UNCLASSIFIED

AD NUMBER

ADB803066

NEW LIMITATION CHANGE

TO

Approved for public release, distribution unlimited

FROM

DISTRIBUTION AUTHORIZED TO DOD ONLY; ADMINISTRATIVE/OPERATIONAL USE; 03 MAR 1999. OTHER REQUESTS SHALL BE REFERRED THROUGH WRIGHT AIR DEVELOPMENT CENTER, MATERIEL LAB, WRIGHT-PATTERSON AFB, OH.

AUTHORITY

WADC [DTIC form 55] 14 Apr 2000

THIS PAGE IS UNCLASSIFIED

AD NUMBER

ADB803066

CLASSIFICATION CHANGES

TO

unclassified

FROM

restricted

AUTHORITY

EO 10501 dtd 5 Nov 1953

(UNPUBLISHED CARD)

U AD-B803 066

ATI 99 727

FAIRCHILD ENGINE AND AIRPLANE CORP., FAIRCHILD AIRCRAFT DIV.,
HAGERSTOWN, MD. (ENGINEERING REPORT NO. R107-016)

PERFORMANCE CALCULATIONS - AND APPENDIX I - MODEL
XC-120 (M-107)

EO 10501 dd 5 NOV 1953

W.F. EVERETT 9 MARCH'49 (REVISIONS 25 SEPT'50) 212PP.
GRAPHS

AERODYNAMICS (2)
PERFORMANCE (2)

AIRPLANES, TRANSPORT - PERFORMANCE
C-120 Aircraft

RESTRICTED

B1/3,5

Transport Aircraft

Reproduced by

CADO

CENTRAL AIR DOCUMENTS OFFICE

WRIGHT-PATTERSON AIR FORCE BASE – DAYTON, OHIO

REEL-C 4543

A.T.I 99727

RESTRICTED

(UNPUBLISHED CARD) RESTRICTED

ATI 99 727 (COPIES OBTAINABLE FROM CADO)

FAIRCHILD ENGINE AND AIRPLANE CORP., FAIRCHILD AIRCRAFT DIV.,
HAGERSTOWN, MD. (ENGINEERING REPORT NO. R107-016)

PERFORMANCE CALCULATIONS - AND APPENDIX I - MODEL
XC-120 (M-107)

W.F. EVERETT 9 MARCH'49 (REVISIONS 25 SEPT'50) 212PP.
GRAPHS

AERODYNAMICS (2)	AIRPLANES, TRANSPORT - PERFORMANCE
PERFORMANCE (2)	C-120

RESTRICTED

RESTRICTED

ENGINEERING REPORT NO.

E107-016

SUBJECT

PERFORMANCE CALCULATIONS

MODEL: XC-120 (M-107)

FAIRCHILD AIRCRAFT
Division of
FAIRCHILD ENGINE & AIRPLANE CORPORATION
HAGERSTOWN, MARYLAND

Date: 9 March 1949

No. Pages: 177, a, b,

Prepared By
W. F. Everett

Approved and Checked By
E. E. Morton

Approved By
A. J. Thieblot
Chief Engineer

REVISIONS

Date	Pages Affected	By	Remarks

REPORT NO. R107-016 FAIRCHILD AIRCRAFT

MODEL XC-120 PREPARED BY CHECKED BY APPROVED BY

DATE 9 March 1949

REVISED

Subject: PERFORMANCE CALCULATIONS

RESTRICTED

TABLE OF CONTENTS

RESTRICTED

PART I -

A. INTRODUCTION

This report presents the performance characteristics and calculations for the Model XC-120 airplane. The report is divided into four parts: Part I which summarizes the results of the calculations, and Parts II, III, and IV which explain in detail the performance methods used and present sample calculations for the "pack on", "pack off", and combination configurations respectively.

The XC-120 is a modified version of the C-119 airplane and features a detachable cargo compartment with both front and rear loading provisions, which is called the "pack". Other major changes over the C-119B are the redesign of the landing gear to quadricycle type and an increase in wing incidence from 3° to 7° at the root chord.

The performance figures as presented herein are based on the latest data available and supersede all other performance figures previously published.

RESTRICTED

PART I

B. PERFORMANCE SUMMARY

It is the purpose of this section to present the final results of the performance calculations of Parts II, III, and IV of this report.

All performance presented herein are based on the latest specification weights except for the summary of Part I-B-4 where several special gross weight conditions are presented. These special weight conditions are defined by reference (1) for Standard Aircraft Characteristics Charts and the data presented are in the form required by this reference.

Figures 1 through 6 present plots of climb and high speed performance versus altitude for the specification weights.

PART I-B-1 2

PERFORMANCE SUMMARY

CONFIGURATION		1. PACK - ON				2. PACK - OFF	
Loading Condition		Normal Take-Off Gross Weight (Normal Design Gross Wt.)		Maximum Alternate Take-Off Gross Weight		Design Gross Weight	
Airplane Characteristics							
Gross Weight	lbs.	64,000		74,000		54,000	
Internal Fuel Capacity	gal.	2670		2670		2670	
Wing Area	sq. ft.	1447.25		1447.25		1447.25	
Aspect Ratio		8.25		8.25		8.25	
Wing Loading (W/S)	lbs./sq. ft.	44.22		51.13		37.31	
Propeller Characteristics							
Model		Hamilton Standard 2H17Q3-26R		Hamilton Standard 2H17G3-26R		Hamilton Standard 2H17Q3-26R	
Diameter/No. of Blades	ft./	15/4		15/4		15/4	
Engine Characteristics							
Model		Pratt & Whitney R-4360-20		Pratt & Whitney R-4360-20		Pratt & Whitney R-4360-20	
Gear Ratio		.425		.425		.425	
Power Rating		Normal	Military	Normal	Military	Normal	Military
Lower Blower BHP/RPM/Alt., ft.		2650/2550/S.L.-6000	3250/2700/S. L.-1500	2650/2550/S.L.-6000	3250/2700/S.L.-1500	2650/2550/S.L.-6000	3250/2700/SL-1500
Maximum High Blower BHP/RPM/Alt.ft.		2300/2550/18000	2500/2700/17000	2300/2550/18000	2500/2700/17000	2300/2550/18000	2500/2700/17000
Performance - 2 Engines - Maximum Speed							
Vmax at Sea Level	mph/knots	220 191	237 206	217 188	235 204	236 205	252 219
Vmax at 5000 ft.	mph/knots	231 200	241 209	227 197	238 206	248 215	257 223
Vmax at 10,000 ft.	mph/knots	234 203	246 214	229 199	241 209	253 220	263 228
Vmax at 15,000 ft.	mph/knots	241 209	250 217	234 203	244 212	261 226	270 234
Vmax at 20,000 ft.	mph/knots	236 205	245 213	221 192	234 203	260 226	266 231
Maximum Speed	mph/knots	244 212	252 219	236 205	245 213	265 230	272 236
Altitude for Max. Speed	ft.	18,000	17000	18,000	17000	18,000	17000
Rate of Climb							
Rate of Climb at Sea Level	ft./min.	1100	1440	800	1115	1550	1960
Rate of Climb at 5000 ft.	ft./min.	1055	1230	750	920	1530	1710
Rate of Climb at 10,000 ft.	ft./min.	875	1010	560	700	1330	1490
Rate of Climb at 15,000 ft.	ft./min.	720	795	415	480	1190	1270
Rate of Climb at 20,000 ft.	ft./min.	440	440	155	160	890	910
Time to Climb							
Time to Climb to 5000 ft.	min.	4.6	3.7	6.4	4.8	3.3	2.8
Time to Climb to 10,000 ft.	min.	9.8	7.9	14.0	10.4	6.8	6.0
Time to Climb to 15,000 ft.	min.	15.6	13.0	24.0	17.5	10.6	9.4
Time to Climb to 20,000 ft.	min.	24.0	22.6	40.2		15.5	13.9

REPORT NO. B107-016 FAIRCHILD AIRCRAFT DIVISION OF FAIRCHILD ENGINE & AIRPLANE CORPORATION
MODEL XC-120 PREPARED BY CHECKED BY
SUBJECT PERFORMANCE CALCULATIONS
APPROVED BY
DATE 9 March 1949
REVISED

PART I-B-1 & 2

CONFIGURATION		1. PACK - ON				2. PACK-OFF	
Loading Condition		Normal Take-Off Gross Weight		Maximum Alternate Take-Off Gross Weight		Design Gross Weight	
Power Rating		Normal	Military	Normal	Military	Normal	Military
Ceilings							
Absolute (R/C = 0 ft./min.)	ft.	24750	25000	21800	22000	28500	29600
Service (R/C = 100 ft./min.)	ft.	23700	23850	20600	20800	27600	28600
Combat (R/C = 500 ft./min.)(1)	ft.		19350		14600		24300
Take-Off (Zero Wind-Sea Level - Flaps Down 20°)							
Unassisted							
Over 50 ft. Obstacle	ft.		2800		4050		1955
Ground Run	ft.		1950		2940		1245
Assisted (4 Jato - 1000 lbs. - 14 sec)							
Over 50 ft. Obstacle	ft.		2270		3210		
Ground Run	ft.		1500		2200		
Cruising - Cruise Power (2)							
Max. Combat Radius	naut. mi.	825		750		1030	
Ave. Speed	mph/knots	158	137.1	162	141	152	132
Payload For	lbs.	5200		15200		0	
Total Mission Time	hrs.	12.35		10.95		15.9	
Max. Combat Range	naut. mi.	1720		1470		2270	
Ave. Speed	mph/knots	160	139.1	172	149.5	152	132
Payload For	lbs.	5200		15200		0	
Total Mission Time	hrs.	12.52		10.0		17.3	
Max. Range	naut. mi.	2270		1930		3050	
Ave. Speed	mph/knots	148	128	160	139	143	124
Payload For	lbs.	5200		15200		0	
Total Mission Time	hrs.	17.7		13.9		24.6	
Stalling Speeds - Power Off (Flaps Neutral - Sea Level)							
Full Load	mph/knots	108.4	94	116.6	101	99.6	86.5
Full Load Less Fuel	mph/knots	93.9	81.4	103.1	89.5	83.5	72.5
Flaps Down (40°) - Sea Level							
Full Load	mph/knots	98.6	85.5	106.1	92.1	90.6	78.5
Full Load Less Fuel	mph/knots	85.4	74.0	93.8	81.4	76.0	65.9
Landing - Power Off - At Landing Gross							
Loading Condition		Normal Landing Gross Weight		Maximum Alternate Landing Gross Weight		Design Gross Weight	
Gross Weight	lbs.	60000		74000		54000	

PART I-B-1 & 2 PERFORMANCE SUMMARY (Cont.)

CONFIGURATION		1. PACK-ON				2. PACK-OFF	
Loading Condition		Normal Take-Off Gross Weight		Maximum Alternate Take-Off Gross Weight		Design Gross Weight	
Landing Distance (Zero Wind-Sea Level-Flaps Down 40°)							
No Reverse Thrust							
Over 50 ft. Obstacle	ft.	2040		2435		1905	
Ground Run	ft.	1275		1570		1170	
With Reverse Thrust							
Over 50 ft. Obstacle	ft.	1530		1800			
Ground Run	ft.	770		940			
Performance - 1 Engine							
Power Rating		Normal	Military	Normal	Military	Normal	Military
Rate of Climb at Sea Level	ft./min.	65	220	-	40		
Service Ceiling	ft.		4400	-	-		
Absolute Ceiling	ft.	6000	7850	-	1600		

NOTES:

(1) Combat ceiling is defined as the altitude at which the airplane has a rate of climb of 500 ft./min. with maximum power.

(2) The cruising problems are defined as follows:

Max Combat Radius (full fuel of 2670 gallons)

Allow 10 minutes operation at normal rated power for warm-up and take-off, climb to 10,000 ft. at normal rated power at speed for best climb, cruise out at speed corresponding to 99% of best economy, land and unload cargo, 10 minutes operation at normal rated power for warm-up and take-off, climb to 10,000 ft. at normal rated power at speed for best climb, cruise back at speed corresponding to 99% of best economy, 5% of useable fuel is held in reserve at all times, all range data are 5% conservative in addition to 10% for installation (total 15%), range is based on distance in climb and cruise.

Max Combat Range (full fuel of 2670 gallons)

Same as for radius except cargo carried entire distance thus eliminating warm-up, take-off, and climb at mid-point.

Max Range (full fuel of 2670 gallons)

Cruise out at 10,000 ft. altitude at best economy until fuel is exhausted. Cargo is carried entire distance, no allowance for warm-up, take-off, climb or reserve. Manufacturer's SFC data used directly.

XC 120 PACK ON

FIG. 1

RATE OF CLIMB & TIME TO CLIMB
NORMAL RATED POWER. 2 ENGINES

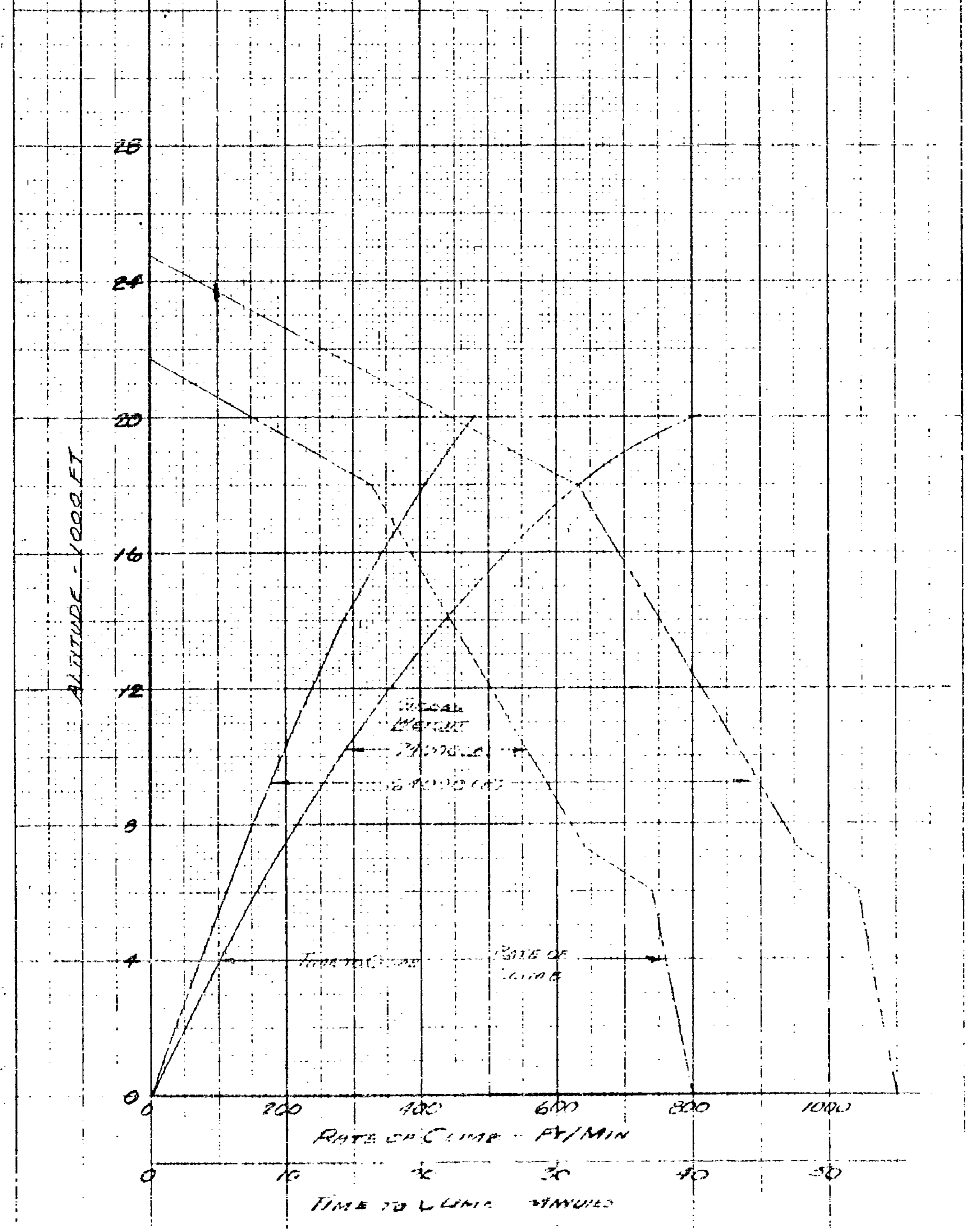
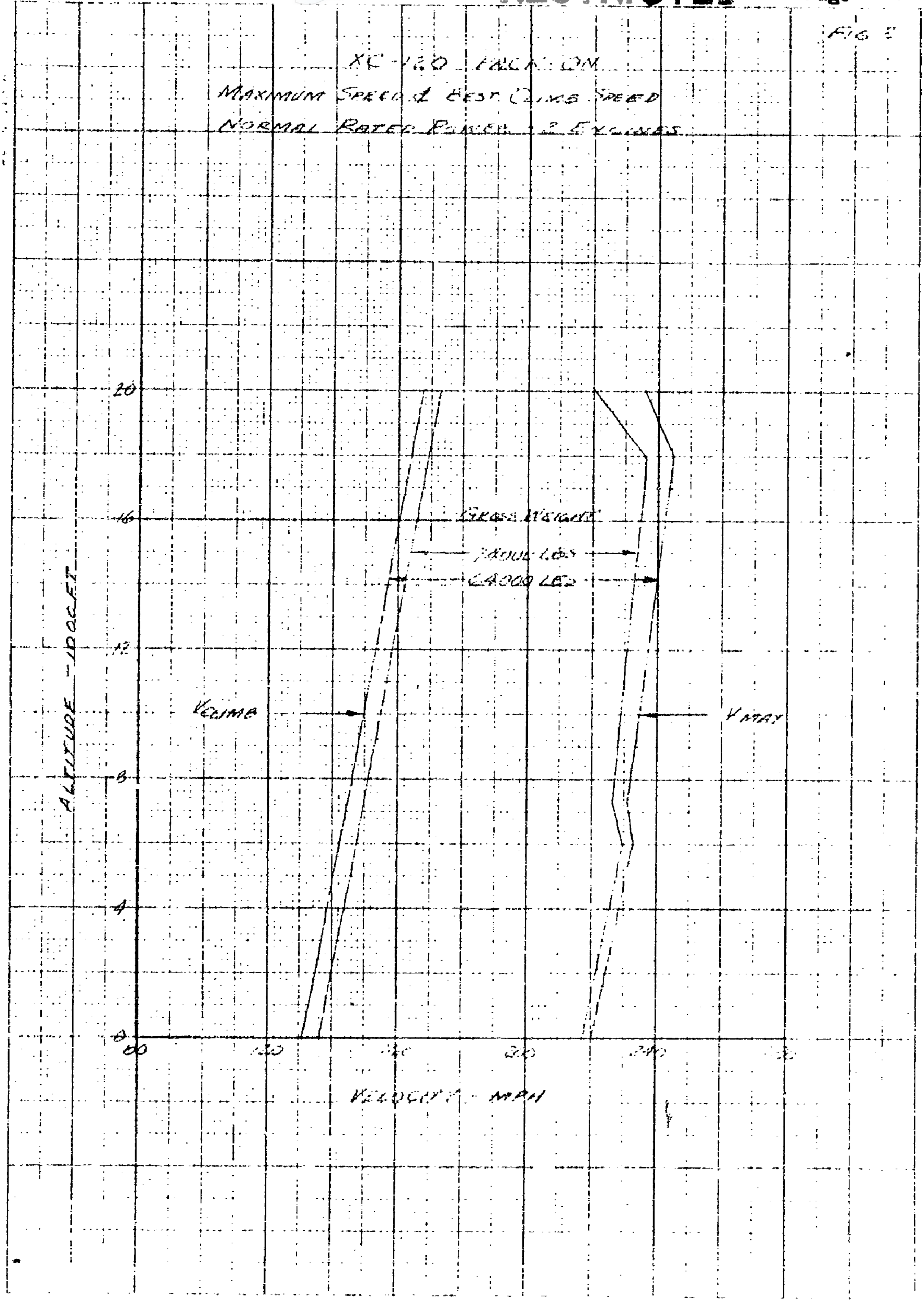


FIG 3



XC-120 PACK ON
MAXIMUM SPEED & BEST CLIMB SPEED
NORMAL RATED POWER - 2 ENGINES

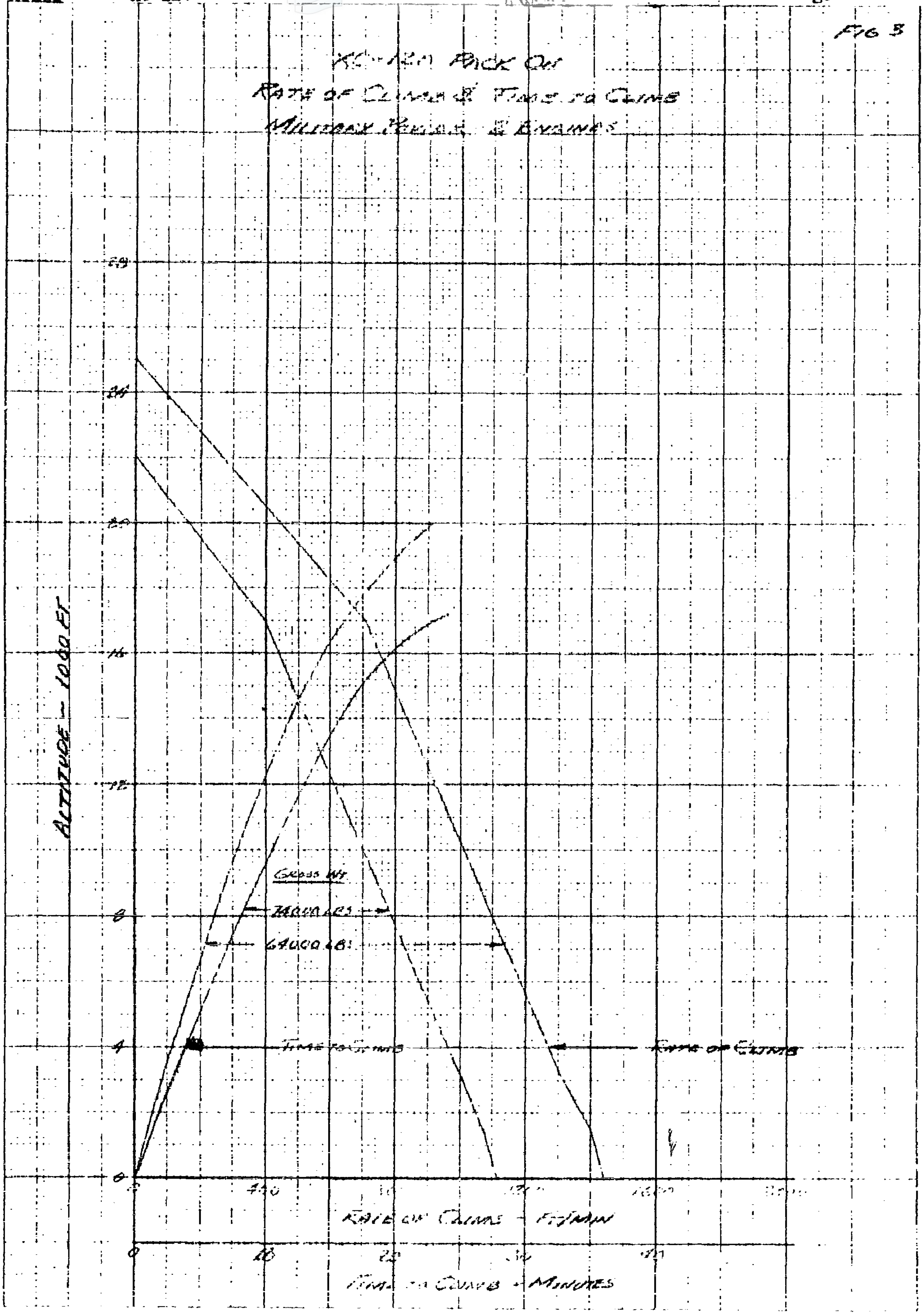


Fig 5
XC-120 Pack On
Rate of Climb & Time to Climb
Military Power, 2 Engines
Altitude – 1000 Ft
28
24
20
16
12
8
4
0
Gross Wt
74000 LBS
64000 LBS
Time to Climb
Rate of Climb
0
400
800
1200
1600
2000
Rate of Climb – Ft/Min
0
10
20
30
40
Time to Climb – Minutes

Fig 4

XC-120 PACK ON
MAXIMUM SPEED & BEST CLIMB SPEED
MILITARY POWER : 2 ENGINES

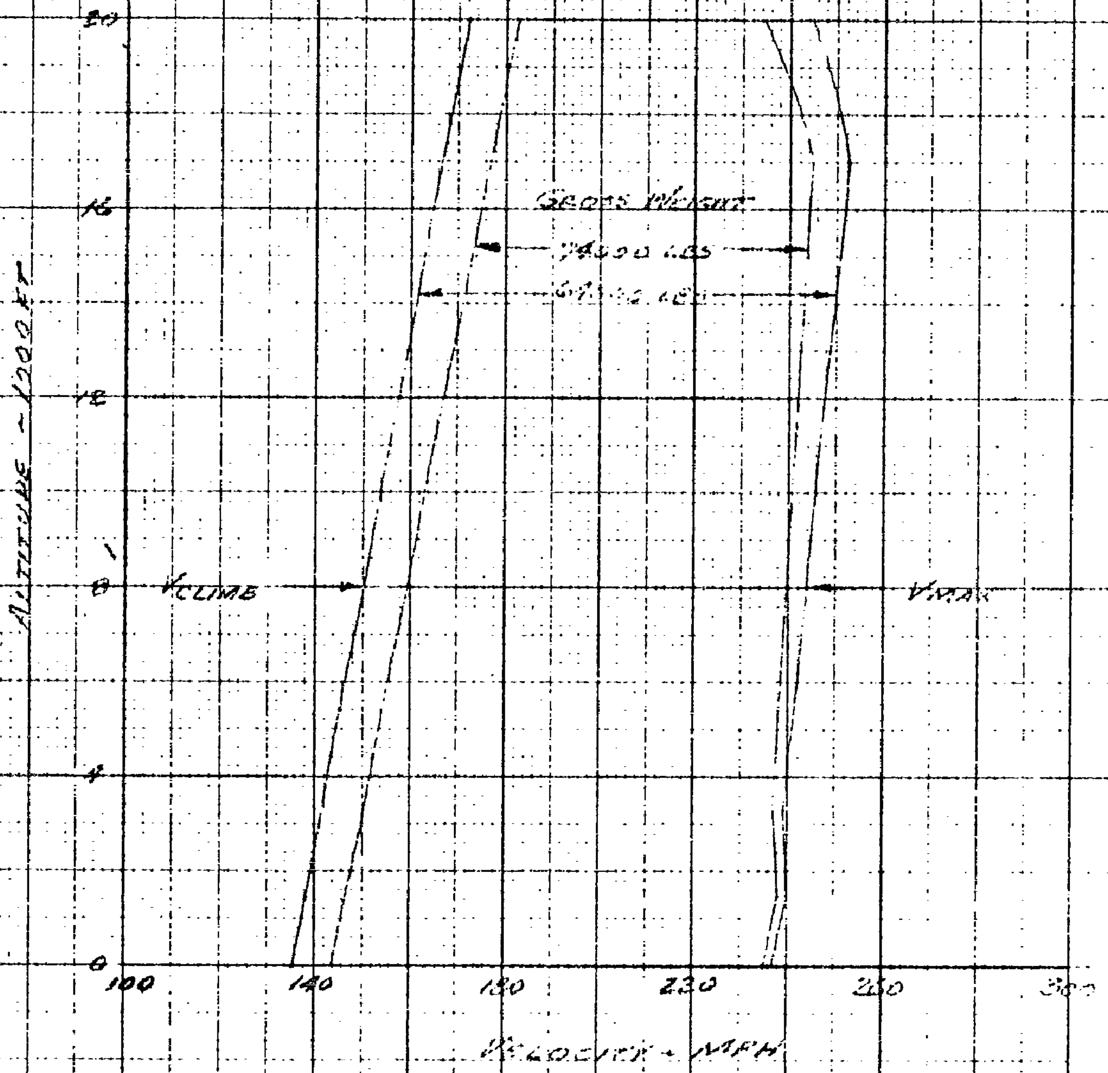


Fig 5

XC-120 PACK OFF
RATE OF CLIMB & TIME TO CLIMB
MILITARY & NORMAL RATED POWER
2 ENGINES - [illegible] LBS.

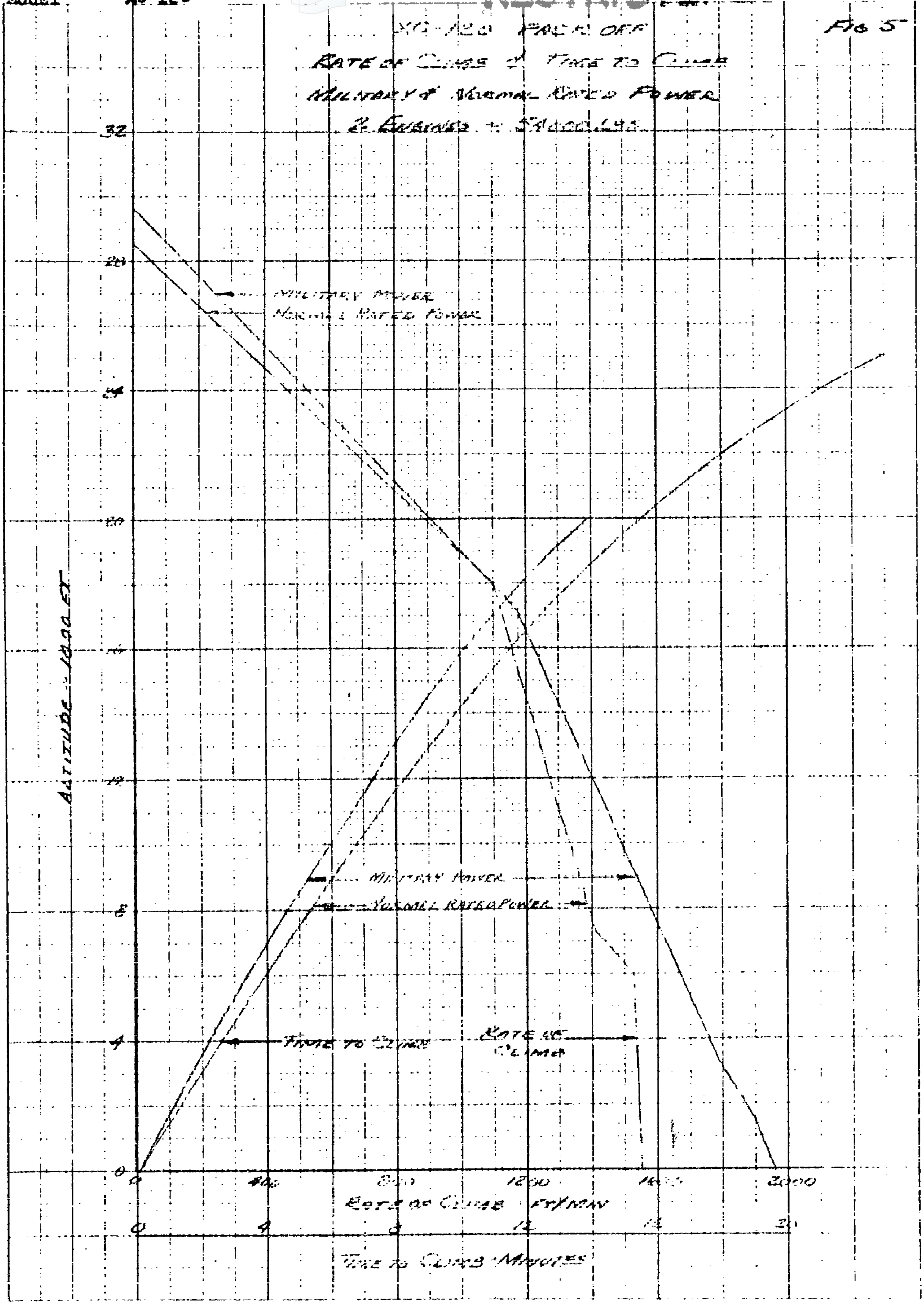


Fig 6

XC-120 Pack Off
Maximum Speed & Best Climb Speed
Military & Normal Rated Power
2 Engines - 54000 Lbs

PART I-B-3

3. Combinations Pack-On and Pack-Off

Because of its unique design, the XC-120 is capable of some missions which are impossible with other aircraft. This is especially true of radius problems where one leg can be with pack-on and the other without pack. The following missions are typical:

Description of Mission		Cruise out without pack to halfway point. Pick up pack and cargo and return to base. Take-off gross weight defined at halfway point.		Cruise out with pack and cargo to halfway point. Drop pack and cargo and return to base without pack. Take-off gross weight defined at beginning of radius.	
Take-Off Gross Wt.,	lbs.	64000	74000	64000	74000
Max Combat Radius(1)	naut. mi.	840	750	900	810
Ave Speed	mph/knots	160 139	162 141	156 136	160 139
Payload For	lbs.	12000	21450	5200	15200
Total Mission Time	hrs.	12.4	11.0	13.6	12.0

NOTES: (1) Definition of maximum combat radius same as preceeding table.

PART I-B-4

4. **Special Conditions For Standard Aircraft Characteristics**

Performance presented herein is that required by reference (1) for Standard Aircraft Characteristic Charts.

PART I-B 4

LOADING AND PERFORMANCE - TYPICAL MISSION

CONDITIONS			BASIC I	RESUPPLY II	SUPPLY III	SUPPLY IV	FERRY V	FERRY VI PACK OFF
Take-Off Weight		lbs.	70,000	70,000	70,000	70,000	58,750	53,650
Fuel/Oil		gal.	2434/120	2670/120	2434/120	2670/120	2670/120	2670/120
Cargo		lb.	13,350	11,950	13,350	11,950	None	None
Wing Loading		lb/sq. ft.	48.9	48.9	48.9	48.9	40.6	37.1
Take-off Power Loading	(1)	lb/bhp	10.88	10.88	10.88	10.88	9.04	8.25
Stall Speed (Power-off, Flaps full down)	(5)	kn.	90.08	90.08	90.08	90.08	82.12	78.47
Take-Off Distance at Sea Level								
Ground Run (no wind)	(3)	ft.	2580	2580	2580	2580	1550	1215
To Clear 50 ft. Obstacle	(3)	ft.	3600	3600	3600	3600	2320	1930
Climb From Sea Level								
Rate of Climb	(2)	fpm	890	890	890	890	1285	1560
Time to 10,000 ft.	(2)	min.	12.0	12.0	12.0	12.0	8.1	6.4
Radius of Action	(4)	n. mi.	750	840	-	-	-	-
Avg. Cruising Speed		kn.	137	137	-	-	-	-
Total Mission Time		hr:min.	11:18	12:36	9:36	10:48	13:51	17:17
Max. Range/Avg. Speed	(4)	n. mi./kn.	-	-	1400/148	1550/146	1860/[illegible]	2275/133
Cruising Altitude		ft.	10,000	10,000	10,000	10,000	10,000	10,000
			PACK OFF	PACK OFF	PACK ON	PACK ON	PACK ON	PACK OFF
Performance Weight		lb.	43,600	44,150	56,000	55,500	43,500	38,420
Performance Alt. (over target)		ft.	10,000	10,000	10,000	10,000	10,000	10,000
Max. Speed (over target)	(1)	kn.	231	230	215	215	218	232
Rate of Climb (over target)	(1)	fpm	2040	2008	1320	1340	1960	2400
Combat Ceiling (500 fpm)	(1)	ft.	27,950	27,750	22,200	22,400	27,250	29,820
Service Ceiling (100 fpm)	(1)	ft.	31,600	31,450	26,400	26,600	30,950	33,100
Service Ceiling (100 fpm)	(2)	ft.	30,500	30,350	26,100	26,280	29,950	31,950
Max. Speed at 17,000 ft.	(1)	kn.	239	238	221	222	226	240
Max. Climb at S. L.	(1)	fpm	2580	2540	1760	1775	2460	2960
Landing Weight (max for mission)		lb.	62,070	61,220	56,000	55,500	43,500	38,420
Landing Ground Roll at S. L.	(3)	ft.	1320	1300	1190	1180	920	825
Total from 50 ft. to stop	(3)	ft.	2100	2070	1920	1910	1570	1430

Notes on the following page

PART I-B-4

LOADING AND PERFORMANCE - TYPICAL MISSION (Cont.)

NOTES: - (1) Take-off power for take-off only and military power for all performance.

(2) Normal power.

(3) Take-off and landing distances are optimum with normal technique; for airport planning add 25%. Landing is without use of reverse thrust provisions which are available and reduce landing ground roll by approximately 40%.

(4) Radius of action is based on unloading pack and cargo at remote base (target) and without refueling return to point of take-off. Max. range based on carrying pack and payload entire distance except for Ferry VI which is pack off.

(5) Stall speeds are for take-off gross weight, sea level, power-off, flaps full down.

(6) Conditions:
(a) Performance based on NACA standard atmosphere.
(b) Radius and range are based on manufacturer's fuel consumption data increased by 15% and full oil carried entire distance.

(7) Cruising Problems:
I. Formula: Basic (750 n. mi. radius)
Allow 10 minutes operation at normal rated power for warm-up and take-off, climb to 10,000 ft. at normal rated power at speed for best climb, cruise out at speed corresponding to 99% of best economy, land and detach pack and cargo, 10 minutes operation at normal rated power for warm-up and take-off, climb to 10,000 ft. at normal rated power at speed for best climb, cruise back at speed corresponding to 99% of best economy, 5% of useable fuel is held in reserve at all times, all range data are 5% conservative in addition to 10% for installation (total 15%), range is based on distance in climb and cruise.

II. Formula: Resupply
Same flight plan as for Basic Mission except maximum radius at maximum take-off weight in lieu of fixed 750 n. mi. radius.

PART I-B-4

LOADING AND PERFORMANCE - TYPICAL MISSION (Concluded)

Notes: (Cont.)

III, IV Formula: Supply

Same as I except pack and cargo carried entire distance thus eliminating warm-up, take-off, and climb out at mid-point. Supply III matches Basic I and Supply IV matches Resupply II.

V, VI Formula: Ferry

Same as III and IV except no cargo carried but full fuel.

Ferry V empty pack carried and Ferry VI no pack.

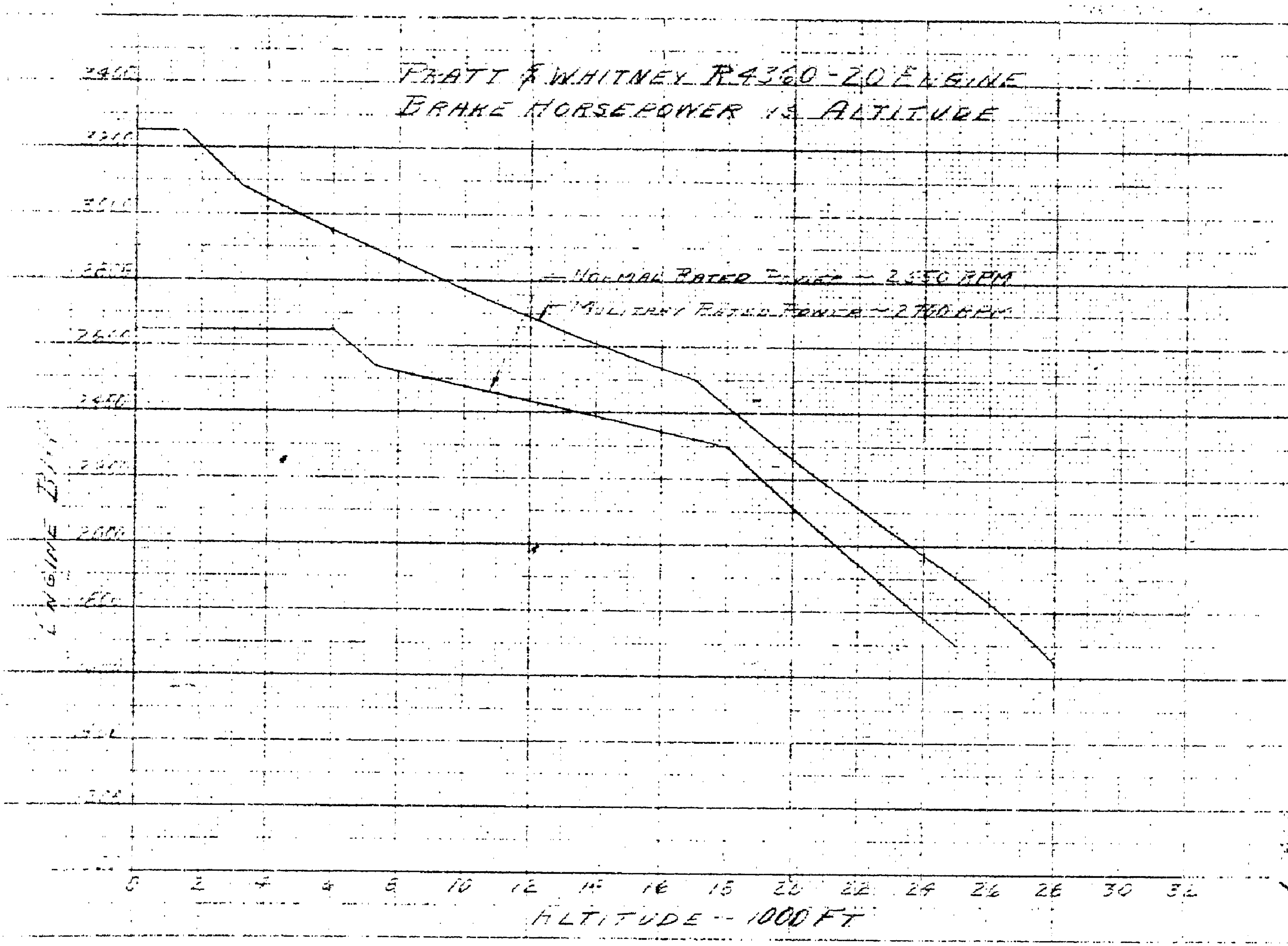
PART I-C

C. POWER PLANT - PROPELLER CHARACTERISTICS

1. Tabulated Characteristics

Power Plant	
Manufacturer	Pratt & Whitney
Designation	R-4360-20
Gear Ratio - Prop RPM/Engine RPM	.425
Normal Rated Power	
Low Blower - BHP/RPM	2650/2550
Altitude - ft.	S. L. - 6000
Max High Blower - BHP/RPM	2300/2550
Altitude - ft.	At 18,000
Military Rated Power (Dry)	
Low Blower - BHP/RPM	3250/2700
Altitude - ft.	S. L. - 1500
Max. High Blower - BHP/RPM	2500/2700
Altitude - ft.	At 17,000
Take-Off Power (Dry) -BHP/RPM at S. L.	3250/2700
Propeller	
Manufacturer	Hamilton Standard
Blade Designation	2H17Q3-26R
Diameter ft.	15.083
Number of Blades	4
Hub Designation	24,260

Fig. 7


PRATT & WHITNEY R4360-20 ENGINE
BRAKE HORSEPOWER VS ALTITUDE

PART II -

PERFORMANCE CALCULATIONS - "PACK ON"

All calculations in this part of the report are for the airplane in the "Pack On" configuration only.

PART II

SECTION A - THRUST HORSEPOWER AVAILABLE

1. General

The thrust horsepower available as used in the performance calculations of this report is defined as:

$$THP_a = (\eta)(BHP)$$

where:

BHP = engine brake horsepower from engine manufacturer's power curves

η = calculated propulsive efficiency

Plots of thrust horsepower available versus speed are presented in figures for conditions as listed in the following table.

Engines Operating	Power Rating	Altitude	Figure No.
2	Normal	Sea Level	14
		6000	14
		7300	15
		18000	15
		25000	16
1	Normal	Sea Level	14
		6000	14
		7300	15
		18000	15
2	Military	Sea Level	17
		1500	17
		3300	18
		17000	18
		20000	19
1	Military	Sea Level	17
		1500	17
		3300	18
		17000	18

PART II

SECTION A - THRUST HORSEPOWER AVAILABLE (Cont.)

2. Engine Characteristics

Power and fuel consumption data were obtained from engine manufacturer's specification, reference (a). A plot of military rated power and of normal rated power versus altitude is shown in figure 7.

The sea level power characteristics of the engine are tabulated below: -

Single Stage - Variable Speed - P. & W. R4360-20

Rating	BHP	RPM
Take-off	3250	2700
Military	3250	2700
Normal	2650	2550

3. Propulsive Efficiency

All propulsive efficiencies were calculated using figure 4 of reference (b) as the basic efficiency chart with appropriate corrections for tip losses and differences in activity factor, thickness ratio, and number of blades. In the low speed region static thrust and thrust versus speed were calculated by the method of reference (c). The thrust horsepower available (η BHP) was then converted to thrust and the two curves were faired together to cover the speed region where both thrust and efficiency systems break down. Figure 8 presents a plot of thrust versus speed for full normal rated power and shows the method of fairing. A similar plot for military rated power is shown in figure 9. A sample calculation for propulsive efficiency at 6000 feet altitude and normal rated power is shown on the following page.

The propeller selection was made in reference (d) for this engine installation on the C-119B airplane. It is kept the same on the XC-120 airplane because the engine installation, the design performance conditions, and the propeller fuselage clearance remain the same as the C-119B.

Subject: PERFORMANCE CALCULATIONS

PART II-A (Cont.)

SAMPLE PROPELLER EFFICIENCY AT 6000 FT. ALTITUDE - NRP

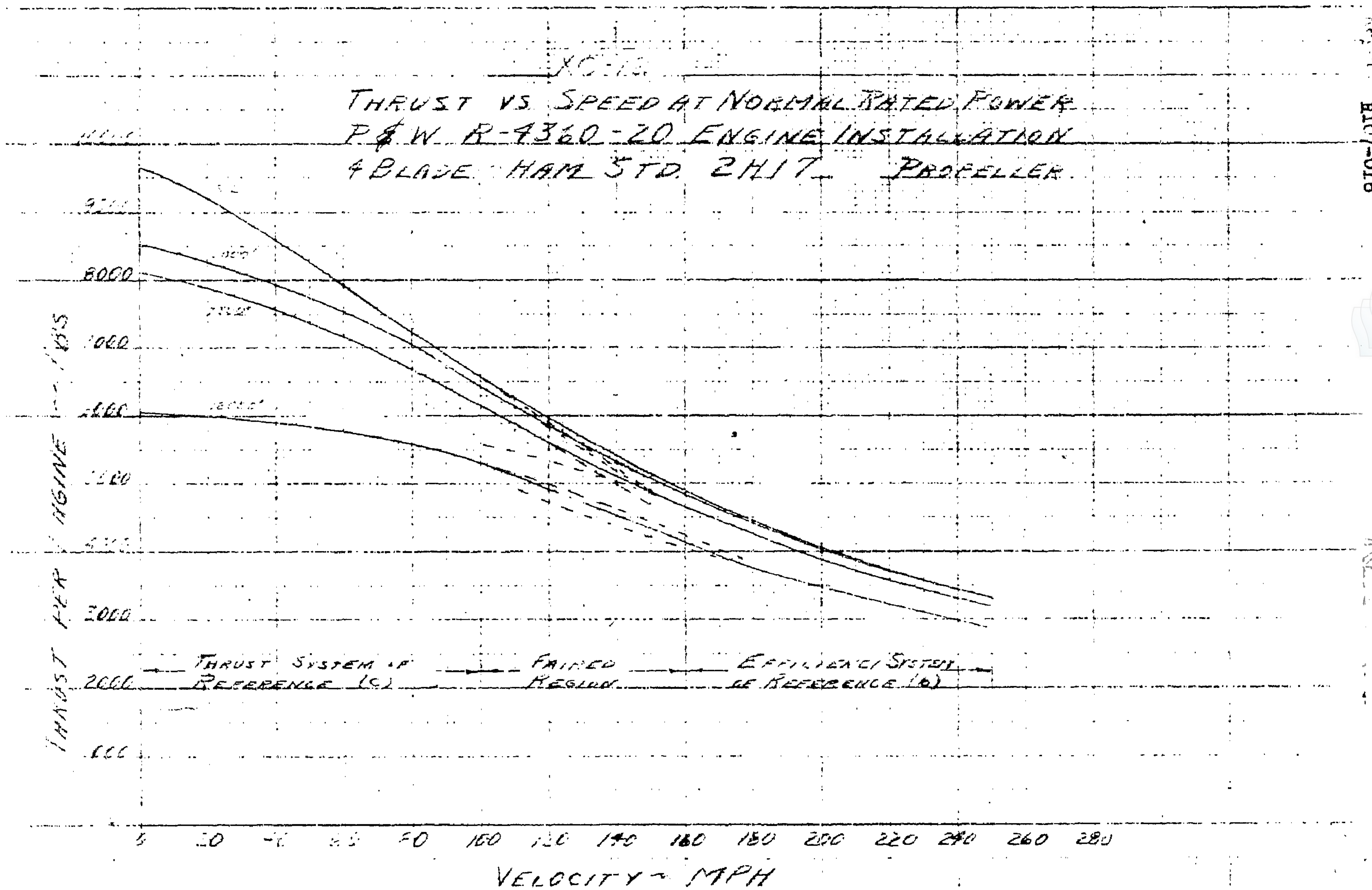
Engine	Pratt & Whitney R4360-20
Altitude	6000 Ft.
BHP	2650
RPM	2550
Gear Ratio	.425
Prop Designation	Hamilton Standard 2H17Q3-26R
Blade Section	NACA
No of Blades	4
Diameter	15 ft.
Activity Factor	147
h/b	.056
Body Diameter/Prop Diameter	.39
σ	.8358
Prop RPM	1084

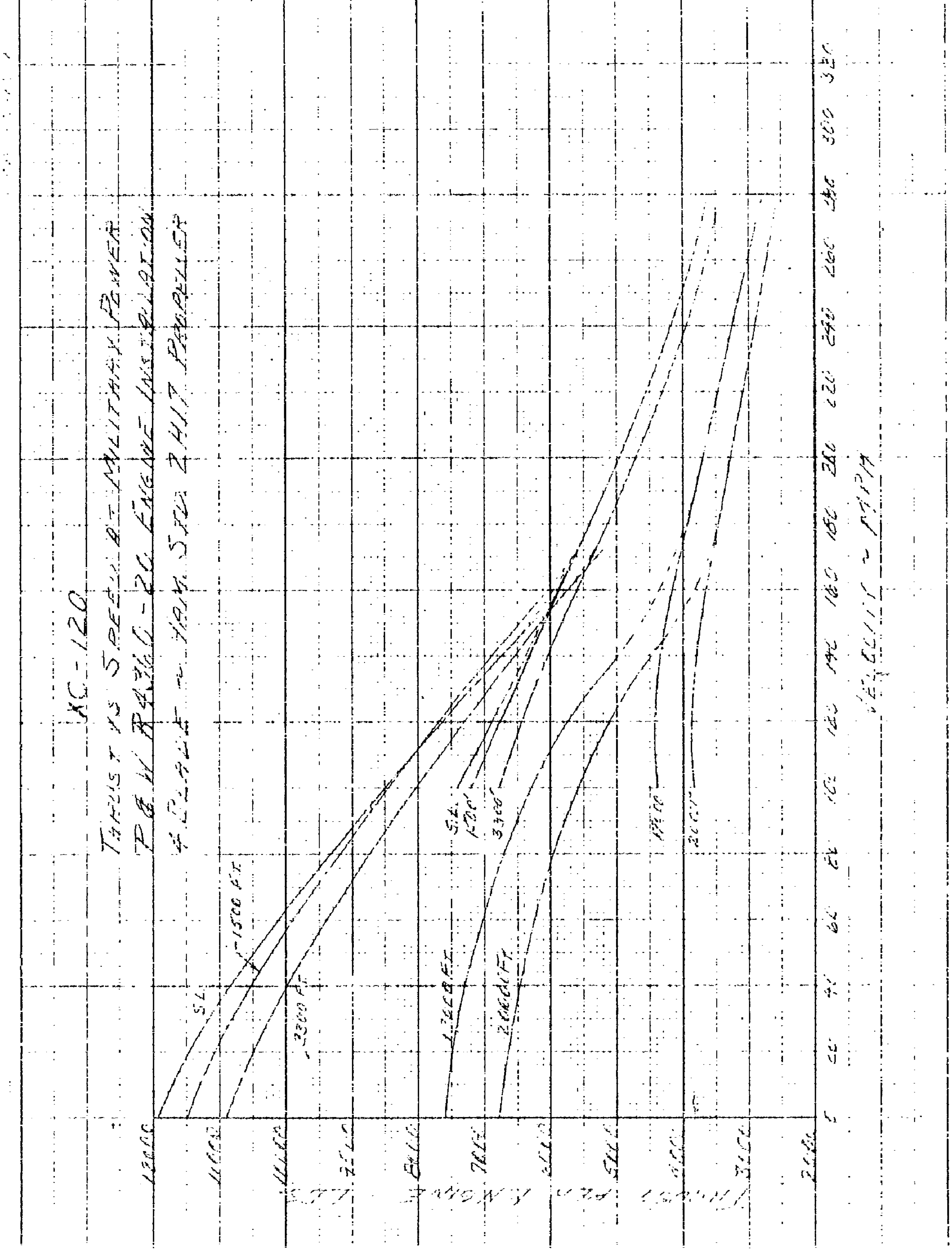
Velocity (MPH)	100	150	200	250
88 Vmph/N_pD	.538	.808	1.078	1.346
C_p = BHP x $10^{11}/2N_p{}^3D^5\sigma$	.158	.158	.158	.158
C_p' = C_p x (corr. for no. blades)	.120	.120	.120	.120
C_p'' = C_p' x (corr. for A.F.)	.090	.090	.090	.090
C_p''' = C_p'' x (corr. for h/b)	.0957	.0957	.0957	.0957
η from figure 4 of reference (b)	67.5	80.1	85.25	87.0
$\beta_{.75R}$ from figure 4 of reference (b)	22.2°	24.8°	28.0°	31.6°
$\pi N_p D/60$ = rotational tip speed	856	856	856	856
$f_c = \dfrac{\text{speed of sound at sea level}}{\text{speed of sound at altitude}}$	1.021	1.021	1.021	1.021
$\cos\phi_t$ (function of 88 Vmph/N_p D)	.984	.967	.945	.920
$(\pi N_p D/60)(f_c/\cos\phi_t)$	.889	.904	.925	.950
$\phi_{.75R}$ = angle of advance	13°	19°	24.5°	29.7°
$\Delta\beta_t$ = blade angle correction to tip speed	-.35°	-.4°	-.55°	-.70°
$\alpha = \beta_{.75R} + \Delta\beta_t - \phi_{.75R}$	8.85°	5.4°	2.95°	1.2°
f_α = tip speed correction for α	1.30	1.105	1.015	1.002
f_h = tip speed correction for h/b	.959	.959	.959	.959
$(\pi N_p D/60)(f_c/\cos\phi_t)(f_\alpha)(f_h)$ = equiv. tip speed	1106	958	900	913
F_T = correction to η for tip speed	.931	1.00	1.00	1.00
F_B = correction to η for body diameter	.996	.996	.996	.996
F_{AF} = correction to η for activity factor	.976	.976	.9765	.9785
F_{BL} = correction to η for number of blades	.982	.983	.984	.9845
η corr = η chart x F_T x F_B x F_{AF} x F_{BL}	60.0	76.6	81.6	83.4

8

XC-120

THRUST VS SPEED AT NORMAL RATED POWER
P&W R-4360-20 ENGINE INSTALLATION
4 BLADE HAM STD 2H17 PROPELLER




XC-120
THRUST VS SPEED AT MILITARY POWER
P&W R4360-20 ENGINE INSTALLATION
4 BLADE ~ HAM. STD. 2H17 PROPELLER
S.L.
1500 FT.
3300 FT.
13200 FT.
20000 FT.
S.L.
1500'
3300'
13200
20000
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
THRUST PER ENGINE ~ LBS
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
VELOCITY ~ MPH

PART II

SECTION B - THRUST HORSEPOWER REQUIRED

1. General

The thrust horsepower required used in the calculation of airplane performance is determined from the following relation:

$$THP_r = DV/375$$

where

D = airplane drag in lbs. = $C_D\ q\ S$
V = true airplane speed in mph
S = gross wing area in sq. ft.

Figure 14 through 19 present plots of thrust horsepower required versus speed for the subject airplane with the "pack on" at various altitudes and gross weights of 44,000, 54,000, 64,000 and 74,000 lbs.

2. Drag Coefficient - Clean Airplane

The drag coefficient of the subject airplane in the "pack on" configuration was determined by evaluating the changes from the present C-119B and adjusting the C-119B polar diagram, which was constructed from C-82 flight test polar with proper allowances for changes. A detailed tabulation of these changes and the corresponding estimated drag changes is presented on the following page. The further change in C_L and C_D due to the change in wing incidence is presented in figure 10. It is noted that the drag analysis is made in terms of K_X where:

K_X = airplane drag coefficient in lb/mph^2 = $\frac{C_{D_0} S}{391}$

S = gross wing area in sq. ft. = 1447.25

The drag coefficient as derived above was checked against that developed in reference (e) by a detailed build-up of the drags of the component parts, and against that derived from reference (f) by correction of the available wind tunnel data. A comparison of the three curves is shown in figure 11 and a reasonable agreement is shown over the entire C_L range.

Subject: PERFORMANCE CALCULATIONS

PART II

SECTION B - THRUST HORSEPOWER REQUIRED (Cont.)

2. Drag Coefficient - Clean Airplane (Cont.)

Fuselage		C-119B	XC-120
Max. Cross Sectional Area	ft.^{2}	143.62	178
Length	ft.	60.104	56
Fineness Ratio = $.886L/\sqrt{A}$		4.45	3.72
RN		1.054×10^8	9.83×10^7
C_{D_0} smooth		.041	.0376
Roughness & Leakage (% smooth fuselage)		60%	100%
C_{D_0} corrected		.0656	.0752
K_X (based on frontal area)	lbs/mph^2	.0241	.03423
$\Delta K_X = +.01013$			
Boom			
Max. Cross Sectional Area	ft.^{2}	30.65	44.6
Length	ft.	63.75	68.5
RN		1.118×10^8	1.20×10^8
T.L.		4° 10'	4° 10'
Fineness Ratio = $.886L/\sqrt{A}$		10.17	9.10
C_D smooth		.0862	.076
Roughness & Leakage (% smooth boom)		57	57
C_D corrected		.1353	.1193
K_X (2 booms)		.0212	.02723
$\Delta K_X = +.00603$			

Using C-119B polar and adjusting for drag differences: -

S_w = 1447.25'

ΔK_X total = +.01616

ΔC_D = .00436

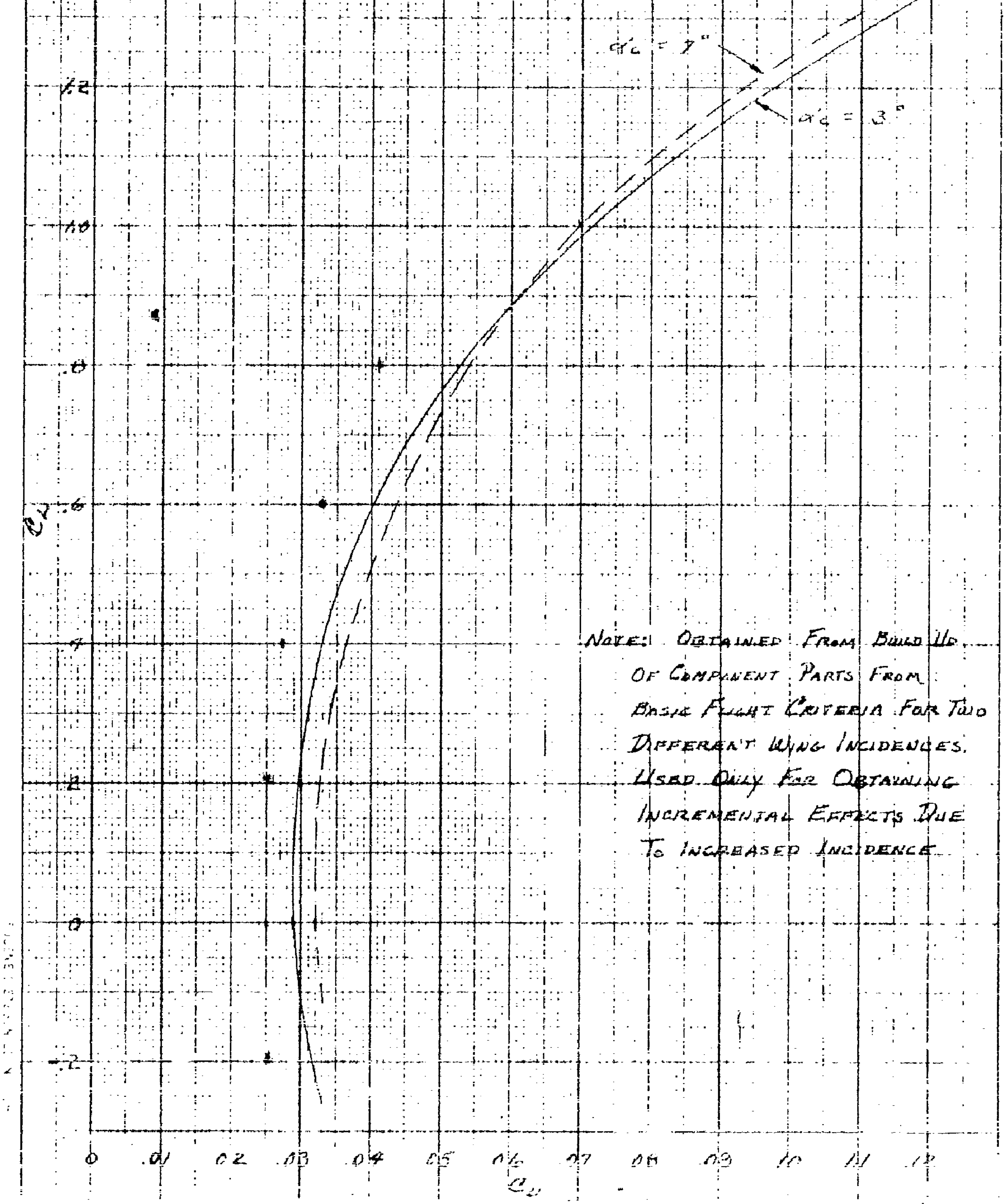
The above drag table corrects for all normal drag changes from the C-119B to the XC-120 except for wing incidence change which is obtained as incremental changes from figure 10.

Estimated Effect of Cowl Flaps Open in Climb

ΔK_X High Speed to Climb = .0274

ΔC_D = .0074 for Climb

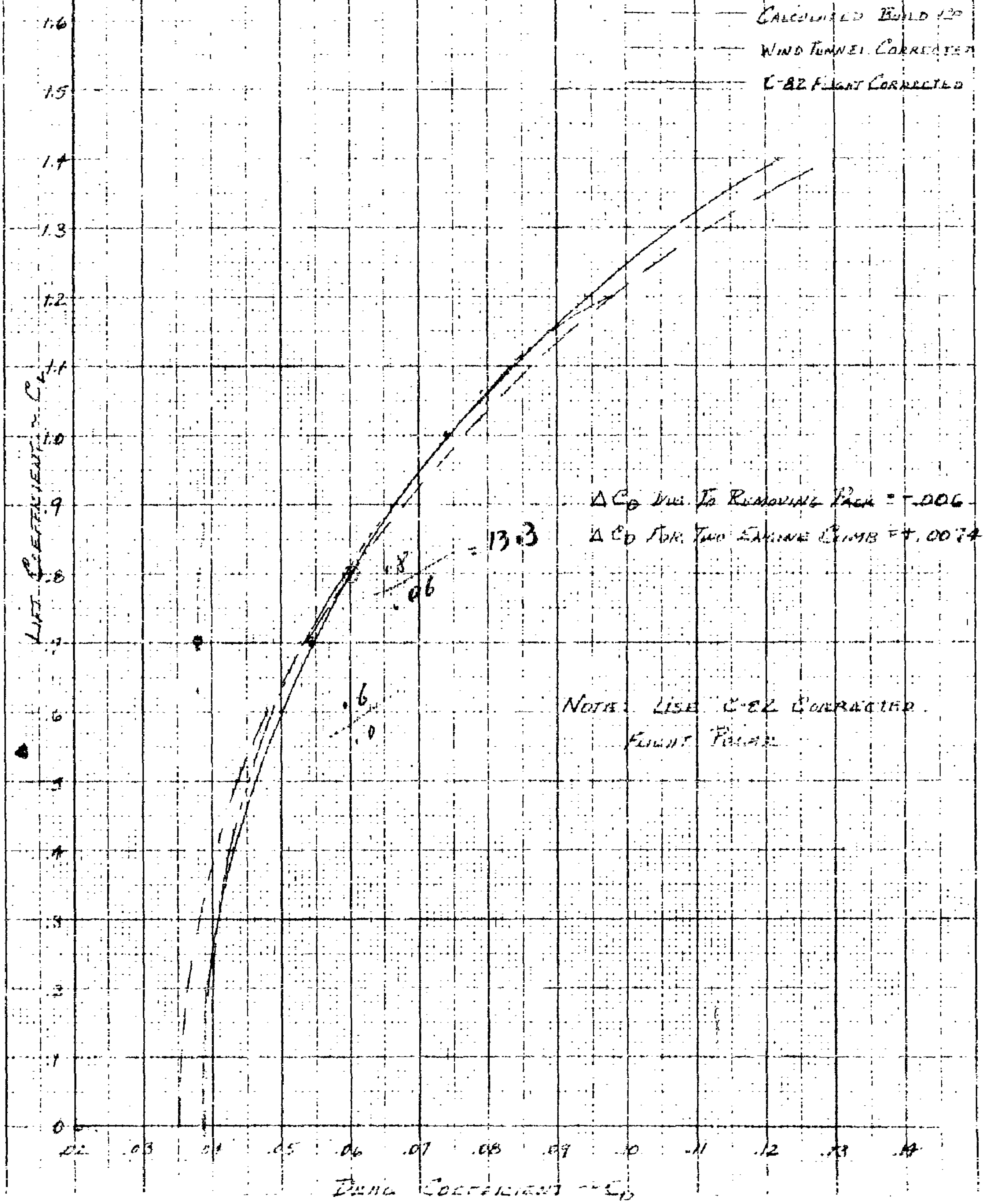
EFFECT OF CHANGE IN WING INCIDENCE FROM 3°-7° FIG 10
BALANCED AIRPLANE
FLAPS UP
POWER OFF
(M-110 CALCULATIONS)



NOTE: OBTAINED FROM BUILD UP OF COMPONENT PARTS FROM BASIC FLIGHT CRITERIA FOR TWO DIFFERENT WING INCIDENCES. USED ONLY FOR OBTAINING INCREMENTAL EFFECTS DUE TO INCREASED INCIDENCE

FIG 11

M-107 B
Polar Diagram
Clean Condition
Pack + Carriage



ΔC_D Due To Removing Pack = -.006
ΔC_D For Two Engine Climb = +.0074

Note: Use C-82 Corrected Flight Polar.

PART II-B THRUST HORSEPOWER REQUIRED (Cont.)

3. Drag of Other Items

a. Deflected Flaps

The increment in drag contributed by deflected wing flaps was obtained from wind tunnel tests and from Fairchild flight tests consisting of maximum speed runs at various flap deflections. These tests were made on the C-82 airplane, but if ΔC_D is based on flap area, the data is applicable to the XC-120 airplane which has the same wing section and wing-flap configurations. Total flap area is 100 sq. ft.

Figure 12 presents a plot of ΔC_{D_F} (based on flap area) due to deflected wing flaps versus flap deflection.

b. Landing Gear Extended

The increment in drag due to extended landing gear is estimated to be $\Delta C_D = .0656$

c. Feathered Propeller

The drag of one propeller feathered for single engine operation is estimated to be approximately 7# per blade at 100 mph. Total ΔC_D (based on wing area) = .0008

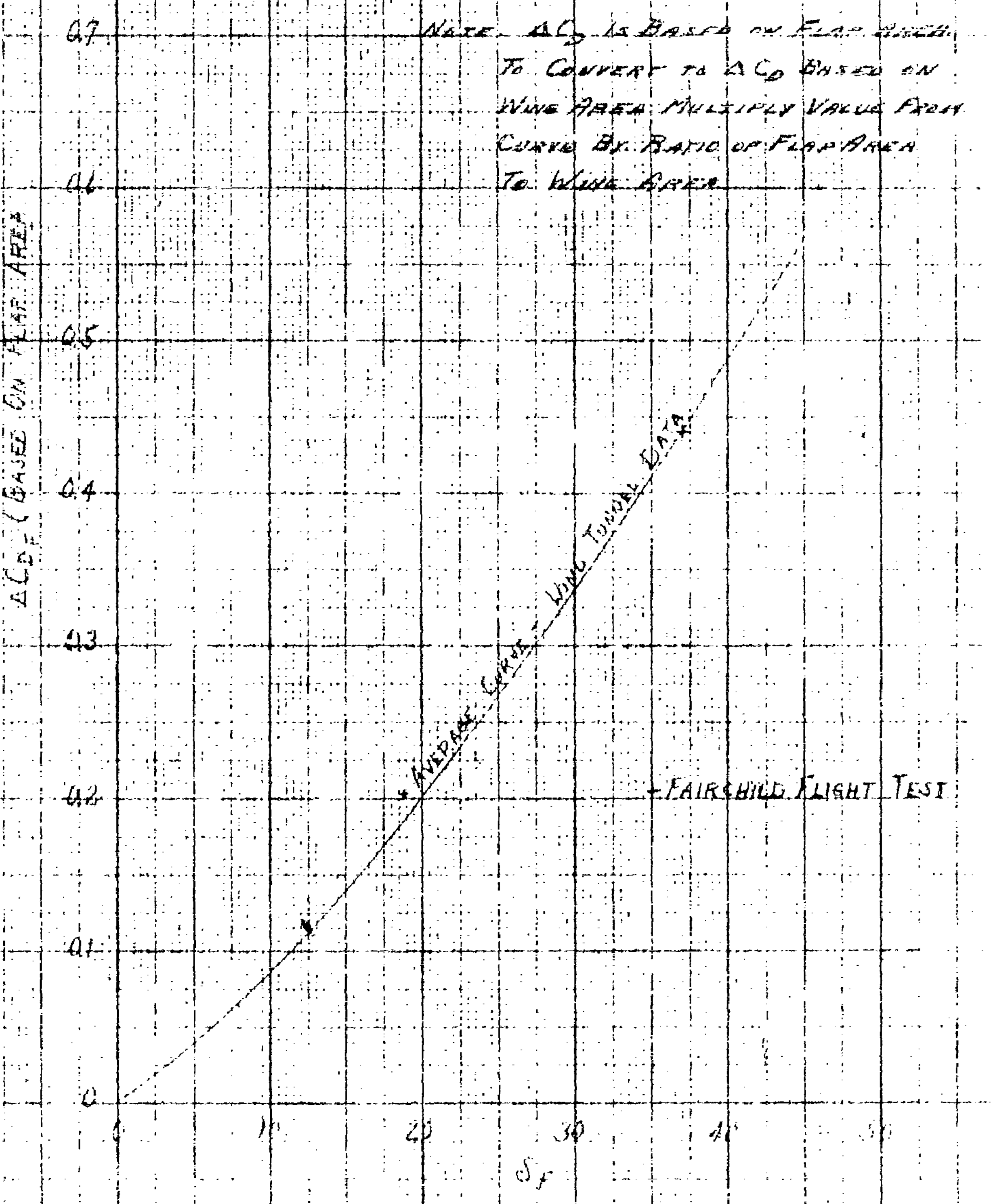
d. Deflected Rudder for Single Engine Operation

For one engine inoperative, it is necessary to deflect the rudder various degrees depending on the speed and power condition to hold the airplane in the zero yaw condition. The increment in drag contributed by the deflected rudder was estimated from the wind tunnel data of reference (g) for the C-82 airplane and shows consistent agreement with the wind tunnel data of reference (f) for the XC-120 with "pack on". Figure 13 shows a plot of yawing moment coefficient C_N versus ΔC_D for the rudder deflection necessary to maintain 0° of yaw in single engine operation.

A sample calculation demonstrating the use of this curve is presented in the following sections under the thrust horsepower required for single engine operation.

Fig. 12

XC-120
ΔC_D Due To Deflected Flaps
vs Flap Deflection

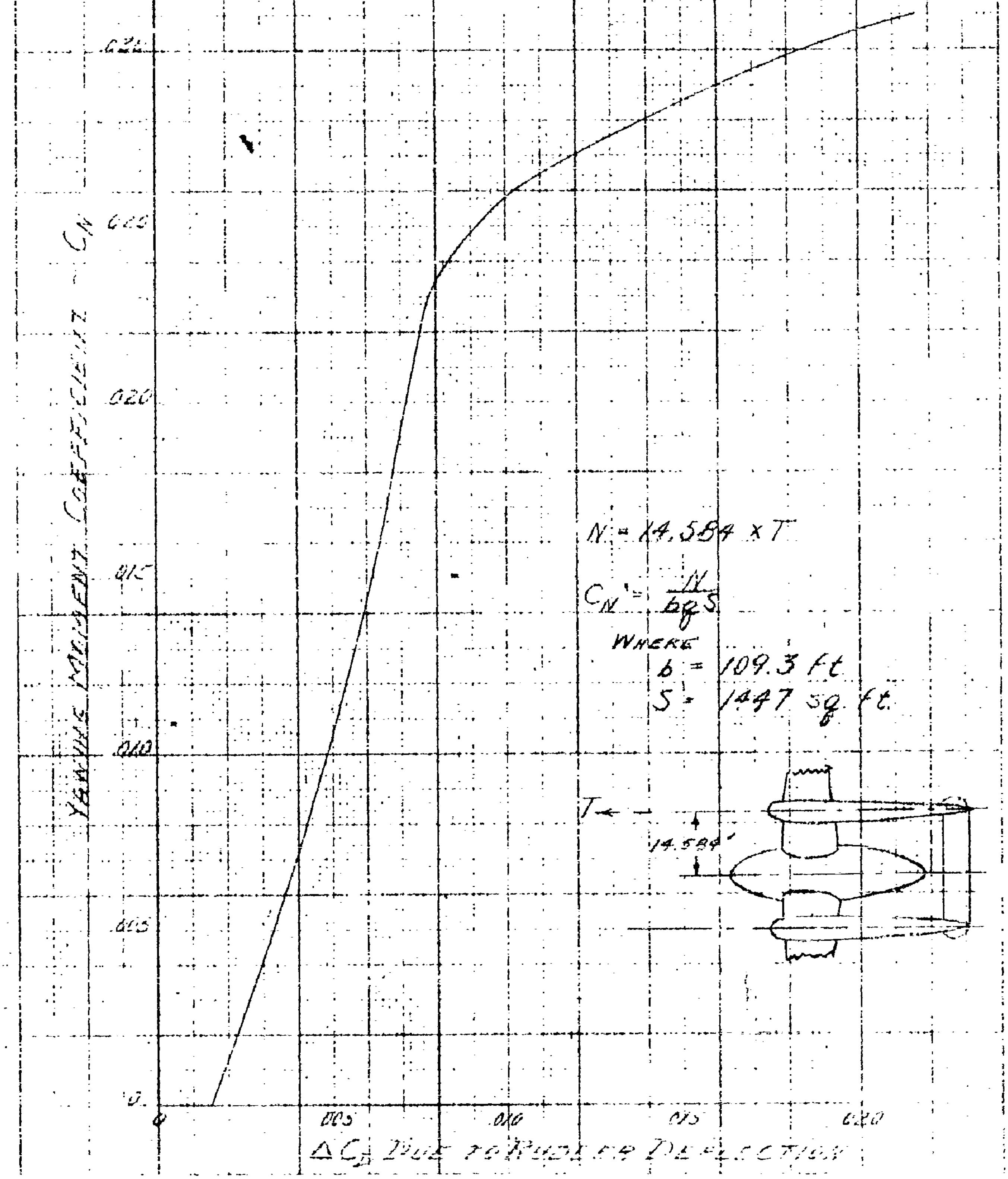


Note: ΔC_D is based on flap area. To convert to ΔC_D based on wing area multiply value from curve by ratio of flap area to wing area.

