

Silver

APOLLO - 15

J. Lawrence

3

Apollo 15

Open GEN Problems

NONE ON Apollo 15 HANDWARE

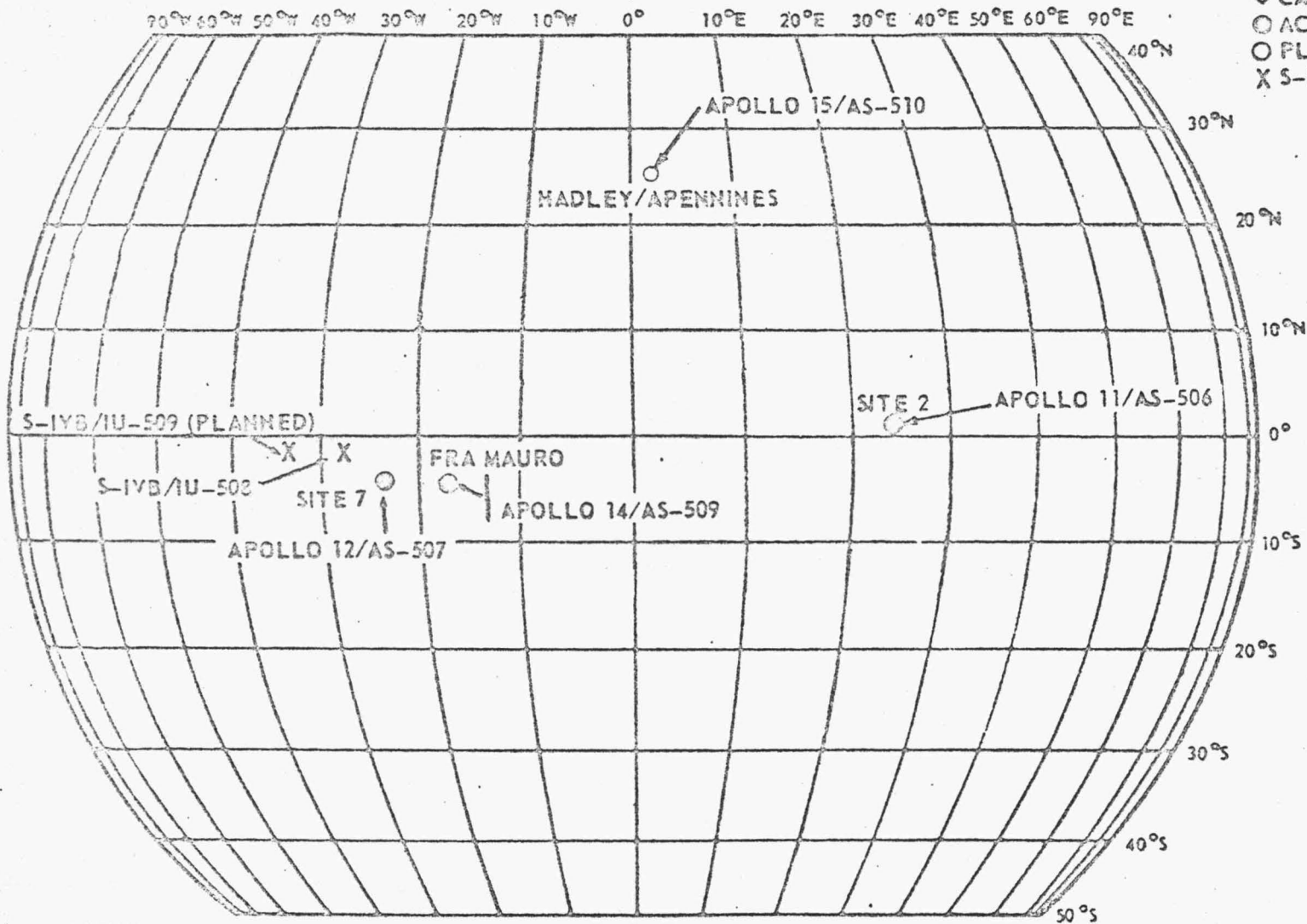
Open GEN FRR Items TO BE REVIEWED
AT FRR BOARD

NONE

APOLLO 15 LANDING SITE

LEGEND:

- ◇ CANDIDATE LANDING SITES
- ACTUAL LANDING SITES
- PLANNED LANDING SITES
- X S-IVB/IU IMPACT POINTS



Boeing Electronics

EP1255

APOLLO 14 EVENTS

-) 40 MINUTE LAUNCH DELAY - AZIMUTH CHANGED FROM 72° TO 75.56°
-) DOCKING PROBLEM
-) LGC TIME UPDATE TO COMPENSATE LAUNCH DELAY
-) DESCENT ABORT SIGNAL
-) LANDING RADAR RANGING SCALE PROBLEM
-) LANDING COORDINATES ($3^{\circ}39'56''$ S. LAT, $17^{\circ}28'42''$ W LONG.)
-) TIME CONSTRAINTS PREVENTED REACHING RIM OF CONE CRATER
-) ABORT GUIDANCE FAILURE DURING RENDEZVOUS
-) ENTRY/LANDING WAS WITHIN 1 NMI OF TARGET

G & N 217/CM 112 Generic Items

- 1) CMC 36 HAS COMPLETED NO MODULE-LEVEL FLATPACK CONTAMINATION Y_A-Y_B VIBRATION SCREEN. IT HAS COMPLETED COMPUTER LEVEL Y_A VIBRATION OF 32 MINUTES AND Y_B VIBRATION OF 43 MINUTES. ECDU 44 DIGITAL MODULES HAVE COMPLETED 60 MINUTES OF Y_A-Y_B VIBRATION SCREEN
- 2) ALL DSKY RELAYS HAVE COMPLETED THE RELAY LEVEL VIBRATION. THE DSKY RELAYS HAVE BEEN VIBRATED AT THE DSKY LEVEL FOR CRITICAL RELAY CONTAMINATION DETECTION
- 3) THE DNA-29 MOTONTACHOMETERS IN Apollo 15 WILL HAVE ACCRUED APPROXIMATELY 2.4 YEARS INCLUDING MISSION TIME, WHICH IS CONSIDERED ACCEPTABLE FOR THIS MISSION.
- 4) BRUSH PLATING ON "F" HARNESS -26 PINS WHICH WERE LATER SUBJECTED TO THE IMPROVED CLEANING PROCESS PER FIELD NEWSLETTER (DELCO ELECTRONICS) No. 93.
- 5) IMU QUICK DISCONNECTS HAVE HAD NO EXPOSURE TO ISOPROPYL ALCOHOL.
- 6) DSKY 75 CONTAINS HIGHER VOLTAGE RELAYS P/N 1005001 AND IS

HARNESSES PROBLEM

AS A RESULT OF AN INTERMITTENT SHORT CIRCUIT IN THE CM "A" HARNESS ON APOLLO 14, PRIOR TO THE MISSION, A HARNESS REINSPECTION PROGRAM WAS INITIATED.

A TOTAL OF 472 CONNECTORS FROM 82 HARNESSES WERE X-RAYED. ALTHOUGH 32 ANOMALIES WERE DISCOVERED DURING THE X-RAY INSPECTION, THE ORIGINAL FAILURE WAS THE ONLY ONE THAT COULD CAUSE AN EQUIPMENT MALFUNCTION.

THE REMAINING 31 ANOMALIES (17 WIRE STRAND INCLUSIONS AND 14 WIRE DEFORMATIONS OF VARYING DEGREE), WHILE UNDESIRABLE, WOULD NOT AFFECT THE RELIABILITY OF THE HARNESSES. HOWEVER, TO PREVENT THEIR FUTURE RECURRENCE THE FOLLOWING ACTION HAS BEEN TAKEN.

- 1) MQA 11 352, X-RAY INSPECTION INSTRUCTIONS, WAS ISSUED TO ESTABLISH THE ACCEPT/REJECT CRITERIA FOR APOLLO G&N HARNESSES. ANY FLIGHT CANDIDATE HARNESS RETURNED TO DELCO ELECTRONICS WILL BE SUBJECTED TO X-RAY INSPECTION PRIOR TO SHIPMENT TO A FIELD SITE.
- 2) FORWARD PRODUCTION ROUTINGS AND PROCESS DESCRIPTION FOR EACH G&N HARNESS

IMPROVE THE FABRICATION METHODS ~~THE~~
FOR CRITICAL STRIPPING, CRIMPING, AND
CONNECTOR ASSEMBLY OPERATIONS. VACUUM
OPERATIONS WERE ADDED TO PREVENT
CONTAMINATION SUCH AS WIRE CLIPPINGS.

3) Q&N HARNESS PROCESS DESCRIPTION
WAS REVISED TO PREVENT CONNECTOR
PIN AND LEAD ASSEMBLY DEFORMATION
PROBLEMS.

TYPE	NUMBER X-RAYED	FOREIGN MATERIAL	WIRE DEFORMATIONS	TOTAL ANOMALIES
UTSCH	316	8	13	21
IGNAL	108	10	0	10
ENDOUT	32	0	0	0
UNKNOWN	<u>16</u>	<u>0</u>	<u>1</u>	<u>1</u>
TOTAL	472	18	14	32

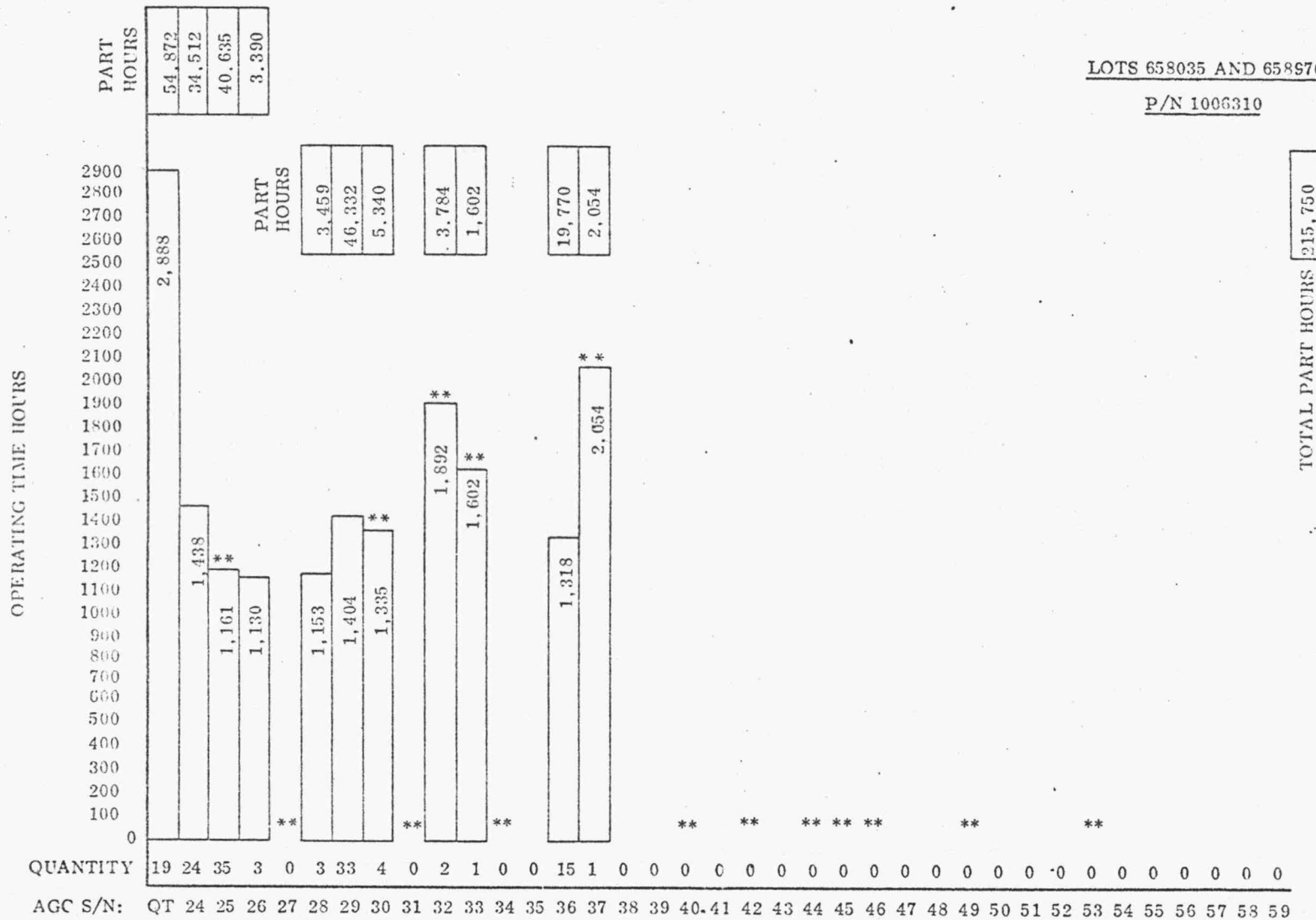
TRANSISTOR, P/N 1006310
LOT 658035 AND 658976
MOTOROLA GOLD-TO-GOLD
THERMO-COMPRESSION BOND

- TRANSISTORS, P/N 1006310, FROM LOTS 658035 AND 658976 FAILED TO MEET ALL REQUIREMENTS OF FLIGHT PROCESSING SPECIFICATION ND 1002266.
- QUANTITIES AND TYPES OF DISCREPANCIES WERE THOROUGHLY REVIEWED. SCREENABLE NATURE OF THE DISCREPANCIES LEAD TO THE CONCLUSION THAT THESE TRANSISTORS ARE FLIGHTWORTHY.
- RAYTHEON CONTRACTUAL WAIVER NUMBER RAY-C-630 AUTHORIZED RELEASE OF 1664 OF THESE TRANSISTORS FOR PRODUCTION USE IN FLIGHT HARDWARE.
- MIT WITHHELD CONCURRENCE ON WAIVER DUE TO CONCERN FOR ADEQUACY OF BONDS.
- TWENTY-FIVE BOND FAILURES (FROM 1,794 PARTS) WERE IDENTIFIED FOLLOWING 20,000 G CENTRIFUGE TESTING. A SECOND CENTRIFUGE TEST WAS PERFORMED ON 439 OF THE SCREENED PARTS WITH ZERO FAILURES. TWENTY OF THESE PARTS WERE SUBJECTED TO A 30,000 G CENTRIFUGE TEST (50 PERCENT OVER REQUIREMENT) WITH ONE FAILURE AT THE POST.
- THERE IS NO KNOWN TIME-TEMPERATURE DEPENDENT FAILURE MECHANISM THAT WILL CAUSE BOND DETERIORATION IN THE GOLD-TO-GOLD BOND CONFIGURATION. THUS, WEAK BONDS ARE SCREENABLE CHARACTERISTICS OF THESE DEVICES.
- THERE HAVE BEEN NO REPORTED BOND FAILURES OF MOTOROLA TRANSISTORS, P/N 1006310, IN COMPUTERS FROM THESE LOTS OR OTHER LOTS.
- FIVE OF THE 15 PREVIOUSLY FLOWN COMPUTERS CONTAINED TRANSISTORS FROM THESE LOTS.

A G C LOT RETRIEVAL INFORMATION

LOTS 658035 AND 658976

P/N 1006310



APOLLO 15:

** Equipment Flew

QT = Qual Test

CMC 50 in 17 June 71

MICROLOGIC

3,736 UNITS PER PGNCs 159,344 UNITS IN
ACTIVE USE

199,864,824 TOTAL PART HOURS

SEVEN POST-ACCEPTANCE FAILURES:

GOLD-ALUMINUM BOND FAILURES

1-69	(AFR 17272)
9-70	(AFR 23861)
9-70	(AFR 23864)
4-71	(AFR 23942)

MICROLOGIC	METALLIZATION
11-70	(AFR 6202)

PARTICLE CONTAMINATION

2-69	(AFR-17275)
9-69	(AFR-18950)

FLAT PACKS

$$\text{FAILURE RATE } (\lambda) = \frac{7}{199,864,824} = 3.50 \times 10^{-8} \text{ FOR EACH FLATPACK}$$

EACH SYSTEM USES 3,736 FLATPACKS

$$\therefore P_s = e^{-25 \times 3,736 \times 3.50 \times 10^{-8}} = 0.99674 \text{ FOR LM}$$

$$P_s = e^{-217 \times 3,736 \times 3.50 \times 10^{-8}} = 0.9719 \text{ FOR CM}$$

FOR CREW SAFETY THE CRITICAL TIME IS APPROXIMATELY 20 MINUTES FOR LM & CM.

$$\therefore P_s = 0.99996 \text{ FOR LM}$$

$$P_s = 0.99996 \text{ FOR CM}$$

McCrone Findings

1) NO CORROSION

2) DEPOSITS

TIN METAL WITH MINOR AMOUNT OF
NONCRYSTALLINE TIN COMPOUNDS CONTAINING
FLUORINE AND CHLORINE OVER TIN

3) DROPLETS

TIN COMPOUNDS CONTAINING FLUORINE
AND CHLORINE

4) TIN CONTAMINATED CHIP AS METALLIC TIN
IN LIQUID OR SOLID FORM

5) DROPLETS FORMED FROM REACTION OF
CHLORO-FLUORO COMPOUND WITH TIN

6) FAILURE DUE TO OPEN METALLIZATION
IN CONDUCTOR LINES.

FINE WINE TRANSFORMERS

PROBABILITY OF SUCCESS

BASIS: CM: 240 HOURS, LM: 25 HOURS

CM: 0.9702

Using PRIMARILY 1010274 TRANSFORMERS

LM: 0.9963

CM: 0.9925

Using PRIMARILY 1010365 TRANSFORMERS

LM: 0.9991

PROBABILITY OF SUCCESS DURING CRITICAL PERIODS

BASIS: CM: 0.4 HOURS

CM: 0.999946

Using PRIMARILY 1010274 TRANSFORMERS

CM: 0.999987

Using PRIMARILY 1010365 TRANSFORMERS

HIGH VOLTAGE RELAYS

USED IN CM ONLY

THE COMMAND MODULE 28 VDC POWER LOWER LIMIT IS 23.5 V

WORSE CASE ANALYSIS SHOWS 17.1 VOLTS AVAILABLE AT DSKY RELAYS IN COMMAND MODULE APPLICATION

THE HIGH VOLTAGE RELAYS (13.5 VOLTS @ 25°C) REQUIRES 15.6 VOLTS TO ~~OPERATE~~ OPERATE AT 71°C (MAXIMUM ALLOWABLE TEMPERATURE PER ICD)

WITH THE CM POWER AT ITS LOWER LIMIT A WORSE CASE ANALYSIS SHOWS THE 13.5 VOLT RELAYS STILL HAVE 1.5 VOLTS MORE THAN THEIR MINIMUM OPERATING VOLTAGES AS A SAFETY FACTOR AT MAXIMUM TEMPERATURE.

ALL DSKYS ARE GIVEN MARGINAL FREQUENCY AND VOLTAGE TESTS FROM 0°C TO 70°C PER PS 2016007

REF: MIT MEMO A9572-66, DATED 8 JULY 1966

APOLLO BLOWER QUALIFICATION TEST

WEEK ENDING

1-24-71

1-31-71

2-7-71

2-14-71

9-5-71

INITIALS

VIBRATION

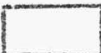
SHOCK

TEMP. CYCLING

HI-LO TEMP.

