NASA SCIENTIFIC AND TECHNICAL INFORMATION FACILITY

OPERATED BY INFORMATICS INFORMATION SYSTEMS COMPANY

POST OFFICE BOX 33 COLLEGE PARK, MARYLAND 20740 TELEPHONE (301) 779-2121

N74-29497

January 9, 1975

NASA, Johnson Space Center
Attn: Mr. Albert Bradley, Chief
Technical Library Branch BM6
Houston, TX 77058

CF 2/13/75

Dear Mr. Bradley:

Please find enclosed a copy of the discrepency report, received by us from NTIS, indicating that portions of this document NASA CR-134351; NAS9-11260 are either missing or illegible. In order to complete our casefiles, it is necessary for us to secure the pages referred to in this report.

We would appreciate your consideration in helping us to obtain the missing pages or a reproducible copy of the illegible pages.

Thank you.

Sincerely yours,

Joseph J. Wall

Our Reference: SQT 74558 R NASA Scientific & Tech. Information Facility Acquisitions Branch

The technical monitor has said that the best available copy has been supplied.

E. Robinson

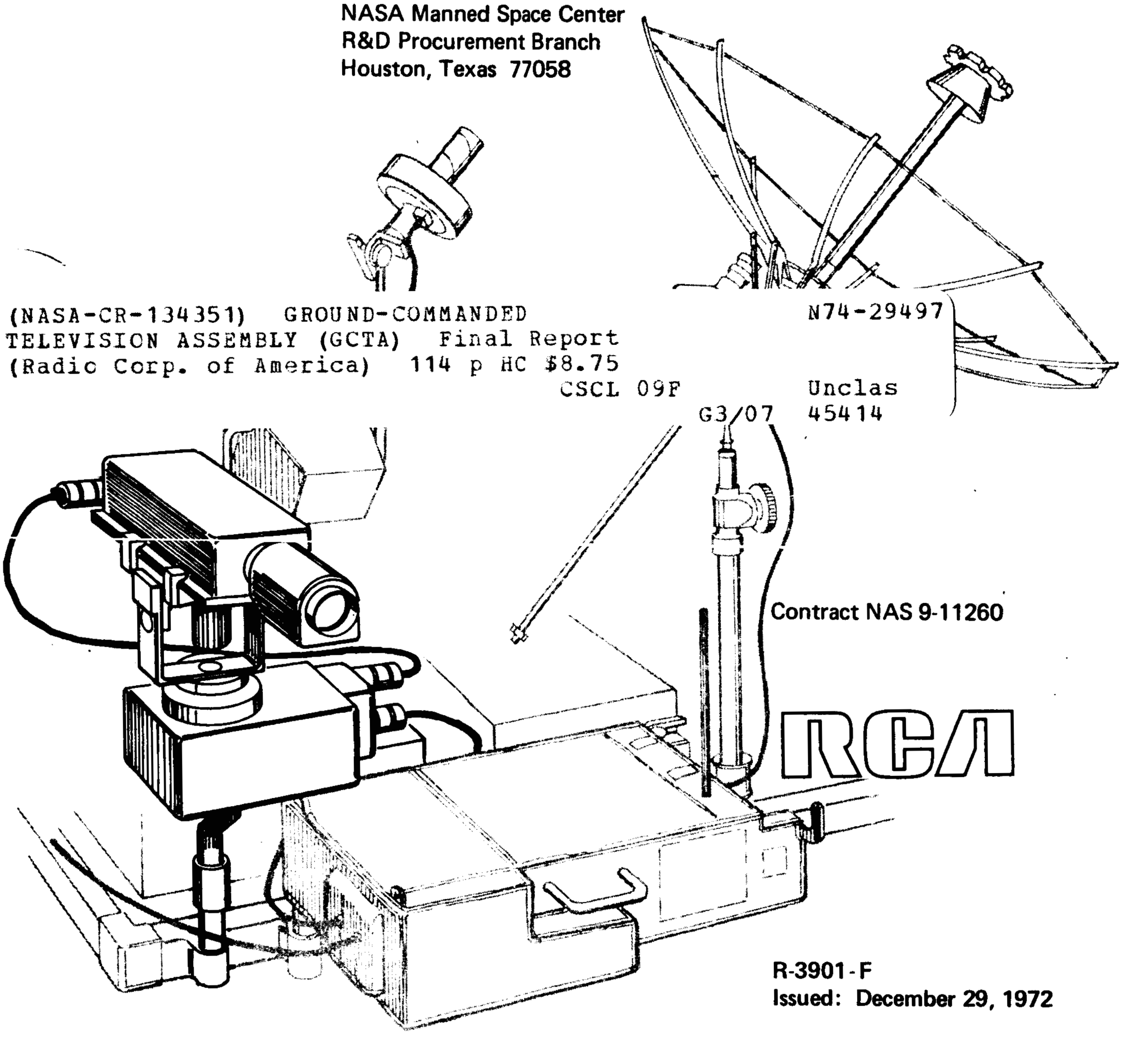
JM6

NASA CR-134351

Ground-Commanded Television Assembly (GCTA)

Final Report

Prepared for:
NASA Manned Space Center
R&D Procurement Branch
Houston, Texas 77058



(NASA-CR-134351) GROUND-COMMANDED TELEVISION ASSEMBLY (GCTA) Final Report (Radio Corp. of America) 114 p HC $8.75 CSCL 09F

N74-29497

Unclas
G3/07 45414

Contract NAS 9-11260

RCA

R-3901-F
Issued: December 29, 1972

RCA | Government and Commercial Systems
Astro-Electronics Division | Princeton, New Jersey 08540

PREFACE

The spectacular television coverage of lunar surface explorations during the Apollo 15, 16, and 17 missions demonstrated the exceptional performance of the RCA Ground-Commanded Television Assembly (GCTA). The GCTA more than satisfied all anticipated requirements for lunar surface television and was fully compliant with NASA specifications.

An initial Interim Report on the GCTA program was issued in February 1972. The document summarized the work performed under Contract NAS 9-11260 from contract award on July 31, 1970 through February 15, 1972.

A second Interim Report was issued on July 31, 1972 to summarize the work performed by RCA to improve the performance and reliability of the GCTA for use during the Apollo 17 mission. The report covered the period from February 16 through July 31, 1972.

The present document finalizes the work performed by RCA under Contract NAS 9-11260 for the NASA Manned Spacecraft Center in Houston, Texas. The report covers the period from July 31 through December 29, 1972.

CONTENTS

Section		Page
I	INTRODUCTION	1
II	YOKE/FACEPLATE QUALIFICATION DATA	6
III	ELEVATION DRIVE IMPROVEMENT PROGRAM	39
IV	APOLLO 17 THERMAL DATA	70
V	EQUIPMENT STATUS	92
VI	DRAWING STATUS	100
APPENDIX A	16 mm SIT QUALIFICATION TEST PROCEDURE	102

ILLUSTRATIONS

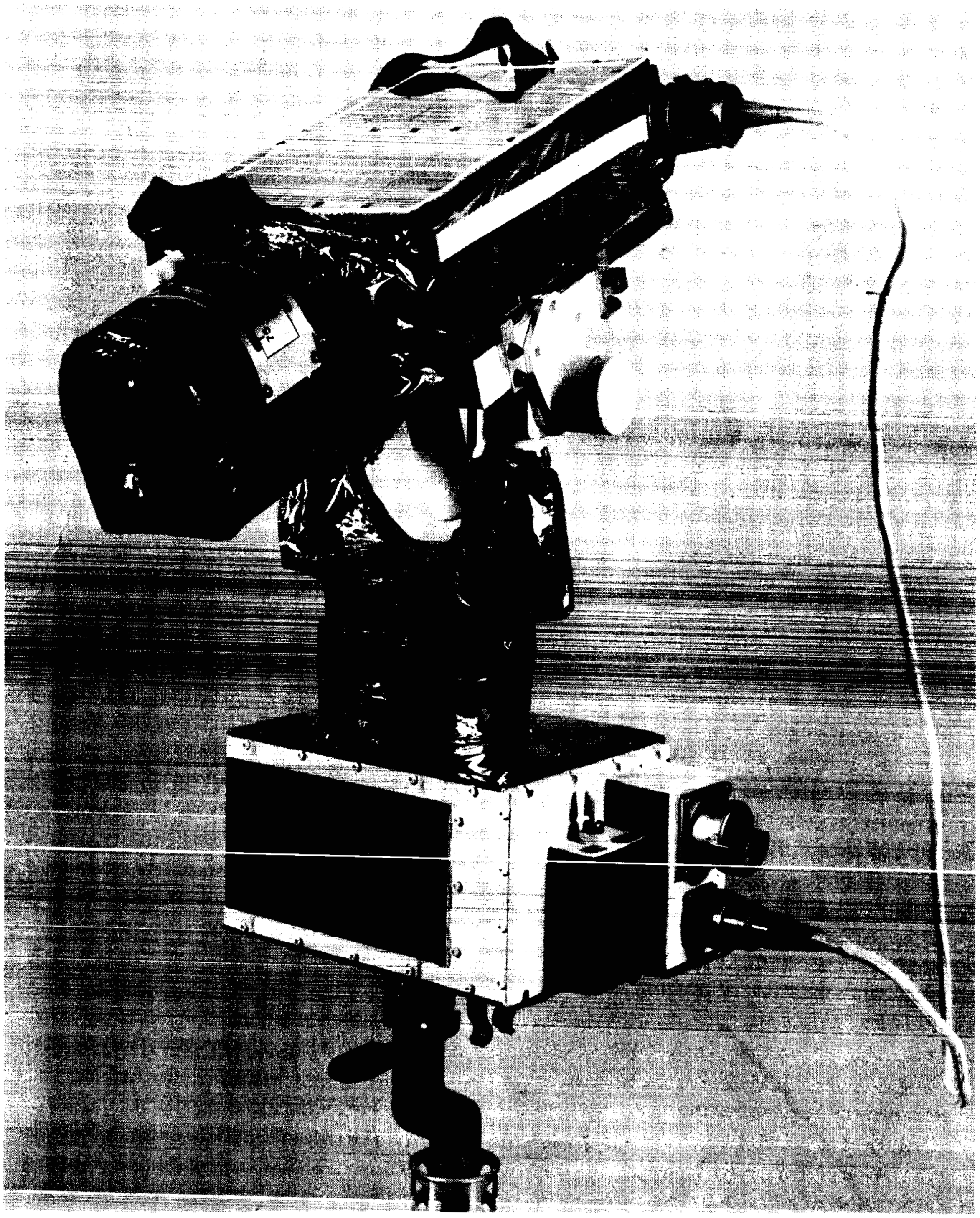
Figure		Page
Frontispiece	RCA Ground-Commanded Television Assembly	
1	CTV Functional Block Diagram	4
2	TCU Functional Block Diagram	5
3	Predicted TCU Elevation Drive Torque Curve	40
4	Peak Torque Contour for Serial No. 006	41
5	Peak Torque Contour for Serial No. 003	42
6	Serial No. 006 Torque Curve after Rework	43
7	Serial No. 006 Post Rework Torque with Damping Springs	44
8	CTV Temperature Telemetry Waveform	70
9	Flight 3 CTV Temperature Telemetry Calibration . . .	81
10	CTV Vidicon Temperature During EVA-1.	83
11	CTV Vidicon Temperature During EVA-2.	84
12	CTV Vidicon Temperature During EVA-3.	85
13	CTV Vidicon Temperature Prior to and During Lunar Liftoff.	86
14	Overall Plot of CTV Temperature on Lunar Surface . .	87
15	SIT Tube Temperature Prediction Curves	88
16	TCU Board Temperature Prediction Curves	89

TABLES

Table		Page
1	SIT Performance Characteristics	2
2	Performance Summary of RCA GCTA	3
3	Elevation Drive Design Parameters	39
4	Elevation Drive Test Program	46
5	Summary of CTV Operating Temperatures	71
6	GCTA Operating Time (1)	90
7	GCTA Operating Time (2)	91

SECTION I

INTRODUCTION



Frontispiece. RCA Ground-Commanded Television Assembly

SECTION I

INTRODUCTION

The RCA Ground-Commanded Television Assembly (GCTA) consists of a Color Television Camera (CTV), a Television Control Unit (TCU) and associated cabling, bracketry, and hardware. The GCTA design is based on the RCA Lunar Surface Color Camera produced for NASA under Contract NAS 9-10781. Both systems use a Silicon Intensifier Target (SIT) sensor and field-sequential color wheel to generate color television images.

The present RCA GCTA system illustrated in the Frontispiece was designed to provide maximum flexibility, potential growth, and ability to withstand the environmental extremes encountered on the lunar surface. Use of the SIT sensor provided high sensitivity, wide intra-scene dynamic range, freedom from microphonics, and rugged construction. Performance of the SIT sensor is summarized in Table 1. An overall summary of GCTA performance is provided in Table 2.

Functional block diagrams of the GCTA Color Television Camera (CTV) and the Television Control Unit (TCU) are provided in Figures 1 and 2.

The Color Television Camera (CTV) uses basic monochrome techniques to produce high-quality, field-sequential color television at standard (NTSC) line and frame rates. The camera uses a single silicon intensifier target (SIT) tube and a synchronous rotating filter wheel to generate color video data. A zoom lens is incorporated with provisions for manual or remote control of zoom and iris settings. Automatic light control (ALC) operating on average or peak scene luminance also is incorporated. ALC may be selected manually or by remote control.

The Television Control Unit (TCU) permits ground-commanded operation of the CTV. A 70-kHz modulated subcarrier signal is sent to the TCU from the LCRU, and the TCU decodes this signal and executes valid real-time commands. The TCU cradle, mechanically driven in azimuth and elevation, holds the CTV for remote pointing in response to ground commands. The TCU electronics provide control signals to operate the zoom, iris, and ALC functions of the camera, and provides CTV power ON/OFF control in response to ground command or manual switch operation. Commands to the LCRU for ON/OFF control of the FM transmitter and ON/OFF control of the 1.25-MHz voice subcarrier also are generated in the TCU. After adding a vertical-interval test signal on line 17 of each field, the TCU routes the CTV composite video output signal to the LCRU.

A short staff at the base of the TCU electronics box mounts the GCTA to a fitting on the LRV chassis frame. The mounting staff has a swing-away capability to allow removal of the LCRU from the LRV chassis frame without removing the GCTA.

TABLE 1. SIT PERFORMANCE CHARACTERISTICS

Parameter	Value
• Spectral Response	3500-7000 Angstroms
• Resolution	Minimum 40% @ 200 TVL
• Signal Current	Typical 400 nA
• Dark Current	Maximum 15 nA @ 30°C
• Sensitivity & Dynamic Range Typical	1 to 10,000 foot-lambert Scene
• Gamma	1.0
• Scene Dynamic Range	32:1 Minimum
• Shading	Maximum 20%
• Operating Temperature	(-10°C to +50°C)
• Life	Minimum 500 Hours

TABLE 2. PERFORMANCE SUMMARY OF RCA GCTA

Parameter	Characteristic
Sensor	Silicon Intensifier Target (SIT) Tube
Sensitivity	Better than 32-dB signal-to-noise ratio at 3 foot-lamberts
Resolution	80 percent response at 200 TVL
ALC Dynamic Range	1000 to 1 (minimum)
Non-linearity	3 percent (maximum)
Shading	20 percent (maximum)
Gray Scale	Ten $\sqrt{2}$ steps
Video Output Level	1 volt p-p into 75-ohm load Full EIA sync
ALC	PEAK or AVERAGE detection modes Remote control with manual override
Optics	
Zoom ratio	6:1
Iris control	f/2.2 to f/22
Pan angle	+214(R), -134(L)
Tilt angle	+85 degrees from horizontal -45
Power	16.65 watts (operate), 7.95 watts (standby)
Physical Characteristics	
Weight	18.24 pounds
Volume	455 cubic inches

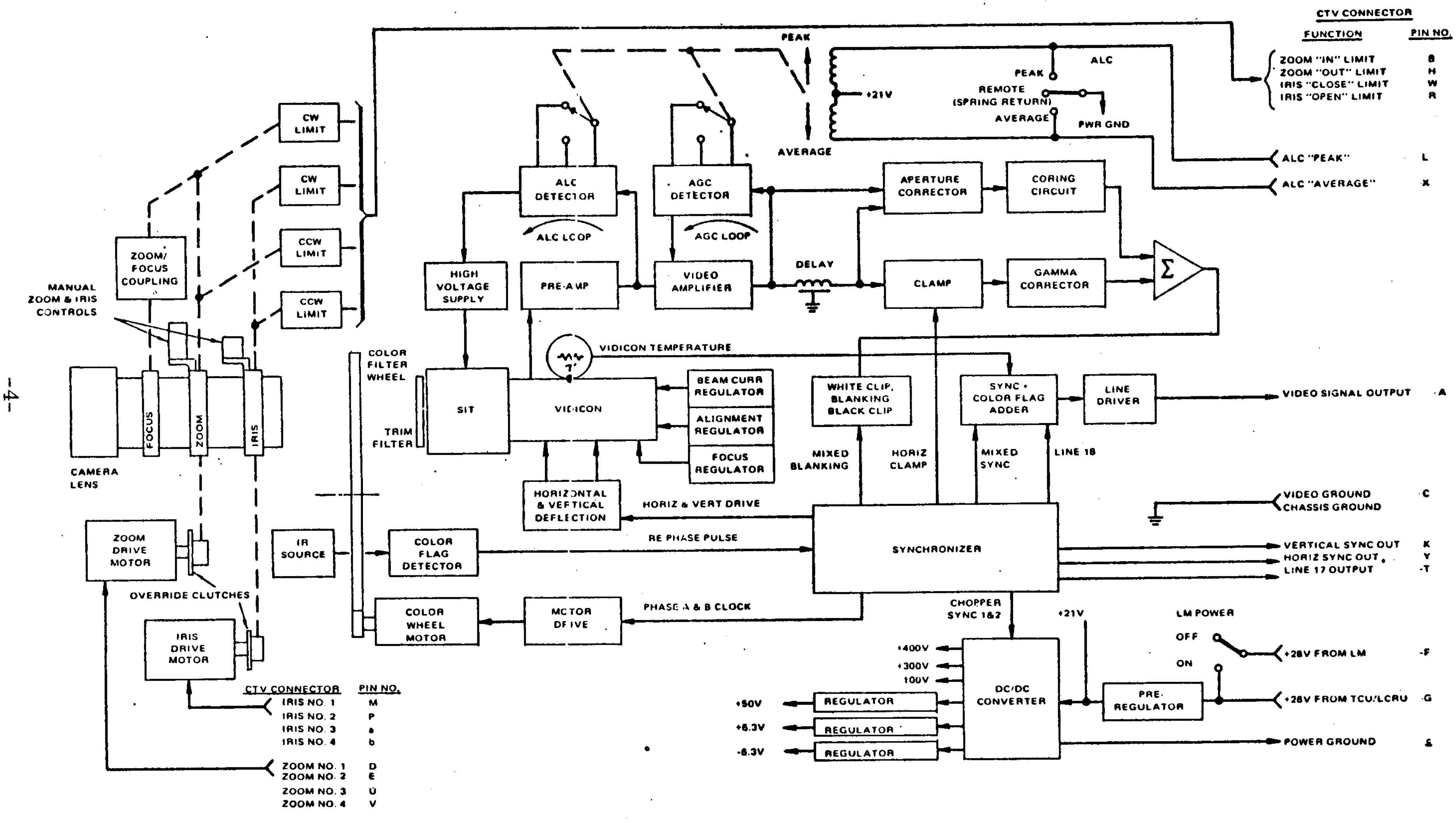


Figure 1. CTV Functional Block Diagram

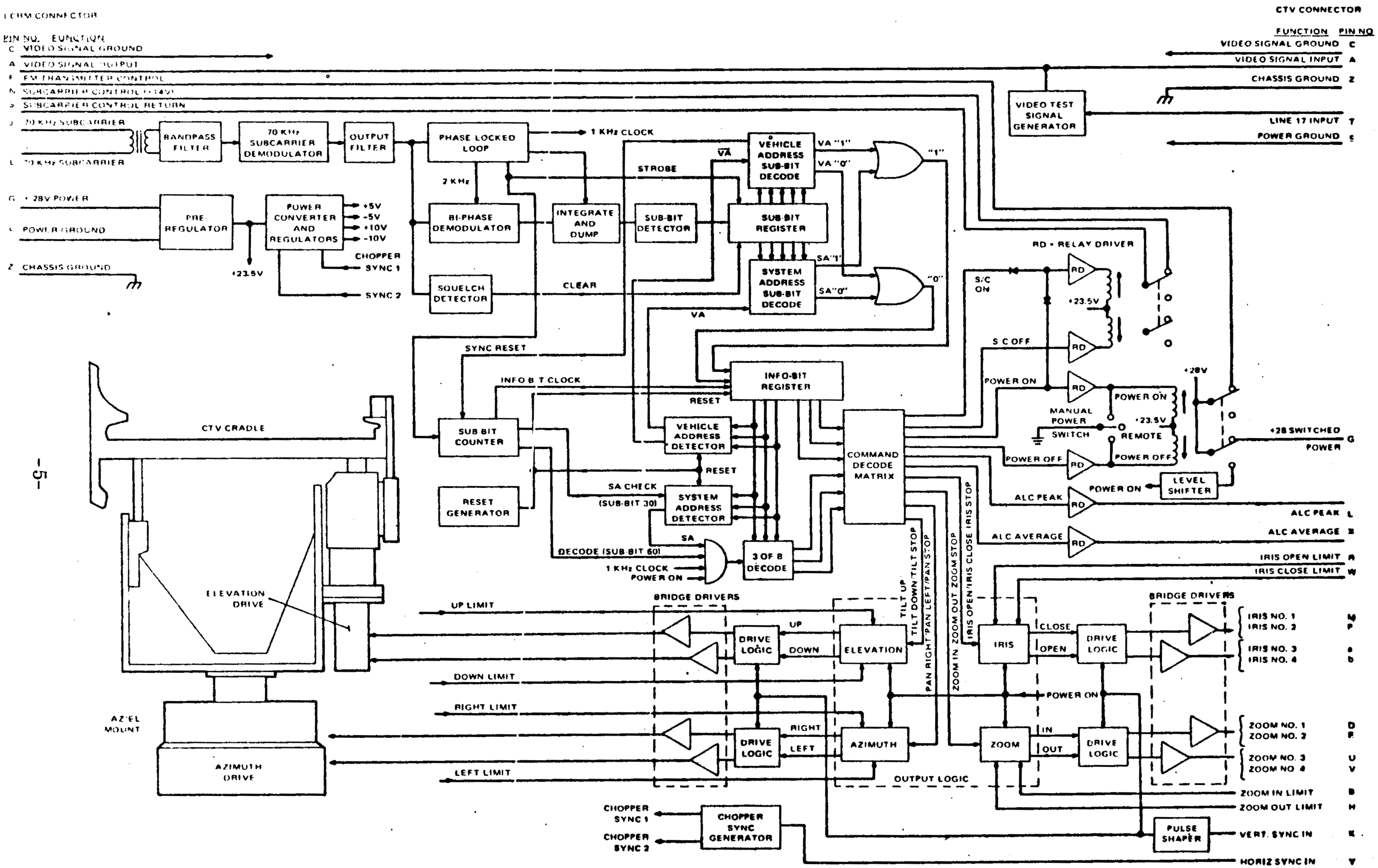


Figure 2. TCU Functional Block Diagram

SECTION II

YOKE/FACEPLATE QUALIFICATION DATA

The GCTA Interim Report issued July 31, 1972 describes the details of design modifications to the Apollo yoke and the addition of a bonded protective faceplate with an integral spectral filter. The yoke modifications were intended to eliminate problems encountered during test of the cameras where open circuits had developed at the connection points on two yoke assemblies. The protective faceplate is intended to eliminate the possibility of discharge phenomena from or through the SIT fiber optics faceplate. By incorporating a spectral filter within the protective faceplate, undesired SIT response to near IR radiation from the color flag detector emitter or from the imaged scene also is eliminated. The protective faceplate filter assembly is detailed in RCA drawing 2269728-501.

To verify the design suitability and integrity of the modifications, qualification tests were conducted on individual yoke assemblies and on a total tube assembly containing a yoke of the new design and a bonded faceplate. The tube assembly qualification procedure was performed in accordance with Appendix A of this report (Qualification Test Procedure), and consisted of the following operations:

1. Sinusoidal Vibration
2. Random Vibration
3. Acceleration
4. Shock
5. Temperature Cycling

The qualification procedure for the yoke assembly is provided as Appendix A in the referenced report. The tests consisted of the following items:

1. Hot step stress testing (to +100° C)
2. Cold step stress testing (to -70° C)
3. Cyclic temperature fatigue tests (-10° C to +65° C)
4. Power ON/OFF cycling fatigue test (-10° C to +65° C)

It was initially planned to start a new yoke at each step above, to isolate the mode in the event of a failure. Printed circuit material constraints limited the availability of new yokes so that a single yoke of new configuration was exposed to all of the qualification tests. Both the yoke and tube assembly have successfully completed their respective qualification tests, thus providing confidence in the integrity of the modifications.

The test data obtained on the total tube assembly prior to, during, and after exposure to the required environmental tests is shown on the following Data Sheets (1 through 8). Spurious signal photographs show that no changes occurred in spots or blemishes. Integrity of the faceplate bond was assured by examining these photographs for interference patterns, and by visual examination of the tube assembly. No evidence of separation was found. The parameter data sheets showed no significant changes at each of the test steps. Dark current variations within ±15 percent are considered normal based on measurement accuracy and small temperature variations at the time of measurement. All dark current values are below the specification maximum (15 nA). The small changes in recorded alignment current reflect operator setup for performance data and do not suggest a change in tube characteristics.

During initial assembly of the test tube/yoke assembly (S/N 710-Q3), high voltage arcing was encountered at the first application of power. The photocathode bleeder resistor was found to be improperly positioned in the assembly, permitting arcing to the ground connection. The resistors were replaced and no further problems were encountered.

Two yoke assemblies were subjected to testing in accordance with the procedure in Appendix A. Serial Number 3-72-1 was of the original design configuration, while S/N 7-31-3 was of the modified design as illustrated in the referenced interim report. On the attached recorder traces, the unit windings are designated as follows:

Test	New	Old
HOT STRESS	V2/H2	V1/H1
COLD STRESS	V1/H1	V2/H2
ON/OFF CYCLING	V2/H2	V1/H1
FATIGUE CYCLING	V2/H2	V1/H1

Data Sheets 9 and 10 present a summary of the data obtained for all of the tests. Several erratic readings are noted on the recorder traces. These were identified as being caused by a noisy potentiometer in the bridge circuit used to establish the current through the windings. The recorder traces are annotated as follows:

Data Sheet No.	Test
11	Hot Stress (NEW)
12	Hot Stress (OLD)
13,14	Cold Stress (NEW)
15,16	Cold Stress (OLD)
17,18	ON/OFF Cycling (OLD)
19,20	ON/OFF Cycling (NEW)
21-26	FATIGUE Cycling (OLD)
27-31	FATIGUE Cycling (NEW)

RECEIVED
OCT 1 9 1972
B. SOLTOFF

INDIVIDUAL TEST DATA
PART I

DATA SHEET

Pre-Environmental Test

Unit: SIT C21129B
Serial No: 710-03
Date: 9/29/72
Test Personnel: CAL
Inspector: BJB

Electrical and Performance

Test Para.	Name	Limits Min	Limits Max	Result	Units
2.1	Lag	-	10	6	%
2.2	Amplitude Response				
	Center	40	-	78	%
	Corner	25	-	30	%
2.3	Cutoff	-120	-65	-80	Vdc
2.4	Sensitivity	100	-	123	uA/lm
2.5	Target Gain	1000	-	1860*	-
2.6	Image Section Gain Change	100	-	84.1*	-
2.7	Dark Current	-	15	7.5	nAdc
2.8	Alignment Field				
	Horizontal	-	20	+15	mAdc
	Vertical	-	20	-18	mAdc
2.9	Shading	-	20	18	%
2.10	Spots or Blemishes	(See Para 2.10)		OK (see photos)	

Mechanical Tests

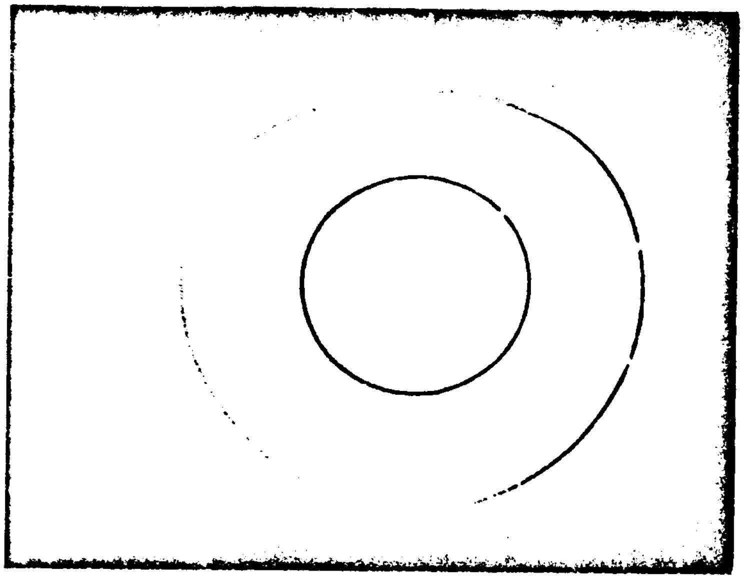
Test Para.	Name	Limits Min	Limits Max	Result	Units
3.0	Dimensions				
	PC Lead	0.90	-	1.2	inch
	Faceplate to flange	4.895	4.915	4.909	inches
3.1	Weight		24	25.2	ounces

*Data taken at initial tube test

DATA SHEET 1

SPURIOUS SIGNAL, PRE ENVIRONMENTAL TESTS

Serial No. 710 - Q3



P____

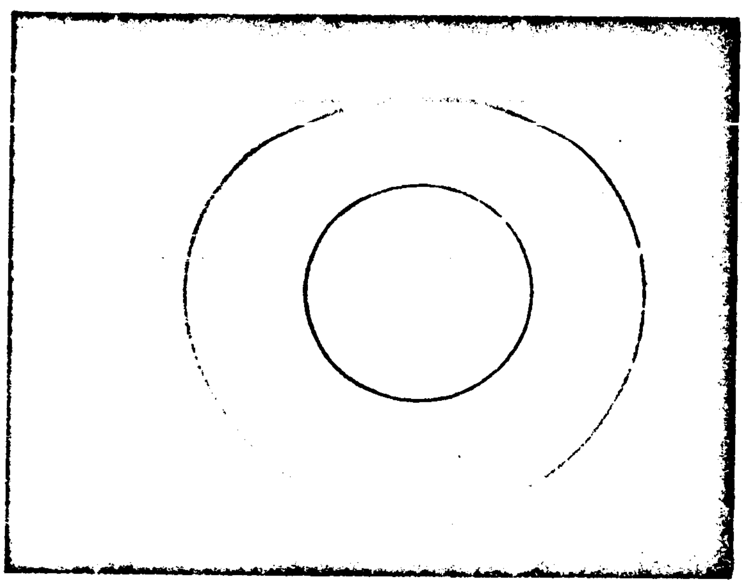
E_{pc} 3 KV

I_t 300 nA

P____

Sweep ____________ /cm

Sens ____________ /cm



P____

E_{pc} 8 KV

I_t 300 nA

Attached by ____________

Date ____________

SIZE	CODE IDENT NO.	DATA SHEET 2
A	49671	
		SHEET

AED 1016 12/67

INDIVIDUAL TEST DATA
PART I

DATA SHEET

Vibrated

Unit: SJT C21129B
Serial No: 710-Q3
Date: 10/1/72
Test Personnel: CAL
Inspector: BJB

Electrical and Performance

Test Para.	Name	Limits Min	Limits Max	Result	Units
2.1	Lag	-	10	8	%
2.2	Amplitude Response				
	Center	40	-	78	%
	Corner	25	-	32	%
2.3	Cutoff	-120	-65	-80	Vdc
2.4	Sensitivity	100	-	124	uA/lm
2.5	Target Gain	1000	-	1860*	-
2.6	Image Section Gain Change	100	-	84.1*	-
2.7	Dark Current	-	15	5.8	nAdc
2.8	Alignment Field				
	Horizontal	-	20	+16	mAdc
	Vertical	-	20	-18	mAdc
2.9	Shading	-	20	18	%
2.10	Spots or Blemishes	(See Para 2.10)		No change (see photos)	

