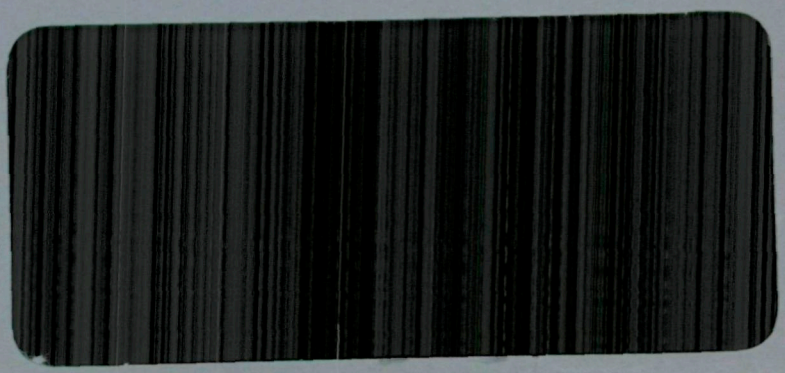


PERKIN-ELMER

PERKIN-ELMER

ELECTRO-OPTICAL DIVISION
NORWALK, CONNECTICUT

REPORT NO. 12507

SYSTEM TEST REPORT - LST SECONDARY MIRROR ARTICULATION MECHANISM

P/N 660 - 0417

PREPARED FOR

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, MARSHALL SPACE FLIGHT CENTER, HUNTSVILLE, ALABAMA

Contract No. NAS 8-29723

DATE: May 10, 1975

Prepared By: W E Kohman
W. E. Kohman

Approved By: D J McCarthy
D. J. McCarthy

REF:

SYSTEM TEST REPORT - LST SECONDARY MIRROR ARTICULATION SYSTEM

1.0 INTRODUCTION

This report documents work performed under Contract NAS 8-29723 Modification No. 2. The activity relates to LST Secondary Mirror Actuation System 660-0267. The system was modified as defined by 660-0417 and re-tested.

2.0 SUMMARY

The modifications performed to convert the system to the 660-0417 configuration are listed as follows:

2.1 Reduce the dummy mirror size to 40cm diameter. The mass corresponds to the LST secondary mirror.

2.2 Remove the two degree of freedom alignment drive mechanism.

2.3 Assemble the modified mirror mass, mirror support flexure, piezoceramic actuators, and position transducers to a simple circular plate so as to provide only the image motion compensation function.

2.4 Perform a simple test series to assure operation comparable to that achieved with the original larger sized assembly.

3.0 DESCRIPTION OF SYSTEM MODIFICATION

Details of the modification are shown on drawing 660-0417. The calculated weight and inertia relationships are as follows.

	LST Secondary Mirror	Mass Simulator
Clear Aperture	38.5cm	-
Diameter	40.0cm	40cm
Weight	23.1 lb.	22.6 lb.
Inertia	.961 in-lb-sec^2	.924 in-lb-sec^2

4.0 SYSTEM TEST

The system was tested in accordance with selected sections of Test Procedure ER 11783. The position sensors were re-calibrated and the actuator voltage to position gain was determined for each axis. The frequency response and threshold were determined for each axis. Data sheets, calculations and plotted data are attached.

GENERAL DATA SHEET - II

33117			SHEET 1 OF 5
AZ. AXIS READOUT INDICATOR CALIBRATION	SPEC: ER-11783	PAPA:	TEST NO:
LST ITEM: LST SECONDARY MIRROR (MODIFIED 660-0417)			DATE: 4 APRIL 75
CLIENT: MSFC	CLIENT REPRESENTATIVE:		TEMP: LAB. RH.
T EQUIPMENT:	MODEL NO:		TESTED BY:
TRUMENTATION:			ENGR. CHECK: PEC 162 4/8/75
			SUPV. CHECK:

TEST #1

PBT VOLTS	MIRROR POSITION IN INCHES AZ.	EL.	MON. LEFT	MON. RIGHT
6.15	-28		0	0
202	+53		-89	+80
405	155		-175	190
600	350		-370	390
800	555		-550	600
1005	765		-785	825
805	700		-700	750
600	600		-600	635
390	460		-460	500
195	315		-325	350
6.1	140		-175	175

TEST #2

PBT VOLTS	MIRROR POSITION IN INCHES AZ.	EL.	MON LEFT	MON RIGHT	TIME IN SECONDS
5.9	-25		0	0	0
208	+72		-90	100	10
402	187		-200	225	20
601	330		-330	360	30
807	500		-480	540	40
1003	660		-630	690	50
804	575		-560	640	60
603	475		-450	530	70
404	350		-330	400	80
198	180		-160	230	90
6.0	30		-40	75	100

TCH OR NOTES:

GENERAL DATA SHEET - II

33117

SHEET 2 OF 5

EL, AXIS READOUT INDICATOR | SPEC: ER-11783 | PARA: | TEST NO:

ITEM: LST SECONDARY MIRROR (MODIFIED 660-0417) | DATE: 4 APRIL 75

NT: MSFC | CLIENT REPRESENTATIVE: | TEMP: LAB. RH.

EQUIPMENT: | MODEL NO: | TESTED BY:

UMENTATION: | ENGR. CHECK: PEC 162 4/8/75 | SUPV. CHECK: C. McClain

TEST #1

PET VOLTS	MIRROR POSITION IN INCHES AZ	EL	MON. TOP	MON. BOTTOM	TIME IN SECONDS
6.18		-60	0	0	10
205		+53	-100	+110	20
395		210	-260	260	30
600		390	-425	410	40
803		570	-600	575	50
1000		740	-775	725	60
800		650	-675	650	70
580		525	-550	540	80
400		380	-410	410	90
200		210	-250	260	100
6.18		40	-75	110	110

TEST #2

PET VOLTS	MIRROR POSITION IN INCHES AZ	EL.	MON TOP	MON BOTTOM	TIME IN SECONDS
6.18		-20	0	0	10
200		+95	+105	-105	20
405		237	275	-245	30
602		410	380	-400	40
799		580	540	-570	50
1009		750	685	-740	60
795		660	610	-650	70
605		545	500	-550	80
397		355	370	-370	90
200		215	225	-250	100
6.1		43	70	-35	110

CH OR NOTES:

GENERAL DATA SHEET - II

O: 33117			SHEET 3 OF 5
ST: FREQUENCY RESPONSE	SPEC:	PARA: 4.2.2.2	TEST NO:
ST ITEM: LST SECONDARY MIRROR (MODIFIED. 660-0417)			DATE: 4 APRIL 75
IENT: MSFC	CLIENT REPRESENTATIVE:		TEMP: LAB. RH.
ST EQUIPMENT:	MODEL NO:		TESTED BY:
STRUMENTATION:			ENGR. CHECK: PEC 162 4/8/75
			SUPV. CHECK: C. McLellan

