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SKYLAB EXPERIMENT PERFORMANCE EVALUATION MANUAL

Appendix B: Experiment M415 Thermal Control Coatings (MSFC), Revised

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Prepared for

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16. ABSTRACT

This appendix contains a series of analyses for Experiment M415, Thermal Control Coatings (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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REVISION CHANGES

Page	Description
	This revision was required because of changes in the Experiment M-415 sensor cover design and its deployment sequence. A detailed list of changes follows:
B-7	Functional Block Number 3.1.1. Rewritten to reflect new time of data acquisition.
B-9	Functional Block Number 3.1.4. Editorial change only.
B-10	Functional Block Number 3.4.1. Rewritten to reflect design and sequence changes.
B-12	Functional Block Number 3.5.1.3. Rewritten to reflect design and sequence changes.
B-15	Figure B-1. Editorial change only.
B-21	Figure B-3. New systems diagram.
B-23	Renumbered sensor specimens according to latest design.
B-28	Editorial change only.
B-37 to B-41	Replaced telemetry signal profile because of design and sequence changes.
B-41	Added combined telemetry signal profile.
B-55	Deleted paragraphs 6 and 7 of the Conclusions and Recommendations.

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DEFINITION OF SYMBOLS

CRT	Cathode Ray Tube
CSM	Command Service Module
EBW	Electric Bridge Wire
FBD	Functional Block Diagram
FO	Functional Objective
HOSC	Huntsville Operations Support Center
IU	Instrument Unit
LES	Launch Escape System
OMSF	Office of Manned Space Flight
P_f	Probability of Failure
P_{f_t}	Total Probability of Failure
P_s	Probability of Success
TBD	To Be Determined
TBS	To Be Supplied

SECTION I.

EXPERIMENT M-415, THERMAL CONTROL COATINGS PRE-FLIGHT OPERATIONS EVALUATION ANALYSIS

TABLE B-I. EXPERIMENT M-415, THERMAL CONTROL COATINGS PRE-FLIGHT OPERATIONS EVALUATION ANALYSIS (Sheet 1 of 8)

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-415, Thermal coatings.				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 duration that the experiment is required to operate and provide useful information.				N/A	No crew participation is required for this experiment. The experiment data acquisition begins upon activation of the Instrument Unit (IU) and will continue through the IU lifetime. After Command Service Module (CSM) separation the IU/S-IVB is rolled about the X-axis such that at local noon the sun-line will pass through a point on the IU exterior midway between two experiment sensor panels (25.5° from IU position II towards position I). This roll position will be maintained until the termination of the experiment. *References* 1, 2, and 3.
3.1.2 *Specify the types of criteria that* are to be maximized or minimized.				N/A	The functional objectives (FO) of Experiment M-415 are: • FO-1: Obtain data to determine the degradation of three thermal control coating materials when subjected to moisture and dust prior to launch, heat and errosion effects from launch, S-IB interstage retrofire, Launch Escape System (LES) tower jettison, and space environment. • FO-2: Obtain data to determine the degradation of three thermal control coating materials when subjected to S-IB interstage retrofire, LES tower jettison, and space environment.

*Critical 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 objectives and does not adversely affect crew safety.

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TABLE B-I. EXPERIMENT M-415, THERMAL CONTROL COATINGS PRE-FLIGHT OPERATIONS EVALUATION ANALYSIS (Sheet 2 of 8)

FUNCTIONAL BLOCK NUMBER AND TITLE	EXPECTED RANGE AND DIMENSION OF VARIABLES			CRITICALITY CATEGORY NUMBER	REMARKS
	MIN.	NOM.	MAX.		
3.1.2 (Concluded)					• FO-3: Obtain data to determine the degradation of three thermal control coating materials when subjected to LES tower jettison and space environment. • FO-4: Obtain data to determine the degradation of three thermal control coating materials when subjected to space environment. References 3 and 4.
3.1.3 Specify the percentage of acceptable max. /min. for each criterion.				N/A	The weighted value for each FO has not been assigned. The FO weights total 100 percent. The weights represent the percentage of detailed test objective that is accomplished when the respective FO has been satisfied. The following arbitrary weighted values are assigned: • FO-1 40 percent • FO-2 30 percent • FO-3 20 percent • FO-4 10 percent. The minimum acceptable percentage for each FO is derived as follows:
	26.64%	33.32%	40%		• FO-1: A minimum of four sensors should function normally to obtain the desired data. This constitutes 66.6 percent of the desired performance or 26.64 percent of the total objective.
	19.98%	24.99%	30%		• FO-2: A minimum of four sensors should function normally to obtain the desired data. This constitutes 66.6 percent of the desired performance or 19.98 percent of the total objective.
	13.32%	16.66%	20%		• FO-3: A minimum of four sensors should function normally to obtain desired data. This constitutes 66.6 percent of the desired performance or 13.32 percent of the total objective.
	6.66%	8.33%	10%		• FO-4: A minimum of four sensors should function normally to obtain desired data. This constitutes 66.6 percent of the desired performance or 6.66 percent of the total objective.
	66.50%	83.25%	100%		• Total percentage of acceptable max. /min. The above values are subjective estimates.

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TABLE B-I. EXPERIMENT M-415, THERMAL CONTROL COATINGS PRE-FLIGHT OPERATIONS EVALUATION ANALYSIS (Sheet 3 of 8)

FUNCTIONAL BLOCK NUMBER AND TITLE	EXPECTED RANGE AND DIMENSION OF VARIABLES			CRITICALITY CATEGORY NUMBER	REMARKS
	MIN.	NOM.	MAX.		
3.1.4 Specify the experiment constraints: • Musts • Must Nots • Wants • Don't Wants.				N/A	• Musts --N/A. • Must Nots --N/A • Wants --After CSM separation the S-IVB/IU shall be rolled about the X-axis such that at local noon the sun-line will pass through a point on the IU exterior midway between two experiment sensor panels. The roll position will be maintained. • Don't Wants --N/A References 1 and 3.
3.1.5 Specify the experiment operational tolerances: • Must • Must Nots • Wants • Don't Wants.				N/A	Refer to pages B-34 through B-44. Specific tolerances for each functional item are TBD.
3.2 Define 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 experiment priority number (numerical statement) for a given Skylab flight designation.				N/A	Experiment M-415 is scheduled for flight on SL-2. No priority number is assigned for this experiment. Reference 5.
3.4 Briefly describe and list the major subsystems for Experiment M-415.				N/A	Refer to functional items 3.4.1 and 3.4.2.

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TABLE B-I. EXPERIMENT M-415, THERMAL CONTROL COATINGS PRE-FLIGHT OPERATIONS EVALUATION ANALYSIS (Sheet 4 of 8)

FUNCTIONAL BLOCK NUMBER AND TITLE	EXPECTED RANGE AND DIMENSION OF VARIABLES			CRITICALITY CATEGORY NUMBER	REMARKS
	MIN.	NOM.	MAX.		
3.4.1 Describe the major functions.				N/A	Experiment M-415 is designed to study the degradation effects of prelaunch, launch and the space environment on the absorpitivity, emissivity, and stability characteristics of various material coatings commonly used for passive thermal control. The results of the experiment will answer questions concerning the design of spacecraft thermal systems. Experiment M-415 is mounted on the IU of AS-206. There are two sensor panels and each panel contains 12 thermal sensors that are arranged in four rows of three per panel. These sensors are coated with three different thermal control coatings. One sensor of each panel will be coated with a black absorbing paint to form a "worst" conditioning base line from which to correlate the data received from the other sensors. The sensors are protected by covers. One set of covers is a bolt on type and is removed prior to launch. The other three sets of covers are deployed by self contained explosive bolts. The second and fourth row of covers are hinged and spring loaded to the panel fairing. When the thruster pryotechnics are ignited, the thruster force will drive the covers outboard away from the panels and cause the covers to rotate and latch. The third row of covers is expelled into space after the CSM has separated from the S-IVB/IU. The covers are deployed by the IU Digital Computer System. Verification of cover expulsion will be provided by the contact switches mounted on the sensor panels. The covers are removed in the following sequence: • First row of covers removed prior to launch • Fourth row of covers deployed immediately prior to S-IVB/Interstage separation and retrofire from S-IVB. Time T_3 + 0.6 sec. • Second row of covers deployed immediately prior to LES jettison during S-IVB powered ascent. Time T_3 + 18 sec. • Third row of covers jettisoned after the CSM has separated from the S-IVB/IU. This occurs after orbital insertion. Time T_4 + 2547 sec. Data acquisition will begin as soon as IU is activated and will continue until the loss of IU power. References 1, 2, and 3.
3.4.2 List the major components.				N/A	The major components of Experiment M-415 are: • Sensors • Thrusters • Contact Switches • Connectors and wiring. References 1 and 2.

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TABLE B-I. EXPERIMENT M-415, THERMAL CONTROL COATINGS PRE-FLIGHT OPERATIONS EVALUATION ANALYSIS (Sheet 5 of 8)

FUNCTIONAL BLOCK NUMBER AND TITLE	EXPECTED RANGE AND DIMENSION OF VARIABLES			CRITICALITY CATEGORY NUMBER	REMARKS
	MIN.	NOM.	MAX.		
3.5 Define the M-415 experiment/carrier subsystem interfaces: • Physical --Mechanical --Electrical --Communication and Data --Support • Environmental --Natural and Induced --Contamination • Operational --Pointing and control --Crew safety --Sequence --Operability.				N/A	A Functional Block Diagram (FBD) is submitted as Figure B-1 and is used as a subsystem component listing. Critical subsystem components will be identified and evaluated for failure and correlated to possible experiment/carrier interface problems.
3.5.1 Sensor panels.				N/A	Refer to functional item 3.5.1.2.1.
3.5.1.2.1 Specify the total probability of failure (P_{f_t}) for the thermal sensor cover gasket.		nil		IIIb	Each sensor cover has one silicone rubber gasket that conforms to MIL-R-5847 class I grade 50. The gasket is bonded to the sensor cover by Epon 403 adhesive and protects the sensor from unwanted exposures until respective covers are expelled. The probability of failure (P_f) is considered to be remote. If the gasket should fail, the following situation could occur: • Mechanical --If the gasket should fracture or crack, the leakage of external atmosphere or other prelaunch conditions would contaminate the sensors and degrade the data of the experiment. There is no way to indicate the failure of the gaskets. Reference 6.

