APOLLO -14

J. LAWRENCE

Apollo 14 Mission H-1

Equipment

G&N 214 (CM-110) G&N 611 (LM-8)

Mission

Manned lunar landing in Fra Mauro Highlands (17°W x 3°S.)

Launch

31 January 1971, 3:23 PM EST ≈ 4 hr window, SA V #50

Mission Objectives

Lunar Surface EVA (2 periods up to 5 hours)
Contingency sample collection
Portable Life Support Systems Recharge
Pre-PDI LM state vector update evaluation
Bulk sample collection
Photographs of candidate exploration sites
Lunar surface characteristics
Lunar environment visibility
Landed LM location
Photographic coverage
Television coverage
Apollo lunar surface experiments, deployment/conduc

Crews

	Prime Crew	Backup Crew
Commander	Shepard	Cernan
CM Pilot	Roosa	Evans
LM Pilot	Mitchell	Engle

APOLLO 14

OPEN G&N PROBLEMS

OWA DUST COVER MOUNTING HARDWARE MISSING

FRR ITEMS REVIEWED AT MSC FRR BOARD

1) OWA DUST COVER MOUNTING HARDWARE MISSING
2) FLATPACK GOLD BALL BOND
3) FLATPACK " CBCS"
4) "A" HARNESS -13 SHORT CIRCUIT
5) FINE WIRE TRANSFORMER

APOLLO 13 CM 109-HARDWARE ANOMOLY

1) OWA "ZERO OPTICS DRIFT

CM-GENERIC ITEMS

1) AN ADDED PREVENTIVE MAINTENANCE REQUIREMENT OF 2,000 HOURS FOR IMU BLOWER MOTORS IS BEIN APPLIED TO IMU'S RECYCLED FOR RETEST/REPAIR OR MODIFICATION. THE BLOWER MOTORS IN IM 7 ARE WELL WITHIN THIS PREVENTIVE MAINTENANC PERIOD, HAVING EXPERIENCED 211 HOURS (S/N 210) AND 211 HOURS (S/N 208) PRIOR TO TCP-K-000.

2) CMC 45 HAS COMPLETED THE MODULE-LEVEL FLATPACK CONTAMINATION Y_A-Y_B VIBRATION

OF 60 MINUTES AND COMPUTER LEVEL Y_A - Y_B VIBRATION OF 14 MINUTES. ECDU 29 HAS EXPERIENCED NO Y_A - Y_B VIBRATION SCREEN.

3) ALL DSKY RELAYS HAVE COMPLETED THE RELAY-LEVEL VIBRATION. THE DSKY RELAYS HAVE BEEN VIBRATED AT THE SYSTEM LEVEL FOR CONTAMINATION DETECTION.

4) THE ONA-21 MOTOR TACHOMETERS IN APOLLO 14 WILL HAVE ACCRUED 4.2 YEARS OR LESS TOTAL TIME, INCLUDING MISSION TIME, WHICH IS CONSIDERED ACCEPTABLE FOR THIS MISSION.

5) EL MODULES 185 AND 195 CURRENTLY IN CM 110 HAVE SUCCESSFULLY COMPLETED THE VACUUM SCREEN FOR SAFETY GLASS DELAMINATIO

6) PINS BRUSH PLATED ON A-17, C-16, AND H-17 HARNESS. ALL THREE HARNESSES WERE LATER SUBJECTED TO THE IMPROVED CLEANING PROCESS.

7) IMU - WIRE BREAKAGE - IMU-7 HAS A NEW 3D HARNESS.

8) IMU QUICK DISCONNECTS ARE TO BE REPLACED AFTER 20 HOURS EXPOSURE T

ISOPROPYL ALCOHOL. THE INSTALLED QUICK DISCONNECTS, P/N 1000135, S/N 30 AND S/N 419 HAVE HAD 5.9 HOURS EXPOSURE TO ISOPROPYL ALCOHOL.

Problem Review

Blower Motor Failure History

Blower S/N	IMU S/N	Operating Time	Date of Failure Report
99	24	553	23 OCT 1967
91	7	1,760	4 MAR 1970
153	48	734	20 MAY 1970
96	9	1,616	16 JULY 1970
27	14	* 2,535 And Flight	
158	46	935 And Flight	28 August 1970

* Blower S/N 27 was found inoperative when the IM was torn down for part evaluation as part of the ALLIS Program. (Apollo 9)

Blower Motor Mission History

Flight	S/C	IMU S/N	Hours	
Apollo 7	CM-101	8	* 2,400	2,500
Apollo 8	CM-103	23	2,200	2,200
Apollo 9	CM-104	14	2,535	2,902
	LM-3	19	1,823	1,823
Apollo 10	CM-106	45	721	721
	LM-4	27	1,333	1,333

Apollo 11	CM-107	17	1441	2,865
	LM-5	11	3,298	799
Apollo 12	CM-108	46	872	872
	LM-6	15	2426	2426
Apollo 13	CM-109	47	700	700
	LM-7	28	358	769

* INCLUDING FLIGHT TIME, OTHER TIMES SHOWN ARE PRIOR TO FLIGHT.

Apollo 14 Blower operating hours - 30 Sept 70.

S/C	IMU S/N	Blower	Hours
CM-110	7	210	211
		208	211
LM-8	21	213	765
		80	1,725

ECDU-20

Problem:

A master alarm occurred during ICDU zero sequence of G&N functional test in CM-113 at NAR. ICDU fail and ISS warning were presen The IGA CDU coarse error was oscillating due to the IG read counter decrementing at -70° second. ECDU S/N 20 was removed from G&N 216 and sent to Delco.

Verification:

ECDU was tested in the G&N configuration in an engineering laboratory system and the oscillation was repeated.
The ECDU trays were separated. The inner gimbal read counter 212 was swapped with another read counter. The oscillati

PROBLEM FOLLOWED READ COUNTER 212. THE FAILU WAS ISOLATED TO THE 2^{-12} BIT COUNTER STAGE.

ISOLATION:

READ COUNTER P/N 2007140 S/N 212 WAS SENT RAYTHEON FOR FAILURE ISOLATION. THE FAILURE OF THE 2^{-12} BIT COUNTER STAGE WAS VERIFIED AT RAYTHEON. FAILURE ANALYSIS HAS ISOLATED THE FAILURE TO A SHORT CIRCUIT BETWEEN LAYER No 1 AND No 15 IN THE MATRIX. (HIGH RESISTANCE SHORT)

"A" HARNESS P/N 2021406, S/N 13

PROBLEM

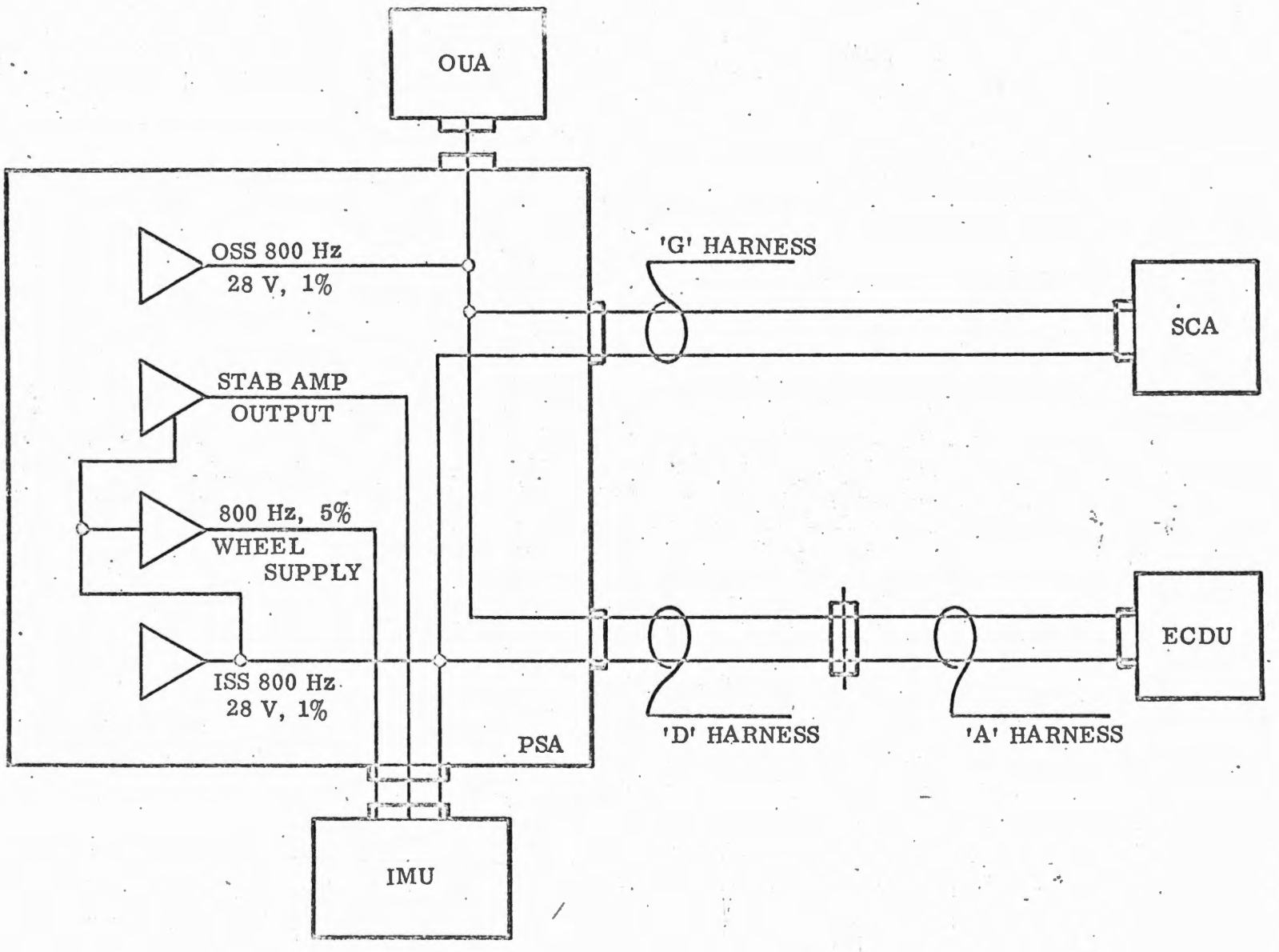
DURING POWER UP OF G&N 214 IN CM-110, OPTICS TURN ON CAUSED 5.25 VOLTS TO BE APPLIED TO THE IMU OPERATE BUSS. APPLICATION OF IMU OPERATE POWER CAUSED 8 VOLTS TO BE APPLIED TO THE OPTICS OPERATE BUSS.

VERIFICATION

LABORATORY SIMULATION WAS ACCOMPLISHED BY SHORTING THE OUTPUTS OF THE 800Ω 1% OSS AND 800Ω 1% ISS MODULES. X-RAY INSPECTION REVEALED AN APPARENT WIRE STRAND BETWEEN PINS 40 AND 41 OF CONNECTOR 56P1 (800Ω 1% ISS/OSS SIGNALS). CONTINUNITY CHECKS CONFIRMED AN INTERMITTENT SHORT BETWEEN THESE TWO CIRCUITS.

ISOLATION:

CONNECTOR WAS SECTIONED AND METALLIC PIECE WAS VERIFIED AS CAUSE OF SHORT BETWEEN PINS 40 AND 41. OPTICAL MEASUREMENT VERIFIES APPROXIMATE 34 GAUGE SIZE OF FOREIGN MATERIAL (SAME AS USED IN WIRES ON PINS 40 AND 41). HOWEVER, ALL STRANDS WERE PRESENT AND INTACT AT CRIMP JOINTS ON WIRES TO PINS 40 AND 41. ANALYSIS OF FOREIGN MATERIAL TO DETERMINE METALLIC CONTENT IS IN PROGRESS.


OUA
OSS 800 Hz
28 V, 1%
STAB AMP
OUTPUT
800 Hz, 5%
WHEEL
SUPPLY
ISS 800 Hz
28 V, 1%
PSA
IMU
'G' HARNESS
SCA
ECDU
'D' HARNESS
'A' HARNESS

COMPUTER S/N 51

PROBLEM:

DURING SPACECRAFT TESTING, OUTPUT CHANNEL 12 BIT 13 (SATURN INJECT SEQUENCE START) WAS SET AND COULD NOT BE RESET.

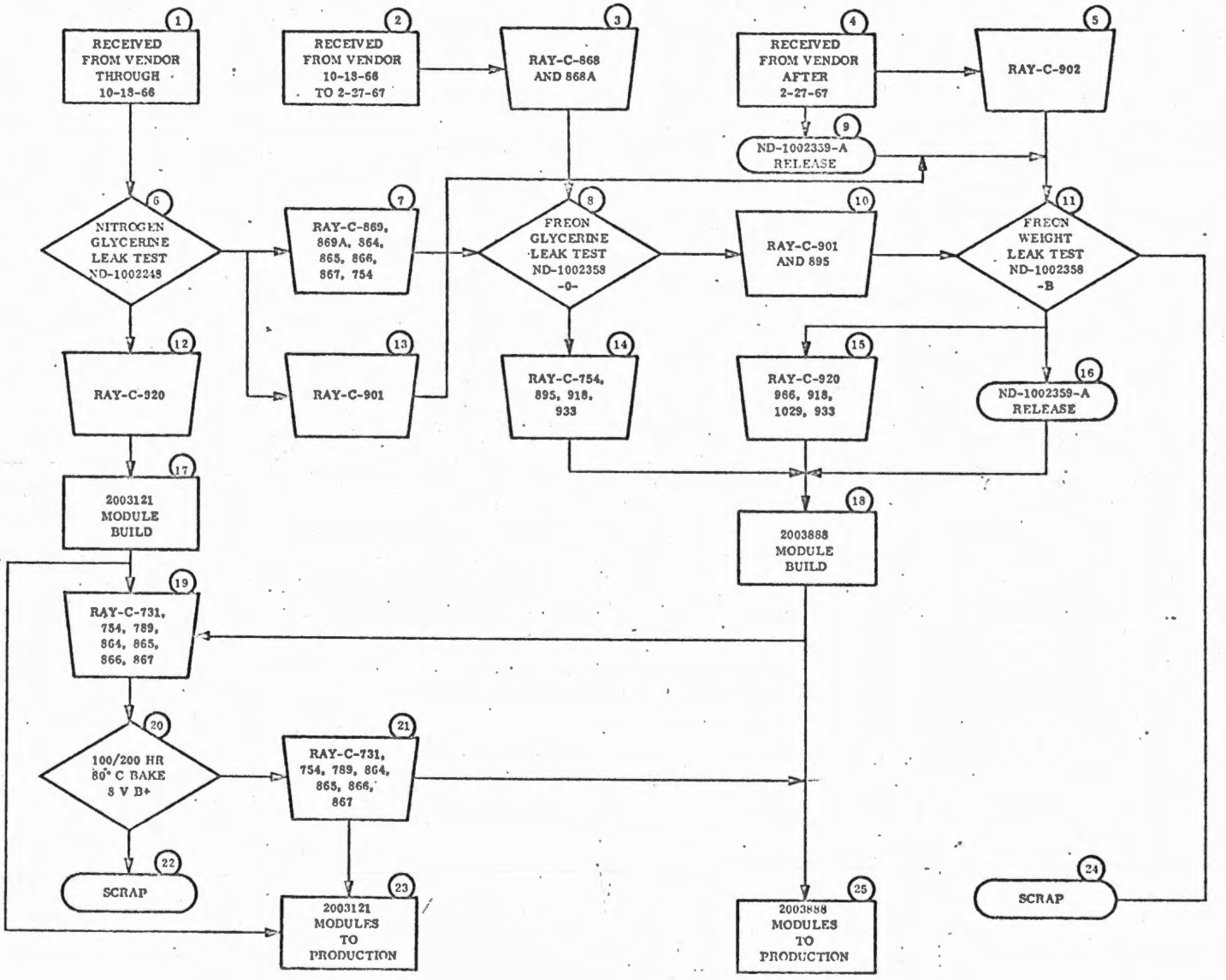
VERIFICATION:

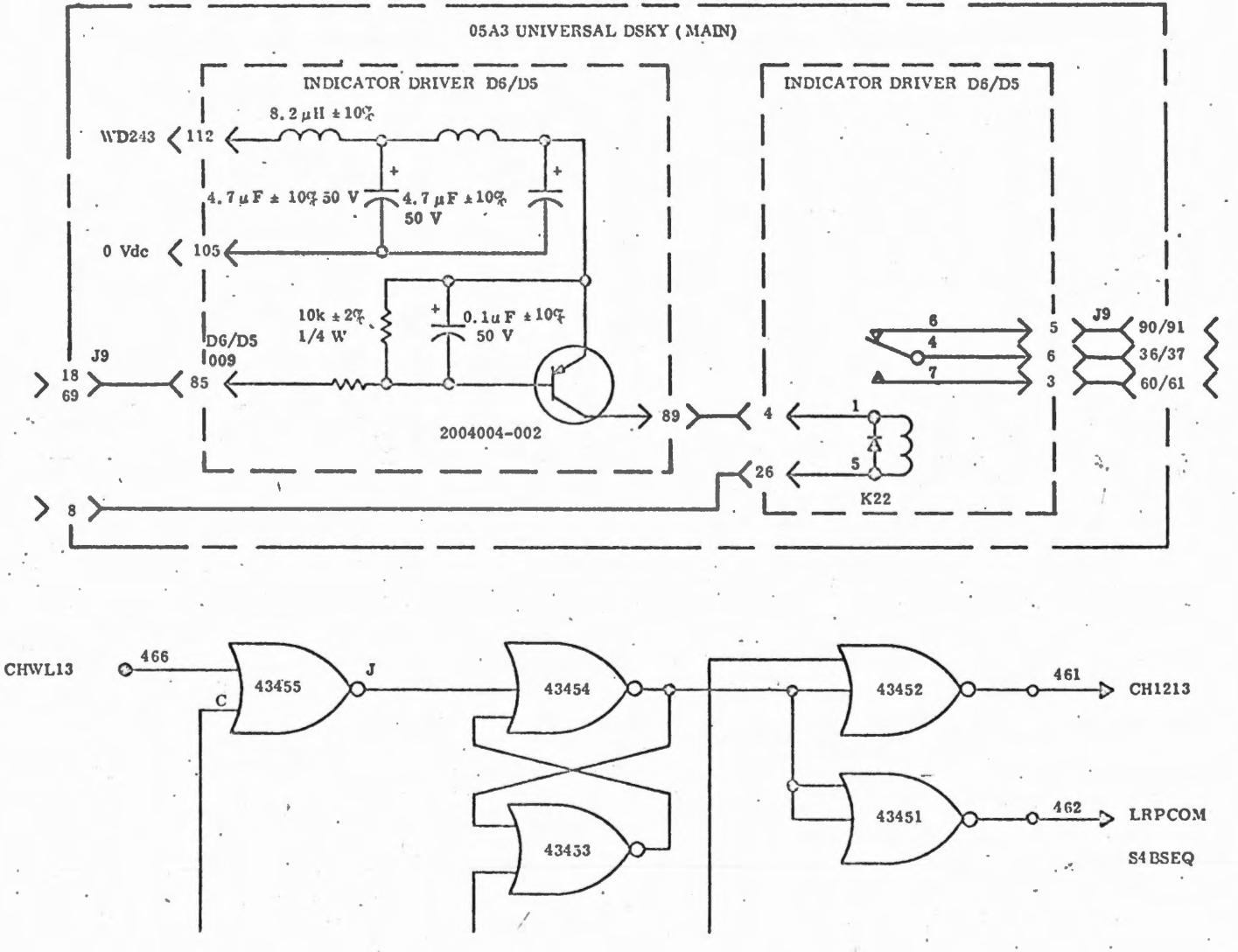
ANALYSIS INDICATED A PROBLEM WITH THE A-16 LOGIC MODULE ONLY. THE A-16 MODULE WAS REMOVED FROM THE COMPUTER AT RAYTHEON AND TESTED AT THE MODULE LEVEL PINS 461 AND 462 REMAINED A HARD "1" WHILE EXERCISING THE CLEAR SIGNAL AT PIN 361.

ISOLATION:

GATE 27 WAS DEPOTTED AND THE HARD "1" CONDITION WAS VERIFIED AT THE ASSOCIATED PINS. THE MICROLOGIC WAS REMOVED AND OPENED. THE CHIP EXHIBITED A MOTTLED APPEARANCE WITH NUMEROUS ERUPTIONS IN THE METALLIZATION. CHEMICAL ANALYSIS INDICATED HIGH TIN AND CHLORIDE CONTENT IN THE AFFECTED AREAS.

