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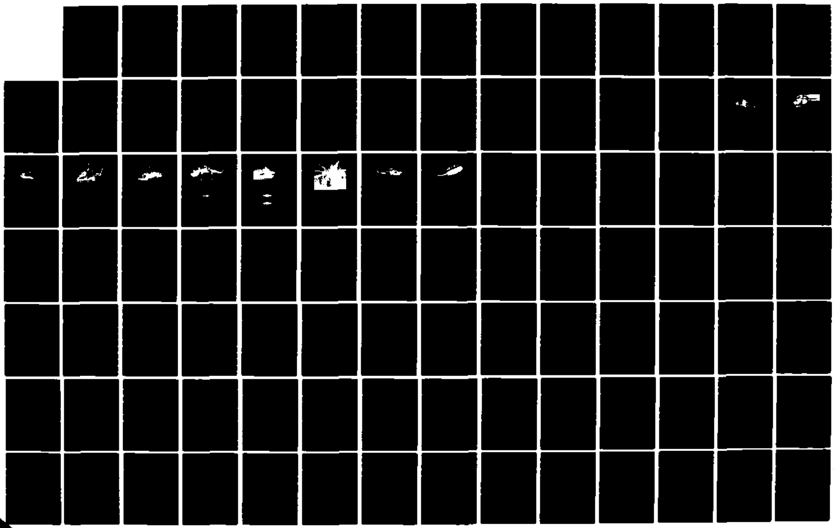

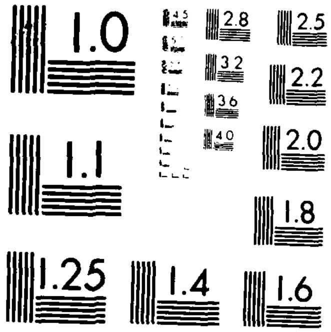

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THESIS

DETERMINATION OF QUANTITATIVE RELATIONSHIPS BETWEEN SELECTED CRITICAL HELICOPTER DESIGN PARAMETERS

by

Ronald S. Petricka

September 1984

Thesis Advisor: D. M. Layton

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This thesis determines the relationships of helicopter design parameters by first depicting graphically all possible pairings of selected design parameter values and then, secondly, depicting graphically respective curve fits for the data point plots which meet an acceptance criteria. In generating the curve plots, the specific constants of each curve equation are determined, thus allowing the designer the ability to derive

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Determination of Quantitative Relationships Between Selected Critical Helicopter Design Parameters

by

Ronald S. Petricka
Captain, United States Army
B.S., United States Military Academy, 1973

Submitted in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE IN AERONAUTICAL ENGINEERING

from the

NAVAL POSTGRADUATE SCHOOL
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A-1

ABSTRACT

This thesis determines the relationships of helicopter design parameters by first depicting graphically all possible pairings of selected design parameter values and then, secondly, depicting graphically respective curve fits for the data point plots which meet an acceptance criteria. In generating the curve plots, the specific constants of each curve equation are determined, thus allowing the designer the ability to derive quantitatively the values of many of the design parameters heretofore selected by trial and error methods.

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I. INTRODUCTION

The evolution of helicopter design has proceeded far beyond the starting point where design decisions were based on a 'trial and error' criteria. In major helicopter industry, the design process has evolved to a largely technical discipline where, with the noted exceptions of technological breakthroughs which cause a drastic departure from the norm (an example being the Hughes NOTAR, a helicopter without a tail rotor!), a new helicopter design is built by piecing together critical design parameters in a fashion dictated by past successful designs. Those critical design parameters, logically, are determined by the intended user's requirements (e.g., carrying capacity, and mission (scout vs. utility vs. attack)), performance requirements (e.g., speed, climb, and range), and the geometric requirements (e.g., length, and width).

Definite relationships between these critical design parameters (30 have been selected), are frequently unavailable, or unknown, and are not used during the preliminary design process. By examining all possible pairings, or permutations, across a large number of present helicopter designs (10 have been chosen), one could produce equations of curves which would consistently, accurately and quickly produce the quantitative value for the design parameter a designer seeks.

A. OBJECTIVES AND SCOPE

The objective of this thesis is to determine if quantitative relationships exist between the pairings of critical helicopter design parameters. If they do exist, specific equations of curves, forming a curve fit of the data, and specific constants, are to be determined.

II. APPROACH TO THE PROBLEM

Thirty design parameters were selected and a data base was compiled of the values of these design parameters for 10 helicopters. The 10 helicopters chosen were selected purposely to represent a varied mix of single-mission aircraft (utility, heavy utility, scout or observation, and attack), and old and new technology, ranging from the 1950's to the late 1970's, to lend creditability to the resulting relationships for use in any future preliminary helicopter design process. Selected design parameters, and the respective values for each of the chosen helicopters are listed in Appendix A. A planform and abstract picture of each helicopter, for referencing, is contained in the same Appendix. Table 1 is a brief summary which illustrates the diversity of the helicopters chosen to compile the data base for this thesis.

Pairing each parameter singularly against each other yielded 435 permutations at the start of the evaluation. The pairings are referenced by 2 numbers. For example, the pairing number '1-30' pairs the first design parameter, Main Rotor Blade Radius, against the thirtieth design parameter, Maximum Gross Weight. Appendix B contains a complete listing of pairings. A simple data point graph (X vs. Y) was made of each pairing and, for the graphs that showed a clear relationship existed, data points are curve fitted yielding a curve equation with specific constants. Both the singular data points, and the curves, generated from the curve equations, are depicted graphically, reinforcing the closeness of the curve fits, and that a relationship does indeed exist.

TABLE 1

Summary Characteristics of Chosen Helicopters

Military Designator	Weight Class	Primary Service	Year of Manufacture	Year of Technology	Mission Purpose
AH64	Medium	USA	1983	1970	Attack
CH58C	Light	USA	1969-78	1960	Observation
SH-3H	Medium	USN	1961-72	1950	Utility
S-76	Medium	USN	1982	1970	Utility
UH-60A	Medium	USA	1979	1970	Utility
CH-54B	Heavy	USA	1974	1960	Utility
CH-53D	Heavy	USN(MC)	1969	1960	Utility
CH-53E	Heavy	USN	1981	1970	Utility
AH-1S	Medium	USA	1970-81	1960	Attack
UH-1H	Medium	USA	1965-76	1950	Utility

In addition to original programs, two pre-existing computer programs were used to facilitate the accomplishment of the thesis objective. The data point plots were generated with 'Helicopter Data Display', written by Captain Gary Bishop, USA, [Ref 1], and the curve fit evaluation was accomplished with 'Crvfit', a Hewlett-Packard hand-held computer program, written by Commander Pat Sullivan, USN, [Ref 2]. The 'Helicopter Data Display' graphic output was re-sized to meet the requirements for thesis submission, and the pre-existing data base revised with additions of data from 3 more helicopters, a deletion of 1, and correction of some incorrect data. The 'Crvfit' program was used as is, with an acceptance criteria, called the correlation factor, of .8 or greater.

III. SOLUTION TO THE PROBLEM

Of the first 435 pairings, 153 were cut from consideration following an initial consultation with Thesis Advisor Prof. Donald Layton based on his own expertise. Those pairings disregarded from further evaluation are indicated by a prefixed "XX" in Appendix B. An example of pairings which were disregarded outright were those involving 'Degree Twist of Blades'. By experience, and verified thru conversations with helicopter company representatives, 'Twist of the Blade' has in the past been decided on by a 'what's on the shelf' selection criteria, thus explaining why some companies produce helicopters predominantly with a -10 degree twist, while others produce helicopters predominantly with a -8 degree twist, or, a 0 degree twist. 282 simple X-Y plots of the remaining pairings were then generated, with the first number of each pairing designated as the X-abcissa, or horizontal axis, and the second number, as the Y-ordinate, or vertical axis. Plots appear in Appendix C and are referenced with figure numbers consistent with the method used to reference the initial pairings (Example: Fig 1-30). The selection for further evaluation for determining curve fits was accomplished by empirically judging whether the data points tended to show that a relationship existed. Those figures referenced with a suffix 'a' indicate that a relationship does exist and a data point curve fit follows. The two examples are illustrated in Figures 3.1 and 3.2.

The data of the data points plots that were questionable were submitted to the Crvfit program which made the final decision as to whether there was an interrelationship with a resulting program correlation factor of .8 or greater.

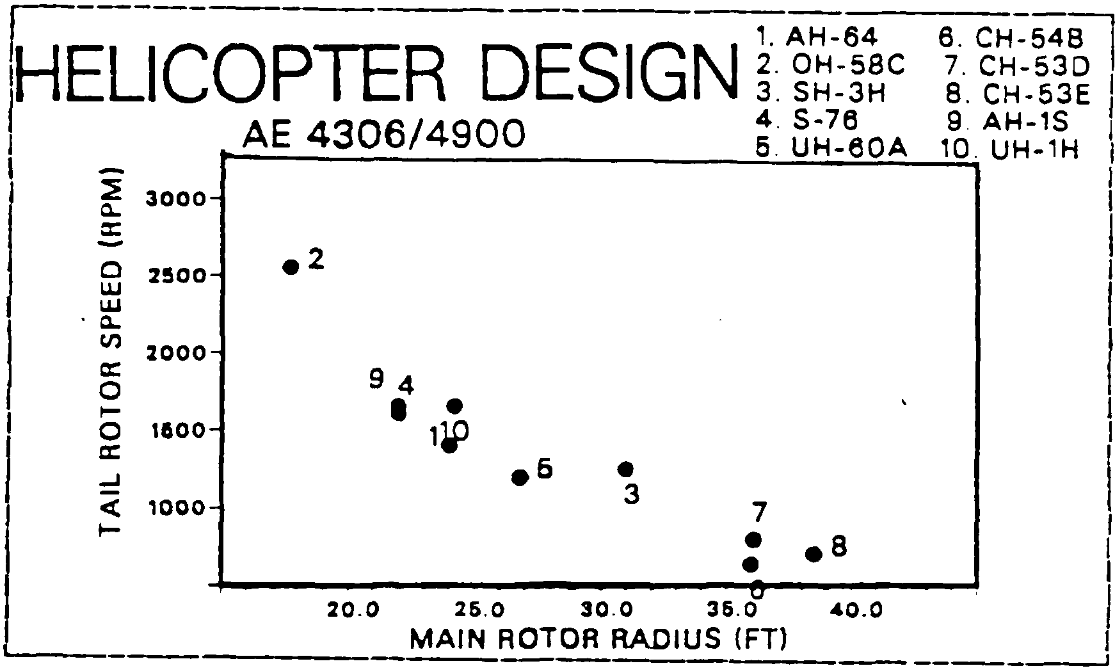


Figure 3.1 Data Point Plot Chosen to be Curve Fitted.

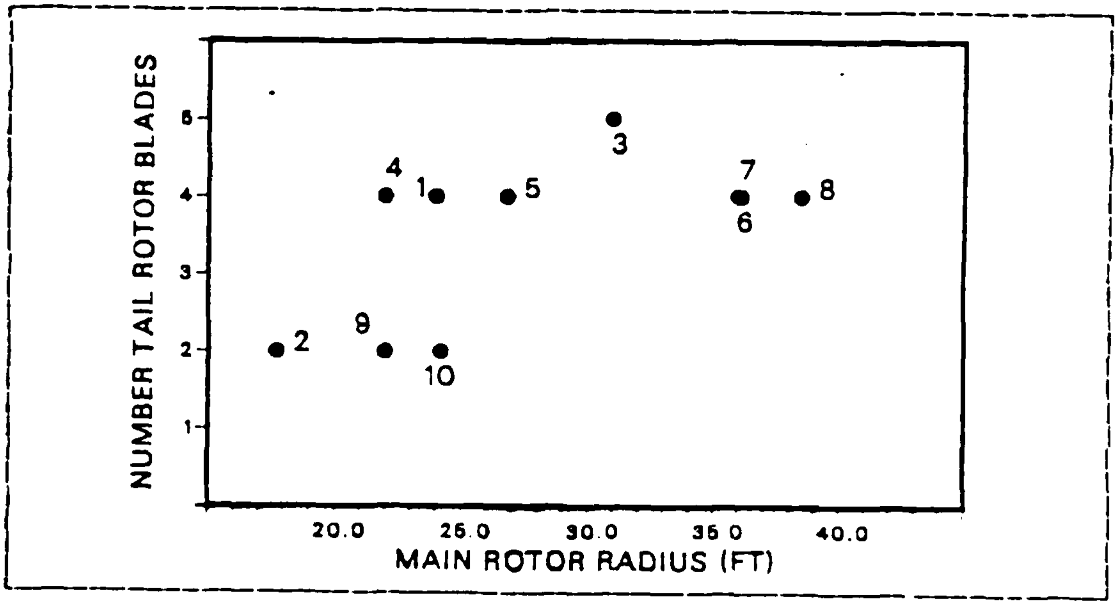


Figure 3.2 Data Point Plot Chosen Not to be Curve Fitted.

At the same time, the 'Crvfit' program determined which of 4 (four) curve types, linear (Type 1), exponential (Type 2), logarithmic (Type 3), or power (Type 4), best fit the data points plotted. An example of one of each of the 4 curves is illustrated in Figures 3.3 through 3.6. Curve fits for the respective pairings, referenced with a suffix 'b', indicating curve fit (Example: Fig 1-30b), and which includes the best curve fit equation, follow their respective data point plots in Appendix C.

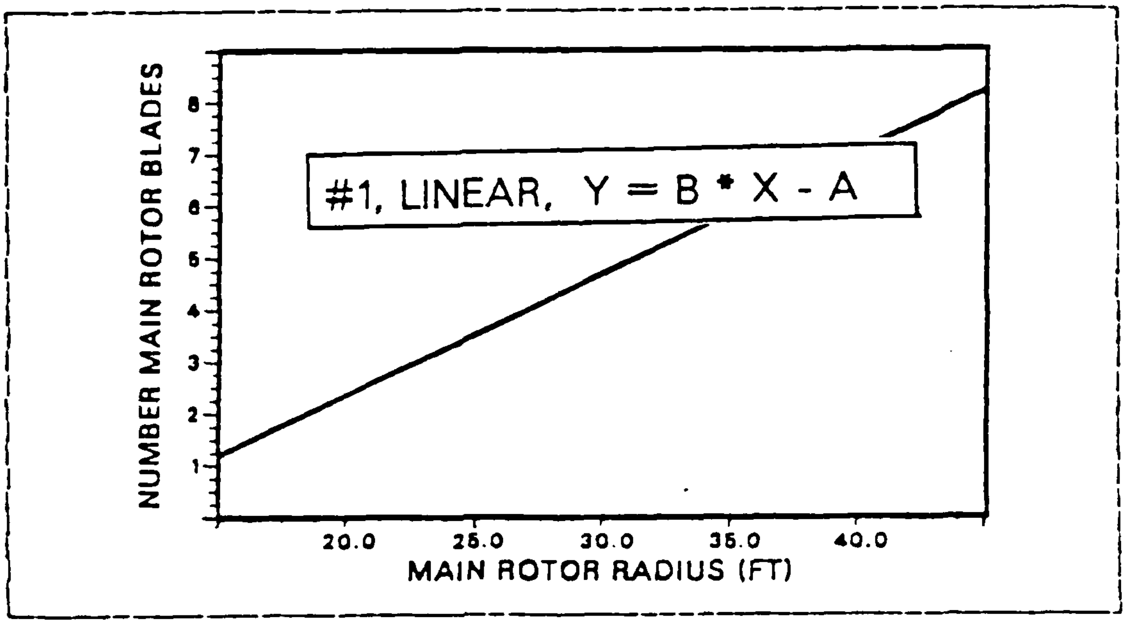


Figure 3.3 Example of Type 1 Curve Fit.

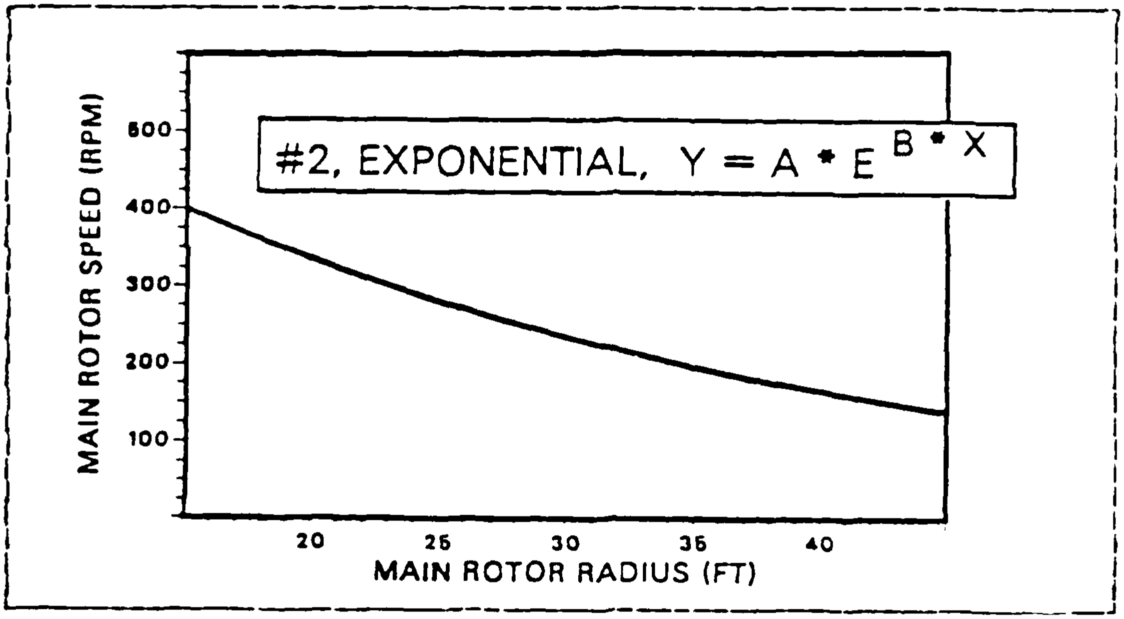


Figure 3.4 Example of Type 2 Curve Fit.

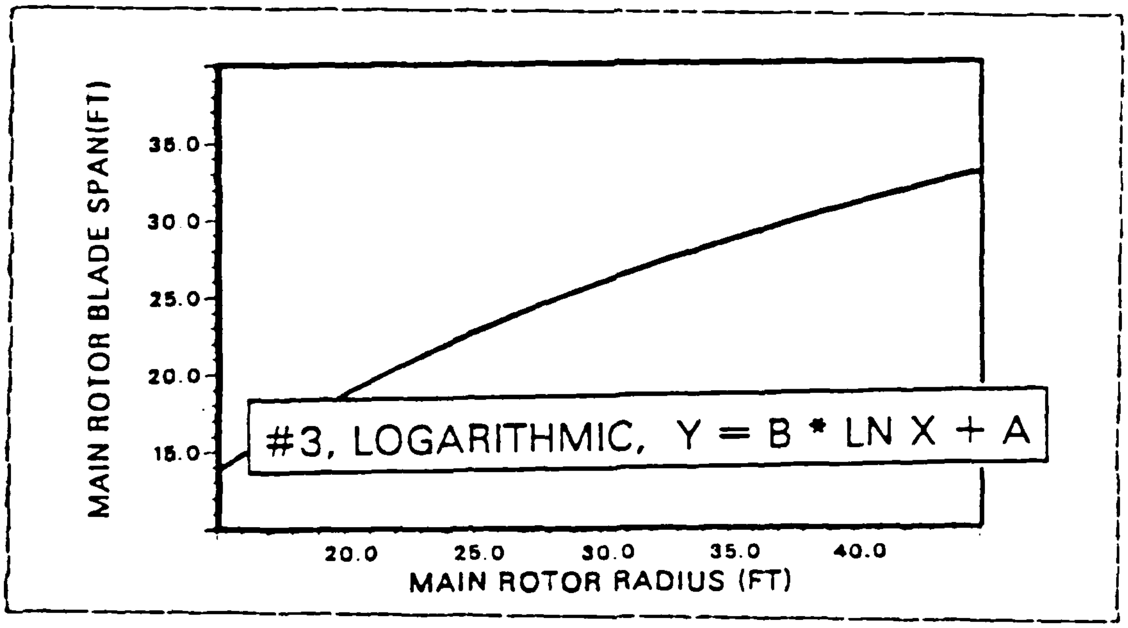


Figure 3.5 Example of Type 3 Curve Fit.

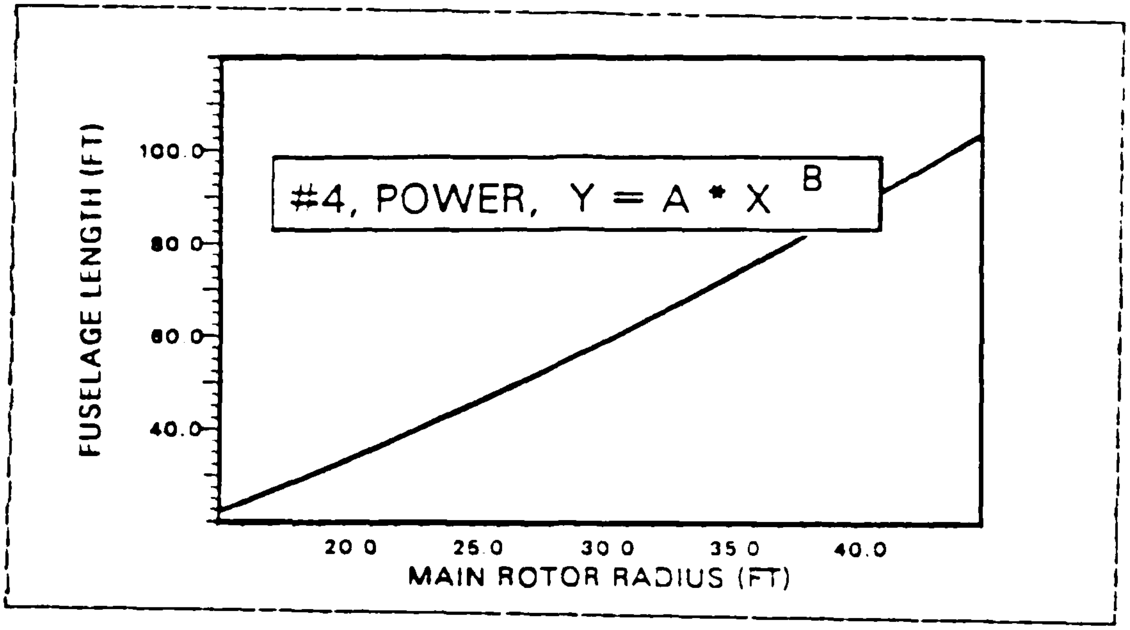


Figure 3.6 Example of Type 4 Curve Fit.

IV. RESULTS AND CONCLUSIONS

282 pairings were evaluated to determine whether an interrelationship existed between the selected design parameters. 185 were determined to produce positive curve fit data which met or exceeded the chosen correlation factor. Of the 30 design parameters selected for evaluation, the parameters Maximum Gross Weight and Operating Weight were most interactive, resulting in positive quantitative relationships with 16 other parameters. This is understandable for both parameters are geometric parameters, driven by mission and performance requirements and both influence many of the others. 10 design parameters had no influence, resulting in no relationship with any other parameter. A demonstration of the validity of the derived relationships is illustrated as follows where both the curve fit equation, and an alternate method (used in AE 4306 Helicopter Design Manual [Ref 3]), are used to generate specific design parameters of Gross Weight and Tail Rotor Radius. The results are compared to an existing, flying helicopter.

Required: Compute Gross Weight, MGW, as a function of Tail Rotor Radius, RTR, given as 2.6 feet.

Curve Fit Equation - $MGW = 324.88 \times RTR^{2.3829} = 3166$ lbs

AE 4306 Design Manual (Alternate Method) - $MGW = 591.716 \times RTR^{2.0} = 4000$ lbs

2.6 feet is the actual tail rotor radius of the OH58C Army Observation/Scout Helicopter whose actual Gross Weight is 2550 lbs.

By comparison, the curve fit equation generates a value of Gross Weight 24% above actual design, whereas the alternate method generates a value 52% above actual design.

Table 2 lists the number of relationships, or the influence of each design parameter upon each other.

TABLE 2

Resultant Relationships of Design Parameters

TABLE 2

Resultant Relationships of Design Parameters

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Total #
1	Main Rotor Radius (ft)		X	X			X	X		X	X	X					X		X	X							X	X	X	X	X	15
2	Tail Rotor Radius (ft)							X		X		X					X										X	X	X		X	9
3	Number of Main Rotor Blades				X		X	X			X						X		X	X								X	X	X	X	12
4	Number of Tail Rotor Blades																										X					2
5	Height of Main Rotor Above Ground (ft)						X												X	X							X	X			X	6
6	Speed of Main Rotor System (rpm)							X			X						X		X	X								X	X		X	11
7	Speed of Tail Rotor System (rpm)									X										X							X	X	X		X	10
8	Chord of Main Rotor (ft)									X																						2
9	Chord of Tail Rotor (ft)											X															X	X			X	8
10	Span of Main Rotor Blade (ft)																		X								X	X			X	7
11	Span of Tail Rotor Blade (ft)																			X							X	X	X		X	8
12	Twist of Main Rotor Blade (degrees)																															0
13	Twist of Tail Rotor Blade (degrees)																															0
14	Profile Drag of Main Rotor Blade																															0
15	Profile Drag of Tail Rotor Blade																		X										X			2
16	Disc Loading of Main Rotor (lb/sq ft)																			X							X	X			X	8
17	Width of Fuselage (ft)																															0
18	Length of Fuselage (ft)																			X							X	X	X		X	11
19	Frontal Horizontal Flat Plate Area (sq ft)																											X	X		X	11
20	Frontal Vertical Flat Plate Area (sq ft)																															0
21	Maximum Forward Velocity (knots)																															0
22	Maximum Range (nm)																															0
23	Rate of Climb (fpm)																															0
24	Hover Ceiling (IGE)																															0
25	Hover Ceiling (OGE)																															0
26	Length of Tail (ft)																											X	X		X	13
27	Operating Weight (lb)																												X	X	X	16
28	Load Weight (lb)																													X	X	13
29	Fuel Weight (lb)																														X	5
30	Maximum Gross Weight (lb)																															16

A. CONCLUSIONS

The objective of this thesis has been achieved by establishing the clear relationships that exist between selected Helicopter design parameters. The curve fit equations that were derived, and the specific constants for each equation, provide the designer, be he professional, in the industry, or student, a means to quantitatively derive values of design parameters that are encountered during the preliminary design process.

Until technological breakthroughs force a drastic departure from the established design norms developed over the last 30 years, the curve fit equations can produce a quantitative, quicker, and more optimum solution than the methods employed to date.

APPENDIX A

REFERENCES FOR DATA BASE AND HELICOPTERS

A. SELECTED DESIGN PARAMETERS AND NOMENCLATURE

TABLE 3

Selected Design Parameters and Nomenclature

Selected Design Parameters	Nomenclature
1. Main Rotor Radius (ft)	R
2. Tail Rotor Radius (ft)	RTR
3. Number of Main Rotor Blades	B
4. Number of Tail Rotor Blades	BTR
5. Height of Main Rotor System above Ground (ft)	HT
6. Speed of Main Rotor System (rpm)	RPM
7. Speed of Tail Rotor System (rpm)	RPMTR
8. Chord of the Main Rotor (ft)	C
9. Chord of the Tail Rotor (ft)	CTR
10. Span of the Main Rotor Blade (ft)	BS
11. Span of the Tail Rotor Blade (ft)	BSTR
12. Twist of Main Rotor Blade (degrees)	TWST
13. Twist of Tail Rotor Blade (degrees)	TWSTR
14. Profile Drag of Main Rotor Blade	CDO
15. Profile Drag of Tail Rotor Blade	CDOTR
16. Disc Loading of Main Rotor System (lb/sq ft)	DL
17. Width of the Fuselage (ft)	WDT
18. Length of the Fuselage (ft)	LGH
19. Frontal Horizontal Flat Plate Area (sq/ft)	FH
20. Frontal Vertical Flat Plate Area (sq/ft)	FV
21. Maximum Forward Velocity (knots)	VM
22. Maximum Range (nm)	
23. Rate of Climb, Maximum Continuous Power (fpm)	RC
24. Hover Ceiling (IGE, in ground effect)	HOVIGE
25. Hover Ceiling (OGE, out of ground effect)	HOVIGE
26. Length of Tail (ft)	LT
27. Operating Weight (lb)	OWT
28. Load Weight (lb)	LWT
29. Fuel Weight (lb)	FWT
30. Maximum Gross Weight (lb)	MGW

E. SELECTED DESIGN PARAMETER VALUES

TABLE 4

Selected Design Parameter Values

TABLE 4

Summary of Design Parameter Values

	AH64	OH58C	SH3H	S76	UH60A	CH54E	CH53D	CH53E	AH1S	JH1H
1. Main Rotor Radius (ft)	24.	17.7	31.	22.	26.8	36.0	36.1	18.5	22.0	24.2
2. Tail Rotor Radius (ft)	4.6	2.6	5.3	4.0	5.5	8.0	8.0	10.0	4.25	4.25
3. Number Main Rotor Blades	4	2	5	4	4	6	6	7	2	2
4. Number Tail Rotor Blades	4	2	5	4	4	4	4	4	2	2
5. Height of Main Rotor above Ground (ft)	12.6	9.6	14.3	10.0	11.2	17.6	15.8	16.0	12.2	13.1
6. Speed of Main Rotor System (rpm)	289	354	203	293	258	185	185	179	24	324
7. Speed of Tail Rotor System (1000 rpm)	1.4	2.55	1.24	1.61	1.19	.631	.792	.699	1.65	1.65
8. Chord of Main Rotor (ft)	1.75	1.08	1.52	1.29	1.75	1.97	2.17	2.44	2.5	1.75
9. Chord of Tail Rotor (ft)	.83	.44	.61	.54	.81	1.28	1.28	1.28	.92	.70
10. Span Main Rotor Blade (ft)	18.8	16.2	29.3	25.0	23.3	29.8	28.9	28.6	18.9	22.0
11. Span Tail Rotor Blade (ft)	3.1	2.3	4.0	3.3	4.25	6.45	6.45	6.53	3.9	3.8
12. Twist of Main Rotor Blade (Degrees)	-9	-10.6	-8	-10	-18	-8	-6	-13.6	-10	-10
13. Twist of Tail Rotor Blade (Degrees)	-8.8	0.0	0.0	-8	-18	-8	-8	-8	0	0
14. Profile Drag of Main Rotor Blade	.009	.009	.009	.009	.008	.0095	.0095	.009	.008	.008
15. Profile Drag of Tail Rotor Blade	.009	.0095	.0105	.015	.008	.0105	.0095	.0095	.011	.011
16. Disc Loading of Main Rotor (lb/sq ft)	8.1	4.68	6.96	6.58	8.95	10.3	10.3	15.0	6.57	5.25
17. Width of Fuselage (ft)	3.96	4.57	7.08	7.0	7.75	7.08	8.83	5.83	11.7	8.6
18. Length of Fuselage (ft)	49.1	23.0	55.2	43.4	50.1	70.2	67.2	99.0	44.3	41.4
19. Frontal Horizontal Flat Plate Area (sq ft)	45.8	13.0	31.2	11.6	25.7	65.0	47.3	63.6	22.3	19.3
20. Frontal Vertical Flat Plate Area (sq ft)	34.7	15.8	36.0	30.0	30.8	99.4	90.0	120.	37.0	39.2
21. Maximum Forward Velocity (knots)	154	116	120	155	156	110	164	146	190	120
22. Maximum Range (nm)	246	330	505	404	275	200	242	430	230	266
23. Rate of Climb (1000 fpm)	2.88	1.42	1.31	1.35	.45	1.7	2.18	2.75	1.62	1.6
24. Hover Ceiling (IGE, 1000 ft)	14.2	7.1	3.7	6.2	7.8	6.3	14.0	6.0	12.2	12.5
25. Hover Ceiling (OGE, 1000 ft)	11.02	4.2	4.0	2.8	3.9	2.4	8.0	1.4	5.0	4.0
26. Length of Tail (ft)	29.7	15.2	36.6	26.5	31.5	44.5	44.5	48.0	21.7	20.9
27. Operating Weight (1000 lbs)	11.02	1.155	13.6	5.6	10.68	19.23	23.63	33.23	6.60	5.21
28. Load Weight (1000 lbs)	2.021	.995	1.759	2.517	7.226	14.19	14.03	24.79	1.64	2.863
29. Fuel Weight (1000 lbs)	1.624	.4	5.641	1.883	2.345	8.58	4.338	15.48	1.76	14.26
30. Max Gross Weight (1000 lbs)	14.6	2.55	21.0	10.0	20.25	42.0	42.0	73.5	10.0	9.5

C. HELICOPTER PLANFORMS AND PICTURES

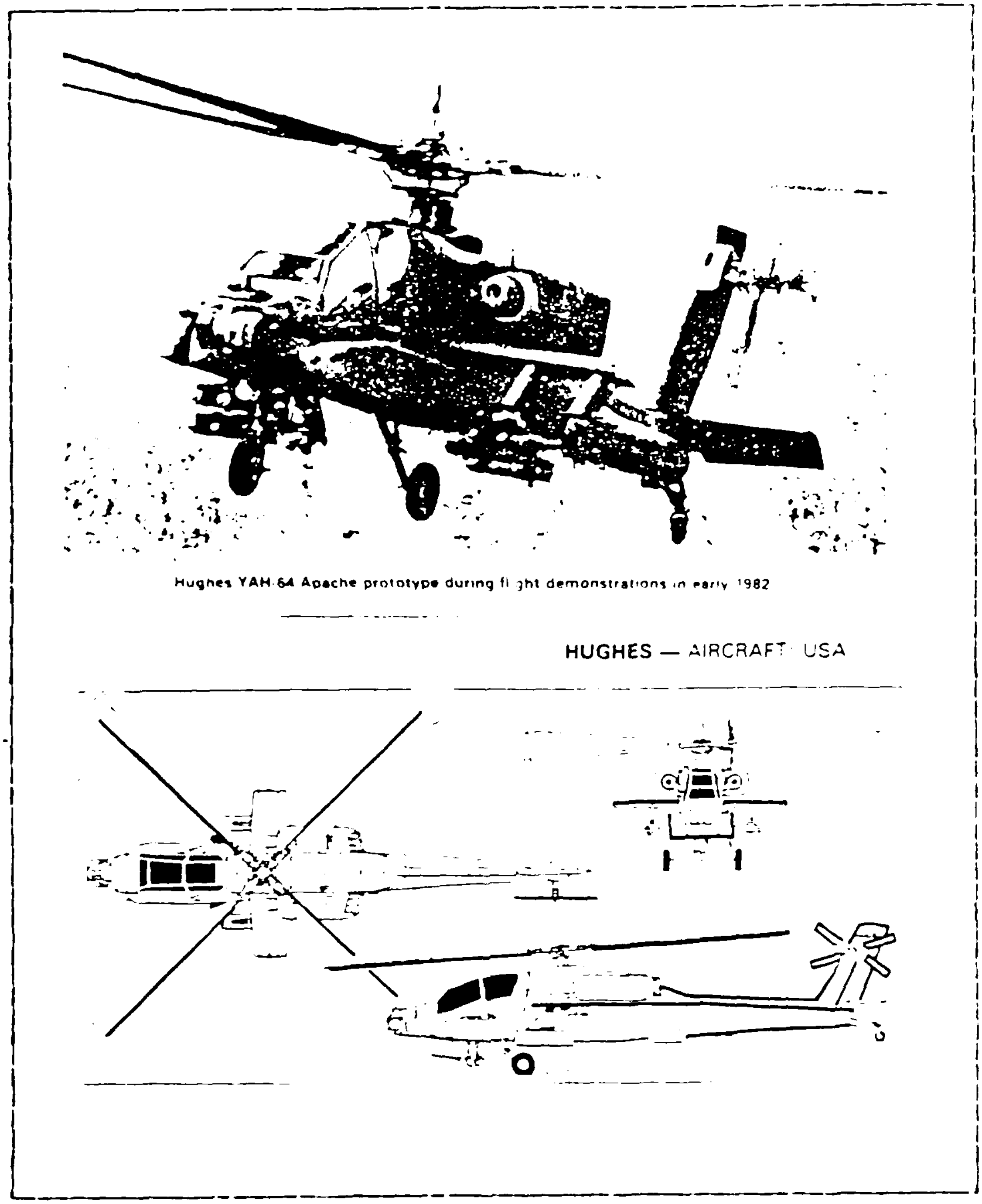
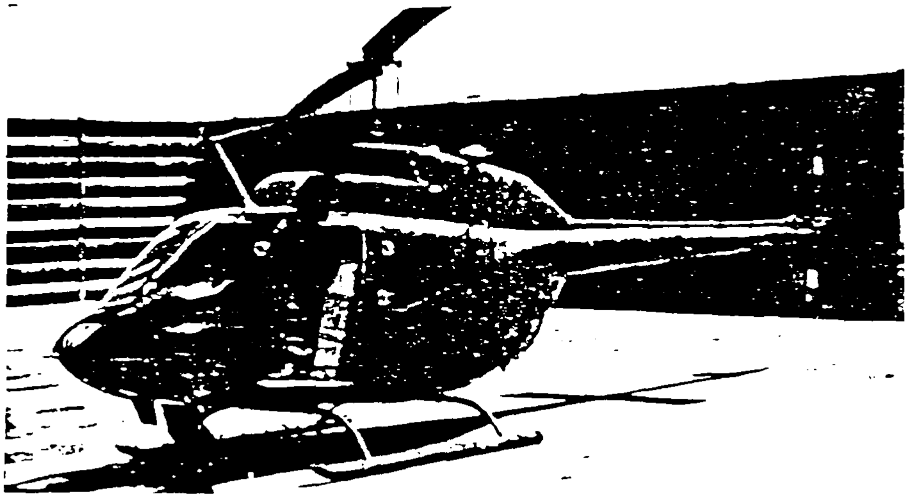


Figure A. 1 AH64 Planform.