LIFE

 COMPLETE

 SCHEDULE

2,000 HOURS
6 UNITS

2,000 HOURS
2 UNITS

5,000 HOURS

5-7-71

5-10-71

2 UNITS

6 UNITS

ONE UNIT
TO ANALYTICAL
TEARDOWN

APOLLO 15 ECDU-44 FAILURE

- OPTICS TRUNNION SERVO TESTED GOOD ON

14 JUNE 1971

- LIGHTNING STRUCK VEHICLE 1730 HOURS MONDAY 14 JUNE 1971

- LM PGNCS TURNED OFF

- CM IMU IN STANDBY AND CMC IN OPERATE

- SUBSEQUENT CM G & N INDICATIONS

- ECDU FAIL ALARM "ON"

- TRUNNION FINE ERROR SIGNAL SATURATED ON T/M

- NO OTHER INDICATIONS OF ADVERSE EFFECT

- LIGHTNING AT 2000 HRS 15 JUNE 1971 DID NOT AFFECT THIS CONDITION

- OTHER SYMPTOMS COMPARABLE TO APOLLO 12

- REMOVED ECDU-44 AND RETURNED TO FACTORY FOR MALFUNCTION

ISOLATION IN AFTERNOON OF WED. 16 JUNE 1971



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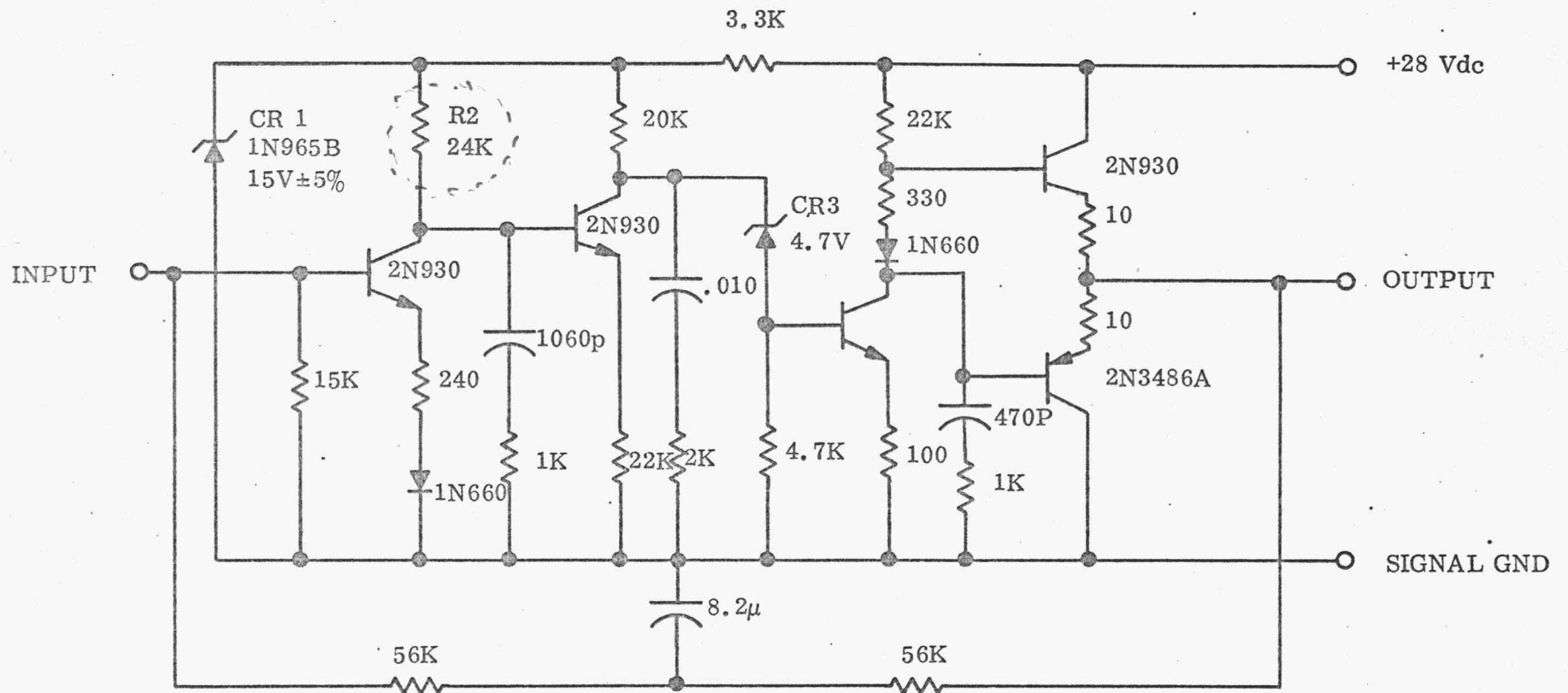
FAILURE VERIFICATION AND DIAGNOSTIC ANALYSIS

- FAILURE VERIFIED AT THE BLACK BOX LEVEL IN EARLY MORNING
OF THURSDAY 17 JUNE 1971
- FAILURE ISOLATED TO AN OPEN RESISTOR
- COULD BE MADE INTERMITTENT BY APPLYING PRESSURE TO
COMPONENT BEFORE REMOVAL FROM MODULE

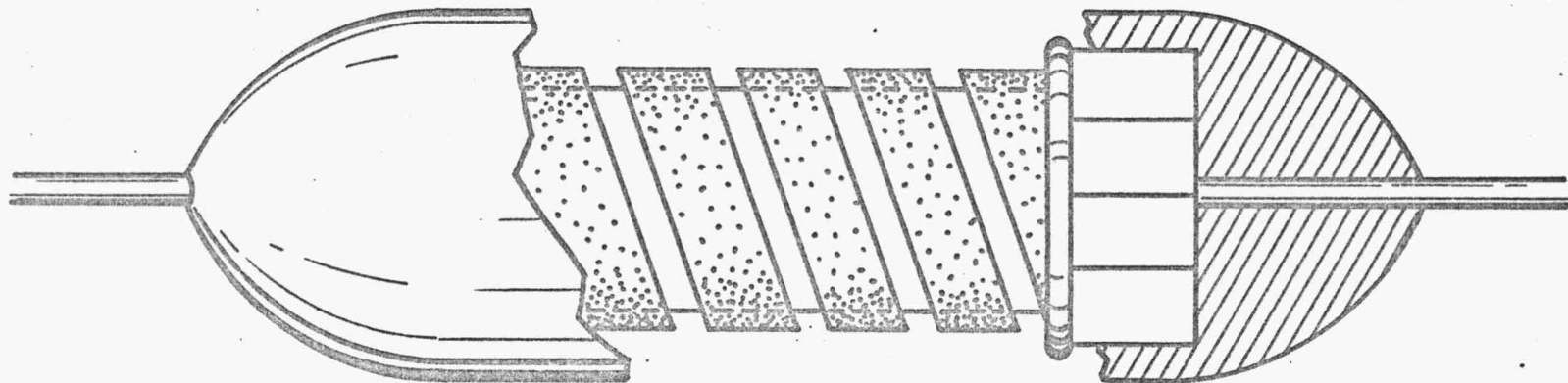


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OP. AMP
SCH 2010019 REV. "E"



GLASS SUBSTRATE RESISTOR



100-PERCENT OVERSTRESS SCREEN $\times$ 1-1/2 RATED WATTAGE FOR 24 HOURS

P/N 1006750 GLASS SUBSTRATE RESISTOR

- USAGE CM 6261 PER G & N
 LM 6103 PER PGNCS
- TOTAL PART OPERATING HOURS 204, 371, 518
- 30 FAILURES DURING MANUFACTURING PROCESS PRIOR TO ACCEPTANCE
— INDUCED AND SCREENED
- 2 INDUCED FAILURES IN FIELD
- THIS IS THE ONLY POST ACCEPTANCE FAILURE EXPERIENCED —



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G & N TRANSIENT/OVERVOLTAGE PROTECTION DEVICE SURVEY

- 100 PERCENT SURVEY ACCOMPLISHED
- 11 CIRCUIT TYPES IDENTIFIED
- NO SINGLE POINT FAILURE IN G & N WHICH HAS CREW SAFETY IMPACT
- TOTAL CIRCUITS UNVERIFIED AT S/C OR BLACK BOX LEVEL TEST

63 LM

91 CM

- TOTAL CIRCUITS UNVERIFIED WHICH HAVE POTENTIAL MISSION
IMPACT

51 LM

44 CM



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QUESTION NO. 1

DOES FAILURE MODE IMPAIR . . . ?

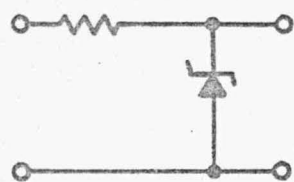
	<u>LM</u>	<u>CM</u>
• PILOT SAFETY	0	0
• MISSION SUCCESS	28	26
• ISOLATED SECONDARY MISSION OBJECTIVE	0	0
• DETAILED TEST OBJECTIVES		
• OPERATIONAL EFFICIENCY	23	18



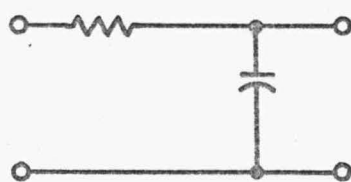
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EP1326

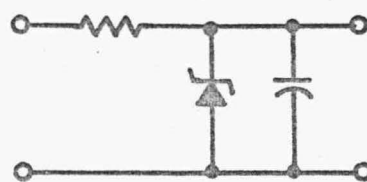
USE OR DISCLOSURE OF DATA HEREON IS SUBJECT TO THE
RESTRICTIONS ON THE TITLE PAGE OF THIS DOCUMENT



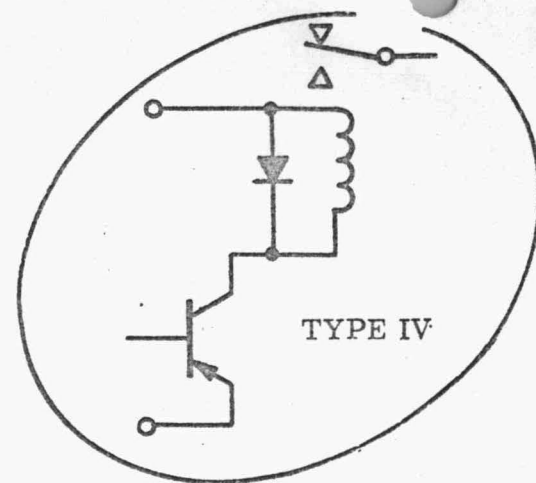
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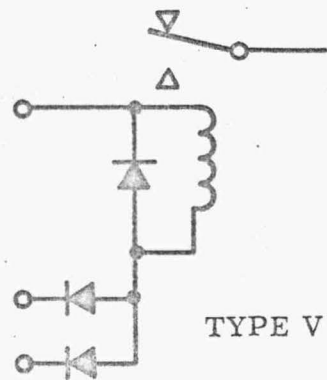
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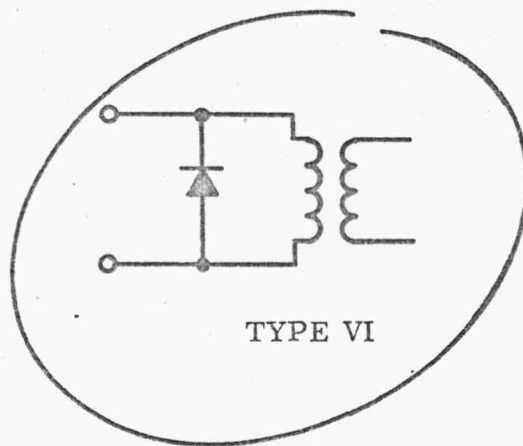
TYPE III



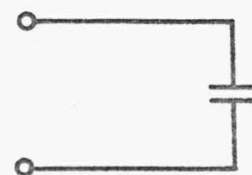
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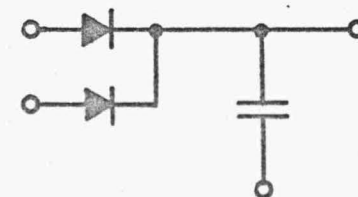
TYPE V



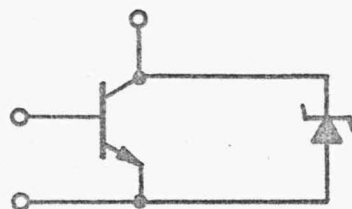
TYPE VI



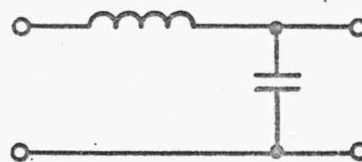
TYPE VII



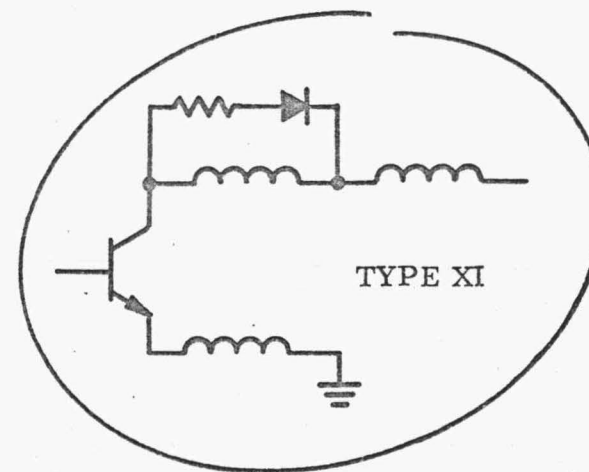
TYPE VIII



TYPE IX



TYPE X



TYPE XI



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QUESTION NO. 2

AT WHAT LEVEL WAS LAST FUNCTIONAL VERIFICATION . . . ?

	<u>CM</u>	<u>LM</u>
• AFTER BLACK BOX ASSEMBLY	0	0
• AFTER MODULE ASSEMBLY	23	25
• PREMODULE ASSEMBLY	3	3

QUESTION NO. 3

IS PATH REDUNDANT ?

	<u>CM</u>	<u>LM</u>
YES	1	1
NO	2	2



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TRANSISTOR TYPES IN SUSCEPTIBLE CIRCUITS

<u>TRANSISTOR TYPE</u>	<u>VOLTAGE* EXPOSURE WITH OPEN</u>	<u>PART SCREEN TEST</u>
P/N 1008814 (PSA) 2N2906	100 V	60 Vdc
P/N 1006310 (DSKY)	100 V	60 Vdc
P/N 1006323 (AGC)	80 V	35 Vdc

*WORST CASE TRANSIENTS WITH OPEN PROTECTIVE DEVICE.



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QUESTION NO. 4

- IS PROTECTION LIKELY TO BE NEEDED?

<u>UNIT</u>	<u>DEVICE FUNCTION</u>	<u>CM</u>	<u>LM</u>
COMPUTER	COMPUTER OPERATE TO STANDBY	NO	YES (5 OPERATIONS)
COMPUTER	COMPUTER OFF TO STANDBY	NO	YES (1 OPERATION)

- SPECIAL TEST CAN BE UTILIZED AT THE MODULE LEVEL TO VERIFY PROTECTIVE DEVICE —
 - POSSIBLY AT THE BLACKBOX LEVEL
 - INVOLVES REMOVAL OF LGC



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CONSIDERATIONS

- CREW SAFETY IS NOT INVOLVED.
- NO PROBLEMS OF THIS TYPE HAVE SURFACED THROUGHOUT THE G & N HISTORY.
- PROPER APOLLO 15 HARDWARE FUNCTION (NOT INCLUDING THESE DIODES) HAS BEEN VERIFIED.
- CURSORY TESTING WITH PROTECTIVE DEVICE OPEN HAS INDICATED NO GROSS PROBLEMS.

RECOMMENDATION

- FLY APOLLO 15 AS IS.

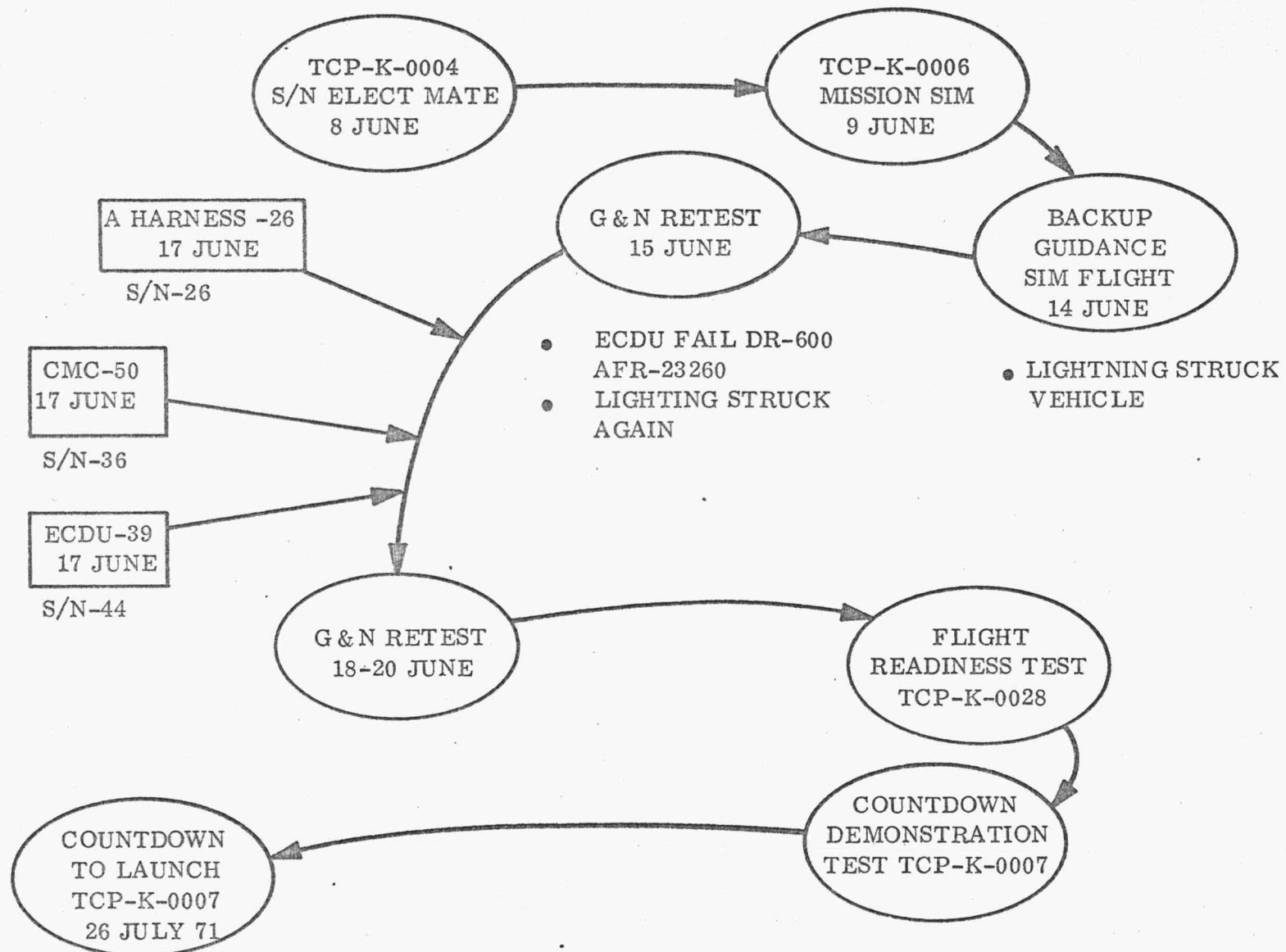
ACTION DUE 6/24/71

- PROBABILITY OF TRANSISTOR FAILURE MODE
- CIRCUIT SIGNATURE WITHOUT PROTECTING DEVICES
- DOCUMENT WORKAROUND FOR FAILURES



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CM-112



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CM 112/CM 110 CONFIGURATION DIFFERENCES

- 1) MISSION PECULIAR ITEMS INCLUDE COLUSSUS III E,
ARTEMIS 72 FLIGHT ROPES, STAR LIST, CHECKLIST AND
ALARM CODES, AND VERB/NOON LIST
- 2) IMU 48 CONTAINS MODIFIED BLOWER MOTORS
PER ECP 1017
- 3) ~~ECDU 44 IDENTIFIES THE ACCEPTABILITY OF
THE TRANSFORMERS PER ECP 1030~~
ECP 4 39 in
17 June 71

REUSED HARDWARE

- 1) SXT LONG EYE RELIEF EYEPiece-2017 FROM
APOLLO 8
- 2) SCT LONG EYE RELIEF EYEPiece-2018 FROM APOLLO 8
- 3) STAR LIST PANEL-1 FROM APOLLO 14