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TABLE B-I. EXPERIMENT M-415, THERMAL CONTROL COATINGS PRE-FLIGHT OPERATIONS EVALUATION ANALYSIS (Sheet 6 of 8)

FUNCTIONAL BLOCK NUMBER AND TITLE	EXPECTED RANGE AND DIMENSION OF VARIABLES			CRITICALITY CATEGORY NUMBER	REMARKS
	MIN.	NOM.	MAX.		
3.5.1.3 Specify P_{f_t} for the Thrusters.	24 Vdc	0.1 28 Vdc 5 A	32 Vdc	IIIa	The sensor cover plates are removed by firing armament thrusters (squibs). Each panel requires six thrusters to initiate and deploy the sensor covers. The thrusters incorporate a pyrotechnic squib that uses a parallel bridgewire circuit. The composition of the pyrotechnic is TBS. The commands to fire the thrusters are issued by the IU and DCS and are preprogrammed. It requires 28 ±3 Vdc at 5 A for 10 msec to fire the thrusters. Four squibs are fired at a time. Each squib circuit requires 150 W of power. The peak power is 600 W for 10 msec. Electrical current is supplied to bridgewires causing them to ignite the pyrotechnic, which generates a gas charge and forces the bolts to break and thrust away from the structure. The P_f for the squibs is considered small. If this should fail, the following situation could happen: • Electrical --It is assumed that failure of any squib to fire could prevent the ejection of a panel cover. This would result in loss of data from that row of sensors. The following indications could be used to determine the failure of squibs: • Failure to receive the K151-601 and K152-602 telemetry signal that is generated when the covers are ejected. References 1 and 7.
3.5.1.4.1 Specify the P_{f_t} for resistance thermometers (sensors).		0.1		IIIb	There are 12 thermal control coated sensors for each panel. The sensing element is a nickel resistance thermometer encased in a thin sheet of Bakelite (RdF STIKON Type 20200). The resistance thermometer is attached to the under side of each sensor disc by an adhesive. Each thermometer gives an individual reading of the heat absorption of the sensor's thermal coating. The resistance thermometer requires nominal 5.0 Vdc for operation. The nominal resistance is 200 ± 0.5 Ω at 70 °F. The temperature measurements are received and processed by the IU Data System. The data are transmitted to the ground through IU telemetry. It is estimated that the Pf for the thermometers is considered to be small. If the thermometers should fail, the following situation could occur: • Electrical --Opening, shorting, or grounding of any one of the resistance thermometers would result in loss of information from that sensor.

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TABLE B-I. EXPERIMENT M-415, THERMAL CONTROL COATINGS PRE-FLIGHT OPERATIONS EVALUATION ANALYSIS (Sheet 7 of 8)

FUNCTIONAL BLOCK NUMBER AND TITLE	EXPECTED RANGE AND DIMENSION OF VARIABLES			CRITICALITY CATEGORY NUMBER	REMARKS
	MIN.	NOM.	MAX.		
3.5.1.4.1 (Concluded)					The following indications could be used to determine the failure of the resistance thermometers: • An open circuit will indicate a full scale reading • A short circuit will indicate a zero reading • Grounding of the lead wires will indicate no change in reading. References 4 and 7.
3.5.1.4.2 Specify the P_{f_t} for resistance thermometers (housekeeping).		0.1		IIIb	A thermometer of higher resistance is attached to the base of each panel. This thermometer provides overall temperature environment within the thermal control coating specimen panel assembly and permits correction for heat exchanges between test surfaces and sensor mounting assembly. It is estimated that the P_f for the thermometers is small. If the thermometers should fail, the following situation could occur. • Electrical --Opening, shorting, or grounding of the thermometers would result in loss of information and make it difficult to compare temperatures. The following indication could be used to determine the failure of the resistance thermometer (housekeeping): • Refer to functional item 3.5.1.4.1. References 4 and 7.
3.5.1.5 Specify the P_{f_t} for the contact switches.		0.1		IIIb	Three contact switches are mounted to each sensor panel base. Each contact switch senses the separation of one of the cover panels. When the sensor cover panels are deployed, the contact switch transmits a telemetry signal to ground indicating that the event has occurred. It is estimated that the P_f for the contact switches is small. If the contact switches should fail, the following situation could occur: • Electrical --It would be impossible to determine deployment of the sensor covers. The following indication can be used to determine the failure of the contact switches. • Failure to receive a change of state signal from measurement Nos. K151-601 and K152-602 indicates that the panel covers failed to deploy or that the contact switches failed to operate. References 2 and 7.

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TABLE B-I. EXPERIMENT M-415, THERMAL CONTROL COATINGS PRE-FLIGHT OPERATIONS EVALUATION ANALYSIS (Sheet 8 of 8)

FUNCTIONAL BLOCK NUMBER AND TITLE	EXPECTED RANGE AND DIMENSION OF VARIABLES			CRITICALITY CATEGORY NUMBER*	REMARKS
	MIN.	NOM.	MAX.		
3.5.1.6 Specify the Pf_t for the connectors and wiring.		0.1		IIIb	The wiring contains circuitry for the sensors and squibs and is connected to the IU. The wires leading to the squibs must be shielded in order to meet the radio frequency and susceptibility requirements. The shorting connectors will remain installed until the firing cable is installed and the shorting connectors are grounded to the IU. The Pf for the wiring is considered to be very small. If this should fail, the following situation could occur: • Electrical --Failure in the sensor wiring would result in loss of information from the sensors. Failure of squib firing circuitry (open circuit) would result in non deployment of sensor covers. The following indication could be used to determine the failure of the wiring and connectors: • Refer to functional item 3.5.1.4.1. References 1 and 7.

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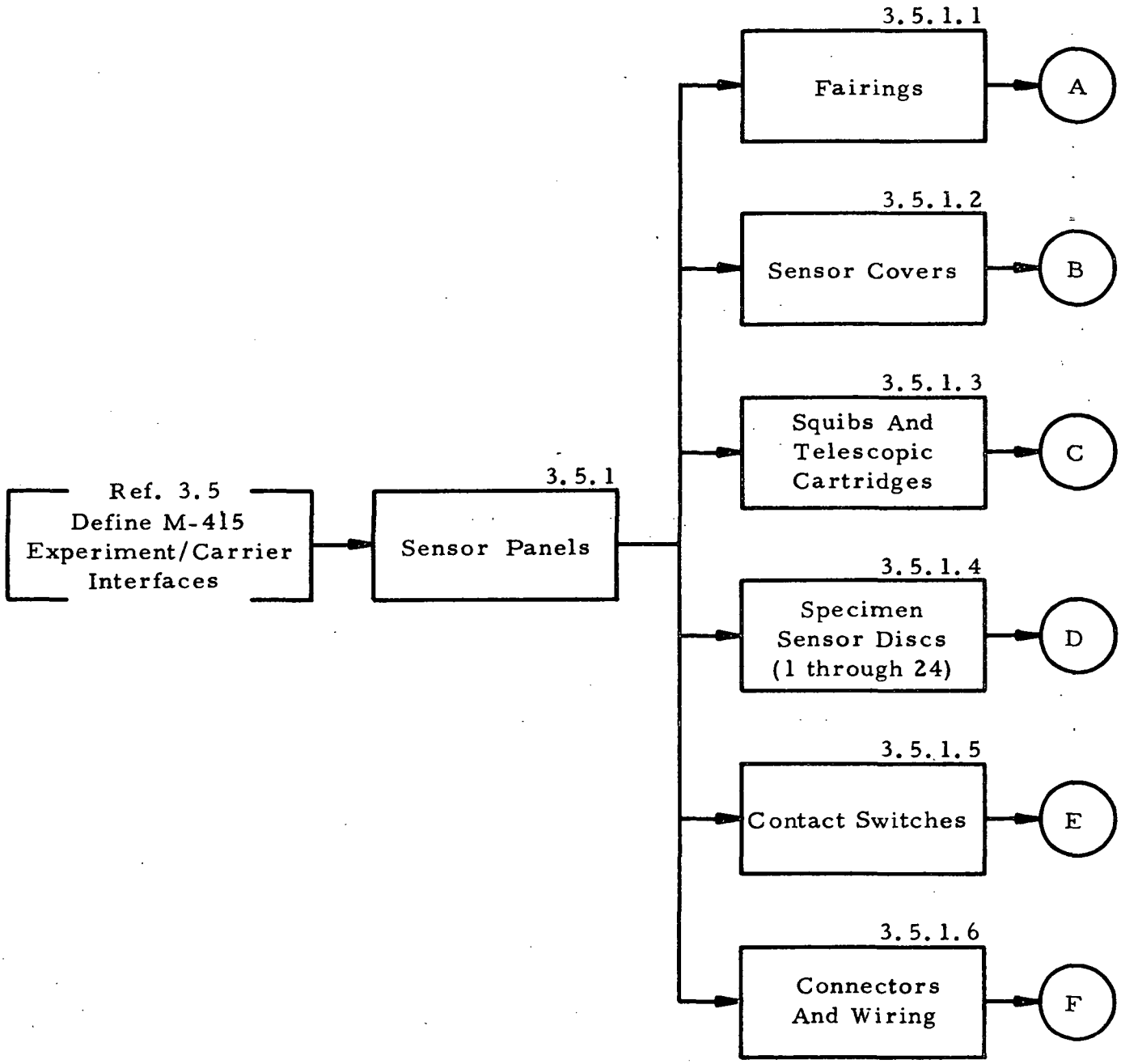


FIGURE B-1. EXPERIMENT M-415, THERMAL CONTROL COATINGS FUNCTIONAL BLOCK DIAGRAM (Sheet 1 of 3)