Bell OH-58A Kiowa turbine-powered light observation helicopter in US Army service (Norman Taylor)

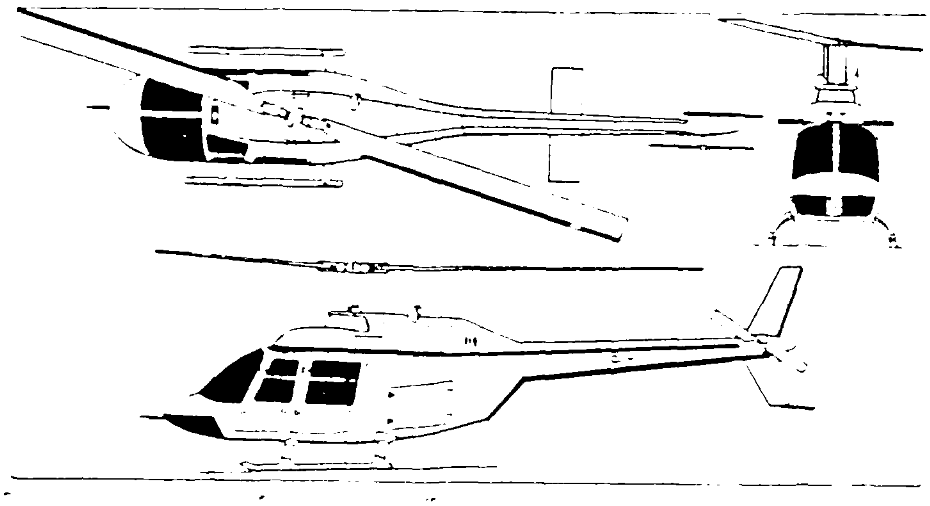
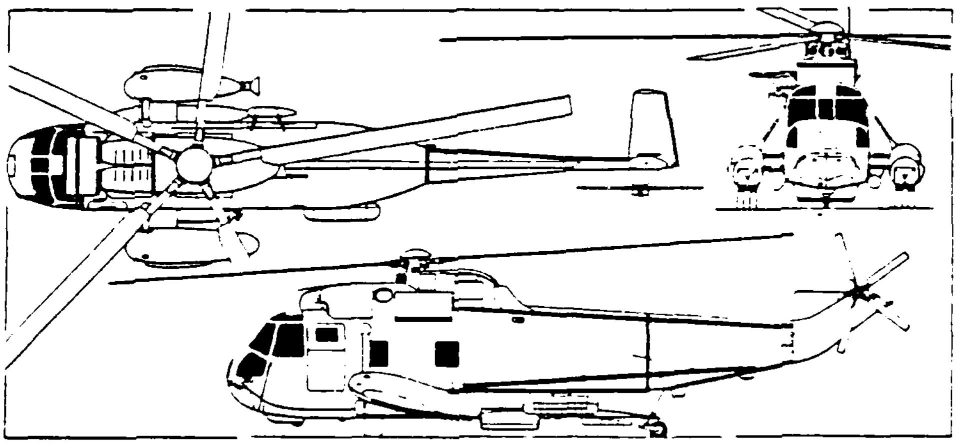


Figure A.2 OH58C Planform.

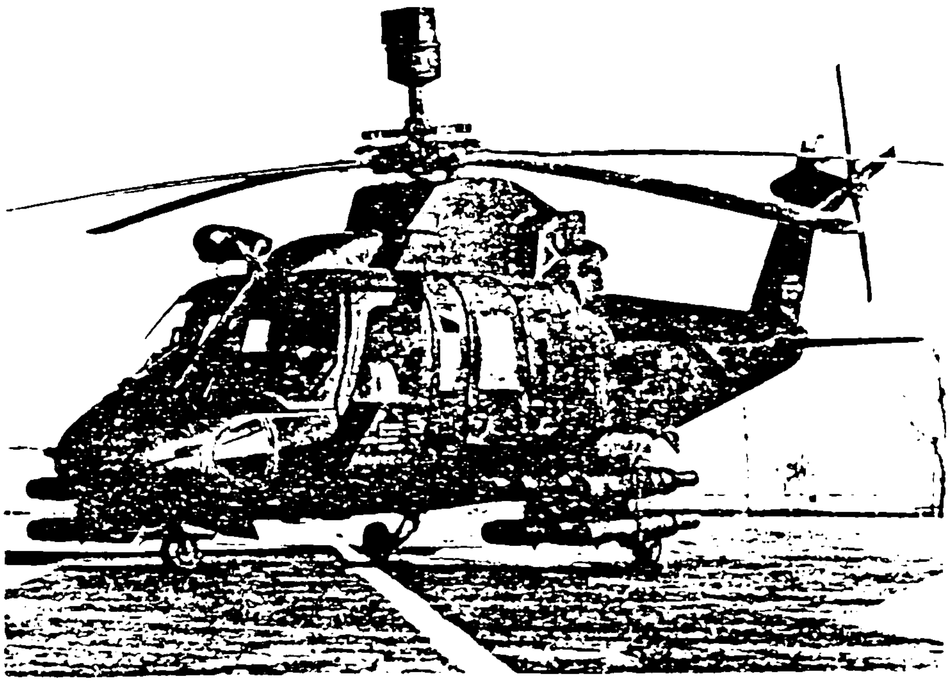
Sikorsky SH-3H multi-purpose helicopter for ASW and expansion of fleet missile defence

SIKORSKY — AIRCRAFT: USA 471

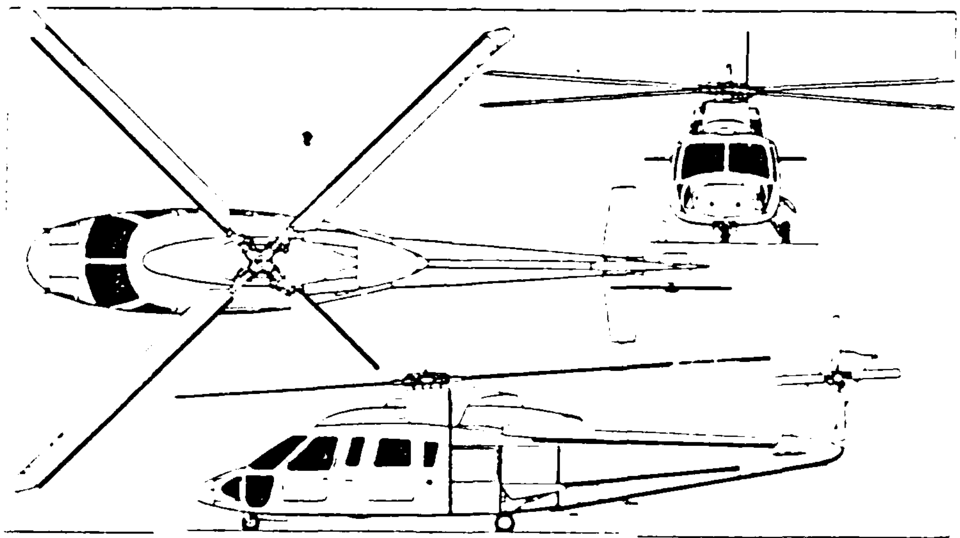


Sikorsky SH-3H twin-engined multi-purpose amphibious helicopter *(Pilot Press)*

Figure A.3 SH-3H Planform.



Sikorsky AUH-76 armed utility helicopter, with externally mounted anti-armour missiles

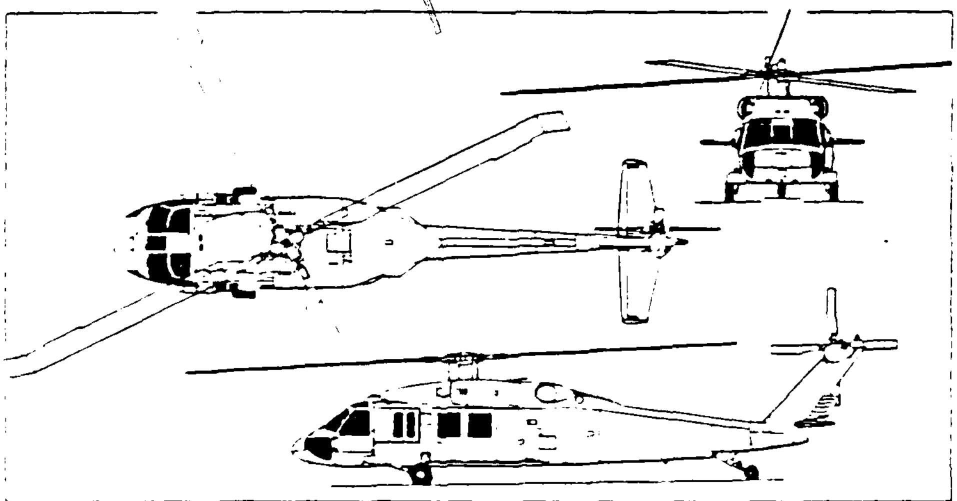


Sikorsky S-76 eight/twelve-passenger commercial transport helicopter

Figure A.4 S-76 Planform.

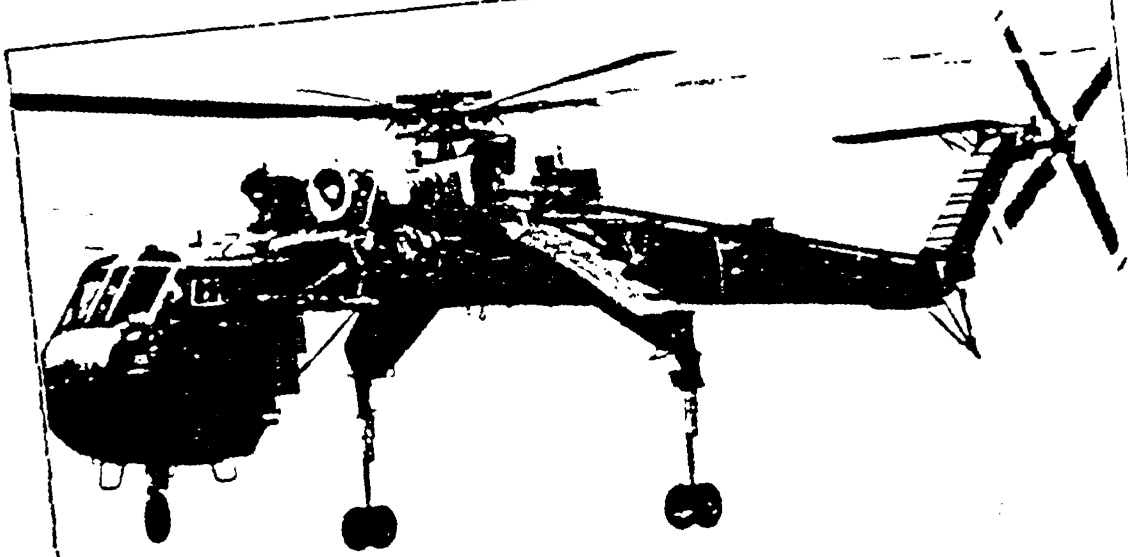
USA: AIRCRAFT — SIKORSKY

UH-60A Black Hawk, equipped with external stores support system, carrying 16 Hellfire missiles in flight qualification test



Sikorsky UH-60A Black Hawk combat assault helicopter (*Pilot Press*)

Figure A.5 UH-60A Planform.



Sikorsky CH-54B of the US Army new heavy-lift utility version of the Skycrane

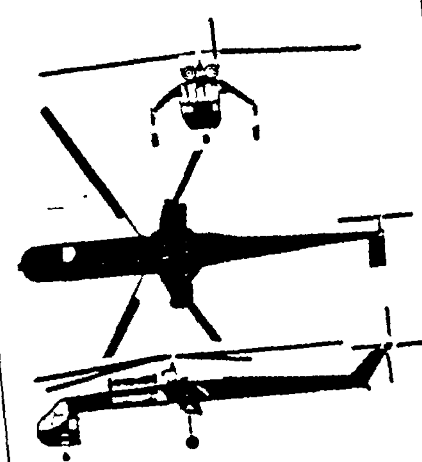
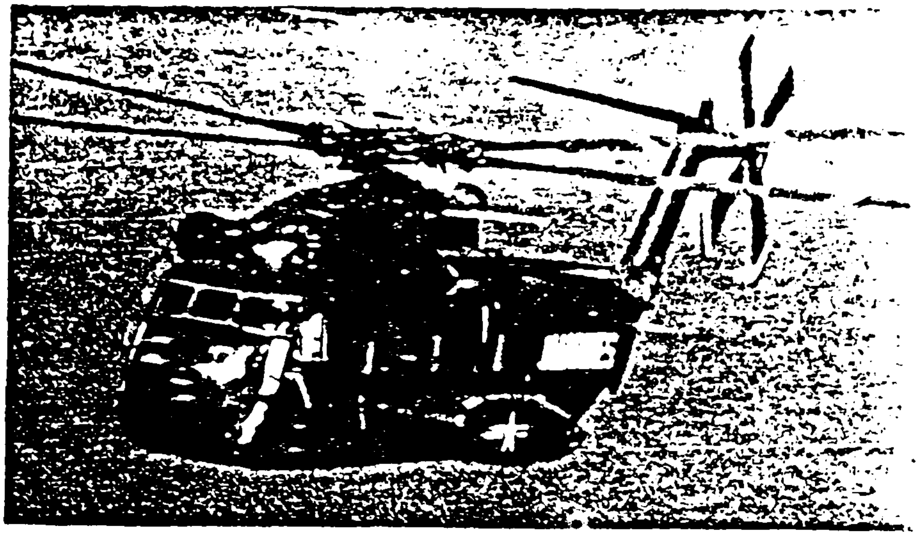


Figure A.6 CH-54B Planform.



Sikorsky CH-53D helicopter of the US Marine Corps

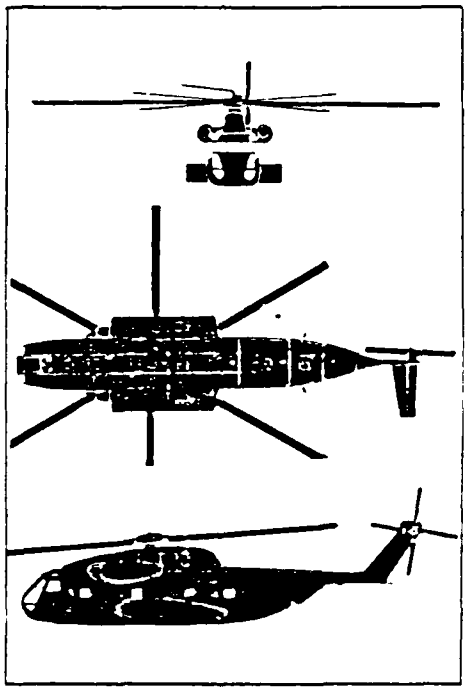
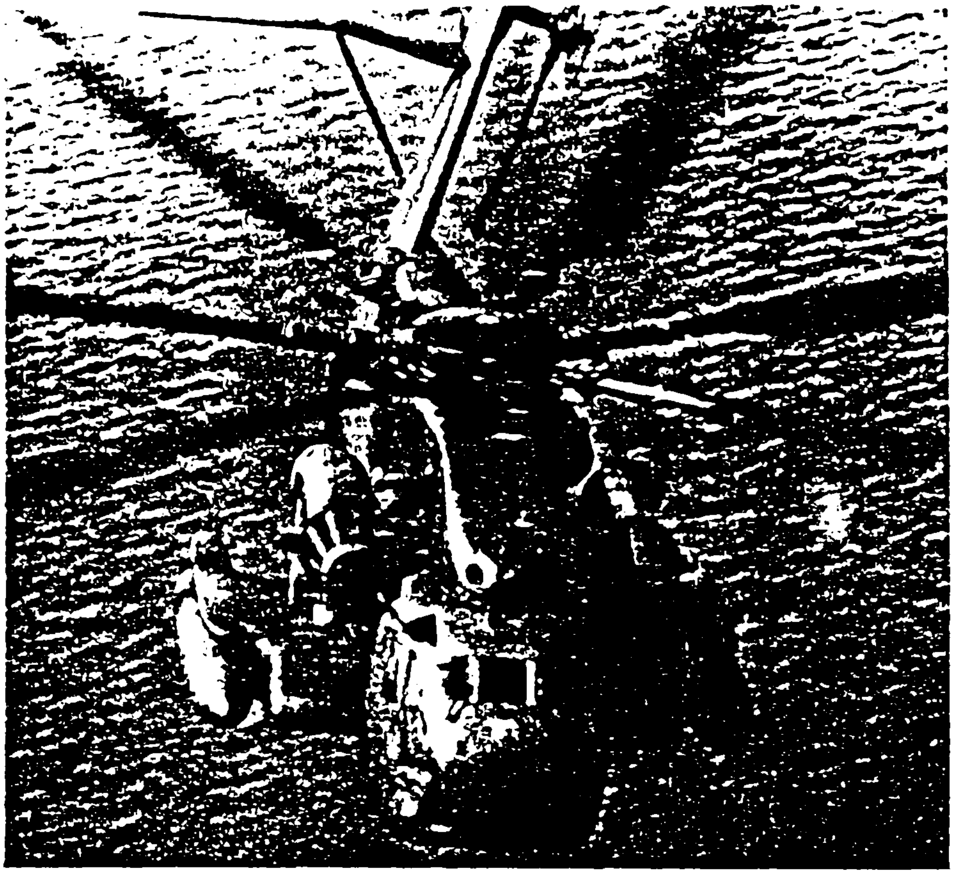
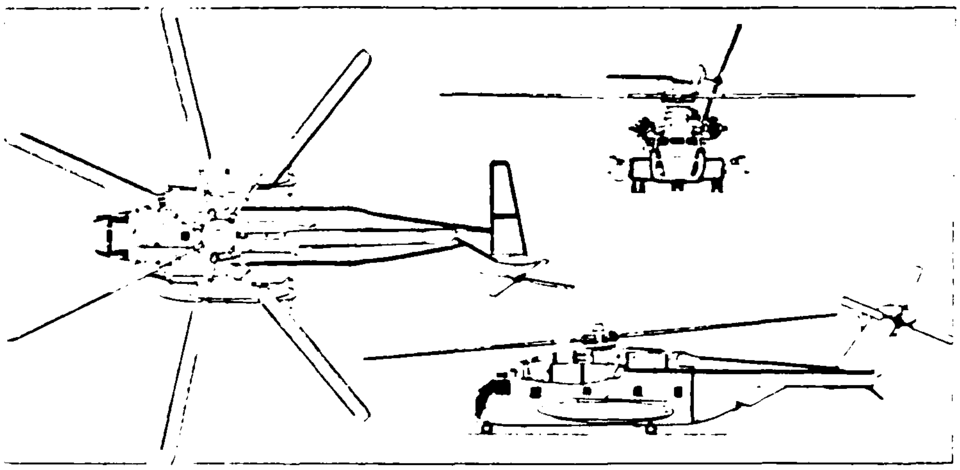


Figure A.7 CH-53D Planform.



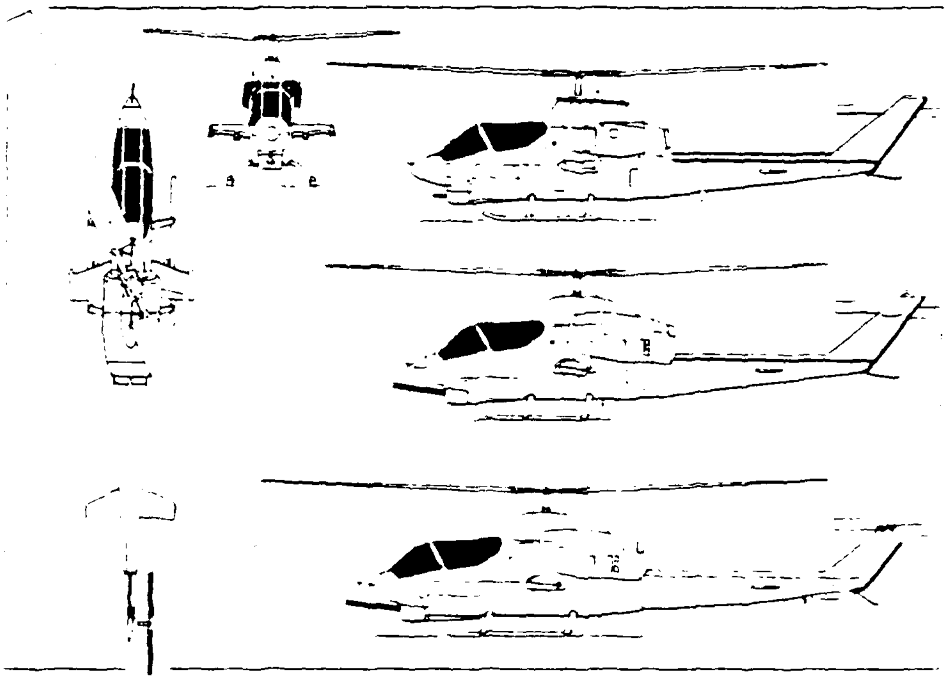
Sikorsky CH-53E Super Stallion heavy-lift helicopter (three General Electric T64-GE-416 turboshaft engines)



Sikorsky CH-53E Super Stallion heavy-lift helicopter (Pilot Press)

Figure A.8 CH-53E Planform.

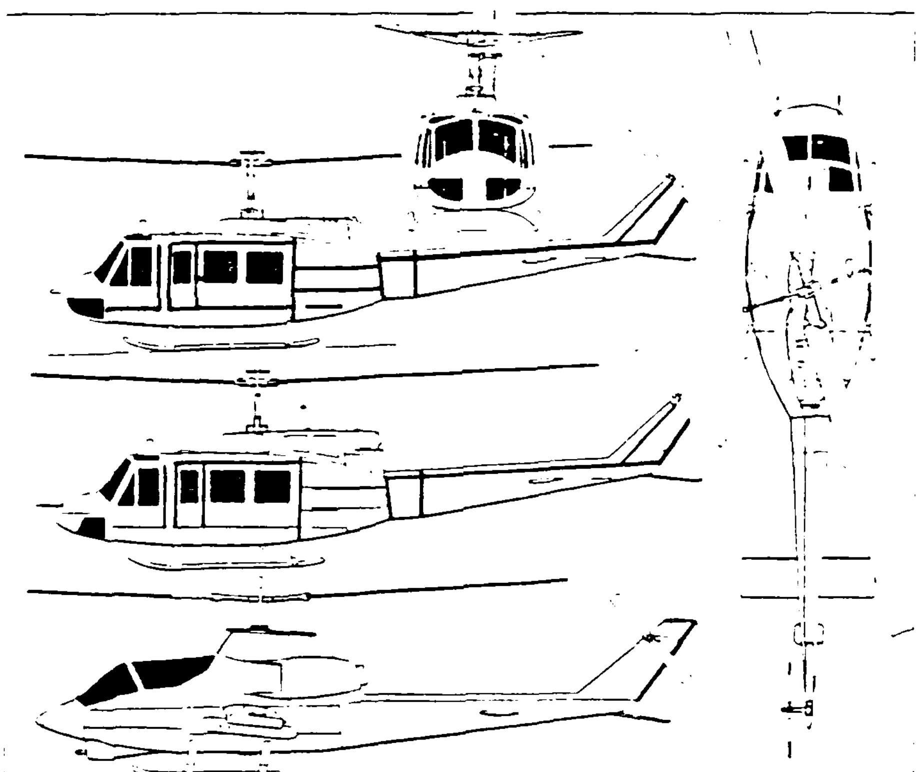
Bell AH-1S TOW-Cobra with flat plate canopy and missile launchers (J. M. G. Gradidge)



Bell AH-1T SeaCobra, with additional side views of AH-1J (centre) and AH-1G (top) (Pilot Press)

Figure A.9 AH-1S Planform.

Bell HH-1H Iroquois local base rescue helicopter in USAF service



Bell UH-1H Iroquois, with additional side views of UH-1N (centre) and AH-1G HueyCobra (bottom)

Figure A.10 UH-1H Planform.