LEAK TEST FLOW DIAGRAM




05A3 UNIVERSAL DSKY (MAIN)
INDICATOR DRIVER D6/D5
INDICATOR DRIVER D6/D5
8.2 μH ±10%
WD243
112
4.7 μF ± 10% 50 V
4.7 μF ±10%
50 V
0 Vdc
105
10k ±2%
1/4 W
0.1u F ±10%
50 V
D6/D5
009
J9
18
69
85
2004004-002
89
4
1
5
26
K22
6
4
7
5
6
3
J9
90/91
36/37
60/61
8
CHWL13
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43452
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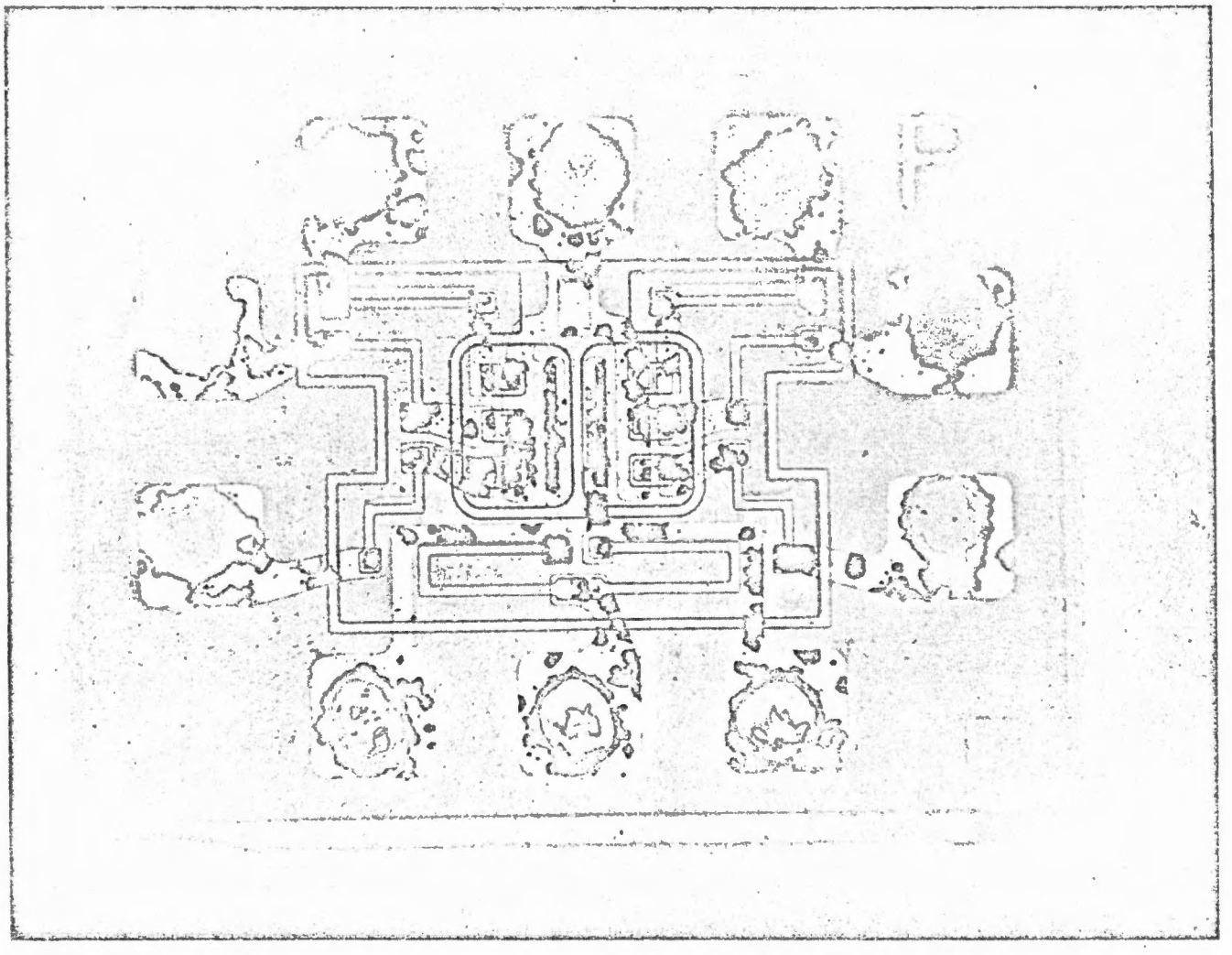
43451
462
LRPCOM
S4BSEQ



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• DUAL NORGATE INTEGRATED CIRCUIT P/N 100 6321

USAGE:

COMPUTER – 2,432 PARTS/COMPUTER
ECDU – 1,304 PARTS/ECDU
TOTAL – 159,344 PARTS

OPERATING HOURS: (AS OF 1 NOV. 70)

COMPUTER – 128,200,448 PART HOURS
ECDU – 60,094,84 PART HOURS
TOTAL – 188,295,288 PART HOURS

HISTORY:

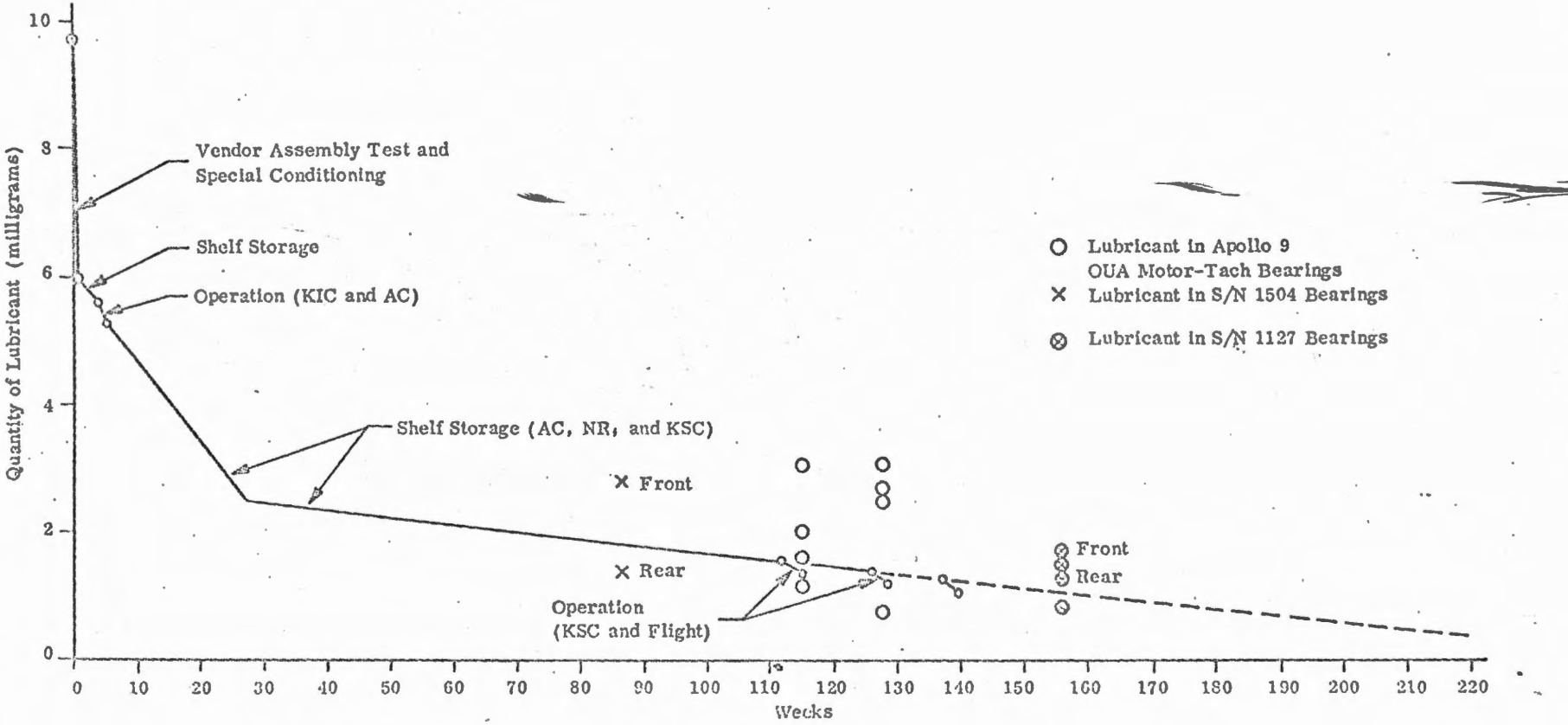
FAILURES DUE TO LIFTED BONDS
BUILD CYCLE – 9
FIELD — 3

FIELD FAILURE SUMMARY

SEPT 1970, ECDU S/N 47, READ COUNTER S/N 269, LOT #99
SEPT 1970, ECDU S/N 48, READ COUNTER S/N 231, LOT 052
JAN 1969, COMPUTER S/N 43, A-6 LOGIC MODULES S/N 44, LO
0331

• MOTOR TACHOMETER

LUBRICANT LOSS DURING LIFE OF OUA MOTOR-TACH



LIMITED LIFE ITEMS

PART NUMBER, DESCRIPTION	LOWEST REPLACEABLE ASSEMBLY	REPLACEMENT CRITERIA	TOTAL TEST TIME/CYCLES	RATIONALE
Motor-tachometer P/N 1012156-4 S/N 1258 S/N 1267 S/N 1268 S/N 1308	OUA-21	4 Years since lubrication	4.2 Years at completion of mission	**Condition** 1. Based upon the test data from 2-year and 3-year old motors, the lubrication quantity retained (LQR) in the bearings was extrapolated to 4 years (assuming that this period was adequate to certify the motor-tachs in Apollo 14) and found to be approximately 0.3 mg and considered flightworthy. 2. Projected LQR curve is biased conservative since 3/4 of actual test motor-tachs LQR was above the curve used for the extrapolation in the above paragraph. 3. The maximum dispersion between similar motor-tachs was 2.3 mg. Test Data from 3-year old motor-tachs was analyzed. 1. All motor-tachs tested to determine flightworthiness as a function of time operated satisfactorily with little or no measurable lubricant. One motor-tach was run with completely dry bearings without anomaly. 2. Lubricant depletion during normal operation at $\approx$ 0.6 mg/yr after the first year. 3. Lubricant depletion during operation at KSC (including altitude test and operation) and during nominal lunar mission $\approx$ 0.2 mg. 4. A supplementary 120-day test in vacuum to a simulated mission profile was performed without significant motor-tach lubricant depletion. **Conclusion** 1. Recognizing the above conditions and test data it is evident that there is little difference between a 4-year-old motor-tach and one that is 4.2 years old. 2. Based on the LQR curve projection there would be 0.2 mg of lubricant remaining before the Apollo 14 mission. 3. Since $\approx$ 0.2 mg is exhausted during the mission and the motor-tachs tested performed nominally on zero and immeasurable lubricant, OUA-21 in Apollo 14 is considered flightworthy. There is an element of risk in the extrapolation; it is considered that this risk is acceptable.

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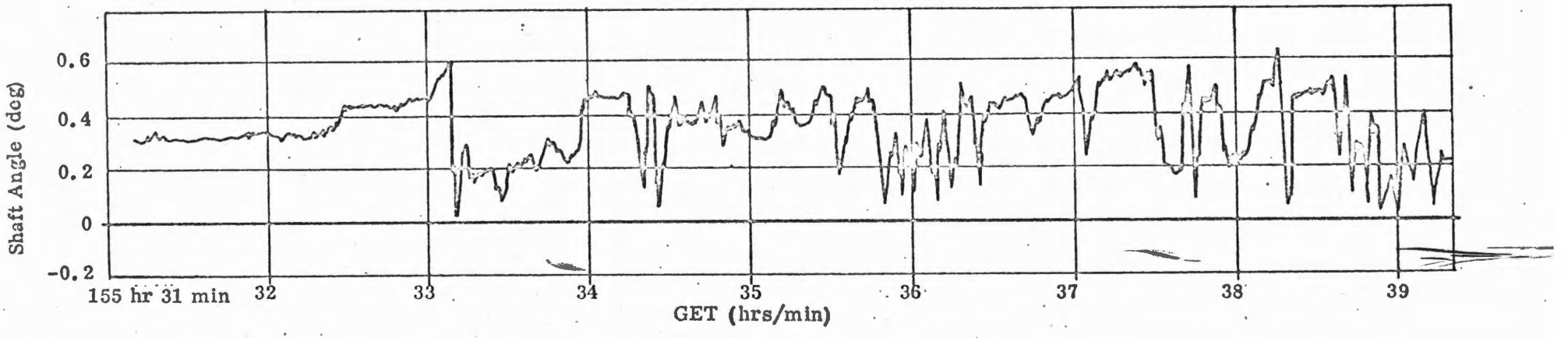
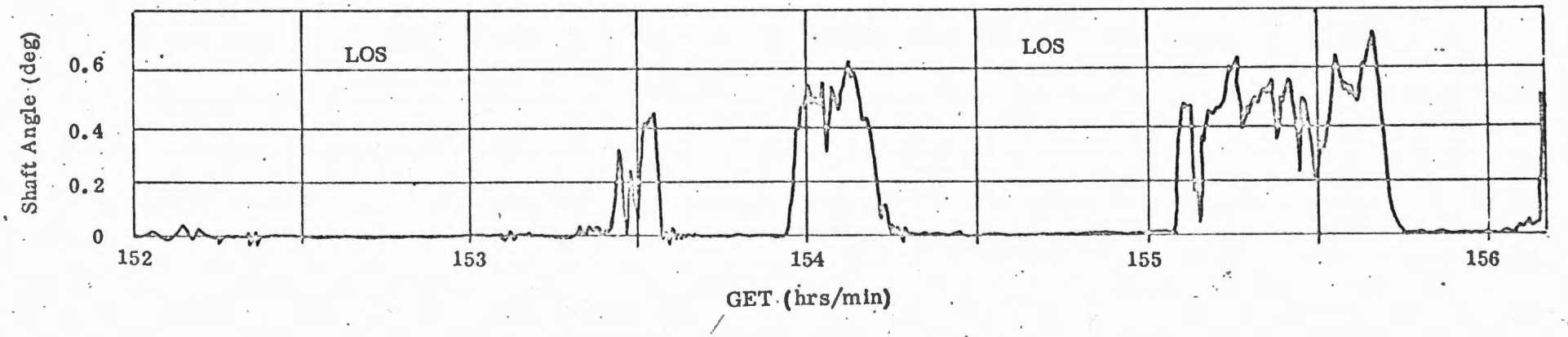
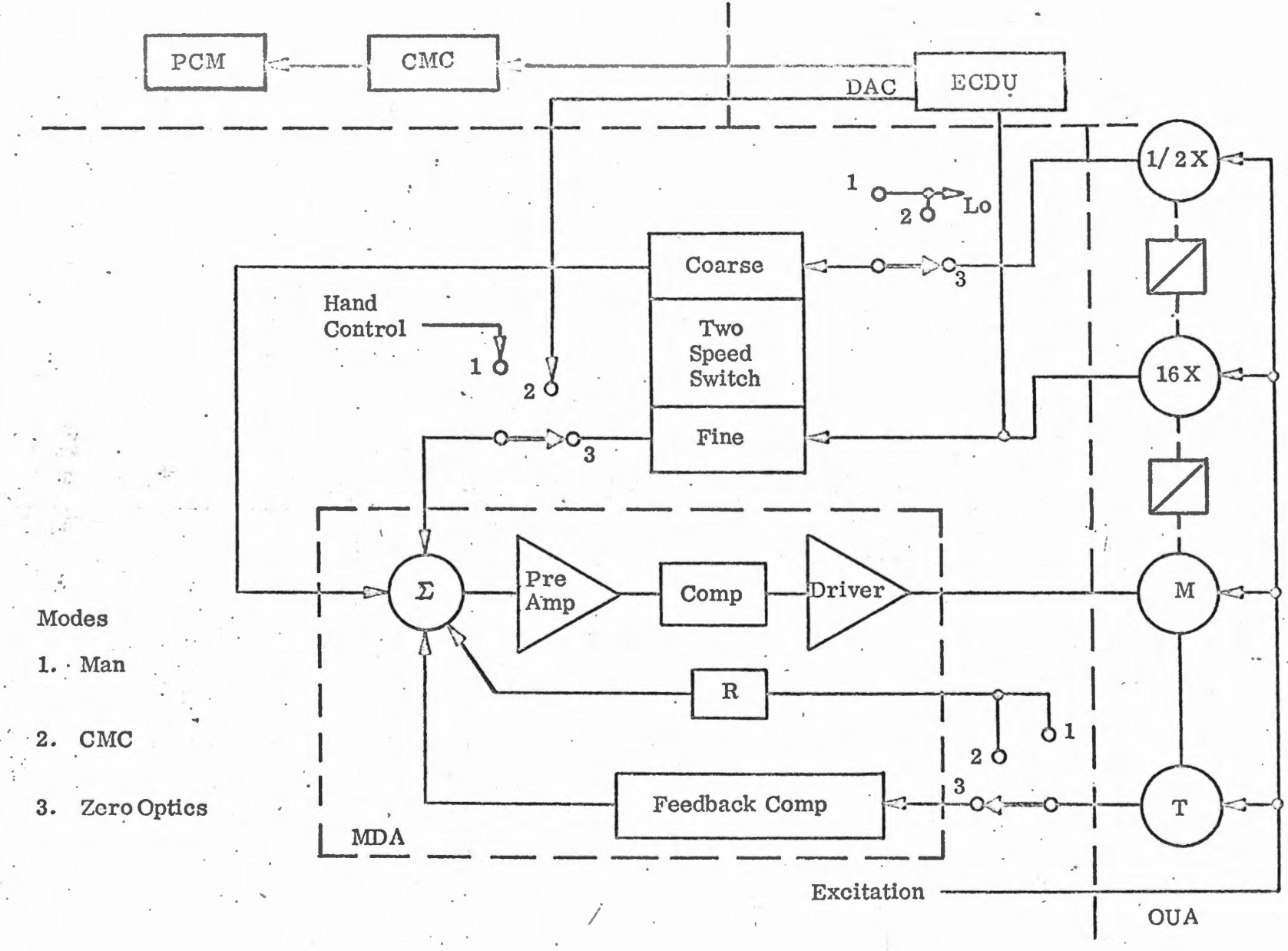
APOLLO 12/CSM 108 OPTICS CDU SHAFT ANGLE DATA



OPTICS SHAFT ANGLE LONG-TERM STABILITY



• OPTICS ZERO DRIFT



Modes

1. Man

2. CMC

3. Zero Optics

CM-109/CM-110 Configuration Differences

1) Mission peculiar items include Comanche 108 flight ropes, star list, alignment procedure panel, check list and alarm codes, verb/noun list
2) CMC-45 includes a restart monitor module, which has not previously flown.
3) GNIC-13 includes the computer aided optics modification, which has not previously flown.
4) Sxt mirror housing includes a halo light shield which has not previously flown.

Reused Hardware

NONE

GTN 214 Ready Spares Support For Apollo 14

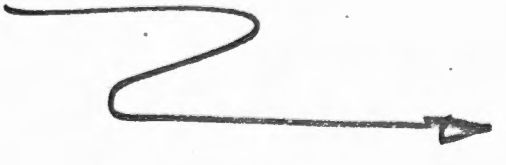
1) Only the follow equipment is available at KSC.

Part No	Component	S/N
2007234-021	SCA	1
2010802-	Flight Ropes	

Other Spares are located at Delco, NAR and GAC.

IMU/PTA	SN-29 and 13
Computer	52
ECDU	23
PSA	24

The following pages show whats in the system and how it got there.