C&N 217 READY SPARES SUPPORT FOR Apollo 15

PART No	COMPONENT	S/N
007203-251	IMU / PEA	IMU-29, PEA-13
007200-151	PSA	24
007222-281	ECDU	39 in S/C 175ave
003993-111	COMPUTER	28 in S/C 175ave
003994-121	DISKY	91, 76
011000-081	OWA	33
021290-051	GNIC	27
007234-021	SCA	1
021294-011	OPTICS SHROUD	22
021406	"A" HARNESS	28 in S/C 175ave
021313	"B" "	2
021314	"C" "	23
021315	"D" "	25
021316	"E" "	7
021317	"F" "	27
021318	"G" "	28
021319	H	27
899982-031	NAV BASE	15
018821-021	COOLANT HOSE	177
010802	FLIGHT ROPES, ARTEMIS 72	Set 2@ KSC

G & N 217 SYSTEM SUMMARY

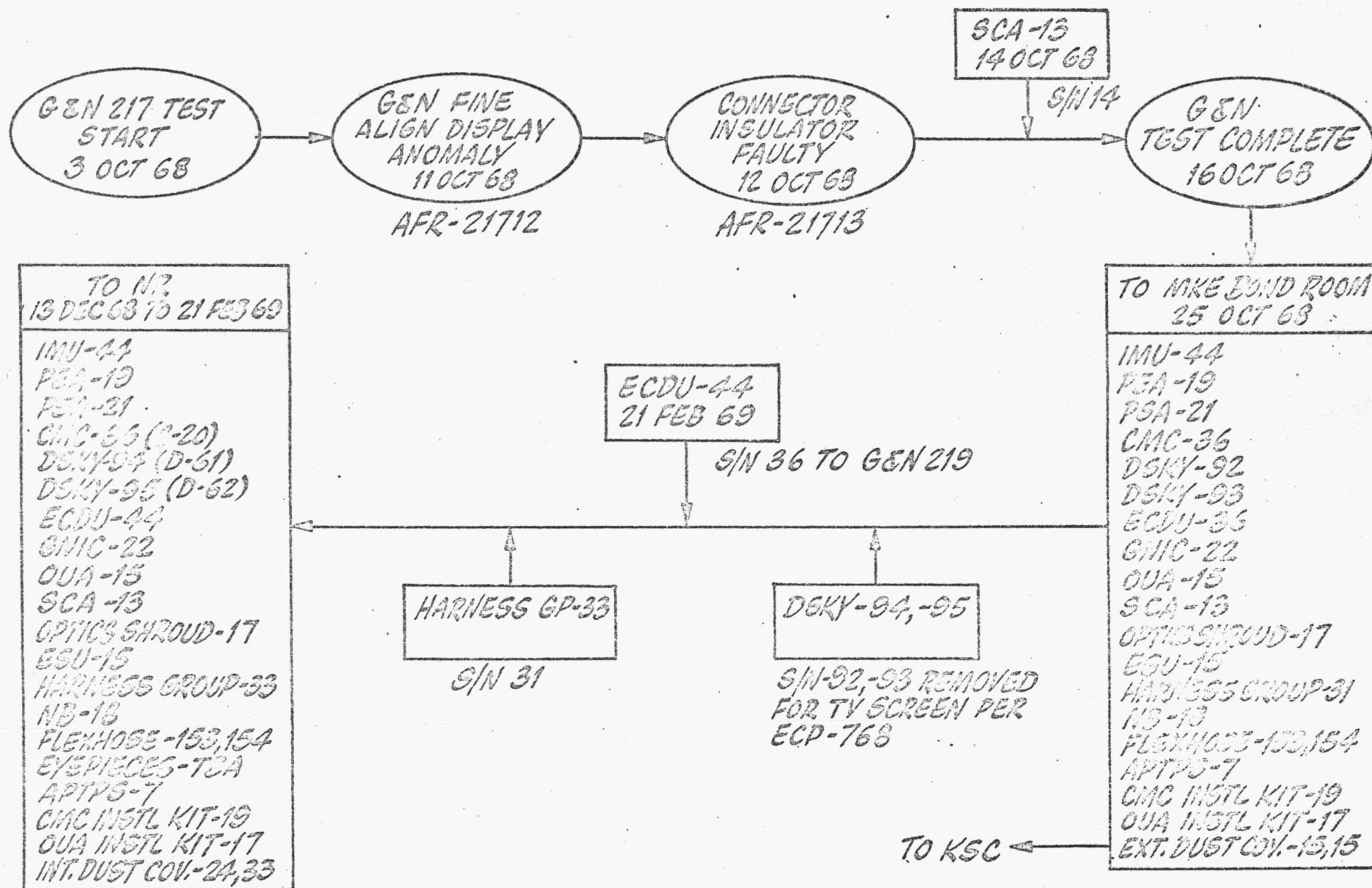
EQUIPMENT	PART NUMBER	S/N	OPERATING HOURS AS OF 31 MAY 1971	WEIGHT
Inertial Measurement Unit (IMU)	2018601-251	48	1,328	41.4
IRIG X		8A 119	1,429	
Y		8A 117	1,416	
Z		8A 125	1,599	
PIPA X		2AP 232		
Y		2AP 265R		
Z		2AP 179		
Blower Motors	2899005	10, 18	267	
PIPA Electronics Assembly (PEA)	2007201-031	23	1,092	8.5
CM Guidance Computer (CMC)	2003993-111	36 (C-20)*	1,410	58.9 —
Flight Ropes	2010802-xxx	*		12.4
DSKY Main	2003994-121	94 (D-61)	955	18.3
DSKY Navigation	2003994-121	75 (D-42)	541	18.2
Power and Servo Assembly (PSA)	2007200-151	21	832	49.7
Signal Conditioner Assembly (SCA)	2007234-021	13	886	5.9
G & N Indicator Control Panel (GNIC)	2021290-051	25	539	14.9
Interconnect Harness Group	2014567-071	33		26.0
Navigation Base	2899982-031	18		11.3
Optical Unit and Bellows Assembly	2010790-181	9		60.6
Optical Unit Assembly (OUA)	2011000-081	29	681	—
Electronic Data Coupling Unit (ECDU)	2007222-281	44*	781	36.9 —
Optics Shroud	2021394-011	17		3.4
Eyeiece Storage Unit (ESU)	2021382-031	15		6.8
Astro sextant Passive Thermal Protective System Assembly (APTPS)	1021373-051	7		4.8
Dust Covers (External)	1021352/62-011	15, 15		—
(Internal)	2012796/97-021	14, 14		0.5
Verb Noun	2899009	1		—
Star Chart	2899003	1 HRE		—
Check List and Alarm Codes	2899008	1		—
Eyeieces				
SCT Eyeiece	2012793-011	2004		2.1
SCT Prism Assembly	2012775	2007		1.1
SXT Eyeiece	2012700-021	2015		0.7
SXT Mirror Assembly	2012791-021	2015		1.3
SCT Long Eye Relief	2012790-011	2018 HRE		1.8
SXT Long Eye Relief	2012748-011	2017 HRE		0.5
Installation Kits (CMC)	2004199-011	19		(in CMC wt)
(OUA)	2899950-021	17		4.5
IMU Coolant Hoses (2)	2018821-021	122, 137		0.9
Eyeiece Filters	2012808/16	8, 8		0.5
			TOTAL	391.9
* Flight Ropes — Colossus III E Artemis 72				
P/N 2010802-381, S/N 442	P/N 2020802-421, S/N 445			
391, S/N 449	-431, S/N 446			
411, S/N 444	-441, S/N 447			

CMC 50 in 62 of 170448

SN 39 in 5/6 of 17 Jun

Radio Electronics

G&N-217/CM-112



SXT MIRROR HSG-
2015 INCL. ECP-753
7 APR 69

OUA TPAC PIN
RETENTION CHECKED
PER ECP-706
5 MAY 69

THERMAL GREASE
APPLIED BETWEEN
PSA-21 & COLDPLATE

LAB
GEN TEST
22-03 FEB 69

PSA-21 JACKING
SCREWS RETORQUED
TO 19 IN. LB. ROLL PINS
INSP. 23 JUN 69

GCT LER-2018 HRE
INCL. ECP-752
26 APR 69

ASSIGNED ECP-752
SUN FILTER
21 MAY 69

GEN217 INSTALLA-
TION COMPLETED
6 OCT 69

EYEPiece LOCK
RINGS ECP-795
24 JUL 68

IMU-44/PEA-19
INSTALLED
10 JUL 69

GEN
CUBANISTEN
T-101 DCS-6504
T-101 CCF 00

PHASE I CARR
SUBSYSTEM
REVIEW
10 JUL 69

DSKY-26-02
ECP-76-EL
RETRC-IT
26 JAN 70

ECU-15 MODIFIED
PER ECP-790
24 OCT 69

IMU-44/FEA-19
4 NOV 69

CINCPAC
START MONITOR
MOD 000005
24100270

SXT LER-2017
HALO ECD-1007
5 MAY 78

IMU HOSES-122,
-137
10 JUL 70

GNIC-25 CMC
AIDED OPTICS
MOD. ECP-792
5 AUG 70

GEN SUBSYSTEM
FUNCTIONAL TEST
DCS-6504
10-13 AUG 70

- S/C POWER LOSS
- OVA LIGHT SPOTS

AFR-17317

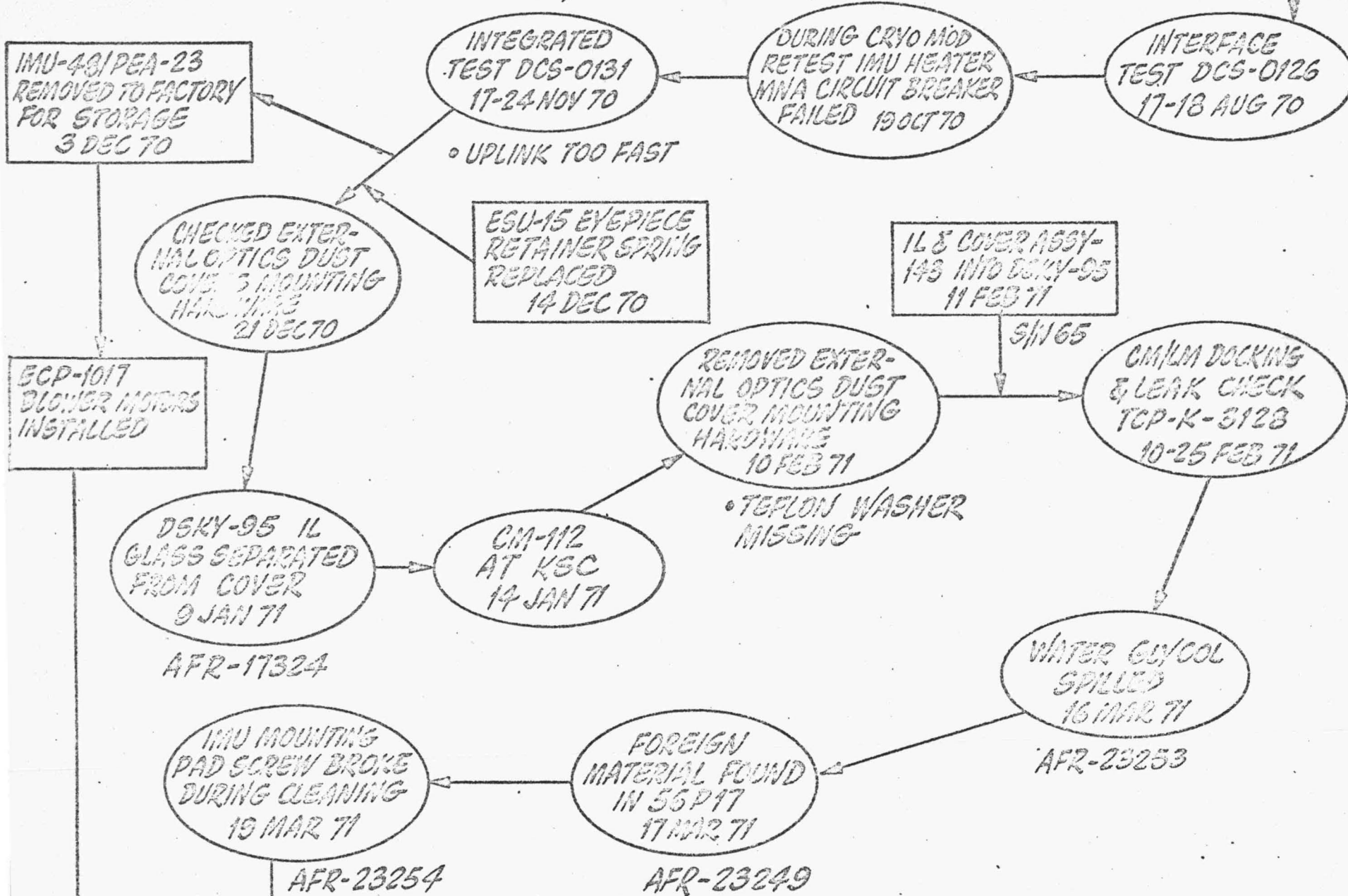
'A' HARNESS
ROLL PINS
CHECKED
25 MAR 70

OUA-15 ↑
OUA-20 YOUNG
MOTOR TACHS
13-14 MAY 70

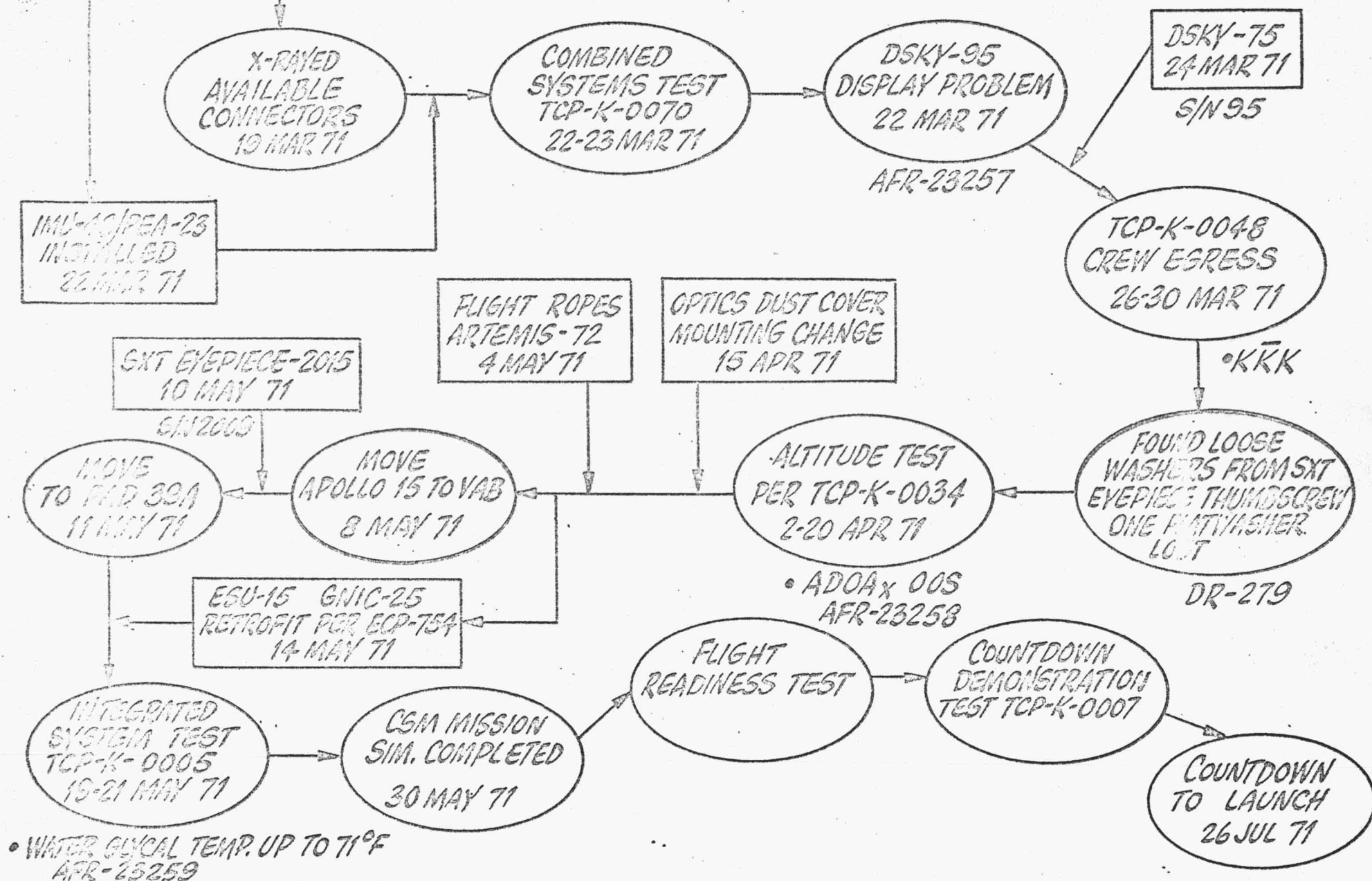
IMU-48/PEA-23
WITH CATIN IRIGS
13 JUL 70

EYEPieces &
FILTERS INSTALLED
6 AUG 70

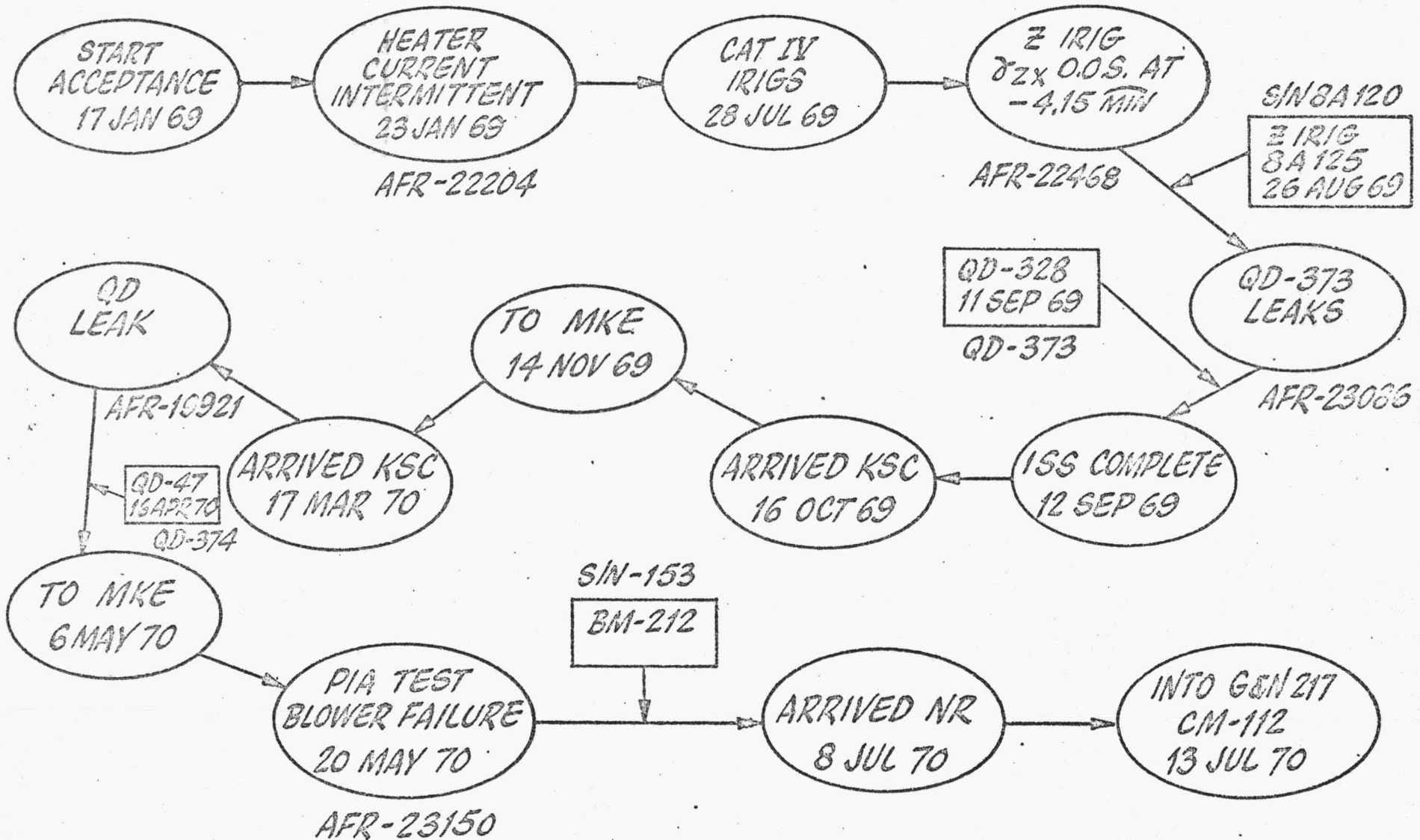
GEN-217/CM-112 (CONTINUED)



