

Mission SL-1/SL-2 SL-3 and SL-4	Period of Interest FLT/Manned	Op. Need Date	Rev Date

Request Contact	Data Recipient	Date Req
Name Organization Phone	Name Mr. W. R. Bock Address S&E-ASTN-SDF MSFC, Alabama 35812 Phone 205-453-3810	Real Qty

Reference Document:

MRD Content

Detailed Requirements:

The Payload Integration Section (S&E-ASTN-SDI) needs to assess the level of housekeeping data for Experiment M-487, Habitability/Crew Quarters. These data are needed 10 min before the experiment, once during midpoint, and at the end of the experiment.

A hard copy of the data should be made available to the user.

Comments & Explanation:

These data will be used to measure and evaluate the experiment/carrier interface so that Skylab Mission evaluation reporting requirements can be fulfilled. (See OMSF Program Directive 55 M-D ML, 138, 5-71).

Originator	Integrator
Name K. S. Purushotham Organization Teledyne Brown Engineering Phone 532-1612 Signature Date	Name J. R. Riquelmy Organization S&E-ASTN-SDF Phone 205-453-3810 Signature Date
Request Aproval	**Implementing Agency**
Name Organization Phone Signature Date	Name Organization Phone Signature Date

MSFC - Form 65 (October 1970)

DRF Control No.	Exp/Sys No. ASTN-SDI/OWS/M-487	Revision -	Date

Detailed Requirements:

Measurement No.	Measurement Name
C 7144-438	Temp, VCS, Wardroom Inlet Gas
C 7255-438	Temp, VCS, Experiment Compartment Inlet Gas
C 7256-438	Temp, VCS, Sleep Compartment Inlet Gas
C 7254-438	Temp, VCS, M/C Inlet Gas
C 7123-437	Temp, TCS, Wardroom Ceiling
C 7032-437	Temp, TCS, Sleep Compartment Ceiling
C 7122-437	Temp, TCS, Experiment Compartment Ceiling
C 7094-441	Temp, TCS, Sleep Compartment Wall
C 7033-443	Temp, TCS, Wardroom Stowage Locker
C 7059-443	Temp, TCS, Wardroom Wall No. 1
C 7040-437	Experiment Compartment Ceiling No. 2

SECTION VI.

EXPERIMENT M-487, HABITABILITY/CREW QUARTERS ENGINEERING CHANGE REQUESTS

Engineering Change Requests for Experiment M-487 are N/A.

SECTION VII.

EXPERIMENT M-487, HABITABILITY/CREW QUARTERS EVALUATION SEQUENCE

TABLE D-III. EXPERIMENT M-487, HABITABILITY / CREW QUARTERS EVALUATION SEQUENCE (Sheet 1 of 9)

Assignments

Mission:

- SL-1/SL-2, SL-3, and SL-4

Orbital Assembly:

- OWS

Carrier:

- The experiment hardware is stowed in Wardroom Locker W749. The locker is located between Positions II and III at OWS Sta. No. 409. 562 (approximate).

Conditions

Crew:

- Any crewmen can perform the experiment

Experiment:

- Experiments M-172, M-092, M-171, and ATM are operating during M-487 experiment.
  --Preparation Phase: TBD hr
  --Operation Phase: TBD hr
  --Termination Phase: TBD hr

Ground Support:

- Prelaunch: N/A
- Post-launch: N/A

Requirements

Functional Objectives:

- FO-1 through FO-9 will be performed on all the missions.