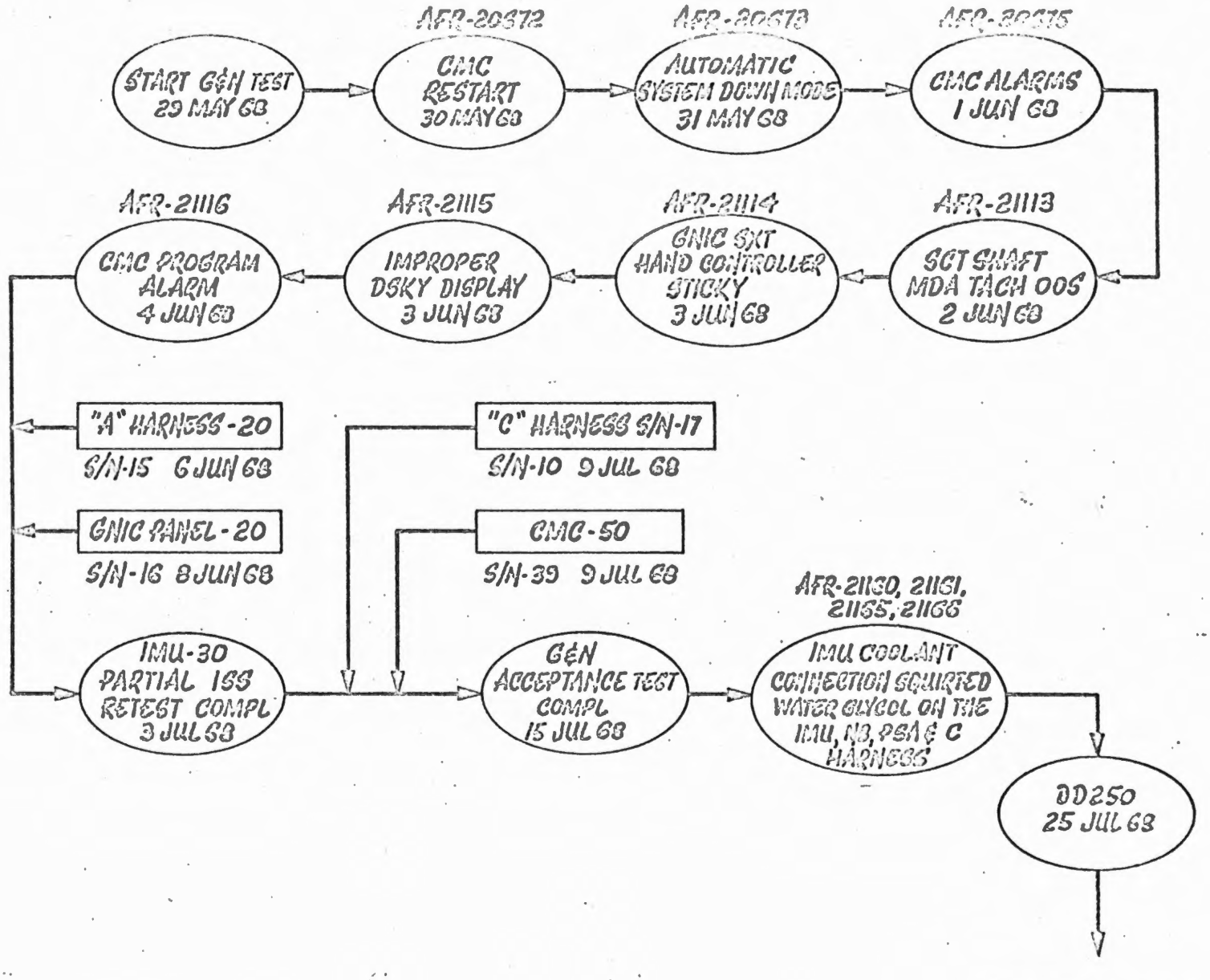


G&N 214 SYSTEM SUMMARY

EQUIPMENT	PART NUMBER	S/N	OPERATING HOURS AS OF 10-31-70	WEIGHT
Inertial Measurement Unit (IMU)	2018601-231	7	3003	41.1
IRIG X		8A109		
Y		8A107		
Z		8A111		
PIPA X		2AP97R		
Y		2AP150		
Z		2AP185		
Blower Motors	2018644	208	211	
		210	211	
PIPA Electronics Assembly (PEA)	2007201-031	5	3220	8.4
CM Guidance Computer(CMC)	2003993-111	45(C-29)	317	59.2
Flight Ropes	2010802-xxx	--*		12.4
DSKY Main	2003994-121	77 (D-44)	898	18.2
DSKY Navigation	2003994-121	69 (D-36)	895	18.1
Power and Servo Assembly (PSA)	2007200-151	10	2523	49.7
Signal Conditioner Assembly (SCA)	2007234-021	12	460	5.9
G & N Indicator Control Panel (GNIC)	2021290-051	13	514	14.6
Interconnect Harness Group	2014567-071	28		24.4
Navigation Base	2899982-031	16		11.2
Optical Unit and Bellows Assembly	2010790-181	7		60.4
Optical Unit Assembly (OUA)	2011000-081	21	735	—
Electronic Data Coupling Unit (ECDU)	2007222-181	23	1320	36.7
Optics Shroud	2021394-011	5		3.5
Eyepiece Storage Unit (ESU)	2021382-021	12		7.0
Astrosextant Passive Thermal Protective System Assembly (APTPS)	1021373-051	5		4.8
Dust Covers (External)	1021352/62	12, 12		—
(Internal)	2012796/97	8, 5		0.5
Verb Noun	2021472	TBA		—
Star Chart	2021473	TBA		—
Check List and Alarm Codes	2021474	TBA		—
Eyepieces				
SCT Eyepiece	2012793-011	2023		2.0
SCT Prism Assembly	2012775	2023		1.1
SXT Eyepiece	2012700-011	2016		0.7
SXT Mirror Assembly	2012791-021	2006		1.3
SCT Long Eye Relief	2012790-011	2022		1.7
SXT Long Eye Relief	2012748-011	2021		0.5
Installation Kits (CMC)	2004199-011	16		(in CMC wt)
(OUA)	2899950-021	15		4.5
IMU Coolant Hoses (2)	2018821-021	120, 129		1.0
			TOTAL	388.9

*, Flight Ropes — Comanche Rev. 108, Set 1

P/N 2010802-181, S/N 424	P/N 2020802-221, S/N 427
191, S/N 425	231, S/N 422
211, S/N 426	241, S/N 423



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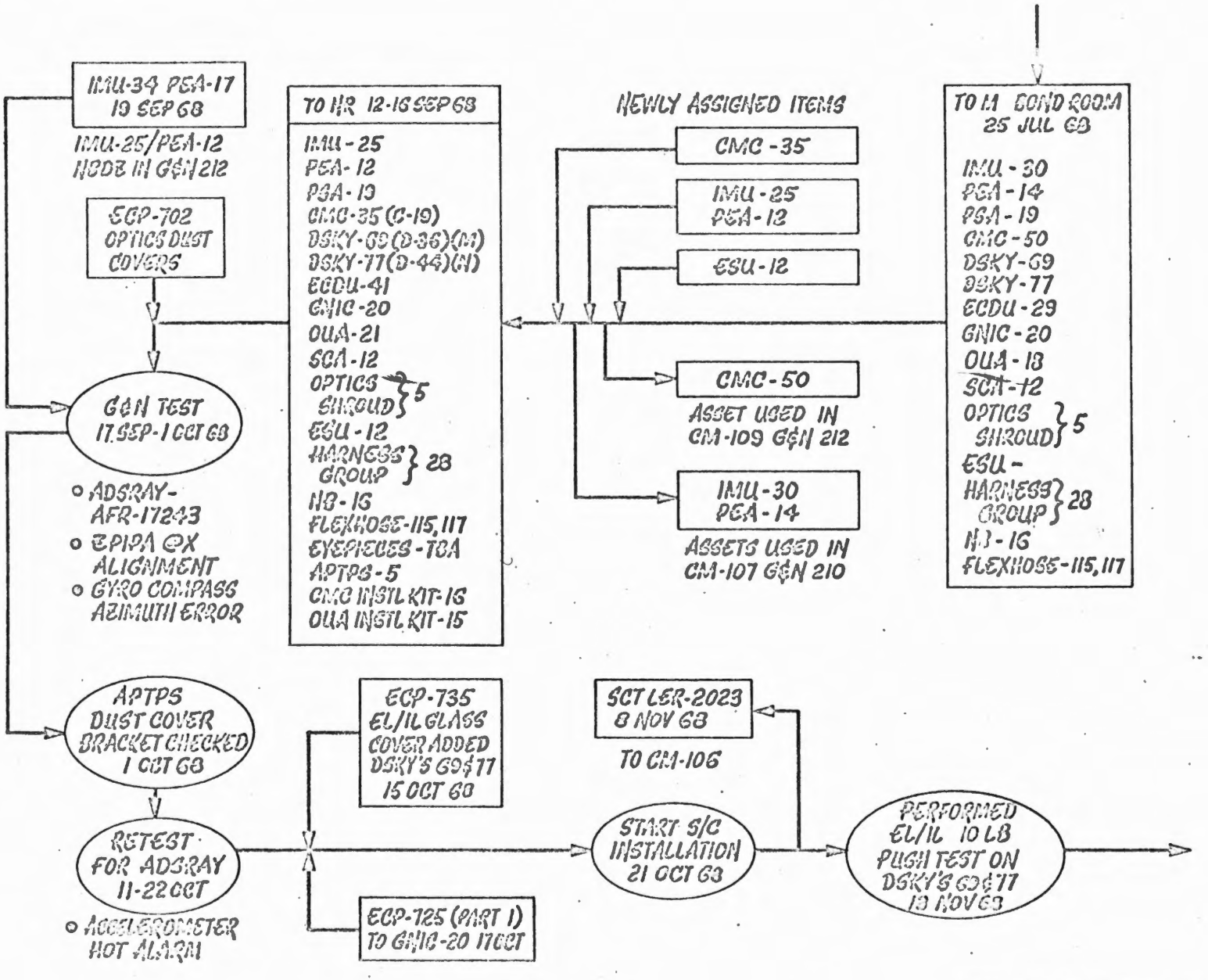

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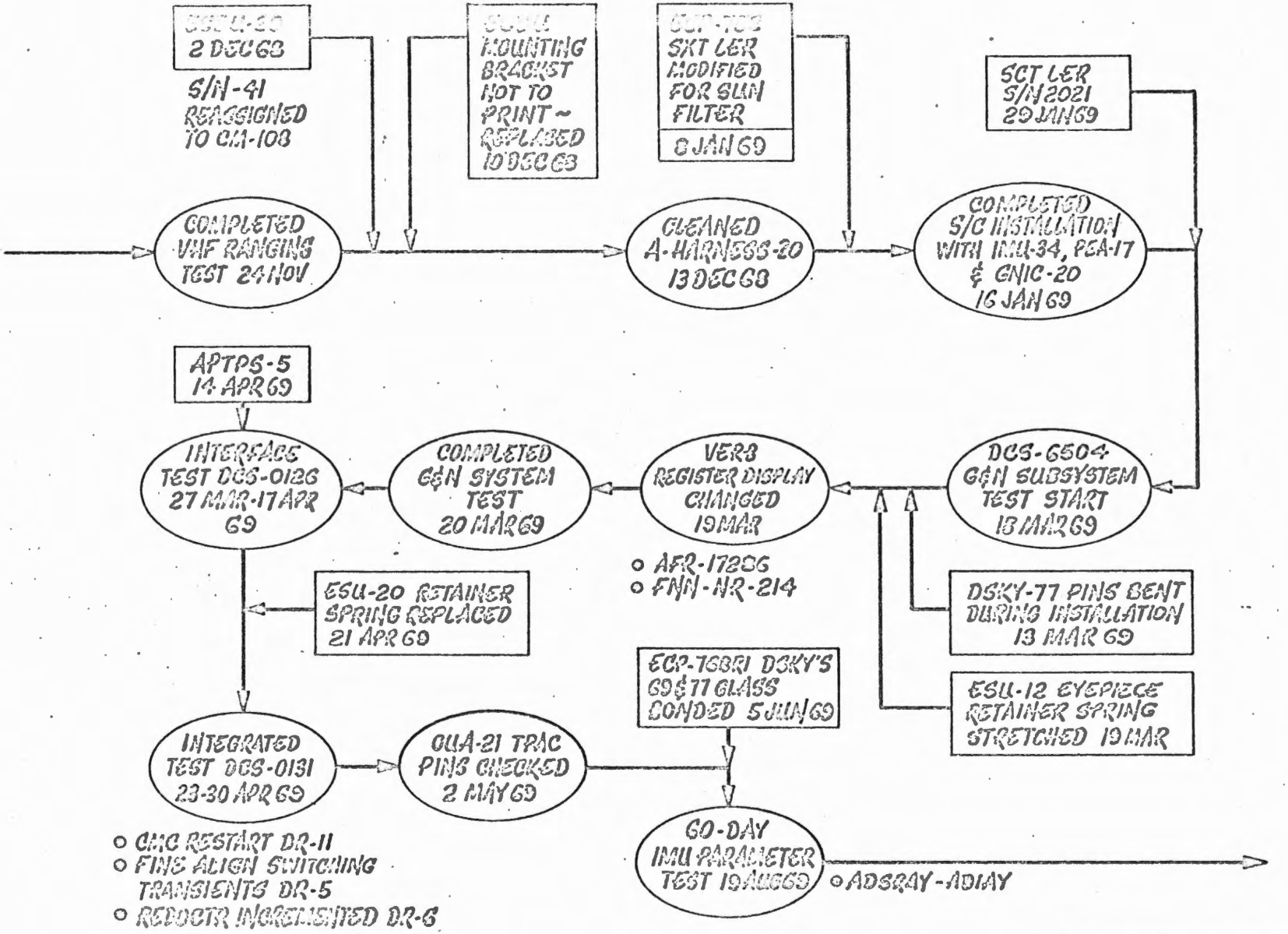

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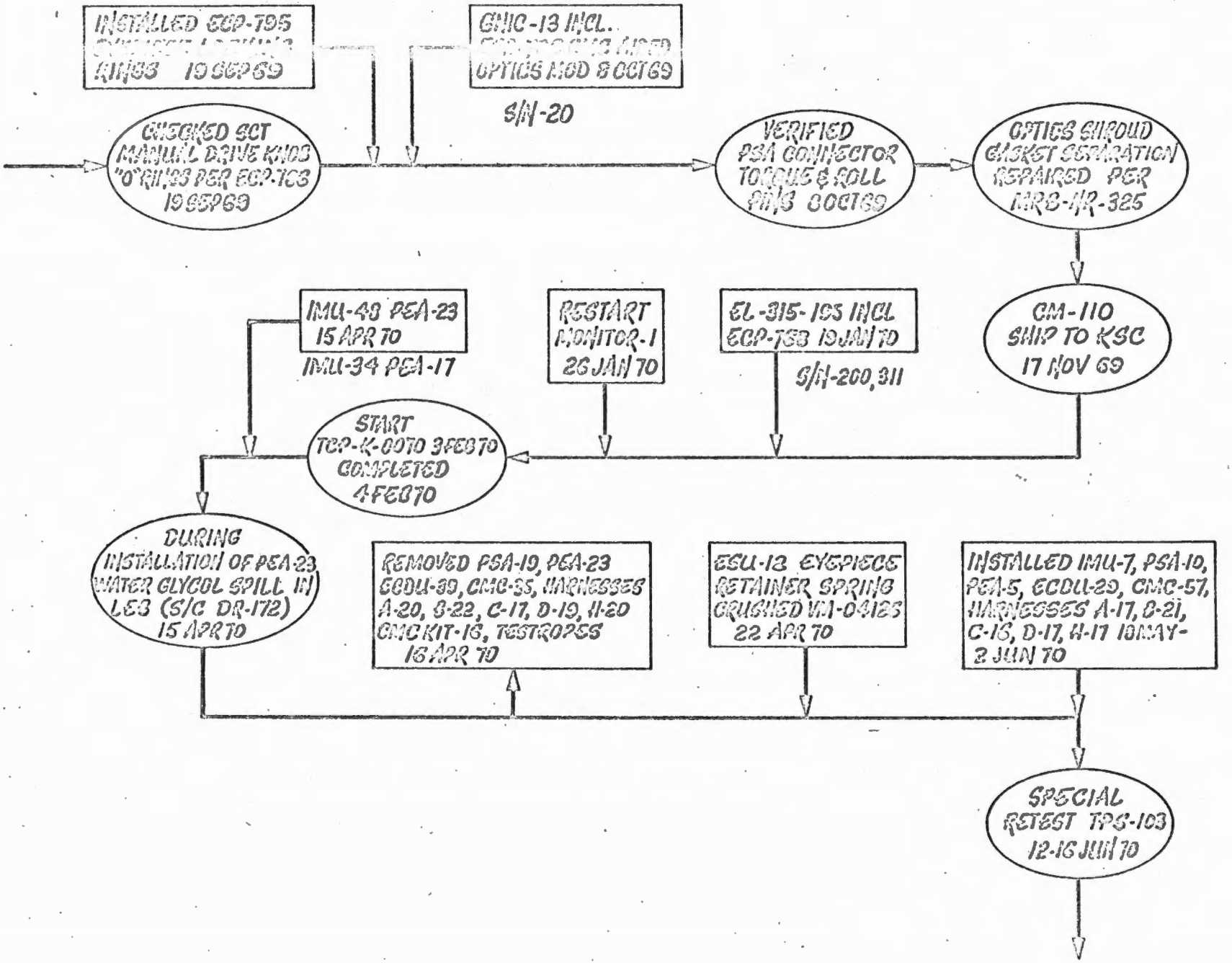
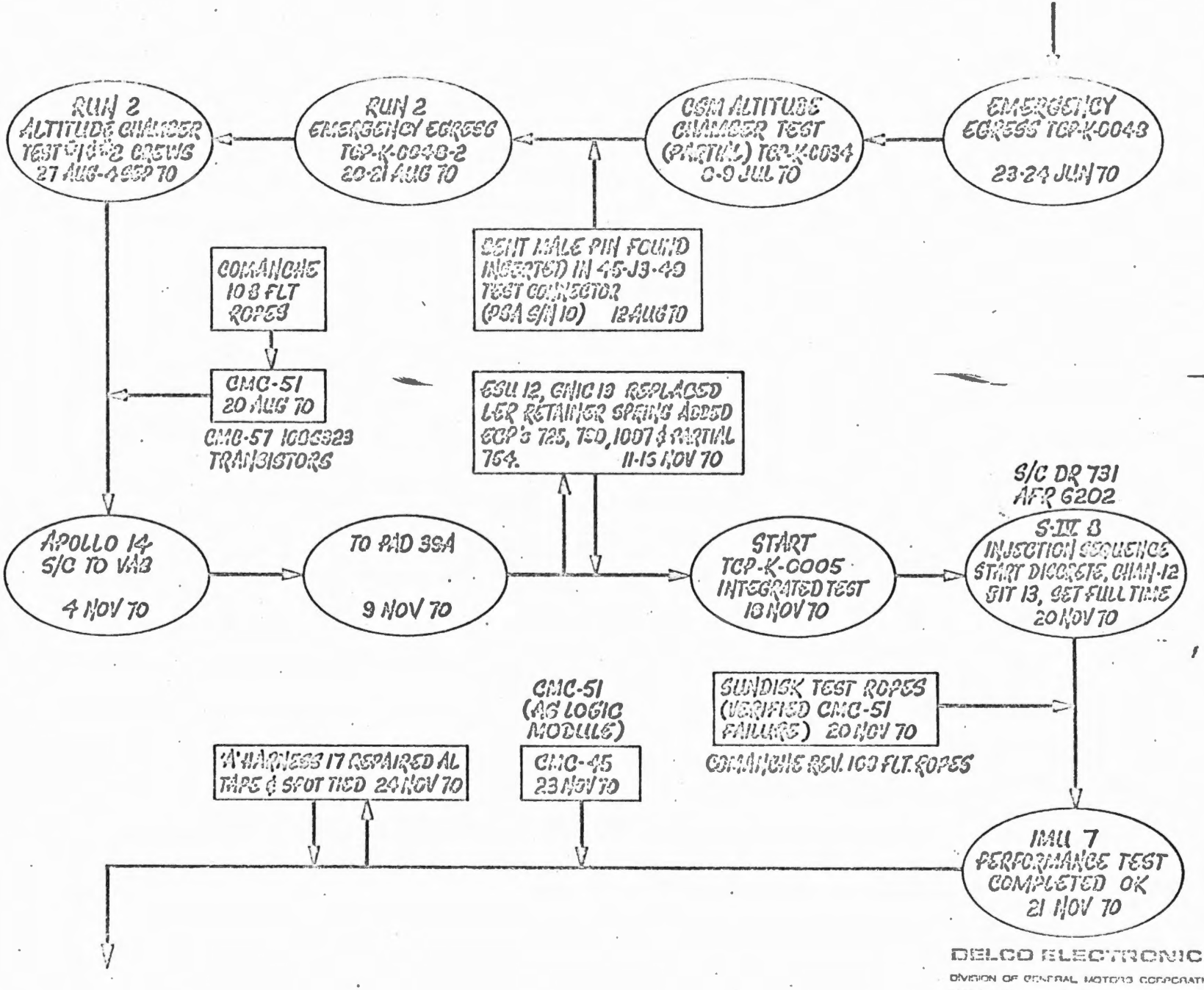

INSTALLED ECP-795
KIT/S3 19 SEP 69
CMC-13 INCL.
OPTICS MOD 8 OCT 69
S/N-20
CHECKED SCT
MANUAL DRIVE KNOB
"O" RINGS PER ECP-763
19 SEP 69
VERIFIED
PSA CONNECTOR
TORQUE & ROLL
PINS 8 OCT 69
OPTICS SHROUD
GASKET SEPARATION
REPAIRED PER
MRB-HR-325
IMU-48 PEA-23
15 APR 70
IMU-34 PEA-17
RESTART
MONITOR-1
26 JAN 70
EL-315-105 INCL
ECP-758 19 JAN 70
S/N-200, 311
CM-110
SHIP TO KSC
17 NOV 69
START
TCP-K-0070 3 FEB 70
COMPLETED
4 FEB 70
DURING
INSTALLATION OF PEA-23
WATER GLYCOL SPILL IN
LEB (S/C DR-172)
15 APR 70
REMOVED PSA-19, PEA-23
ECDU-39, CMC-35, HARNESSES
A-20, B-22, C-17, D-19, H-20
CMC KIT-16, TESTROPES
16 APR 70
ESU-13 EYEPIECE
RETAINER SPRING
CRUSHED VIA 0-4126
22 APR 70
INSTALLED IMU-7, PSA-10,
PEA-5, ECDU-29, CMC-57,
HARNESSES A-17, B-21,
C-16, D-17, H-17 18 MAY-
2 JUN 70
SPECIAL
RETEST TPS-103
12-16 JUN 70