APPENDIX 3

CRITICAL DESIGN PARAMETER PAIRINGS AND REFERENCE SYSTEM

TABLE 5

Main Rotor Radius Pairings

1 - MAIN ROTOR BLADE RADIUS IN FEET
2 - TAIL ROTOR BLADE RADIUS IN FEET

1 - MAIN ROTOR BLADE RADIUS IN FEET
3 - NUMBER OF MAIN ROTOR BLADES

1 - MAIN ROTOR BLADE RADIUS IN FEET
4 - NUMBER OF TAIL ROTOR BLADES

1 - MAIN ROTOR BLADE RADIUS IN FEET
5 - HEIGHT OF MAIN ROTOR SYSTEM ABOVE GROUND IN FEET

1 - MAIN ROTOR BLADE RADIUS IN FEET
6 - SPEED OF MAIN ROTOR SYSTEM IN RPM

1 - MAIN ROTOR BLADE RADIUS IN FEET
7 - SPEED OF TAIL ROTOR SYSTEM IN RPM

1 - MAIN ROTOR BLADE RADIUS IN FEET
8 - CHORD OF MAIN ROTOR BLADE IN FEET

1 - MAIN ROTOR BLADE RADIUS IN FEET
9 - CHORD OF TAIL ROTOR BLADE IN FEET

1 - MAIN ROTOR BLADE RADIUS IN FEET
10 - SPAN OF MAIN ROTOR BLADE IN FEET

1 - MAIN ROTOR BLADE RADIUS IN FEET
11 - SPAN OF TAIL ROTOR BLADE IN FEET

1 - MAIN ROTOR BLADE RADIUS IN FEET
12 - TWIST OF MAIN ROTOR BLADE IN DEGREES

KK 1 - MAIN ROTOR BLADE RADIUS IN FEET
13 - TWIST OF TAIL ROTOR BLADE IN DEGREES

1 - MAIN ROTOR BLADE RADIUS IN FEET
14 - PROFILE DRAG OF MAIN ROTOR BLADE

KK 1 - MAIN ROTOR BLADE RADIUS IN FEET
15 - PROFILE DRAG OF TAIL ROTOR BLADE

KK 1 - MAIN ROTOR BLADE RADIUS IN FEET
16 - DISC LOADING OF THE MAIN ROTOR SYSTEM

KK 1 - MAIN ROTOR BLADE RADIUS IN FEET
17 - WIDTH OF THE FUSELAGE IN FEET

1 - MAIN ROTOR BLADE RADIUS IN FEET
18 - LENGTH OF THE FUSELAGE IN FEET

1 - MAIN ROTOR BLADE RADIUS IN FEET
19 - FRONTAL FLAT PLATE AREA IN SQUARE FEET

1 - MAIN ROTOR BLADE RADIUS IN FEET
20 - VERTICAL FLAT PLATE AREA IN SQUARE FEET

1 - MAIN ROTOR BLADE RADIUS IN FEET
21 - MAXIMUM VELOCITY IN KNOTS

1 - MAIN ROTOR BLADE RADIUS IN FEET
22 - MAXIMUM RANGE IN NAUTICAL MILES

1 - MAIN ROTOR BLADE RADIUS IN FEET
23 - RATE OF CLIMB IN FEET PER MINUTE,
MAXIMUM CONTINUOUS POWER

1 - MAIN ROTOR BLADE RADIUS IN FEET
24 - HOVER CEILING (IN GROUND EFFECT)
IN FEET

1 - MAIN ROTOR BLADE RADIUS IN FEET
25 - HOVER CEILING (OUT OF GROUND EFFECT)
IN FEET

1 - MAIN ROTOR BLADE RADIUS IN FEET
26 - LENGTH OF THE TAILBOOM IN FEET

1 - MAIN ROTOR BLADE RADIUS IN FEET
27 - OPERATING WEIGHT IN POUNDS

1 - MAIN ROTOR BLADE RADIUS IN FEET
28 - LOAD WEIGHT IN POUNDS

1 - MAIN ROTOR BLADE RADIUS IN FEET
29 - FUEL WEIGHT IN POUNDS

1 - MAIN ROTOR BLADE RADIUS IN FEET
30 - MAXIMUM GROSS WEIGHT IN POUNDS

TABLE 6

Tail Rotor Radius Pairings

XX 2 - TAIL ROTOR BLADE RADIUS IN FEET
3 - NUMBER OF MAIN ROTOR BLADES

2 - TAIL ROTOR BLADE RADIUS IN FEET
4 - NUMBER OF TAIL ROTOR BLADES

XX 2 - TAIL ROTOR BLADE RADIUS IN FEET
5 - HEIGHT OF MAIN ROTOR SYSTEM ABOVE GROUND IN FEET

XX 2 - TAIL ROTOR BLADE RADIUS IN FEET
6 - SPEED OF MAIN ROTOR SYSTEM IN RPM

2 - TAIL ROTOR BLADE RADIUS IN FEET
7 - SPEED OF TAIL ROTOR SYSTEM IN RPM

XX 2 - TAIL ROTOR BLADE RADIUS IN FEET
8 - CHORD OF MAIN ROTOR BLADE IN FEET

2 - TAIL ROTOR BLADE RADIUS IN FEET
9 - CHORD OF TAIL ROTOR BLADE IN FEET

XX 2 - TAIL ROTOR BLADE RADIUS IN FEET
10 - SPAN OF MAIN ROTOR BLADE IN FEET

2 - TAIL ROTOR BLADE RADIUS IN FEET
11 - SPAN OF TAIL ROTOR BLADE IN FEET

XX 2 - TAIL ROTOR BLADE RADIUS IN FEET
12 - TWIST OF MAIN ROTOR BLADE IN DEGREES

2 - TAIL ROTOR BLADE RADIUS IN FEET
13 - TWIST OF TAIL ROTOR BLADE IN DEGREES

XX 2 - TAIL ROTOR BLADE RADIUS IN FEET
14 - PROFILE DRAG OF MAIN ROTOR BLADE

2 - TAIL ROTOR BLADE RADIUS IN FEET
15 - PROFILE DRAG OF TAIL ROTOR BLADE

2 - TAIL ROTOR BLADE RADIUS IN FEET
16 - DISC LOADING OF THE MAIN ROTOR SYSTEM

XX 2 - TAIL ROTOR BLADE RADIUS IN FEET
17 - WIDTH OF THE FUSELAGE IN FEET

XX 2 - TAIL ROTOR BLADE RADIUS IN FEET
18 - LENGTH OF THE FUSELAGE IN FEET

XX 2 - TAIL ROTOR BLADE RADIUS IN FEET
19 - FRONTAL FLAT PLATE AREA IN SQUARE FEET

XX 2 - TAIL ROTOR BLADE RADIUS IN FEET
20 - VERTICAL FLAT PLATE AREA IN SQUARE FEET

2 - TAIL ROTOR BLADE RADIUS IN FEET
21 - MAXIMUM VELOCITY IN KNOTS

XX 2 - TAIL ROTOR BLADE RADIUS IN FEET
22 - MAXIMUM RANGE IN NAUTICAL MILES

2 - TAIL ROTOR BLADE RADIUS IN FEET
23 - RATE OF CLIMB IN FEET PER MINUTE, MAXIMUM CONTINUOUS POWER

2 - TAIL ROTOR BLADE RADIUS IN FEET
24 - HOVER CEILING (IN GROUND EFFECT) IN FEET

2 - TAIL ROTOR BLADE RADIUS IN FEET
25 - HOVER CEILING (OUT OF GROUND EFFECT) IN FEET

2 - TAIL ROTOR BLADE RADIUS IN FEET
26 - LENGTH OF THE TAILBOOM IN FEET

2 - TAIL ROTOR BLADE RADIUS IN FEET
27 - OPERATING WEIGHT IN POUNDS

2 - TAIL ROTOR BLADE RADIUS IN FEET
28 - LOAD WEIGHT IN POUNDS

XX 2 - TAIL ROTOR BLADE RADIUS IN FEET
29 - FUEL WEIGHT IN POUNDS

2 - TAIL ROTOR BLADE RADIUS IN FEET
30 - MAXIMUM GROSS WEIGHT IN POUNDS

TABLE 7

Number of Main Rotor Blades Pairings

3 - NUMBER OF MAIN ROTOR BLADES
4 - NUMBER OF TAIL ROTOR BLADES

3 - NUMBER OF MAIN ROTOR BLADES
5 - HEIGHT OF MAIN ROTOR SYSTEM ABOVE GROUND IN FEET

3 - NUMBER OF MAIN ROTOR BLADES
6 - SPEED OF MAIN ROTOR SYSTEM IN RPM

3 - NUMBER OF MAIN ROTOR BLADES
7 - SPEED OF TAIL ROTOR SYSTEM IN RPM

3 - NUMBER OF MAIN ROTOR BLADES
8 - CHORD OF MAIN ROTOR BLADE IN FEET

XX 3 - NUMBER OF MAIN ROTOR BLADES
9 - CHORD OF TAIL ROTOR BLADE IN FEET

3 - NUMBER OF MAIN ROTOR BLADES
10 - SPAN OF MAIN ROTOR BLADE IN FEET

XX 3 - NUMBER OF MAIN ROTOR BLADES
11 - SPAN OF TAIL ROTOR BLADE IN FEET

3 - NUMBER OF MAIN ROTOR BLADES
12 - TWIST OF MAIN ROTOR BLADE IN DEGREES

XX 3 - NUMBER OF MAIN ROTOR BLADES
13 - TWIST OF TAIL ROTOR BLADE IN DEGREES

3 - NUMBER OF MAIN ROTOR BLADES
14 - PROFILE DRAG OF MAIN ROTOR BLADE

XX 3 - NUMBER OF MAIN ROTOR BLADES
15 - PROFILE DRAG OF TAIL ROTOR BLADE

3 - NUMBER OF MAIN ROTOR BLADES
16 - DISC LOADING OF THE MAIN ROTOR SYSTEM

3 - NUMBER OF MAIN ROTOR BLADES
17 - WIDTH OF THE FUSELAGE IN FEET

3 - NUMBER OF MAIN ROTOR BLADES
18 - LENGTH OF THE FUSELAGE IN FEET

3 - NUMBER OF MAIN ROTOR BLADES
19 - FRONTAL FLAT PLATE AREA IN SQUARE FEET

```
XX  3 - NUMBER OF MAIN ROTOR BLADES
   20 - VERTICAL FLAT PLATE AREA IN SQUARE FEET

    3 - NUMBER OF MAIN ROTOR BLADES
   21 - MAXIMUM VELOCITY IN KNOTS

    3 - NUMBER OF MAIN ROTOR BLADES
   22 - MAXIMUM RANGE IN NAUTICAL MILES

    3 - NUMBER OF MAIN ROTOR BLADES
   23 - RATE OF CLIMB IN FEET PER MINUTE,
        MAXIMUM CONTINUOUS POWER

    3 - NUMBER OF MAIN ROTOR BLADES
   24 - HOVER CEILING (IN GROUND EFFECT)
        IN FEET

    3 - NUMBER OF MAIN ROTOR BLADES
   25 - HOVER CEILING (OUT OF GROUND EFFECT)
        IN FEET

    3 - NUMBER OF MAIN ROTOR BLADES
   26 - LENGTH OF THE TAILBOOM IN FEET

    3 - NUMBER OF MAIN ROTOR BLADES
   27 - OPERATING WEIGHT IN POUNDS

    3 - NUMBER OF MAIN ROTOR BLADES
   28 - LOAD WEIGHT IN POUNDS

    3 - NUMBER OF MAIN ROTOR BLADES
   29 - FUEL WEIGHT IN POUNDS

    3 - NUMBER OF MAIN ROTOR BLADES
   30 - MAXIMUM GROSS WEIGHT IN POUNDS
```

TABLE 8

Number of Tail Rotor Blades Pairings

```
XX   4 - NUMBER OF TAIL ROTOR BLADES
     5 - HEIGHT OF MAIN ROTOR SYSTEM ABOVE
         GROUND IN FEET

XX   4 - NUMBER OF TAIL ROTOR BLADES
     6 - SPEED OF MAIN ROTOR SYSTEM IN RPM

     4 - NUMBER OF TAIL ROTOR BLADES
     7 - SPEED OF TAIL ROTOR SYSTEM IN RPM

XX   4 - NUMBER OF TAIL ROTOR BLADES
     8 - CHORD OF MAIN ROTOR BLADE IN FEET

     4 - NUMBER OF TAIL ROTOR BLADES
     9 - CHORD OF TAIL ROTOR BLADE IN FEET

XX   4 - NUMBER OF TAIL ROTOR BLADES
    10 - SPAN OF MAIN ROTOR BLADE IN FEET

     4 - NUMBER OF TAIL ROTOR BLADES
    11 - SPAN OF TAIL ROTOR BLADE IN FEET

XX   4 - NUMBER OF TAIL ROTOR BLADES
    12 - TWIST OF MAIN ROTOR BLADE IN DEGREES

     4 - NUMBER OF TAIL ROTOR BLADES
    13 - TWIST OF TAIL ROTOR BLADE IN DEGREES

XX   4 - NUMBER OF TAIL ROTOR BLADES
    14 - PROFILE DRAG OF MAIN ROTOR BLADE

     4 - NUMBER OF TAIL ROTOR BLADES
    15 - PROFILE DRAG OF TAIL ROTOR BLADE

XX   4 - NUMBER OF TAIL ROTOR BLADES
    16 - DISC LOADING OF THE MAIN ROTOR SYSTEM

XX   4 - NUMBER OF TAIL ROTOR BLADES
    17 - WIDTH OF THE FUSELAGE IN FEET

     4 - NUMBER OF TAIL ROTOR BLADES
    18 - LENGTH OF THE FUSELAGE IN FEET

XX   4 - NUMBER OF TAIL ROTOR BLADES
    19 - FRONTAL FLAT PLATE AREA IN SQUARE FEET

XX   4 - NUMBER OF TAIL ROTOR BLADES
    20 - VERTICAL FLAT PLATE AREA IN SQUARE FEET
```

4 - NUMBER OF TAIL ROTOR BLADES
21 - MAXIMUM VELOCITY IN KNOTS

XX 4 - NUMBER OF TAIL ROTOR BLADES
22 - MAXIMUM RANGE IN NAUTICAL MILES

XX 4 - NUMBER OF TAIL ROTOR BLADES
23 - RATE OF CLIMB IN FEET PER MINUTE, MAXIMUM CONTINUOUS POWER

4 - NUMBER OF TAIL ROTOR BLADES
24 - HOVER CEILING (IN GROUND EFFECT) IN FEET

4 - NUMBER OF TAIL ROTOR BLADES
25 - HOVER CEILING (OUT OF GROUND EFFECT) IN FEET

4 - NUMBER OF TAIL ROTOR BLADES
26 - LENGTH OF THE TAILBOOM IN FEET

4 - NUMBER OF TAIL ROTOR BLADES
27 - OPERATING WEIGHT IN POUNDS

4 - NUMBER OF TAIL ROTOR BLADES
28 - LOAD WEIGHT IN POUNDS

4 - NUMBER OF TAIL ROTOR BLADES
29 - FUEL WEIGHT IN POUNDS

4 - NUMBER OF TAIL ROTOR BLADES
30 - MAXIMUM GROSS WEIGHT IN POUNDS

TABLE 9

Height of Main Rotor System Pairings

	5 -	HEIGHT OF MAIN ROTOR SYSTEM ABOVE GROUND IN FEET
	6 -	SPEED OF MAIN ROTOR SYSTEM IN RPM
XX	5 -	HEIGHT OF MAIN ROTOR SYSTEM ABOVE GROUND IN FEET
	7 -	SPEED OF TAIL ROTOR SYSTEM IN RPM
	5 -	HEIGHT OF MAIN ROTOR SYSTEM ABOVE GROUND IN FEET
	8 -	CHORD OF MAIN ROTOR BLADE IN FEET
XX	5 -	HEIGHT OF MAIN ROTOR SYSTEM ABOVE GROUND IN FEET
	9 -	CHORD OF TAIL ROTOR BLADE IN FEET
XX	5 -	HEIGHT OF MAIN ROTOR SYSTEM ABOVE GROUND IN FEET
	10 -	SPAN OF MAIN ROTOR BLADE IN FEET
XX	5 -	HEIGHT OF MAIN ROTOR SYSTEM ABOVE GROUND IN FEET
	11 -	SPAN OF TAIL ROTOR BLADE IN FEET
XX	5 -	HEIGHT OF MAIN ROTOR SYSTEM ABOVE GROUND IN FEET
	12 -	TWIST OF MAIN ROTOR BLADE IN DEGREES
XX	5 -	HEIGHT OF MAIN ROTOR SYSTEM ABOVE GROUND IN FEET
	13 -	TWIST OF TAIL ROTOR BLADE IN DEGREES
	5 -	HEIGHT OF MAIN ROTOR SYSTEM ABOVE GROUND IN FEET
	14 -	PROFILE DRAG OF MAIN ROTOR BLADE
XX	5 -	HEIGHT OF MAIN ROTOR SYSTEM ABOVE GROUND IN FEET
	15 -	PROFILE DRAG OF TAIL ROTOR BLADE
	5 -	HEIGHT OF MAIN ROTOR SYSTEM ABOVE GROUND IN FEET
	16 -	DISC LOADING OF THE MAIN ROTOR SYSTEM
	5 -	HEIGHT OF MAIN ROTOR SYSTEM ABOVE GROUND IN FEET
	17 -	WIDTH OF THE FUSELAGE IN FEET
	5 -	HEIGHT OF MAIN ROTOR SYSTEM ABOVE GROUND IN FEET
	18 -	LENGTH OF THE FUSELAGE IN FEET
	5 -	HEIGHT OF MAIN ROTOR SYSTEM ABOVE GROUND IN FEET
	19 -	FRONTAL FLAT PLATE AREA IN SQUARE FEET
	5 -	HEIGHT OF MAIN ROTOR SYSTEM ABOVE GROUND IN FEET
	20 -	VERTICAL FLAT PLATE AREA IN SQUARE FEET
	5 -	HEIGHT OF MAIN ROTOR SYSTEM ABOVE GROUND IN FEET
	21 -	MAXIMUM VELOCITY IN KNOTS

XX 5 - HEIGHT OF MAIN ROTOR SYSTEM ABOVE GROUND IN FEET
22 - MAXIMUM RANGE IN NAUTICAL MILES

5 - HEIGHT OF MAIN ROTOR SYSTEM ABOVE GROUND IN FEET
23 - RATE OF CLIMB IN FEET PER MINUTE, MAXIMUM CONTINUOUS POWER

5 - HEIGHT OF MAIN ROTOR SYSTEM ABOVE GROUND IN FEET
24 - HOVER CEILING (IN GROUND EFFECT) IN FEET

5 - HEIGHT OF MAIN ROTOR SYSTEM ABOVE GROUND IN FEET
25 - HOVER CEILING (OUT OF GROUND EFFECT) IN FEET

5 - HEIGHT OF MAIN ROTOR SYSTEM ABOVE GROUND IN FEET
26 - LENGTH OF THE TAILBOOM IN FEET

5 - HEIGHT OF MAIN ROTOR SYSTEM ABOVE GROUND IN FEET
27 - OPERATING WEIGHT IN POUNDS

5 - HEIGHT OF MAIN ROTOR SYSTEM ABOVE GROUND IN FEET
28 - LOAD WEIGHT IN POUNDS

XX 5 - HEIGHT OF MAIN ROTOR SYSTEM ABOVE GROUND IN FEET
29 - FUEL WEIGHT IN POUNDS

5 - HEIGHT OF MAIN ROTOR SYSTEM ABOVE GROUND IN FEET
30 - MAXIMUM GROSS WEIGHT IN POUNDS

TABLE 10

Speed of Main Rotor Pairings

```
      6 - SPEED OF MAIN ROTOR SYSTEM IN RPM
      7 - SPEED OF TAIL ROTOR SYSTEM IN RPM

      6 - SPEED OF MAIN ROTOR SYSTEM IN RPM
      8 - CHORD OF MAIN ROTOR BLADE IN FEET

XX    6 - SPEED OF MAIN ROTOR SYSTEM IN RPM
      9 - CHORD OF TAIL ROTOR BLADE IN FEET

      6 - SPEED OF MAIN ROTOR SYSTEM IN RPM
     10 - SPAN OF MAIN ROTOR BLADE IN FEET

XX    6 - SPEED OF MAIN ROTOR SYSTEM IN RPM
     11 - SPAN OF TAIL ROTOR BLADE IN FEET

      6 - SPEED OF MAIN ROTOR SYSTEM IN RPM
     12 - TWIST OF MAIN ROTOR BLADE IN DEGREES

XX    6 - SPEED OF MAIN ROTOR SYSTEM IN RPM
     13 - TWIST OF TAIL ROTOR BLADE IN DEGREES

      6 - SPEED OF MAIN ROTOR SYSTEM IN RPM
     14 - PROFILE DRAG OF MAIN ROTOR BLADE

XX    6 - SPEED OF MAIN ROTOR SYSTEM IN RPM
     15 - PROFILE DRAG OF TAIL ROTOR BLADE

      6 - SPEED OF MAIN ROTOR SYSTEM IN RPM
     16 - DISC LOADING OF THE MAIN ROTOR SYSTEM

XX    6 - SPEED OF MAIN ROTOR SYSTEM IN RPM
     17 - WIDTH OF THE FUSELAGE IN FEET

      6 - SPEED OF MAIN ROTOR SYSTEM IN RPM
     18 - LENGTH OF THE FUSELAGE IN FEET

      6 - SPEED OF MAIN ROTOR SYSTEM IN RPM
     19 - FRONTAL FLAT PLATE AREA IN SQUARE FEET

      6 - SPEED OF MAIN ROTOR SYSTEM IN RPM
     20 - VERTICAL FLAT PLATE AREA IN SQUARE FEET

      6 - SPEED OF MAIN ROTOR SYSTEM IN RPM
     21 - MAXIMUM VELOCITY IN KNOTS

XX    6 - SPEED OF MAIN ROTOR SYSTEM IN RPM
     22 - MAXIMUM RANGE IN NAUTICAL MILES
```

6 - SPEED OF MAIN ROTOR SYSTEM IN RPM
23 - RATE OF CLIMB IN FEET PER MINUTE,
MAXIMUM CONTINUOUS POWER

6 - SPEED OF MAIN ROTOR SYSTEM IN RPM
24 - HOVER CEILING (IN GROUND EFFECT)
IN FEET

6 - SPEED OF MAIN ROTOR SYSTEM IN RPM
25 - HOVER CEILING (OUT OF GROUND EFFECT)
IN FEET

XX 6 - SPEED OF MAIN ROTOR SYSTEM IN RPM
26 - LENGTH OF THE TAILBOOM IN FEET

6 - SPEED OF MAIN ROTOR SYSTEM IN RPM
27 - OPERATING WEIGHT IN POUNDS

6 - SPEED OF MAIN ROTOR SYSTEM IN RPM
28 - LOAD WEIGHT IN POUNDS

XX 6 - SPEED OF MAIN ROTOR SYSTEM IN RPM
29 - FUEL WEIGHT IN POUNDS

6 - SPEED OF MAIN ROTOR SYSTEM IN RPM
30 - MAXIMUM GROSS WEIGHT IN POUNDS

TABLE 11

Speed of Tail Rotor Radius Pairings

XX 7 - SPEED OF TAIL ROTOR SYSTEM IN RPM
8 - CHORD OF MAIN ROTOR BLADE IN FEET

7 - SPEED OF TAIL ROTOR SYSTEM IN RPM
9 - CHORD OF TAIL ROTOR BLADE IN FEET

XX 7 - SPEED OF TAIL ROTOR SYSTEM IN RPM
10 - SPAN OF MAIN ROTOR BLADE IN FEET

7 - SPEED OF TAIL ROTOR SYSTEM IN RPM
11 - SPAN OF TAIL ROTOR BLADE IN FEET

XX 7 - SPEED OF TAIL ROTOR SYSTEM IN RPM
12 - TWIST OF MAIN ROTOR BLADE IN DEGREES

7 - SPEED OF TAIL ROTOR SYSTEM IN RPM
13 - TWIST OF TAIL ROTOR BLADE IN DEGREES

XX 7 - SPEED OF TAIL ROTOR SYSTEM IN RPM
14 - PROFILE DRAG OF MAIN ROTOR BLADE

7 - SPEED OF TAIL ROTOR SYSTEM IN RPM
15 - PROFILE DRAG OF TAIL ROTOR BLADE

7 - SPEED OF TAIL ROTOR SYSTEM IN RPM
16 - DISC LOADING OF THE MAIN ROTOR SYSTEM

XX 7 - SPEED OF TAIL ROTOR SYSTEM IN RPM
17 - WIDTH OF THE FUSELAGE IN FEET

XX 7 - SPEED OF TAIL ROTOR SYSTEM IN RPM
18 - LENGTH OF THE FUSELAGE IN FEET

7 - SPEED OF TAIL ROTOR SYSTEM IN RPM
19 - FRONTAL FLAT PLATE AREA IN SQUARE FEET

XX 7 - SPEED OF TAIL ROTOR SYSTEM IN RPM
20 - VERTICAL FLAT PLATE AREA IN SQUARE FEET

7 - SPEED OF TAIL ROTOR SYSTEM IN RPM
21 - MAXIMUM VELOCITY IN KNOTS

XX 7 - SPEED OF TAIL ROTOR SYSTEM IN RPM
22 - MAXIMUM RANGE IN NAUTICAL MILES

XX 7 - SPEED OF TAIL ROTOR SYSTEM IN RPM
23 - RATE OF CLIMB IN FEET PER MINUTE, MAXIMUM CONTINUOUS POWER

7 - SPEED OF TAIL ROTOR SYSTEM IN RPM
24 - HOVER CEILING (IN GROUND EFFECT)
IN FEET

7 - SPEED OF TAIL ROTOR SYSTEM IN RPM
25 - HOVER CEILING (OUT OF GROUND EFFECT)
IN FEET

7 - SPEED OF TAIL ROTOR SYSTEM IN RPM
26 - LENGTH OF THE TAILBOOM IN FEET

7 - SPEED OF TAIL ROTOR SYSTEM IN RPM
27 - OPERATING WEIGHT IN POUNDS

7 - SPEED OF TAIL ROTOR SYSTEM IN RPM
28 - LOAD WEIGHT IN POUNDS

XX 7 - SPEED OF TAIL ROTOR SYSTEM IN RPM
29 - FUEL WEIGHT IN POUNDS

7 - SPEED OF TAIL ROTOR SYSTEM IN RPM
30 - MAXIMUM GROSS WEIGHT IN POUNDS

TABLE 12

Chord of Main Rotor Blade Pairings

```
     8 - CHORD OF MAIN ROTOR BLADE IN FEET
     9 - CHORD OF TAIL ROTOR BLADE IN FEET

     8 - CHORD OF MAIN ROTOR BLADE IN FEET
    10 - SPAN OF MAIN ROTOR BLADE IN FEET

XX   8 - CHORD OF MAIN ROTOR BLADE IN FEET
    11 - SPAN OF TAIL ROTOR BLADE IN FEET

     8 - CHORD OF MAIN ROTOR BLADE IN FEET
    12 - TWIST OF MAIN ROTOR BLADE IN DEGREES

XX   8 - CHORD OF MAIN ROTOR BLADE IN FEET
    13 - TWIST OF TAIL ROTOR BLADE IN DEGREES

     8 - CHORD OF MAIN ROTOR BLADE IN FEET
    14 - PROFILE DRAG OF MAIN ROTOR BLADE

XX   8 - CHORD OF MAIN ROTOR BLADE IN FEET
    15 - PROFILE DRAG OF TAIL ROTOR BLADE

     8 - CHORD OF MAIN ROTOR BLADE IN FEET
    16 - DISC LOADING OF THE MAIN ROTOR SYSTEM

XX   8 - CHORD OF MAIN ROTOR BLADE IN FEET
    17 - WIDTH OF THE FUSELAGE IN FEET

     8 - CHORD OF MAIN ROTOR BLADE IN FEET
    18 - LENGTH OF THE FUSELAGE IN FEET

     8 - CHORD OF MAIN ROTOR BLADE IN FEET
    19 - FRONTAL FLAT PLATE AREA IN SQUARE FEET

     8 - CHORD OF MAIN ROTOR BLADE IN FEET
    20 - VERTICAL FLAT PLATE AREA IN SQUARE FEET

     8 - CHORD OF MAIN ROTOR BLADE IN FEET
    21 - MAXIMUM VELOCITY IN KNOTS

XX   8 - CHORD OF MAIN ROTOR BLADE IN FEET
    22 - MAXIMUM RANGE IN NAUTICAL MILES

XX   8 - CHORD OF MAIN ROTOR BLADE IN FEET
    23 - RATE OF CLIMB IN FEET PER MINUTE,
         MAXIMUM CONTINUOUS POWER

     8 - CHORD OF MAIN ROTOR BLADE IN FEET
    24 - HOVER CEILING (IN GROUND EFFECT)
         IN FEET
```

8 - CHORD OF MAIN ROTOR BLADE IN FEET
25 - HOVER CEILING (OUT OF GROUND EFFECT)
IN FEET

8 - CHORD OF MAIN ROTOR BLADE IN FEET
26 - LENGTH OF THE TAILBOOM IN FEET

8 - CHORD OF MAIN ROTOR BLADE IN FEET
27 - OPERATING WEIGHT IN POUNDS

8 - CHORD OF MAIN ROTOR BLADE IN FEET
28 - LOAD WEIGHT IN POUNDS

XX 8 - CHORD OF MAIN ROTOR BLADE IN FEET
29 - FUEL WEIGHT IN POUNDS

8 - CHORD OF MAIN ROTOR BLADE IN FEET
30 - MAXIMUM GROSS WEIGHT IN POUNDS

TABLE 13

Chord of Tail Rotor Blade Pairings

XX	9 - CHORD OF TAIL ROTOR BLADE IN FEET 10 - SPAN OF MAIN ROTOR BLADE IN FEET	
	9 - CHORD OF TAIL ROTOR BLADE IN FEET 11 - SPAN OF TAIL ROTOR BLADE IN FEET	
XX	9 - CHORD OF TAIL ROTOR BLADE IN FEET 12 - TWIST OF MAIN ROTOR BLADE IN DEGREES	
	9 - CHORD OF TAIL ROTOR BLADE IN FEET 13 - TWIST OF TAIL ROTOR BLADE IN DEGREES	
XX	9 - CHORD OF TAIL ROTOR BLADE IN FEET 14 - PROFILE DRAG OF MAIN ROTOR BLADE	
	9 - CHORD OF TAIL ROTOR BLADE IN FEET 15 - PROFILE DRAG OF TAIL ROTOR BLADE	
XX	9 - CHORD OF TAIL ROTOR BLADE IN FEET 16 - DISC LOADING OF THE MAIN ROTOR SYSTEM	
XX	9 - CHORD OF TAIL ROTOR BLADE IN FEET 17 - WIDTH OF THE FUSELAGE IN FEET	
XX	9 - CHORD OF TAIL ROTOR BLADE IN FEET 18 - LENGTH OF THE FUSELAGE IN FEET	
XX	9 - CHORD OF TAIL ROTOR BLADE IN FEET 19 - FRONTAL FLAT PLATE AREA IN SQUARE FEET	
XX	9 - CHORD OF TAIL ROTOR BLADE IN FEET 20 - VERTICAL FLAT PLATE AREA IN SQUARE FEET	
	9 - CHORD OF TAIL ROTOR BLADE IN FEET 21 - MAXIMUM VELOCITY IN KNOTS	
	9 - CHORD OF TAIL ROTOR BLADE IN FEET 22 - MAXIMUM RANGE IN NAUTICAL MILES	
XX	9 - CHORD OF TAIL ROTOR BLADE IN FEET 23 - RATE OF CLIMB IN FEET PER MINUTE, MAXIMUM CONTINUOUS POWER	
	9 - CHORD OF TAIL ROTOR BLADE IN FEET 24 - HOVER CEILING (IN GROUND EFFECT) IN FEET	
	9 - CHORD OF TAIL ROTOR BLADE IN FEET 25 - HOVER CEILING (OUT OF GROUND EFFECT) IN FEET	

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    9 - CHORD OF TAIL ROTOR BLADE IN FEET
   26 - LENGTH OF THE TAILBOOM IN FEET

    9 - CHORD OF TAIL ROTOR BLADE IN FEET
   27 - OPERATING WEIGHT IN POUNDS

    9 - CHORD OF TAIL ROTOR BLADE IN FEET
   28 - LOAD WEIGHT IN POUNDS

XX  9 - CHORD OF TAIL ROTOR BLADE IN FEET
   29 - FUEL WEIGHT IN POUNDS

    9 - CHORD OF TAIL ROTOR BLADE IN FEET
   30 - MAXIMUM GROSS WEIGHT IN POUNDS
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TABLE 14

Span of Main Rotor Pairings

```
    10 - SPAN OF MAIN ROTOR BLADE IN FEET
    11 - SPAN OF TAIL ROTOR BLADE IN FEET

    10 - SPAN OF MAIN ROTOR BLADE IN FEET
    12 - TWIST OF MAIN ROTOR BLADE IN DEGREES

XX  10 - SPAN OF MAIN ROTOR BLADE IN FEET
    13 - TWIST OF TAIL ROTOR BLADE IN DEGREES

    10 - SPAN OF MAIN ROTOR BLADE IN FEET
    14 - PROFILE DRAG OF MAIN ROTOR BLADE

XX  10 - SPAN OF MAIN ROTOR BLADE IN FEET
    15 - PROFILE DRAG OF TAIL ROTOR BLADE

    10 - SPAN OF MAIN ROTOR BLADE IN FEET
    16 - DISC LOADING OF THE MAIN ROTOR SYSTEM

    10 - SPAN OF MAIN ROTOR BLADE IN FEET
    17 - WIDTH OF THE FUSELAGE IN FEET

    10 - SPAN OF MAIN ROTOR BLADE IN FEET
    18 - LENGTH OF THE FUSELAGE IN FEET

    10 - SPAN OF MAIN ROTOR BLADE IN FEET
    19 - FRONTAL FLAT PLATE AREA IN SQUARE FEET

    10 - SPAN OF MAIN ROTOR BLADE IN FEET
    20 - VERTICAL FLAT PLATE AREA IN SQUARE FEET

    10 - SPAN OF MAIN ROTOR BLADE IN FEET
    21 - MAXIMUM VELOCITY IN KNOTS

XX  10 - SPAN OF MAIN ROTOR BLADE IN FEET
    22 - MAXIMUM RANGE IN NAUTICAL MILES

    10 - SPAN OF MAIN ROTOR BLADE IN FEET
    23 - RATE OF CLIMB IN FEET PER MINUTE,
         MAXIMUM CONTINUOUS POWER

    10 - SPAN OF MAIN ROTOR BLADE IN FEET
    24 - HOVER CEILING (IN GROUND EFFECT)
         IN FEET

    10 - SPAN OF MAIN ROTOR BLADE IN FEET
    25 - HOVER CEILING (OUT OF GROUND EFFECT)
         IN FEET

    10 - SPAN OF MAIN ROTOR BLADE IN FEET
    26 - LENGTH OF THE TAILBOOM IN FEET
```