Mechanical Tests

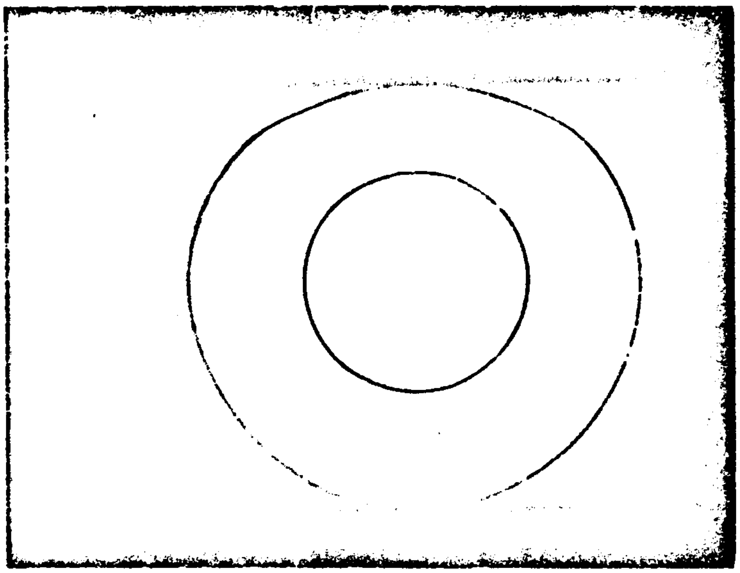
Test Para.	Name	Limits Min	Limits Max	Result	Units
3.0	Dimensions				
	PC Lead	0.90	-	1.2	inch
	Faceplate to flange	4.895	4.915	4.909	inches
3.1	Weight	-	24	25.2	ounces

*Data taken at initial tube test

DATA SHEET 3

SPURIOUS SIGNAL, POST VIBRATION

Serial No. 710-Q3



P____

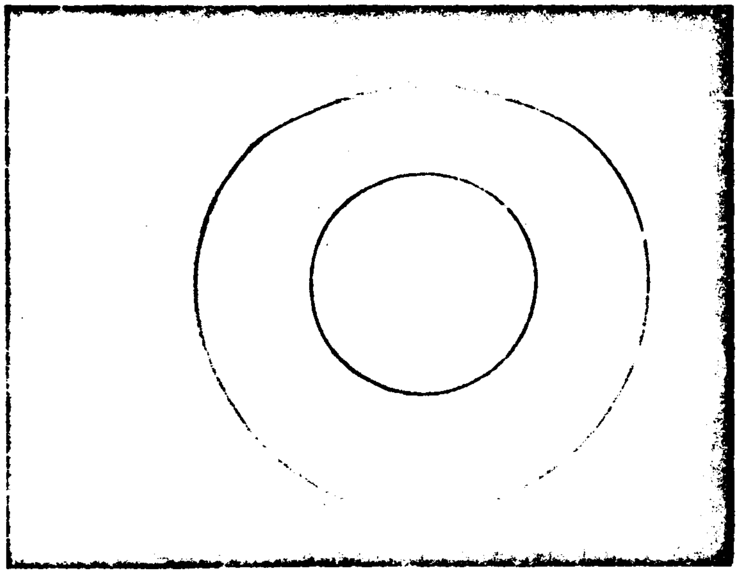
E_{PC} 3 kV

I_t 300 nA

P____

Sweep ________ /cm

Sens ________ /cm



P____

E_{PC} 8 kV

I_t 300 nA

Attached by BMS

Date 11/13/72

SIZE	CODE IDENT NO.	
A	49671	DATA SHEET 4
		SHEET

INDIVIDUAL TEST DATA
PART I

DATA SHEET

Shocked & Accelerated

Unit: SJT C21129B
Serial No: 710-Q3
Date: 10/2/72
Test Personnel: CAL
Inspector: BJB

Electrical and Performance

Test Para.	Name	Limits Min	Limits Max	Result	Units
2.1	Lag	-	10	6	%
2.2	Amplitude Response				
	Center	40	-	78	%
	Corner	25	-	30	%
2.3	Cutoff	-120	-65	-80	Vdc
2.4	Sensitivity	100	-	123	uA/lm
2.5	Target Gain	1000	-	1860*	-
2.6	Image Section Gain Change	100	-	84.1*	-
2.7	Dark Current	-	15	6.1	nAdc
2.8	Alignment Field				
	Horizontal	-	20	+12	mAdc
	Vertical	-	20	-16	mAdc
2.9	Shading	-	20	18	%
2.10	Spots or Blemishes (See Para 2.10)				

Mechanical Tests

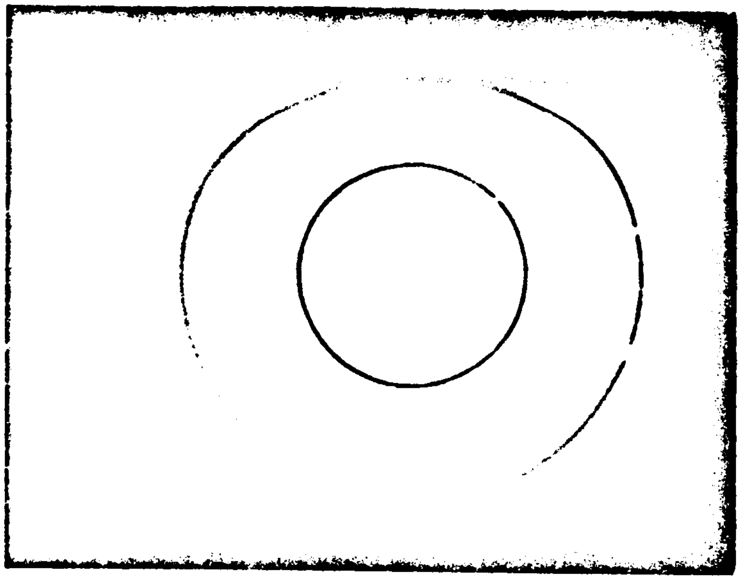
Test Para.	Name	Limits Min	Limits Max	Result	Units
3.0	Dimensions				
	PC Lead	0.90	-	1.2	inch
	Faceplate to flange	4.895	4.915	4.909	inches
3.1	Weight	-	24	25.2	ounces

*Data taken at initial tube test

DATA SHEET 5

SPURIOUS SIGNAL, POST SHOCK & ACCELERATION

Serial No. 710-Q3



P

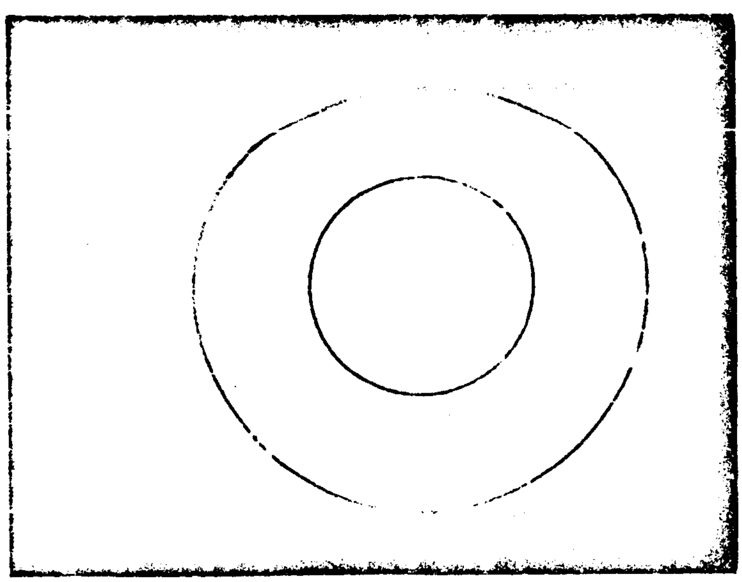
Epc 3 kV

It 300 nA

P

Sweep /cm

Sens /cm



P

Epc 8 kV

It 300 nA

SIZE	CODE IDENT NO.	DATA SHEET 6
A	49671	
		SHEET

Attached by BmS

Date 11/13/72

AED 1016 12/67

INDIVIDUAL TEST DATA
PART I

DATA SHEET
Temperature Cycled

Unit: SJT C21129B
Serial No: 710-Q3
Date: 10/4/72
Test Personnel: CAL
Inspector: BJB

Electrical and Performance

Test Para.	Name	Limits Min	Limits Max	Result	Units
2.1	Lag	-	10	8	%
2.2	Amplitude Response -				
	Center	40	-	78	%
	Corner	25	-	35	%
2.3	Cutoff	-120	-65	-80	Vdc
2.4	Sensitivity	100	-	122	uA/lm
2.5	Target Gain	1000	-	1860*	-
2.6	Image Section Gain Change	100	-	84.1*	-
2.7	Dark Current	-	15	5.8	nAdc
2.8	Alignment Field				
	Horizontal	-	20	+11	mAdc
	Vertical	-	20	-20	mAdc
2.9	Shading	-	20	14	%
2.10	Spots or Blemishes	(See Para 2.10)		No change (see photos)	

Mechanical Tests

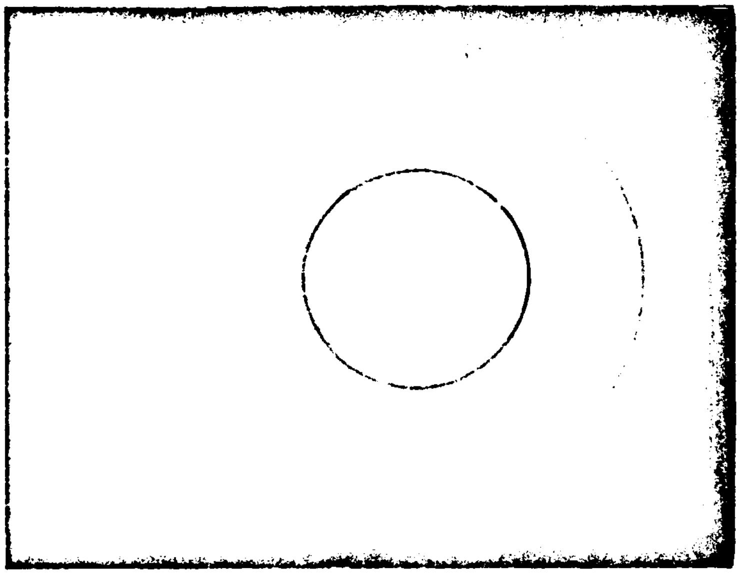
Test Para.	Name	Limits Min	Limits Max	Result	Units
3.0	Dimensions				
	PC Lead	0.90	-	1.2	inch
	Faceplate to flange	4.895	4.915	4.909	inches
3.1	Weight	-	24	25.2	ounces

*Data taken at initial tube test

DATA SHEET 7

SPURIOUS SIGNAL, POST THERMAL CYCLING

Serial No. 710-Q3



P____

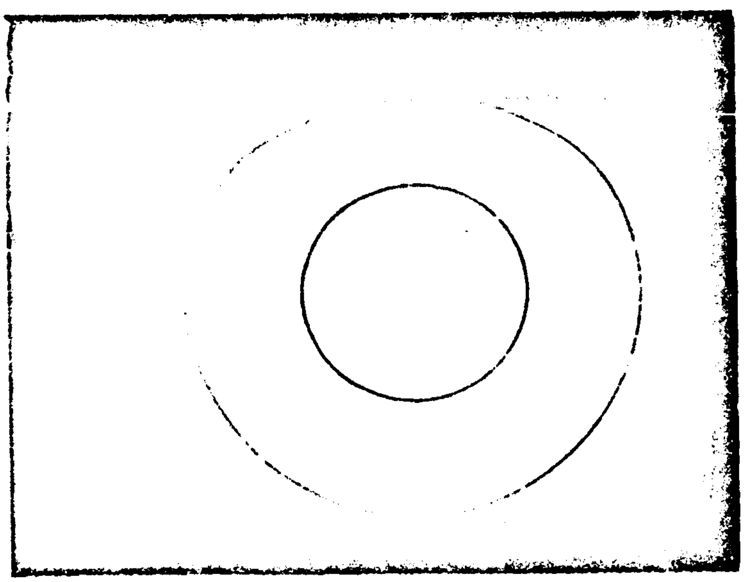
E_{PC} 3 kV

I_t 300 nA

P____

Sweep ______ /cm

Sens ______ /cm



P____

E_{PC} 8 kV

I_t 300 nA

Attached by [signature]

Date 11/13/72

SIZE	CODE IDENT NO.	DATA SHEET 8
A	49671	
		SHEET

AED 1016 12/67

Apollo Environmental Yoke Testing Data Sheets

Pre Test Data		LH (mh)	LV (mh)	RH (ohms)	RV (ohms)
Unit #1	7-31-3	1.9	1.9	28.6	28.2
Unit #2	3-72-1 (old)	1.96	2.02	30.5	31.4

Hot Temp. Stress	Ambient (26.7°C)	+40°C	+50°C	+60°C	+70°C	+80°C	+90°C	+100°C		Inductance (mh)
Unit #1 7-13-3 Hor	28.92	30.32	31.32	32.36	33.36	34.36	35.4	36.48	ohms	1.98
Ver	27.60	28.92	29.88	30.88	31.84	32.80	33.8	34.76	"	1.91
Unit #2 3-72-1 Hor	30.64	32.04	33.12	34.24	35.32	36.32	37.44	38.56	"	1.97
Ver	32.28	33.8	34.88	36.08	37.20	38.28	39.44	40.6	"	2.01

Cold Temp. Stress	Ambient (23°C)	+10°C	0°C	-10°C	-20°C	-30°C	-40°C	-50°C	-60°C	-70°C		Inductance (mh)
Unit #1 7-13-3 Hor	27.4	26.3	25.5	24.4	23.4	22.3	21.2	20.3	19.2	18.0	ohms	1.97
Ver	27.6	26.3	25.2	24.1	23.1	22.0	21.0	20.0	19.0	17.7	"	1.99
Unit #2 3-72-1 Hor	30.8	29.2	28.0	26.7	25.7	24.5	23.3	22.3	21.1	19.7	"	1.91
Ver	31.5	29.9	28.6	27.3	26.2	25.0	23.8	22.8	21.6	20.1	"	1.97

Fatigue Eval.		Cycle 1		Cycle 2		Cycle 3		Cycle 4		Cycle 5		Cycle 6		Cycle 7		Cycle 8		Cycle 9		Cycle 10	
	Amb (27°C)	+65	-10	+65	-10	+65	-10	+65	-10	+65	-10	+65	-10	+65	-10	+65	-10	+65	-10	+65	-10
Unit #1 7-13-3 Hor	29.1	32.6	24.8	32.7	24.8	31.5	24.9	32.7	24.8	32.8	24.9	32.8	25.0	32.7	24.9	32.7	24.9	32.8	25.0	32.9	24.9
Ver	28.0	31.4	23.9	31.5	23.8	32.8	24.0	31.5	23.8	31.4	24.0	31.6	24.1	31.5	23.9	31.5	23.9	31.5	24.0	31.5	23.9
Unit #2 3-72-1 Hor	30.8	34.6	26.3	34.7	26.2	34.7	26.4	34.7	26.3	34.8	26.4	34.7	26.4	34.6	26.3	34.6	26.4	34.8	26.4	34.7	26.3
Ver	32.5	36.4	27.7	36.6	27.6	36.6	27.7	36.6	27.7	36.6	27.8	36.6	27.9	36.5	27.7	36.5	27.8	36.7	27.9	36.5	27.8

DATA SHEET 9

On[illegible] C[illegible]s @[illegible]5°C

	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12	#13	#14	#15	#16	#17	#18	#19	#20	
Unit #1 7-13-3 Hor	32.4	32.5	32.5	32.5	32.6	32.7	32.7	32.7	32.7	32.7	32.7	32.7	32.7	32.6	32.6	32.7	32.7	32.7	32.7	32.7	ohms
Ver	31.2	31.2	31.3	31.3	31.3	31.3	31.4	31.4	31.4	31.4	31.4	31.3	31.3	31.3	31.3	31.4	31.4	31.4	31.4	31.4	"
Unit #2 3-72- Hor	34.6	34.6	34.6	34.6	34.6	34.7	34.7	34.7	34.7	34.6	34.6	34.6	34.6	34.6	34.6	34.7	34.7	34.7	34.6	34.6	"
Ver	36.4	36.4	36.4	36.4	36.4	36.4	36.5	36.5	36.5	36.5	36.4	36.4	36.4	36.4	36.4	36.5	36.4	36.4	36.4	36.4	"

On-Off Cycles @ -10°C

	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12	#13	#14	#15	#16	#17	#18	#19	#20
Unit #1 7-13-3 Hor	25.0	25.0	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8
Ver	24.0	24.0	23.9	23.9	23.9	23.9	23.9	23.9	23.9	23.9	23.9	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
Unit #2 3-72-1 Hor	26.4	26.4	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.2	26.2	26.2	26.2	26.2	26.2
Ver	27.8	27.8	27.7	27.7	27.8	27.8	27.8	27.8	27.8	27.8	27.8	27.7	27.7	27.7	27.6	27.6	27.6	27.6	27.6	27.6

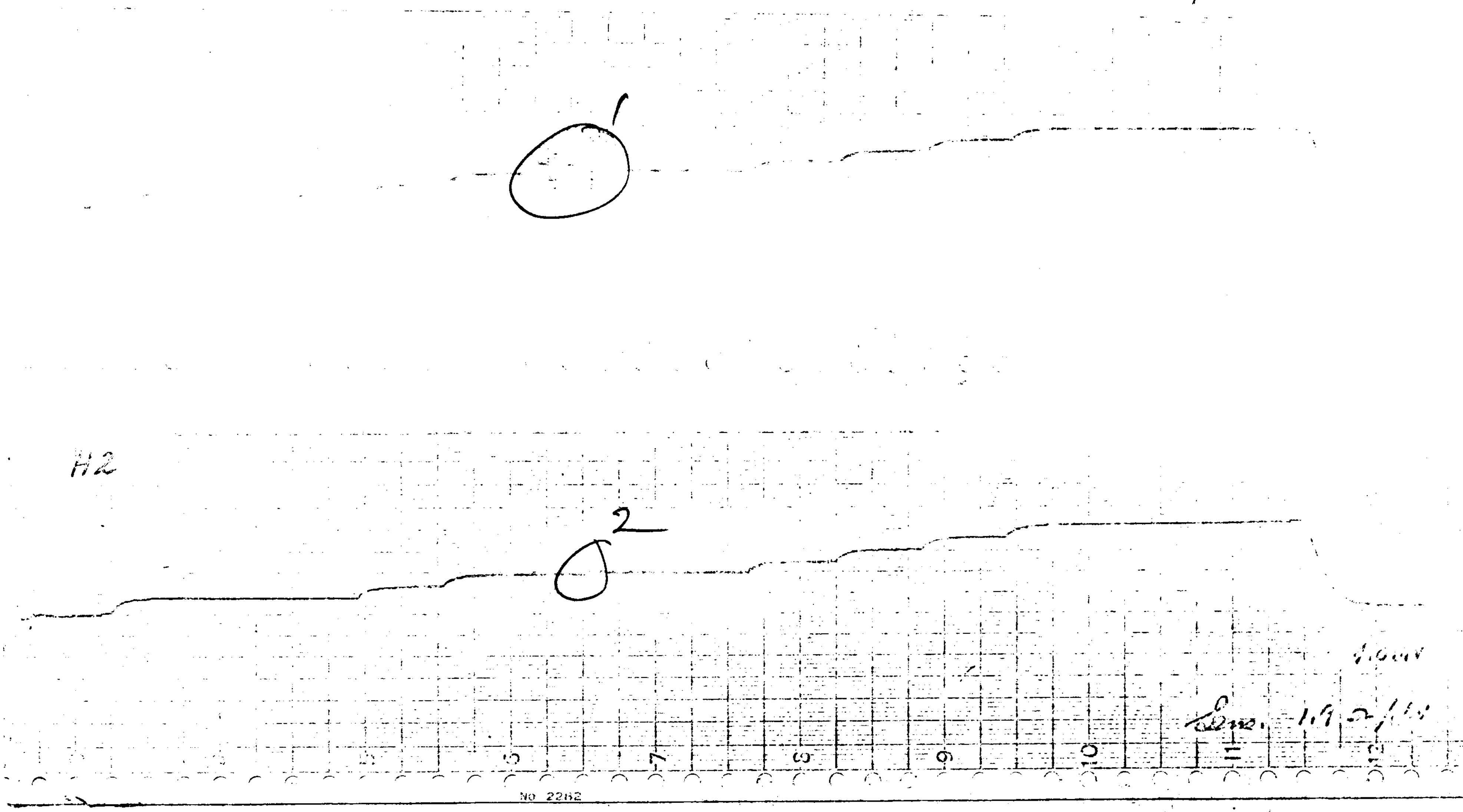
On-Off Cycles @ +25°C

	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12	#13	#14	#15	#16	#17	#18	#19	#20	
Unit #1 7-13-3 Hor.	28.5	28.4	28.4	28.4	28.4	28.3	28.4	28.3	28.3	28.4	28.4	28.3	28.3	28.3	28.3	28.4	28.4	28.3	28.4	28.4	ohms
Ver	27.4	27.3	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	"
Unit #2 3-72-1 Hor	30.1	30.1	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	"
Ver	31.7	31.6	31.6	31.6	31.6	31.5	31.5	31.5	31.5	31.6	31.6	31.6	31.5	31.5	31.5	31.5	31.6	31.5	31.5	31.5	"

		L Hor	L Ver
Unit #1	7-13-3	2.01mh	2.0mh
Unit #2	3-72-1	1.98mh	2.05mh

DATA SHEET 10

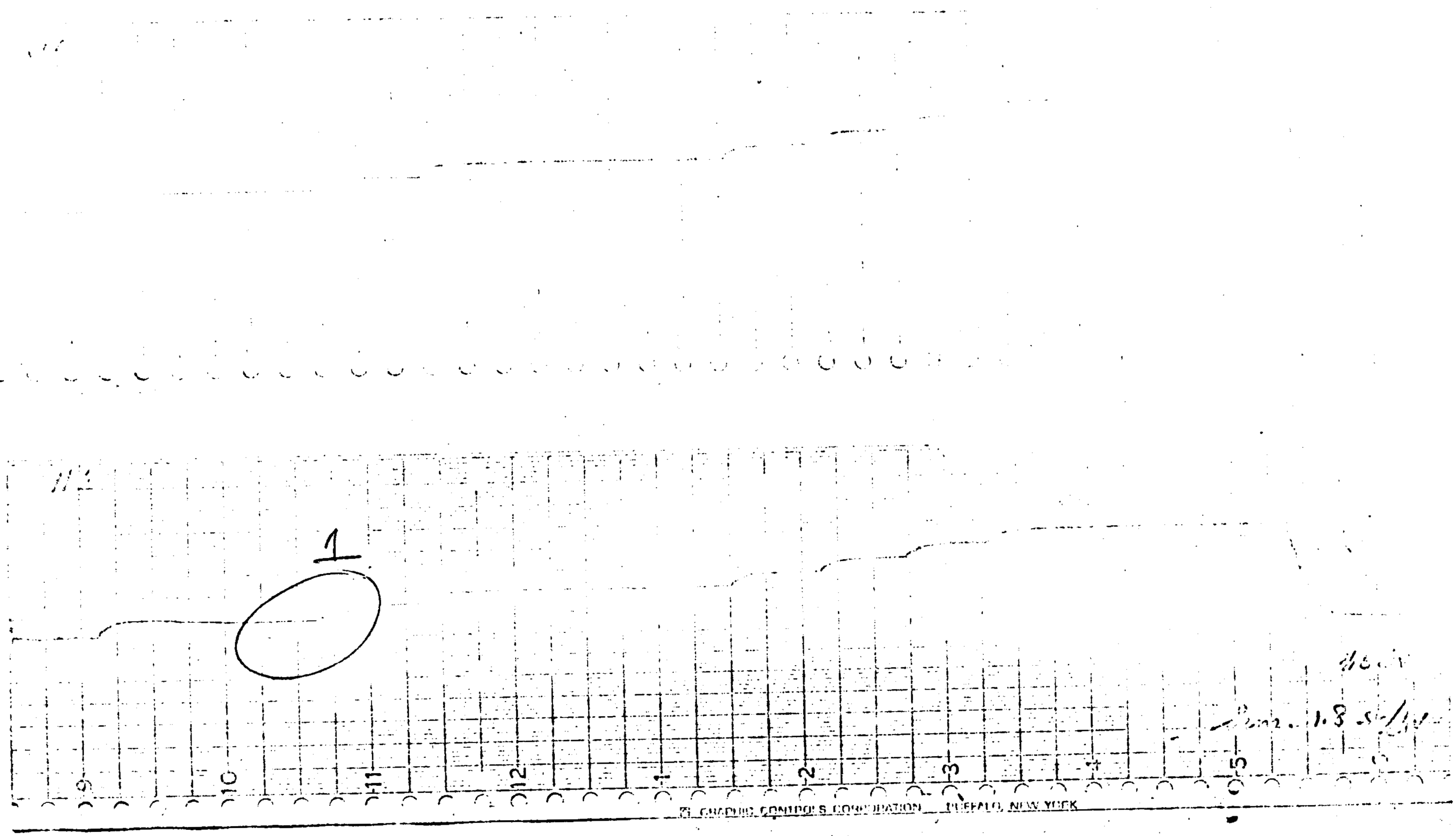
New Unit



1. Trace jumped while recording data. It is strongly felt that technician caused jump by bumping potentiometer in circuitry.
2. Circuit box intentionally jarred causing slight jump in trace.

DATA SHEET 11

Old Unit



1 Strip Recorder Paper Drive Inoperative causing skip in trace.

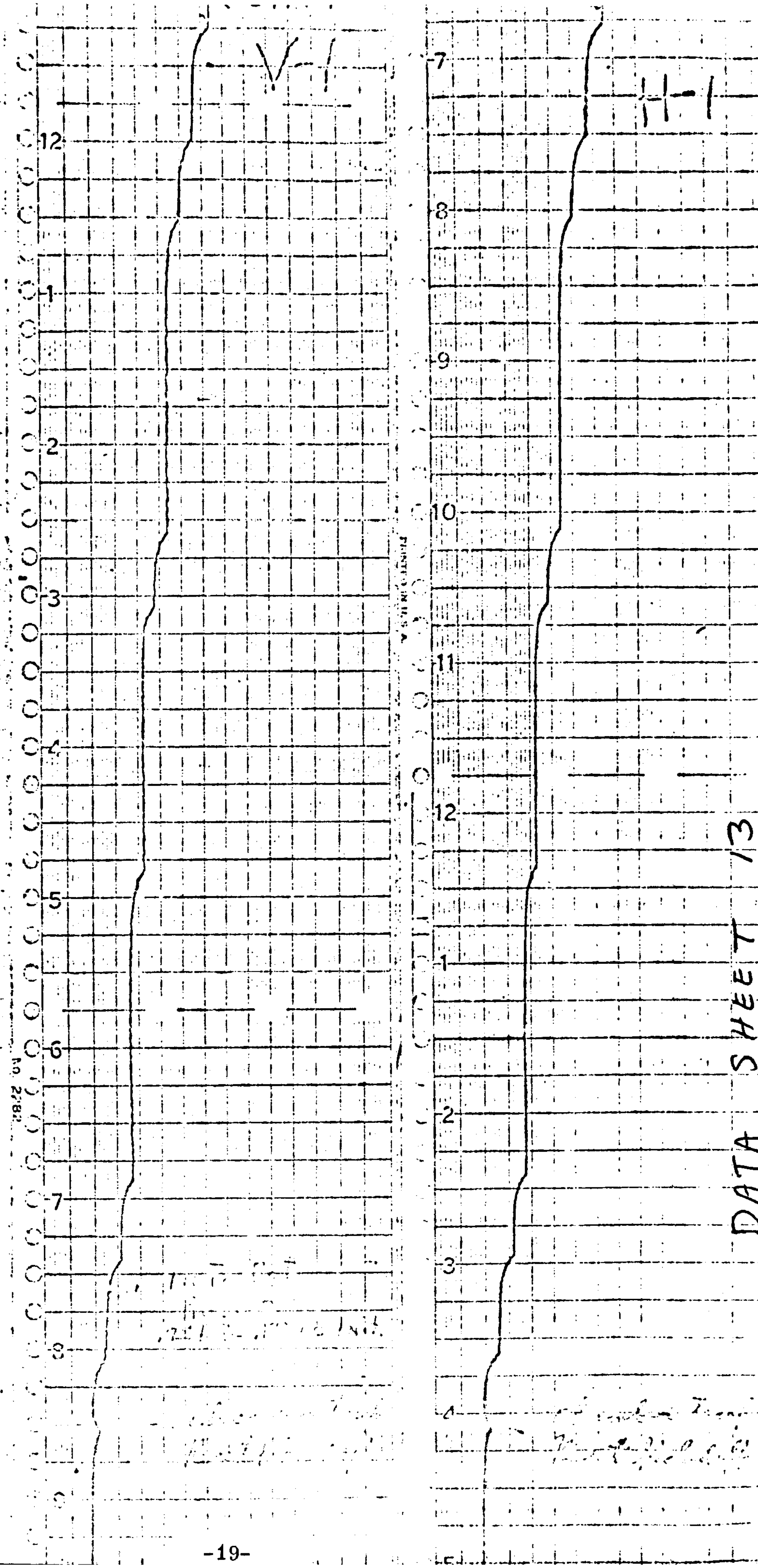
DATA SHEET 12

Page 1 of 2

Page H1 and

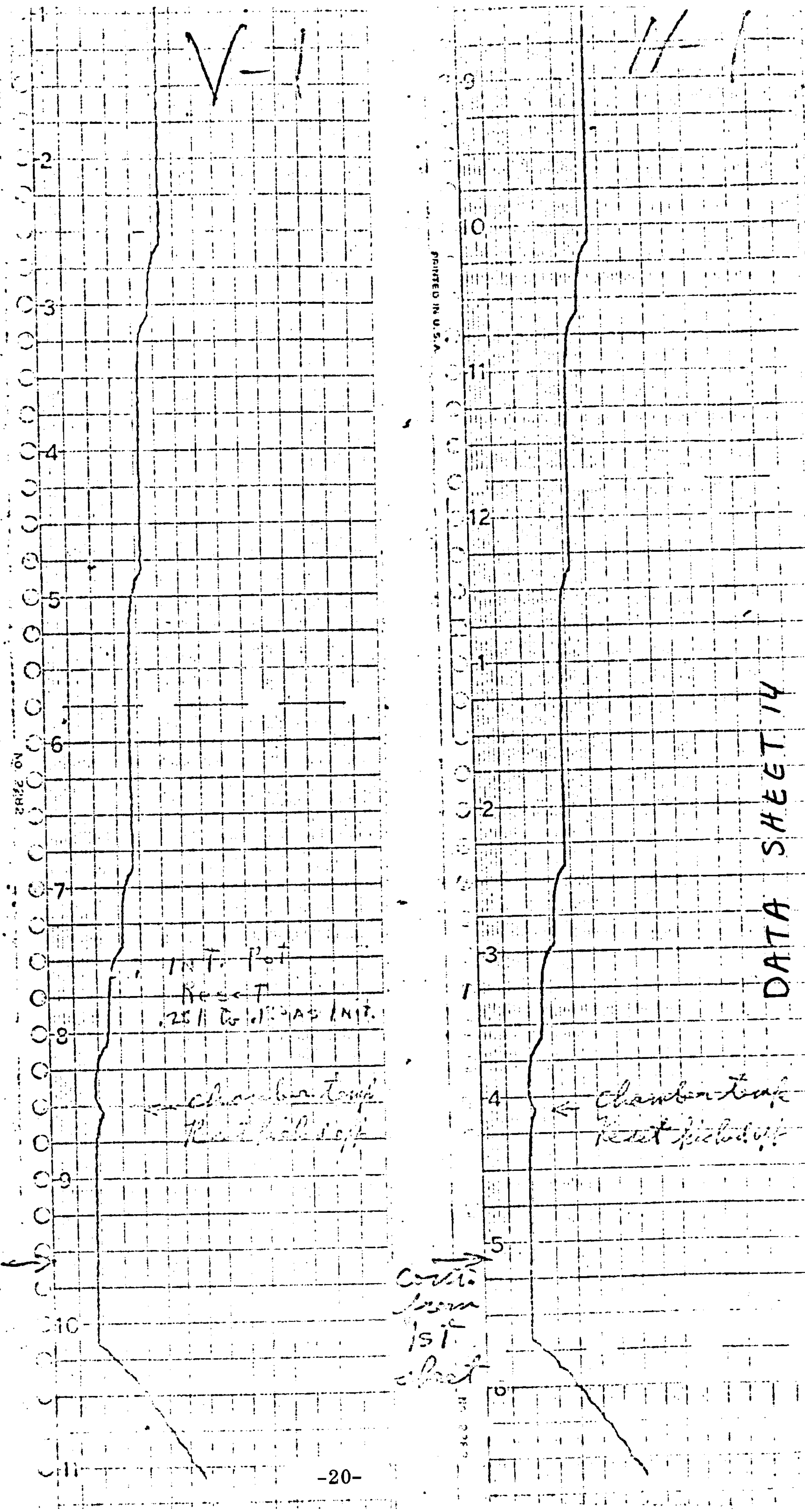
V1 recordings

(NEW YOKE)



V. H-1. recordings

(NEW YOKE)