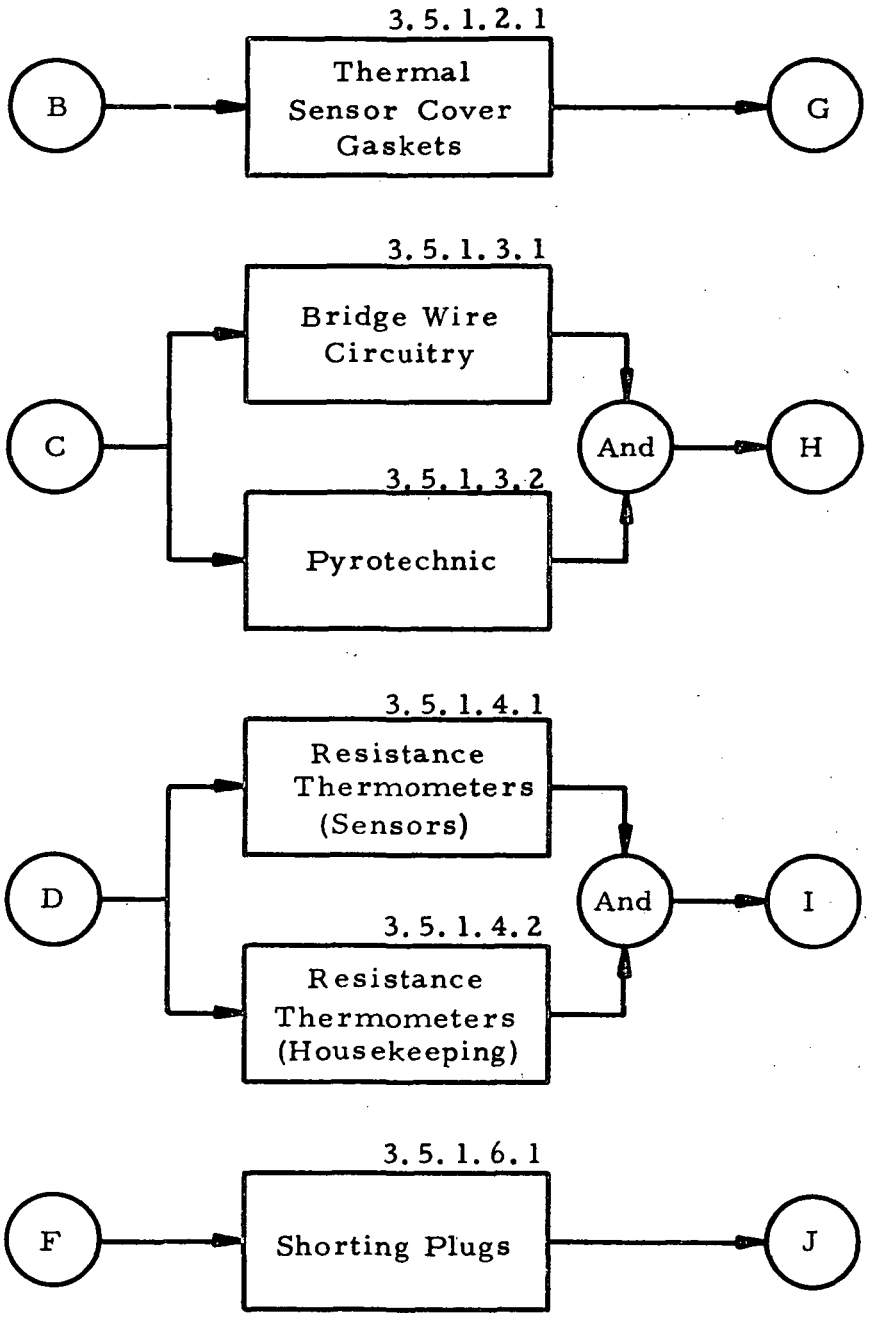


FIGURE B-1. EXPERIMENT M-415, THERMAL CONTROL COATINGS FUNCTIONAL BLOCK DIAGRAM (Sheet 2 of 3)

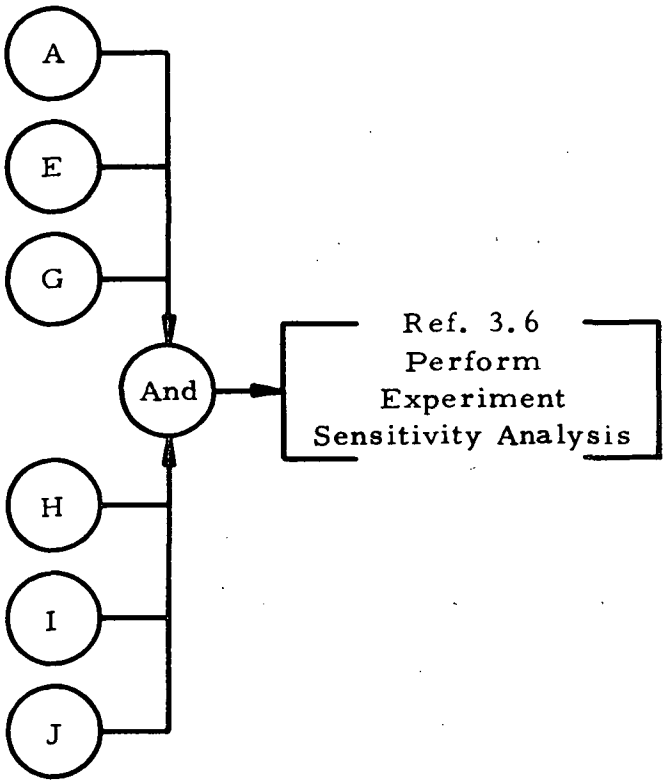
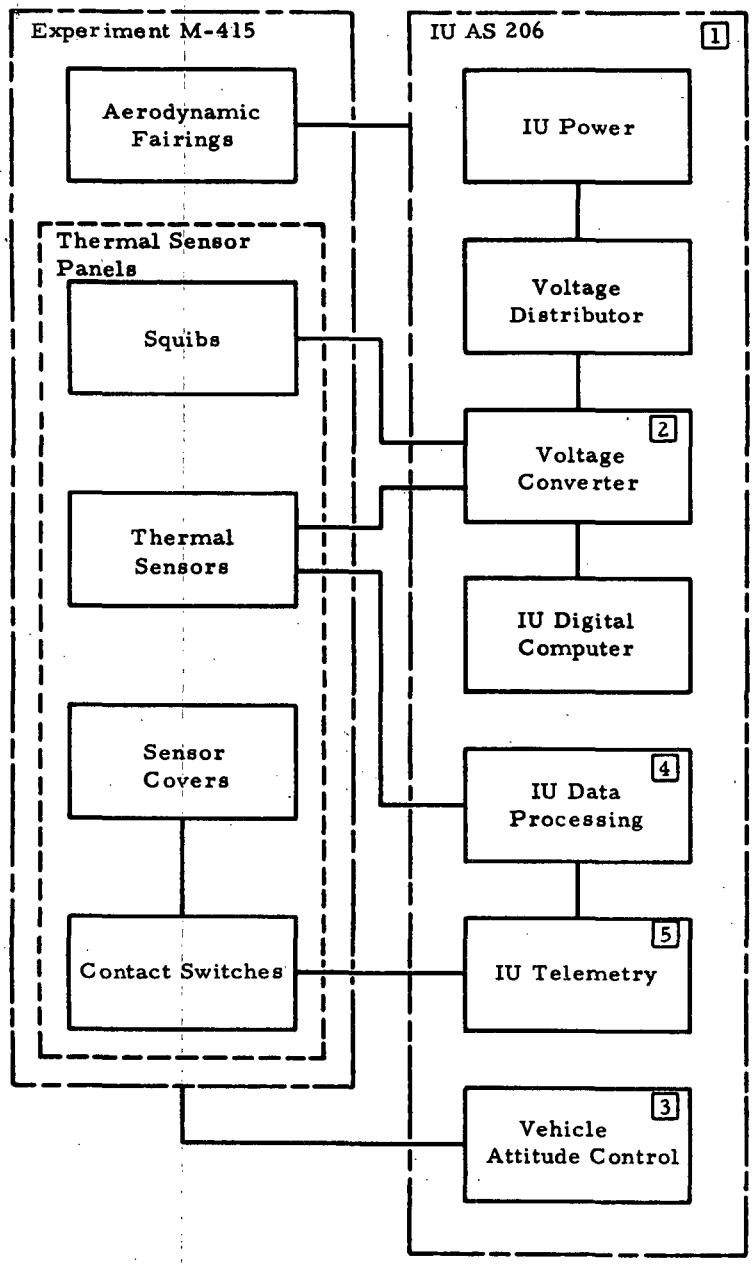


FIGURE B-1. EXPERIMENT M-415, THERMAL CONTROL COATINGS FUNCTIONAL BLOCK DIAGRAM (Sheet 3 of 3)

SECTION II.