10 - SPAN OF MAIN ROTOR BLADE IN FEET
27 - OPERATING WEIGHT IN POUNDS

10 - SPAN OF MAIN ROTOR BLADE IN FEET
28 - LOAD WEIGHT IN POUNDS

XX 10 - SPAN OF MAIN ROTOR BLADE IN FEET
29 - FUEL WEIGHT IN POUNDS

10 - SPAN OF MAIN ROTOR BLADE IN FEET
30 - MAXIMUM GROSS WEIGHT IN POUNDS

TABLE 15

Span of Tail Rotor Pairings

11 - SPAN OF TAIL ROTOR BLADE IN FEET
12 - TWIST OF MAIN ROTOR BLADE IN DEGREES

11 - SPAN OF TAIL ROTOR BLADE IN FEET
13 - TWIST OF TAIL ROTOR BLADE IN DEGREES

XX 11 - SPAN OF TAIL ROTOR BLADE IN FEET
14 - PROFILE DRAG OF MAIN ROTOR BLADE

11 - SPAN OF TAIL ROTOR BLADE IN FEET
15 - PROFILE DRAG OF TAIL ROTOR BLADE

XX 11 - SPAN OF TAIL ROTOR BLADE IN FEET
16 - DISC LOADING OF THE MAIN ROTOR SYSTEM

XX 11 - SPAN OF TAIL ROTOR BLADE IN FEET
17 - WIDTH OF THE FUSELAGE IN FEET

XX 11 - SPAN OF TAIL ROTOR BLADE IN FEET
18 - LENGTH OF THE FUSELAGE IN FEET

11 - SPAN OF TAIL ROTOR BLADE IN FEET
19 - FRONTAL FLAT PLATE AREA IN SQUARE FEET

11 - SPAN OF TAIL ROTOR BLADE IN FEET
20 - VERTICAL FLAT PLATE AREA IN SQUARE FEET

11 - SPAN OF TAIL ROTOR BLADE IN FEET
21 - MAXIMUM VELOCITY IN KNOTS

XX 11 - SPAN OF TAIL ROTOR BLADE IN FEET
22 - MAXIMUM RANGE IN NAUTICAL MILES

XX 11 - SPAN OF TAIL ROTOR BLADE IN FEET
23 - RATE OF CLIMB IN FEET PER MINUTE, MAXIMUM CONTINUOUS POWER

11 - SPAN OF TAIL ROTOR BLADE IN FEET
24 - HOVER CEILING (IN GROUND EFFECT) IN FEET

11 - SPAN OF TAIL ROTOR BLADE IN FEET
25 - HOVER CEILING (OUT OF GROUND EFFECT) IN FEET

11 - SPAN OF TAIL ROTOR BLADE IN FEET
26 - LENGTH OF THE TAILBOOM IN FEET

11 - SPAN OF TAIL ROTOR BLADE IN FEET
27 - OPERATING WEIGHT IN POUNDS

11 - SPAN OF TAIL ROTOR BLADE IN FEET
28 - LOAD WEIGHT IN POUNDS

XX 11 - SPAN OF TAIL ROTOR BLADE IN FEET
29 - FUEL WEIGHT IN POUNDS

11 - SPAN OF TAIL ROTOR BLADE IN FEET
30 - MAXIMUM GROSS WEIGHT IN POUNDS

TABLE 16

Twist of Main Rotor Blade Pairings

	12 - TWIST OF MAIN ROTOR BLADE IN DEGREES 13 - TWIST OF TAIL ROTOR BLADE IN DEGREES
	12 - TWIST OF MAIN ROTOR BLADE IN DEGREES 14 - PROFILE DRAG OF MAIN ROTOR BLADE
XX	12 - TWIST OF MAIN ROTOR BLADE IN DEGREES 15 - PROFILE DRAG OF TAIL ROTOR BLADE
	12 - TWIST OF MAIN ROTOR BLADE IN DEGREES 16 - DISC LOADING OF THE MAIN ROTOR SYSTEM
XX	12 - TWIST OF MAIN ROTOR BLADE IN DEGREES 17 - WIDTH OF THE FUSELAGE IN FEET
XX	12 - TWIST OF MAIN ROTOR BLADE IN DEGREES 18 - LENGTH OF THE FUSELAGE IN FEET
XX	12 - TWIST OF MAIN ROTOR BLADE IN DEGREES 19 - FRONTAL FLAT PLATE AREA IN SQUARE FEET
XX	12 - TWIST OF MAIN ROTOR BLADE IN DEGREES 20 - VERTICAL FLAT PLATE AREA IN SQUARE FEET
	12 - TWIST OF MAIN ROTOR BLADE IN DEGREES 21 - MAXIMUM VELOCITY IN KNOTS
XX	12 - TWIST OF MAIN ROTOR BLADE IN DEGREES 22 - MAXIMUM RANGE IN NAUTICAL MILES
XX	12 - TWIST OF MAIN ROTOR BLADE IN DEGREES 23 - RATE OF CLIMB IN FEET PER MINUTE, MAXIMUM CONTINUOUS POWER
XX	12 - TWIST OF MAIN ROTOR BLADE IN DEGREES 24 - HOVER CEILING (IN GROUND EFFECT) IN FEET
XX	12 - TWIST OF MAIN ROTOR BLADE IN DEGREES 25 - HOVER CEILING (OUT OF GROUND EFFECT) IN FEET
XX	12 - TWIST OF MAIN ROTOR BLADE IN DEGREES 26 - LENGTH OF THE TAILBOOM IN FEET
XX	12 - TWIST OF MAIN ROTOR BLADE IN DEGREES 27 - OPERATING WEIGHT IN POUNDS
XX	12 - TWIST OF MAIN ROTOR BLADE IN DEGREES 28 - LOAD WEIGHT IN POUNDS
XX	12 - TWIST OF MAIN ROTOR BLADE IN DEGREES 29 - FUEL WEIGHT IN POUNDS
XX	12 - TWIST OF MAIN ROTOR BLADE IN DEGREES 30 - MAXIMUM GROSS WEIGHT IN POUNDS

TABLE 17

Twist of Tail Rotor Blade Pairings

XX 13 - TWIST OF TAIL ROTOR BLADE IN DEGREES
14 - PROFILE DRAG OF MAIN ROTOR BLADE

13 - TWIST OF TAIL ROTOR BLADE IN DEGREES
15 - PROFILE DRAG OF TAIL ROTOR BLADE

XX 13 - TWIST OF TAIL ROTOR BLADE IN DEGREES
16 - DISC LOADING OF THE MAIN ROTOR SYSTEM

XX 13 - TWIST OF TAIL ROTOR BLADE IN DEGREES
17 - WIDTH OF THE FUSELAGE IN FEET

XX 13 - TWIST OF TAIL ROTOR BLADE IN DEGREES
18 - LENGTH OF THE FUSELAGE IN FEET

XX 13 - TWIST OF TAIL ROTOR BLADE IN DEGREES
19 - FRONTAL FLAT PLATE AREA IN SQUARE FEET

XX 13 - TWIST OF TAIL ROTOR BLADE IN DEGREES
20 - VERTICAL FLAT PLATE AREA IN SQUARE FEET

XX 13 - TWIST OF TAIL ROTOR BLADE IN DEGREES
21 - MAXIMUM VELOCITY IN KNOTS

XX 13 - TWIST OF TAIL ROTOR BLADE IN DEGREES
22 - MAXIMUM RANGE IN NAUTICAL MILES

XX 13 - TWIST OF TAIL ROTOR BLADE IN DEGREES
23 - RATE OF CLIMB IN FEET PER MINUTE,
MAXIMUM CONTINUOUS POWER

XX 13 - TWIST OF TAIL ROTOR BLADE IN DEGREES
24 - HOVER CEILING (IN GROUND EFFECT)
IN FEET

XX 13 - TWIST OF TAIL ROTOR BLADE IN DEGREES
25 - HOVER CEILING (OUT OF GROUND EFFECT)
IN FEET

XX 13 - TWIST OF TAIL ROTOR BLADE IN DEGREES
26 - LENGTH OF THE TAILBOOM IN FEET

XX 13 - TWIST OF TAIL ROTOR BLADE IN DEGREES
27 - OPERATING WEIGHT IN POUNDS

XX 13 - TWIST OF TAIL ROTOR BLADE IN DEGREES
28 - LOAD WEIGHT IN POUNDS

XX 13 - TWIST OF TAIL ROTOR BLADE IN DEGREES
29 - FUEL WEIGHT IN POUNDS

13 - TWIST OF TAIL ROTOR BLADE IN DEGREES
30 - MAXIMUM GROSS WEIGHT IN POUNDS

TABLE 18

Profile Drag of Main Rotor Blade Pairings

14 - PROFILE DRAG OF MAIN ROTOR BLADE
15 - PROFILE DRAG OF TAIL ROTOR BLADE

14 - PROFILE DRAG OF MAIN ROTOR BLADE
16 - DISC LOADING OF THE MAIN ROTOR SYSTEM

XX 14 - PROFILE DRAG OF MAIN ROTOR BLADE
17 - WIDTH OF THE FUSELAGE IN FEET

XX 14 - PROFILE DRAG OF MAIN ROTOR BLADE
18 - LENGTH OF THE FUSELAGE IN FEET

XX 14 - PROFILE DRAG OF MAIN ROTOR BLADE
19 - FRONTAL FLAT PLATE AREA IN SQUARE FEET

XX 14 - PROFILE DRAG OF MAIN ROTOR BLADE
20 - VERTICAL FLAT PLATE AREA IN SQUARE FEET

14 - PROFILE DRAG OF MAIN ROTOR BLADE
21 - MAXIMUM VELOCITY IN KNOTS

XX 14 - PROFILE DRAG OF MAIN ROTOR BLADE
22 - MAXIMUM RANGE IN NAUTICAL MILES

14 - PROFILE DRAG OF MAIN ROTOR BLADE
23 - RATE OF CLIMB IN FEET PER MINUTE, MAXIMUM CONTINUOUS POWER

14 - PROFILE DRAG OF MAIN ROTOR BLADE
24 - HOVER CEILING (IN GROUND EFFECT) IN FEET

14 - PROFILE DRAG OF MAIN ROTOR BLADE
25 - HOVER CEILING (OUT OF GROUND EFFECT) IN FEET

XX 14 - PROFILE DRAG OF MAIN ROTOR BLADE
26 - LENGTH OF THE TAILBOOM IN FEET

14 - PROFILE DRAG OF MAIN ROTOR BLADE
27 - OPERATING WEIGHT IN POUNDS

14 - PROFILE DRAG OF MAIN ROTOR BLADE
28 - LOAD WEIGHT IN POUNDS

XX 14 - PROFILE DRAG OF MAIN ROTOR BLADE
29 - FUEL WEIGHT IN POUNDS

14 - PROFILE DRAG OF MAIN ROTOR BLADE
30 - MAXIMUM GROSS WEIGHT IN POUNDS

TABLE 19

Profile Drag of Tail Rotor Blade Pairings

XX 15 - PROFILE DRAG OF TAIL ROTOR BLADE
16 - DISC LOADING OF THE MAIN ROTOR SYSTEM

XX 15 - PROFILE DRAG OF TAIL ROTOR BLADE
17 - WIDTH OF THE FUSELAGE IN FEET

15 - PROFILE DRAG OF TAIL ROTOR BLADE
18 - LENGTH OF THE FUSELAGE IN FEET

XX 15 - PROFILE DRAG OF TAIL ROTOR BLADE
19 - FRONTAL FLAT PLATE AREA IN SQUARE FEET

XX 15 - PROFILE DRAG OF TAIL ROTOR BLADE
20 - VERTICAL FLAT PLATE AREA IN SQUARE FEET

15 - PROFILE DRAG OF TAIL ROTOR BLADE
21 - MAXIMUM VELOCITY IN KNOTS

XX 15 - PROFILE DRAG OF TAIL ROTOR BLADE
22 - MAXIMUM RANGE IN NAUTICAL MILES

15 - PROFILE DRAG OF TAIL ROTOR BLADE
23 - RATE OF CLIMB IN FEET PER MINUTE, MAXIMUM CONTINUOUS POWER

15 - PROFILE DRAG OF TAIL ROTOR BLADE
24 - HOVER CEILING (IN GROUND EFFECT) IN FEET

15 - PROFILE DRAG OF TAIL ROTOR BLADE
25 - HOVER CEILING (OUT OF GROUND EFFECT) IN FEET

15 - PROFILE DRAG OF TAIL ROTOR BLADE
26 - LENGTH OF THE TAILBOOM IN FEET

15 - PROFILE DRAG OF TAIL ROTOR BLADE
27 - OPERATING WEIGHT IN POUNDS

15 - PROFILE DRAG OF TAIL ROTOR BLADE
28 - LOAD WEIGHT IN POUNDS

XX 15 - PROFILE DRAG OF TAIL ROTOR BLADE
29 - FUEL WEIGHT IN POUNDS

15 - PROFILE DRAG OF TAIL ROTOR BLADE
30 - MAXIMUM GROSS WEIGHT IN POUNDS

TABLE 20

Disc Loading of the Main Rotor System Pairings

16 - DISC LOADING OF THE MAIN ROTOR SYSTEM
17 - WIDTH OF THE FUSELAGE IN FEET

16 - DISC LOADING OF THE MAIN ROTOR SYSTEM
18 - LENGTH OF THE FUSELAGE IN FEET

16 - DISC LOADING OF THE MAIN ROTOR SYSTEM
19 - FRONTAL FLAT PLATE AREA IN SQUARE FEET

16 - DISC LOADING OF THE MAIN ROTOR SYSTEM
20 - VERTICAL FLAT PLATE AREA IN SQUARE FEET

16 - DISC LOADING OF THE MAIN ROTOR SYSTEM
21 - MAXIMUM VELOCITY IN KNOTS

16 - DISC LOADING OF THE MAIN ROTOR SYSTEM
22 - MAXIMUM RANGE IN NAUTICAL MILES

16 - DISC LOADING OF THE MAIN ROTOR SYSTEM
23 - RATE OF CLIMB IN FEET PER MINUTE, MAXIMUM CONTINUOUS POWER

16 - DISC LOADING OF THE MAIN ROTOR SYSTEM
24 - HOVER CEILING (IN GROUND EFFECT) IN FEET

XX 16 - DISC LOADING OF THE MAIN ROTOR SYSTEM
25 - HOVER CEILING (OUT OF GROUND EFFECT) IN FEET

XX 16 - DISC LOADING OF THE MAIN ROTOR SYSTEM
26 - LENGTH OF THE TAILBOOM IN FEET

XX 16 - DISC LOADING OF THE MAIN ROTOR SYSTEM
27 - OPERATING WEIGHT IN POUNDS

XX 16 - DISC LOADING OF THE MAIN ROTOR SYSTEM
28 - LOAD WEIGHT IN POUNDS

XX 16 - DISC LOADING OF THE MAIN ROTOR SYSTEM
29 - FUEL WEIGHT IN POUNDS

16 - DISC LOADING OF THE MAIN ROTOR SYSTEM
30 - MAXIMUM GROSS WEIGHT IN POUNDS

TABLE 21

Width of the Fuselage Pairings

17 - WIDTH OF THE FUSELAGE IN FEET
18 - LENGTH OF THE FUSELAGE IN FEET

17 - WIDTH OF THE FUSELAGE IN FEET
19 - FRONTAL FLAT PLATE AREA IN SQUARE FEET

17 - WIDTH OF THE FUSELAGE IN FEET
20 - VERTICAL FLAT PLATE AREA IN SQUARE FEET

17 - WIDTH OF THE FUSELAGE IN FEET
21 - MAXIMUM VELOCITY IN KNOTS

XX 17 - WIDTH OF THE FUSELAGE IN FEET
22 - MAXIMUM RANGE IN NAUTICAL MILES

17 - WIDTH OF THE FUSELAGE IN FEET
23 - RATE OF CLIMB IN FEET PER MINUTE, MAXIMUM CONTINUOUS POWER

17 - WIDTH OF THE FUSELAGE IN FEET
24 - HOVER CEILING (IN GROUND EFFECT) IN FEET

17 - WIDTH OF THE FUSELAGE IN FEET
25 - HOVER CEILING (OUT OF GROUND EFFECT) IN FEET

17 - WIDTH OF THE FUSELAGE IN FEET
26 - LENGTH OF THE TAILBOOM IN FEET

17 - WIDTH OF THE FUSELAGE IN FEET
27 - OPERATING WEIGHT IN POUNDS

17 - WIDTH OF THE FUSELAGE IN FEET
28 - LOAD WEIGHT IN POUNDS

17 - WIDTH OF THE FUSELAGE IN FEET
29 - FUEL WEIGHT IN POUNDS

17 - WIDTH OF THE FUSELAGE IN FEET
30 - MAXIMUM GROSS WEIGHT IN POUNDS

TABLE 22

Length of Fuselage Pairings

18 - LENGTH OF THE FUSELAGE IN FEET
19 - FRONTAL FLAT PLATE AREA IN SQUARE FEET

18 - LENGTH OF THE FUSELAGE IN FEET
20 - VERTICAL FLAT PLATE AREA IN SQUARE FEET

18 - LENGTH OF THE FUSELAGE IN FEET
21 - MAXIMUM VELOCITY IN KNOTS

18 - LENGTH OF THE FUSELAGE IN FEET
22 - MAXIMUM RANGE IN NAUTICAL MILES

18 - LENGTH OF THE FUSELAGE IN FEET
23 - RATE OF CLIMB IN FEET PER MINUTE,
MAXIMUM CONTINUOUS POWER

18 - LENGTH OF THE FUSELAGE IN FEET
24 - HOVER CEILING (IN GROUND EFFECT)
IN FEET

18 - LENGTH OF THE FUSELAGE IN FEET
25 - HOVER CEILING (OUT OF GROUND EFFECT)
IN FEET

18 - LENGTH OF THE FUSELAGE IN FEET
26 - LENGTH OF THE TAILBOOM IN FEET

18 - LENGTH OF THE FUSELAGE IN FEET
27 - OPERATING WEIGHT IN POUNDS

18 - LENGTH OF THE FUSELAGE IN FEET
28 - LOAD WEIGHT IN POUNDS

XX 18 - LENGTH OF THE FUSELAGE IN FEET
29 - FUEL WEIGHT IN POUNDS

18 - LENGTH OF THE FUSELAGE IN FEET
30 - MAXIMUM GROSS WEIGHT IN POUNDS

TABLE 23

Frontal Horizontal Flat Plate Area Pairings

19 - FRONTAL FLAT PLATE AREA IN SQUARE FEET
20 - VERTICAL FLAT PLATE AREA IN SQUARE FEET

19 - FRONTAL FLAT PLATE AREA IN SQUARE FEET
21 - MAXIMUM VELOCITY IN KNOTS

19 - FRONTAL FLAT PLATE AREA IN SQUARE FEET
22 - MAXIMUM RANGE IN NAUTICAL MILES

XX 19 - FRONTAL FLAT PLATE AREA IN SQUARE FEET
23 - RATE OF CLIMB IN FEET PER MINUTE, MAXIMUM CONTINUOUS POWER

XX 19 - FRONTAL FLAT PLATE AREA IN SQUARE FEET
24 - HOVER CEILING (IN GROUND EFFECT) IN FEET

XX 19 - FRONTAL FLAT PLATE AREA IN SQUARE FEET
25 - HOVER CEILING (OUT OF GROUND EFFECT) IN FEET

XX 19 - FRONTAL FLAT PLATE AREA IN SQUARE FEET
26 - LENGTH OF THE TAILBOOM IN FEET

19 - FRONTAL FLAT PLATE AREA IN SQUARE FEET
27 - OPERATING WEIGHT IN POUNDS

19 - FRONTAL FLAT PLATE AREA IN SQUARE FEET
28 - LOAD WEIGHT IN POUNDS

XX 19 - FRONTAL FLAT PLATE AREA IN SQUARE FEET
29 - FUEL WEIGHT IN POUNDS

19 - FRONTAL FLAT PLATE AREA IN SQUARE FEET
30 - MAXIMUM GROSS WEIGHT IN POUNDS

TABLE 24

Frontal Vertical Flat Plate Area Pairings

XX 20 - VERTICAL FLAT PLATE AREA IN SQUARE FEET
21 - MAXIMUM VELOCITY IN KNOTS

XX 20 - VERTICAL FLAT PLATE AREA IN SQUARE FEET
22 - MAXIMUM RANGE IN NAUTICAL MILES

20 - VERTICAL FLAT PLATE AREA IN SQUARE FEET
23 - RATE OF CLIMB IN FEET PER MINUTE, MAXIMUM CONTINUOUS POWER

20 - VERTICAL FLAT PLATE AREA IN SQUARE FEET
24 - HOVER CEILING (IN GROUND EFFECT) IN FEET

20 - VERTICAL FLAT PLATE AREA IN SQUARE FEET
25 - HOVER CEILING (OUT OF GROUND EFFECT) IN FEET

XX 20 - VERTICAL FLAT PLATE AREA IN SQUARE FEET
26 - LENGTH OF THE TAILBOOM IN FEET

20 - VERTICAL FLAT PLATE AREA IN SQUARE FEET
27 - OPERATING WEIGHT IN POUNDS

20 - VERTICAL FLAT PLATE AREA IN SQUARE FEET
28 - LOAD WEIGHT IN POUNDS

XX 20 - VERTICAL FLAT PLATE AREA IN SQUARE FEET
29 - FUEL WEIGHT IN POUNDS

20 - VERTICAL FLAT PLATE AREA IN SQUARE FEET
30 - MAXIMUM GROSS WEIGHT IN POUNDS

TABLE 25

Maximum Forward Velocity Pairings

21 - MAXIMUM VELOCITY IN KNOTS
22 - MAXIMUM RANGE IN NAUTICAL MILES

21 - MAXIMUM VELOCITY IN KNOTS
23 - RATE OF CLIMB IN FEET PER MINUTE, MAXIMUM CONTINUOUS POWER

21 - MAXIMUM VELOCITY IN KNOTS
24 - HOVER CEILING (IN GROUND EFFECT) IN FEET

21 - MAXIMUM VELOCITY IN KNOTS
25 - HOVER CEILING (OUT OF GROUND EFFECT) IN FEET

XX 21 - MAXIMUM VELOCITY IN KNOTS
26 - LENGTH OF THE TAILBOOM IN FEET

21 - MAXIMUM VELOCITY IN KNOTS
27 - OPERATING WEIGHT IN POUNDS

21 - MAXIMUM VELOCITY IN KNOTS
28 - LOAD WEIGHT IN POUNDS

XX 21 - MAXIMUM VELOCITY IN KNOTS
29 - FUEL WEIGHT IN POUNDS

21 - MAXIMUM VELOCITY IN KNOTS
30 - MAXIMUM GROSS WEIGHT IN POUNDS

TABLE 26

Maximum Range Pairings

22 - MAXIMUM RANGE IN NAUTICAL MILES
23 - RATE OF CLIMB IN FEET PER MINUTE, MAXIMUM CONTINUOUS POWER

XX 22 - MAXIMUM RANGE IN NAUTICAL MILES
24 - HOVER CEILING (IN GROUND EFFECT) IN FEET

XX 22 - MAXIMUM RANGE IN NAUTICAL MILES
25 - HOVER CEILING (OUT OF GROUND EFFECT) IN FEET

XX 22 - MAXIMUM RANGE IN NAUTICAL MILES
26 - LENGTH OF THE TAILBOOM IN FEET

22 - MAXIMUM RANGE IN NAUTICAL MILES
27 - OPERATING WEIGHT IN POUNDS

22 - MAXIMUM RANGE IN NAUTICAL MILES
28 - LOAD WEIGHT IN POUNDS

22 - MAXIMUM RANGE IN NAUTICAL MILES
29 - FUEL WEIGHT IN POUNDS

22 - MAXIMUM RANGE IN NAUTICAL MILES
30 - MAXIMUM GROSS WEIGHT IN POUNDS

TABLE 27

Rate of Climb Pairings

23 - RATE OF CLIMB IN FEET PER MINUTE
MAXIMUM CONTINUOUS POWER
24 - HOVER CEILING (IN GROUND EFFECT)
IN FEET

23 - RATE OF CLIMB IN FEET PER MINUTE
MAXIMUM CONTINUOUS POWER
25 - HOVER CEILING (OUT OF GROUND EFFECT)
IN FEET

23 - RATE OF CLIMB IN FEET PER MINUTE
MAXIMUM CONTINUOUS POWER
26 - LENGTH OF THE TAILBOOM IN FEET

23 - RATE OF CLIMB IN FEET PER MINUTE
MAXIMUM CONTINUOUS POWER
27 - OPERATING WEIGHT IN POUNDS

23 - RATE OF CLIMB IN FEET PER MINUTE
MAXIMUM CONTINUOUS POWER
28 - LOAD WEIGHT IN POUNDS

23 - RATE OF CLIMB IN FEET PER MINUTE
MAXIMUM CONTINUOUS POWER
29 - FUEL WEIGHT IN POUNDS

23 - RATE OF CLIMB IN FEET PER MINUTE
MAXIMUM CONTINUOUS POWER
30 - MAXIMUM GROSS WEIGHT IN POUNDS

TABLE 28

Hover Ceiling (IGE) Pairings

24 - HOVER CEILING (IN GROUND EFFECT)
IN FEET
25 - HOVER CEILING (OUT OF GROUND EFFECT)
IN FEET

XX 24 - HOVER CEILING (IN GROUND EFFECT)
IN FEET
26 - LENGTH OF THE TAILBOOM IN FEET

24 - HOVER CEILING (IN GROUND EFFECT)
IN FEET
27 - OPERATING WEIGHT IN POUNDS

24 - HOVER CEILING (IN GROUND EFFECT)
IN FEET
28 - LOAD WEIGHT IN POUNDS

XX 24 - HOVER CEILING (IN GROUND EFFECT)
IN FEET
29 - FUEL WEIGHT IN POUNDS

24 - HOVER CEILING (IN GROUND EFFECT)
IN FEET
30 - MAXIMUM GROSS WEIGHT IN POUNDS

TABLE 29

Hover Ceiling (OGE) Pairings

XX 25 - HOVER CEILING (OUT OF GROUND EFFECT) IN FEET
26 - LENGTH OF THE TAILBOOM IN FEET

25 - HOVER CEILING (OUT OF GROUND EFFECT) IN FEET
27 - OPERATING WEIGHT IN POUNDS

25 - HOVER CEILING (OUT OF GROUND EFFECT) IN FEET
28 - LOAD WEIGHT IN POUNDS

XX 25 - HOVER CEILING (OUT OF GROUND EFFECT) IN FEET
29 - FUEL WEIGHT IN POUNDS

25 - HOVER CEILING (OUT OF GROUND EFFECT) IN FEET
30 - MAXIMUM GROSS WEIGHT IN POUNDS

TABLE 30

Length of Tail Pairings

26 - LENGTH OF THE TAILBOOM IN FEET
27 - OPERATING WEIGHT IN POUNDS

26 - LENGTH OF THE TAILBOOM IN FEET
28 - LOAD WEIGHT IN POUNDS

XX 26 - LENGTH OF THE TAILBOOM IN FEET
29 - FUEL WEIGHT IN POUNDS

26 - LENGTH OF THE TAILBOOM IN FEET
30 - MAXIMUM GROSS WEIGHT IN POUNDS

TABLE 31

Operating Weight Pairings

27 - OPERATING WEIGHT IN POUNDS
28 - LOAD WEIGHT IN POUNDS

27 - OPERATING WEIGHT IN POUNDS
29 - FUEL WEIGHT IN POUNDS

27 - OPERATING WEIGHT IN POUNDS
30 - MAXIMUM GROSS WEIGHT IN POUNDS

TABLE 32

Load Weight Pairings

28 - LOAD WEIGHT IN POUNDS
29 - FUEL WEIGHT IN POUNDS

28 - LOAD WEIGHT IN POUNDS
30 - MAXIMUM GROSS WEIGHT IN POUNDS

TABLE 33

Fuel Weight Pairings

29 - FUEL WEIGHT IN POUNDS
30 - MAXIMUM GROSS WEIGHT IN POUNDS

APPENDIX C

DATA POINT PLOTS, CURVE FITS, AND CURVE FIT EQUATIONS

Main Rotor Radius Pairings.

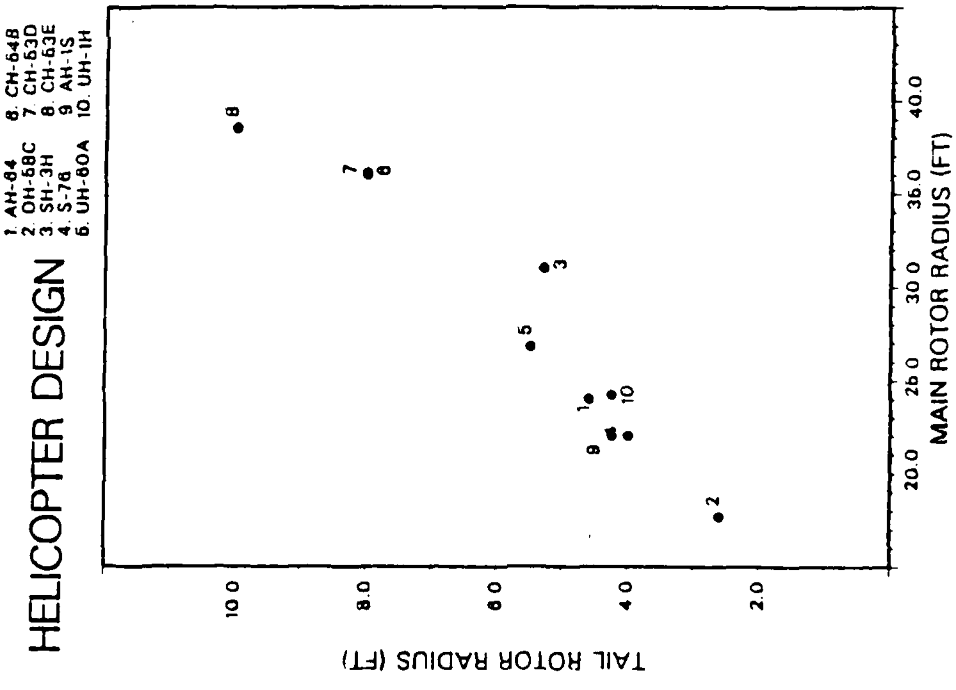


Fig. 1-2a.

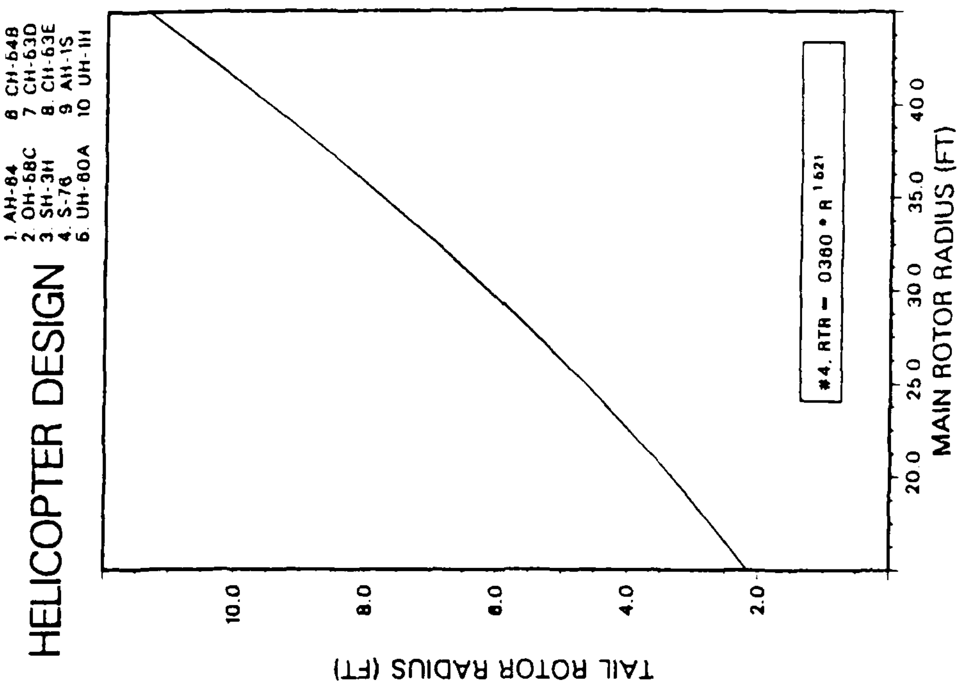


Fig. 1-2b.

Fig. 1-2a and 1-2b.

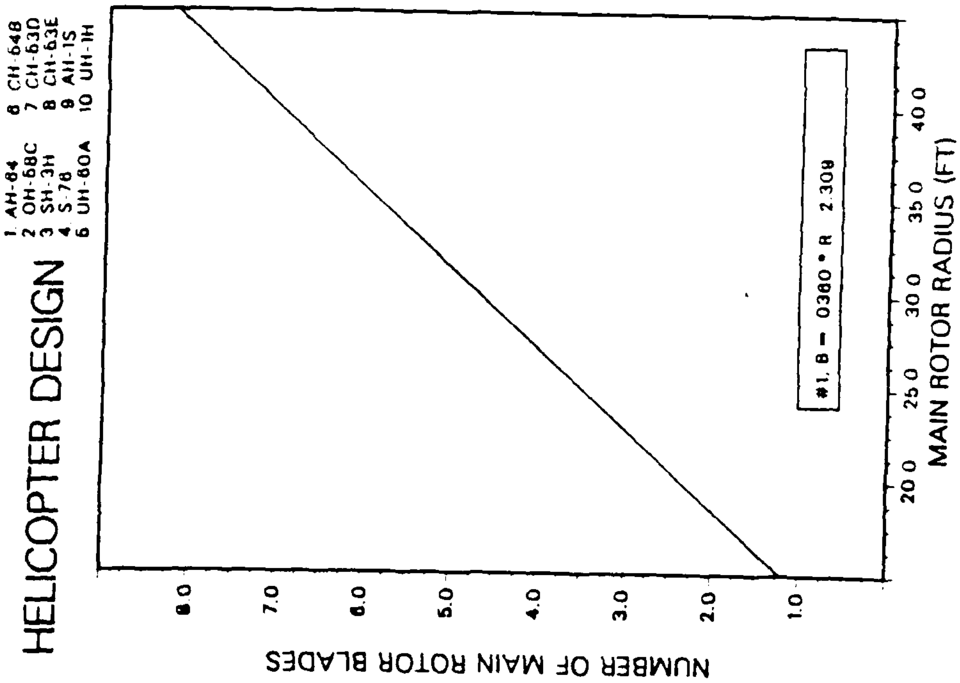


Fig. 1-3b.

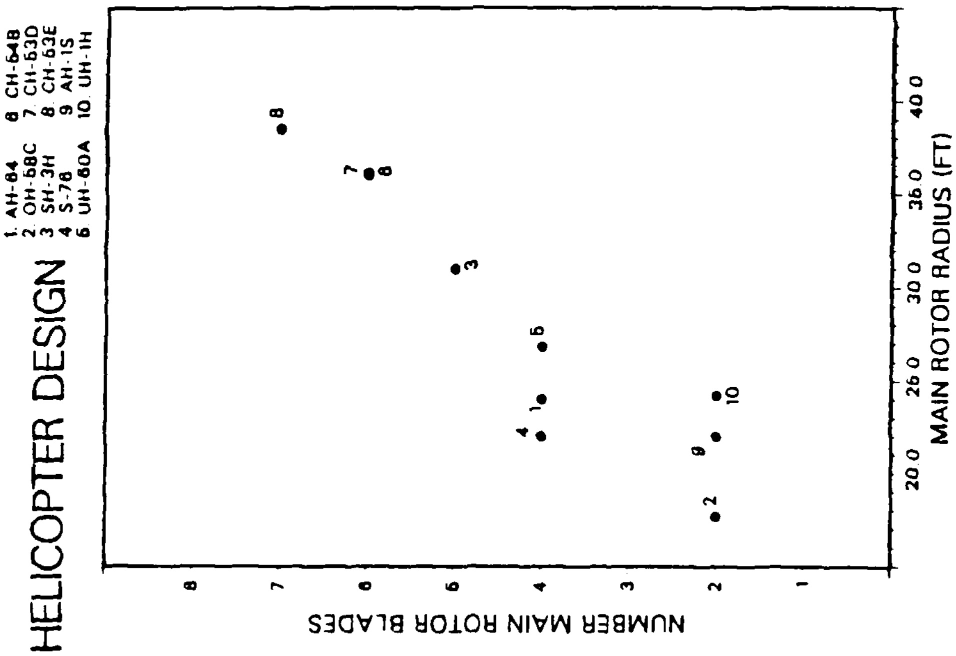


Fig. 1-3a.