Fig. 13

XC 120

Yawing Moment Coefficient C_N vs
ΔC_D Due to Deflected Rudder
to Maintain 0° Yaw in
Single Engine Operation



N = 14.584 x T

$C_N' = \frac{N}{bqS}$

Where
b = 109.3 ft
S' = 1447 sq. ft.

SECTION B - THRUST HORSEPOWER REQUIRED (Cont.)

4. Thrust Horsepower Required Versus Speed

a. Two Engine Operation

Thrust horsepower required for two engine operation was calculated using the polar diagram of figure 11 for gross weights of 44,000, 54,000, 64,000 and 74,000 lbs. A sample calculation is shown on the following page for a gross weight of 64,000 lbs. Results of these computations are plotted in the figures tabulated below.

Altitude	Figure
Sea Level	14 and 17
1500'	17
3300'	18
6000'	14
7300'	15
17000'	18
18000'	15
20000'	19
25000'	16

PART II-B-4 (Cont.)

SAMPLE CALCULATIONS - THP REQUIRED - 2 ENGINE OPERATION - GROSS WEIGHT 64,000 LBS.

High Speed - Cowl Flaps Closed

C_L	C_D	$q = \frac{W}{C_L S}$	$D = C_D q S$
.2	.0394	221	12020
.3	.0408	147	8660
.4	.0429	110	6820
.5	.0460	88.4	5890
.6	.0502	73.6	5350
.7	.0549	63.1	5010
.8	.0600	55.2	4795

Climb - Cowl Flaps Open 15°

C_L	C_D	$q = \frac{W}{C_L S}$	$D = C_D q S$
.7	.0623	63.1	5690
.8	.0674	55.2	5390
.9	.0737	49.1	5240
1.0	.0813	44.2	5200
1.1	.0906	40.2	5270
1.2	.1020	36.8	5440
1.3	.1159	34.0	5700

After finding speed (V) and THP_R at Sea Level, corresponding velocities and power required at any desired altitude may be obtained readily by the following relation: -

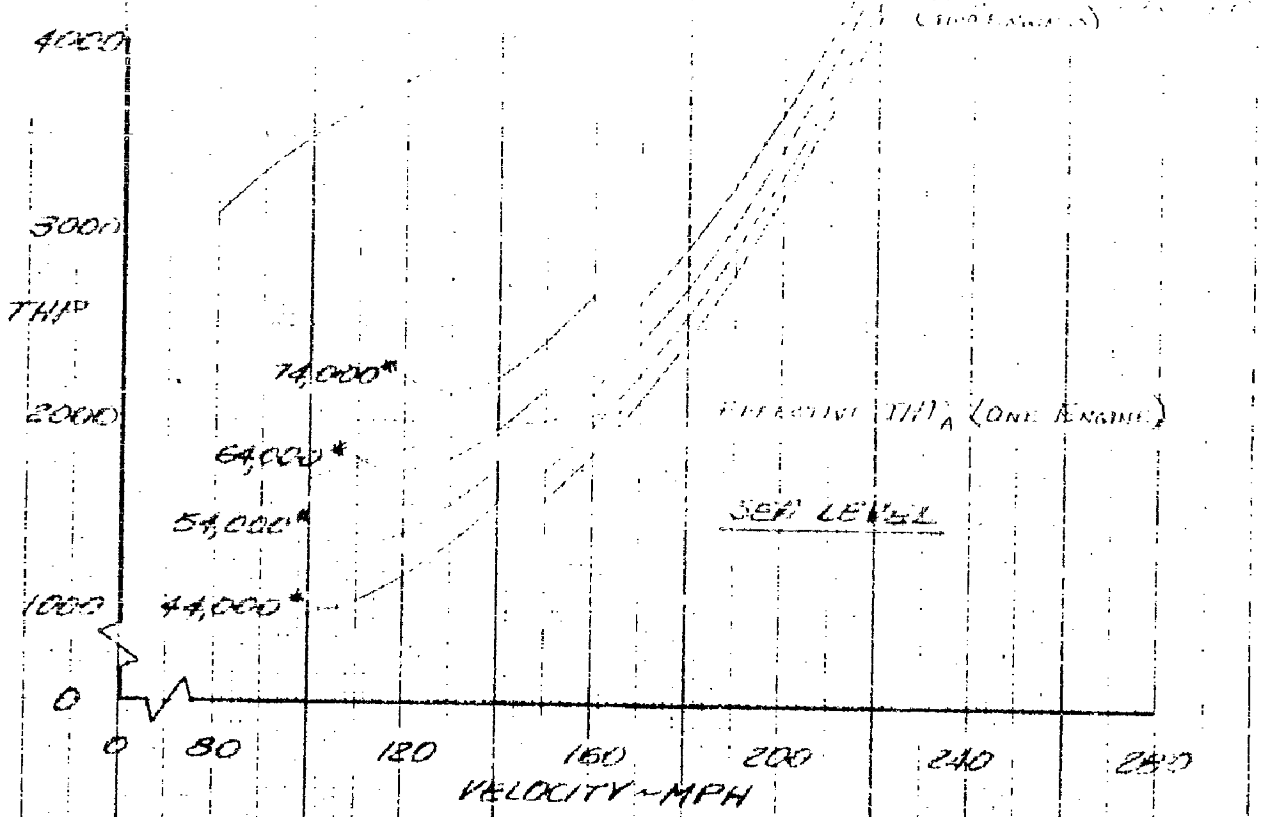
$$V_{alt.} = V_{S.L.} \sqrt{1/\sigma}_{\,alt.} \qquad THP_{R(alt.)} = THP_{R(S.L.)} \sqrt{1/\sigma}_{\,alt.}$$

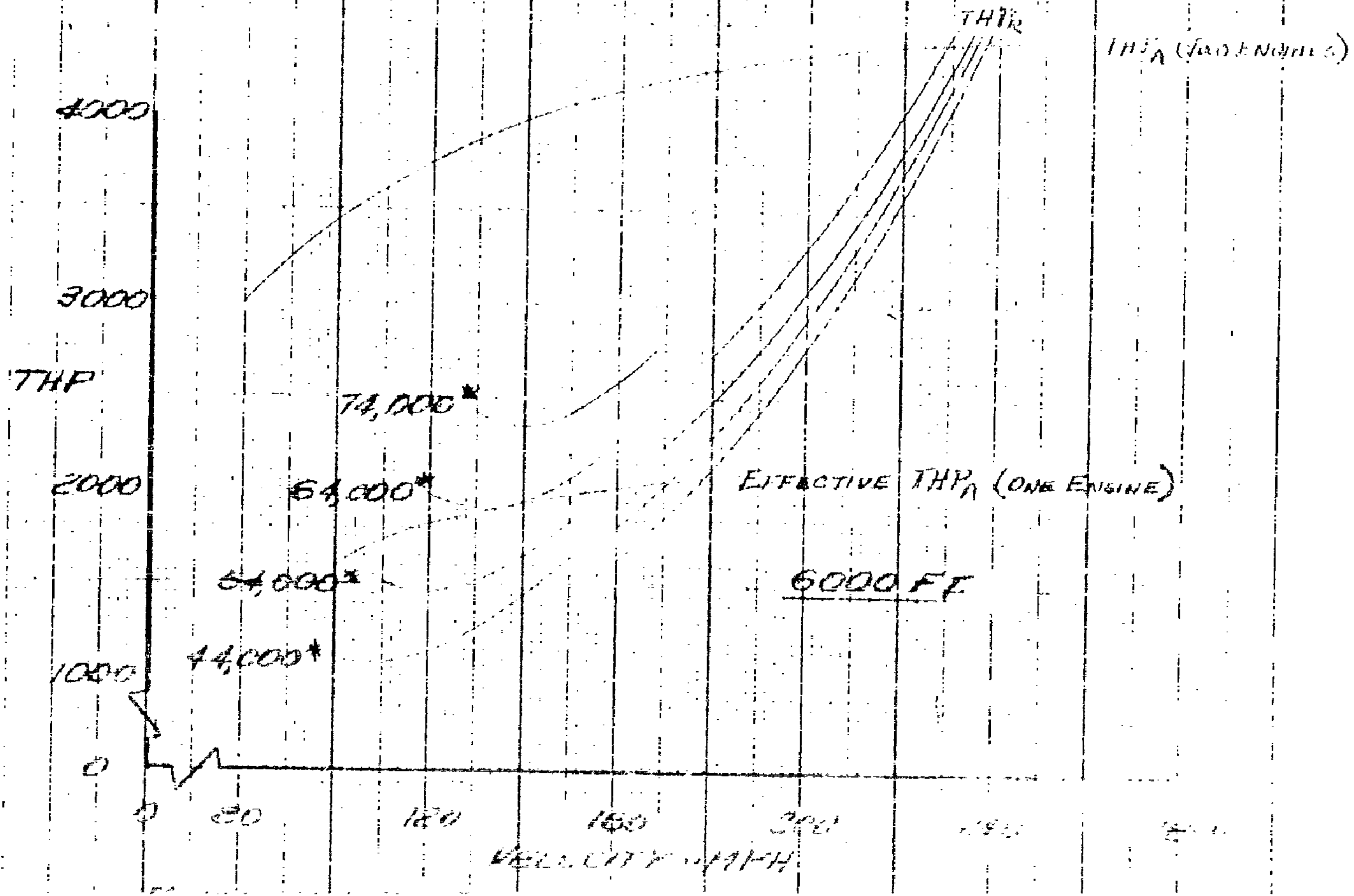
Altitude Condition		Sea Level		6000 Ft.		7300 Ft.		18000 Ft.	
	C_L	V	THP_R	V	THP_R	V	THP_R	V	THP_R
High Speed	.2	294	9870	321.8	10796	328	11013	389	13076
	.3	240	5560	262.5	6027	267.9	6148	318	7300
	.4	208	3805	227.9	4162	232.0	4246	276	5041
	.5	186	2913	203.7	3186	207.2	3250	246	3859
	.6	169.8	2420	186.	2647	189.1	2700	225	3206
	.7	157.	2103	172.	2300	175.0	2347	208	2786
	.8	147.	1880	160.9	2056	164.0	2098	194.8	2491
Climb	.7	157	2380	172.0	2603	175.0	2656	208	3153
	.8	147	2110	160.9	2308	164.0	2354	194.8	2795
	.9	138.7	1939	152.0	2121	154.8	2164	183.8	2569
	1.0	131.5	1822	144.0	1993	146.7	2033	174	2414
	1.1	125.2	1761	137.0	1926	139.7	1965	166	2333
	1.2	120.0	1740	131.2	1903	133.9	1941	159	2305
	1.3	115.2	1752	126.1	1916	128.6	1955	152.7	2321

Speed and THP_R may be found for any other desired gross weight at a given altitude and C_L from the above data by using the following relations:

$$V_{wgt.} = V_{64,000} \left[\frac{W}{64,000}\right]^{\frac{1}{2}} ; \quad THP_{R_{wgt.}} = THP_{R_{64,000}} \left[\frac{W}{64,000}\right]^{3/2}$$

XC-120 PACKPLANE

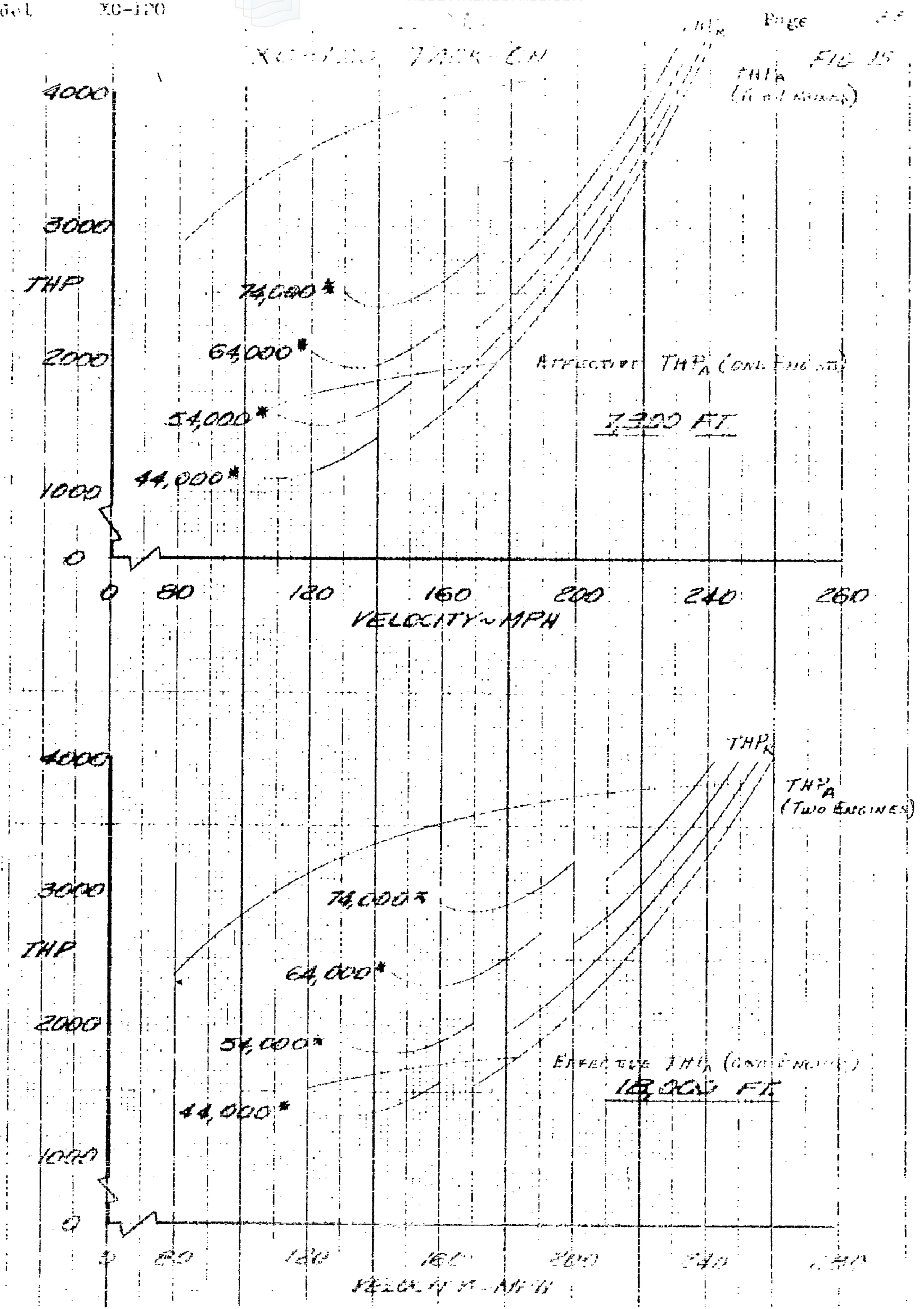




POWER REQUIRED AND AVAILABLE. NORMAL RATED POWER ONE [illegible]

XC-120 PACK-ON

FIG 15

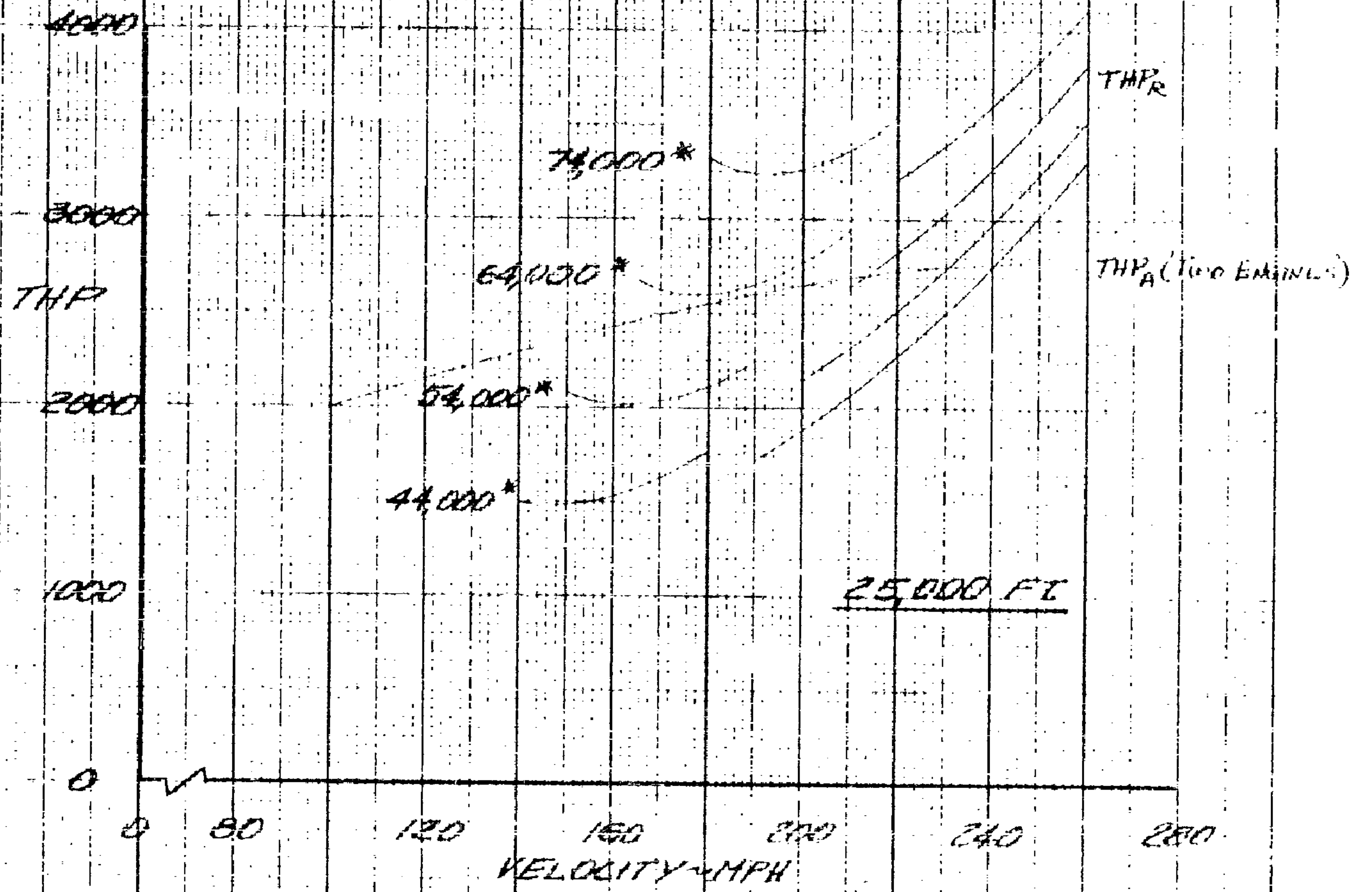


POWER REQUIRED AND AVAILABLE, NORMAL RATED POW[illegible]

[illegible]

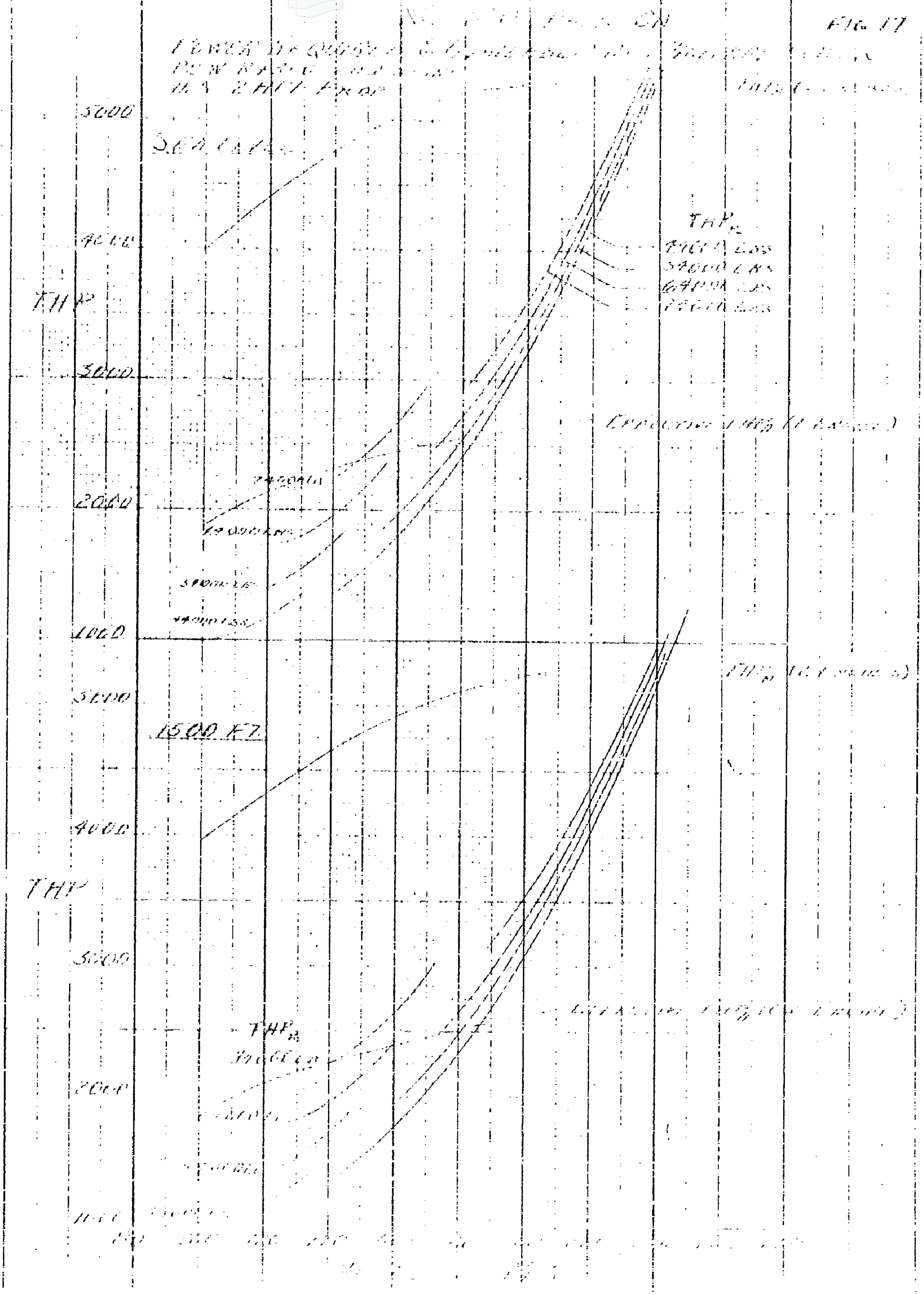
XC-120 PACK-ON

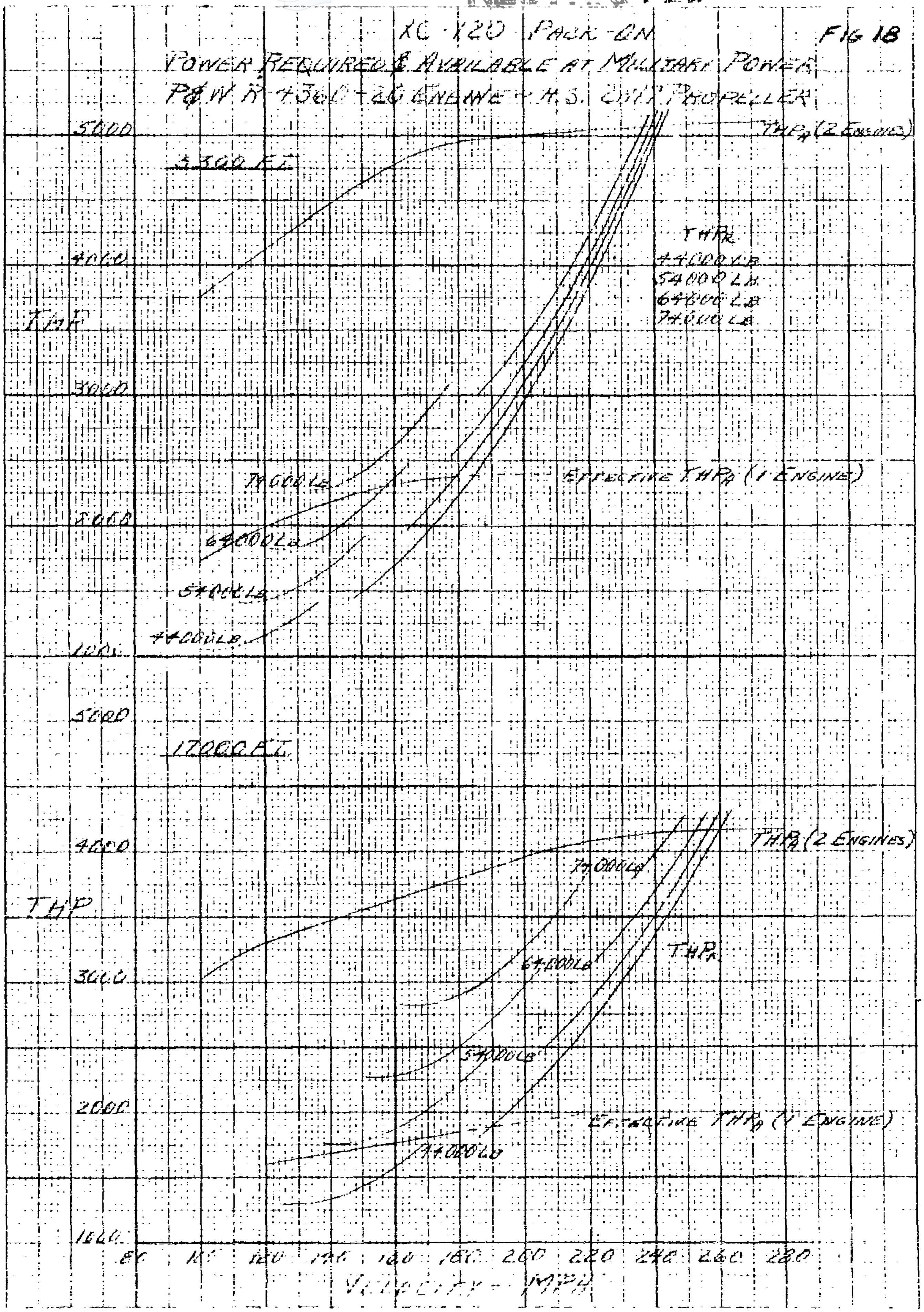
FIG 16



POWER REQUIRED AND AVAILABLE NORMAL RATED POWER TWO ENGINES

FIG. 17


5000
SEA LEVEL
4000
THP
3000
2000
1000
THP_R
79000 LBS
64000 LBS
5000
1500 FT.
4000
THP
3000
THP_R
2000



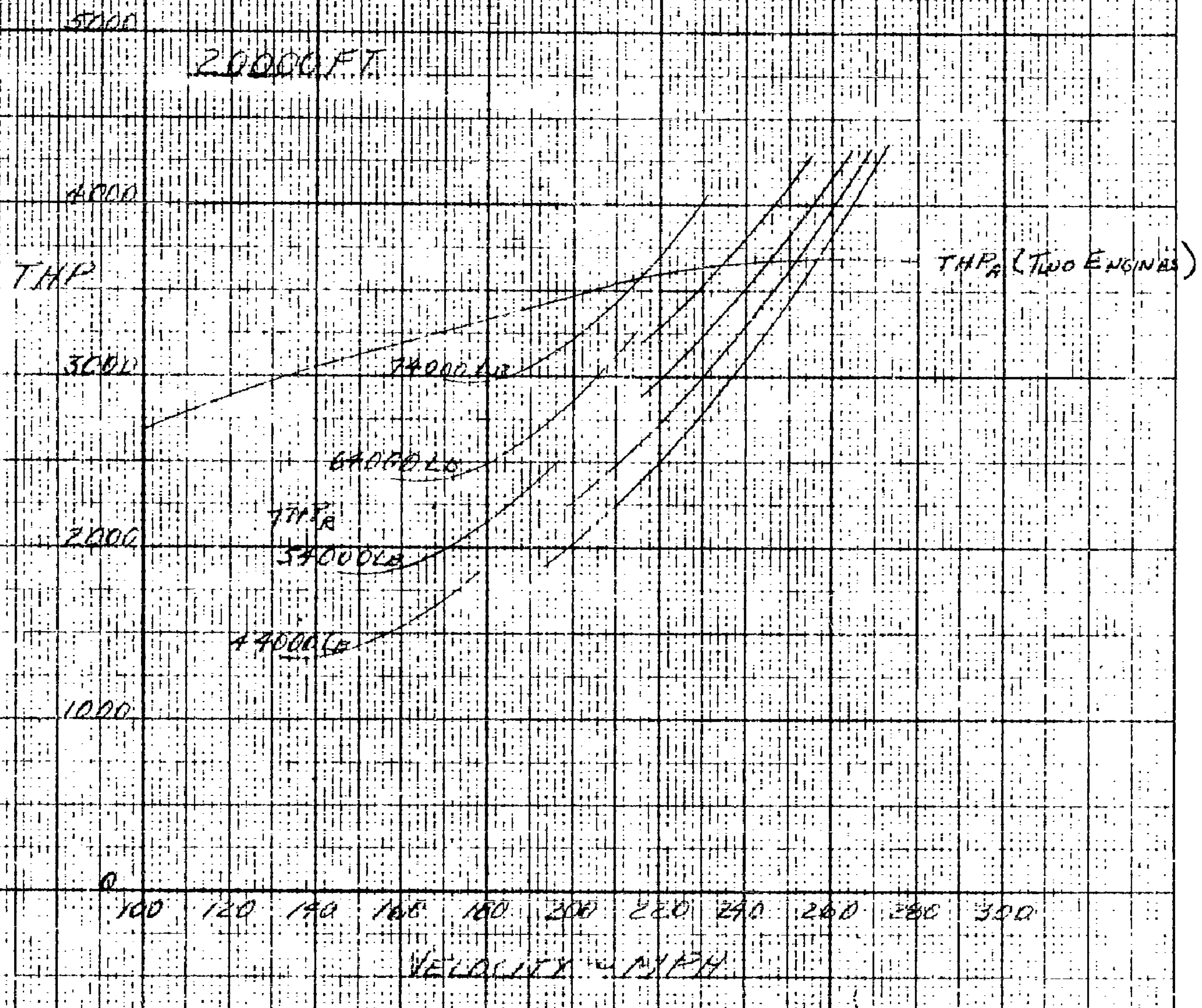
XC-120 PACK-ON

FIG 18

POWER REQUIRED & AVAILABLE AT MILITARY POWER
P&W R-4360-20 ENGINE + H.S. [illegible] PROPELLER

FIG 18

XC-120 PACK-ON
POWER REQUIRED & AVAILABLE AT MILITARY POWER
P&W R4360-20 ENGINE INSTALLATION
4 BLADE - HAM. STD. 2H17 PROPELLER



PART II-B-4 (Cont.)

b. Single Engine Operation

For single engine operation the Δ THP required due to deflected rudder and one feathered propeller was calculated using figure 13 for the deflected rudder and the estimated drag quoted on page 29 for the feathered propeller. Figure 20 presents a plot of Δ THP required due to deflected rudder and feathered propeller versus airplane speed with altitude parameters for single engine operation at normal rated power. Figure 21 presents a similar plot for single engine operation at military rated power. In addition to the increase in power required due to deflected rudder and feathered propeller there is a decrease in power required due to the closed engine cowl flaps and oil cooler flaps on the dead engine. This decrease is taken as one half the drag increase from high speed to climb condition or $\Delta C_D = -.0037$.

The net Δ THP required due to deflected rudder, feathered propeller, and closed engine and oil cooler flaps on the dead engine was subtracted from the THP available for convenience, instead of being added to the THP required. Figure 14 through 19 show effective THP available for single engine operation where: -

$$\text{Effective THP}_{a(1\ \text{engine})} = \frac{\text{THP}_{a(2\ \text{engines})}}{2} - \Delta \text{THP}_r \text{ due to deflected rudder and feathered propeller}$$

$$- \Delta \text{THP}_r \text{ due to closed cowl flaps and oil cooler flaps}$$

PART II-B-4 (Cont.)

b. Single Engine Operation (Cont.)

Sample Calculation - ΔTHP_r due to deflected rudder and feathered propeller at zero yaw - single engine operation

Formulae:

$$N = \bar{y} \times T$$

$$C_N = \frac{N}{b\,q\,S} = \frac{\bar{y}\,T}{b\,q\,S} = .0000921\,\frac{T}{q}$$

where:

N = normal force

$\bar{y}$ = 14.584 ft. (distance from propeller centerline to airplane

T = Thrust in lbs. = THP x 375/Vmph

C_N = normal force coefficient

b = 109.27 ft.

q = dynamic pressure

S = wing area = 1447.27 sq. ft.

Sea Level - Military Power

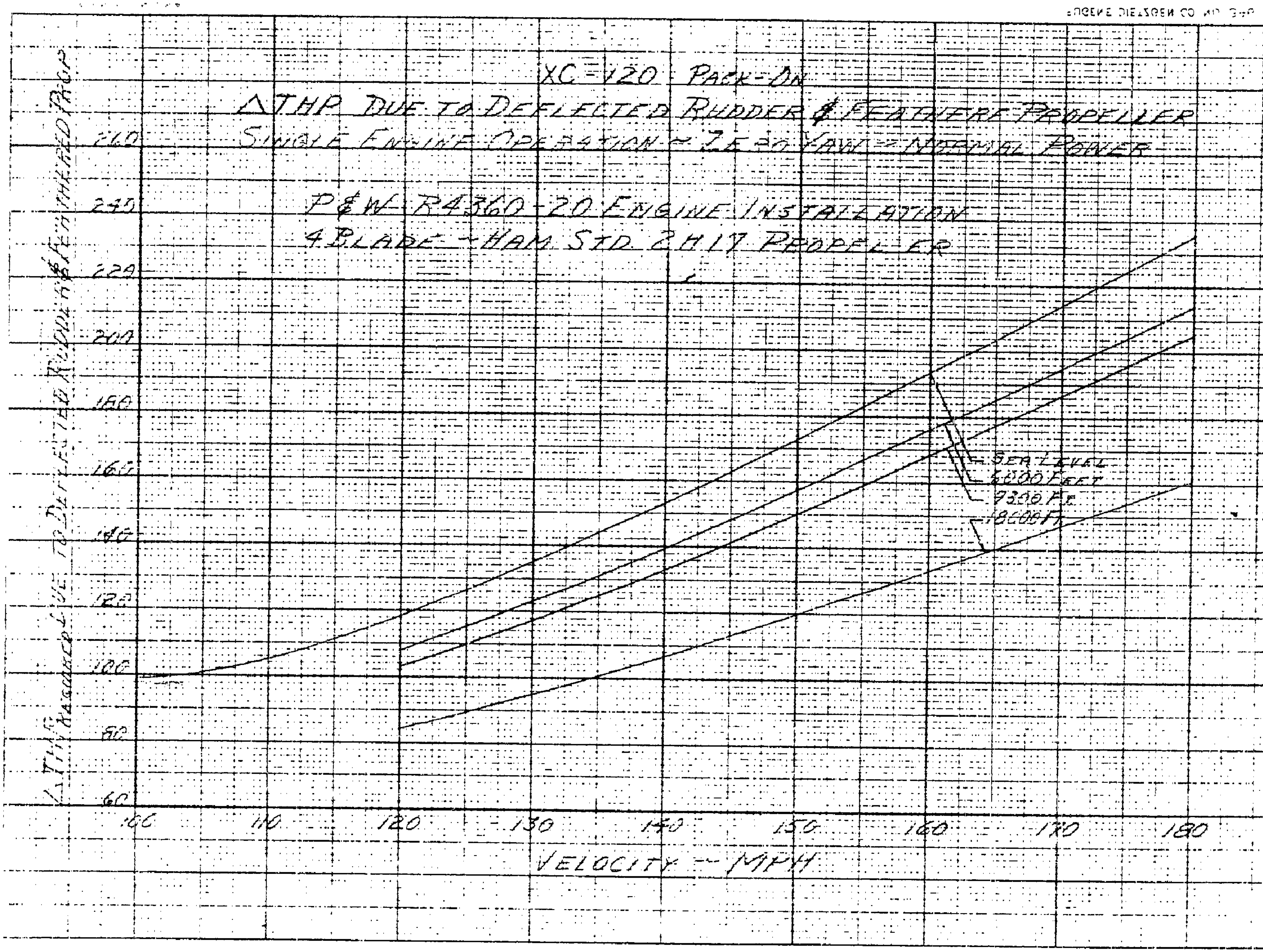
V_{mph}	THP_a	T lbs.	q $\frac{lbs.}{ft.^2}$	C_N	ΔC_{D_R}	ΔC_{D_P}	$\Delta C_{D_{R-P}}$	D lbs.	ΔTHP_r
100	2000	7500	25.58	.0270	.01192	.0008	.01272	471	126
120	2202	6880	36.6	.01724	.00663	.0008	.00743	396	127
140	2380	6380	50.1	.01172	.00530	.0008	.00610	443	165
160	2520	5900	65.4	.00832	.00434	.0008	.00514	487	208
180	2610	5440	82.9	.00605	.00363	.0008	.00443	531	255

Sample Calculation - ΔTHP_r due to closing engine cowl flaps and oil cooler on dead engine - single engine operation

Sea Level

V_{mph}	q $\frac{lbs.}{ft.^2}$	ΔC_D	ΔD lbs.	ΔTHP_r
100	25.58	.0037	137	36.5
120	36.8	.0037	197	63.0
140	50.1	.0037	268	100.0
160	65.4	.0037	350	149.0
180	82.9	.0037	444	213.0

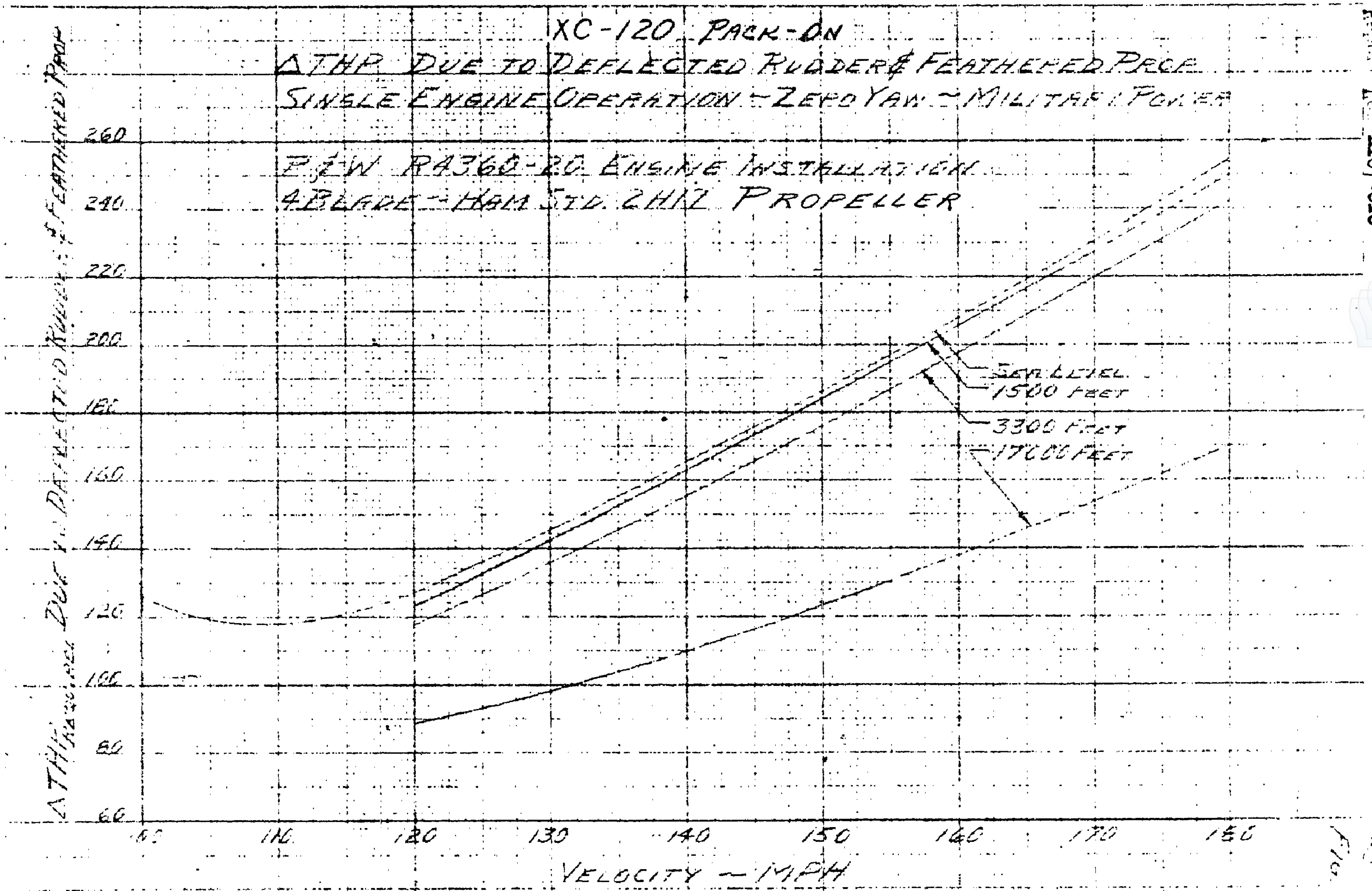
FIG 30



XC-120 PACK-ON
ΔTHP DUE TO DEFLECTED RUDDER & FEATHERED PROPELLER
SINGLE ENGINE OPERATION ~ 7.5° YAW ~ NORMAL POWER

P&W R4360-20 ENGINE INSTALLATION
4 BLADE - HAM STD 2H17 PROPELLER

Fig. 21



XC-120 PACK-ON

ΔTHP DUE TO DEFLECTED RUDDER & FEATHERED PROP.

SINGLE ENGINE OPERATION ~ ZERO YAW ~ MILITARY POWER

P & W R4360-20 ENGINE INSTALLATION

4 BLADE ~ HAM. STD. 2H17 PROPELLER

PART II-C

C. CLIMB AND CEILING CALCULATIONS

Maximum rates of climb have been computed for the subject airplane at gross weights of 44,000, 54,000, 64,000 and 74,000 lbs. with the "pack on" at both normal rated and military power. Rate of climb is determined from the maximum difference of horsepowers available and required as obtained from figures 14 through 19 according to the usual relationship:

$$\text{Rate of Climb} = (THP_a - THP_r)\frac{33000}{G.W.} \quad \text{ft./min.}$$

Maximum rate of climb versus altitude for the gross weights listed above is presented in figures 22 through 25 for two engine and single engine operation at normal rated and military power.

Service ceiling (R/C = 100 ft./min.), absolute ceiling (R/C = 0 ft./min.), and combat ceiling (R/C = 500 ft./min. on maximum power) have been obtained from these plots of calculated rates of climb. A plot of service ceiling versus gross weight is presented in figures 26 and 28 for two engine operation at normal and military power, respectively. Figures 27 and 29 present plots of absolute and service ceilings versus gross weight for single engine operation at normal rated and military power, respectively. Figure 28 also presents a plot of combat ceiling versus gross weight where combat ceiling is defined as the altitude where the maximum rate of climb is 500 ft./min. during two engine operation at maximum (military) power.

Time to climb was obtained by a step-by-step integration of the rate of climb curves:

$$\text{Time to Climb} = \int_0^H \left[1/(R/C)\right] dh$$

Time to climb versus altitude is presented on figures 22 and 24 for two engine operation at normal rated and military power, respectively.

FIG 22

XC-120 PACK ON
RATE OF CLIMB AND TIME TO CLIMB
NORMAL RATED POWER TWO ENGINES

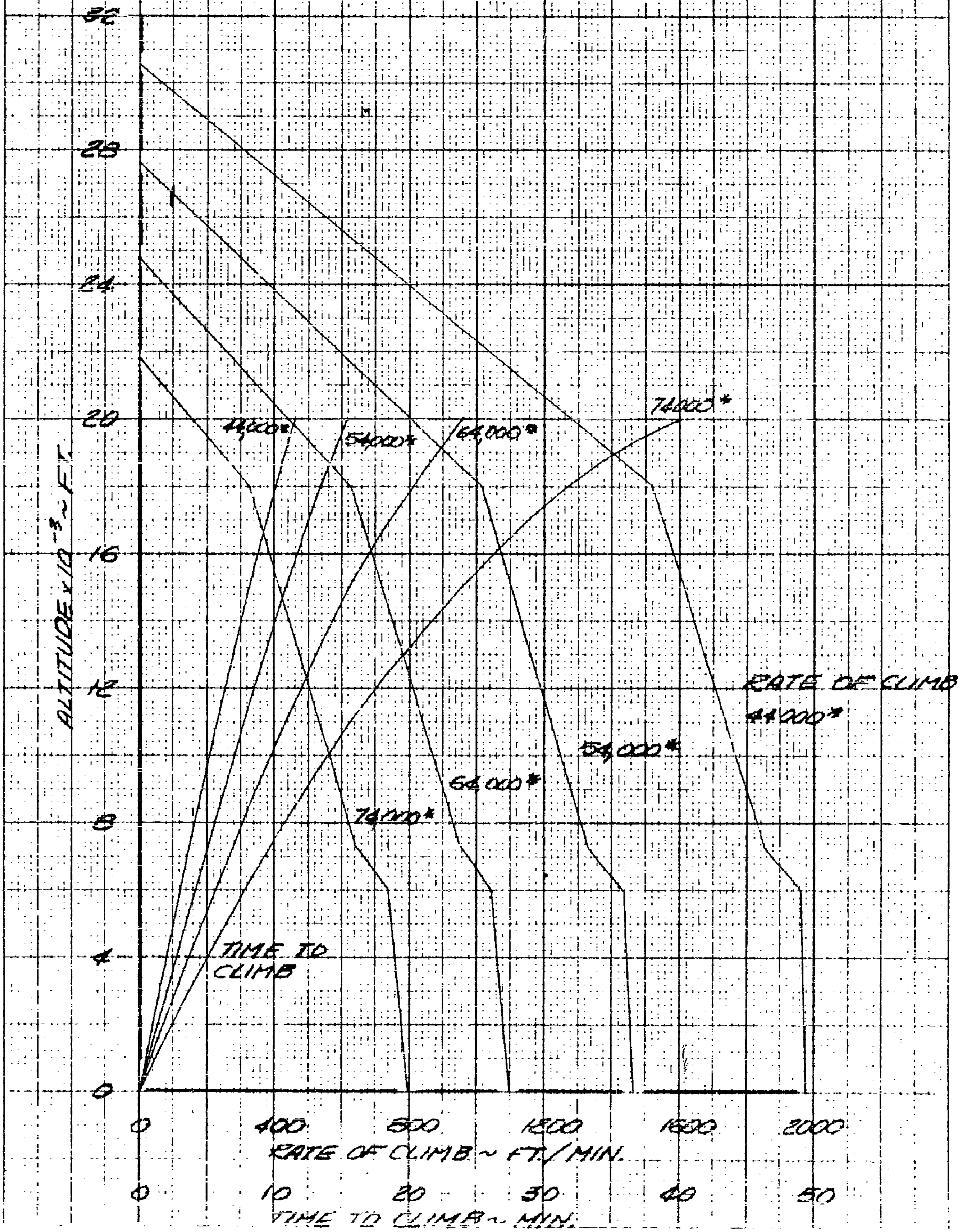
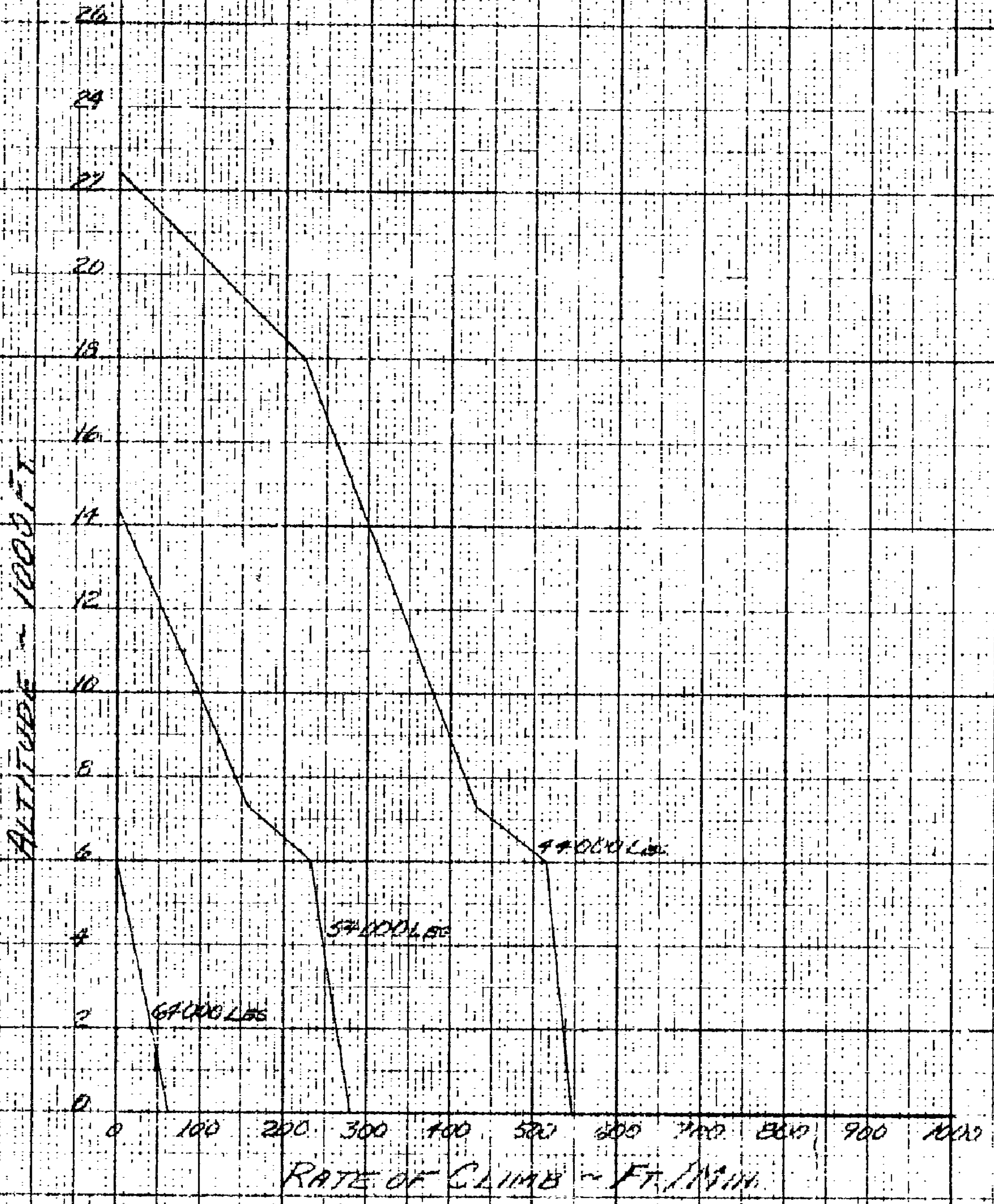


FIG. 23

XC-120 [illegible]

SINGLE ENGINE RATE OF CLIMB VS ALTITUDE
P&W R-4360-20 ENGINE INSTALLATION
4 BLADE - HAMILTON STANDARD 2H17 PROP

NORMAL RATED POWER



XC-120 PACK-ON

FIG 24

RATE OF CLIMB & TIME TO CLIMB VS ALTITUDE
P&W R4360-20 ENGINE ~ 4 BLADE H.S. 2H17 PROP
TWO ENGINE MILITARY POWER AVAILABLE

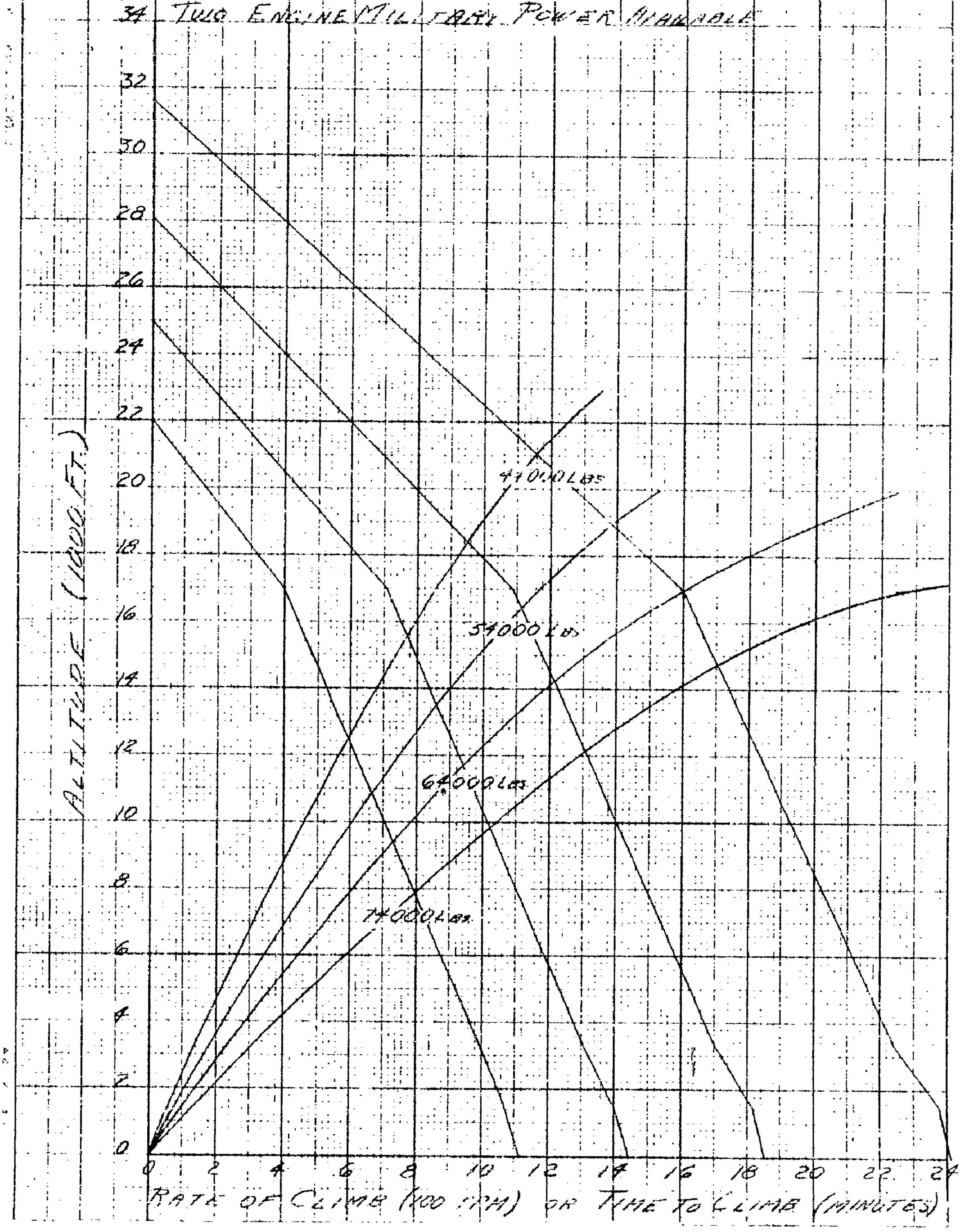


FIG 25

XC-120
SINGLE ENGINE RATE OF CLIMB VS. ALTITUDE
P & W R4360-20 ENGINE INSTALLATION

MILITARY POWER

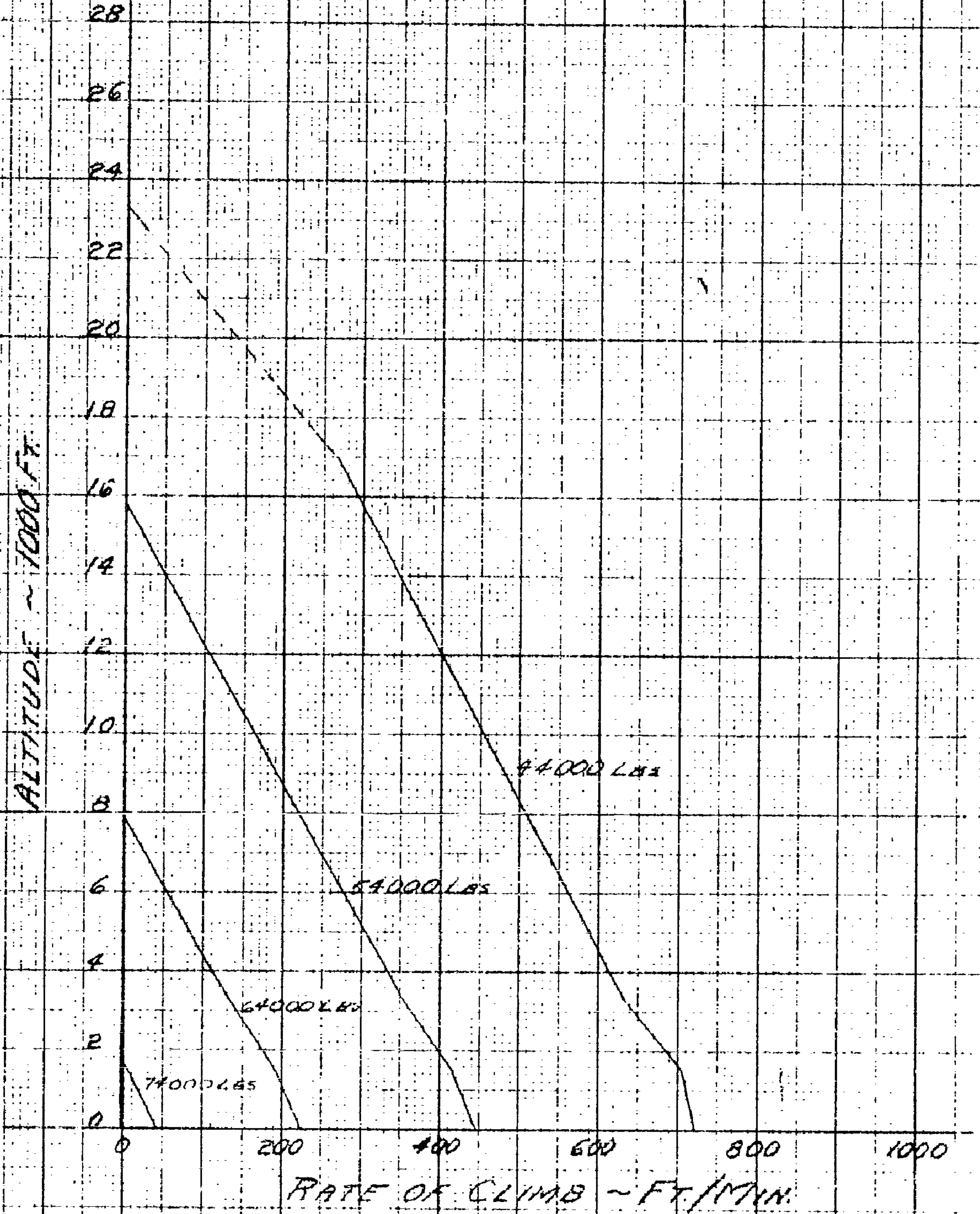
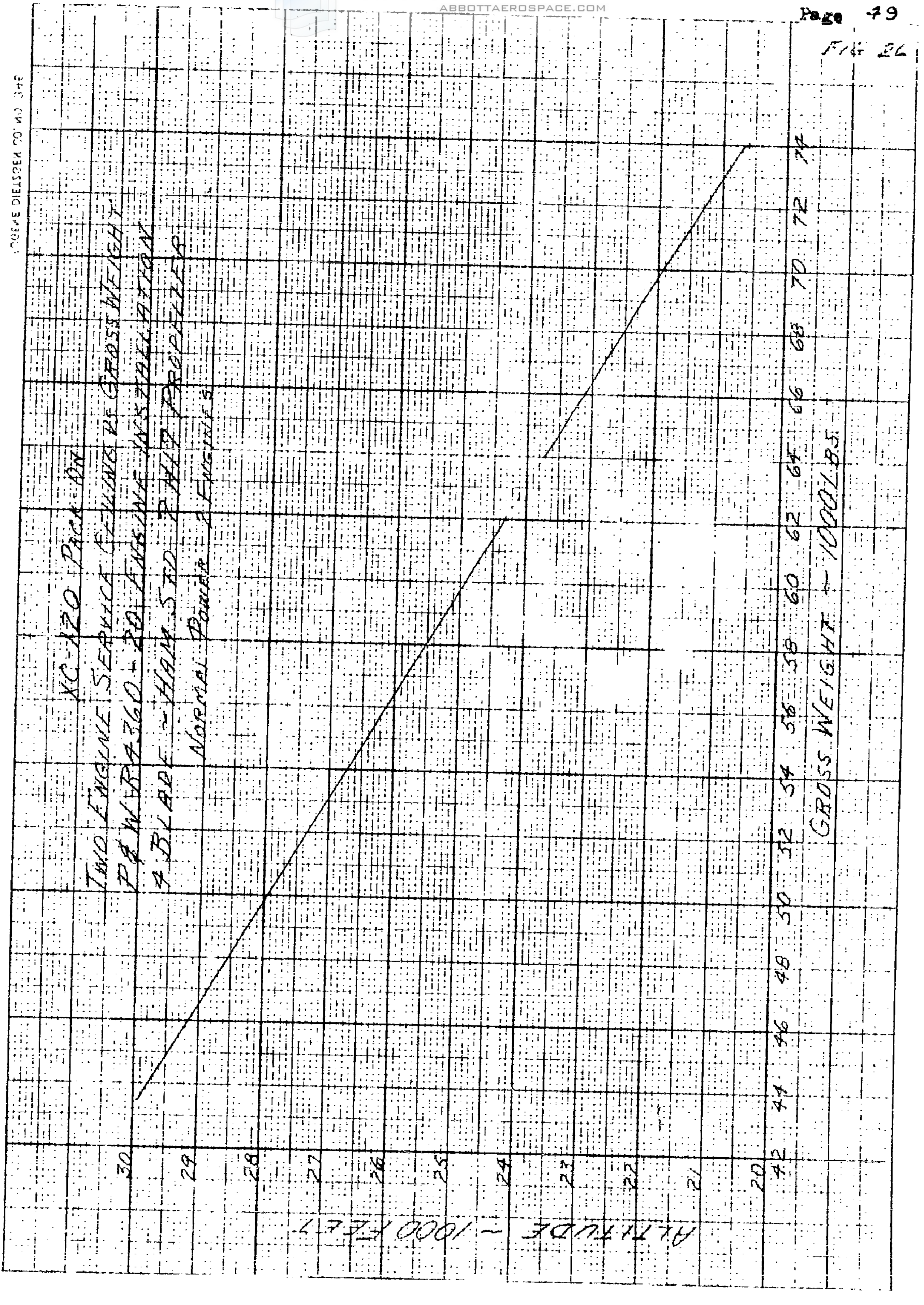
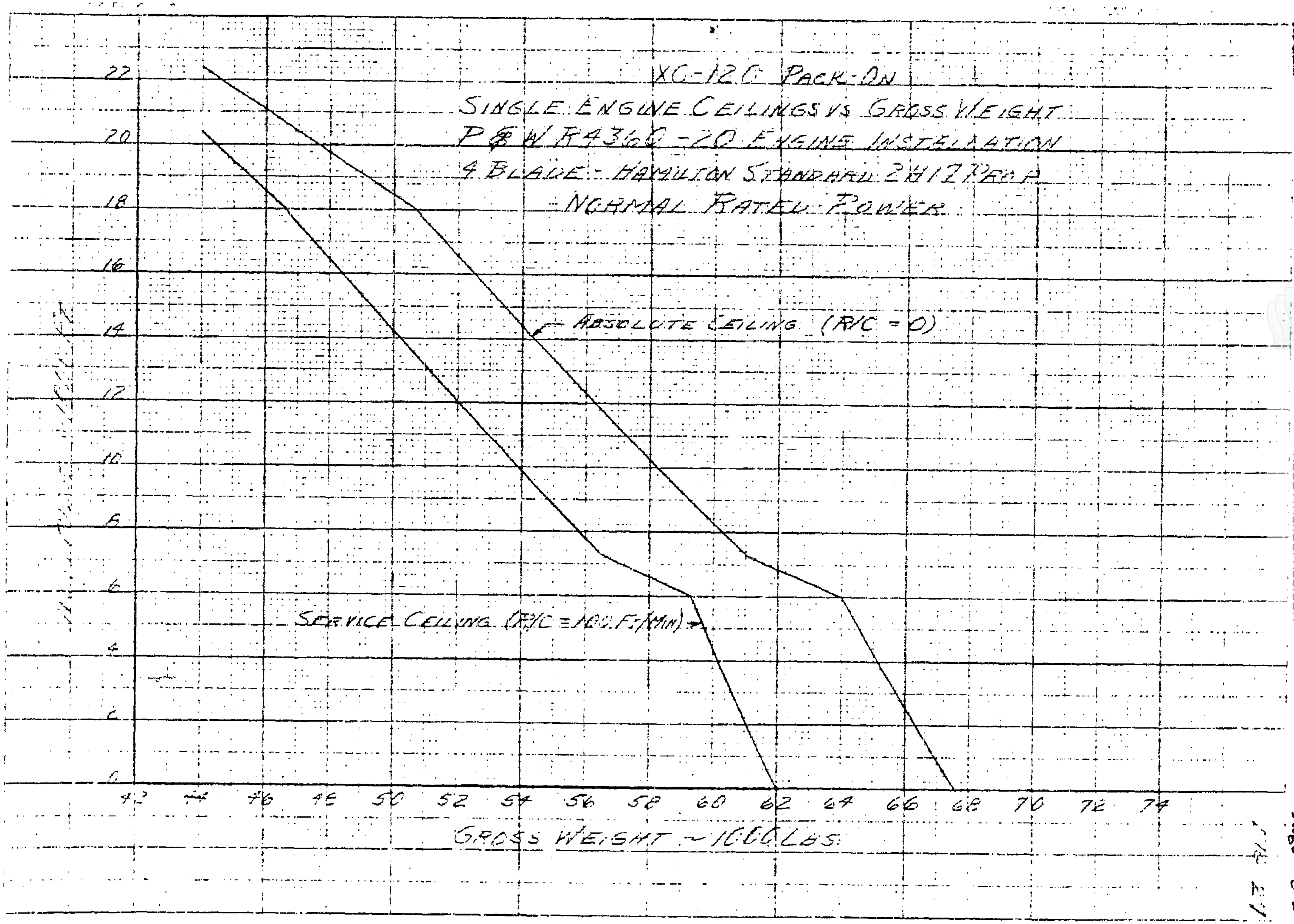


FIG 26


XC-120 PACK ON
TWO ENGINE SERVICE CEILING vs GROSS WEIGHT
P&W R4360-20 ENGINE INSTALLATION
4 BLADE ~ HAM STD PROPELLER
NORMAL POWER 2 ENGINES
GROSS WEIGHT ~ 1000 LBS
42
44
46
48
50
52
54
56
58
60
62
64
66
68
70
72
74
ALTITUDE ~ 1000 FT
30
29
28
27
26
25
24
23
22
21
20



XC-120 PACK-ON
SINGLE ENGINE CEILINGS VS GROSS WEIGHT
P & W R4360-20 ENGINE INSTALLATION
4 BLADE - HAMILTON STANDARD 2H17 PROP
NORMAL RATED POWER

FIG 18

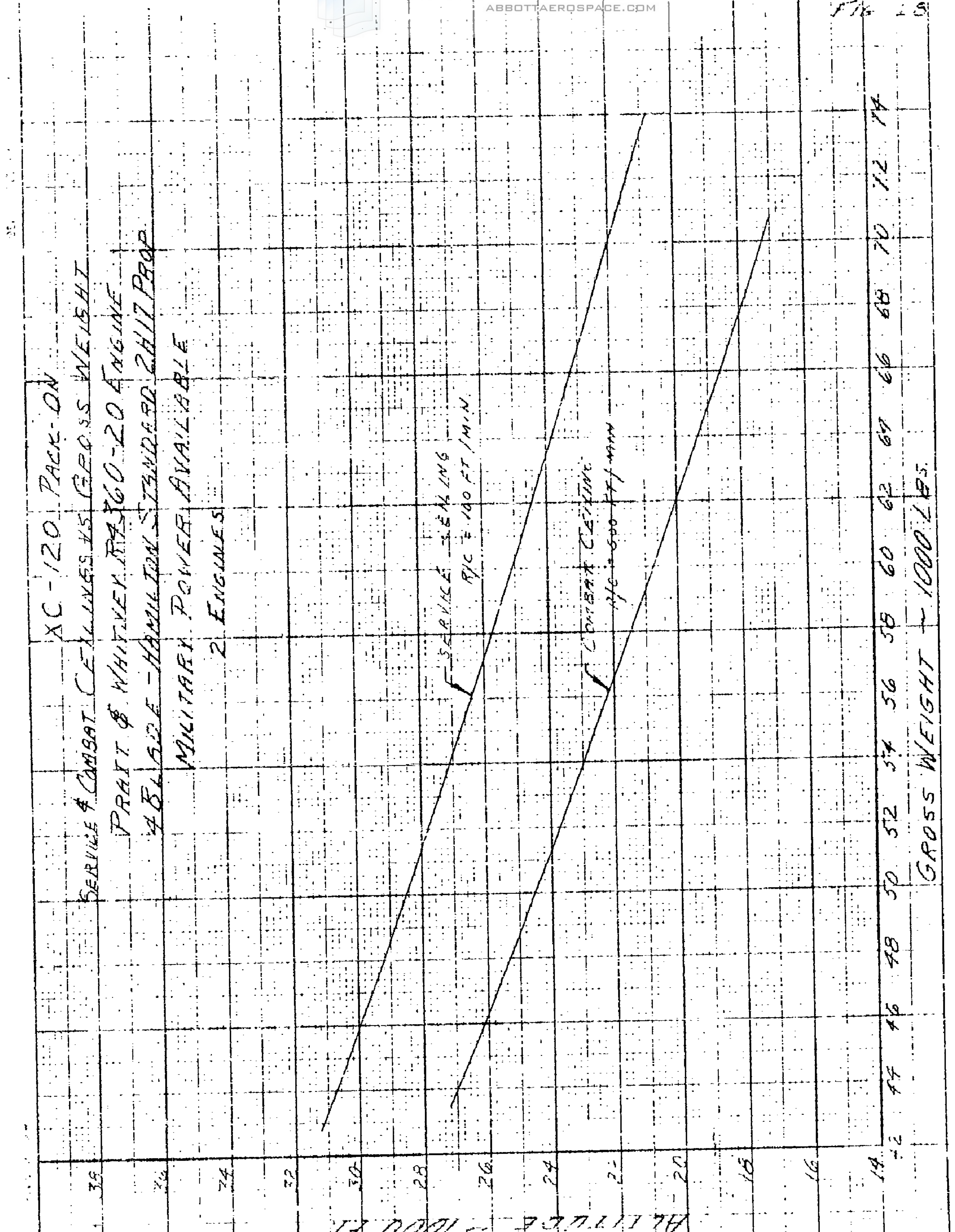
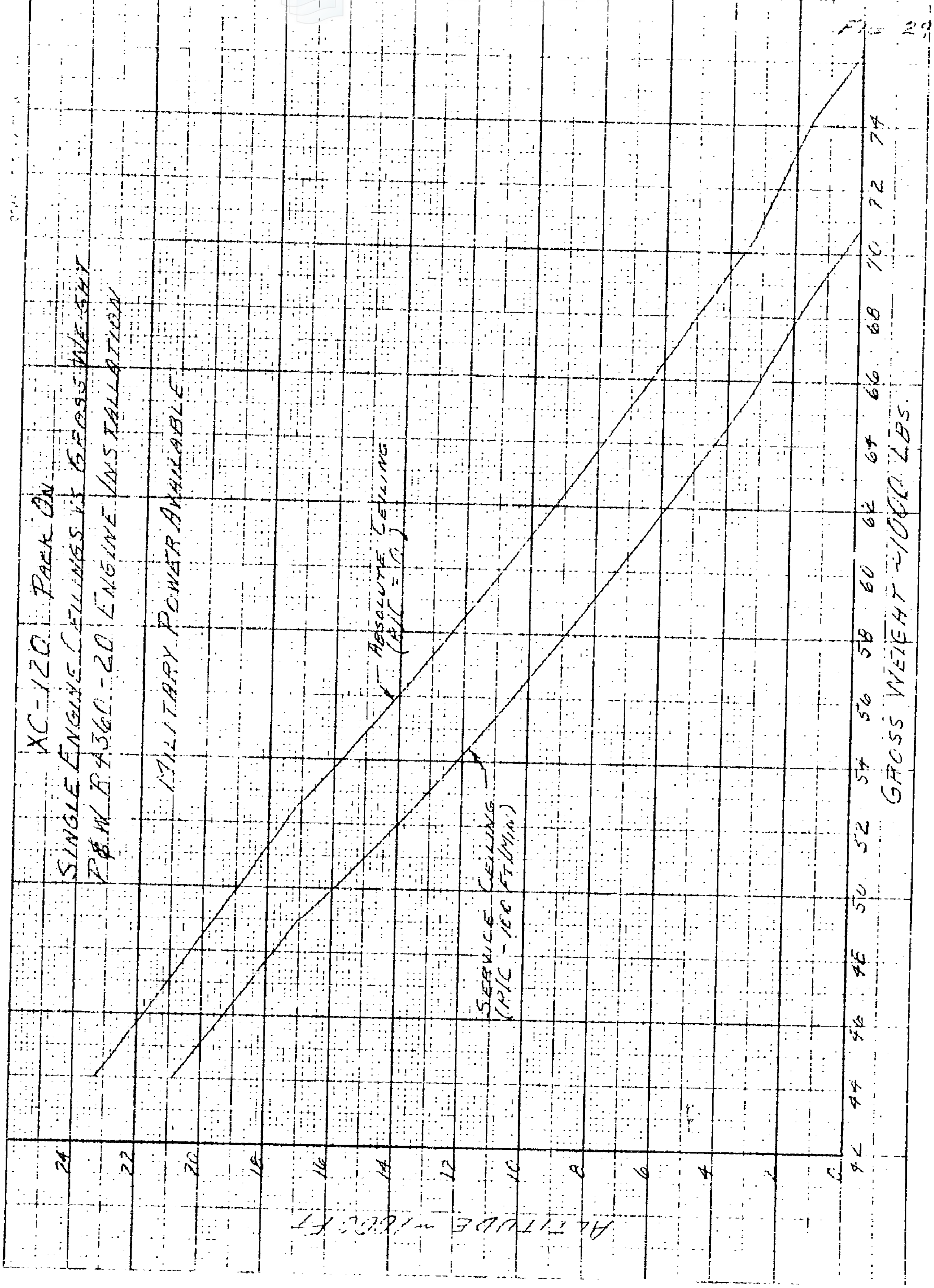

XC-120 PACK-ON
SERVICE & COMBAT CEILINGS VS GROSS WEIGHT
PRATT & WHITNEY R4360-20 ENGINE
4 BLADE - HAMILTON STANDARD 2H17 PROP
MILITARY POWER AVAILABLE
2 ENGINES
SERVICE CEILING
R/C = 100 FT/MIN
COMBAT CEILING
R/C = 500 FT/MIN
GROSS WEIGHT ~ 1000 LBS.
42
44
46
48
50
52
54
56
58
60
62
64
66
68
70
72
74
ALTITUDE ~ 1000 FT
14
16
18
20
22
24
26
28
30
32
34
36
38

Fig. 29


XC-120 Pack On
Single Engine Ceilings vs Gross Weight
P&W R4360-20 Engine Installation
Military Power Available
Absolute Ceiling (R/C = 0)
Service Ceiling (R/C - 100 FT/MIN)
Gross Weight ~1000 LBS.
Altitude ~1000 FT
42
44
46
48
50
52
54
56
58
60
62
64
66
68
70
72
74
0
2
4
6
8
10
12
14
16
18
20
22
24

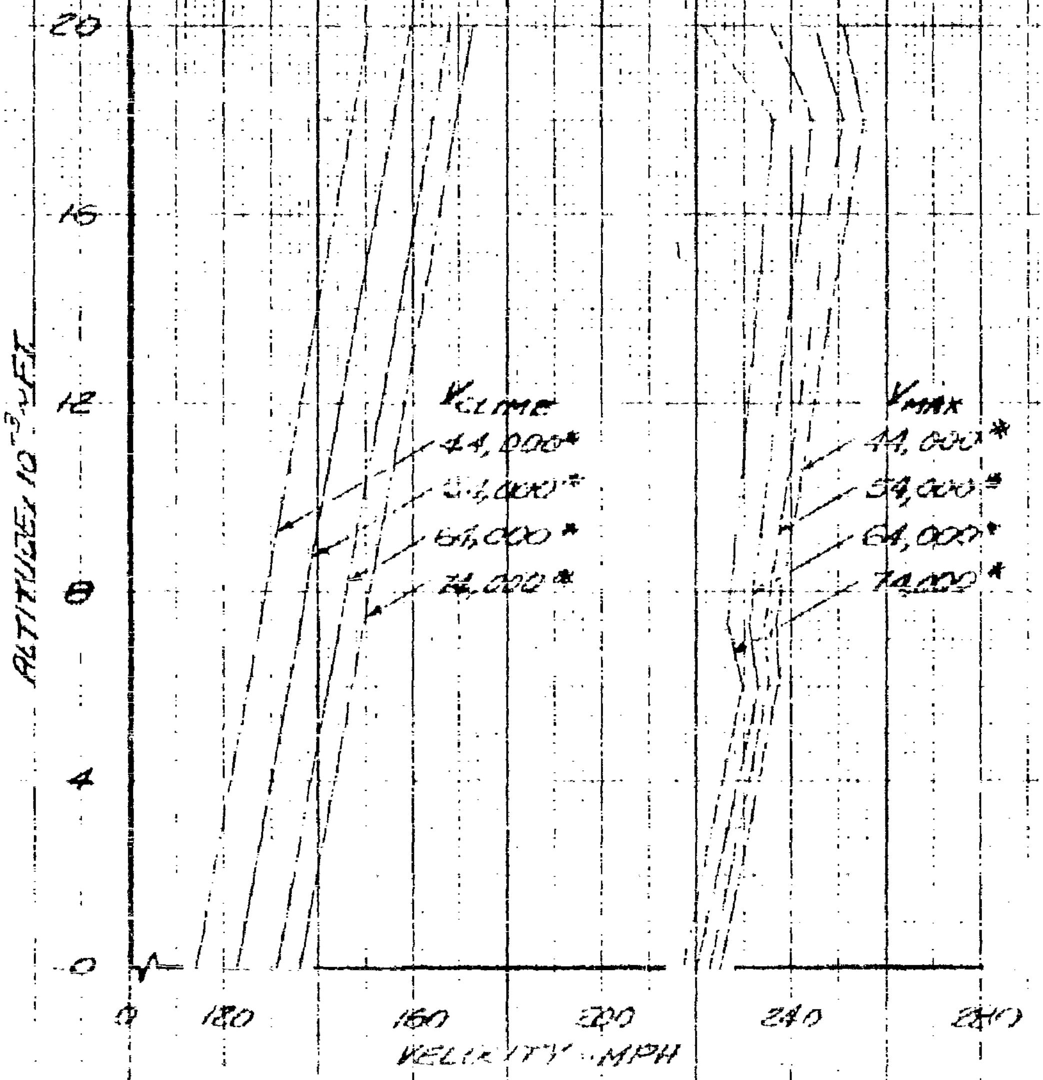
PART II-D

D. MAXIMUM SPEED AND CLIMB SPEED CALCULATIONS

Maximum speeds were obtained from figures 14 through 19 at the intersections of the power required and available curves. Speeds for maximum rates of climb were obtained from the same figures at the maximum difference between thrust horsepower required and available. Maximum speeds and best climb speeds versus altitude for two engine operation are presented on figure 30 for normal rated power and figure 31 for military rated power. Speeds for best climb for single engine operation are shown in figure 32 for normal rated power and on figure 33 for military power.