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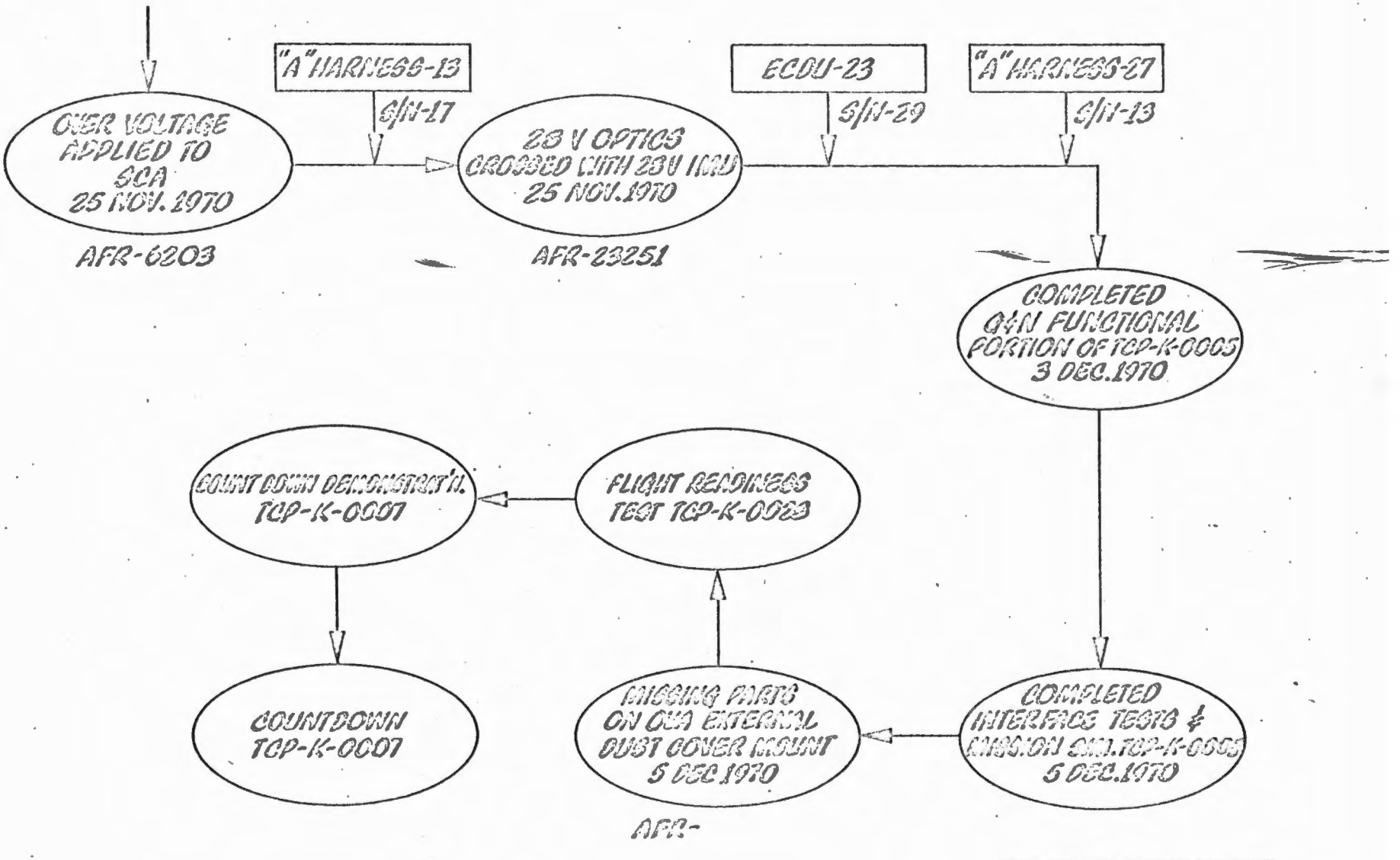

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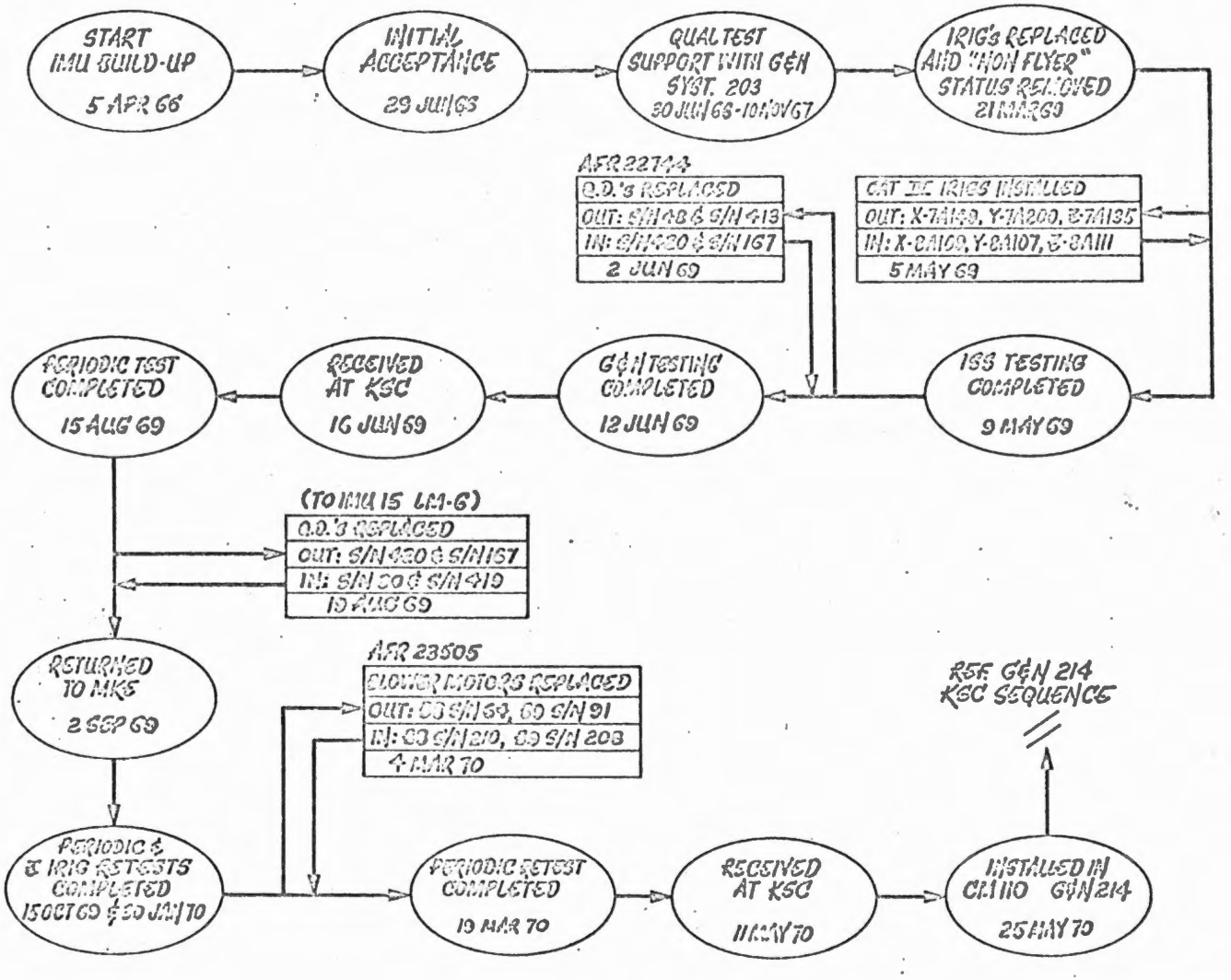
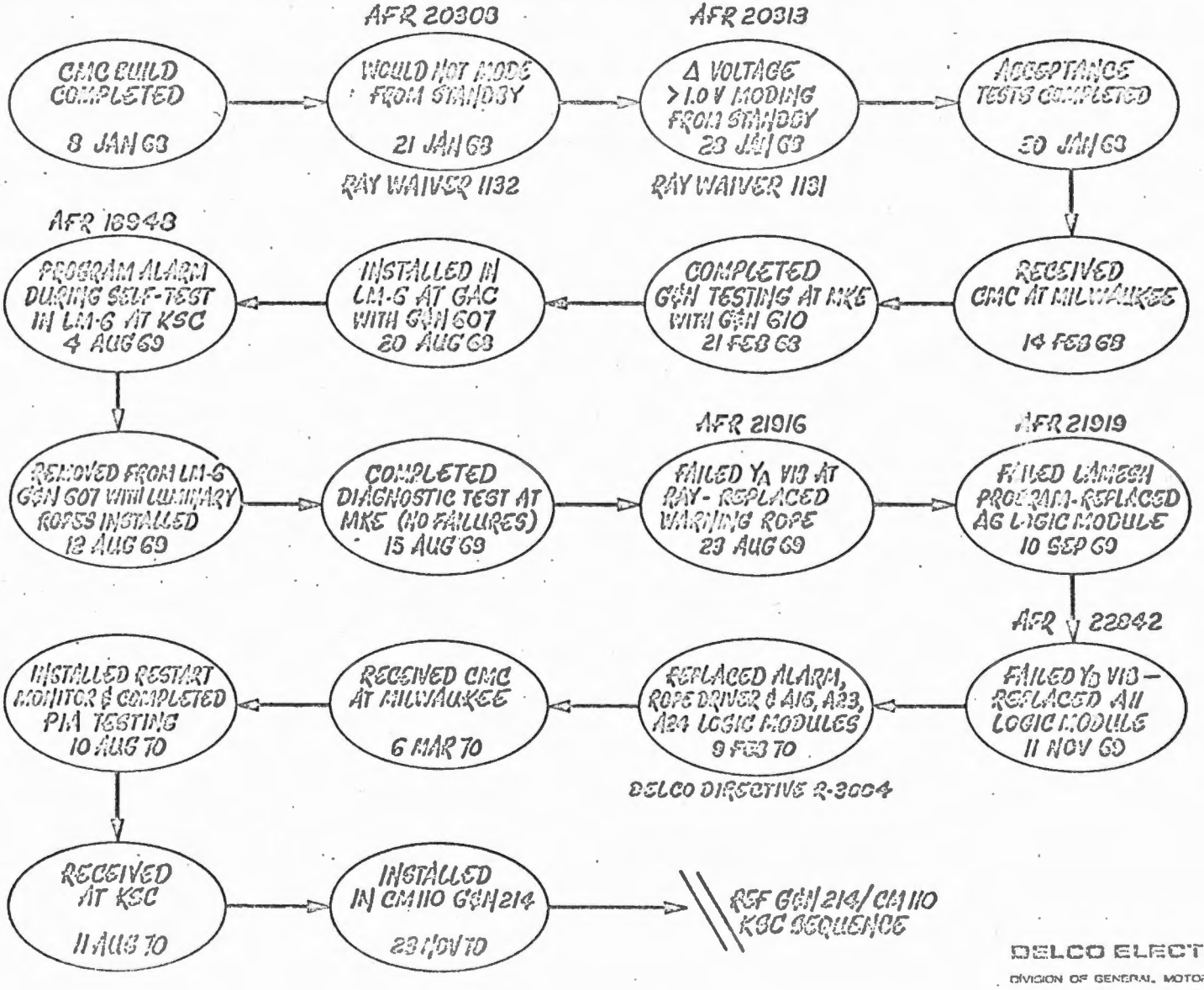

START IMU BUILD-UP 5 APR 66
INITIAL ACCEPTANCE 29 JUN 68
QUAL TEST SUPPORT WITH GEN SYST. 203 30 JUN 68 - 10 NOV 67
IRIG's REPLACED AND "HON FLYER" STATUS REMOVED 21 MAR 69
AFR 22744
Q.D.'s REPLACED
OUT: S/N 408 & S/N 413
IN: S/N 420 & S/N 167
2 JUN 69
CAT IIC IRIGS INSTALLED
OUT: X-7A139, Y-7A200, Z-7A135
IN: X-8A109, Y-8A107, Z-8A111
5 MAY 69
PERIODIC TEST COMPLETED 15 AUG 69
RECEIVED AT KSC 16 JUN 69
G&N TESTING COMPLETED 12 JUN 69
ISS TESTING COMPLETED 9 MAY 69
(TO IMU IS LM-6)
Q.D.'s REPLACED
OUT: S/N 420 & S/N 167
IN: S/N 20 & S/N 419
19 AUG 69
RETURNED TO MKS 2 SEP 69
AFR 23505
BLOWER MOTORS REPLACED
OUT: CO S/N 69, CO S/N 91
IN: CO S/N 210, CO S/N 208
4 MAR 70
REF G&N 214 KSC SEQUENCE
PERIODIC & IRIG RETESTS COMPLETED 15 OCT 69 & 30 JAN 70
PERIODIC RETEST COMPLETED 19 MAR 70
RECEIVED AT KSC 11 MAY 70
INSTALLED IN CM 110 G&N 214 25 MAY 70

CM-110, G&N 614, CMC S/N 45

VIB. TIME: Y_A-Y_B MODULE LEVEL ½ MIN.; Y_A-Y_B COMPUTER LEVEL 14 MIN.



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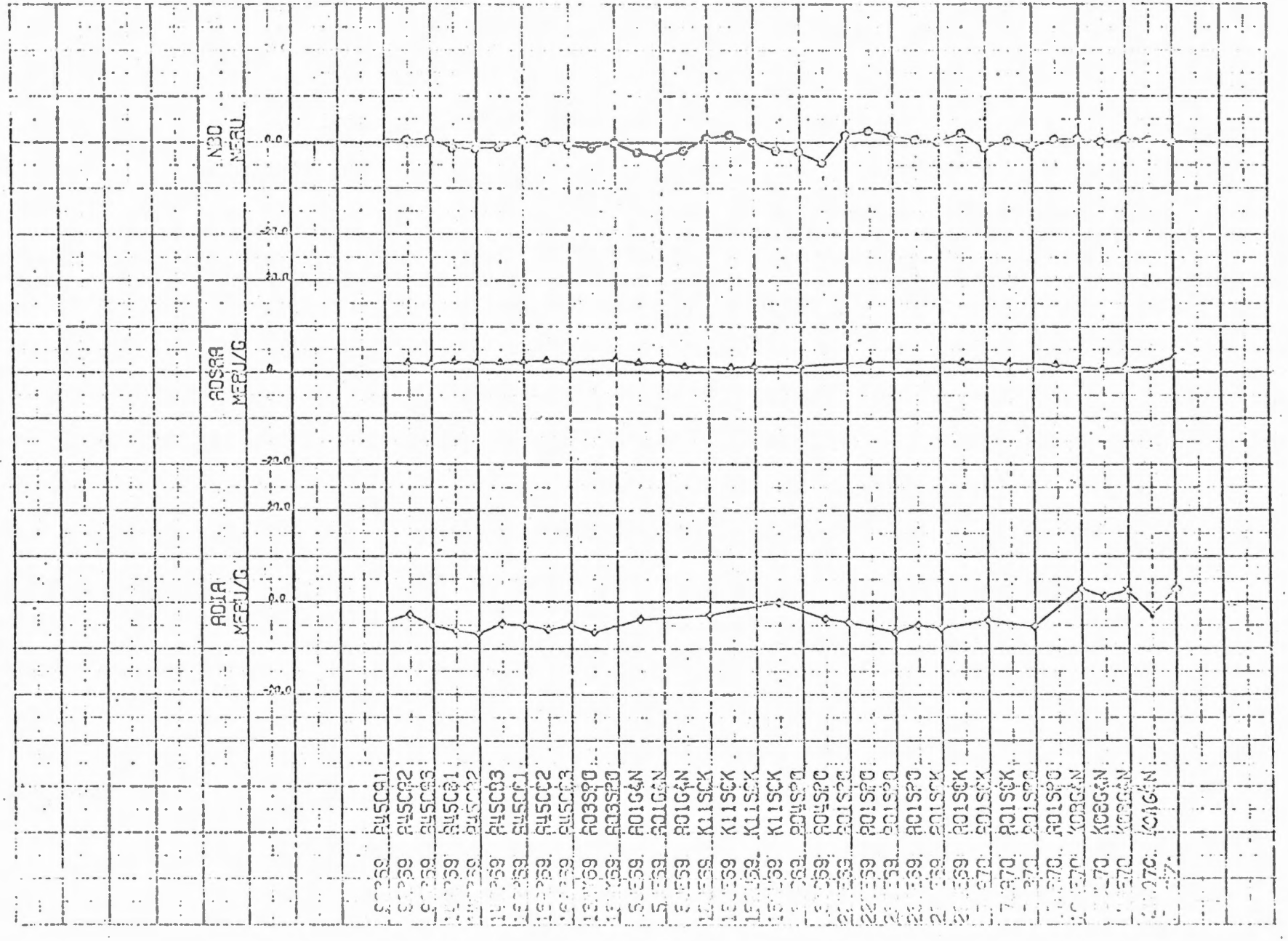
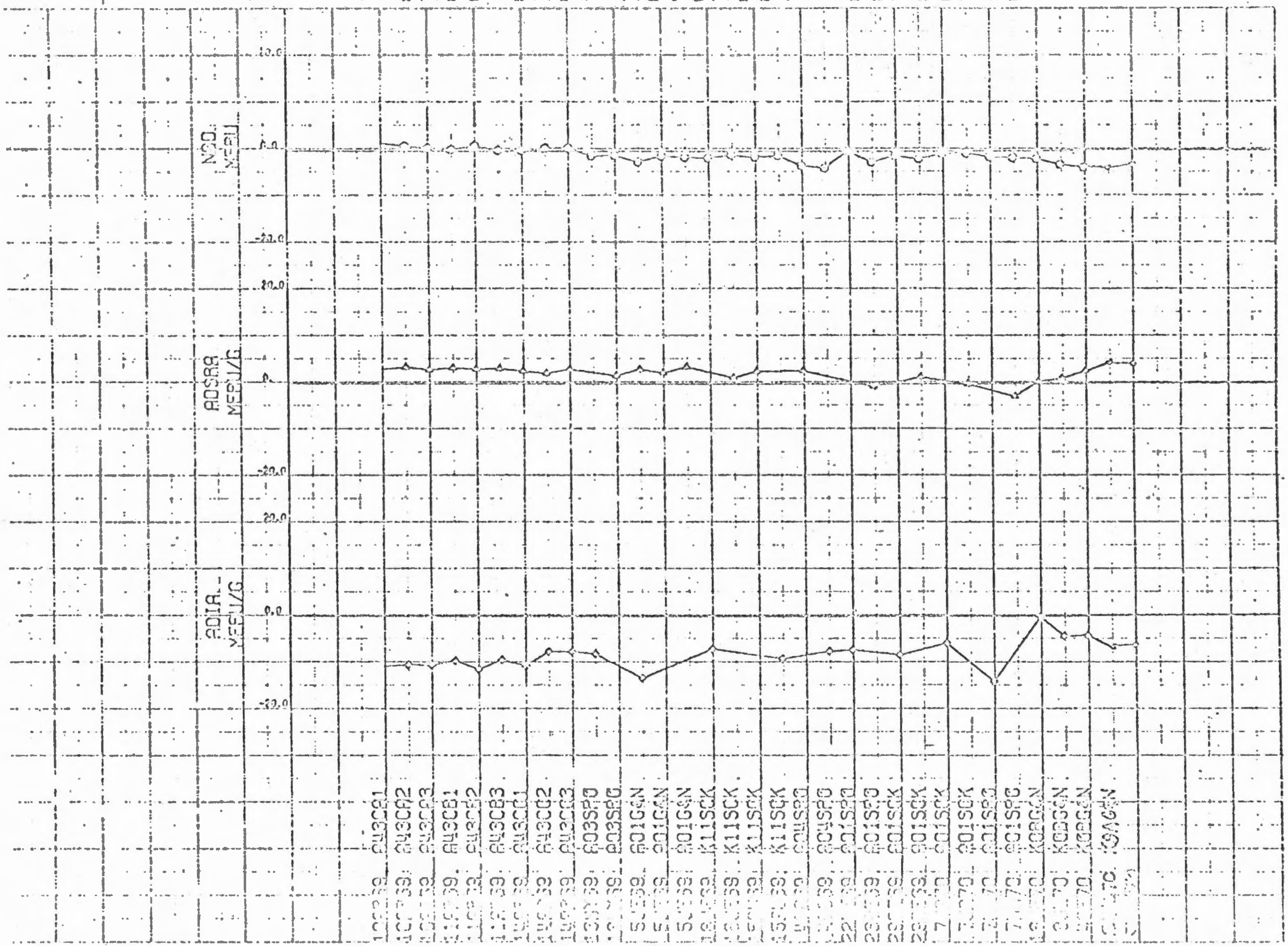
X IRIG .UNIT NO. 8A109 ~~09/09/70~~ 12/3/70