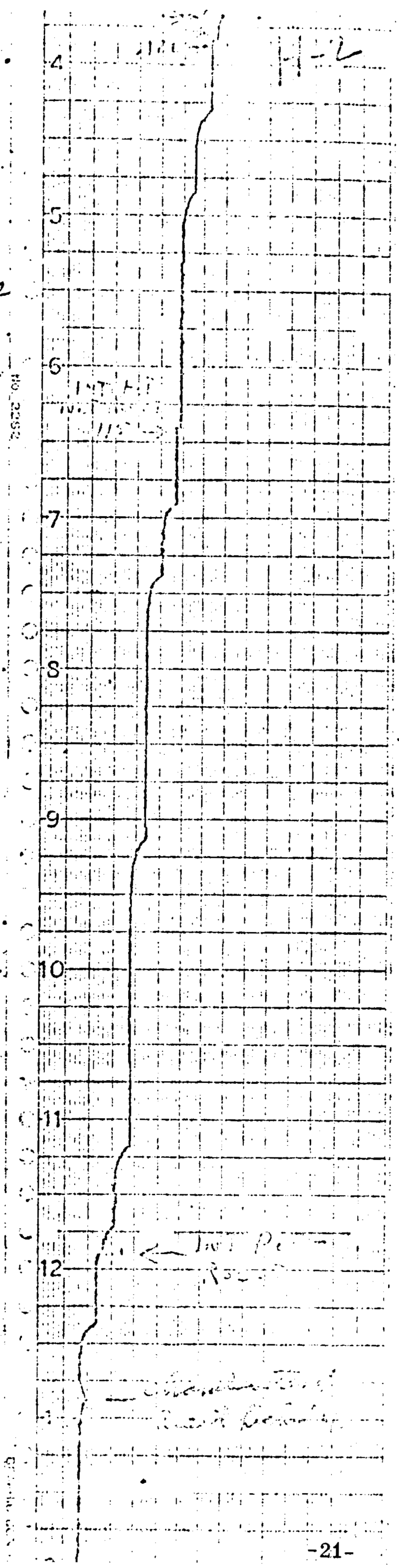


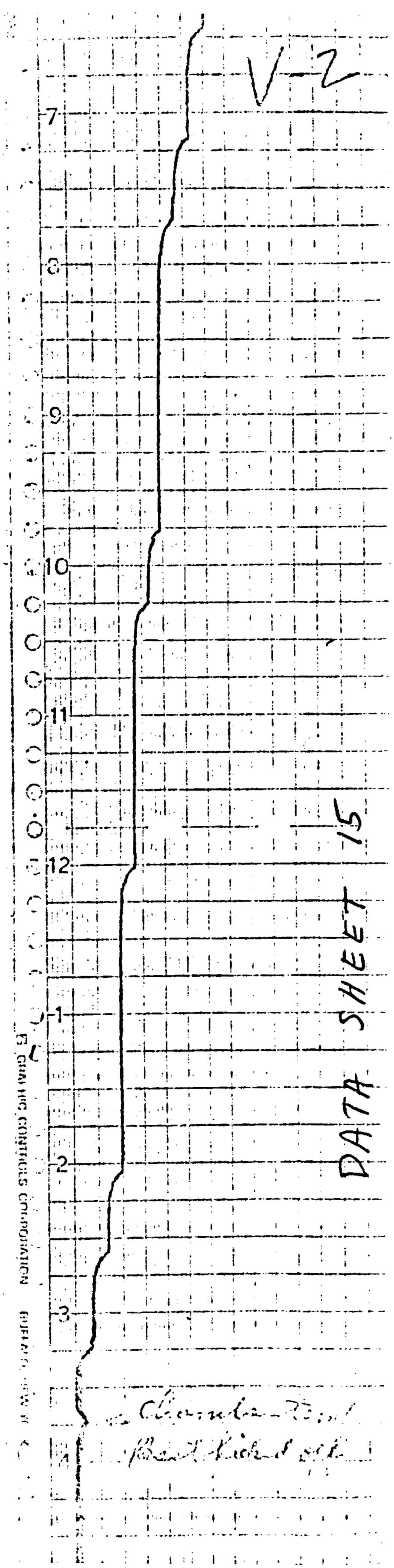
continuation from 1st sheet

Cont. from 1st sheet

Page 1 of
v page H2
V2 recordings

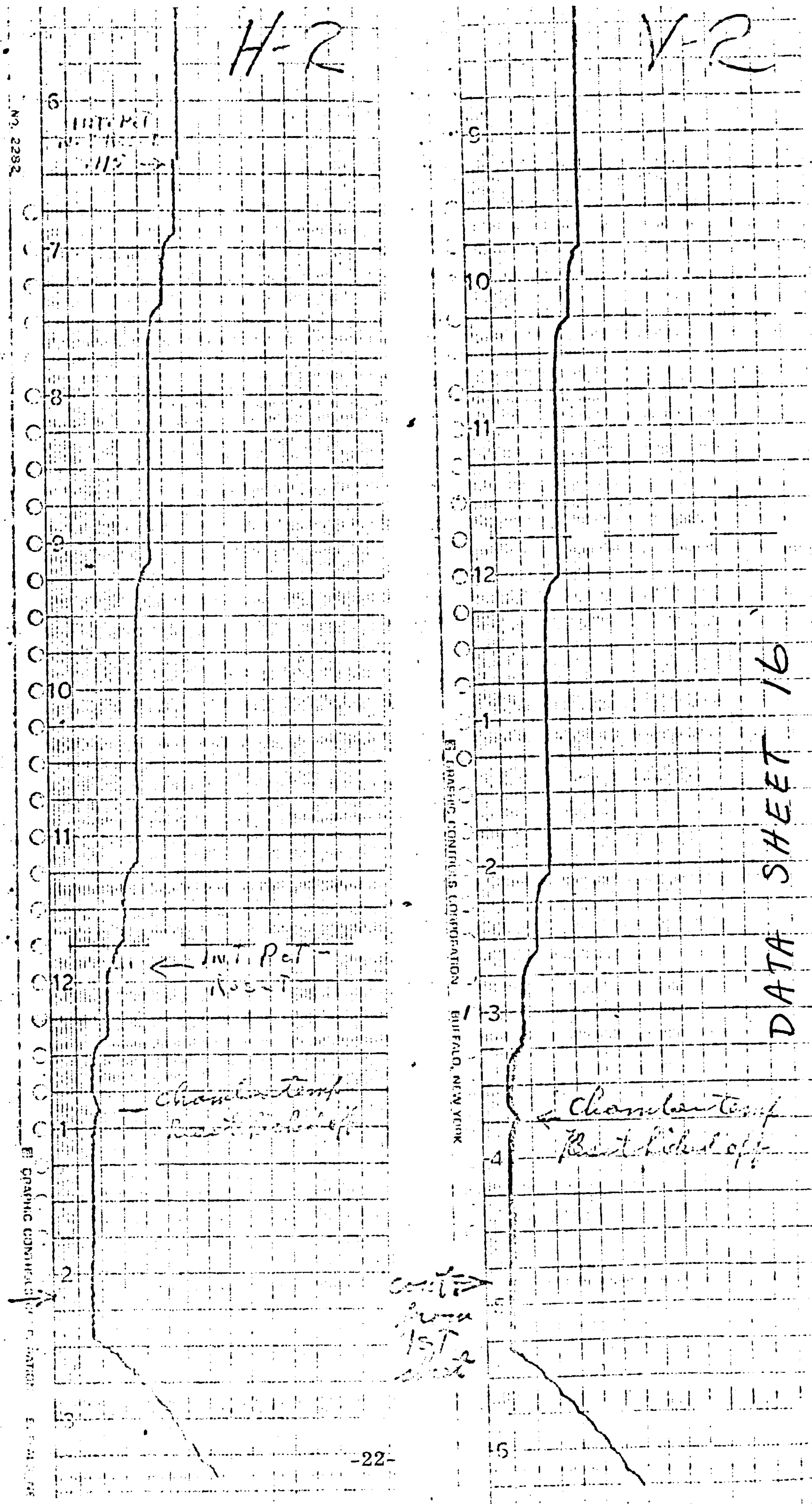
(OLD YOKE)



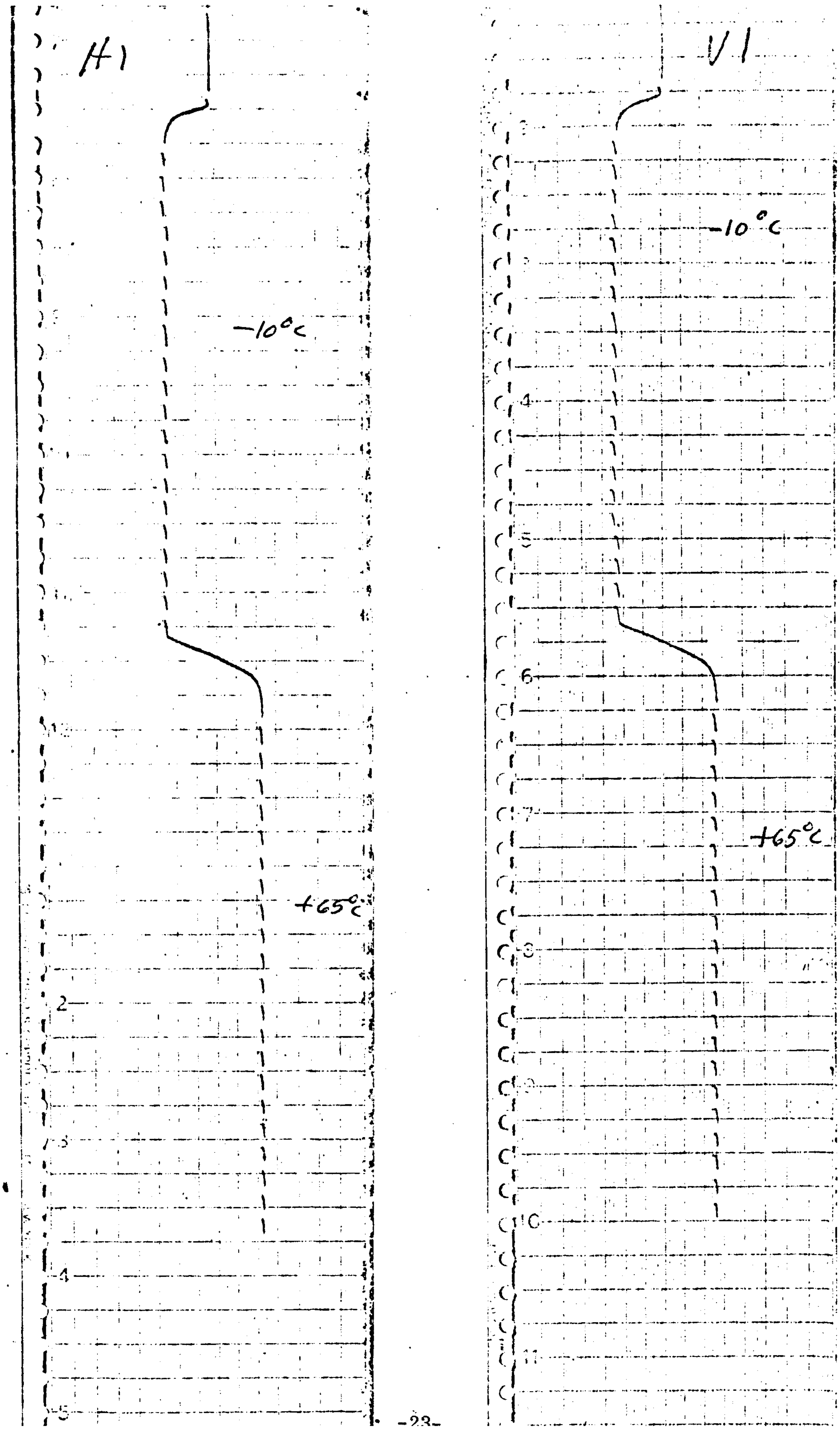


Page 2 of
V2 H2
recordings
(OLD YOKE)