FIG. 30

XC-120 PACK ON
SPEED IN CLIMB AND IN LEVEL FLIGHT
NORMAL RATED POWER TWO ENGINES.



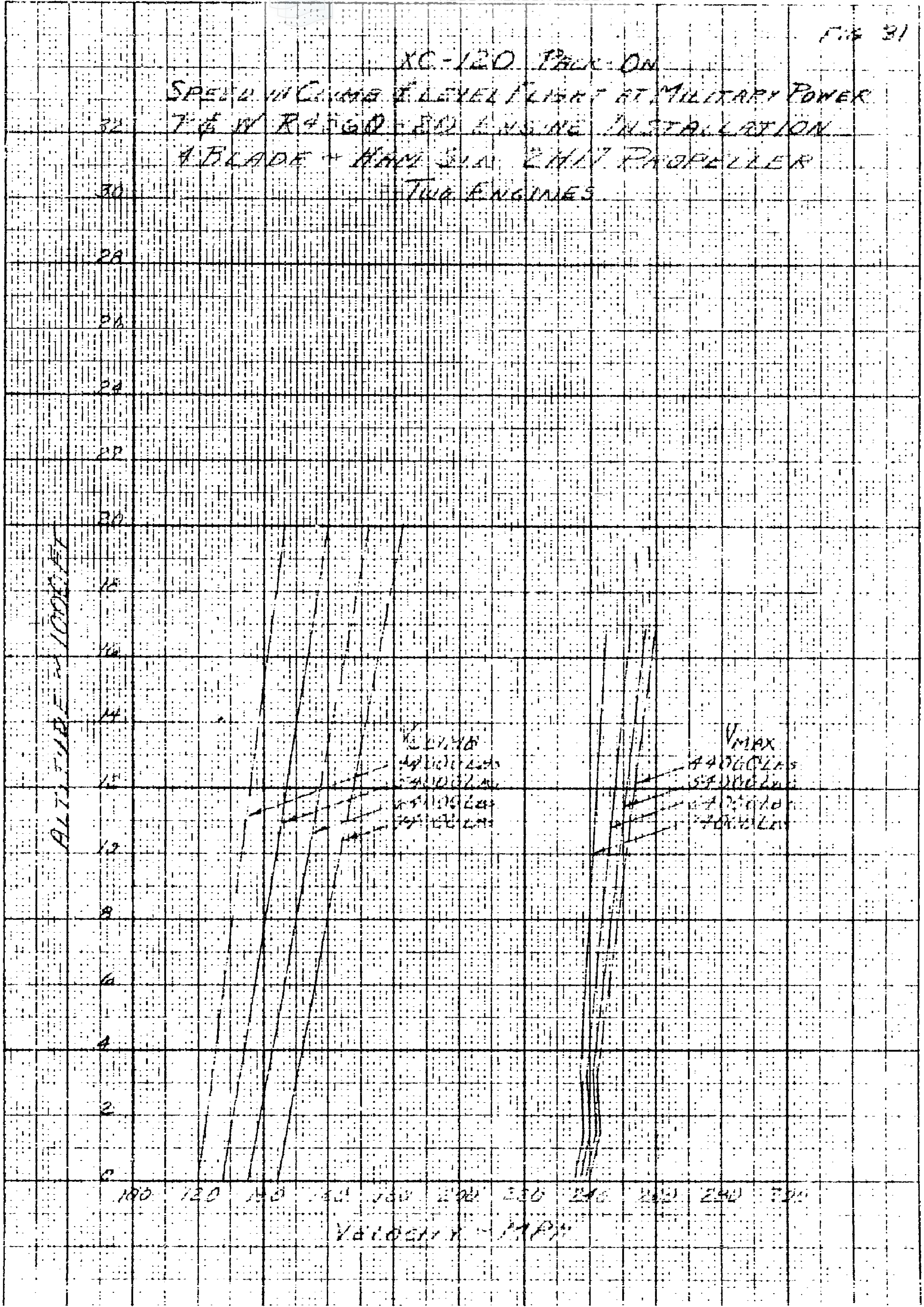


FIG 31

XC-120 PACK-ON
SPEED IN CLIMB & LEVEL FLIGHT AT MILITARY POWER
P & W R4360-20 ENGINE INSTALLATION
4 BLADE - HAM STD 2H17 PROPELLER
TWO ENGINES

FIG 32

XC-120 PACK-ON

SINGLE ENGINE CLIMBING SPEED VS ALTITUDE

P & W R4360-20 ENGINE INSTALLATION

4 BLADE - HAM STD 2H17 PROPELLER

NORMAL RATED POWER

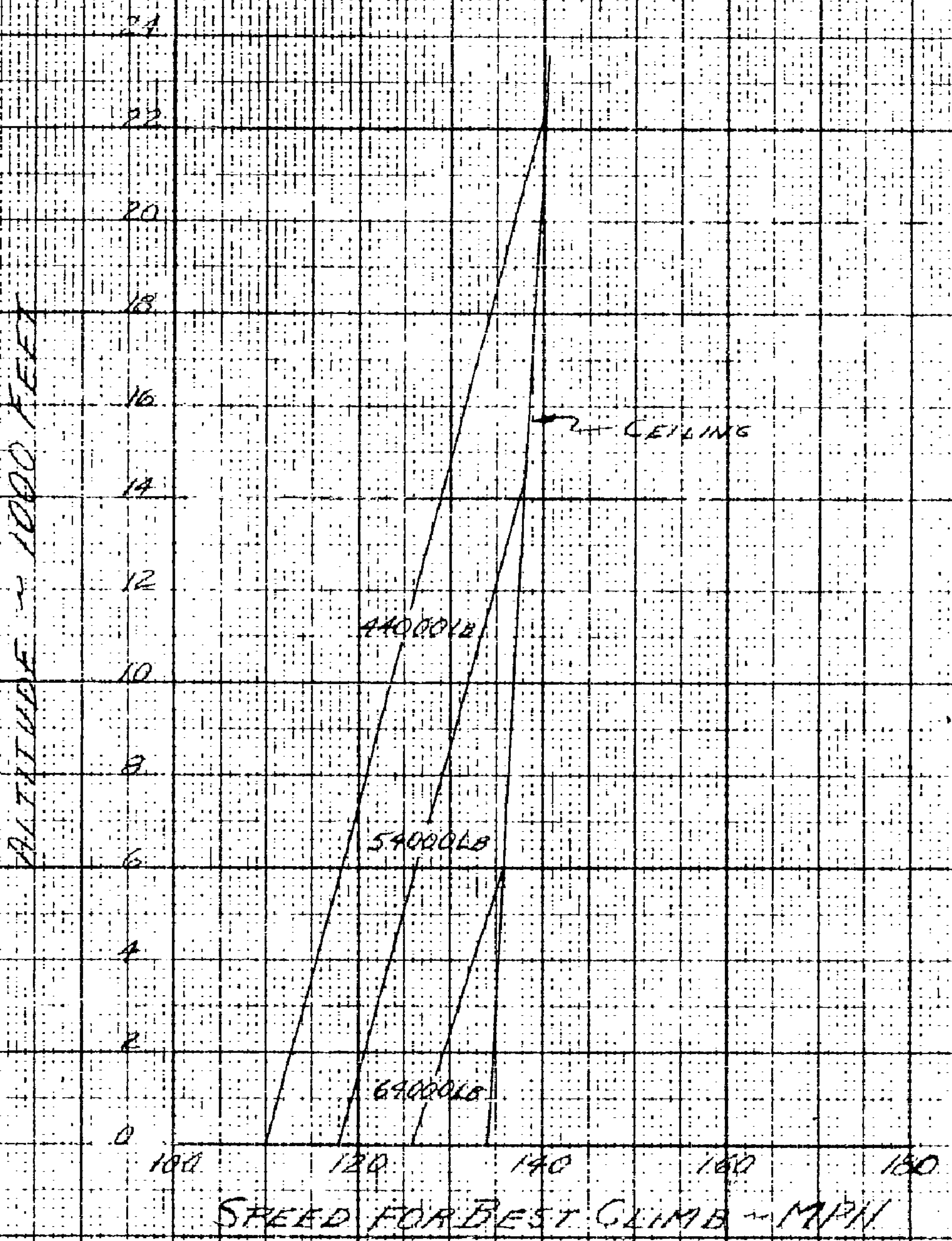
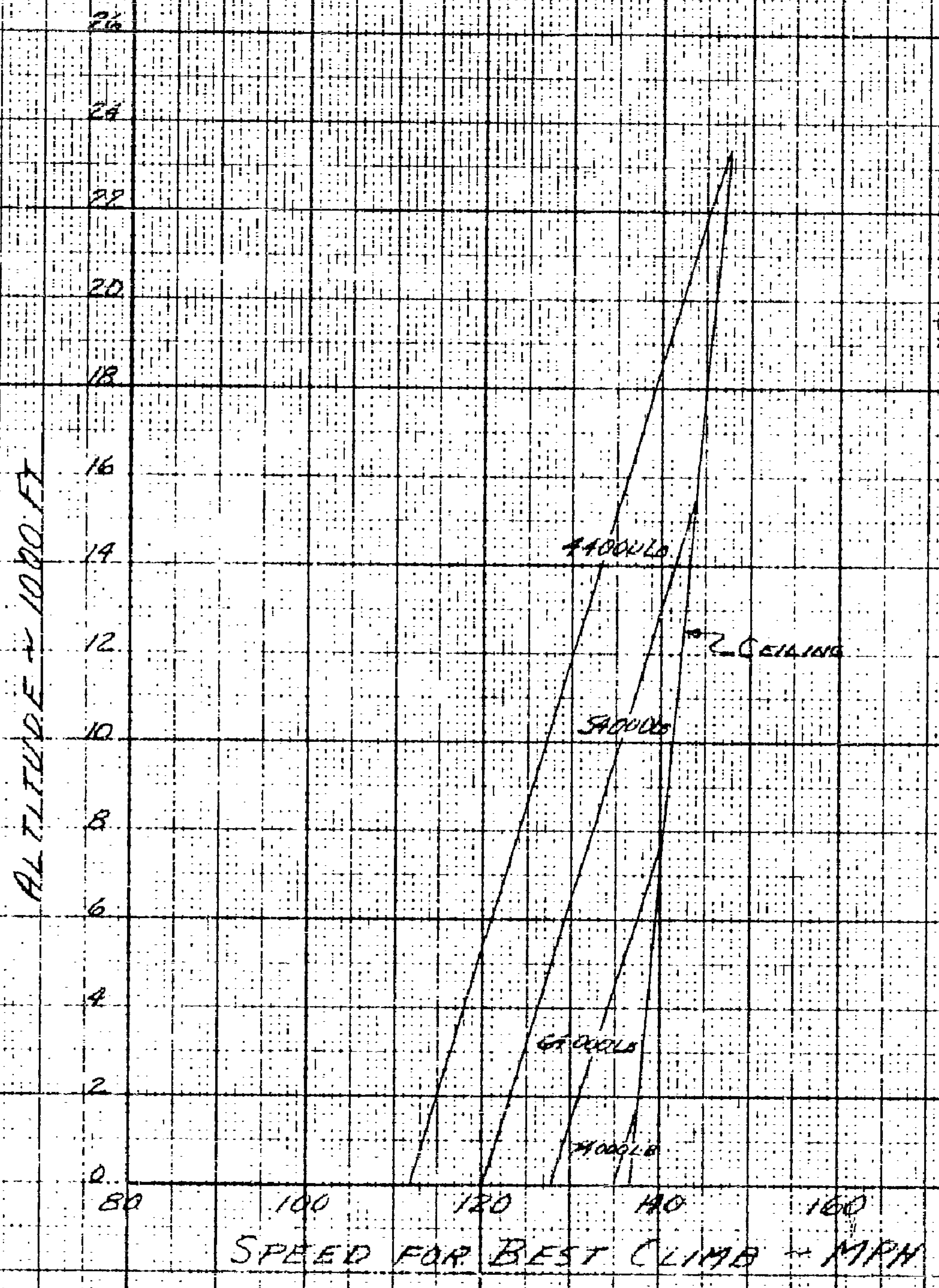


FIG. 35

XC-120 PACK-ON
SINGLE ENGINE CLIMBING SPEED VS ALTITUDE
P&W R4360-20 ENGINE INSTALLATION
MILITARY POWER



PART II-E

E. CRUISING CALCULATIONS

1. Cruising Power Required and Available

All cruising calculations on the subject airplane are made at a standard altitude of 10,000 ft. using manufacturer's power and SFC data for low blower operation from reference (a). Preliminary calculations indicate that maximum mi./lb. at any speed and altitude will be realized when cruising at limiting BHP (limited by full throttle, BMEP, or prop load). This limiting BHP line is plotted against engine RPM in figure 34 as it is crossplotted from reference (a) for engine normal operation in low blower at 10,000 ft. Manufacturer's SFC along this limiting BHP line is plotted versus BHP in figure 35 and is used directly for the computation of maximum range. This SFC curve is then increased by 15% and plotted versus BHP in figure 35 for use in the computation of combat radius and combat range. Efficiencies at various points along the limiting BHP line of figure 34 were calculated as already described in the power available section. The power available lines are plotted against speed at constant BHP in figure 36. Cruising power required was calculated using the high speed polar (cowl flaps closed). Power required at 10,000 ft. is then plotted against speed for gross weights of 44,000 54,000, 64,000 and 74,000 lbs. in figure 36.

FIG. 34

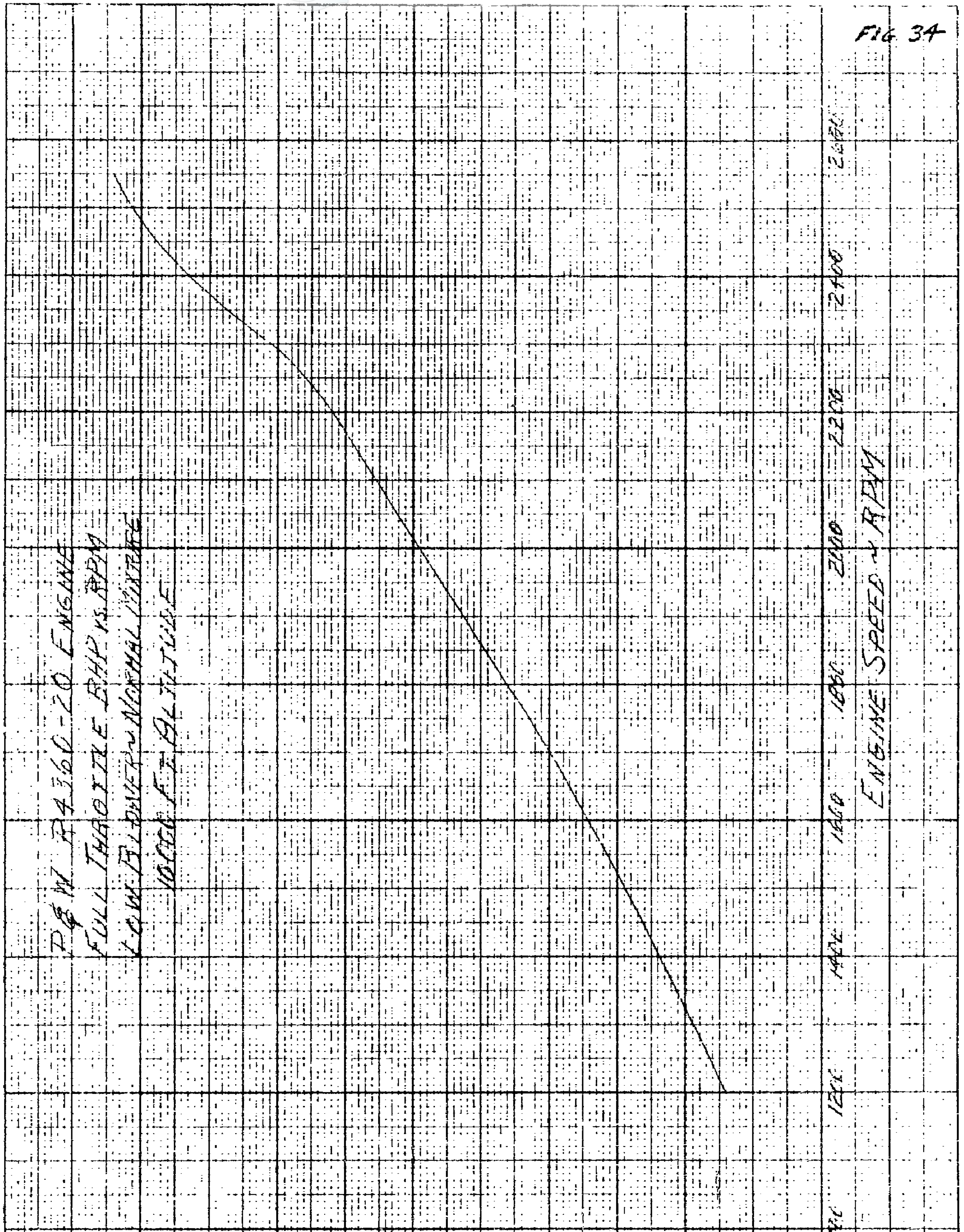
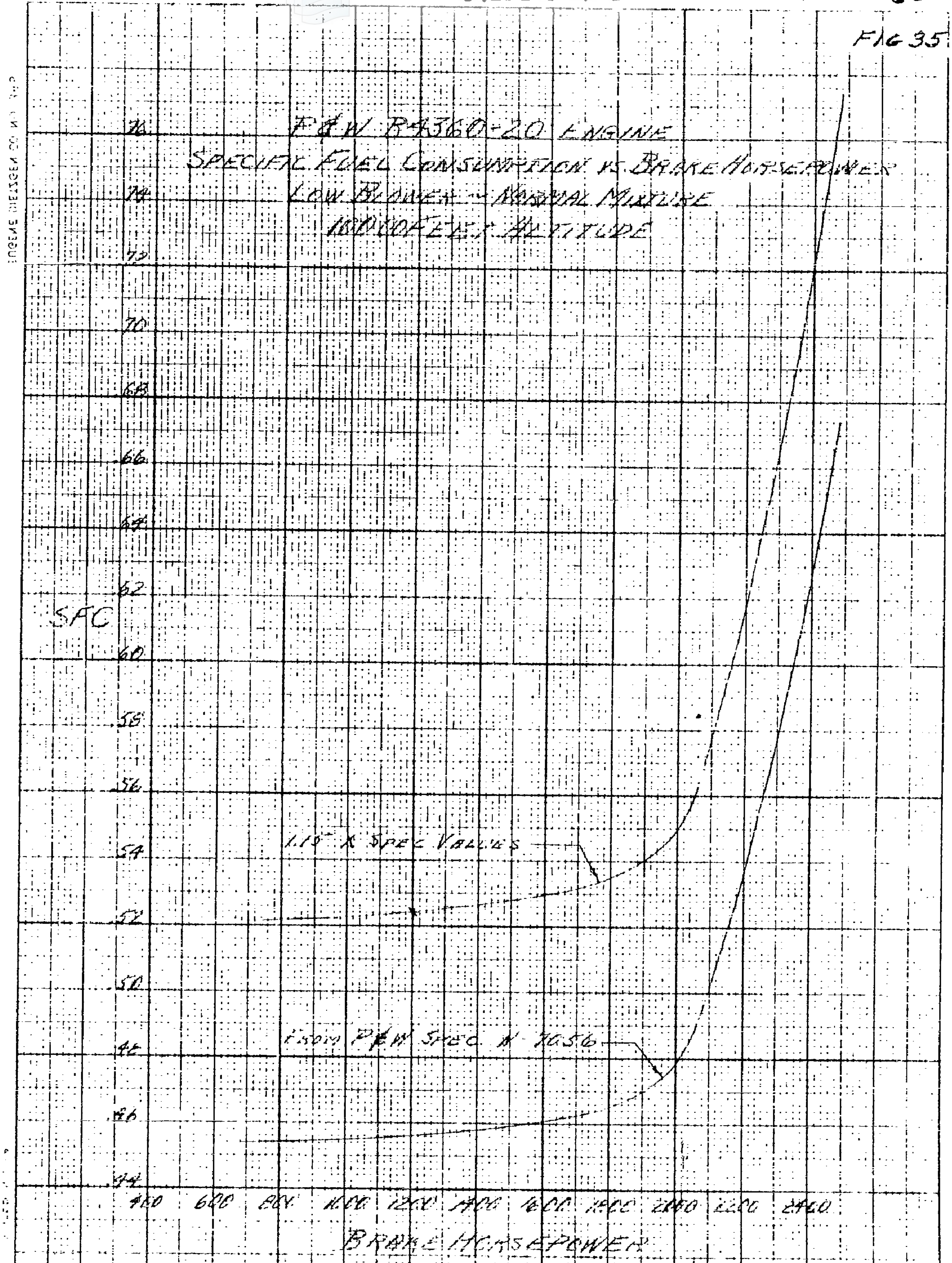

P&W R4360-20 ENGINE
FULL THROTTLE BHP vs. RPM
LOW BLOWER ~ NORMAL MIXTURE
10000 FT. ALTITUDE
ENGINE SPEED ~ RPM
1200
1400
1600
1800
2000
2200
2400
2600
BRAKE HORSEPOWER
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400

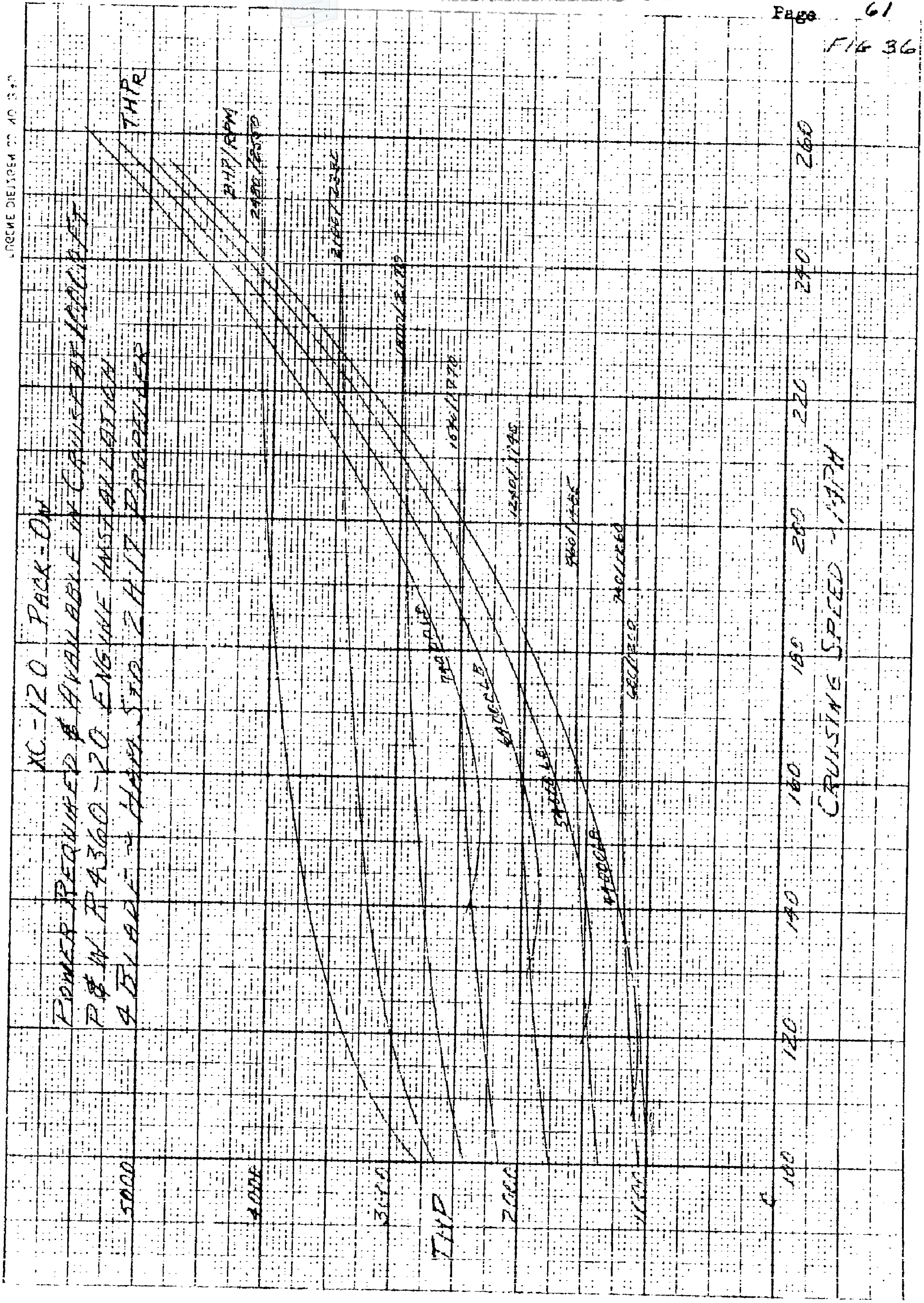
FIG 35



P&W R4360-20 ENGINE
SPECIFIC FUEL CONSUMPTION VS BRAKE HORSEPOWER
LOW BLOWER - NORMAL MIXTURE
18000 FEET ALTITUDE

RESTRICTED

FIG 36



PART II-E

E. CRUISING CALCULATIONS (Cont.)

2. Miles per Pound Calculations

For any desired BHP, the SFC may be read from figure 35 and fuel consumption for two engines cruise is

$$\#/\text{hr.} = 2 \times \text{BHP} \times \text{SFC}$$

Then for the desired BHP, the airplane speed obtaining with any gross weight may be read from figure 36, and miles/lb. is

$$\text{mi./lb. of fuel} = \text{mi./hr.} \div \#/\text{hr.}$$

These calculations are made for gross weights of 44,000, 54,000, 64,000, and 74,000 lbs. using each of the SFC curves of figure 35. Figure 37 shows mi./lb. of fuel versus speed with gross weight and BHP parameters as based on the manufacturer's SFC data, and figure 38 shows a similar plot based on SFC's as increased 15% over the manufacturer's data. A sample calculation is shown below for 64,000 lb. gross weight.

Sample mi./lb. calculation for 64,000 lb. gross weight
(Based on Manufacturer's SFC)

BHP	RPM	SFC	#/hr.	Vmph	mi./lb.
2480	2550	.674	3340	234.4	.0702
2100	2330	.502	2110	217.7	.1031
1800	2170	.465	1674	202.0	.1206
1540	1970	.460	1417	186.2	.1316
1240	1740	.4565	1133	131.0	.1154

RESTRICTED

FIG. 37

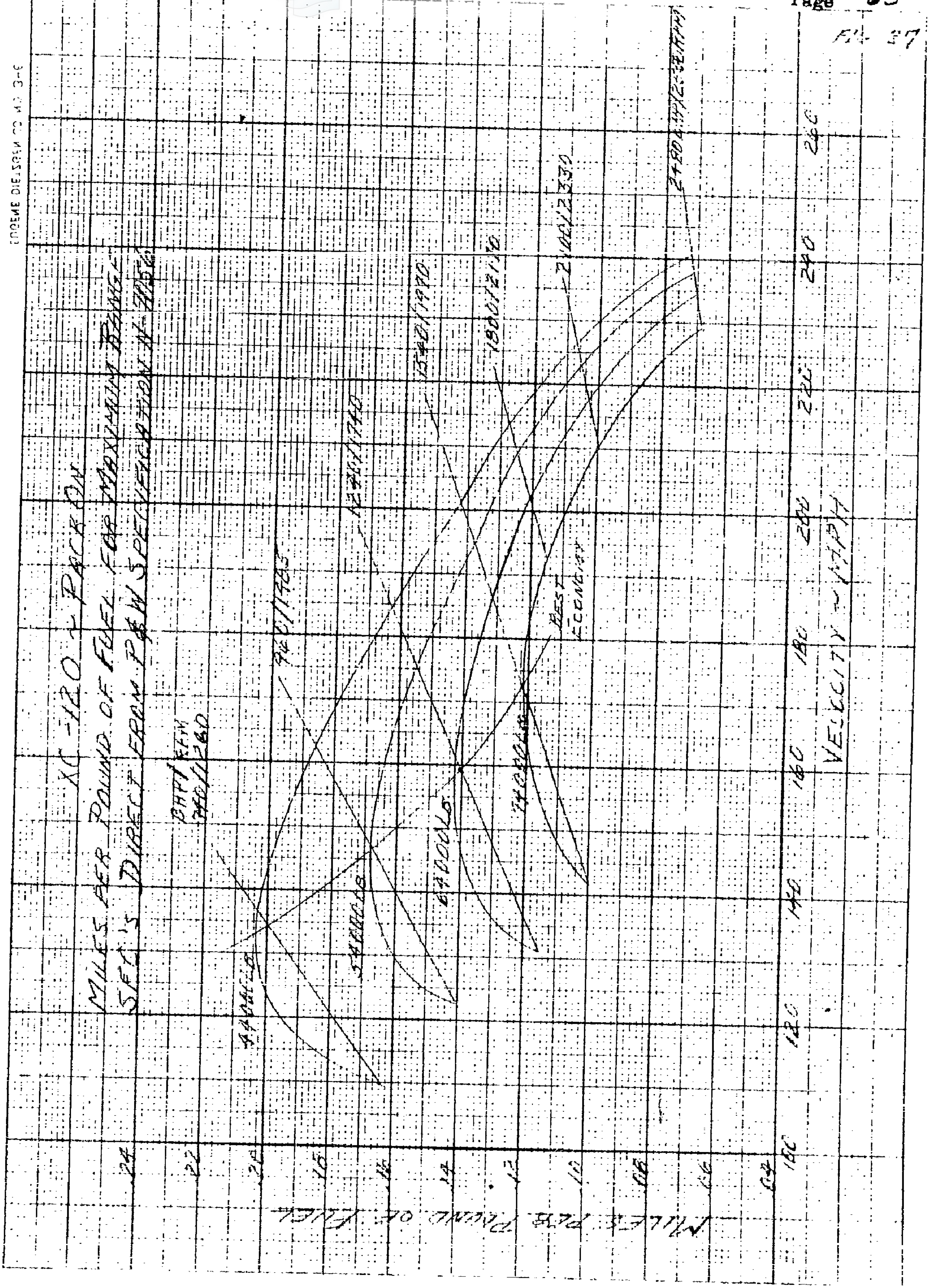
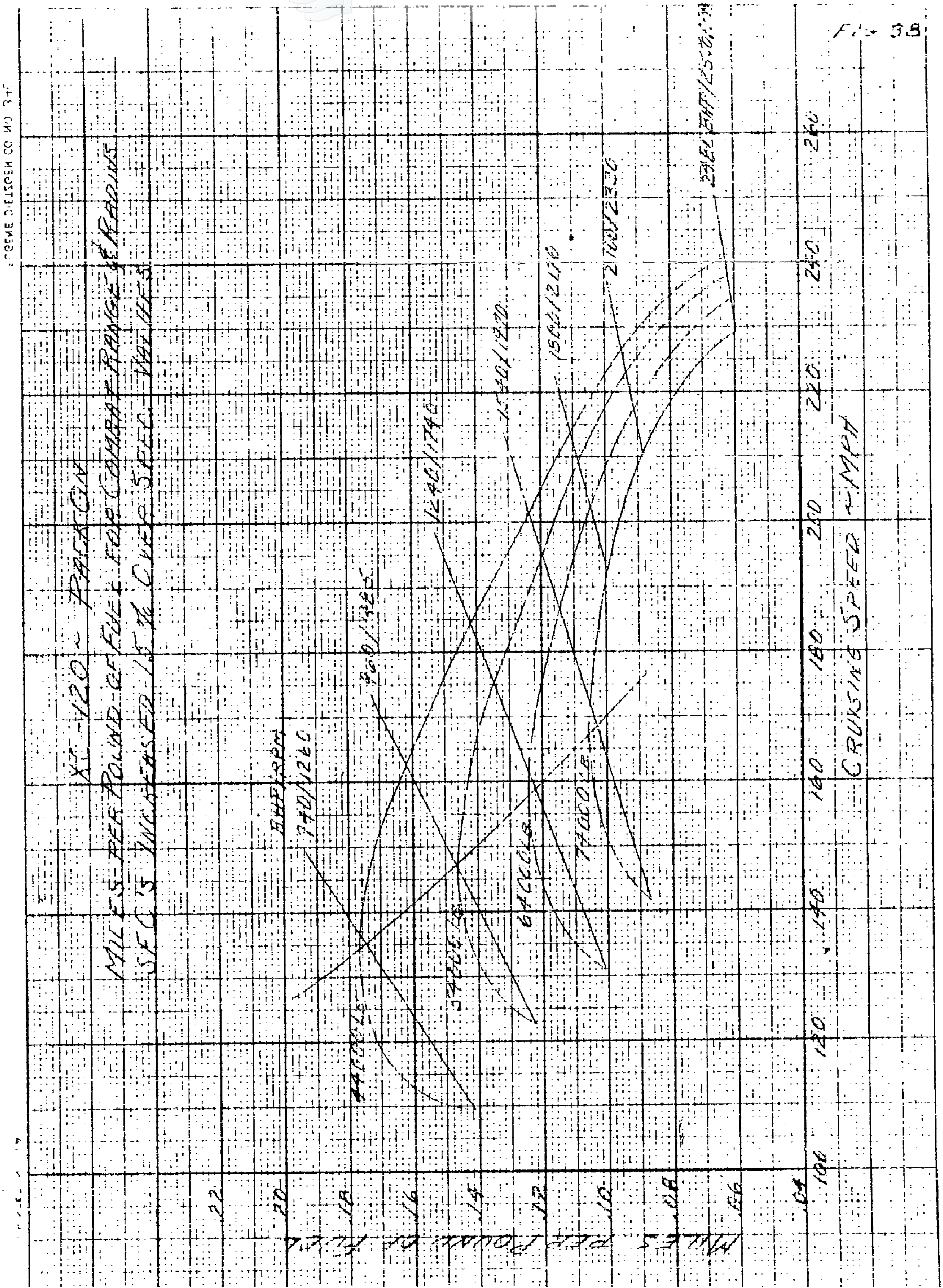


Fig. 38


XC-120 ~ PACK ON
MILES PER POUND OF FUEL FOR COMBAT RANGE & RADIUS
SFC'S INCREASED 1.5% OVER SPEC. VALUES
BHP/RPM
770/1220
960/1320
1240/1740
1540/1870
1560/2100
2100/2350
2381 BHP/2550 RPM
24000 LB
34000 LB
64000 LB
74000 LB
MILES PER POUND OF FUEL
.22
.20
.18
.16
.14
.12
.10
.08
.06
.04
CRUISING SPEED ~ MPH
100
120
140
160
180
200
220
240
260

PART II-E (Cont.)

2. Miles per Pound Calculations (Cont.)

For the combat radius and combat range calculations of parts 3 and 4 of this section, the peaks of the mi./lb. of fuel curves of figure 38 are connected to form the "best economy" line. Mi./lb. along this line are multiplied by 99% and speeds are read at the resulting mi./lb. values. Corresponding hrs./lb. of fuel are then found as

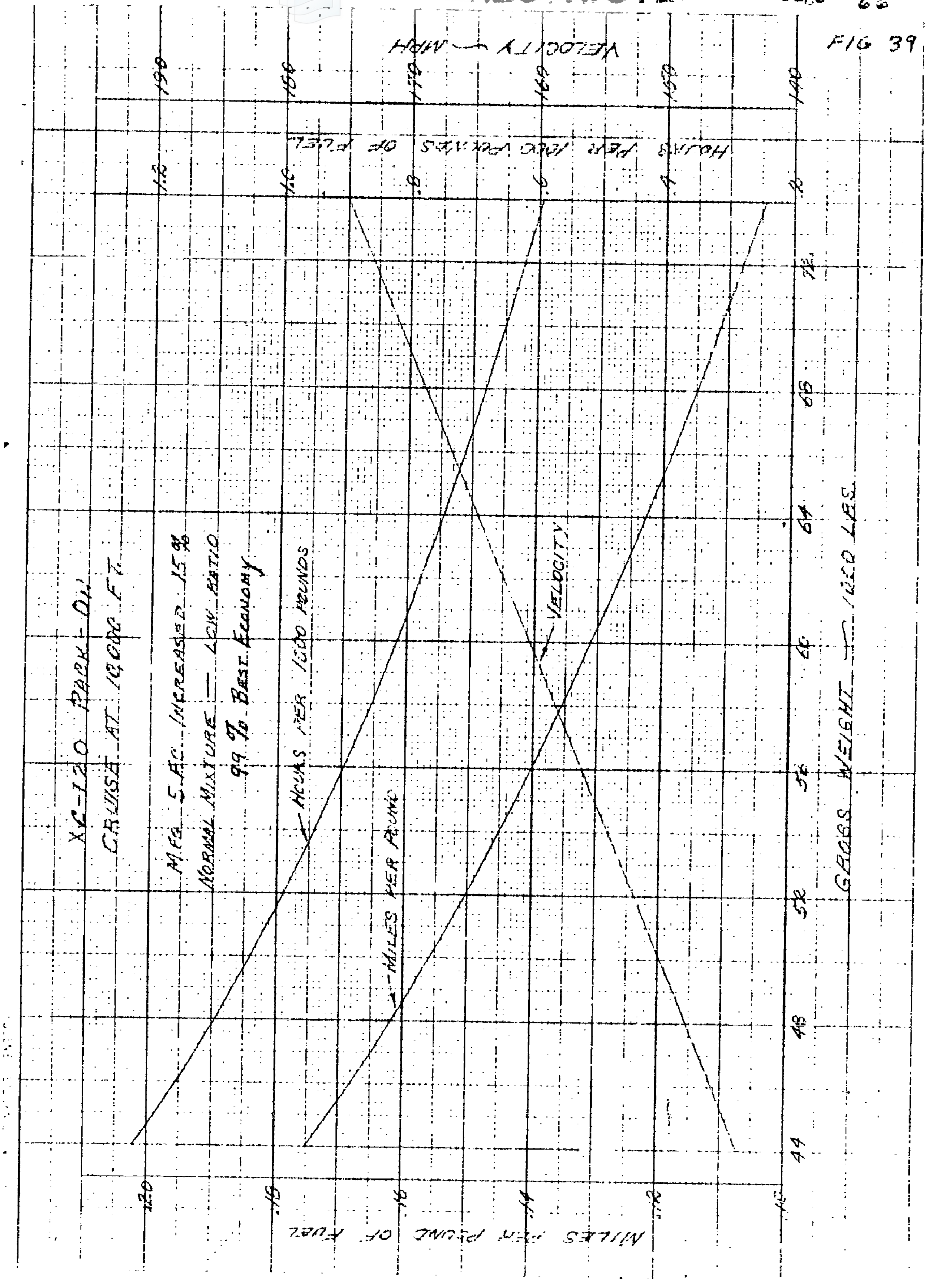
hr./lb. of fuel = mi./lb. of fuel ÷ Vmph

These computations are shown below and 99% best mi./lb. of fuel with corresponding speeds and hrs./lb. of fuel are plotted against gross weight in figure 39 which forms the basis for the combat radius and combat range problems of the following section.

Computation for Combat Cruise Problem

Gross Weight	Best mi./lb. of fuel	99% Best mi./lb. of fuel	V at 99% Best mi./lb. of fuel	Hr./1000 lb. of fuel at 99% best mi./lb.
44,000	.1770	.1750	143.5	1.220
54,000	.1462	.1450	154.	.941
64,000	.1240	.1228	164.5	.746
74,000	.1055	.1044	175.	.596

FIG 39


XC-120 PACK-ON
CRUISE AT 10000 FT.
M.F.G. C.Ac. INCREASED 15%
NORMAL MIXTURE — LOW RATIO
99 % BEST ECONOMY
VELOCITY → MPH
190
180
170
160
150
140
HOURS PER 1000 POUNDS OF FUEL
1.2
1.0
.8
.6
.4
.2
HOURS PER 1000 POUNDS
MILES PER POUND
VELOCITY
MILES PER POUND OF FUEL
.20
.18
.16
.14
.12
.10
GROSS WEIGHT — 1000 LBS.
72
68
64
60
56
52
48
44

PART II-E CRUISING CALCULATIONS (Cont.)

2. Miles per Pound Calculations (Cont.)

For the maximum range calculations of part 5 of this section, the peaks of the mi./lb. of fuel curves of figure 37 are connected to form the "best economy line". Values from this best economy line are multiplied by .95 to get best mi./lb. of fuel and oil. This step allows 1/20 of the fuel consumed by weight as oil consumed. Corresponding hr./lb. of fuel and oil are then found as

hr./lb. of fuel and oil = mi./lb. of fuel and oil ÷ Vmph

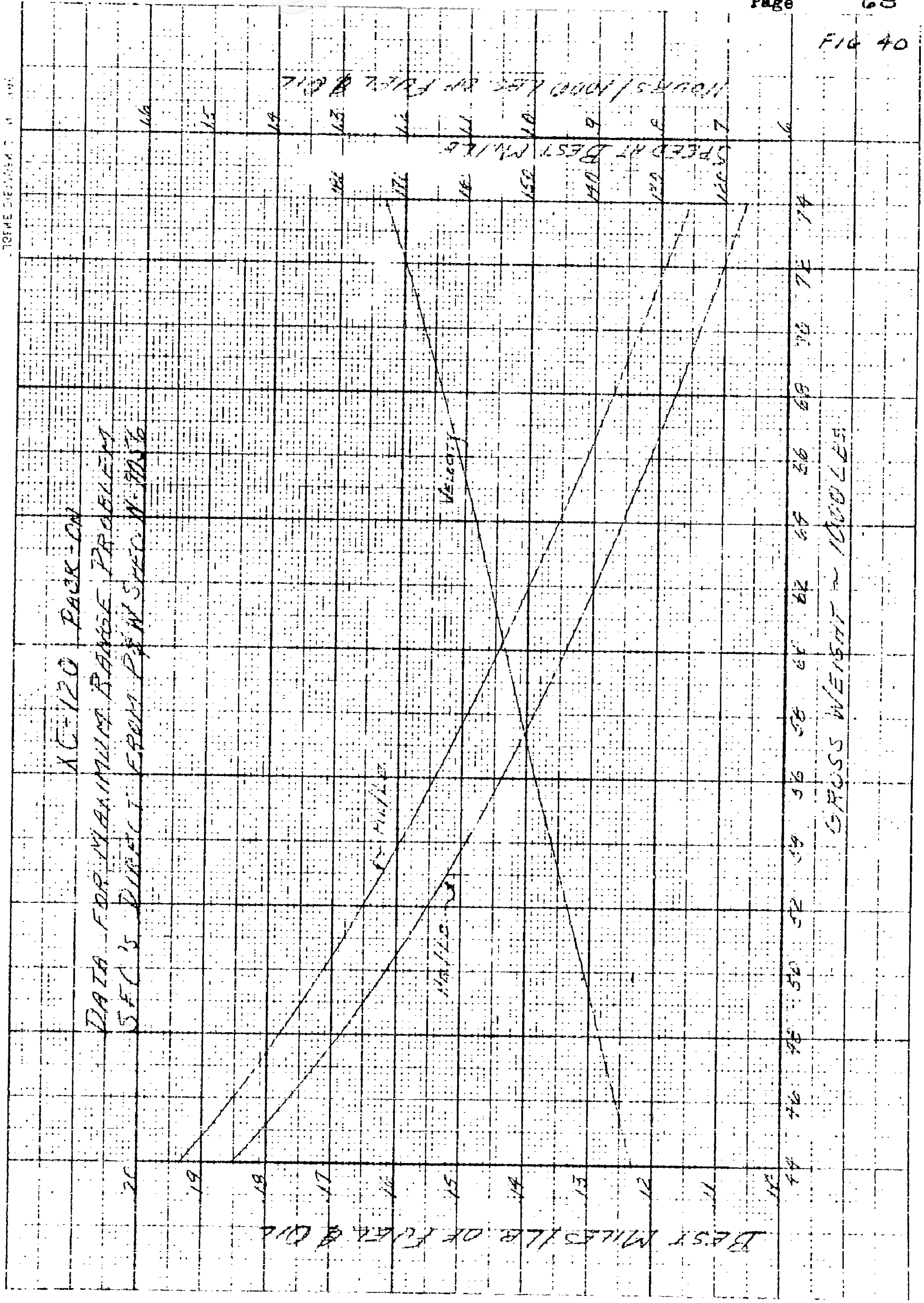
These computations are shown below and best mi./lb. of fuel and oil, best hrs./lb. of fuel and oil, and corresponding speeds are plotted against gross weight in figure 40, which forms the basis for the maximum range calculations in part 5 of this section

Calculations for Best Economy Cruise

Gross Weight	Vmph	Best mi./lb. of fuel	Best mi./lb. of fuel and oil	Best hr./lb. of fuel and oil
44,000	133	.2035	.1933	.001453
54,000	146.2	.1682	.1598	.001093
64,000	158.2	.1423	.1352	.000855
74,000	173	.1214	.1153	.000666

RESTRICTED

FIG 40



PART II-E CRUISING CALCULATIONS (Cont.)

3. Combat Radius of Action

Combat radius of action is defined and computed in this report according to the requirements of reference (i). The general flight plan for this problem is summarized in the following steps: -

a. Allow ten minutes operation at normal rated power for warm up and take-off.

b. Climb to 10,000 feet at normal rated power and speed for best climb.

c. Cruise out at 10,000 feet at speed for 99% best miles per pound of fuel.

d. Land and unload cargo or detach pack at mid-point.

e. Allow ten minutes operation at normal rated power for warm-up and take-off for return.

f. Climb to 10,000 feet at normal rated power and speed for best climb.

g. Cruise back at 10,000 feet at speed for 99% best miles per pound of fuel.

h. Land at point of origin.

Notes: -

1. Five percent of total usable fuel at take-off is held in reserve at all times.

2. Range is obtained in climb and cruise steps only - no range is obtained in landing.

3. All range data are 15% conservative (SFC's are increased by 5% in addition to a 10% increase estimated for installation, duct losses, accessories, etc. - making SFC's 15% above manufacturer's data).

PART II-E (Cont.)

3. Combat Radius of Action (Cont.)

4. Full oil is considered carried all the way.

5. Total time is time consumed in warm-up, take-off, climb, and cruise.

6. Flight time is time in climb and cruise only.

7. Average speed is total range divided by flight time.

Because of its unique design, the XC-120 is capable of more than the usual number of missions under the above definition of combat radius. Only those missions, however, in which the pack is carried all the way are considered in this section; other possible missions with pack off or combination configurations will be found under the approprate headings in parts III and IV of this report.

Combat radius of action and flight time are computed by integration of the mi./lb. and hrs./lb. curves of figure 39 in which this data is given at speeds for 99% best economy and based on 1.15 x manufacturer's SFC data as noted above. This integration is a trial and error procedure in which the fuel used on the trip out is assumed for a first approximation and adjusted until the range out equals the range back. Range in climb with the pack on is developed from the time to climb and climb speed curves of figures 22 and 30 and is plotted versus gross weight in figure 41. The two pack-on missions possible are: -

1. Pack and cargo out, unload cargo, empty pack back. Combat radius under these terms is plotted against take-off gross weight with fuel and cargo load parameters in figure 42 and corresponding total time is plotted in the same manner in figure 43.

2. Empty pack out, pick up cargo, pack and cargo back. Combat radius for this problem is plotted versus take-off gross weight for return in figure 44 and corresponding total time is plotted in like manner in figure 45.

A sample calculation of combat radius of action is shown on the following page for a take-off gross weight of 74,000 lbs.

RESTRICTED

SAMPLE CALCULATIONS
COMBAT RADIUS OF ACTION

Take-off gross weight	lbs.	74000	74000	74000	74000	74000
Total fuel	lbs.	16020	15000	10000	5000	3000
Fuel for reserve	lbs.	801	750	500	250	150
Fuel used in warm up & take off	lbs.	700	700	700	700	700
Climb gross weight	lbs.	73300	73300	73300	73300	73300
Fuel used in climb out	lbs.	943	943	943	943	943
Range in climb out	mi.	32.8	32.8	32.8	32.8	32.8
Time to climb out	hrs.	.226	.226	.226	.226	.226
Gross weight at start of cruise out	lbs.	72357	72357	72357	72357	72357
Fuel assumed for cruise out	lbs.	7200	6700	3900	1200	95
Average gross weight for cruise out	lbs.	68757	69007	70407	71757	72310
Mi./lb. of fuel		.1160	.1154	.1130	.1105	.110
Range in cruise out	mi.	835	774	440	133	10.5
hrs./1000 lb. of fuel		.663	.659	.640	.623	.617
Time to cruise out	hrs.	4.775	4.410	2.497	.748	.059
Landing gross weight	lbs.	65157	65657	68457	71157	72262
Drop cargo	lbs.	15238	16258	21258	26258	28258
Take off gross weight for return	lbs.	49919	49399	47199	44899	44004
Fuel for return	lbs.	6376	5907	3957	1907	1112
Fuel used in warm up & take off	lbs.	700	700	700	700	700
Climb gross weight	lbs.	49219	48699	46499	44199	43304
Fuel used in climb back	lbs.	421	418	391	362	352
Range in climb back	Mi ~~km.~~	13.00	12.9	11.9	10.9	10.5
Time to climb back	hrs.	.1012	.1000	.0940	.0872	.0848
Gross weight at start of cruise back	lbs.	48798	48281	46108	43837	42952
Fuel for cruise back	lbs.	5264	4789	2866	845	60
Average gross weight for cruise back	lbs.	46166	45886	44675	43415	42922
Mi./lb. of fuel		.1605	.161	.1635	.166	.1675
Range in cruise back	mi.	845	770	470	140	10.1
hrs./1000 lb. of fuel		1.050	1.056	1.078	1.100	1.110
Time to cruise back	hrs.	5.525	5.050	3.045	.330	.067
Total range including climb- Out	mi.	868	807	473	166	43
Back	mi.	858	783	482	151	21
Radius of action -	mi.	863	795	477	159	32
Flight time	hrs.	10.627	9.786	5.862	1.991	.436
Total time	hrs.	10.960	10.119	6.195	2.324	.769

FIG 41

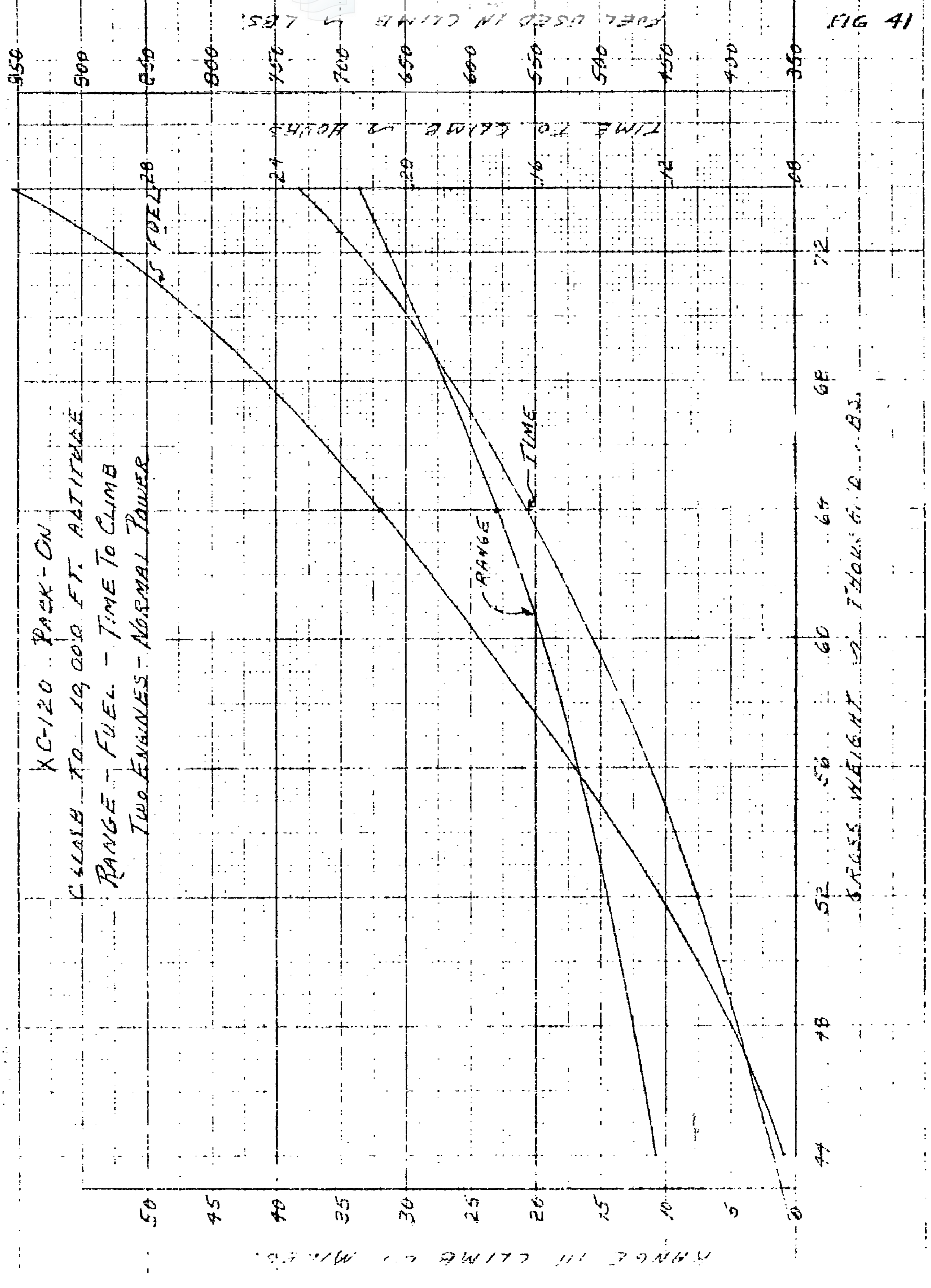

XC-120 PACK-ON
CLIMB TO 10,000 FT. ALTITUDE
RANGE - FUEL - TIME TO CLIMB
TWO ENGINES - NORMAL POWER
FUEL USED IN CLIMB ~ LBS
950
900
850
800
750
700
650
600
550
500
450
400
350
TIME TO CLIMB ~
28
24
20
16
12
08
FUEL
TIME
RANGE
GROSS WEIGHT ~ THOUSANDS LBS.
76
72
68
64
60
56
52
48
44
RANGE IN CLIMB ~ MILES
50
45
40
35
30
25
20
15
10
5
0

FIG 42

XC-120 PACK-ON
TAKE-OFF GROSS WEIGHT VS COMBAT RADIUS
WITH FUEL AND CARGO PARAMETERS

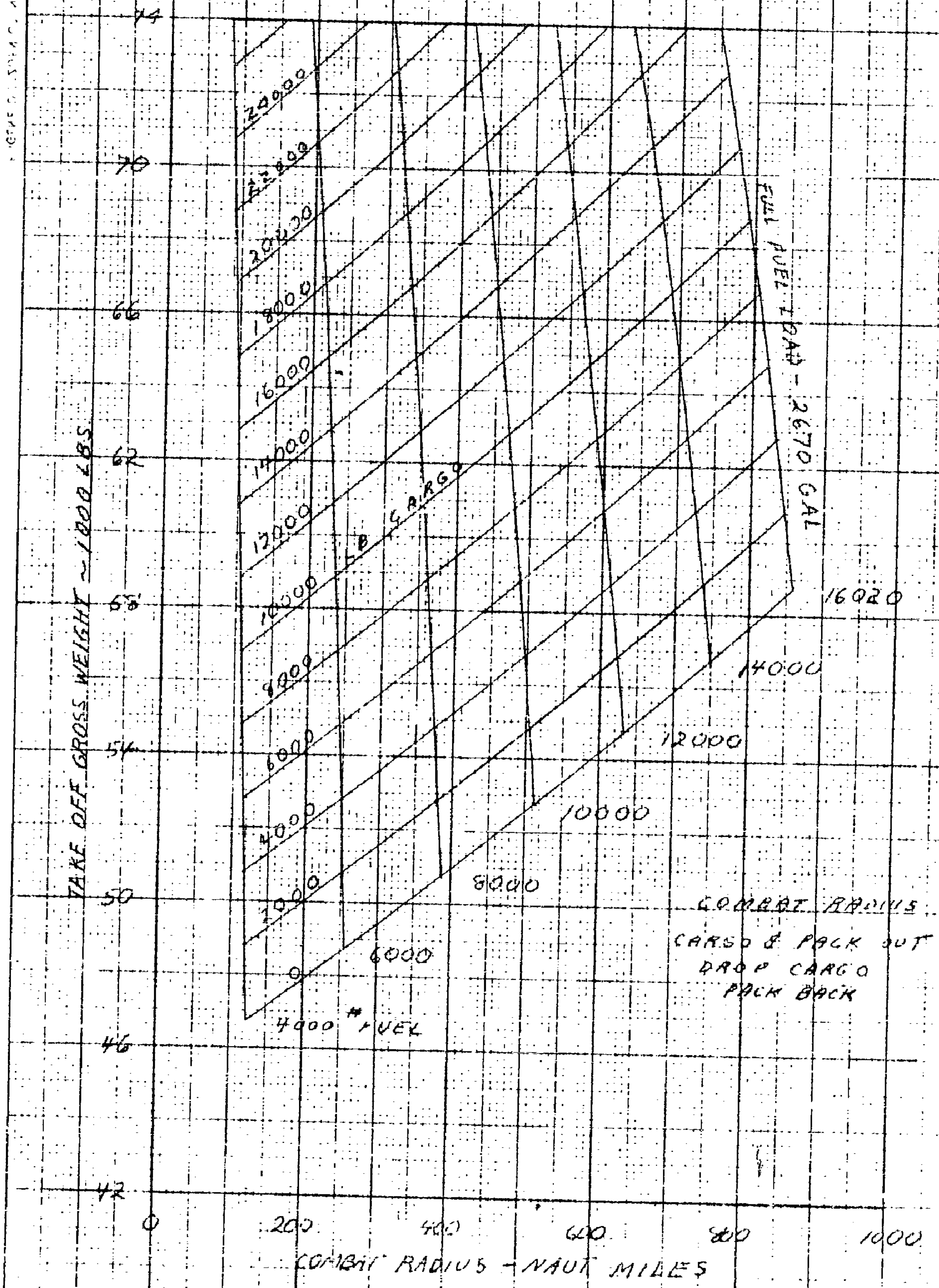
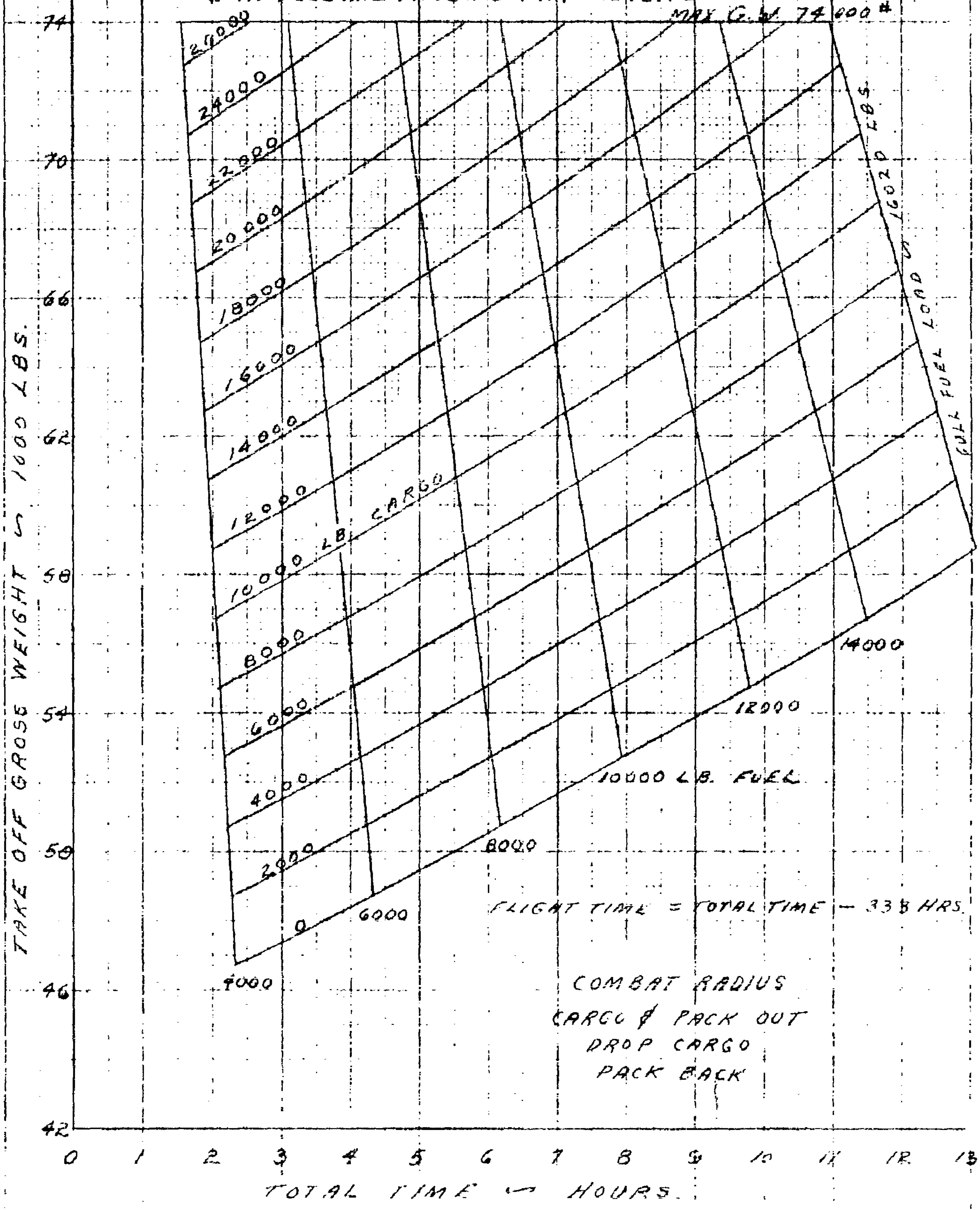


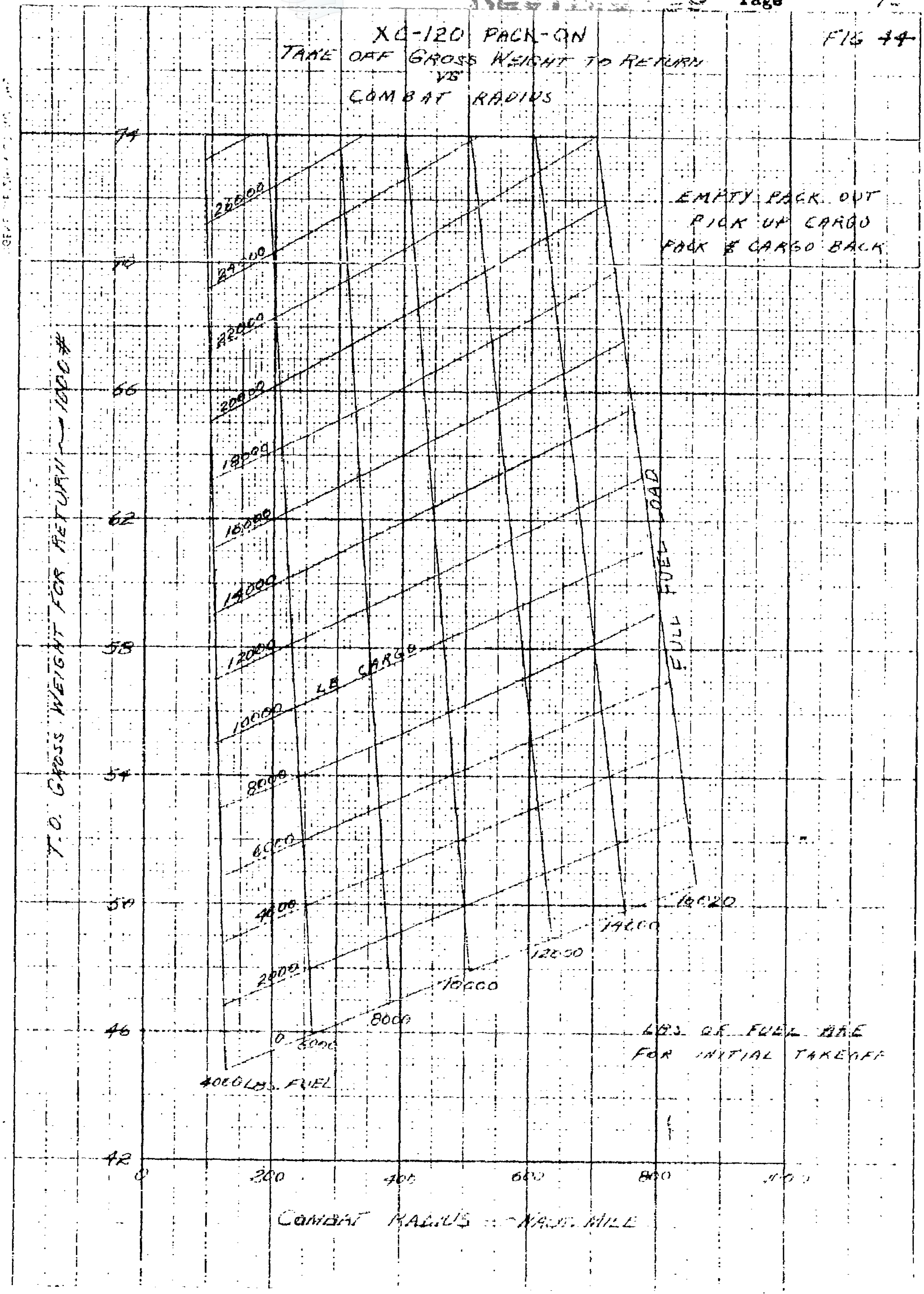
FIG 43

TAKE OFF GROSS WEIGHT VS TOTAL TIME WITH FUEL AND PAYLOAD PARAMETERS



FLIGHT TIME = TOTAL TIME — 3.38 HRS.

COMBAT RADIUS
CARGO & PACK OUT
DROP CARGO
PACK BACK



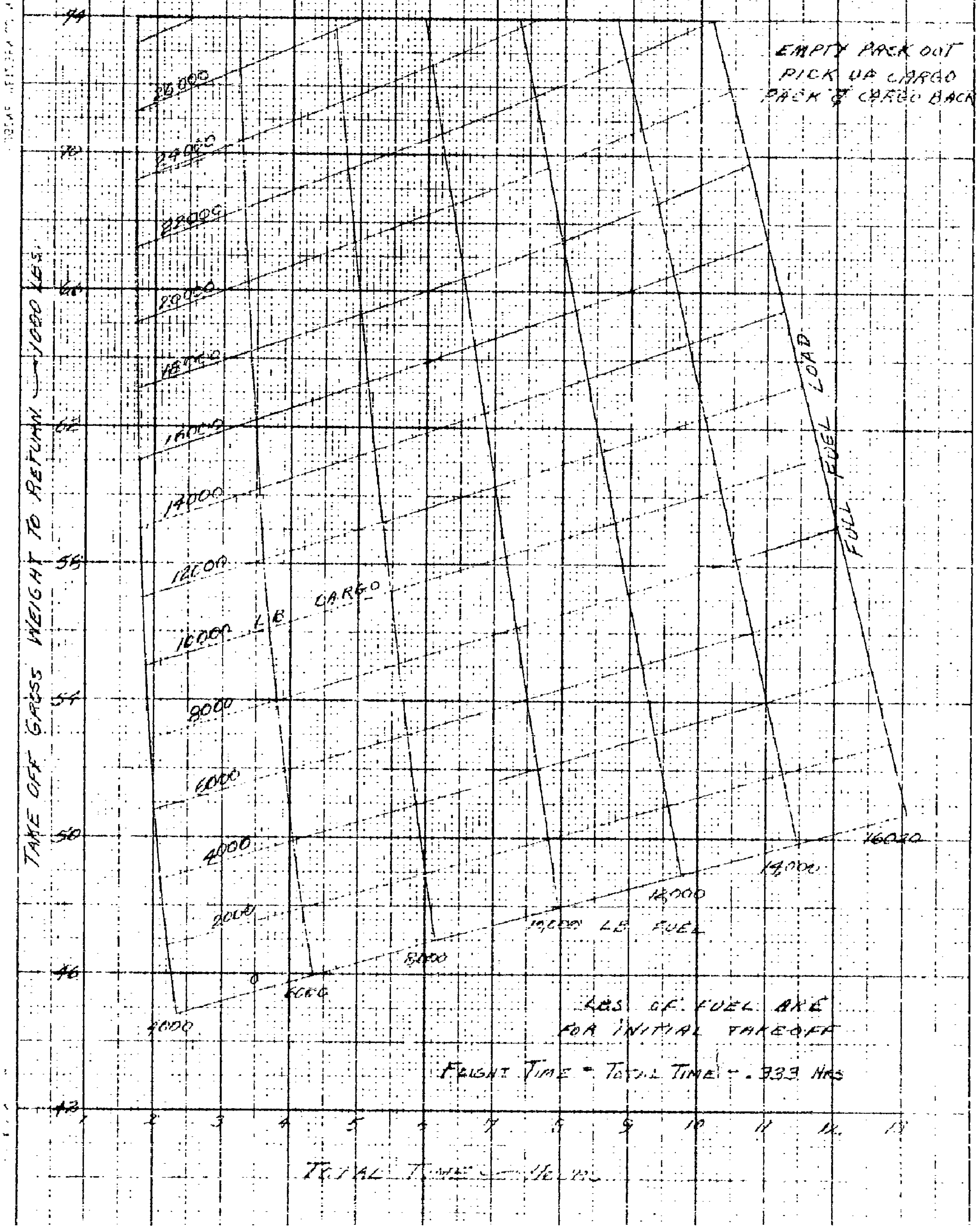
XC-120 PACK-ON
TAKE OFF GROSS WEIGHT TO RETURN "VS" COMBAT RADIUS

FIG 44

XC-120 PACK-ON

TAKE OFF GROSS WEIGHT TO RETURN VS TOTAL TIME

FIG 45



PART II-E CRUISING CALCULATIONS

4. Combat Range

Combat range is defined and computed in this report according to the requirements of reference (1). The general flight plan for this problem is summarized in the following steps: -

a. Allow ten minutes operation at normal rated power for warm-up and take-off.

b. Climb to 10,000 feet at normal rated power at speed for best climb.

c. Cruise at 10,000 feet at speed for 99% of best miles per pound of fuel.

d. Land

Notes: -

1. Five percent of total usable fuel at take-off is held in reserve at all times.

2. Range is obtained in climb and cruise steps only - no range is obtained in landing.

3. All range data is 15% conservative, (SFC's are increased by 5% in addition to a 10% increase estimated for installation, duct losses, accessories, etc. - making SFC's 15% above manufacturer's data).

4. Full oil is considered carried all the way.

5. Total time is time consumed in warm-up, take-off, climb, and cruise.

6. Flight time is time in climb and cruise only.

7. Average speed is total range divided by flight time.

PART II-E-4 (Cont.)

4. Combat Range (Cont.)

Combat range and corresponding flight time with the pack on are computed by a straightforward integration of the miles per pound of fuel curves of figure 39.