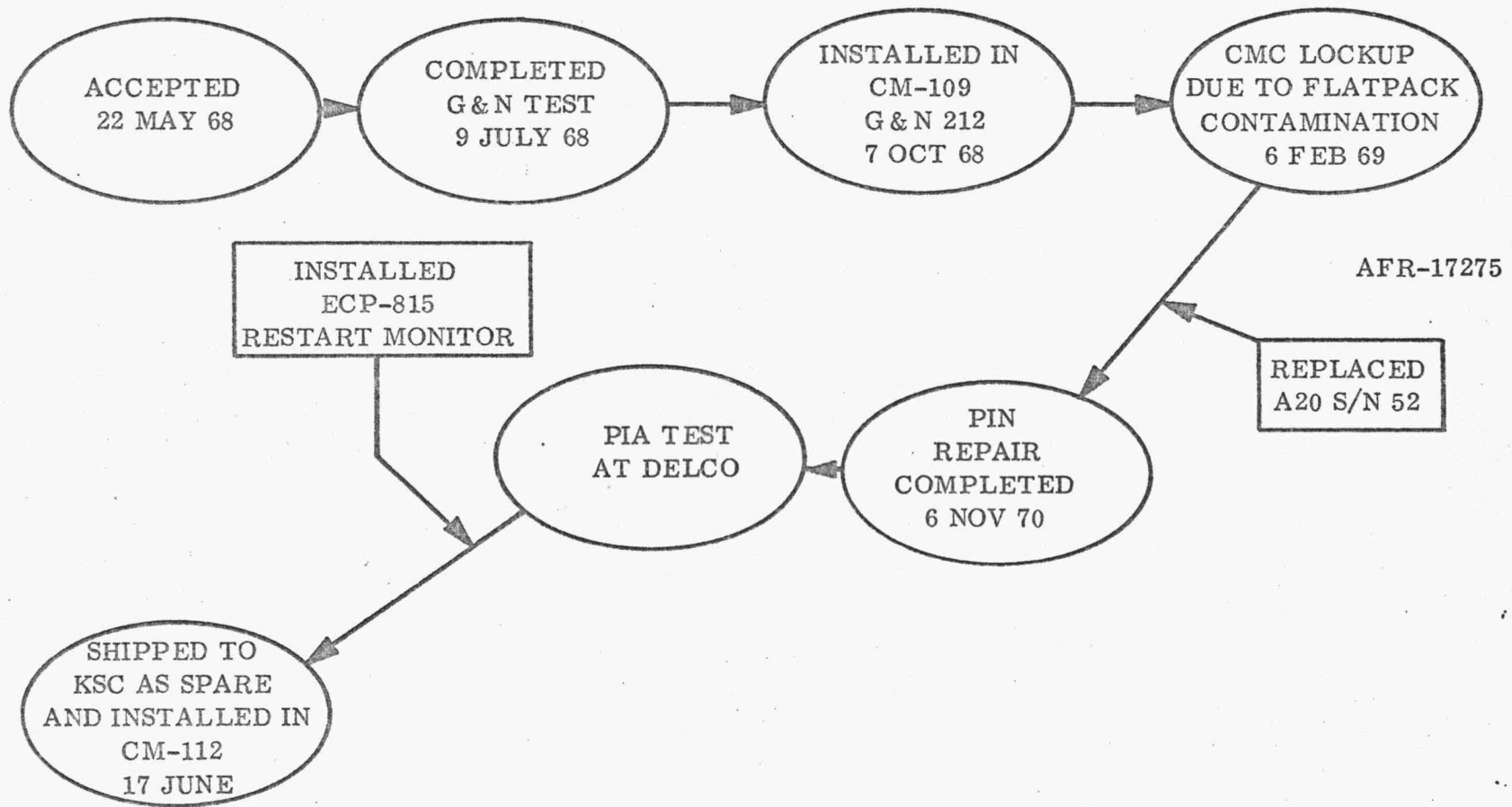
G&N-217/CM-112 (CONTINUED)



IMU-48

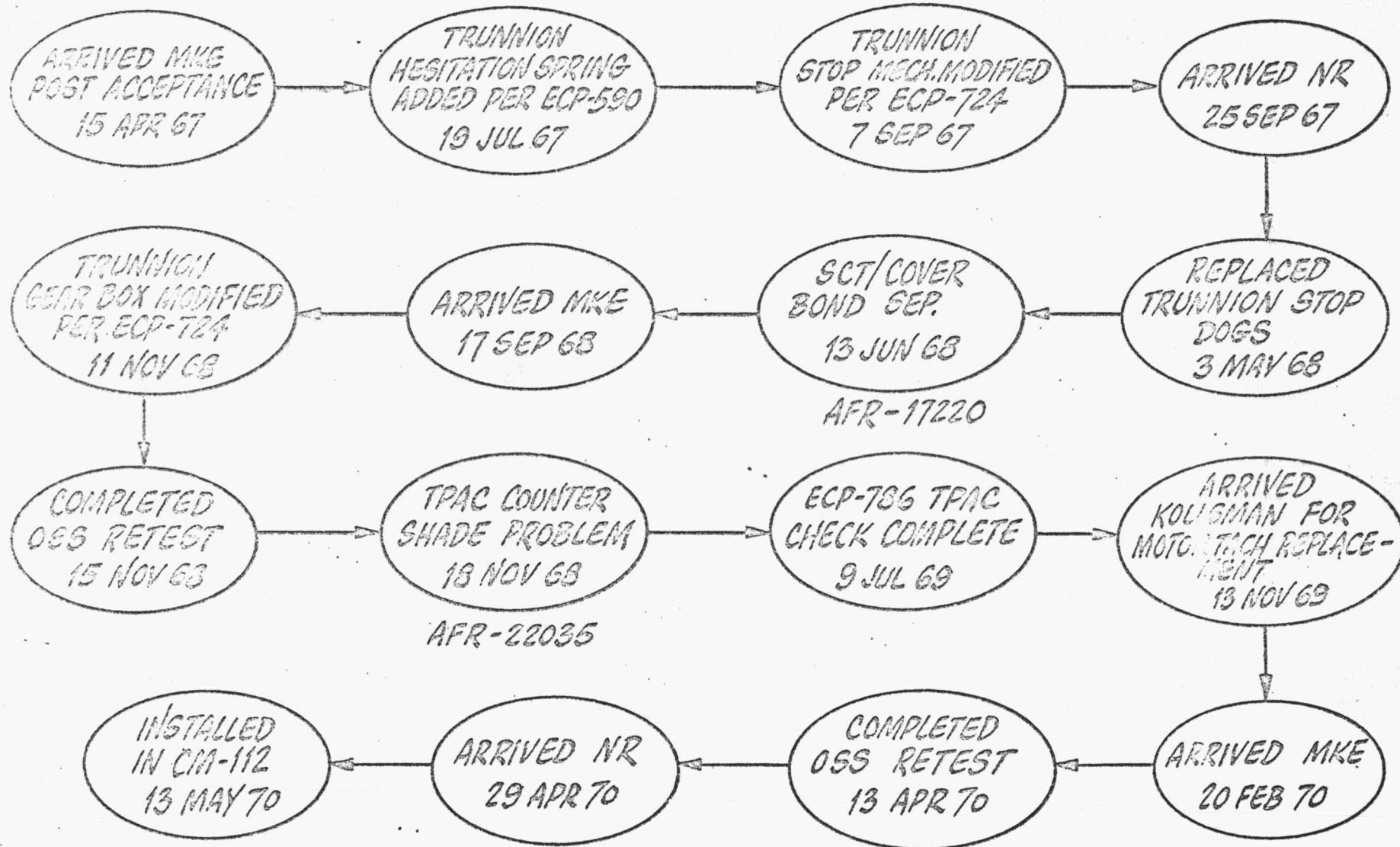


CMC-50 (C-34)



Delco Electronics

OUA-29



PGNCS-614 LM 10 Generic Items

IMU QUICK DISCONNECTS ARE TO BE REPLACED AFTER 30 HOURS EXPOSURE TO ISOPROPYL ALCOHOL. THE INSTALLED QUICK DISCONNECT P/N 1000135, S/N 312 & S/N 395 HAVE HAD 2.1 HOURS EXPOSURE TO ISOPROPYL ALCOHOL.

FLATPACK CONTAMINATION LGC 29 HAS COMPLETED 2 MINUTES OF COMPUTER LEVEL YA-YB VIBRATION SCREEN. THE 60 MINUTE MODULE LEVEL FLATPACK VIBRATION SCREENING FOR CONTAMINATION HAS BEEN ACCOMPLISHED ECDW 47 MODULES ALSO HAVE EXPERIENCED MODULE LEVEL YA-YB VIBRATION SCREENING

3 RELAY VIBRATION SCREEN. THE DSKY 63 IDM MODULES HAVE COMPLETED THE VIBRATION SCREEN AT THE MODULE LEVEL AS WELL AS THE RELAY LEVEL SCREEN. THE DSKY RELAYS HAVE NOT BEEN VIBRATED AT THE SYSTEM LEVEL FOR CONTAMINATION DETECTION.

LM 8 (G & N 611) / LM 10 (G & N 614)

CONFIGURATION DIFFERENCES

MISSION PECULIAR ITEMS

FLIGHT ROPES IN LM 10 WILL BE LUMINARY 210, WHILE THE ROPES FOR LM 8 WERE LUM 178

G & N COMPONENT ITEMS:

1. "B" HARNESS 19 WAS X-RAYED PER ECP-1026.
2. LM 10 LGC 29 (-091 CONFIGURATION) INCLUDES A 20 VOLT "V-FAIL" LEVEL PER ECP-719, WHICH HAS FLOWN PREVIOUSLY ON Apollo 12
3. IMU 12 (-241 CONFIGURATION) INCLUDES IMPROVED BLOWER MOTORS PER ECP-1017 WHICH HAVE NOT PREVIOUSLY FLOWN.

REUSED HARDWARE

NONE

Q & N 614 Ready SPANES For Apollo 15

PART Number	COMPONENT	S/N
5007001-131	IMU/PTA	IMU 33/PTA 16
5007200-081	PSA	15
2007222-301	ECDW	49
2003993-111	LGC	50
2003994-091	DSKY	68
6014512-081	CCRD	7
6007013-021	SCA	6
6010677	"A" HARNESS	24
6010678	"B" HARNESS	22
6899980-021	NAVE BASE	19
6011000-111	AOT	25
2010802	FLIGHT ROPES	SET 20 KSC
	LUMINARY, REV 210	

G & N 614 SYSTEM SUMMARY

EQUIPMENT	PART NUMBER	SERIAL NUMBER	OPERATING HOURS AS OF 31 MAY 1971	WEIGHT (lb)
IMU Assembly (IMU)	2018601-241	12	3,122	40.9
PIP Assembly, Prealigned	2018844-021	X-2AP172 Y-2AP171 Z-2AP292		
25 IRIG Assembly	2021500-151	X-8A201 Y-8A203 Z-8A202	1,068 1,013 1,048	
Blower Motors	2899005	3, 7	144	
Pulse Torque Assembly (PTA)	6007000-041	5	2,558	14.5
Power and Servo Assembly (PSA)	6007200-081	8	1,909	17.8
Electronic Data Coupling Unit (ECDU)	2007222-301	47	540	37.9
Computer Control and Reticle Dimmer Assy	6014512-081	19	120	1.6
Signal Conditioner Assembly (SCA)	6007013-021	2	918	5.5
LM Guidance Computer (LGC)	2003993-091	29 (C-9)	1,491	57.6
DSKY	2003994-091	63 (D-30)	1,192	18.2
Alignment Optical Telescope (AOT)	6011000-111	17	155	24.0 ^②
Navigation Base Assembly	6899980-021	15		5.2
'A' Harness	6010677	26		14.9
'B' Harness	6010678	19		4.3
High Density Filter Assembly	6022856-A	110		0.1
Installation Kit, Computer	6004000-051	33		0.4
Installation Kit, SCA	6007020	9		0.2
Flight Ropes	2010802-xxx	- ^①		12.6
			Total	255.7

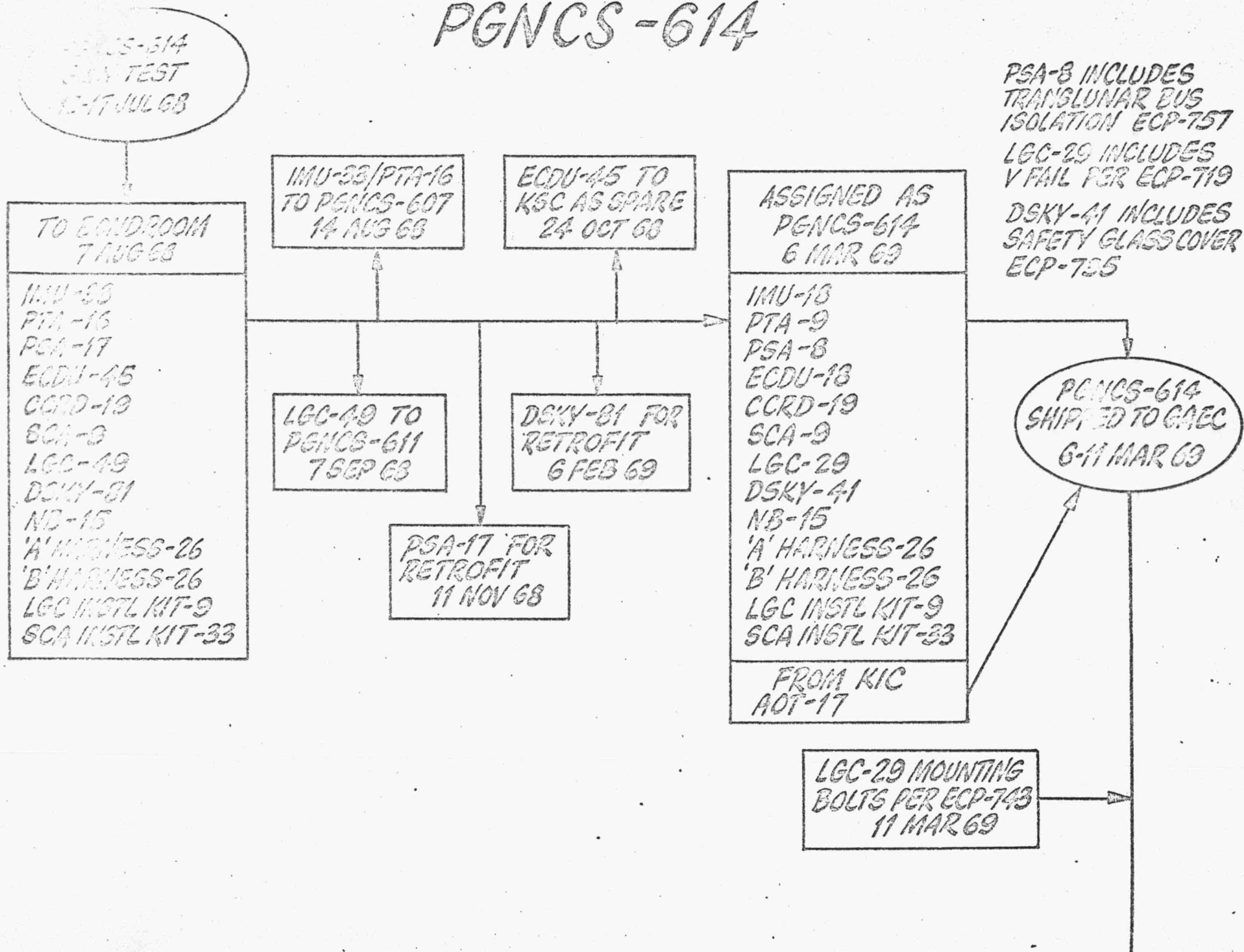
^① Flight Ropes — Luminary 210

^② Includes weight of AOT Sunshade P/N 6011876

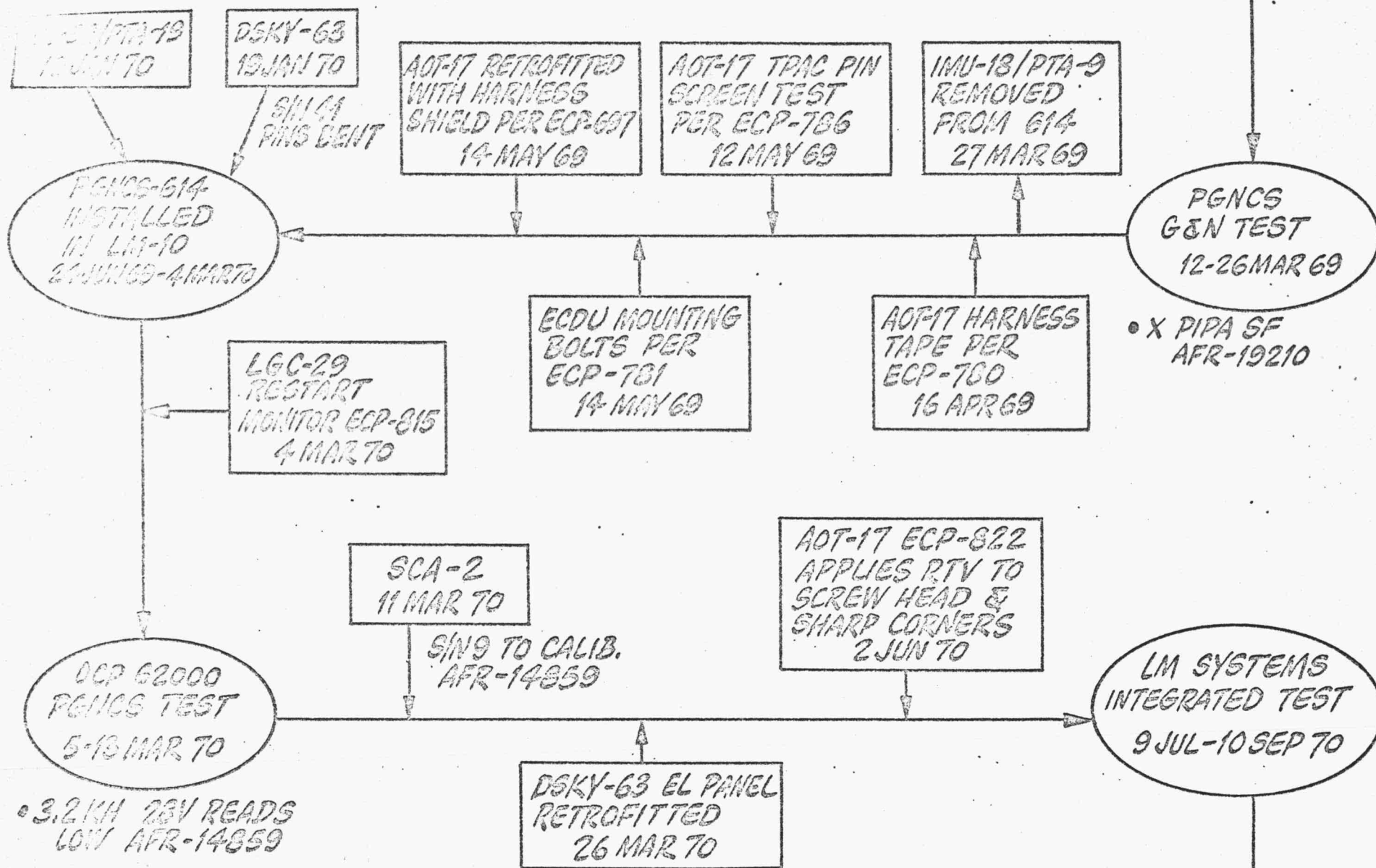
P/N 2010802-451 S/N 454	P/N 2010802-481 S/N 508
-461 S/N 455	-491 S/N 509
-471 S/N 507	-511 S/N 459