FREQ IN HZ	PZT VOLTS	ELEVATION IND. MILLIVOLTS	BIAS VOLTS	FREQ IN HZ.	PZT VOLTS	ELEVATION IND. MILLIVOLTS	BIAS VOLTS
1	± 200	400	300	140	± 200	250	300
2		480		150		375	
3		480		160		230	
4		465		170		380	
5		430		180		175	
6		435		190		200	
7		425		200		80	
8		425		220		80	
9		415		240		80	
10		410		PEAK @ 255		950	
20		280		260	± 200	80	300
30		275					
40		280					
50		290					
60		290					
70		280					
80		280					
90		270					
100		250					
110		235					
120		205					
130	± 200	300	300				

TCH OR NOTES:

GENERAL DATA SHEET - II

D: 33117			SHEET 4 OF 5
EST: FREQUENCY RESPONSE	SPEC:	PARA: 4.2.2.2	TEST NO:
TEST ITEM: LST SECONDARY MIRROR (MODIFIED 660-0417)			DATE: 4 APRIL 75
CLIENT: MSFC	CLIENT REPRESENTATIVE:		TEMP: LAB. RH.
TEST EQUIPMENT:	MODEL NO:		TESTED BY:
INSTRUMENTATION:			ENGR. CHECK: PEC 162 4/8/75
			SUPV. CHECK: C McZimmerman

	FREQ IN HZ	PZT VOLTS	AZIMUTH IND MILLI VOLTS	BIAS VOLTS			FREQ IN HZ	PZT VOLTS	AZIMUTH IND MILLI VOLTS	BIAS VOLTS		
	1	±200	285	300			140	±200	235	300		
	2	↓	355	↓			150	↓	235	↓		
	3		355				160		335			
	4		350				170		165			
	5		335				180		190			
	6		330				190		320			
	7		320				200		110			
	8		315				220		125			
	9		310				240	↓	125	↓		
	10		310				260	±200	410	300		
	20		235									
	30		225									
	40		235									
	50		250									
	60		250									
	70		250									
	80		250									
	90		245									
	100		245									
	110		225									
	120	↓	210	↓								
	130	±200	235	300								

SKETCH OR NOTES:

GENERAL DATA SHEET - II

D: 33117			SHEET 5 OF 5
ST: CROSS AXIS COUPLING	SPEC:	PARA: 4.4	TEST NO:
EST ITEM: LST SECONDARY MIRROR (MODIFIED 660-0417)			DATE: 4 APRIL 75
IENT: MSFC	CLIENT REPRESENTATIVE:		TEMP: LAB. RH.
ST EQUIPMENT:	MODEL NO:		TESTED BY: C. MC.
STRUMENTATION:			ENGR. CHECK: C. MC.
			SURV. CHECK: PEC 162 4/8/75.

AZIMUTH PZT VOLTS	BIAS VOLTS	AZIMUTH IND. READING	ELEVATION IND. READING	ELEVATION PZT VOLTS	BIAS VOLTS	ELEVATION IND READING	AZIMUTH IND READING
± 200	300	120×10^{-6} IN	$< .1\times10^{-6}$ IN	± 200	300	90×10^{-6} IN	0
± 300	400	150×10^{-6} IN	$< .2\times10^{-6}$ IN	± 400	500	170×10^{-6} IN	$< .1\times10^{-6}$ IN
THRESHOLD TEST							
100×10^{-3} P-P	205	since ragged	—	100×10^{-3} P-P	430	since ragged	—
50×10^{-3} P-P	205	threshold.		20×10^{-3}	430	threshold —	

KETCH OR NOTES:

BY W.E. Edmonds DATE 5/9/75 SUBJECT TEST PROCEDURE — SHEET NO. 1 OF 7

CHKD. BY ____ DATE ____ LST SECONDARY MIRROR — JOB NO. ____

ER 11783

I DETERMINE VOLTAGE/ANGLE GAIN-ELEVATION AXIS

1. MIRROR EL = $\frac{[+650 - (20)]\ \text{MIN}}{800\ \text{VOLTS}} = .7875 \times 10^{-6}\ \frac{\text{IN}}{\text{VOLT}}$

2. MIRROR AZ = 0

3. MONITOR BOTTOM = $\frac{[+600 - (0)]\ \text{MIN}}{800\ \text{VOLTS}} = .750 \times 10^{-6}\ \frac{\text{IN}}{\text{VOLT}}$

4. MONITOR TOP = $\frac{[+585 - (10)]\ \text{MIN}}{800} = .7187 \times 10^{-6}\ \frac{\text{IN}}{\text{VOLT}}$

5. AVERAGE MONITOR GAIN

$$\frac{(.750 + .7187)\ 10^{-6}\ \text{IN/VOLT}}{2} = .734 \times 10^{-6}\ \frac{\text{IN}}{\text{VOLT}}$$

MONITOR ACCURACY = $\frac{.750 - .734}{.734} = .0218$

$\pm$ 2.18 %.

6. SCALE FACTOR — MIRROR ELEVATION

S.F. = $\frac{.734}{.7875} = .932$

BY _____ DATE _____ SUBJECT _____ SHEET NO. _____ OF 7

CHKD. BY _____ DATE _____ JOB NO. _____

II 4.2.2.1 TOTAL ANGULAR RANGE

$$\text{RANGE} = \frac{770 \times 10^{-6}\ \text{IN.} \times .932}{7.76\ \text{IN}} = 9.248 \times 10^{-5}\ \frac{\text{RAD}}{1000\ \text{V.}}$$

$$\Theta = \frac{92.48 \times 10^{-6}\ \text{RAD}/1000\ \text{V}}{4.848 \times 10^{-6}\ \frac{\text{RAD}}{\text{SEC}}} = 19.076\ \frac{\text{SEC}}{1000\ \text{VOLT}}$$

$$\pm 9.54\ \text{SEC}$$

$$\text{GAIN} = .01908\ \frac{\text{SEC}}{\text{VOLT}}$$

III 4.2.2.2 FREQUENCY RESPONSE @ 4 HZ

$$db = 20 \log \frac{I_1}{I_0} = 20 \log \frac{465}{400}$$

$$= 20 \log 1.1625 = +1.308$$

FREQ Hz	PZT VOLTS	POSITION EC MILLIVOLT	ATTENUATION db
1	±200	400	0
2		480	+1.583
3		480	+1.583
4		465	+1.308
5		430	+0.628
6		435	+0.728
7		425	+0.526
8		425	+0.526
9		415	+0.319
10		410	+0.214
20		280	−3.098
40		280	−3.098
60		290	−2.793
80		280	−3.098
100		250	−4.082
120		205	−5.806
140		250	−4.082
160		230	−4.806
180		175	−7.180
200		80	−13.979
240		80	−13.979
255	PEAK	880	+6.848
260	↓	80	−13.979

IV 4.2.2.3 THRESHOLD

$$.020 \text{ VOLT} \times .01908 \frac{\text{SEC}}{\text{VOLT}} = 0.00038 \text{ SEC}$$

V DETERMINE VOLTAGE/ANGLE GAIN - AZIMUTH AXIS

1. MIRROR AZ = $\frac{(+655 - 85)\text{ MIN}}{800 \text{ VOLTS}} = 0.7125 \times 10^{-6} \frac{\text{IN}}{\text{VOLT}}$

2. MIRROR EL = 0

3. MONITOR RIGHT = $\frac{(+670 - 85)\text{ MIN}}{800 \text{ VOLT}} = 0.73125 \times 10^{-6} \frac{\text{IN}}{\text{VOLT}}$