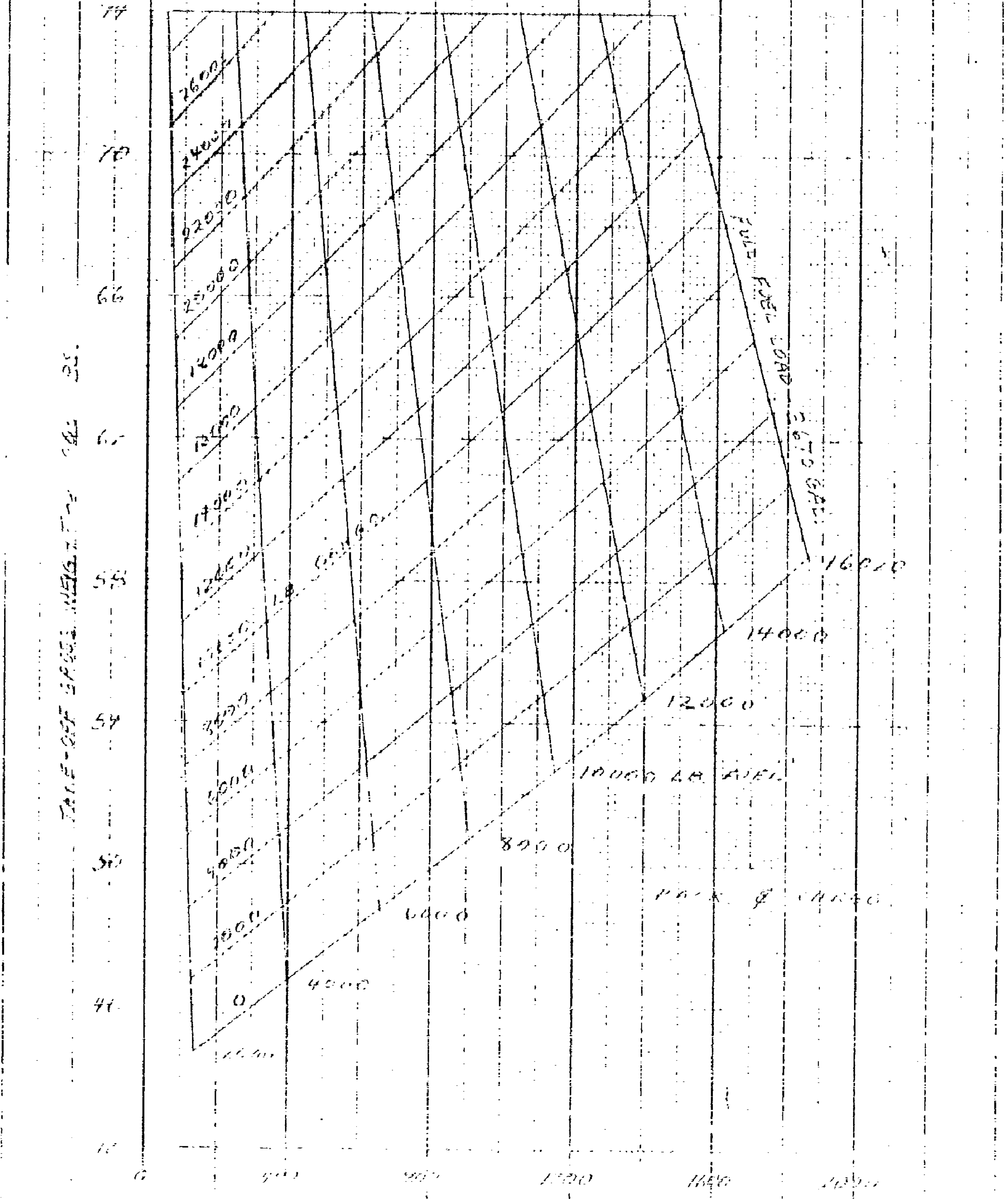
Range in climb is again taken from figure 41. A sample calculation for combat range at 74,000 lbs. take-off gross weight is shown on the following page. Similar computations were made at various take-off gross weights and the results were used to plot the grid of combat range versus take-off gross weight with fuel and cargo load parameters as shown in figure 46. Total time for combat range is plotted versus airplane take-off gross weight with cargo and fuel load parameters in figure 47.

SAMPLE CALCULATION
COMBAT RANGE

Take-off gross weight	lbs.	74000	74000	74000	74000	74000
Total fuel	lbs.	16020	13020	10020	7020	4020
Cargo	lbs.	15238	18238	21238	24238	27238
Fuel for reserve	lbs.	801	651	501	351	201
Fuel used for warm up & take-off	lbs.	700	700	700	700	700
Climb gross weight	lbs.	73300	73300	73300	73300	73300
Fuel used in climb	lbs.	940	940	940	940	940
Range in climb	mi.	33	33	33	33	33
Time to climb	hrs.	.226	.226	.226	.226	.226
Gross weight at start of cruise	lbs.	72360	72360	72360	72360	72360
Fuel for cruise	lbs.	13579	10729	7879	5029	2179
Average gross weight for cruise	lbs.	65571	66995	68420	69845	71270
Mi./lb. of fuel		.1215	.1190	.1165	.1140	.1114
Range in cruise	mi.	1650	1280	920	574	243
Hr./1000 lb. of fuel		.71	.69	.67	.65	.63
Time to cruise	hrs.	9.65	7.4	5.28	3.27	1.37
Landing gross weight	lbs.	58781	61631	64481	67331	70181
Total range including climb	mi.	1683	1313	953	607	276
Flight time	hrs.	9.88	7.63	5.51	3.50	1.60
Total time	hrs.	10.05	7.80	5.68	3.67	1.77

TAKE-OFF GROSS WEIGHT VS COMBAT RANGE FIG 14
WITH FUEL AND PAYLOAD PARAMETERS

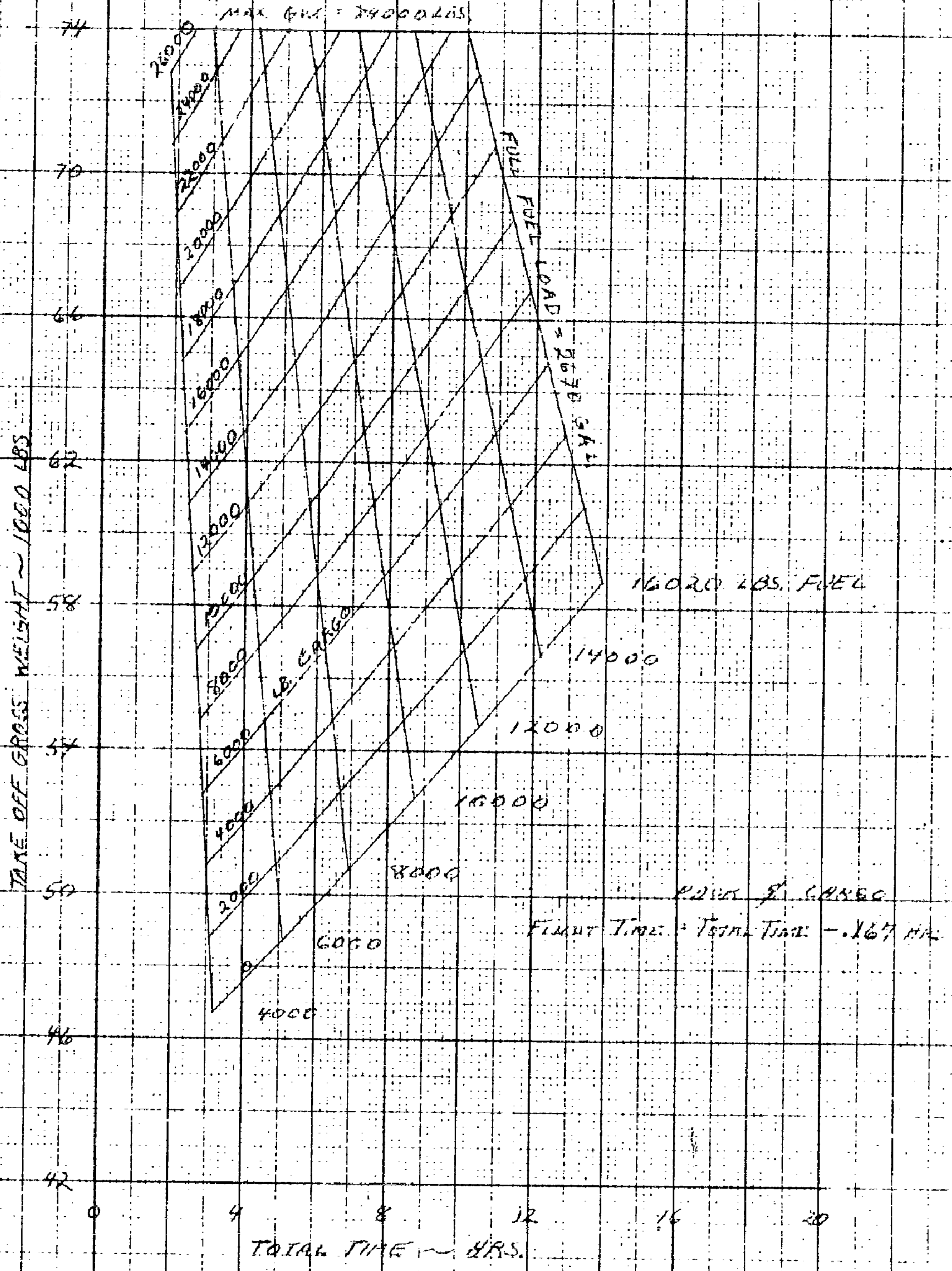
MAXIMUM GROSS WEIGHT 74000#



XC-120, PACK-ON

Fig 47

TAKE-OFF GROSS WEIGHT VS TIME FOR COMBAT RANGE
WITH FUEL AND PAYLOAD PARAMETERS



[illegible] CARGO

FLIGHT TIME = TOTAL TIME − .167 HR.

PART II-E-5

5. Maximum Range and Endurance

Since one pound of fuel and oil in the proper proportions is equal to one pound of weight change in flight, maximum range and endurance on the subject airplane are computed by the following integrations: -

$$\text{Range} = \int_{\text{Take-off Gross Weight}}^{\text{Landing Gross Weight}} (\text{miles/lb. of fuel and oil})\, dw$$

$$\text{Endurance} = \int_{\text{Take-off Gross Weight}}^{\text{Landing Gross Weight}} (\text{hr./lb. of fuel and oil})\, dw$$

For each range figure the average operating speed was read from figure 40 at the average cruise weight and the cargo load was determined as: -

Cargo Load = (T.O.G.W.) - (Basic Wt. + Cruise Fuel and Corresponding Oil).

On this basis maximum range and endurance were computed using the data of figure 40 which is based directly on manufacturer's SFC data from reference (a).

Maximum range is plotted against take-off gross weight with cargo and fuel load parameters in figure 48, while the corresponding endurance or flight time is plotted in figure 49. It is noted that this concept of maximum range makes no allowance for warm-up, take-off, climb, headwinds, or reserve.

MODEL XC-120

MAXIMUM RANGE WITH PACK ON

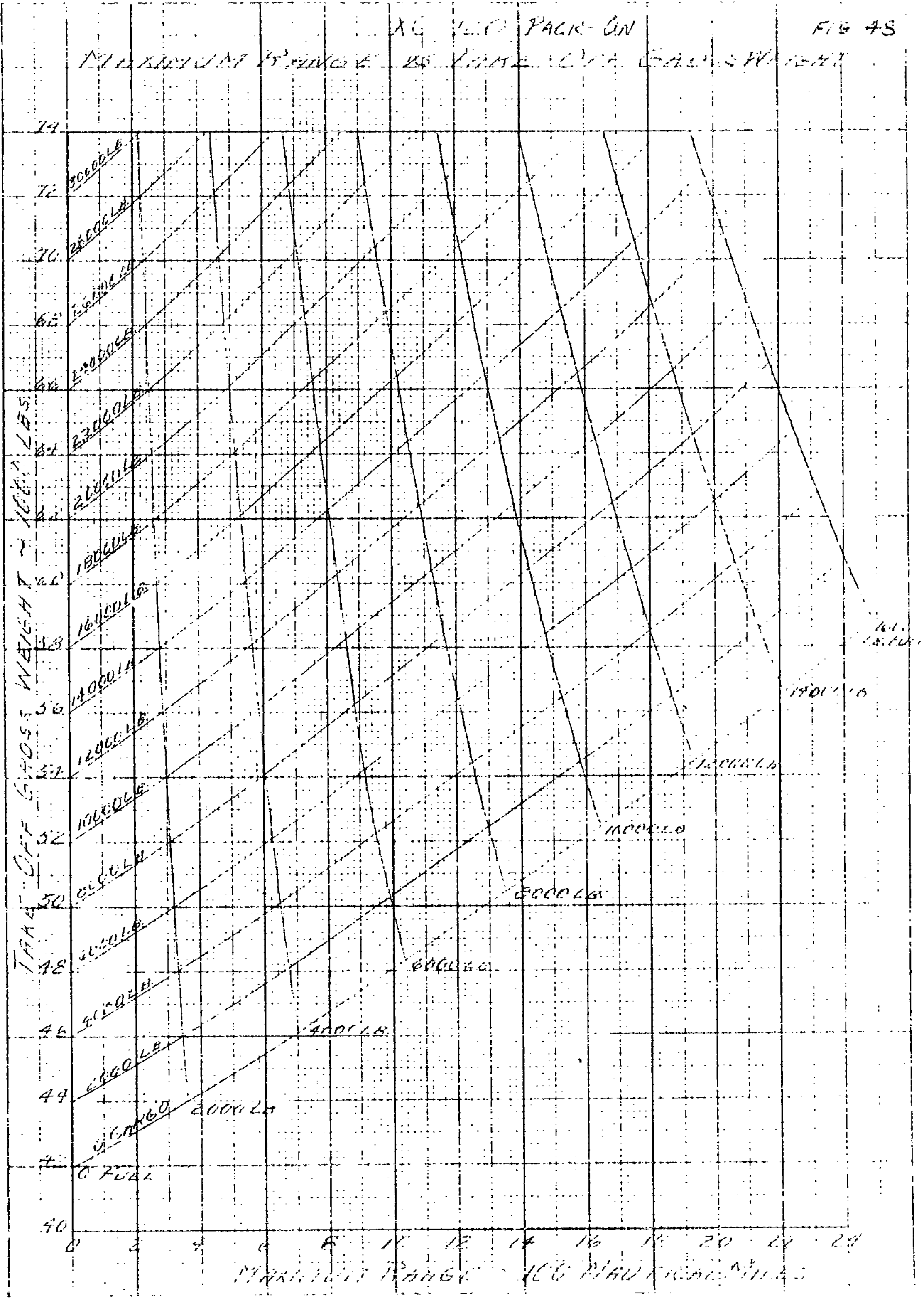
BASIC WT. = 41941 Lbs. FULL FUEL - USABLE OIL = 16821 Lbs.

① Take-Off Gross Wt. lbs.	② Fuel Load lbs.	③ Fuel - Usable Oil 1.05 x ② lbs.	④ Fuel - Usable Oil - Cargo ① - 41941 lbs.	⑤ Cargo ④ - ③ lbs.	⑥ Av. Cruise Weight ① - ½ x ③ lbs.	⑦ Best mi./lb. of fuel - oil from graph mi./lbs.	⑧ Range ⑦ x ③ Statute mi.	Best hr./lb. of fuel - oil x 1000 from graph	Endurance hrs.	Av. Operating Speed ⑧ ÷ ⑩ mph
74000	0	0	32059	32059	74000	.1155	0	.666	0	
	4000	4200	32059	27859	71900	.1195	502	.703	2.95	170.1
	8000	8400	32059	23659	69800	.1235	1037	.743	6.24	166.2
	12000	12600	32059	19459	67700	.1277	1609	.786	9.90	162.5
	16020	16821	32059	15238	65590	.1320	2222	.822	13.83	160.5
70000	0	0	28059	28059	70000	.1230	0	.739	0	
	4000	4200	28059	23859	67900	.1272	534	.778	3.27	163.3
	8000	8400	28059	19659	65800	.1316	1105	.818	6.87	160.8
	12000	12600	28059	15459	63700	.1361	1715	.861	10.85	158.1
	16020	16821	28059	11238	61590	.1407	2367	.907	15.26	155.1
64000	0	0	22059	22059	64000	.1353	0	.855	0	
	4000	4200	22059	17859	61900	.1401	588	.900	3.78	155.6
	8000	8400	22059	13659	59800	.1449	1217	.947	7.95	153.1
	12000	12600	22059	9459	57700	.1500	1890	.997	12.56	150.5
	16020	16821	22059	5238	55590	.1553	2612	1.050	17.66	147.9
60000	0	0	18059	18059	60000	.1444	0	.942	0	
	4000	4200	18059	13859	57900	.1495	628	.992	4.17	150.6
	8000	8400	18059	9659	55800	.1548	1300	1.044	8.77	148.2
	12000	12600	18059	5459	53700	.1603	2020	1.101	13.87	145.6
	16020	16821	18059	1238	51590	.1666	2802	1.176	19.78	141.7
54000	0	0	12059	12059	54000	.1598	0	1.092	0	
	4000	4200	12059	7859	51900	.1656	696	1.156	4.86	143.2
	8000	8400	12059	3659	49800	.1721	1446	1.221	10.25	141.1
	11485	12059	12059	0	47970	.1782	2149	1.288	15.53	138.4
50000	0	0	8059	8059	50000	.1713	0	1.215	0	
	4000	4200	8059	3859	47900	.1785	750	1.290	5.42	138.4
	7675	8059	8059	0	45970	.1852	1493	1.368	11.02	135.5
44000	0	0	2059	2059	44000	.1933	0	1.453	0	
	1961	2059	2059	0	42970	.1980	408	1.503	3.09	132.0

XC-120 PACK-ON

FIG 48

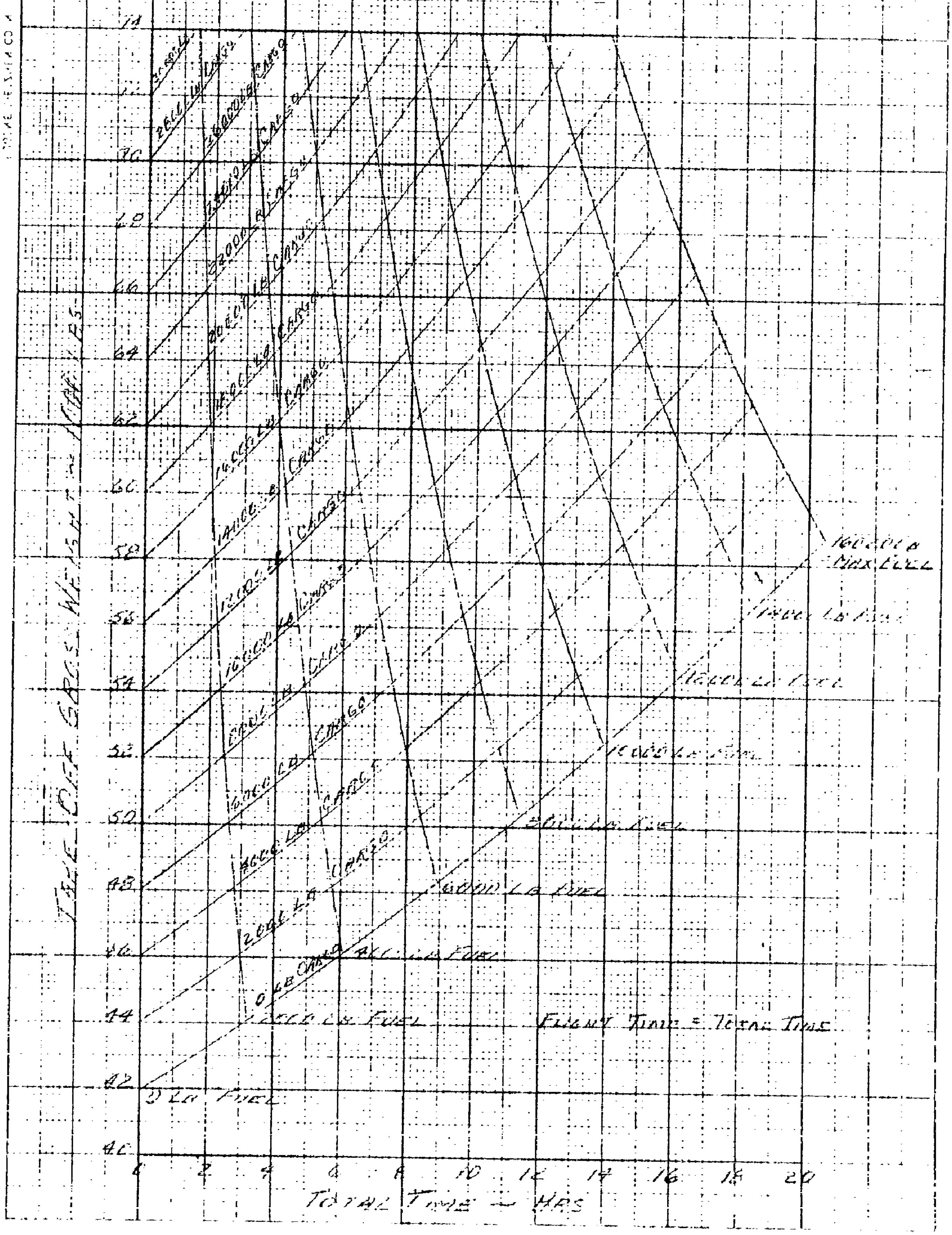
MAXIMUM RANGE vs TAKE-OFF GROSS WEIGHT



XC-120 Pack-On

Fig 47

Take-Off Gross Weight vs Total Time for Max Range



PART II-F

F. STALLING SPEEDS

Maximum lift coefficients used for the calculation of stalling speeds were obtained from Army and Fairchild flight test data. Tests were made at various flap deflections and were corrected for trim to the most unfavorable c.g. location (approximately 20% MAC). Figure 50 presents a plot of maximum lift coefficient versus flap deflection as obtained in this manner with cowl flaps closed, gear down, and power off. Stalling speeds are plotted versus gross weight in figure 51 as computed from these maximum coefficients by the formula

$$V_{S(mph)} = \sqrt{391\, W / C_{L_{max}} \sigma S}$$

where

W = airplane gross weight

$C_{L_{max}}$ is taken from figure 50

S = airplane wing area = 1447.25 sq. ft.

σ = density ratio

XC-120

Variation of $C_{L_{max}}$ With Flap Deflection

Corrected for Trim to Most Unfavorable C.G. Position (Approximately 20% MAC)

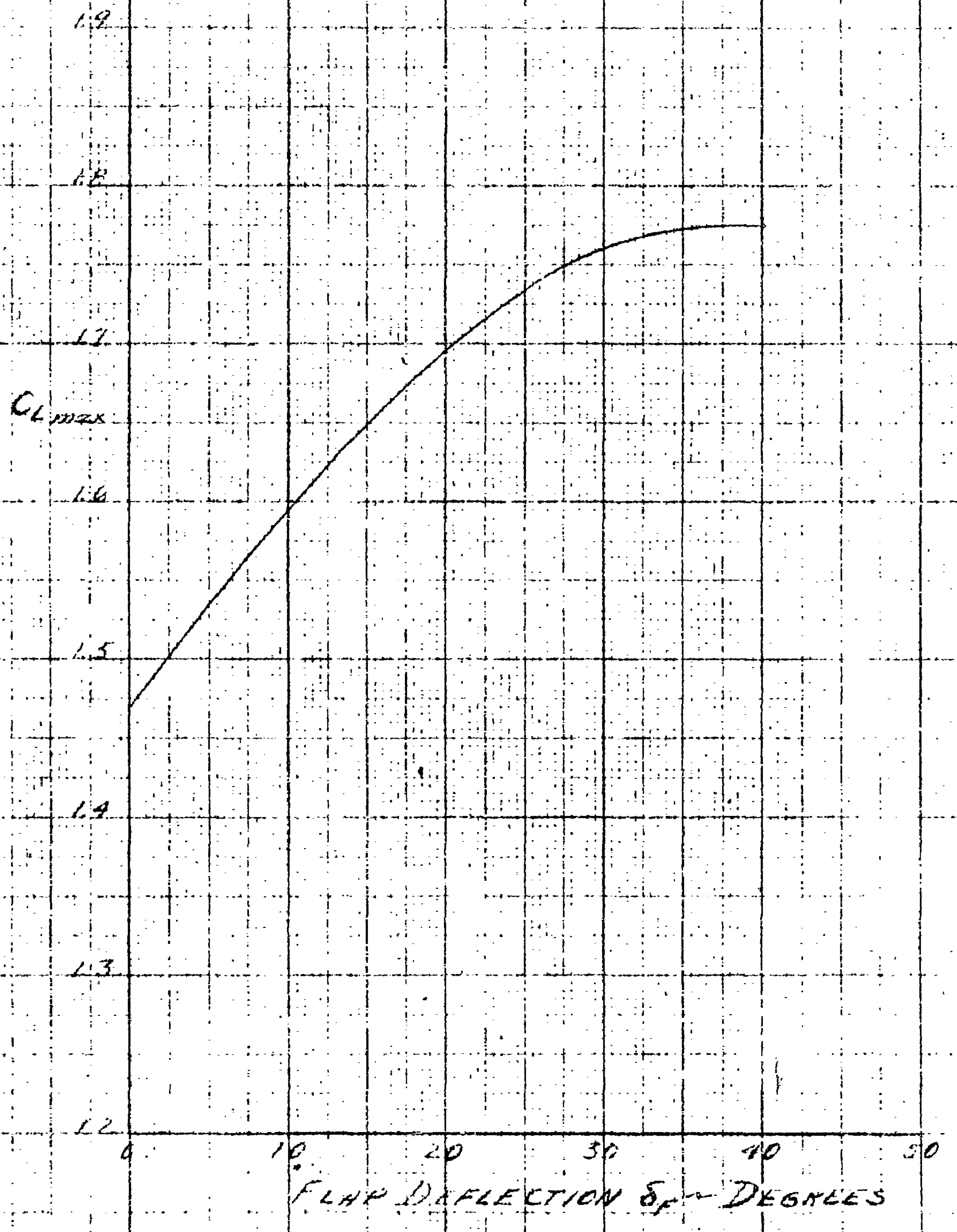
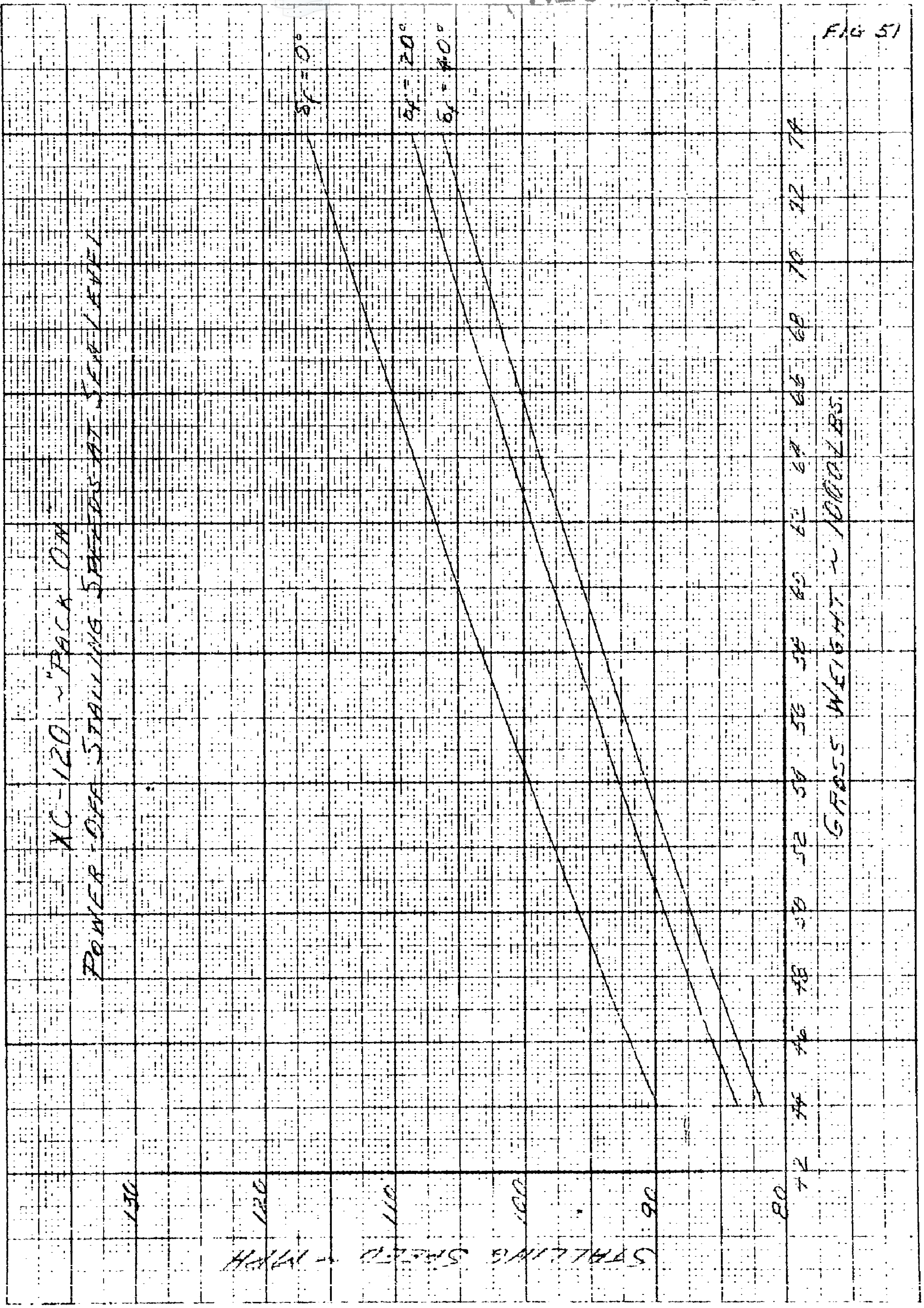


FIG 51


XC-120 ~ "PACK ON"
POWER-OFF STALLING SPEEDS AT SEA LEVEL
δf = 0°
δf = 20°
δf = 40°
GROSS WEIGHT ~ 1000 LBS.
42
44
46
48
50
52
54
56
58
60
62
64
66
68
70
72
74
STALLING SPEED ~ MPH
80
90
100
110
120
130

PART II-G

G. TAKE-OFF DISTANCE

1. Unassisted Take-Off

Take-off distance over a 50 ft. obstacle was calculated in three steps as follows:

(1) Ground run of airplane from rest to stall speed at .9 $C_{L_{max}}$ (take-off flap deflection).

(2) Transition of airplane assuming speed along the flight path remains constant.

(3) Steady climb after transition is completed to 50 ft. altitude at take-off speed.

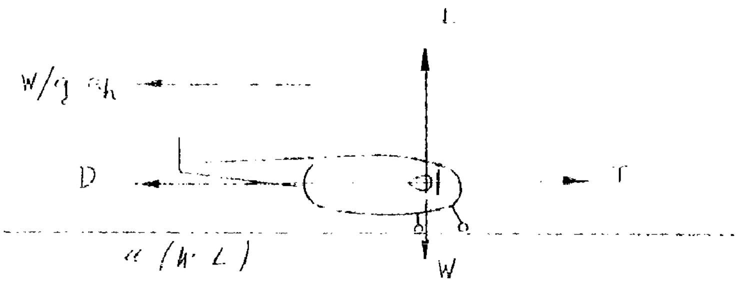
Thrust versus airplane speed was calculated by the method of reference (c). Figure 52 presents a plot of thrust versus speed for the subject airplane at sea level. As stated previously, jet thrust is neglected in all power calculations.

Take-off calculations are made for gross weights of 44,000, 60,000, and 74,000 lb. Ground run in take-off is plotted versus gross weight in figure 57 and total take-off distance over a 50 ft. obstacle is plotted versus gross weight in figure 58.

A detailed explanation of the method used is shown in the following pages along with sample calculations for a take-off gross weight of 74,000 lbs.

PART II-G (Cont.)

1. Ground Run (Cont.)



$$T-D-\mu(W-L)-(W/g)a_h = 0$$

$$a_h = \frac{T-D-\mu(W-L)}{(W/g)} = \frac{F}{M}$$

Select a range of speeds from 0 up to a speed corresponding to stalling speed at .9 $C_{L_{max}}$.

Calculate a_h and plot (V/a_h) versus V. Integrate under curve to obtain ground run.

Assume $\delta_f = 20^\circ$ $C_{L_{max}} = 1.696$ (figure 50)

Assume run with thrust line level. The take-off polar diagram is presented in figure 53.

$C_{L_{run}} = .890$ $C_{D_{run}} = .1590$

$C_{L_{T.O.}} = .9\, C_{L_{max}} = .9(1.696) = 1.528$

$\mu = .02$, $q = .001189\,(V_{fps})^2$, $D = q\,S\,C_D$, $L = q\,S\,C_L$

$$V_{T.O.} = \sqrt{\frac{391 \times 74000}{1.528 \times 1447.25}} = 114.4 \text{ mph} = 168 \text{ fps}$$

$a_h = F/M = F/2300$

$W = 74000$ lbs. $S = 1447.25$ sq. ft.

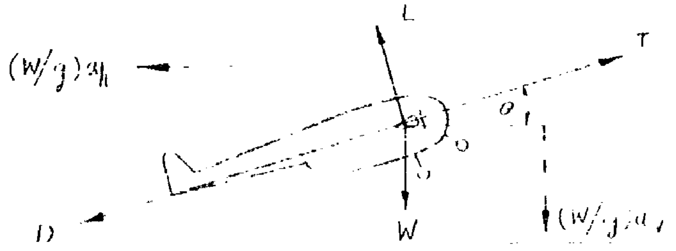
PART II-G-1 (Cont.)

Method of Take-Off Analysis

V_{fps}	q (#/ft.^{2})	D (#)	L (#)	W-L (#)	D + μ(W-L) #	T (#)	F (#)	a_h	V/a_h
0	0	0	0	74000	1480	21960	20480	8.93	0
40	1.90	437	2450	71550	1431	20660	18792	8.18	4.89
80	7.60	1750	9780	64220	1284	18960	15926	6.94	11.53
100	11.89	2740	15320	58680	1174	18000	14086	6.14	16.28
129.3	19.87	4570	25600	48400	968	16460	10822	4.71	27.45
140.	23.3	5360	30000	44000	880	15920	9680	4.21	33.20
151.	27.15	6240	35000	39000	780	15400	8380	3.65	41.30
168.	33.6	7730	43300	30700	614	14680	6336	2.76	60.90

V/a_h versus V is plotted and integrated in figure 54

2. Transition of Airplane



Assume airplane speed along flight path remains constant and equal to take-off speed.

Tangential acceleration is zero and since θ is small,

$$a_h \approx 0$$

$$\Sigma H: T \cos\theta - L \sin\theta - D \cos\theta - (W/g)a_h \approx 0$$

$$\text{since } \cos\theta \approx 1 \text{ and } a_h \approx 0$$

$$\sin\theta \approx (T - D)/L$$

$$\Sigma V: T \sin\theta + L \cos\theta - D \sin\theta - W - (W/g)a_v \overset{!}{=} 0$$

$$\frac{(T - D)\sin\theta + L - W}{W} \approx a_v/g$$

$$T - D \approx L \sin\theta$$

PART II-G-1 (Cont.)

(2) Transition of Airplane (Cont.)

$$\frac{(L \sin\theta)\sin\theta + L - W}{W} = \frac{a_v}{g}$$

$$W = q_{T.O.} \; S \; C_{L_{T.O.}}$$

$$\frac{L \sin^2\theta + L - W}{W} = \frac{a_v}{g}$$

$$\sin^2\theta \frac{C_L}{C_{L_{T.O.}}} + \frac{C_L}{C_{L_{T.O.}}} - 1 = \frac{a_v}{g}$$

so:

$$a_v = g\left[\frac{C_L}{C_{L_{T.O.}}}(\sin^2\theta + 1) - 1\right]$$

Since $\sin\theta = (R/C)/V_{T.O.}$ and $R/C = \left(\frac{T-D}{W}\right) V_{T.O.}$

$$D = T - \frac{W(R/C)}{V_{T.O.}}$$

Therefore, use the following procedure for transition: -

Assume arbitrary values of R/C in ft./sec.

Find $D = T - (W(R/C)/V_{T.O.})$

Find $C_D = D/q_{T.O.} S$

Find C_L corresponding to C_D above from take-off polar diagram (this C_L can in no place exceed $C_{L_{max}}$)

Find $\sin\theta = (R/C)/V_{T.O.}$

Find $a_v = g\left[\frac{C_L}{C_{L_{T.O.}}}(\sin^2\theta + 1) - 1\right]$

Plot a_v versus R/C from R/C = 0 to $a_v = 0$. Check the actual C_L of the airplane for the assumed rates of climb - this C_L cannot exceed $C_{L_{max}}$.

PART II-G-1 (Cont.)

(2) **Transition of Airplane** (Cont.)

This method is more precise than the approximate methods of Schrenk and Wetmore. These methods assume that the airplane pulls $C_{L_{max}}$ throughout the entire transition period. However, in many cases the airplane cannot pull $C_{L_{max}}$ for the entire period without losing speed due to the high drag attitude (especially if take-off speed is appreciably above the stall speed). The above method shows the C_L which the airplane can actually pull while maintaining a constant speed (which closely approximates true conditions) and enables a more accurate step-by-step integration of the airplane flight path.

Figure 53 presents a plot of the polar diagram for the airplane in the take-off configuration with cowl flaps full open, gear down, wing flaps deflected 20°.

A sample calculation is shown below for a_v at various assumed rates of climb.

$V = 168$ fps $W = 74000$ lbs. $C_{L_{T.O.}} = 1.528$

$T_{T.O.} = 14680$ (two engines) $q_{T.O.} = 33.6$ #/ft.^{2}

$D_{T.O.} = 12750$ lbs. $R/C_{(C_L = C_{L_{max}})} = 4.39$ ft./sec.

R/C fps	$\frac{W(R/C)}{V_{T.O.}}$	D lbs.	C_D	C_L	sin	$\sin^2$ -1	$C_L/C_{L_{T.O.}}$	7 x 8	a_v ft/sec^2
4.39	1930	12750	.2630	1.696	.0261	1.0007	1.111	1.112	3.61
6	2640	12040	.2485	1.667	.0357	1.0013	1.090	1.091	2.93
7	3080	11600	.2395	1.645	.0416	1.0017	1.076	1.078	2.51
8	3520	11160	.2300	1.615	.0476	1.0023	1.056	1.058	1.87
9	3960	10720	.2210	1.573	.0535	1.0029	1.030	1.030	1.06
10	4400	10280	.2120	1.507	.0595	1.0035	.986	.990	-.32

PART II-C-1 (Cont.)

(2) Transition of Airplane (Cont.)

Figure 55 shows a_v and C_L during transition plotted against assumed rate of climb. These curves are integrated from R/C = 0 to $a_v = 0$ by using the mid-point formulas shown below:

$$\Delta t = \Delta R/C \Big/ \left(\frac{a_{v_1} + a_{v_2}}{2}\right)$$

$$\Delta S_v = \Delta t \left(\frac{(R/C)_1 + (R/C)_2}{2}\right)$$

$$\Delta S_h = \Delta t \; V_{T.O.} \text{ (fps)}$$

A sample integration at gross weight of 74000 lbs. is shown below:

$(R/C)_1$ fps	$(R/C)_2$ fps	$\Delta(R/C)$ fps	Ave(R/C) fps	a_{v_1} ft/sec^2	a_{v_2} ft/sec^2	ave a_v ft/sec^2	Δt sec	ΔS_v ft	ΔS_h ft	S_v ft	S_h ft	t sec
0	4.39	4.39	2.20	3.61	3.61	3.61	1.214	2.7	204	2.7	204	1.214
4.39	6	1.61	5.20	3.61	2.93	3.27	.492	2.6	83	5.3	287	1.706
6	7	1.00	6.5	2.93	2.51	2.72	.368	2.4	62	7.7	349	2.074
7	8	1.00	7.5	2.51	1.87	2.19	.456	3.4	77	11.1	426	2.730
8	9	1.00	8.5	1.87	1.06	1.47	.683	5.8	115	16.9	541	3.413
9	9.81	.81	9.41	1.06	0	.53	1.528	14.4	256	31.3	797	4.941
9.81	9.81	0	9.81	0	0	0	1.905	18.7	320	50.	1117	6.846

Horizontal and vertical distances during transition are plotted against each other in figure 56.

(3) Steady Rate of Climb to 50 ft. Altitude

From the preceding step the rate of climb of the airplane after transition is already determined ($a_v = 0$) and also the vertical distance during transition.

PART II-G-1 (Cont.)

(3) Steady Rate of Climb to 50 ft. Altitude (Cont.)

So:

$$S_H(\text{steady climb}) = \frac{50 \text{ ft.} - S_V(\text{during transition})}{R/C \text{ at } a_V = 0} (V_{T.O.})$$

$$S_H = \frac{50 - 31.3}{9.81} 168 = 320 \text{ ft.}$$

It is noted from figure 56 that, at the lighter gross weights, the airplane reaches an altitude of 50 ft. before the steady rate of climb is attained; i.e., for these gross weights, step (3) is unnecessary.

(4) Summary of Take-Off Distance

Gross Weight	lbs.	44000	60000	74000
Ground Run	ft.	759	1639	2936
Transition	ft.	588	783	797
Steady Climb to 50 ft. Altitude	ft.	0	0	0
Total Take-off Distance Over 50 ft. Obstacle	ft.	1347	2422	4053

FIG 52

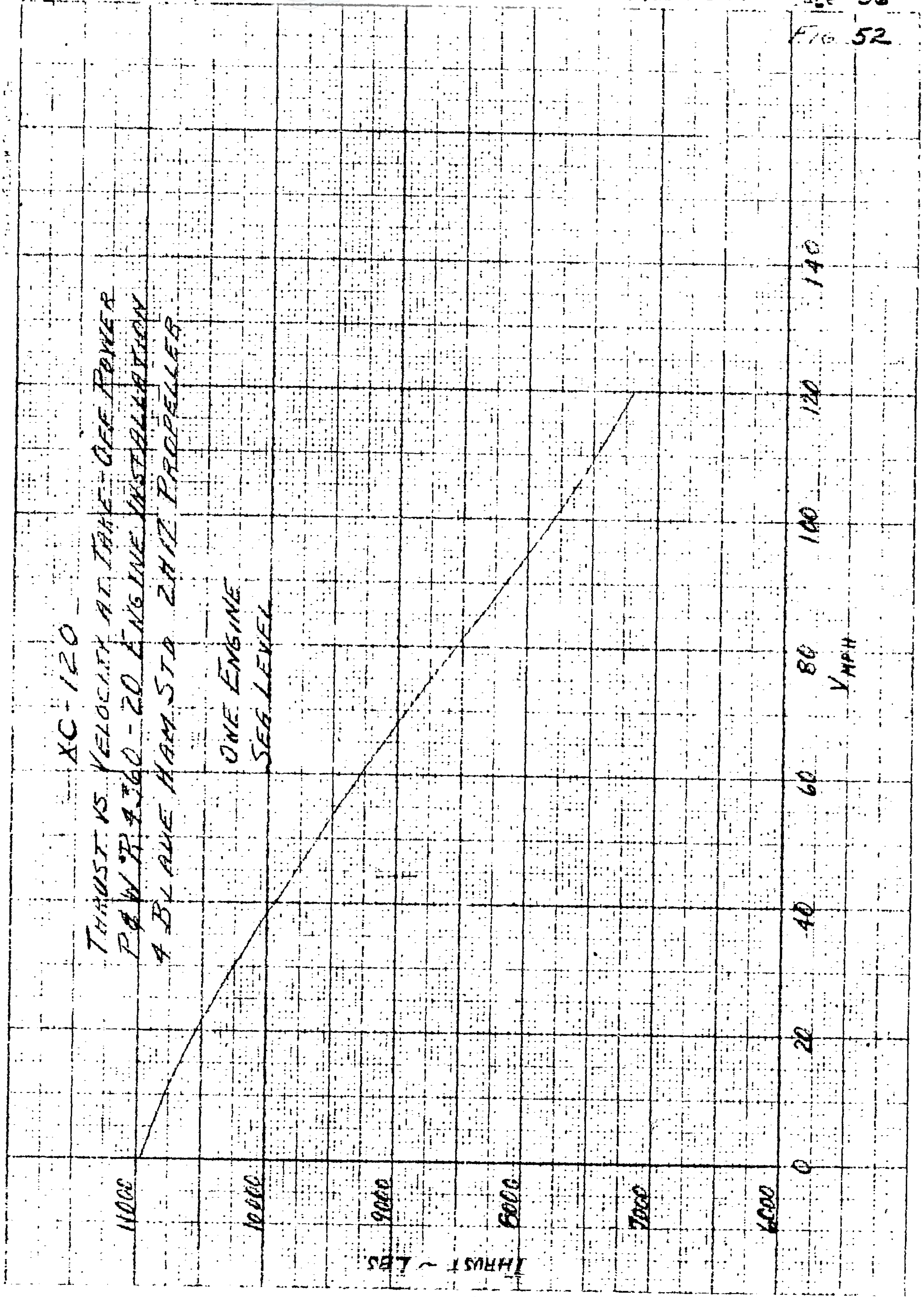

XC-120
THRUST VS VELOCITY AT TAKE-OFF POWER
P&W R-4360-20 ENGINE INSTALLATION
4 BLADE HAM STD 2H12 PROPELLER
ONE ENGINE
SEA LEVEL
0
20
40
60
80
100
120
140
V MPH
11000
10000
9000
8000
7000
6000
THRUST ~ LBS

FIG 53

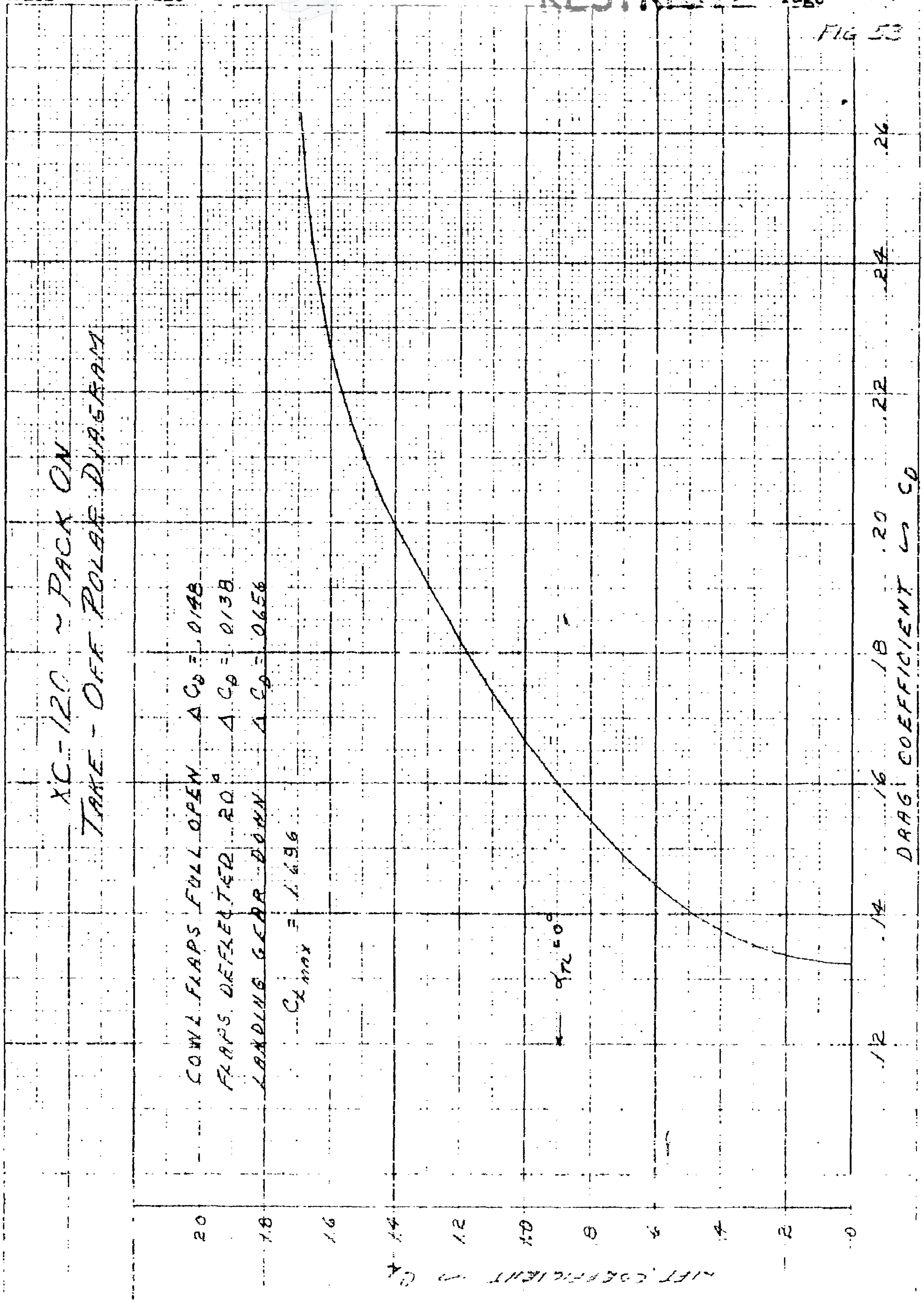

XC-120 ~ PACK ON
TAKE-OFF POLAR DIAGRAM
COWL FLAPS FULL OPEN ΔCD = .0148
FLAPS DEFLECTED 20° ΔCD = .0138
LANDING GEAR DOWN ΔCD = .0656
CL MAX = 1.696
αTL = 0°
DRAG COEFFICIENT ~ CD
.12
.14
.16
.18
.20
.22
.24
.26
LIFT COEFFICIENT ~ CL
0
.2
.4
.6
.8
1.0
1.2
1.4
1.6
1.8
2.0

FIG. 54

XC-120 - PACK ON
UNASSISTED TAKE-OFF
GROUND RUN DETERMINATION

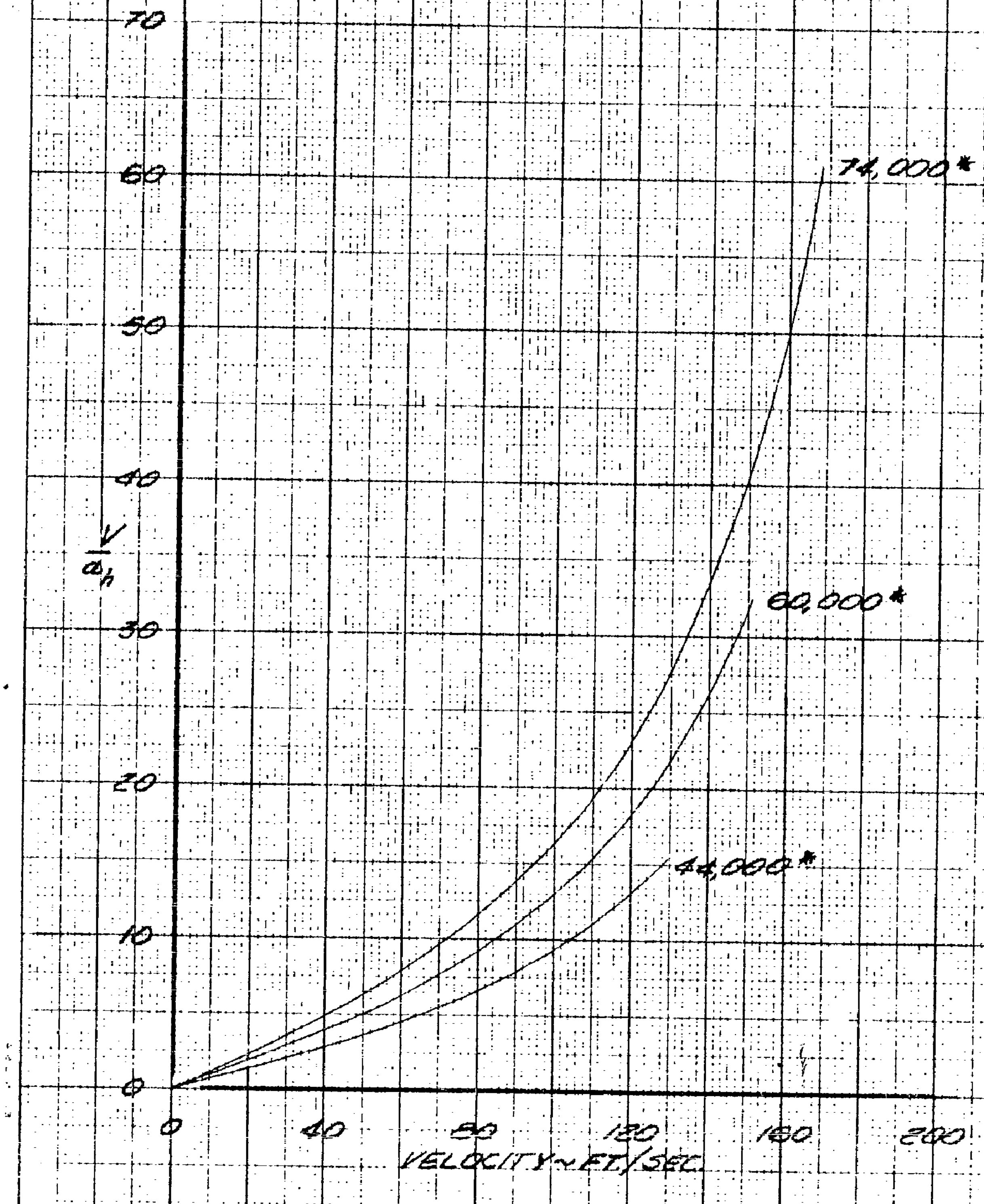
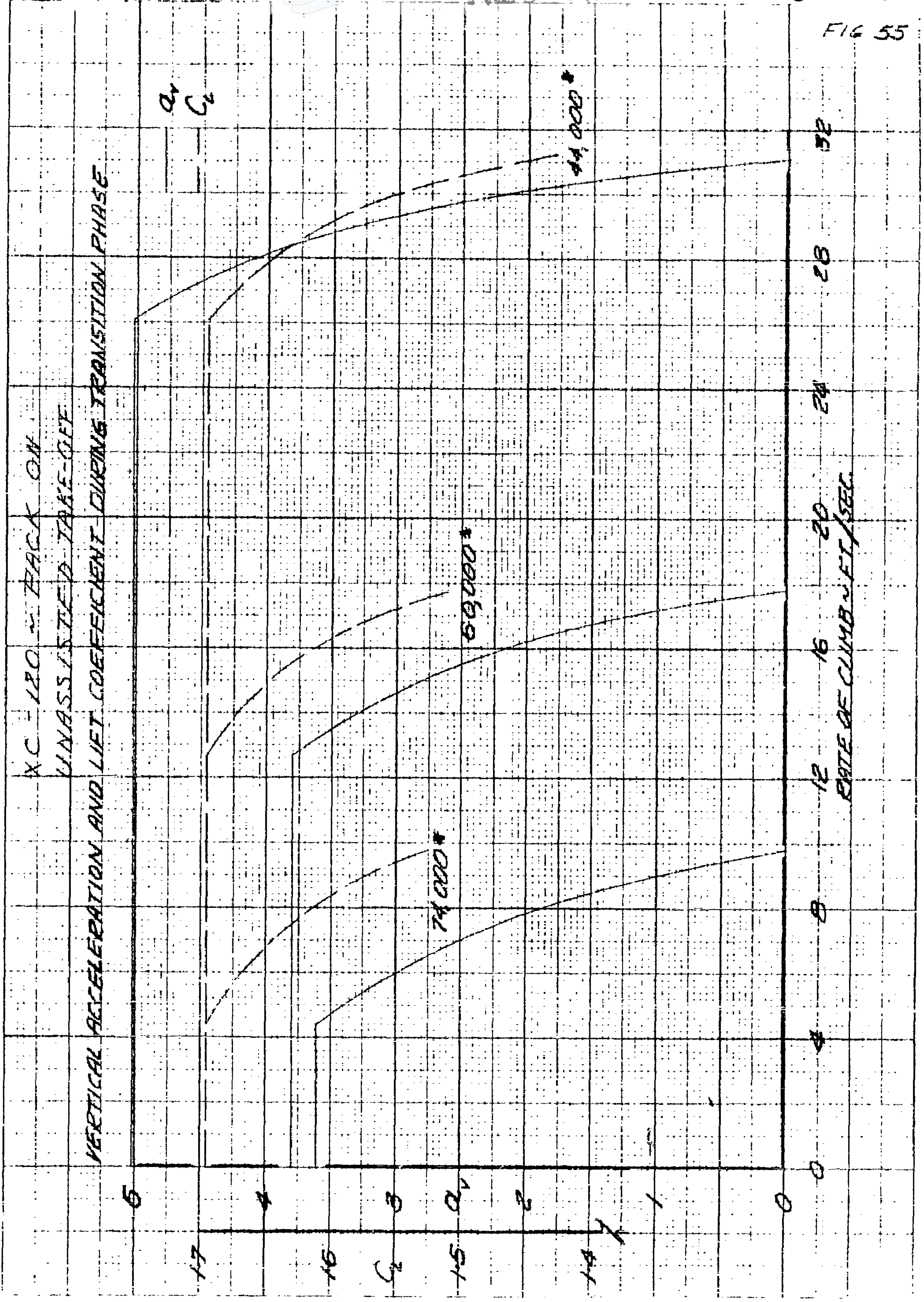
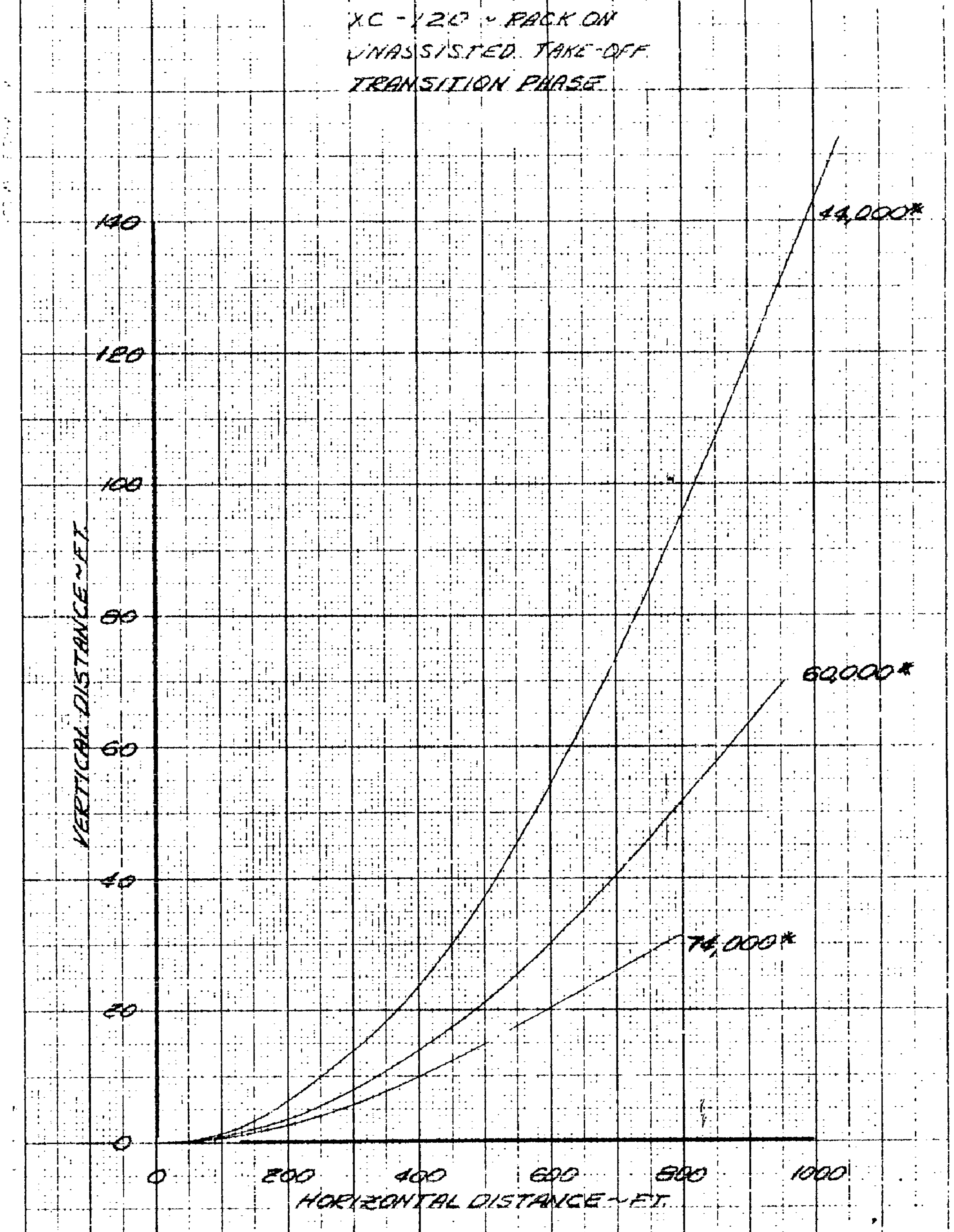


FIG 55



XC-120 – PACK ON
UNASSISTED TAKE-OFF
VERTICAL ACCELERATION AND LIFT COEFFICIENT DURING TRANSITION PHASE

FIG 56


XC-120 ~ PACK ON
UNASSISTED TAKE-OFF
TRANSITION PHASE
VERTICAL DISTANCE ~ FT.
0
20
40
60
80
100
120
140
HORIZONTAL DISTANCE ~ FT.
0
200
400
600
800
1000
44,000#
60,000#
74,000#

RESTRICTED

FIG 57

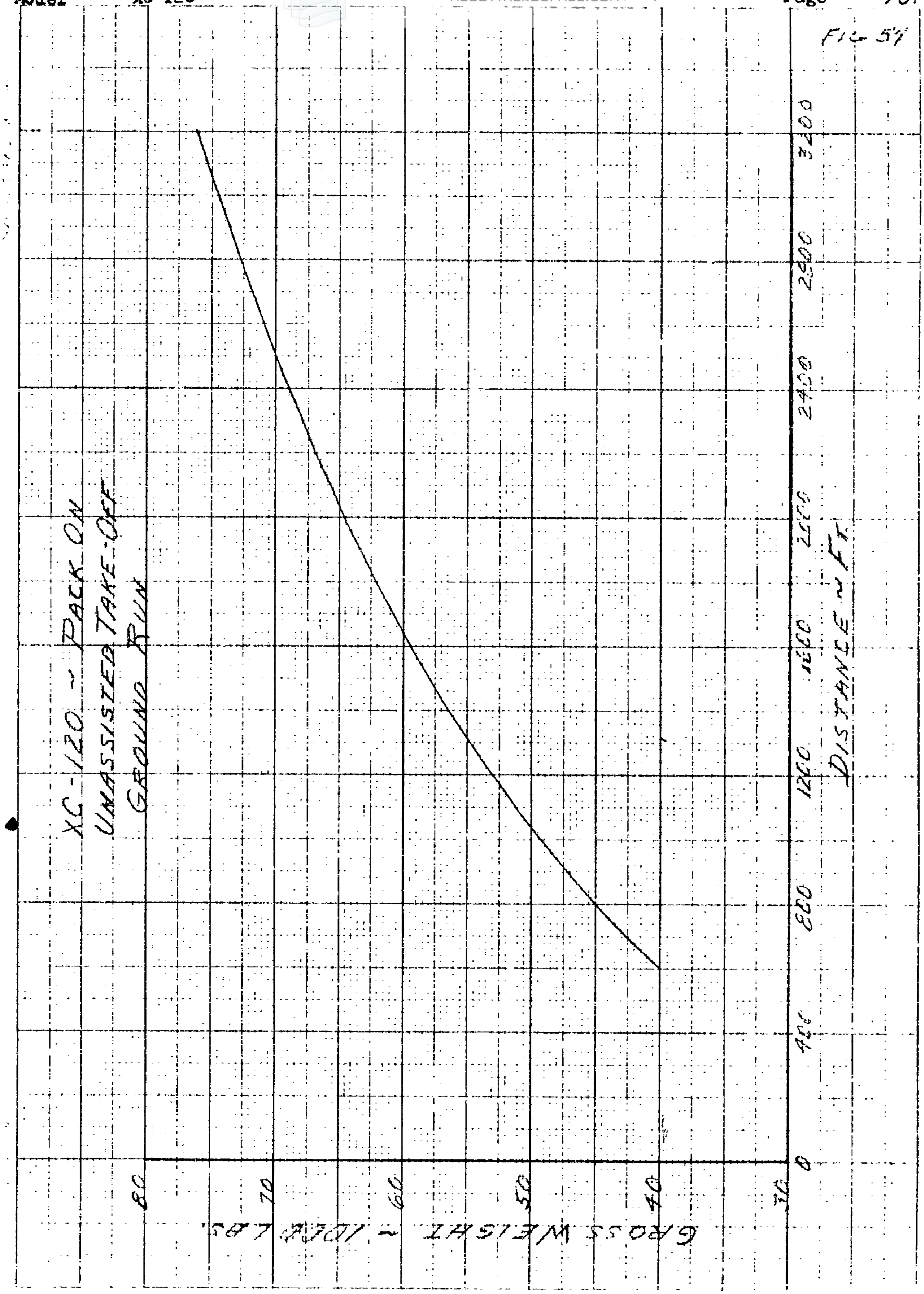
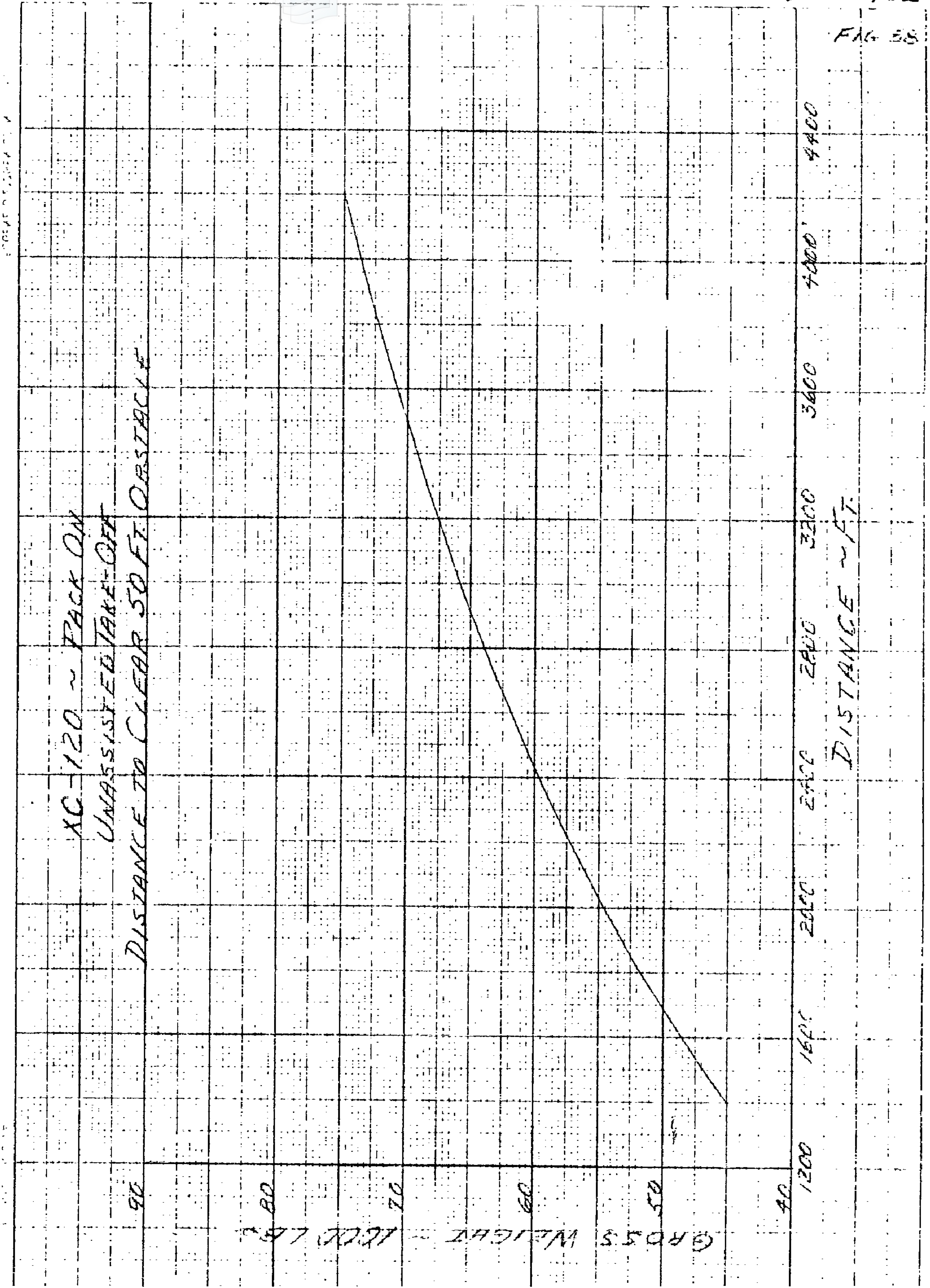


FIG. 58



XC-120 ~ PACK ON
UNASSISTED TAKE-OFF
DISTANCE TO CLEAR 50 FT. OBSTACLE

PART II-G TAKE-OFF DISTANCE (Cont.)

2. Jet Assisted Take-Off

At the customer's request the effect on take-off distance of using one or more Jato units, each rated at 1000 lb. thrust and 14 seconds duration, has been investigated. For this purpose, the same method of calculation was used and the ground run, transition and steady climb to fifty feet were computed using the additional thrust of one, two, and four jato units at each gross weight. A sample calculation for 74000 lb. gross weight with one unit is shown in the following pages.

The integrated values of time and distance covered are plotted against speed during the ground run for gross weights of 74000, 60000, and 44000 lbs. in figures 59 through 64. From these curves the increment of distance from V_0 (airplane at rest) to V_1 (speed at which jato is started) is read from the line for unassisted take-off (0 units); the increment of distance from V_1 to V_2 (speed at which jato expires) is read from the line for the desired number of units; and the increment of distance from V_2 to $V_{T.O.}$ is read from the line for unassisted take-off. These increments are then added together to give the total distance covered during the ground run.

The transition phase calculations are then repeated using the additional thrust due to the jato and the time and horizontal distance traversed in reaching 50 ft. are determined graphically. It is then assumed that the remaining time of the 14 seconds jato duration is used up in the ground run and the total distance to clear 50 ft. is determined as if the jato expires exactly at S_{50}.

Ground run and total horizontal distances to clear 50 ft. are plotted against time to start Jato on figures 65 through 67 for gross weights of 74000, 60000, and 44000 lbs. From these figures it is seen that the time at which the jato is started is more critical at the higher gross weight.

The optimum points for each gross weight from these figures are used to plot ground run and total distance to clear 50 ft. against gross weight with number of unit parameters in figures 68 and 69, respectively.

PART II-G (Cont.)

2. Jet Assisted Take-Off (Cont.)

Method of Take-Off Analysis (Cont.)

(1) Ground Run

The computation for V/a_h versus V with jet assistance is the same as for the unassisted take-off except that the available thrust is increased by the increment furnished by the jato units.

Since $F = T - [D + \mu(W-L)]$

the increment in thrust may be added directly to F from the previous calculation for unassisted take-off. Then $a_h = F/M$ and V/a_h is computed exactly as before. A sample tabulation for 74,000 lb. gross weight is shown below:

74,000 lbs. M = 2298

		1 Jato Unit			2 Jato Units			4 Jato Units		
V fps	F Unassisted	F	a_h	V/a_h	F	a_h	V/a_h	F	a_h	V/a_h
0	20480	21480	9.35	0	22480	9.79	0	24480	10.67	0
40	18792	19792	8.61	4.65	20792	9.05	4.42	22792	9.91	4.04
80	15926	16926	7.37	10.87	17926	7.80	10.26	19926	8.67	9.22
100	14086	15086	6.56	15.26	16086	7.00	14.28	18086	7.87	12.71
120	11980	12980	5.65	21.25	13980	6.08	19.73	15980	6.95	17.27
129.3	10822	11822	5.15	25.12	12822	5.58	23.18	14822	6.45	20.06
140	9680	10680	4.65	30.13	11680	5.08	27.56	13680	5.95	23.54
151	8380	9380	4.08	37.02	10380	4.52	33.40	12380	5.39	28.00
168	6336	7336	3.19	52.7	8336	3.63	46.25	10336	4.50	37.30

Then $\Delta S_h = (\Delta V)(\text{average } V/a_h)$

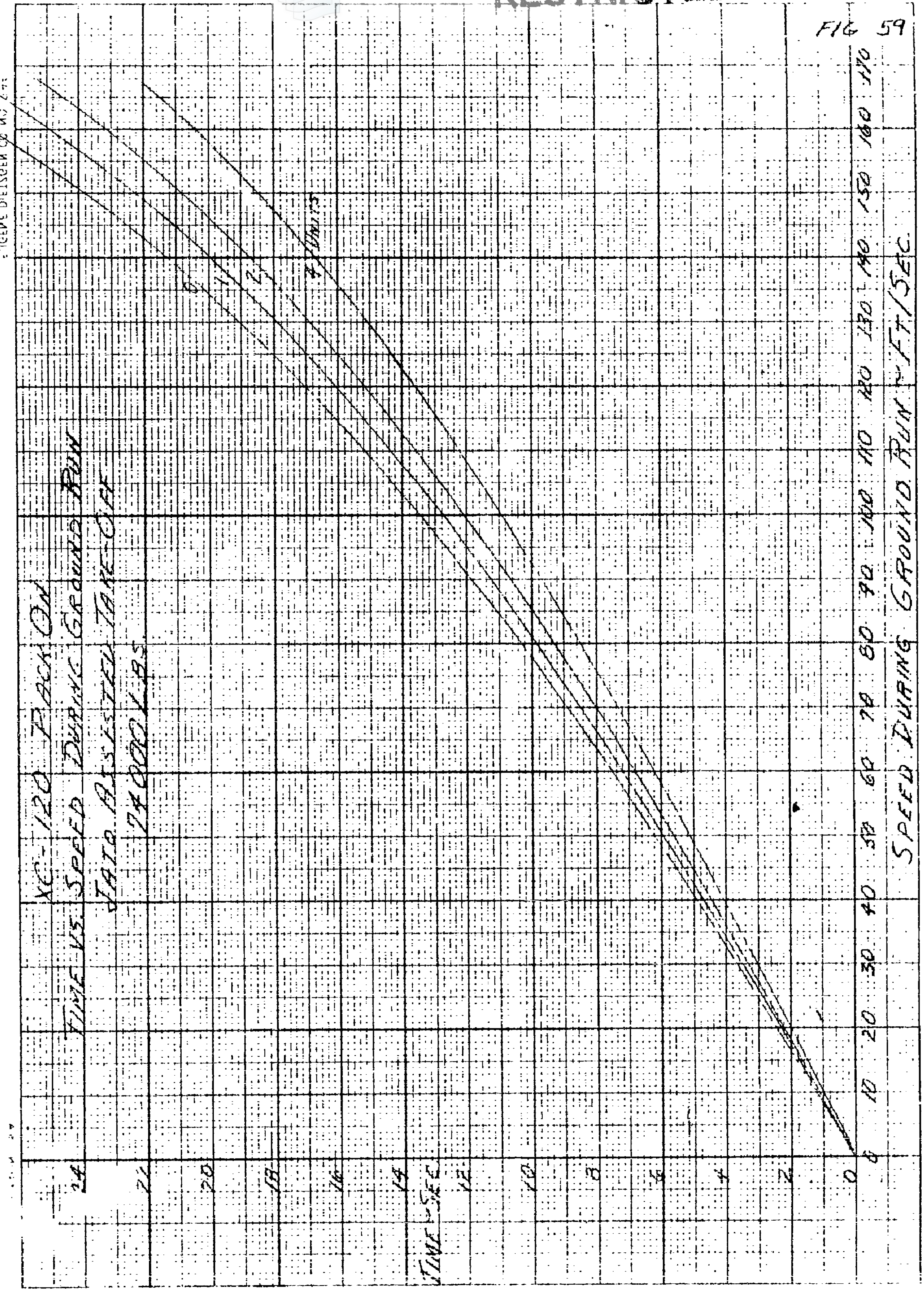
and $\Delta t = (\Delta S_h)\ (\text{average } V)$

A sample tabular integration is shown below and time and distance are plotted versus speed in figures 59 through 64

74,000 lbs. One Unit

V_1 fps	V_2 fps	V fps	Ave V fps	$(V/ah)_1$	$(V/a_h)_2$	Av (V/a_h)	ΔS_h ft	Δt ft	S_h ft	t sec
0	40	40	20	0	4.65	2.33	93	4.65	93	4.65
40	80	40	60	4.65	10.87	7.76	311	5.18	404	9.83
80	100	20	90	10.87	15.26	13.07	261	2.90	665	12.73
100	120	20	110	15.26	21.25	18.26	365	3.32	1030	16.05
120	129.3	9.3	124.65	21.25	25.12	23.19	216	1.73	1246	17.78
129.3	140.	10.7	134.65	25.12	30.13	27.63	296	2.20	1546	19.98
140	151	11.	145.5	30.13	37.02	33.58	369	2.54	1911	22.52
151	168	17.	159.5	37.02	52.70	44.86	761	4.77	2672	27.29

FIG 59



XC-120 PACK ON
TIME VS. SPEED DURING GROUND RUN
JATO ASSISTED TAKE-OFF
74000 LBS.