LEGEND: ○ N3D △ A0SA9 ◇ A01A

0023-31-5

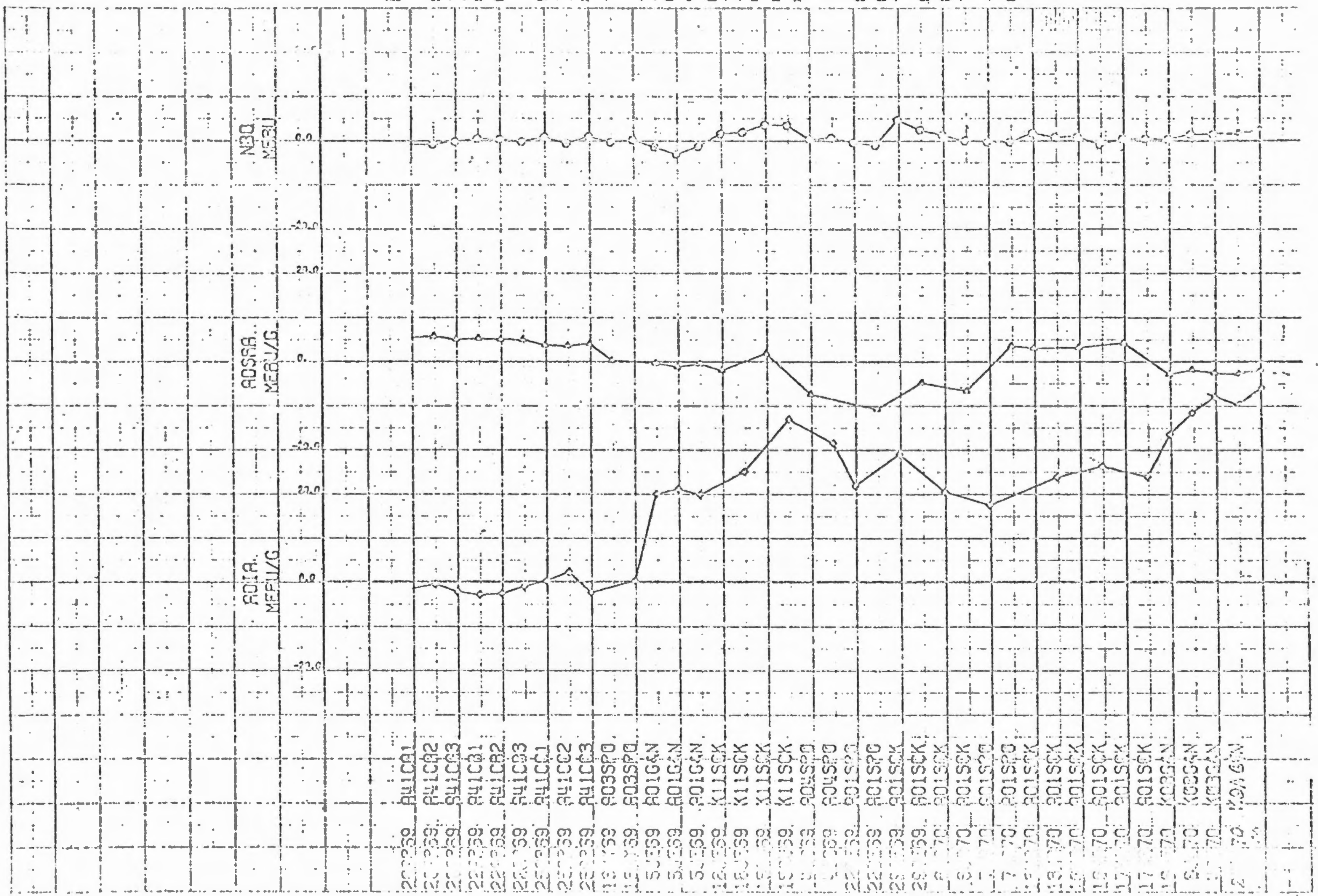
Y IRIG UNIT NO.8A107 ~~09/09~~ 12/03/70



LEGEND: ○ NDO △ ADSRA ◇ ADIA

0023-31-8

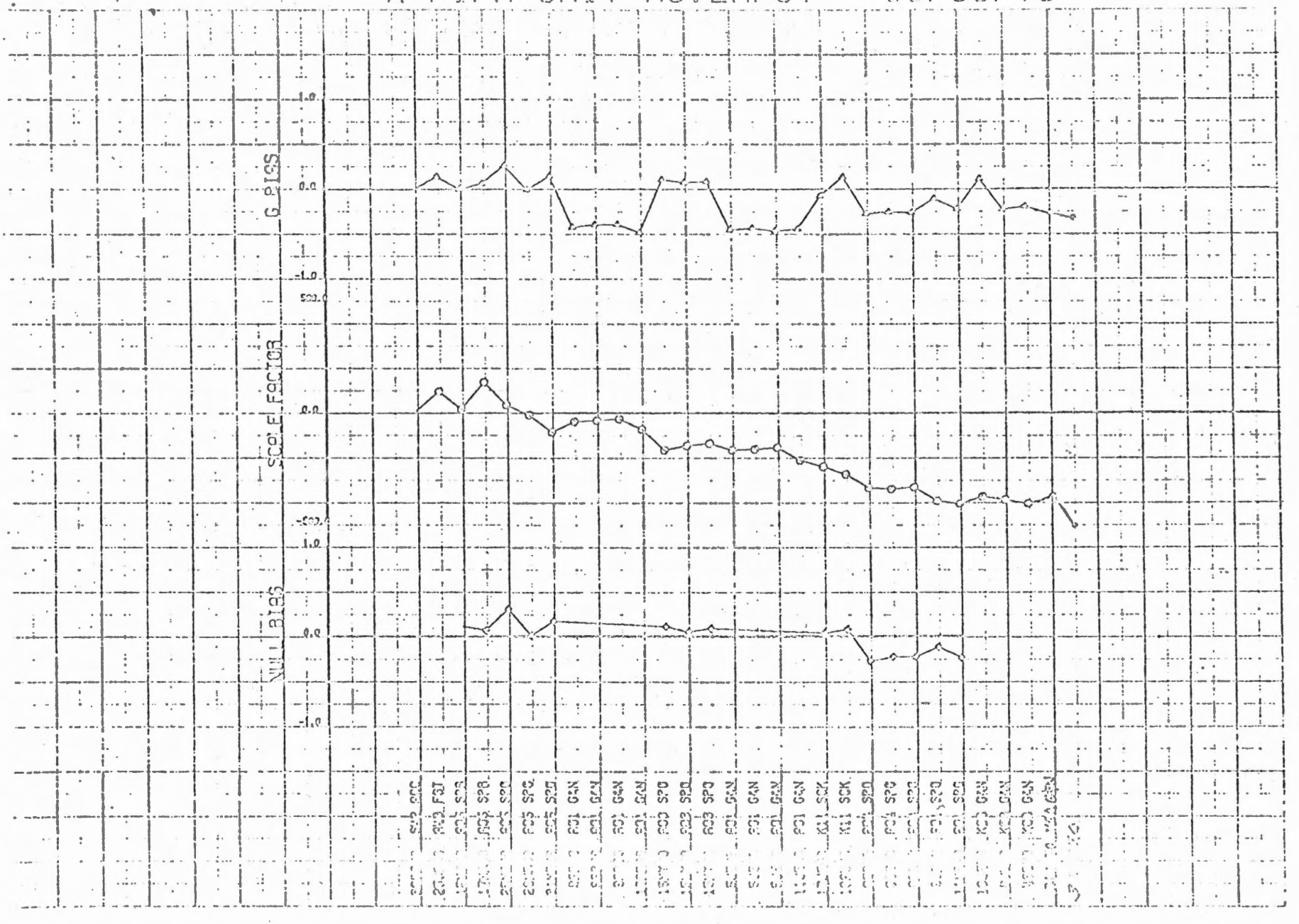
Z IRIG UNIT NO.8A111 12/3/70



LEGEND: ○ N30 △ ADSRA ◇ ADIA

0023-31-11

X PIPA UNIT NO. 2AP97 ~~05/05~~ 12/03/70



LEGEND: ○ SF △ GBIAS ◇ NBIAS

0023-31-13

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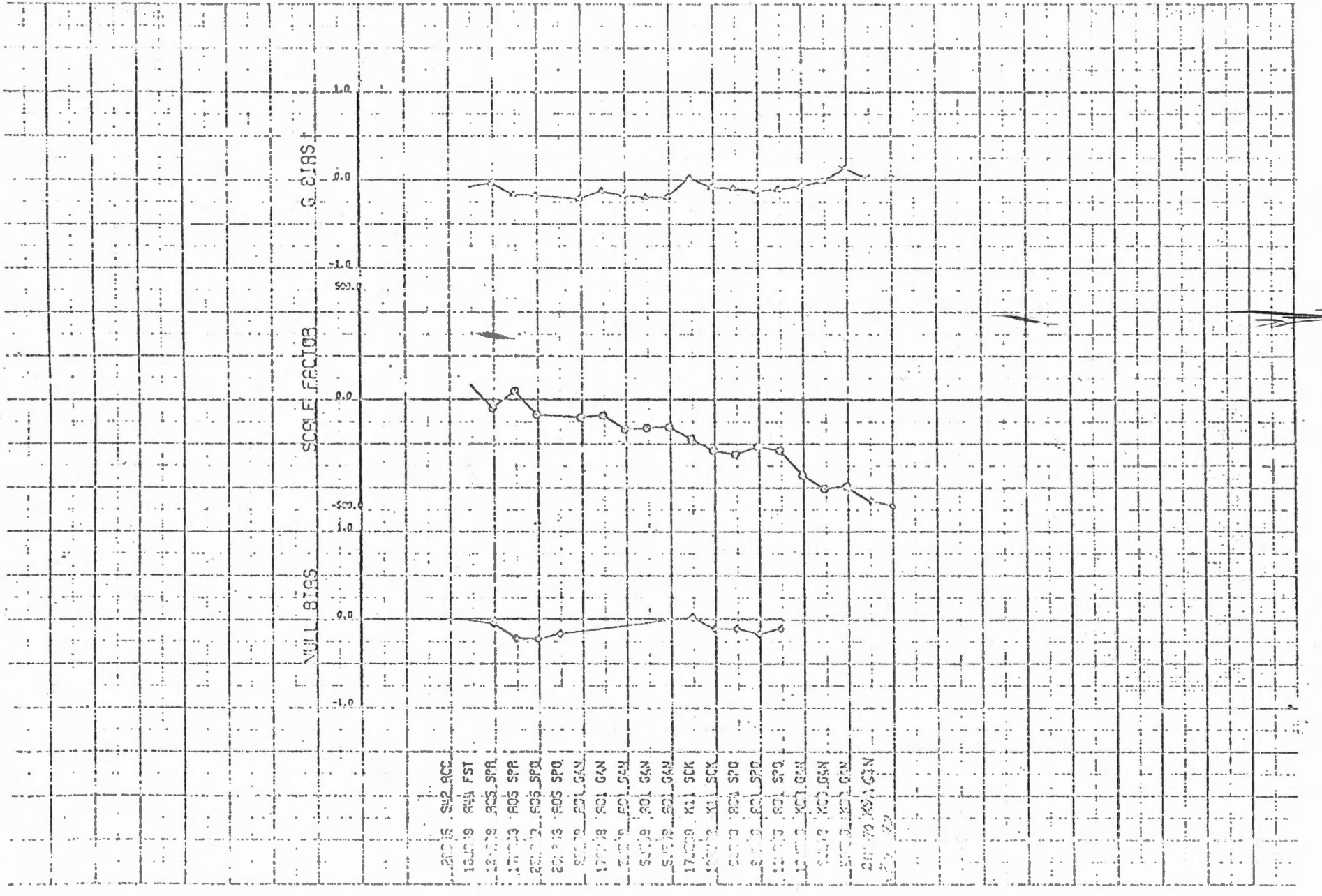

LEGEND: ○ SF △ GBIAS ◇ NBIAS

0023-31-15

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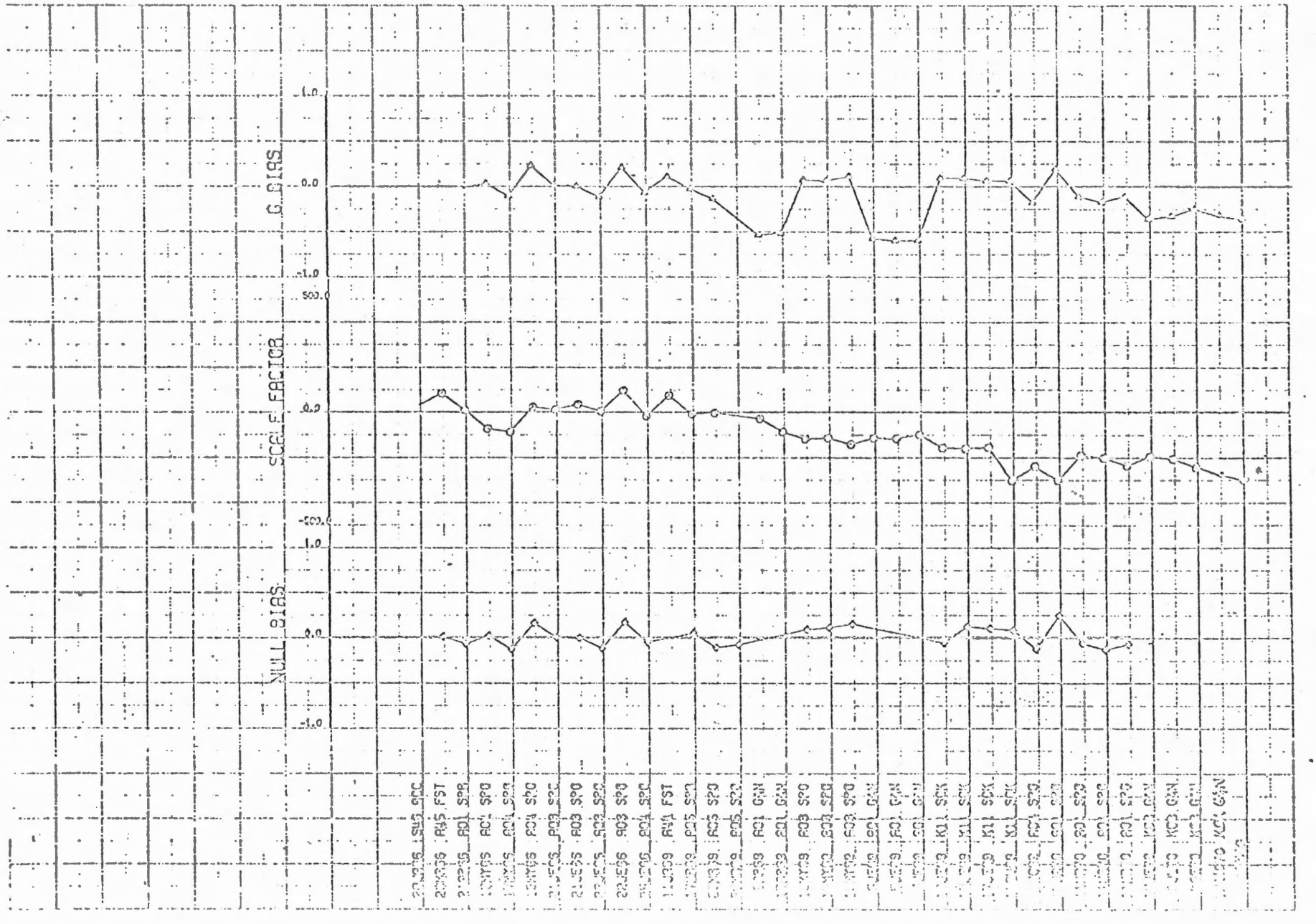


LEGEND: ○ SF △ GBIAS ◇ NBIAS

0623-31-18

LM

LM-Generic Items

1) An added preventive maintenance requirement for IMU blower motors (2,000 hours) is being applied to IMU's recycled for retest/repair or modification. The blower motors in IMU 21 are well within the preventative maintenance period, having experienced 1,725 hours (s/n 80) and 765 hours (s/n 213).

2) IMU quick disconnects are to be replaced after 20 hours exposure to isopropyl alcohol. IMU quick disconnect couplings were replaced in IMU 21 at the factory. The installed quick disconnect, p/n 1000135, s/n 51 has had 6.5 hours, and s/n 432 has had zero hours exposure to isopropyl alcohol since replacement.

4) DSK EL modules are being vacuum tested in order to detect possible safety glass delaminations. This has been implemented on LM-8, DSKY s/n:

5) Flatpack contamination. LGC-49 has completed 112 minutes of computer level Y_A-Y_B vibration screen. However, no module-level flatpack vibration screening for contamination has been accomplished on this unit. ECDU-28 modules also have not experienced any module-level Y_A-Y_B vibration screening.

6) RELAY VIBRATION SCREEN. THE DSKY RELAYS HAVE BEEN VIBRATED AT THE SYSTEM LEVEL FOR CONTAMINATION DETECTION. THE DSKY 96 IDM MODULES HAVE NOT COMPLETED THE VIBRATION SCREEN AT THE MODULE LEVEL.

PROBLEM REVIEW

ECDU-47

PROBLEM:

AN IMU CDU FAIL/ISS WARNING OCCURRED DURING VERTICAL DRIFT TEST WHILE GAN 616 WAS BEING TESTED AT DELCO. WHEN THE INNER GIMBAL WAS COARSE ALIGNED TO AN ANGLE OF 2.8° OR GREATER, THE ECDU INNER GIMBAL AXIS BECAME UNSTABLE, WITH THE READ LOOP EITHER COUNTING CONTINUOUSLY OR BREAKING INTO A LIMIT CYCLE.

VERIFICATION:

ECDU S/N 47 WAS REMOVED FROM GAN 616. ECDU S/N 47 WAS TESTED AT THE ECDU LEVEL. THE FAILURE WAS VERIFIED AS AN UNSTABLE INNER GIMBAL ECDU FINE READ LOOP. THE READ LOOP ERROR TEST INDICATED A LOOP INSTABILITY AT FINE RESOLVER ANGLE.

THE ECDU WAS THEN TESTED IN AN ENGINEERING LABORATORY SYSTEM. THE FAILURE OF INNER GIMBAL CONTINUOUS COUNTER OR LIMIT CYCLE PROBLEM REPEATED. THE IG READ COUNTER AND THE IG QUADRANT SELECTOR MODULES WERE SWAPPED AND THE PROBLEM FOLLOWED THE IG READ COUNTER S/N 260 AND WAS ISOLATED TO GATE 6-605 OR ASSOCIATED LEADS.

ISOLATION:

READ COUNTER P/N 2007140, S/N 269 WAS SENT TO RAYTHEON TO PERFORM ISOLATION TESTING, WHERE IT WAS DETERMINED THAT THE TOP LEAD OF GATE 6-605 WOULD NOT PROCESS A LOGIC "ONE". THE MODULE WAS DEPOTTED AND THE FAILURE VERIFIED AT THE 6-605 GATE. RAYTHEON FAILURE ANALYSIS STATES:

1) THE ANALYSIS OF ELECTRICAL TESTS SHOWED AN OPEN AT PIN 1 OF GATE 6-605, AND AN ABNORMALLY HIGH RESISTANCE IN SERIES WITH THE EMITTER OF ABOUT 170 OHMS.
2) WHEN THE BONDING WIRES WERE PULL TESTED, THE DIE BALL BONDS ASSOCIATED WITH PINS 1, 5, AND 6 LIFTED AT ZERO GRAMS FORCE. THE VISUAL APPEARANCE OF THE BONDING REGIONS INDICATED THAT FORMATION OF GOLD ALUMINUM COMPOUNDS

(INTERMETALLIC COMPOUNDS) PLAYED A ROLE IN WEAKING THE BONDS, THE BONDS LIFTED IN THE GOLD RICH REGION.

ECDU - 48

Problem:

READ COUNTER WAS STABLE AT 11 1/4 INCREMENTS WHILE THE ECDU TRUNNION LOOP BECAME UNSTABL AT ALL OTHER ANGLES BREAKING INTO A CONTINUOUS UP COUNT CAUSING THE ECDU TRUNNION LOOP TO LIMIT CYCLE. PROBLEM OCCURRED IN G&N CONFIGURATION AND ACCEPTANCE TEST OF G&N 616 WHEN RENDEZVOUS RADAR POWER WAS APPLIED.