4. MONITOR LEFT = $\frac{+640 - 85}{800 \text{ VOLT}} = 0.69375 \times 10^{-6} \frac{\text{IN}}{\text{VOLT}}$

5. AVERAGE MONITOR GAIN

$$\frac{(.6938 + .73125)}{2} 10^{-6} \text{IN/VOLT} = 0.7125 \times 10^{-6} \frac{\text{IN}}{\text{VOLT}}$$

$$\text{MONITOR ACCURACY} = \frac{.73125 - .7125}{.7125} = .0263$$

2.63 %

6. SCALE FACTOR - MIRROR AZIMUTH

$$SF = \frac{.7125}{.7125} = 1.0$$

VI 4.2.2.1 TOTAL ANGULAR RANGE

$$\frac{(793-85)10^{-6}\,IN \times 1.0}{7.76\,IN} = 9.1237 \times 10^{-5} \frac{RAD}{1000\,V}$$

$$\Theta = \frac{91.237 \times 10^{-6}\ RAD/1000\,V}{4.848 \times 10^{-6} \frac{RAD}{SEC}} = 18.819 \frac{SEC}{1000\ VOLT}$$

$$\pm 9.409\ SEC.$$

$$GAIN = 0.0188 \frac{SEC}{VOLT}$$

VII 4.2.2.2 FREQUENCY RESPONSE @ 4 Hz

$$db = 20 \log \frac{I_1}{I_2} = 20 \log \frac{350}{285} = +1.784$$

FREQ Hz	PZT VOLTS	POSITION A2 MILLIVOLT	ATTENUATION db
1	±200	285	0
2		355	+1.908
3		355	+1.908
4		350	+1.784
5		335	+1.404
6		330	+1.273
7		320	+1.006
8		315	+.869
9		310	+.730
10		310	+.730
20		235	-1.675
40		235	-1.675
60		250	-1.138
80		250	-1.138
100		245	-1.313
120		210	-2.653
140		235	-1.675
160		335	+1.404
180		190	-3.522
190		320	+1.006
200		110	-8.269
220		125	-7.158
240		125	-7.158
260		410	+3.158

BY _____ DATE _____ SUBJECT _____ SHEET NO. 7 OF 7

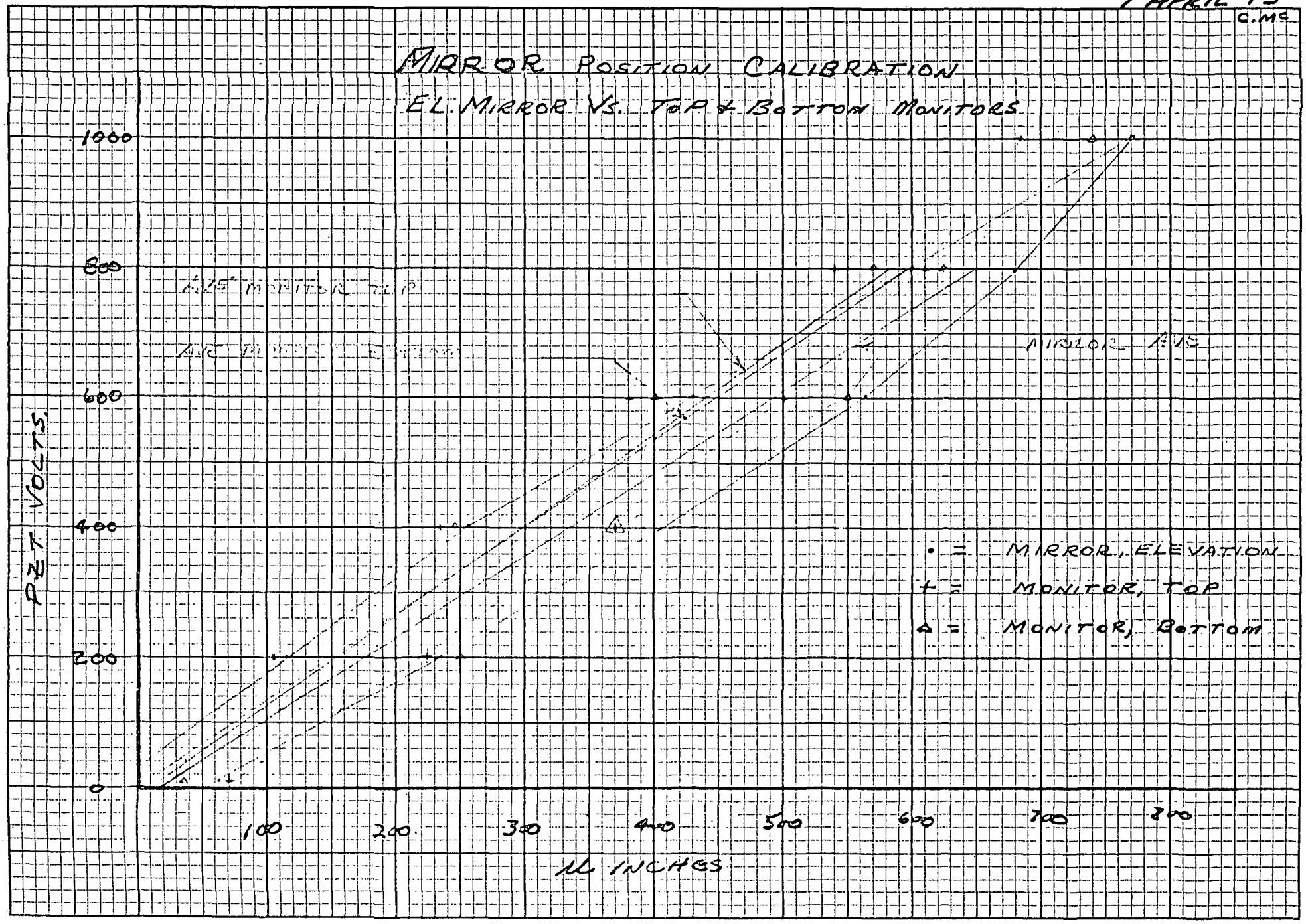
CHKD. BY _____ DATE _____ JOB NO. _____

VIII 4.2.2.3 THRESHOLD

$$.050 \text{ VOLT} \times 0.0188 \frac{\text{SEC}}{\text{VOLT}} = 0.00094 \text{ SEC}$$