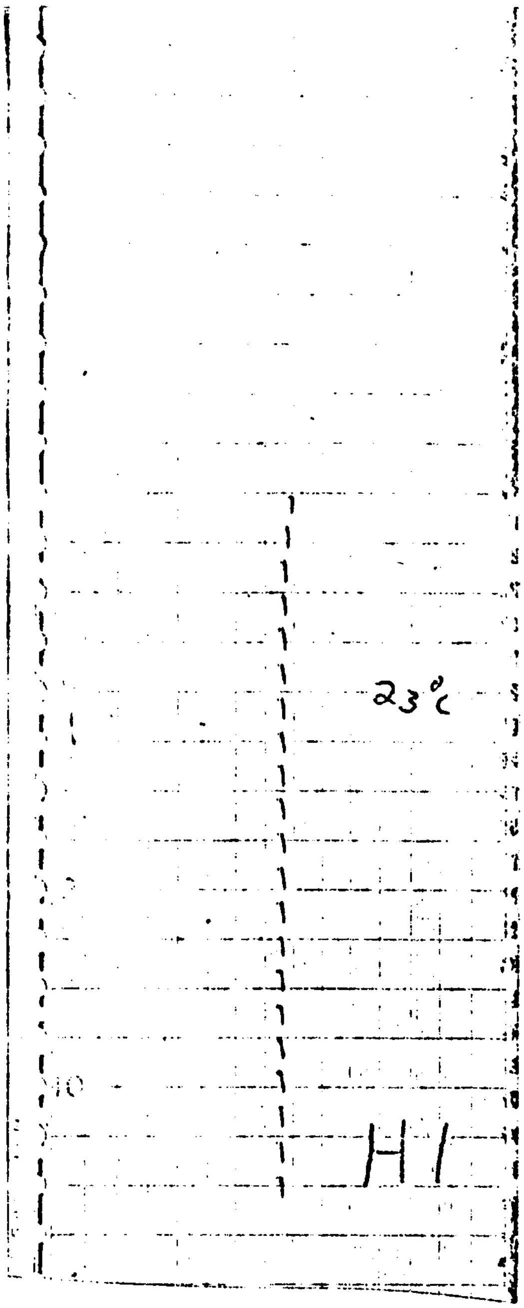
continuation from 1st sheet →

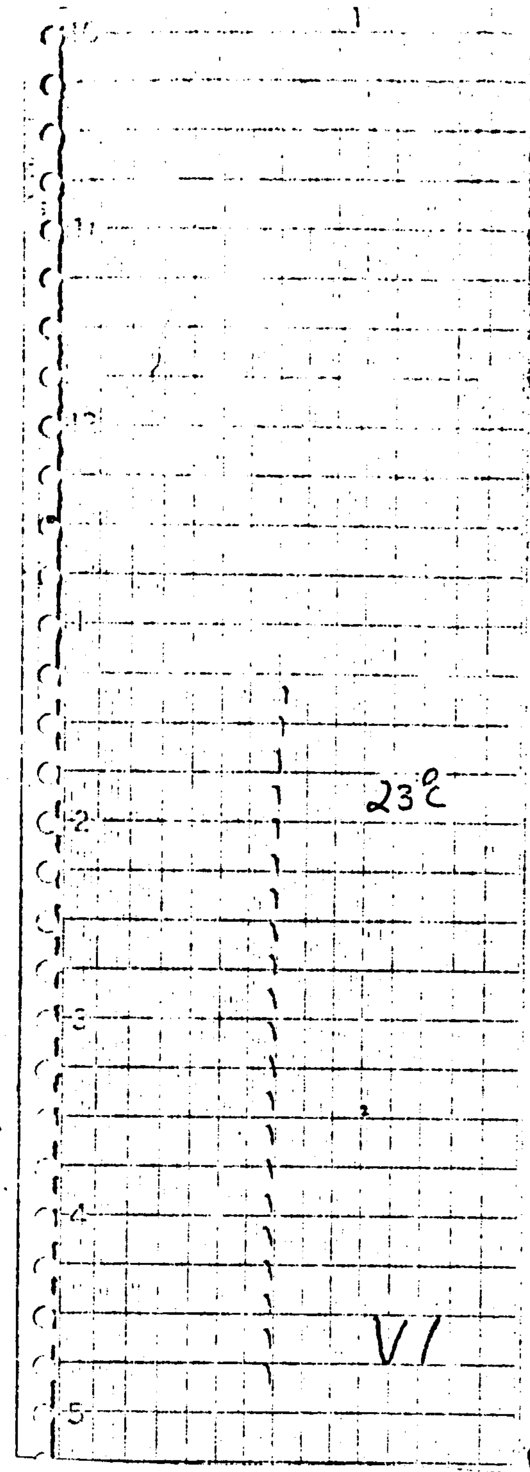


ON/OFF



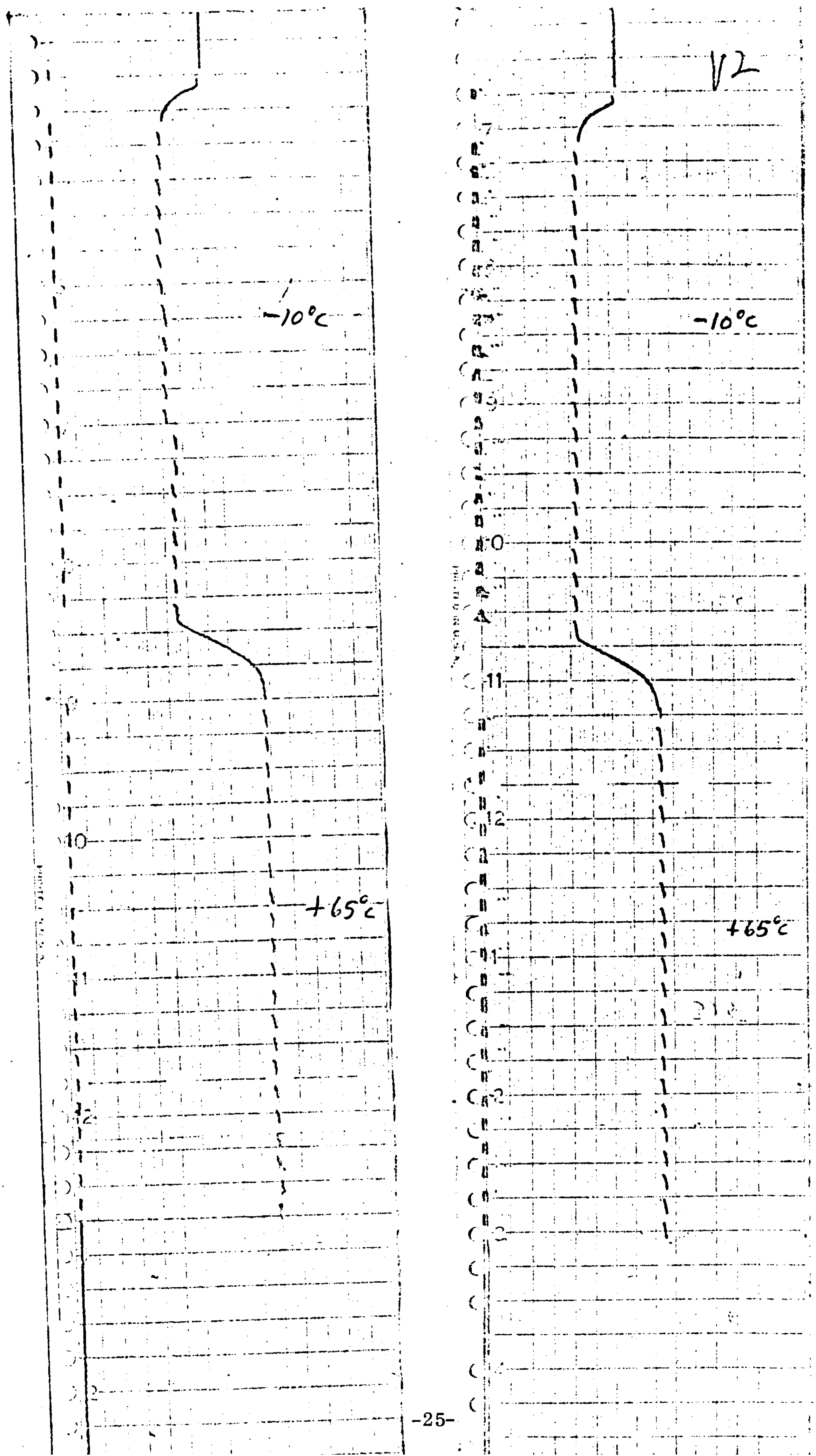
DATA SHEET 17

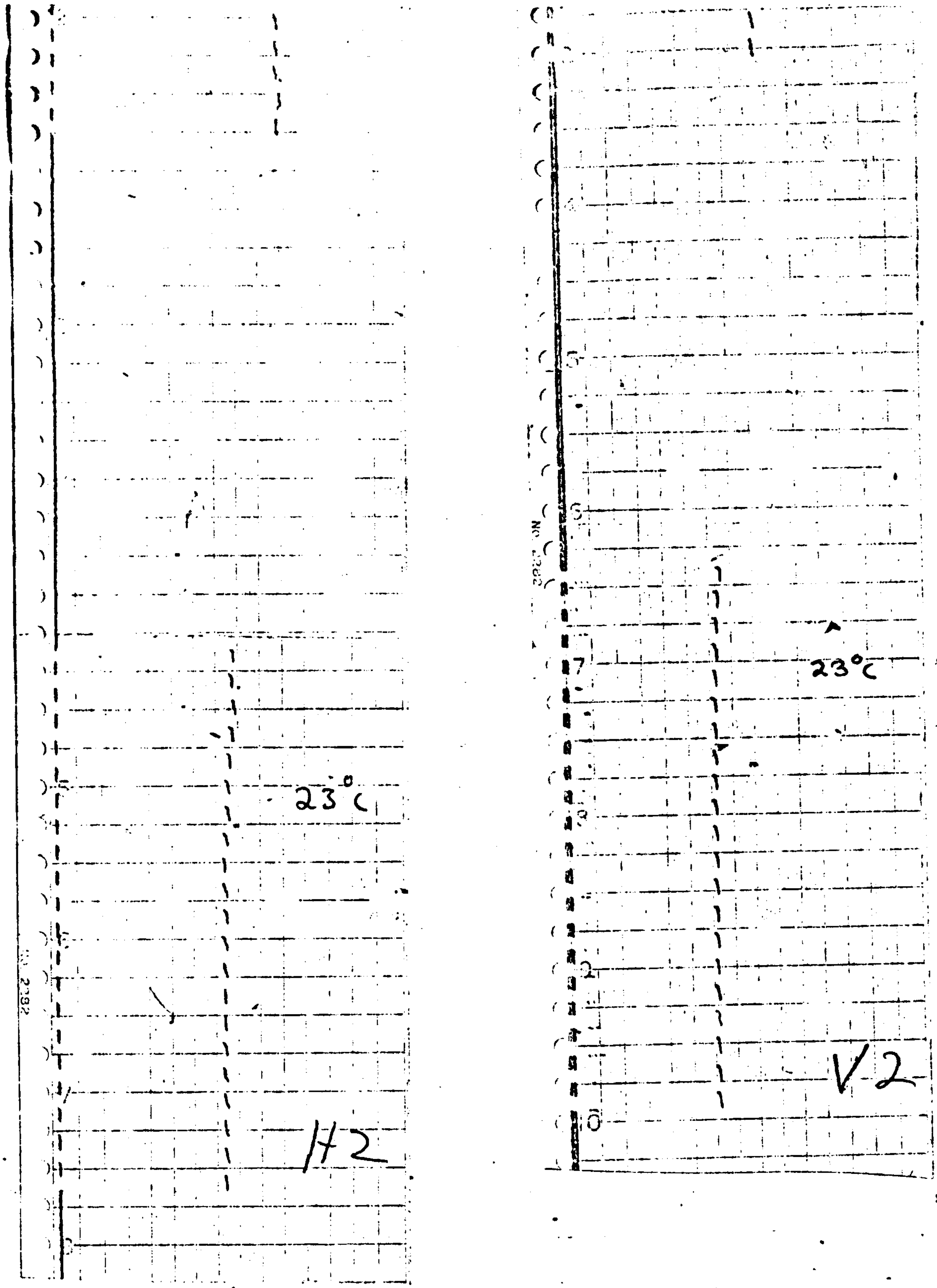




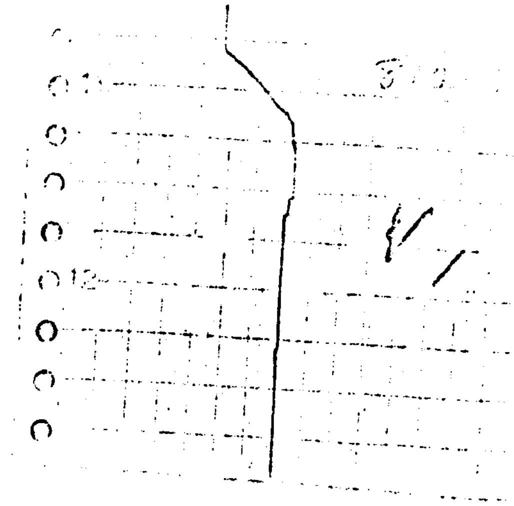
DATA SHEET 18

DATA SHEET 19



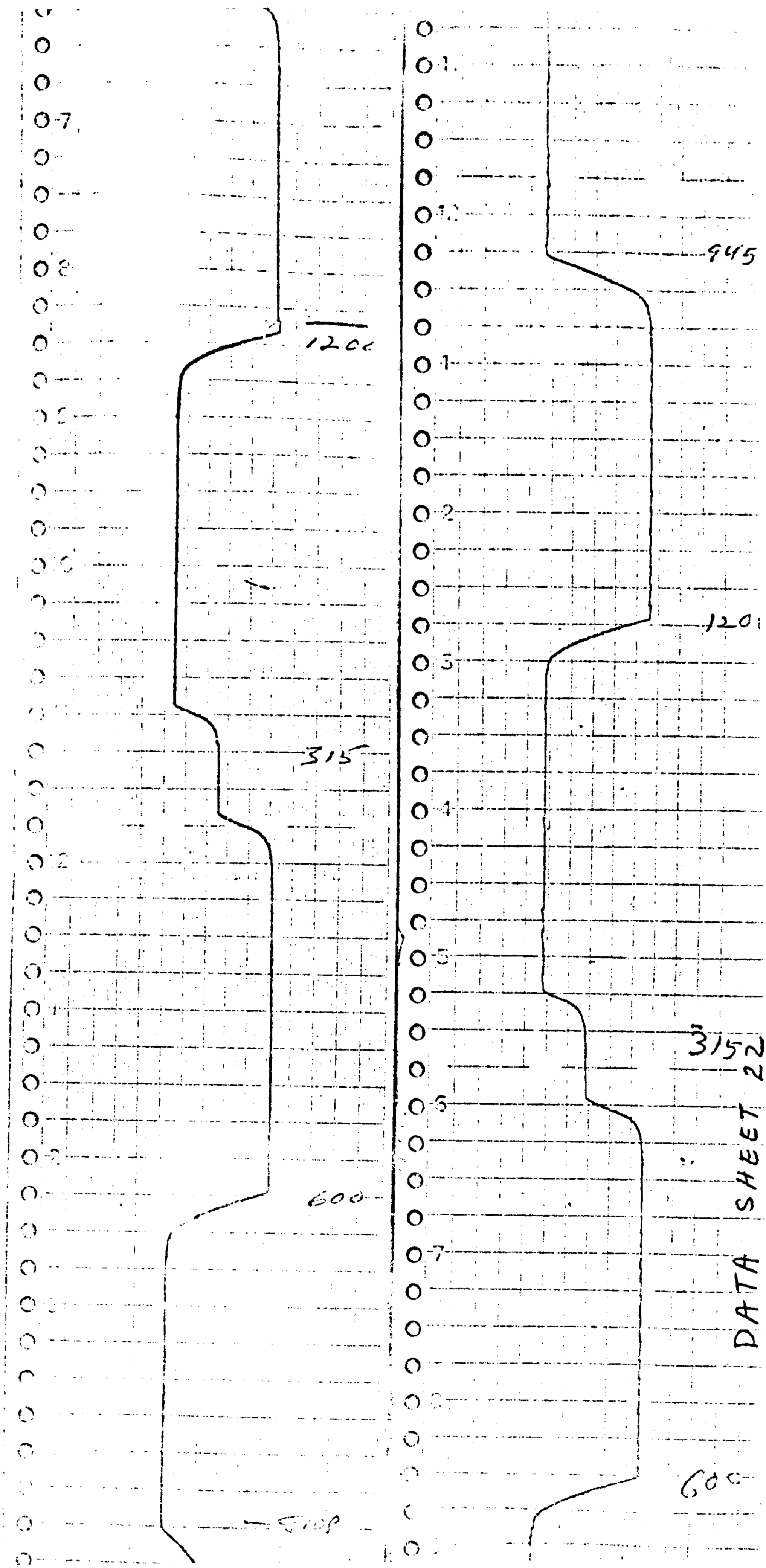


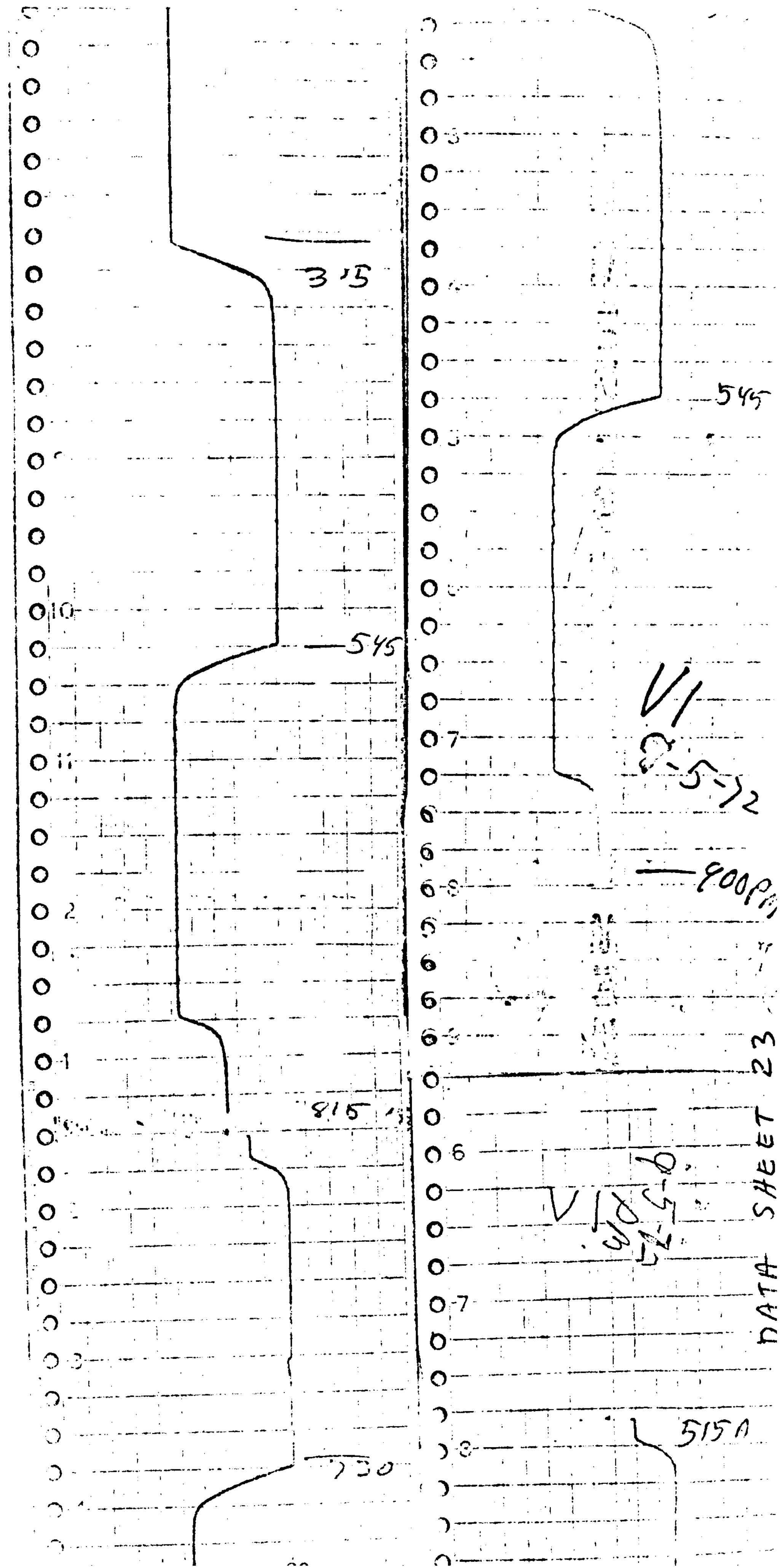
DATA SHEET 20

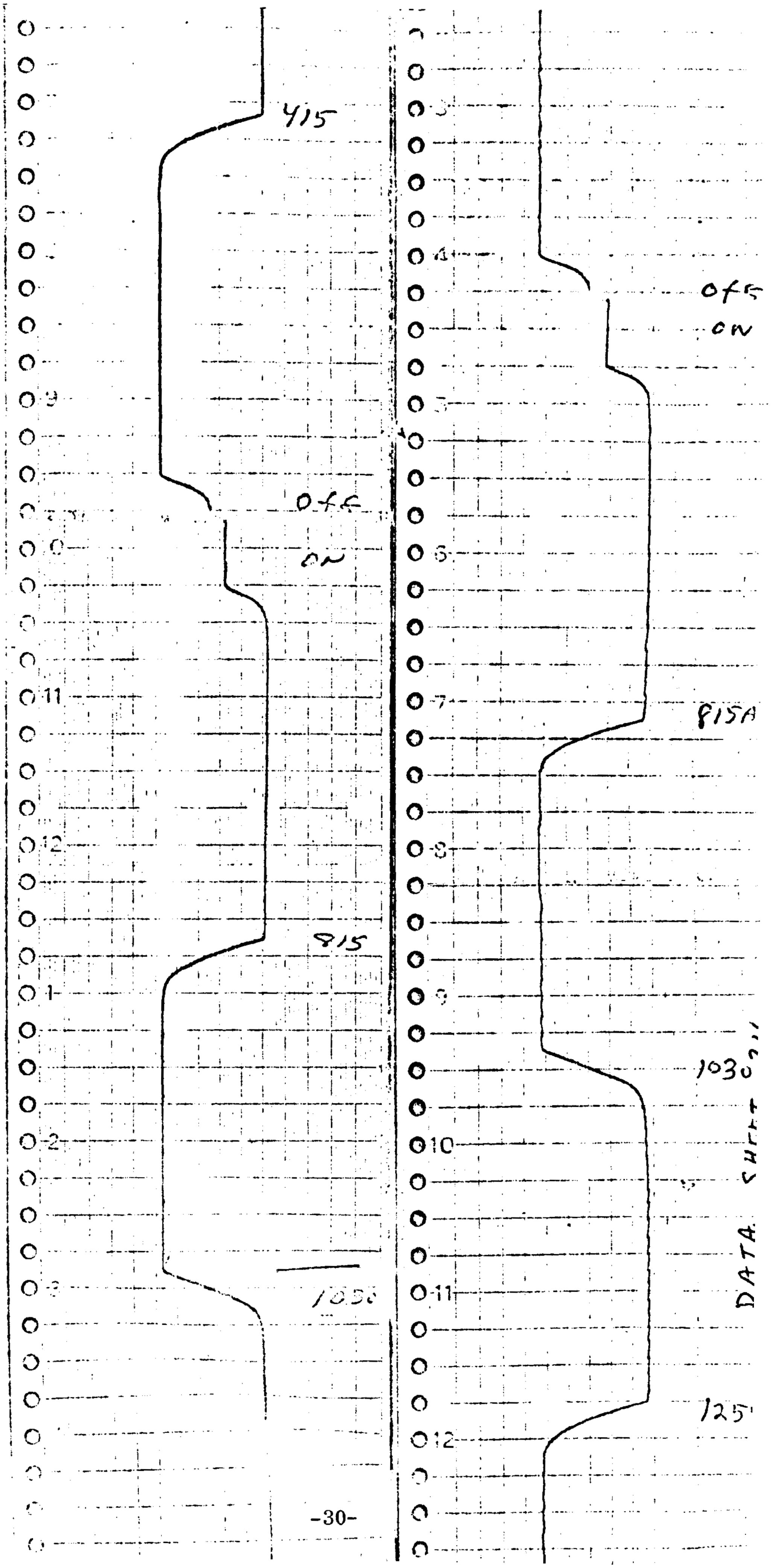


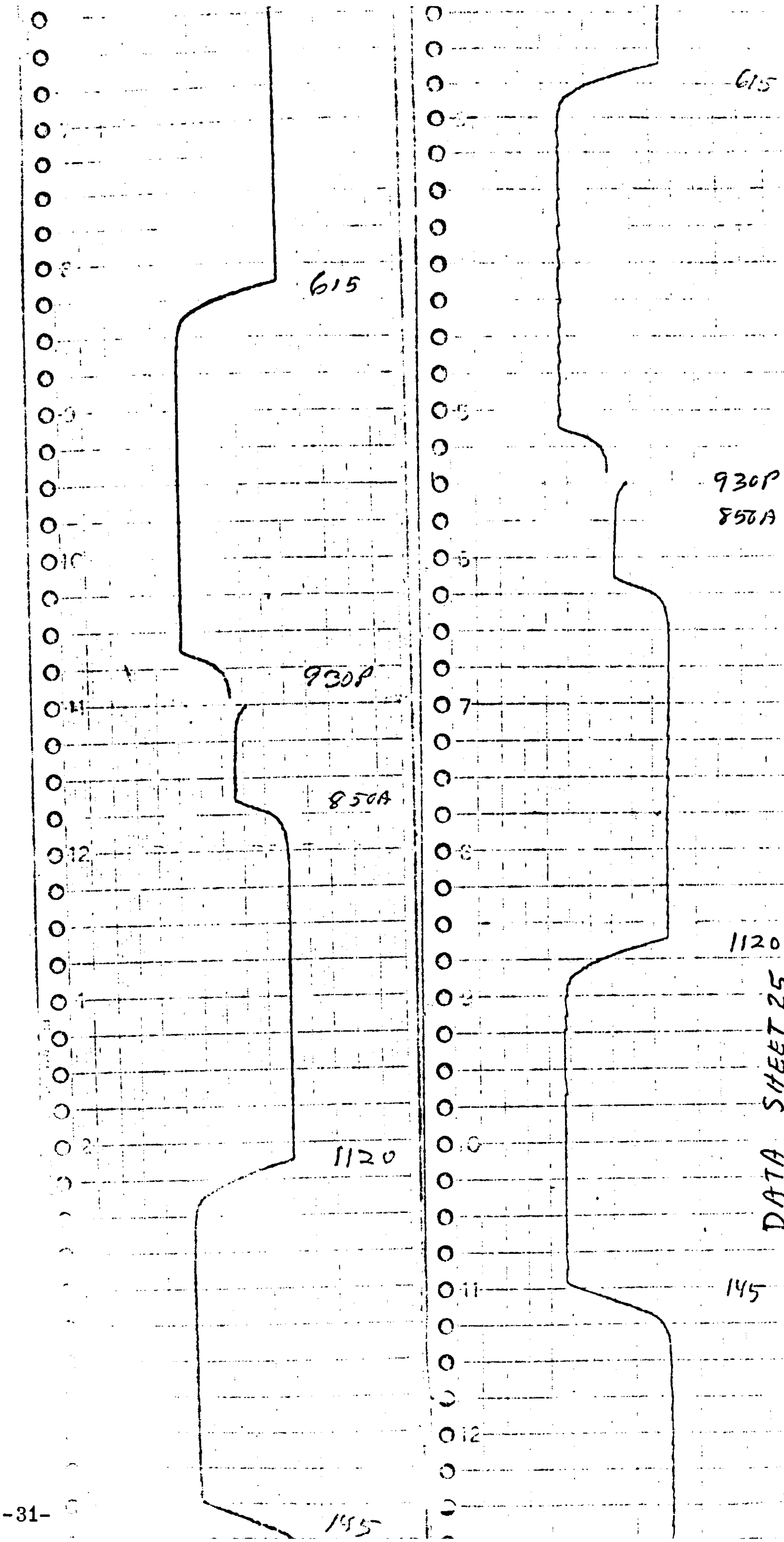
Fatigue

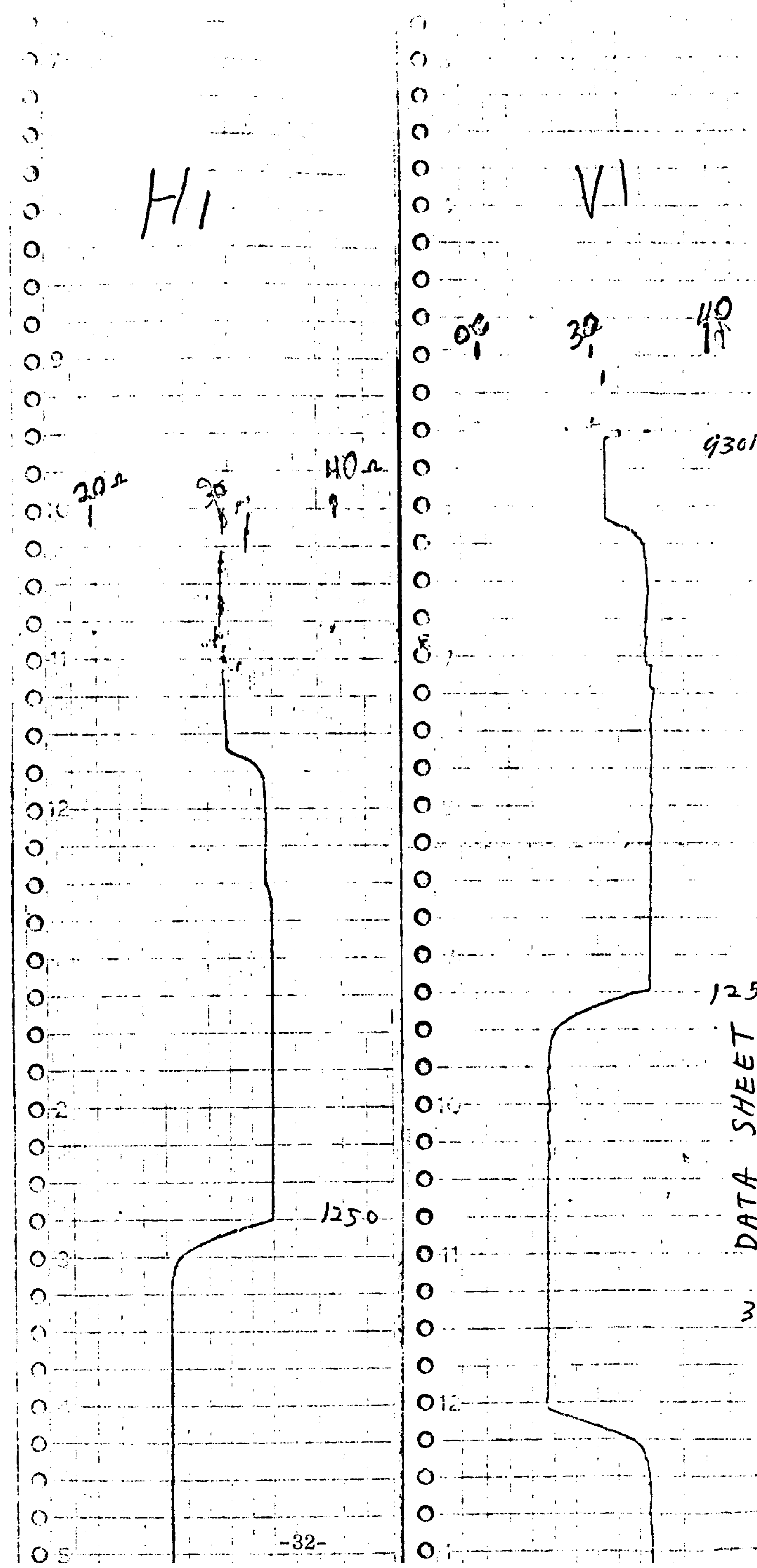
DATA SHEET 21

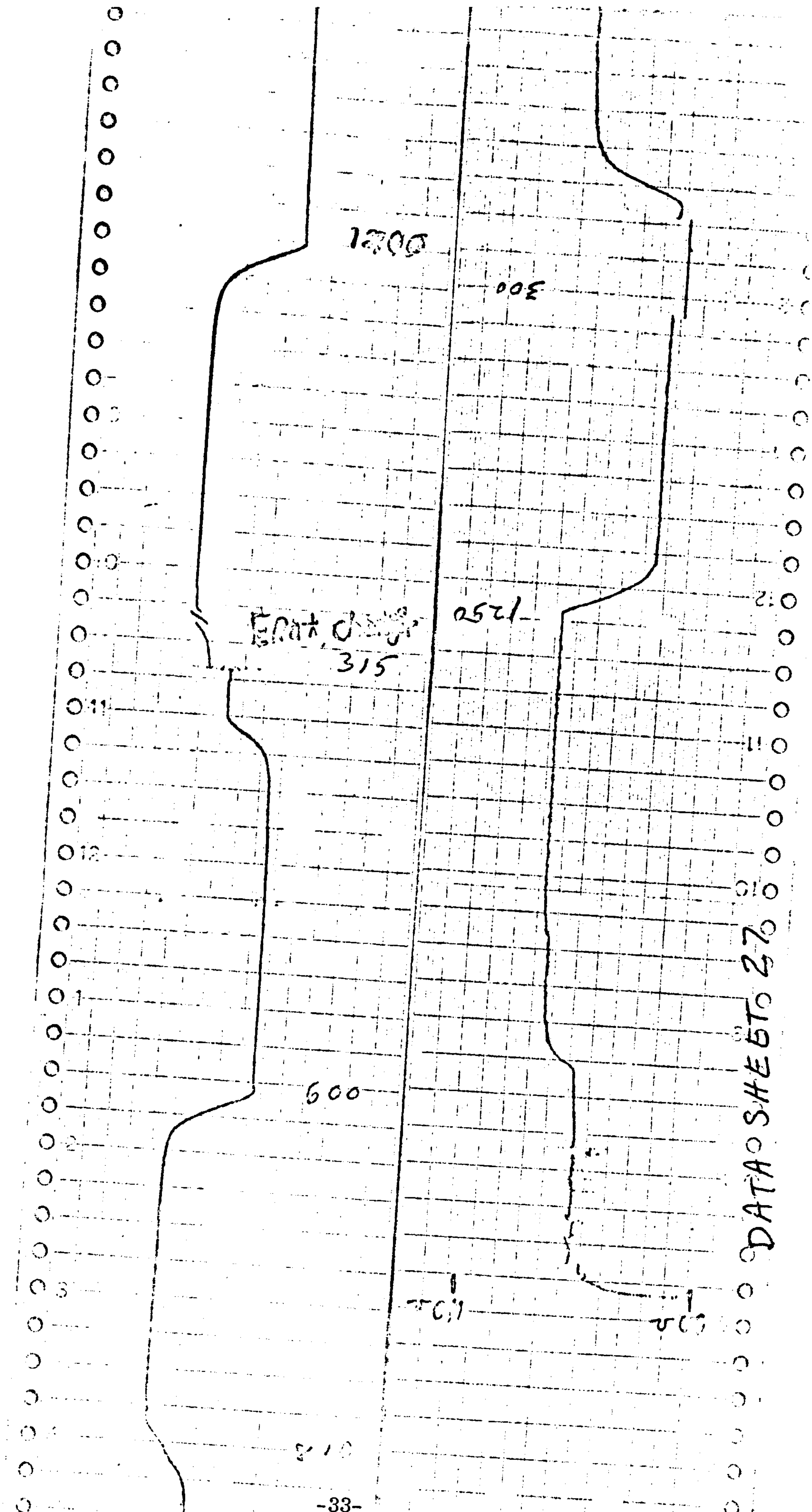

1200
315
600
Stop
945
1200
315
600
DATA SHEET 22

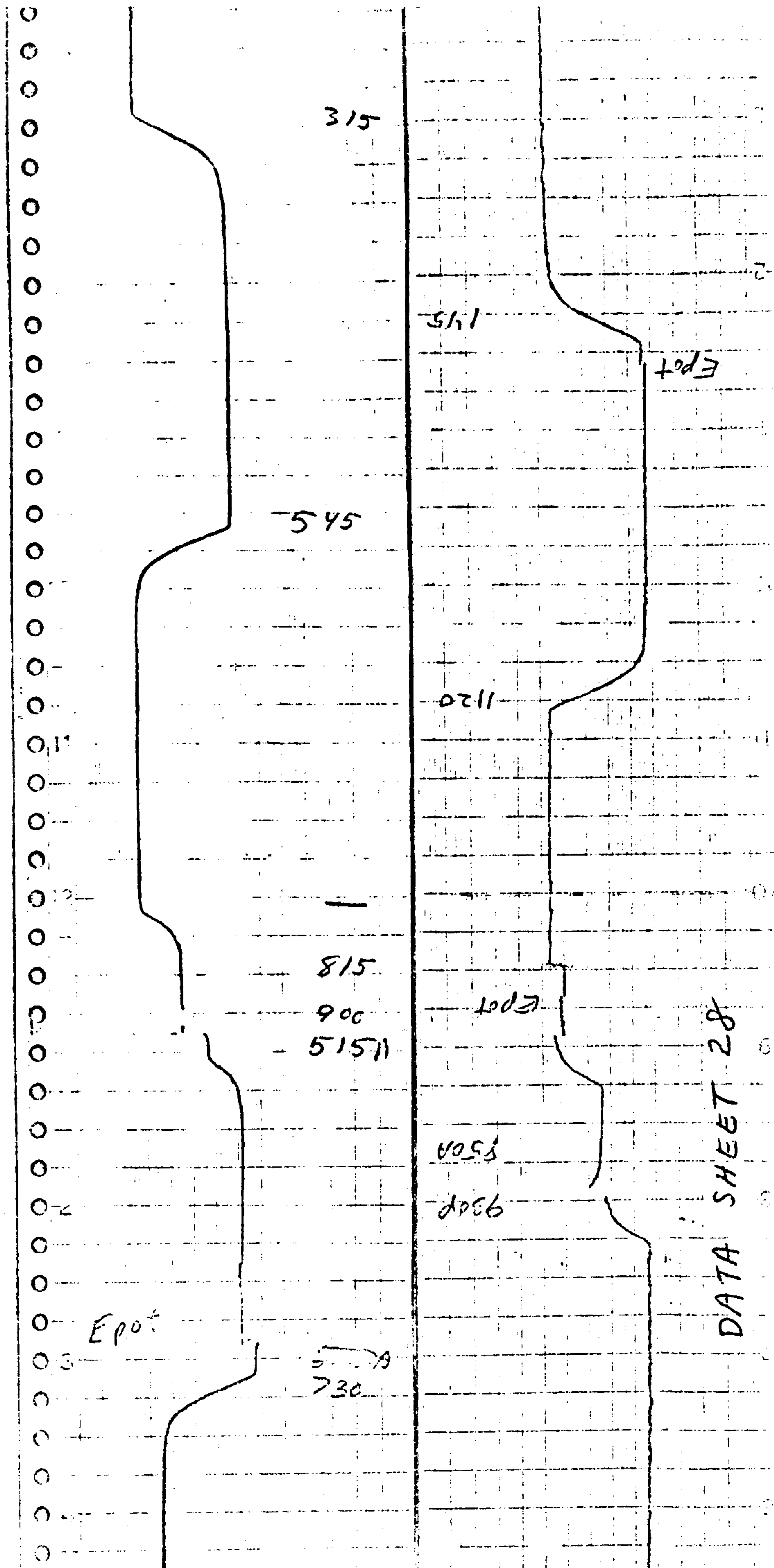

545
815
545
515A
DATA SHEET 23

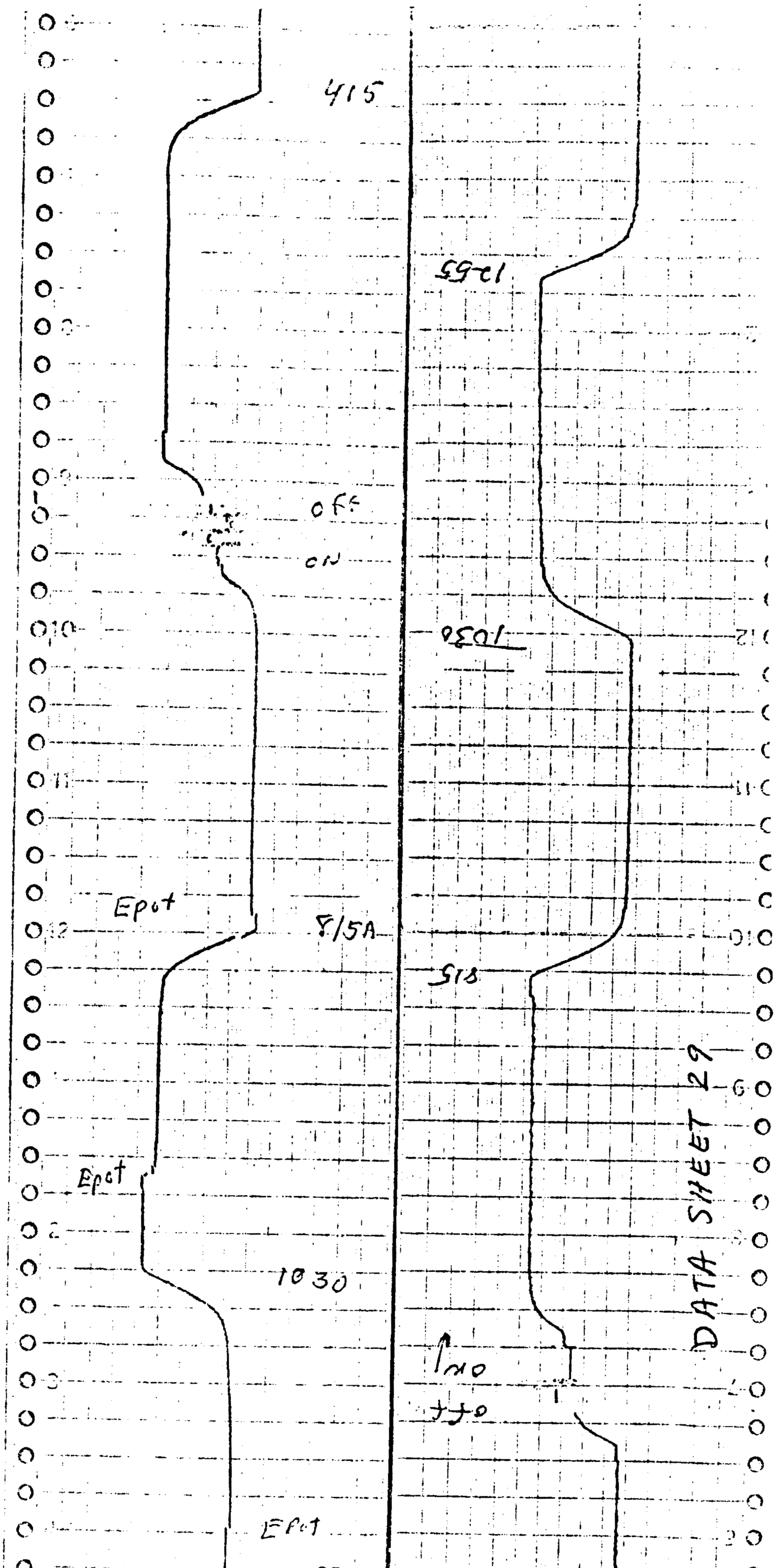

415
off
on
815
off
on
815A
DATA SHEET
125

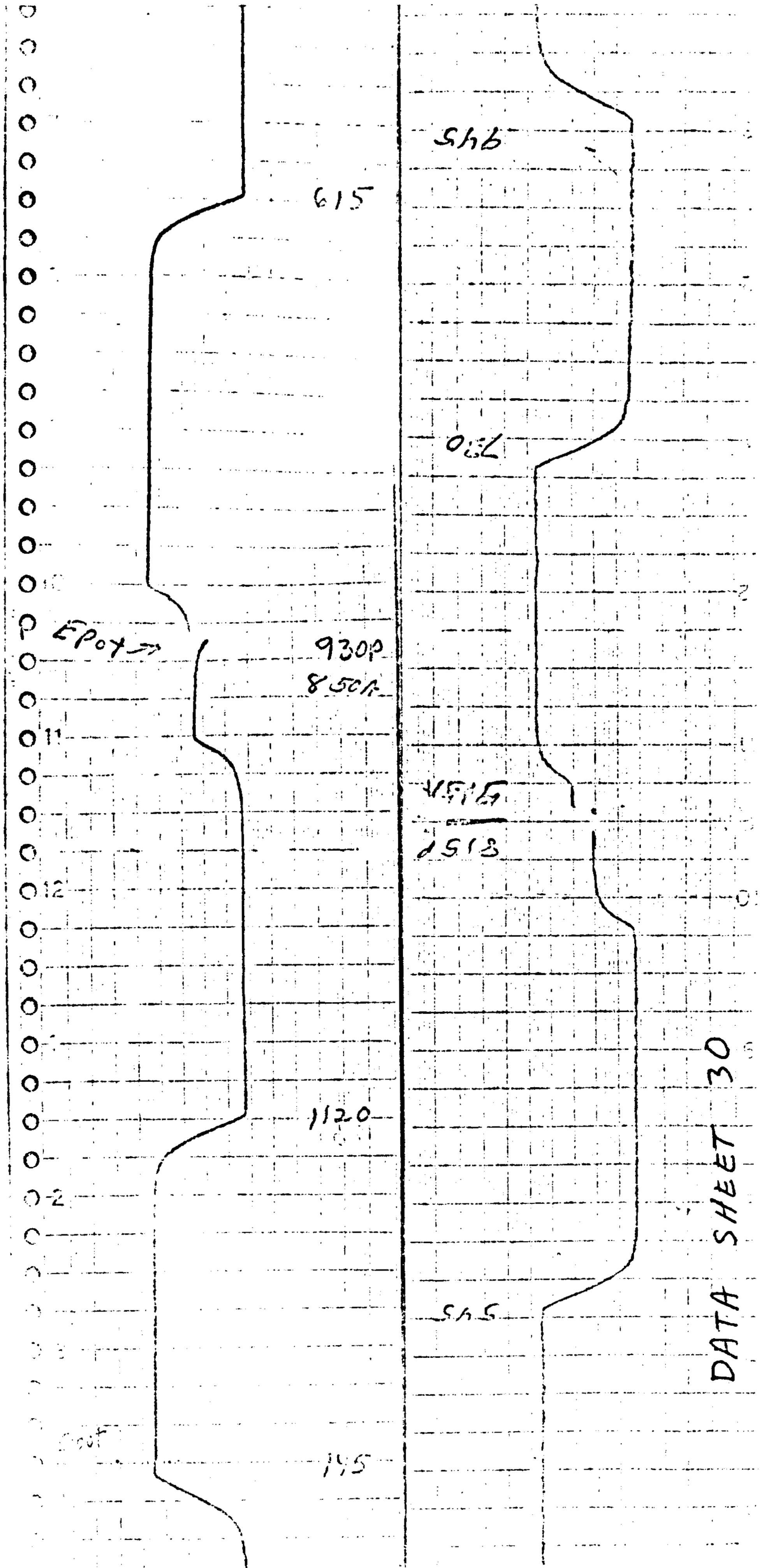

615
930P
850A
1120
615
930P
850A
1120
145
DATA SHEET 25

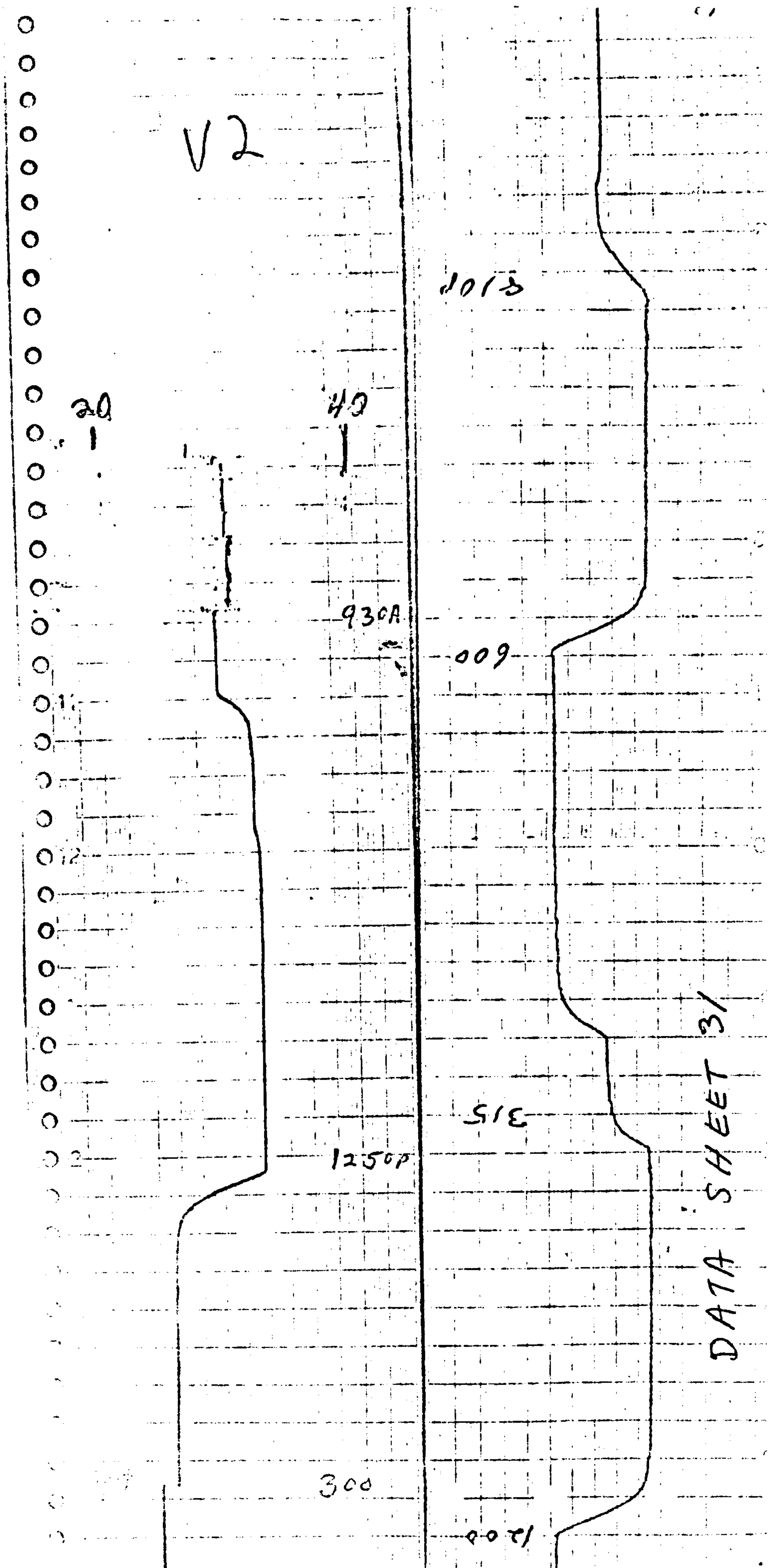

H1
V1
20Ω
40Ω
1250
DATA SHEET 3


1200
300
1250
315
600
DATA SHEET 27


315
545
815
900
515
Epot
730
DATA SHEET 28


415
1265
OFF
ON
1030
Epot
8/5A
815
Epot
1030
ON
OFF
Epot
DATA SHEET 29


615
930P
1120
DATA SHEET 30


V2
20
40
930A
1250P
300
DATA SHEET 31

The test program has successfully demonstrated the ability of the redesigned yoke, and the protective faceplate design, to meet the Apollo requirements. Since a yoke of old design also passed all of the tests, there is a strong indication that handling and assembly techniques contributed to the original problem. The new design provides greater strength in the area of the flying leads and will be specified on any future procurement.

SECTION III

ELEVATION DRIVE IMPROVEMENT PROGRAM

The TCU elevation drive rotates the CTV carriage -45° to +85° from the horizontal at a rate of approximately 3° per second. The driver is a 90° per step 60-hertz permanent magnet stepper motor coupled to a 48:1 integral gearhead. A 36:1 spiroid skew axis gear set coupled to the gearhead output by a bellows coupling drives the CTV carriage directly. A clutch is incorporated between the output of the gear set and the carriage to permit manual override of the elevation function.

TABLE 3. ELEVATION DRIVE DESIGN PARAMETERS

Component	Efficiency	Gear Ratio	Dev. Torque (oz. in.)	Speed (rpm)	Max. Load Torque (oz. in.)	Margin (oz. in)
Motor			0.5	900	0.09	5:1
Gearhead	80%	48:1	19	18.7	3.5	5.4:1
Spiroid Pinion / Spiroid Ring Gear	50%	36:1	340	0.52	120	2.8:1
Load at 85° Position			340		120	2.8:1

The following data were collected during tests performed on TCU F-3 (Serial Number 006) and TCU F-5 (Serial Number 008) to determine the cause of jitter observed in the TCU elevation drive. During the course of the investigation into the problem with Serial Nos. 002, and 003 which showed that the design numbers were conservative in motor output torque (minimum - 0.7 oz. in.) and gearhead efficiency (83 percent). Some variations between units were observed in spiroid and carriage efficiency, particularly on Flight III. Serial No. 006 measured higher torque than the other TCU's.

Serial Nos. 002 and 003 were found to be close to the predicted curve, Figure 3, for the torque at the spiroid pinion. Graphs, Figures 4 and 5 show peak torque contours for the various assemblies as measured with a strain gage load cell applied to the spiroid pinion in place on a motor gearhead. Figure 6 shows the Serial No. 006 curve after rework and Figure 7, Serial No. 006 post rework with damping springs installed. It is significant and not yet clear why Serial No. 006 initially showed higher torque than the other units in spite of the modifications in finishes, alignments and adjustment. The higher torque level on Serial No. 006 apparently had little effect on the system with a good motor installed. Serial No. 003's motor and drive electronics operated Serial No. 006 spiroid and carriage mechanisms with three times the normal 1/6 g test weight in place. From the onset of the problem on Serial No. 006 during acceptance testing, many modifications and cures were tried. Table 4 shows the test program that was initiated.