EXPERIMENT M-415, THERMAL CONTROL COATINGS INTERFACE BLOCK DIAGRAM



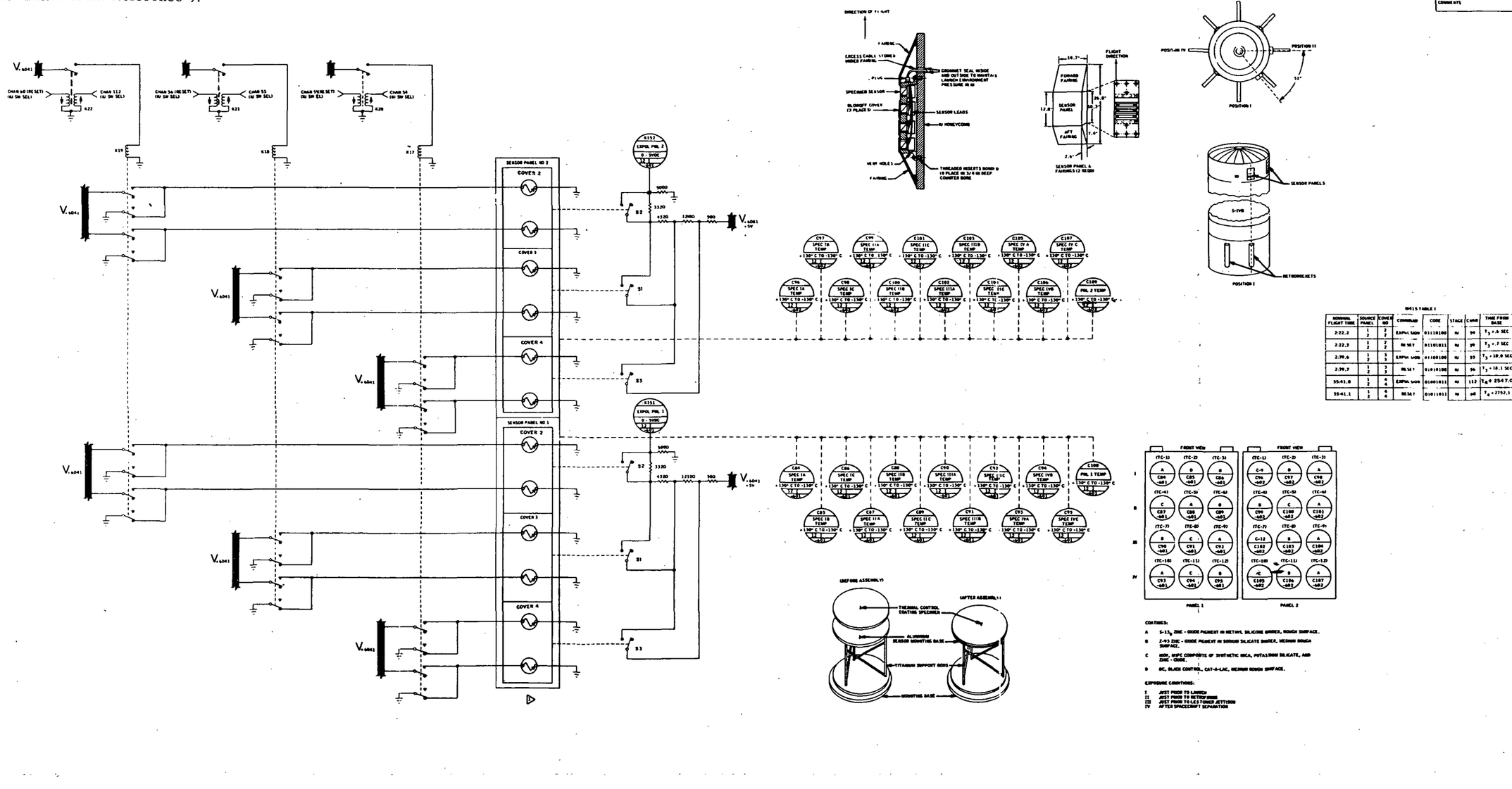
Code	Data Source	Remarks
1	N/A	There is a mechanical interface between the IU structure and the aerodynamic fairings. The fairings are provided so that the panel can be kept in a laminar flow air stream during launch. Turbulence would cause an uneven separation of contamination and temperature from the sensor panel.
2	K151-601 K152-602	There is an electrical interface between the IU Voltage Converter and Experiment M-415 sensors. The sensors will receive 5 Vdc from the Voltage Converter. There is an electrical interface between the IU Voltage Converter and the squibs. The squibs will receive 28 Vdc from the converter to deploy the sensor covers.
3	H60-603	There is no direct interface between the Vehicle Attitude Control System and Experiment M-415. The vehicle is required to perform certain attitude maneuvers so that at local noon the sun-line will pass through a point on the IU exterior midway between the two sensor panels. The Vehicle Attitude Control System controls the pitch, yaw, and roll maneuvers that maintain vehicle attitude during data acquisition.
4	Refer to Table B-II	There is an Instrumentation and Communication interface between the IU Data Processing Module and Experiment M-415 Thermal Sensors. The IU Data Processing Module will process all the sensor measurements and begin transmitting signals by IU telemetry immediately upon activation of the IU.
5	K151-601 K152-602	There is an Instrumentation and Communication interface between the IU telemetry and the contact switches. Upon deployment of the thermal sensor covers, the contact switches will transmit signals through IU telemetry to verify that the sensor covers have deployed.

FIGURE B-2. EXPERIMENT M-415, THERMAL CONTROL COATINGS INTERFACE BLOCK DIAGRAM AND DEFINITION

SECTION III.

EXPERIMENT M-415, THERMAL CONTROL COATINGS SYSTEMS DIAGRAM

Note: Taken from Reference 9.



NOMINAL FLIGHT TIME	SOURCE PANEL	COVER NO	COMMAND
2:22.2	1	2	EXPH SIGN
2:22.3	1	2	RESET
2:39.6	1	3	EXPH SIGN
2:39.7	1	3	RESET
55:01.0	1	4	EXPH SIGN
55:41.1	1	4	RESET

M415 TABLE I

CORE	STAGE	CMD	TIME FROM BASE
01110100	IU	95	T_3 + 5 SEC
01101011	IU	99	T_3 + 7 SEC
01100100	IU	55	T_3 + 10.0 SEC
01010100	IU	56	T_3 + 10.1 SEC
01001011	IU	112	T_4 @ 2547.0
01011011	IU	60	T_4 + 2757.1

COATINGS:

A S-13, ZINC - OXIDE PIGMENT IN METHYL SILICONE BINDER, ROUGH SURFACE.

B Z-93 ZINC - OXIDE PIGMENT IN SODIUM SILICATE BINDER, MEDIUM ROUGH SURFACE.

C 401M, GSFC COMPOSITE OF SYNTHETIC MICA, POTASSIUM SILICATE, AND ZINC - OXIDE.

D 6C, BLACK CONTROL, CAT-A-LAC, MEDIUM ROUGH SURFACE.

EXPOSURE CONDITIONS:

I JUST PRIOR TO LAUNCH
II JUST PRIOR TO RETROFIRE
III JUST PRIOR TO LES TOWER JETTISON
IV AFTER SPACECRAFT SEPARATION

FIGURE B-3. EXPERIMENT M-415, THERMAL CONTROL COATINGS SYSTEMS DIAGRAM

SECTION IV.

EXPERIMENT M-415, THERMAL CONTROL COATINGS DATA REQUIREMENTS SUMMARY

EXPERIMENT M-415, THERMAL CONTROL COATINGS DATA REQUIREMENTS SUMMARY

Measurement Name	Range and Dimension of Variable	Measurement Number	Telemetry Assignment Channel	Data Return	Data Time	Remarks
Specimen TC-1 Panel No. 1, Temperature	-130 to 130 °C	C84-601	DP1A0-06-01-00	Continuous	Real	
Specimen TC-2 Panel No. 1, Temperature	-130 to 130 °C	C85-601	DP1A0-06-02-00	Continuous	Real	
Specimen TC-3 Panel No. 1, Temperature	-130 to 130 °C	C86-601	DP1A0-06-03-00	Continuous	Real	
Specimen TC-4 Panel No. 1, Temperature	-130 to 130 °C	C87-601	DP1A0-06-04-00	Continuous	Real	
Specimen TC-5 Panel No. 1, Temperature	-130 to 130 °C	C88-601	DP1A0-06-05-00	Continuous	Real	
Specimen TC-6 Panel No. 1, Temperature	-130 to 130 °C	C89-601	DP1A0-06-06-00	Continuous	Real	
Specimen TC-7 Panel No. 1, Temperature	-130 to 130 °C	C90-601	DP1A0-06-07-00	Continuous	Real	
Specimen TC-8 Panel No. 1, Temperature	-130 to 130 °C	C91-601	DP1A0-06-08-00	Continuous	Real	
Specimen TC-9 Panel No. 1, Temperature	-130 to 130 °C	C92-601	DP1A0-06-09-00	Continuous	Real	
Specimen TC-10 Panel No. 1, Temperature	-130 to 130 °C	C93-601	DP1A0-06-10-00	Continuous	Real	
Specimen TC-11 Panel No. 1, Temperature	-130 to 130 °C	C94-601	DP1A0-07-05-00	Continuous	Real	
Specimen TC-12 Panel No. 1, Temperature	-130 to 130 °C	C95-601	DP1A0-07-06-00	Continuous	Real	
Specimen TC-1 Panel No. 2, Temperature	-130 to 130 °C	C96-602	DP1A0-07-07-00	Continuous	Real	
Specimen TC-2 Panel No. 2, Temperature	-130 to 130 °C	C97-602	DP1A0-07-08-00	Continuous	Real	
Specimen TC-3 Panel No. 2, Temperature	-130 to 130 °C	C98-602	DP1A0-17-08-00	Continuous	Real	
Specimen TC-4 Panel No. 2, Temperature	-130 to 130 °C	C99-602	DP1A0-17-09-00	Continuous	Real	
Specimen TC-5 Panel No. 2, Temperature	-130 to 130 °C	C100-602	DP1A0-07-09-00	Continuous	Real	
Specimen TC-6 Panel No. 2, Temperature	-130 to 130 °C	C101-602	DP1A0-18-02-00	Continuous	Real	
Specimen TC-7 Panel No. 2, Temperature	-130 to 130 °C	C102-602	DP1A0-18-03-00	Continuous	Real	
Specimen TC-8 Panel No. 2, Temperature	-130 to 130 °C	C103-602	DP1A0-18-04-00	Continuous	Real	
Specimen TC-9 Panel No. 2, Temperature	-130 to 130 °C	C104-602	DP1A0-18-05-00	Continuous	Real	
Specimen TC-10 Panel No. 2, Temperature	-130 to 130 °C	C105-602	DP1A0-18-06-00	Continuous	Real	
Specimen TC-11 Panel No. 2, Temperature	-130 to 130 °C	C106-602	DP1A0-18-07-00	Continuous	Real	
Specimen TC-12 Panel No. 2, Temperature	-130 to 130 °C	C107-602	DP1A0-18-10-00	Continuous	Real	
Temperature						
Panel No. 1	-130 to 130 °C	C108-601	DP1A0-21-09-00	Continuous	Real	
Panel No. 2	-130 to 130 °C	C109-602	DP1A0-21-10-00	Continuous	Real	
Deployment of Covers						
Panel No. 1	0 to 5 Vdc	K151-601	DP1A0-19-09-00	Discrete	Real	
Panel No. 2	0 to 5 Vdc	K152-602	DP1A0-19-10-00	Discrete	Real	
6D31 Bus Voltage	0 to 35 Vdc	M14-601	CP1A0-04-06-00 DP1A0-04-06-00	Continuous	Real	

SECTION V.