Experiment Evaluation Team - Key Personnel Locator

Name	Responsibility	Office Address, Symbol, and Telphone Number
Mr. C. C. Johnson	Principal Investigator (PI)	MSC, Houston, Texas, 713-483-3491
Mr. Gaylord Huffman	Experiment Developer (ED)	MSFC, Bldg. 4201, PM-SL-SW, 205-453-0820
Mr. Robert Bond	Experiment Developer (ED)	MSC, Houston, Texas, 713-483-3491
Mr. Gaylord Huffman	MSFC Experiment Manager (EM)	MSFC, Bldg. 4201, PM-SL-SW, 205-453-0820
Mr. Jack Stokes	S&E Integration Engineer (IE)	MSFC, Bldg. 4610, S&E-ASTN-SMH, 205-453-3793
Mr. W. R. Bock	Technical Discipline Manager (TDM)	MSFC, Bldg. 4610, S&E-ASTN-SDF, 205-453-3810
Mr. K. S. Purushotham	Experiment Operation Engineer (EOE)	Teledyne Brown Engineering Company, Huntsville, Alabama, 205-532-1612
Mr. Charles Evans	Experiment Integration Engineer (EIE)	MMC, Denver, Colorado, 303-794-5211, ext. 2094
Mr. John L. Nelson	Experiment Flight Controller (EFC)	MSC, Houston, Texas, Bldg. 30FC-4, 713-453-4717

TABLE D-III. EXPERIMENT M-487, HABITABILITY/CREW QUARTERS EVALUATION SEQUENCE (Sheet 2 of 9)

Operation Step Number*	Crewman**	Test Procedure	Evaluation (Check One)		See Contingency Plan Number	Remarks
			Satis-factory	Anom-aly		
P - 60 min GMT 12:00 for SL-1/SL-2; GMT 13:30 for SL-3; GMT TBD for SL-4.		Experiment Evaluation Team manned and available. Contact Experiment M-487 Technical Discipline Manager, S&E-ASTN-SD: HOSC Telephone No.: TBD, Astronautics Laboratory Telephone No. 205-453-3810. Reference: Skylab Flight Plan, SL-1/SL-2, SL-3,and SL-4, MSC No. TBD, Latest revision, May 2, 1972.				
P - 10 min GMT 12:50 for SL-1/SL-2; GMT 14:20 for SL-3; GMT TBD for SL-4.		Commence experiment preparation (ground action).				

*P - Preparation
O - Operations
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OBS - Observer (Science Pilot)
PLT - Pilot
ALL - TP/OBS/PLT

MSFC - One Time Form 17-1 (March 1972)

TABLE D-III. EXPERIMENT M-487, HABITABILITY/CREW QUARTERS EVALUATION SEQUENCE (Sheet 3 of 9)

Operation Step Number*	Data: Return: Recorder Number	Measurement Name, Number, and Signal	Telemetry Assignment Channel	Function**	Frequency***	Range and Dimension of Variables	Limits of Concern	Evaluation: Check: Satisfactory	Evaluation: Check: Anomaly	Remarks****	Contingencies: See Contingency Plan Number	Contingencies: Remarks
P 1.0	Determine experiment status.											
P 1.1	Acquire status and evaluate performance of the following measurements:											
	TBS	Temperature, VCS, Wardroom Inlet gas C 7144-438	WP1A150A52LO21	H	C	Range: 40 to 100 °F Read: 65 to 80 °F						
	TBS	Temperature, VCS, Experiment Compartment Inlet gas C 7255-438	WP1B104A14LB04	H	C	Range: 40 to 100 °F Read: 65 to 80 °F						
	TBS	Temperature, VCS, Sleep Compartment Inlet gas C 7256-438	WP1A050A43LM18	H	C	Range: 40 to 100 °F Read: 65 to 80 °F						
	TBS	Temperature, VCS, Mixing Chamber Inlet gas C 7254-436	WP1B104A10LB03	H	C	Range: 40 to 100 °F Read: 65 to 80 °F						

*P - Preparation
O - Operations
T - Termination
L - Lift-off (Booster)

**E - Event
H - Housekeeping
A - Analog
D - Digital

***C - Continuous
I - Intermittent
D - Discrete
(Specified number of times)

****R - Real Time
N - Near/Real Time
A - All Time

ASTN-72-1-OT (Jan 72)