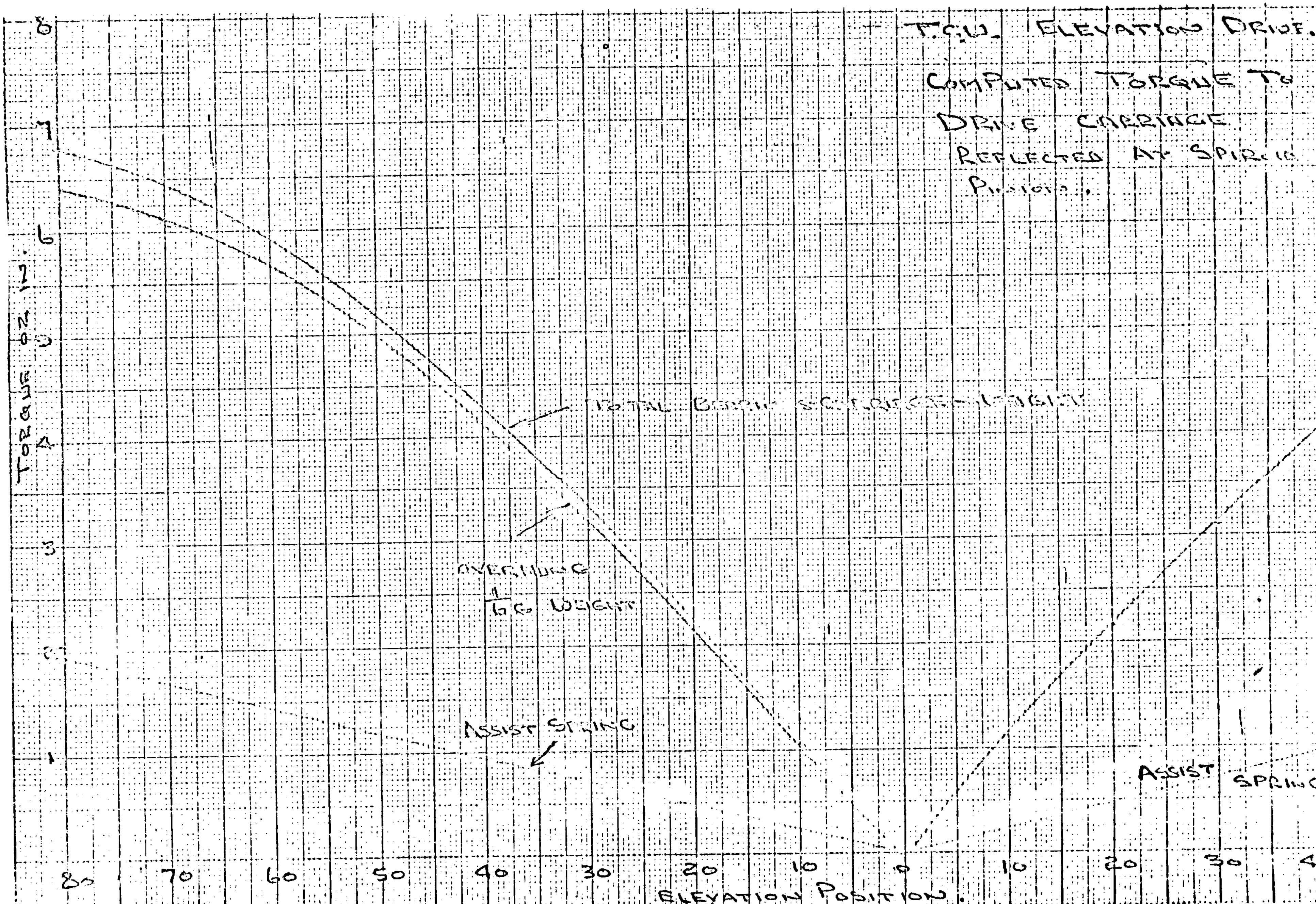


Figure 3. Predicted TCU Elevation Drive Torque Curve

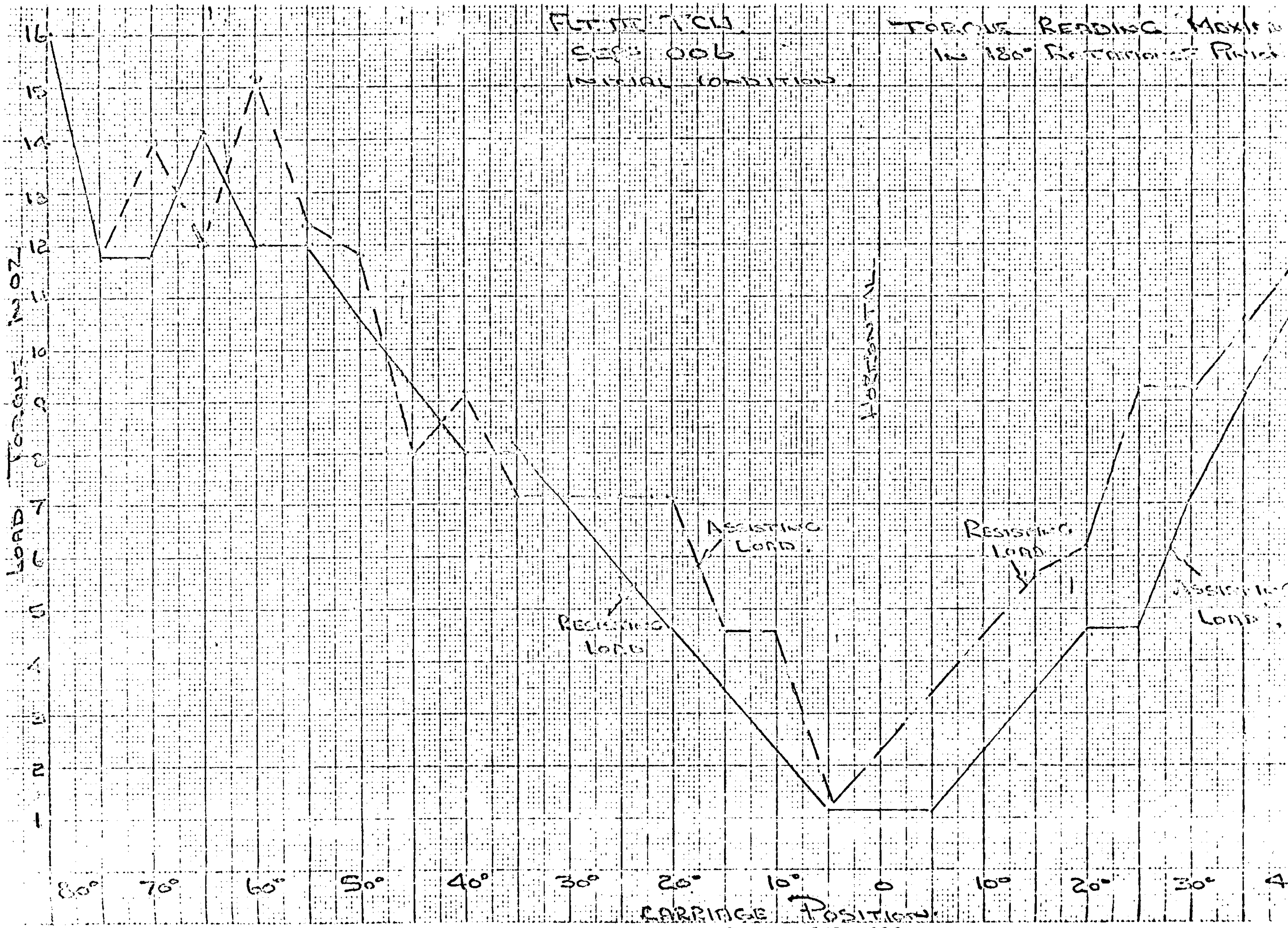


Figure 4. Peak Torque Contour for Serial No. 006

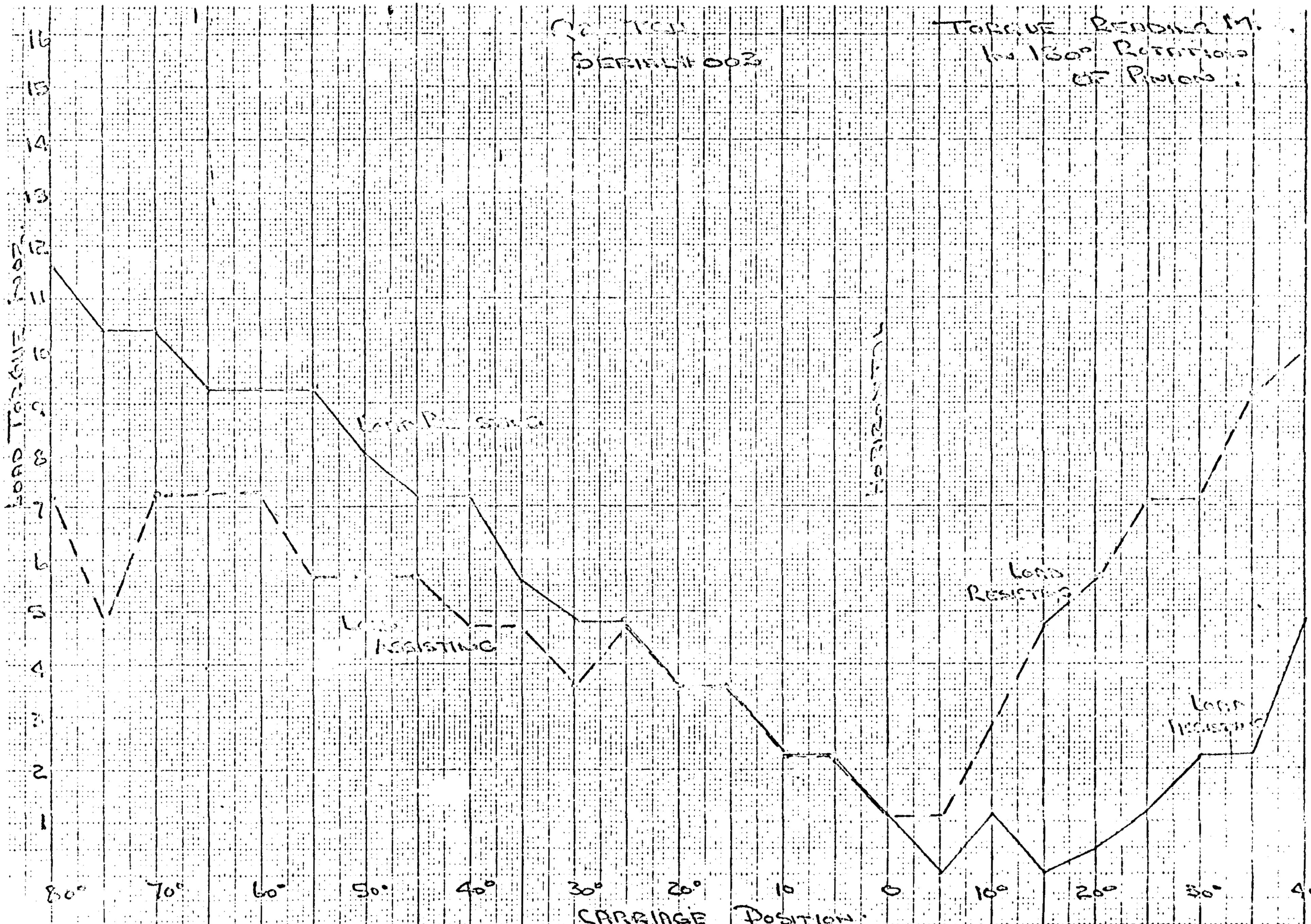


Figure 5. Peak Torque Contour for Serial No. 003

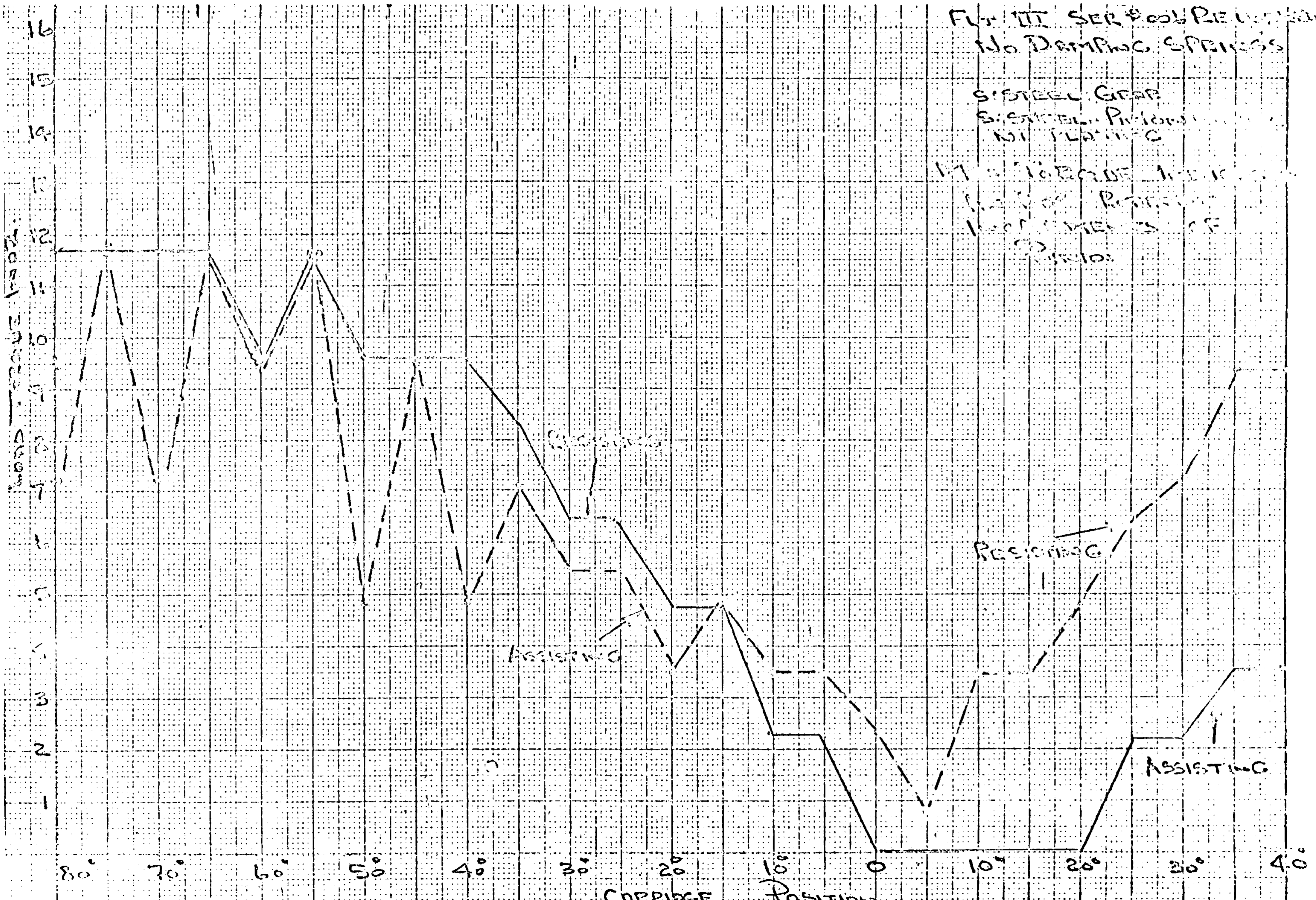


Figure 6. Serial No. 006 Torque Curve After Rework

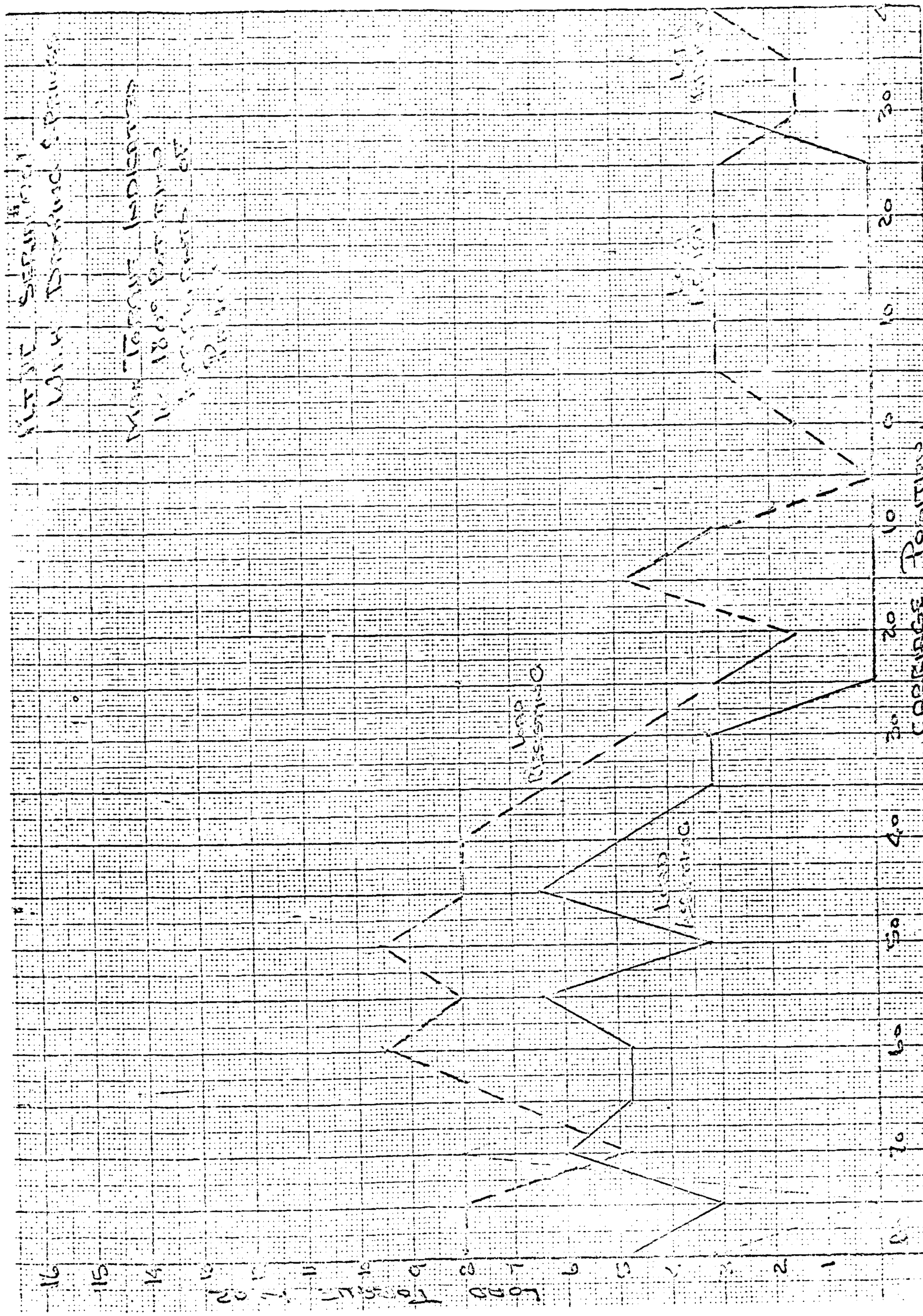


Figure 7. Serial No. 006 Post Rework Torque with Damping Springs

Initially the jitter was quite random in occurrence, always occurring in vacuum, and it would heal after a period of up to 50 minutes from repressurizing the chamber. As the various modifications to reduce friction, improve efficiency, and correct alignments were made, the problem worsened to the point where one cycle of the mechanism in vacuum would induce the jitter. The jitter was occurring at progressively lower elevation angle to the point where it occurred in the up and down direction (load assisting) at approximately 20°. This indicated that we were encountering a threshold position where load (overhung angle) was very sensitive. If stick slip or gear efficiency were the problem, some improvement would have been seen with the many improvements in fit and surface condition. In no instance did the gear surfaces exhibit galling or particle transfer expected if asperity welding had reduced the gearhead efficiency to the measured level. The lubricant film was intact on gear and pinion surfaces following the many disassemblies. The possibility of a resonance in the motor gearhead or in the upper drive train was investigated. A soft coupling was added between the motor/gearhead and the spiroid pinion. No change was seen in the jitter condition during a vacuum test.

Two further tests were conducted to investigate the resonance theory. In one, the TCU assembly was vibrated at 0.5 g level from 5 to 60 hertz while operating in an attempt to induce jitter. This was followed by a test where the input frequency to step the motor was varied from 10 to 100 hertz; in neither case was the jitter induced or, in the latter test eliminated. Some improvement was noted at the lower motor stepping frequency which at the time was not significant. However, it is predictable when considering the motor overshoot theory.

Following the test series called for in Table 4, no conclusive cause could be found for the jitter phenomenon. Indications were that it was load sensitive (position of carriage), and was aggravated during vacuum exposure. The effect of vacuum is partly due to the overall loss of efficiency in vacuum (threshold torque condition) and more probably due to the loss of viscous damping at the small air gap between the rotor and stator.

In discussing the problem with Kearfott engineers, several questions arose on the behavior of the motor when stalled. Further testing revealed the motors could be degraded by stalling and/or backdriving.

Measurement on the Serial No. 006 motor gearhead revealed that the stall torque was 24 ounce inches. However, the measuring torque-watch would backdrive the motor rotor in excess of 10 revolutions before it regained the original stall torque level. An oscillating mode was set up. Further investigation at the Kearfott plant and RCA found the cause to be low (almost zero) detent torque in the unpowered state.

TABLE 4. ELEVATION DRIVE TEST PROGRAM

POSSIBLE PROBLEM AREA	INVESTIGATION ACTION	COMMENTS
1. Stick Slip	Measure torque variations with 1/6 g load on carriage at normal speed.	No conclusion from torque measurements No improvement following mass treatment to gear set.
2. Torsional Resonance in drive train	Accelerate on carriage - Measure frequency and "Q"	Predominant frequency 15 hertz not measured for "Q"
3. Lubrication	Analysis - Spectral analysis of grease from serial #006 TCU and new sample. Compatibility with G300 and stainless steel	Quantity as lubricated No changes in IR Scans of used and new
4. Spiroid - Gearform Assem	Measurement of components - Blue gear teeth to verify mesh - efficiency measurement of gear set	Set up verified - blue showed good contact - efficiency 50% as predicted
5. Gearhead	Verify assembly modified to insure motor engagement	Assembly at Kearfott - Torque Test
6. Motor	Torque test motor and motor gearhead	In Air at AED & Kearfott - Showed greater than specified torque
7. Torque Margin	Find max load available [illegible] Torque will drive by calc. & measurement	Measured margin worst case verified 2.8:1
8. [illegible] Bearing (V[illegible]EL)	Verify dimensions - investigate vacuum compatibility	Size verified - material properties better in vacuum
9. Dimensional Analysis	Check dimensionally -- all parts in elevation - drive assembly	Misalignment in carriage and #006 gearhead corrected
10. Electrical		No indication of improper drive conditions

TABLE 4. ELEVATION DRIVE TEST PROGRAM (Continued)

11.	Axial Motion of Pinion	Underload w/dial indicator	Initially .0025 freeplay - bearing preloaded with no improvement
12.	Change Preload	Loosen gear endcap	No improvement
13.	External Vibration Induced	Put on vibration table 10-60 Hz less than 1/2 g input	TCU operating with amp without 1/6 g load no jitter varying from 10-60 Hz and dwell for 1 minute at 15 Hz.
14.	Examine Bellows Q-2/F-5	Measure stiffness and similarity	met specification
15.	Add torsionally soft coupling between motor and Spiroid pinion	Operate system in vacuum	no change in jitter condition
16.	Change motor stepping frequency	Vary frequency 10 Hz to 100 Hz	Slight improvement at lower frequency No significant change.

This condition was related to the jitter problem after the motor and driver from Serial No. 003 was used to drive the Serial No. 006 elevation assembly. Three times the normal 1/6 g load was carried without jitter or noticeable change in the current trace. The Serial No. 006 motor had jittered previously with the normal 1/6 g load. The Serial No. 003 motor was demagnetized by manually moving the rotor with the stator energized. On reinstalling the motor in the Serial No. 006 elevation drive, the jitter occurred at the normal load level.

A theory on the effect of the low detent torque is that in the back driving mode (load assisting the motor), the rotor overshoots the pole position and greatly reduces torque developed in the motor. The overshoot is generated by the free falling overhung weight loading the spiroid pinion after a step increment has been completed. A small rotation of the spiroid pinion is magnified 48 times. The motor detent torque acts as a damper to this overshoot by permitting the motor to step discrete increments, starting at a pole position, thus developing full rated torque.

The spring damper assembly (RCA Drawing No. 2275697) achieves a similar effect by reducing the acceleration of the overhung weight, reducing the back-drive force and the tendency to overshoot. The spring also provides damping by the significant hysteresis inherent in a low rate torsion spring wrapped around a center hub. The spring applies a force of 2.2 inch pounds at a maximum elevation position of 85 degrees. This force is approximately 1/3 of the nominal overhung moment. The spring rate is low enough to avoid carriage resonant problems.

No penalty is foreseen in installing the damper spring. In addition, the spring reduces the required drive torque by storing energy in the motor assisting direction which is returned when the motor is lifting the weight when opposing gravity. All interface and storage requirements are met with the springs installed on the TCU.

Other methods of damping were considered: - damping of the motor and coulomb damping at the CTV carriage. These methods introduce parasitic loads which are very difficult to control under the extreme environmental conditions, and they also degrade the available torque margin.

The fully-magnetized motor will operate the TCU and meet design requirements without problem. The demagnetization phenomenon is not fully understood at this time. To insure that inadvertent reduction in the motor performance does not affect the use of the TCU, it is recommended that the damping springs described be fitted to all flight TCU's.

For future procurement, the current rotor material (Alinco V) will be changed to a more stable magnet material having a greatly reduced tendency to demagnetize. A discrete detent torque requirement also will be specified.

During the elevation drive improvement program, a variety of tests were performed. The following material is a short chronological history of the tests performed on the Flight 3 (006) and Flight 5 (008) TCU's (date of the test, the configuration of the TCU under test, the test conditions, and the results of the tests are included).

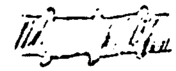
BLE	DA	C	TCU	GEAR DRIVE	MOTOR	SYMPT	TEST CONDITIONS ENVIRON.	TEMP.	REMA
1	9/1	006	Flt III	Flt III	Flt III	No jitter	Air	Ambient	Thermal vacuum setup
						Jitter	Vacuum	+25°C	a. System operated through critical pressure b. System operated for 2 hours after re-establishing pressure. Spec of $2x10^{-5}$torr or less c. Jitter observed on 1st cycle of elevation up d. Elevation activated for 7 up/down cycles, jitter observed on 6 of 7 up cycles e. Vented bell jar
	9/5					Jitter	Vacuum	+25°C	f. Pumped down to pressure spec g. Jitter observed on 1st cycle of evaluation up, repeatable on every up cycle h. Vented bell jar i. Jitter occurred for 2 up cycles after venting, but not reprovable after 2 cycle
2	9/5	003	Flt III	Flt III	Flt III	Spurious Signal	Air	Ambient	a. Disassembled Elev.drive, examined, relubricated gears reassembled elev.drive, adj. back lash b. Retested after assembly for 13½ up/down cycles. No jitter observed c. Retested TCU-006 per minutes of T.R.B. (T.D.R. 54-380) d. During retest observed spurious signal (not jitter) -tests not satisfactory due to spurious signal e. Tested TCU-008 (same test outlined for TCU-006) Tests satisfactory, no jitter
	9/6								f. Assembled TCU-006 with 008 gear drive & motor Retested, results satisfactory, no jitter

OBLEM	DA	CTV	TCU	GEAR DRIVE	MOTOR	SYMP	TEST CONDITIONS ENVIRON.	TEST CONDITIONS TEMP.	REMA
3	9/7	006	Flt III	Flt V (no rework)	Flt V	No jitter	Air	Ambient	a. Thermal vacuum setup - no jitter observed
	9/8					No jitter	Vacuum	+25°C	a. One hour after turn on, commanded elevation down for 36 sec. - no jitter b. Elevation drive activated 1½ up/down cycles 4 hrs after turn on - no jitter observed c. Elevation drive activated 10 up/down cycles 4.4 hrs after turn on - no jitter observed
						a. No jitter b. Up limit switch not activated c. Cradle hang up	Vacuum	+50°C	a. Elevation drive activated 1 down/up cycles 5.2 hrs afte turn on - no jitter observe b. 5.6 hrs after turn on, conducted elevation drive test Elevation activated 12 down, up cycles - No jitter observed c. Up limit switch not engaged Drove into mechanical stop. Cradle momentarily hung up when down command sent d. On 8th & 12th up cycle, drove into mechanical stop
	9/9					a. Up limit switch not activated b. Cradle hang up			a. Elevation drive activated immediately after turn on. Up limit switch not activated b. Elevation drive activated 4 hrs after turn on - no jitter observed c. Elevation drive activated 4.6 hrs after turn on for 5 up/down cycles - no jitte observed. Elev. d. Drove into mechanical up stop. Momentary cradle hang up when down command sent

PROBLEM	D[redacted]	CTV	TCU	GEAR DRIVE	MOTOR	SYM[redacted]OM	TE[redacted]CON[redacted]TIONS ENVIRON.	TEMP.	REM[redacted]S
						No jitter	Vacuum	$-10^{o}C$	a. Elevation drive activated for 1½ down/up cycles 3.7 hrs after turn on - no ji b. Up limit activated normal c. Elevation drive activated for 5 up/down cycles - no jitter observed d. Up limit switch activated normally
	9/10						Vacuum	$0^{o}C$	a. Elevation drive activated 1½ down/up cycles 3.5 hrs after turn on No jitter observed. Up li switch activated normally b. Elevation drive activated for 5 down/up cycles 3.7 after turn on - no jitter observed Up limit switch activated normally
						Jitter	Vacuum	$+25^{o}C$	a. Elevation drive activated 2.5 hrs after turn on. Jitter observed in first cycle, and observed in following 5 up cycles. No jitter observed in elevat down b. Up limit switch activated normally c. Elevation drive activated additional up/down cycles jitter observed in all up cycles No jitter in elevation do
	9/11					Jitter	Vacuum	$+25^{o}C$	a. Completed test per TP-OP-2265826, started engineer evaluation, system turned 15.3 hrs after last opera b. Elevation drive activated no jitter observed on 1st cycle. Limit switch OK. (served jitter on 2nd up

ROBLEM	DA.	CTV	TCU	GEAR DRIVE	MOTOR	SYMP OM	TES ON ION ENVIRON.	TEMP.	REMA S
									cycle, spike @ 34 sec. c. Elevation drive cycled up/down - jitter got progressively worse
						Intermittent Jitter	Air	Ambient	a. Vented chamber. System turned on 1.7 hrs after venting. Bell down b. Elevation drive activated No jitter on 1st & 2nd up cycle. Jitter observed on 3rd & 4th up cycle, not on 5th & 6th up cycle. Spike observed on 7th up cycle. No jitter observed on 8th through 15th up cycle c. Raised bell. Elevation dri activated for approximatel 20 cycles. No jitter observed

OBLEM	DATE	CTV	TCU	GEAR DRIVE	MOTOR	SYMPTOM	TEST CONDITION ENVIRON.	TEST CONDITION TEMP.	REMARKS
				REWORK GEAR HEADS					
4	9/12	003	FLT III	FLT V Reworked	FLT V	No Jitter	Air	Amb.	a. Bench test after FLT V elevation drive gearhead reworked. b. No jitter observed, no thermal vacuum.
5	9/13	003	FLT III	FLT V	FLT V	Spurious Signal, Glitch	Air	Amb.	a. Bench test - 2 hr run in of F-5 gear drive and F-5 motor in F-3 TCU. b. Disengaged clutch for tes reversed up/down direction approx. every ½ hour during test observed 5 occurrences spurious signal and 4 occurrences of single glitch. Neither resembles jitter waveform. c. At conclusion of test, en gaged clutch ran 8 up/down cycles. No jitter observed.
6	9/14	003	FLT III	FLT V	FLT V	Spurious Signal	Air	Amb.	a. 2 hour run in test on bench. No jitter observed.
7	9/15	003	FLT V	FLT III	-	No Jitter	Air	Amb.	a. Disengaged clutch for tes reversed up/down cycles approximately every ½ hour. During test observed, 2 sing glitches. No jitter observe
8	9/15		FLT III	FLT III	-	-	-	-	a. No operation. Installed elevation drive (S/N 006) ir TCU-006.
			FLT V	FLT V	-	-	-	-	b. No operation. Installed elevation drive (S/N 008) ir TCU-008.
9	9/16	003	FLT V	FLT V	FLT V	Spurious Signal	Air	Amb.	a. Adjustment of azimuth and elevation limit switches prior to acceptance test. b. Spurious signal observed twice during testing.