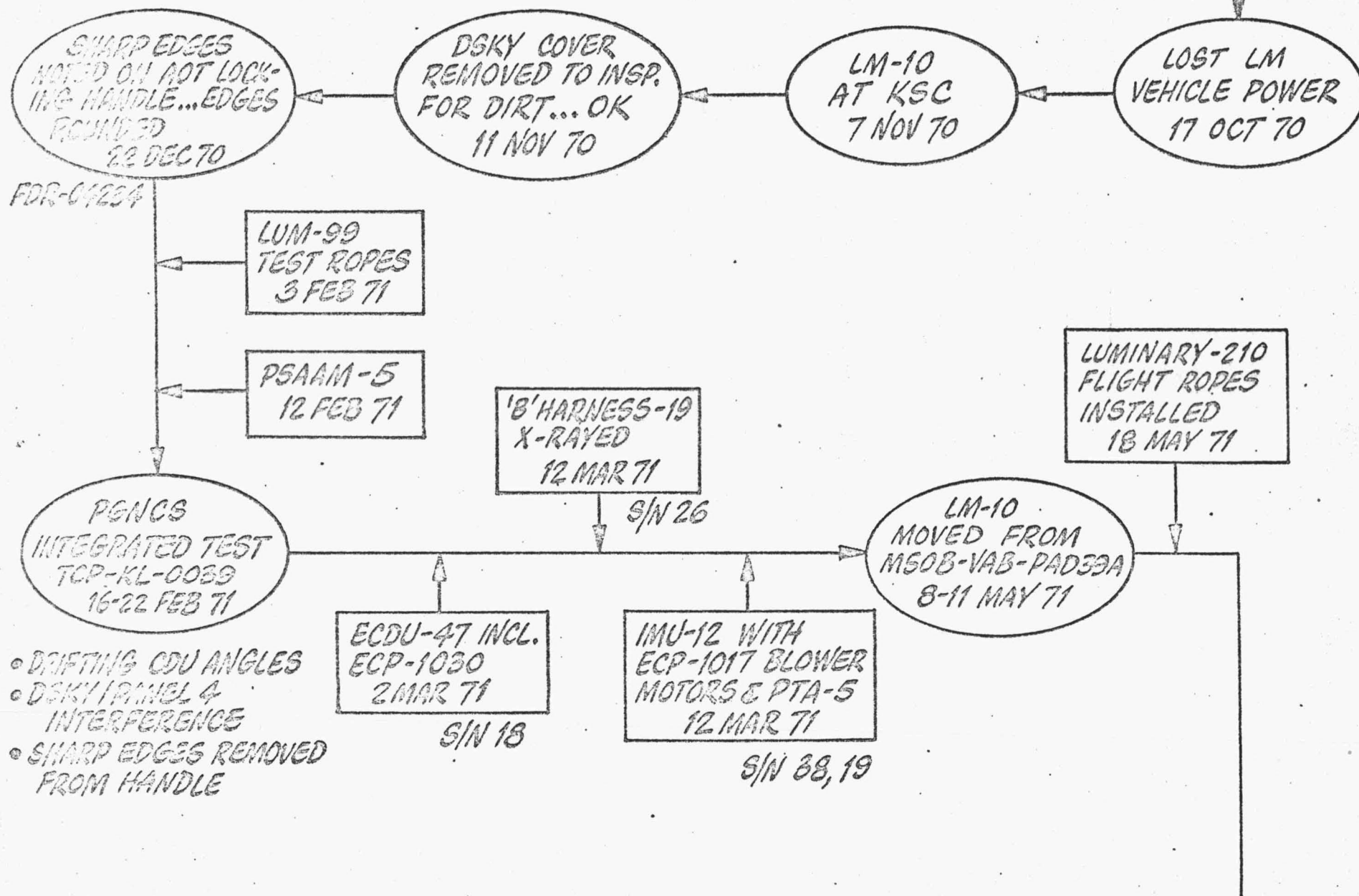
PGNCS-614



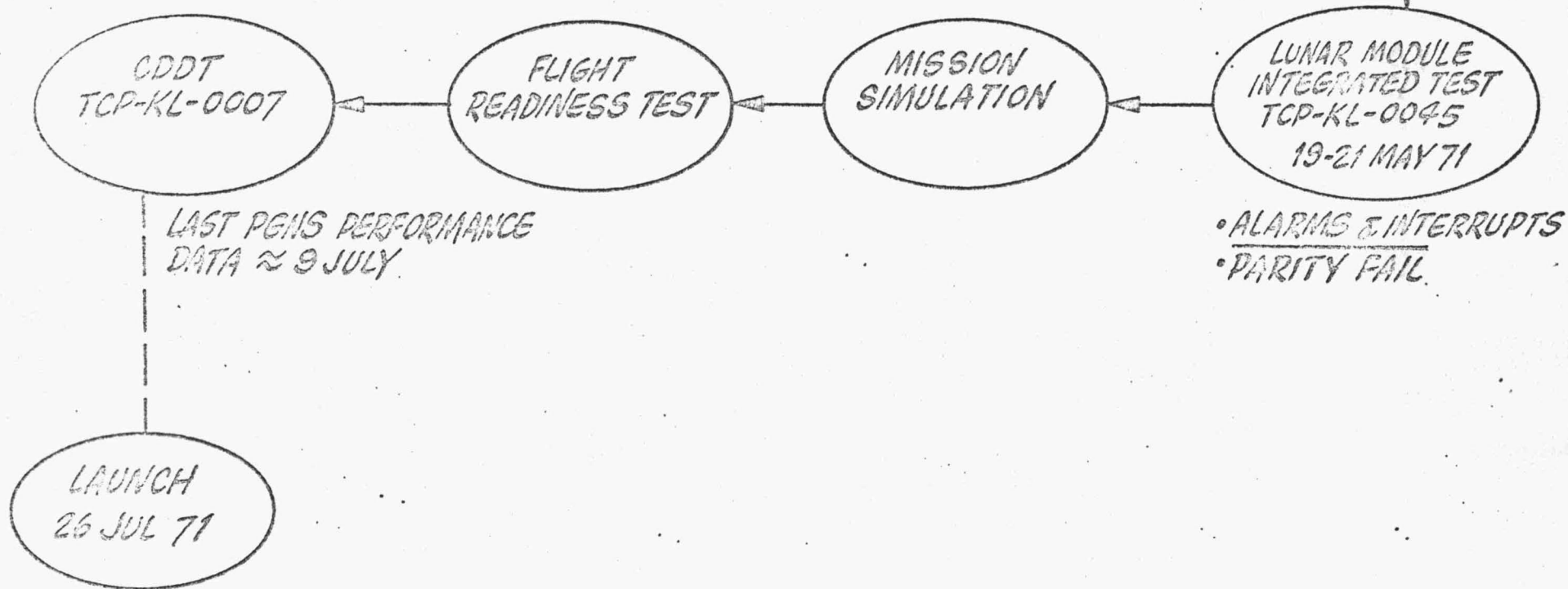
PGNCS-614 (CONTINUED)



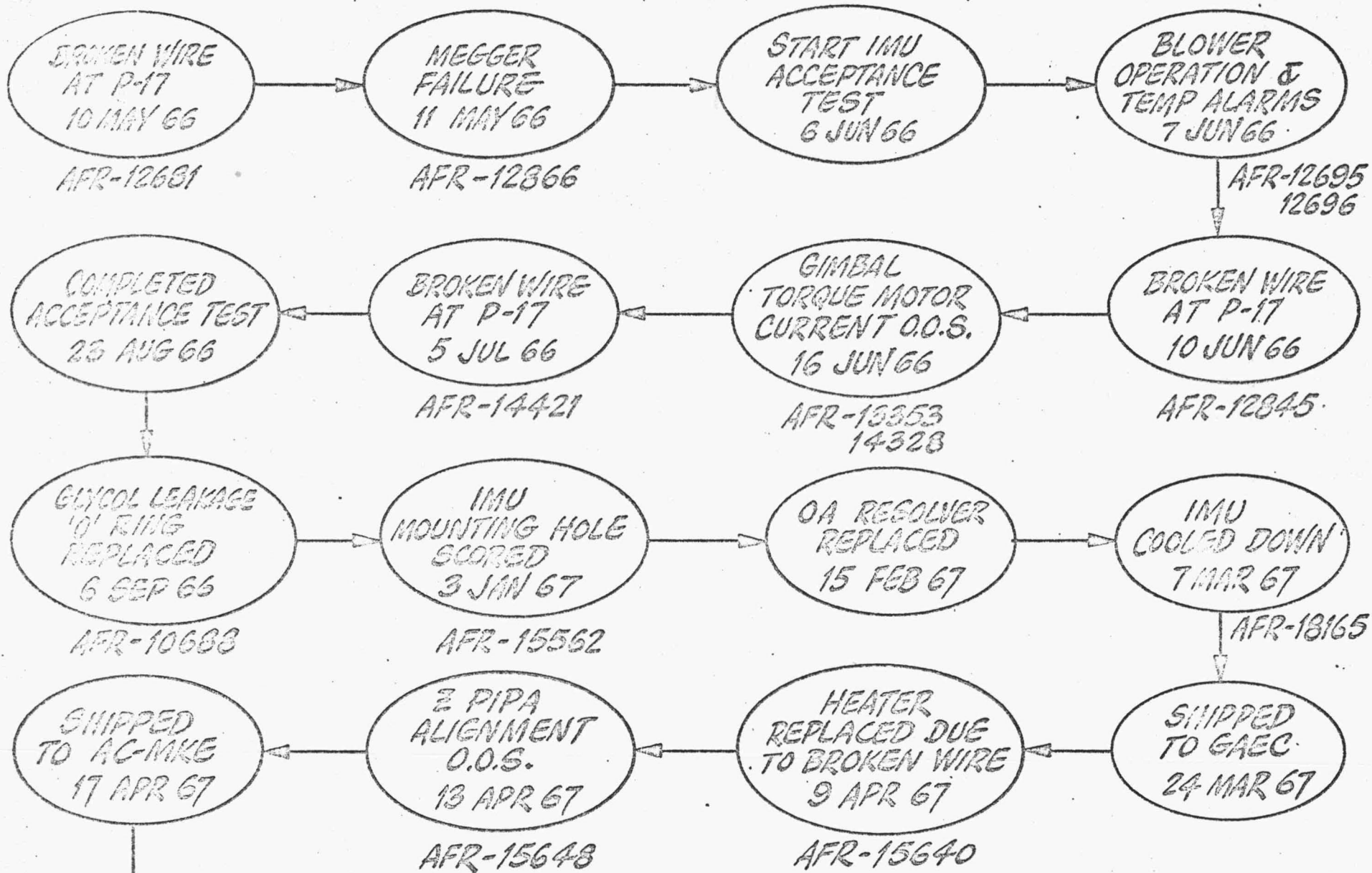
PGNCS-614 (CONTINUED)



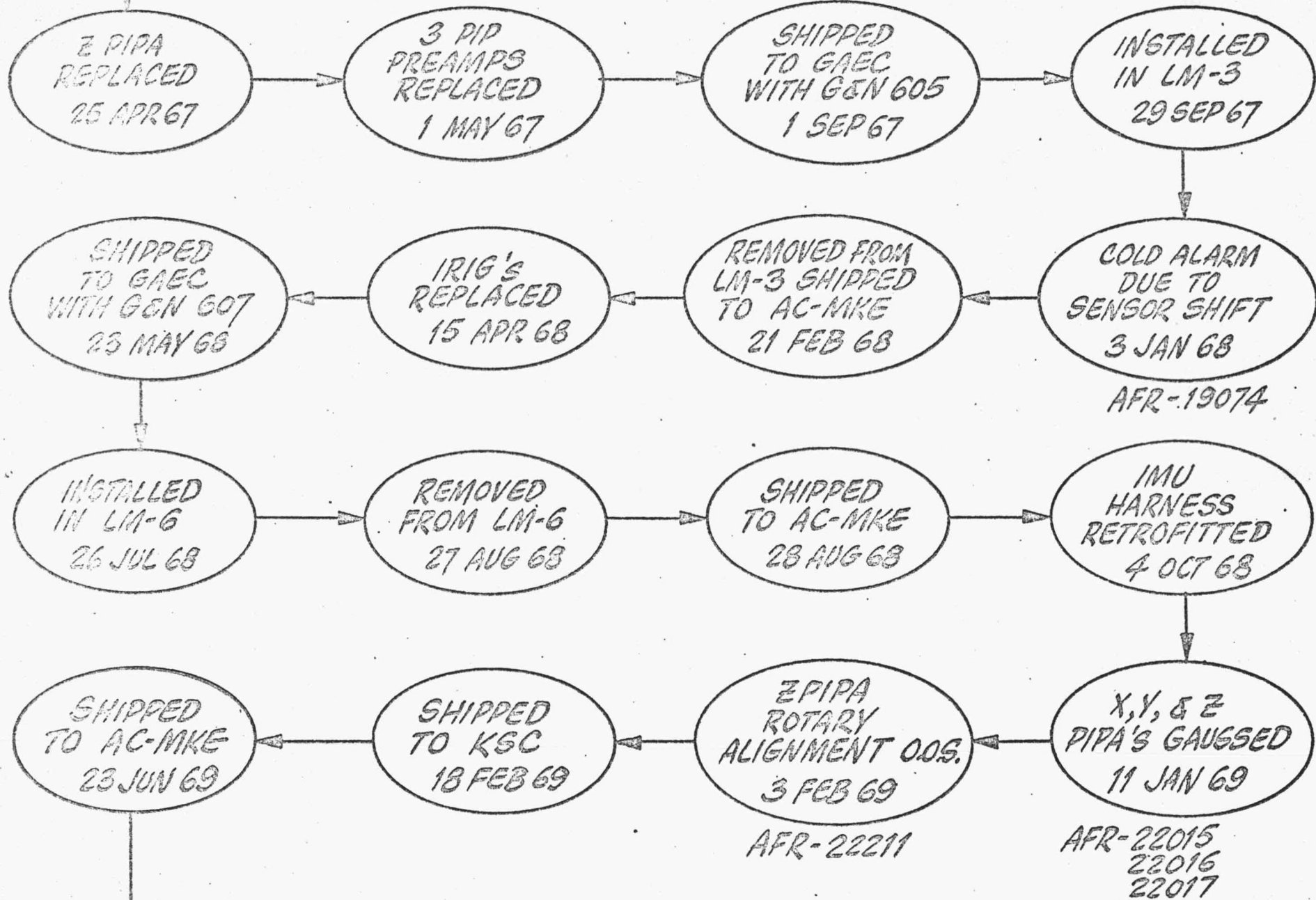
PGNCS-614 (CONTINUED)



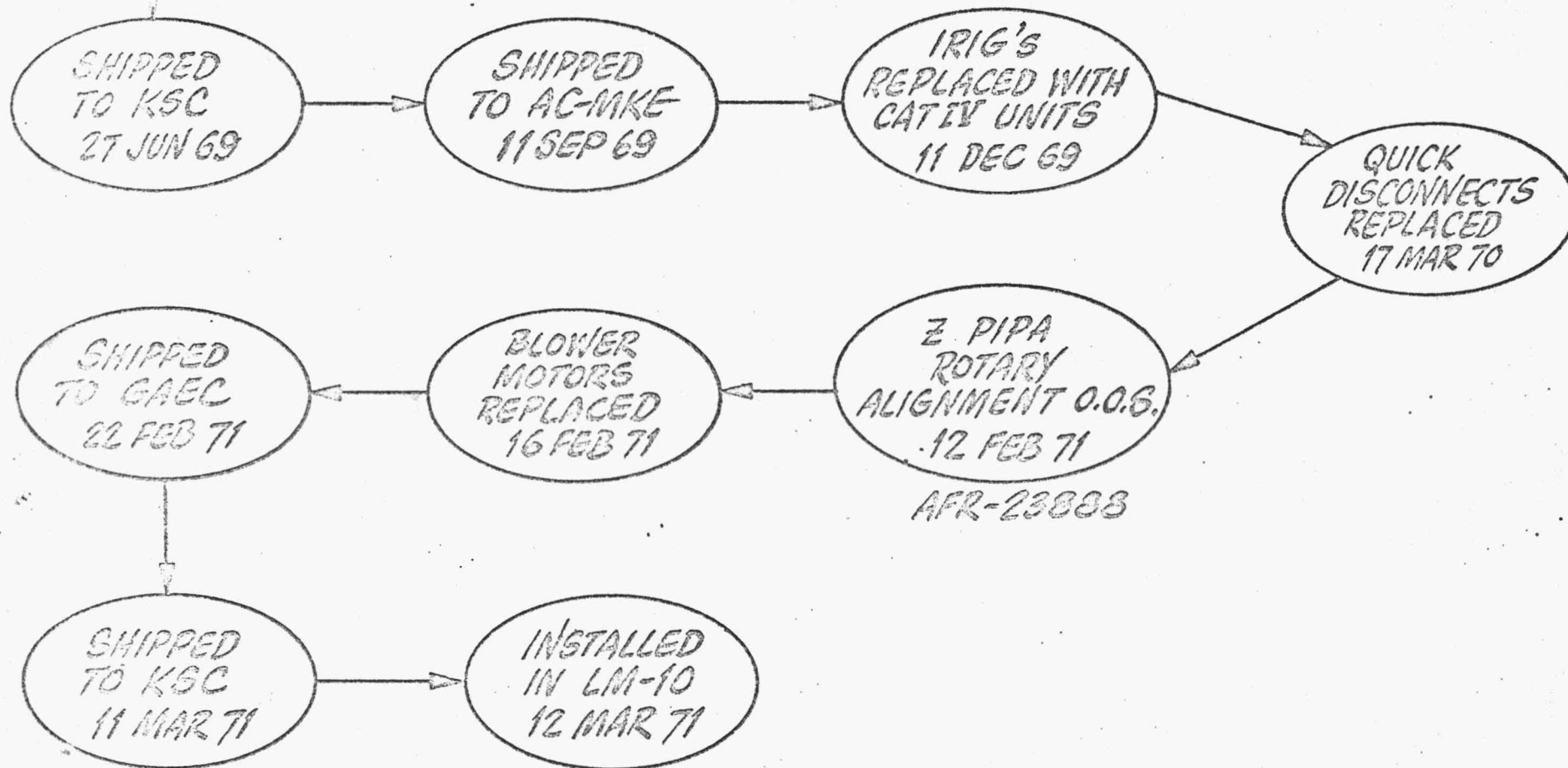
IMU S/N 12



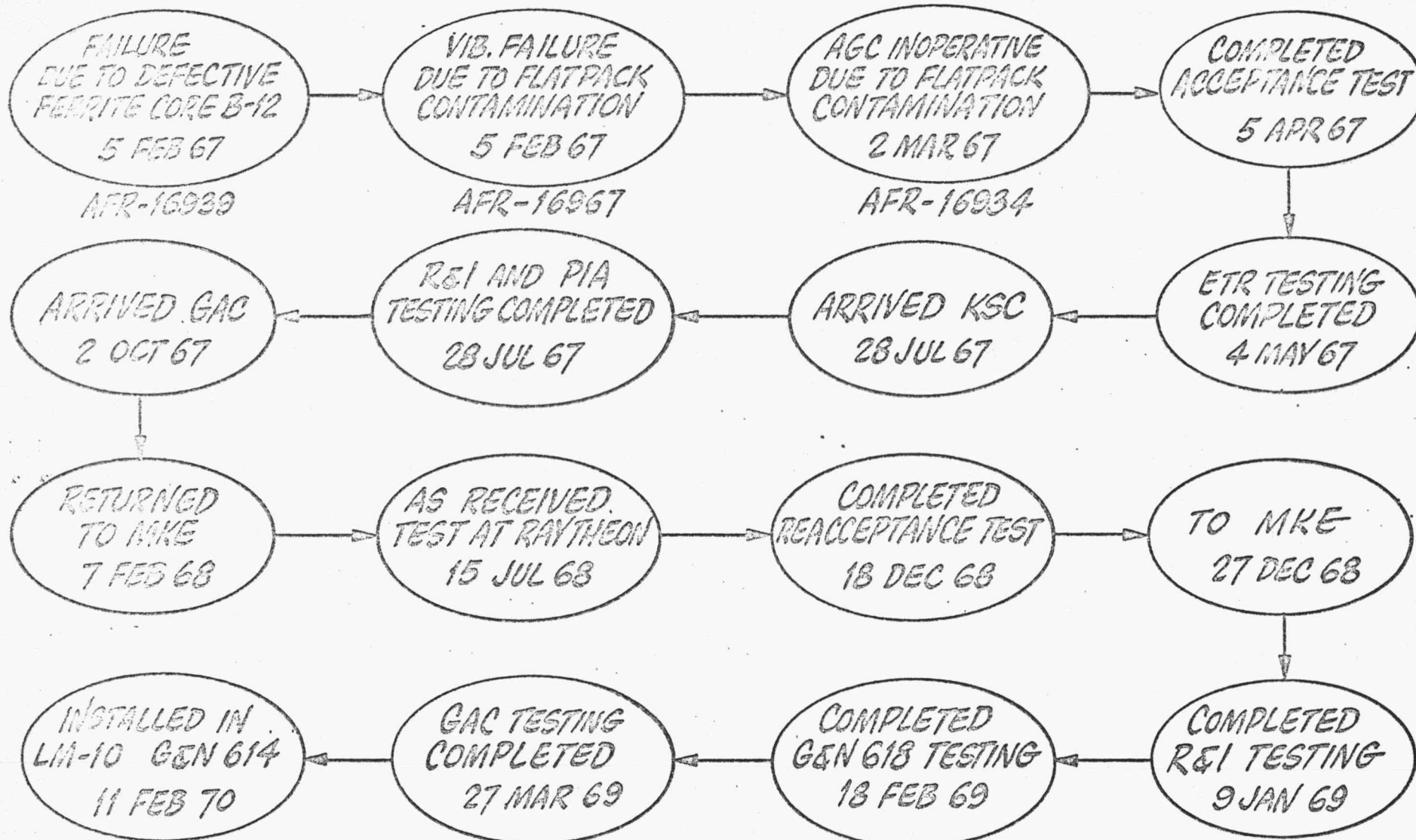
IMU S/N 12 (CONTINUED)