TABLE D-III. EXPERIMENT M-487, HABITABILITY/CREW QUARTERS EVALUATION SEQUENCE (Sheet 4 of 9)

Operation Step Number*	Data: Return: Recorder Number	Measurement Name, Number, and Signal	Telemetry Assignment Channel	Function**	Frequency***	Range and Dimension of Variables	Limits of Concern	Evaluation: Check: Satisfactory	Anomaly	Remarks****	Contingencies: See Contingency Plan Number	Remarks
P 1.1 (Continued)	TBS	Temperature, TCS, Wardroom Ceiling		H	C	Range: 0 to 120 °F						
		C 7123-437	WP1A150A48LQ20			Read: 65 to 85 °F						
	TBS	Temperature, TCS, Sleep Compartment Ceiling		H	C	Range: 0 to 120 °F						
		C 7032-437	WP1A150A40LQ18			Read: 65 to 85 °F						
	TBS	Temperature, TCS, Experiment Compartment Ceiling		H	C	Range: 0 to 120 °F						
		C 7122-437	WP1A050A23LM13			Read: 65 to 85 °F						
	TBS	Temperature, TCS, Sleep Compartment Wall		H	C	Range: 0 to 120 °F						
		C 7094-441	WP1A010A35LM16			Read: 65 to 85 °F						
	TBS	Temperature, TCS, Wardroom Stowage Locker		H	C	Range: 0 to 120 °F						
		C 7033-443	WP1A150A32LQ16			Read: 65 to 85 °F						

*P - Preparation
O - Operations
T - Termination
L - Lift-off (Booster)

**E - Event
H - Housekeeping
A - Analog
D - Digital

***C - Continuous
I - Intermittent
D - Discrete
(Specified number of times)

****R - Real Time
N - Near/Real Time
A - All Time

ASTN-72-1-OT (Jan 72)

TABLE D-III. EXPERIMENT M-487, HABITABILITY/CREW QUARTERS EVALUATION SEQUENCE (Sheet 5 of 9)

Operation Step Number*	Data: Return: Recorder Number	Measurement Name, Number, and Signal	Telemetry Assignment Channel	Function**	Frequency***	Range and Dimension of Variables	Limits of Concern	Evaluation: Check: Satisfactory	Evaluation: Check: Anomaly	Remarks****	Contingencies: See Contingency Plan Number	Contingencies: Remarks
P 1.1 (Concluded)	TBS	Temperature, TCS, Wardroom Wall No. 1		H	C	Range: 0 to 120 °F						
		C 7059-443	WP1B150A30LQ08			Read: 65 to 85 °F						
	TBS	Temperature, TCS, Experiment Compartment Ceiling		H	C	Range: 0 to 120 °F						
		C 7040-437	WP1A150A20LQ13			Read: 65 to 85 °F						
	TBS	Voltage: Power Distribution Control System (PDCS) OWS Bus No. 1		H	C	Range: 0 to 35 Vdc						
		M 7002-440	WP1B050A21LH05			Read: 24 to 30 Vdc						
	TBS	Voltage: PDCS, OWS Bus No. 2		H	C	Range: 0 to 35 Vdc						
		M 7003-440	WP1B010A21LH05			Read: 24 to 35 Vdc						

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O - Operations
T - Termination
L - Lift-off (Booster)

**E - Event
H - Housekeeping
A - Analog
D - Digital

***C - Continuous
I - Intermittent
D̄ - Discrete
(Specified number of times)

****R - Real Time
N - Near/Real Time
Ā - All Time

ASTN-72-1-OT (Jan 72)

TABLE D-III. EXPERIMENT M-487, HABITABILITY/CREW QUARTERS EVALUATION SEQUENCE (Sheet 6 of 9)