RESTRICTED

FIG 60

XC-120 - PACK ON

SPEED VS DISTANCE COVERED IN GROUND RUN

JATO ASSISTED TAKE-OFF

72000 LB.

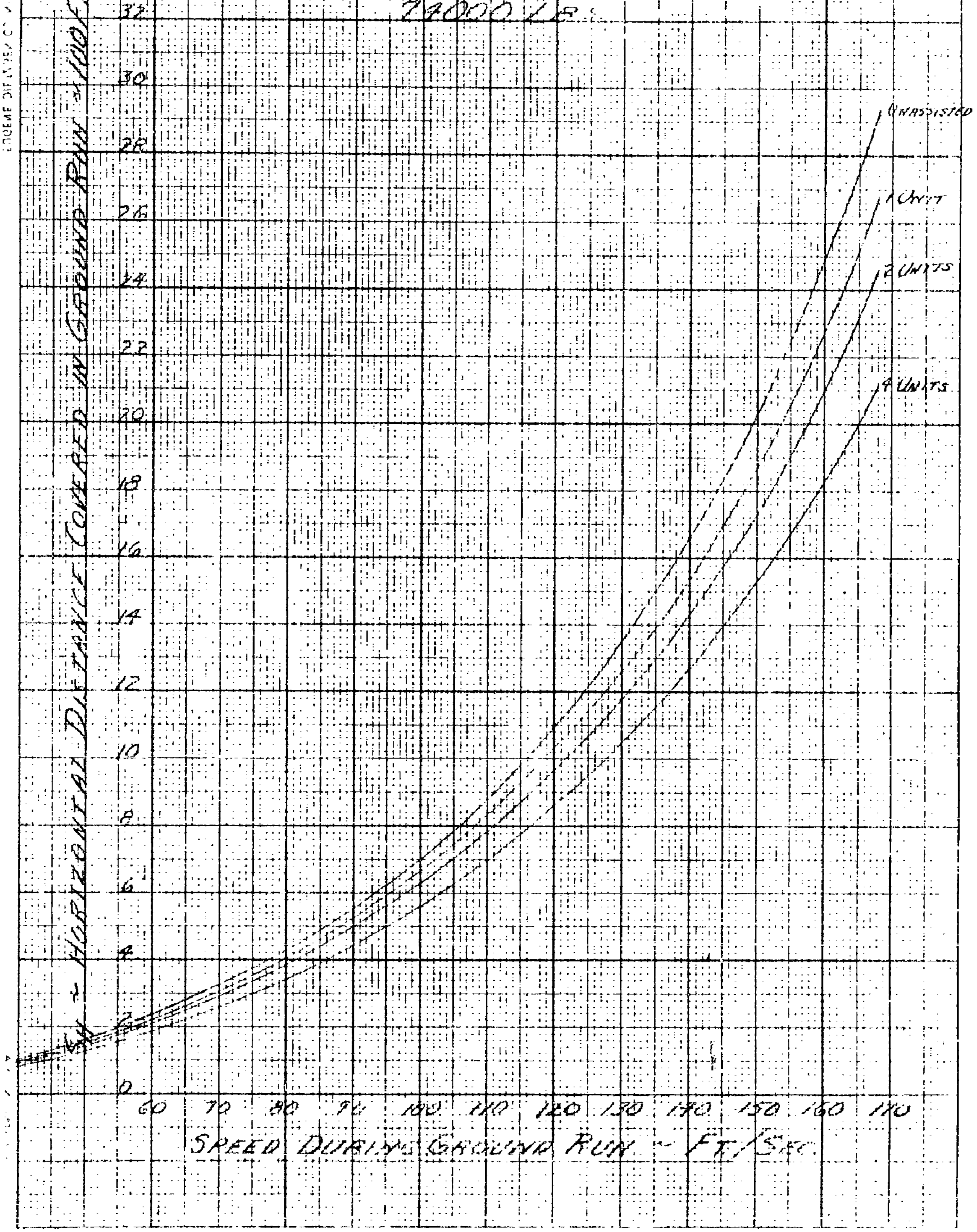


FIG. 61

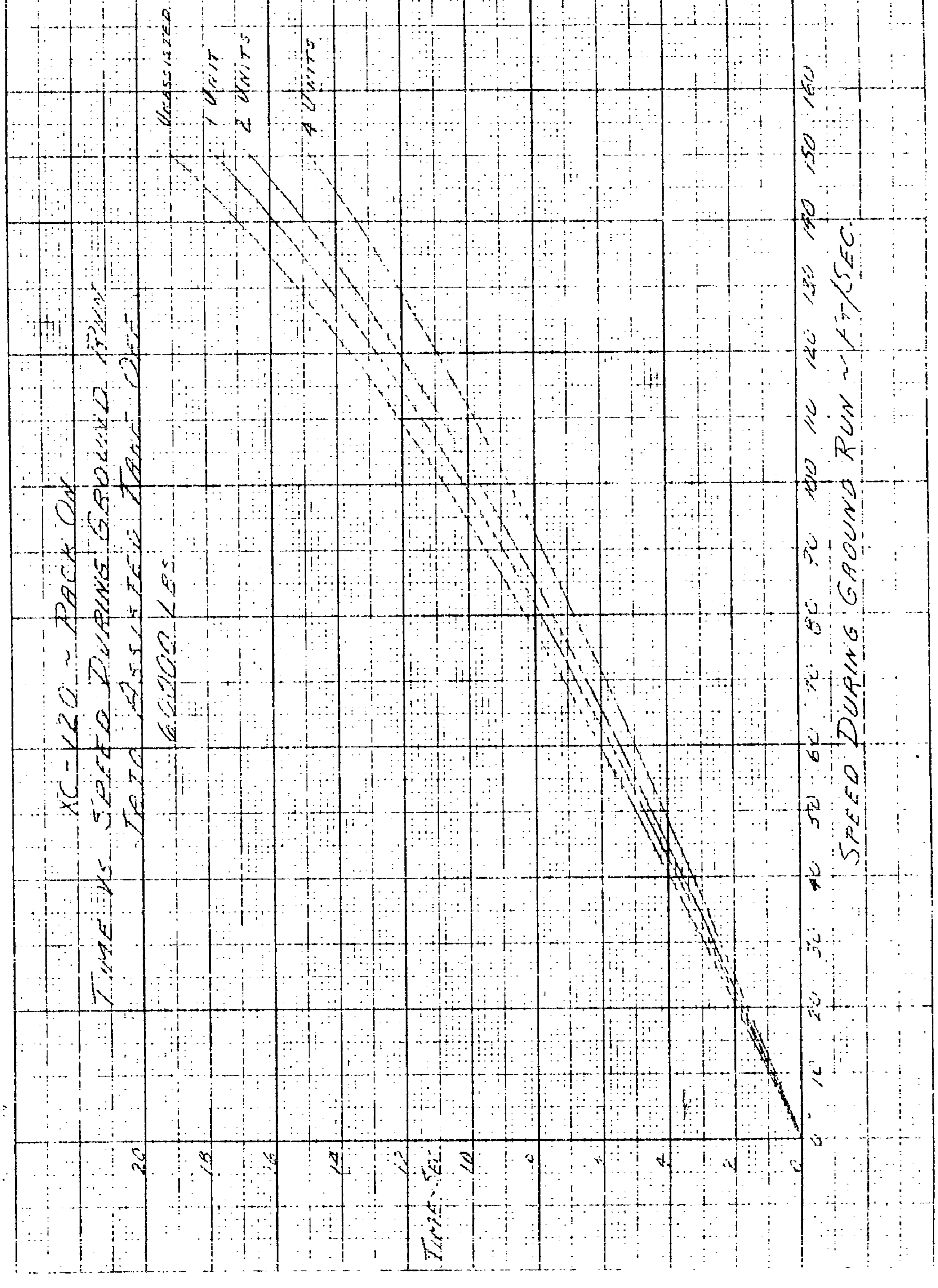

XC-120 ~ PACK ON
TIME VS SPEED DURING GROUND RUN
JATO ASSISTED TAKE OFF
66000 LBS
UNASSISTED
1 UNIT
2 UNITS
4 UNITS
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
SPEED DURING GROUND RUN ~ FT/SEC
0
2
4
6
8
10
12
14
16
18
20
TIME ~ SEC

FIG 62.

XC-120 ~ PACK ON
SPEED VS DISTANCE COVERED IN GROUND RUN
JATO ASSISTED TAKE-OFF
65000 LBS.

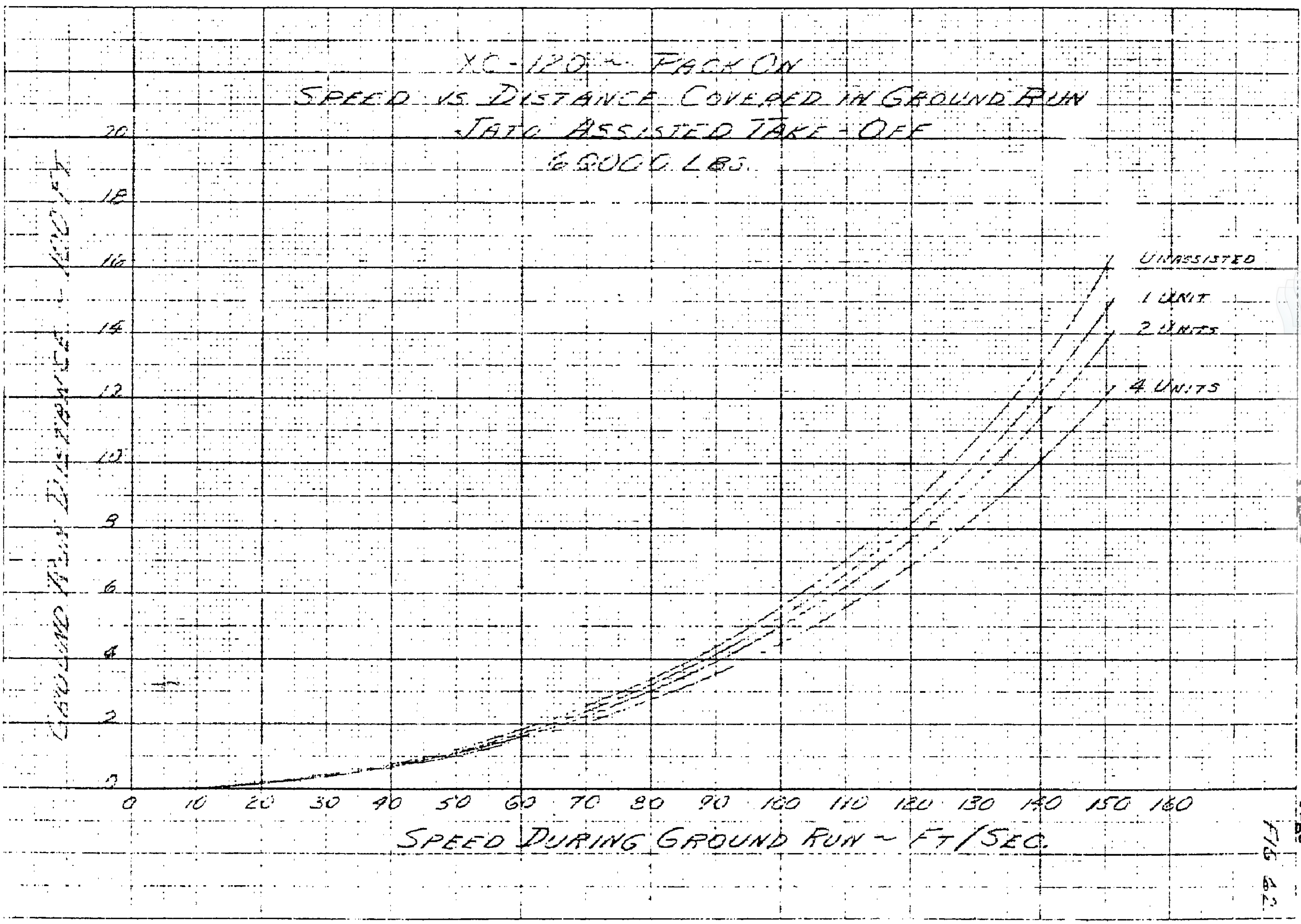


FIG 63

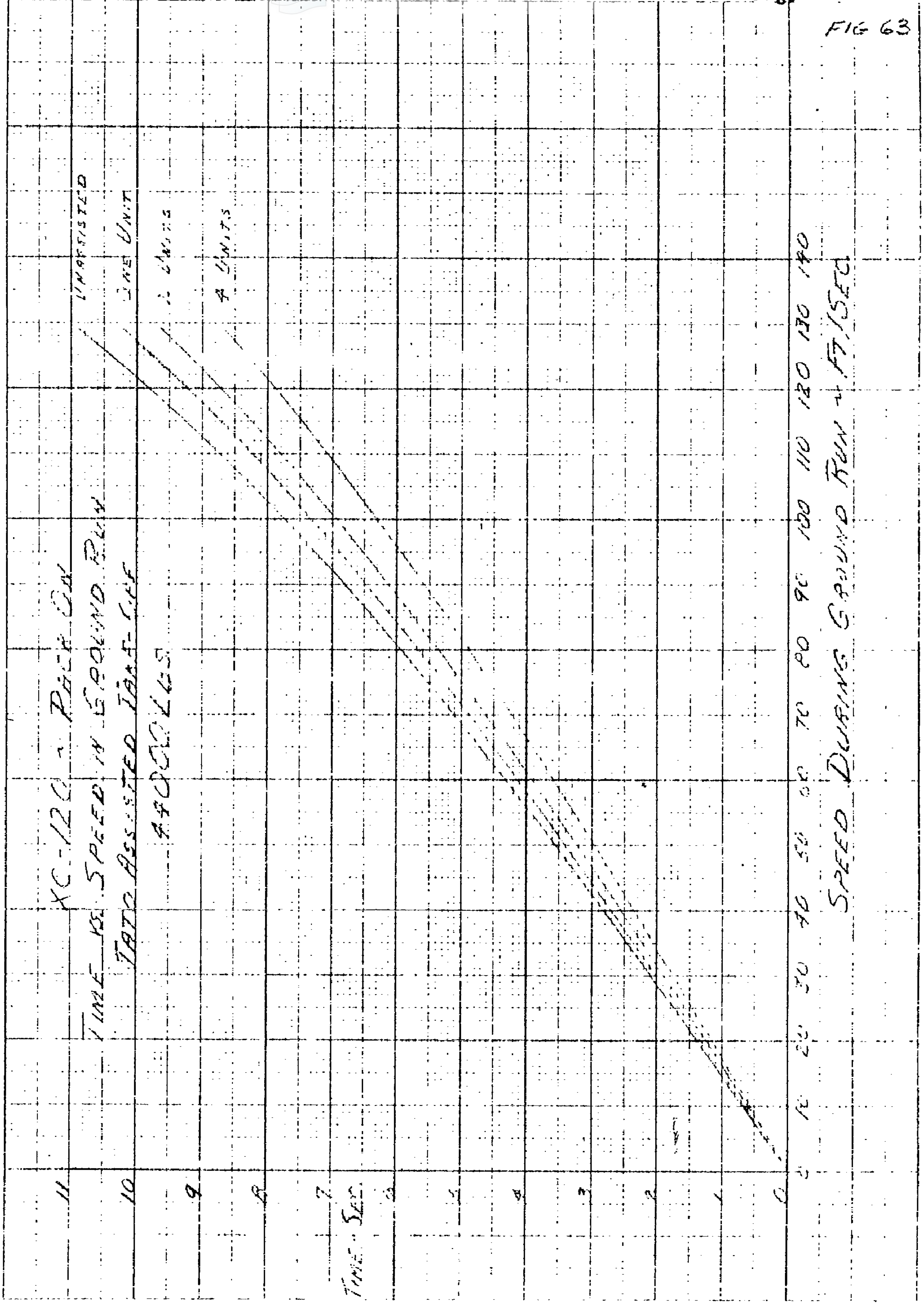
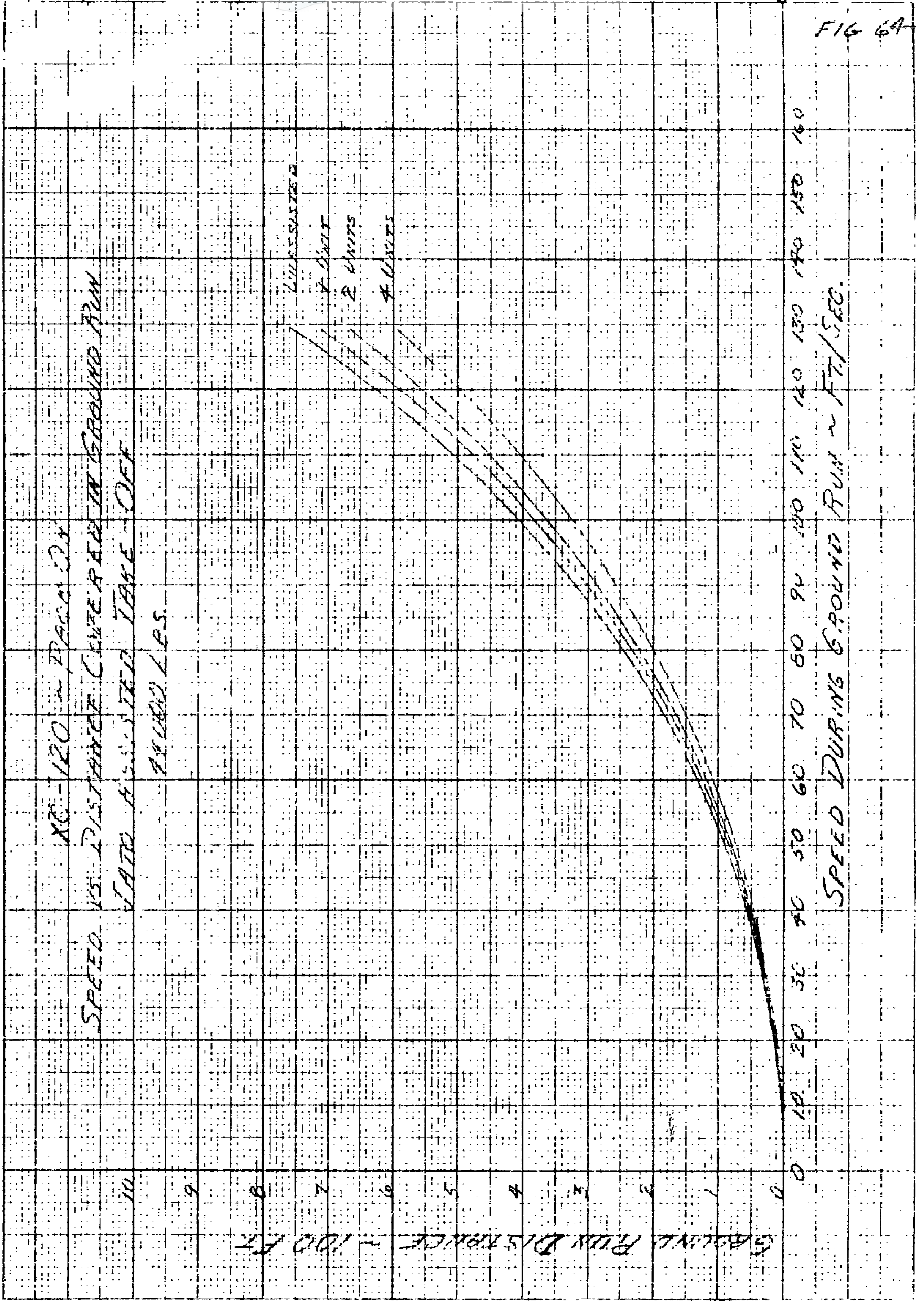

XC-120 - Pack On
Time vs. Speed in Ground Run
JATO Assisted Take-Off
46000 Lbs

FIG 6A



XC-120 ~ PACK OFF
SPEED VS. DISTANCE COVERED IN GROUND RUN
JATO ASSISTED TAKE OFF
[illegible] LBS.

PART II-G-2 (Cont.)

(1) Ground Run (Cont.)

Summation of Effect of Jato on Ground Run for 14 Seconds Duration

74000 lb. Gross Weight

No. of Units		0	1	2	4
Start Assist at t_1 seconds		0	0	0	0
Assist Ends at t_2 seconds		14	14	14	14
V_1 (at t_1)	fps	0	0	0	0
V_2 (at t_2)	fps	103.3	108.2	112.7	122.5
ΔS (from V_0 to V_1)	ft.	0	0	0	0
ΔS (from V_1 to V_2)	ft.	760	800	835	908
ΔS (from V_2 to $V_{T.O.}$)	ft.	2176	2091	2000	1776
S_G (total from V_0 to $V_{T.O.}$	ft.	2936	2891	2835	2684
Start Assist at t_1 seconds		5	5	5	5
Assist Ends at t_2 seconds		19	19	19	19
V_1 (at t_1)	fps	40.7	40.7	40.7	40.7
V_2 (at t_2)	fps	129.8	134.4	139.0	148.1
ΔS (from V_0 to V_1)	ft.	105	105	105	105
ΔS (from V_1 to V_2)	ft.	1245	1282	1314	1390
ΔS (from V_2 to $V_{T.O.}$)	ft.	1586	1451	1321	1078
S_G (total from V_0 to $V_{T.O.}$)	ft.	2936	2838	2740	2573
Start Assist at t_1 seconds		10	10	10	10
Assist Ends at t_2 seconds		24	24	24	24
V_1 (at t_1)	fps	77.8	77.8	77.8	77.8
V_2 (at t_2)	fps	150.6	155.0	159.5	168
ΔS (from V_0 to V_1)	ft.	402	402	402	402
ΔS (from V_1 to V_2)	ft.	1650	1680	1710	1790
ΔS (from V_2 to $V_{T.O.}$)	ft.	884	691	478	0
S_G (total from V_0 to $V_{T.O.}$)	ft.	2936	2773	2590	2192
Start Assist at t_1 seconds			14.02	12.6	
Assist Ends at t_2 seconds			28.02	26.6	
V_1 (at t_1)	fps		103.5	94.9	
V_2 (at t_2)	fps		168	168	
ΔS (from V_0 to V_1)	ft.		763	620	
ΔS (from V_1 to V_2)	ft.		1950	1891	
ΔS (from V_2 to $V_{T.O.}$)	ft.		0	0	
S_G (total from V_0 to $V_{T.O.}$)	ft.	2936	2713	2511	

PART II-G-2 (Cont.)

(1) Ground Run (Cont.)

Summation of Effect of Jato on Ground Run for 14 Seconds Duration (Cont.)

74,000 lb. Gross Weight

No. of Units					
Start Assist at t_1 seconds			17	17	17
Assist Ends at t_2 seconds			31	31	31
V_1 (at t_1)	fps		119.9	119.9	119.9
V_2 (at t_2)	fps		----	----	
ΔS (from V_0 to V_1)	ft.		1097	1097	1097
ΔS (from V_1 to V_2)	ft.		1642	1489	1250
ΔS (from V_2 to $V_{T.O.}$)	ft.		0	0	0
S_G (total from V_0 to $V_{T.O.}$)	ft.	2936	2739	2586	2347

PART II-G-2

(2) Transition of Airplane

The method of computing a_v and C_L versus R/C during the transition is the same with jet assist as without except that the thrust at take-off speed is increased by the capacity of the number of units considered. A sample calculation for 74,000 lbs. with one unit is shown below: -

$$\text{Initial R/C} = \frac{T_{T.O.} - D_{T.O.}}{W_{T.O.}} V_{T.O.}$$

$$\text{(With One Unit)} = \frac{15680 - 12750}{74000} \times 168 = 6.65 \text{ ft. sec.}$$

1	2	3	4	5	6	7	8	9	10
$(R/C)_{fps}$	$\frac{W(R/C)}{V_{T.O.}}$	D lbs.	C_D	C_L	$\sin\theta$	$\sin^2\theta + 1$	$\frac{C_L}{C_{L_{T.O.}}}$	7 x 8	a_v ft/sec^2
6.65	2930	12750	.2630	1.696	.0396	1.00157	1.111	1.114	3.668
8	3520	12160	.2506	1.674	.0476	1.0023	1.097	1.101	3.25
10	4400	11280	.2325	1.623	.0595	1.0035	1.062	1.068	2.19
12	5290	10390	.2142	1.527	.0714	1.0051	.999	1.004	.13
14	6160	9520	.1964	1.368	.0834	1.0070	.895	.901	-3.19
16	7050	8630	.1780	1.163	.0952	1.0091	.762	.769	-7.44

The R/C where $a_v = 0$ was determined graphically and the R/C versus a_v curve is numerically integrated below:

$(R/C)_1$ fps	$(R/C)_2$ fps	(R/C) fps	Ave(R/C) fps	a_{v_1} ft/sec^2	a_{v_2} ft/sec^2	Ave a_v ft/sec^2	Δt sec	ΔS_v ft	ΔS_h ft	S_v ft	S_H ft	t sec
0	6.65	6.65	3.33	3.668	3.668	3.668	1.811	6.03	304	6.03	304	1.811
6.65	8.	1.35	7.33	3.668	3.25	3.459	.39	2.86	66	8.89	370	2.201
8.	10.	2.00	9.00	3.25	2.19	2.72	.735	6.61	123	15.5	493	2.936
10.	12.06	2.06	11.03	2.19	0	1.10	1.872	20.7	314	36.2	807	4.808
12.06	12.06	0	12.06	0	0	0	1.143	13.8	192	50.0	999	5.95

(3) Steady Climb to 50 ft. (74,000 lbs.)

$$S_H \text{ steady climb} = \frac{50 - 36.2}{12.06} 168 = 192 \text{ ft.}$$

PART II-G-2 (Cont.)

(4) Summation of Effect of Jato with 14 Seconds Duration

74,000 Lbs. Take-Off Gross Weight

Number of Units		0	1	2	4
Start Jato at t_1 seconds		0	0	0	0
S_G	ft.	2936	2891	2835	2684
S_{50}	ft.	1117	1117	1117	1117
S_{total}	ft.	4053	4008	3952	3801
Start Jato at t_1 seconds		5	5	5	5
S_G	ft.	2936	2838	2740	2573
S_{50}	ft.	1117	1117	1117	1117
S_{total}	ft.	4053	3955	3857	3690
Start Jato at t_1 seconds		10	10	10	10
S_G	ft.	2936	2773	2590	2192
S_{50}	ft.	1117	1117	1117	1117
S_{total}	ft.	4053	3890	3707	3309
Start Jato at t_1 seconds		-	14.02	12.6	-
S_G	ft.		2713	2511	
S_{50}	ft.		1117	1117	
S_{total}	ft.		3830	3628	
Start Jato at t_1 seconds		17	17	17	17
S_G	ft.	2936	2739	2586	2347
S_{50}	ft.				
Time from take-off to 50 ft.	sec.	6.85	5.95	5.50	5.15
Time Jato runs during ground run	sec.	7.15	8.05	8.50	8.85
Indicated time to reach $V_{T.O.}$	sec.	29.60	27.29	25.31	22.17
Indicated time to turn on Jato	sec.	22.45	19.24	16.81	13.32
V at which Jato is turned on	fps.	144.8	136.8	129.6	117.7
$\Delta S_{G_{0-1}}$	ft.	1830	1560	1345	1040
$\Delta S_{G_{1-T.O.}}$	ft.	1106	1227	1281	1290
S_G total	ft.	2936	2787	2626	2330
S_{50}	ft.	1117	999	928	867
Total over 50 ft.	ft.	4053	3786	3554	3197
t_1 = actual time Jato is started	sec.	22.45	20.55	19.00	16.6

XC-120 PACK-ON

FIG. 65

EFFECT OF JATO ON TAKE OFF AT 74000 LBS.

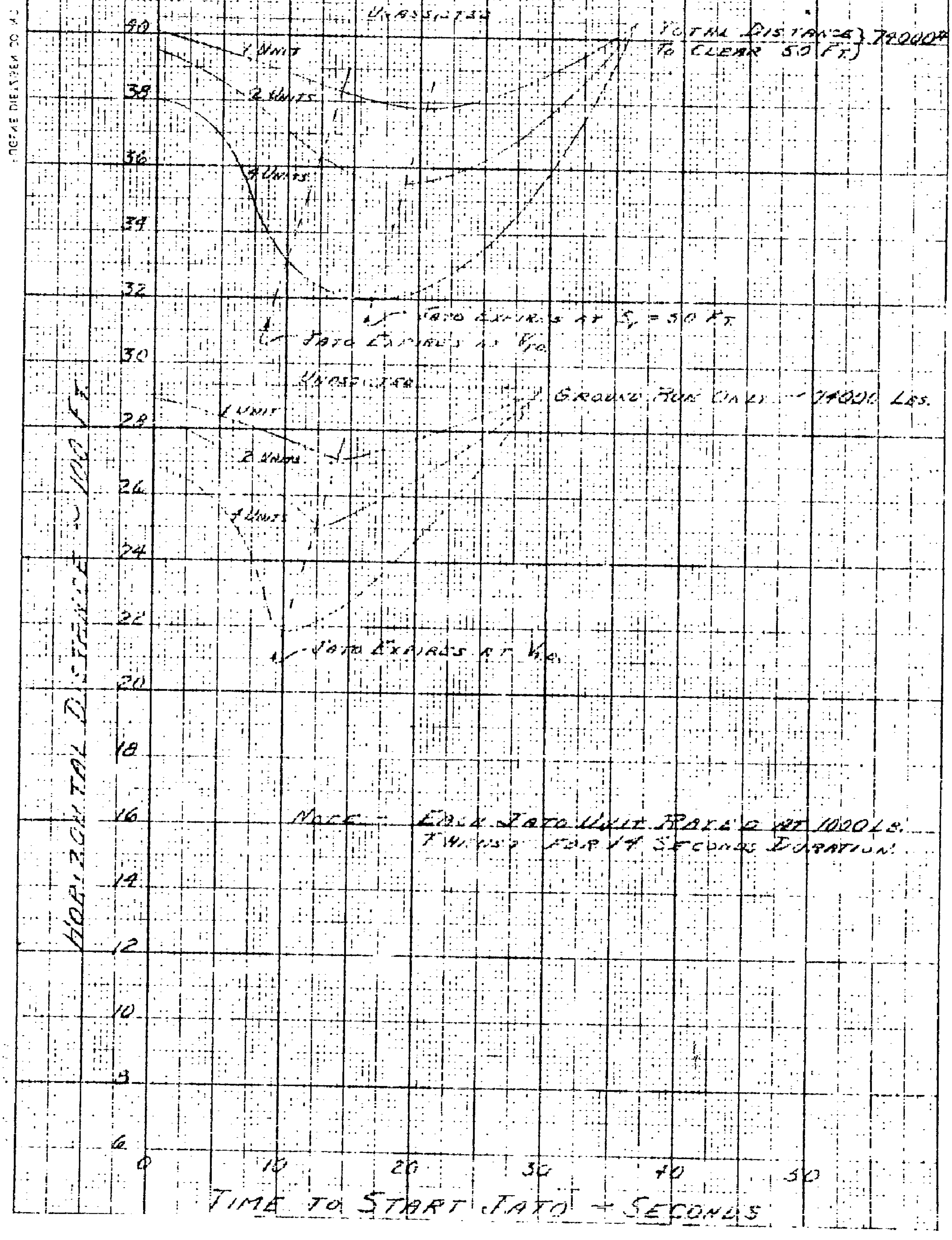
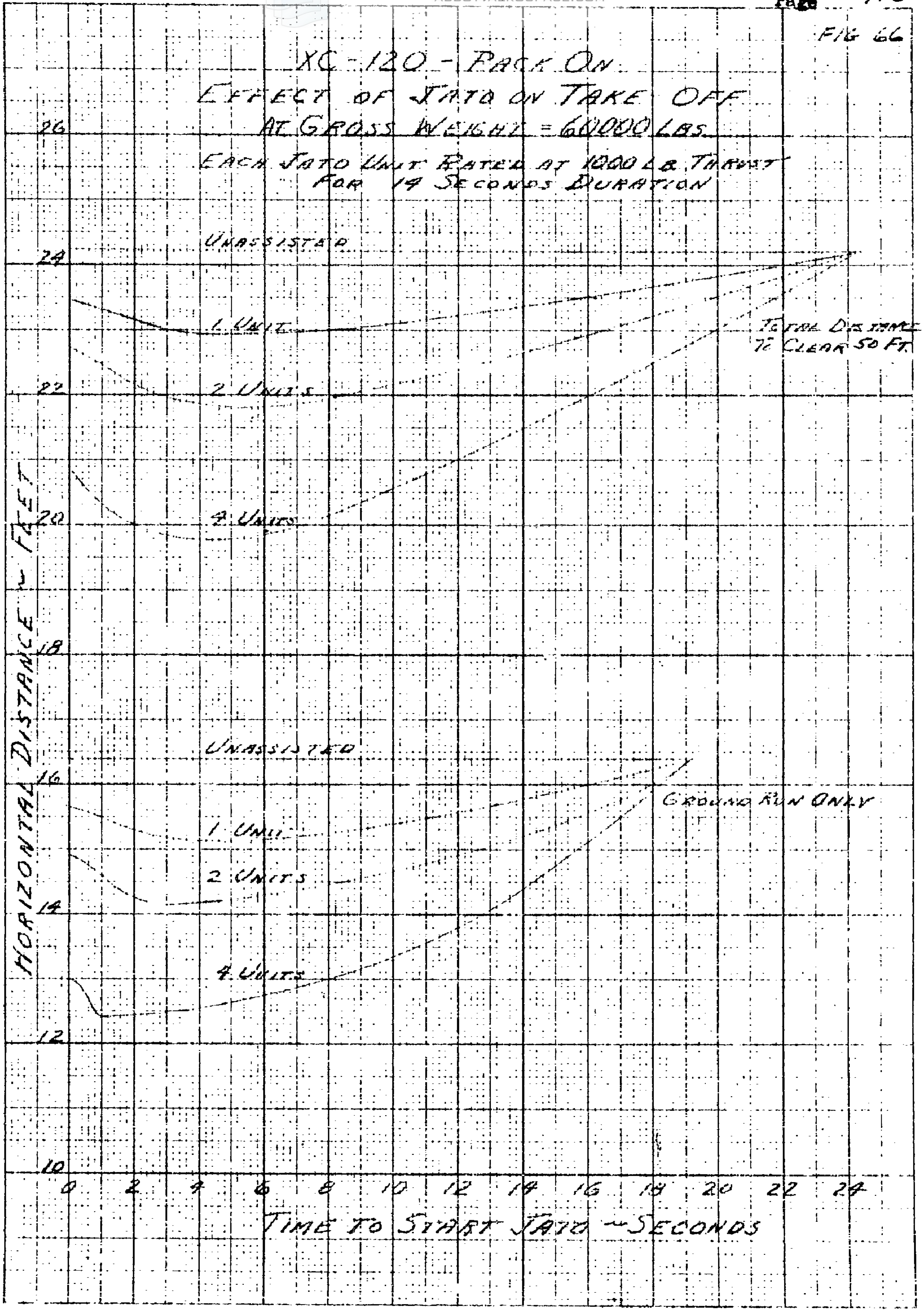


FIG 66



XC-120 - PACK ON
EFFECT OF JATO ON TAKE OFF
AT GROSS WEIGHT = 60000 LBS.
EACH JATO UNIT RATED AT 1000 LB THRUST
FOR 14 SECONDS DURATION

FIG 67

XC-120 ~ PACK ON
EFFECT OF JATO ON TAKE-OFF
AT GROSS WEIGHT = 44000 LB

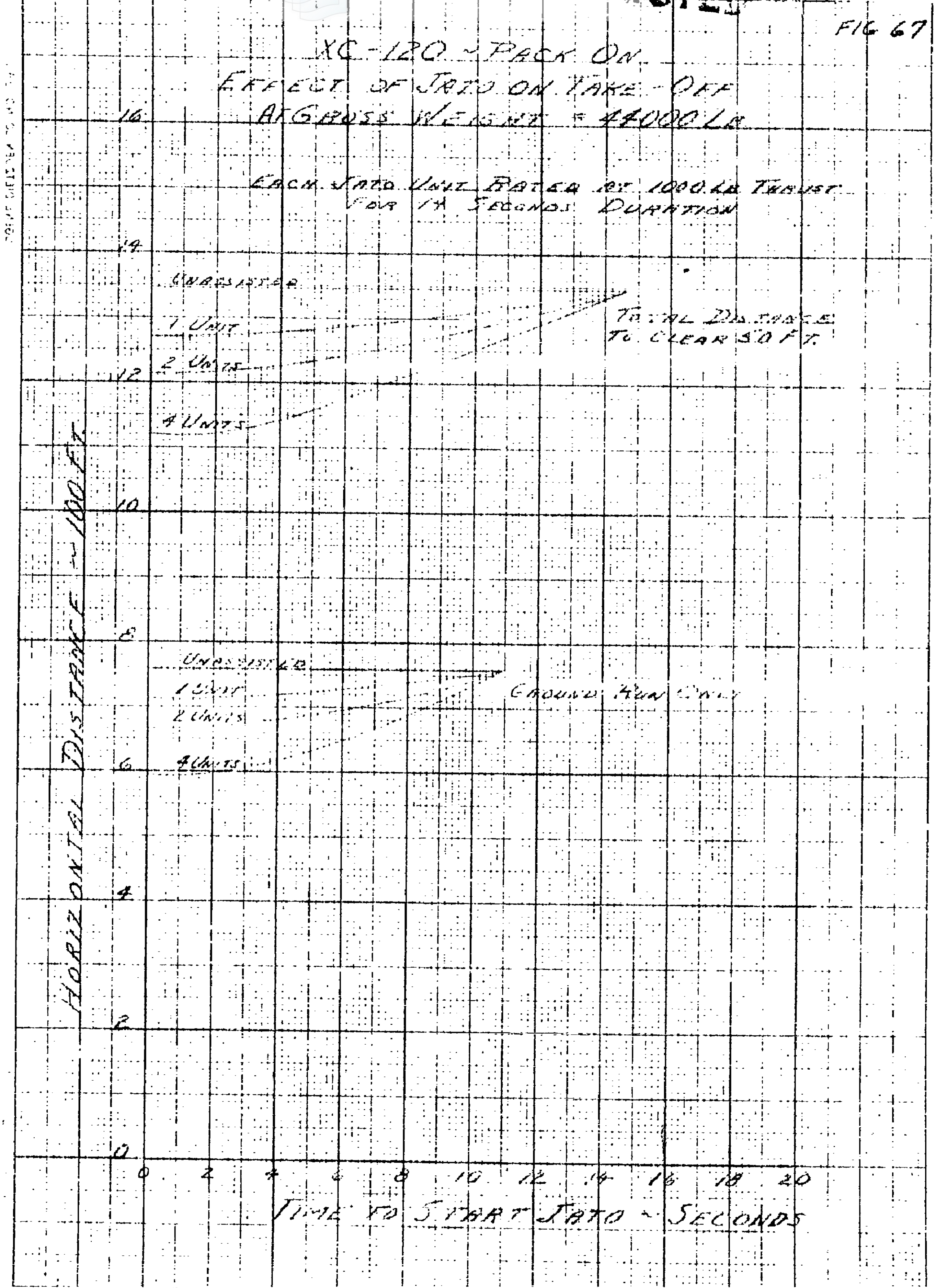
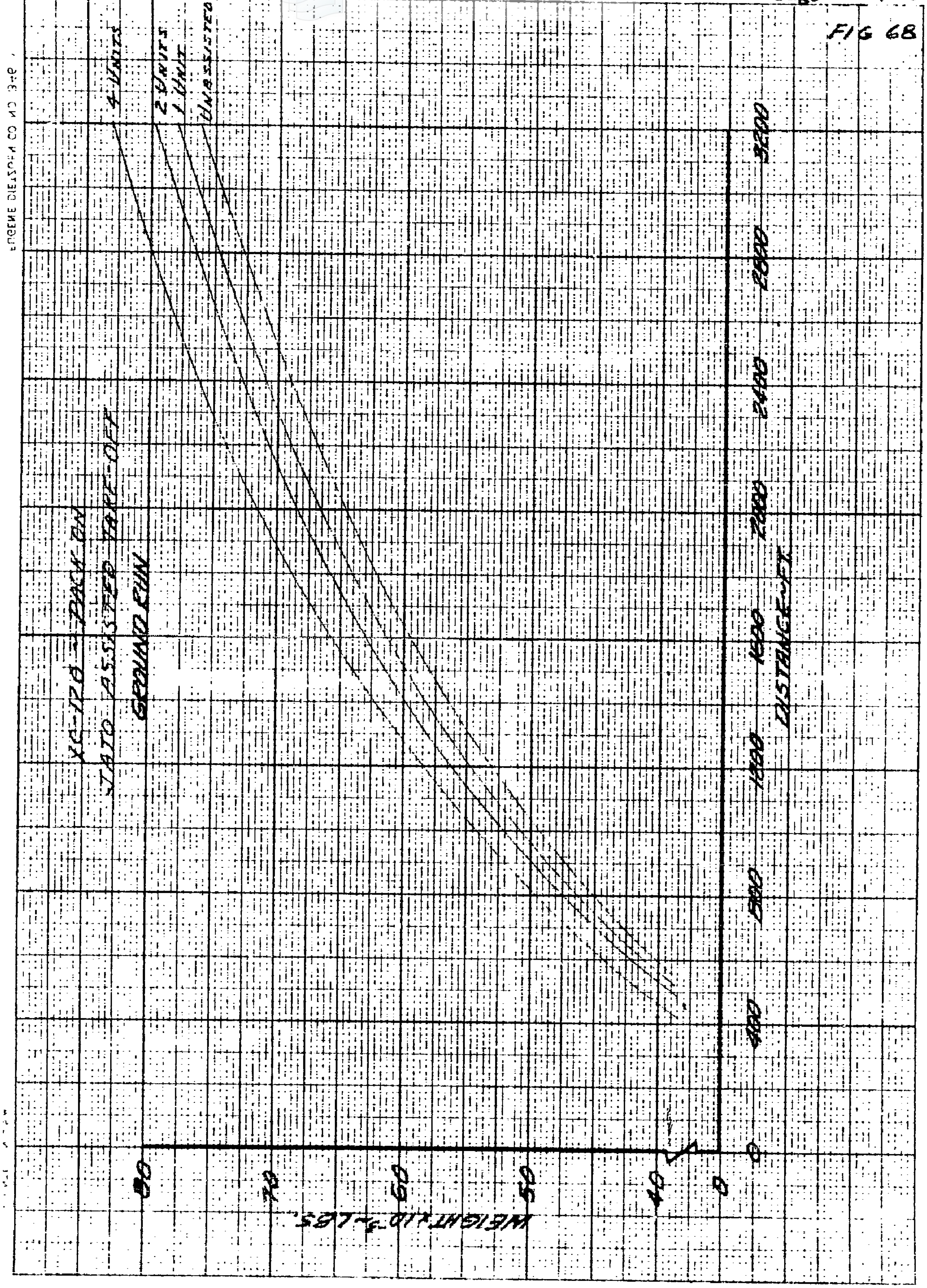
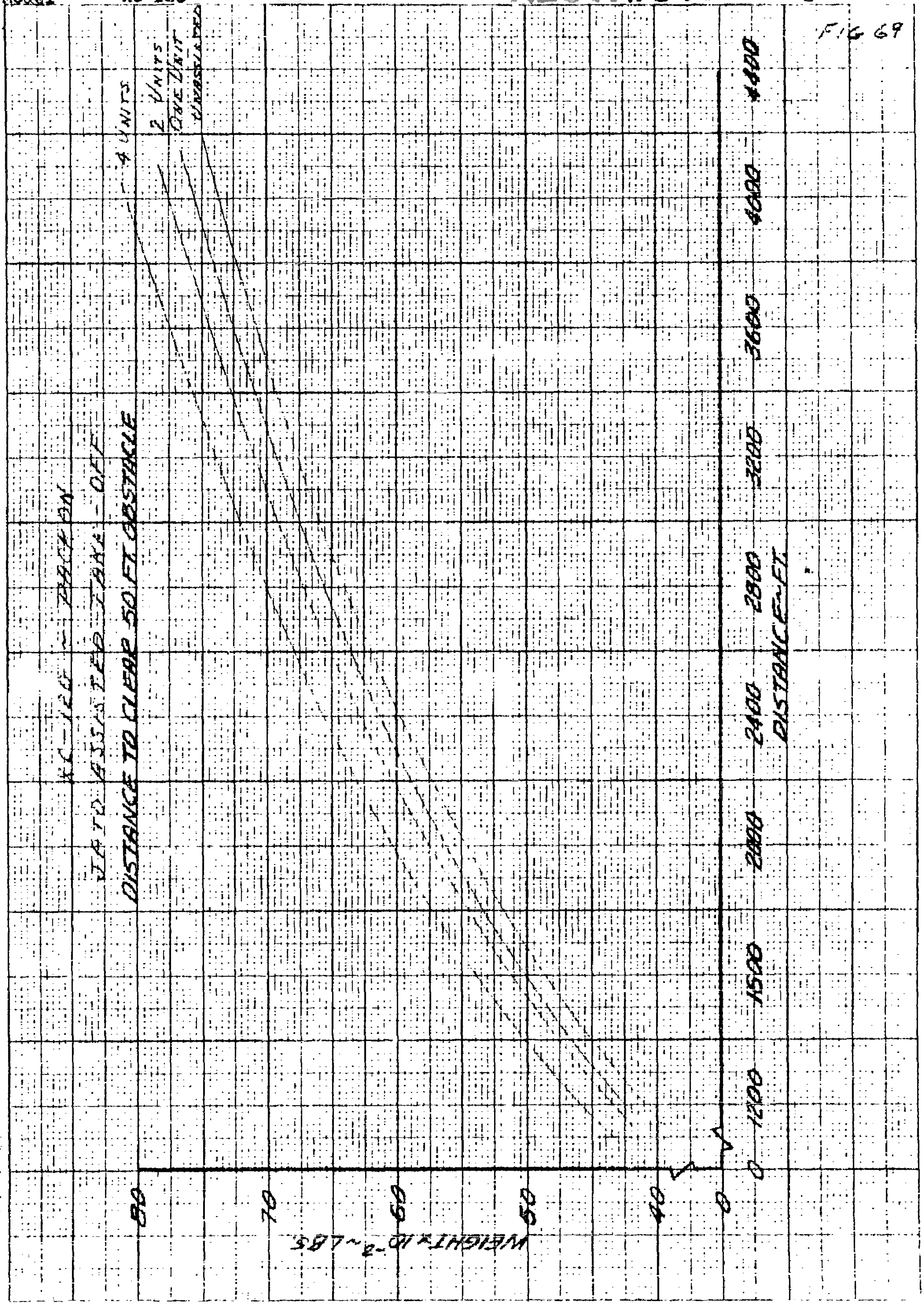


FIG 68


XC-120 - PACK ON
JATO ASSISTED TAKE-OFF
GROUND RUN
4 UNITS
2 UNITS
1 UNIT
UNASSISTED
DISTANCE-FT
0
400
800
1200
1600
2000
2400
2800
3200
WEIGHT x10^-3 LBS
0
40
50
60
70
80

RESTRICTED

FIG 69



PART II-H

H. LANDING DISTANCE

Landing distance over a 50 ft. obstacle was computed for the airplane at several landing gross weights using the method of reference (h) with some modifications for change in attitude of the airplane during the ground run. The polar diagram for the airplane in the landing configuration is shown in figure 70. Landing distance has been calculated without reverse thrust (which will be available) and the effects of reverse thrust have been estimated from available data. A detailed explanation of the method is given below with a sample calculation for the design gross weight of 64,000 lbs. Landing distance versus gross weight is presented in figure 71.

(1) Approach

Assume approach in glide at $V_G = 1.1 \; V_{Stall}$

$f = 40^{\circ}$ $\qquad C_{L_{max}} = 1.775$ (from figure 50)

$S_{G\ell} = 50 \dfrac{W}{D_{G\ell}}$, (from reference (h))

$W = L = C_{L_{G\ell}} \, q \, S$

$D_{G\ell} = C_{D_{G\ell}} \, q \, S$

Therefore,

$$S_{G\ell} = 50 \frac{C_{L_{G\ell}}}{C_{D_{G\ell}}}$$

$$C_{L_{G\ell}} = 1.775/(1.1)^2 = 1.465$$

$C_{D_{G\ell}} = .2183$ (from figure 70)

Then,

$S_{G\ell} = 50 \dfrac{1.465}{.2183} = 335$ ft. (for all gross weight)

(2) Transition

From reference (h), $S_T = .067W \left[\dfrac{V_{G\ell}^2 - V_g^2}{D_{G\ell} + D_g} \right]$ where V_G & V_g are in mph

Since $D = C_D \, q \, S$

PART II-H LANDING DISTANCE (Cont.)

(2) Transition (Cont.)

and $q = V^2\sigma/391$

$$S_T = .067 \times 391 \times \frac{W}{S}\left[\frac{q_{Gl} - q_S}{C_{D_{Gl}}q_{Gl} + C_{D_S}q_S}\right]$$

but $q = \frac{W}{S} \cdot \frac{1}{C_L}$

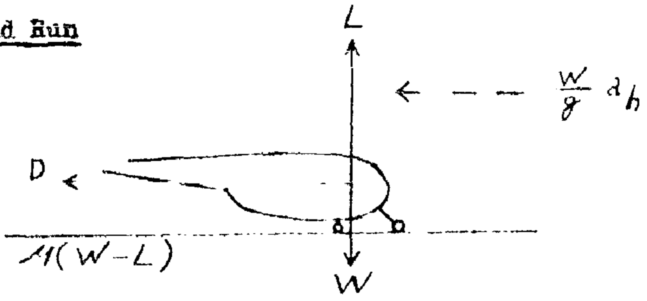
therefore $$S_T = 26.2\,\frac{W}{S}\left[\frac{C_{L_S} - C_{L_{Gl}}}{C_{L_S}C_{D_{Gl}} + C_{L_{Gl}}C_{D_S}}\right]$$

C_{L_S}	$= 1.775$	$C_{L_{Gl}}$	$= 1.465$
C_{D_S}	$= .2745$	$C_{D_{Gl}}$	$= .2183$

and $S_T = 10.3\ W/S$

$S_T = 10.3\ W/S = 10.3\ \frac{64000}{1447} = 455$ ft. for 64,000 lbs.

(3) Ground Run



Assume that sufficient control exists to hold the stalling attitude down to a speed of 85% of V_{stall} when the airplane settles to a three point attitude. In other words the airplane attitude is changing throughout the ground run.

Now:

$$-\frac{W}{g}a_h = D + \mu(W-L)$$

$$a_h = \frac{D + \mu(W-L)}{-\frac{W}{g}}$$

PART II-H LANDING DISTANCE (Cont.)

(3) Ground Run (Cont.)

$$-\frac{W}{g}V\left[\frac{dV}{dS_{GR}}\right] = \frac{1}{2}\rho SV^2\left(C_D - C_L\mu\right) + \mu W$$

$$dS_{GR} = \frac{-W/g\,V(dV)}{\mu W + 1/2\,\rho SV^2\left(C_D - \mu C_L\right)}$$

If the attitude of the airplane changes integrate from V_S to V_M (minimum speed for sufficient control to maintain stalling attitude) and from V_M to 0.

$$S_{GR} = \int dS = \int_{V_S}^{V_M}(\text{———}) + \int_{V_M}^{0}(\text{———}) = \Delta S_{S-M} + \Delta S_{M-O}$$

$$S_{GR} = \frac{W}{2g}\left[\frac{V_S{}^2}{D_S - \mu L_S}\log_e\frac{\mu W + D_{SM} - \mu L_{SM}}{\mu W + D_S - \mu L_S} + \frac{V_M{}^2}{D_{OM} - \mu L_{OM}}\log_e\frac{\mu W}{\mu W + D_{OM} - \mu L_{OM}}\right]$$

Now since:

$$W = q_S S\, C_{L_S} \quad \text{where} \quad q_S = \frac{1}{2}\rho V_S^2$$

$$\text{and} \quad V_M = .85\, V_S$$

$$q_M = (.85)^2\, q_S$$

so:

$$\Delta S_{S-M} = -\frac{W}{S}\,\frac{1}{\rho g\left(C_{D_S} - \mu C_{L_S}\right)}\;\ell n\left[\frac{(.85)^2\,\frac{\left(C_{D_S} - \mu C_{L_S}\right)}{C_{L_S}} + \mu}{\frac{\left(C_{D_S} - \mu C_{L_S}\right)}{C_{L_S}} + \mu}\right]$$

and for ΔS_{M-O}, $V_1 = V_M = .85\, V_S$, $V_2 = 0$

So:

$$\Delta S_{M-O} = -\frac{W}{S}\,\frac{1}{\rho g\left(C_{D_O} - \mu C_{L_O}\right)}\;\ell n\left[\frac{\mu}{(.85)^2\,\frac{\left(C_{D_O} - \mu C_{L_O}\right)}{C_{L_S}} + \mu}\right]$$

PART II-H LANDING DISTANCE (Cont.)

(3) Ground Run (Cont.)

$C_{L_S} = 1.775$ $C_{L_0} = 1.025$ $\mu = .3$

$C_{D_S} = .2745$ $C_{D_0} = .1806$

$$\Delta s_{S-M} = -\frac{W}{S}\,\frac{1}{32.2 \times .002378\left[.2745-(.3 \times 1.775)\right]}\,\ell n\left[\frac{(.85)^2\left[\frac{.2745-(.3 \times 1.775)}{1.775}\right]+.3}{\left[\frac{.2745-(.3 \times 1.775)}{1.775}\right]+.3}\right]$$

$$\Delta s_{M-0} = -\frac{W}{S}\,\frac{1}{32.2 \times .002378\left[.1806-(.3 \times 1.025)\right]}\,\ell n\left[\frac{.3}{(.85)^2\left[\frac{.1806-(.3 \times 1.025)}{1.775}\right]+.3}\right]$$

$$\Delta s_{S-M} = 50.6\,\frac{W}{S}\,\ell n\left[\frac{.195}{.1547}\right] = 50.6\,\frac{W}{S}\,\ell n \quad 1.260$$

$$\Delta s_{M-0} = 103.0\,\frac{W}{S}\,\ell n\left[\frac{.3}{.2494}\right] = 103.0\,\frac{W}{S}\,\ell n \quad 1.203$$

$\ell n \; 1.260 = .2315$; $\ell n \; 1.203 = .1850$

$$s = \frac{W}{S}\left[(50.6 \times .2315) + (103.0 \times .1850)\right]$$

$$= 30.77 \; W/S$$

$$s_G = 30.77\,\frac{64000}{1447} = 1360 \text{ ft. for } 64{,}000 \text{ lbs.}$$

(4) Total Landing Distance Over 50 Ft. Obstacle

Gross Weight	lbs.	44000	54000	64000
Gliding Distance	ft.	335	335	335
Transition	ft.	313	384	455
Ground Run	ft.	935	1147	1360
Total Over 50 ft.	ft.	1583	1866	2150

PART II-H LANDING DISTANCE (Cont.)

(5) Effect of Reverse Thrust on Landing Distance

The effect of reverse thrust on landing distance is to reduce the ground run appreciably. From data available on other airplanes with reversing provisions, it is estimated that the ground run will be reduced by approximately 40%. Gliding and transition distance will remain the same. The total landing distance over a 50 ft. obstacle with reversed thrust is tabulated below:

Gross Weight	lbs.	44000	54000	64000
Gliding Distance	ft.	335	335	335
Transition Distance	ft.	313	384	455
Ground Run	ft.	571	688	816
Total Over 50 ft.	ft.	1219	1407	1606

RESTRICTED

FIG 70

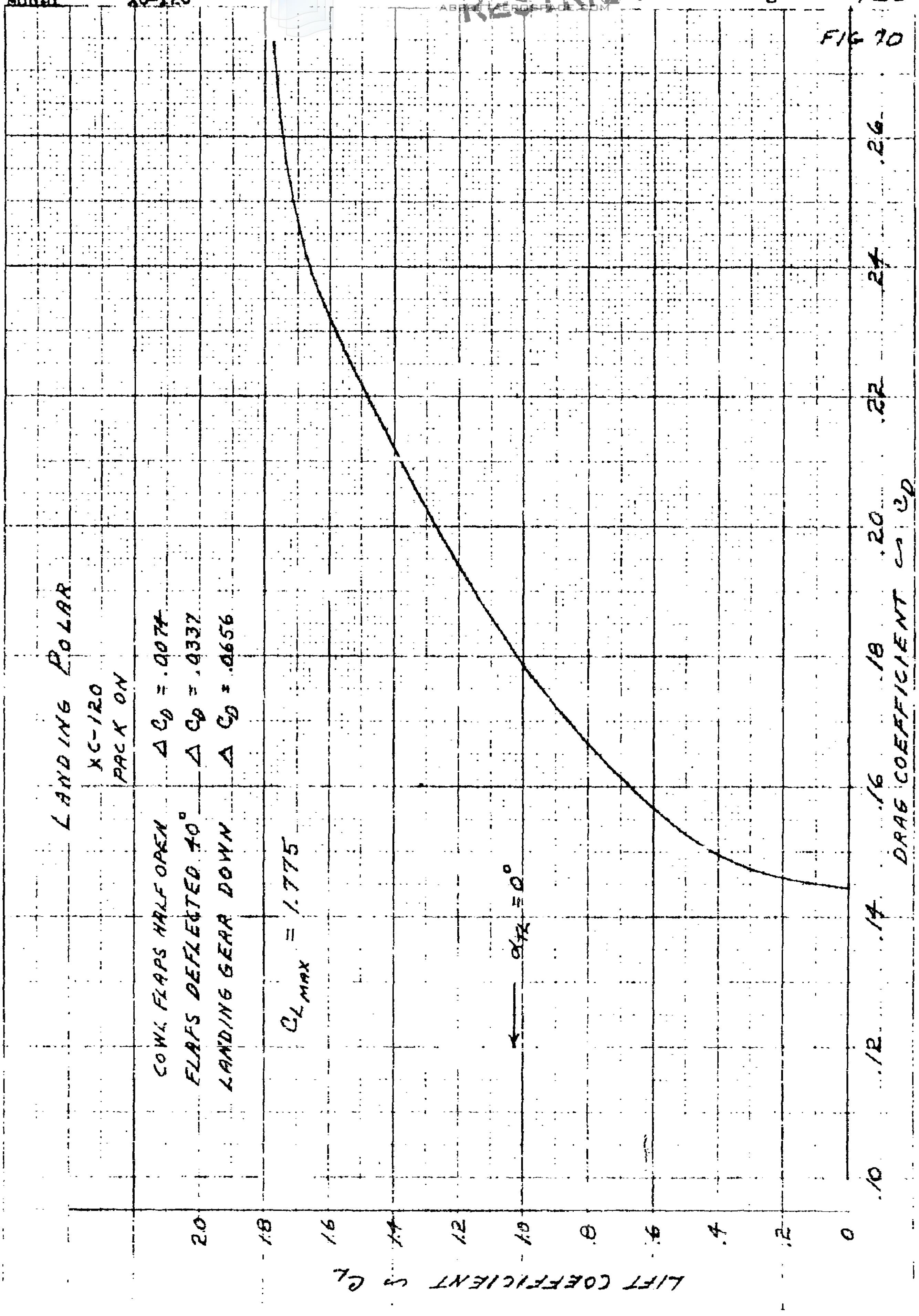
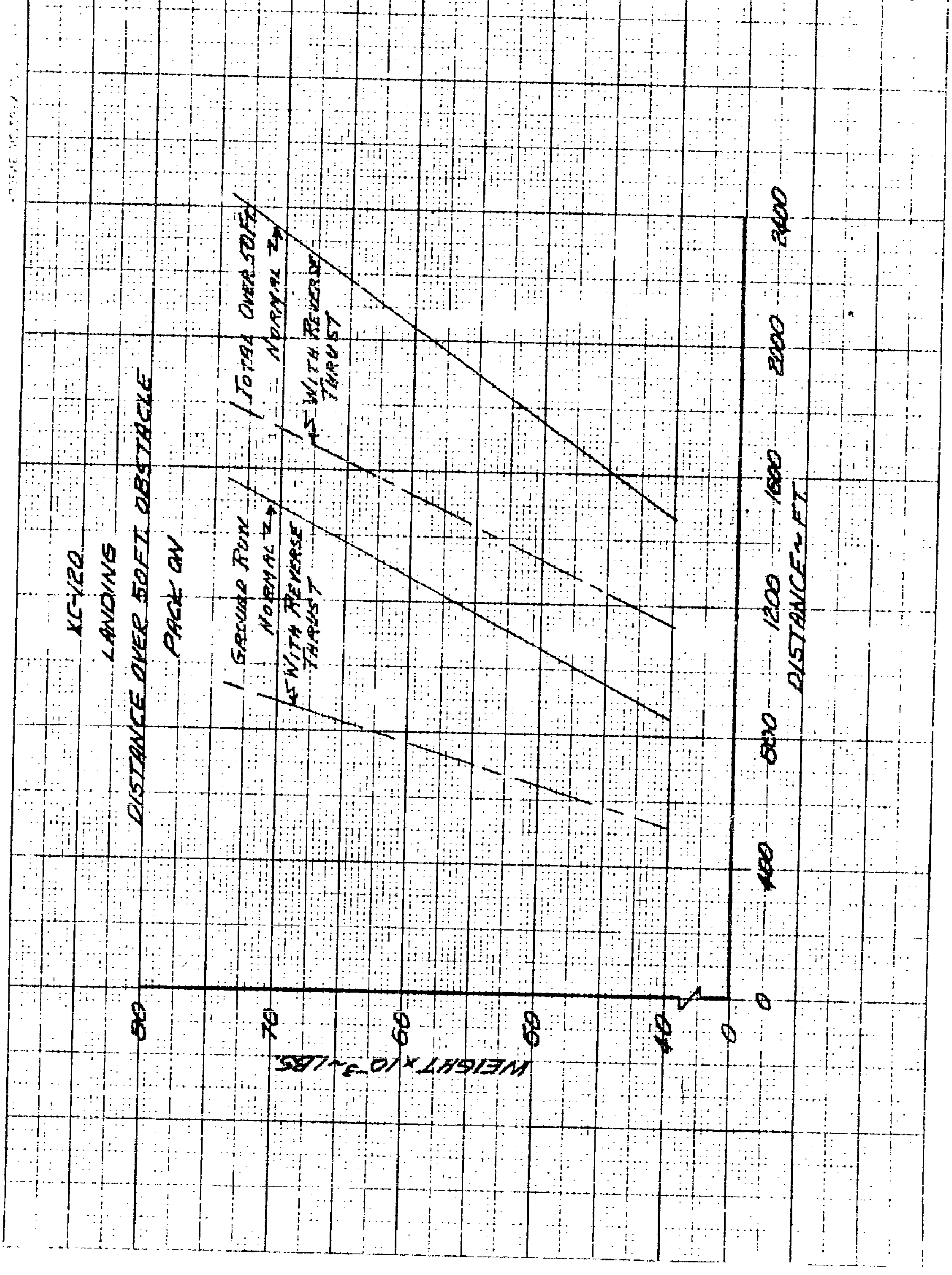


FIG 71


XC-120
LANDING
DISTANCE OVER 50 FT. OBSTACLE
PACK ON
TOTAL OVER 50 FT.
NORMAL
WITH REVERSE THRUST
GROUND RUN
NORMAL
WITH REVERSE THRUST
DISTANCE ~ FT.
0
400
800
1200
1600
2000
2400
WEIGHT × 10⁻³ ~ LBS.
80
70
60
50
40
0

PART III

PERFORMANCE CALCULATIONS - PACK OFF

All calculations in this part of the report are for the airplane in the "Pack Off" configuration only.

PART III-A

A. THRUST HORSEPOWER AVAILABLE

The thrust horsepower available for the airplane in the "pack off" configuration is exactly the same as was computed in section A of Part II. Plots of thrust horsepower available versus speed for various altitudes are presented in figures 72 through 74 for normal power and figures 75 through 77 for military power.

B. THRUST HORSEPOWER REQUIRED

1. General

The thrust horsepower required for the airplane with the "pack off" is determined from the same relation as used for "pack on":

$$THP_r = DV/375$$

where D is based on a C_D corrected for "pack off" as explained below.

Figures 72 through 77 present plots of thrust horsepower required versus speed for the subject airplane at various altitudes and gross weights of 34,000, 44,000, and 54,000 lbs.

2. Drag Coefficient - Clean Airplane

The drag coefficient of the subject airplane in the "pack off" configuration was determined by evaluating the changes from the "pack on" configuration and adjusting the "pack on" polar diagram as shown below: -

Fuselage Max. Cross Sectional Area	sq. ft.	57.3
Fuselage Length	ft.	50
Fineness Ratio = $.886\ L/\sqrt{A}$		5.85
Reynolds Number		8.775×10^7
C_{D_0} Smooth		.0509
Roughness & Leakage (sq. fuselage)	% smooth	60%
$C_{D\ corr.}$ (Pack Off)	-	.0815
K_X (Pack Off)	lb/mph^2	.01192
K_X (Pack On from Part II-B-2)	lb/mph^2	.03423
ΔK_X (Pack On to Pack Off)	lb/mph^2	-.02231
$\Delta C_D = 391\ K_X/S$	-	-.00602

PART III-B-2 (Cont.)

This checks exactly with results of pack-on and pack-off 5 ft. wind tunnel tests.

The estimated effect of cowl flaps open in climb is still

$$\Delta C_D = -.0074 \text{ for climb}$$

3. Drag of Other Items

a. Deflected Flaps

The increment in drag contributed by deflected wing flaps when the airplane is in the "pack-off" condition is exactly the same as that presented in figure 12 for the airplane with the "pack-on".

b. Landing Gear Extended

The increment in drag due to extended landing gear is:

$$\Delta C_D = .0656$$

4. Thrust Horsepower Required versus Speed

Thrust horsepower required for the airplane in the "pack-off" configuration was computed using the polar diagram of figure 11 with a constant $\Delta C_D = (-.0062)$ subtracted for removal of pack. The method of calculation is exactly the same as that for which a sample is shown in Part II-B-4. Results of these computations are plotted in the figures tabulated below for gross weights of 34,000, 44,000 and 54,000 lbs.