IMU S/N 12 (CONTINUED)



LGC-29 (C-9)



• RESTART
AFR-22212

1 July 1971

M E M O R A N D U M

TO: N. Sears
P. Felleman
R. Lones
G. Silver ✓
K. Kido

FROM: J. A. Lawrence

SUBJECT: Update of the Apollo 15 Report

- 1) Delete CMC-36 History since it is no longer in CM-112. Replace with attached CMC 50 history.
- 2) More recent inertial parameter data, before and since the lightning has verified excellent IMU performance.

	CM	LM	
Max Δ PIPA SF	28	37	Parts/ 10^6
Max Δ PIPA BIAS	0.1	0.0	CM/SEC ²
Max Δ NBD	0.9	0.5	MERU
Max Δ ADOA	0.6	0.0	MERU/g
Max Δ ADSRA	0.3	0.4	MERU/g
Max Δ ADIA	1.1	1.0	MERU/g

All of the above are within the granularity of the test performed.

- 3) ECDU-44 Failure was isolated to a Corning Glass resistor failure. This is the only failure of this part throughout the program. The part has accumulated $>204 \times 10^6$ operating parts hours to date.
- 4) Review of the G & N Transient/Overvoltage protection devices has revealed the following:
 - a) No single point failure has a crew safety impact.
 - b) Two computer circuits (4V power supply and 14 V power supply) in LM are recognized as circuits likely to need protection. All others do not impact mission success or work arounds exist.

- c) A special test is to be developed at the S/c or black box level to verify protection.
- 5) Attached are copies of viewgraphs presented at the MSC/FRR by Delco Electronics on 18 June 1971.
- 6) Attached is a revised sequence chart for G & N-217 including ECDU-44, CMC-36 and "A" harness-26 replacement and post lightning retest. The LM system remains effective as is since the post lightning retest indicated excellent performance and no hardware was affected.
- 7) LM power to G & N was removed for approximately 13 Sec., during the mission sim. test, and reapplied erroneously. The IRIG's were degaussed and retest is acceptable.

J. A. Lawrence

M E M O R A N D U M

TO: N. Sears
P. Felleman
R. Lones
G. Silver ✓
K. Kido

FROM: J. A. Lawrence

DATE: 12 July 1971

SUBJECT: Update #2 of the Apollo 15 Report

The attached represents refined/updated data on the G & N Transient/Overvoltage Protection Analysis.

On Friday, 25 June, the Apollo 15 Vehicle was again hit by lightning with no apparent adverse effects.

The FRR Board at NASA Headquarters decided that the hardware was acceptable and to proceed toward a launch on 26 July 1971.

The computer S/N-36 which was removed (for no technical but for precautionary reasons) evidenced a transformer hi-resistance (230K Ω) short in the 3200 Hz output to the PSA during test in the S/C and would not have adversely affected G & N performance in the mission.

J.A. Lawrence

Question No. 1

Does failure mode impair:

	<u>CM</u>	<u>LM</u>
Pilot Safety	0	0
Mission Success	7	7
Isolated Secondary Mission Objective	0	0
Detailed Test Objectives	0	0
Operational Efficiency		

Question No. 2

At what level was last functional verification:

After Black Box Assembly	0	0
After Module Assembly	4	4
Pre-Module Assembly	3	3

Question No. 3

Is path redundant?

Yes	1	1
No	2	2

Question No. 4

Is protection likely to be needed?

<u>Device Function</u>	<u>CM</u>	<u>LM</u>
Computer Mode Switching	No	Yes (6 operation

- If transistor fails shorted LGC will be inoperative
- If transistor fails open LGC will function continually in operate mode
- Based on analysis and history the transistor will fail shorted for the open diode condition

A special test has been documented to verify protective diode integrity.

- Can only be performed on factory test equipment and only at the module level
- Involves removal of the LGC

P/N 1006323 Transistor

An analysis was performed comparing the energy and frequency of the pulse applied to the transistor with the design characteristics of the transistor.

--There is very low probability of failure; Based on power dissipation calculations there is a 880: 1 safety margin in the diode failed mode

An operating test with a transistor driving a relay with an open diode has completed 10,000 cycles without indication of problem at elevated voltage

Other Consideration

Crew safety is not involved; No problems of this type have surfaced throughout the G & N history.

Proper Apollo 15 hardware function (not including those diodes) has been verified.

Recommendation

Fly Apollo 15 as is.

RECEIVED

JUN 22 1971

George

GEORGE SILVER

Subject: Apollo 15
CM 112, IMU S/N 48
Performance Data

Date 6/19/71

X

Y

Z

IRIGs

NBD (meru)

+0.8

-2.9

-4.1

ADSR (meru/g)

-7.4

+15.2

-3.2

ADIA (meru/g)

-11.5

(10) -4.5
 (8) -1.7

-0.2

ADOA (meru/g)

+4.4

+1.2

+0.4

PIPA's

SF (ppm)

-394

-182

-174

Bias (cm/sec²)

+0.86

-0.09

-0.28

Source: R. O'Donnell
 Recorder: S. Helfant Date 6/21/71

Distr:

J. Gilmore
 J. Feldman
 G. Bukow

G. Silver
 R. Jones
 S. Helfant

George

RECEIVED
JUN 1 1971
GEORGE SILVER

Subject: Apollo 15
CM 112, IMU S/N 48
Performance Data

Date 6/10/71

X

Y

Z

IRIGs

NBD (meru)

+0.5

-3.8

-4.5

ADSRM (meru/g)

-7.1

+15.1

-3.0

ADIA (meru/g)

-12.6

(10) -6.9

0.0

ADDA (meru/g)

+4.5

(8) -1.3
+1.1

+1.0

PIPA's

SF (ppm)

-409

-188

-202

Bias (cm/sec²)

+0.86

-0.12

-0.17

Source: R. Gilbert
Receiver: S. Helfant Date 6/11/71

Distrib:

J. Gilmore
J. Feldman
G. Bukow

G. Silver
R. Jones
S. Helfant

TCP 5

RECEIVED

MAY 20 1971

GEORGE SILVER

RECEIVED

MAY 20 1971

GEORGE SILVER

Subject: Apollo 15
 CM 112, IMU S/N 48
 Performance Data

Date 5/19/71

X

Y

Z

IRIGs

NBD (meru)

- 0.1 ✓

- 3.9 ✓

- 4.8 ✓

ADSR (meru/g)

- 6.9 ✓

+ 16.4 ✓

- 3.3 ✓

ADIA (meru/g)

- 12.1 ✓

(10) - 7.0 ✓

- 0.1 ✓

ADDA (meru/g)

+ 4.5 ✓

(8) - 1.0 ✓

+ 0.6 ✓

+ 1.2 ✓

PIPA's

SF (ppm)

- 399 ✓

- 175 ✓

- 235 ✓

Bias (cm/sec²)

+ 0.92 ✓

- 0.06 ✓

- 0.22 ✓

Source: R. O'DonnellReceiver: S. Helfant Date 5/20/71

Distr:

J. Gilmore
 J. Feldman
 G. Burkow

S. Silver
 R. Jones
 S. Helfant

George

Subject: Apollo 15
CM 112, IMU S/N 98
Performance Data

Date April 13, '71 X Y Z

IRIGs

NBD (meru)

ADSR (meru/g)

ADIA (meru/g)

ADDA (meru/g)

Resun -1.7

+1.4

-1.7

-4.5

-8.0

+14.4

-1.3

-11.0

$\frac{(10) - 3.2}{(8) + 1.5}$

+0.7

+5.3

+1.1

+1.8

Resun +4.06

PIPA's

SF (ppm)

-373

-146

-113

Bias (cm/sec²)

+0.81

-0.12

-0.26

Source: R. Gilbert

Receiver: S. Helfert Date 4/13/71

Distr:

J. Gilmore
J. Feldman
G. Bukow

S. Silver
R. Jones
S. Helfert

RECEIVED TCP 48
MAR 26 1971
GEORGE SILVER *Gerye*

Subject: Apollo 15
CM 112, IMU S/N 78
Performance Data

Date 3/23/71

X

Y

Z

IRIGs

NBD (meru)

+1.0

+ 0.3

-3.9

ADSRA (meru/g)

-10.3

+13.8

-2.0

ADIA (meru/g)

-5.5

$\frac{(10) + 6.1}{(8) + 1.1}$

-1.9

ADDA (meru/g)

+4.1

+1.1

+1.1

PIPA's

SF (ppm)

-407

-129

-96

Bias (cm/sec²)

+ .77

- .04

- .44

Source: R. Gilbert

Receiver: S. Helfant Date 3/26/71

Distr:

J. Gilmore
J. Feldman
G. Bukow

G. Silver
R. Jones
S. Helfant

Subject: Apollo 15

CM , IMU S/N 38 LM 10
Performance Data

George
RECEIVED
FEB 20 1971
GEORGE SILVER

IMU
removed

Date 17 FEB 71

X

Y

Z

IRIGs

NBD (meru)

+2.1

-1.6

+4.0

ADSRA (meru/g)

+1.7

+9.3

-7.9

ADIA (meru/g)

+12.6

(10) -0.2
(8) +0.5

+0.2

ADDA (meru/g)

+1.6

+0.2

+1.5

PIPA's

SF (ppm)

-1002

-669

-313

Bias (cm/sec²)

+1.65

+1.49

+1.51

Source: R. Gilbert

Receiver: S. Helfant Date 2/19/71

Distr:

J. Gilmore
J. Feldman
G. Bukow

G. Silver
R. Jones
S. Helfant

RECEIVED

JUN 18 1971

George

GEORGE SILVER

Subject: *Apollo 15*

CM , IMU S/N 12, LM 10
Performance Data

Date 6/17/71

X

Y

Z

IRIGs

NBD (meru)

+3.4

-3.1

+0.7

ADSR (meru/g)

-5.1

+5.1

-4.7

ADIA (meru/g)

+7.7

(10) -2.2
(8) 0.0

+8.0

ADDA (meru/g)

+1.5

+0.9

+0.5

PIPA's

SF (ppm)

-906

-834

-1367

Bias (cm/sec²)

+1.73

+1.43

+1.41

Source: R. O'Donnell

Receiver: S. Helfant Date 6/18/71

Distr:

J. Gilmore

G. Silver

J. Feldman

R. Jones

G. Bukow

S. Helfant

George
RECEIVED

JUN 14 1971

GEORGE SILVER

Subject: Apollo 15

CM -, IMU S/N 12, LM-~~10~~ 10

Performance Data

Date 6/11/71

X

Y

Z

IRIGs

NBD (meru)

ADSR (meru/g)

ADIA (meru/g)

ADOA (meru/g)

+3.4	-2.6	+0.8
-5.2	+4.7	-4.9
+7.6	(10) -1.0 (8) -0.1	+9.0
+1.5	+1.0	+0.5

PIPA's

SF (ppm)

Bias (cm/sec²)

-912	-797	-1339
+1.70	+1.40	+1.42

Source: R. Gilbert

Receiver: S. Helfant Date 6/14/71

Distr:

J. Gilmore
J. Feldman
G. Bukow

S. Silver
R. Jones
S. Helfant

TCP 45

Subject: Apollo 15CM , IMU S/N 12, LM -10
Performance DataDate 5/19/71

X

Y

Z

IRIGs

NBD (meru)

+3.0

-1.7

+1.3

ADSR (meru/g)

-5.3

+5.0

-4.8

ADIA (meru/g)

+6.7

(10) ~~+9.2~~
(8) ~~+0.4~~

+9.2

ADDA (meru/g)

+1.6

+0.9

+0.5

PIPA's

SF (ppm)

-914

-852

-1383

Bias (cm/sec²)

+1.76

+1.45

+1.42

Source: R. O'DonnellRecover: S. Helfant Date 5/20/71

Distr:

J. Gilmore
J. Feldman
G. BurkowS. Silver
R. Jones
S. Helfant

RECEIVED

MAR 19 1971

GEORGE SILVER

George

Subject: Apollo 15

CM -, IMU S/N 12, LM 10
Performance Data

Date 3/17/71

X

Y

Z

IRIGs

WBD (meru)

+3.5

+0.3

+1.6

ADSRM (meru/g)

-6.2

+3.0

-3.4

ADIA (meru/g)

+4.0

(10) -2.2
(8) -3.0

+5.5

ADDA (meru/g)

+1.4

+1.0

+0.7

PIPA's

SF (ppm)

-938

-855

-1290

Bias (cm/sec²)

+1.65

+1.37

+1.42

Source: R. Gelfert

Receiver: S. Helfant Date 3-19-71

Distr:

J. Gilmore

G. Silver

J. Feldman

R. Jones

G. Burkow

S. Helfant

T. Wainionmaa

Silver

THE CHARLES STARK DRAPER LABORATORY
A DIVISION OF MASSACHUSETTS INSTITUTE OF TECHNOLOGY
68 ALBANY STREET
CAMBRIDGE, MASSACHUSETTS 02139

RECEIVED
MAR 29 1971
GEORGE SILVER

AG: #54-71
24 March 1971

Through: Resident Apollo Spacecraft Project Office
Massachusetts Institute of Technology
Charles Stark Draper Laboratory
75 Cambridge Parkway
Cambridge, Massachusetts 02142

To: National Aeronautics and Space Administration
Manned Spacecraft Center
Houston, Texas 77058
Mr. C. Frasier/EG
Attention: Mr. R. Albon/PP7
Mr. M. Holley/EG44

Subject: Apollo 15 - Inertial Component Data Evaluation

Reference: AG #42-71, 11 March 1971, Status of Spare and
Flight Assigned IMUs

Enclosure: ISS Memo #71-57, "Apollo 15 System Recommendations"
23 March 1971

Gentlemen:

The attached memo details MIT/CSDL recommendations and comments regarding the inertial component flight worthiness status of IMU assigned to Apollo 15 mission. It is provided as a supplement to the referenced report and corresponds to recommendations furnished to M. Biggs, NASA/Houston. The table below provides a summary of these recommendations and identifies the date of the most recent tests, which were also included in this evaluation.

<u>IMU</u>	<u>Assignment</u>	<u>Latest Test</u>	<u>Comment</u>
48	Flight - CM	23 March '71	Flight worthy
12	Flight - LM	17 March '71	" "

AG: #54-71
24 March 1971
Page 2

<u>IMU</u>	<u>Assignment</u>	<u>Latest Test</u>	<u>Comment</u>
29	Prime Spare - CM	19 Feb. '71	Flight worthy
33	Prime Spare - LM	25 March '71	Flight worthy but recommend readjustment Z PIPA bias
9	Backup Spare - CM	28 Dec. '70	Y PIPA, Y Gyro data instabilities - addi- tional testing reqd.
28	Backup Spare - LM	15 Jan. '71	Not flight worthy

Very truly yours,

David G. Hoag
David G. Hoag

JPG:ced

cc:

R. Ragan
A. Laats
G. Silver
R. Lones
G. Bukow
S. Helfant (5)
Central Files (2)
J. Lawrence
M. Lynn, Delco
J. Wachholz, Delco
M. Biggs, MSC
C. Frasier, MSC
J. Feldman
A. Metzger (2)
G. Edmonds
N. Sears
R. O'Donnell
T. Lawton
B. Doran, MSFC
G. Doane, MSFC
B. Gaines, MSFC

C. S. Draper Laboratory
Division of Massachusetts Institute of Technology
Cambridge, Massachusetts

ISS Memo No. 71-57

To: J. Gilmore
From: J. Feldman/G. Bukow
Date: 23 March 1971
Subject: Apollo 15 Flight System Assignments and Recommendations

The following Inertial Measurement Units (IMU's) have been assigned to the Apollo 15 flight by Delco Electronics.

	<u>Flight System</u>	<u>Prime Spare</u>	<u>Backup Spare</u>
CM S/N :	48	29	9
LM S/N :	12	33	28

In ISS Memo No. 71-54 "Status of Spare & Flight Assigned IMU's - 26 February 1971" significant levels of gyro drift instability were reported for several of these systems.

All performance and diagnostic data for these systems has been reviewed with the following conclusions:

IMU S/N 48 (CM Flight System):

- (1) The Y gyro (8A117) had shown an ADIA shift of 17.9 meru/g between 20 November 69 and 5 February 70. Per Delco, wattmeter and ball beat measurements* show no evidence of bearing deterioration. Samples of these traces have been requested for MIT review.
- (2) From previous tests and known storage positions, the 15.7 meru/g ADSRA_Y positive ramp is believed to be due to a long term gravity transient phenomena.

*taken on 10 February 1971

- (3) All accelerometer data for this system indicate flight worthy instruments.
- (4) This IMU is considered flight worthy.

IMU S/N 12 (LM Flight System):

- (1) The NBD_Y instability (total range 8.6 meru between 23 March & 25 Nov. 1970) now appears to be more stable. The range of the last ten data points is 4.5 meru. It is believed that the exhibited instabilities do not represent a reliability hazard although a remote possibility exists. Similar instabilities have been experienced in other systems prior to their flight commitment and no difficulties were encountered. With respect to the mission performance the NBD_Y uncertainties corresponding to the observed changes result in insignificant perilune errors and allow a 60% margin from the mission rule descent and ascent limits.
- (2) All accelerometer data for this system indicate flight worthy instruments.
- (3) This system is considered flight worthy.

IMU S/N 29 (Prime CM Spare System):

Both past and present inertial component data indicate a flight worthy system.