Fig. 1-3a and 1-3b.

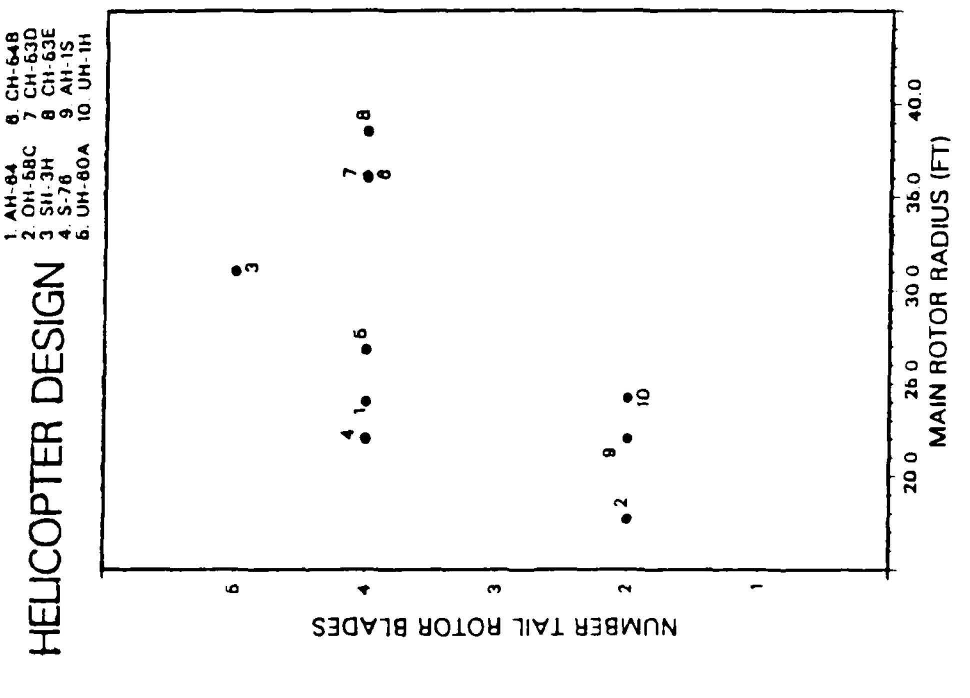


Fig. 1-4.

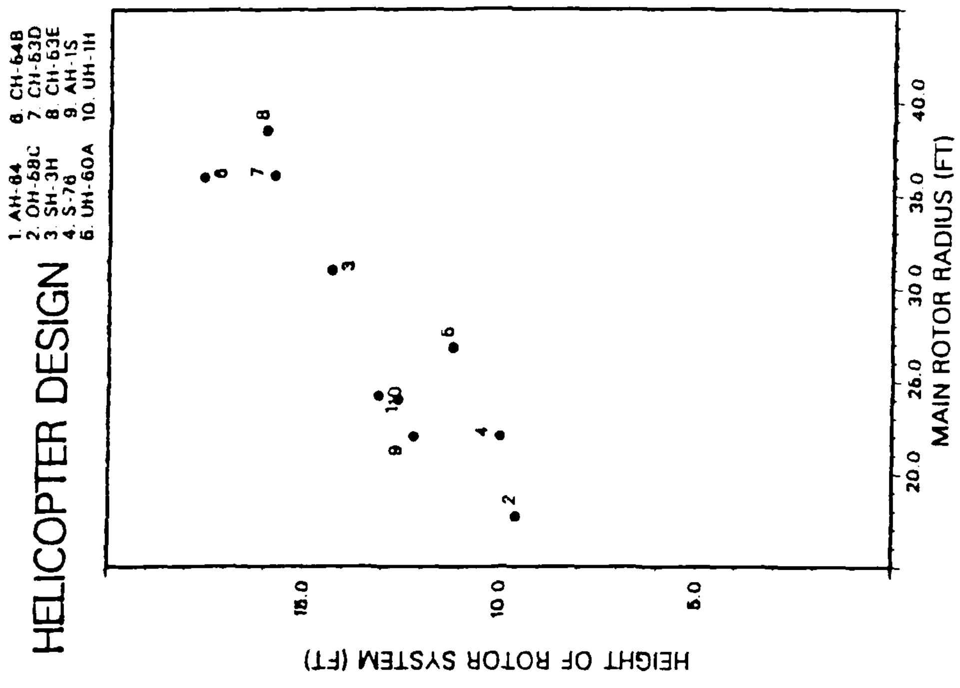


Fig. 1-5.

Fig. 1-4 and 1-5.

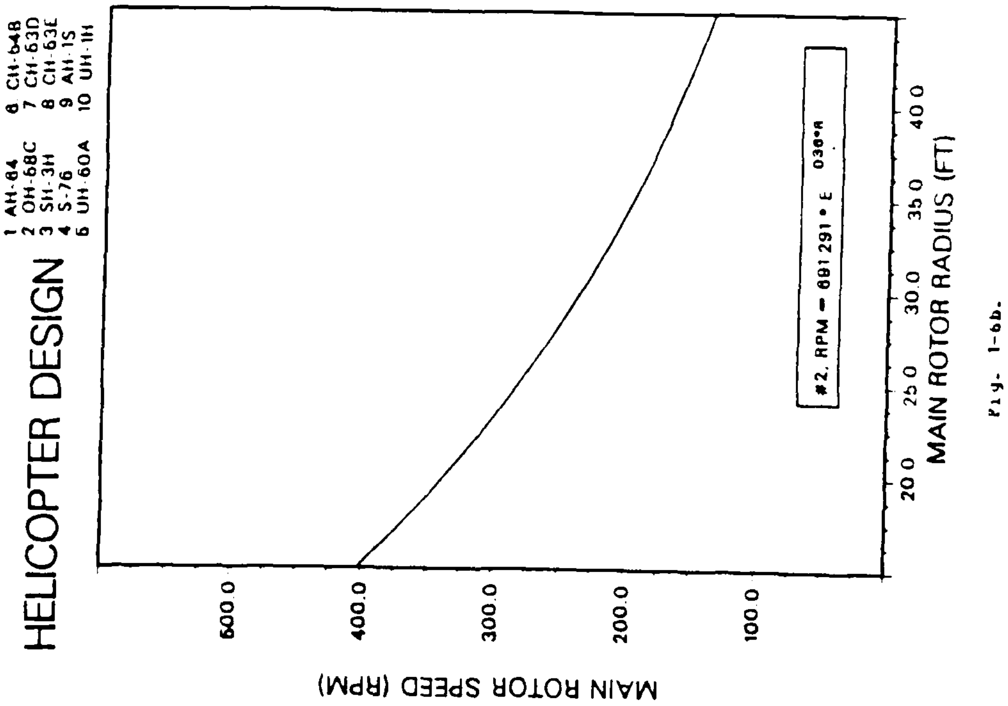


Fig. 1-6b.

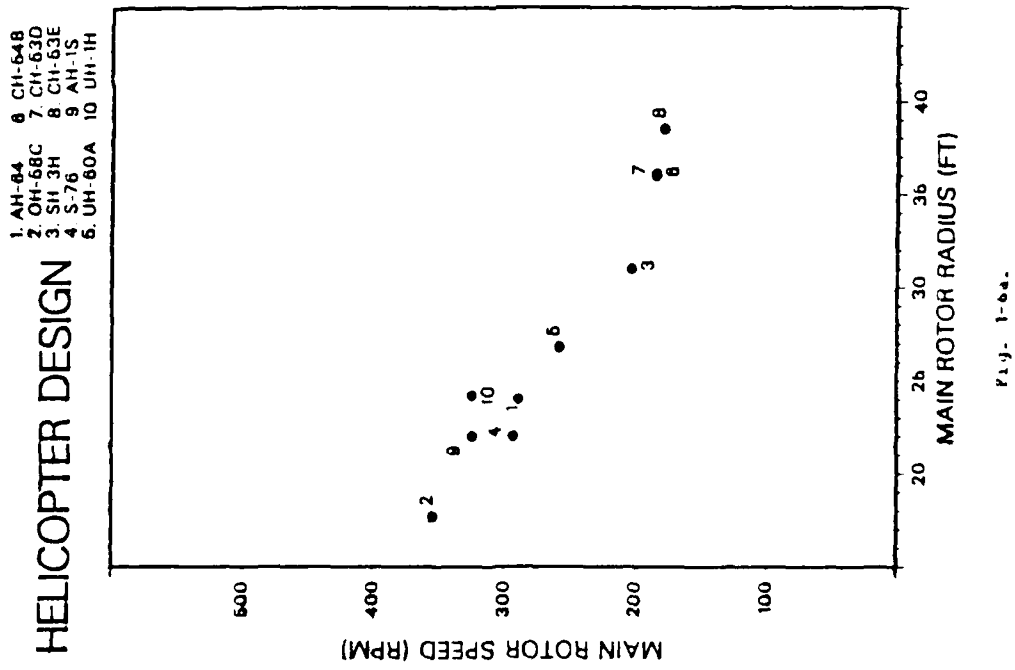


Fig. 1-6a.

Fig. 1-6a and 1-6b.

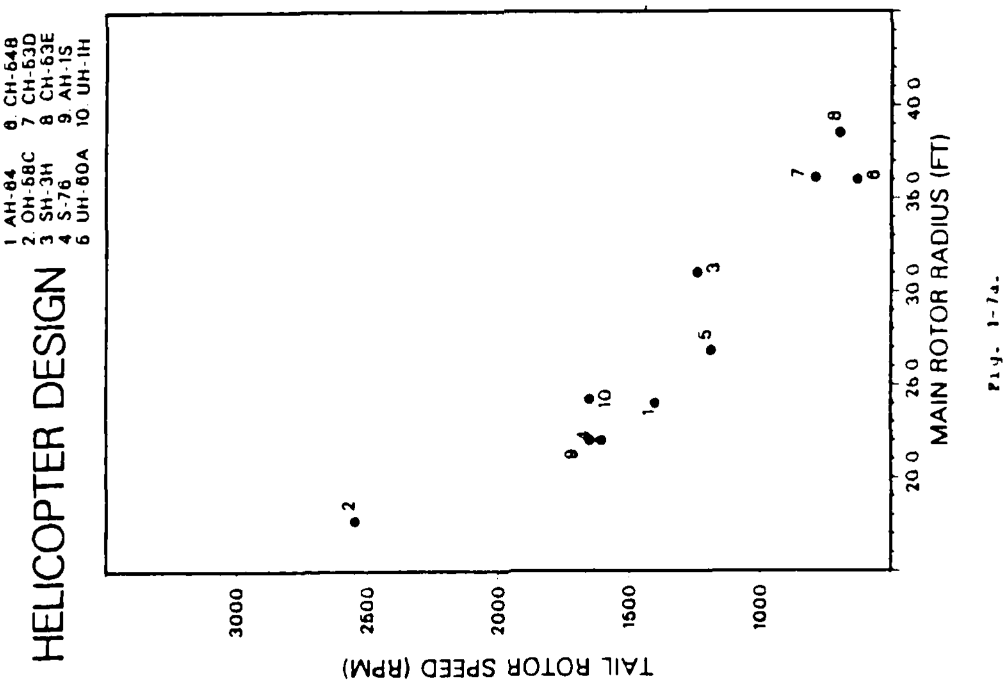


Fig. 1-7a.

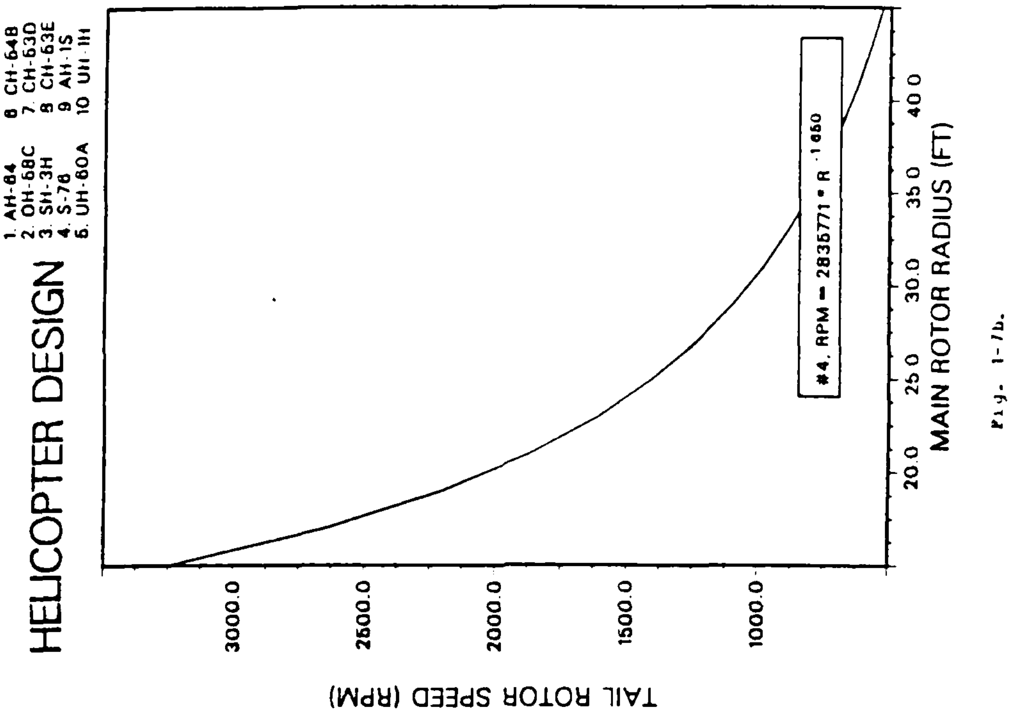


Fig. 1-7b.

Fig. 1-7a and 1-7b.

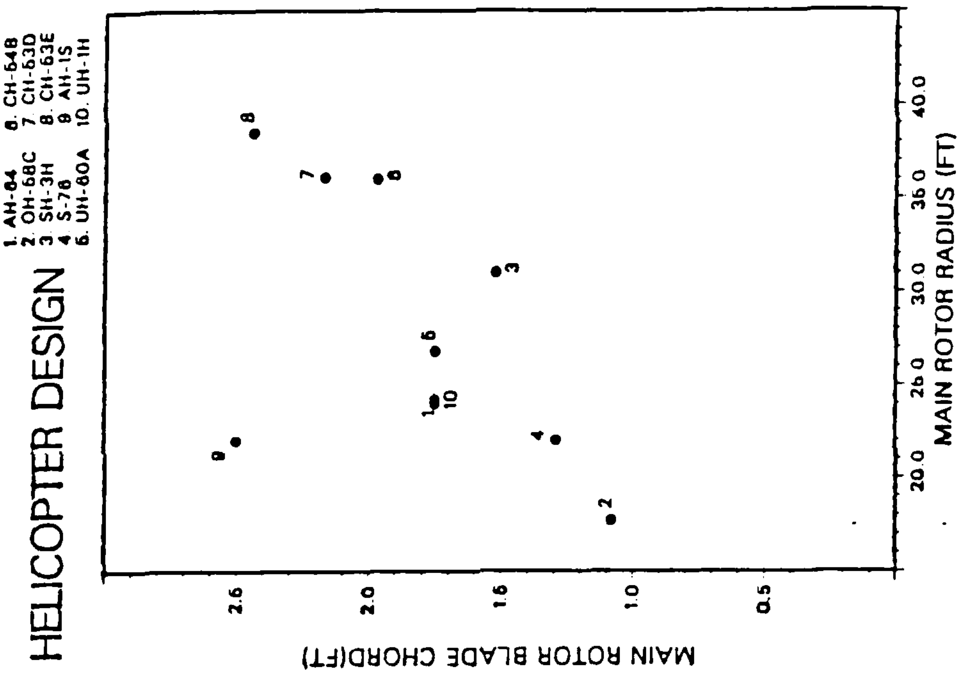

HELICOPTER DESIGN
1. AH-64
2. OH-58C
3. SH-3H
4. S-76
5. UH-60A
6. CH-54B
7. CH-53D
8. CH-53E
9. AH-1S
10. UH-1H
MAIN ROTOR BLADE CHORD(FT)
MAIN ROTOR RADIUS (FT)
2.5
2.0
1.5
1.0
0.5
20.0
25.0
30.0
35.0
40.0

Fig. 1-8.

Fig. 1-8.

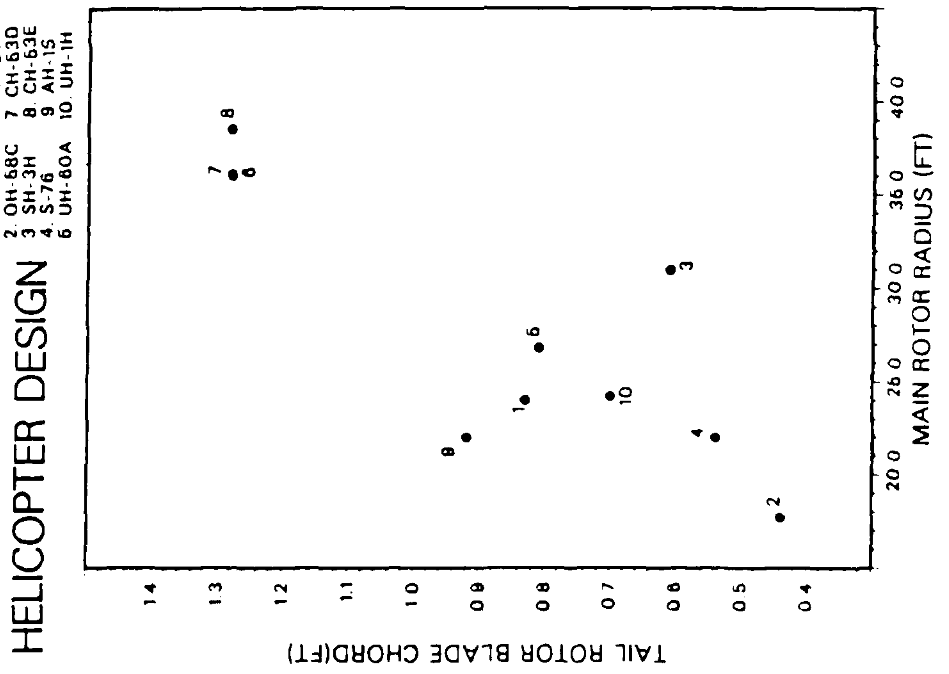


Fig. 1-9a.

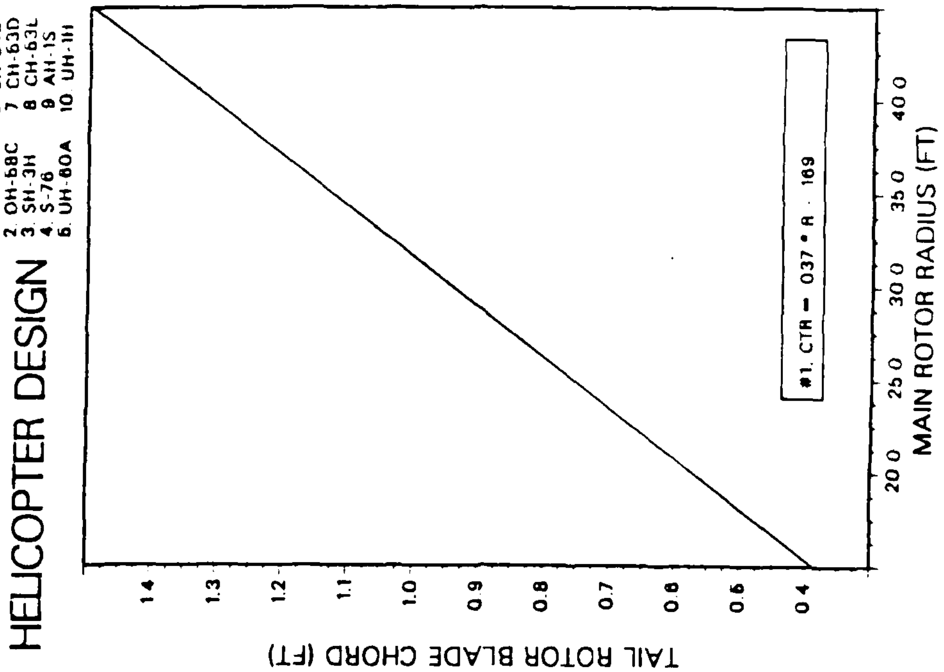


Fig. 1-9b.

Fig. 1-9a and 1-9b.

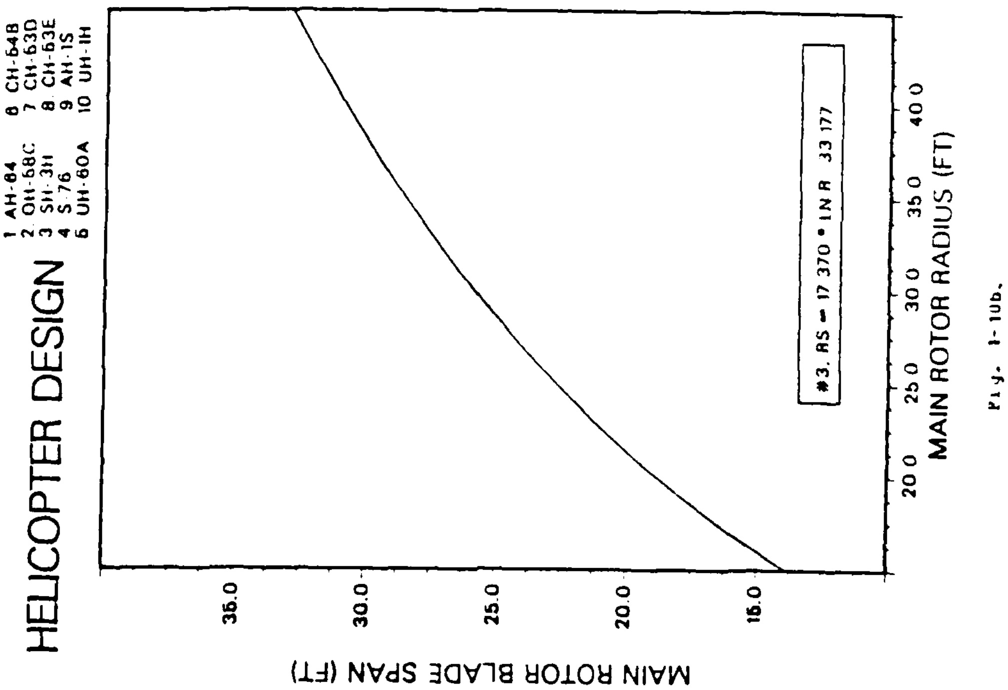


Fig. 1-10b.

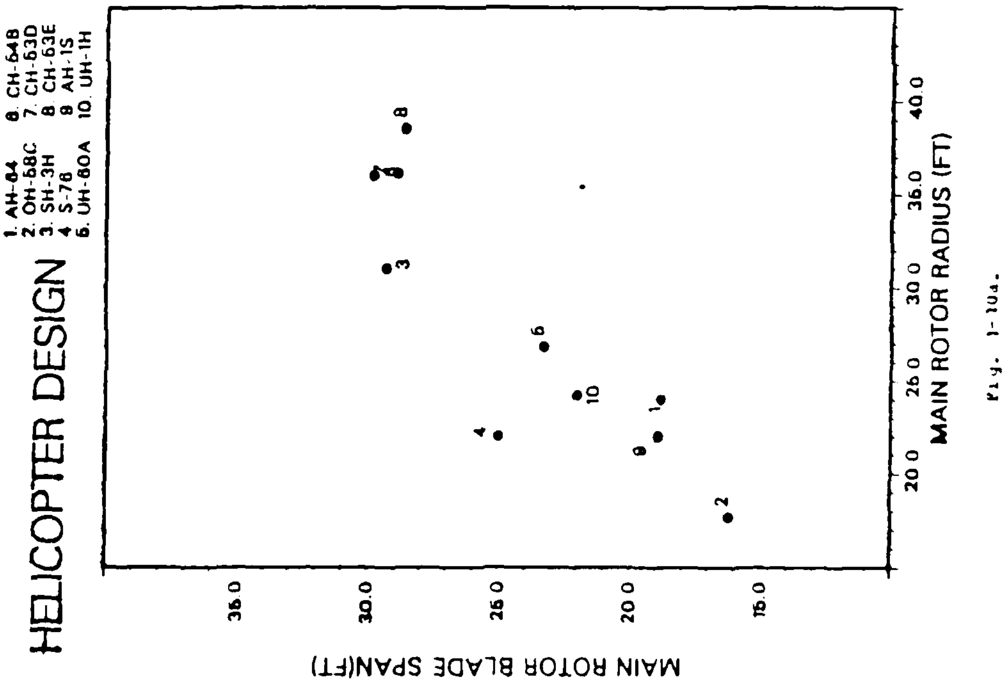


Fig. 1-10a.

Fig. 1-10a and 1-10b.

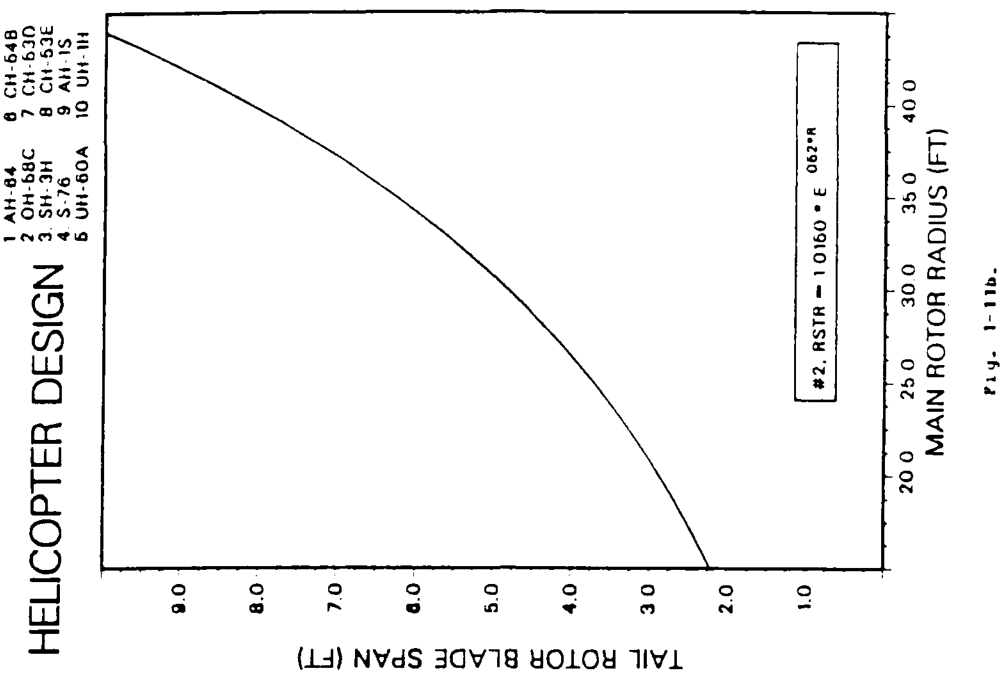


Fig. 1-11b.

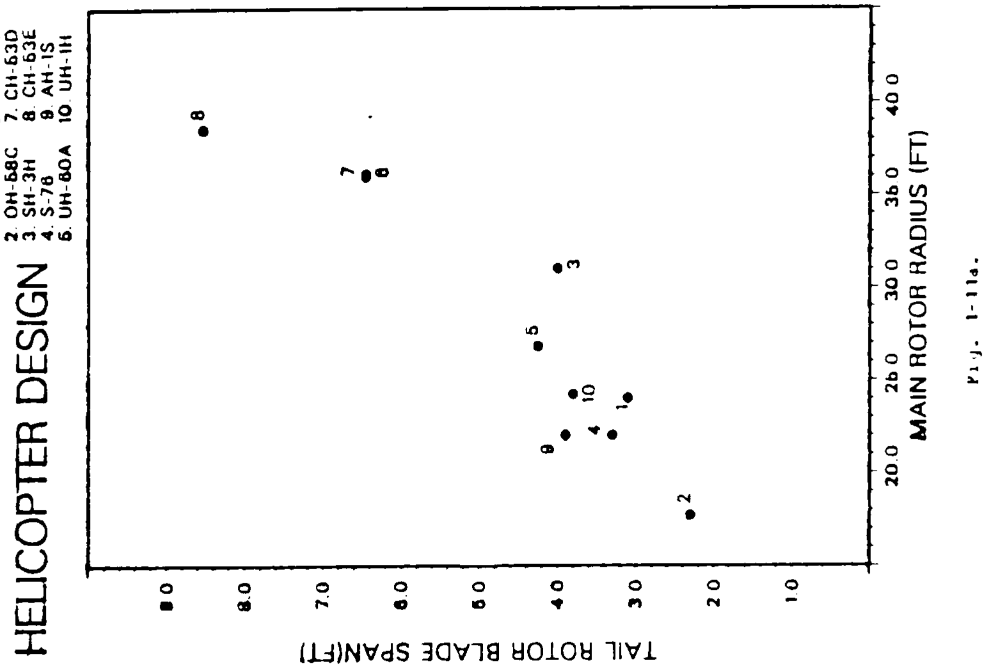
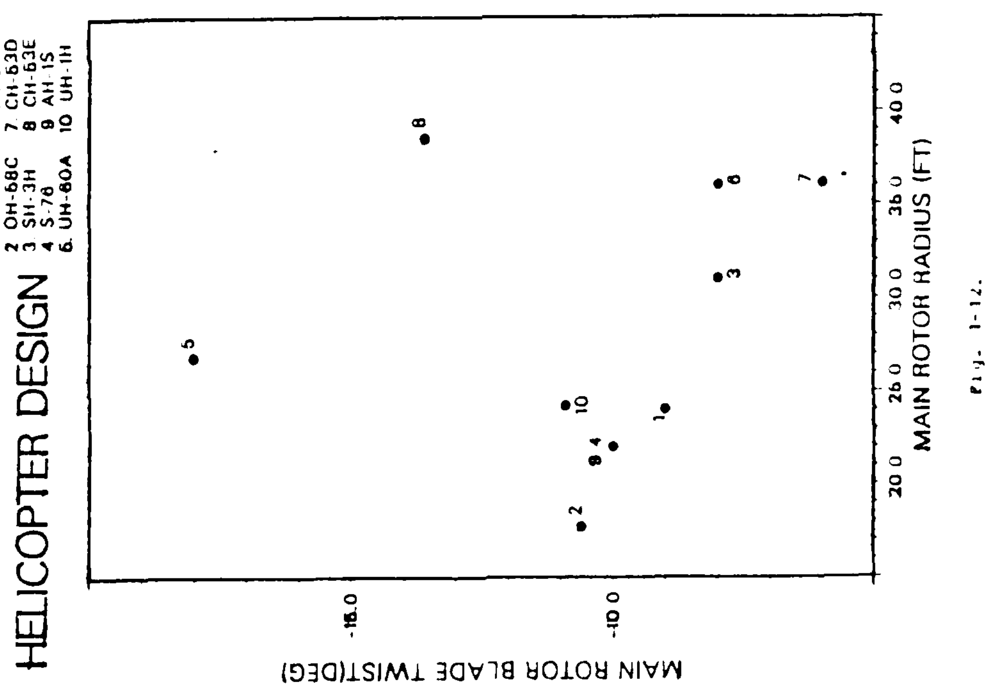


Fig. 1-11a.

Fig. 1-11a and 1-11b.



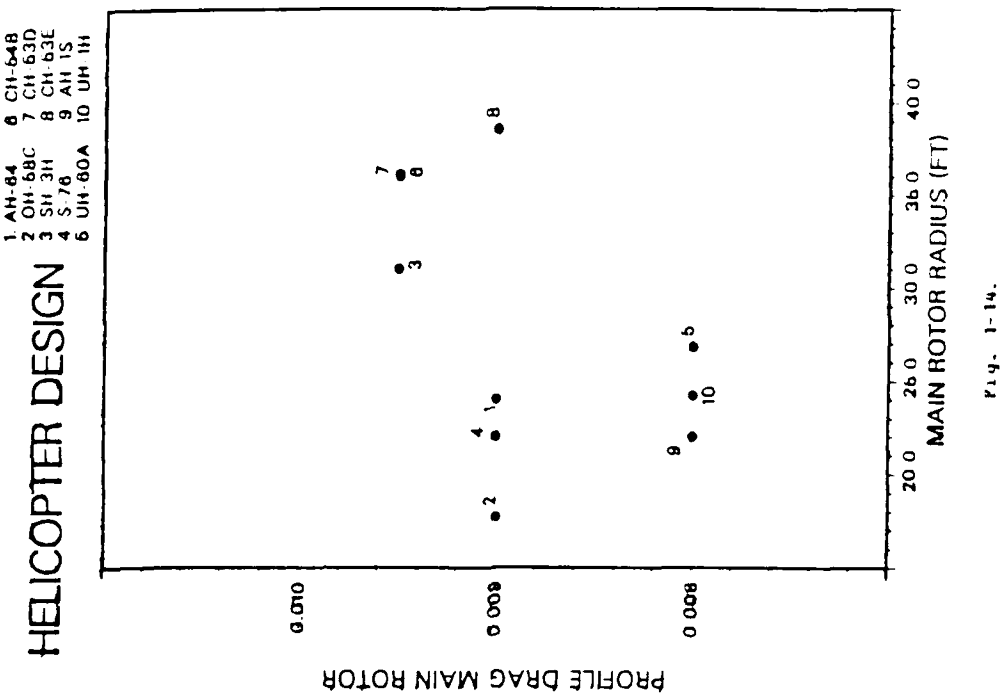


Fig. 1-12 and 1-14.