7 APRIL 75
C.Mc

MIRROR POSITION CALIBRATION
EL. MIRROR VS. TOP & BOTTOM MONITORS

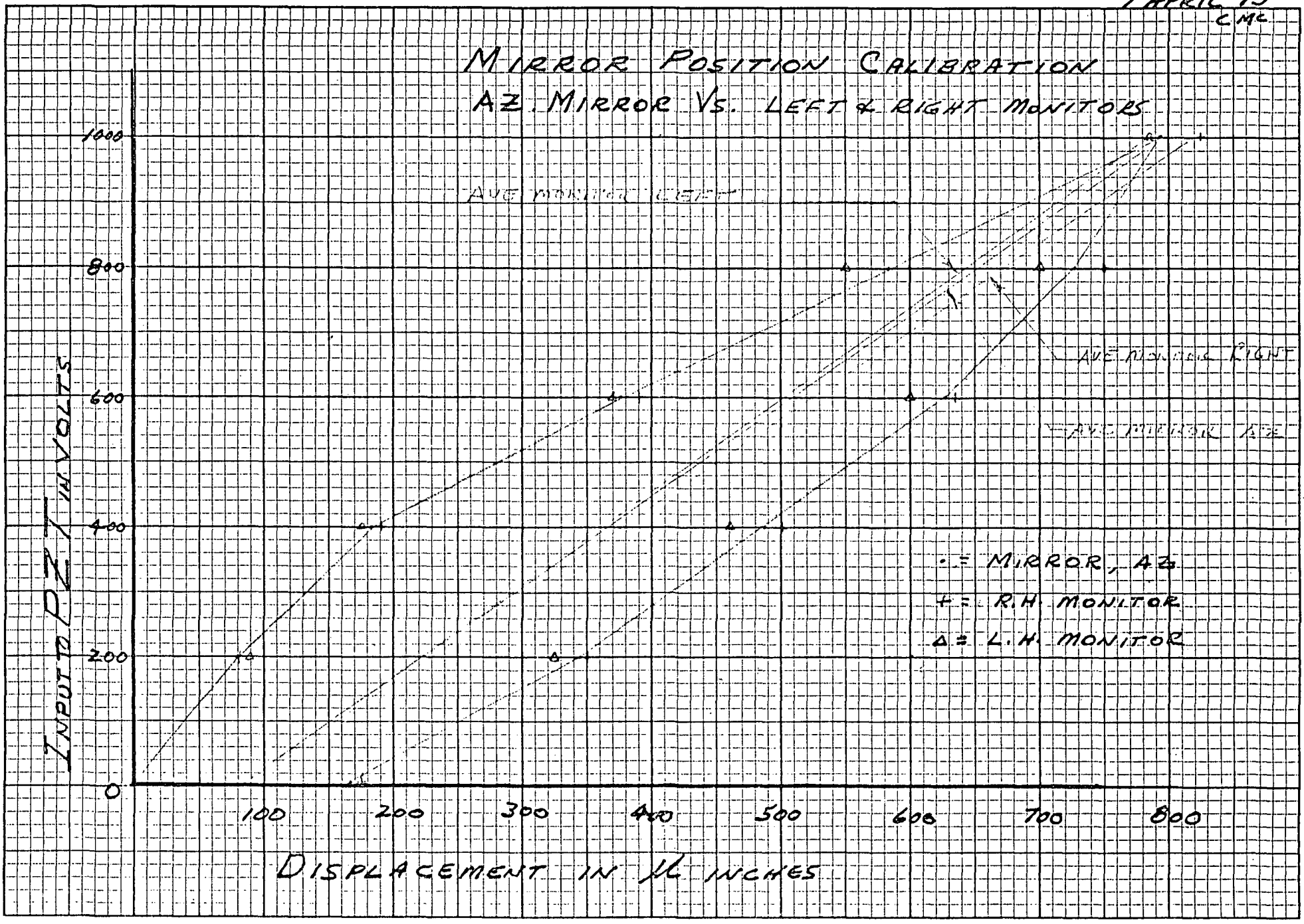


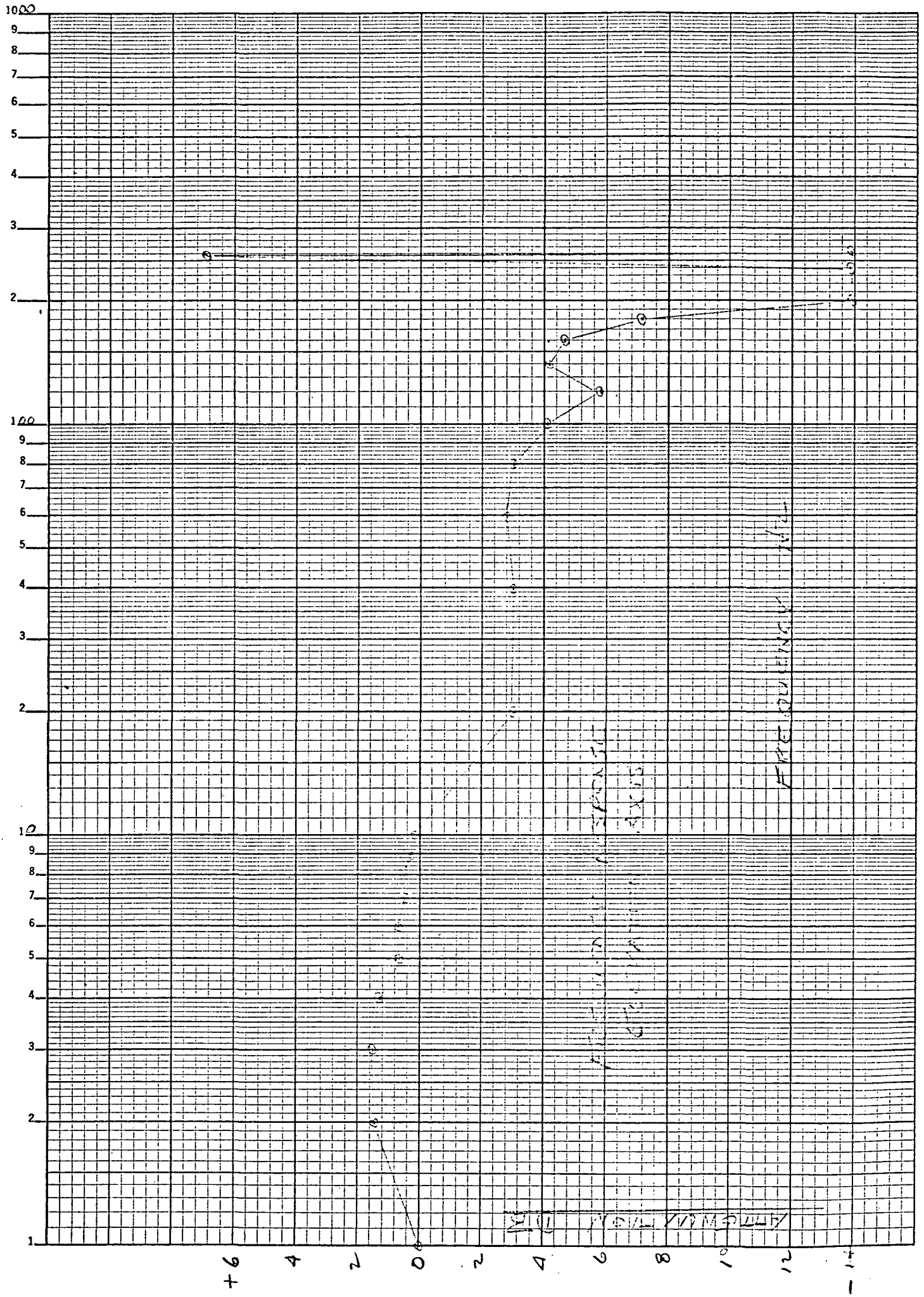
7 APRIL 75