Operation Step Number*	Crewman**	Test Procedure	Evaluation (Check One)		See Contingency Plan Number	Remarks
			Satis-factory	Anom-aly		
P = 0 min GMT 13:00 for SL-1/SL-2; GMT 14:30 for SL-3; GMT TBD for SL-4.	*Commence experiment preparation* (flight action).					
P 2.0	PLT/ANY	Conduct Velometer Calibration Checkout.				
P 2.1		Remove the velometer and probe from the stowage container.				
P 2.1.1		Plug the probe into the connector at the front of the instrument.				
P 2.1.2		Cap the probe with a rubber cap and hold the probe in a vertical position with the cable hanging down.				
P 2.1.3		Press and hold the ON-OFF switch.				
P 2.1.4		Calibrate the velometer indicator to read zero velocity.			P214A1 P214B1	
P 2.2	PLT/ANY	Conduct sound level meter and frequency analyzer checkout.				
P 2.2.1		Remove the sound level meter and frequency analyzer pan from the stowage container and perform battery check.				
P 2.2.1.1		Pull out KNOB 1 and set to position BATT.				
P 2.2.1.2		Verify the meter pointer.			P2212A1	Should deflect within the area marked "Battery"
P 2.2.2	PLT/ANY	Check the amplifier and the meter circuit.			P222A1	
P 2.2.2.1		Set KNOB 1 to position LIN and turn KNOB 3 fully clockwise.				

*P - Preparation
O - Operations
T - Termination
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OBS - Observer (Science Pilot)
PLT - Pilot
ALL - TP/OBS/PLT

MSFC - One Time Form 17-1 (March 1972)

TABLE D-III. EXPERIMENT M-487, HABITABILITY/CREW QUARTERS EVALUATION SEQUENCE (Sheet 7 of 9)

Operation Step Number*	Crewman**	Test Procedure	Evaluation (Check One)		See Contingency Plan Number	Remarks
			Satis-factory	Anom-aly		
P 2.2.2.2		Turn KNOB 2 fully counter clockwise until REF mark appears in the red circle to the right.				
P 2.2.2.3		Verify the meter pointer on the upper red scale (should be equal to the K value of the microphone).				
P 2.3	PLT/ANY	Remove the digital thermometer and probe from the stowage container.				
P 2.3.1		Install the probe on the thermometer and prepare for operation.				
O 1.0	PLT/ANY	Commence experiment operation.				
O 1.1		Velometer Operation.				
O 1.1.1		Remove the cap from the probe.				
O 1.1.2		Hold the probe in the air stream where it is required to obtain a measurement of air velocity. (The probe must be held in such a way that any movement should be perpendicular to the open end of the probe).				
O 1.1.3		Press the ON-OFF switch downwards and obtain readings.			O112A1	Repeat the experiment as many times as necessary to obtain an average reading.
O 1.1.4		Voice record both subjective and objective comments about the readings.				
O 1.2		Sound Level Meter and Frequency Analyzer Operation.				
O 1.2.1		Sound Measurement:				
O 1.2.1.1		Pull out KNOB 1.				
O 1.2.1.2		Set KNOB to position LIN.				
O 1.2.1.3		Rotate KNOB 2 clockwise until meter deflection reads between 0 and 10 dB.			01213A1	

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OBS - Observer (Science Pilot)
PLT - Pilot
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MSFC - One Time Form 17-1 (March 1972)

TABLE D-III. EXPERIMENT M-487, HABITABILITY/CREW QUARTERS EVALUATION SEQUENCE (Sheet 8 of 9)