EXPERIMENT M-415, THERMAL CONTROL COATINGS DATA REQUEST FORMS

DATA REQUEST FORM Skylab Program	DRF Control No.	Date 11/29/71
	Exp/Sys No. ASTN-SD/SIB/M-415-032	Revision

Mission	Period of Interest	Op. Need Date	Rev Date
SL-2	FLT/MANNED		

Request Contact	Data Recipient	Date Req
Name Organization Phone	Name W. R. Bock Address S&E-ASTN-SDF Phone MSFC, Alabama 35812 205-453-3810	REAL Qty 1

Reference Document: ERD: M-415, SE-010-011-24 5-15-71;RFP: MSC - 03625 5-2-72

MRD Content

Detailed Requirements:

Experiment M-415 SC-4020 Plots

Provide 4020 plots for the following:
Parameters associated with the operation of Experiment M-415.

Comments & Explanation:

Originator	Integrator
Name W. R. Bock Organization MSFC/S&E-ASTN-SDF Phone 205-453-3810 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 Contrl No.	Exp/Sys No. ASTN-SD/SIB/M415-032	Revision	Date

Detailed Requirements:

Meas. No.	Title
C84-601	TEMP, Specimen TC-1 Panel 1
C85-601	TEMP, Specimen TC-2 Panel 1
C86-601	TEMP, Specimen TC-3 Panel 1
C87-601	TEMP, Specimen TC-4 Panel 1
C88-601	TEMP, Specimen TC-5 Panel 1
C89-601	TEMP, Specimen TC-6 Panel 1
C90-601	TEMP, Specimen TC-7 Panel 1
C91-601	TEMP, Specimen TC-8 Panel 1
C92-601	TEMP, Specimen TC-9 Panel 1
C93-601	TEMP, Specimen TC-10 Panel 1
C94-601	TEMP, Specimen TC-11 Panel 1
C95-601	TEMP, Specimen TC-12 Panel 1
C96-602	TEMP, Specimen TC-1 Panel 2
C97-602	TEMP, Specimen TC-2 Panel 2
C98-602	TEMP, Specimen TC-3 Panel 2
C99-602	TEMP, Specimen TC-4 Panel 2
C100-602	TEMP, Specimen TC-5 Panel 2
C101-602	TEMP, Specimen TC-6 Panel 2
C102-602	TEMP, Specimen TC-7 Panel 2
C103-602	TEMP, Specimen TC-8 Panel 2
C104-602	TEMP, Specimen TC-9 Panel 2
C105-602	TEMP, Specimen TC-10 Panel 2
C106-602	TEMP, Specimen TC-11 Panel 2
C107-602	TEMP, Specimen TC-12 Panel 2
C108-601	TEMP, Panel 1
C109-602	TEMP, Panel 2

DATA REQUEST FORM Skylab Program	DRF Control No.	Date
	Exp/Sys No. ASTN-SD/SIB/M-415	Revision

Mission	Period of Interest	Op. Need Date	Rev Date
SL-2	FLIGHT/MANNED		

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

Reference Document: ERD: M-415, SE-010-011-24 5-15-71:RFP:MSC - 03625 5-2-72

MRD Content

Detailed Requirements:

The Payload Integration Section (S&E-ASTN-SDI) requires the capability to monitor experiment M-415 event data. These data should be displayed on the console in the form of a light.

Comments & Explanation:

These data will be used to measure and evaluate the integrity of experiment/carrier interfaces so that the Skylab Mission Evaluation reporting requirements can be fulfilled (See OMSF Program Directive 35, M-D ML 3200-138, 5-71).

Originator	Integrator
Name K. S. Purushotham Organization Teledyne Brown Engineering Co. Phone 205-532-1612 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 Contrl No.	Exp/Sys No.	Revision	Date
	ASTN-SD/SIB/M-415		

Detailed Requirements:

Measurement No.	Measurement Name
K-151-601	Panel No. 1, Deployment of Covers
K-152-602	Panel No. 2, Deployment of Covers

DATA REQUEST FORM Skylab Program	DRF Control No.	Date
	Exp/Sys No. ASTN-SD/S-IB/M415	Revision

Mission	Period of Interest	Op. Need Date	Rev Date
SL-2	FLT/MANNED		

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

Reference Document: ERD: M-415, SE-010-011-24 5-15-71:RFP:MSC - 03625 5-2-72

MRD Content

Detailed Requirements:

The S&E-ASTN-SDI section needs to assess the level of the IU 6D31 Bus Voltage. The voltage level is needed 30 min before the start of the experiment.

The voltage level should be displayed as analog data on a cathode ray tube (CRT). Capability of providing a hard copy of the data presented on the CRT should be made available to the user.

Comments & Explanation:

These data will be used to measure and evaluate the experiment/carrier interfaces so that the Skylab Mission Evaluation reporting requirements can be fulfilled (See OMSF Program Directive 35, M-D MC 3200-138, 5-71).

Originator	Integrator
Name K. S. Purushotham Organization Teledyne Brown Engineering Co. Phone Huntsville, Alabama Signature 205-532-1612 Date	Name Organization Phone Signature Date
Request Aproval	**Implementing Agency**
Name Organization Phone Signature Date	Name Organization Phone Signature Date

MSFC - Form 65 (October 1970)

DRF Contrl No.	Exp/Sys No. ASTN-SD/S-IB/M415	Revision	Date

Detailed Requirements:

Measurement No.	Measurement Name
M14-601	IU 6D-31 Bus Voltage

SECTION VI.

EXPERIMENT M-415, THERMAL CONTROL COATINGS ENGINEERING CHANGE REQUESTS

Engineering Change Requests for Experiment M-415 are N/A.

SECTION VII.

EXPERIMENT M 415, THERMAL CONTROL COATINGS EVALUATION SEQUENCE

TABLE B-III. EXPERIMENT M-415, THERMAL CONTROL COATINGS EVALUATION SEQUENCE (Sheet 1 of 11)

Assignments

Mission:

- SL-2

Orbital Assembly:

- S-IVB/IU Booster Stage

Carrier:

- Instrument Unit of AS 206

Conditions

Crew

- N/A

Experiment:

- No other IU experiment is operating during Experiment M-415
  --Power: 28Vdc supplied by IU Bus Voltage 6D31.
  --Preparation Phase: N/A
  --Operation Phase: N/A
  --Termination Phase: N/A

Ground Support:

- Remove Row 1 covers prior to launch.
- Monitor all experiment telemetry data (26 data measurements).

Requirements

Functional Objectives:

- FO-1 through FO-4 are to be accomplished on SL-2 (refer to functional item 3.1.2).

Experiment Evaluation Team - Key Personnel Locator

Name	Responsibility	Office Address, Symbol, and Telephone Number
Mr. E. C. McKannon	Principal Investigator (PI)	MSFC, Bldg. 4610, S&E-ASTN-MM, 205-453-5500
Mr. E. C. McKannon	Experiment Developer (ED)	MSFC, Bldg. 4610, S&E-ASTN-MM, 205-453-5500
Mr. Bill Jenkins	MSFC Experiment Manager (EM)	MSFC, Bldg. 4201, PM-SL-DP, 205-453-3182
Mr. Estell Lowe	S&E Integration Engineer (IE)	MSFC, Bldg. 4610, S&E-SP-P, 205-453-2574
Mr. Bob Lake	S&E Experiment Engineer (EE)	MSFC, Bldg. 4200, S&E-R, 205-453-1119
Mr. W. R. Bock	Technical Discipline Manager (TDM)	MSFC, Bldg. 4610, S&E-ASTN-SDF, 205-453-3810
Mr. K. S. Purushotham	Experiment Operations Engineer (EOE)	Teledyne Brown Engineering Company, Huntsville, Alabama, 205-532-1612
Mr. Don Slater	Experiment Integration Engineer (EIE)	Martin Marietta Corporation, Denver, Colorado, 303-794-5451
Mr. Don Townsley	Experiment Flight Controller (EFC)	MSC, Houston, Texas, 713-483-4617

TABLE B-III. EXPERIMENT M-415, THERMAL CONTROL COATINGS EVALUATION SEQUENCE (Sheet 2 of 11)

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
L = -60 min GMT: 14:59 for SL-2	Experiment Evaluation Team manned and available. Contact Experiment M-415, Technical Discipline Manager, S&E-ASTN-SD: HOSC Telephone No. TBD, Astronautics Laboratory Telephone No. 205-453-3810.											
	Reference: Skylab Flight Plan SL-1 through SL-4, MSC, May 1, 1972.											
L = -30 min GMT: 15:19 for SL-2	Commence experiment preparation (ground action).											
P 1.0	Determine experiment status.											
P 1.1	Acquire status and evaluate the performance of the IU Bus Voltage (6D31).											
	TBS	6D31 Bus Voltage		H	C	Range: 0 to 35 Vdc					P11A1 P11B1	
		M14-601	CP1A0-04-06-00 DP1A0-04-06-00			Read: 24 to 32 Vdc	20 to 32 Vdc					
P 1.2	Measure or verify Panel No. 1 electric bridge wire (EBW) resistance:											
	TBS	Squib No. 1	N/A	G	$\bar{D}$ one-time	Total Ω ____ Line Ω ____ EBW Ω ____	EBW Ω 0.90 to 1.45				P12A1 P12B1 P12C1	Subtract the line resistance from the total resistance to determine EBW resistance value.
	TBS	Squib No. 2	N/A	G	$\bar{D}$ one-time	Total Ω ____ Line Ω ____ EBW Ω ____	EBW Ω 0.90 to 1.45				P12A1 P12B1 P12C1	Subtract the line resistance from the total resistance to determine EBW resistance value.
	TBS	Squib No. 3	N/A	G	$\bar{D}$ one-time	Total Ω ____ Line Ω ____ EBW Ω ____	EBW Ω 0.90 to 1.45				P12A1 P12B1 P12C1	Subtract the line resistance from the total resistance to determine EBW resistance value.