CMC

MIRROR POSITION CALIBRATION

AZ. MIRROR VS. LEFT & RIGHT MONITORS

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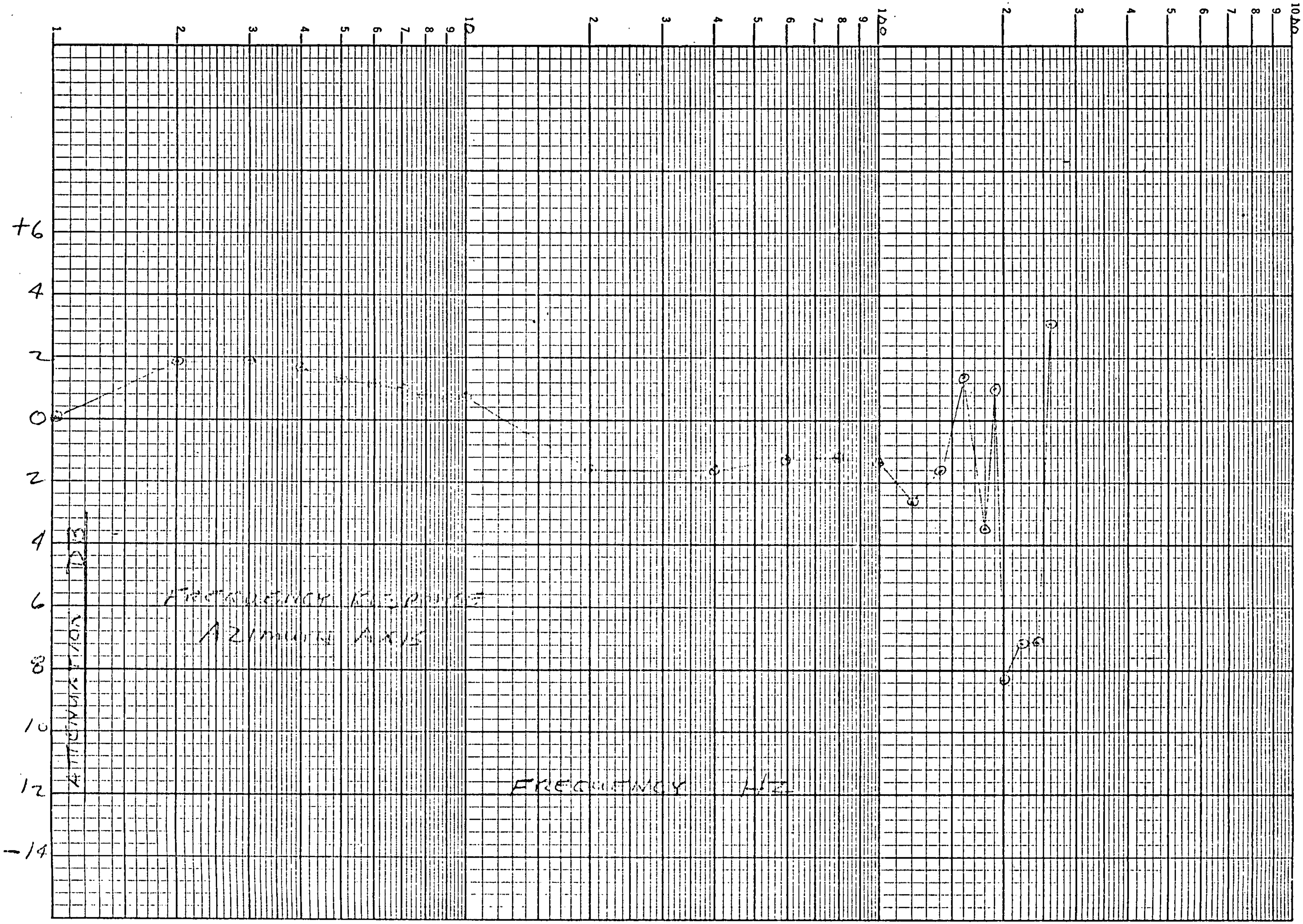
14