Altitude	Figure
Sea Level	72 and 75
1500	75
3300	76
6000	72
7300	73
17000	76
18000	73
20000	77
25000	74

FIG 72

POWER REQUIRED AND AVAILABLE
NORMAL RATED POWER. TWO ENGINES
XC-120 AIRPLANE PACK OFF

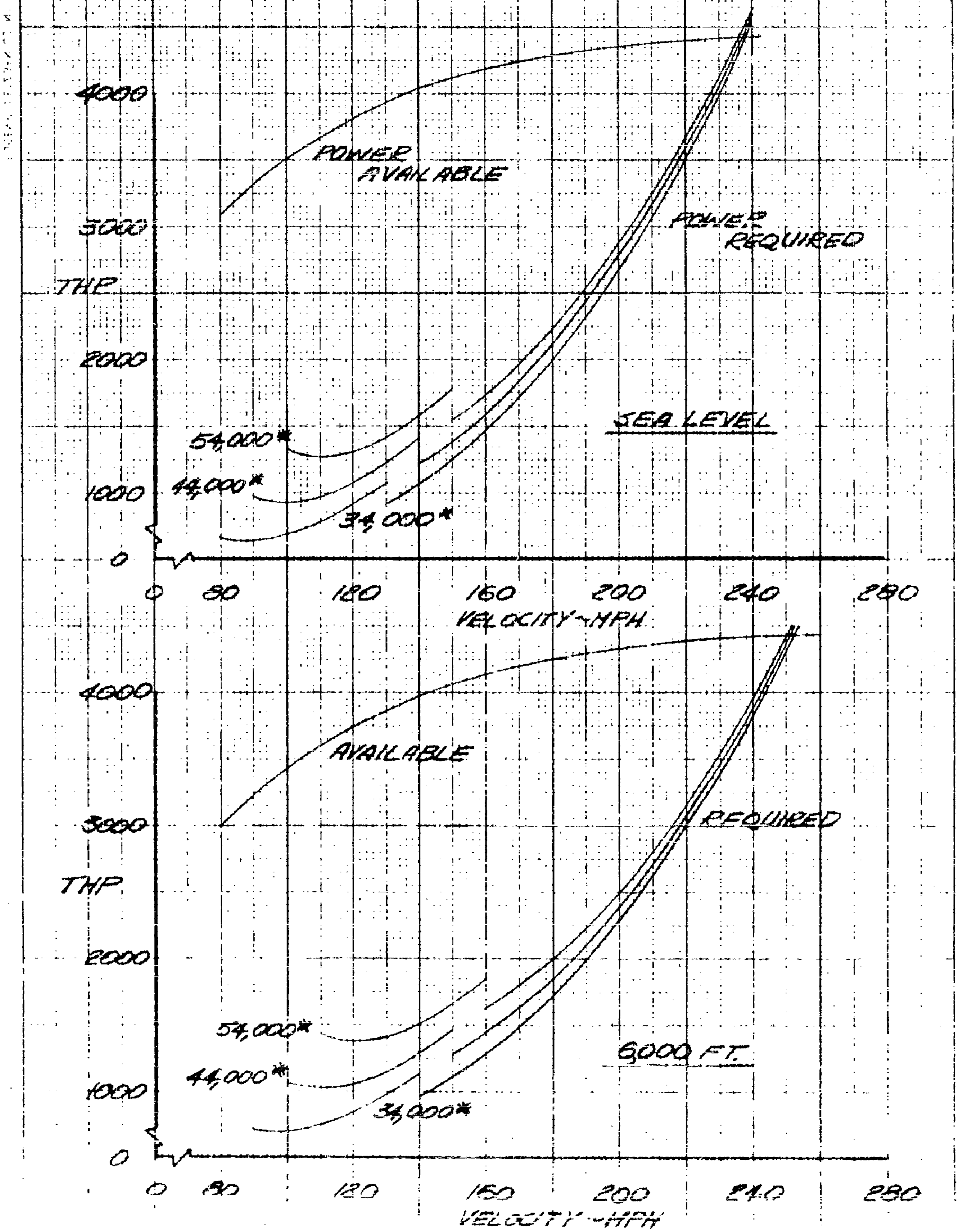
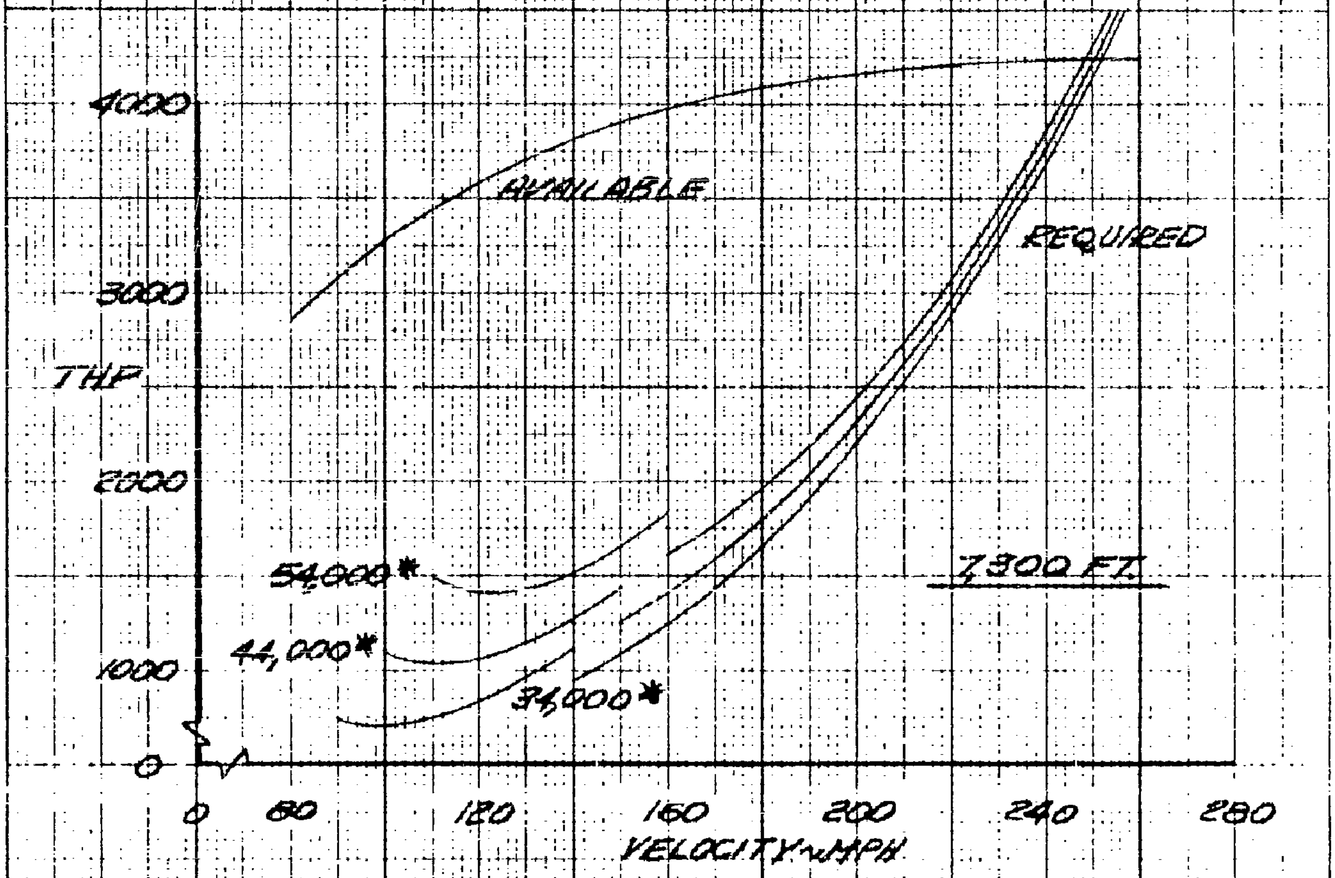


FIG 73

POWER REQUIRED AND AVAILABLE
NORMAL RATED POWER TWO ENGINES
XC-120 AIRPLANE PACK OFF



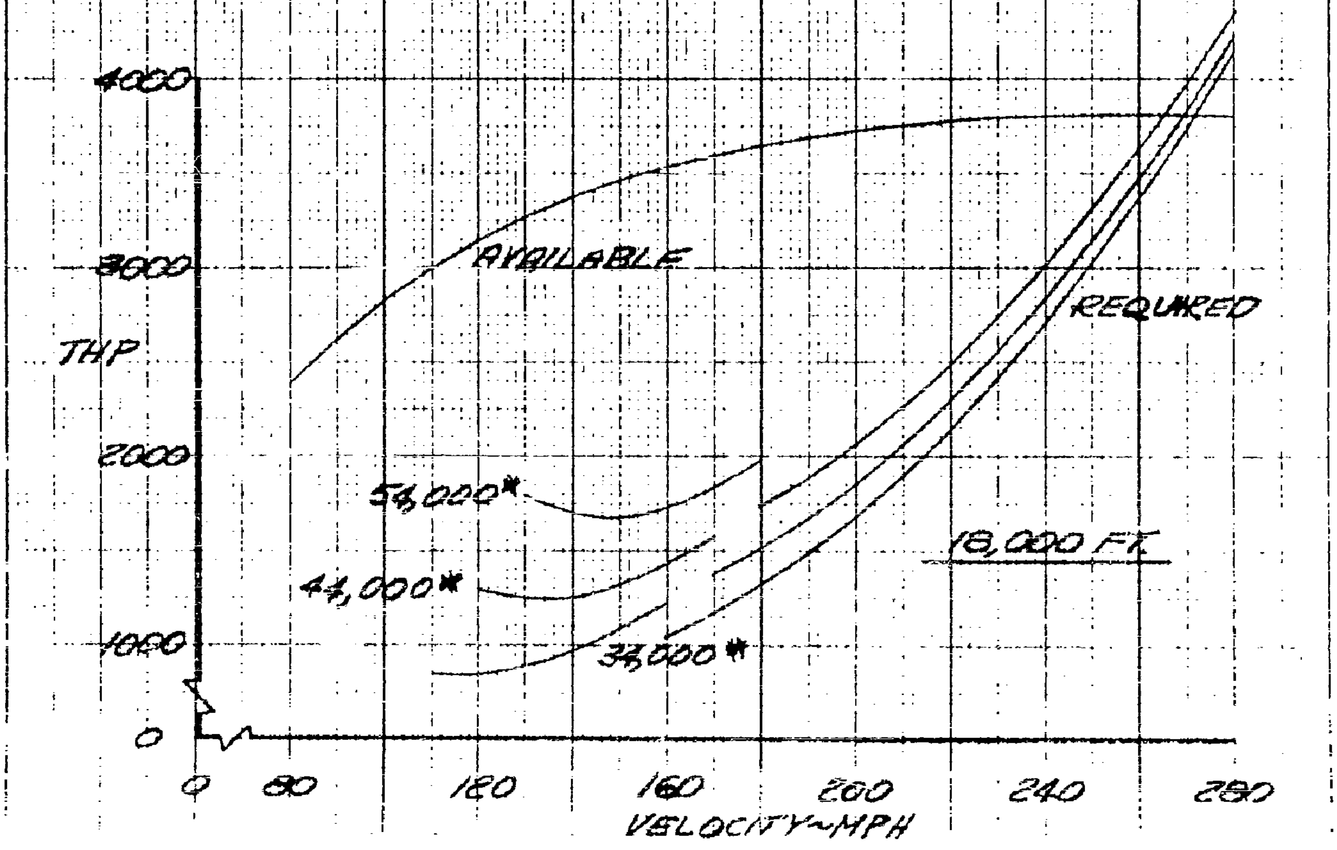
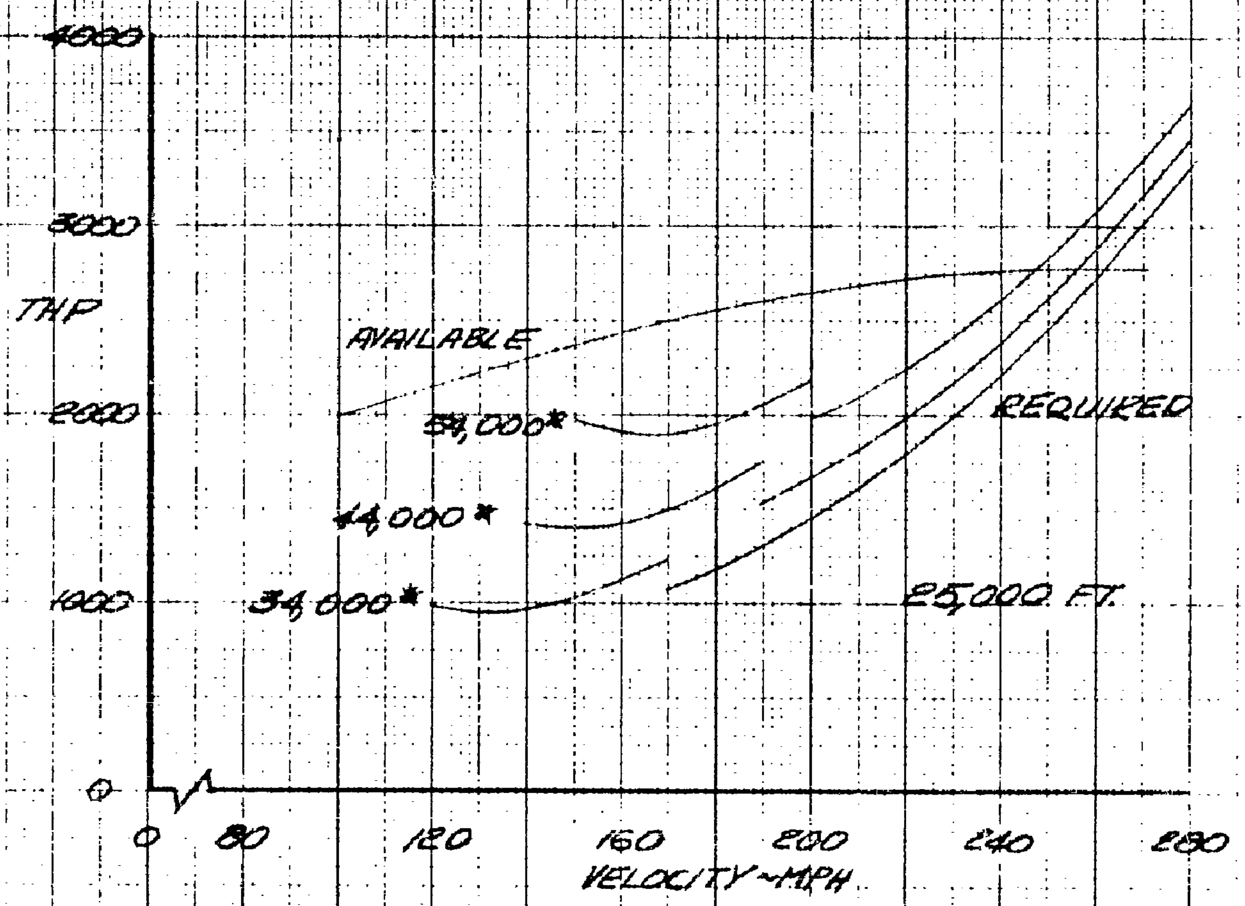


FIG 74

POWER REQUIRED AND AVAILABLE
NORMAL RATED POWER TWO ENGINES
XC-120 AIRPLANE PACK OFF



XC-120 AIRPLANE PACK OFF
POWER REQUIRED & AVAILABLE
MILITARY POWER

FIG 75

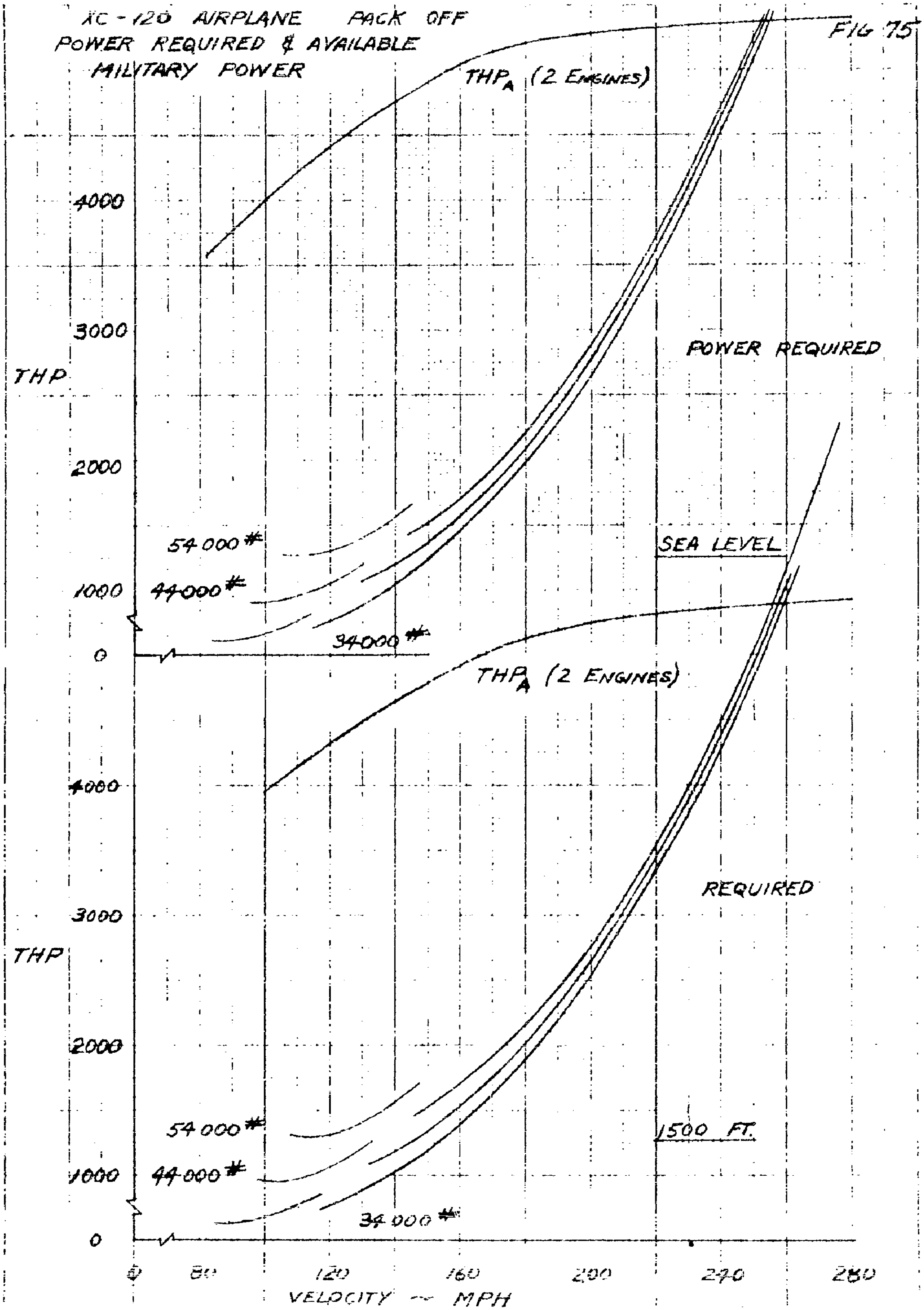


FIG 76

XC-120 AIRPLANE PACK OFF
POWER REQUIRED AND AVAILABLE
MILITARY POWER

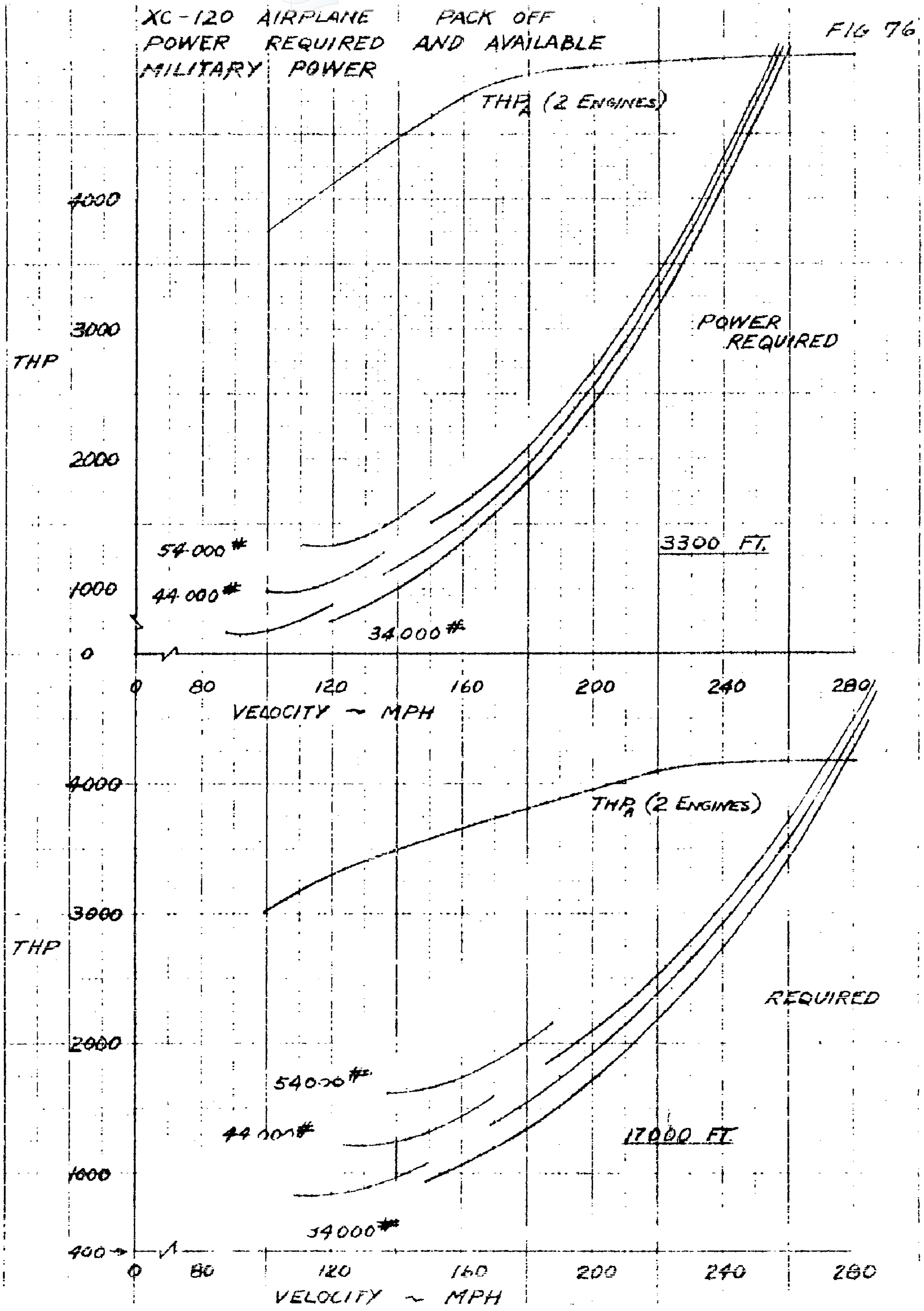
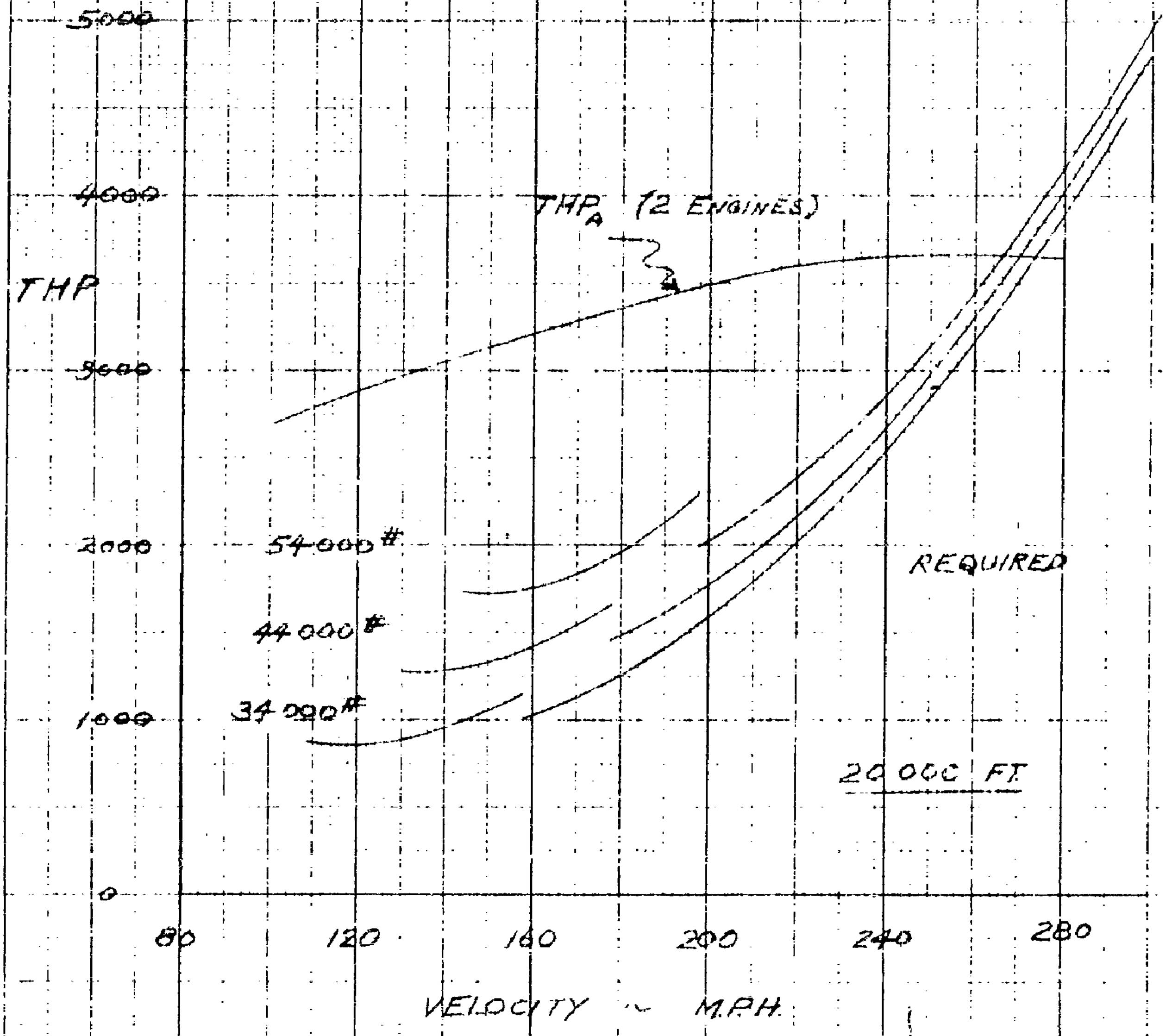


FIG 77

XC-120 PACK OFF
POWER REQUIRED AND AVAILABLE
MILITARY POWER



PART III-C CLIMB AND CEILING CALCULATIONS

Maximum rates of climb have been computed for the subject airplane with the pack off at both normal rated and military power at gross weights of 34,000 44,000 and 54,000 lbs. The method of calculation is the same as that for the "pack on" condition.

Maximum rate of climb versus altitude for the gross weights listed above are presented in figures 78 and 79 for normal and military power, respectively. These rate of climb curves were then integrated to get time to climb which is plotted in the same figures.

Service ceiling is crossplotted against gross weight in figure 80 for both normal and military power. Combat ceiling (500 ft/min - military power) is presented in figure 81.

FIG. 78

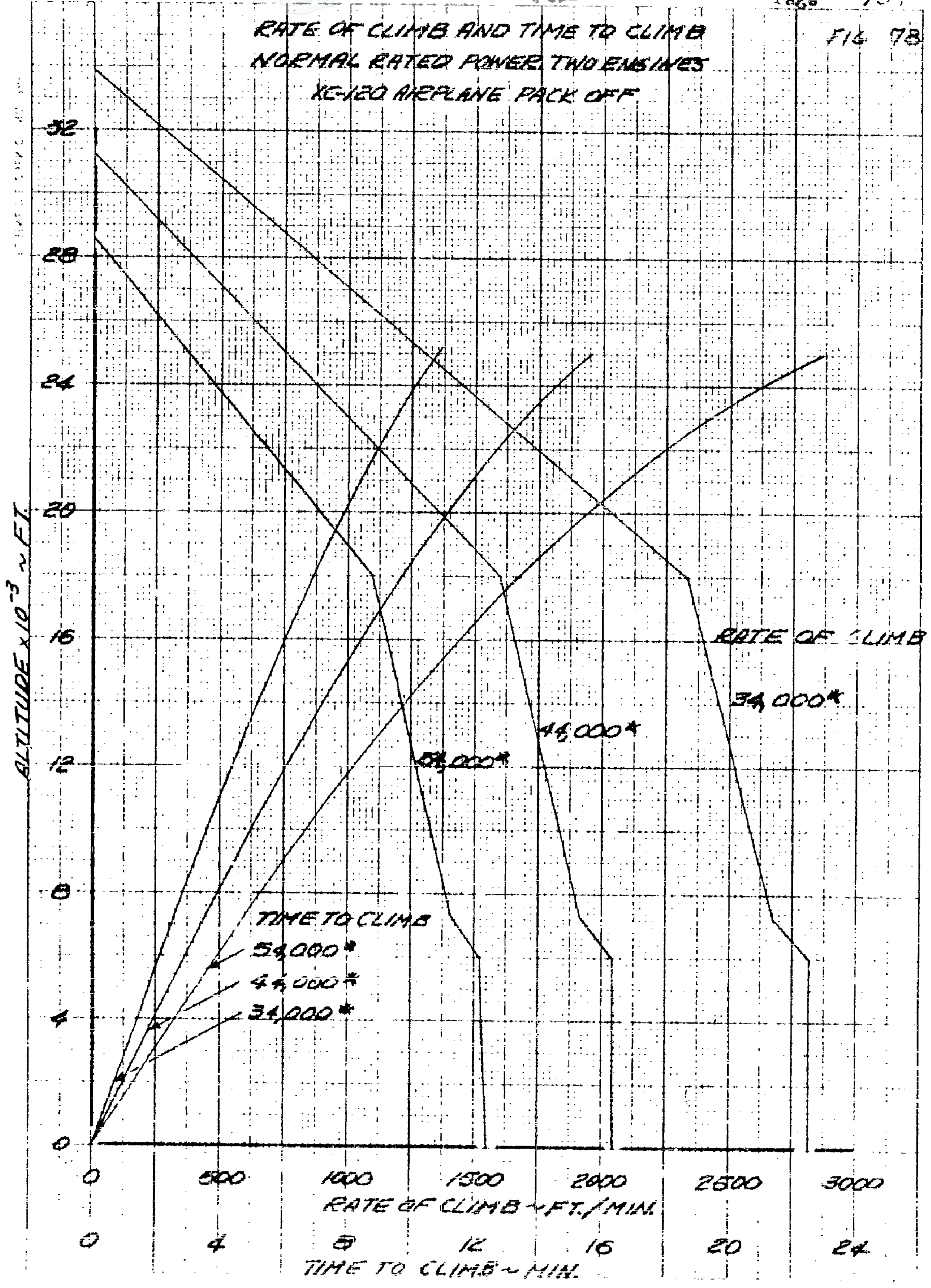

RATE OF CLIMB AND TIME TO CLIMB
NORMAL RATED POWER, TWO ENGINES
XC-120 AIRPLANE PACK OFF
ALTITUDE x 10^-3 ~ FT.
32
28
24
20
16
12
8
4
0
RATE OF CLIMB
34,000#
44,000#
54,000#
TIME TO CLIMB
54,000#
44,000#
34,000#
0
500
1000
1500
2000
2500
3000
RATE OF CLIMB ~ FT./MIN.
0
4
8
12
16
20
24
TIME TO CLIMB ~ MIN.

FIG 77

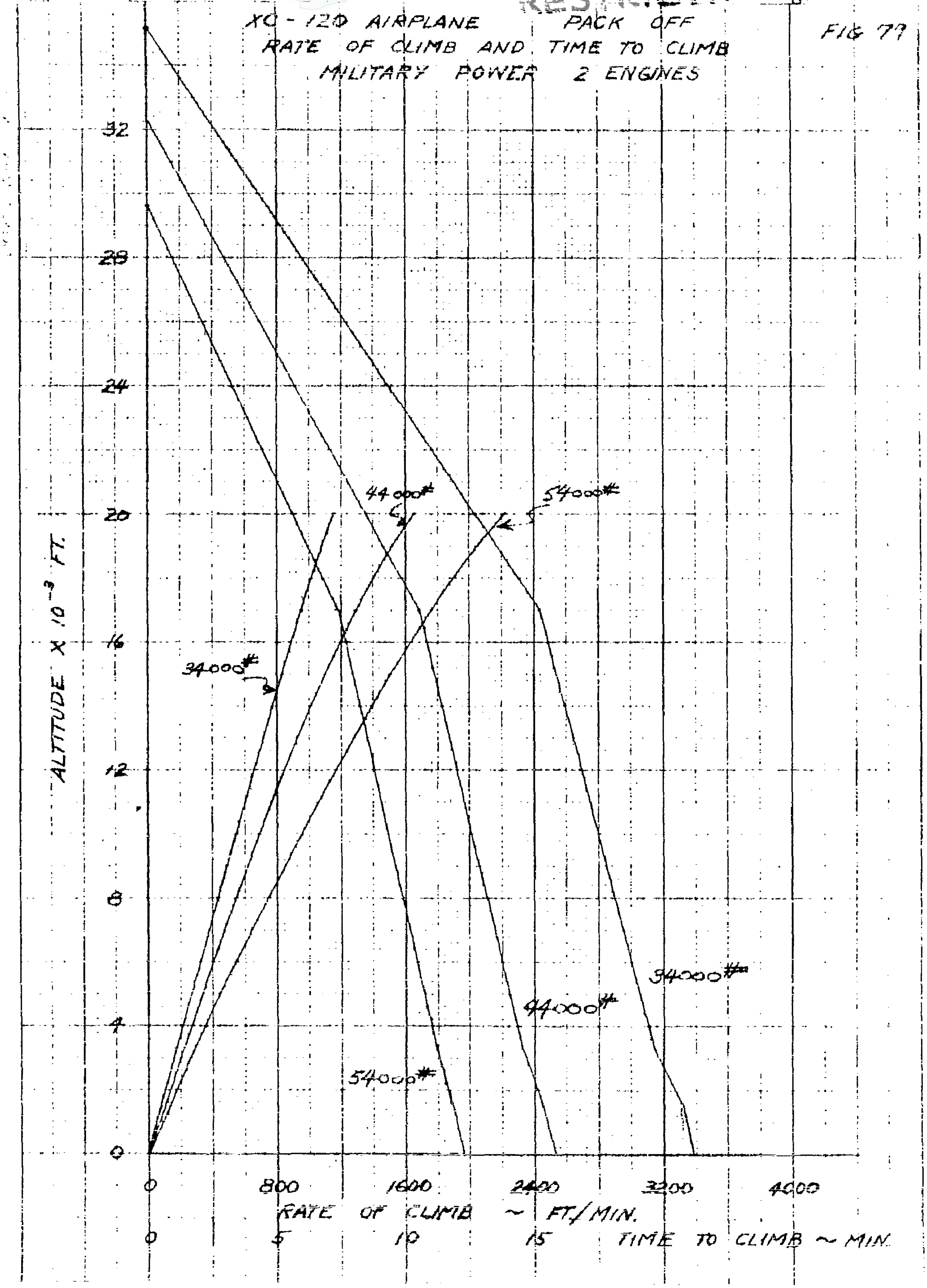
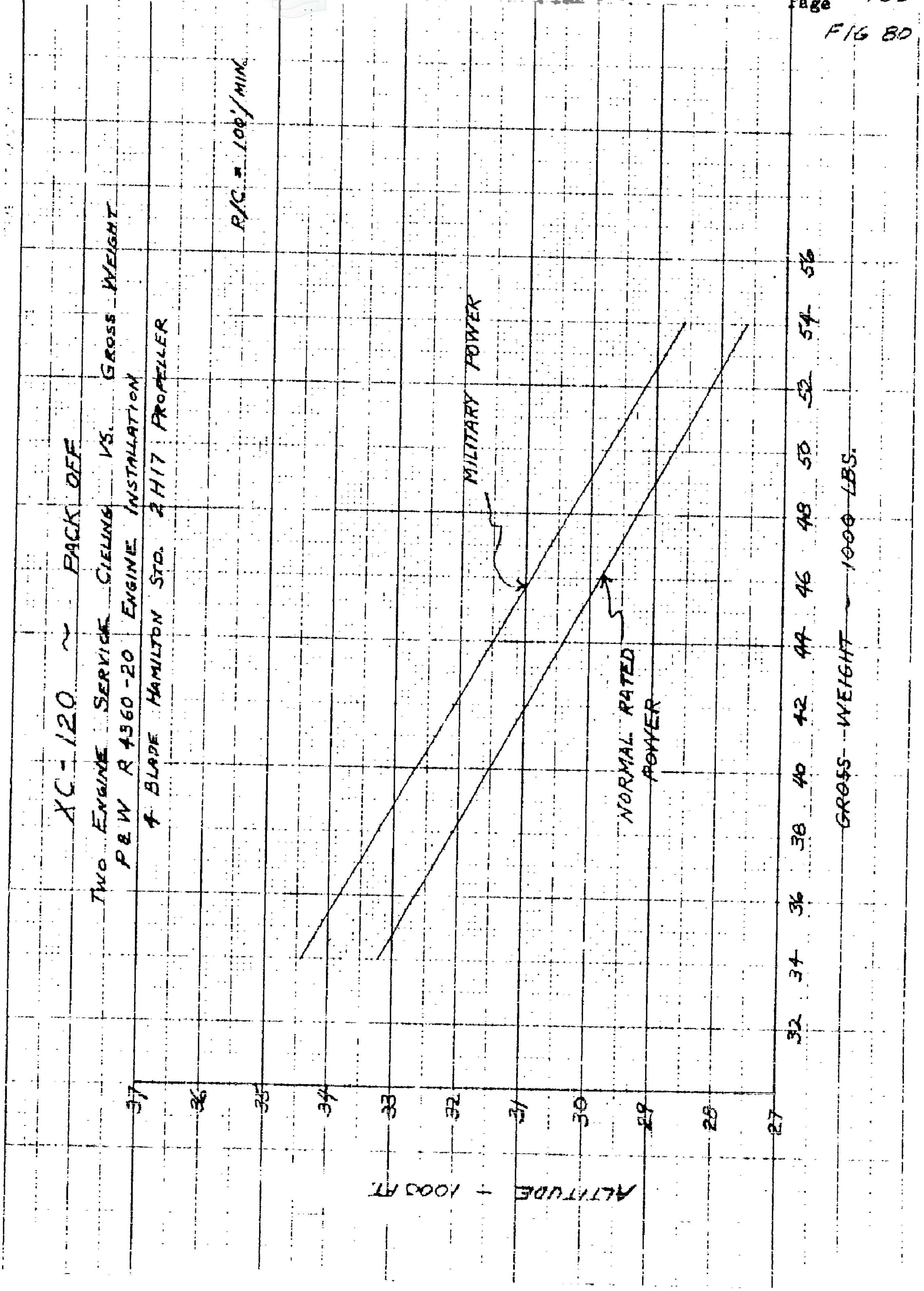

XC-120 AIRPLANE PACK OFF
RATE OF CLIMB AND TIME TO CLIMB
MILITARY POWER 2 ENGINES
ALTITUDE X 10⁻³ FT.
0
4
8
12
16
20
24
28
32
0
800
1600
2400
3200
4000
RATE OF CLIMB ~ FT/MIN.
0
5
10
15
TIME TO CLIMB ~ MIN.
34000#
44000#
54000#
34000#
44000#
54000#

FIG 80



XC-120 ~ PACK OFF

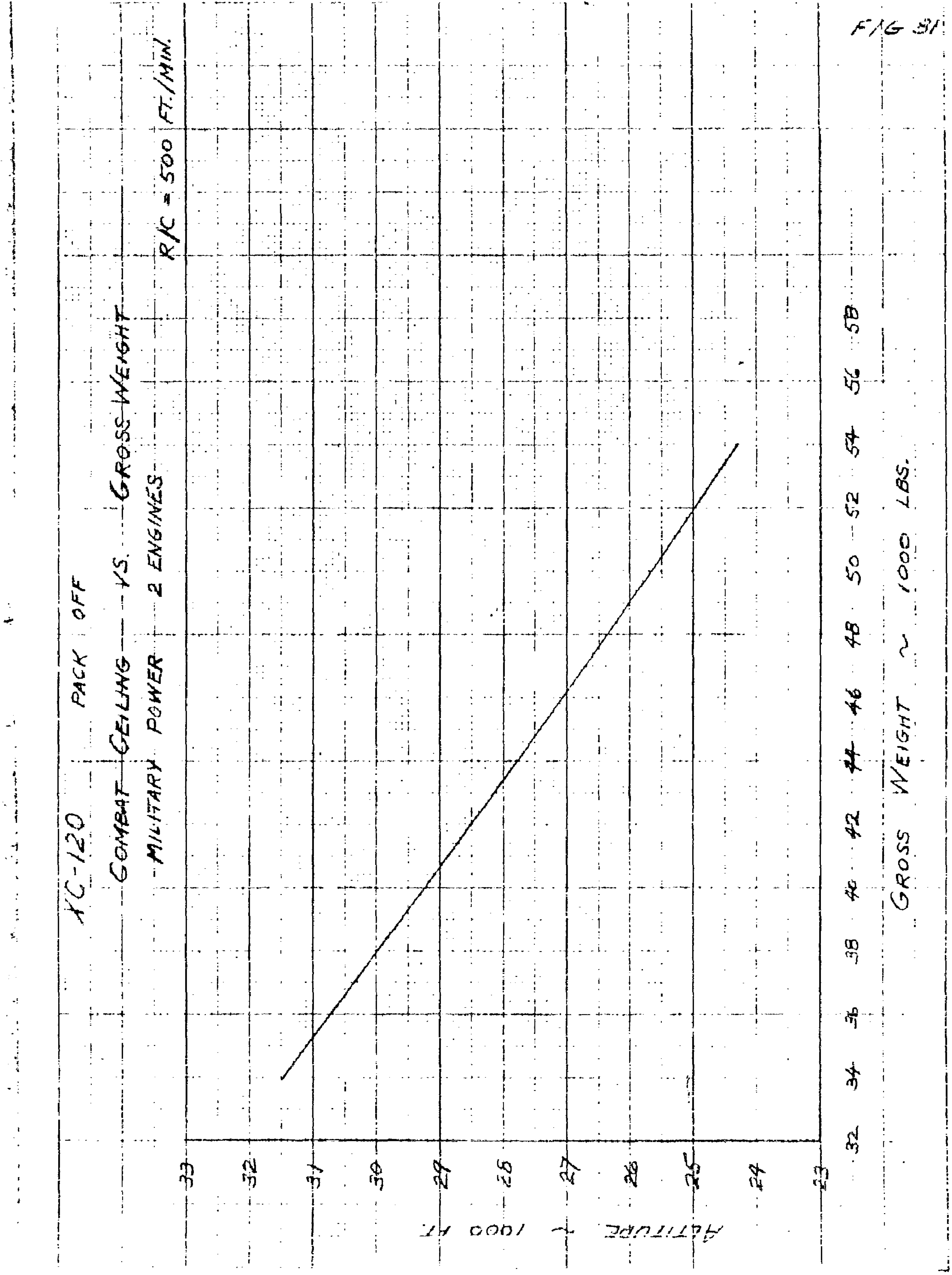
TWO ENGINE SERVICE CIELING VS. GROSS WEIGHT

P&W R 4360-20 ENGINE INSTALLATION

4 BLADE HAMILTON STD. 2H17 PROPELLER

R/C = 100'/MIN.

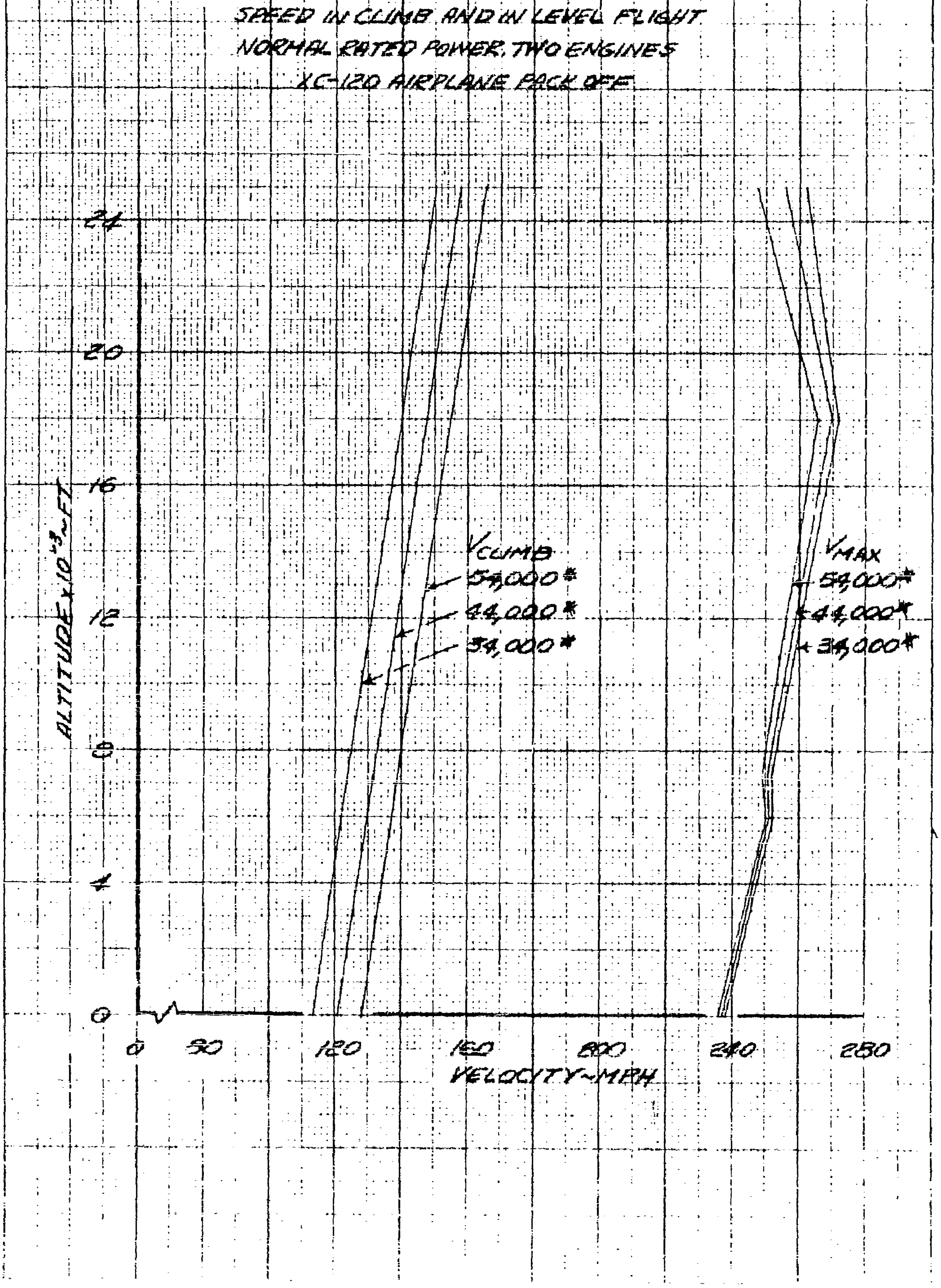
FIG 31


XC-120 PACK OFF
COMBAT CEILING VS. GROSS WEIGHT
MILITARY POWER 2 ENGINES
R/C = 500 FT./MIN.
33
32
31
30
29
28
27
26
25
24
23
ALTITUDE ~ 1000 FT
32
34
36
38
40
42
44
46
48
50
52
54
56
58
GROSS WEIGHT ~ 1000 LBS.

PART III-D MAXIMUM SPEED AND CLIMB SPEED CALCULATIONS

Maximum speeds for the airplane in the "pack off" configuration were obtained from figures 72 through 77 at the intersections of the power required and available curves. Speeds for maximum rates of climb were obtained from the same figures in the course of the rate of climb calculation. Maximum speed and best climb speed versus altitude are shown for gross weights of 34,000 44,000 and 54,000 lbs. in figure 82 for normal rated power operation and in figure 83 for military power operation.

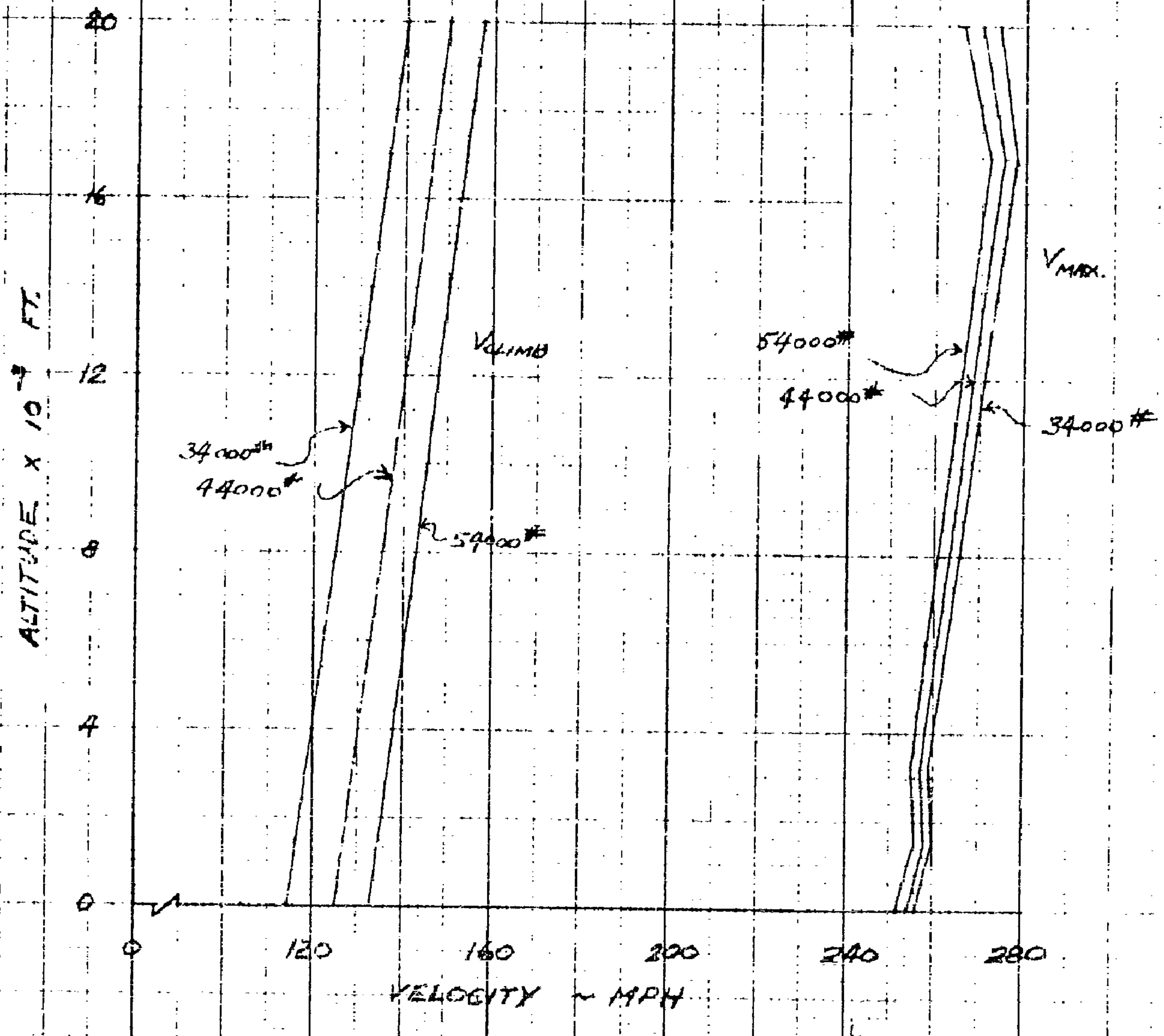
FIG 82



SPEED IN CLIMB AND IN LEVEL FLIGHT
NORMAL RATED POWER, TWO ENGINES
XC-120 AIRPLANE PACK OFF

Fig 53

XC-120 AIRPLANE PACK OFF
SPEED IN CLIMB AND IN LEVEL FLIGHT
MILITARY POWER TWO ENGINES



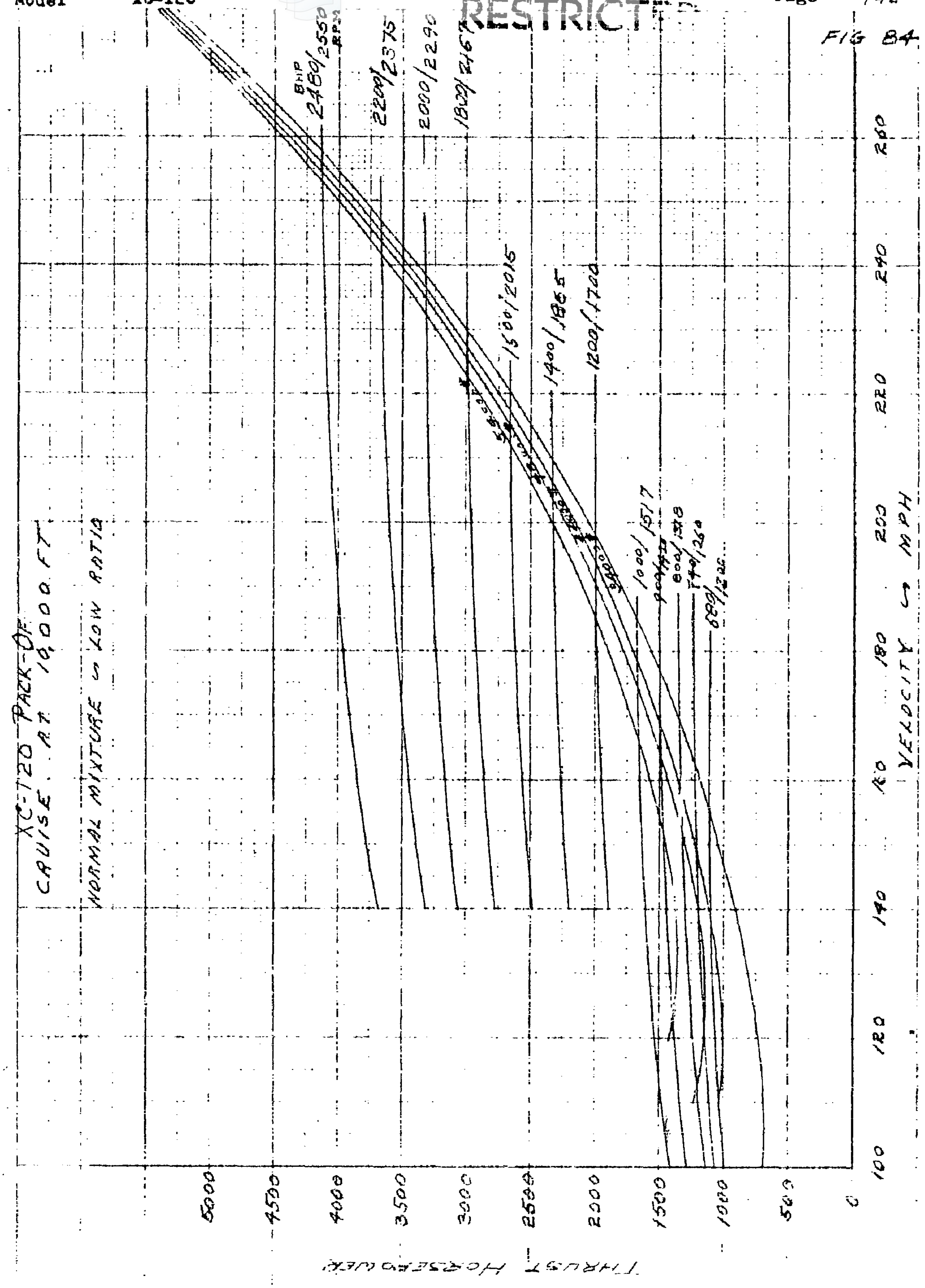
PART III-E

E. CRUISING CALCULATIONS

1. Cruising Power Required and Available

Cruising calculations for the airplane with the pack off are made at the standard altitude of 10,000 feet using the same power and fuel consumption data as was used with pack on. The limiting BHP versus RPM curve of figure 34, the SFC versus BHP curves of figure 35, and the THP_a versus speed curves of figure 35 are, therefore, still applicable. Cruising power required was computed using the high speed polar of figure 11 with the constant ΔC_D for pack-off. Cruising power required and available at 10,000 feet with the pack off are plotted versus speed in figure 84.

FIG 84


XC-120 PACK-OF
CRUISE AT 10,000 FT
NORMAL MIXTURE ~ LOW RATIO
BHP
RPM
2480/2550
2200/2375
2000/2290
1800/2167
1500/2015
1400/1865
1200/1700
1000/1517
900/1410
800/1318
740/1260
680/1226
VELOCITY ~ MPH
100
120
140
160
180
200
220
240
260
THRUST HORSEPOWER
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000

PART III-E (Cont.)

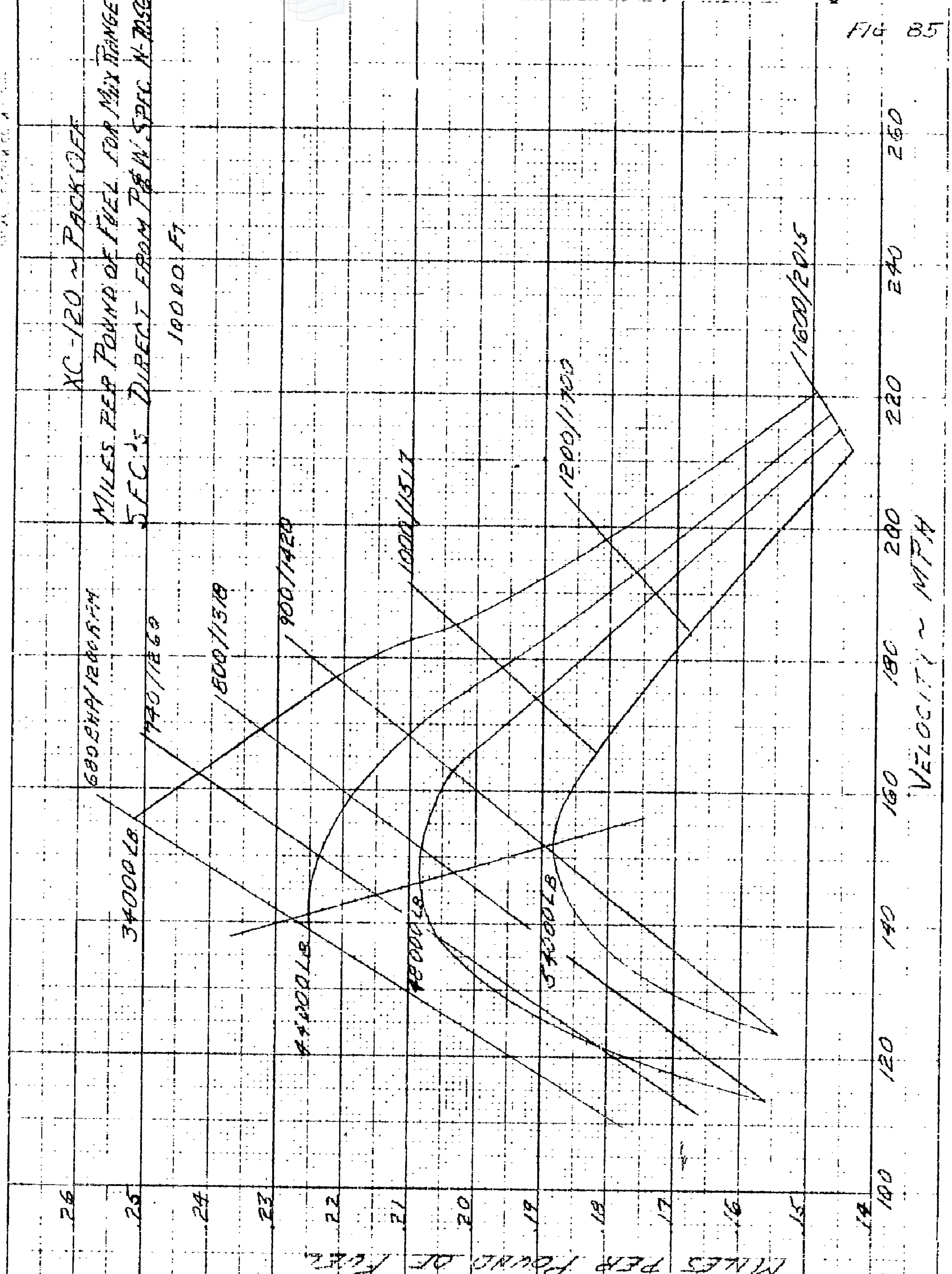
2. Miles per Pound Calculations

The miles per pound calculations for the airplane in the pack off condition are made in the same manner as were those with pack on. Miles per pound of fuel versus speed as based directly on the manufacturer's SFC data for use in the maximum range calculation are shown in figure 85; the corresponding plot as made by increasing the manufacturer's SFC by 15% for use in the combat range and radius problems is shown in figure 86.

Figure 86 is then used to get the miles per pound at the speed for 99% of best economy as required for the combat range and radius problems and this data is plotted versus gross weight in figure 87.

In like manner figure 88 is developed from figure 85 for use in computing maximum range.

FIG 85



XC-120 ~ PACKOFF
MILES PER POUND OF FUEL FOR MAX RANGE
SFC'S DIRECT FROM P&W SPEC. N-7056
10000 FT

FIG 86

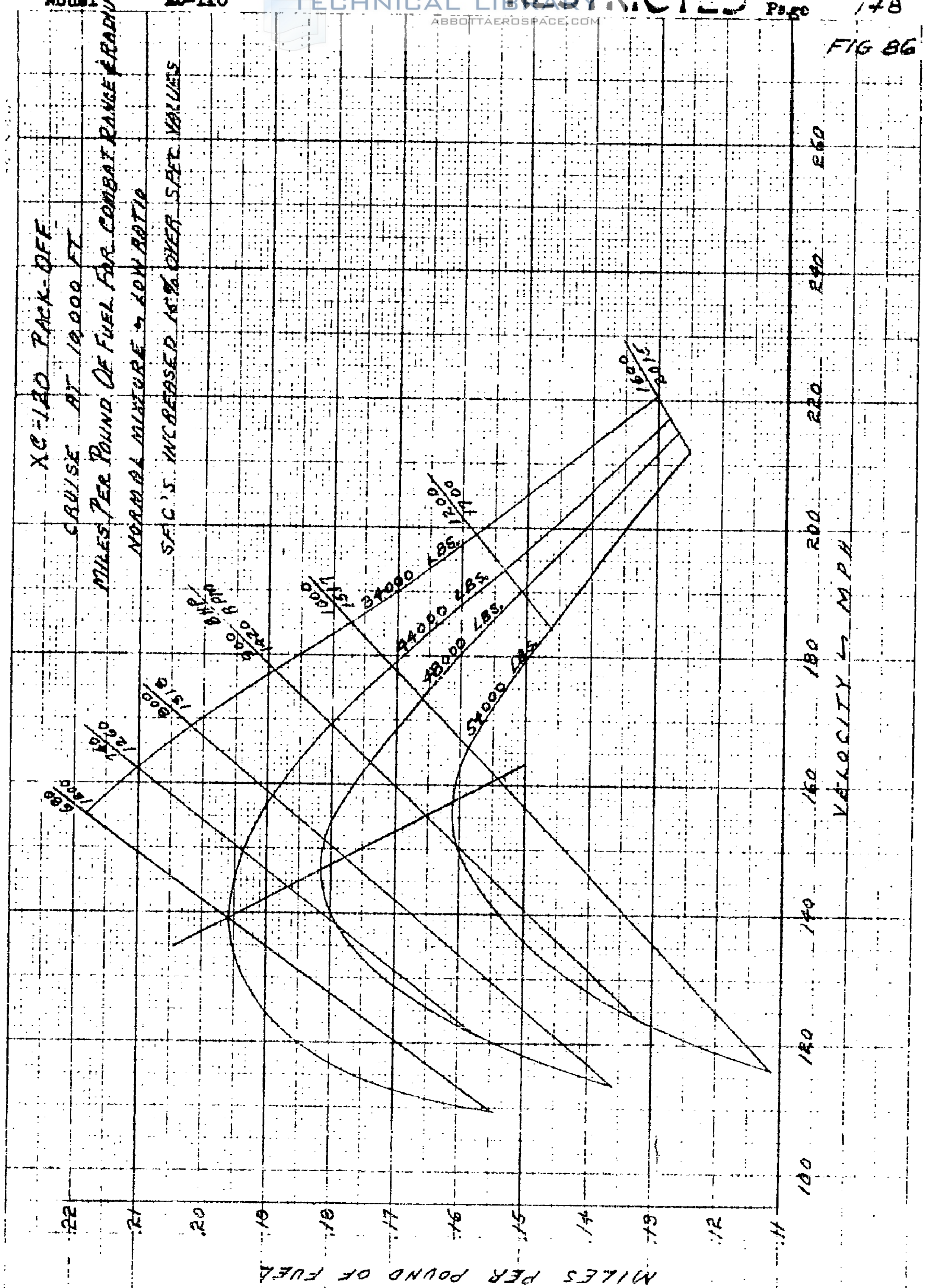

XC-120 PACK-OFF
CRUISE AT 10,000 FT
MILES PER POUND OF FUEL FOR COMBAT RANGE & RADIUS
NORMAL MIXTURE - LOW RATIO
SFC'S INCREASED 15% OVER SPEC VALUES
34000 LBS.
44000 LBS.
54000 LBS.
48000 LBS.
BHP / RPM
1600 / 2015
1200 / 1470
1000 / 1571
1400 / 1420
800 / 1510
1200 / 1200
1600 / 688
100
120
140
160
180
200
220
240
260
VELOCITY - MPH
.22
.21
.20
.19
.18
.17
.16
.15
.14
.13
.12
.11
MILES PER POUND OF FUEL

FIG 97

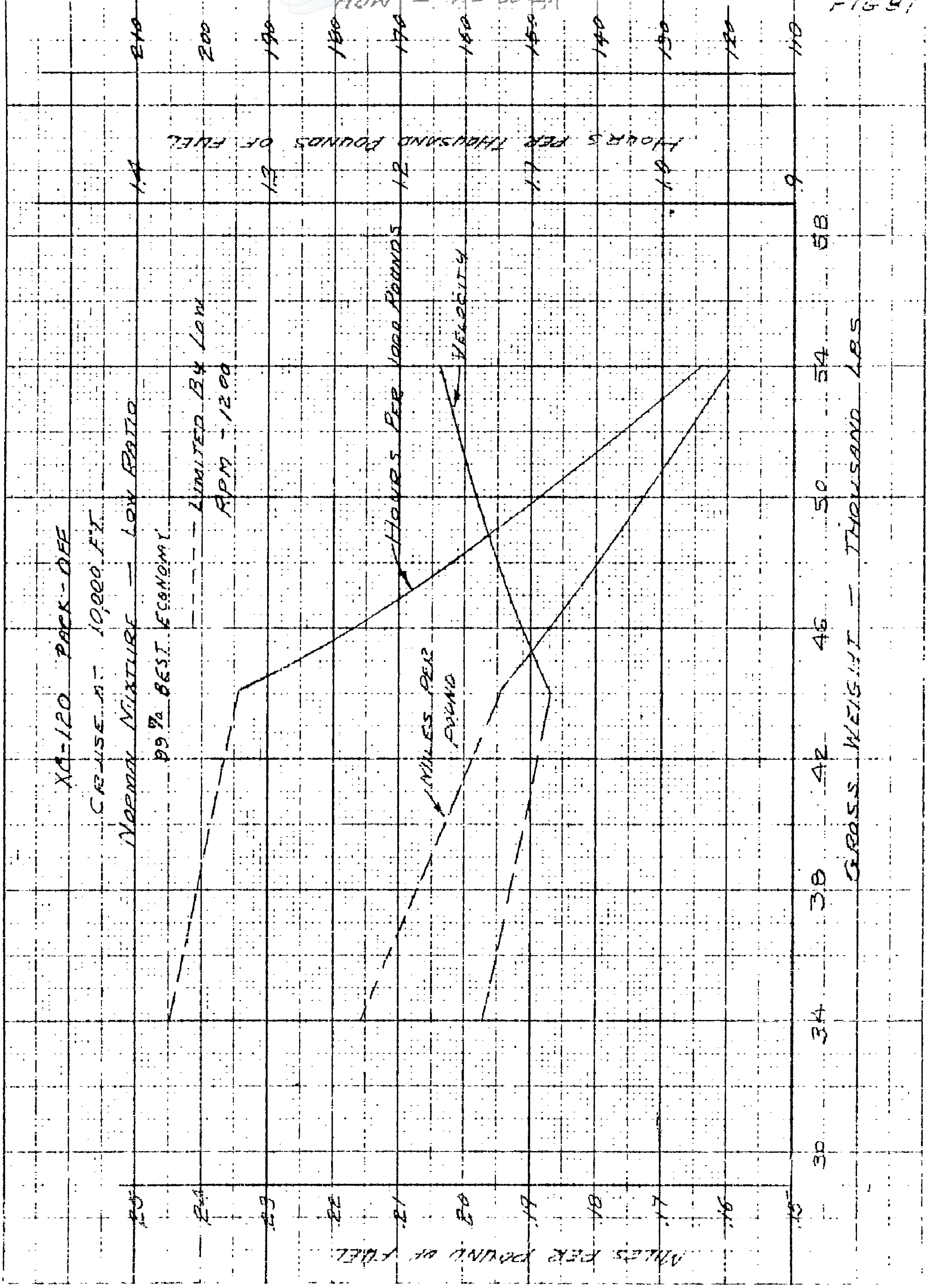

XC-120 PACK-OFF
CRUISE AT 10,000 FT.
NORMAL MIXTURE — LOW RATIO
99% BEST ECONOMY
– – – LIMITED BY LOW RPM - 1200
HOURS PER 1000 POUNDS
VELOCITY
MILES PER POUND
GROSS WEIGHT — THOUSAND LBS
30
34
38
42
46
50
54
58
HOURS PER THOUSAND POUNDS OF FUEL
1.4
1.3
1.2
1.1
1.0
.9
210
200
190
180
170
160
150
140
130
120
110
MILES PER POUND OF FUEL
.25
.24
.23
.22
.21
.20
.19
.18
.17
.16
.15

FIG 88

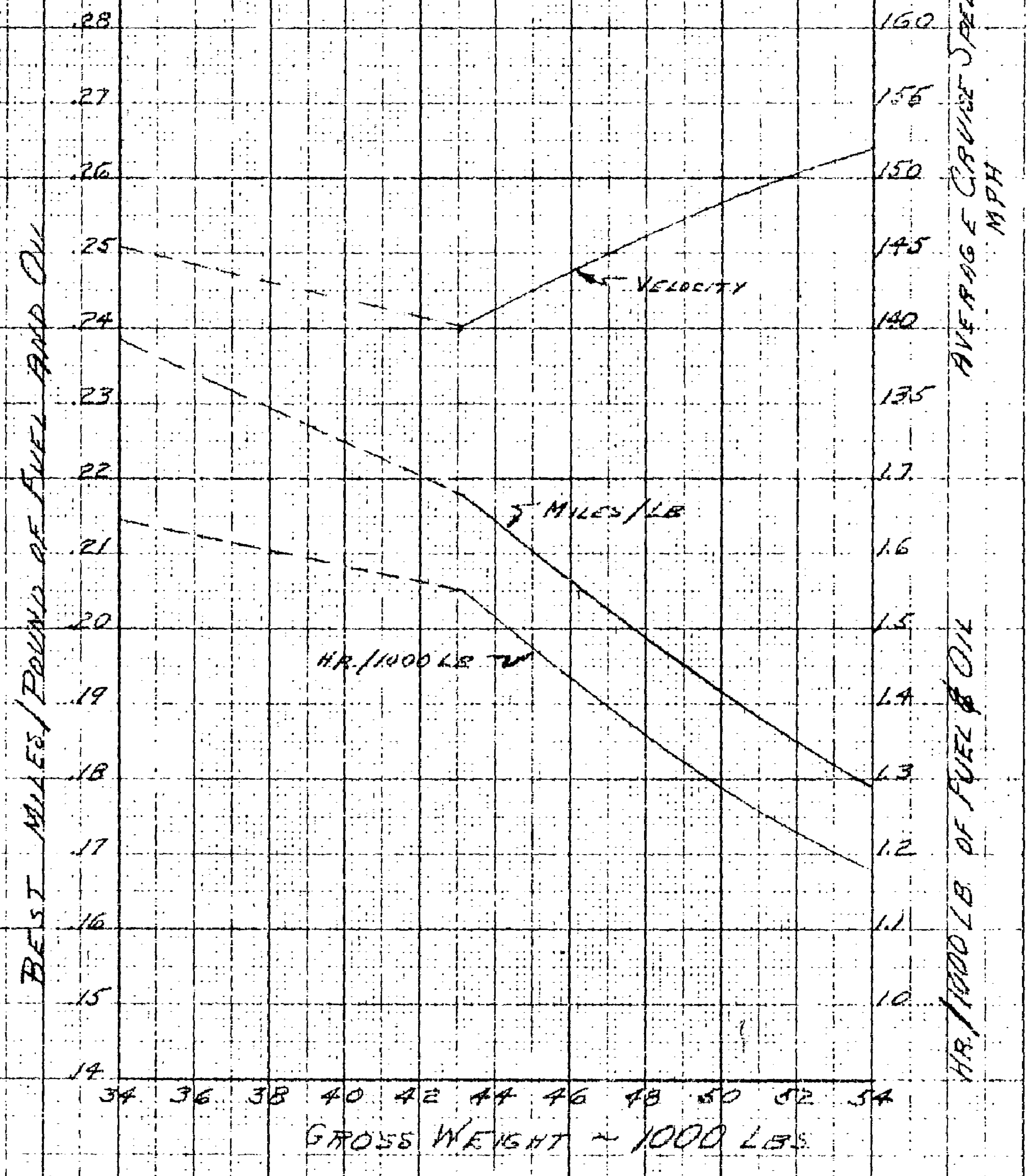
XC-120 ~ PACK OFF

DATA FOR MAXIMUM RANGE PROBLEM

SFC'S DIRECT FROM P&W SPEC N-7056

NORMAL MIXTURE - LOW RATIO

10000 FT



PART III-E CRUISING CALCULATIONS (Cont.)

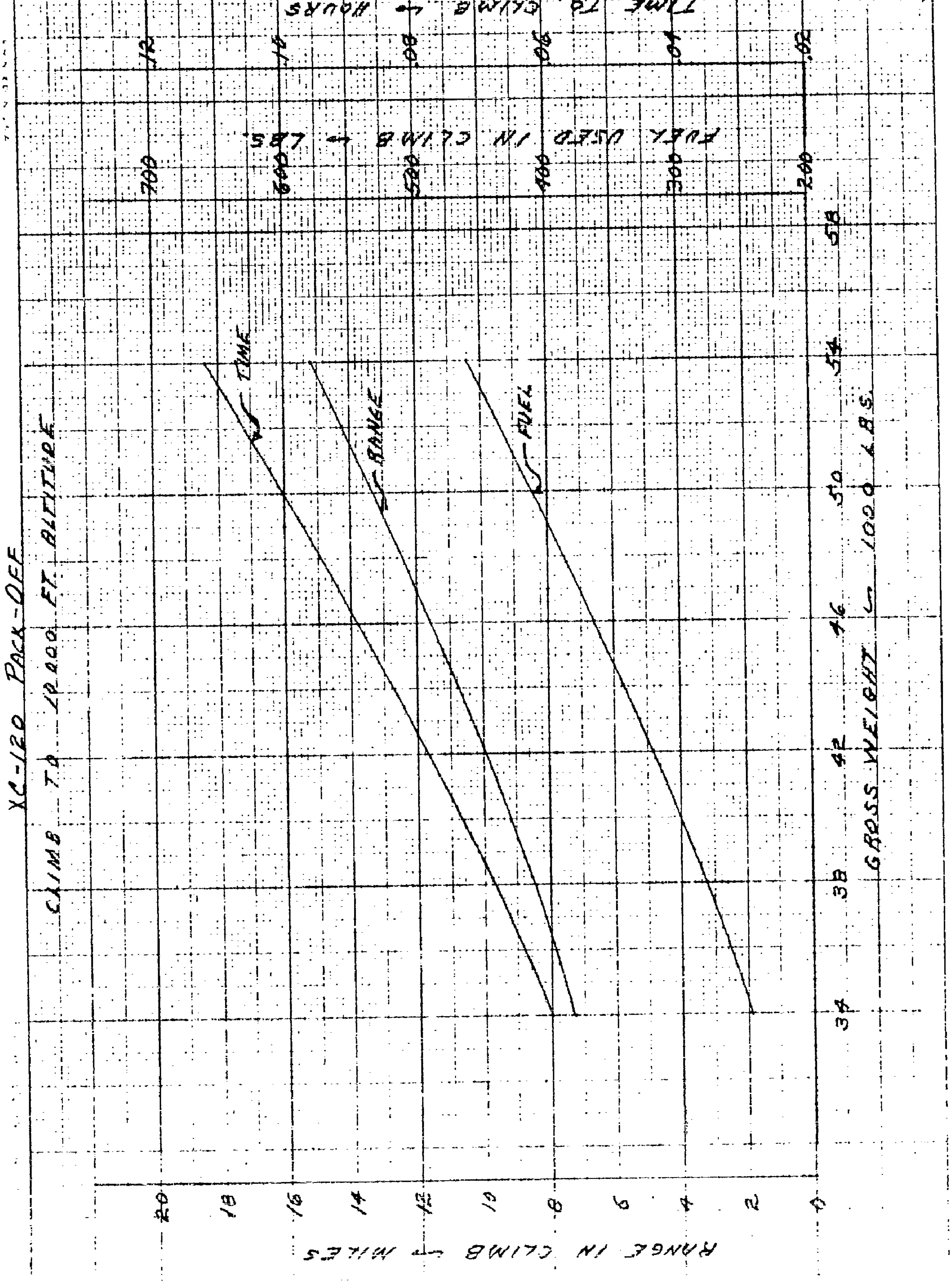
3. Combat Radius of Action

Combat radius of action with the pack off is computed in the same manner as was used with the pack on, by integration of the mi/lb and hr/lb curves of figure 87. These curves were prepared using 1.15 times the manufacturer's SFC's and speeds for 99% of best economy.

Combat radius and fuel load for combat radius with the pack off are plotted against take-off gross weight in figure 90 while total time for combat radius is shown in figure 91.

RESTRICTED

FIG 89


XC-120 PACK-OFF
CLIMB TO 10,000 FT. ALTITUDE

RESTRICTED

XC-120 PACK OFF

COMBAT RADIUS

FIG 90

TAKE-OFF GROSS WEIGHT VS COMBAT RADIUS & FUEL

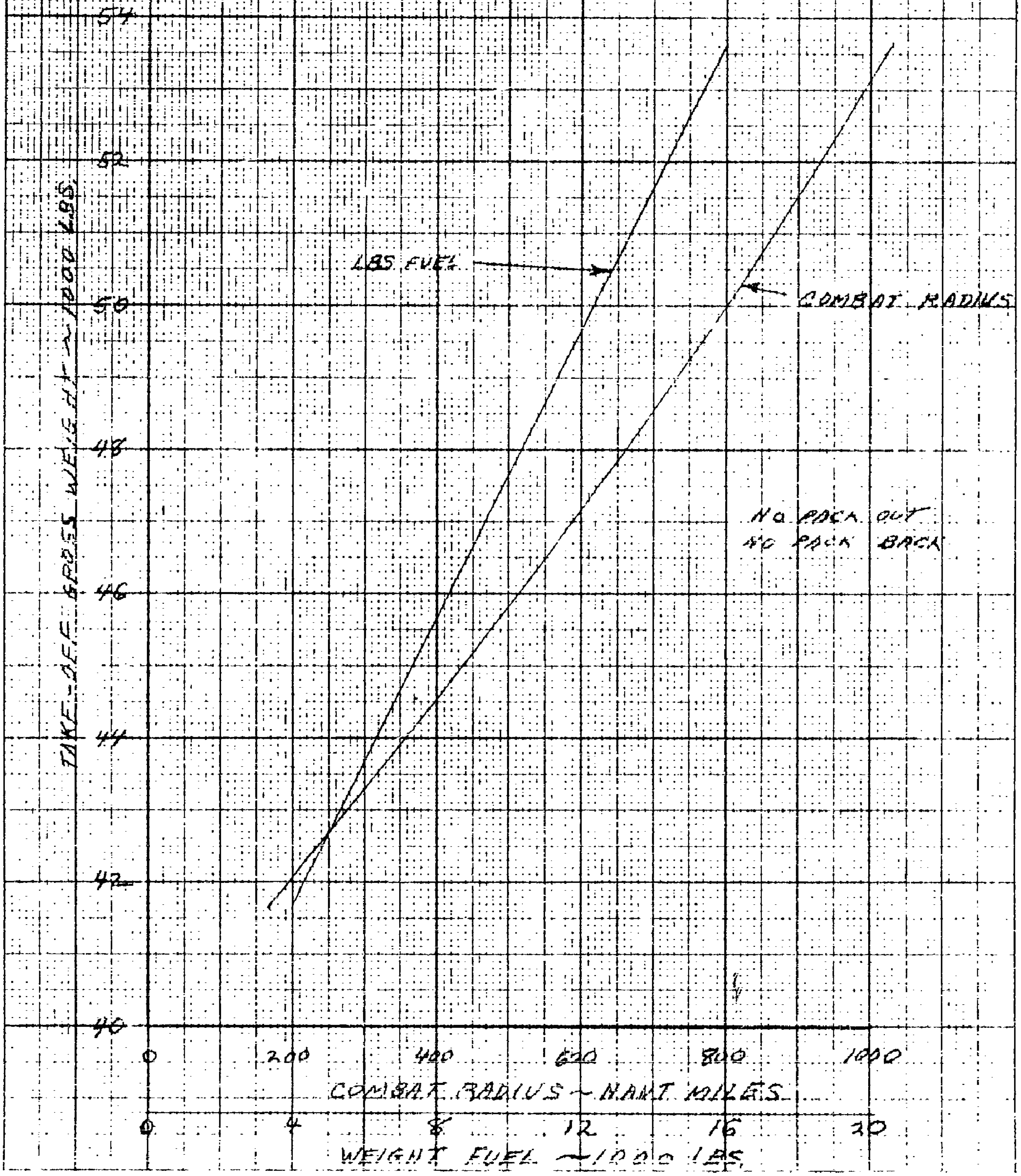
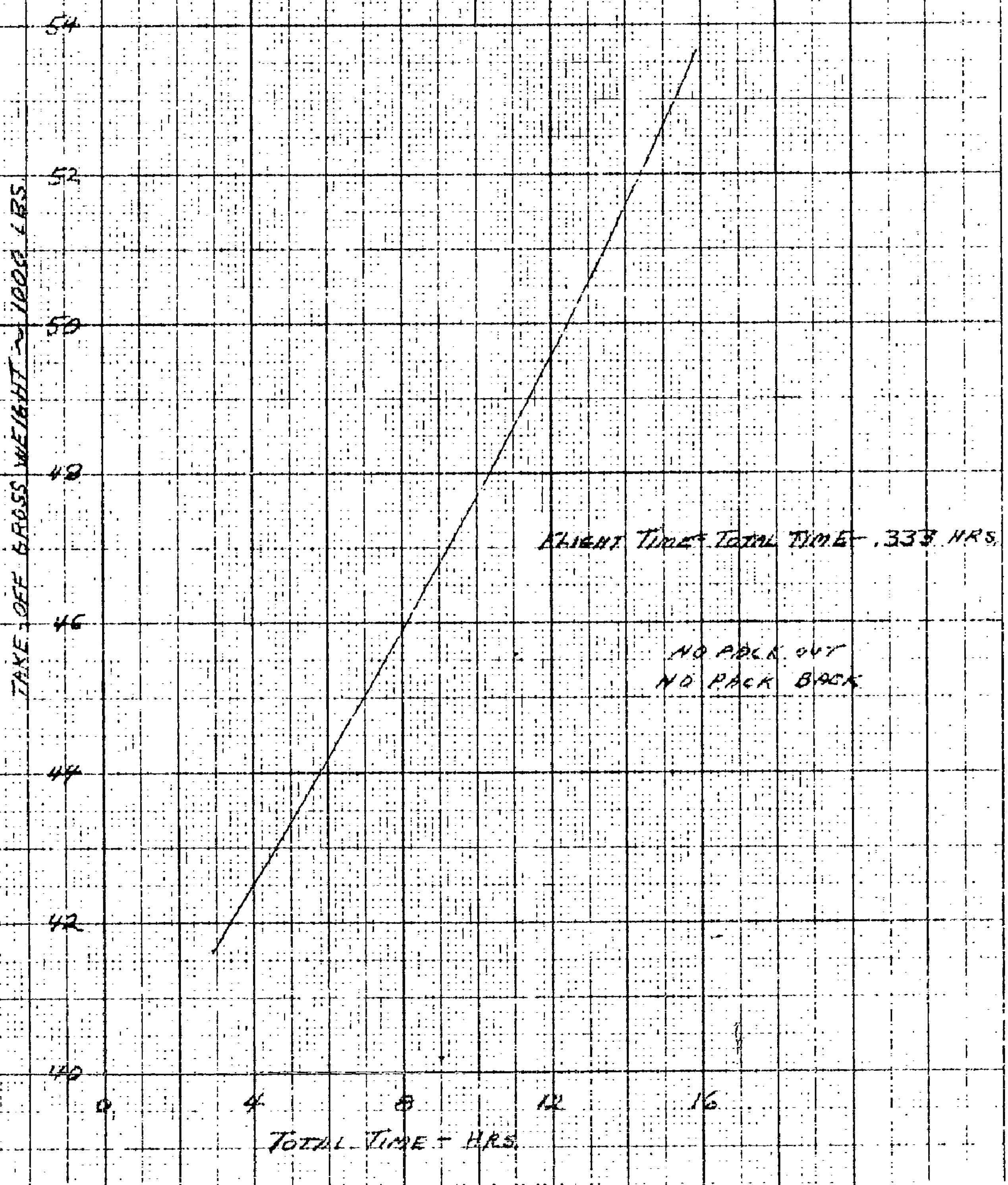


FIG 91

XC-120 PACK-OFF
TAKE-OFF GROSS WEIGHT VS TOTAL TIME
COMBAT RADIUS



FLIGHT TIME = TOTAL TIME - .333 HRS.