Operation Step Number*	Crewman**	Test Procedure	Evaluation (Check One)		See Contingency Plan Number	Remarks
			Satis-factory	Anom-aly		
O 1.2.1.4		Set KNOB 1 to the desired position.				
O 1.2.1.5		Rotate KNOB 3 (if necessary) counter clockwise to obtain a deflection between 0 and 10 dB (do not use KNOB 2 at this stage. KNOB 2 will overdrive the input amplifier).				
O 1.2.1.6		Obtain the reading on the meter together with value shown in the red circle.				
O 1.2.2		Frequency Measurement:				
O 1.2.2.1		Calibrate the instrument using Operation Step Nos. P 2.2.1.1 through P 2.2.2.3.				
O 1.2.2.2		Repeat Operation Step Nos. O 1.2.1 through O 1.2.1.3.				
O 1.2.2.3		Set KNOB 1 to EXT FILT.				
O 1.2.2.4		Repeat Operation Step No. O 1.2.1.6.				
		Voice record subjective and objective comments about the measurements.				
O 1.3		Digital Temperature Sensor Operation.				
O 1.3.1		Place the probe on the measurement surface.				
O 1.3.2		Set the temperature range switch to the desired position.				
O 1.3.3		Push the readout switch and observe the digital display.			O133A1	
O 1.3.4		Voice record both subjective and objective comments of the measurement.				
		Note: M-487 experiment measurements are conducted in the following areas:				

*P - Preparation
O - Operations
T - Termination
L - Lift-off (Booster)

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OBS - Observer (Science Pilot)
PLT - Pilot
ALL - TP/OBS/PLT

MSFC - One Time Form 17-1 (March 1972)

TABLE D-III. EXPERIMENT M-487, HABITABILITY/CREW QUARTERS EVALUATION SEQUENCE (Sheet 9 of 9)

Operation Step Number*	Crewman**	Test Procedure	Evaluation (Check One)		See Contingency Plan Number	Remarks
			Satis-factory	Anom-aly		
O 1.3.4 (Concluded)		• Sleep compartment • Wardroom • Waste management • Experiment compartment • Forward compartment.				
T 1.0		Terminate the Velometer Operation.				
T 1.1		Release the ON-OFF switch.				
T 1.1.1		Install the cap on the probe.				
T 1.1.2		Remove the probe from the instrument.				
T 1.1.3		Stow the instrument and probe in the stowage container.				
T 1.2		Terminate sound level meter and frequency analyzer operation.				
T 1.2.1		Push KNOB 1 to turn the POWER OFF.				
T 1.2.2		Return KNOBS 2 and 3 to the original postion.				
T 1.2.3		Stow the sound level meter and frequency analyzer.				
T 1.3		Terminate digital temperature sensor.				
T 1.3.1		Turn power switch off.				
T 1.3.2		Remove the sensing probe.				
T 1.3.3		Stow digital temperature sensor and probe in the stowage container.				

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T - Termination
L - Lift-off (Booster)

**TP - Test Pilot (Commander)
OBS - Observer (Science Pilot)
PLT - Pilot
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MSFC - One Time Form 17-1 (March 1972)

SECTION VIII.

EXPERIMENT M-487, HABITABILITY/CREW QUARTERS MALFUNCTION AND CONTINGENCY PLAN OUTLINE

TABLE D-IV. EXPERIMENT M-487, HABITABILITY/CREW QUARTERS MALFUNCTION AND CONTINGENCY PLAN OUTLINE - EXPERIMENT PREPARATION (P)

Operation Step Number	Experiment/Crew Tasks	Possible Malfunction	Contingency Plan	Remarks (malfunctions,corrections,results)
P 2.1.4	Calibrate the velometer to make the indicator read zero velocity.	P214A The velometer indicator does not deflect.	P214A1 Replace the battery.	Probable cause is a weak battery.
			P214A2 Continue the experiment.	
		P214B Velometer cannot be calibrated.	P2124B1 Continue the experiment in degraded mode.	
P 2.2.1.2	Verify the meter pointer.	P2212A The meter does not deflect.	P2212A1 Replace the battery.	Suspect weak battery.
			P2212A2 Continue the experiment.	
P 2.2.2	Check the amplifier circuit.	P222A The pointer does not move. Probable failure in the electronic circuitry.	P222A1 Terminate the use of sound level meter; partial loss of experiment.	