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

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A - Analog
D - Digital
G - Ground Test

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$\bar{D}$ - Discrete
(Specified number of times)

**** R - Real Time
N - Near/Real Time
$\bar{A}$ - All Time

ASTN-72-1-OT (Jan 72)

TABLE B-111. EXPERIMENT M-415, THERMAL CONTROL COATINGS EVALUATION SEQUENCE (Sheet 3 of 11)

Operation Step Number*	Data: Return: Recorder Number	Measurement Name, Number, and Signal	Telemetry Assignment Channel	Functions**	Frequency***	Range and Dimension of Variables	Limits of Concern	Evaluation: Check: Satisfactory	Evaluation: Check: Anomaly	Remarks****	Contingencies: See Contingency Plan Number	Contingencies: Remarks
P 1.2 (Concluded)	TBS	Squib No. 4	N/A	G	$\bar{D}$ one-time	Total Ω ____ Line Ω ____ EBW Ω ____	EBW Ω 0.90 to 1.45			R	P12A1 P12B1 P12C1	Subtract the line resistance from the total resistance to determine EBW resistance value.
	TBS	Squib No. 5	N/A	G	$\bar{D}$ one-time	Total Ω ____ Line Ω ____ EBW Ω ____	EBW Ω 0.90 to 1.45			R	P12A1 P12B1 P12C1	Subtract the line resistance from the total resistance to determine EBW resistance value.
	TBS	Squib No. 6	N/A	G	$\bar{D}$ one-time	Total Ω ____ Line Ω ____ EBW Ω ____	EBW Ω 0.90 to 1.45			R	P12A1 P12B1 P12C1	Subtract the line resistance from the total resistance to determine the EBW resistance value.
P 1.3	Measure or verify Panel No. 2 EBW resistance.											
	TBS	Squib No. 1	N/A	G	$\bar{D}$ one-time	Total Ω ____ Line Ω ____ EBW Ω ____	EBW Ω 0.90 to 1.45			R	P13A1 P13B1 P13C1	Subtract the line resistance from the total resistance to determine EBW resistance value.
	TBS	Squib No. 2	N/A	G	$\bar{D}$ one-time	Total Ω ____ Line Ω ____ EBW Ω ____	EBW Ω 0.90 to 1.45			R	P13A1 P13B1 P13C1	Subtract the line resistance from the total resistance to determine the EBW resistance value.
	TBS	Squib No. 3	N/A	G	$\bar{D}$ one-time	Total Ω ____ Line Ω ____ EBW Ω ____	EBW Ω 0.90 to 1.45			R	P13A1 P13B1 P13C1	Subtract the line resistance from the total resistance to determine the EBW resistance value.
	TBS	Squib No. 4	N/A	G	$\bar{D}$ one-time	Total Ω ____ Line Ω ____ EBW Ω ____	EBW Ω 0.90 to 1.45			R	P13A1 P13B1 P13C1	Subtract the line resistance from the total resistance to determine the EBW resistance value.
	TBS	Squib No. 5	N/A	G	$\bar{D}$ one-time	Total Ω ____ Line Ω ____ EBW Ω ____	EBW Ω 0.90 to 1.45			R	P13A1 P13B1 P13C1	Subtract the line resistance from the total resistance to determine the EBW resistance value.

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

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H - Housekeeping
A - Analog
D - Digital
G - Ground Test

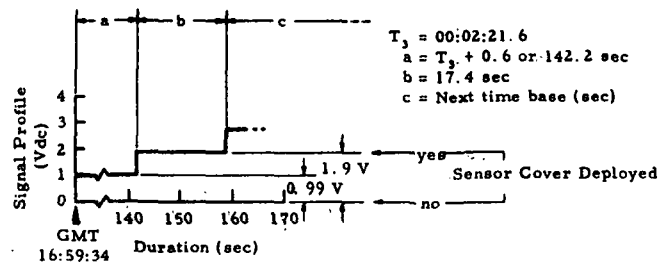
*** C - Continuous
I - Intermittent
$\bar{D}$ - Discrete
(Specified number of times)

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

ASTN-72-1-OT (Jan 72)

TABLE B-III. EXPERIMENT M-415, THERMAL CONTROL COATINGS EVALUATION SEQUENCE (Sheet 4 of 11)

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 1.3 (Concluded)	TBS	Squib No. 6	N/A	G	$\bar{D}$ one-time	Total Ω ___ Line Ω ___ EBW Ω ___	EBW Ω 0.90 to 1.45			P13A1 P13B1 P13C1		Subtract the line resistance from the total resistance to determine the EBW resistance value.
L = 0.0 min GMT: 16:59:34 for SL-2	Commence experiment operations.											
O 1.0	Acquire the following performance data.											
O 1.1	Monitor the expulsion of sensor covers from Panel Nos. 1 and 2 and verify the change of state for removal of the cover.											
O 1.1.1	TBS	Panel No. 1: Cover No. 4 deployment K 151-601	DP1A0-19-09-00	E	$\bar{D}$ one-time	Range: 0 to 5 Vdc Read: 1.9 Vdc	1.9 to 2.1 Vdc			O111A1 O111A2		



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

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H - Housekeeping
A - Analog
D - Digital
G - Ground Test

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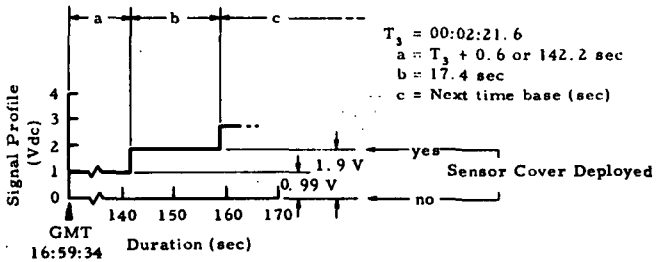
$\bar{D}$ - Discrete (Specified number of times)

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

ASTN-72-1-OT (Jan 72)

TABLE B-III. EXPERIMENT M-415, THERMAL CONTROL COATINGS EVALUATION SEQUENCE (Sheet 5 of 11)

Operation Step Number*	Data: Return: Recorder Number	Measurement Name, Number, and Signal	Telemetry Assignment Channel	Function**	Frequency***	Range and Dimension of Variables	Evaluation: Limits of Concern	Check: Satisfactory	Check: Anomaly	Remarks****	Contingencies: See Contingency Plan Number	Remarks
O 1.1.2	TBS	Panel No. 2: Cover No. 4 deployment K 152-602	DP1A0-19-10-00	E	$\bar{D}$ one-time	Range: 0 to 5 Vdc Read: 1.9 Vdc	1.9 to 2.1 Vdc				O112A1	
O 1.1.3	TBS	Panel No. 1: Cover No. 2 deployment K 151-601	DP1A0-19-09-00	E	$\bar{D}$ one-time	Range: 0 to 5 Vdc Read: 2.84 Vdc	2.84 to 3.1 Vdc				O113A1	



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

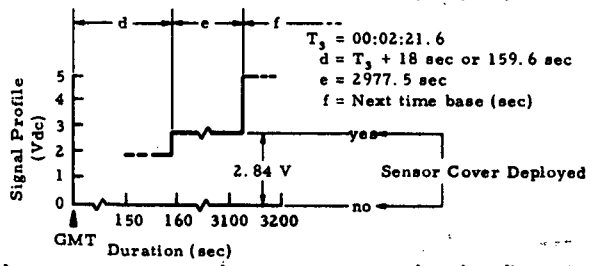
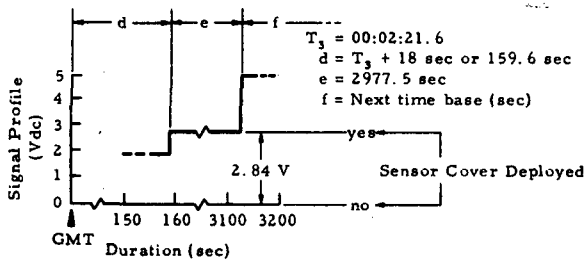
**E - Event
H - Housekeeping
A - Analog
D - Digital
G - Ground Test

***C - Continuous
I - Intermittent
$\bar{D}$ - Discrete
(Specified number of times)

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

ASTN-72-1-OT (Jan 72)

TABLE B-III. EXPERIMENT M-415, THERMAL CONTROL COATINGS EVALUATION SEQUENCE (Sheet 6 of 11)

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
O 1.1.3 (Concluded)												
O 1.1.4	TBS	Panel No. 2: Cover No. 2 deployment K 152-602	DP1A0-19-10-00	E	$\bar{D}$ one-time	Range: 0 to 5 Vdc Read: 2.84 Vdc	2.84 to 3.1 Vdc			O114A1		
												

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

** E - Event
H - Housekeeping
A - Analog
D - Digital
G - Ground Test

*** C - Continuous
I - Intermittent
$\bar{D}$ - Discrete (Specified number of times)

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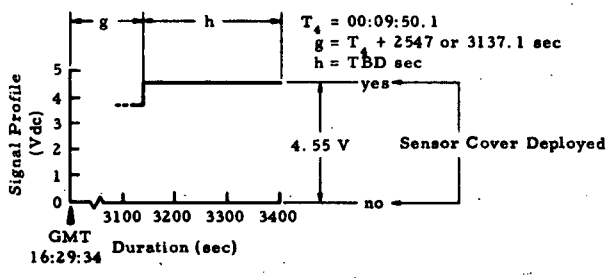
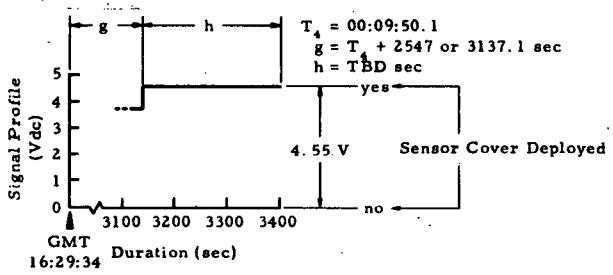
$\bar{A}$ - All Time