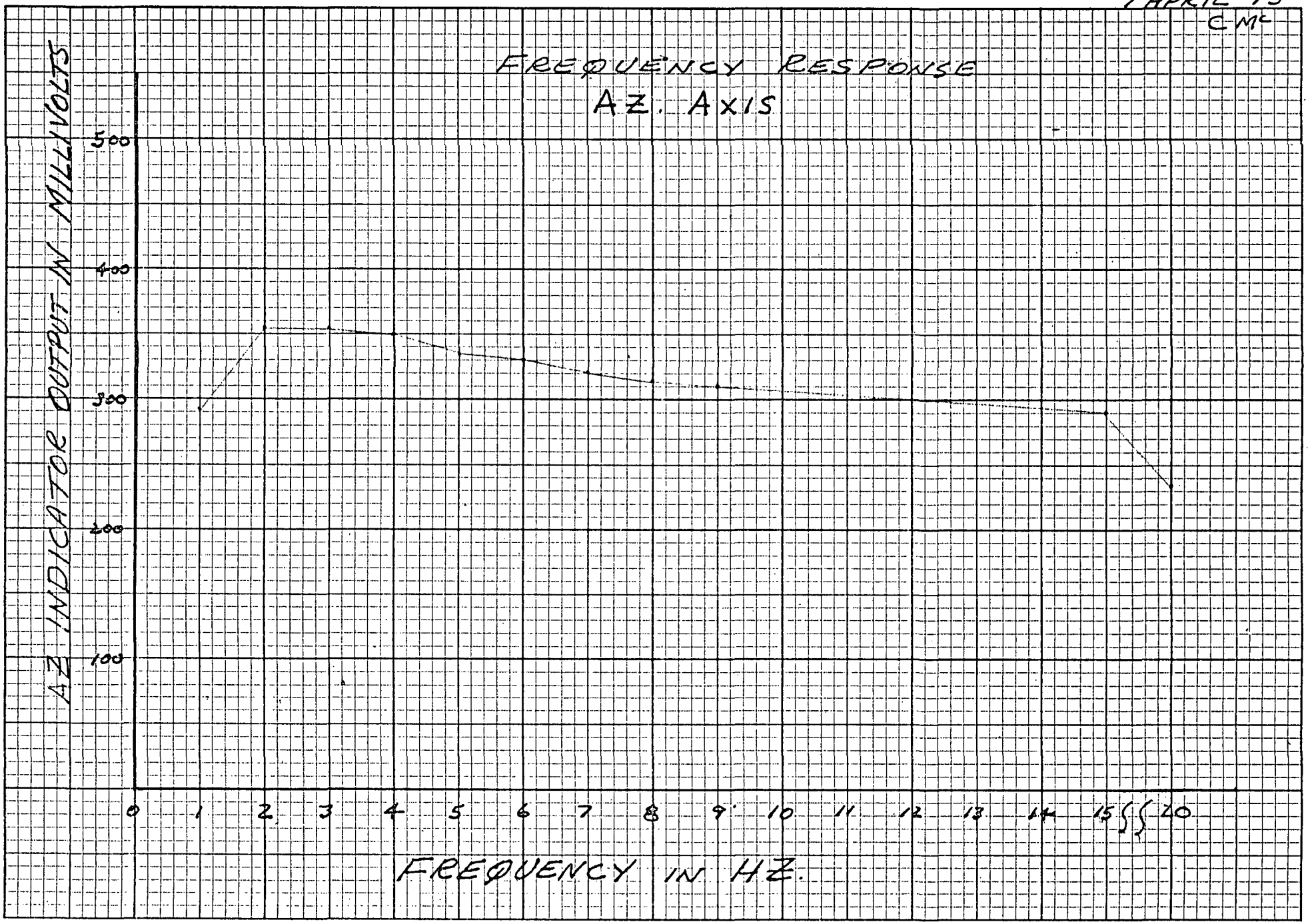


7 APRIL 75

C Mc

FREQUENCY RESPONSE

AZ. AXIS



7 APRIL 75

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