Verification:

PROBLEM WAS DUPLICATED AND VERIFIED IN AN ISS TEST CONFIGURATION AN THE ENGINEERI LABORATORY SYSTEM. ISOLATION WAS COMPLET TO THE READ COUNTER MODULE S/N 231 AN FINALLY VERIFIED BY SWAPPING MODULES. THE PROBLEM FOLLOWED READ COUNTER S/N 23

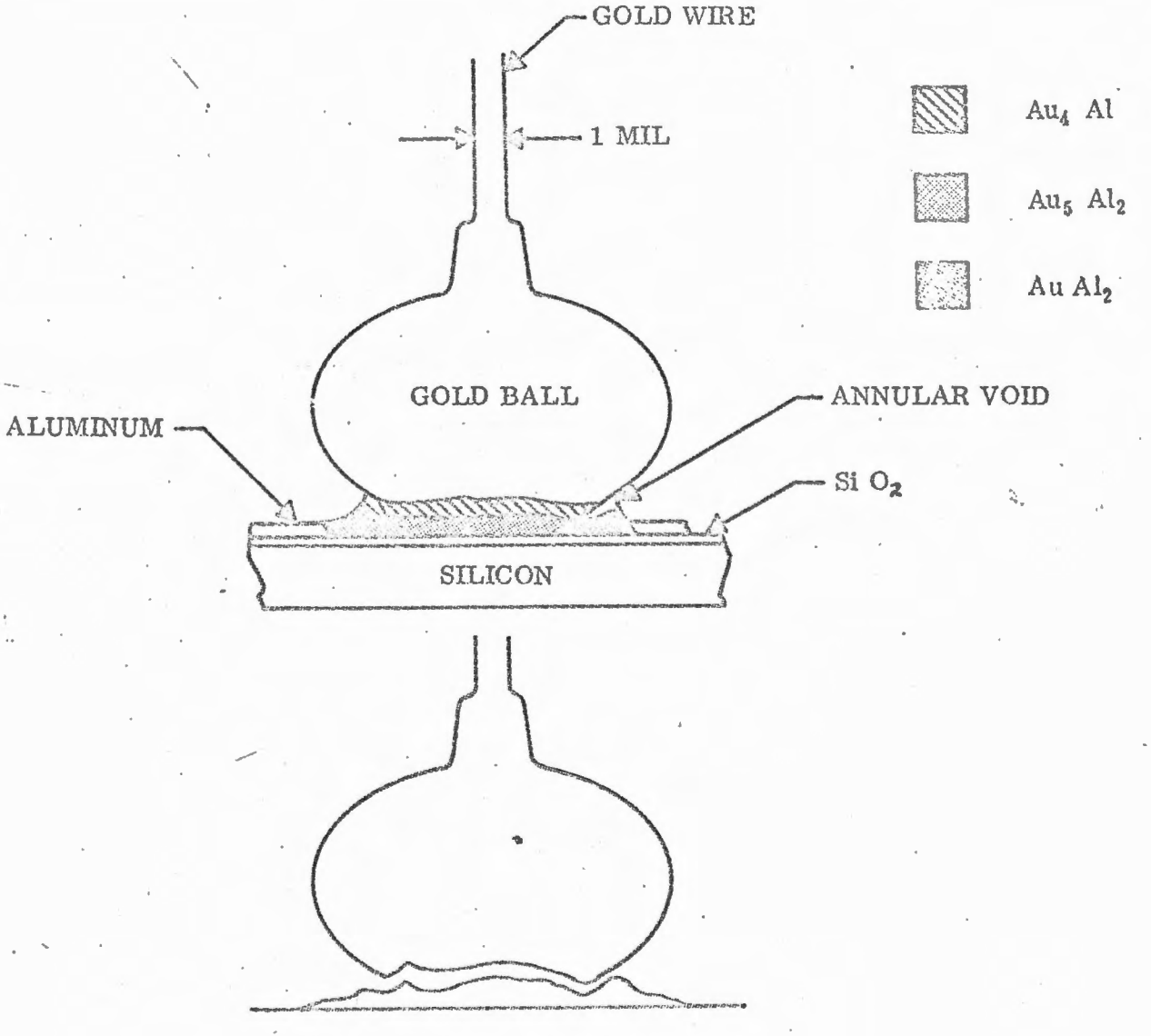
Isolation

THE READ COUNTER MODULE S/N 231 WAS SHIPPED TO RAYTHEON AND

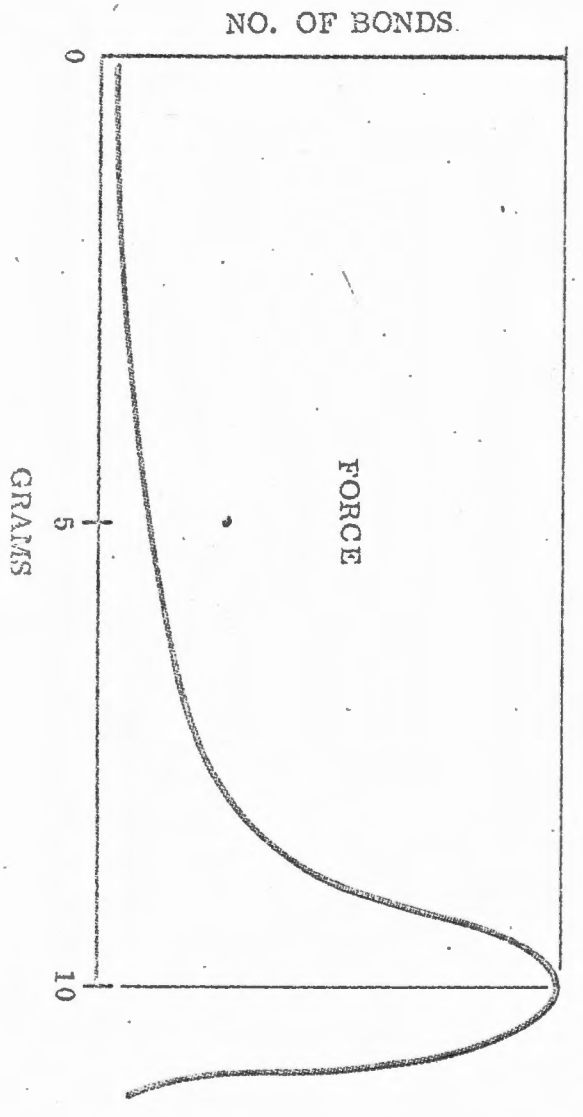
TESTED IN PART AT THE MODULE LEVEL. THE 2^{-10} COUNTER STAGE WAS VERIFIED TO BE INDEPENDENT. TESTING OF THE FINE LOGIC D9 OUTPUT SIGNAL APPEARED TO BE NORMAL (1.5 V); HOWEVER, THE TESTING WAS NOT COMPLETE. THE MODULE WAS THEN TESTED ON THE MANUAL TEST FIXTURE AND THE FINE LOGIC ANOMALY REPEATED AND ISOLATED TO GATE 6-591. A STATIC INPUT TEST WAS PERFORMED TO ISOLATE THE 2^{-10} COUNTER BIT PROBLEM. TESTING OF CIRCUITRY REVEALED GATE 6-501 WAS NOT FUNCTIONAL. GATE-501 IS THE SISTER GATE TO 591 WHICH HAD BEEN PREVIOUSLY DEFINED AS THE CAUSE OF THE FINE LOGIC. PROBLEM. RAYTHEON FAILURE ANALYSIS REPORT STATED THAT THE FLATPACK FAILED DUE TO MULTIPLE OPENS ASSOCIATED WITH PINS 2, 5, 6, 7, 8 AND 10. THE OPENS WERE DUE TO LIFTED GOLD BONDS AT THE DIE. IT APPEARS THAT THE BOND FAILURES WERE RELATED TO THE FORMATION OF GOLD ALUMINUM INTERMETALLIC COMPOUNDS (THE BOND LIFTED IN THE GOLD RICH REGION).

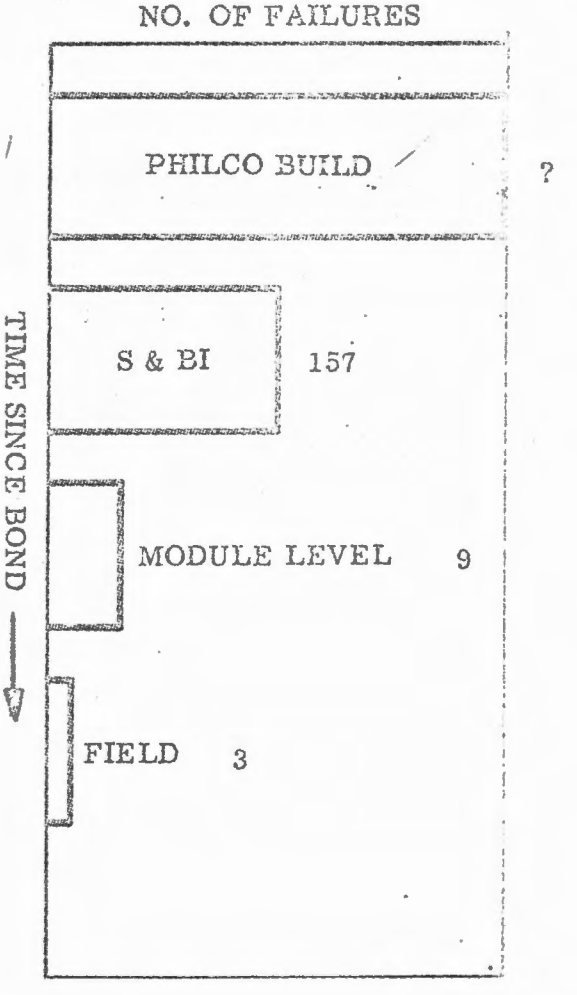
TYPICAL GOLD ALUMINUM THERMOCOMPRESSION BOND

WITH PHASES IDENTIFIED



OPEN THERMOCOMPRESSION BOND


NO. OF BONDS
0
5
10
GRAMS
FORCE


NO. OF FAILURES
PHILCO BUILD
?
S & BI
157
MODULE LEVEL
9
FIELD
3
TIME SINCE BOND

ECD-26

Problem:

During LM-8, G&N 611 testing at KSC and after a coarse align command of the OG axis from 270° to 0°, the OG was in error by approximately 194°. The fine error and DAC output varied in phase and magnitude indicating large errors in the ECDU rea loop. The OG 16X sine output indicated a intermittent read loop and periodically drove in one direction at 35°/s rate.

Verification:

ECDU-26 was removed from G&N 611 and returne to DELCO. In engineering laboratory tes the outer gimbal coarse align problem wa repeated and verified. MSA and Quad Reject Module S/N 127 failure resulting in the loss o fine ternary output was verified during a single Axis ECDU closed read loop testing.

Isolation:

MSA and Quad Reject Module S/N 127 was sent to failure analysis. The failure was caused by a high resistan condition between terminal No. 2 and No. 3 of transformer T-1, P/N 1010274. The failure was isolated to an open circuit in th 2-3 section of the primary winding. A fracture and kink were foun at the flange of the bobbin where the winding process reverses. Apparently the kink, being trapped between the bobbin flange and the preceeding layer wire, was subjected to compression during thermal excursions of the module

THE REPEATED COMPRESSIONS RESULTED IN THE FRACTURE.

FINE WIRE TRANSFORMER FAILURE HISTORY

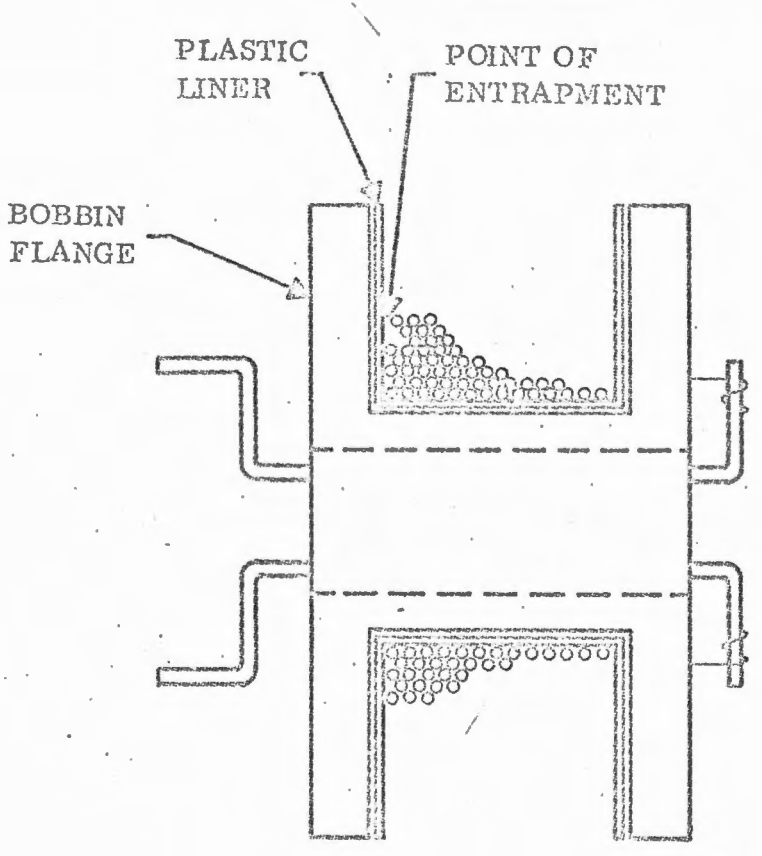
APPROXIMATELY 326 FINE WIRE TRANSFORMERS (AWG #40 OR SMALLER) ARE USED PER APOLLO MISSION INCLUDING BOTH CM AND LM. THESE TRANSFORMERS ARE OF 24 DIFFERENT PART NUMBER TYPES. FOURTEEN (14) OF THE 24 TYPES HAVE NOT EXPERIENCED FAILURES OF ANY KIND THROUGHOUT THE LIFE OF THE PROGRAM. FIELD FAILURES HAVE BEEN EXPERIENCED ON 4 OF THESE 24 TYPES. THESE FAILURES, ALL OF WHICH INVOLVED OPEN WINDINGS, ARE DETAILED AS FOLLOWS:

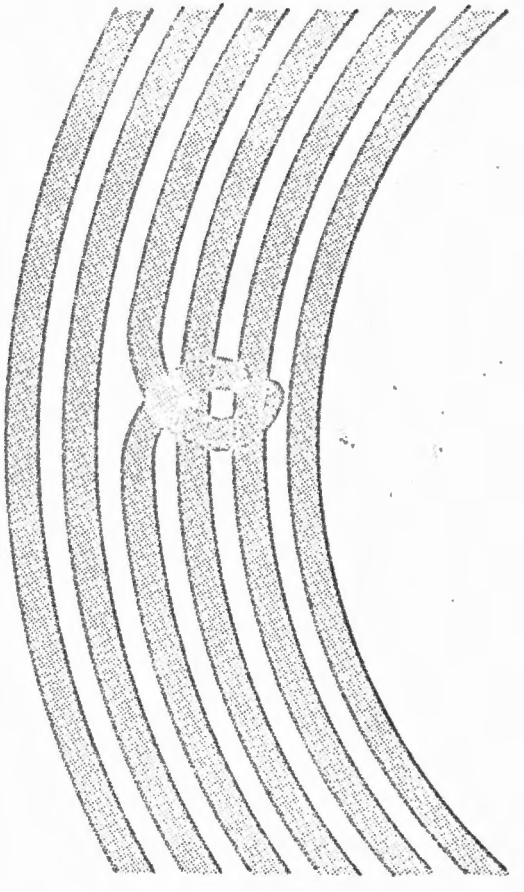
PART NUMBER	HISTORY
1008842	1 FIELD FAILURE IN LM-10 AT GAC IN 1
1010274	3 FIELD FAILURES (1) IN CM-2TV-1 AT NAR IN
	(1) IN THE NAR LABS. IN 19
	(1) IN CM-110 AT KSC IN 19
1010324	1 FIELD FAILURE IN LM-1 AT KSC IN 19
1010753	1 FIELD FAILURE IN MSC LABS. (PI-4) IN 19

* THIS FAILURE RESULTED FROM DAMAGE TO THE TRANSFORMER DURING A PREVIOUS REPAIR AND WAS NOT CAUSED BY THE PART ITSELF.

LM 8 FAILURE

TRANSFORMER, P/N 1010274 ECDU, S/N 26





LM-6 / LM-7 Configuration Differences

1) Mission Peculiar Items
   Flight Ropes in LM 8 will be Luminary 178 Set 1. LM-7 flight ropes were Lum 131, Revision 1, Set 1.

2) LM-8 LGC configuration includes a restart module not previously flown.

Reused Hardware

NONE

G & N 611 Ready Spares Support For Apollo 14

1) Only the following equipment is availab at KSC.

Part No	Component	s/N
6014512-081	CCRD	8, 7
6007013-021	SCA	6
2010802	Flight Ropes	Set 2

Othe Spares are located at Delco, GAC and KIC.

IMU/PTA	s/N 12 and 5
PSA	15
ECDU	32
LGC	55
DSky	68
AOT	25

The following pages show whats in the system and how it got there →

G&N 611 SYSTEM SUMMARY

EQUIPMENT	PART NUMBER	SERIAL NUMBER	OPERATING HOURS AS OF 31 OCT 70	WEIGHT (lb)
IMU Assembly (IMU)	2018601-221	21	2,759	41.0
PIP Assembly, Prealigned	2018844-021	X - 2 AP 222 Y - 2AP 92R Z - 2AP 228		
25 IRIG Assembly	2021500-111	X - 8C 124 Y - 8A 139 Z - 8A 122	1,054 673 1,109	
Blower Motors	2018644	80 213	1,725 765	
Pulse Torque Assembly (PTA)	6007000-041	10	2,354	14.5
Power and Servo Assembly (PSA)	6007200-081	6	2,402	17.8
Electronic Data Coupling Unit (ECDU)	2007222-261	28	1,075	37.5
Computer Control and Reticle Dimmer Assy	6014512-081	14	312	1.6
Signal Conditioner Assembly (SCA)	6007013-021	5	750	5.6
LM Guidance Computer (LGC)	2003993-071	49	1,457	58.3
DSKY	2003994-091	96	906	18.4
Alignment Optical Telescope (AOT)	6011000-111	21	86	23.8
Navigation Base Assembly	6899980-021	11		5.3
A Harness	6010677	23		15.8
B Harness	6010678	27		4.4
AOT Conical Sunshade and Radar Shield	6011876	6		—
High Density Filter Assembly	6022856	108		0.1
Installation Kit, Computer	6004000-051	31		0.4
Installation Kit, SCA	6007020	6		0.1
Flight Ropes	2010802-xxx	—[1]	—	12.4
			Total	257.0

[1]Flight Ropes — Luminary Revision 178

P/N 2010802-321	S/N 430	P/N 2010802-351	S/N 439
-331	S/N 431	-361	S/N 434
-341	S/N 432	-371	S/N 435

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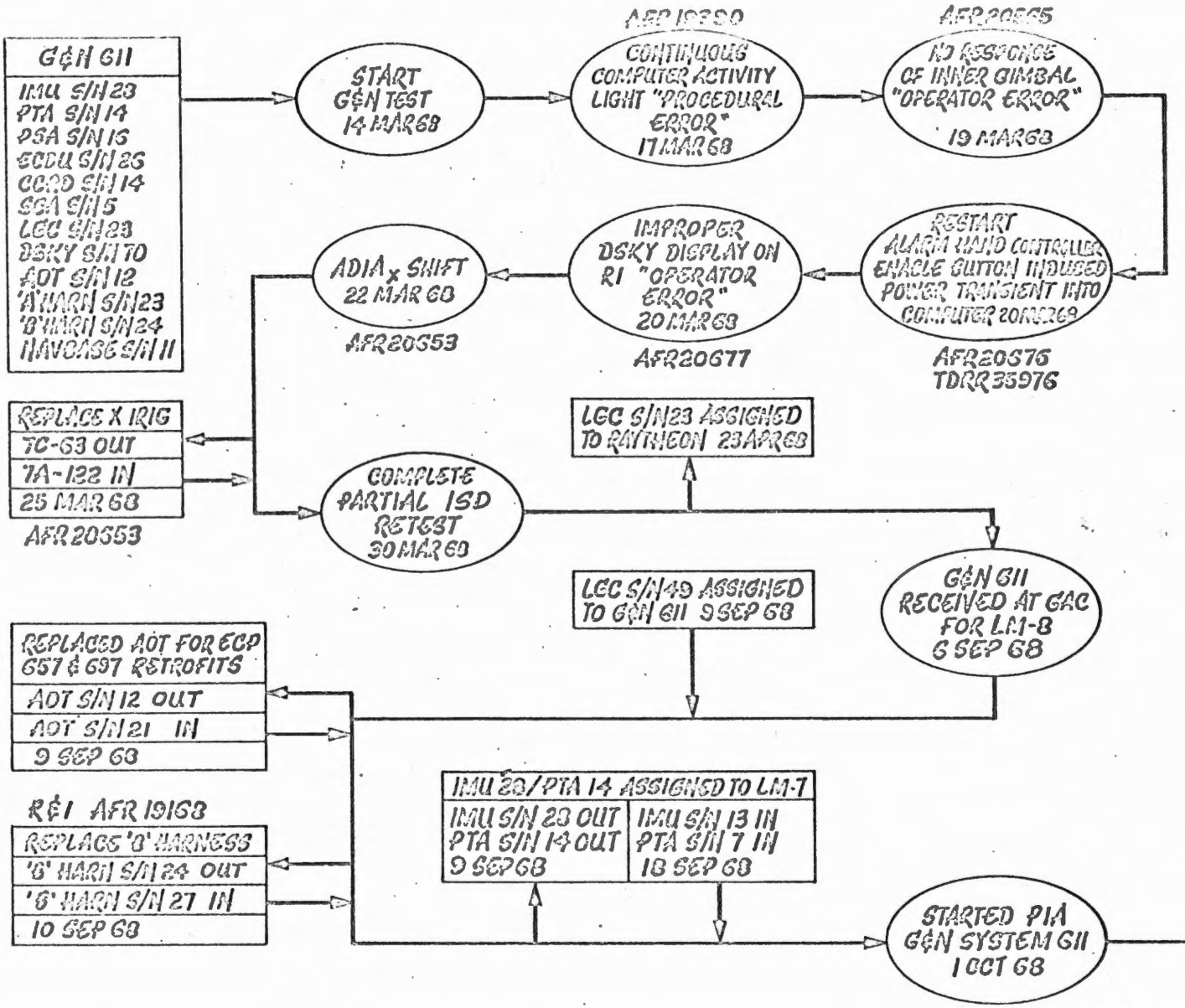
LM8, G&N G11 IN-HOUSE SEQUENCE