IMU S/N 33 (Prime LM Spare System):

- (1) The bias of the Z PIPA (2AP-294) has shifted after adjustment to a value near 1 cm/sec. Since an additional shift in bias might result in a null coincidence problem during flight it is recommended that bias be readjusted to 1.5 cm/sec.
- (2) All other inertial components data on this system indicate flight worthy instruments.
- (3) After readjustment, additional data should be taken for the Z PIPA before it is considered for flight.

IMU S/N 9 (Backup CM Spare System):

- (1) From previous test and known storage positions, the $ADSRA_Y$ (15 meru/g) and $ADIA_Y$ (24 meru/g) drift changes are diagnosed as long term storage transients.

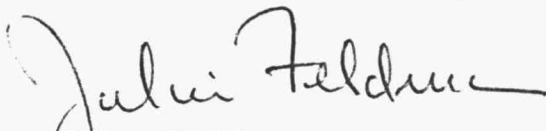
- (2) Additional wattmeter data to confirm the soundness of the wheel package after the 24 meru/g ADIA_Y drift change is needed.
- (3) The Y PIPA has a history of bias instability and marginal 6 point transient test results. This instrument requires additional test data before flight committment.
- (4) This system requires additional testing before considering for flight.

IMU S/N 28 (Backup LM Spare System):

- (1) The X and Z ADIA and ADSRA instabilities have been partially confirmed as long term gravity transients. However, the cause of BD_Y and ADSRA_Y instability have not been confirmed. The wheel package condition has not been evaluated and it is recommended that additional drift measurements, wattmeter and ball beat data be taken on this system before it is considered for flight.
- (2) The Y accelerometer bias and scale factor instability indicates marginal but adequate performance. Additional data is required.
- (3) The Z accelerometer is scheduled for diagnostic testing and replacement.

This system is presently not flight worthy.

The ADSRA and ADIA instabilities noted in IMU S/N's 48, 9 and 28 confirm the early indications of long term gravity transients reported in RASIC Memo No. 27 dated 28 April 1970.


Julius Feldman


George Bukow

JF/GB/df
Distribution:
D. Hoag
G. Silver
R. Lones
G. Edmonds
A. Laats

S. Helfant
R. Ragan
N. Sears
J. Feldman
G. Bukow

Unique Aspects of Apollo 15

- 1) LUNAR ORBIT STAY TIME INCREASED BY $78\frac{1}{2}$ HOURS
- 2) LUNAR SURFACE STAY TIME INCREASED BY $33\frac{1}{2}$ HOURS
- 3) FIRST USE OF THE "LUNAR ROVING VEHICLE"
- 4) FIRST USE OF ORBITAL SENSING INSTRUMENTS (OSI)
- 5) FIRST LAUNCH OF THE LUNAR ORBIT SUBSATELLITE
- 6) FIRST TRANSEARTH COAST EVA FROM THE CSM.

APOLLO 15 MISSION

<u>EVENT</u>	<u>TIME GET</u>	<u>TIME EDT</u>
Launch	00:00	Mon. 7/26/71 9:34 AM
TLI	02:49	7/26/71 12:24 PM
MCC 1	11:56	7/26/71 9:30 PM
MCC 2	30:56	Tues. 7/27/71 4:30 PM
MCC 3	56:31	Wed. 7/28/71 6:05 PM
MCC 4	73:31	Thur. 7/29/71 11:05 AM
LOI	78:31	7/29/71 4:05 PM
DOI	82:40	7/29/71 8:13 PM
Undock	100:14	Fri. 7/30/71 1:48 PM
PDI	104:29	7/30/71 6:03 PM
Landing	104:41	7/30/71 6:15 PM
Standup EVA	106:10	7/30/71 7:44 PM
First EVA	119:50	Sat. 7/31/71 9:24 AM
End First EVA	126:50	7/31/71 4:24 PM
Second EVA	141:15	Sun. 8/1/71 6:49 AM
End Second EVA	148:15	8/1/71 12:49 PM
Third EVA	161:50	Mon. 8/2/71 3:24 AM
End Third EVA	167:50	8/2/71 9:24 AM
Ascent	171:37	8/2/71 1:11 PM
Docking	173:30	8/2/71 3:04 PM
TEI	223:44	Wed. 8/4/71 5:18 PM
MCC 5	240:46	Thur. 8/5/71 10:10 AM
MCC 6	272:58	Fri. 8/6/71 6:32 PM
MCC 7	291:58	Sat. 8/7/71 1:32 PM
EI	294:58	8/7/71 4:32 PM

G. Silber

C. S. Draper Laboratory
Division of Massachusetts Institute of Technology
Cambridge, Massachusetts

Apollo Guidance and Navigation
System Test Group Memo No. 1659

To: Distribution
From: George P. Edmonds, Jr. and Robert Lones
Date: 28 June 1971
Subject: System Hardware Support for Apollo 15

The following chart shows the SCAMA room hardware communicators for the Apollo 15 flight. These hardware communicators are responsible for gathering all data from the SCAMA lines on hardware "action items" and relaying this information to G. Edmonds or his designee for a particular problem.

	Date	4:00 AM to Noon	Noon to 8:00 PM	8:00 PM to 4:00 AM
Mon.	Launch Day	J. Gallagher ⁽¹⁾	G. Cox ⁽²⁾	None
Tues.	L + 1	None	None	None
Wed.	L + 2	None	None	None
Thurs.	L + 3	None	E. Grace	None
Fri.	L + 4	None	R. Sheridan ⁽³⁾	None
Sat.	L + 5	None	None	None
Sun.	L + 6	None	None	None
Mon.	L + 7	V. Megna ⁽⁴⁾	K. Kido ⁽²⁾	None
Tues.	L + 8	None	None	None
Wed.	L + 9	None	D. Sheridan ⁽²⁾	None
Thurs.	L + 10	None	None	None
Fri.	L + 11	None	None	None
Sat.	L + 12	None	W. Prince ⁽²⁾	None

The following is a list of hardware specialists. These people will be either at work or at the listed phone number or will call the SCAMA room (Ext. 1336, 7 or UN 4-3298) and give a number at which they can be reached.

-
- (1) Shift starts at 8:00 first day.
 - (2) Complete shift may not be required.
 - (3) Shift start a few minutes early for PGNS power up.
 - (4) Shift start somewhat before power up PGNS.

Hardware Specialists (require access to front half)

TABLE II

<u>G&N System</u>	<u>Office</u>	<u>Home Phone</u>
Edmonds, George	821-577	864-8942
Grace, Ed	821-201	456-3526
Laats, Ain	6414	729-8896
Harrison, Jim	821-270	924-1332
<u>ISS and Inertial Components</u>		
Gilmore, Jerry - General*	821-271	527-4642
McKern, Dick	821-275	449-0339
Lory, Charles	821-272	527-7205
Feldman, Julius - GYRO	821-256	244-4839
Bukow, George - ACCELEROMETERS	821-254	963-7479
Booth, Bob	821-277	285-3569
<u>Optics</u>		
Karthas, George*	821-512	332-7642
Yorgy, Larry - SERVO	821-322	922-1714
Parr, Tom - ONBOARD NAVIGATION	821-331	484-2065
<u>PSA, PAS and CDU Electronics</u>		
Cushing, Ray*	821-556	887-8670
<u>Thermal</u>		
Hickey, Ed*	821-405	785-0850
Jurgelewicz, Charles	821-411	769-1005
Katz, Bert	821-521	277-5682
<u>Computer</u>		
Hall, Eldon*	821-471	326-8526
Hopkins, Al	821-451	868-4898
Bowler, Don	821-473	924-2394

* Principle Contacts

TABLE II (Cont'd)

<u>Radar</u>	<u>Office</u>	<u>Home Phone</u>
Johnson, Leonard*	821-567	749-0085
Tanner, Walter	821-333	358-7909
Saltzberg, William	821-568	899-1822
Blanchard, Earl	821-322	843-2279

*Principle Contacts


R. Lones
System Test Group


George P. Edmonds, Jr.
System Test Group

GPE/RL/df
Distribution:

E. Grace
W. Prince
V. Megna
M. Adams
J. Harrison
D. Hoag
J. Gilmore
P. Heinemann
G. Cox
L. Johnson
G. Bukow
R. Sheridan
J. St. Amand
I. Johnson
MIT at KSC/MSC
J. Suomala
D. Dolan (Central Files)
R. Werner
G. Edmonds
R. Lones
A. Laats

R. McKern
G. Karthas
K. Kido
S. Copps
J. Lawrence
K. Goodwin
C. Lorgy
P. Felleman
G. Silver
J. Feldman
L. Yorgy
T. Parr
R. Cushing
E. Hickey
C. Jurgelewicz
B. Katz
E. Hall
A. Hopkins
D. Grief
N. Sears
R. Booth

To: P. Felleman
 From: K. Goodwin
 Date: July 21, 1971
 Subject: ASPO 45 Schedule

All Time Central Daylight Savings				
EVENT	DATE	8AM - 4PM	4PM - 12 Mid	12 Mid - 8AM
Launch	Mon. July 26	Lones/Lawton	Goodwin/Olsson	Reasor
MCC#1	Tues. July 27	Lones	Goodwin	Reasor
MCC#2	Wed. July 28	Lones	Goodwin	Reasor
LOI	Thurs. July 29	Gilbert	Goodwin	Reasor
Landing	Fri. July 30	Gilbert/Goodwin	Goodwin	Lones
EVA I	Sat. July 31	Gilbert	Reasor	Lones
EVA II	Sun. Aug. 1	Goodwin	Reasor	Lones
Ascent	Mon. Aug. 2	Goodwin	Reasor	Lones
Subsat				
Launch	Tues. Aug. 3	Gilbert	Olsson/Goodwin	Goodwin
TEI	Wed. Aug. 4	Reasor	Lones	Goodwin
MCC#5	Thurs. Aug. 5	Reasor	Lones	Goodwin
MCC#6	Fri. Aug. 6	Reasor	Lones	Goodwin
Entry	Sat. Aug. 7	Reasor/Lones		

Backup Crew and Phone Numbers (AC 713)

Ed Olsson 9-488-5605
 Tom Lawton 8-877-2991
 George Reasor 8-534-4723
 Ken Goodwin 9-623-8368
 Bob Lones 8-932-4541
 Rom Gilbert 8-932-4541

ASPO 45: 483-3451
 MIT: 483-6134
 AGC: 483-5666

Cambridge: 87-617-865-7336

Distribution:

MIT/MSO (10)
 MIT/KSC
 G. Edmonds
 B. Werner (2)

Silver
G. Silver

APOLLO 15 SCHEDULE

ACE ROOM #1

SAT JULY 24	0000 - 0400	R. GILBERT
	0400 - 1500	R. O'DONNELL
	1500 - 0200	W. PRINCE
SUN JULY 25	0200 - 1200	R. GILBERT
	1200 - 2000	R. O'DONNELL
	2000 - 0500	W. PRINCE
MON JULY 26	0500 - LAUNCH	R. GILBERT

MIT OFFICE / ACE ROOM #2

SAT JULY 24	1200 - 1800	FELLMAN
	1800 - 2400	—
SUN JULY 25	0000 - 0600	SILVER
	0600 - 1200	FELLMAN - METZGER
	1200 - 1800	BERMAN - M'ATKEE
	1800 - 2400	STUBBS - MARINO
MON JULY 26	0000 - 0600	HARRISON - GREENE
	0600 - LAUNCH	SILVER

PREPARED BY: P. FELLEMAN

APOLLO 15 MANNING SCHEDULE

DATE: 7/13/71

SHEET 1
OF 2

	D A T E	ON C.D.T.	OFF C.D.T.	ON GET	OFF GET	SPAN			EVENTS
MON	7/26	0730	1530	T-1	7	COPPS			LAUNCH, TLI
		1530	2330	7	15	LARSON			MCC 1
TUES	7/27	2330	0730	15	23	FELLEMAN			
	0730	1530	23	31	SILVER				MCC 2
		1530	2330	31	39	COPPS			
WED	7/28	2330	0730	39	47	LARSON			
		0730	1530	47	55	FELLEMAN			
		1530	2330	55	63	SILVER			MCC 3
THURS	7/29	2330	0730	63	71	COPPS			
		0730	1530	71	79	LARSON			MCC 4, LTI
		1530	2330	79	87	FELLEMAN			DOI
FRI	7/30	2330	0730	87	95	SILVER			
		0730	1730	95	105	LARSON			UNDOCK PDI
		1730	2330	105	111	FELLEMAN			SEVA
SAT	7/31	2330	0730	111	119	SILVER			
		0730	1530	119	127	COPPS			EVA 1
		1530	2330	127	135	LARSON			
SUN	8/1	2330	0730	135	143	FELLEMAN			EVA 2
		0730	1530	143	151	SILVER			
		1530	2330	151	159	COPPS			
MON	8/2	2330	0730	159	167	FELLEMAN			EVA 3
		0730	1530	167	175	LARSON			ASCENT RENDEZVOUS
		1530	2330	175	183	SILVER			
TUE	8/3	2330	0730	183	191	COPPS			
		0730	1530	191	199	FELLEMAN			
		1530	2330	199	207	LARSON			
WED	8/4	2330	0730	207	215	SILVER			
		0730	1530	215	223	COPPS			

[illegible]

APOLLO 15
SCOTT - WORDEN - IRWIN
AS 511/CSM 112/LM 10
ENDEAVOR/FALCON

TIME (EDT)	TIME (GET)	EVENT	COMMENTS
JULY 26 9:34A	00:00	LAUNCH	
12:24A	2:49:58	TLI (TRANSLUNAR INJECT)	$\Delta V = 10421$ FPS
12:59A	3:25:00	TRANSPOSITION & DOCK	
1:30P	4:16:00	CSM/LM EJECTION	$\Delta V = 0.4$ FPS
9:30P	11:55:54	MCC-1 (MIDCOURSE CORRECTION)	$\Delta V = \text{NOM ZERO}$
JULY 27 4:30P	30:55:54	MCC-2	$\Delta V = \text{NOM ZERO}$
7:19P	33:45:00	IVT TO LM	
JULY 28 6:05P	56:31:15	MCC-3	$\Delta V = \text{NOM ZERO}$
JULY 29 11:05A	73:31:15	MCC-4	$\Delta V = \text{NOM ZERO}$
4:05P	78:31:15	LOI (LUNAR ORBIT INSERTION)	$\Delta V = 2998$ FPS ORBIT: 170/58.3 nm
4:48P	79:14:27	SIVB LUNAR IMPACT	LAT: 3.66°S LONG: 7.58°W
8:13P	82:39:33	DOI (DESCENT ORBIT INSERT)	$\Delta V = 207.6$ FPS ORBIT: 58.4/9.6 nm
JULY 30 8:32A	94:58:00	LANDING SITE	
1:47P	100:13:56	UNDOCK AND SEPARATION	$\Delta V = 1.0$ FPS ORBIT: 59.8/8.4 nm
3:09P	101:34:55	CSM CIRCULARIZATION	$\Delta V = 70.8$ FPS ORBIT: 64.7/54.5 nm
6:03P	104:28:55	PDI (POWERED DESCENT INIT.)	$\Delta V = 6700$ FPS
6:15P	104:40:57	LM LUNAR TOUCHDOWN	HADLEY-APENNINE LAT/LONG: 26.1°N/3.65°E
7:44P	106:10:00	STANDUP EVA (SEVA)	
JULY 31 9:24A	119:50:00	EVA#1	DURATION: 7 HOURS
AUG 1 6:44A	141:10:00	EVA#2	DURATION: 7 HOURS
AUG 2 3:24A	161:50:00	EVA#3	DURATION: 6 HOURS
6:46A	165:12:50	LOPC (LUNAR ORBIT PLANE CHANGE)	$\Delta V = 308.6$ FPS ORBIT: 59.8/59.2 nm
1:11P	171:37:23	LM ASCENT	$\Delta V = 6055$ FPS ORBIT: 45.6/9.0 nm
2:03P	172:29:39	TPI (TERMINAL PHASE INIT.)	$\Delta V = 73.6$ FPS ORBIT: 61.5/43.9 nm
3:09P	173:35:00	DOCKING	
6:55P	177:20:50	LM JETTISON	
8:39P	179:05:37	LM DEORBIT	$\Delta V = 201$ FPS ORBIT: 62/-53 nm
9:04P	179:30:48	LM LUNAR IMPACT	LAT/LONG: 22.25°N/1.67°E
AUG 4 2:59P	221:25:52	CSM SHAPE	$\Delta V = 64$ FPS ORBIT: 77.6/57.5 nm
4:10P	222:36:13	SUBSAT LAUNCH	
5:20P	223:46:06	TEI (TRANSEARTH INJECT)	$\Delta V = 3049$ FPS
AUG 5 8:20A	238:46:06	MCC-5	$\Delta V = \text{NOM ZERO}$
11:41A	242:07:00	TRANSEARTH EVA	
AUG 6 3:54P	270:20:00	PRESS CONFERENCE	
6:32P	272:58:20	MCC-6	$\Delta V = \text{NOM ZERO}$
AUG 7 1:32P	291:58:20	MCC-7	$\Delta V = \text{NOM ZERO}$
4:17P	294:43:00	CM/SM SEPARATION	
4:46P	295:12:00	CM SPLASH DOWN	LAT/LONG: 26°N/158°W (PACIFIC OCEAN)

NOTES:

FIRST LUNAR ROVING VEHICLE (LRV)

FIRST TV OF LM ASCENT

FIRST TRANSEARTH EVA

EXTENDED TOTAL MISSION DURATION: 12.3 days

EXTENDED LUNAR SURFACE STAY TIME: 67.3 hrs

EXTENDED LUNAR SURFACE EVA: 20 hrs

FIRST SUBSATELLITE DEPLOYED IN LUNAR ORBIT

TRANSLUNAR TIME: 75 hrs. 36 min.

LUNAR ORBIT TIME: 145 hrs. 06 min.

TRANSEARTH TIME: 71 hrs. 12 min.

Massachusetts Institute of Technology

Charles Stark Draper Laboratory

23S Memo 71-13

TO: Distribution
FROM: Philip Felleman
DATE: 18 May 1971
SUBJECT: Apollo 15 Mission

S. Silver
RECEIVED
MAY 19 1971
GEORGE SILVER

Attached to this memo, you will find an abbreviated mission schedule for the significant events of the mission. The times are given in GET (Ground Elapsed Time) and EDT (Eastern Daylight Time). The source was the Operational Trajectory (MSC Internal Note 71-FM-130 dated April 16, 1971).

Distribution:

R. Ragan
D. Hoag
L. Larson
N. Sears
R. Battin

S. Copps
R. Larson
Division Directors
Eldon Hall
J. Laning

R. Millard
G. Stubbs
J. Harper
J. Lawrence

Massachusetts Institute of Technology
Charles Stark Draper Laboratory

G. Silver

RECEIVED
MAY 26 1971
GEORGE SILVER

23S Memo 71-14

TO: Distribution
FROM: P. Felleman
DATE: 26 May 1971
SUBJECT: Motel Reservations at MSC for Apollo 15 Mission

The Lab has reserved a block of rooms for the mission at the Ramada Inn, directly across NASA 1 from the center. The following reservations have been made:

P. Felleman	7/26 - 8/7
S. Copps	7/25 - 8/7
D. Hoag	7/25 - 8/7
R. Gilbert	7/26 - 8/7
R. Lones	7/25 - 8/7
Dr. C.S. Draper	7/29 - 8/2
R. Ragan	7/29 - 8/2
R. Battin	7/29 - 8/2
N. Sears	7/26 - 8/7

If these accomodations are not acceptable, please let me know as soon as possible.