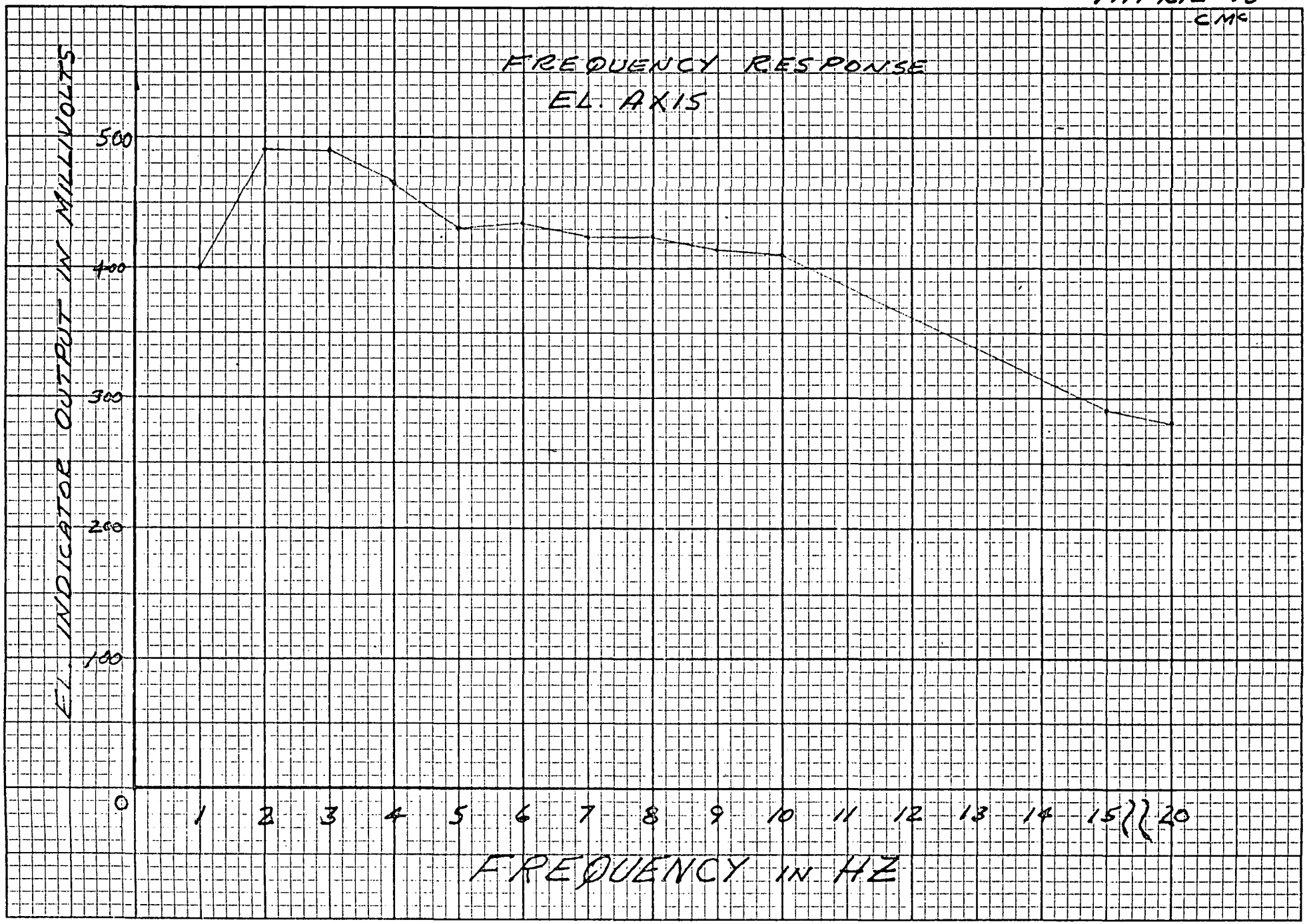
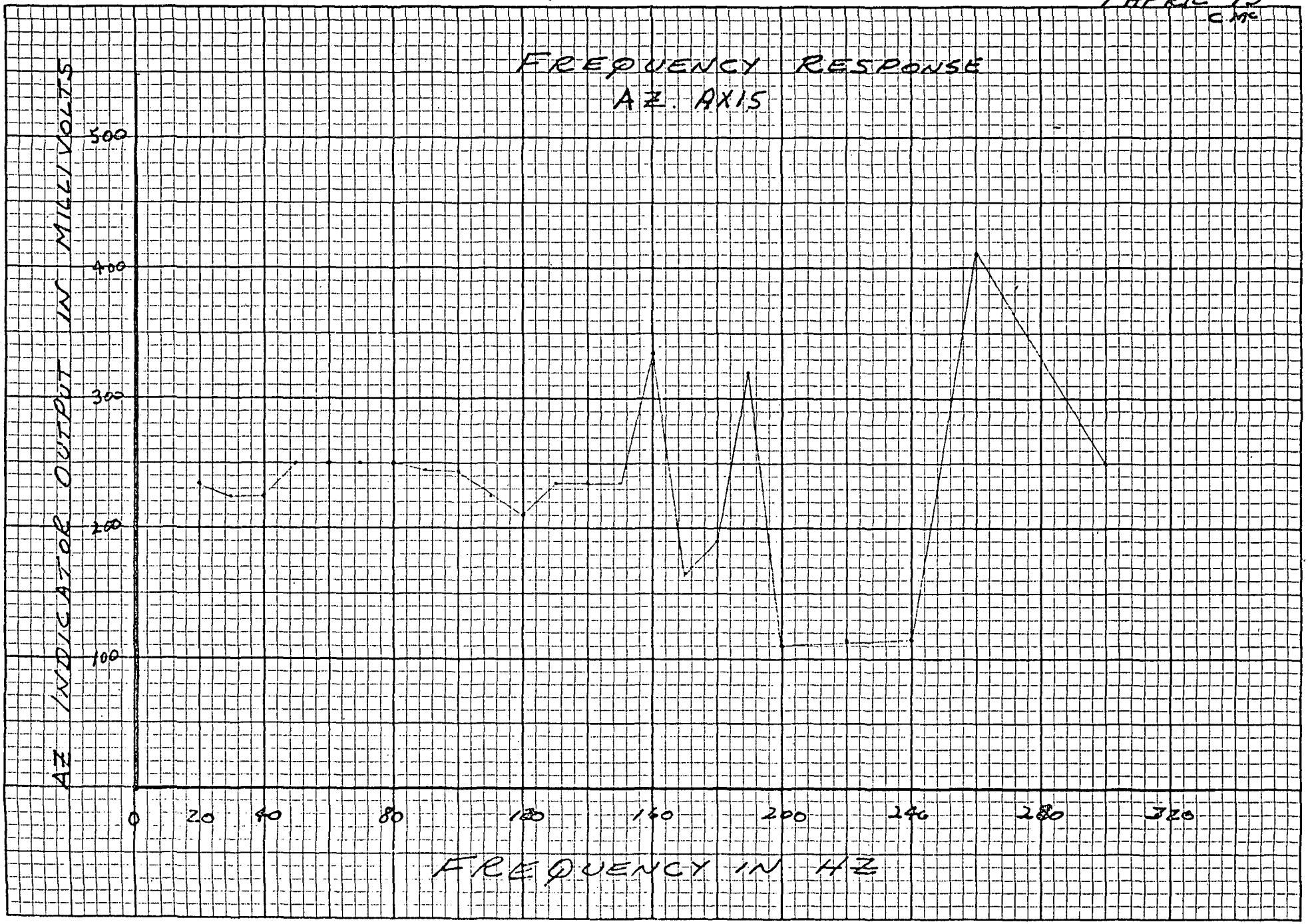
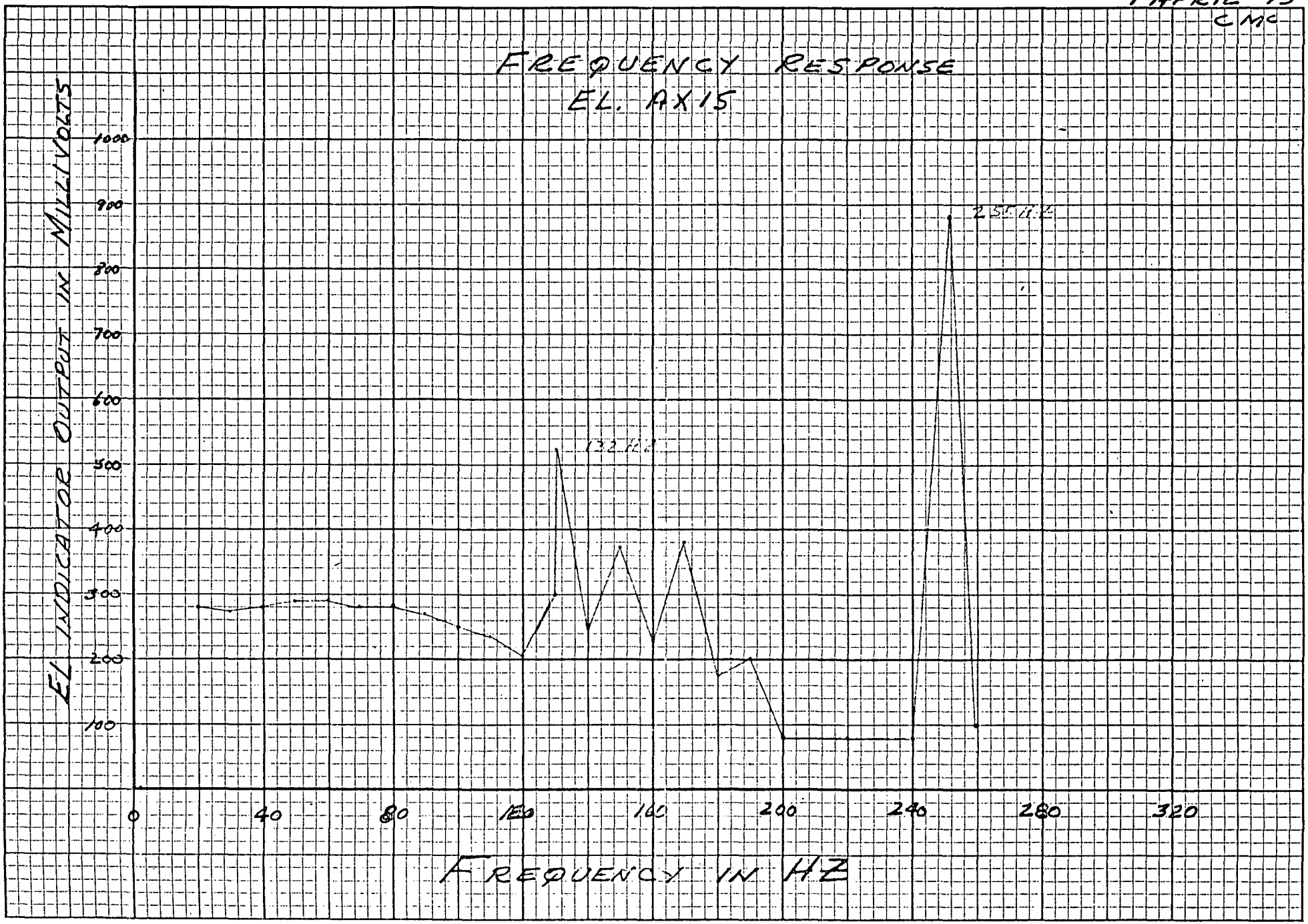