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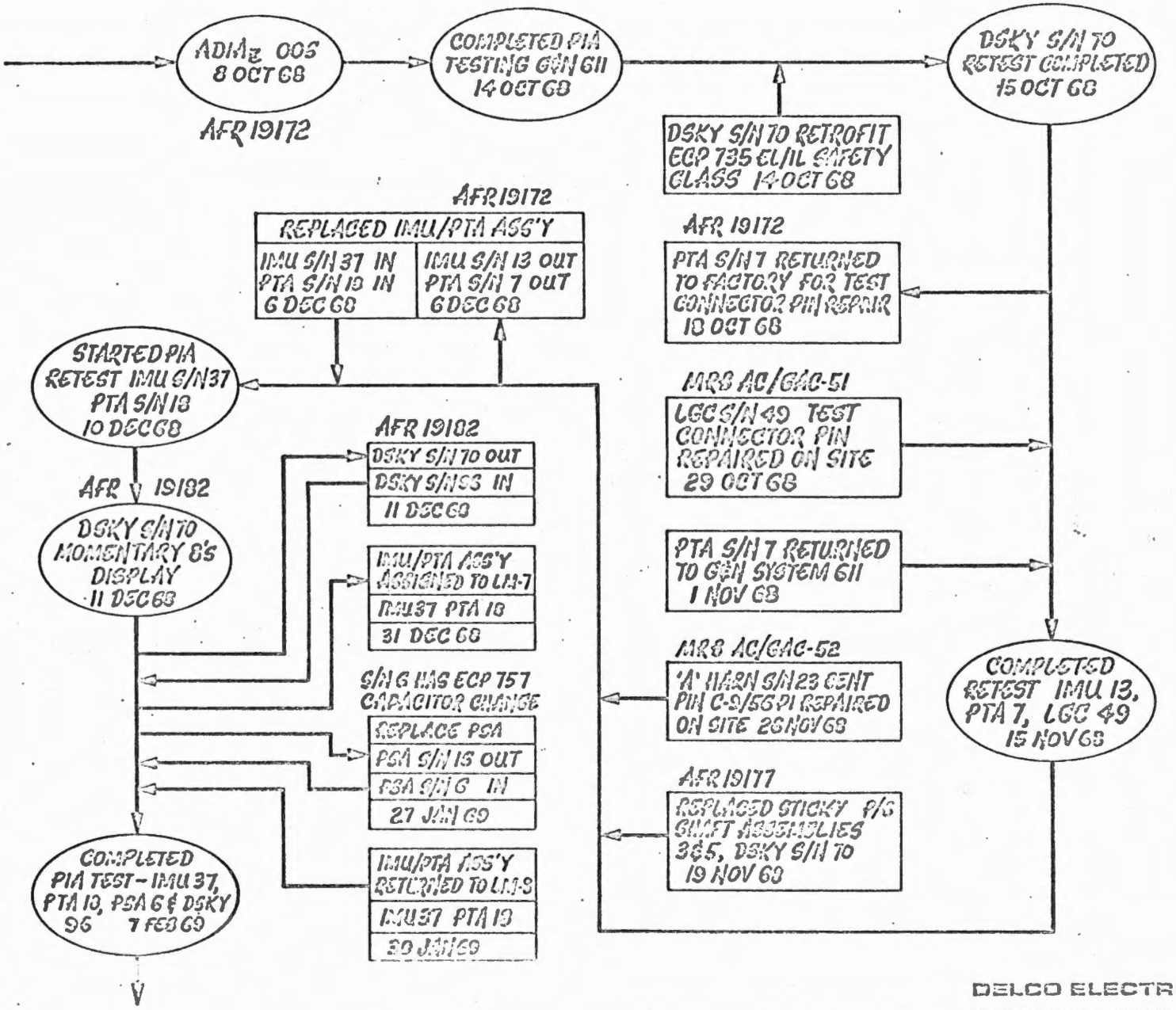
EP0642



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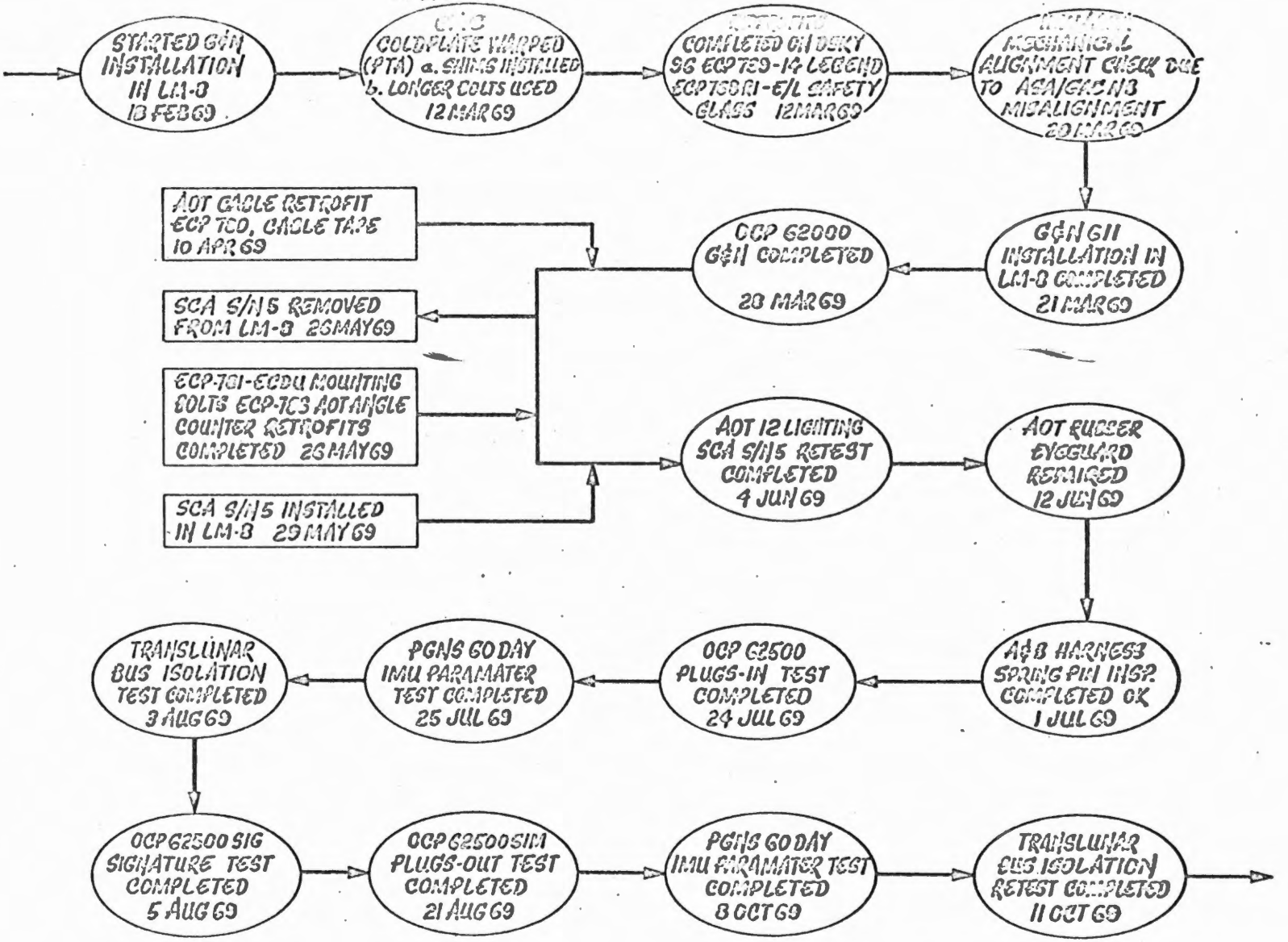
MRR 05-2910



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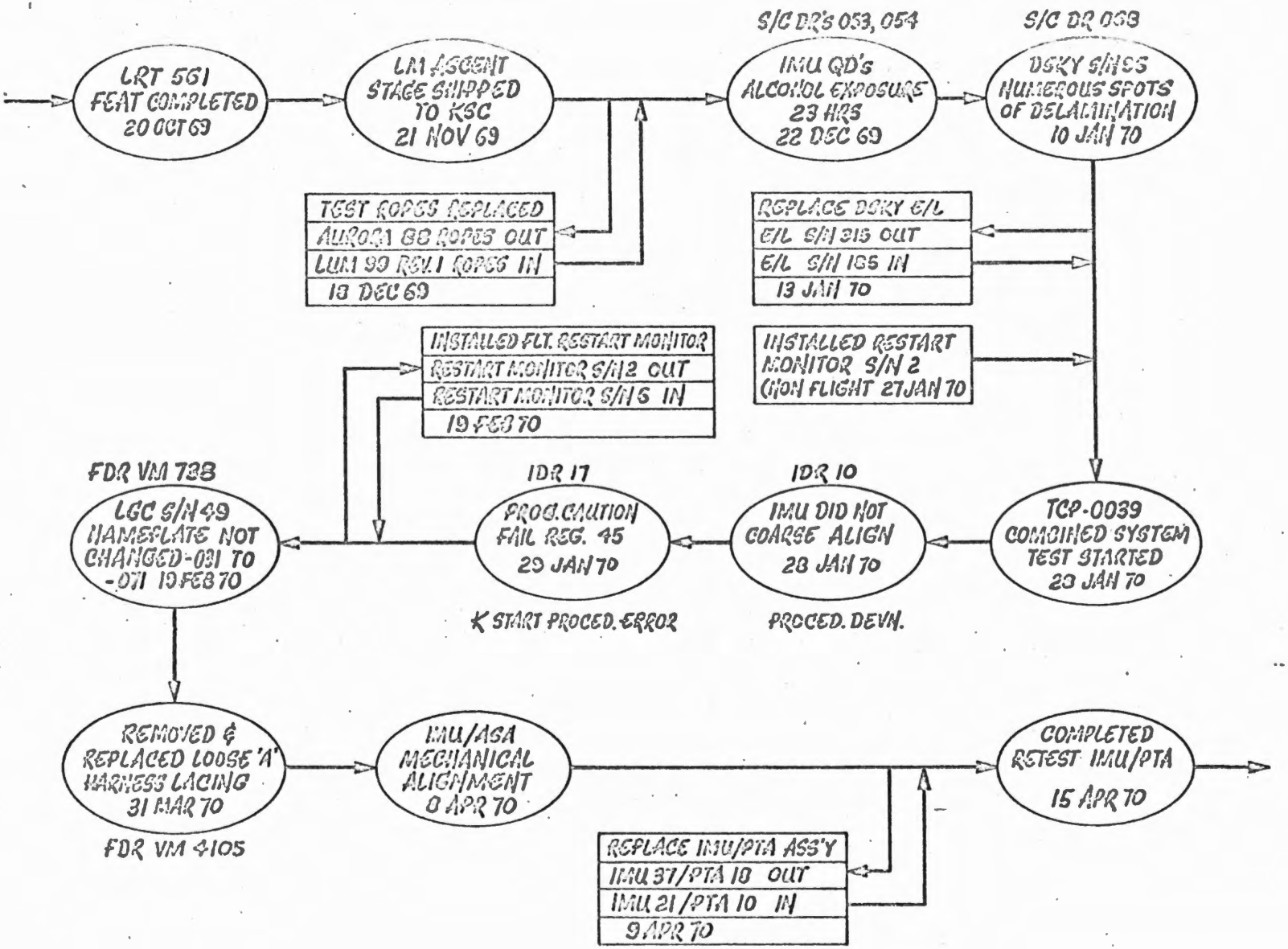

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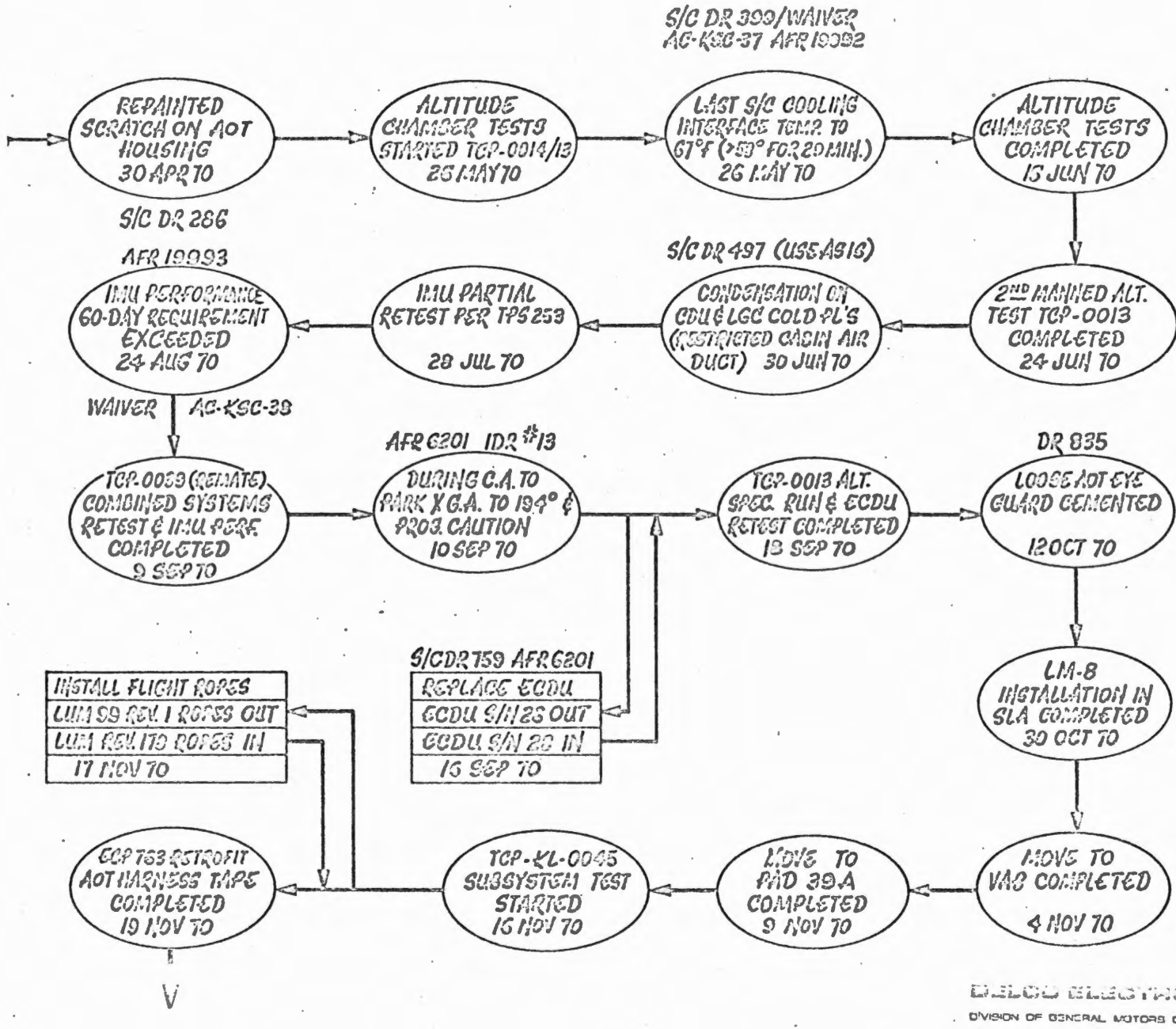

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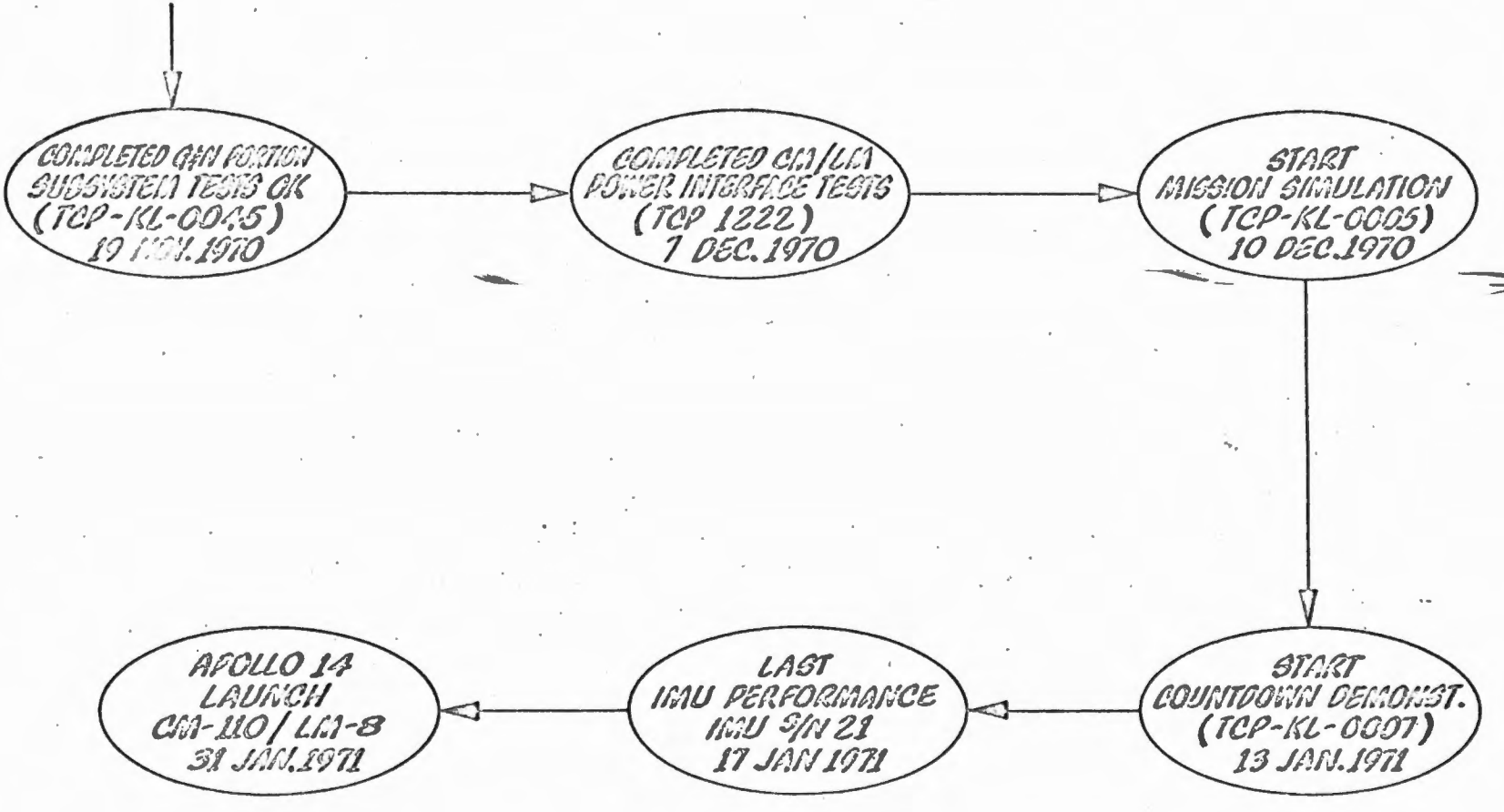

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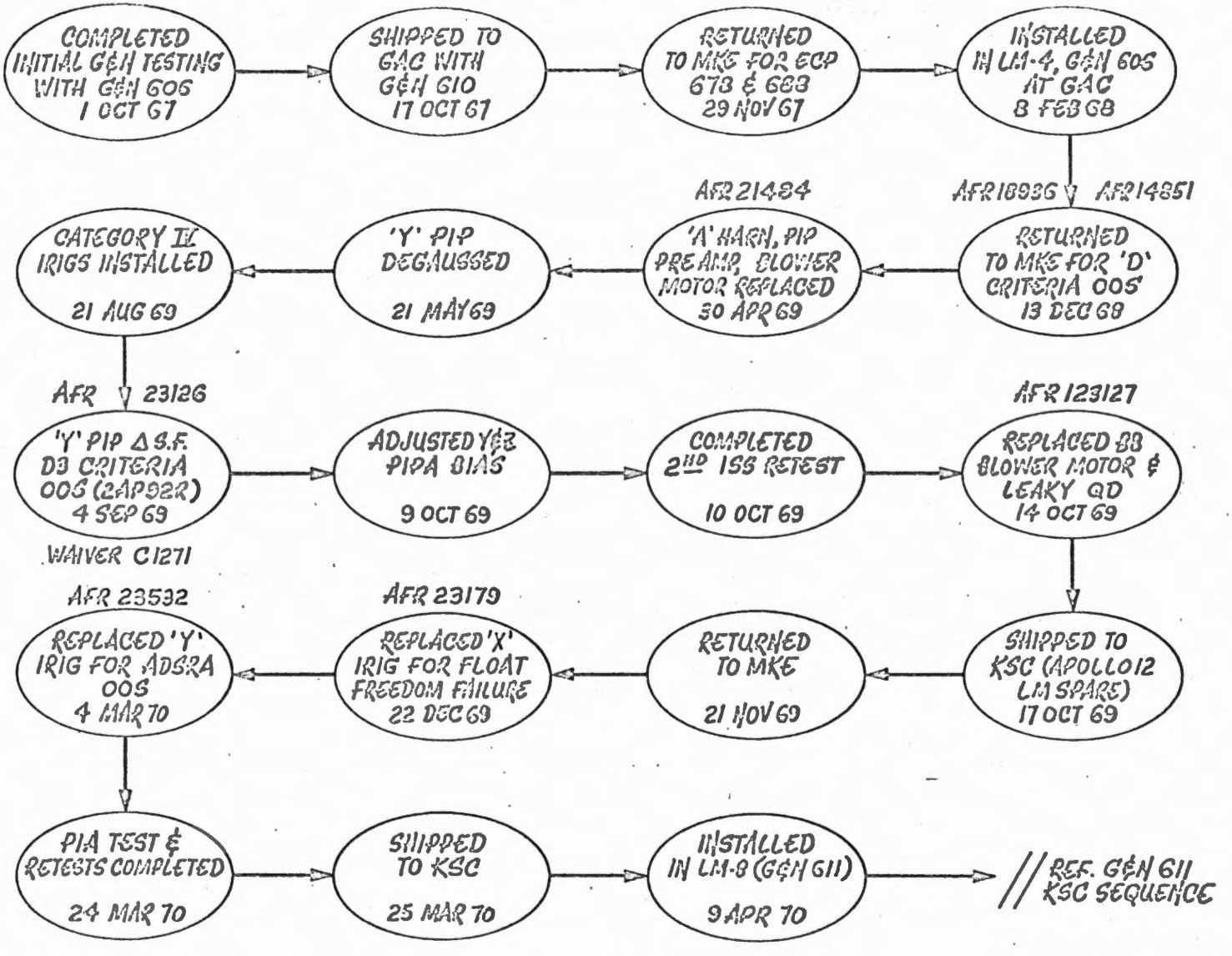
LM-8, GEN 611, IMU S/N 21