P

TABLE D-V. EXPERIMENT M-487, HABITABILITY/CREW QUARTERS MALFUNCTION AND CONTINGENCY PLAN OUTLINE - EXPERIMENT OPERATION (O)

Operation Step Number	Experiment/Crew Tasks	Possible Malfunction	Contingency Plan	Remarks (malfunctions, corrections, results)
O 1.1.2	Press the ON-OFF switch downwards and obtain readings.	O112A No indication on the meter. Thermocouple elements are broken.	O112A1 Terminate the experiment.	
O 1.2.1.3	Rotate KNOB 2 clockwise until the meter deflection reads between 0 and 10 dB.	O1213A Erratic indication; probably a defective switch.	O1213A1 Recycle the switch. If no change in state, terminate the experiment.	
O 1.3.3	Push the readout switch and observe digital display.	O133A No digital display.	O133A1 Use the other surface temperature sensor (digital type) and continue the experiment.	

O

TABLE D-VI. EXPERIMENT M-487, HABITABILITY/CREW QUARTERS MALFUNCTION AND CONTINGENCY PLAN OUTLINE - EXPERIMENT TERMINATION (T)

Operation Step Number	Experiment/Crew Tasks	Possible Malfunction	Contingency Plan	Remarks (malfunctions, corrections, results)
	No contingency plans are identified for the Termination Section of this experiment at this time.			

T

ASTN-OT-9 (Feb. 72)

SECTION IX.

EXPERIMENT M-487, HABITABILITY/CREW QUARTERS MALFUNCTION ANALYSIS

The material contained in this section is an excerpt from Reference 8.

17. Habitability/Crew Quarters, M487

The objective of Experiment 487 is to accumulate engineering data concerning the habitability features of the OWS for use in the design of future manned spacecraft. The functions to be performed in achieving this objective are of a minor nature and entail only a minimal malfunction analysis. Typical of the problem that might be encountered is the restoration of an instrument, e.g., the velometer, to a useful state by replacing its batteries.

Table 17.1 Operational Functions and Malfunction Analysis Items, M487

Operational Function	Malfunction Analysis Item
17.1 Provide Air Flow Measurement	17.1.1 Velometer Fails
17.2 Provide Noise Meas. Capability/Frequency Analysis	17.2.1 Sound Pressure Level Meter Fails
17.3 Provide Surface Temperature Sensing Capability	17.3.2 Digital Thermometer Fails