7 APRIL 75

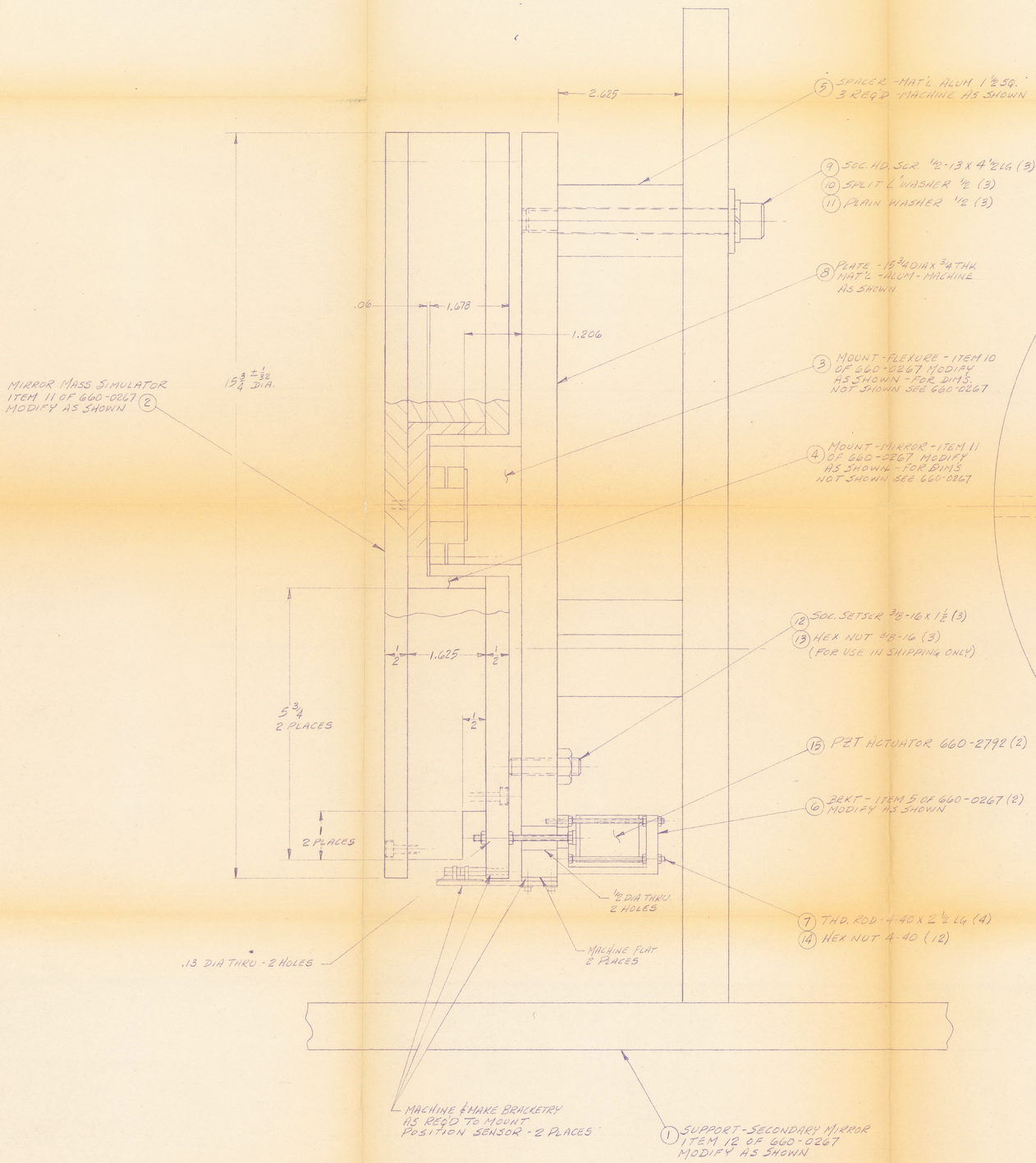

FREQUENCY RESPONSE
AZ. AXIS
AZ INDICATOR OUTPUT IN MILLIVOLTS
500
400
300
200
100
0
20
40
80
180
140
200
240
280
320
FREQUENCY IN HZ

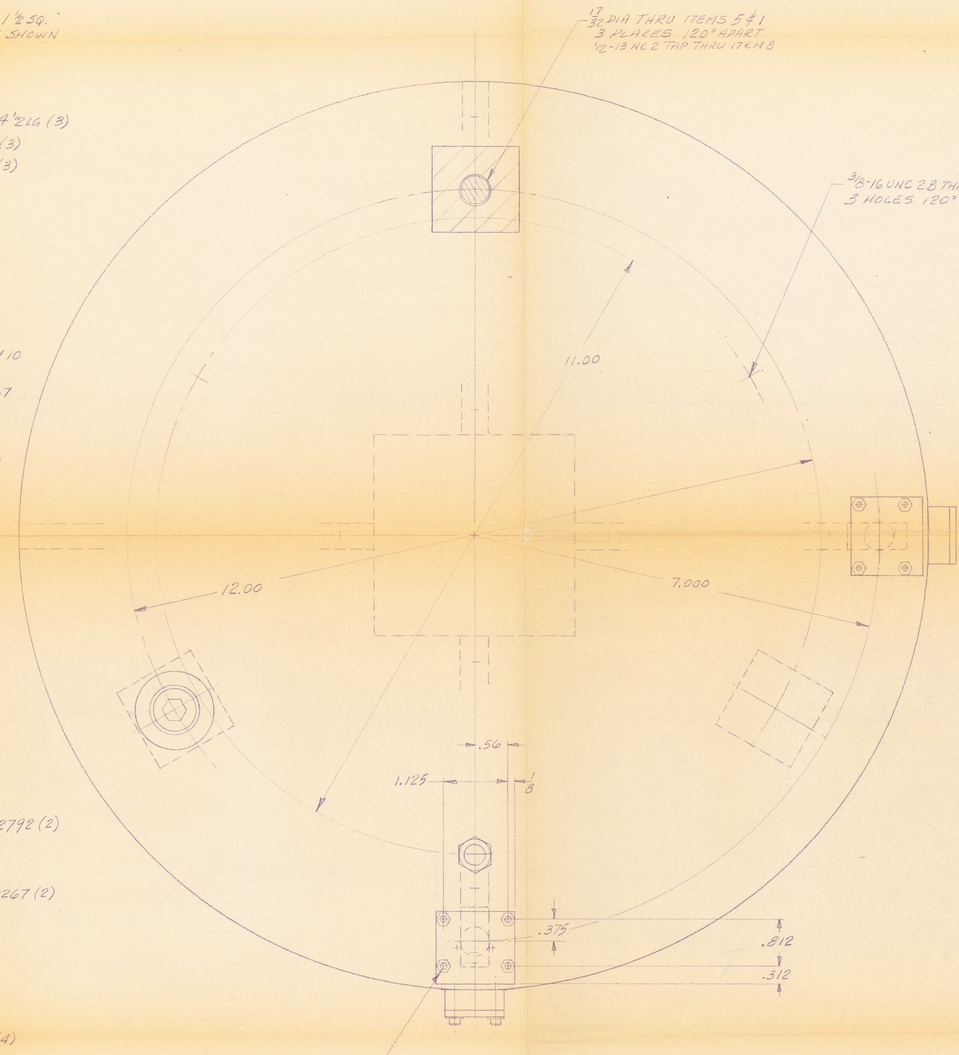
7 APRIL 75

CMC



REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED





NOTES:

1. REF. TO DWG 660-0267 FOR PARTS NOT IDENTIFIED REMACHINE AS REQ'D.

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES FRACTIONS ± 1/64 DECIMALS .XX ± .01 .XXX ± .005 ANGLES ± 2°	ORIG DATE 11-4-74
MACH COR—.005 TO .015 R OR CHAM SH MATL—BREAK EDGES .005 MAX R	DRAFTSMAN P.L.B.
ALL √ SURFACES TO BE 125 √ AA	CHECKER
DIM AND TOL APPLY BEFORE FIN. TREAT.	APPROVED
MATERIAL —	APPROVED
FINISH —	CONTRACT NO.
	DESIGN ACTIVITY APPROVAL
	OTHER APPROVAL

NEXT ASSY	QTY	USED ON	QTY
	1		

APPLICATION

PERKIN-ELMER
ELECTRO-OPTICAL DIVISION NORWALK, CONNECTICUT

LST SECONDARY MIRROR ACTUATOR SYSTEM MODIFICATION

SIZE	CODE IDENT NO.	DWG NO.
E	46555	660-0417

SCALE 1/1 | WT | SHEET

DWG NO. 660-0417

KREGG INC. 04681P

FORM NO. 2-0747