[redacted]LL[redacted]	DA[redacted]	C[redacted]	[redacted]U	[redacted]GEA[redacted]RI[redacted]	MO[redacted]	[redacted]PT[redacted]	[redacted]VIRON	TEMP.	REMARKS
0	9/20	003	FLT III Rebuilt	T III Gear Heads	FLT III	Spurious Signal 	Air	Amb.	a. Replaced pinion, ring gear, reset gear (thermal vacuum setup). b. TCU instrumented to monitor elevation motor drive waveforms during T/V testing (at motor samping board). c. Monitored CTV input current & GCTA input current. d. Spurious signal observed during elevation up, observed simultaneously on CTV input current. No jitter observed.
	9/21					Jitter Spurious Signal	Vacuum	+25°C	a. Approx. 1 hr after turn on at +25°C, elevation activated for 17 sec in up direction. Turned off before limit switch No jitter observed. b. 1.4 hrs after turn on at +25°C, elevation activated. Jitter observed on all up cycles. Recorder monitoring elevation motor drive voltages showed no abnormality during jitter period. System turned off. c. Terminated tests per TP-OP-2265826. System turned on (vacuum) after 3 hrs off period. Jitter observed on 1st up cycle. Jitter observed on following 7 up cycles. Observed spurious signal. d. Vented bell jar slowly, allowing TCU to operate during pressure rise to 1 atmosphere. Jitter observed on all up cycles to 1 atmosphere.
	9/22	003	006-F3	006-F3 Rebuilt Gear Heads	FLT III	Jitter	Air	Amb.	a. TCU in chamber, bell raised TCU in air 16 hrs before turn on. b. Jitter observed on 1st elevation up cycle.

PROBLEM	DATE	CTV	TCU	GEAR DRIVE	MOTOR	SYMPTOM	TEST CONDITIONS ENVIRON.	TEMP.	REMARKS
10 (cont'd)									c. Removed 2-lb weight, nc jitter observed on elevati up cycles (2). d. Replaced 2-lb weight, jitter observed on 1st ele vation up cycle.
11	9/22	003	FLT V	FLT III	-	No Jitter	Air	Amb.	a. Thermal vacuum setup. CTV 003 outside chamber. N jitter observed. b. Thermal vacuum test not
	9/30	003	FLT III	FLT III	FLT III	Spurious Signal	Air	Amb.	a. Thermal vacuum setup. C 003 outside chamber. b. Observed 1 occurrence of spurious signal. c. No jitter observed.
	10/1					Spurious Signal	Vacuum	+25°C	a. 1 full cycle of elevatic up. No jitter observed. b. 2 occurrences of spuriou signal. c. 2 hrs operation @ +25°C.
						Spurious Signal	Vacuum	+50°C	a. 1 hr after turn on at +5 elevation drive activated u for 10 sec. No jitter. b. 1.4 hrs after turn on @ +50°C, elevation drive acti vated up to limit (12 sec operation). Jitter observe on next up cycle. (Occurre @ 34 sec.) Jitter on next up cycle. TCU platform lef horiz. System turned off. c. 2 hrs operation @ +50°C.
						Spurious Signal	Vacuum	+40°C	a. 1 hr after turn on @ +40 elevation drive activated u for 12 sec. No jitter. b. 1.5 hrs after turn on @ +40°C, elevation up activat Jitter observed @ 15 sec up from horiz. Jitter observe on next elev. up cycle @ 28 sec. Jitter observed on next up cycle.

PROBLEM	DATE	CTV	TCU	GEAR DRIVE	MOTOR	SYMPTOM	TEST CONDITIONS ENVIRON.	TEMP.	REMARKS
12 (cont'd)									c. 2 hrs operation @ +40°C.
	10/2	003	006-F3	006-F3	FLT III	No Jitter	Vacuum	-10°C	a. Activated elevation drive up 3 cycles immediately afte temp stabilization. No jitter. Platform left in horiz position. b. 1 hr after turn on @ -10° activated elevation up for 15 sec. No jitter. c. 1.5 hrs after turn on at -10°C activated elevation up 1½ cycles. No jitter. d. At turn off activated elevation up 1 cycle - No jitter. Platform left in horiz. position. e. Returned to +25°C.
						Spurious Signal	Air	Amb.	a. Vented chamber. b. Turned unit on. Activate elevation up 2 cycles; no jitter observed. c. Turn chamber brine unit to increase chamber vibratic activated elevation up for up cycles - no jitter.
	10/3					No Jitter	Air	Amb.	a. Attempts to reproduce jitter failed. b. Operated TCU elevation, with & without weight, chang C.G. - no jitter. c. Obtained jitter waveform by physically stalling TCU platform.
	10/5 10/6	Reworked (Gear Head Replaced) Tested Motor Torque Clutch Backlash at .004"							a. Removed elev. drive assy: removed gear train from mot & inspected. Reduced backlash a clutch drive to .004" max. b. Replaced S/N 006 elev. dr assy with S/N 008 drive assy Retained existing motor and gearhead (S/N 009-3)

ROBLEM	DAT	CTV	TCU	GEAR DRIVE	MOTOR	SYMP M	EST ONDI IONS ENVIRON.	TEMP.	REMA S
13	10/7	003	FLT III	FLT V	FLT III	No Jitter	Air	Amb.	a. Thermal vacuum setup CTV-003 outside chamber. No jitter observed.
							Vacuum	+25°C	a. Elevation drive activated up 1 cycle after turn on; no jitter observed. b. Elevation drive up activat 1.5 hrs and at turn off. No jitter. c. 2 hrs of operation @ +25°C
	10/10	006-F3	006-F3	FLT V	FLT III	No Jitter	Vacuum	+50°C	a. Elevation drive activated 2 up cycles during 2 hr test period. No jitter.
						No Jitter	Vacuum	+40°C	a. Elevation drive activated 1 cycle at turn on; no jitter observed. b. Elevation drive activated 1 cycle 1.5 hrs after turn on No jitter. c. Just prior to turn off, elevation activated up $1\frac{1}{2}$ cyc observed glitch on each cycle near max. up limit. d. Total operating time at +40°C - 2 hrs.
						No Jitter	Vacuum	-10°C	a. Elevation drive activated up from horiz. position to max. up. At turn on - No Jitter observed. b. Approx. 1.5 hrs from turn on, elevation up activated 2 cycles; no jitter observed c. Just prior to turn off, elevation activated up for 1 cycles. No jitter observed. Platform left in horiz. pos. d. 2 hrs operation at -10°C.

BLEM	DAT	CTV	TCU	GEAR DRIVE	MOTOR	SYMP [redacted]	EST[redacted]ND[redacted]ONS ENVIRON.	TEMP.	REMAI
13 ont'd						Spurious Signal Jitter	Vacuum	0°C	a. After 1.5 hrs of operation at 0°C, elevation up activate 1 cycle, jitter observed on 1st cycle @ 34 sec. Elevatio activated up. Jitter observe on both cycles. b. 2 hrs operation at 0°C.
						Jitter	Vacuum	+25°C	a. Jitter observed on 1st up cycle, and on all following cycles. Jitter starts $\gtrsim 20^{o}$ up from Horiz. b. Brine unit and pump turned off. Jitter still present.
						Jitter	Air	Amb.	a. Vented chamber. Jitter observed on 3rd up cycle. Spike on 7th up cycle. Elevation up activated several more times - jitter observed.
	10/11	FLT II	FLT III	FLT V	FLT III	Jitter	Air	Amb.	a. Raised bell jar. Elevatio cycled several times; jitter observed on all up cycles (5) Jitter appeared to reduce in severity, prior to jitter dis appearing, observed only spik on two preceeding up cycles. b. Elevation drive cycled up 17 times. No jitter observed Cycled up/down rapidly, on 19th up cycle observed jitter No further jitter observed on up cycles. c. Increased TCU platform loading by 200 gms, 500 gms, cycled elevation up/down - no jitter observed.
14	10/11	003	FLT V	FLT III	FLT V	No Jitter	Air	Amb.	a. Thermal vacuum setup. No jitter observed.
	10/12					No Jitter	Vacuum	+25°C	a. Elevation drive up cycled $1\frac{1}{2}$ times after turn on - no jitter.

PROBLEM	D[redacted]	CTV	TCU	GEAR DRIVE	MOTOR	SY[redacted]OM	TEST CONDITIONS ENVIRON.	TEMP.	[redacted] REM[redacted]
14 (cont'd)	10/12	003	FLT V	FLT III	FLT V	No Jitter			b. $1\frac{1}{2}$ hrs after turn on, el vation up cycled $1\frac{1}{2}$ times - no jitter.
						Jitter			c. Just prior to turn off, after 2 hrs operation cycle elevation up. observed slig jitter on 1st up cycle.
						Jitter			d. Cycled elevation up 2.5 hrs after turn on - jitter observed.
						Jitter			e. Cycled elevation up 3 hr after turn on - jitter ob- served (much larger in ampl tude). Set TCU platform to point where jitter just sta ted. Turned system off.
						Jitter	Air	Amb.	a. Vented bell jar. Elevat drive cycled up/down 5 tim (not full up or down travel Observed jitter on all up cycles. System cycled OFF/ Activated elevation down co mand, observed jitter on do cycle. Jitter on next elev tion up cycle. Cycled elev tion up 4 more cycles - jit observed. Removed 2-lb CTV simulated weight, cycled el vation drive up - no jitter observed. Replaced weight, changed CG, jitter observed No further jitter on elevat down observed. b. Removed TCU from chamber for bench test. c. Set up TCU on bench for testing. Cycled elevation jitter observed on 1st up cycle. Jitter observed on following 6 up cycles. Sys turned off, removed elevati motor, measured torque re- quired to drive TCU platfo

[redacted]

ROBLEM	DA	CTV	TCU	GEAR DRIVE	MOTOR	SYMI M	TEST CONDITIONS ENVIRON.	TEMP.	REMA S
14 (cont'd)	10, 12	003	FLT V	FLT III	FLT V	Jitter	Air	Amb.	c.. (continued) with weight. Stalled motor by hand, obtained signature; replaced motor; cycled elevation up 5 cycles; no jitter observed

RO[redacted]	[redacted]	[redacted]	[redacted] TCU [redacted]	G[redacted] D[redacted]E	[redacted]OR [redacted]	[redacted]MP[redacted]	[redacted] ENV[redacted]N.	[redacted]MP. [redacted]	[redacted] [redacted] RE[redacted] [redacted]
15	10/12	003	Flt III Flt III	Flt V Q II	Flt III Q II		Air Air	Ambient Ambient	a. Engineering tests as follc 1. Flt III TCU (vacuum) + Flt V elev. drive(vacu 2. Flt III TC (vacuum)+Q elev. drive (air). 3. Q II TCU (air)+ Flt V elev. drive (vacuum). b. Set-up Test - No jitter observed.
	10/13	003	Flt III	Flt V	Flt III	Jitter	Vacuum	+25°C	a. No jitter on first up cyc jitter observed on second and third up cycle. b. Turned system off replace Flt III TCU with QII TCU
		003	Q II	Flt V	Flt III	No Jitter	Vacuum	+25°C	a. No jitter observedon thre elevation up cycles. Repl QII TCU with Flt III TCU.
		003	Flt III	Flt V	Flt III	Jitter	Vacuum	+25°C	a. Jitter observed on first elevation up cycle (27 se up from max down position) jitter observed as stall and run. Jitter observed on all 5 elevation up cyc b. Replaced Flt III TCU with Q2 TCU.
		003	Q II	Flt V	Flt III	No Jitter	Vacuum	+25°C	a. No jitter observed on 2 elevation up cycles.
		003	Flt III	Q II	Q II	No Jitter	Vacuum	+25°C	a. No jitter observed on thr elevation up cycles. b. Compensating springs on Q TCU. c. System cycled OFF/ON; ele cycled up 4 times - no jitter observed.
		003	Flt III	Flt V	Flt III	Spike No Jitter	Vacuum	+25°C	a. Elevation cycled up 6 tim no jitter observed. 2 spi observed on fifth up cycl b. System cycled OFF/ON, ele cycled up four times, no jitter.

BL[redacted]	D[redacted]	C[redacted]	[redacted]CU	[redacted]GE[redacted]DRI[redacted]	M[redacted]R	[redacted]PT[redacted]	[redacted]VI[redacted].	[redacted]P.	[redacted] RE[redacted]
15 (Contd.)	10/13	003	Flt III	Flt V	Flt III	No Jitter	Vacuum	+25°C	c. After 20 minute inactive period, elev. cycled up four times, no jitter observed.
						No Jitter			d. System cycled OFF/ON; 1 up cycle, no jitter
						Jitter			e. Lowered system input voltage to +25 volts, cycled elev up, jitter observed o first, second cycle.
						Jitter			f. Raised system input voltag to +28 volts, cycled elev. up 9 times, jitter observe on 5th up cycle.
						No Jitter			g. System cycled OFF/ON, elev up cycled 9 times, no jitte
						Jitter (Elev. Up) Jitter (Elev. Down)			h. Lowered input supply volta to +25 volts. Cycled elev. up/down jitter observed on 2nd through 6th up cycle. Jitter observed on 4th, 5th 7th, 8th, 9th, 10th, 11th, 13th 14th, 15th down cycles.
									i. Lowered input voltage to +25 volts, cycled elev. up/down jitter observed on first up cycle, no jitter on second up cycle. Jitter observed on 1st & 2nd down cycles.
						Jitter			j. Raised input supply voltag to +28 volts. Jitter observed on 1st & 2nd up cycles. No jitter on 2 down cycles. System turned off.
			QII	Flt V	Flt III	Jitter			k. Jitter observed on 2nd, 4t 6th up cycle. No jitter observed on elev. down cycle. System turned off.
			Flt III	Flt V	Flt III	Jitter			l. Jitter observed on 1st, 2nd 3rd. Elevation up cycle. No jitter observed on dow cycle.

PROBLEM	D[redacted]	CTV	TCU	GEAR DRIVE	MOTOR	SY[redacted]OM	T[redacted] CO[redacted]TIONS ENVIRON.	TEMP.	RE[redacted]KS
15 (Contd.)	10/13	003	Flt III	Flt V	Flt III	Jitter			m. Lowered input voltage to +25 volts. Jitter observe on 1st, 2nd, 3rd up/down cycles.
									n. Raised input voltage to +28 volts. No jitter obs 2 cycles up/down.
						Glitch			o. Raised input voltage to 33.75 volts. Spike obse on 2nd up cycle.
						Jitter			p. Lowered input voltage to +28 volts. Elev. cycled five times. Jitter obser on third up cycle. Syster turned off.
	10/14	003	Flt III	Flt V	Flt III	No Jitter			a. 10 up/down cycles, no ji Turned off one hr.
						Jitter	Vacuum	+25°C	b. Cycled elev. up/down 12 Spikes observed on 4th u cycle. Jitter observed 8th,9th,10th, 11th, 12th down cycles. System turn off for 1/2 hour.
			Flt III	-	004 (Spare)	-	Air	Ambient	a. Cycled up/down, measured torque.
			Flt III	Flt V	Flt III	Jitter	Vacuum	+25°C	a. Cycled elev. up/down 3½t Jitter observed on 2nd, up cycles. Spike on 4 do cycle.
			QII	Flt V	Flt III	Jitter			a. Jitter on 1st up cycle. jitter on down cycle. Ch to Flt III TCU QII motor gear drive.
			Flt III	QII	QII	No Jitter			a. Cycled elev. up/down two cycles. No jitter.
			Flt III	QII	QII	Introduce Jitter			a. Stalled TCU carriage by obtain stall signature.

[redacted]OBLEM	DAT	CTV	TCU	GEAR DRIVE	MOTOR	SYMP[redacted]	TEST CONDITIONS ENVIRON.	TEMP.	REMAR[redacted]
15 (Cntd.)	10/14	003	Flt III	Flt V	Flt III	Jitter			a. Jitter observed on 1st elev up cycle. Obtained stall signature on expanded scale No jitter on down cycle. Repeated cycling up/down. Jitter observed on all up cycles.
			QII	Flt V	Flt III	Jitter			a. Cycled elev. up/down. Jitter observed on all up cycles.
			Flt III	Flt III	Flt III	Jitter	Air	Ambient	a. System turned on two hours after venting. b. Jitter observed on 3rd up cycle. c. Bypassed bell jar feed thru connectors. Jitter present. d. Obtained motor stall signature in up/down postions (hand stall). After hand stalling observed jitter on elevation down.
	10/17		Flt III	Flt III	Flt III	No Jitter	Air	Ambient	a. eleven up/down cycles - no jitter.

)BJ[redacted]	D[redacted]	C[redacted]	[redacted]CU	[redacted]GEA[redacted]DRI[redacted]	M[redacted]R	[redacted]PT[redacted]	[redacted]VI[redacted]ON[redacted]	TE[redacted]P.	[redacted] REMARKS [redacted]
16	10/17 72	003	F3-006			No Resonance	Air	Ambient	a. Low frequency vibration of TCU, 0.5 G from 5 Hz to 60 Hz at ½ octave/minute. TCU elevation operational during vibration, slight indication of resonance at 14, & 23 Hz. No weight in TCU cradle. b. Dwelled at 14 and 23 Hz to check for resonance. None indicated. c. Added 2 lb. weight to TCU cradle, operate TCU elevation during vibration swept from 6 to 30 Hz @ ½ octave/minute. No resonan indicated.
17 .cuum ·st of ; Motor Gear ousing ıly	10/23 72 ↓ 10/27 72	003 (Air)	Q2-003 (Air)	F-3 (006)	F-3 (009)	No Loss of motor Torque in Vacuum	Vacuum	+25°C	a. Vacuum test of F-3 elevation gear drive and motor. b. Test Set-up 1. Fixed load attached to output of elevation gear drive utilizing elevation clutch as load. 2. Strain guage used to monitor performance of motor in vacuum. c. 63.5 hrs total time in vacuum, 5.2 hrs. total operating time of motor. Motor cycled in both directions. d. Results: Measured a decre of 7% in motor torque.
18	10/28 72	003	F3-(006)			No Jitter	Air	Ambient	a. Pre vibration, post vibration, & thermal vacuum setup. No TCU elevation drive jitter observed CTV-003-Q2 placed in chamber.

ːBLEM	DATE	CTV	TCU	GEAR DRIVE	MOTOR	SYMPT	TEST CONDITIONS ENVIRON.	TEST CONDITIONS TEMP.	REM
(Cont.)	10/31 72	003	F3-006			Jitter	Vacuum	+25°C	a. No jitter on 1st elev. up cycle. Jitter observed on 2nd up cycle.
						Jitter	Air	Ambient	b. Jitter observed on elev. u after chamber vented. TCU operated for 10 minutes then turned off.
						No Jitter	Air	Ambient	c. 35 minutes after chamber vented, elevation jitter now existant.
19 nt les in llows, gear using	10/31 72	003	F3-006	F3	?	No Jitter	Air	Ambient	a. Drilled vent holes in bellows, & gear housing. b. Observed single spike in elevation up, observed decrease in AC component or current during last 8 sec. of up travel.
						Jitter	Vacuum	+25°C	a. Jitter observed on 5th up cycle, spike on 4th up cyc
						Jitter	Air	Ambient	b. Vented bell jar after 3 h operation in vacuum. Jit observed on 1st up cycle action venting. Jitter present 20 minutes after venting chamber. TCU observed to vibrate with elev. drive.
						No Jitter	Air	Ambient	c. Remove TCU from fixture, turned TCU on side with gear housing up, TCU put in normal position. No jitter in either case. d. Unable to reproduce jitte with TCU bolted to fixtur
20 [illegible]	11/1 72 → 11/3/ 72	003	Q2-003			No Jitter	Air	Ambient	a. Thermal vacuum setup. No jitter observed.
						No Jitter	Vacuum	+25°C	b. Thermal vacuum testing - 50 up/down elevation cycl c. Total time in vacuum 27 h

OBLEM	DA	CTV	TCU	GEAR DRIVE	MOTOR	SYM[redacted]M	TES[redacted]ON[redacted]IONS ENVIRON.	TEMP.	REMA[redacted]S
21 [illegible]acuum est TCU N007-F4 /6 G eight	11/4 72 →	003	F4-007			No Jitter	Air	Ambient	a. Thermal vacuum setup. Drc into up mechanical stop. Misaligned limit switch acturately repaired. No elevation jitter.
	11/6 72					No Jitter	Vacuum	+25°C	b. No jitter observed. Performed 4 tests on TCU per TP-OP-2265825. 1/6 G weight.
									c. Total time in vacuum ____
[illegible] acuum est TCU SN007-F4 /3 G eight	11/6 72 →	003				No Jitter	Air	Ambient	a. Thermal vacuum setup. 2 elevation up cycles with 1/3 G weight. No jitter.
	11/7 72					No Jitter	Vacuum	+25°C	b. Turned TCU on for 1 hr before testing elevation drive.
									c. 2 elevation up cycles, w[illegible] 1/3 G weight. No jitter.
									d. Total time in vacuum [illegible]
23 Vacuum est of CU SN 006-F3. ested as fol ollows, a.S t ellows . TCU ounted n staff . Staff ounted n low frequenc s. ixture [illegible]	11/3 72	002-Q1 (out side chamber)	006-F3			No Jitter	Air	Ambient	Thermal Vacuum setup.
	11/4 72					Jitter	Vaccum	+25°C	Jitter on 3rd elevation cycle.
	11/5 72					Jitter	Vacuum	+25°C	Jitter on 1st elevation cycle.
						Jitter	Vacuum	+25°C	Elevation motor synced from external source. cycled elevation up @ frequencies from 55Hz to 100 hz. Jitter observed all up cycles. Elevation motor synced from external source. Cycled elevation up, swe motor frequencies from 2 to 100 Hz. Jitter presen at all frequencies.
						Jitter	Vacuum	+25°C	Returned to integral motor sync, elev. Jitter present in up & down positions.

PROBLEM	DA	CTV	TCU	GEAR DRIVE	MOTOR	SYM[redacted]M	TE[redacted]CON[redacted]IONS ENVIRON.	TEMP.	REMA[redacted]S
23 (cont'd) Nitrogen Atmosphere						Jitter	Nitrogen	+25°C	Vented chamber by back filling with nitrogen. Jitter present. Cycled elevation up 40 cycles, jitter present on all cycles of elevation. Ele drive cycled in nitrogen atmosphere over a period of 4 hrs.
1/6 G Springs						No Jitter	Air	Ambient	Raised Bell. added 1/6 G compensator springs. No jitter observed. Jitter present with springs removed. Cycled elevati 10 up/down cycles with 1 G springs on, no jitter present.
24 1/6 G Compen- sator Springs Soft, Bellows TCU on staff, Staff on low reg Rib Fix.	11/6 72	002- Q1	006-F3			No Jitter	Vacuum	+25°C	a. Cycled elevation 30 up/ down cycles. No Jitter observed.
	11/7 72					Jitter (removed 1/6 G springs)	Air	Ambient	b. 1/6 G springs removed after venting, jitter observed.
25	11/15 11/16 11/17	003	006-F3	Flt III		No Jitter	ATP Air Vacuum Air		a. F3 tested with damping spring on eact test. No discrepancies encountere

SECTION IV

APOLLO 17 THERMAL DATA

The GCTA CTV used during the Apollo 17 mission included a temperature sensor to measure vidicon sleeve temperatures near the SIT target. The temperature telemetry information was contained in a pulse, modulated to indicate temperature level, inserted in line 18 of the CTV composite video output signal. Figure 8 illustrates the telemetry waveform.

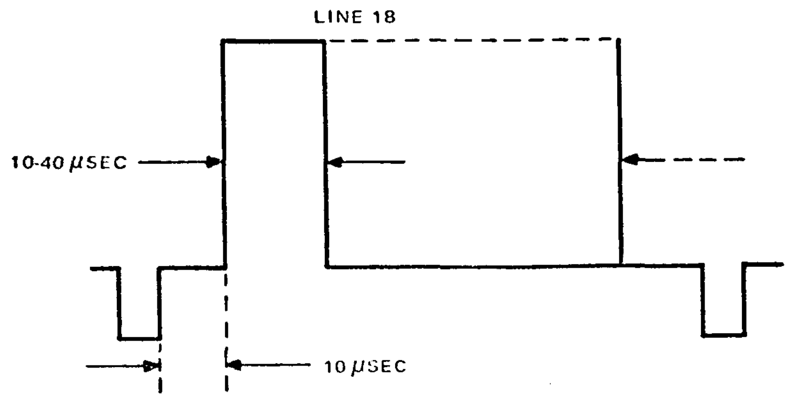


Figure 8. CTV Temperature Telemetry Waveform

A summary of CTV temperature measurements obtained during the Apollo 17 mission EVA-1, EVA-2, EVA-3 and lunar liftoff is shown in Table 5. The temperatures obtained were based on the calibration curve shown in Figure 9, which was obtained during the CTV alignment test. The dotted portion of the calibration curve is a theoretical projection. The temperature telemetry was calibrated to a maximum temperature of 122°F.

The initial temperature of the CTV at the start of EVA-1 was measured to be 53.6°F. The predicted temperature at turn on was 50°F. During the course of EVA-1, the CTV reached a maximum temperature of 86.0°F. The predicted temperature was 87°F for an α of 0.2 (slight dust). The CTV had operated within the predicted temperature extremes at the conclusion of the first EVA. The CTV lens was pointed down 45° with the radiator away from the sun after the EVA.

TABLE 5. SUMMARY OF CTV OPERATING TEMPERATURES

Time from LM Touchdown (hr: min)	EVA Elapsed Time hr: min	Temperature Telemetry Pulse Width (μsec.)	Vidicon Temperature °F	Notes
4:01	0:00	—	—	Beginning of EVA, No T.V.
5:11	1:10	29.1	53.6	T.V. on - LM sight
5:16	1:15	29.0	54.0	
5:21	1:20	29.0	54.0	
5:26	1:25	28.9	55.0	
5:31	1:30	28.7	56.0	
5:36	1:35	28.5	57.2	
5:41	1:40	28.3	58.5	
5:46	1:45	28.1	59.5	
5:51	1:50	28.0	60.0	
5:56	1:55	27.8	61.2	
6:01	2:00	27.7	61.7	
6:02	2:01	—	—	T.V. off
6:10	2:09	27.7	61.7	T.V. on ALSEP sight
6:16	2:15	27.7	61.7	
6:21	2:20	27.5	62.6	
6:26	2:25	27.3	63.8	
6:31	2:30	27.1	64.7	
6:36	2:35	26.8	66.1	
6:41	2:40	26.7	66.5	
6:46	2:45	26.5	67.5	
6:51	2:50	26.2	69.0	
6:56	2:55	26.2	69.0	

EVA-1

Time From LM Touchdown (hr:min)	EVA Elapsed Time hr:min	Temperature Telemetry Pulse Width (μsec.)	Vidicon Temperature °F	Notes
7:01	3:00	26.1	69.5	
7:06	3:05	26.0	69.8	
7:11	3:10	25.8	71.8	
7:16	3:15	25.6	71.7	
7:21	3:20	25.4	72.5	
7:26	3:25	25.2	73.5	
7:31	3:30	25.0	74.5	
7:36	3:35	24.8	75.3	
7:41	3:40	24.6	76.0	
7:46	3:45	24.4	77.2	
7:51	3:50	24.2	78.0	
7:56	3:55	23.9	79.3	
8:01	4:00	23.5	81.0	
8:06	4:05	23.2	82.5	
8:11	4:10	23.0	83.5	
8:16	4:15	22.8	84.4	
8:21	4:20	22.7	84.7	
8:26	4:25	22.5	85.7	
8:31	4:30	22.4	86.0	
8:34	4:33	22.4	86.0	TV OFF
9:04	5:03	23.9	79.3	TV ON - STATION 1
9:11	5:10	23.6	80.7	
9:16	5:15	23.5	81.0	

EVA-1

Time from LM Touchdown (hr: min)	EVA Elapsed Time hr: min	Temperature Telemetry Pulse Width (μsec.)	Vidicon Temperature °F	Notes
9:21	5:20	23.4	81.6	
9:26	5:25	23.3	82.0	
9:30	5:29	—	—	T.V. OFF
9:52	5:51	23.8	79.8	TV ON - SEP SIGHT
9:55	5:55	23.8	79.8	
10:01	6:00	23.7	80.3	
10:06	6:05	23.7	80.3	
10:11	6:10	23.5	81.0	TV OFF
10:16	6:14	23.5	81.0	TV ON - LM SIGHT
10:21	6:20	23.2	82.5	
10:26	6:25	23.0	83.5	
10:29	6:28	22.8	84.4	TV OFF - EVA CLOSE OUT
:	:	.	.	
:	:	.	.	
:	:	.	.	
:	:	.	.	
:	:	.	.	
:	:	.	.	
:	:	.	.	
:	:	.	.	
:	:	.	.	
:	:	.	.	
:	:	.	.	

EVA- 2

Time From LM Touchdown (hr: min)	EVA Elapsed Time hr: min	Temperture Telemetry Pulse Width (µsec.)	Vidicon Temperature °F	Notes
27:41	0:04	28.5	57.2	TV ON - LM SIGHT
27:47	0:10	28.5	59.5	
27:52	0:15	27.5	61.2	
27:57	0:20	27.4	63.3	
28:02	0:25	27.1	64.7	
28:07	0:30	26.7	66.5	
28:12	0:35	26.2	69.0	
28:15	0:38	26.0	69.8	TV OFF
29:40	2:03	26.5	67.5	TV ON - STATION 2
29:42	2:05	26.4	68.0	
29:47	2:10	26.1	69.5	
29:52	2:15	25.8	71.8	
29:57	2:20	25.4	72.5	
30:04	2:[illegible]	25.0	74.5	
30:07	2:30	24.7	75.7	
30:13	2:[illegible]	24.3	77.5	
30:17	2:40	24.0	79.0	
30:22	2:45	23.5	81.0	
30:27	2:50	23.1	83.0	
30:32	2:55	22.8	84.4	
30:37	3:00	22.4	86.0	
30:40	3:03	22.3	86.5	TV OFF
31:24	3:47	22.5	85.7	TV ON - STATION 3

EVA-2

Time from LM Touchdown (hr:min)	EVA Elapsed Time hr:min	Temperature Telemetry Pulse Width (μsec.)	Vidicon Temperature °F	Notes
31:27	3:50	22.4	86.0	
31:32	3:55	22.1	87.5	
31:37	4:00	21.9	88.4	
31:42	4:05	21.6	89.6	
31:47	4:10	21.2	91.4	
31:52	4:15	20.9	92.7	
31:57	4:20	20.6	94.0	TV OFF
32:18	4:41	20.8	93.2	TV ON STATION 4
32:22	5:45	20.4	95.8	
32:27	5:50	20.1	96.0	
32:32	5:55	19.8	97.5	
32:37	5:00	19.6	98.3	
32:42	5:05	19.4	99.0	MANUAL OVERIDE OF CTV
32:47	5:10	19.3	99.5	
32:49	5:12	—	—	TV OFF
33:20	5:43	20.1	96.0	TV ON - STATION 5
33:22	5:45	20.0	96.8	
33:27	5:50	19.8	97.5	
33:31	5:55	19.6	98.3	
33:37	6:00	19.4	99.0	
33:42	6:05	19.2	100.0	
33:47	6:10	19.0	100.8	TV OFF
34:09	6:32	19.5	95.6	TV ON - LM SIGHT

EVA-2

TIME FROM LM TOUCHDOWN (hr: min)	EVA ELAPSED TIME hr: min	TEMPERATURE TELEMETRY PULSE WIDTH (μsec.)	VIDICON TEMPERATURE °F	NOTES
34:17	6:40	19.2	100.0	
34:22	6:45	19.0	100.8	
34:27	6:50	18.7	102.2	
34:32	6:55	18.4	103.5	
34:36	6:59	18.1	104.5	TV OFF - EVA CLOSE OUT
:	:	.	.	
:	:	.	.	
:	:	.	.	
:	:	.	.	
:	:	.	.	
:	:	.	.	
:	:	.	.	
:	:	.	.	
:	:	.	.	
:	:	.	.	
:	:	.	.	
:	:	.	.	
:	:	.	.	
:	:	.	.	
:	:	.	.	
:	:	.	.	
:	:	.	.	
:	:	.	.	