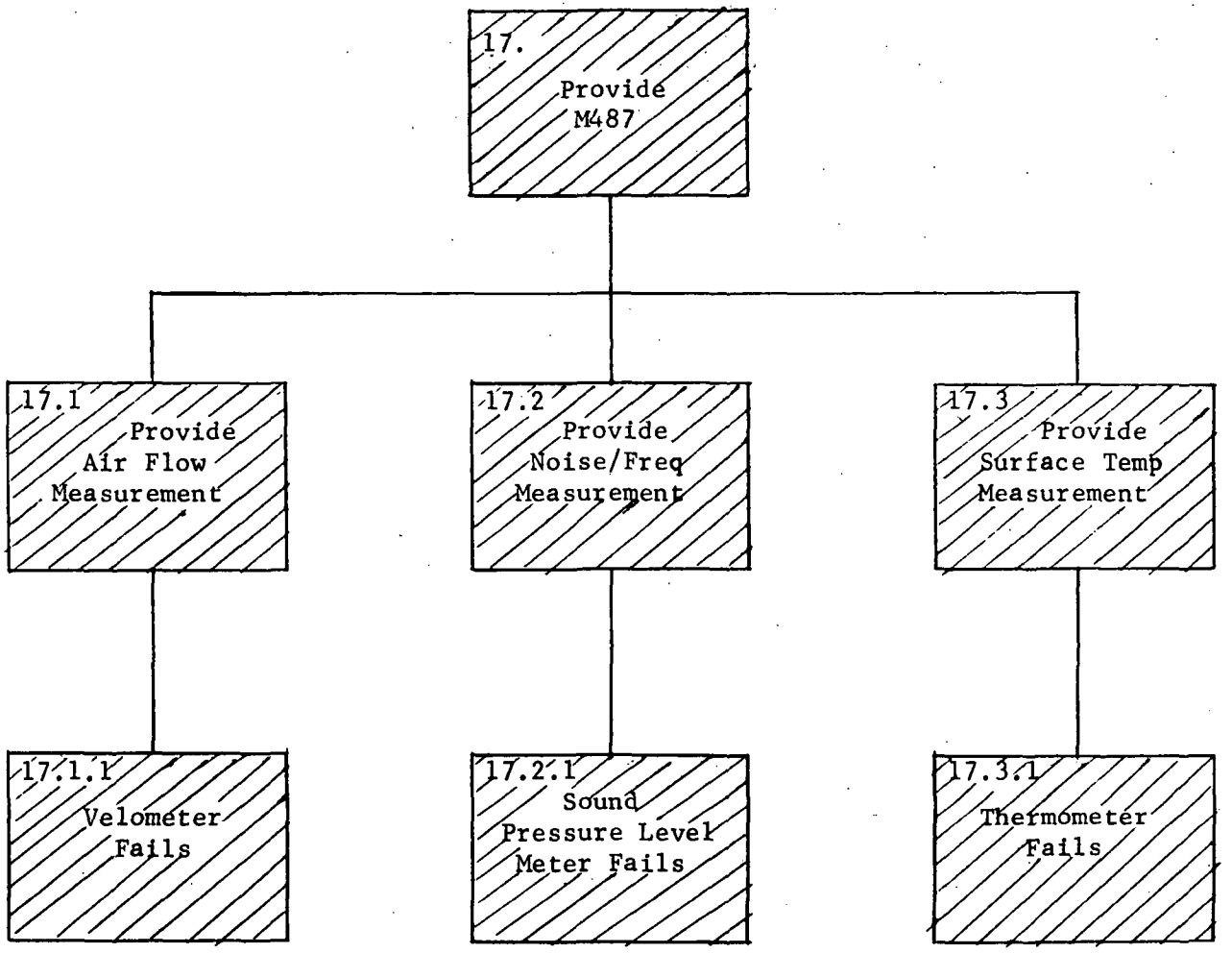

Figure 17.1 Functional Flow and Malfunction Analysis Diagram, Experiment M487

MALFUNCTION ANALYSIS CHART, M487

MALFUNCTION	INDICATION		EFFECT			ACTION
MALFUNCTION OR CONDITION	PRIMARY MEASUREMENTS	SUPPORT MEASUREMENTS	MISSION/CREW	SYSTEM/SUBSYSTEM	SYSTEM/ INTERACTION	CREW OR COMMAND
17. Provide M487						
17.1 Provide Air Flow Measurement						
17.1.1 Air Flow Meter Failure (Sensor, Circuit or Battery)	Crew Observation (U): Meter reads zero or exhibits erratic behavior.	None	Mission: None Crew: Experiment timeline revision.	Air flow data not available.	None	Ground Action: None Crew Action: Phases D, F & H 1. Replace batteries, or 2. Replace probe and/or entire unit on next visitation.
17.2 Provide Noise Measurement Capability and Frequency Analysis						
17.2.1 Sound Pressure Level Meter Failure (Microphone, Circuit, Octave Filter Set or Battery)	Crew Observation (U): Meter reads zero or exhibits erratic behavior.	None	Mission: None Crew: Exp timeline revision.	Noise data not available.	None	Ground Action: None Crew Action: Phases D, F & H 1. Replace batteries, or 2. Replace microphone and/or entire unit on next visitation.
17.3 Provide Surface Temperature Sensing Capability						
17.3.1 Digital Thermometer Failure	Crew Observation (U): Meter reads zero or exhibits erratic behavior.	None	Mission: None Crew: Exp timeline revision.	Surface temperature data not available.	None	Ground Action: None Crew Action: Phases D, F & H. 1. Replace batteries, or 2. Replace sensor and/or entire unit on next visitation.