PART III-E CRUISING CALCULATIONS (Cont.)

4. Combat Range

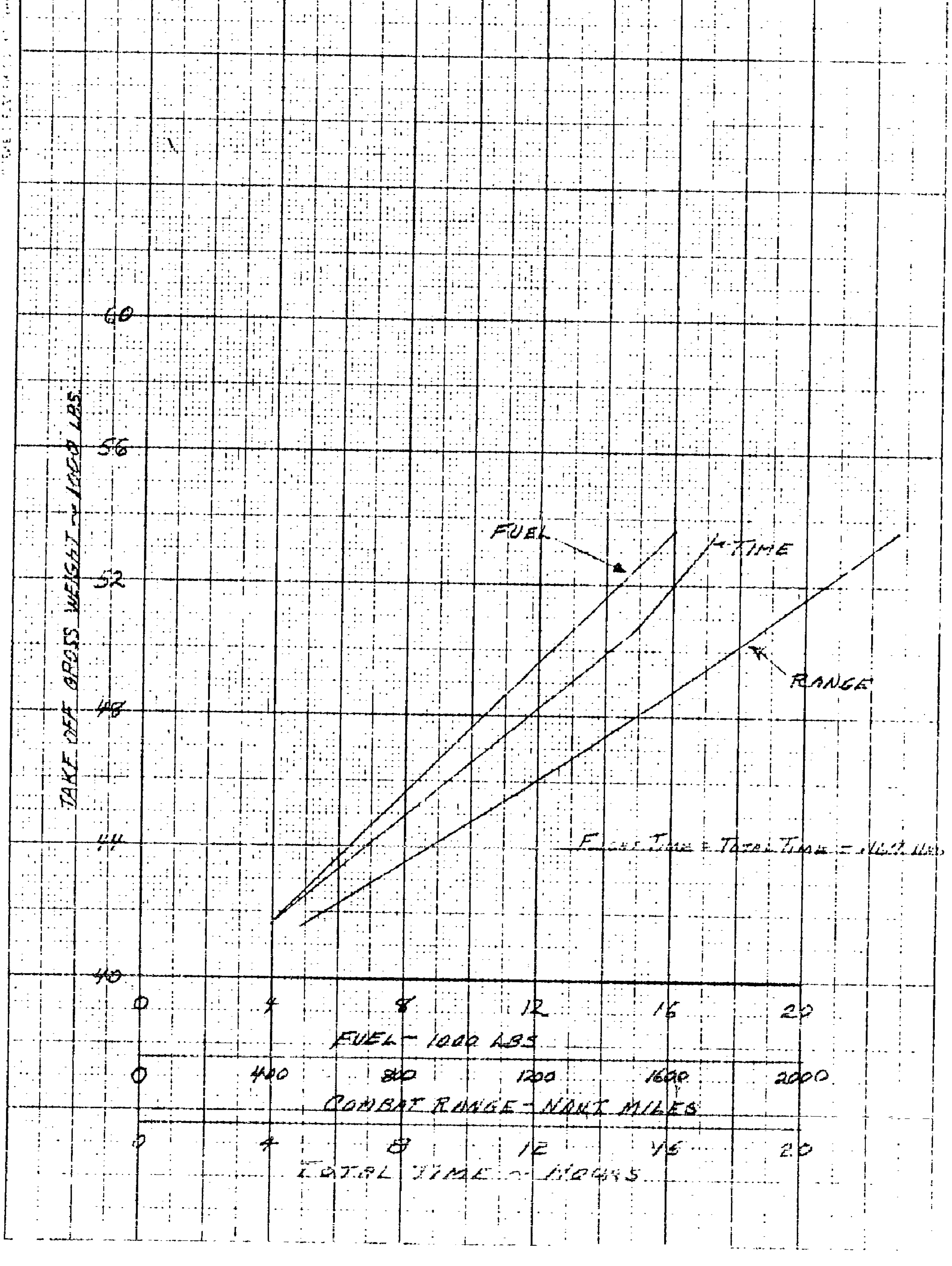
Combat range and time for combat range with the pack off are computed using the mi/lb and hr/lb of fuel curves of figure 87 in the same manner as was done for the pack on.

Combat range, with corresponding fuel and total time is plotted against take-off gross weight for the pack off condition in figure 92.

RESTRICTED

FIG 92

XC-120 PACK OFF
COMBAT RANGE

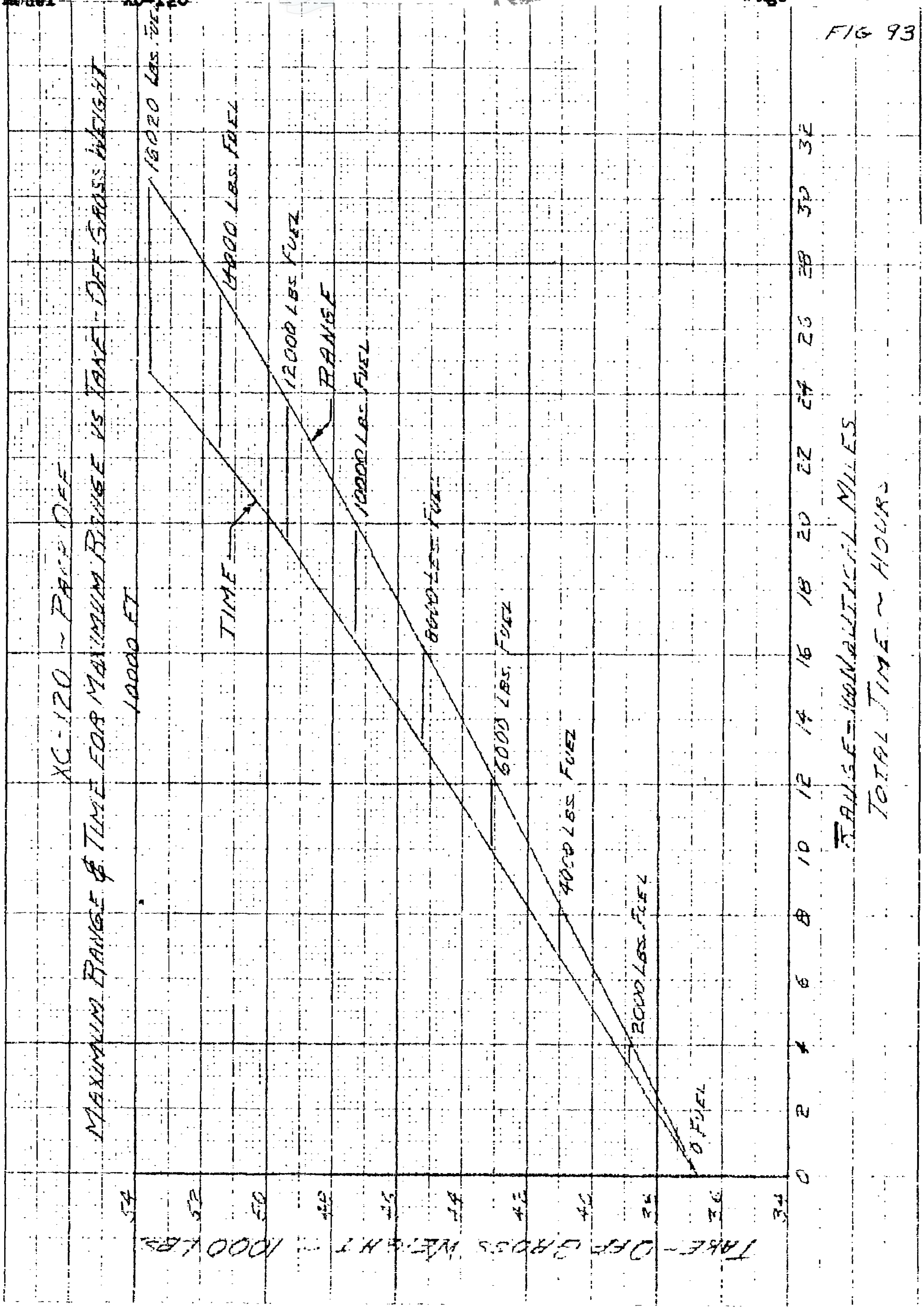


PART III-E CRUISING CALCULATIONS (Cont.)

5. Maximum Range

Maximum range and time for maximum range are plotted versus take-off gross weight for the airplane with the pack off in figure 93. Fuel loads are marked on these curves at 2000 lb. increments, but there is no cargo parameter as there is no provision for cargo with the pack off. These range and flight time curves were derived from the mi/lb and hrs/lb curves of figure 88 which are based directly on the manufacturer's SFC. This derivation is parallel to that used with the pack on and again maximum range makes no allowance for warm-up, take-off, climb, head winds, or reserve.

FIG 93


XC-120 ~ PBS DEF
MAXIMUM RANGE & TIME FOR MAXIMUM RANGE VS TAKE-OFF GROSS WEIGHT
10000 FT
16020 LBS FUEL
14000 LBS FUEL
12000 LBS FUEL
10000 LBS FUEL
8000 LBS FUEL
6000 LBS FUEL
4000 LBS FUEL
2000 LBS FUEL
0 FUEL
TIME
RANGE
RANGE ~ 100 NAUTICAL MILES
TOTAL TIME ~ HOURS
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
TAKE-OFF GROSS WEIGHT ~ 1000 LBS
54
52
50
48
46
44
42
40
38
36
34

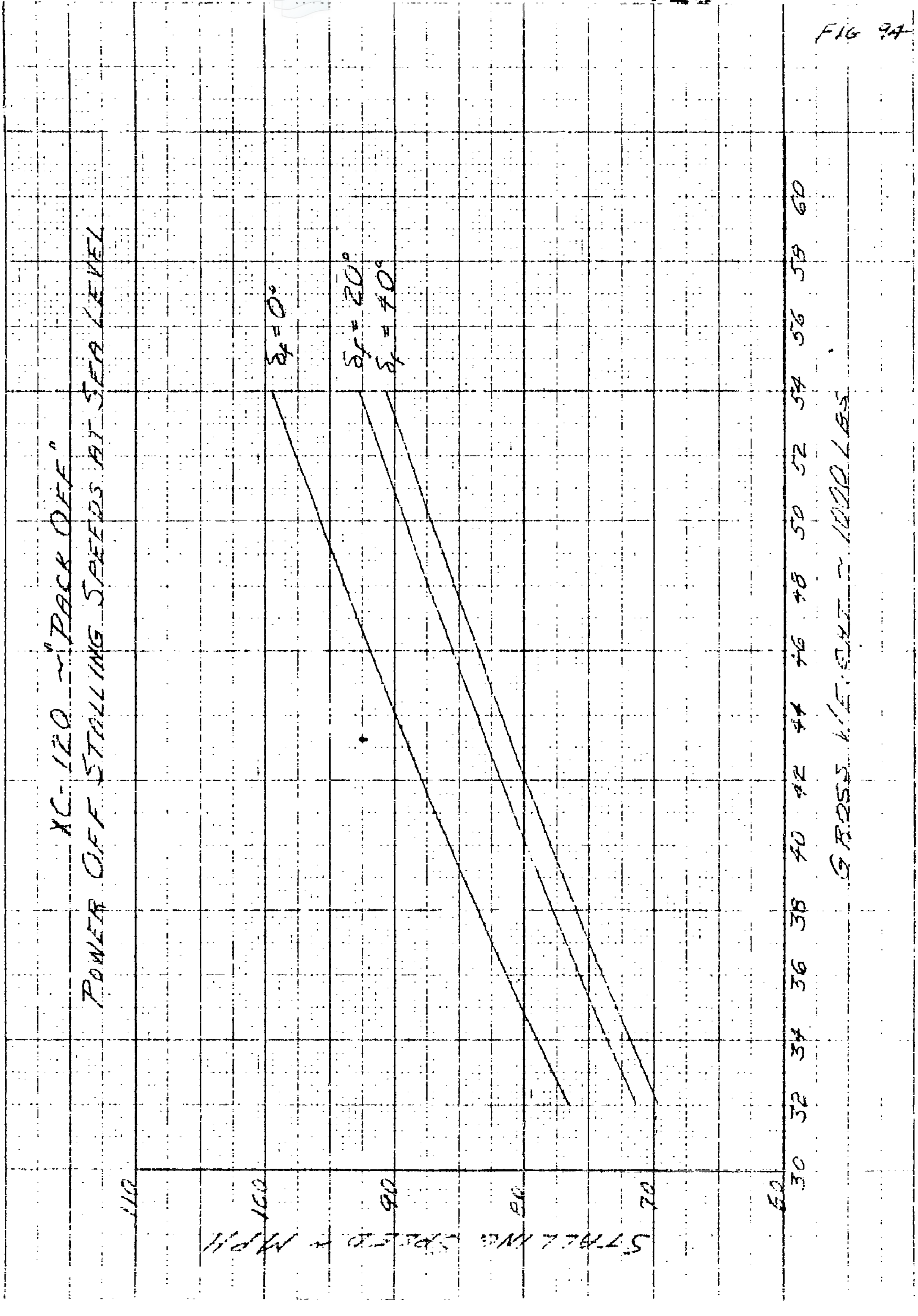
PART III-F

F. STALLING SPEEDS

Maximum lift coefficients used for the calculation of stalling speeds with the pack off are the same as those used for the pack on calculations as shown in figure 50. Stalling speeds are therefore the same for a given gross weight whether the pack is on or off. Stalling speeds are plotted versus gross weight in figure 94 for the gross weight range possible with the pack off.

RESTRICTED

FIG 9A


XC-120 ~ "PACK OFF"

POWER OFF STALLING SPEEDS AT SEA LEVEL

PART III-G

G. TAKE-OFF DISTANCE

Take-off distance over a 50 ft. obstacle was calculated for the airplane with the pack-off in the same manner as used for the pack-on. Available thrust versus airplane speed is still the same as that presented in figure 52. Ground run was determined for gross weights of 34,000, 44,000 and 54,000 lbs. by integrating the curves of V/a_h versus V as shown in figure 96. Transition distance was computed by the integration of the R/C versus a_v curves as shown in figure 97. These curves are based on the polar diagram for the airplane in the take-off configuration with the pack-off as plotted in figure 95. Because the airplane attains more than 50 ft. altitude during transition at all possible gross weights with the pack-off, vertical and horizontal distances are plotted against each other in figure 98 and the transition distance to 50 ft. altitude is read off this graph.

No jet assisted take-off calculations are made for the pack-off configuration. Since,

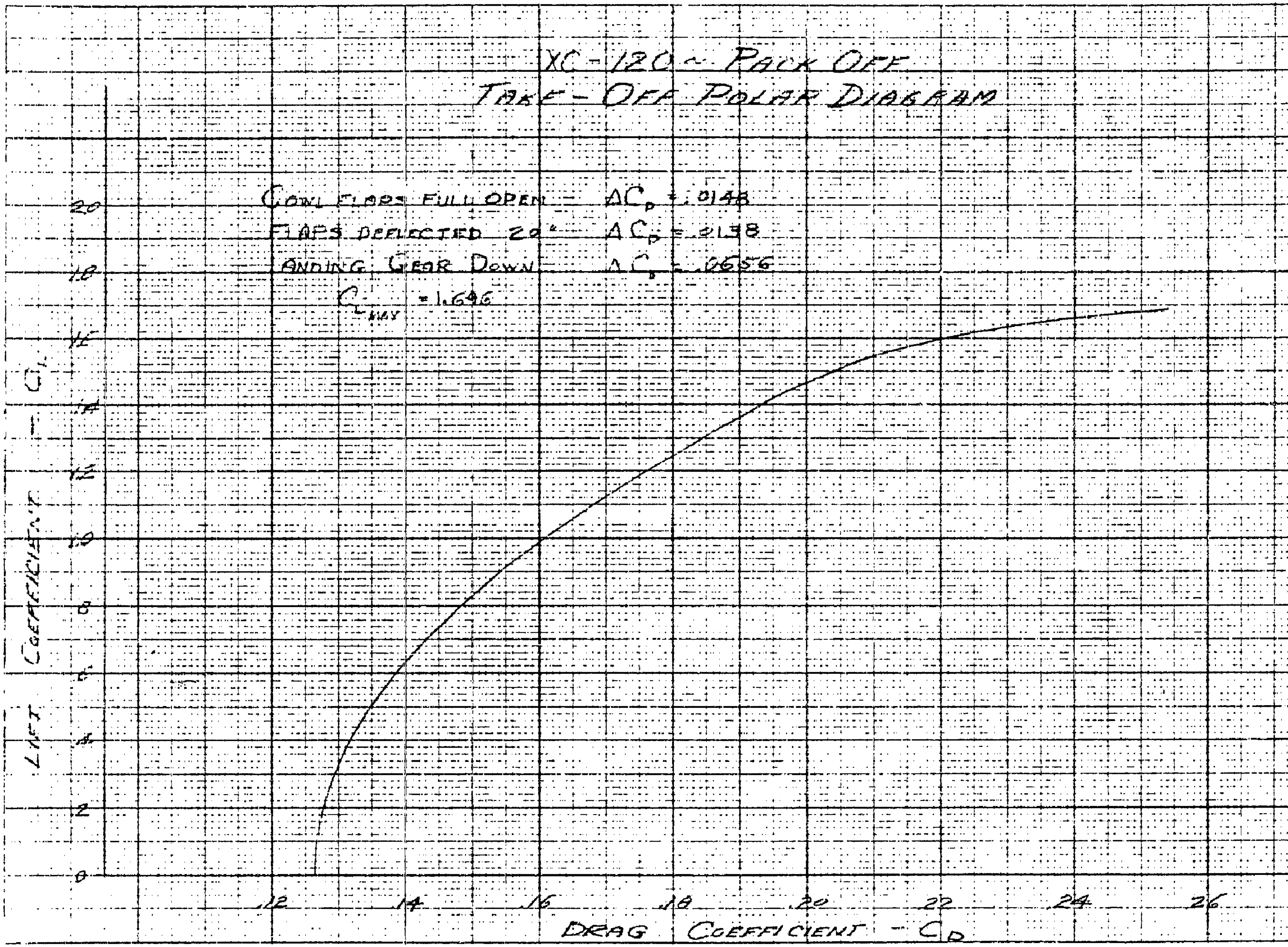
1. The take-off distances unassisted for the same gross weights pack-on and pack-off are so nearly the same that a good estimate of the effect of the jets can be had from the pack-on calculations.

2. At these low gross weights the take-off distances either pack-off or pack-on are already so short as to make the jet assist unnecessary.

Summary of Take-Off Distances - Pack-Off

Gross Weight	lbs.	34000	44000	54000
Ground Run	ft.	400	744	1244
Transition to 50 ft.	ft.	412	588	710
Total Over 50 ft.	ft.	812	1332	1954

Ground run and total take-off distance over a fifty foot obstacle are plotted versus gross weight in figures 99 and 100.

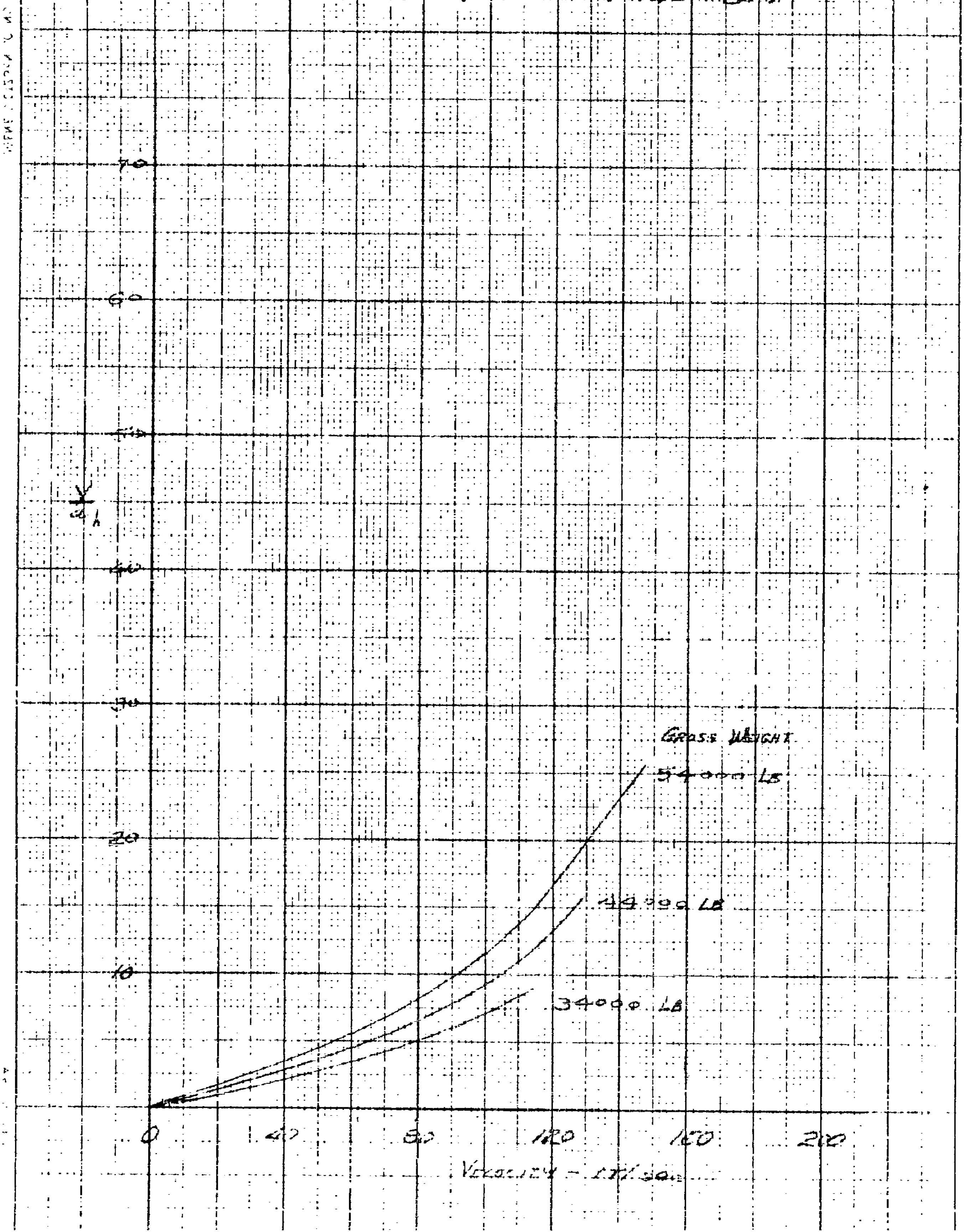

XC-120 ~ PACK OFF
TAKE-OFF POLAR DIAGRAM

COWL FLAPS FULL OPEN — $\Delta C_D = .0148$
FLAPS DEFLECTED 20° — $\Delta C_D = .0138$
LANDING GEAR DOWN — $\Delta C_D = .0656$
$C_{L_{MAX}} = 1.646$

FIG 95

FIG 96

XC-120 - TAKE OFF
GROUND RUN IN TAKE-OFF



RESTRICTED

FIG 97

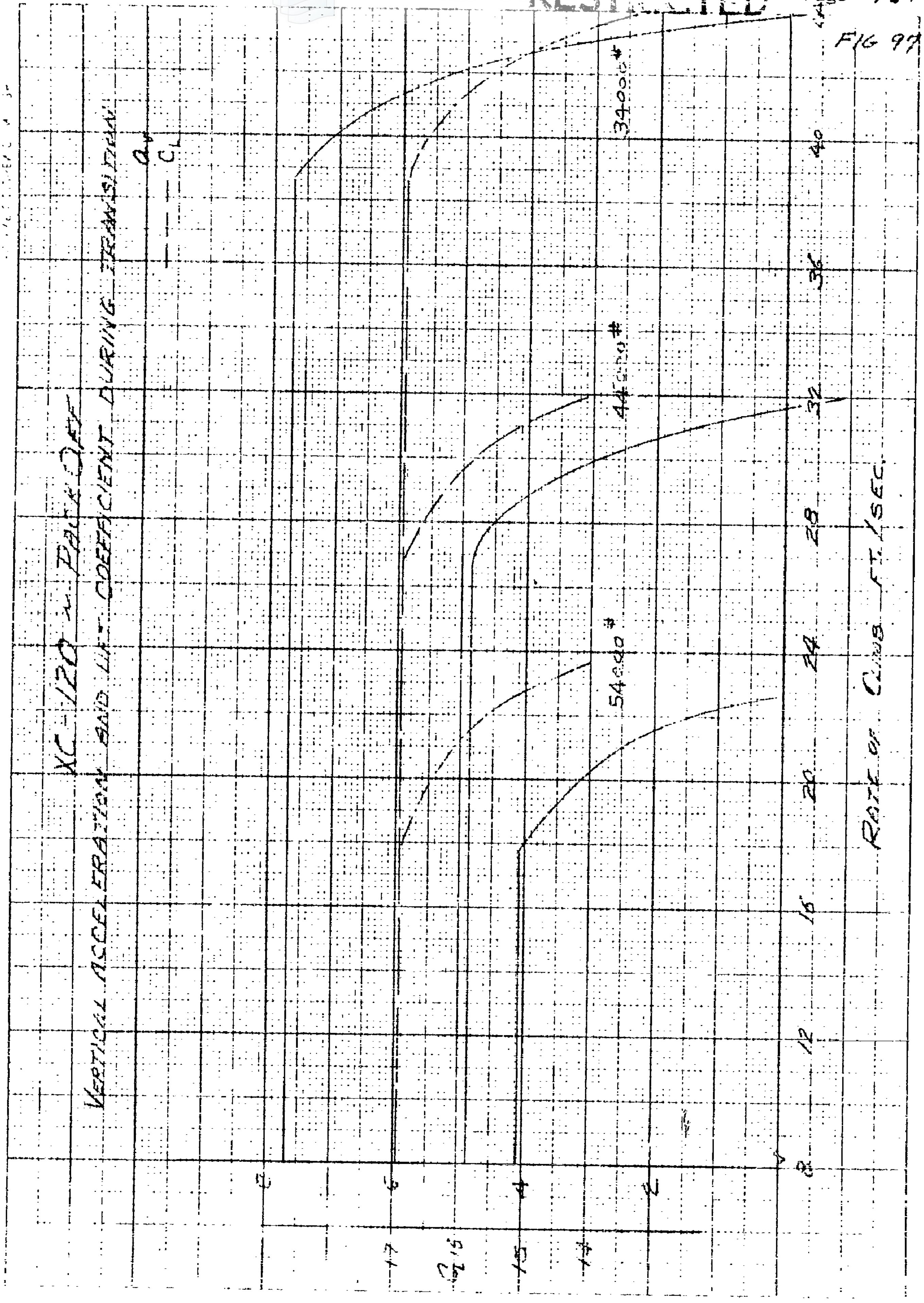
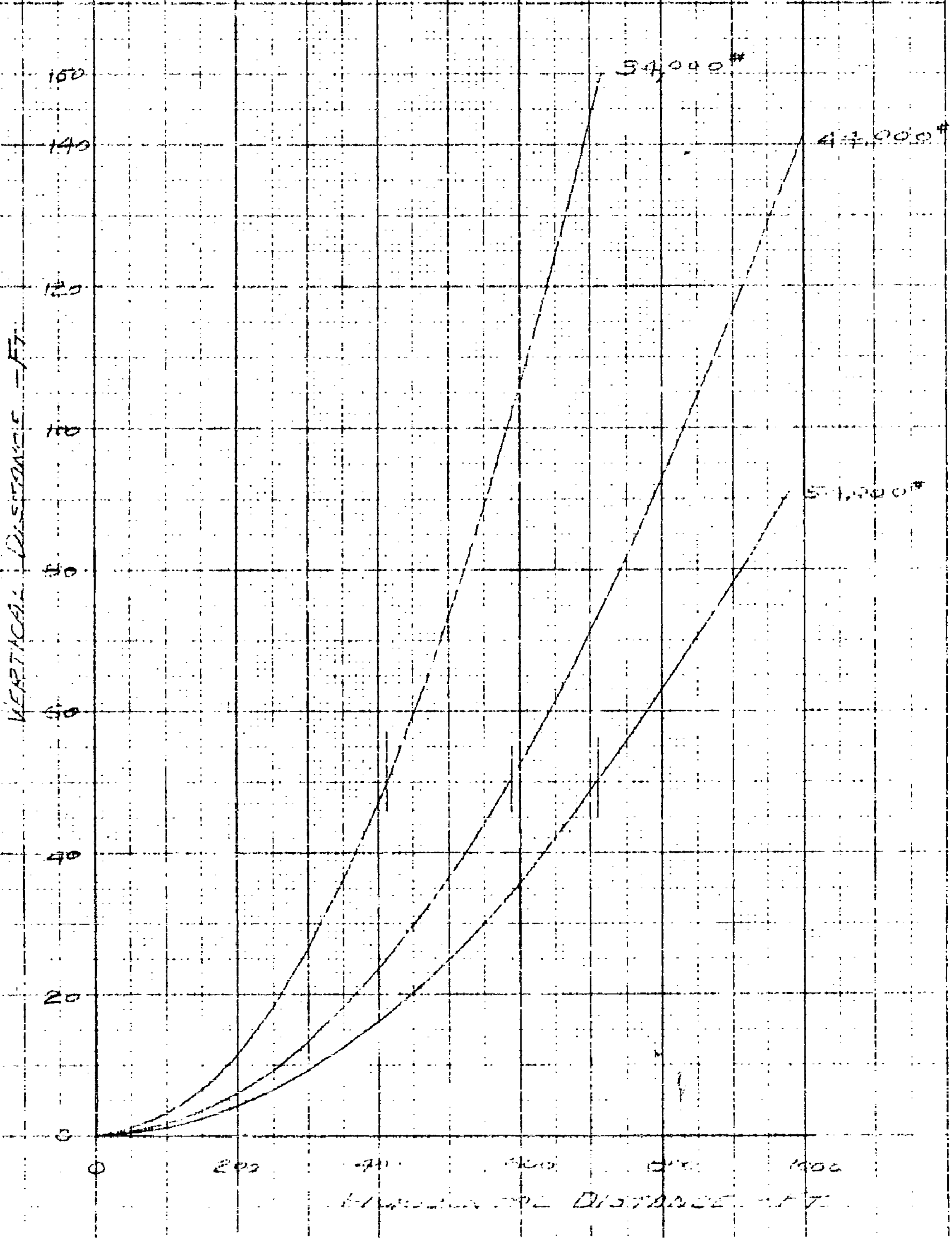


FIG 75

XC-120 ~ PACK OFF
TRANSITION PHASE IN TAKE OFF



RESTRICTED

FIG 99

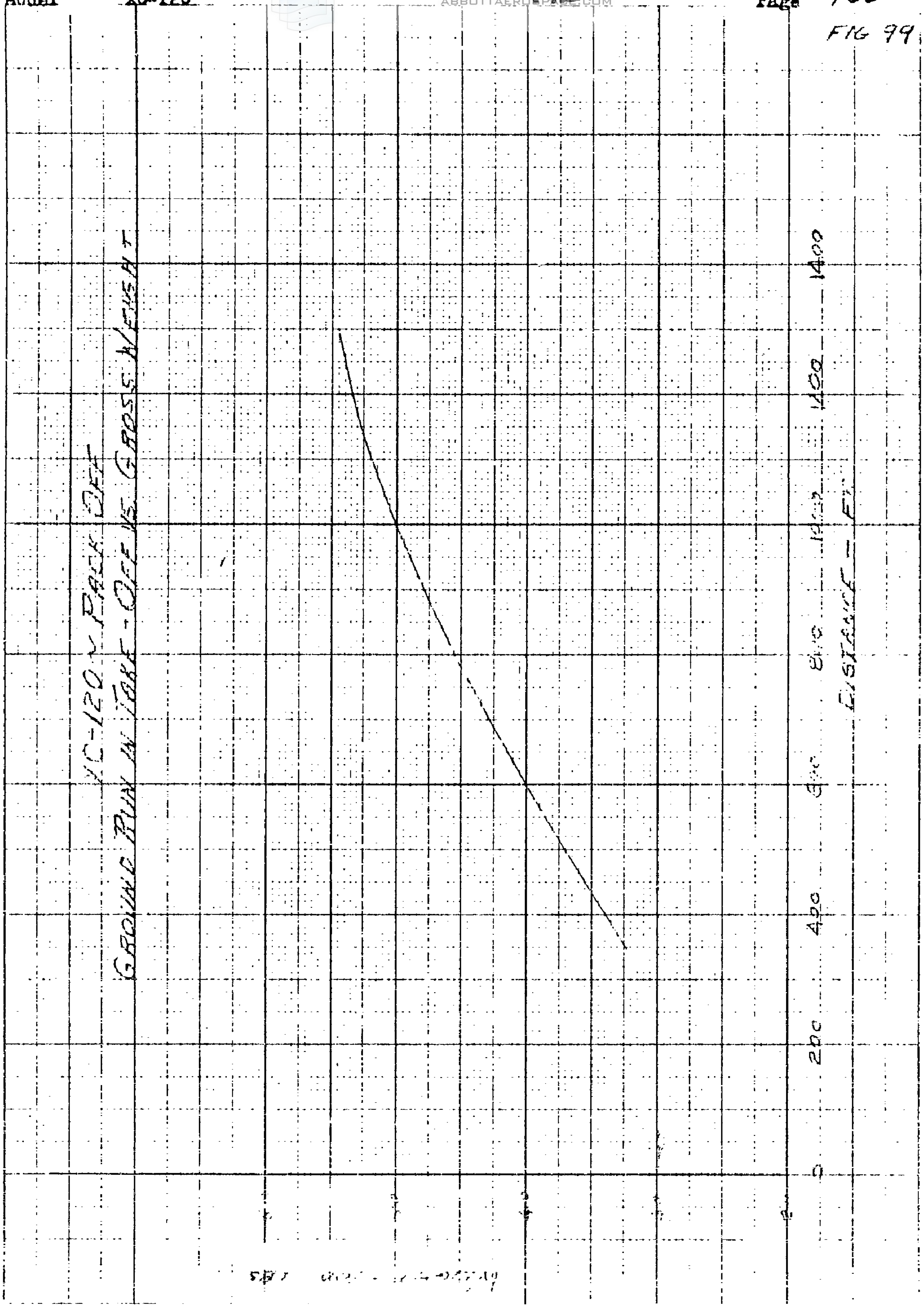
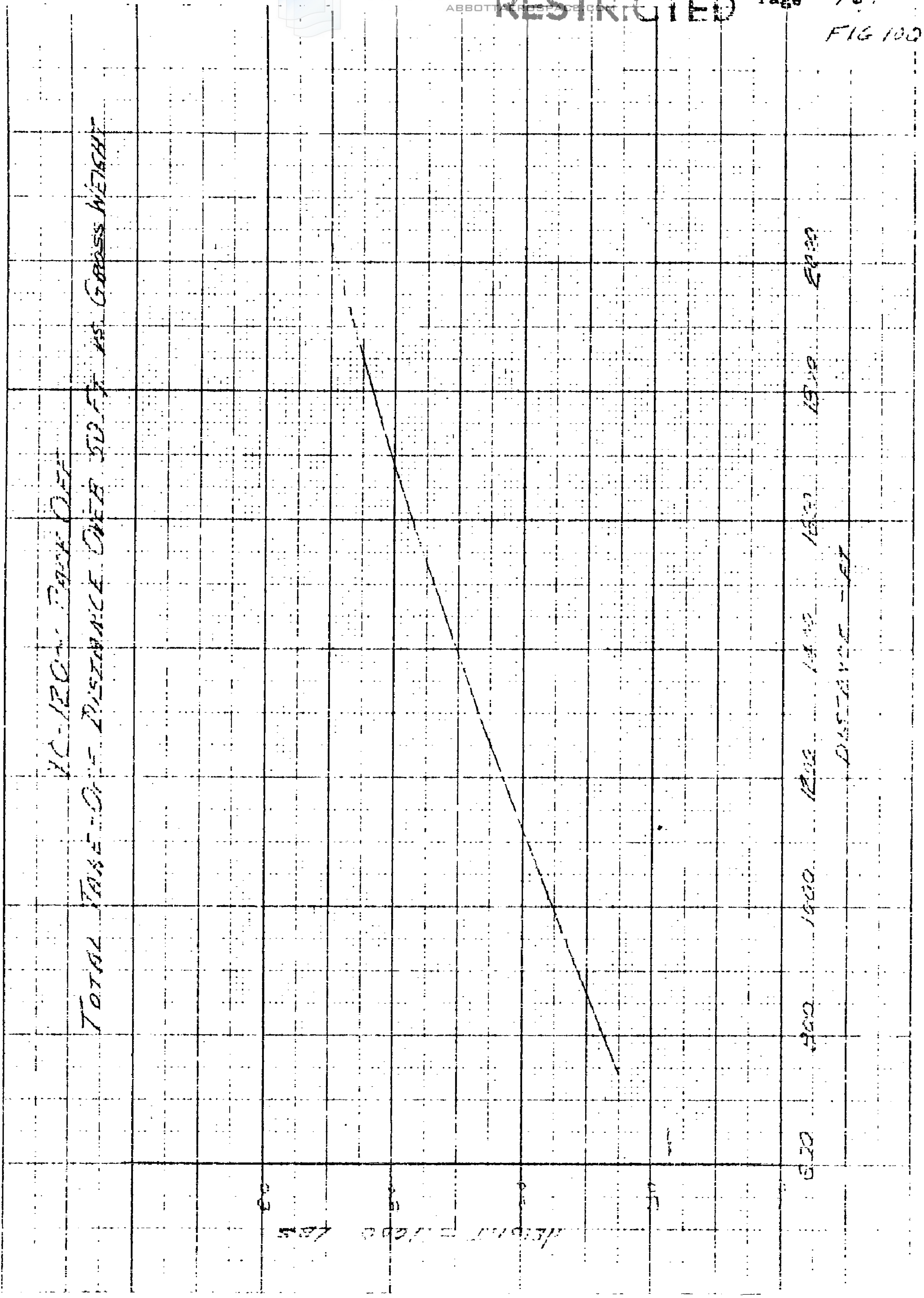


FIG 100


XC-120 - TAKE OFF
TOTAL TAKE-OFF DISTANCE OVER 50 FT. vs GROSS WEIGHT
600
800
1000
1200
1400
1600
1800
2000
DISTANCE - FT

PART III-H

H. LANDING DISTANCE

Landing distance over a 50 ft. obstacle was computed for the airplane with the pack-off at gross weights of 34,000, 44,000, and 54,000 lbs. by the same method as was used for the "pack-on" calculations. The effect of reverse thrust is again estimated to be a reduction of 40% in the ground run. On this basis the landing distances over a 50 ft. obstacle are tabulated below and graphed in figure 102 both with and without the effect of reverse thrust. All calculations are based on the polar diagram of figure 101.

Total Landing Distance Over 50 ft. Obstacle

1 - Without Reverse Thrust

Gross Weight	lbs.	34000	44000	54000
Gliding Distance	ft.	345	345	345
Transition Distance	ft.	248	320	393
Ground Run	ft.	735	952	1168
Total Over 50 ft.	ft.	1328	1617	1906

2 - With Reverse Thrust

Gross Weight	lbs.	34000	44000	54000
Gliding Distance	ft.	345	345	345
Transition Distance	ft.	248	320	393
Ground Run	ft.	441	571	701
Total Over 50 ft.	ft.	1034	1236	1439

FIG 101

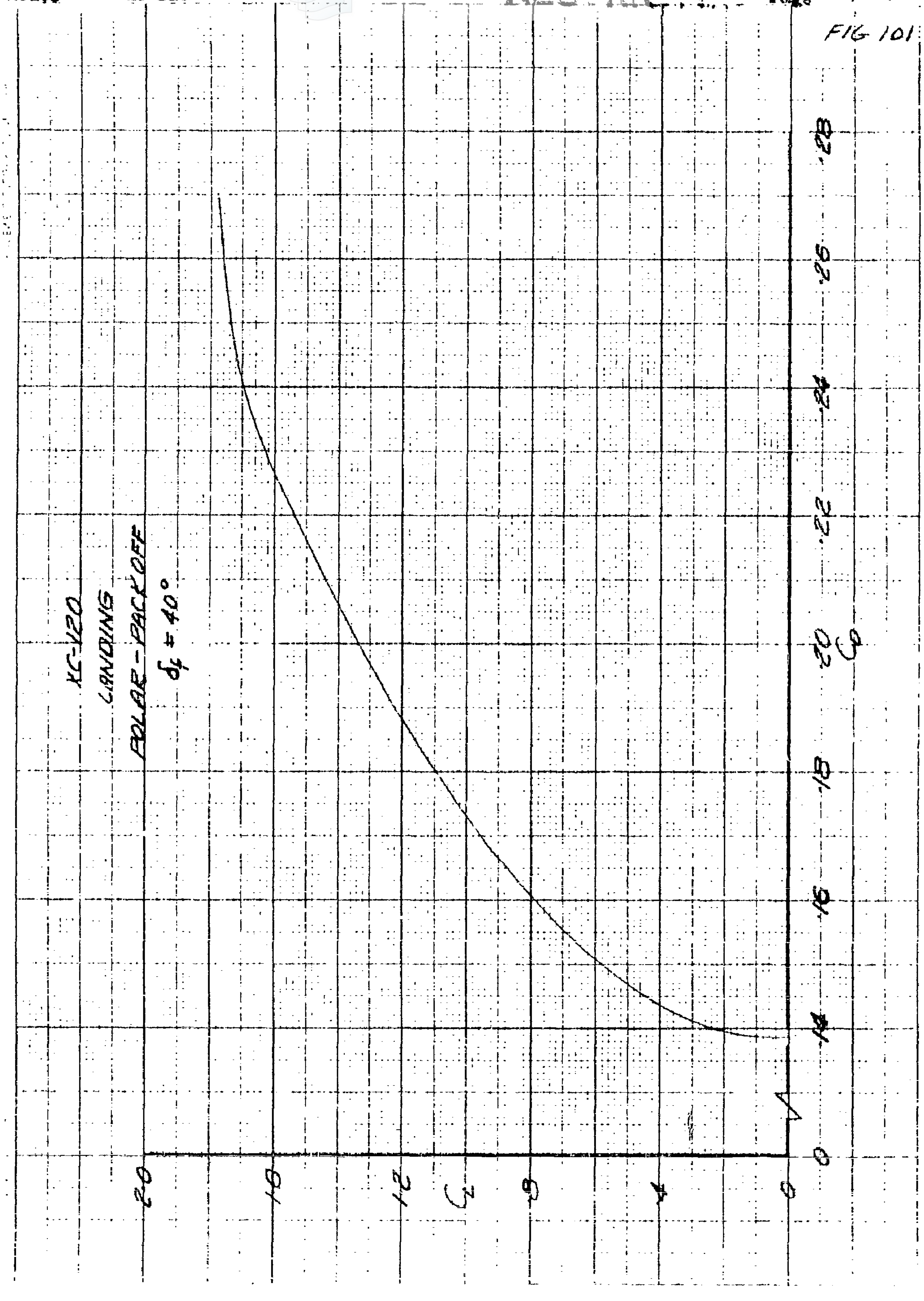
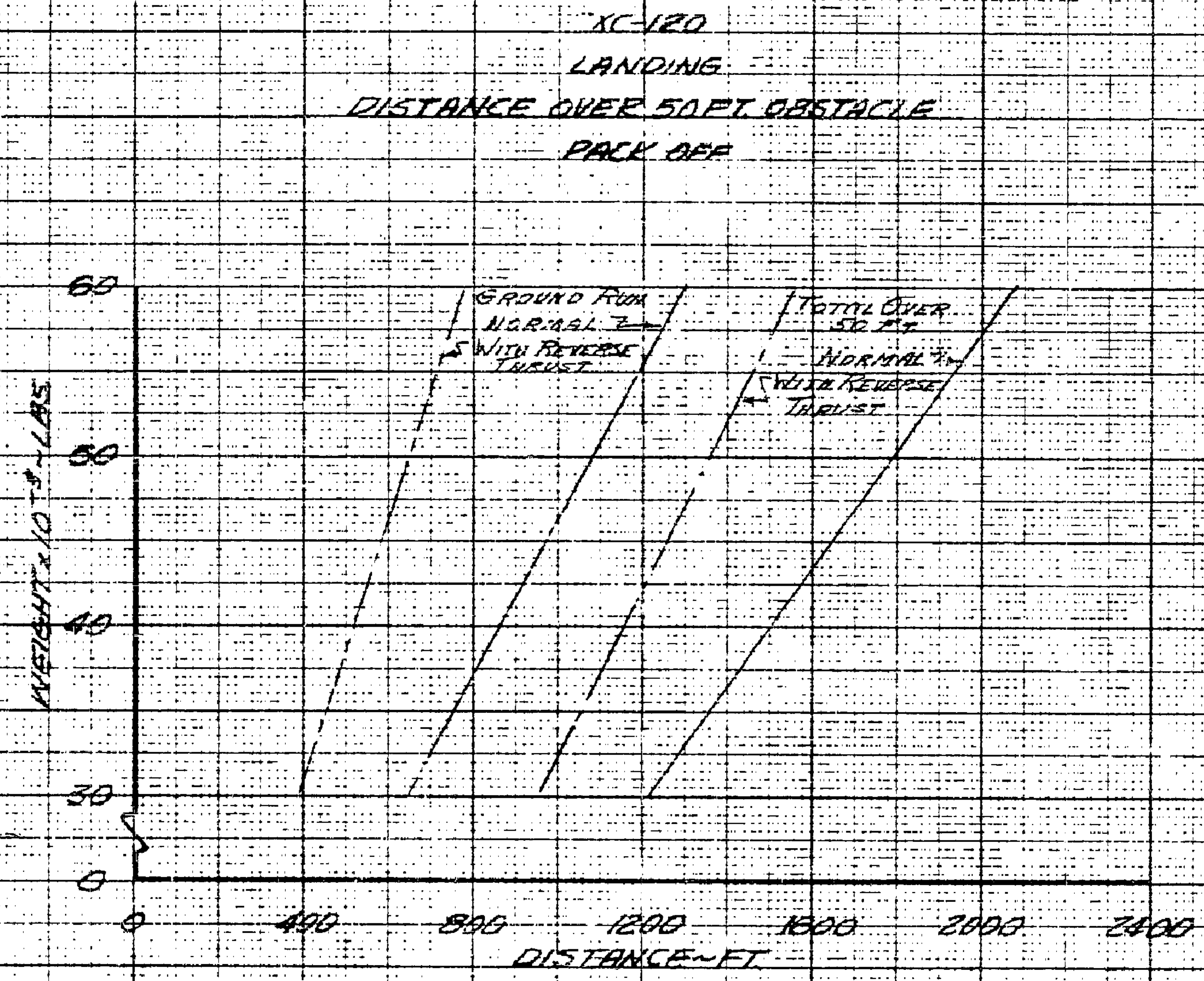

XC-120
LANDING
POLAR - PACK OFF
$\delta_f = 40°$
C_D
C_L
0
.14
.16
.18
.20
.22
.24
.26
.28
0
4
8
12
16
20

FIG 102


XC-120
LANDING
DISTANCE OVER 50 FT. OBSTACLE
PACK OFF
GROUND RUN
NORMAL
WITH REVERSE THRUST
TOTAL OVER 50 FT
NORMAL
WITH REVERSE THRUST
60
50
40
30
0
WEIGHT x 10⁻³ ~ LBS
0
400
800
1200
1600
2000
2400
DISTANCE~FT.

PART IV -

PERFORMANCE CALCULATIONS - COMBINATION CONFIGURATIONS

All calculations in this part of the report are for radius of action with pack-on for trip out and pack-off for return or vice versa.

PART IV - (Cont.)

SECTION A - GENERAL

Because of its unique design, the XC-120 is capable of some missions which are impossible with other aircraft. Like a trailer truck, the pack and carrier in combination can perform the following combat radius of action problems:

1. Pack and cargo out, drop pack and cargo, no pack back.
2. No pack out, pick up pack and cargo, pack and cargo back.

SECTION B - CRUISING CALCULATIONS

Computations for these two problems are made in the same manner and conform to the same general definition as was used in part II-E-3 for the pack-on missions. In this case, however, the mi./lb. and hr./lb. of figure 39 can only be used for the pack-on segment of the radius while the data of figure 87 must be used for the pack-off segment.

Combat radius and total time grids for these two problems are shown in figures 103 thru. 106.

XC-120

TAKE-OFF GROSS WEIGHT VS COMBAT RADIUS
WITH FUEL AND PAYLOAD PARAMETERS

FIG 103

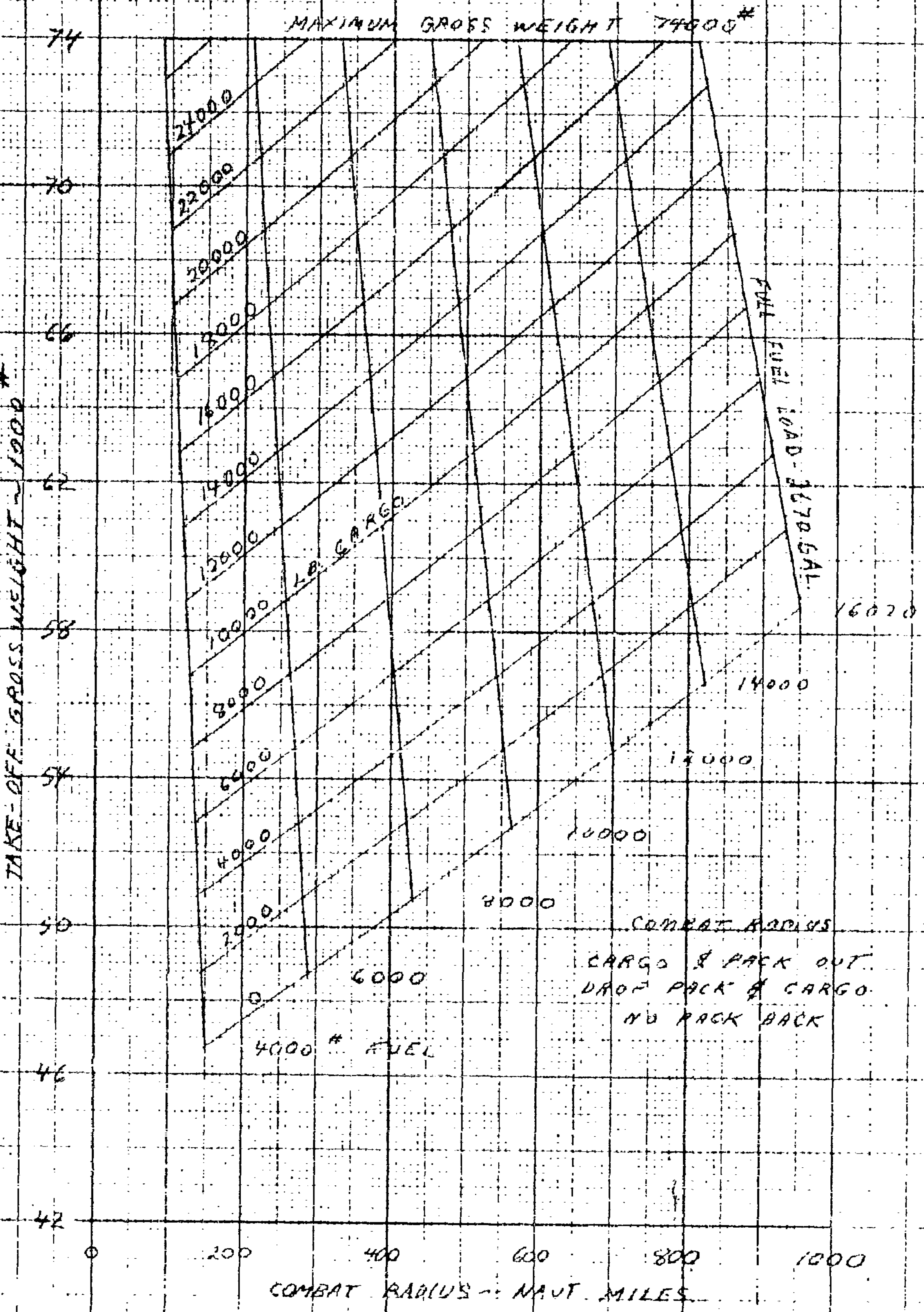
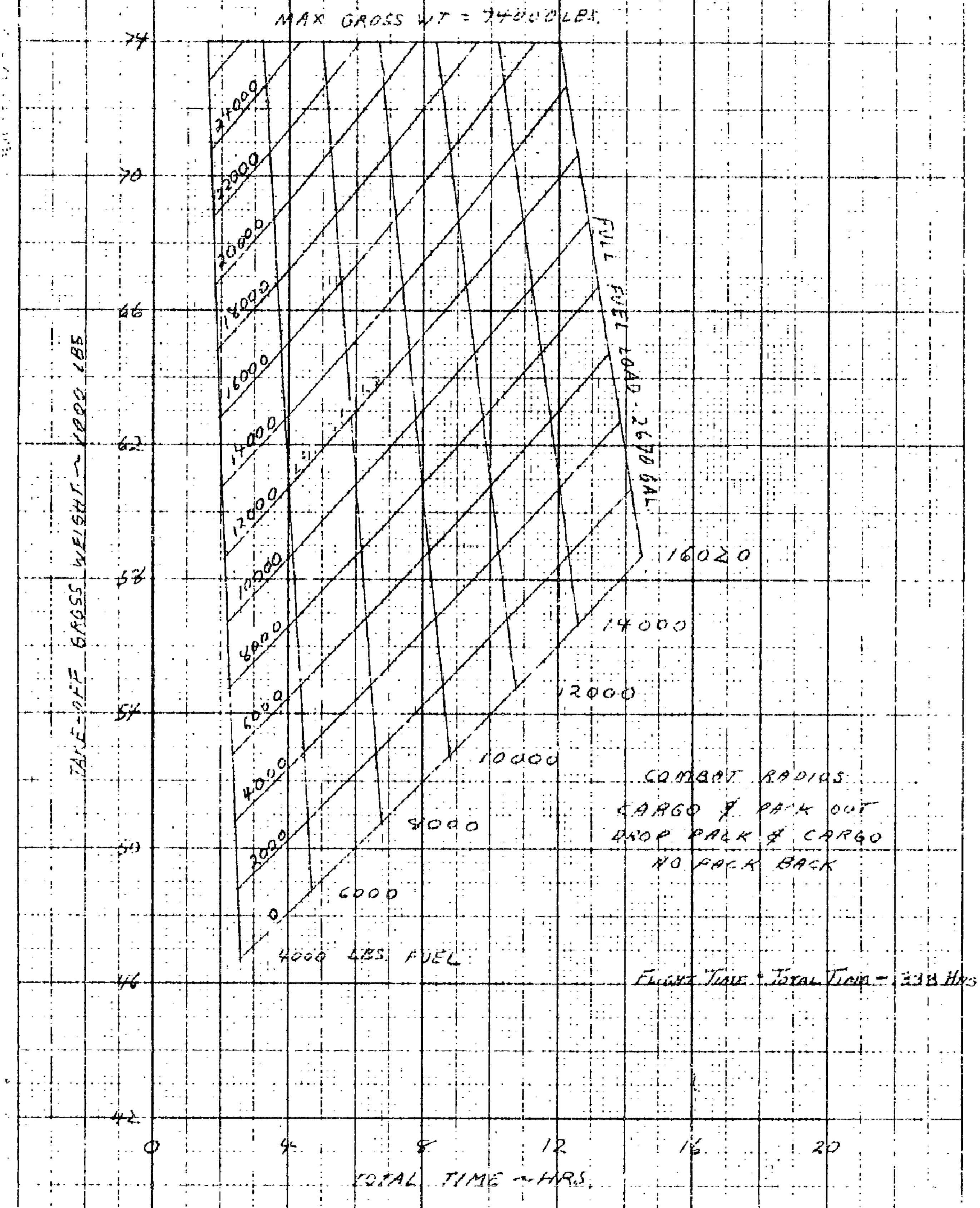


FIG 104

XC-120P

TAKE OFF GROSS WEIGHT, VS TOTAL TIME WITH FUEL AND PAYLOAD PARAMETERS



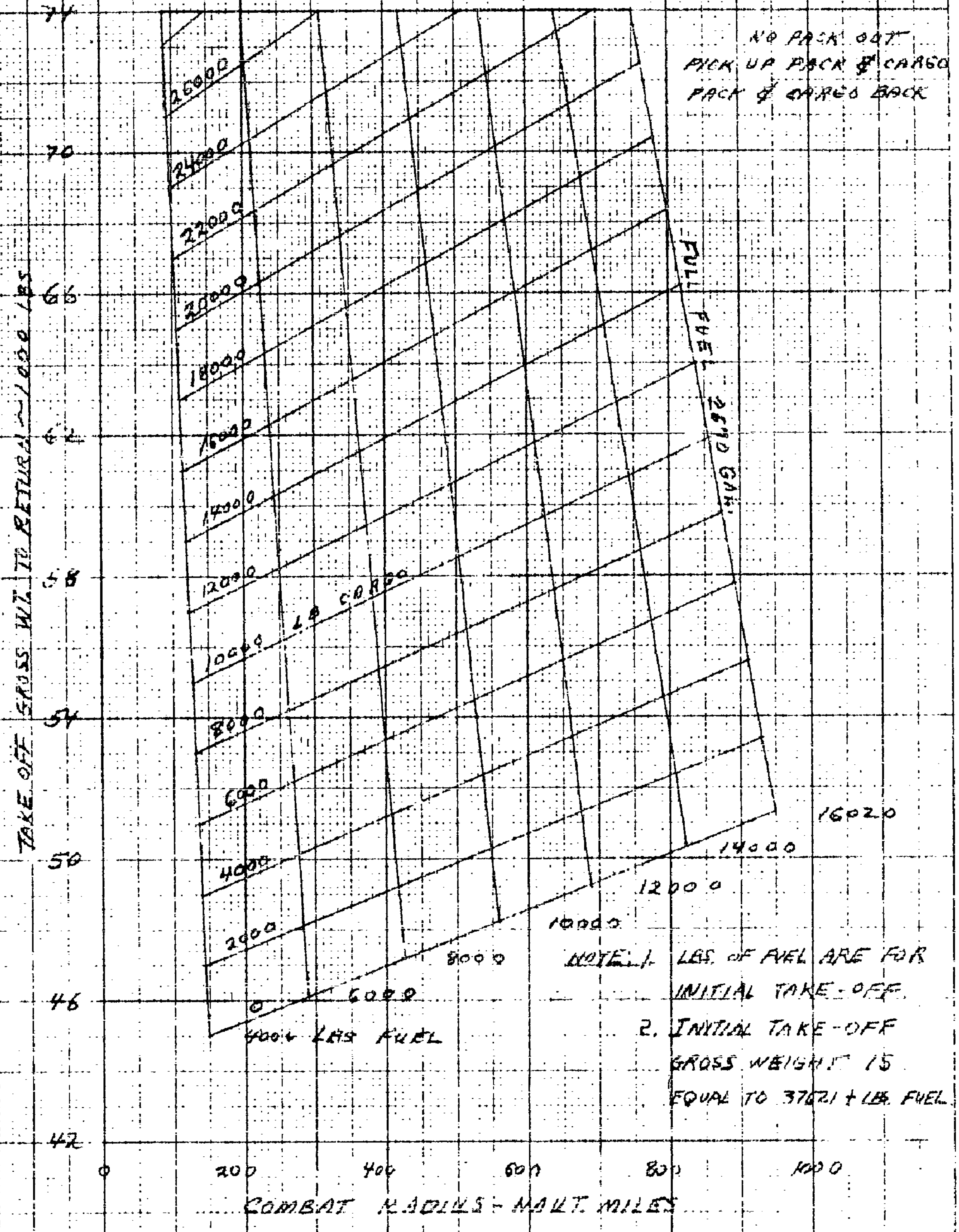
COMBAT RADIUS
CARGO & PACK OUT
DROP PACK & CARGO
NO PACK BACK

Flight Time = Total Time − .338 Hrs

XC-120

TAKE OFF GROSS WEIGHT VS COMBAT RADIUS
WITH FUEL AND CARGO PARAMETERS

FIG 105



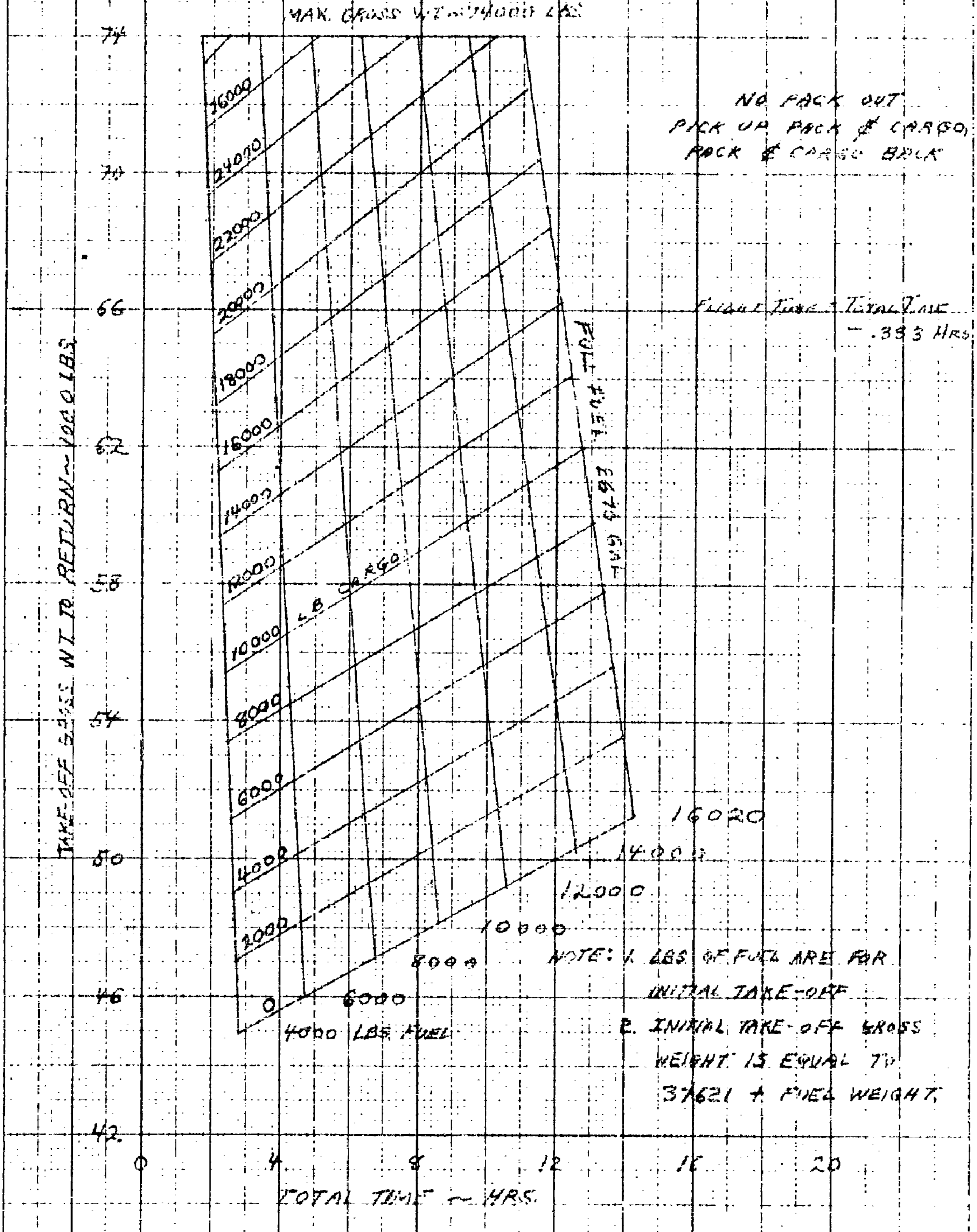
NOTE: 1. LBS. OF FUEL ARE FOR INITIAL TAKE-OFF.

2. INITIAL TAKE-OFF GROSS WEIGHT IS EQUAL TO 37621 + LBS. FUEL.

XC-120

FIG-106

TAKE-OFF GROSS WEIGHT VS TOTAL TIME
WITH FUEL AND CARGO PARAMETERS



NO PACK OUT
PICK UP PACK & CARGO
PACK & CARGO BACK

FLIGHT TIME = TOTAL TIME
− .333 HRS

NOTE: 1. LBS OF FUEL ARE FOR
INITIAL TAKE-OFF
2. INITIAL TAKE-OFF GROSS
WEIGHT IS EQUAL TO
37621 + FUEL WEIGHT.

REFERENCES

(a) Pratt & Whitney Specification N-7056, Model R4360-20, dated 17 December 1946.

(b) NACA Advance Restricted Report 3I25, "Representative Operating Charts of Propellers Tested in the NACA 20-ft. Propeller Research Tunnel", by Gray and Mastrocola, dated September 1943.

(c) Hamilton Standard Method of Propeller Performance Calculations, dated 1941.

(d) Fairchild Engineering Report R110-011, "Performance Calculations Model C-119B", dated 8 May 1948.

(e) Fairchild Engineering Report R107-012, "Basic Aerodynamic Data", dated 9 July 1948.

(f) Preliminary Data from Tests of the 1/32 Scale Model of the XC-120 Airplane in the Wright Field 5-Foot Tunnel.

(g) NACA Confidential Memorandum Report, "Wind Tunnel Tests of the 1/14 Scale Powered Model of the Fairchild XC-82 Airplane, IV Lateral Stability and Control", by Crandall and Weil, dated 11 August 1943.

(h) Army Handbook of Instructions for Airplane Designers - 8th. Edition, Volume I, Revision 7, dated November 1943.

(i) AAF Exhibit REOA9-4, "Standard Aircraft Characteristics Charts, Preparation of", dated 25 September 1948.

ENGINEERING REPORT NO.

R107-016

SUBJECT

PERFORMANCE CALCULATIONS

MODEL: XC-120 (M-107)

FAIRCHILD AIRCRAFT
Division of
FAIRCHILD ENGINE & AIRPLANE CORPORATION
HAGERSTOWN, MARYLAND

Date: 9 March 1949

No. Pages: 177, a, b,

Prepared By *W. F. Everett*
W. F. Everett

Approved and Checked By *E E Morton*
E. E. Morton

Approved By
A. J. Thieblot
Chief Engineer

REVISIONS

Date	Pages Affected	By	Remarks
9/25/50	Table of Contents page b	GTG	
	Addendum - Appendix I -		
	pages 178 thru 208		

Form FA 23

TABLE OF CONTENTS (Cont.)

APPENDIX I –

APPENDIX I -

PART I-A

A. INTRODUCTION

It is the purpose of this Appendix to present additional performance information necessary to substantiate the XC-120 Standard Aircraft Characteristics Charts in accordance with the requirements of reference (App. I-1).

Two sets of characteristics charts have been prepared by Fairchild Aircraft for the XC-120 airplane. Reference (App.I-2) was based on the estimated fuel capacity of 2670 gallons and all fuel consumptions were 15% conservative. No substantiating calculations (based on the original performance report of which this Appendix is a part) were presented. The revised characteristics are based on an actual weighed airplane, the use of bladder tanks with a capacity of 2798 gallons, and a conservative factor of 5% as a service tolerance to allow for practical operation.

APPENDIX I -

PART I-B

B. PERFORMANCE SUMMARY

Performance as presented herein is the same as that of reference (App. I-3).

PERFORMANCE SUMMARY

CONDITIONS			BASIC		MAX. FUEL		FERRY RANGE	
			RADIUS I	RANGE II	RADIUS III	RANGE IV	PACK ON V	PACK OFF VI
Take-Off Weight,		lb	70,700	70,700	70,700	70,700	61,401	56,299
Fuel at 6 lb/gal		lb	13,407	13,407	16,788	16,788	16,788	16,788
Load (Cargo)		lb	12,680(6)	12,680	9299	9299	0	0
Wing Loading		lbs/sq ft	48.85	48.85	48.85	48.85	42.43	38.90
Stall Speed (Power Off)		kn	90	90	90	90	83.8	80.3
Take-Off Ground Run at S.L.	(1)(4)	ft	2580	2580	2580	2580	1740	1470
Take-Off to Clear 50'	(1)(4)	ft	3600	3600	3600	3600	2560	2150
Rate of Climb at S.L.	(3)	fpm	890	890	890	890	1190	1450
Time: S.L. to 10,000'	(3)	min	12.3	12.3	12.3	12.3	9.0	7.2
Service Ceiling (100 fpm)	(3)	ft	21,700	21,700	21,700	21,700	24,500	26,950
Service Ceiling (One Engine Out)	(2)	ft	S.L.	S.L.	S.L.	S.L.	6250	-
COMBAT RANGE	(5)	n mi	-	1270	-	1645	1950	2400
Avg. Cruising Speed		kn	-	143	-	142	133	135
Cruising Altitude		ft	-	10,000	-	10,000	10,000	10,000
Total Mission Time		hr	-	9.04	-	11.77	14.85	17.99
COMBAT RADIUS	(5)	n mi	750	-	975	-	-	-
Avg. Cruising Speed		kn	136	-	136	-	-	-
Cruising Altitude		ft	10,000	-	10,000	-	-	-
Total Mission Time		hr	11.34	-	14.74	-	-	-
FIRST LANDING WEIGHT	(7)	lb	62,930	58,560	60,920	55,330	46,290	41,190
Ground Roll at S.L.	(4)(8)	ft	1340	1240	1295	1180	982	885
Total from 50'	(4)(8)	ft	2120	2000	2065	1905	1650	1535
COMBAT WEIGHT	(7)	lb	45,150	58,560	46,520	55,330	46,290	41,190
Combat Altitude		ft	10,000	10,000	10,000	10,000	10,000	10,000
Combat Speed	(2)	kn	231	215	230	216	218	232
Combat Climb	(2)	fpm	1950	1210	1870	1340	1880	2210
Combat Ceiling (500 fpm)	(2)	ft	27,350	21,250	26,900	22,450	25,950	28,800
Service Ceiling (100 fpm)	(3)	ft	30,100	25,350	29,700	26,300	29,050	31,200
Service Ceiling (one engine out)	(3)	ft	-	6380	-	3450	18,280	-
Take-Off Ground Run at S.L.	(1)(4)	ft	790	1540	845	1335	860	610
Take-Off to Clear 50'	(1)(4)	ft	1400	2300	1485	2055	1470	1190
Rate of Climb at S.L.	(3)	fpm	1970	1290	1900	1410	1840	2220
Max. Speed at 17,000'	(2)	kn	238	221	238	223	226	240
LANDING WEIGHT	(7)	lb	40,180	58,560	40,350	55,330	46,290	41,190
Ground Roll at S.L.	(4)(8)	ft	865	1240	870	1180	980	885
Total from 50'	(4)(8)	ft	1510	2000	1510	1905	1650	1535

SEE NOTES ON NEXT PAGE

APPENDIX I -

PART I-B

NOTES:

(1) Take-off power
(2) Maximum power
(3) Normal power
(4) Take-off and landing distances are obtainable at sea level using normal technique. For airport planning add 25% to distances shown.
(5) Detailed descriptions of the RADIUS & RANGE Missions are given below.
(6) Maximum cargo for 750 N. Mi. radius.
(7) For radius if radius mission is shown.
(8) Without reverse thrust

CONDITIONS:

(a) Performance basis: estimated data.
(b) In computing RADIUS & RANGE, specific fuel consumptions have been increased 5% to allow for variations in fuel flow in service aircraft.
(c) Performance is based on powers shown in reference (4).

RADIUS: Missions I & III

Warm-up and take-off, climb to 10,000 feet cruising altitude at normal power, cruise out at long range speeds, land and detach cargo pack. Without refueling, warm-up and take-off, climb to 10,000 ft. altitude at normal power, cruise back at long range speeds. Range free allowances: 20 minutes at normal power for warm-up and take-offs, 5% initial fuel for endurance and landing reserve.

RANGE: Missions II, IV, V, & VI

Warm-up and take-off, climb to 10,000 feet cruising altitude at normal power. Cruise out at long range speeds (one way flight only). Range free allowances: 10 minutes at normal power for warm-up and take-off, 10% of initial fuel for endurance and landing reserve.

NOTICE: Range missions II, IV & V: The "Pack" is carried the entire distance and the performance figures shown are for the "Pack-On" configuration. Range mission VI is "Pack-Off" all the way.

APPENDIX I -

PART II-A

II. CALCULATIONS

A. THRUST HORSEPOWER AVAILABLE

All power available calculations were made using the same methods previously presented in Part II-A of the basic report.