EVA-3

Time from LM Touchdown (hr:min)	EVA Elapsed Time hr:min	Temperture Telemetry Pulse Width (μsec.)	Vidicon Temperature °F	Notes
50:37	0:10	28.2	59.0	TV ON - LM SIGHT
50:42	0:15	27.8	61.2	
50:47	0:20	27.4	63.3	
50:52	0:25	27.0	65.0	
50:57	0:30	26.5	67.5	
51:00	0:33	26.4	69.0	TV OFF
51:40	1:13	24.9	75.0	TV ON - STATION 6
51:47	1:20	24.7	75.7	
51:52	1:25	24.2	78.0	
51:57	1:30	23.7	63.3	
52:02	1:35	23.1	83.0	
52:07	1:40	22.5	85.7	
52:12	1:45	22.1	87.5	
52:17	1:50	21.7	89.3	
52:22	1:55	21.2	91.0	
52:27	2:00	20.7	93.5	
52:32	2:05	20.2	95.6	
52:37	2:10	19.6	98.3	
52:42	2:15	18.9	101.3	
52:47	2:20	18.5	103.0	
52:50	2:23	18.3	104.0	TV OFF
53:00	2:33	18.2	104.3	TV ON - STATION 7
53:02	2:35	18.1	104.5	

EVA-3

Time from LM Touchdown (hr: min)	EVA Elapsed Time hr: min	Temperature Telemetry Pulse Width (µsec.)	Vidicon Temperature °F	Notes
53:07	2:40	17.8	105.9	
53:12	2:45	17.5	107.3	
53:17	2:50	17.1	109.0	
53:19	2:52	17.0	109.4	TV OFF
53:40	3:13	17.2	108.5	TV ON – STATION 8
53:47	3:20	16.8	110.3	
53:52	3:25	16.5	111.5	
53:57	3:30	16.2	113.0	
54:07	3:40	15.7	115.0	
54:12	3:45	15.5	116.5	
54:17	3:50	15.2	117.5	
54:21	3:54	15.0	118.0	TV OFF
54:45	4:18	15.6	115.7	TV ON – STATION 9
54:52	4:25	15.3	117.0	
54:57	4:30	15.1	118.3	
55:02	4:35	14.9	119.3	
55:07	4:40	14.7	120.2	
55:12	4:45	14.4	122.0	
55:17	4:50	14.2	123.0	
55:22	4:55	14.1	123.7	
55:27	5:00	13.8	125.0	
55:36	5:09	13.5	126.5	TV OFF
56:09	5:42	14.8	119.8	TV ON – LM SIGHT

EVA-3

Time from LM Touchdown (hr: min)	EVA Elapsed Time hr: min	Temperature Telemetry Pulse Width (μsec)	Vidicon Temperature °F	Notes
56:17	5:50	14.5	121.3	
56:22	5:55	14.4	122.0	
56:27	6:00	14.1	123.7	
56:32	6:05	14.0	124.0	
56:37	6:10	13.8	125.0	
56:42	6:15	13.6	126.0	TV OFF
56:45	6:18	—— .	—— .	TV ON, TV OFF 6:21
56:48	6:21	—— .	—— .	TRAVERSE TV TO R.I.P SPOT
56:51	6:24	13.3	127.5	TV ON - ROVER R.I.P SPOT
56:57	6:30	13.1	128.5	
57:02	6:35	12.9	129.7	
57:07	6:40	12.7	131.0	
57:09	6:42	12.4	132.5	
57:17	6:50	12.5	134.5	
57:22	6:55	12.5	132.0	
57:27	7:00	12.4	132.5	
57:32	7:05	12.3	133.0	TV OFF
57:33	7:06	12.3	133.0	TV ON
57:34	7:07	12.3	133.0	TV OFF
:	:	.	.	
:	:	.	.	
:	:	.	.	
:	:	.	.	

[redacted] - LIFTOFF

Time from LM Touchdown (hr: min)	EVA Elapsed Time hr: min	Temperature Telemetry Pulse Width (μsec.)	Vidicon Temperature °F	Notes
74:20	0:00	23.4	81.6	TV on - Pre lift off
74:25	:05	23.3	82.0	
74:30	:10	23.0	83.5	
74:35	:15	22.7	84.7	
74:40	:20	22.2	86.0	
74:45	:25	21.9	88.4	
74:50	:30	21.5	90.0	
74:53	:33	21.2	91.4	
74:55	:35	21.1	91.8	
74:56	:36	21.0	92.3	
74:57	:37	21.0	92.3	
74:58	:38	20.9	92.7	
74:59	:39	20.8	93.2	
75:00	:40	20.7	93.5	LM Liftoff
75:02	:42	20.3	95.3	
75:03	:43	20.3	95.3	TV off
:	:	.	.	
:	:	.	.	
:	:	.	.	
:	:	.	.	
:	:	.	.	
:	:	.	.	
:	:	.	.	

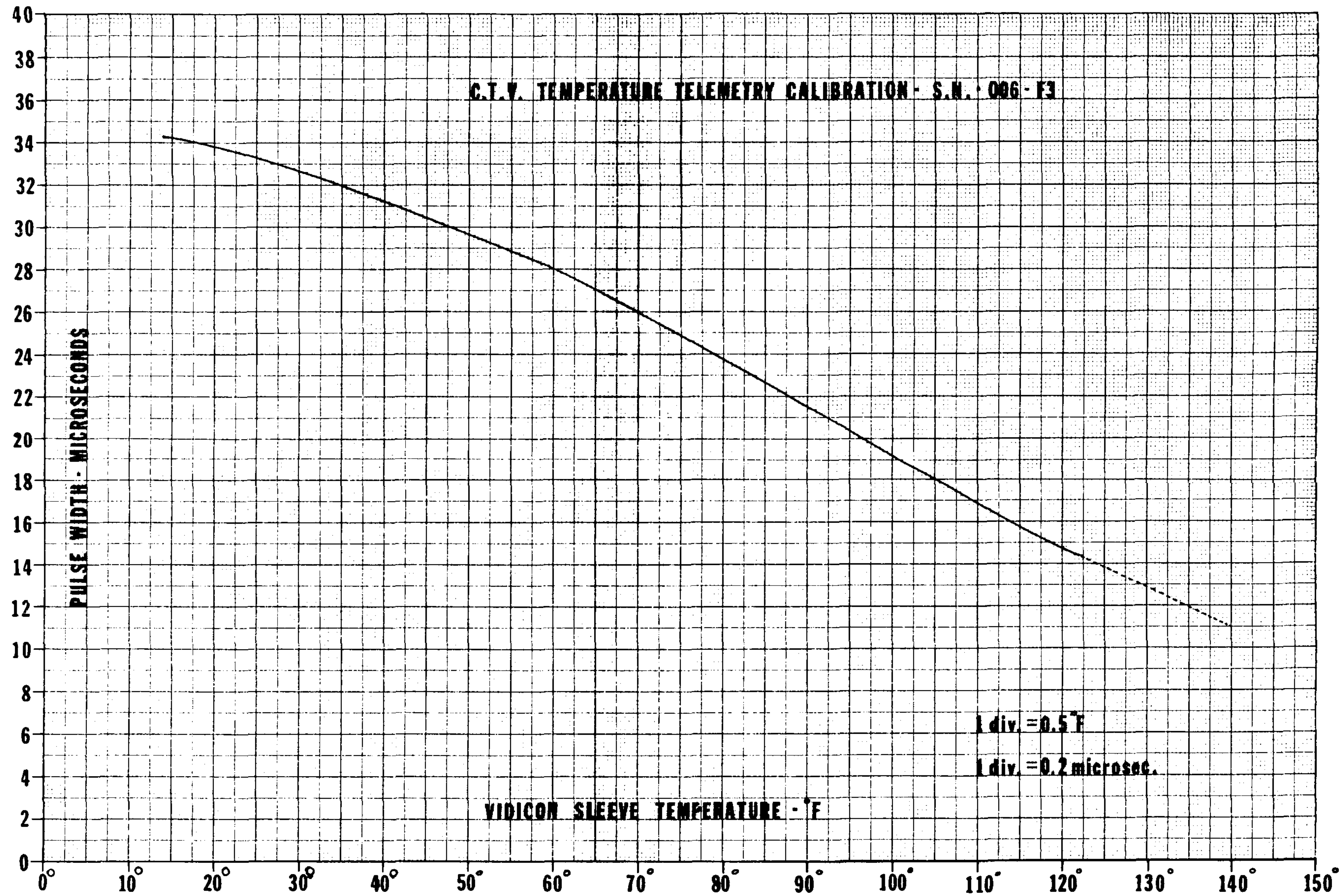


Figure 9. Flight 3 CTV Temperature Telemetry Calibration

After being off for 17 hours and 12 minutes, the GCTA was turned ON for EVA-2. At turn on, the CTV temperature was measured to be 57.2° F, approximately 26° hotter than predicted (for an α of 0.2). A maximum temperature of 90° F ($\alpha = 0.2$) had been predicted for the end of EVA-2. However, the CTV reached a maximum temperature of 104.5° F, approximately 14° hotter than predicted. At the conclusion of EVA-2, the lens was pointed down 45° with the radiator away from the sun for maximum cooling.

After a cool down period of 16 hours and 1 minute, the GCTA was again turned ON for EVA-3. It had been predicted that the CTV would cool down to 52° F ($\alpha = 0.2$) at the beginning of EVA-3. This prediction was exceeded by 7° F with a CTV temperature of 59° F at turn on. During EVA-3 the CTV reached a maximum temperature of 134.5° F. The predicted maximum was 122° F ($\alpha = 0.2$). Although the CTV operated above predicted temperature levels no apparent degradation occurred in picture quality. At the conclusion of EVA-3, the lunar rover was moved to its final lunar position, and the CTV was stowed with its radiator horizontal.

The CTV was turned on 43 minutes prior to LM liftoff. At this time, the CTV temperature was 81.6° F. At liftoff, the CTV reached a temperature of 95.3° F. The predicted maximum temperature at liftoff was 106° F ($\alpha = 0.2$).

A plot of CTV temperature vs EVA time for EVA-1, EVA-2, and EVA-3 is shown in Figures 10, 11 and 12 respectively. Figure 13 is a plot of the CTV temperature prior to liftoff. The CTV temperatures during EVA-1, EVA-2, EVA-3 and liftoff have been plotted on a single graph and are shown in Figure 14. Included for reference are the temperature prediction curves shown in Figures 15 and 16 for the CTV SIT tube and the TCU component boards. The curves were obtained from LCRU/GCTA thermal control data by E. T. Chementi dated 11/15/72.

During the lunar mission, the GCTA operating time was thirteen hours and twenty-two minutes (13:22). A summary of GCTA operating times is provided in Tables 6 and 7.

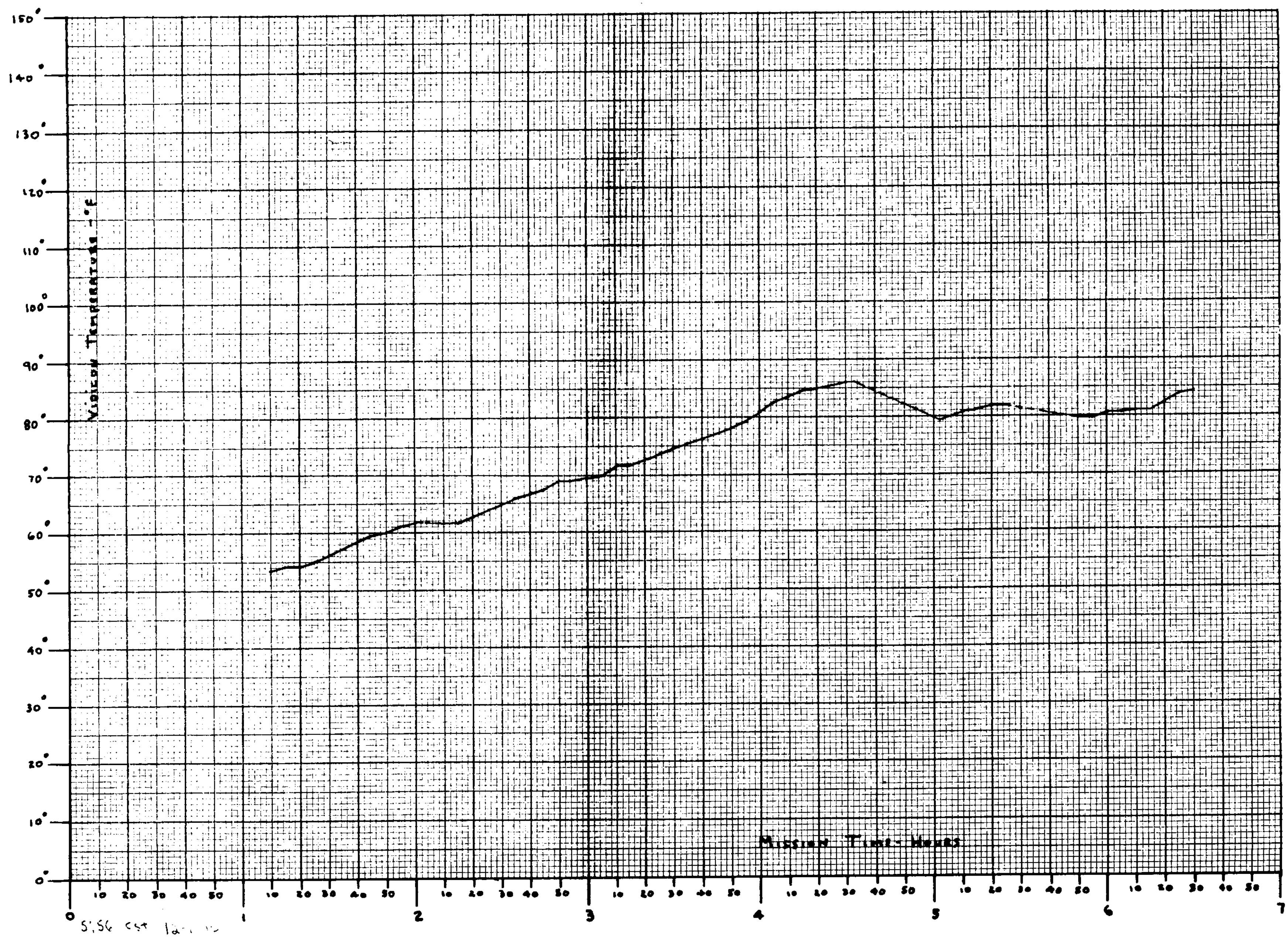


Figure 10. CTV Vidicon Temperature During EVA-1

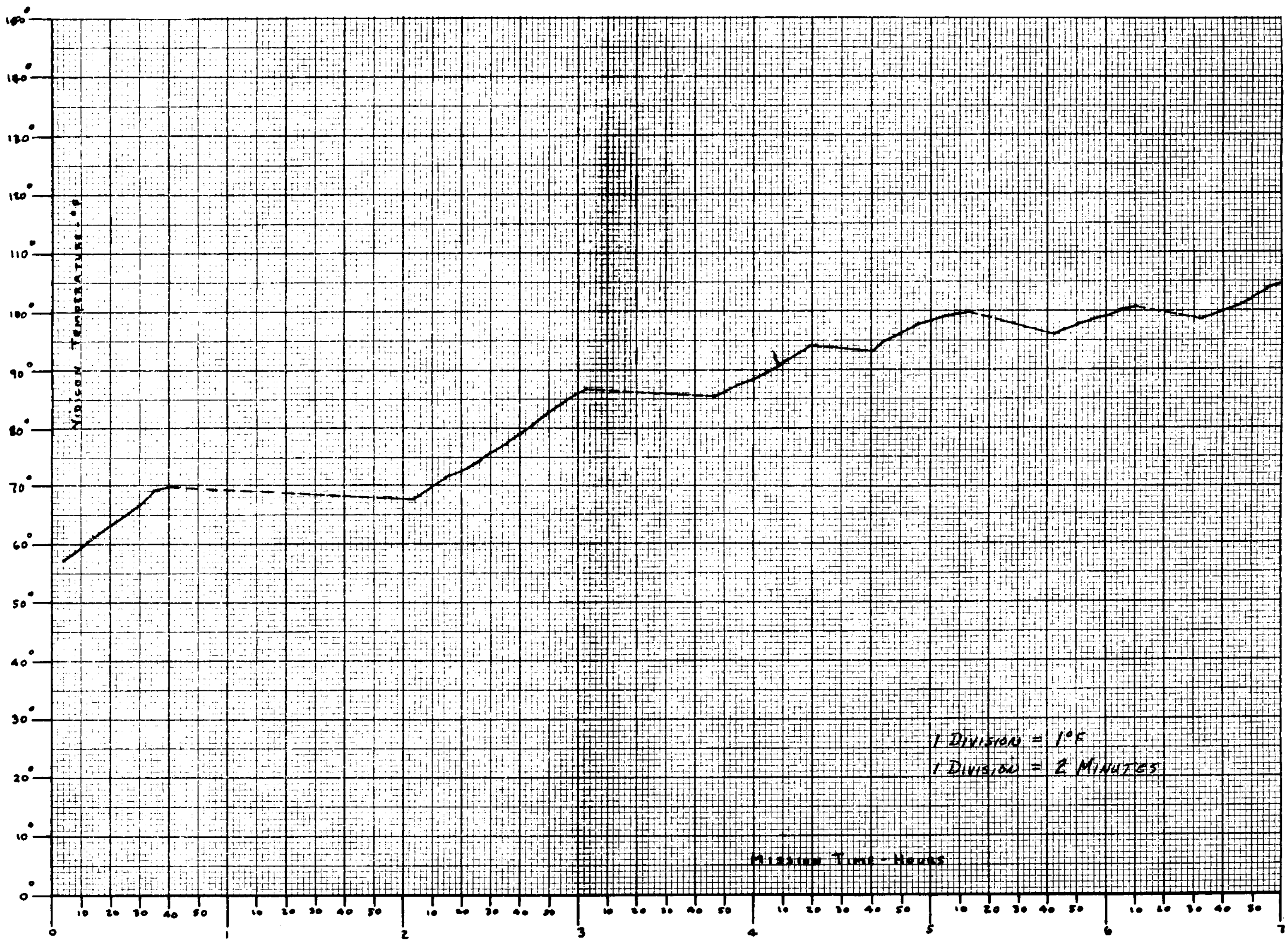


Figure 11. CTV Vidicon Temperature During EVA-2

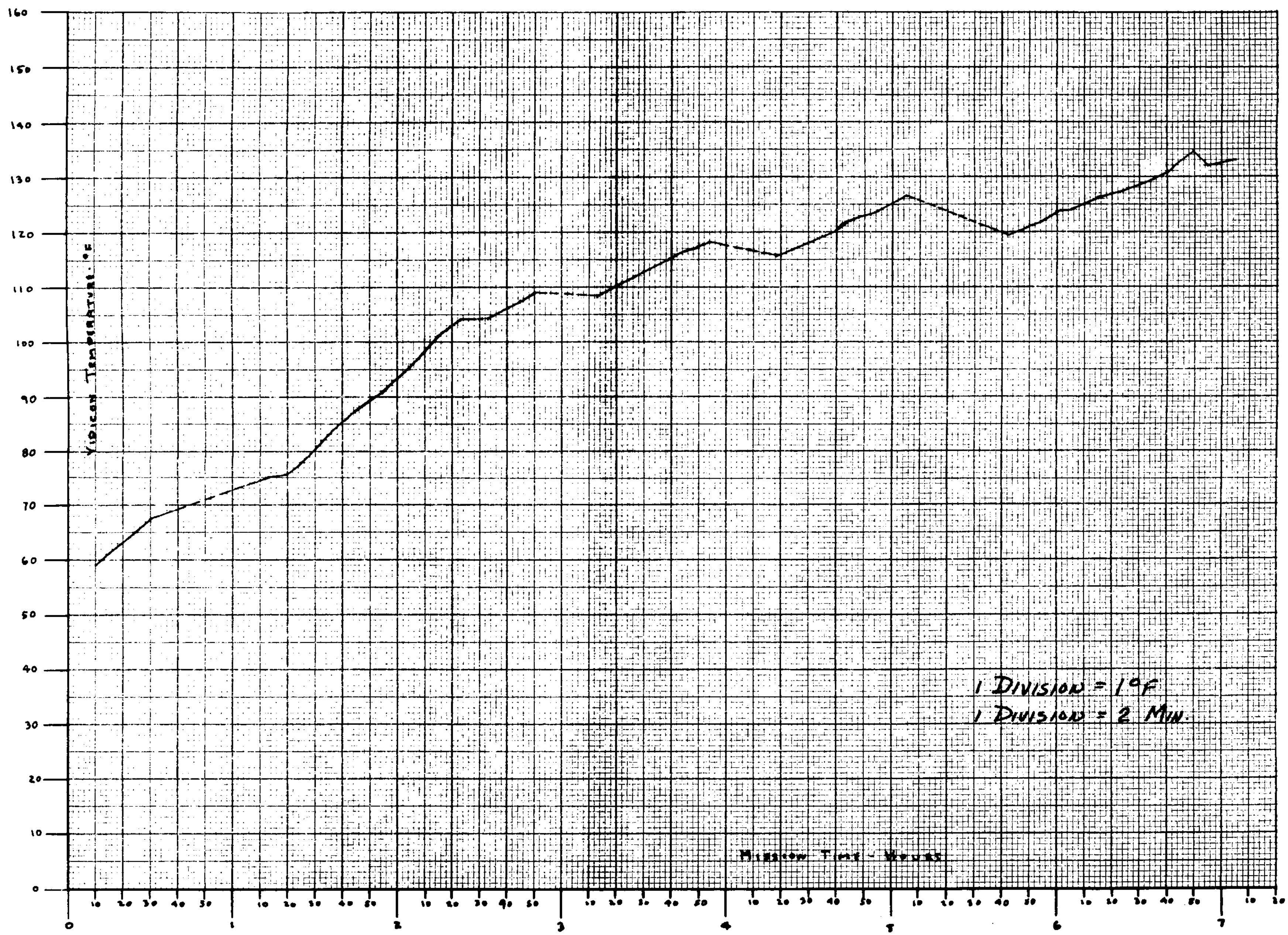


Figure 12. CTV Vidicon Temperature During EVA-3

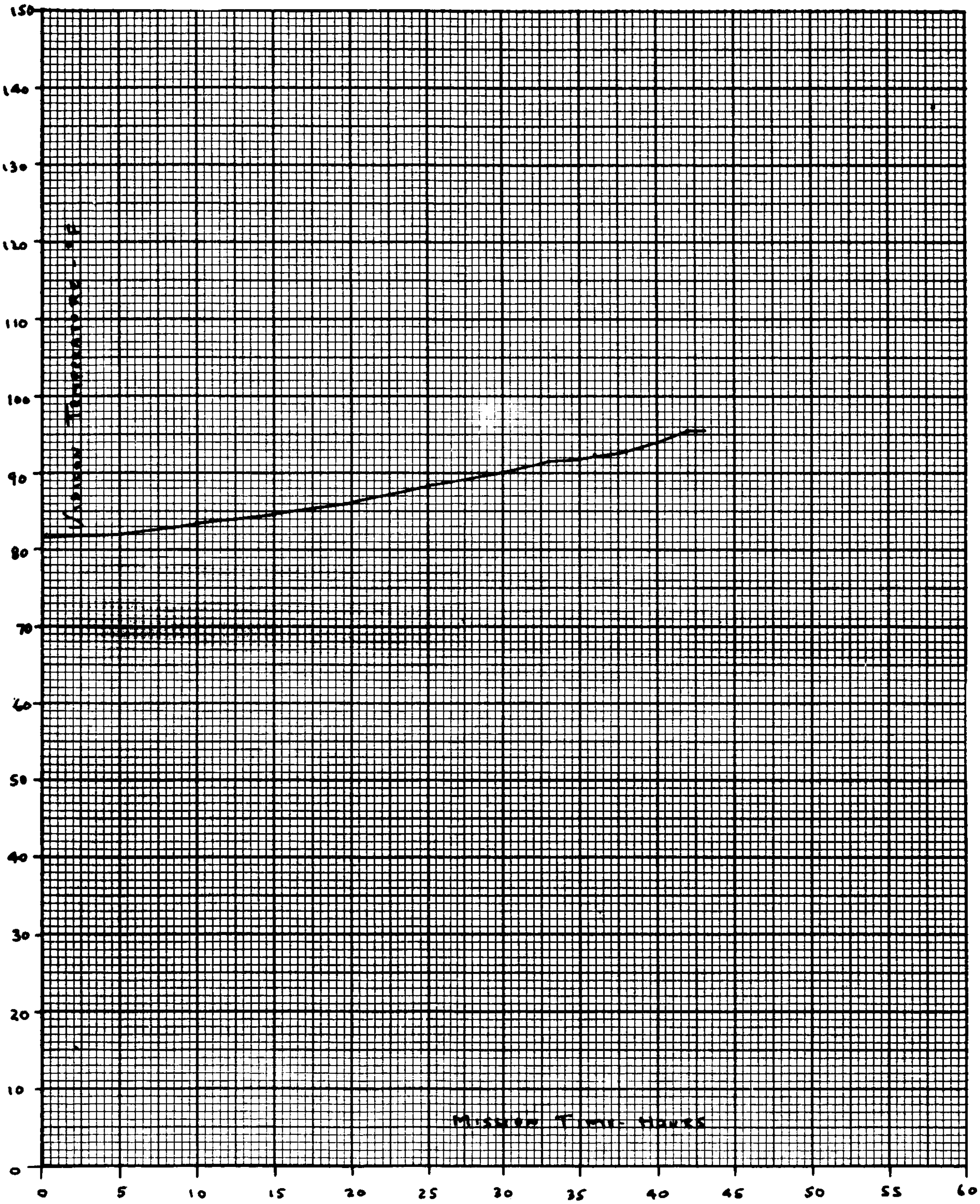


Figure 13. CTV Vidicon Temperature Prior to and During Lunar Liftoff

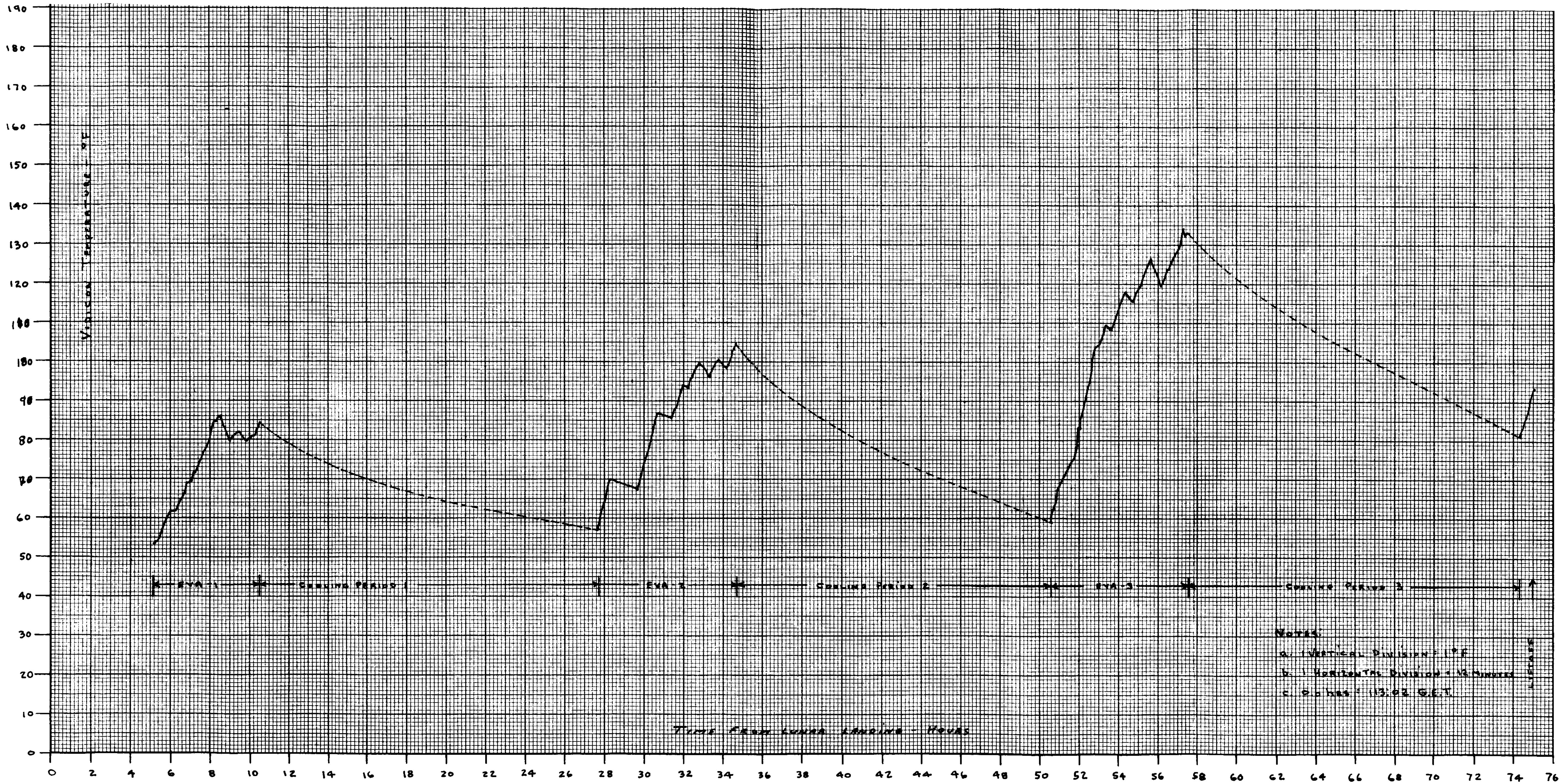


Figure 14. Overall Plot of CTV Temperature on Lunar Surface

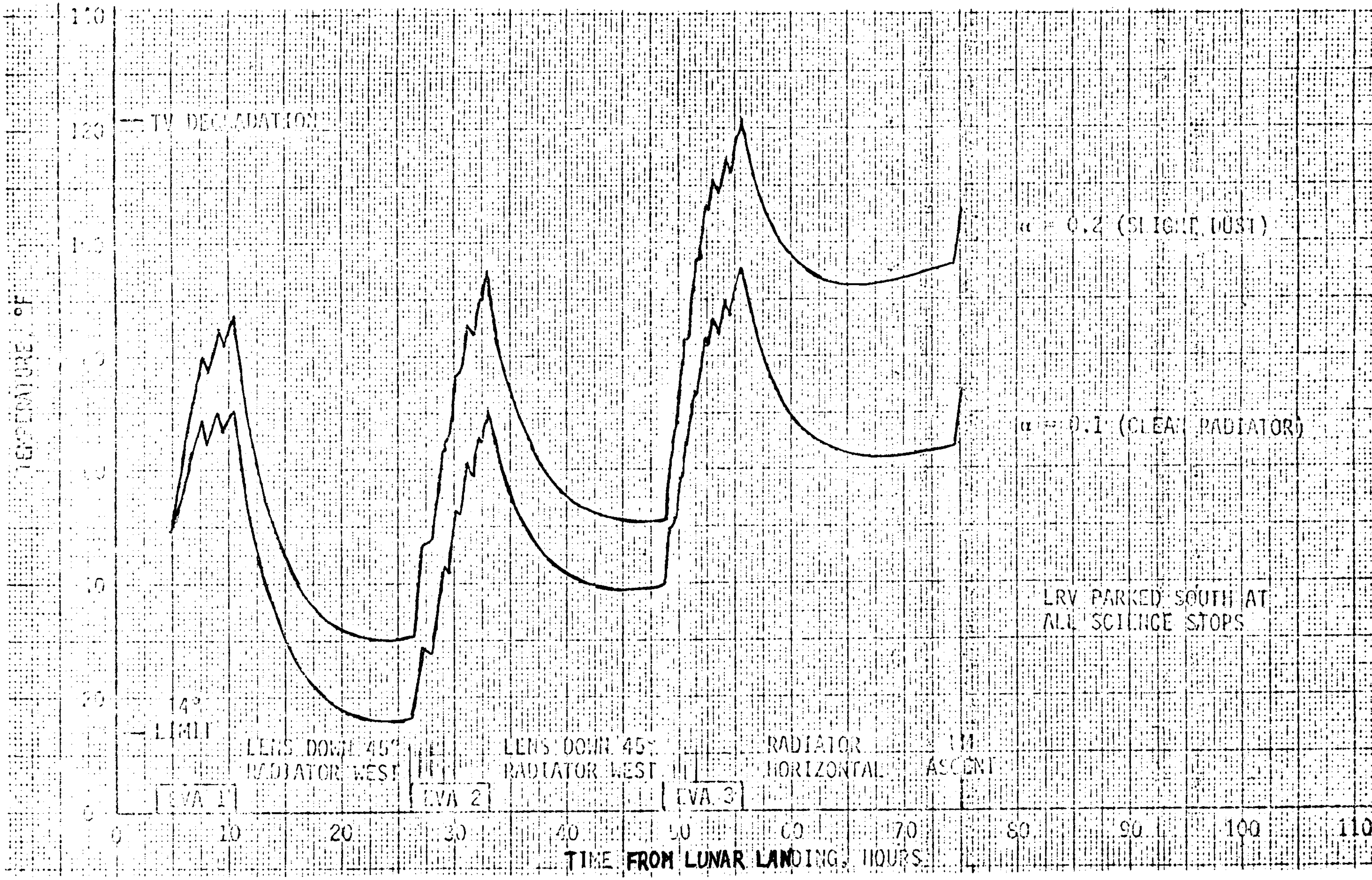


Figure 15. SIT Tube Temperature Prediction Curves

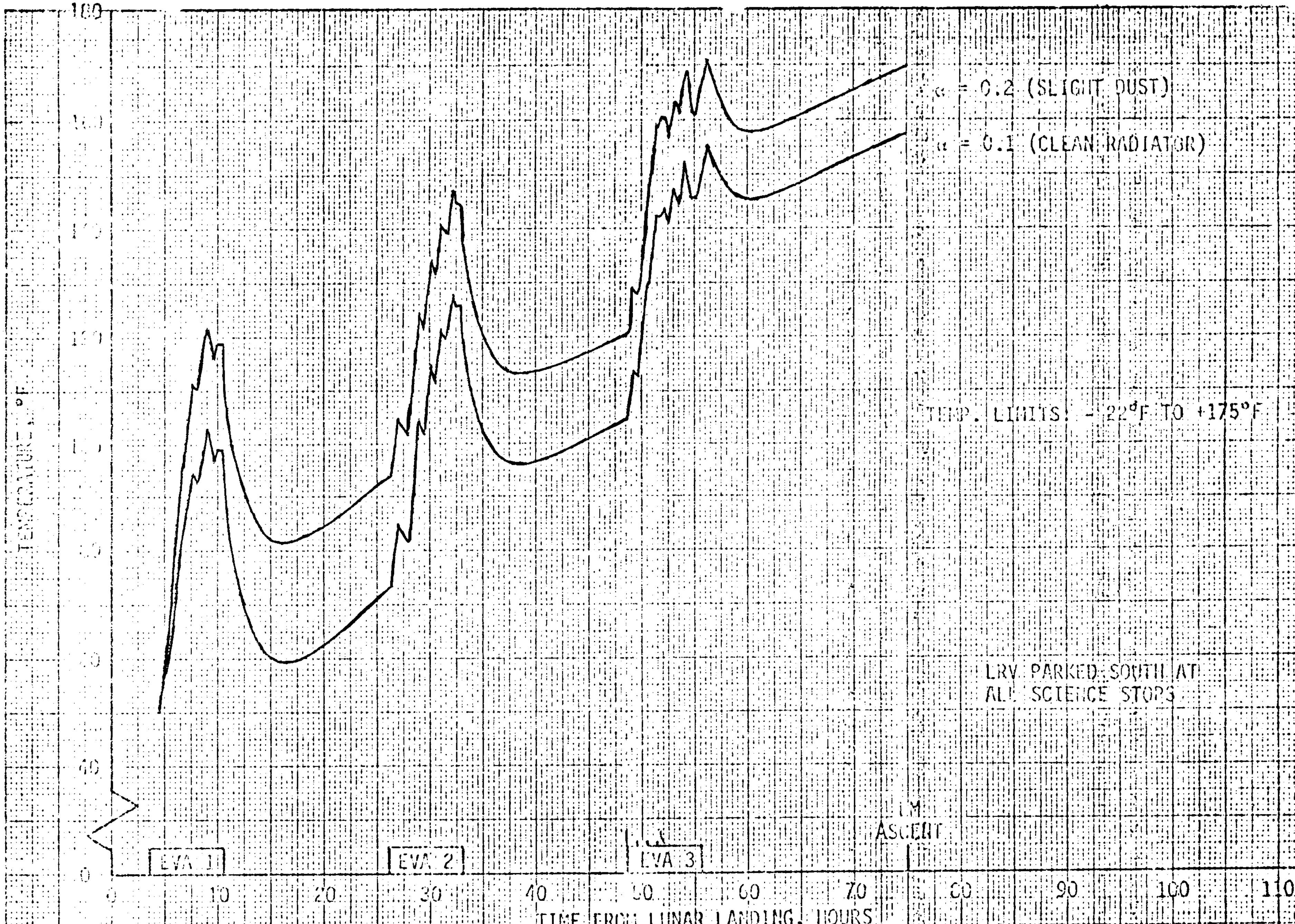


Figure 16. TCU Board Temperature Prediction Curves

TABLE 6. GCTA OPERATING TIME (1)