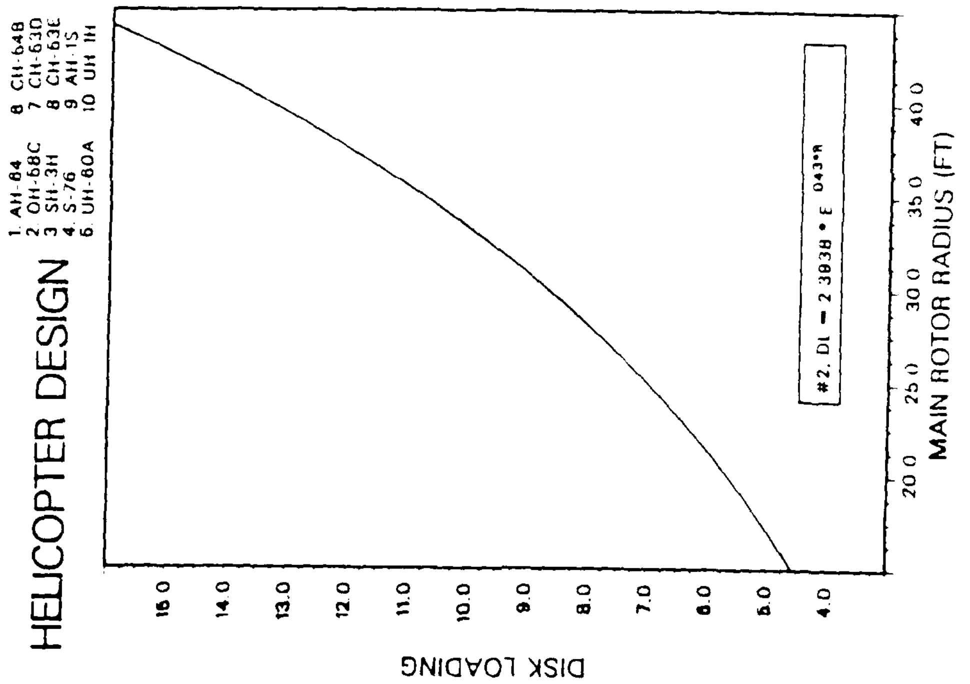


Fig. 1-16b.

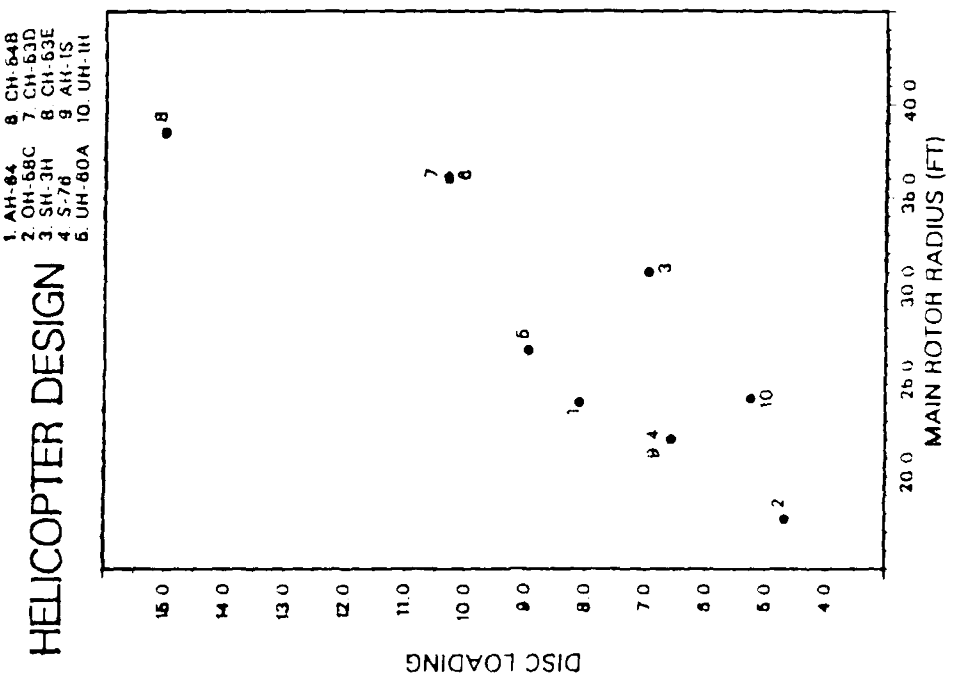


Fig. 1-16a.

Fig. 1-16a and 1-16b.

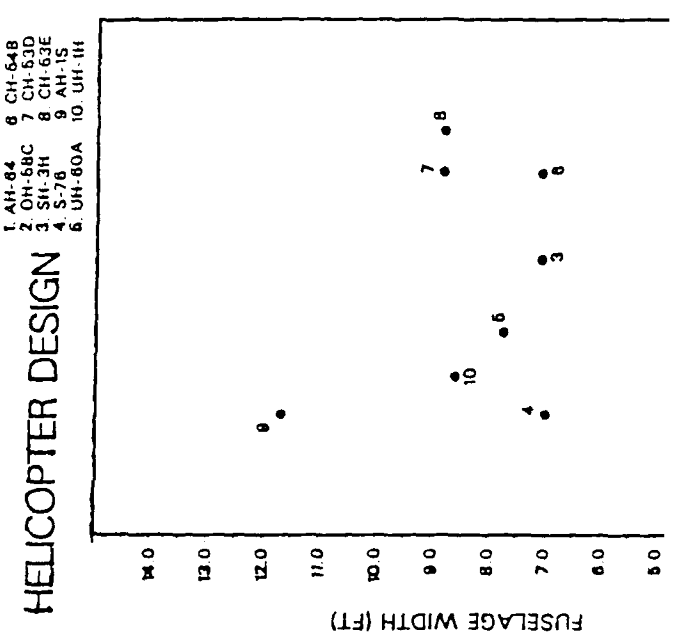

HELICOPTER DESIGN
1. AH-64
2. OH-58C
3. SH-3H
4. S-76
5. UH-60A
6. CH-54B
7. CH-53D
8. CH-53E
9. AH-1S
10. UH-1H
FUSELAGE WIDTH (FT)
14.0
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0

Fig. 1-17.

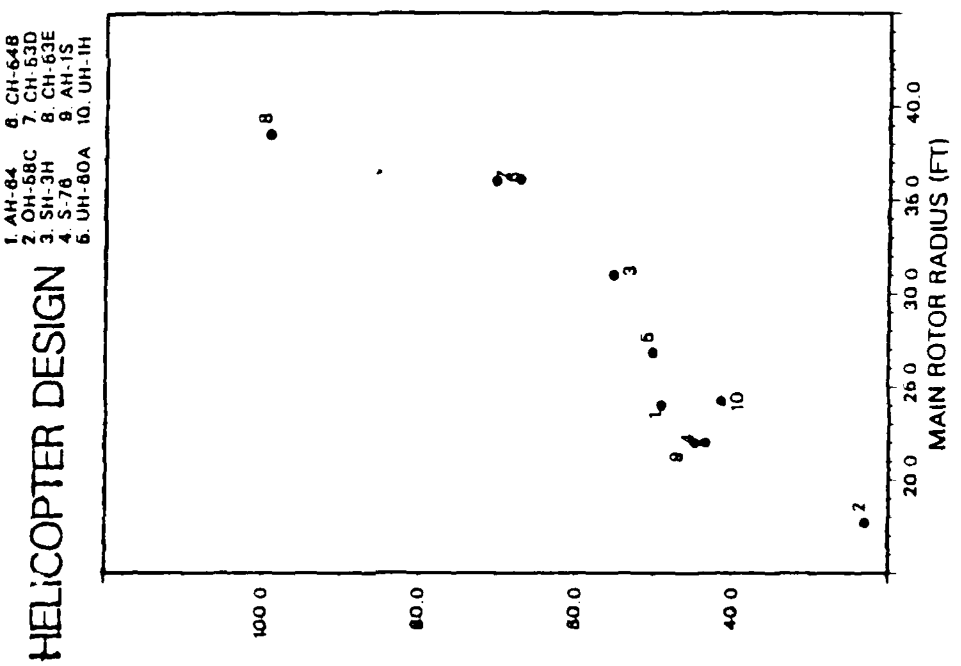


Fig. 1-18a.

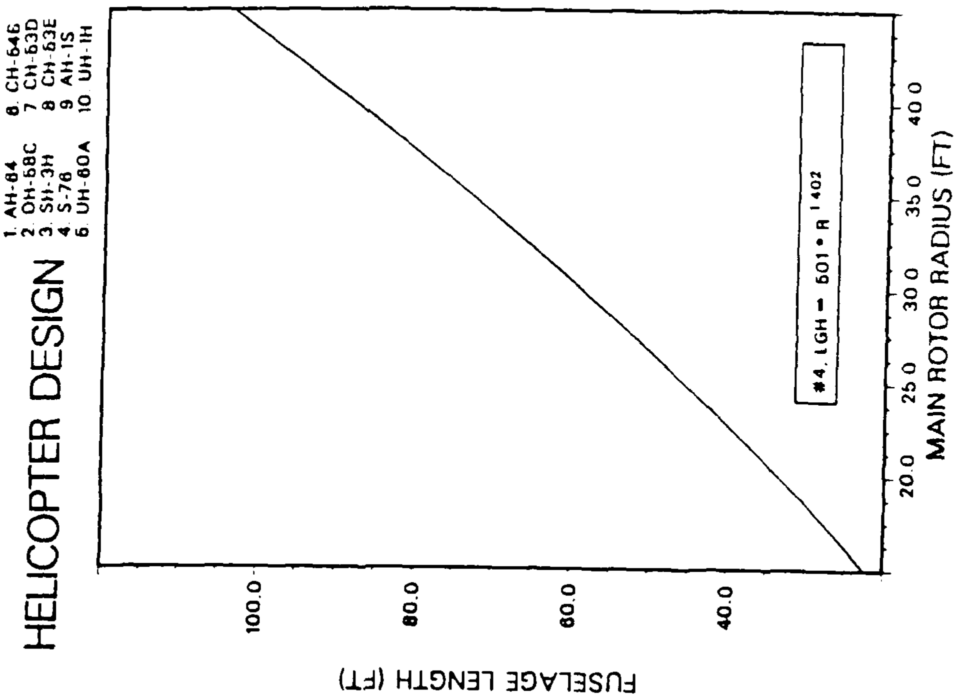
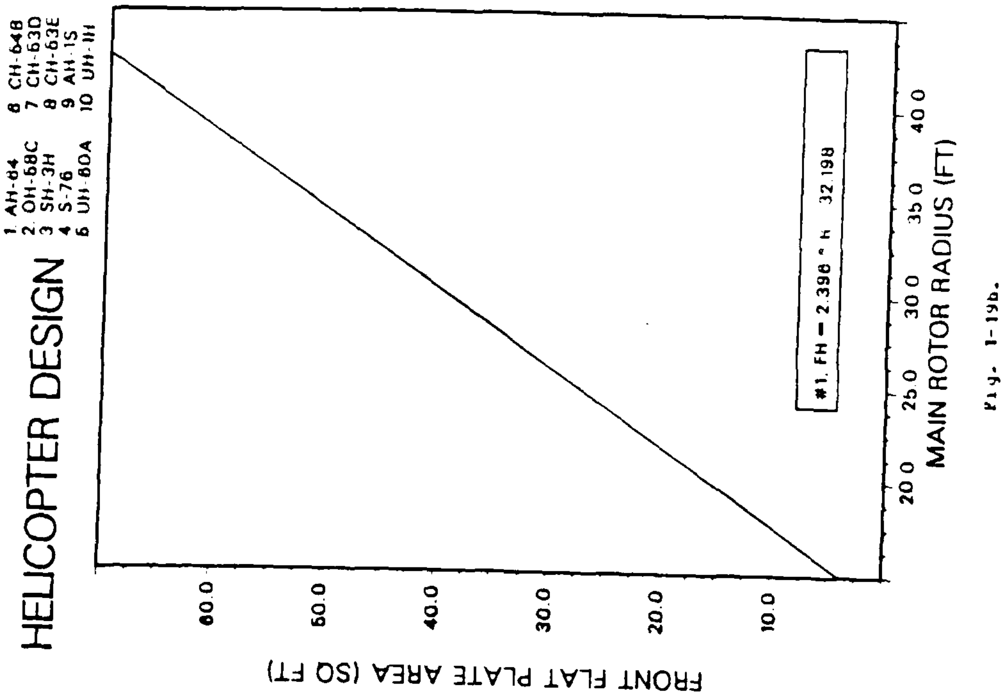


Fig. 1-18b.

Fig. 1-18a and 1-18b.



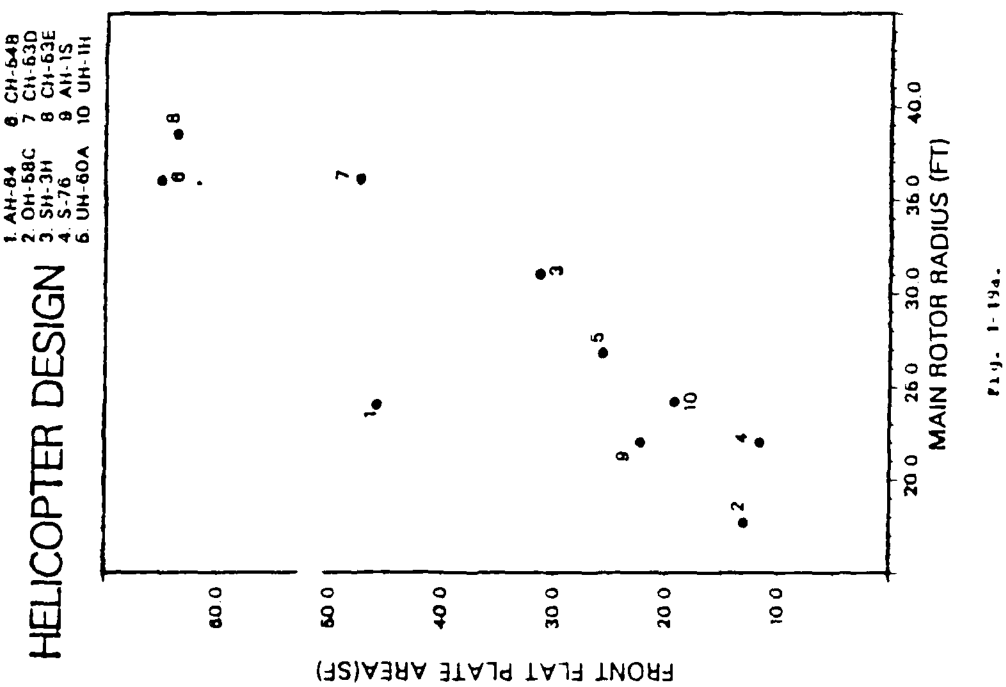


Fig. 1-19a and 1-19b.

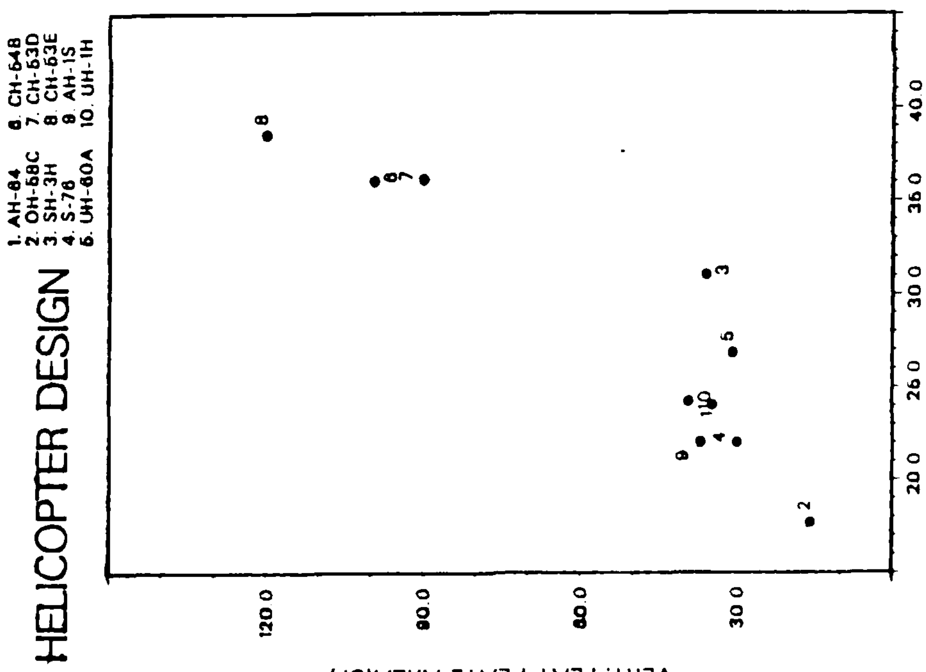


Fig. 1-20.

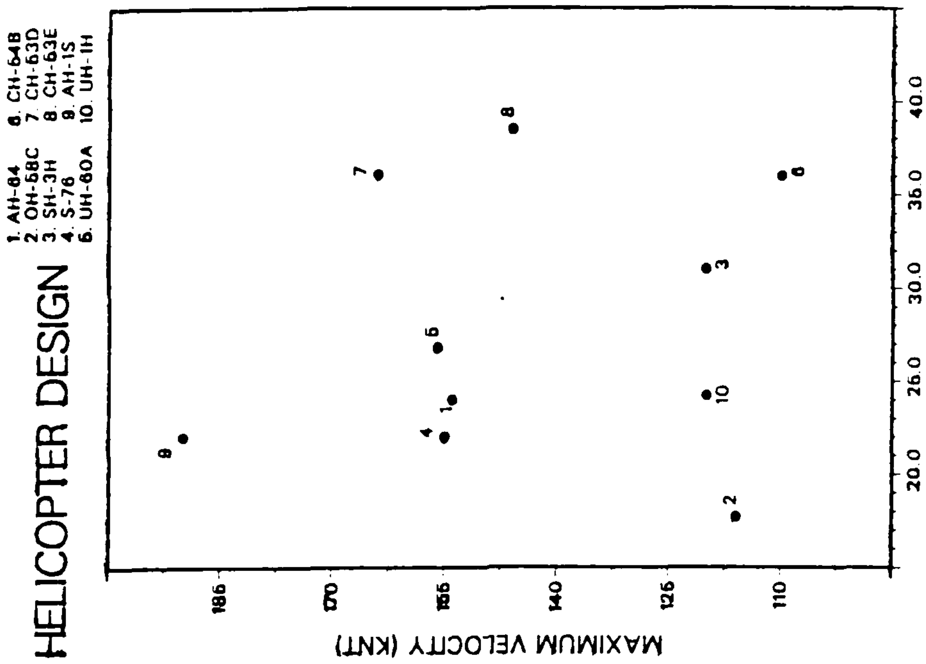


Fig. 1-21.

Fig. 1-20 and 1-21.

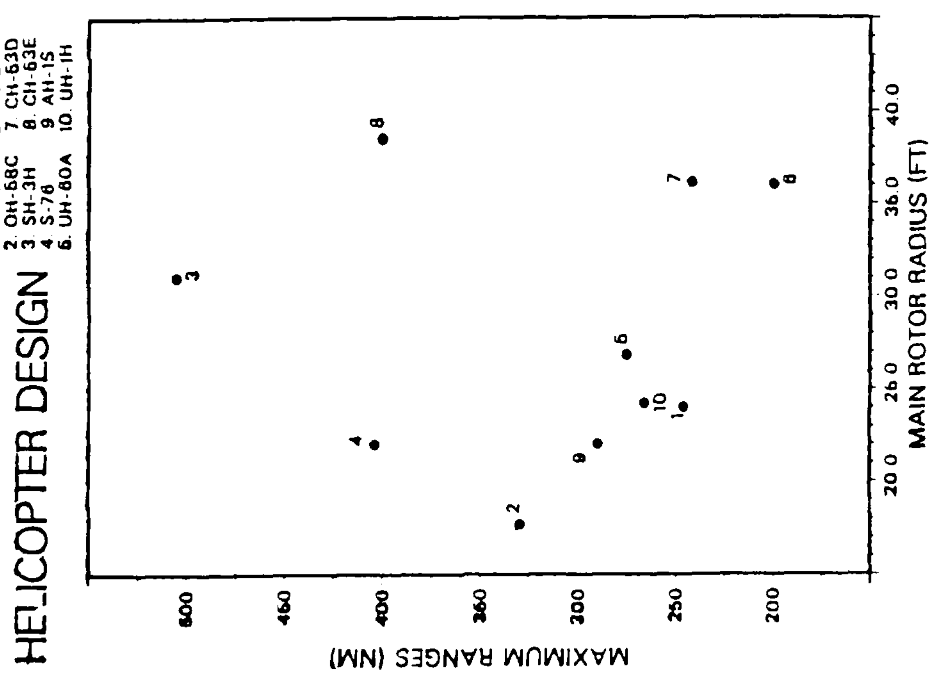


Fig. 1-22.

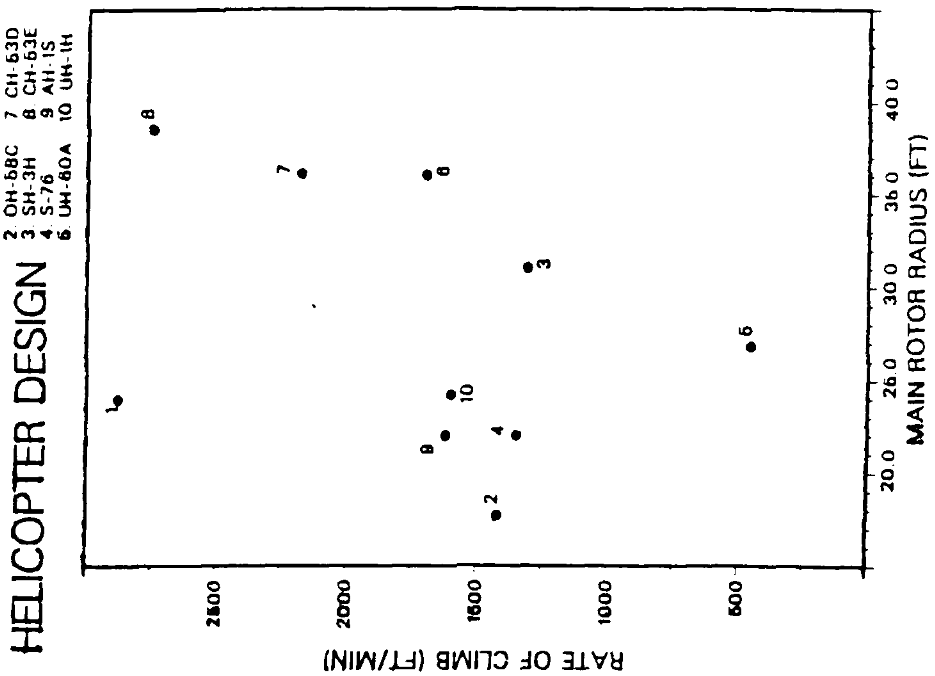


Fig. 1-23.

Fig. 1-22 and 1-23.

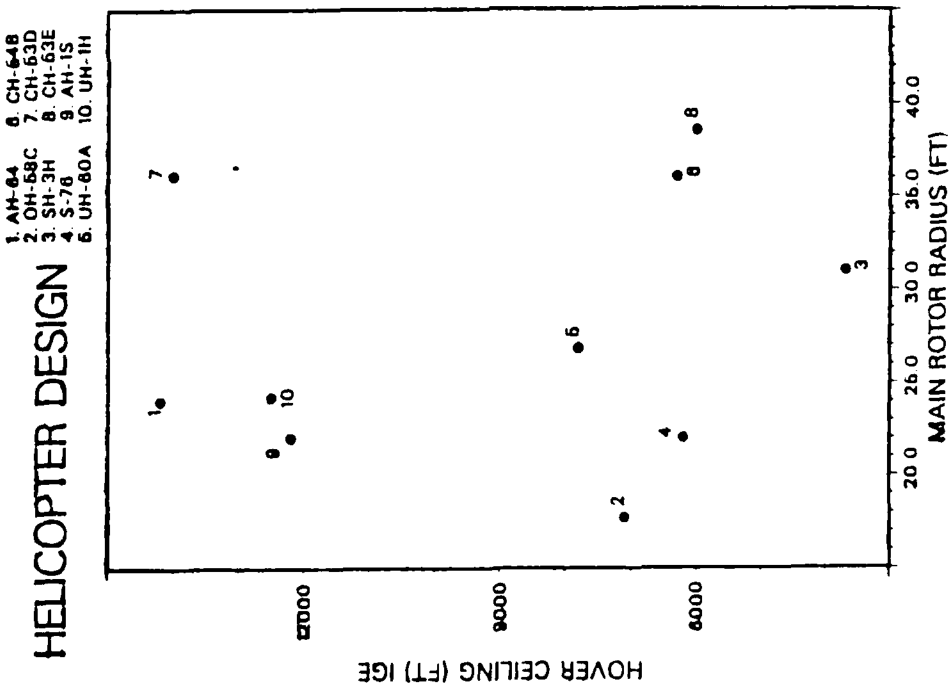


Fig. 1-24.

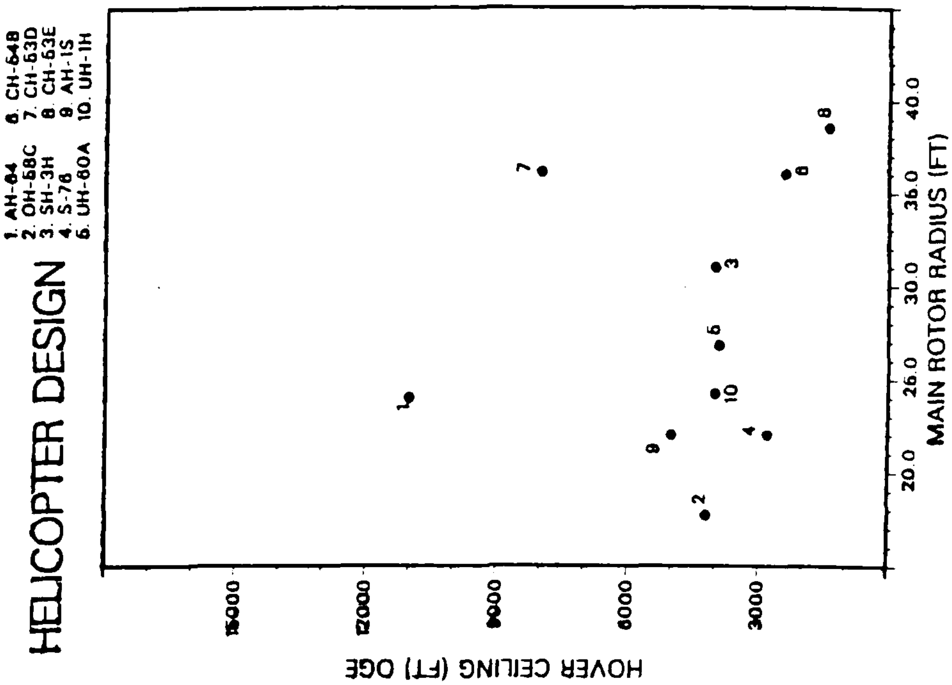


Fig. 1-25.

Fig. 1-24 and 1-25.

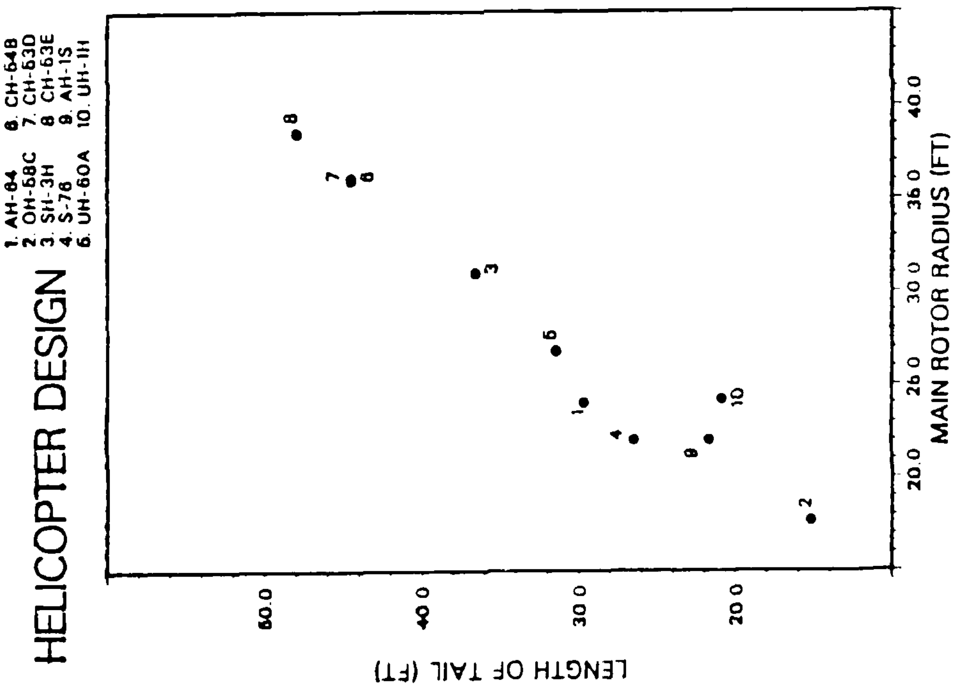


Fig. 1-26a.

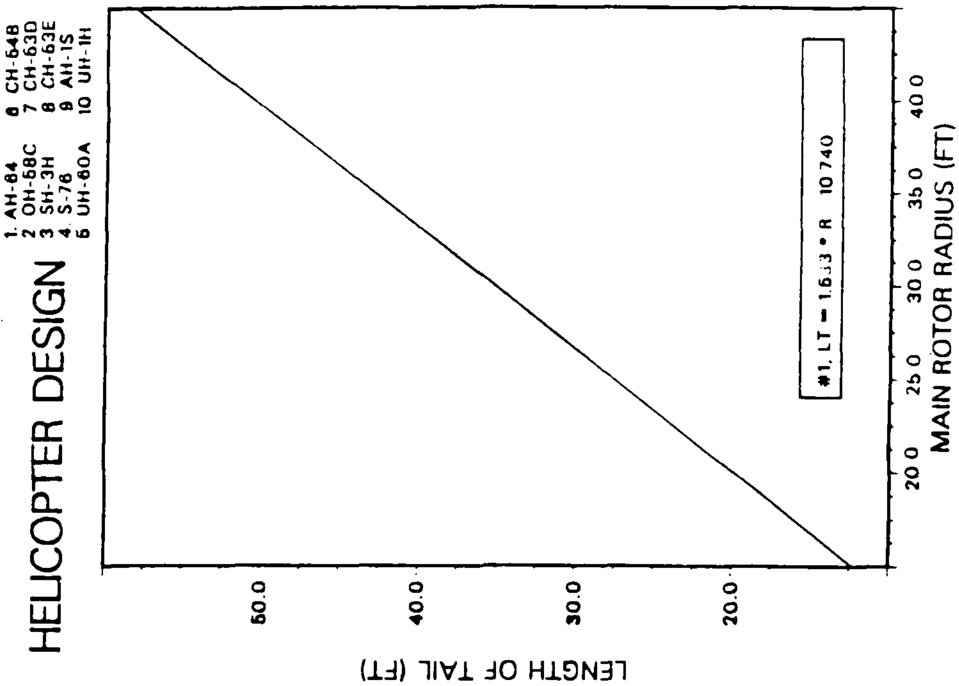


Fig. 1-26b.

Fig. 1-26a and 1-26b.