ASTN-72-1-OT (Jan 72)

TABLE B-III. EXPERIMENT M-415, THERMAL CONTROL COATINGS EVALUATION SEQUENCE (Sheet 7 of 11)

Operation Step Number*	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	Evaluation: Remarks****	Contingencies: See Contingency Plan Number	Contingencies: Remarks
O 1.1.5	TBS	Panel No. 1: Cover No. 3 deployment. K 151-601	DP1A0-19-09-00	E	$\bar{D}$ one-time	Range: 0 to 5 Vdc Read: 4.55 Vdc	4.55 to 5.0 Vdc				O115A1	
O 1.1.6	TBS	Panel No. 2: Cover No. 3 deployment. K 152-602	DP1A0-19-10-00	E	$\bar{D}$ one-time	Range: 0 to 5 Vdc Read: 4.55 Vdc	4.55 to 5.0 Vdc				O116A1	





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

ASTN-72-1-OT (Jan 72)

** E - Event
H - Housekeeping
A - Analog
D - Digital
G - Ground Test

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I - Intermittent
$\bar{D}$ - Discrete (Specified number of times)

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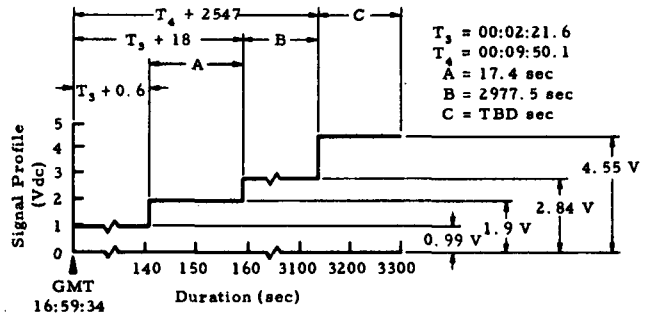
Ā - All Time

TABLE B-III. EXPERIMENT M-415, THERMAL CONTROL COATINGS EVALUATION SEQUENCE (Sheet 8 of 11)

Operation Step Number*	Data: Return: Recorder Number	Data: Return: Measurement Name, Number, and Signal	Data: Return: Telemetry Assignment Channel	Data: Return: Function**	Data: Return: Frequency***	Data: Return: Range and Dimension of Variables	Data: Evaluation: Limits of Concern	Data: Evaluation: Check: Satisfactory	Data: Evaluation: Check: Anomaly	Data: Evaluation: Remarks****	Contingencies: See Contingency Plan Number	Contingencies: Remarks
O 1.2		Panel Nos. 1 and 2: Covers 4, 2, and 3 deployment										



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

**E - Event
H - Housekeeping
A - Analog
D - Digital
G - Ground Test

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

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A - All Time

ASTN-72-1-OT (Jan 72)

TABLE B-III. EXPERIMENT M-415, THERMAL CONTROL COATINGS EVALUATION SEQUENCE (Sheet 9 of 11)

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
O 1.3	Monitor Panel and Specimen Sensor Temperatures.											
O 1.3.1	TBS	Panel No. 1: Specimen Temperatures		A	C	Range: -135 to 135 °C				R	O131A1	
		Specimen No. / Measurement No.	Telemetry Assignment Channel			Read: 20 to 100 °C	-135 to 135°C					
		TC-1 / C 84-601	DP1A0-06-01-00									
		TC-2 / C 85-601	DP1A0-06-02-00									
		TC-3 / C 86-601	DP1A0-06-03-00									
		TC-4 / C 87-601	DP1A0-06-04-00									
		TC-5 / C 88-601	DP1A0-06-05-00									
		TC-6 / C 89-601	DP1A0-06-06-00									
		TC-7 / C 90-601	DP1A0-06-07-00									
		TC-8 / C 91-601	DP1A0-06-08-00									
		TC-9 / C 92-601	DP1A0-06-09-00									
		TC-10 / C 93-601	DP1A0-06-10-00									
		TC-11 / C 94-601	DP1A0-07-05-00									
		TC-12 / C 95-601	DP1A0-07-06-00									
O 1.3.2	TBS	Panel No. 1 Temperature		A	C	Range: -135 to 135 °C				R	O132A1	
		C 108-601	DP1A0-21-09-00			Read: 20 to 100 °C	-135 to 135°C					

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

** E - Event
H - Housekeeping
A - Analog
D - Digital
G - Ground Test

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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 B-III. EXPERIMENT M-415, THERMAL CONTROL COATINGS EVALUATION SEQUENCE (Sheet 10 of 11)

Operation Step Number*	Data: Return: Recorder Number	Data: Return: Measurement Name, Number, and Signal	Data: Return: Telemetry Assignment Channel	Data: Return: Functions**	Data: Return: Frequency***	Data: Return: Range and Dimension of Variables	Data: Evaluation: Limits of Concern	Data: Evaluation: Check: Satisfactory	Data: Evaluation: Check: Anomaly	Data: Evaluation: Remarks****	Contingencies: See Contingency Plan Number	Contingencies: Remarks
O 1.4	Monitor Panel and Specimen Sensor Temperatures.											
O 1.4.1	TBS	Panel No. 2: Specimen Temperatures.		A	C	Range: -135 to 135 °C Read: 20 to 100 °C	-135 to 135°C				0141A1	
		Specimen No. / Measurement No.	Telemetry Assignment Channel									
		TC-1 / C 96-602	DP1A0-07-07-00									
		TC-2 / C 97-602	DP1A0-07-08-00									
		TC-3 / C 98-602	DP1A0-17-08-00									
		TC-4 / C 99-602	DP1A0-17-09-00									
		TC-5 / C 100-602	DP1A0-07-09-00									
		TC-6 / C 101-602	DP1A0-18-02-00									
		TC-7 / C 102-602	DP1A0-18-03-00									
		TC-8 / C 103-602	DP1A0-18-04-00									
		TC-9 / C 104-602	DP1A0-18-05-00									
		TC-10 / C 105-602	DP1A0-18-06-00									
		TC-11 / C 106-602	DP1A0-18-07-00									
		TC-12 / C 107-602	DP1A0-07-10-00									
O 1.4.2	TBS	Panel No. 2: Temperature C 109-602	DP1A0-21-10-00	A	C	Range: -135 to 135 °C Read: 20 to 100 °C	-135 to 135°C				0142A1	

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

**E - Event
H - Housekeeping
A - Analog
D - Digital
G - Ground Test

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

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

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TABLE B-III. EXPERIMENT M-415, THERMAL CONTROL COATINGS EVALUATION SEQUENCE (Sheet 11 of 11)

Operation Step Number*	Data: Return: Recorder Number	Data: Return: Measurement Name, Number, and Signal	Data: Return: Telemetry Assignment Channel	Data: Return: Function**	Data: Return: Frequency***	Data: Return: Range and Dimension of Variables	Data: Return: Limits of Concern	Data: Evaluation: Check: Satisfactory	Data: Evaluation: Check: Anomaly	Data: Evaluation: Remarks****	Contingencies: See Contingency Plan Number	Contingencies: Remarks
L = + TBD min	Commence Experiment Termination.											
T 1.0	Experiment M-415 is conducted on an open-ended basis until loss of IU power, attitude control, telemetry, etc.: Causes of termination at an undeterminable time.									T1A1		

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

**E - Event
H - Housekeeping
A - Analog
D - Digital
G - Ground Test

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

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

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SECTION VIII.

EXPERIMENT M-415, THERMAL CONTROL COATINGS MALFUNCTION AND CONTINGENCY PLAN OUTLINE

TABLE B-IV. EXPERIMENT M-415, THERMAL CONTROL COATINGS MALFUNCTION AND CONTINGENCY PLAN OUTLINE - EXPERIMENT PREPARATION (P)

Operation Step Number	Experiment/Crew Tasks	Possible Malfunction	Contingency Plan	Remarks (malfunctions, corrections, results)
P 1.1	Acquire the status and evaluate the performance of the IU Bus Voltage (6D31).	P11A IU Bus Voltage is decreasing.	P11A1 Continue with the experiment.	
		P11B IU Bus Voltage is lost.	P11B1 Terminate the experiment.	
P 1.2	Measure or verify panel No. 1 bridge wire resistance.	P12A Low resistance.	P12A1 Continue with the experiment.	
		P12B High resistance.	P12B1 Reference: • P12A1.	
		P12C Open.	P12C1 Reference: • P12A1.	
P 1.3	Measure or verify panel No. 2 bridge wire resistance.	P13A Low resistance.	P13A1 Reference: • P12A1.	
		P13B High resistance.	P13B1 Reference: • P12A1.	
		P13C Open.	P13C1 Reference: • P12A1.	

P

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TABLE B-V. EXPERIMENT M-415, THERMAL CONTROL COATINGS MALFUNCTION AND CONTINGENCY PLAN OUTLINE - EXPERIMENT OPERATION (O)
(Sheet 1 of 2)

Operation Step Number	Experiment/Crew Tasks	Possible Malfunction	Contingency Plan	Remarks (malfunctions,corrections,results)
O 1.1.1	Panel No. 1: Cover No. 4 deployment.	O111A Cover cannot be deployed.	O111A1 Initiate the panel deployment command signal using the rf command link to the IU switch selector command system. O111A2 Continue with experiment.	
O 1.1.2	Panel No. 2: Cover No. 4 deployment.	O112A Reference: O111A.	O11A1 Reference: • O111A1. • O111A2.	
O 1.1.3	Panel No. 1: Cover No. 2 deployment.	O113A Reference: • O111A.	O113A1 Reference: • O111A1. • O111A2.	
O 1.1.4	Panel No. 2: Cover No. 2 deployment.	O114A Reference: • O111A.	O114A1 Reference: • O111A1. • O111A2.	
O 1.1.5	Panel No. 1: Cover No. 3 deployment.	O115A Reference: • O111A.	O115A1 Reference: • O111A1. • O111A2.	
O 1.1.6	Panel No. 2: Cover No. 3 deployment.	O116A Reference: • O111A.	O116A1 Reference: • O111A1. • O111A2.	