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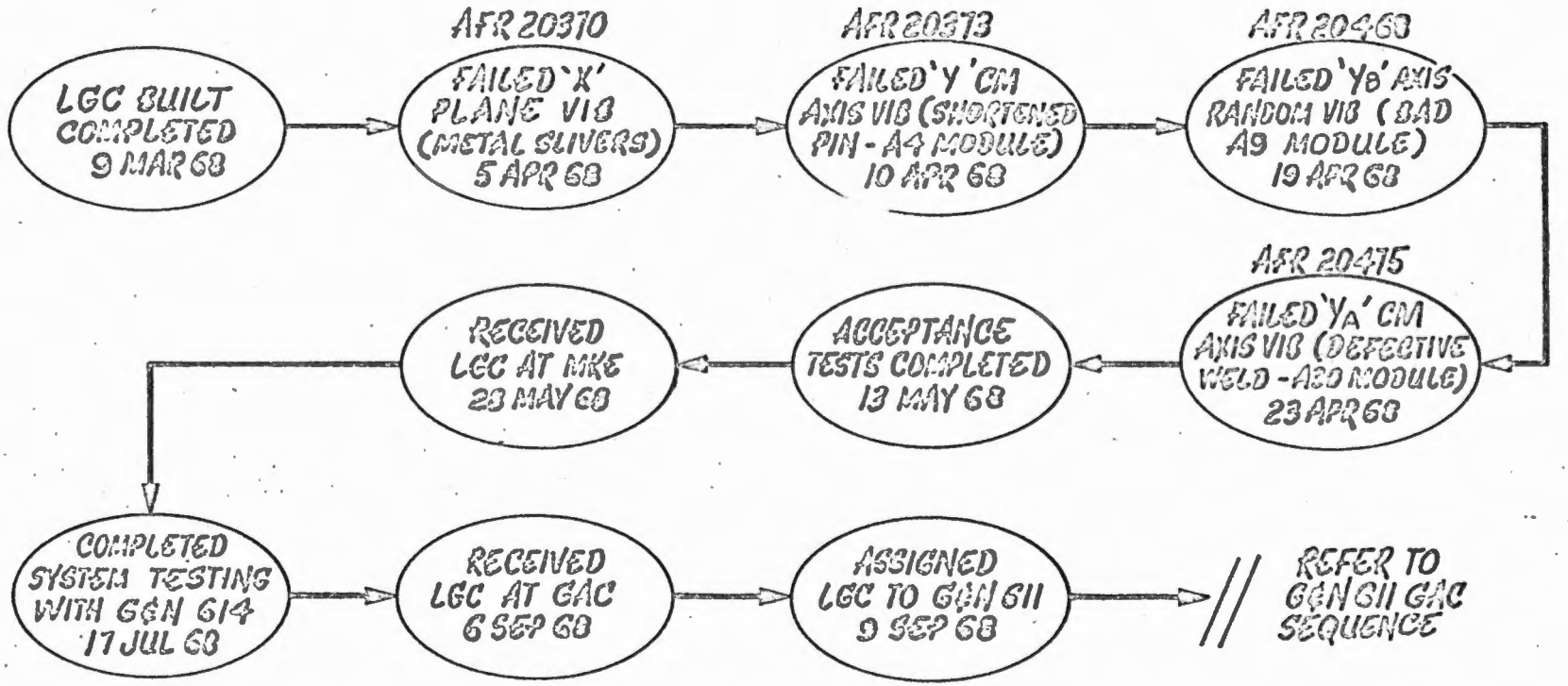
LM-2 G&N GII, LGC S/N 40

VIB TIME: Y_A Y_B MODULE LEVEL 0; Y_A COMPUTER LEVEL 57 MIN; Y_B COMPUTER LEVEL 55.12 MIN



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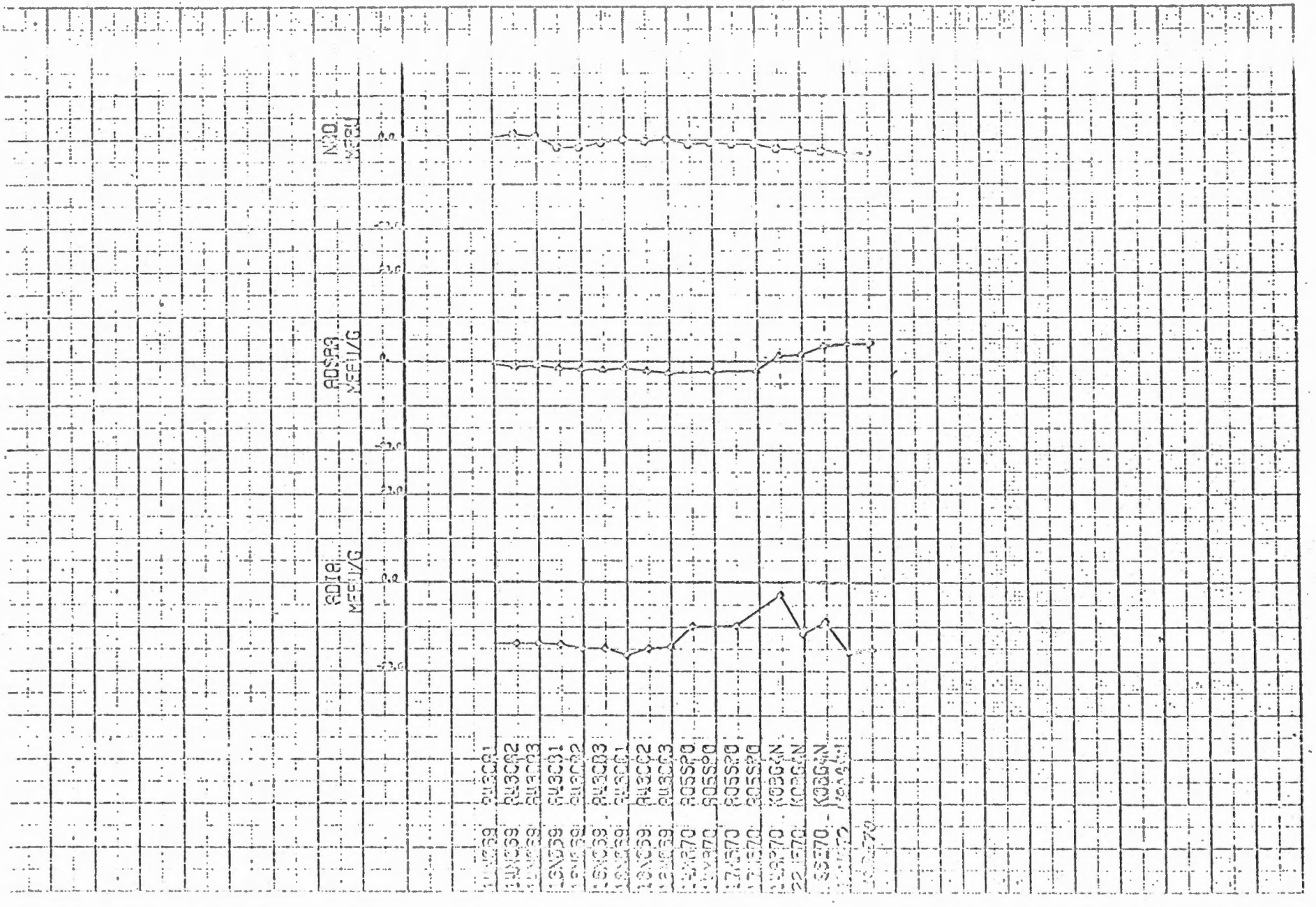
X IRIG UNIT NO.8C124 ~~00~~/~~00~~/70 12/03

LEGEND: ○ NFD △ ADSRA ◇ ADIA

0023-30-5

Y IRIG UNIT NO. 8A139 12/03/70



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0023-30-7

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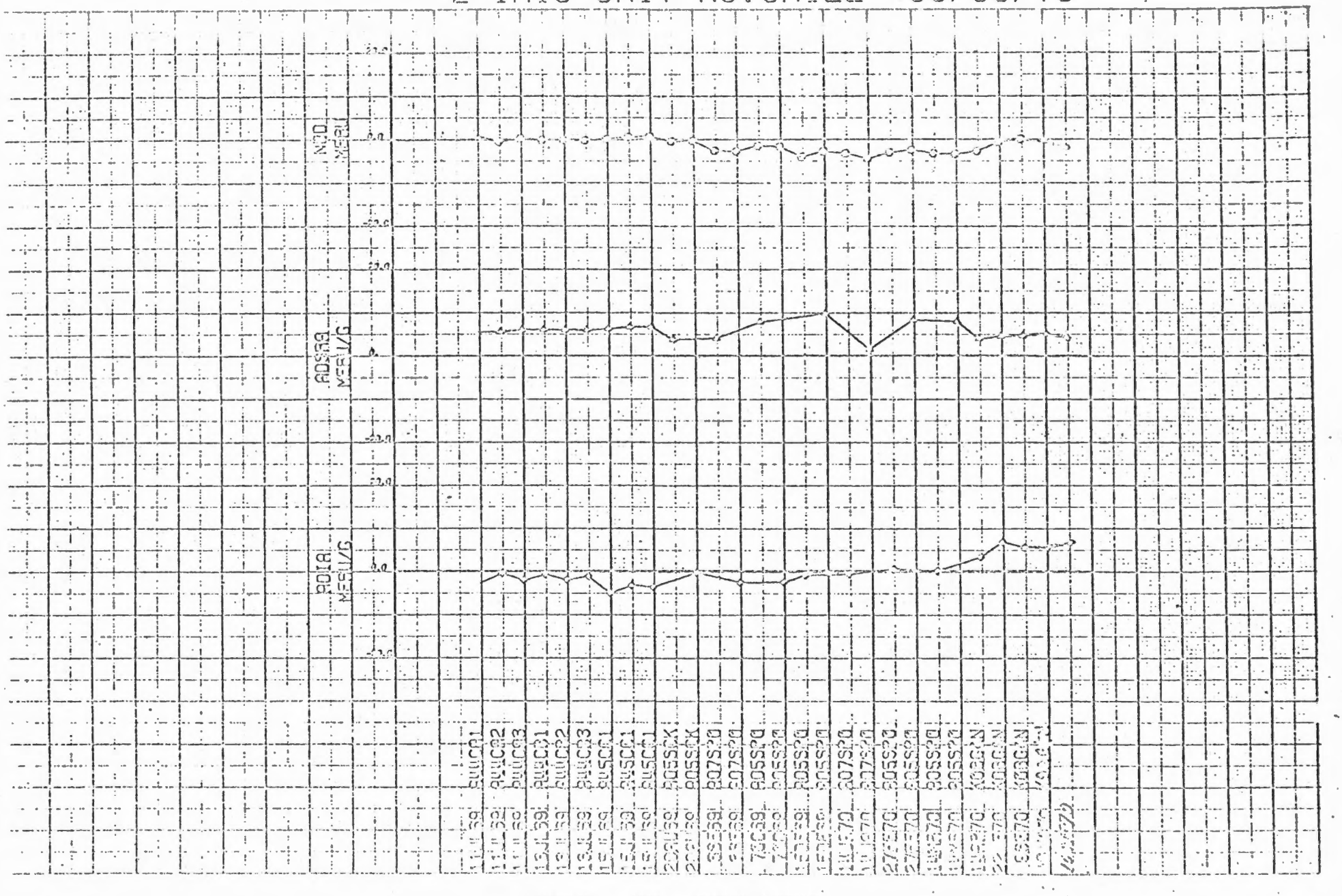

LEGEND: ○ NOD △ ADSRB ◇ ADIB

0023-30-10

X PIPA UNIT NO. 2AP222 ~~05/05~~ 12/03/70

LEGEND: ◎ SF △ GBIAS ◇ NBIAS

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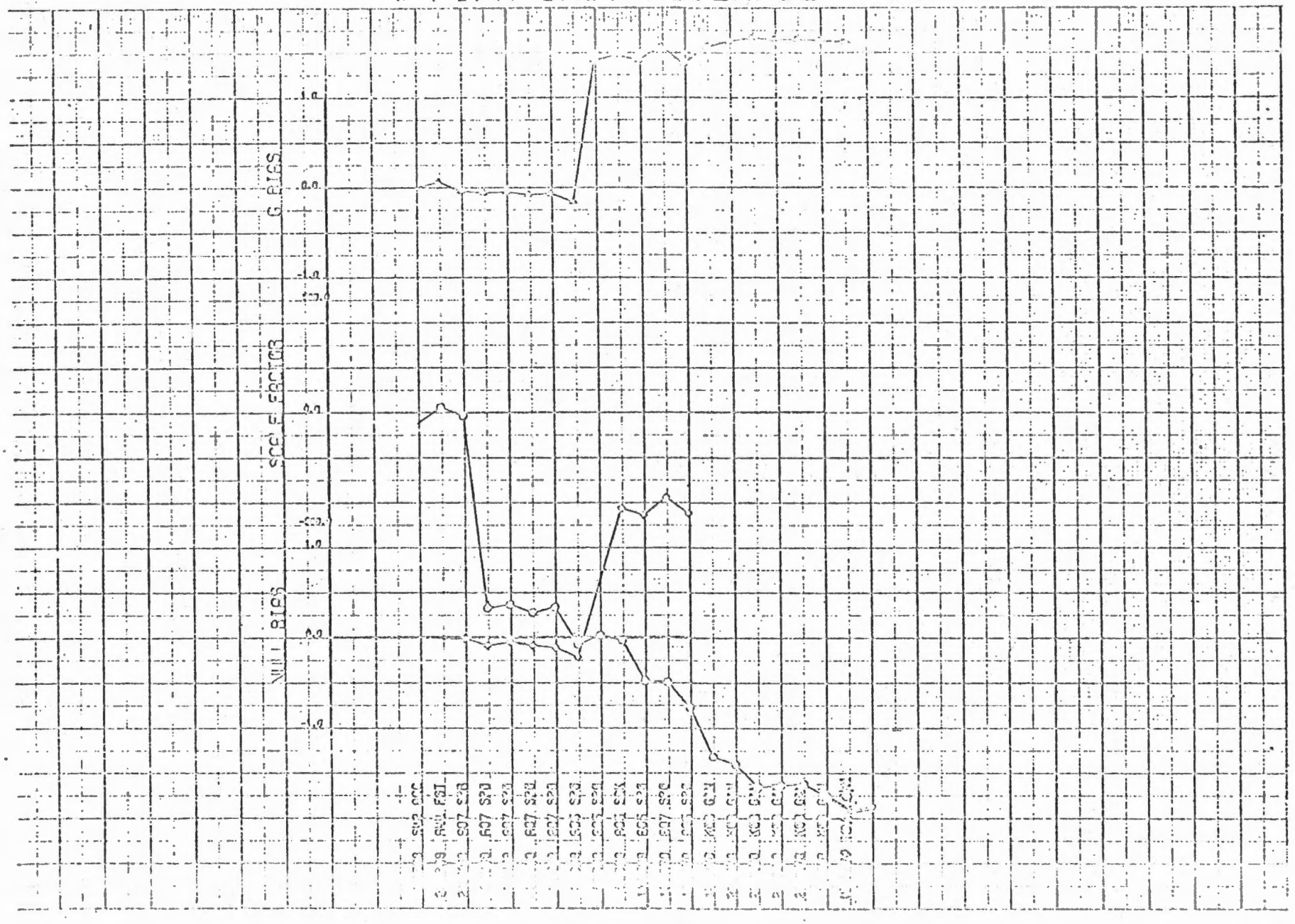
Y PIPA UNIT NO. 2AP92

12/03/70



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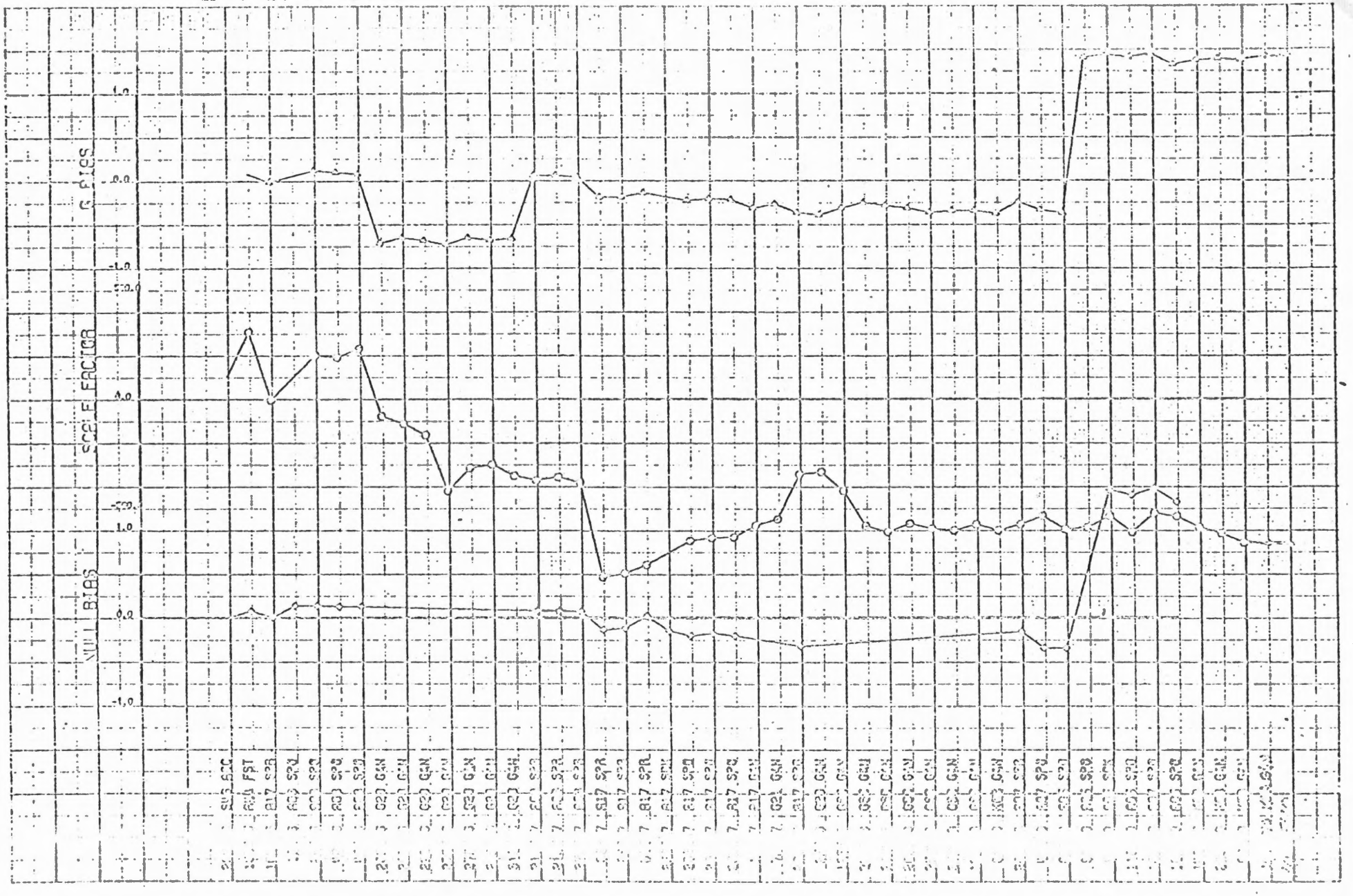

LEGEND: ○ SF △ GBIAS □ NBIAS

0023-30-18