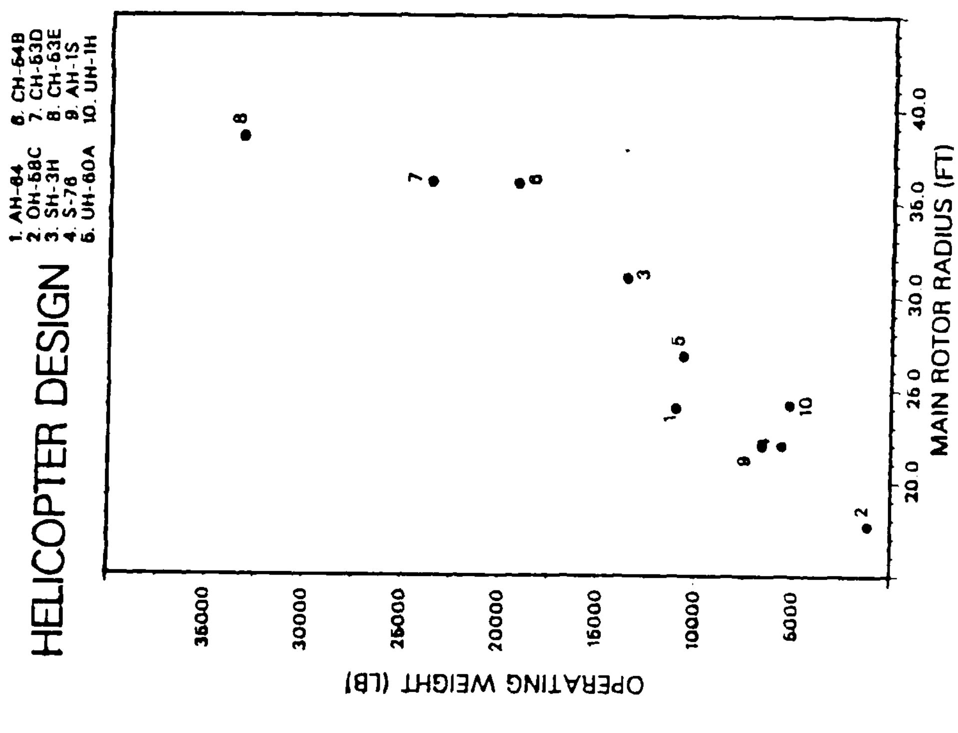


Fig. 1-27a.

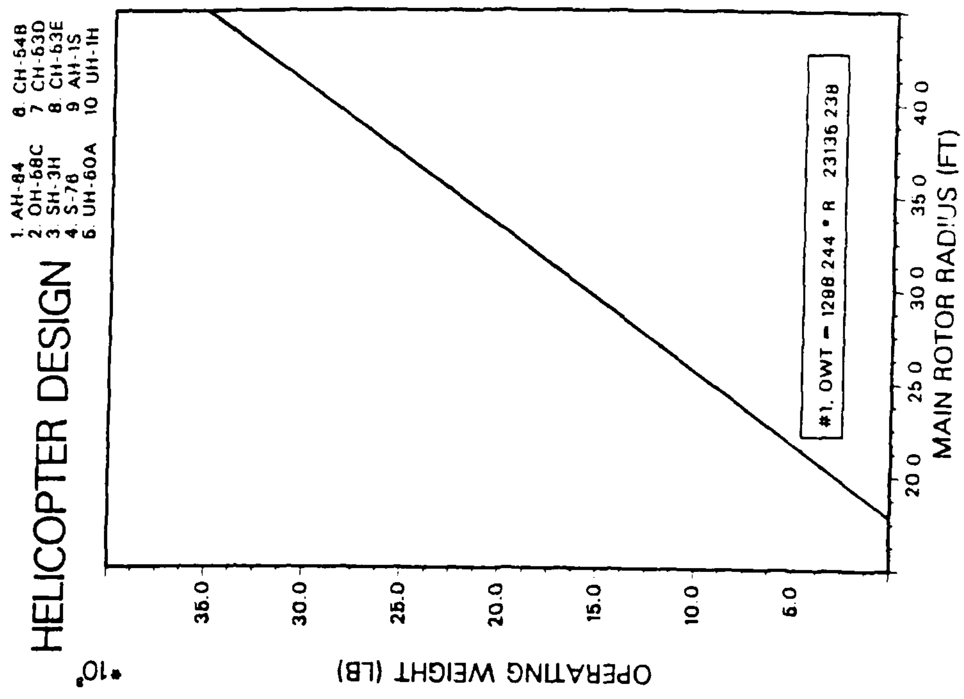
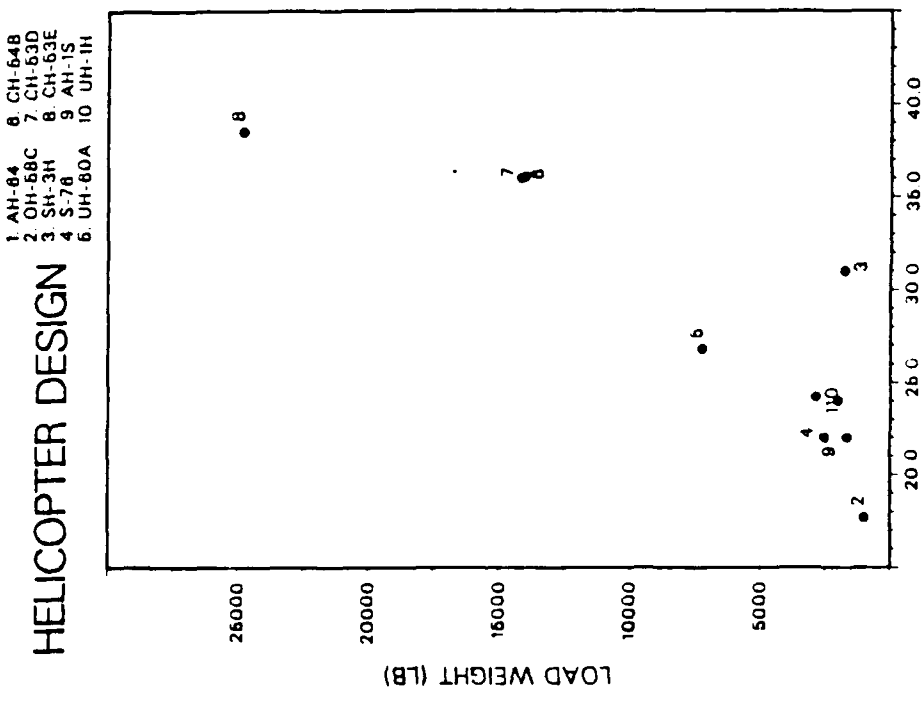


Fig. 1-27b.

Fig. 1-27a and 1-27b.



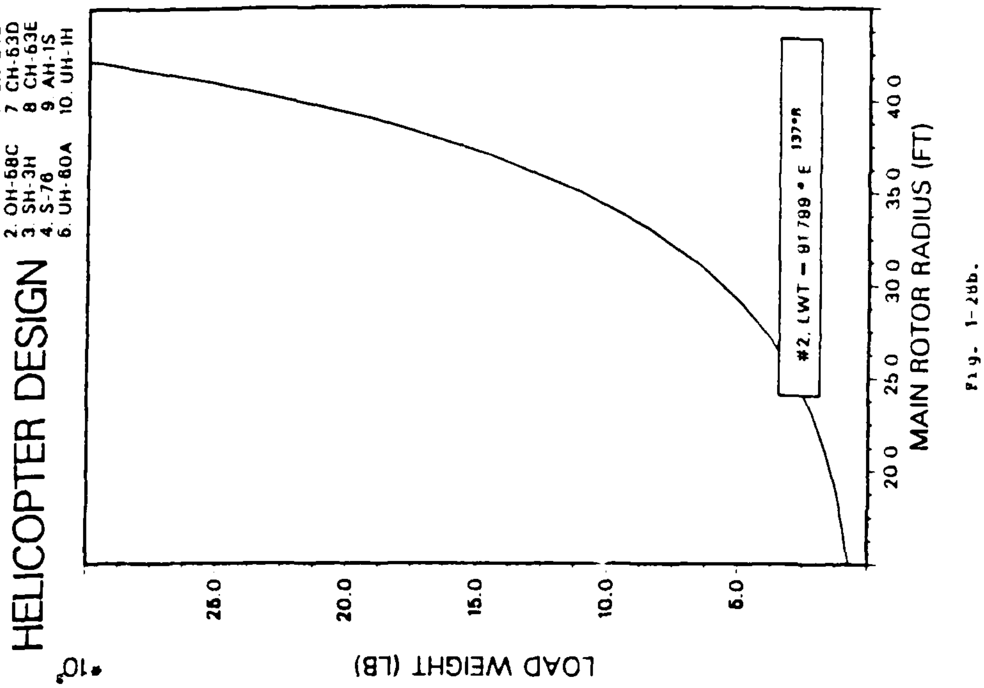


Fig. 1-28a and 1-23b.

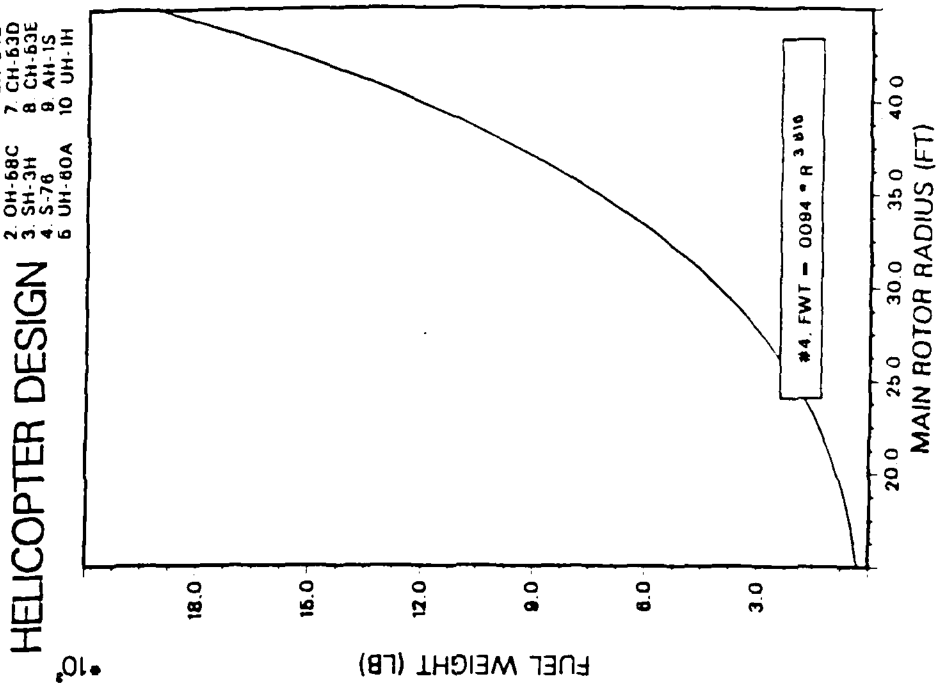


Fig. 1-29b.

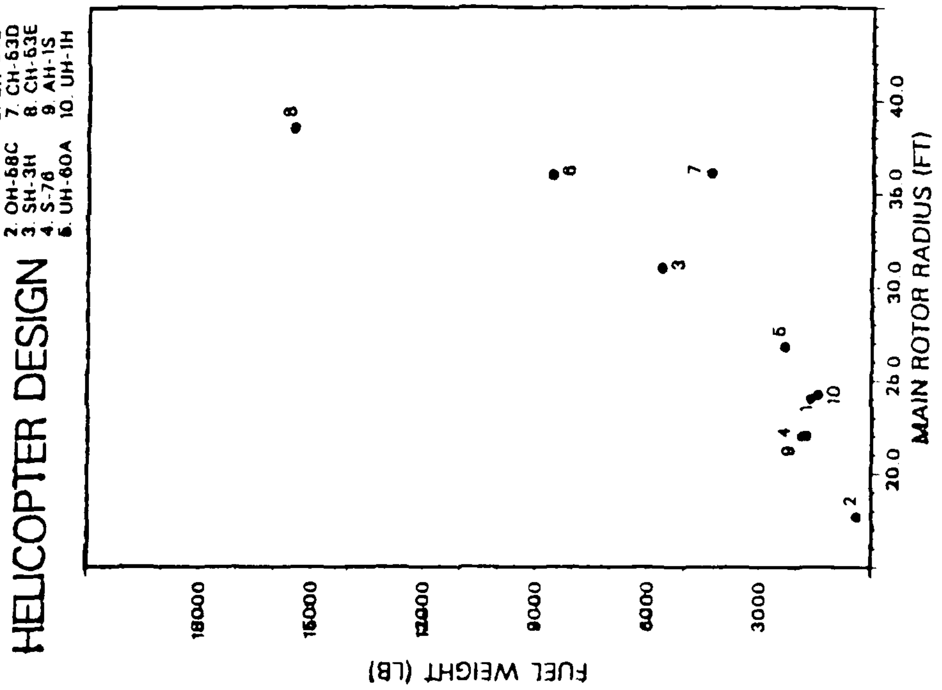


Fig. 1-29a.

Fig. 1-29a and 1-29b.

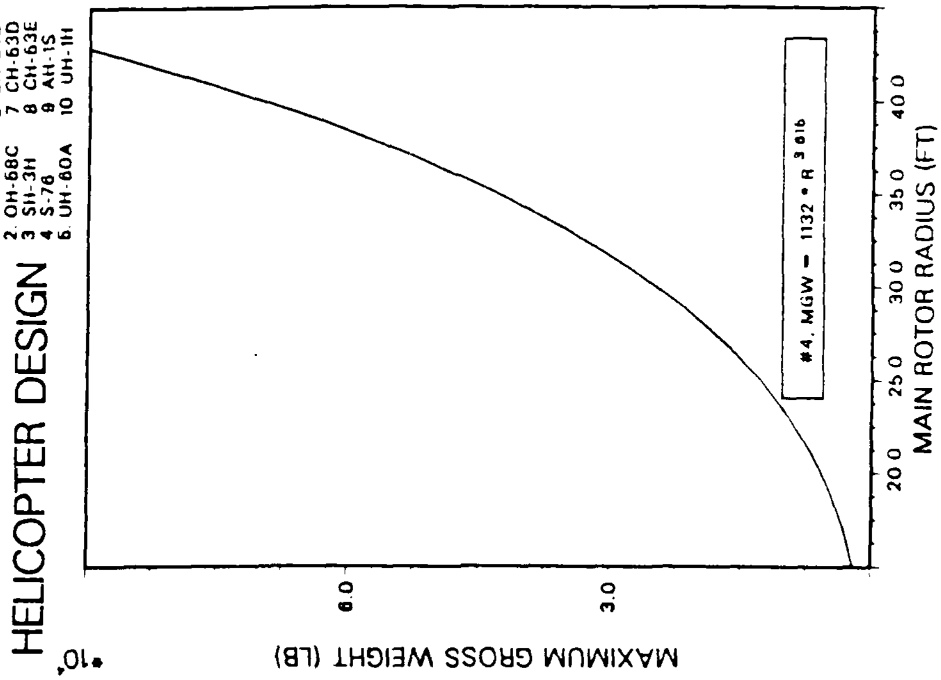


Fig. 1-30b.

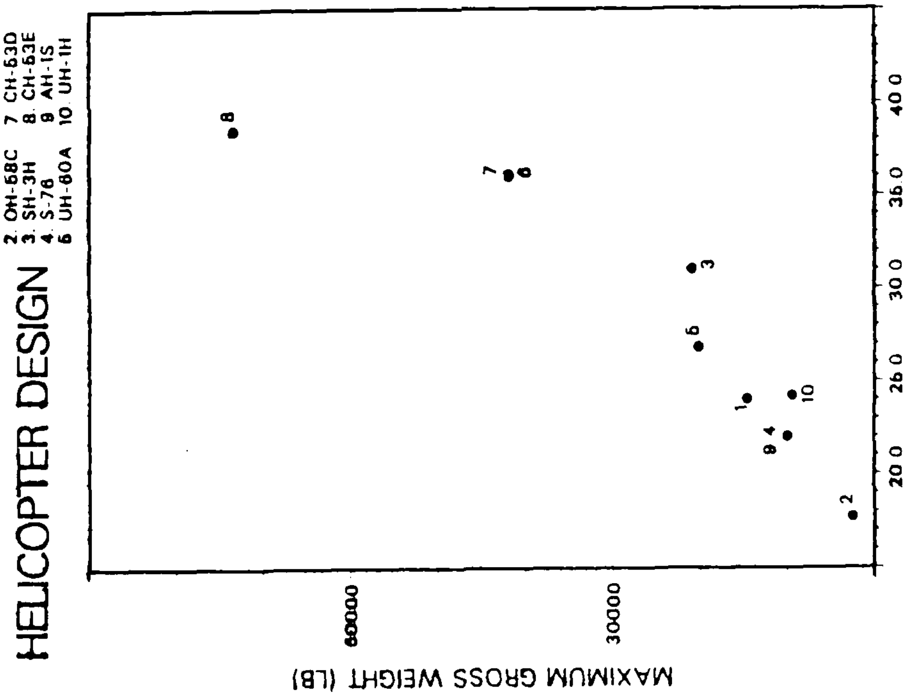


Fig. 1-30a.

Fig. 1-30a and 1-30b.

Tail Rotor Radius Pairings.

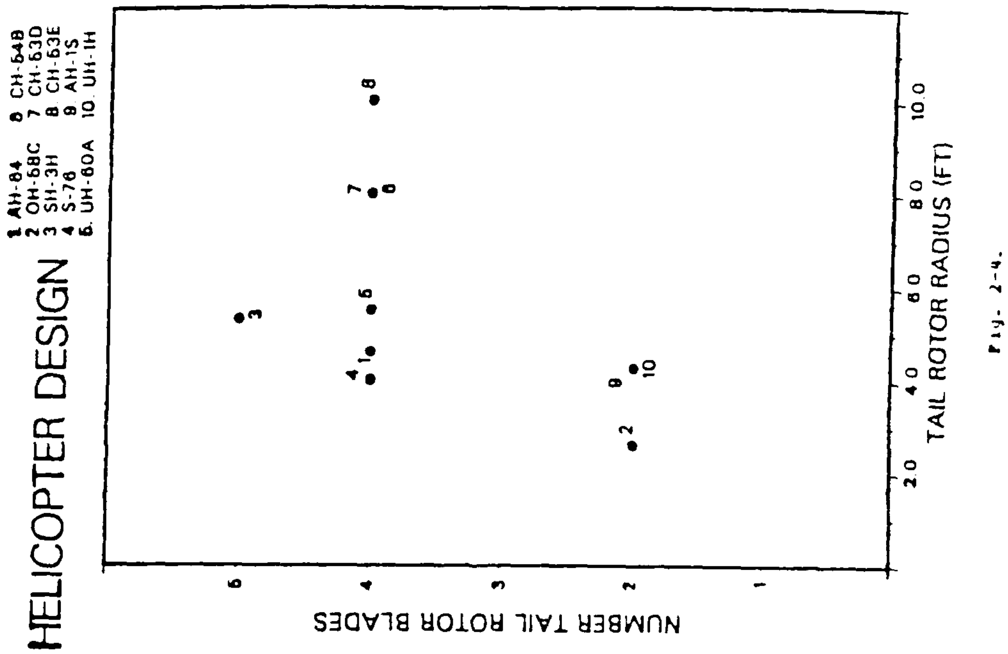

HELICOPTER DESIGN
1 AH-64
2 OH-58C
3 SH-3H
4 S-76
5 UH-60A
6 CH-54B
7 CH-53D
8 CH-53E
9 AH-1S
10 UH-1H
NUMBER TAIL ROTOR BLADES
TAIL ROTOR RADIUS (FT)
Fig. 2-4.

Fig. 2-4.

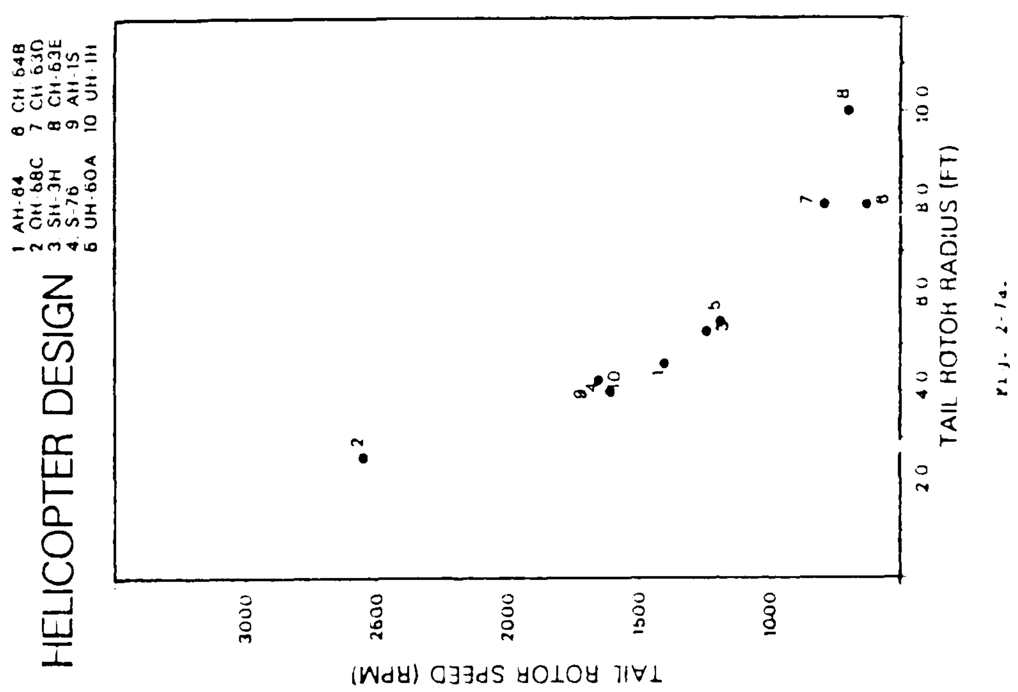


Fig. 2-7a.

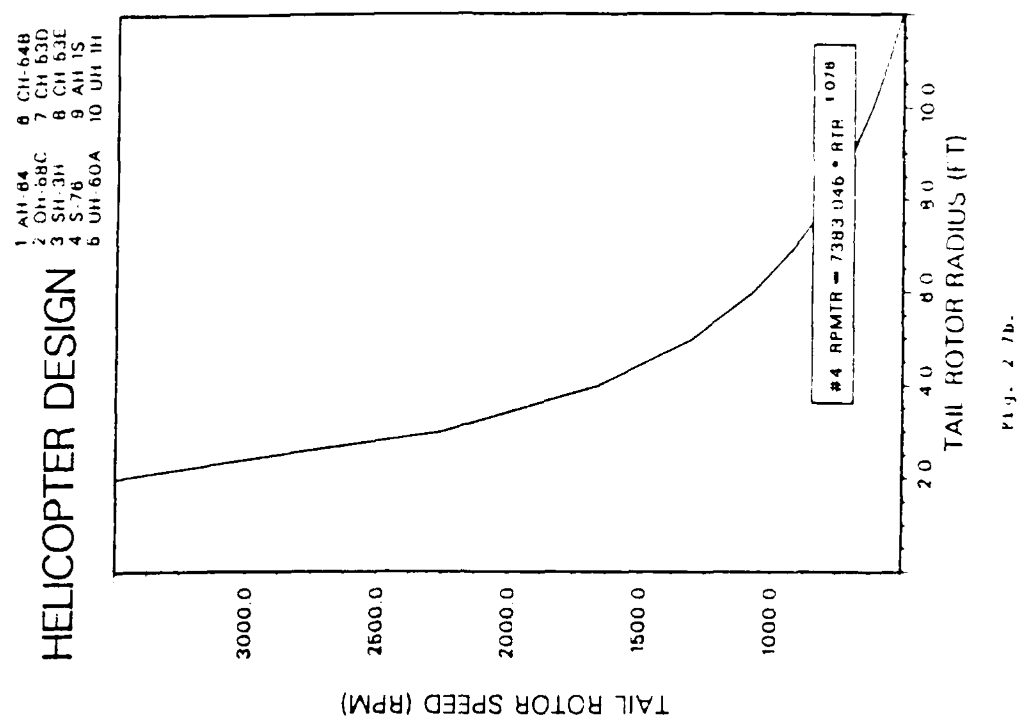
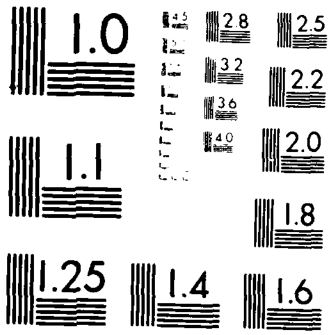


Fig. 2-7b.

Fig. 2-7a and 2-7b.

AD-A152 034 DETERMINATION OF QUANTITATIVE RELATIONSHIPS BETWEEN SELECTED CRITICAL HELICOPTER DESIGN PARAMETERS(U) NAVAL POSTGRADUATE SCHOOL MONTEREY CA R S PETRICKA SEP 84 2/4

UNCLASSIFIED F/G 1/3 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A

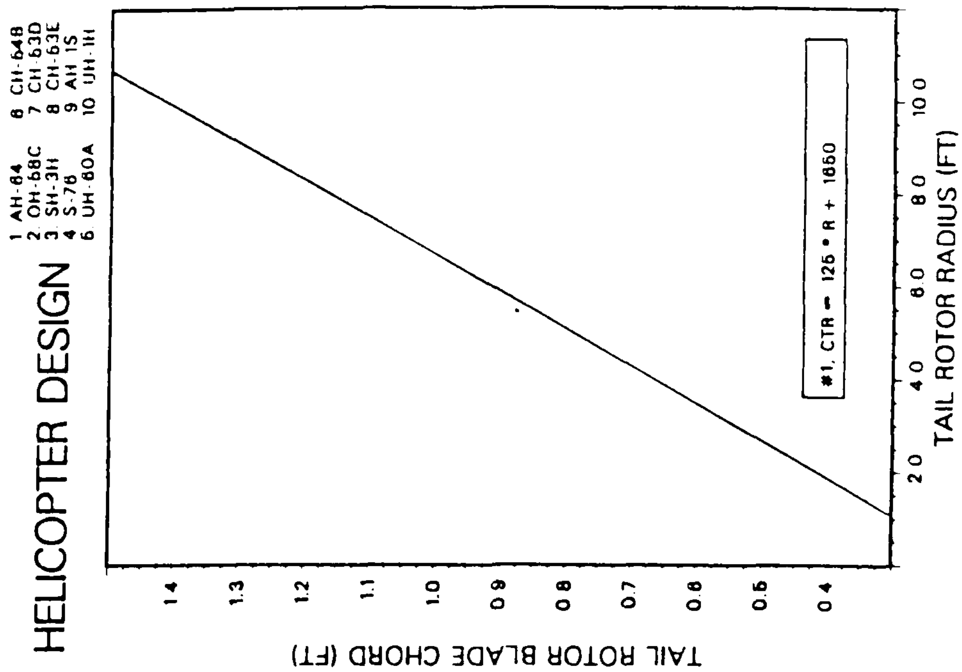


Fig. 2-9b.

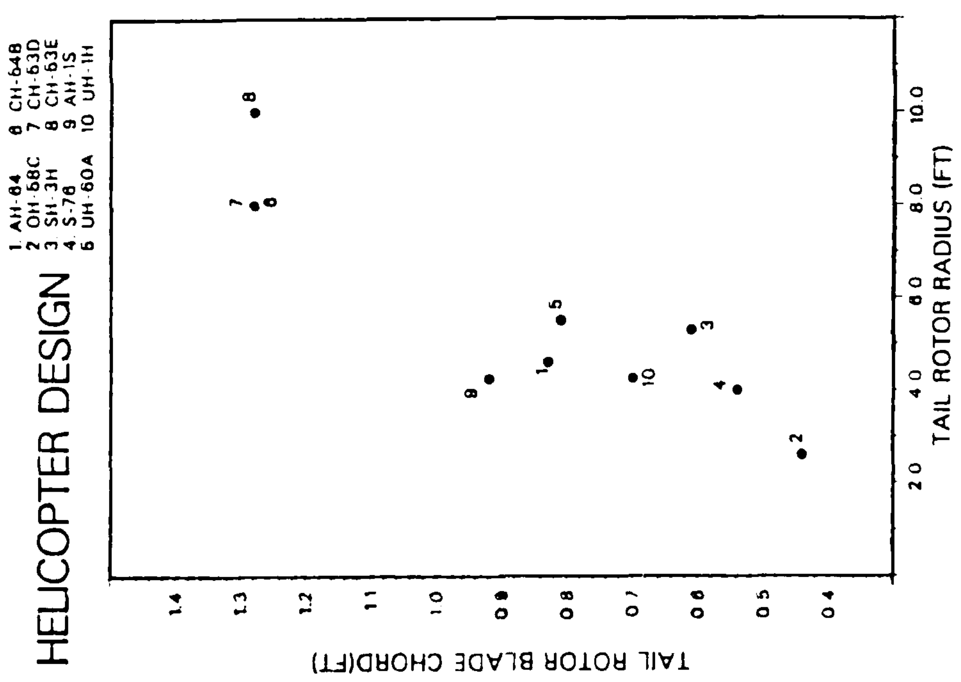


Fig. 2-9a.

Fig. 2-9a and 2-9b.

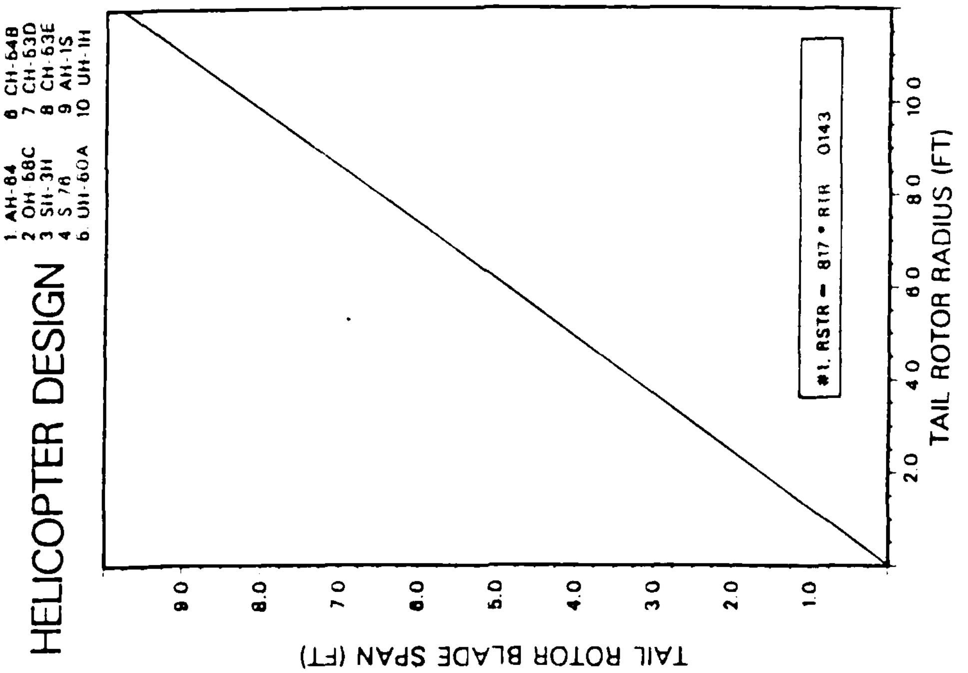


Fig. 2-11b.

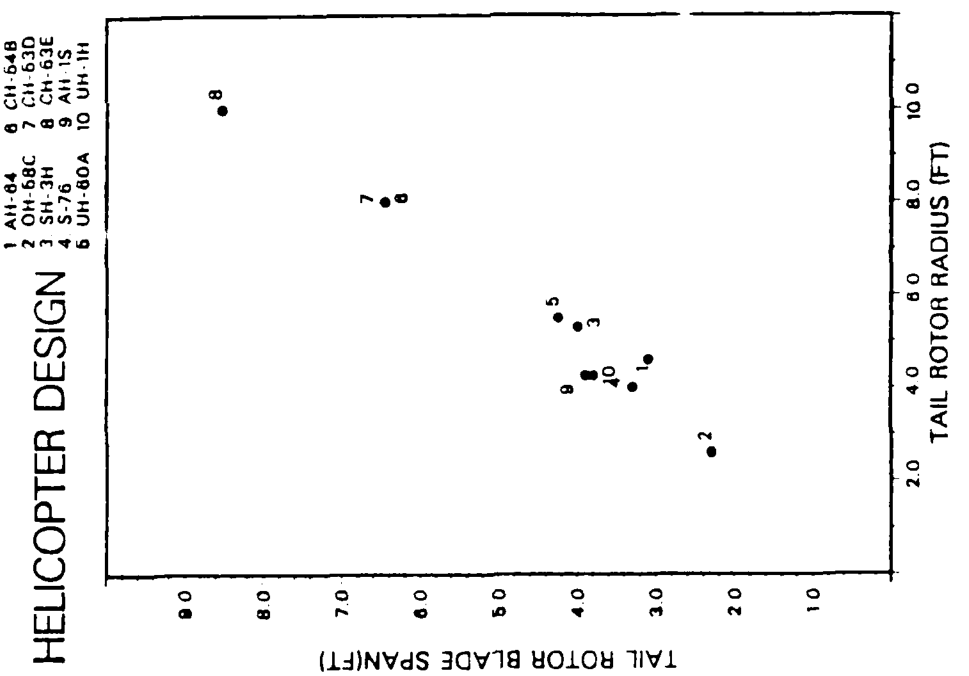


Fig. 2-11a.

Fig. 2-11a and 2-11b.