Distribution:

Dr. C.S. Draper	S. Copps
R. Ragan	R. Larson
D. Hoag	R. Gilbert
R. Battin	G. Silver
N. Sears	K. Goodwin

G. Silver

6

THE CHARLES STARK DRAPER LABORATORY
A DIVISION OF MASSACHUSETTS INSTITUTE OF TECHNOLOGY
68 ALBANY STREET
CAMBRIDGE, MASSACHUSETTS 02139

AG 96-71
26 May 1971

RECEIVED
MAY 22 1971
GEORGE SILVER

National Aeronautics & Space Administration
Manned Spacecraft Center
Houston, Texas 77058

Attention: Mr. Scott H. Simpkinson PA
Through: NASA/RASPO at MIT/DL
Subject: MIT Support for Apollo 15
Gentlemen:

In order to facilitate MIT support in the SPAN room for the Apollo 15 Mission, it is hereby requested that mission badges be provided for the following personnel:

Philip G. Felleman
Russell A. Larson
Stephen L. Copps
George L. Silver

In addition, as we previously have had, we request two (2) general MIT/SPAN badges for use by other support personnel as required. The access list for these badges is:

David G. Hoag
Thomas A. Lawton
Norman E. Sears
Robert Lones
Romilly Gilbert
Kenneth R. Goodwin

We understand that we shall only have one (1) person in the SPAN room at a time and we shall adhere to that policy.

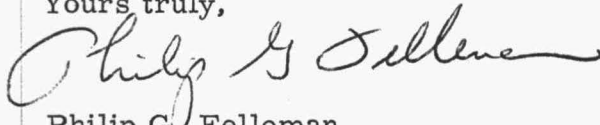
I sincerely hope that our support will prove satisfactory, and

-2-

AG 96-71
26 May 1971

if you should have any questions, they may be directed to myself at MIT,
Extension 821-504 or Mr. Thomas Lawton, our representative at MSC,
(Extension 4807).

Yours truly,



Philip G. Felleman
Deputy Associate Director

Distribution:

R. Ragan
D. Hoag
L. Larson
R. Battin
N. Sears
R. Larson
G. Silver
S. Copps
T. Lawton
J. Williams FS5
R. Lones

M. Brooks FC
J. Roach FC
J. Lawrence
J. Vyner PP7
M. Holley EG14
T. Gibson FS5
R. Albon PP7
Nasa Raspo at MIT
MIT/DL at MSC/KSC
Central Files (2)

Massachusetts Institute of Technology

Charles Stark Draper Laboratory

23S Memo 71-15

TO: Distribution
FROM: P. G. Felleman
DATE: 26 May 1971
SUBJECT: MIT Support during Apollo 15

G. Silver
RECEIVED
MAY 26 1971
GEORGE SILVER

As usual, the Laboratory will support the upcoming Apollo 15 Mission at KSC, MSC and Cambridge. At MSC, our support will include:

SPAN: P. Felleman
S. Copps
R. Larson
G. Silver

ASPO 15: R. Lones
G. Reasor
K. Goodwin
R. Gilbert

General: D. Hoag
N. Sears
T. Lawton

At Cambridge, there will be the SCAMA communicators on a 24 hour basis and hardware and software specialist support as required.

It is also expected that Raytheon personnel will be in the SCAMA room as in Apollo 14.

Distribution:

R. Ragan
D. Hoag
L. Larson
R. Battin
N. Sears
R. Millard
G. Levine
M. Hamilton
D. Fraser
J. Nevins

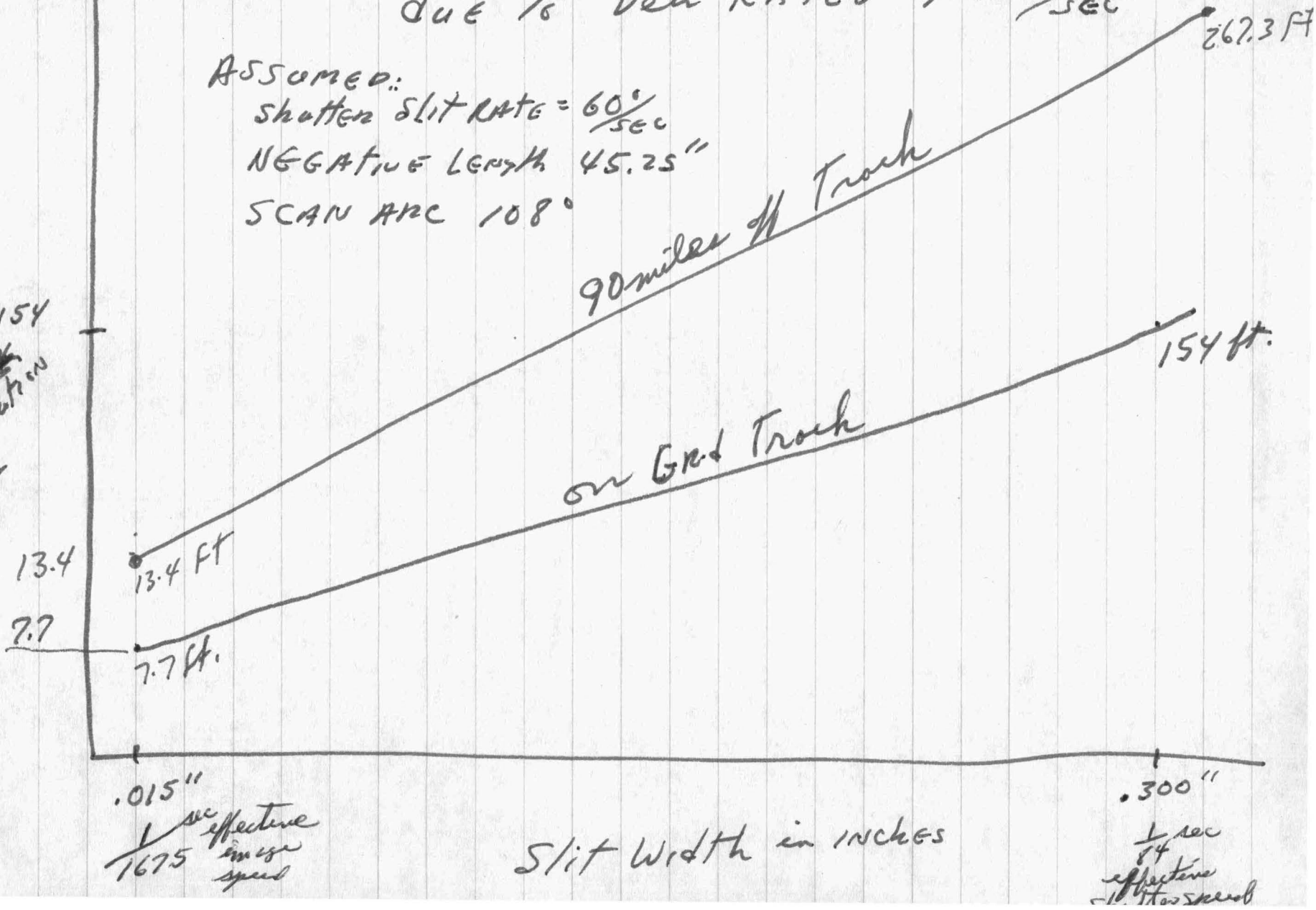
T. Fitzgibbon
J. Gilmore
G. Silver
J. Laning
E. C. Hall
J. Barker
S. Copps
R. Larson
R. Lones
K. Goodwin

MIT/KSC
MIT/MSC
Group 23S

PAN CAMERA Resolution due to Veh Rates of .036°/sec

Assumed:
Shutter SLIT RATE = 60°/sec
NEGATIVE LENGTH 45.25"
SCAN ARC 108°

~~Resolution~~
Resolution
in
ft



12960 ft

036°

$$12960 = 7.734 \text{ ft}$$

1.0005968

$$12960 = 154.22 \text{ ft}$$

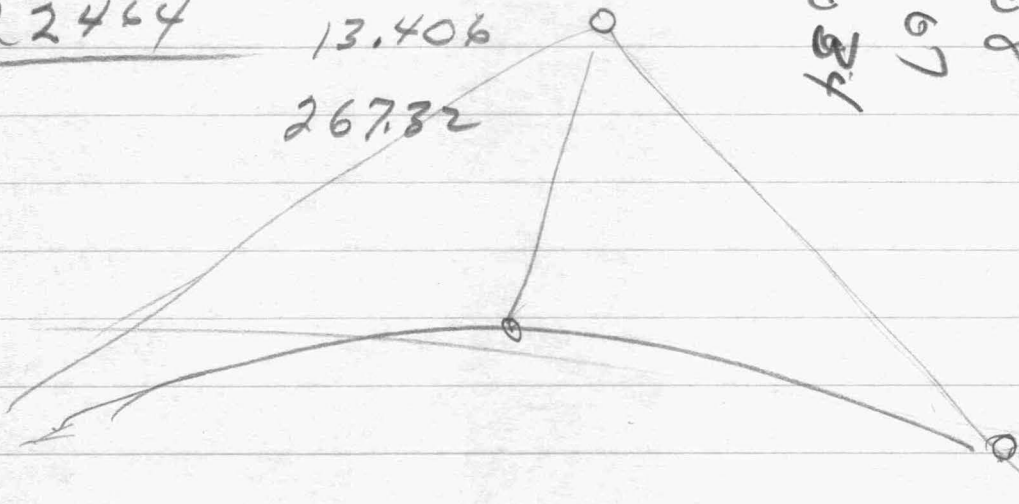
.0119

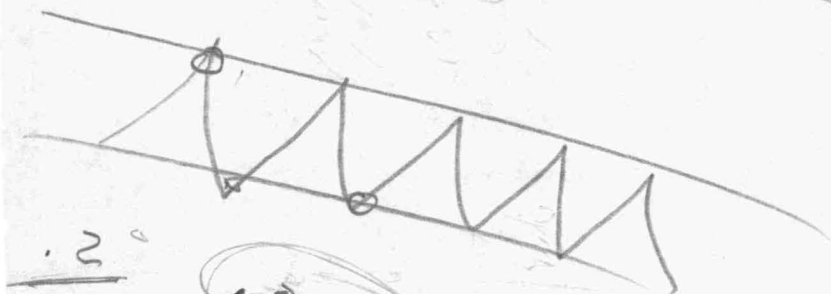
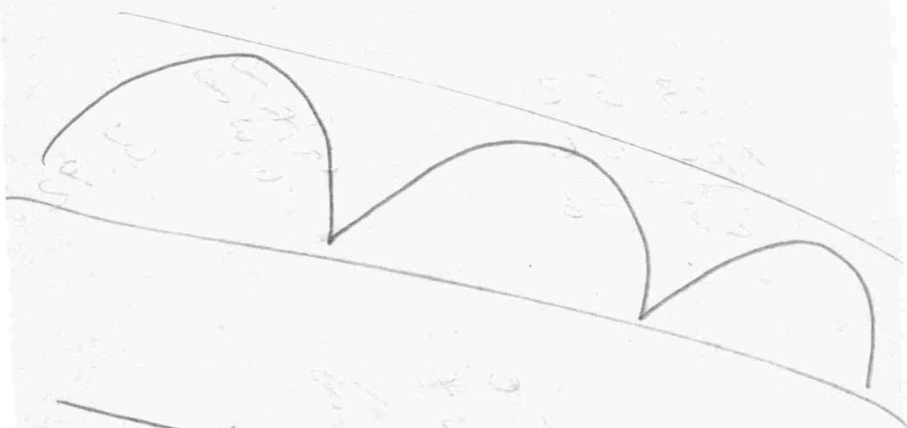
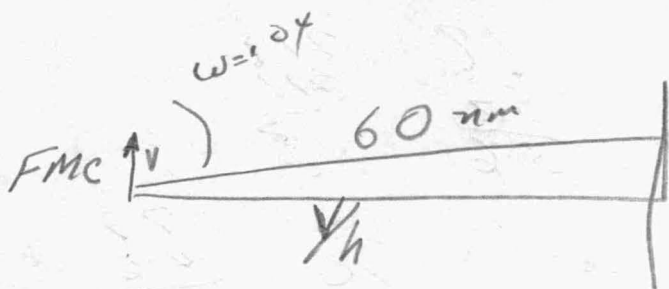
+ 1 +
180°
190°
800°
251.0000

22464

13.406

267.32





2°

0.04

0.00032

$\times \frac{1}{125}$

$\times 60 \times 6000 = 115.2$

$$\begin{array}{r} 88 \\ 52 \\ \hline 36 \end{array}$$

$$\begin{array}{r} 218 \\ 211 \\ \hline 7 \end{array}$$

.60

10

$$\begin{array}{r} 79 \\ 46 \\ \hline 33 \end{array}$$

$$\begin{array}{r} 226 \ 71 \\ 21 \ 28 \\ \hline 4.43 \end{array}$$

11

$$\begin{array}{r} 193 \ 52 \\ 170 \ 06 \\ \hline 23 \ 46 \end{array}$$

$$\begin{array}{r} 98 \\ 43 \\ \hline 55 \end{array} \quad 3.92$$

$$\begin{array}{r} 164 \ 18 \\ 162 \ 19 \end{array}$$

$$\frac{\frac{g}{h} \times}{\frac{g}{h} \text{ more}} = \text{more}$$

-3.42

$$\frac{360^\circ}{6 \text{ sec}} = 60^\circ/\text{sec} \quad \frac{108^\circ}{60^\circ/\text{sec}} =$$

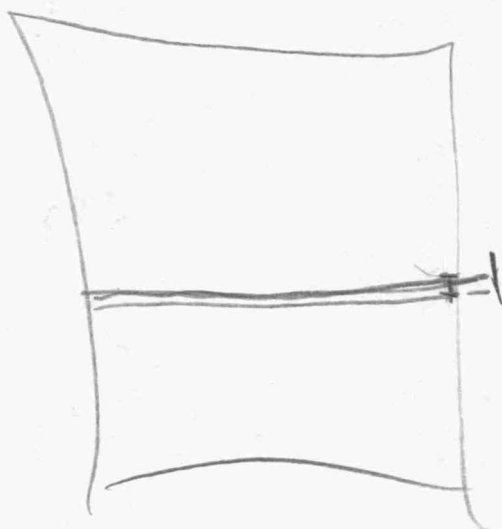
$$45.25'' \text{ long} = 108^\circ$$

$$\frac{360^\circ}{6 \text{ sec}} : 108^\circ \quad .418888 \frac{''}{\text{deg.}} \times \frac{60^\circ}{\text{sec}}$$

$$\frac{1 \text{ sec}}{1675} \quad .015'' \quad \frac{25.1333''}{\text{sec}} \quad \frac{0.015''}{0.3''}$$

$$.0005968 \text{ sec}$$

$$.0119 \text{ sec} \approx \frac{1}{84} \text{ sec}$$



I

100

SEC 4

LM-11
33
Final Computer
24 March 72
Jerry Gelman
says go with
existing numbers
10:25
Calbed Ray Parker
10:40 CST
Calbed Dick Carl
10:45 CST

	13 Dec 71	15 Mar 72	S/C 1st 24 Mar 72	S/C 2nd 24 March 72	FINAL COMP.	MIT INITIAL CO
X IRIG						
NBD { D ₁ 6 D ₂ 9 D ₃ 11	-0.1	-1.73	+0.3	+0.3 *6	<u>18 ft</u>	-0.3
ADSRA { 21 25	-3.7	-0.2	+0.2	-0.3		-1.0
ADIA { 17 33 40	12.9	.11.4	10.2	+13.1		13
Y IRIG						
NBD	1.7	0.1	-1	-0.9 1.5	2.9 ft/sec Before Notion	0.6
ADSRA	-5.3	-7.2	-6.7	-6.7 (2.7)		-4.0
ADIA	-5.3	-5.9	-5.8	-8.3 1.0 -3.68		-3.0
Z IRIG						
NBD	-3.1	-1.1	-2.7	-2.3 3		-2.6
ADSRA	4.6	6.8	3.7	+3.6		3.0
ADIA	13.8	11.9	15.8	+12.7 (3.7)		14.0
X-PIP						
Bias { D ₁ 0.5 D ₂ 0.7 D ₃ 0.9	1.85	1.87	1.86	1.83 .01		1.84
SF { 400 500 600	-959	-801	-838	-816 94		-890
Y-PIP						
Bias	1.6	1.59	1.60	1.57 .03	122 ft CTP	1.60
SF	-398	-398	-421	-403 3		-400
Z-PIP						
Bias	1.18	1.16	1.23	1.23 .01	284 ft ZR .2 ft/sec ZV	1.16
SF	-491	-443	-524	-526 56		-470

X	+0.9
Y	-0.3
Z	+0.4

Recent
errors
less than
500 ft

Block II/LM

DATA SHEET IMU PERFORMANCE TEST

G&N SYSTEM

SPACECRAFT

DATE

216

CM-113

4-14-72

TEST LOCATION

TIME OF TEST

ZULU

TCP NO.

LC-39A

0007 COUNT

A. Record the following test data:

TIME (Z)	POSITION (R3)	QUANTITY	LINE	DISPLAY
	1	+ NBDY-ADOAY	1	(H) 0.24
	2	+ NBDZ-ADOAZ	2	(H) 3.05
	2	-X PIPA G	3	(H) 979.48627
	2	-NBDX + ADIAX	4	(H) 11.90
	3	+NBDX - ADOAX	5	(H) 1.71
	4	+NBDY + ADSRAY	6	(H) 13.61
	4	-Z PIPA G	7	(H) 979.63293
	4	+NBDZ + ADIAZ	8	(H) 15.50
	5	+Y PIPA G	9	(H) 981.71869
	6	-Y PIPA G	10	(H) 979.31311
	7	-NBDX + .707 ADSRAX- .707 ADOAX	11	(H) 5.68
	8	.707 (-NBDZ - NBDY) + .5 (ADSRAY+ADSRAX+ADIAZ-ADIAZ)	12	(H) 5.25
	9	-NBDZ+.707ADSRAX-.707ADOAZ	13	(H) 0.85
	10	.707 (NBDY-NBDX) + .5 (ADIAZ-ADIAX+ADSRAX+ADOAY)	14	(H) 11.54
	11	-NBDX - ADOAX	15	(H) 1.89
	11	+Z PIPA G	16	(H) 979.45917
	12	NBDY + ADOAY	17	(H) 0.06
	12	+X PIPA G	18	(H) 979.41925
	13	NBDZ + ADOAZ	19	(H) 2.69

IMU PERFORMANCE CRITERIA

VEHICLE NO. CM113		GEN NO. 216		IMU NO. 29		DATE 4-14-72		
PROCEDURE TCP K0007		LOCATION LC 39A				TIME		
CALCULATION IDENTIFIER	PARAMETER	Xi-3	Xi-2	Xi-1	Xi	D1	D2	D3
01	SF _x	-254	-280	-266	-252	14	28	54
02	SF _y	-1279	-1304	-1320	-1337	17	33	58
03	SF _z	-379	-369	-396	-348	48	75	85
04	Bias x	-0.04	-0.03	-0-	-.03	.03	.06	.07
05	Bias y	+1.15	+1.17	+1.17	1.20	.03	.03	.05
06	Bias z	-0.15	-0.11	-0.11	-.08	.03	.03	.07 .07
07	NBD _x	-2.0	-1.3	-1.7	-1.8	.1	.5	1.2
08	NBD _y	+0.1	-2.0	+0.7	-0.1	.8	3.5	5.6
09	NBD _z	-1.3	-2.7	-2.1	-2.8	.7	1.3	2.7
10	ADOA _x °	-0.5	-0.5	-0.4	0	.		
11	ADOZ _y °	-0.1	+0.5	-0.3	0			
12	ADOA _z °	+0.3	+0.2	-0-	0.1			
13	ADSR _{Ax}	-11.8	-10.6	-10.7	-10.6	.1	.2	1.4
14	ADSR _{Ay}	-13.3	-11.3	-13.1	-13.4	.3	2.1	4.1
15	ADSR _{Az}	-5.0	-5.0	-5.4	-5.0	.4	.8	.8
16	ADIA _x	+5.8	+9.0	+8.5	10.1	1.6	2.1	5.3
18	ADIA _y	+14.1	+15.5	+16.1	18.3	2.2	2.8	4.2
17	ADIA _y (x) Pos 10	-8.2	-6.8	-8.8	-4.7	4.1	6.1	7.5
19	ADIA _y (z) Pos 8	-7.5	-3.5	-7.0	-6.4	.6	4.1	8.1