B. THRUST HORSEPOWER REQUIRED

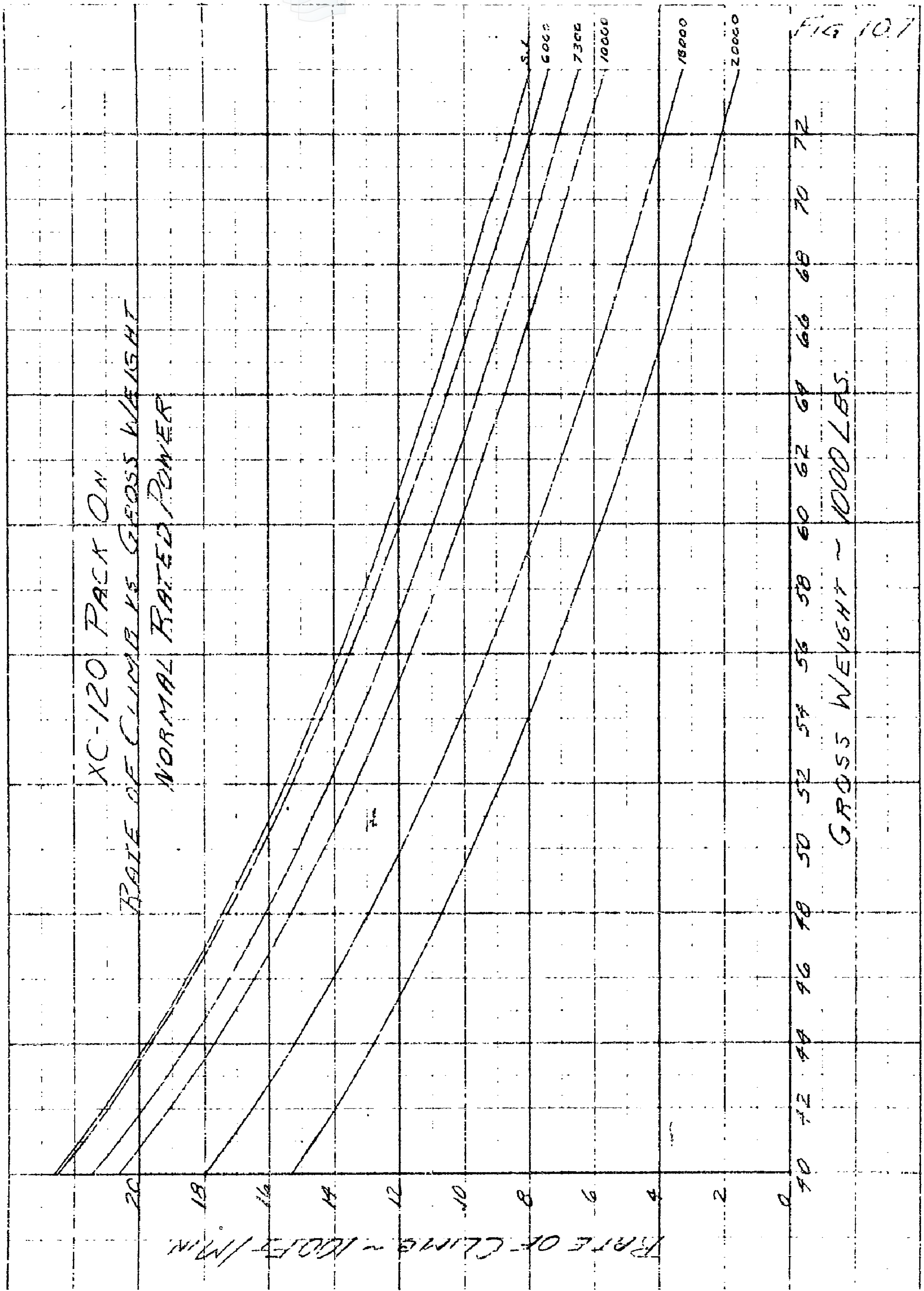
All power required calculations were made using the same methods previously described in Part II-B of the basic report.

C. CLIMB AND CEILING CALCULATIONS

The data of figures 22, 24, 78 & 79 of the basic report have been cross plotted against gross weight for use in the preparation of reference (App. I-3). Plots of rate-of-climb vs gross weight, normal and military power, pack-off and pack-on are plotted in figures 107, 108, 109, and 110. Figure 111 is a plot of time to climb at normal rated power pack-on at 10,000 ft. for use in reference (App. I-3).

All other data used in reference (App. I-3) can be obtained from the main body of the report.

FIG 107



XC-120 PACK ON
RATE OF CLIMB VS GROSS WEIGHT
NORMAL RATED POWER

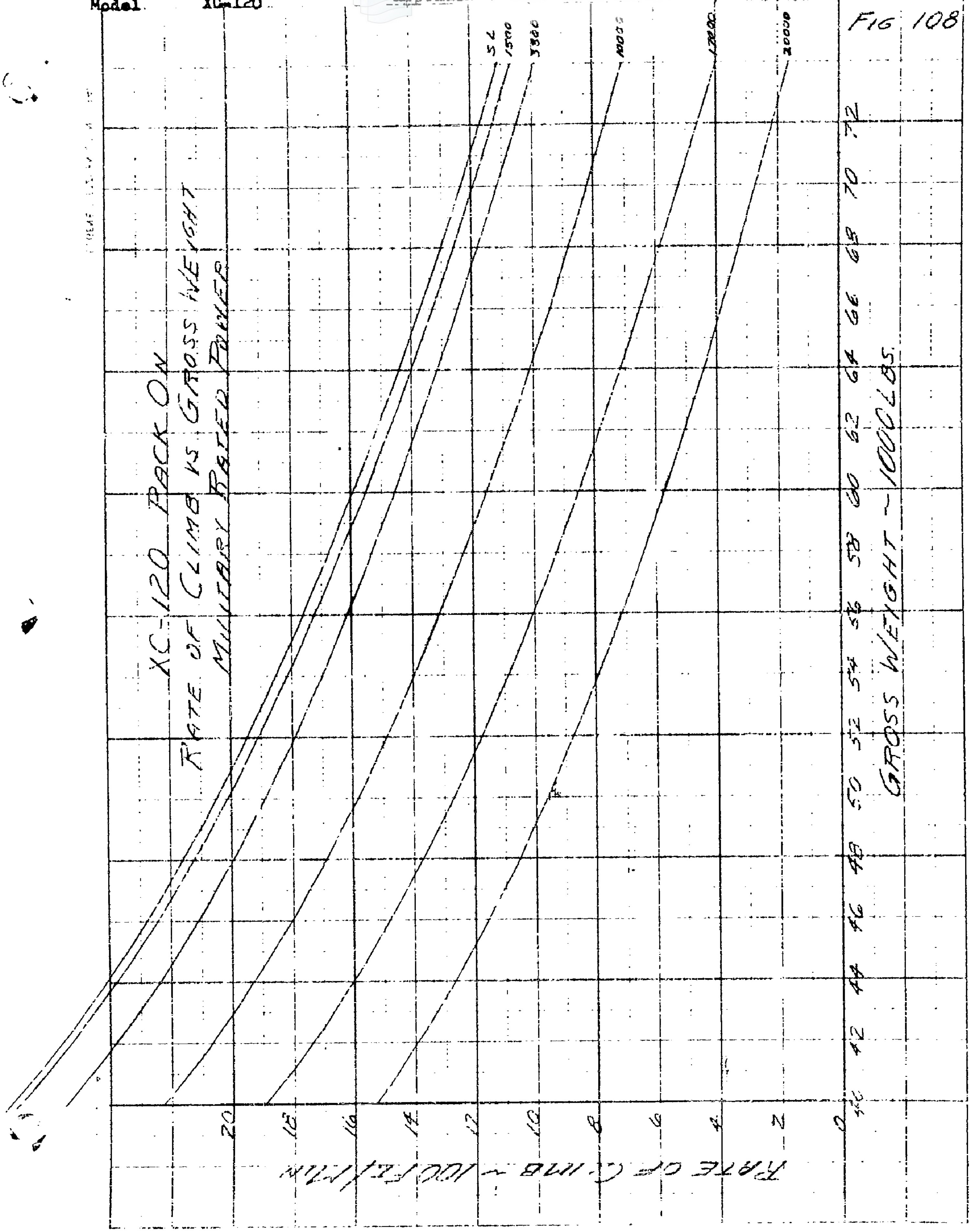


FIG 108
XC-120 PACK ON
RATE OF CLIMB VS GROSS WEIGHT
MILITARY RATED POWER
SL
1500
5000
10000
15000
20000
40
42
44
46
48
50
52
54
56
58
60
62
64
66
68
70
72
GROSS WEIGHT ~ 1000 LBS.
0
2
4
6
8
10
12
14
16
18
20
RATE OF CLIMB ~ 100 FT/MIN

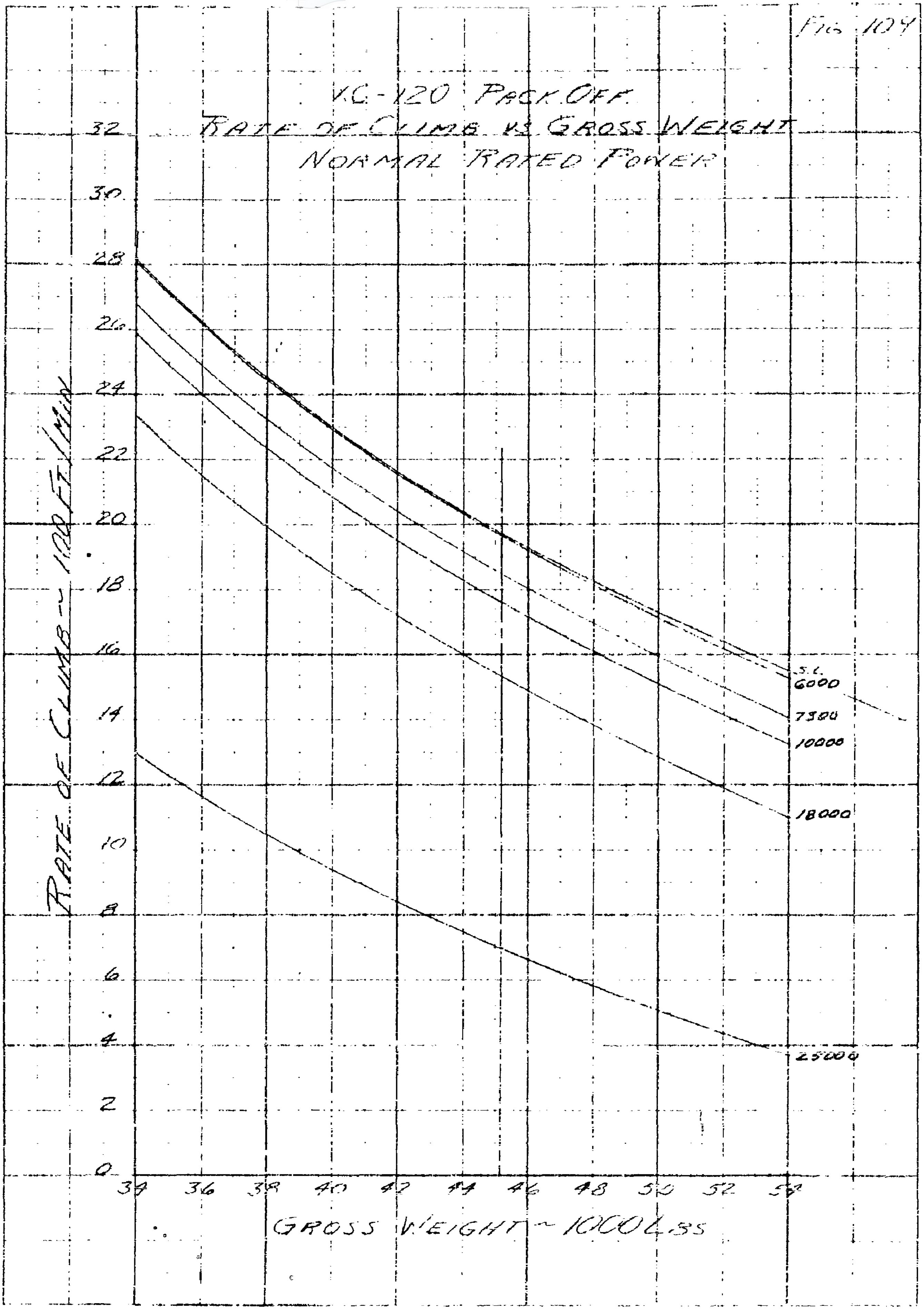


FIG 104

XC-120 PACK OFF
RATE OF CLIMB VS GROSS WEIGHT
NORMAL RATED POWER

Fig. 11C

XC-120 PACK OFF
RATE OF CLIMB VS. GROSS WEIGHT
MILITARY RATED POWER

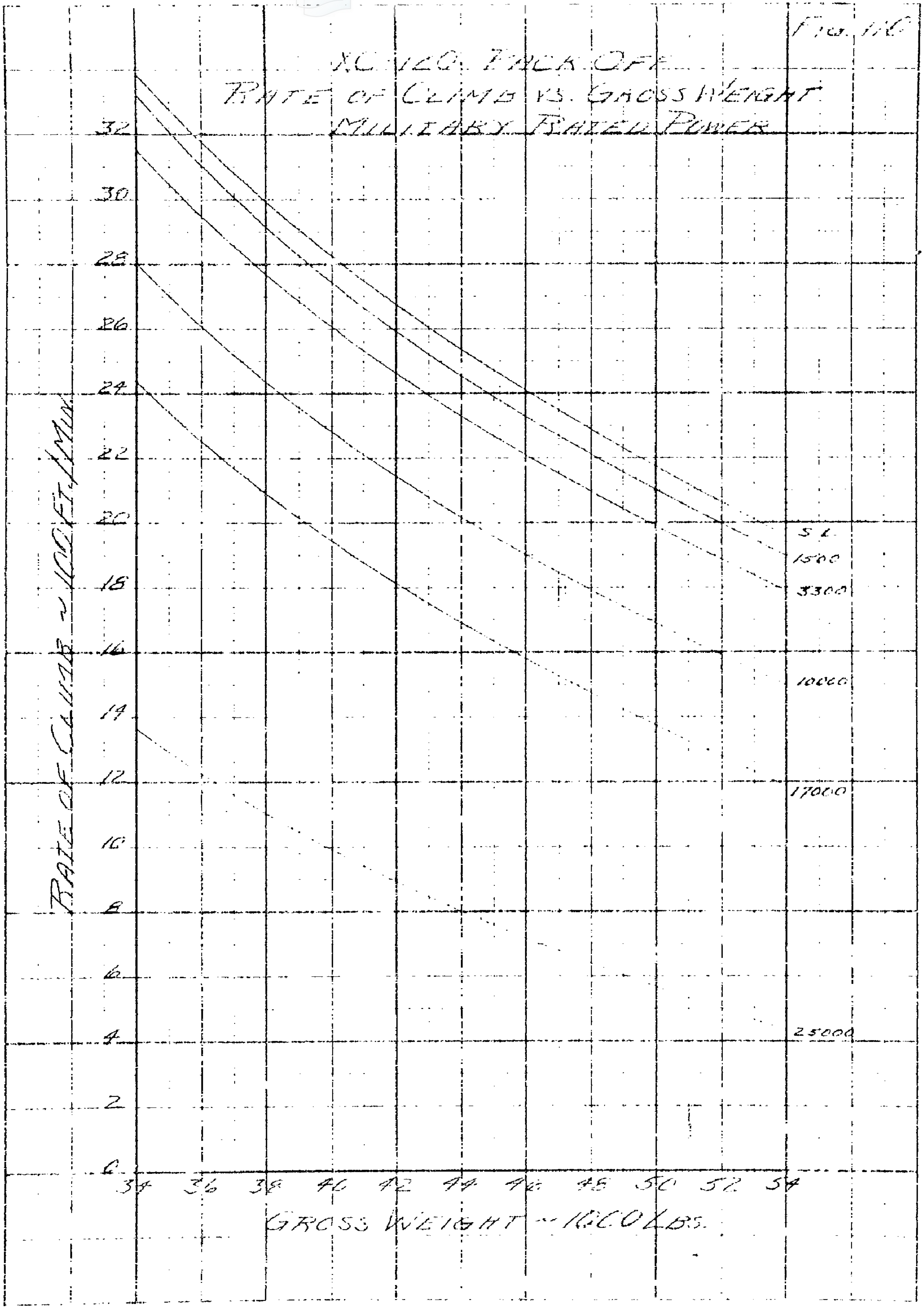
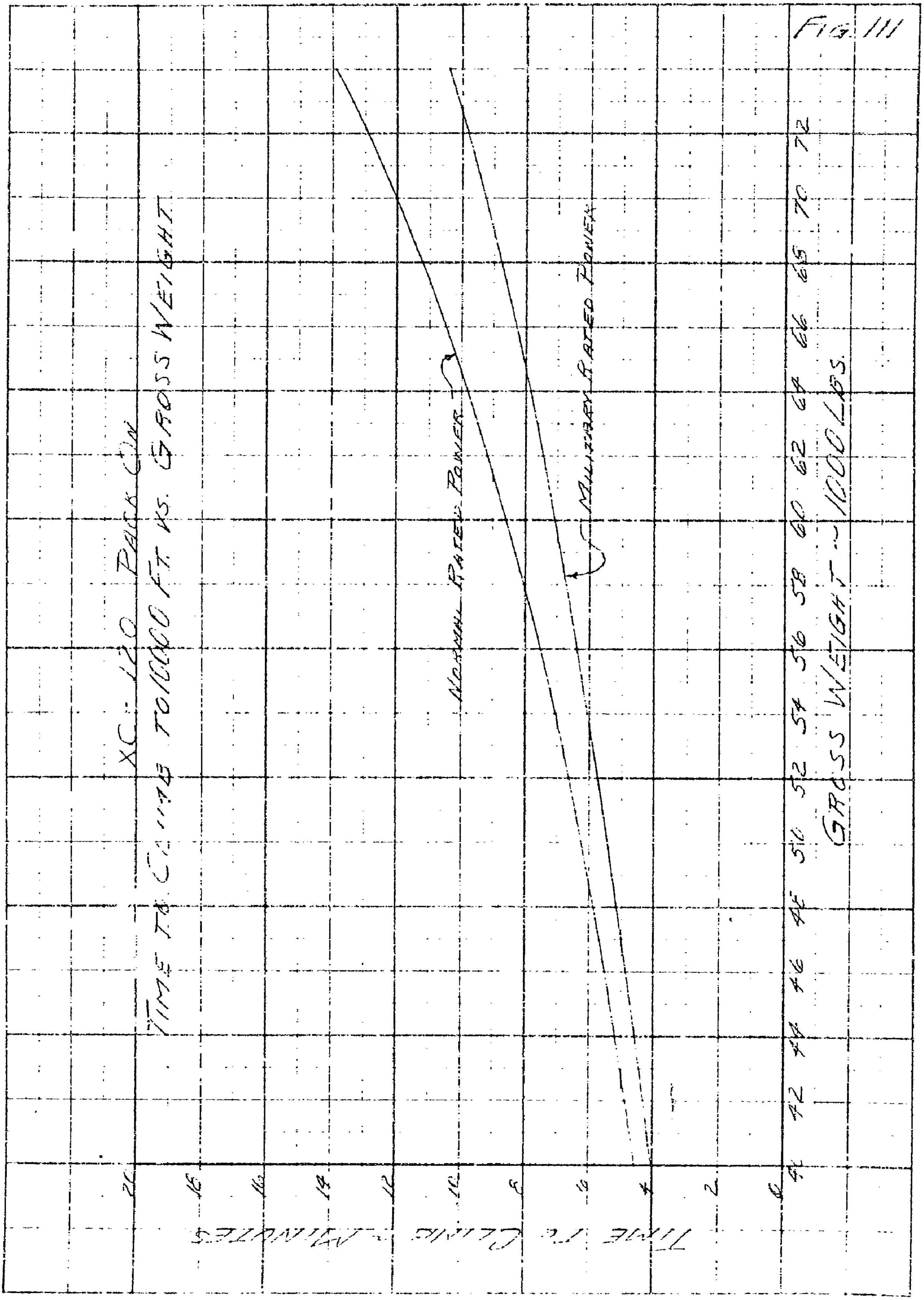


FIG. 111


XC-120 PACK ON
TIME TO CLIMB TO 10000 FT. VS. GROSS WEIGHT
NORMAL RATED POWER
MILITARY RATED POWER
GROSS WEIGHT ~ 1000 LBS.
TIME TO CLIMB ~ MINUTES
40
42
44
46
48
50
52
54
56
58
60
62
64
66
68
70
72
0
2
4
6
8
10
12
14
16
18
20

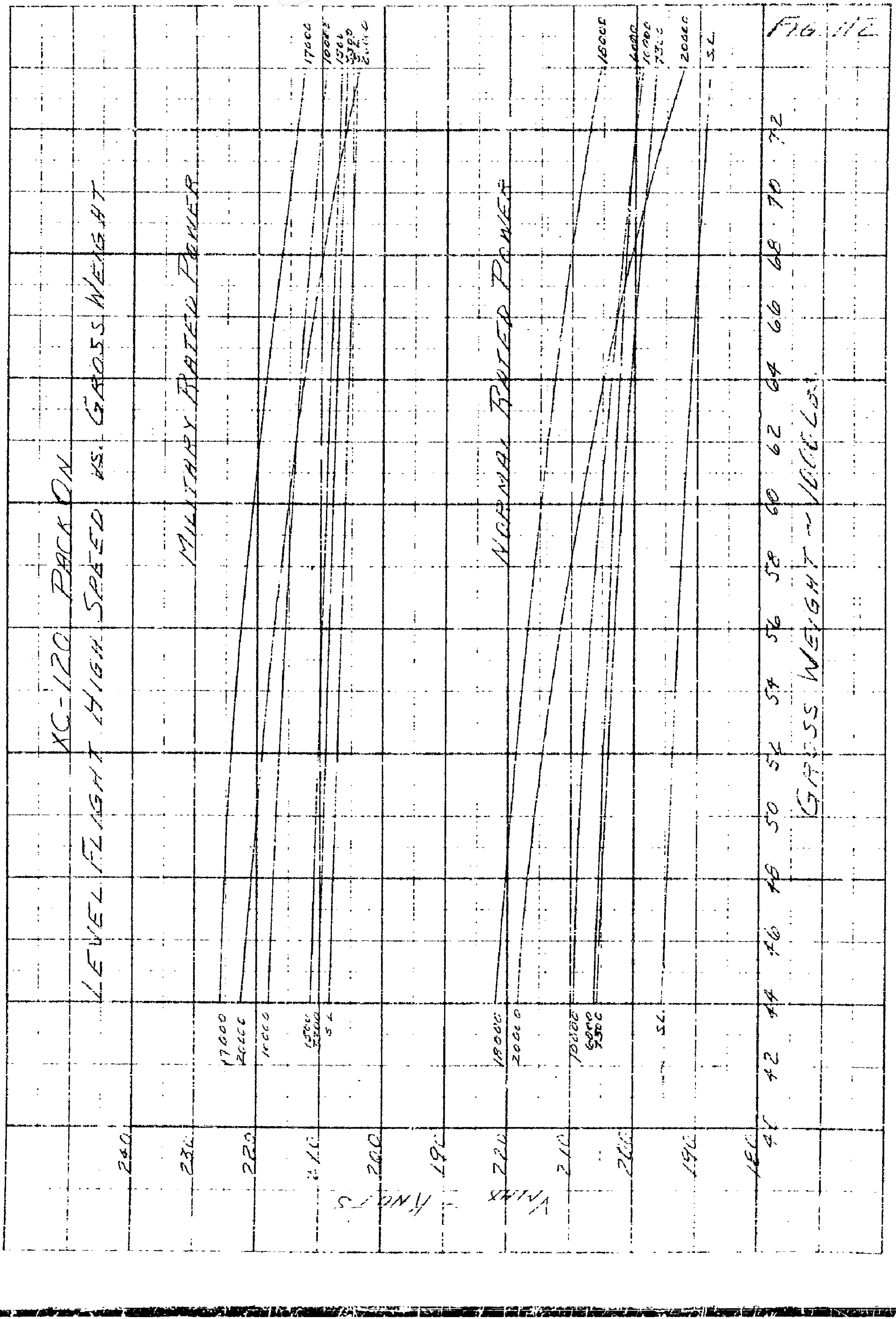
APPENDIX I -

PART II-D

D. MAXIMUM SPEED AND CLIMB SPEED

Maximum speeds are plotted versus gross weight, normal and military power, pack-off and pack-on, using the data of figures 30, 31, 82 and 83 in figures 112 and 113 for use in the preparation of reference (App. I-3).

FIG. 112


XC-120 PACK ON
LEVEL FLIGHT HIGH SPEED VS. GROSS WEIGHT
MILITARY RATED POWER
NORMAL RATED POWER
17000
20000
10000
15000
5000
S.L.
18000
20000
10000
6000
7500
S.L.
42
44
46
48
50
52
54
56
58
60
62
64
66
68
70
72
GROSS WEIGHT ~ 1000 LBS
240
230
220
210
200
190
220
210
200
190
180
VMAX ~ KNOTS

XC-120 PACK OFF
LEVEL FLIGHT HIGH SPEED VS. GROSS WEIGHT

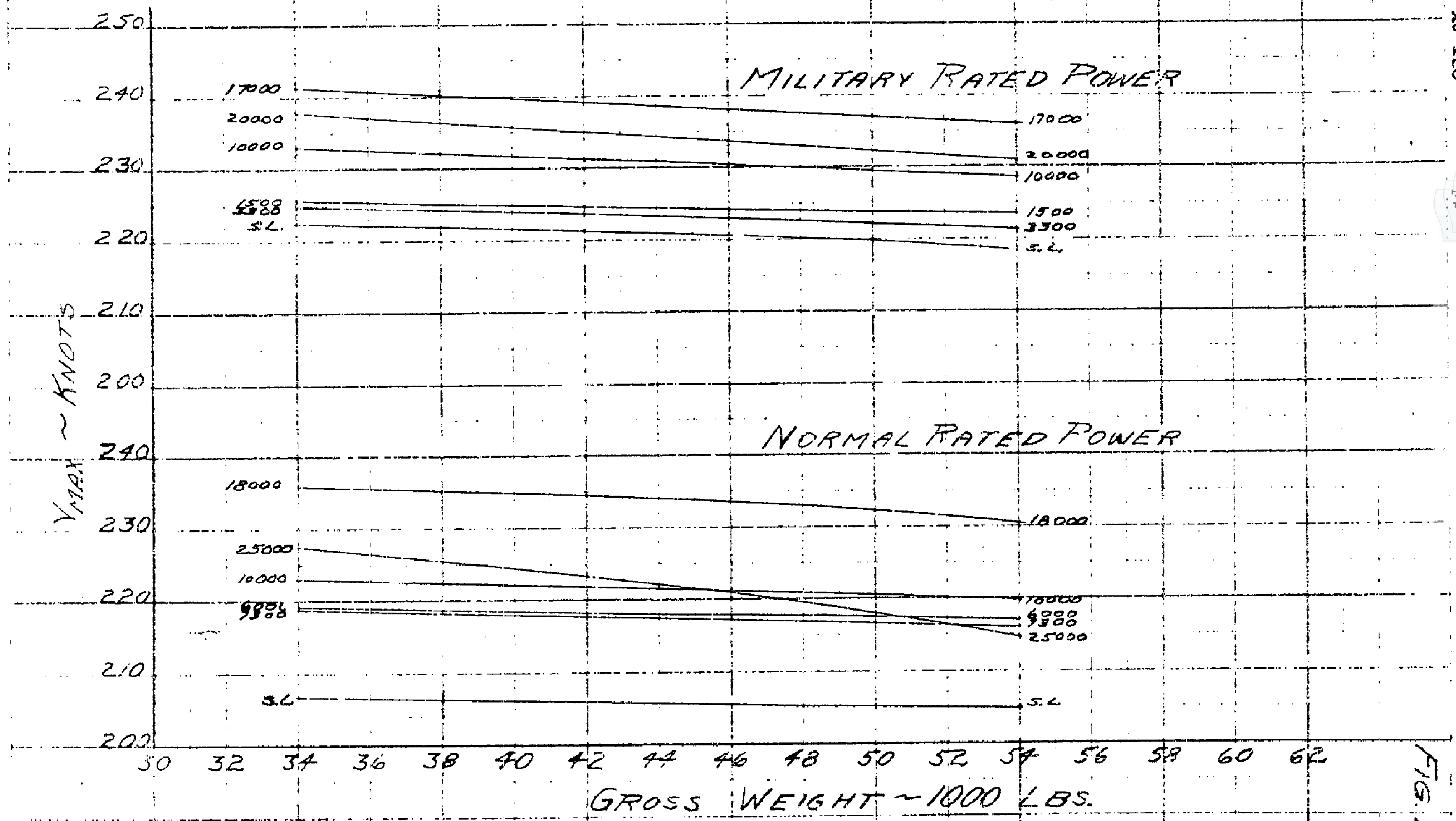


FIG. 113

APPENDIX I -

PART II-B-[illegible]

E. CRUIS[illegible]

1. General

The cruising [illegible] were based directly on the engine manufacturer's specification data. Reference (App. I-2) of this Appendix was based on revised cruising requirements which included a 15% increase in the manufacturer's SFC data and an [illegible] fuel capacity of 2670 gallons. Reference (App. I-3) has been prepared to meet the requirements of reference (App. I-1) using 5% increase in manufacturer's SFC values and bladder tanks of 2798 gallons capacity.

2. Determination of Limiting Take-Off Gross Weight

Maximum take-off gross weight is the greatest weight which satisfies all the criteria of reference (App. I-1)

(a) Gross weight shall not exceed the weight of the airplane fully loaded with fuel and cargo capacity for which space and/or tankage is provided, with cargo density figured at 70 lbs./cu. ft.

Weight Empty , lbs.	42,396
Trapped Fuel & Oil	290
Crew	1000
Miscellaneous Equipment	27
Full Oil	900
Basic Wt. = T.O.G.W. less fuel & cargo	44,613
Full Fuel (2798 gal.)	16,788
Max. Cargo for 2900 Cu.Ft. @ 70 #/cu.ft.	203,000
Total for this Limitation	264,401 lbs.

(b) Maximum take-off gross weight for take-off, taxi and ground handling.

74,000 lbs. with nose gear critical

(c) Wing shall make good a flight limit load factor of at least 2.0g.

Gross weight varies with fuel load. With enough fuel for flight, in all cases this will be greater than other limits set herein.

APPENDIX I -

PART II-B-2

(d) Cargo supporting structure shall make good an applied load factor of at least 2.0.

The XC-120 can support a concentrated vehicle load of 30,000 lbs. at a 2 "g" limit load factor.

(e) The take-off ground run at sea level shall not exceed 8000 feet.

From figure 58 of the main report, the take-off gross weight which would require an 8000 ft. ground run is estimated to be approximately 95,000 lbs.

(f) The maximum rate-of-climb at sea level and standard atmospheric conditions with normal power shall not be less than 500 ft/min.

From figure 107 the limiting gross weight for this condition is estimated to be in excess of 80,000 lbs.

(g) The service ceiling with maximum power and one engine inoperative shall not be less than sea level.

From figure [illegible] the limiting gross weight for this condition is shown to be 70,700 lbs.

(h) The center of gravity will remain within the established limits during flight.

The limiting take-off gross weight is therefore, 70,700 lbs. at which gross weight all of the above requirements are satisfied.

Maximum landing gross weight is the greatest gross weight at which the aircraft satisfies all the criteria of paragraph 3.2.1.7. of reference (App. I-1).

(a) The aircraft shall make good a design limit sinking speed of [illegible] feet per second with one (1) "g" wing lift acting for the landing conditions of ANC-[illegible].

[illegible] lbs. maximum landing

APPENDIX I -

PART [illegible]

(c) The aircraft has no provisions for increasing the inflight gross weight and cannot exceed the maximum take-off gross weight.

Maximum take-off gross weight = 70,700 lbs.

From these considerations it is apparent that the maximum landing weight will be limited to 70,700 lbs.

3. Cruising Power Required and Available

Cruising power required and available for the purposes of this Appendix are the same as those in the main report.

4. Nautical Miles per Pound Calculations

Reference (App. I-4) of this Appendix being a later revision of reference (a) of the main report is used in the preparation of reference (App. I-3). A plot of BHP vs RPM is given in figure 114 which is essentially the same as figure 34 in the main body of the report except for changes above 1800 BHP (which is above the cruising range in this section). A plot of SFC vs BHP from reference (App. I-4) is presented in figure 115. The calculations for nautical miles per pound of fuel are the same as for the main report, except that all calculations are in nautical units. A sample calculation is shown below for a gross weight of 64,000 lbs. and nautical miles per lb. of fuel are plotted vs speed with BHP and gross weight parameters for pack-on in figure 116. Pack-off data is the same as the main body of the report except SFC's are increased 5%.

BHP	RPM	SFC	#/hr x 1.05	Vknots	N. Mi./lb. of Fuel
2100	2339	.5025	[illegible]	188.5	.085
1800	2175	.4668	1761	175.1	.0995
1540	1973	.4596	1482	161.2	.1089
1240	1750	.4661	1188	139.7	.1172

The peaks of the nautical miles per pound of fuel curves of figure 116 are joined to form the "best economy line". Values along this line are then multiplied by .99 in accordance with the requirements of reference (App. I-1) that cruise shall be the speed for 99% of best economy. These speeds are then read from figure 116 and the corresponding [illegible] per pound of fuel are found by the [illegible].

APPENDIX I -

PART II-9 b

Hr./lb. of fuel = Naut. Mi./lb. of fuel ÷ V_{knots}

The computations are shown below "pack-on". Nautical miles per pound of fuel at 99% best economy are plotted against gross weight in figures 117 and 118 which form the basis for the combat range and combat radius problems of the following section.

PACK-ON

Gross Weight LBS.	Best Economy N. Mi/lb	99% Best Economy		
		N. Mi/lb	Vknots	hr/1000 lb.
44,000	.1671	.1655	125.5	1.32
54,000	.1390	.1375	134.5	1.026
64,000	.1172	.1160	144.0	.805
74,000	.1006	.0995	155.0	.641

Fig 114

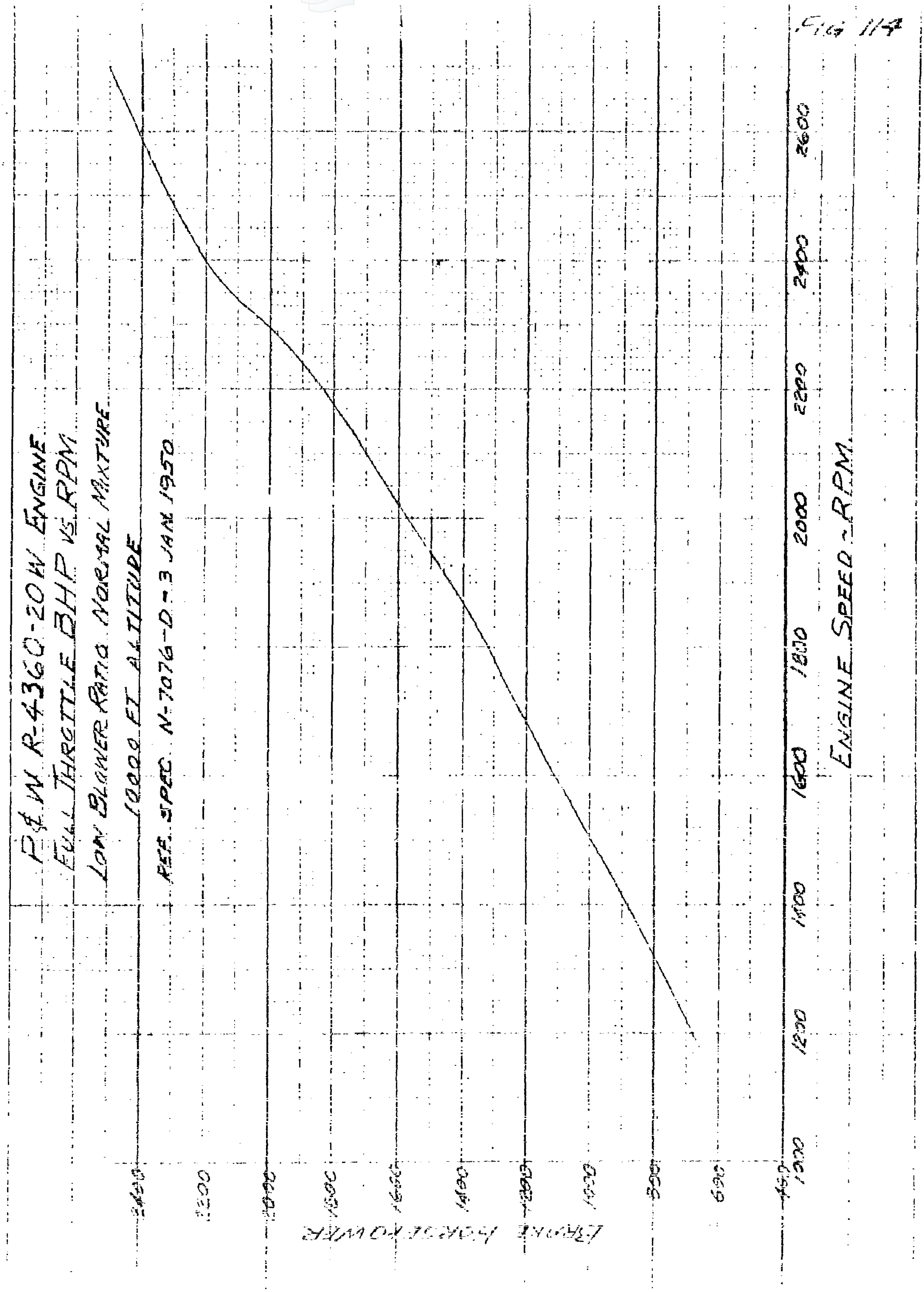
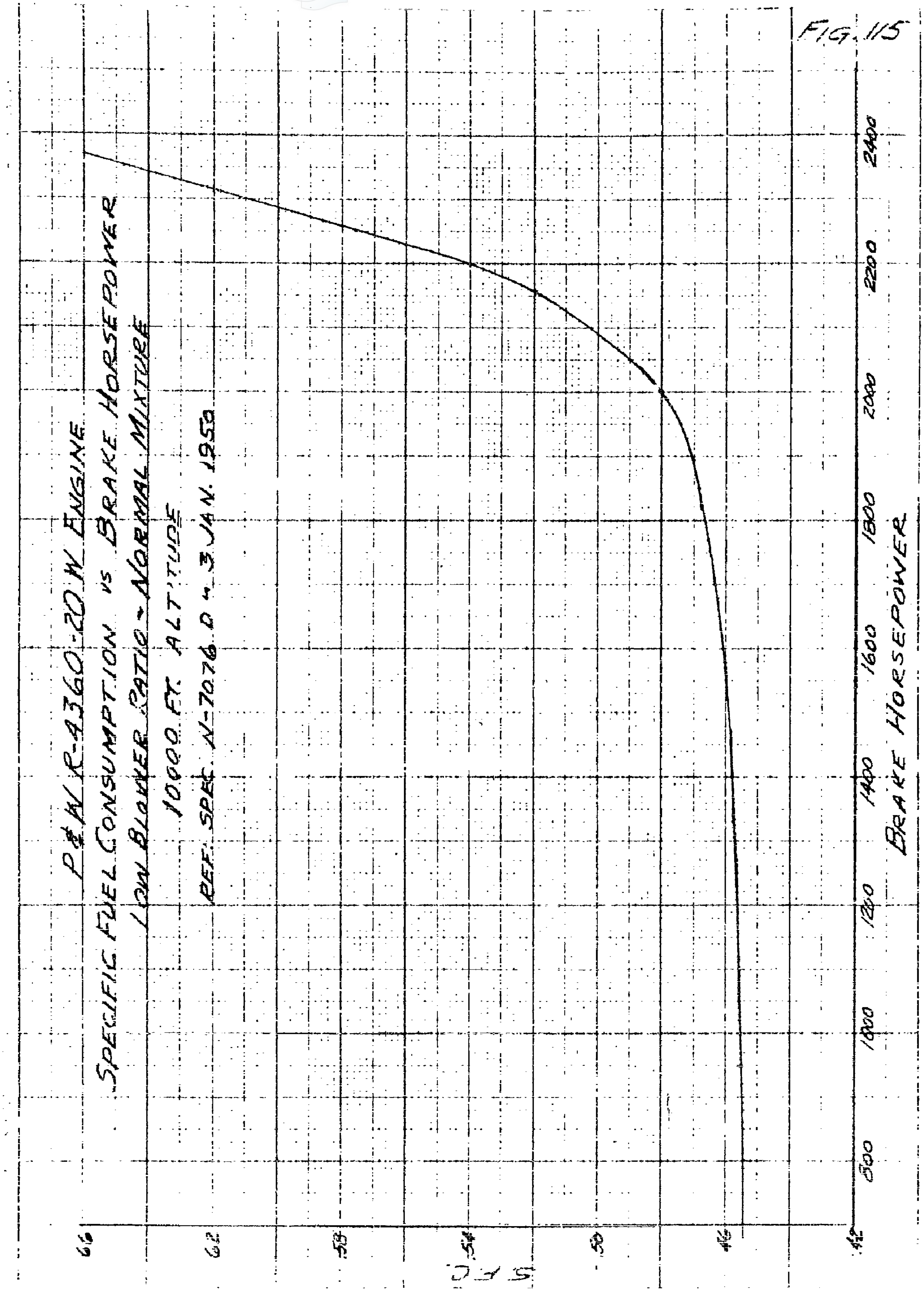

P&W R-4360-20W ENGINE
FULL THROTTLE BHP VS RPM
LOW BLOWER RATIO NORMAL MIXTURE
10000 FT ALTITUDE
REF. SPEC N-7076-D - 3 JAN 1950
BRAKE HORSEPOWER
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
ENGINE SPEED ~ RPM.
1000
1200
1400
1600
1800
2000
2200
2400
2600

FIG. 115


P&W R-4360-20W ENGINE

SPECIFIC FUEL CONSUMPTION vs BRAKE HORSEPOWER

LOW BLOWER RATIO - NORMAL MIXTURE

10000 FT. ALTITUDE

REF: SPEC. N-7076 D - 3 JAN. 1950

FIG. 116

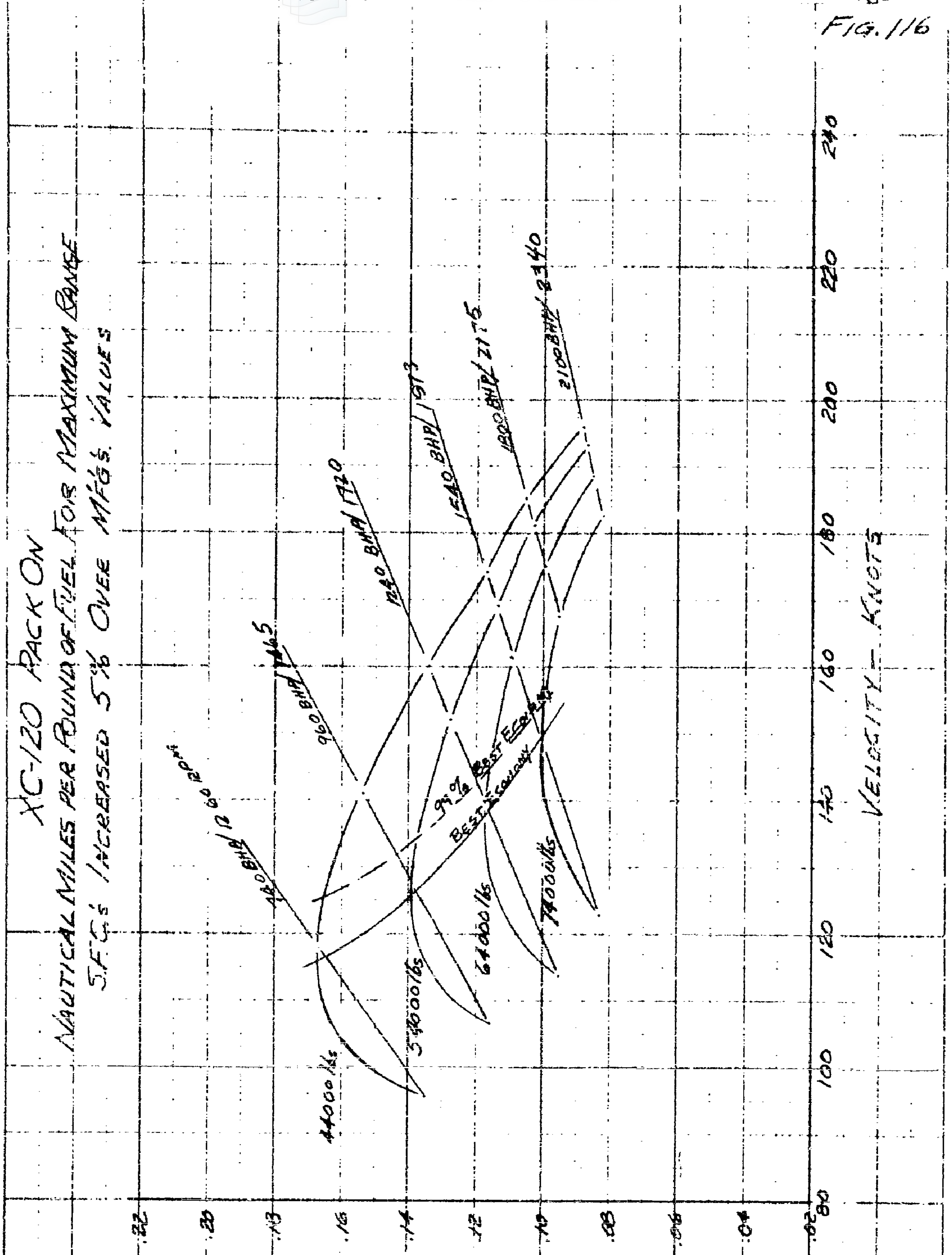
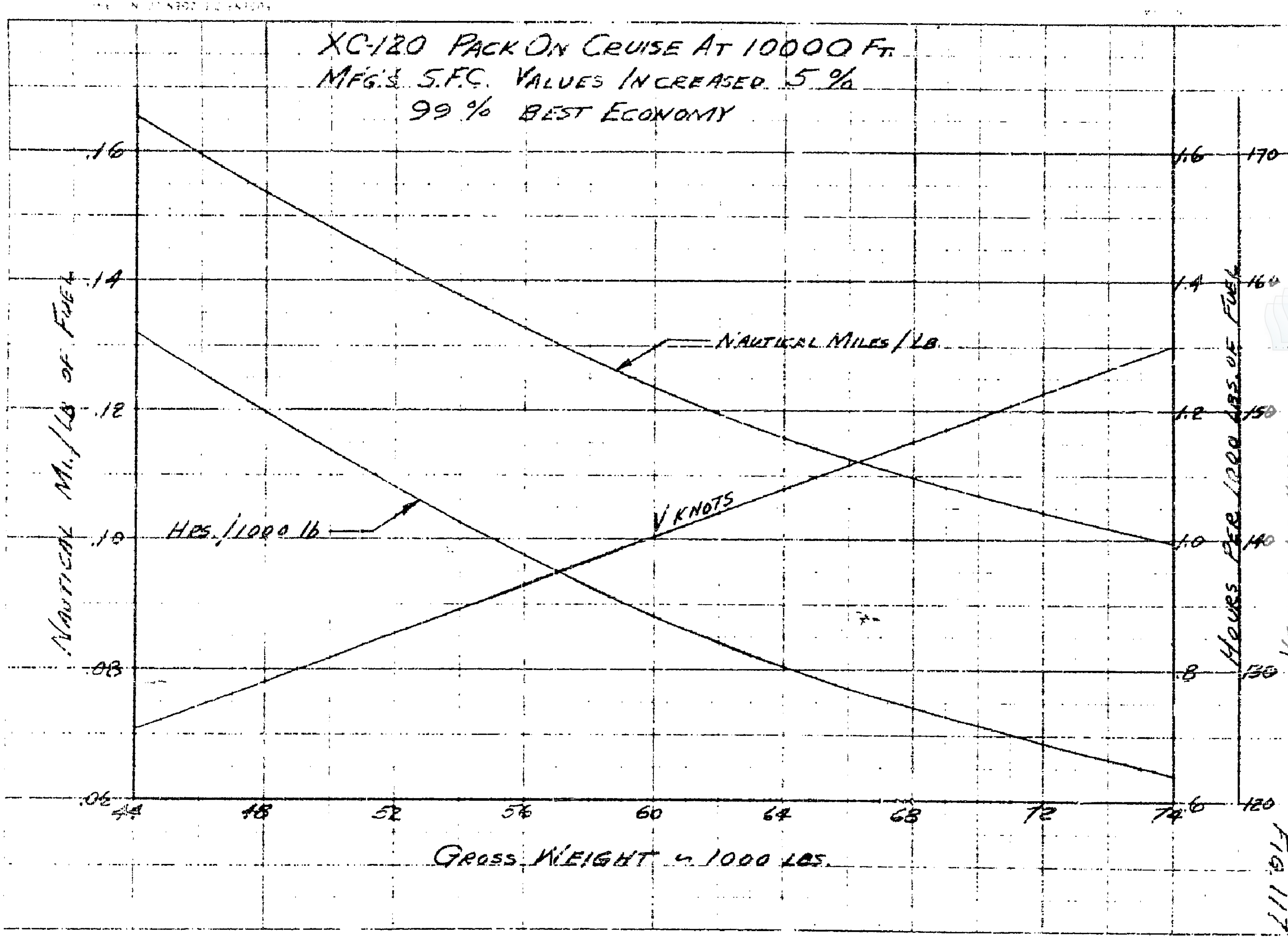

XC-120 PACK ON
NAUTICAL MILES PER POUND OF FUEL FOR MAXIMUM RANGE
SFC's INCREASED 5% OVER MFG'S. VALUES

FIG. 117



XC-120 PACK ON CRUISE AT 10000 FT.
MFG'S S.F.C. VALUES INCREASED 5 %
99 % BEST ECONOMY

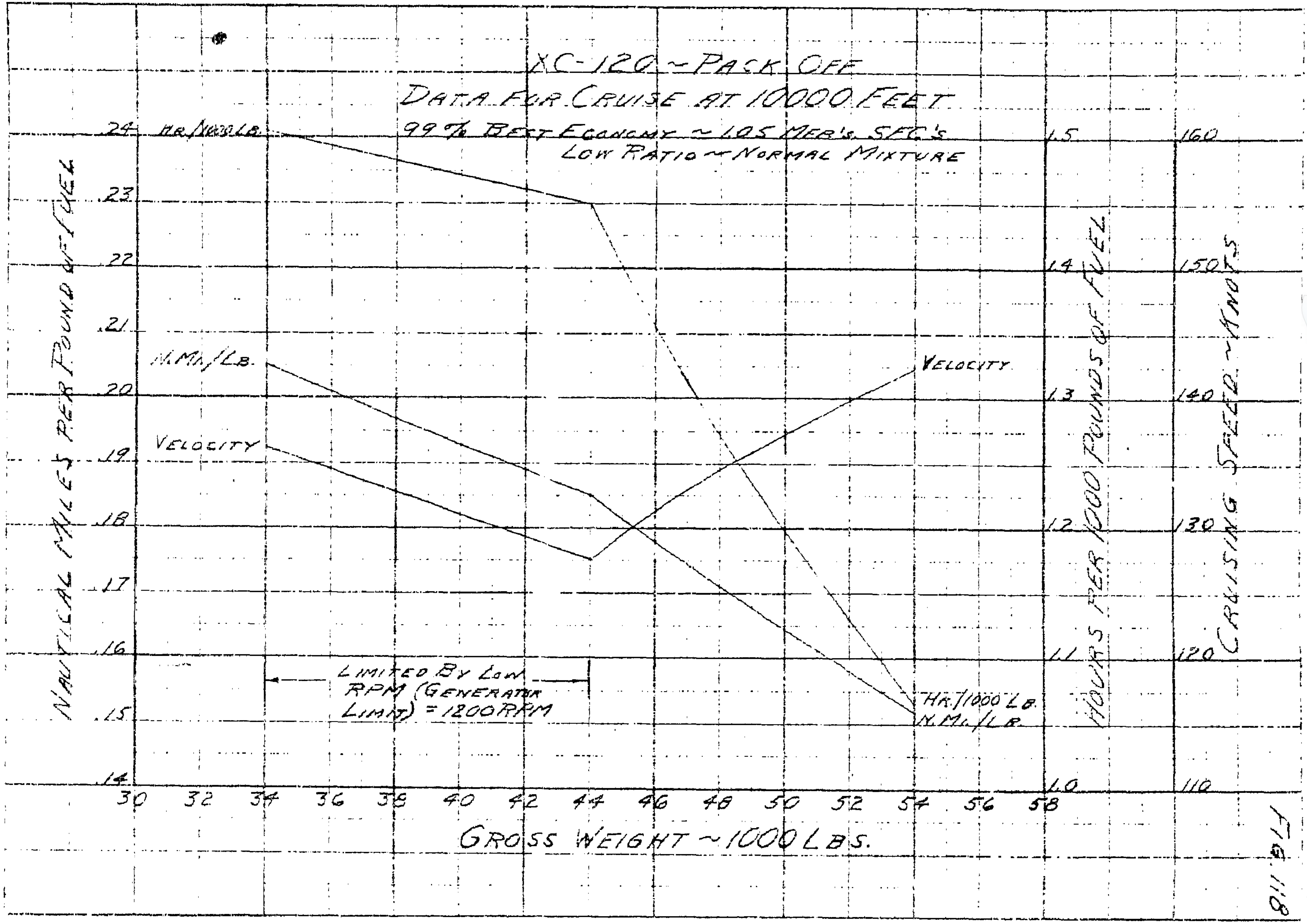


FIG. 118

XC-120 ~ PACK OFF
DATA FOR CRUISE AT 10000 FEET
99% BEST ECONOMY ~ 1.05 MER'S SFC'S
LOW RATIO ~ NORMAL MIXTURE
NAUTICAL MILES PER POUND OF FUEL
.24
.23
.22
.21
.20
.19
.18
.17
.16
.15
.14
HOURS PER 1000 POUNDS OF FUEL
1.5
1.4
1.3
1.2
1.1
1.0
CRUISING SPEED ~ KNOTS
160
150
140
130
120
110
GROSS WEIGHT ~ 1000 LBS.
30
32
34
36
38
40
42
44
46
48
50
52
54
56
58
HR./1000 LB.
N.MI./LB.
VELOCITY
VELOCITY
HR./1000 LB.
N.MI./LB.
LIMITED BY LOW RPM (GENERATOR LIMIT) = 1200 RPM

APPENDIX I -

PART II-E-4

Since reference (App. I-1) requires that fuel used in warm-up, take-off, and climb should be accounted for in all range calculations, these items are computed here for pack-on. Pack-off computations are made in the same manner.

Warm-Up and Take-Off

As per reference (App. I-1) ten minutes operation at normal rated power is allowed for warm-up and take-off.

Fuel = S.F.C x 1.05 x No. of Engs. x BHP x 10/60 hrs.

= .72 x 1.05 x 2 x 2650 x .1667

Fuel = 668 lbs. for 10 min. operation

Climb

Fuel used in climb to 10,000 ft. = SFC x 1.05 x No. of Engs.
x BHP x T/C

and

Range in climb to 10,000 ft. = T/C x Avg. Vclimb in knots

Using the data of reference (App. I-4) and figures 22 and 78, fuel used and range are computed and plotted with time against gross weight in figures 119 pack-on and 120 pack-off.

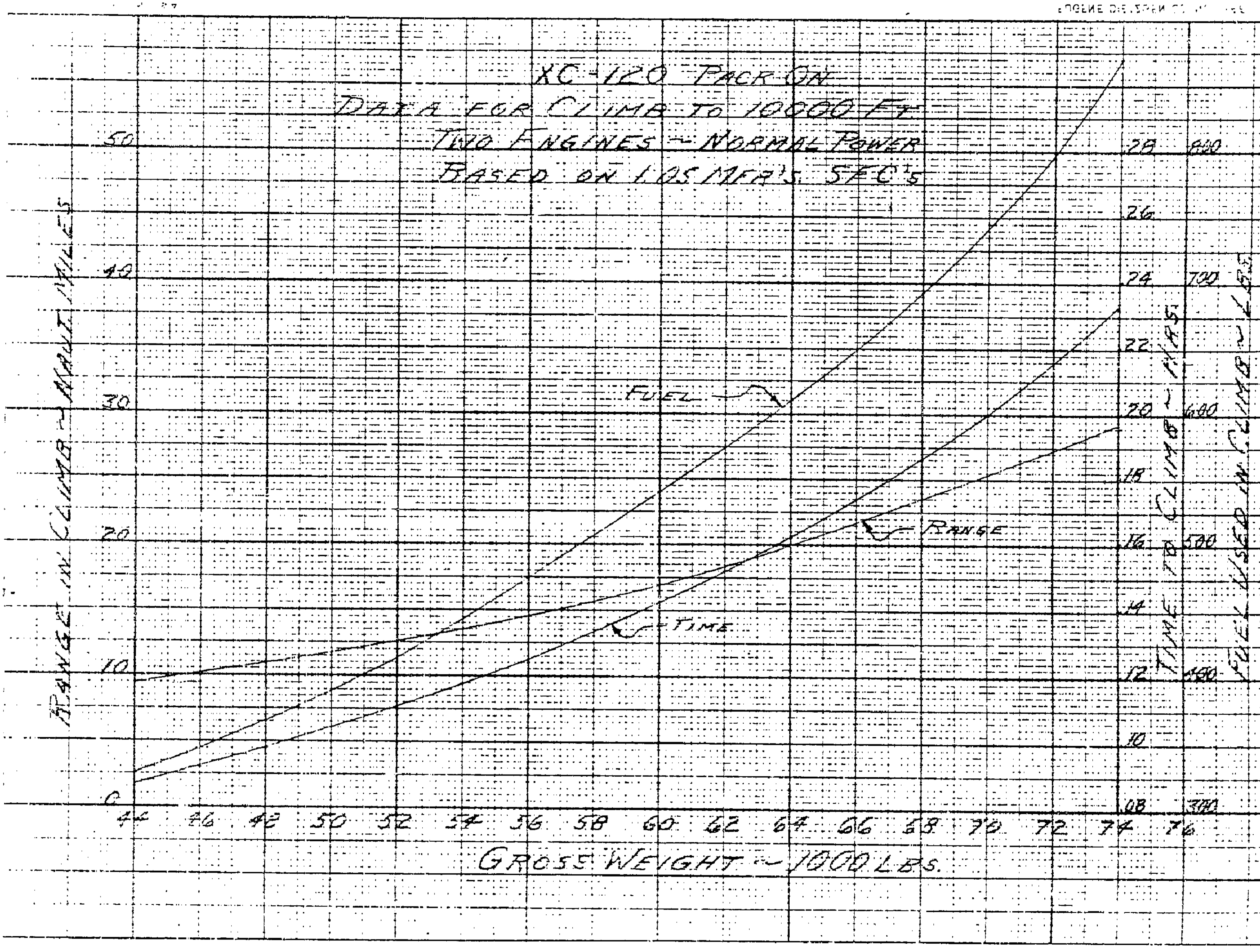
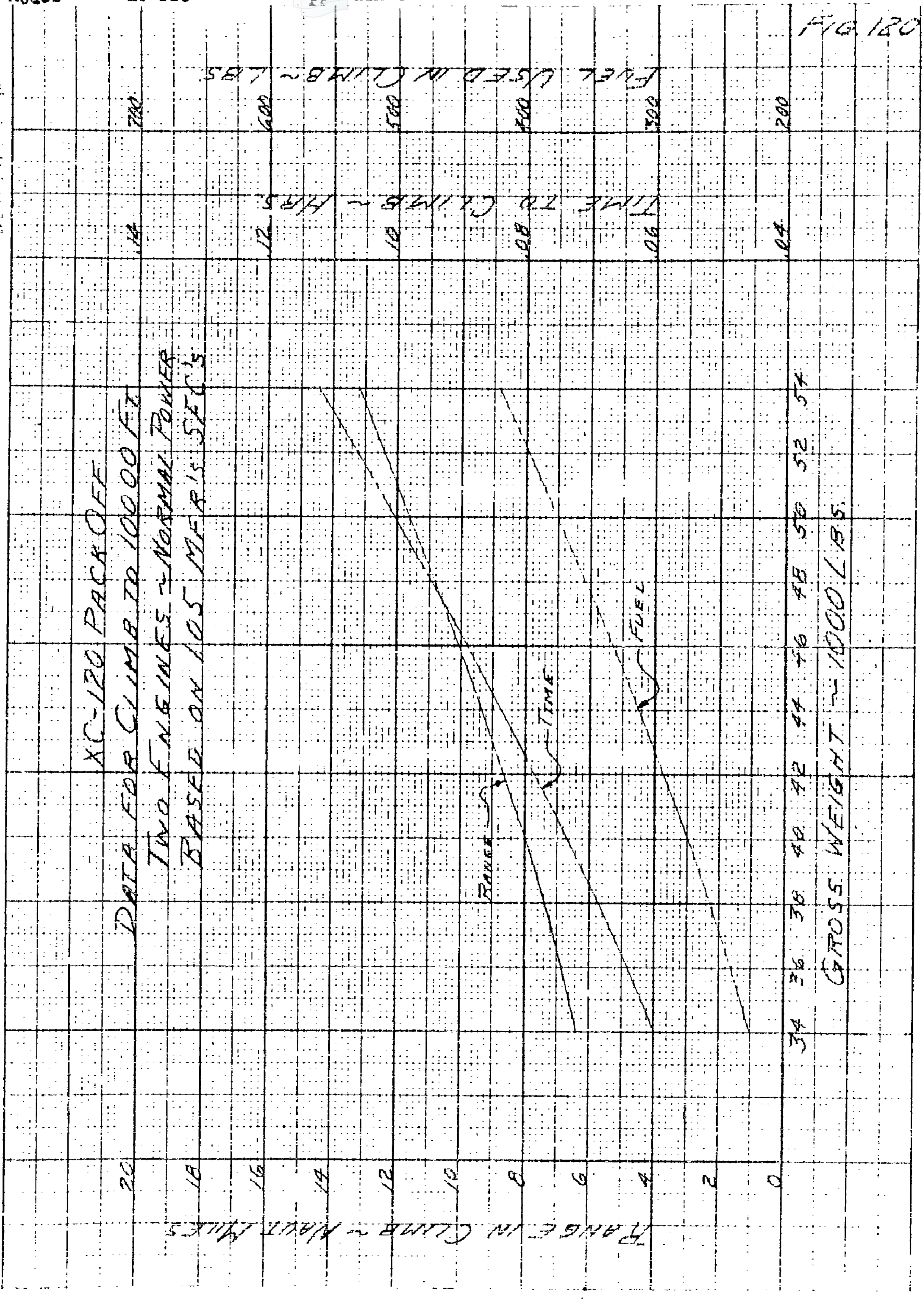

XC-120 PACK ON
DATA FOR CLIMB TO 10000 FT
TWO ENGINES ~ NORMAL POWER
BASED ON 1.05 MFR'S SFC'S
RANGE IN CLIMB ~ NAUT MILES
0
10
20
30
40
50
GROSS WEIGHT ~ 1000 LBS.
44
46
48
50
52
54
56
58
60
62
64
66
68
70
72
74
76
TIME TO CLIMB ~ HRS
.08
10
12
14
16
18
20
22
24
26
28
FUEL USED IN CLIMB ~ LBS
300
400
500
600
700
800
FUEL
RANGE
TIME

FIG 119

FIG. 120


XC-120 PACK OFF
DATA FOR CLIMB TO 10000 FT
TWO ENGINES ~ NORMAL POWER
BASED ON 105 MPH IS SEC'S
FUEL USED IN CLIMB ~ LBS
700
600
500
400
300
200
TIME TO CLIMB ~ HRS
.14
.12
.10
.08
.06
.04
RANGE
TIME
FUEL
34
36
38
40
42
44
46
48
50
52
54
GROSS WEIGHT ~ 1000 LBS
20
18
16
14
12
10
8
6
4
2
0
RANGE IN CLIMB ~ NAUT. MILES

APPENDIX I -

PART II-B-5

5. Combat Range and Radius of Action Calculations

Combat range and radius of action are computed in accordance with reference (App. I-1) under these requirements oil is considered to be carried all the way. Range and endurance for any flight leg are therefore computed by the following integrations over the weight change due to fuel consumption only:

$$\text{RANGE (Naut. Mi.)} \int_{\text{Take-Off Gross Weight less Climb Fuel}}^{\text{Landing Gross Wt.}} (\text{Naut. Mi./Lb of fuel})\,d_W$$

$$\text{ENDURANCE (hours)} = \int_{\text{Take-Off Gross Weight less Climb Fuel}}^{\text{Landing Gross Weight}} (\text{hours/lb. of fuel})\,d_W$$

Where nautical miles per pound of fuel and hours per 1000 lb. of fuel may be read from figures 117 "pack-on" and 118 "pack-off".

The combat radius of action formula is:

Allow 10 minutes operation at normal rated power for warm-up and take-off, climb to 10,000 ft. at normal rated power at speed for best climb, cruise out at speed for 99% of best economy, land and detach cargo pack; allow 10 minutes operation at normal rated power for warm-up and take-off, climb to 10,000 ft. at normal rated power at speed for best climb, cruise back at speed for 99% of best economy, 5% of useable fuel is held in reserve at all times, all range data are 5% conservative (5% increase in SFC'S), range is based on distance in climb and cruise.

Calculations for combat radius of action have been made at various gross weights, fuel, and cargo loads. A sample calculation is shown on the following page and complete results are plotted in figure 121.

The flight plan for combat range is the same as for combat radius except that cargo is carried the entire distance; there is no landing, unloading, or take-off at mid-point; and the specified fuel reserve is 10% of the useable fuel.

A sample calculation for combat range follows that for combat radius and the results are plotted in figure 122.

Subject: PERFORMANCE CALCULATIONS

APPENDIX I -
PART II-E-5

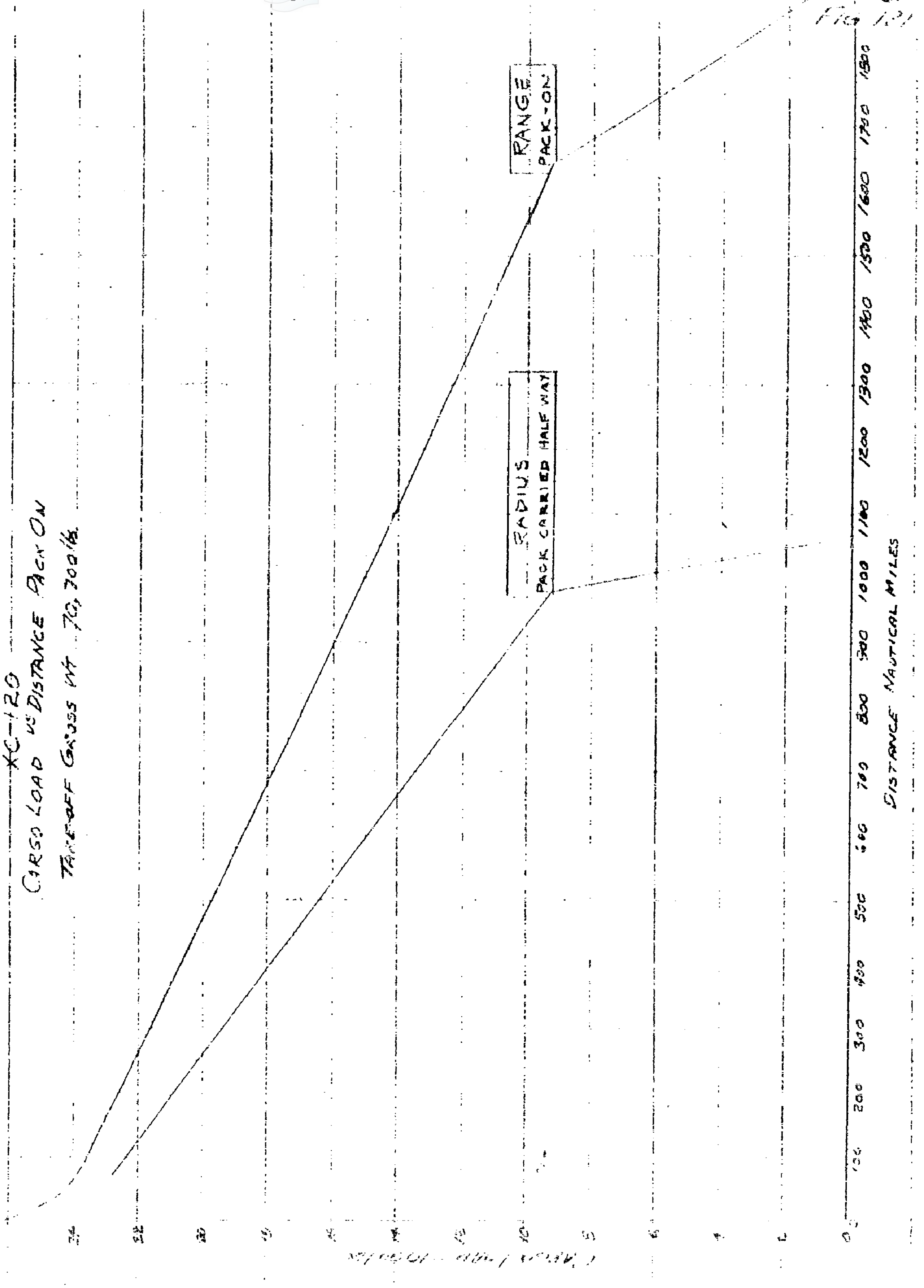
BASIC MISSION
RADIUS OF ACTION

Take-off gross weight	lbs	70,700
Total fuel	lbs	13,407
Fuel for reserve	lbs	670
Fuel used in warm up & take off	lbs	668
Climb gross weight	lbs	70,032
Fuel used in climb out	lbs	743
Range in climb out	Naut mi	25
Time to climb out	hrs	.200
Gross weight at start of cruise out	lbs	69,289
Fuel assumed for cruise out	lbs	6360
Average gross weight for cruise out	lbs	66,109
Naut. Mi./lb. of fuel		.1125
Range in cruise out	Naut mi	715
hrs./1000 lb. of fuel		.771
Time to cruise out	hrs	4.9
Landing gross weight	lbs	62,929
Drop cargo	lbs	12,680
Take off gross weight for return	lbs	45,147
Fuel for return	lbs	4966
Fuel used in warm up & take off	lbs	668
Climb gross weight	lbs	44,479
Fuel used in climb back	lbs	316
Range in climb back	Naut mi	9.6
Time to climb back	hrs	.085
Gross weight at start of cruise back	lbs	44,163
Fuel for cruise back	lbs	3982
Average gross weight for cruise back	lbs	42,172
Naut. Mi./lb. of fuel		.1886
Range in cruise back	Naut mi	751
hrs./1000 lb. of fuel		1.460
Time to cruise back	hrs	5.814
Total range including climb	Naut mi	1500.9
Radius of action	Naut mi	750.4
Flight time	hrs	11.003
Total time	hrs	11.336
Average Speed	kn	136.4

APPENDIX I -
PART II-E-5

		RANGE Pack-off Ferry Range		Pack-On
Take-off gross weight	lbs	56,299		70,700
Total fuel	lbs	16,788		16,788
Cargo	lbs	0		9299
Fuel for reserve	lbs	1679		1679
Fuel used for warm up & take-off	lbs	668		668
Climb gross weight	lbs	55,631		70,032
Fuel used in climb	lbs	438		743
Range in climb	Naut. mi	16		25
Time to climb	hrs	.117		.200
Gross weight at start of cruise	lbs	55,193		69,289
Fuel for cruise	lbs	14,003		13,698
Average gross weight for cruise	lbs	48,192		62,440
Naut. Mi./lb. of fuel		.1702		.1186
Range in cruise	Naut. mi	2383		1620
hr./1000 lb. of fuel		1.265		.835
Time to cruise	hrs	17.71		11.4
Landing gross weight	lbs	41,190		55,329
Total range including climb	Naut. mi	2399		1645
Flight time	hrs	17.827		11.6
Total time	hrs	17.994		11.77
Average Speed	kn	134.5		142

Fig 121


XC-120
Cargo Load vs Distance Pack On
Takeoff Gross Wt 70,700 lb
RANGE PACK-ON
RADIUS PACK CARRIED HALF WAY
Distance Nautical Miles
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
0
2
4
6
8
10
12
14
16
18
20
22
24

APPENDIX I -

PART II-F

F. **STALLING SPEEDS**

Stalling speeds are the same as computed in Part II-F and III-F of the main report.

G. **TAKE-OFF DISTANCE**

The take-off distance computations in the main body of the report are adequate for Standard Aircraft Characteristics.

H. **LANDING DISTANCE**

Landing distances as computed in the main body of the report are adequate for the purposes of reference (App. I-3).

APPENDIX I -

PART III - REFERENCES

(1) Military Specification MIL-C-5011, "Charts; Standard Aircraft Characteristics and Performance, Piloted Aircraft", dated 27 July 1949.

(2) "Standard Aircraft Characteristics Charts" - XC-120 Airplane, dated 1 March 1949.

(3) "Standard Aircraft Characteristics Charts" - XC-120 Airplane, dated 25 September 1950.

(4) Pratt & Whitney Engine Specification N-7056-D, dated 3 January 1950.

REEL-C 4543

A.T.I 99727

RESTRICTED

DEFENSE TECHNICAL INFORMATION CENTER REQUEST FOR RELEASE OF LIMITED DOCUMENT

NOTE: This form may be classified if necessary. See instructions on reverse.

DTIC CONTROL NO 0077013

USER ROUTING Code P/DB2507

SECTION I REQUESTING ORGANIZATION

1 REQUESTING ORGANIZATION AND ADDRESS
[redacted]

2. DTIC USER CODE NO 06616

3 DATE OF REQUEST 14 Mar 00

4. TYPE OF COPY AND QUANTITY
☒ Paper Copy 1 Copy(s) ☐ Microfiche ______ Copy(s)

5 CONTRACT NUMBER

6 CONTRACT SECURITY LEVEL

7 GOVERNMENT SPONSOR AND ADDRESS, (Contractors Only)

8. METHOD OF PAYMENT (X ONE)
☐ VISA ☐ MC ☐ AMX
☒ Charge to NTIS Deposit Account No. [redacted]
☐ Bill My Organization to the Attention of: ______

9. CONTRACT MONITOR AND TELEPHONE NUMBER (Contractors Only)

10. NAME, TITLE, PHONE NUMBER OF REQUESTING OFFICIAL
[redacted]

SECTION II. BIBLIOGRAPHIC INFORMATION

11. AD NUMBER (If Known)
AD-B803066

12. (TITLE REPORT NUMBER, AUTHOR(S)), ETC
Performance Calculations - and Appendix I - Model XC-120 (M-107), 212 pages

SECTION III. REQUESTER JUSTIFICATION

13 REQUESTER JUSTIFICATION (Explain need in detail)

A paper copy of this unclassified document, currently releasable to DOD only, is being requested for administrative use in a preliminary project study. NASA-DFRC engineers are looking at several possible concepts for future Unmanned Aerial Vehicle applications. This historical document may help determine a future NASA REVCON (Revolutionary Concept) proposal to be engineered at this Center.

SECTION IV. RELEASING AGENCY

1 RELEASING AGENCY ADDRESS (If Known)

WRIGHT AIR DEVELOPMENT CTR
WRIGHT-PATTERSON AFB OH

2 RELEASING AGENCY DECISION (If the report was developed under the SBIR Program refer to instruction B 2 on the reverse of this form)

☐ APPROVED FOR RELEASE TO THE ABOVE REQUESTER
☐ DISAPPROVED, REASON FOR DISAPPROVAL.
☒ APPROVED FOR PUBLIC RELEASE
☐ DISTRIBUTION AUTHORIZED TO U S. GOV'T AGENCIES & THEIR CONTRACTORS.
☐ DISTRIBUTION AUTHORIZED TO U S. GOV'T AGENCIES ONLY
☐ DISTRIBUTION AUTHORIZED TO DoD ONLY
☐ DISTRIBUTION AUTHORIZED TO DoD & THEIR CONTRACTORS

28 APR 2000

#902946 DJ

3 NAME AND TITLE OF RELEASING OFFICIAL
Forest H. [illegible]

4. TELEPHONE NO.
[illegible]

5 SIGNATURE
F. H. [illegible]

6. DATE
[illegible]

DTIC FORM OCT 96 55

PREVIOUS EDITIONS MAY BE USED UNTIL STOCK IS EXHAUSTED

** TOTAL PAGE 19 **