MISSION PHASES:
A. All Phases
B. Boost to Orbit
C. Activation
D. 1st Visitation
E. 1st Storage
F. 2nd Visitation
G. 2nd Storage
H. 3rd Visitation

SECTION X. CONCLUSIONS AND RECOMMENDATIONS

1. The measurement equipment used in Experiment M-487 is considered off-the-shelf items. Minimum modification has been made to some of the equipment so that it can be prepared for flight application. An analysis of the measurement devices indicates that the hardware is relatively simple and has a minimum chance of failure. If a failure should occur, it would result in a Category III failure. Based on our knowledge of the experiment, it is difficult to determine how the objective and subjective data are to be evaluated and used in meeting the objectives of the experiment. We have been unable to determine how the Principal Investigator (PI) intends to use the design and performance data in evaluation of the M-487 experiment and the application of these data for future spacecraft design.

2. A Systems Diagram (Figure D-3) has been devised and depicts how crew activities, tasks, and attitudes are related to their living quarters and environment. Tangible and intangible design attributes of the crew's living and work areas are to be considered. The crew activity consists of:

    - Waste Management
    - Food Management
    - Personal Hygiene
    - Sleep Provisions
    - Off-Duty Activities
    - Housekeeping Activities.

    The crew will select all or any one of the following tasks with respect to the above activities. The tasks are:

    - Retrieval
    - Preutilization
    - Utilization
    - Post-utilization
    - Stowage.

The crew will make subjective comments related to the above activities and tasks by using the following parameters:

- Architecture
- Mobility Aids and Restraints
- Air Temperature, Velocities, and Humidity
- Touch Temperature
- Illumination
- Noise
- Clothing
- Odors
- Decor
- Communication.

To evaluate the above parameters, certain portable measuring instruments are provided and will be used where applicable:

- Velometer
- Sound Level Meter and Frequency Analyzer
- Digital Temperature Sensor
- Ambient Thermometers
- Measuring Tape
- Spring Scale.

Additional supportive equipment, e.g., DAC, camera, film cassettes, lenses, spotmeter, and CO_2 dewpoint monitors, are used in the performance of Experiment M-487.

REFERENCES

1. Experiment Requirements Document for Experiment M-487, Habitability/Crew Quarters. SE-010-049-2H, CCBD No. 800-71-0632, Marshall Space Flight Center, Huntsville, Alabama, July 21, 1971.

2. Mission Requirement Document. Volume I: First Skylab Mission SL-1/SL-2, I-MRD-001E, Manned Spacecraft Center, Houston, Texas, November 1, 1971.

3. Mission Requirement Document. Volume II: Second Skylab Mission SL-3, I-MRD-001E, Manned Spacecraft Center, Houston, Texas, June 14, 1972.

4. Mission Requirement Document. Volume III: Third Skylab Mission SL-4, I-MRD-001E, Manned Spacecraft Center, Houston, Texas, June 14, 1972.

5. Skylab Experiment Operations Handbook. Volume I: Experiment Descriptions, MSC-00924, Manned Spacecraft Center, Houston, Texas, November 19, 1971.

6. Skylab Program Directive No. 43B, M-D ML 3200.125, NASA Office of Manned Space Flight, Washington, D. C., March 27, 1972.

7. Skylab Orbital Workshop Formal Critical Design Review (CDR), Experiment M-487. Volume I, McDonnell Douglas Astronautics Company, Huntington Beach, California, June 1972.

8. Wilcoxson, C. B., et al: Mission Operations Design Support, Volume III. OWS Experiments Malfunction Analyses, Rev. A, ED-2002-1244, Martin Marietta Corporation, Denver, Colorado, May 12, 1972.