O

TABLE B-V. EXPERIMENT M-415, THERMAL CONTROL COATINGS MALFUNCTION AND CONTINGENCY PLAN OUTLINE - EXPERIMENT OPERATION (O)
(Sheet 2 of 2)

Operation Step Number	Experiment/Crew Tasks	Possible Malfunction	Contingency Plan	Remarks (malfunctions,corrections,results)
O 1.3	Monitor panel and specimen sensor temperatures (see Operation Step Nos. O 1.3.1 and O 1.3.2).			
O 1.3.1	Panel No. 1: Specimen Temperatures.	O131A Erratic operation due to open or short circuit.	O131A1 Continue to monitor the sensor temperatures for the remainder of the flight.	
O 1.3.2	Panel No. 1: Temperature.	O132A Reference: • O131A	O132A1 Reference: • O131A1	
O 1.4	Monitor Panel No. 2: Specimen Sensor Temperatures (see Operation Step Nos. O 1.4.1 and O 1.4.2).			
O 1.4.1	Panel No. 2: Specimen Temperatures.	O141A Reference: • O131A	O142A1 Reference: • O131A1	
O 1.4 2	Panel No 2: Temperature	O142A Reference: • O131A	O142A1 Reference: • O131A1	

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TABLE B-VI. EXPERIMENT M-415, THERMAL CONTROL COATINGS MALFUNCTION AND CONTINGENCY PLAN OUTLINE - EXPERIMENT TERMINATION (T)

Operation Step Number	Experiment/Crew Tasks	Possible Malfunction	Contingency Plan	Remarks (malfunctions, corrections, results)
T 1.0	Experiment M-415 is "open-ended".	T1A N/A	T1A1 N/A	

T

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SECTION IX.

EXPERIMENT M-415, THERMAL CONTROL COATINGS MALFUNCTION ANALYSES

The material contained in this section is an excerpt from Reference 10.

9. THERMAL CONTROL COATINGS, M415

The primary M415 operational functions requiring analysis are presented in Table 9.1. Figure 9.1 depicts the relationship used to develop this table.

Table 9.1 Operational Functions and Malfunction Analysis Items, M415

Operational Function	Sub-Function	Malfunction Analysis Item
9.1 Expel Panel Covers	9.1.1 Expel Panel 1 Covers	9.1.1.1 Row 2 Cover Failure 9.1.1.2 Row 3 Cover Failure 9.1.1.3 Row 4 Cover Failure
	9.1.2 Expel Panel 2 Covers	9.1.2.1 Row 2 Cover Failure 9.1.2.2 Row 3 Cover Failure 9.1.2.3 Row 4 Cover Failure

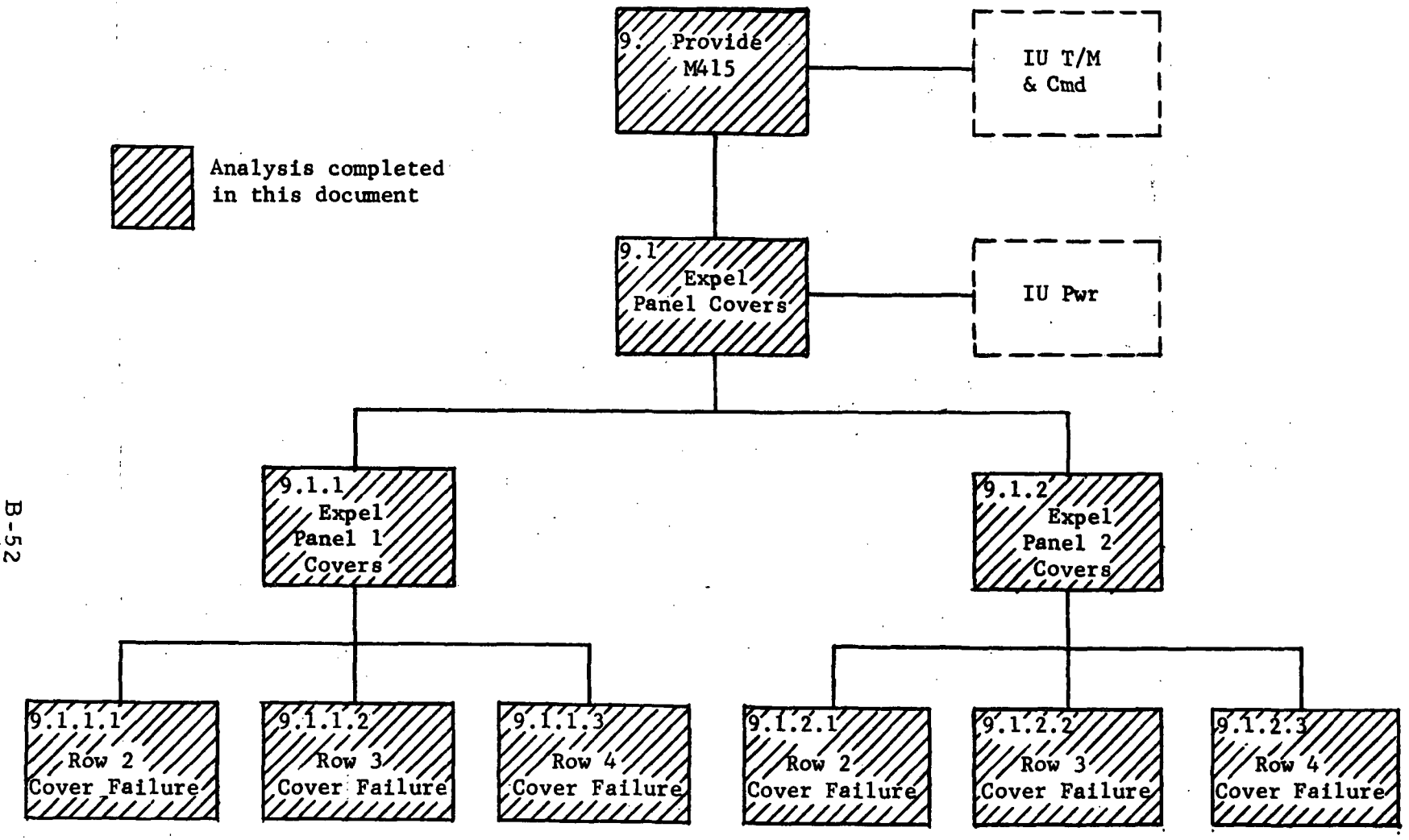

Figure 9.1 Functional Flow and Malfunction Analysis Diagram, M415

MALFUNCTION ANALYSIS CHART, M415

MALFUNCTION	INDICATION		EFFECT			ACTION
MALFUNCTION OR CONDITION	PRIMARY MEASUREMENTS	SUPPORT MEASUREMENTS	MISSION/CREW	SYSTEM/SUBSYSTEM	SYSTEM/ INTERACTION	CREW OR COMMAND
9. Provide M415 9.1 Expel Panel Covers 9.1.1 Expel Panel 1 Covers (Row 1 removed pre-launch)	K151, Panel 1 Deployed.		Mission: None Crew: None		None	Ground Action: Phase C Crew Action: None 1. Reissue appropriate CCS Sw Sel Cmd: a. Deploy Row 2 cover, or b. Deploy Row 3 cover, or c. Deploy Row 4 cover.
9.1.1.1 Row 2 Cover Failure	(U): No voltage level change immediately before retrofire.	C87, C88, and C99; Specimen Temps (U): Temp levels lower than expected. Note: Temp T/M not available until after 4th row covers are expelled.		Loss of Row 2 Thermal Control Coating data.		
9.1.1.2 Row 3 Cover Failure	(U): No voltage level change immediately before LES jettison.	C90, C91, and C92; Specimen Temps (U): Same as 9.1.1.1 Crew Observation (U): Do not audibly detect armament thrusters firing. (This is an inconclusive cue.)		Loss of Row 3 Thermal Control Coating data.		

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

MALFUNCTION ANALYSIS CHART, M415

MALFUNCTION	INDICATION		EFFECT			ACTION
MALFUNCTION OR CONDITION	PRIMARY MEASUREMENTS	SUPPORT MEASUREMENTS	MISSION/CREW	SYSTEM/SUBSYSTEM	SYSTEM/ INTERACTION	CREW OR COMMAND
9.1.1.3 Row 4 Cover Failure	(U): No voltage level change after CSM separation.	C93, C94, and C95; Specimen Temps. (U): Same as 9.1.1.1. Crew Observation (U): Do not observe cover expulsion. (This is an inconclusive cue.)		Loss of Row 4 Thermal Control Coating data.		
9.1.2 Expel Panel 2 Covers (Row 1 removed pre-launch)	K152, Panel 2 deployed		Mission: None Crew: None		None	Ground Action: Phase C Crew Action: None 1. Same as 9.1.1, Step 1.
9.1.2.1 Row 2 Cover Failure	(U): Same as 9.1.1.1	C99, C100, and C101; Specimen Temps (U): Same as 9.1.1.1		Same as 9.1.1.1		
9.1.2.2 Row 3 Cover Failure	(U): Same as 9.1.1.2	C102, C103, and C104; Specimen Temps (U): Same as 9.1.1.1 Crew Observation (U): Same as 9.1.1.2		Same as 9.1.1.2		
9.1.2.3 Row 4 Cover Failure	(U): Same as 9.1.1.3	C105, C106, and C107; Specimen Temps (U): Same as 9.1.1.1. Crew Observation (U): Same as 9.1.1.3		Same as 9.1.1.3		

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 M415 Thermal Control Coatings experiment does not require the flight crew to participate. The experiment is mounted on the IU of SL-2 and will be operated by the IU electronic subsystem. The experiment data will become available immediately upon lift-off. The experiment will continue to operate through the IU lifetime.

2. The probability that sensor covers could be deployed prematurely is quite small. If this should occur with the third row of covers, it could come in contact with the vehicle and possibly cause damage that could affect the mission and the crew safety.

REFERENCES

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

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