	EVA ELAPSED TIME (hr:min)		TV ON TIME hr:min
	TV ON	TV OFF	
EVA-1	1:10	2:01	0:51
	2:09	4:33	2:24
	5:03	5:29	0:26
	5:51	6:10	0:19
	6:14	6:28	0:14
TOTAL 'ON' hr:min	———	———	4:14

	EVA ELAPSED TIME (hr:min)		TV ON TIME hr:min
	TV ON	TV OFF	
EVA-2	0:04	0:38	0:34
	2:03	3:03	1:00
	3:47	4:20	0:33
	4:41	5:12	0:31
	5:43	6:10	0:27
	6:32	6:59	0:27
TOTAL 'ON' hr:min	———	———	3:32

	EVA ELAPSED TIME (hr:min)		TV ON TIME hr:min
	TV ON	TV OFF	
EVA 3	0:10	0:33	0:23
	1:13	2:23	1:10
	2:33	2:52	0:19
	3:13	3:54	0:41
	4:18	5:09	0:51
	5:42	6:15	0:33
	6:18	7:05	0:47
	7:06	7:07	0:01
TOTAL 'ON' hr:min	———	———	4:45

LIFTOFF			TV ON TIME hr:min
	TV ON	TV OFF	
TOTAL	0:00	0:43	0:43

TOTAL TV "ON" TIME 13:14

TABLE 7. GCTA OPERATING TIME (2)

Date	EVA	Event	G.M.T.	Time from Lunar Landing
12-11-72		Lunar Landing	13:55	0:00
	EVA 1	TV ON	19:06	5:11
		TV OFF	20:57	6:02
		TV ON	20:05	6:10
		TV OFF	22:29	8:34
		TV ON	22:59	9:04
		TV OFF	23:25	9:30
		TV ON	23:47	9:52
12-12-72		TV OFF	00:06	10:11
		TV ON	00:10	10:15
		TV OFF	00:24	10:29
	EVA-2	TV ON	17:36	27:41
		TV OFF	18:10	28:15
		TV ON	19:35	29:40
		TV OFF	20:35	30:40
		TV ON	21:19	31:24
		TV OFF	21:52	31:57
		TV ON	22:13	31:18
		TV OFF	22:44	32:49
		TV ON	23:15	33:20
		TV OFF	23:42	33:47
12-13-72		TV ON	24:04	34:09
		TV OFF	00:31	34:36
	EVA-3	ON	16:32	50:37
		OFF	16:55	51:00
		ON	17:35	51:40
		OFF	18:45	52:50
		ON	18:55	53:00
		OFF	19:14	53:19
		ON	19:35	53:40
		OFF	20:16	54:21
		ON	20:40	54:45
		OFF	21:31	55:36
		ON	22:04	56:09
		OFF	22:37	56:42
		ON	22:40	56:45
		OFF	23:27	57:32
		ON	23:28	57:33
		OFF	23:29	57:34
12-14-72	Liftoff	ON	16:12	74:20
		Liftoff	16:55	75:00
		OFF	16:58	75:03

SECTION V

EQUIPMENT STATUS

The following GCTA indentured serial number list indicates the latest numbers assigned to GCTA equipment and piece parts that are serialized. The revision status of each unit or part manufactured also is shown. The list has been updated to reflect all product improvement effort.

INDENTURED SERIAL NUMBER LIST - GROUND COMMANDED TELEVISION ASSEMBLY (GCTA) DATE OF ISSUE 11/21/72

PART NO.	DESCRIPTION	Assy Lvl	EMC S/N 001 REV. Dwg	FL	S/N	Q1 S/N 002 See Note 1 REV. Dwg	FL	S/N	Q2 S/N 003 See Note 2 REV. Dwg	FL	S/N	F1 S/N 004 See Note 3 REV. Dwg	FL	S/N	F2 S/N 005 See Note 4 REV. Dwg	FL	S/N	F3 S/N 006 See Note 5 REV. Dwg	FL	S/N	F4 S/N 007 See Note 6 REV. Dwg	FL	S/N	F5 S/N 008 See Note 7 REV. Dwg	FL	S/N
2265826-501	GCTA	*1	+	+	+	+	+	+	+	+	+	A	C	004	+	+	+	+	+	+	+	+	+	+	+	+
2265826-502	GCTA	1	+	+	+	D	D	002	D	D	003	+	+	+	D	D	005	D	D	006	D	D	007	D	D	008
2265261-502	Stowage Mt. Ass'y	2	+	+	+	D	D	002	D	D	003	C	C	004	D	D	005	D	D	006	D	D	007	D	D	008
1978797-501	Hinge Ass'y	3	+	+	+	C	B	002	C	B	003	B	A	004	C	B	005	C	B	006	C	B	007	C	B	008
2268104-501	Cable Ass'y	*3	+	+	+	+	+	+	+	+	+	-	-	004	+	+	+	+	+	+	+	+	+	+	+	+
2268104-502	Cable Ass'y	3	+	+	+	A	A	002	A	A	003	+	+	+	A	A	005	A	A	006	A	A	007	A	A	008
2265825-501	TCU	*2	+	+	+	+	+	+	+	+	+	J	G	004	+	+	+	+	+	+	+	+	+	+	+	+
2265825-502	TCU	2	+	+	+	M	K	002	M	K	003	+	+	+	L	J	005	M	K	006	M	K	007	M	K	008
2262457-501	Comp Bd.-Motor Damping	*3	+	+	+	+	+	+	+	+	+	B	B	004	+	+	+	+	+	+	+	+	+	+	+	+
2262457-503	Comp Bd.-Motor Damping	3	+	+	+	C	C	005	C	C	004	+	+	+	C	C	007	C	C	009	C	C	015	C	C	014
2264290-501	Azimuth Drive Ass'y	*3	+	+	+	+	+	+	+	+	+	C	C	004	+	+	+	+	+	+	+	+	+	+	+	+
2260194-102	Motor Gearhead Ass'y	*4	+	+	+	+	+	+	+	+	+	A	+	NA	+	+	+	+	+	+	+	+	+	+	+	+
2270035-502	Cable Ass'y (3.5 ft)	3	+	+	+	D	D	006	D	D	005	D	D	003	D	D	001	D	D	004	D	D	009	D	D	010
2270661-501	Azimuth Drive Ass'y	3	+	+	+	A	A	002	A	A	003	+	+	+	A	A	005	A	A	006	A	A	007	A	A	008
2260594-3	Mot. Gearhead Ass'y	5	+	+	+	B	+	025-2	B	+	036-1	B	+	+	B	+	028-3	B	+	015-10	B	+	023-7	B	+	011-9
2265822-501	Elect. Encl. Ass'y	*3	+	+	+	+	+	+	+	+	+	H	E	004	+	+	+	+	+	+	+	+	+	+	+	+
2265823-502	Elect. Encl. Ass'y	3	+	+	+	K	G	002	K	G	003	+	+	+	K	G	005	K	G	006	K	G	007	K	G	008
22[illegible]457-501	Mot. Damping Network	4	+	+	+	C	C	003	C	C	008	B	B	004	C	C	011	C	C	012	C	C	016	C	C	013
2265296-501	Bi-Phase Demod.	4	+	+	+	D	E	002	D	E	003	D	E	004	D	E	005	D	E	006	D	E	007	D	E	008
2265606-501	Mod.-DC/DC Conv.	*4	+	+	+	+	+	+	+	+	+	H	K	004	+	+	+	+	+	+	+	+	+	+	+	+
2265606-504	Mod.-DC/DC Conv.	4	+	+	+	J	L	002	J	L	003	+	+	+	J	L	005	J	L	006	J	L	007	J	L	008
2265607-501	Command Control	4	+	+	+	C	E	002	C	E	003	C	E	004	C	E	005	C	E	006	C	E	007	C	E	008
2265608-501	Demod.-70 kHz	4	+	+	+	E	H	002	E	H	003	E	H	004	E	H	005	E	H	006	E	H	007	E	H	008
2265613-501	Digital Decoder Bd.	4	+	+	+	D	D	002	G	E	003	G	E	004	G	E	005	G	E	006	G	E	007	G	E	008
2265615-501	Voltage Reg. Bd.	4	+	+	+	F	G	002	F	G	003	F	G	004	F	G	005	F	G	006	F	G	007	F	G	008
2265611-501	Decoder, Matrix Bd.	4	+	+	+	D	D	002	D	D	003	D	D	004	D	D	005	D	D	006	D	D	007	D	D	008
2265899-501	Test Sig. Gen. Bd.	4	+	+	+	J	G	002	J	G	003	J	G	004	J	G	005	J	G	006	J	G	007	J	G	008
2270362-501	Noise Filter Bd.	4	+	+	+	-	-	005	-	-	003	-	-	001	-	-	002	-	-	004	-	-	006	-	-	007
2271061-501	Motor Drive Bd.	4	+	+	+	D	C	002	D	C	003	C	B	004	D	C	005	D	C	006	D	C	007	D	C	008
2271061-503	Motor Drive Bd.	*4	+	+	+	+	+	+	+	+	+	C	B	004	+	+	+	+	+	+	+	+	+	+	+	+
2271061-504	Motor Drive Bd.	4	+	+	+	D	C	002	D	C	003	D	C	004	D	C	005	D	C	006	D	C	007	D	C	009
2265824-501	Mast Ass'y	3	+	+	+	E	E	002	E	E	003	D	C	004	E	E	008	E	E	006	E	E	007	E	E	005
2260594-1	Mot. & Gearhead Ass'y	*5	+	+	+	+	+	+	+	+	+	B	+	NA	+	+	+	+	+	+	+	+	+	+	+	+
2260594-3	Mot. & Gearhead "	5	+	+	+	B	+	025-2	B	+	036-1	+	+	+	B	+	028-3	B	+	015-10	B	+	023-7	B	+	011-9

Size A | Code Ident No. 49671 | 1972482

Sheet 3

AED 772

Indentured
Serial Number List

RCA | Government and Commercial Systems
Astro Electronics Division | Princeton, New Jersey

RCA

Date of Issue 11/21/72

Part Number	Description	Assy Level	S/N 001 EMC Rev Dwg	S/N 001 EMC Rev PL	S/N 001 EMC S/N	S/N 002 Q1 Rev Dwg	S/N 002 Q1 Rev PL	S/N 002 Q1 S/N	S/N 003 Q2 Rev Dwg	S/N 003 Q2 Rev PL	S/N 003 Q2 S/N	S/N 004 F1 Rev Dwg	S/N 004 F1 Rev PL	S/N 004 F1 S/N	S/N 005 F2 Rev Dwg	S/N 005 F2 Rev PL	S/N 005 F2 S/N	S/N 006 F3 Rev Dwg	S/N 006 F3 Rev PL	S/N 006 F3 S/N	S/N 007 F4 Rev Dwg	S/N 007 F4 Rev PL	S/N 007 F4 S/N	S/N 008 F5 Rev Dwg	S/N 008 F5 Rev PL	S/N 008 F5 S/N
2265834-501	Elev. Drive Ass'y	*3	+	+	+	+	+	+	+	+	+	C	C	004	+	+	+	+	+	+	+	+	+	+	+	+
2260594-1	Mot & Gearhead Ass'y	*4	+	+	+	+	+	+	+	+	+	+	+	NA	+	+	+	+	+	+	+	+	+	+	+	+
2271530-501	Elev. Drive Ass'y	3	+	+	+	B	A	002	B	A	003	+	+	+	B	A	005	B	A	006	B	A	007	B	A	008
2260594-4	Mot & Gearhead Ass'y	4	+	-	+	B	+	001-1	B	+	008-10	+	+	+	B	+	005-6	B	+	009-3	B	+	007-8	B	+	003-2
2265840-501	CTV	*2	+	+	+	+	+	+	+	+	+	E	D	004	+	+	+	+	+	+	+	+	+	+	+	+
2265840-502	CTV	2	+	+	+	H	G	002	K	G	003	+	+	+	K	H	005	N	L	006	L	J	007	N	L	008
2260510-1	H.V. Power Supply	3	+	+	+	D	+	010	D	+	012	D	+	004	D	+	015	E	+	016	D	+	017	E	+	021
2260594-2	Motor, Gearhead	4	+	+	+	B	+	035-3	B	+	033-4	-	+	002-17	B	+	003-18	B	+	019-12	B	+	013-8	B	+	016-14
2260594-2	Motor, Gearhead	4	+	+	+	B	+	031-6	B	+	017-13	B	+	007-16	B	+	005-1	B	+	010-9	B	+	041-10	B	+	022-15
1978745-1	Lens, Modified	5	+	+	+	A	+	NA	A	+	NA	A	+	1251346	A	+	1291868	A	+	1291131	A	+	1291202	A	+	1291054
2262450-501	Mot Damp. Net. Ass'y	3	+	+	+	C	C	0024	C	C	003	C	C	005	C	C	004	C	C	007	C	C	008	C	C	006
2263224-501	Conn. Block Ass'y	3	+	+	+	F	D	002	F	D	003	F	D	005	F	D	004	F	D	006	F	D	007	F	D	008
1974835-501	Diode Bd Ass'y	4	+	+	+	B	B	002	B	B	003	B	B	004	B	B	005	B	B	006	B	B	007	B	B	008
2264701-501	Handle Ass'y	3	+	+	+	B	A	002	B	A	003	B	A	004	B	A	005	B	A	006	B	A	007	B	A	008
2264779-501	Filter Wheel Dr Ass'y	3	+	+	+	-	-	003	-	-	002	-	-	004	A	A	005	A	A	006	A	A	007	A	A	008
1971381-1	Motor	4	+	+	+	C	+	71-2-19	C	+	71-2-18	C	+	71-3-26	C	+	71-3-21	C	+	71-3-27	C	+	70-12-16	C	+	71-3-25
2264292-501	Mod, Color Flag Det.	4	+	+	+	A	C	002	A	C	003	A	C	004	B	D	011	B	D	014	B	D	012	B	D	013
2264795-501	Vidicon Yoke Ass'y	3	+	+	+	D	A	002	D	A	003	D	A	004	D	A	005	B/	A/	/008	D	A	007	B/	A	008
2260102-1	Vidicon	4	+	+	+	D	-	264-15	D	-	161	C	-	165	D	-	202	D/	/	/384	D	-	594AF5	D/	/	643-[illegible]
2264795-502	Vidicon Yoke Ass'y	3	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	E	B	006	+	+	+	+	+	+
2260102-2	Vidicon	4	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	E	-	694-F6	+	+	+	+	+	+
2264795-503	Vidicon Yoke Ass'y	3	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	E	B	008
2260102-3	Vidicon	4	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	E	-	643-F5
2265833-501	Mod-Electrode Div.	4	+	+	+	A	A	002	A	A	003	A	A	004	A	A	005	A	A	113	A	A	007	A	A	008
2265815-501	Sync Gen Ass'y	3	+	+	+	B	E	002	B	E	003	B	E	004	B	E	005	B	E	007	B	E	008	B	E	006
2265817-501	Video Ass'y	*3	+	+	+	+	+	+	+	+	+	H	H	004	+	+	+	+	+	+	+	+	+	+	+	+
2265817-503	Video Ass'y	3	+	+	+	J	J	002	J	J	003	+	+	+	J	J	005	J	J	006	J	J	007	J	J	008
2265828-501	Current Reg Ass'y	3	+	+	+	D	D	002	D	D	003	D	D	004	D	D	005	D	D	006	D	D	007	D	D	008
2265829-501	Motor Drive Ass'y	3	+	+	+	C	D	002	C	D	003	C	D	004	C	D	005	C	D	007	C	D	006	C	D	008

\- = No Revision
* = Equipment Unique to S/N 004, F1
NA = Information Not Available
\+ = Not Applicable

AED 1403 4 72

Size	Code Ident No.	
A	49671	1972482
		Sheet 4

Indentured
Serial Number List

RCA | Government and Commercial Systems
Astro Electronics Division | Princeton, New Jersey

RCA

Date of Issue 8/21/72

Part Number	Description	Ass'y Level	EMC S/N 001 Rev Dwg	EMC S/N 001 Rev PL	EMC S/N	Q1 S/N 002 Rev Dwg	Q1 S/N 002 Rev PL	Q1 S/N	Q2 S/N 003 Rev Dwg	Q2 S/N 003 Rev PL	Q2 S/N	F1 S/N 004 Rev Dwg	F1 S/N 004 Rev PL	F1 S/N
2265830-501	Pwr Supply Reg Ass'y	3	+	+	+	G	K	003	G	K	002	G	K	004
2265831-501	Pwr Supply, DC Conv.	3	+	+	+	E	D	002	E	D	003	E	D	004
2265832-501	Vert & Horiz Defl Assy	3	+	+	+	J	J	002	J	J	003	J	J	004
2270011-501	Pre-Amp Ass'y	3	+	+	+	E	E	002	E	E	003	E	E	005
2271057-501	ALC Comp Bd	3	+	+	+	J	H	002	J	H	003	H	H	004
2270066-501	Cable Ass'y (100-ft)	2	+	+	+	D	A	002	D	A	001	D	A	003

Part Number	F2 S/N 005 Rev Dwg	F2 S/N 005 Rev PL	F2 S/N	F3 S/N 006 Rev Dwg	F3 S/N 006 Rev PL	F3 S/N	F4 S/N 007 Rev Dwg	F4 S/N 007 Rev PL	F4 S/N	F5 S/N 008 Rev Dwg	F5 S/N 008 Rev PL	F5 S/N
2265830-501	G	K	005	G	K	006	G	K	007	G	K	008
2265831-501	E	D	005	E	D	006	E	D	008	E	D	009
2265832-501	J	J	005	J	J	006	J	J	007	J	J	008
2270011-501	E	E	004	E	E	008	E	E	007	E	E	006
2271057-501	J	H	005	J	H	006	J	H	007	J	H	008
2270066-501	D	A	006	D	A	005	D	A	007	D	A	NA

- – No Revision
* – Equipment Unique to S/N 004, F1
NA – Information Not Available
+ – Not Applicable

AED 1403 4/72

CONFIGURATION DIFFERENCES ON GCTA

NOTES:

		Part No.	Incorp. Rev. Dwg	Incorp. Rev. PL
1.	Q1(S/N002) Differences	2265826-502	D	D
	a. Digital Decoder Bd., Not Changed	2265613-501	D	D
	b. CTV, Partially Changed	2265840-502	H	G
	c. Filter Wheel Drive Ass'y.	2264779-501	-	-
	d. Mod. Color Flag Det.	2264293-501	A	C
	e. Thermal Control Blanket (Velcro) Not Changed	2271424-505	-	-
	f. Shaft, Not Changed	1974845-1	D	+
	g. H.V. Pwr. Supply, Not Changed	2260510-1	D	+
	h. Changed Strap Handle	2269344-502	A	A
2.	Q2(S/N003) Differences	2265826-502	D	D
	a. CTV, Partially Changed	2265840-502	K	G
	b. Filter Wheel Dr. Ass'y.	2264779-501	-	-
	c. Mod. Color Flag Det.	2264293-501	A	C
	d. Thermal Control Blanket (Velcro) Not Changed	2271424-505	-	-
	e. Shaft, Not Changed	1974845-1	D	+
	f. H.V. Pwr. Supply, Not Changed	2260510-1	D	+
	g. Changed Strap Handle	2269344-502	A	A
3.	F1(S/N004) Differences	2265826-501	A	C
	a. Cable Ass'y.	2268104-501	-	-

CONFIGURATION DIFFERENCES ON GCTA (Continued)

		Part No.	Incorp. Rev. Dwg	PL
b.	TCU	2265825-501	J	G
c.	Comb. Bd. - Motor Damping	2262457-501	B	B
d.	Azimuth Drive Ass'y.	2264290-501	C	C
e.	Motor Gearhead Ass'y.	2260194-102	A	+
f.	Elect. Encl. Ass'y.	2265823-501	H	E
g.	Mod. - DC/DC Conv.	2265606-501	H	K
h.	Motor Drive Bd.	2271061-503	C	B
i.	Motor & Gearhead Ass'y.	2260594-1	B	+
j.	Elevation Drive Ass'y.	2265834-501	C	C
k.	Motor & Gearhead Ass'y.	2260594-1	-	+
l.	CTV	2265840-501	E	D
m.	Filter Wheel Dr. Ass'y.	2264779-501	-	-
n.	Mod. Color Flag. Det.	2264293-501	A	C
o.	Vidicon	2260102-1	C	+
p.	Video Ass'y.	2265817-501	H	H
q.	ALC Comp. Bd.	2271057-501	H	H
r.	Shaft, Not Changed	1974845-1	D	+
s.	H.V. Pwr. Supply, Not Changed	2260510-1	D	+

CONFIGURATION DIFFERENCES ON GCTA (Continued)

	Part No.	Incorp. Rev. Dwg	Incorp. Rev. PL
4. F2(S/N005) Differences	2265826-502	D	D
a. Shaft, Not Changed	1974845-1	D	-
b. H.V. Power Supply, Not Changed	2260510-1	D	-
5. F3(S/N006) Differences	2265826-502	D	D
a. All changes are Cut-In			
b. H.V. Power Supply, Changed	2260510-1	E	-
c. Color Camera Ass'y, Changed	2265840-502	N	L
d. Spacer, Incorporated	2268311-1	-	-
e. Revised Thermal Blankets	2271424-508, 509	B	A
f. Revised Vidicon Yoke Ass'y	2264795-502	E	B
g. Vidicon	2260102-2	E	-
h. Revised Lens Actuator Ass'y	2262410-502	D	C
i. Changed Bracket-Adapter	1974442-2	D	+
j. Changed Bracket	2262910-2	C	-
k. Revised to New Retainer Lens	2275192-1	A	+
l. Changed Switch Bracket	1974484-2	C	+
m. Added New Spacer Gear Housing	2269681-2	B	+
n. Changed Strap Handle	2269344-502	A	A
o. Added Kit-Assy Spring Damper	2275697-501	-	-
6. F4 (S/N007) Differences	2265826-502	D	D
a. H.V. Power Supply, Not Changed	2260510-1	D	+
b. Color Camera Assy, Changed	2265840-502	L	J
c. Spacer, Not Incorporated	2268311-1	+	-
d. Revised Thermal Blankets	2271424-508 -509	B	A
e. Changed Strap Handle	2269344-502	A	A
f. Added Kit Assy Spring Damper	2275697-501	-	-

	Part No.	Incorp. Rev. Dwg	PL
7. F5(S/N008) Differences	2265826-502	D	D
a. All Changes are Cut-In			
b. H.V. Power Supply, Changed	2260510-1	E	+
c. Color Camera Ass'y, Changed	2265840-502	N	L
d. Spacer, Incorporated	2268311-1	-	+
e. Revised Thermal Blankets	2271424-508 509	B	A
f. Revised Vidicon Yoke Ass'y	2265795-503	E	B
g. Vidicon	2260102-3	E	-
h. Revised Lens Actuator Ass'y	2262410-502	D	C
i. Changed Bracket Adapter	1974442-2	D	+
j. Changed Bracket	2262910-2	C	+
k. Revised to New Retainer Lens	2275192-1	A	+
l. Changed Switch Bracket	1974484-2	C	+
m. Added New Spacer Gear Housing	2269681-1	B	+
n. Added New Spacer Gear Housing	2269681-2	B	+
o. Changed Strap Handle	2269344-502	A	A
p. Added Kit Assy, Spring Damper	2275697-501	-	-

SECTION VI

DRAWING STATUS

Updated drawings generated since July 31, 1972 have been forwarded to NASA/MSC to reflect product improvement changes in GCTA equipment. The following Contract Class I and Class II changes have been submitted:

Class I Changes

Drawing No.	Rev.	Remarks
1972482*	F	Changes will delineate new strap handle, kit assembly, and S/N changes for elevation drive and motor gearhead assembly, resulting from F.I.A. Report No. P-RC-0043, approved by TWX No. 5106852652 dated 11-20-72.
2265825*	M	
PL-2265825*	K	
PD-2265826*	H	
2269344*	A	
PL-2269344*	A	

Class II Changes

Drawing No.	Rev.	Remarks
1972482*	C, D	Changes will provide clearance under worst case dimension conditions and clearance for IRIS/ZOOM knobs.
1974442*	D	↓
1974487*	B	↓
2262410*	D	↓
PL-2262410*	D	↓
2262910*	C	↓
2265840*	N	↓
PL-2265840*	L	↓
PD-2265840*	J, K	Dimensional change will allow rear lens flange to fully seat in lens retainer.
2269681*	A	
2275192*	A	

*Multiple ECN

Class II Changes (continued)

Drawing No.	Rev.	Remarks
TP-2265825*	A	Make minor corrections, revise temperature time profile and limits. This will now conform to the requirements of Qualification/Acceptance Test Procedure, TP-OP-2265826.
TP-ET-2265826*	E	
TP-2265840*	B	
1972482	E	Interchange S/N callout of elevation drive and motor gearhead assembly for F-3 and F-5.
1974878	B	Correct number of teeth callout for gear
2268311	A	Correct dimension of hole location
2275697	A	Add, in lbs. to notes 3, 4 and 5.

*Multiple ECN

APPENDIX A

16mm SIT QUALIFICATION TEST PROCEDURE

Revision 1

APOLLO PROJECT

P.O. No. IDT GX-1F5210-0665-F37

Qualification Test Procedure

for

16mm Silicon Intensifier Target Tube, Type C21129B

Manufacturer - RCA Corporation
Industrial Tube Division

August 3, 1972

Supersedes: October 9, 1970

Table of Tests

Test	Test Name
2.1	Sinusoidal Vibration
2.2	Random Vibration
2.3	Acceleration
2.4	Shock
2.5	Temperature Cycling

List of Test Equipment

Test Equipment	Characteristics Required
1. Vibration Exciter	Ling (3500# or 2000# system)
2. Random Motion Console #892090	MB Model T 388
3. Rotary Accelerator #892083	Schaevitz Model B-10-D
4. Medium Impact Shock Machine	Barry Control Model 16805
5. Temperature Chamber	Am. RSCH. Corp. 5036-100400
6. Special Holding Fixture	Model 1191

Test Procedures

1. General - Unless otherwise specified, all tests shall be performed on a potted tube assembly under the conditions listed below. Upon completion of the qualification test program, the tube assembly shall meet the optical and electrical performance requirements of part 1 Acceptance Test Procedure for Center Resolution, Dark Current, Grid 1 cutoff voltage and alignment field current.

1.1 No voltages are applied to the tube assembly as the tests are non-operative.

1.2 Axes orientation according to Figure 1.

2. Qualification tests.

2.1 Sinusoidal Vibration

a) Requirement - The tube assembly shall withstand sinusoidal vibration in X, Y, and Z axes.

b) Conditions - The tube assembly, non-operating, will be suitably clamped in a special holding fixture such that the assembly Z axis will be either horizontal or with the faceplate up. Vibration shall be at a peak displacement amplitude of 0.25 inch or 6.0 g peak (whichever gives less acceleration) from 5 to 100 to 5 Hz at a rate of two octaves per minute.

c) Measurement - See General, Section 1.

2.2 Random Vibration

a) Requirement - The tube assembly shall withstand random vibration in the X, Y, and Z axes.

b) Conditions - The tube assembly, non-operating, will be suitably clamped in a special holding fixture such that the assembly Z axis will be either horizontal or with the faceplate up. Vibration in the range of 20 to 2000 Hz for a duration of two minutes per axis and with a flat spectrum at 0.01 g^2/Hz in the Z axis, at 0.10 g^2/Hz from 20-1300 Hz with -12 db/oct rolloff from 1300 to 2000 in the Y axis, and at 0.03 g^2/Hz 20-100 with increase to 150 Hz and at 0.10 g^2/Hz 150-250 with decrease to 400 Hz and 0.03 g^2/Hz 400-650 with -12db/oct rolloff 650-2000 in X axis.

c) Measurement - See General, Section 1.

2.3 Acceleration

a) Requirement - The tube assembly shall be capable of withstanding 20g of acceleration in each axis.

b) Conditions - The tube assembly, non-operating, will be suitably clamped in a special holding fixture. Acceleration level will be essentially uniform throughout the assembly and for the Z axis will be in the negative direction only. After obtaining 20g, the level will be maintained for three minutes. One run will be made in each axis.

c) Measurement - See General, Section 1.

2.4 Shock

a) Requirement - The tube assembly shall be capable of withstanding three shocks of 20 ± 2g for 11 ± 2.2 milliseconds (half-sine pulses) in each direction of the three mutually perpendicular axes for a total of 18 shocks.

b) Conditions - The tube assembly, non-operating, will be suitably clamped in a special holding fixture.

c) Measurement - See General, Section 1.

2.5 Temperature Cycling

a) Requirement - The tube assembly shall withstand high and low temperature cycling with the upper temperature of +65°C and the lower temperature of -15°C.

b) Conditions - The tube assembly, non-operating, will be maintained at -15°C for at least five minutes. The temperature will then be increased to +65°C in less than 100 minutes and the assembly will be maintained at +65°C for at least five minutes before returning to room temperature. Cycling will be conducted between -15°C and +65°C for a minimum of five cycles.

c) Measurement - See General, Section 1.

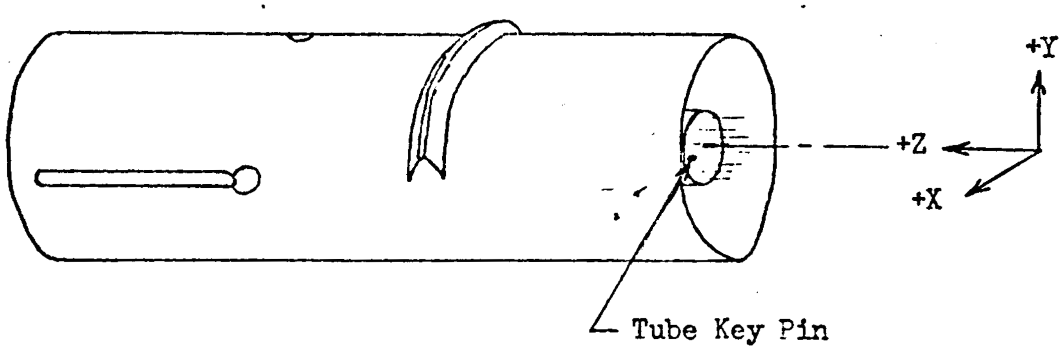


Figure 1. Axis Orientation