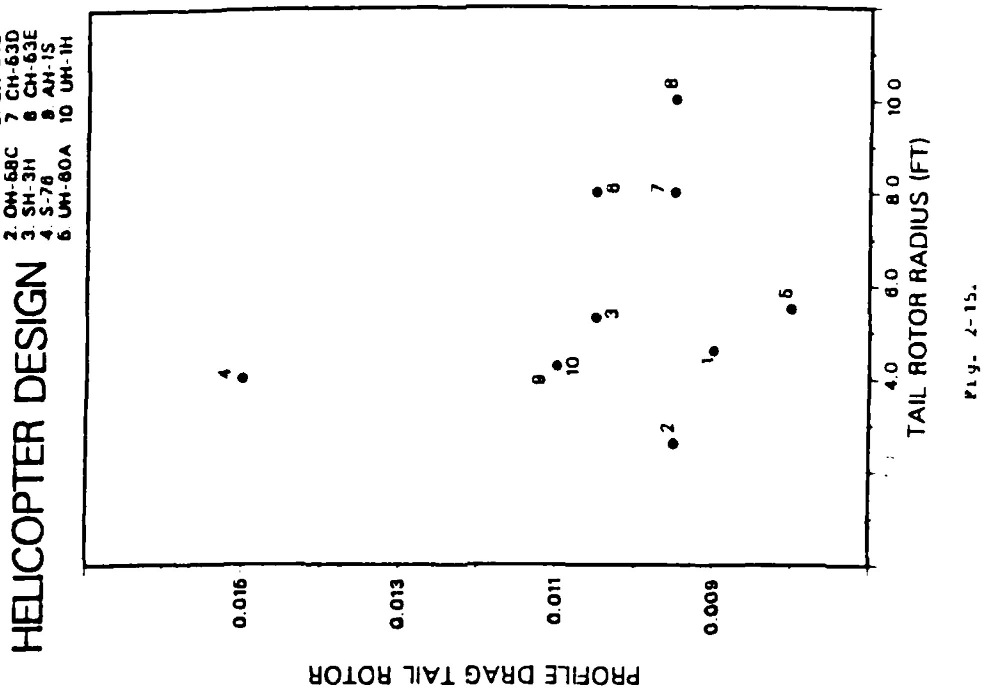


Fig. 2-15.

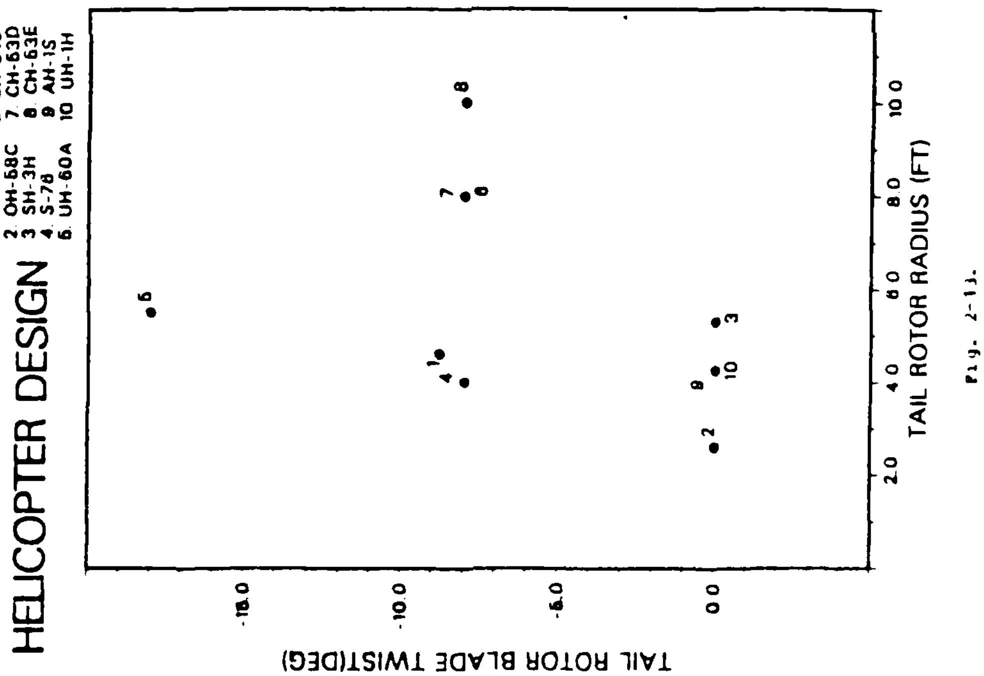


Fig. 2-13.

Fig. 2-13 and 2-15.

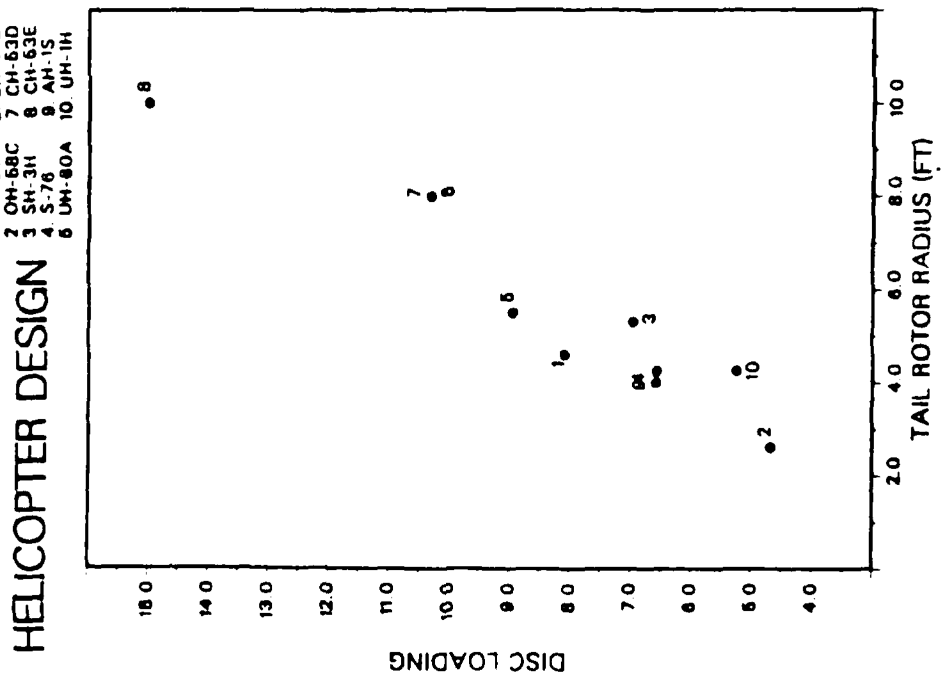


Fig. 2-16a.

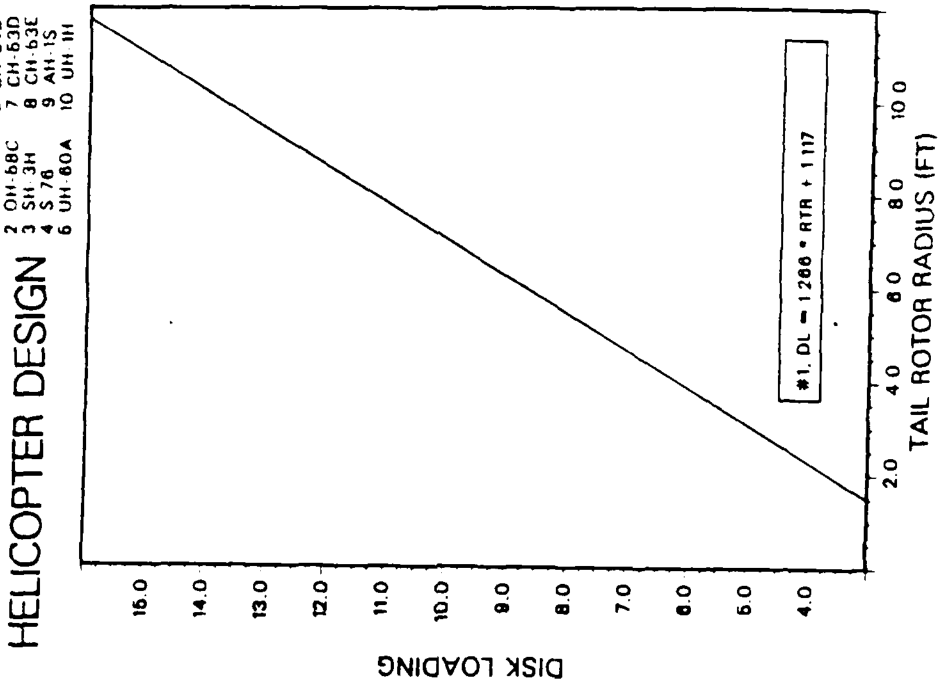


Fig. 2-16b.

Fig. 2-16a and 2-16b.

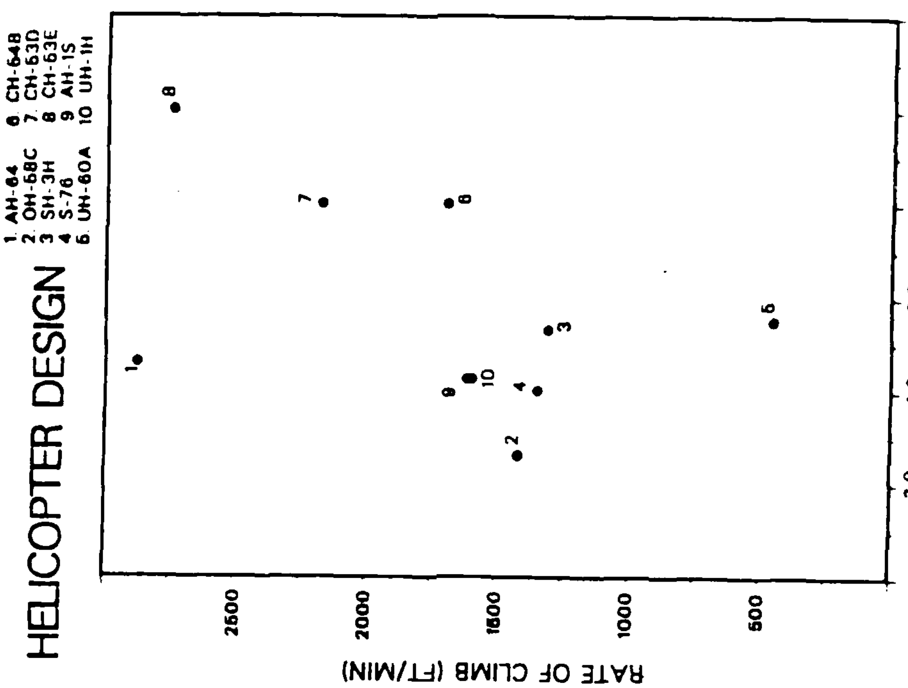


Fig. 2-23.

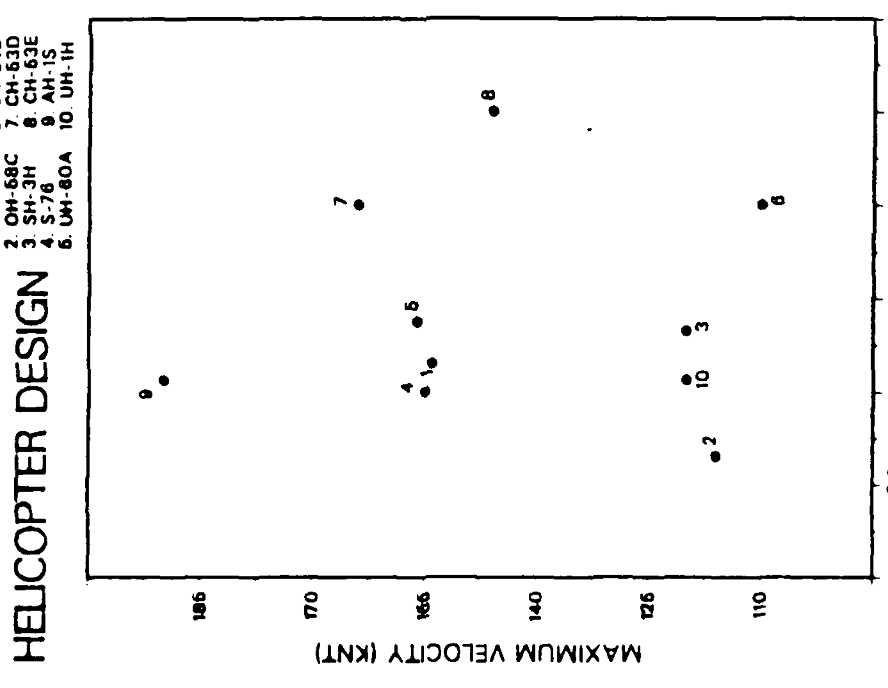


Fig. 2-21.

Fig. 2-21 and 2-23.

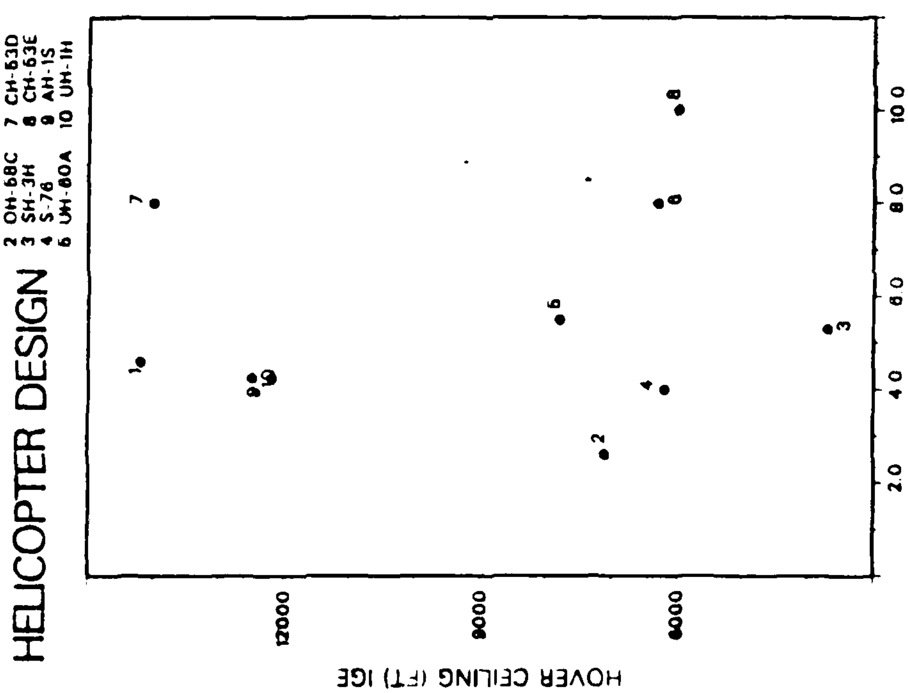


Fig. 2-24.

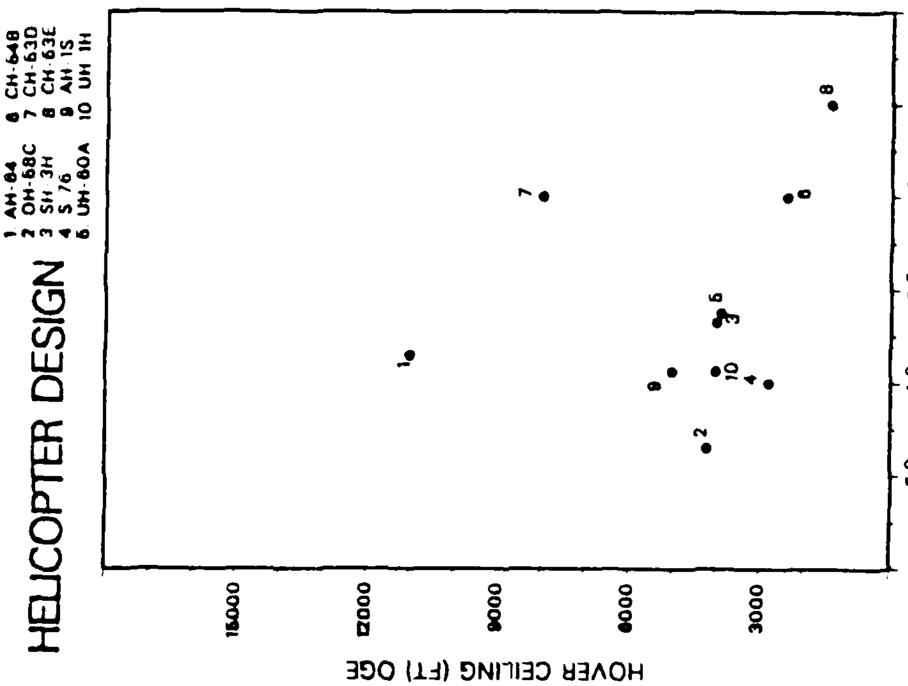


Fig. 2-25.

Fig. 2-24 and 2-25.

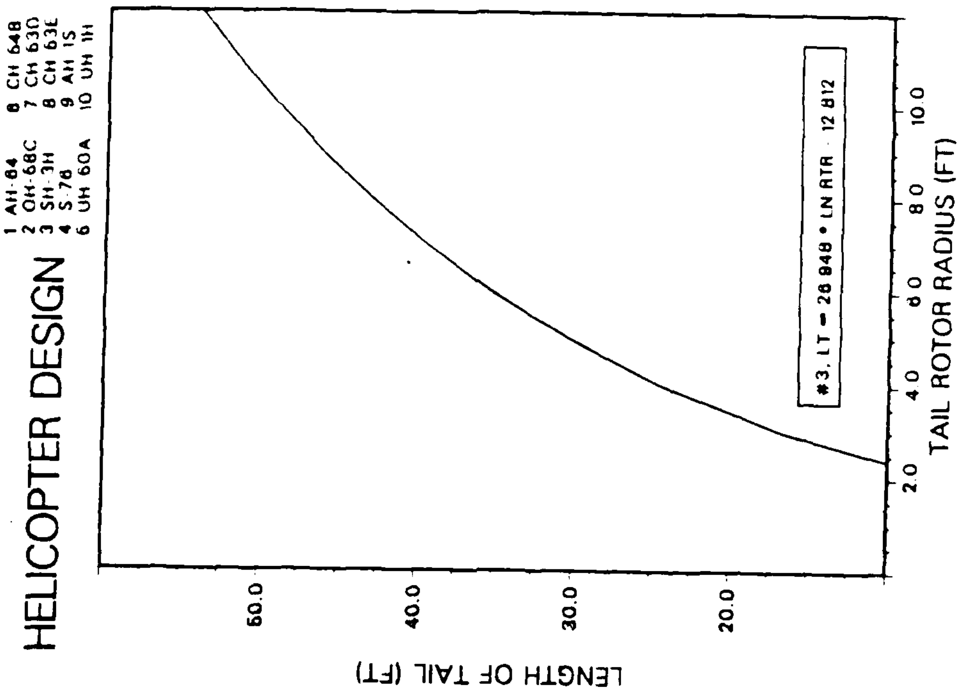


Fig. 2-26b.

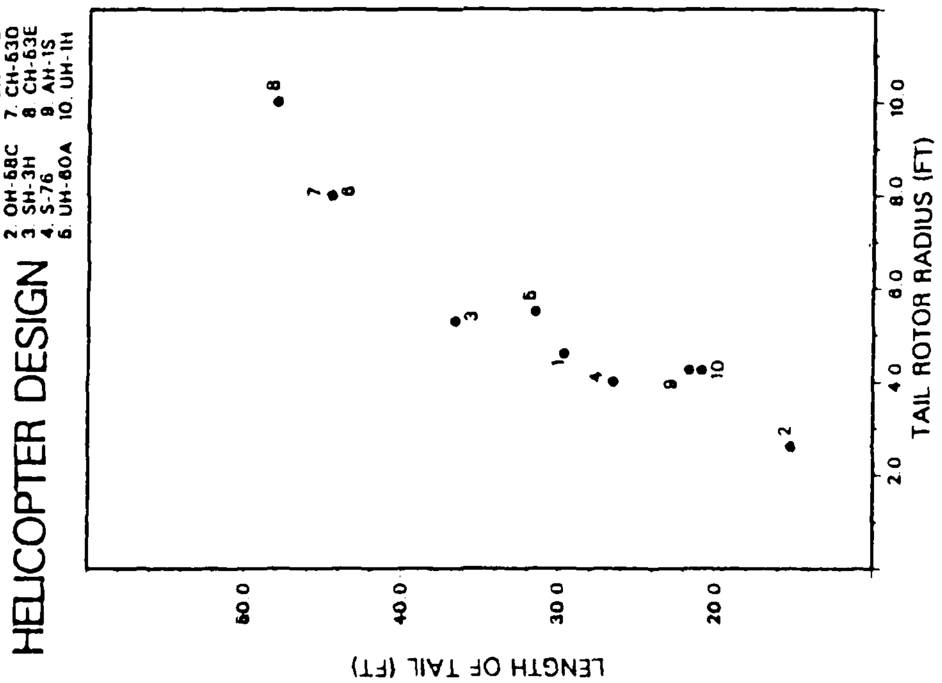


Fig. 2-26a.

Fig. 2-26a and 2-26b.

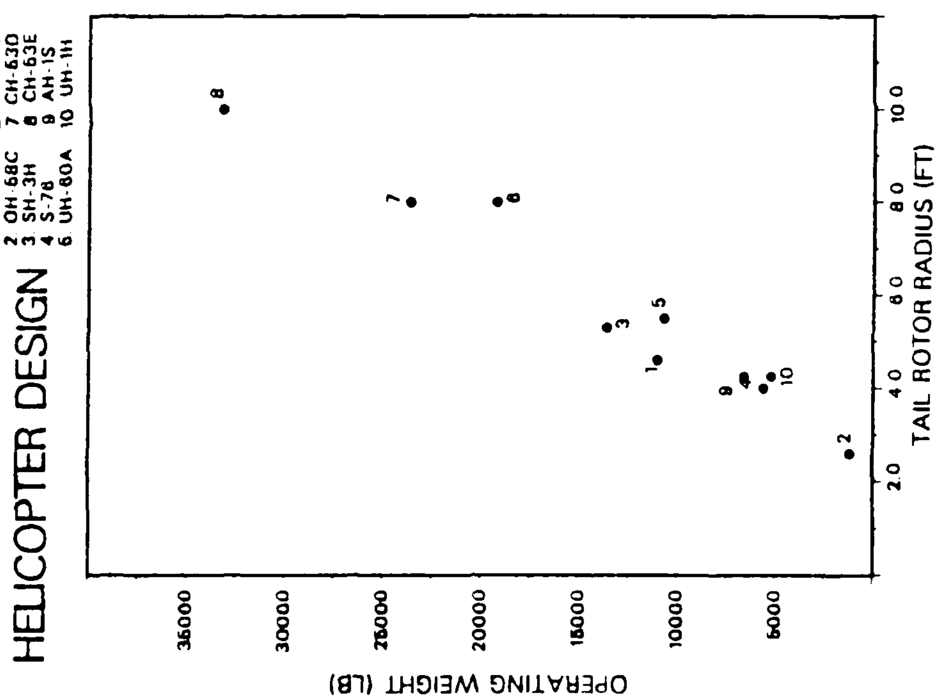


Fig. 2-27a.

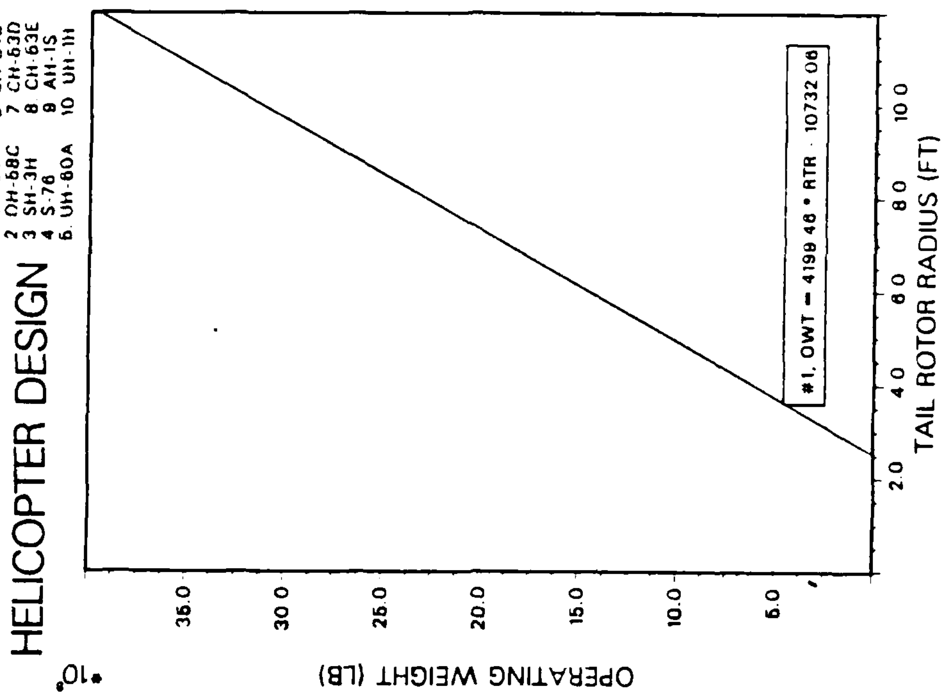


Fig. 2-27b.

Fig. 2-27a and 2-27b.

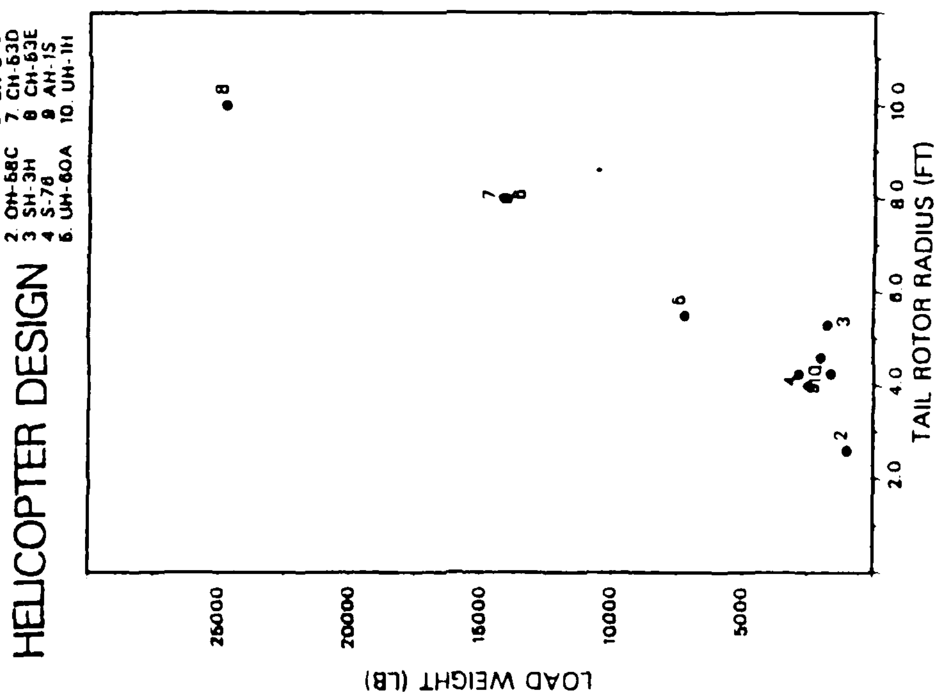


Fig. 2-28a.

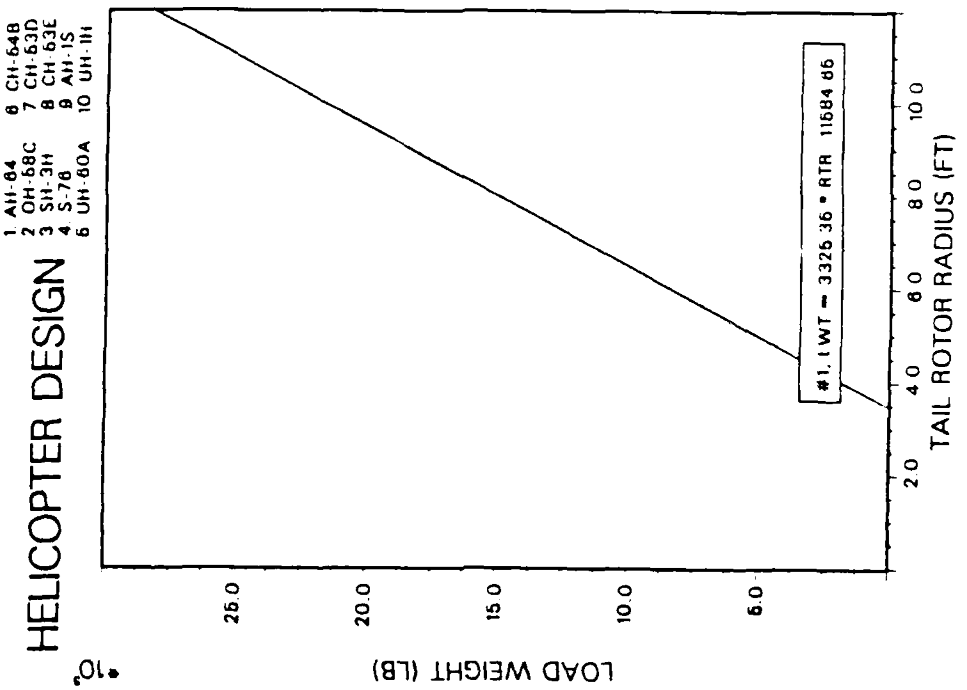


Fig. 2-28b.

Fig. 2-28a and 2-28b.

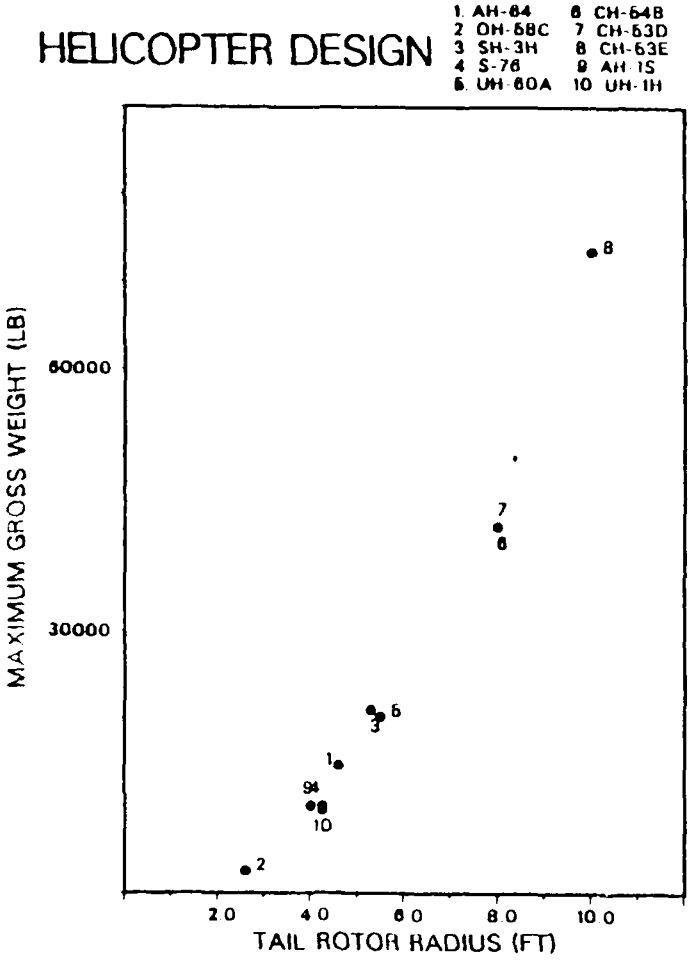


Fig. 2-30a.

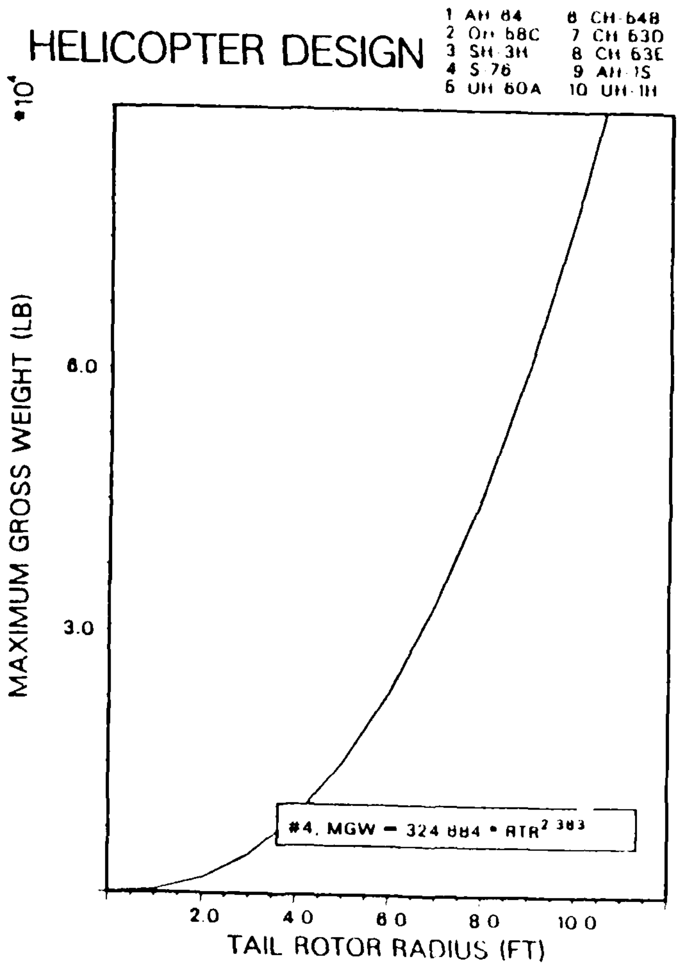


Fig. 2-30b.

Fig. 2-30a and 2-30b.

Number of Main Rotor Blades Pairings.

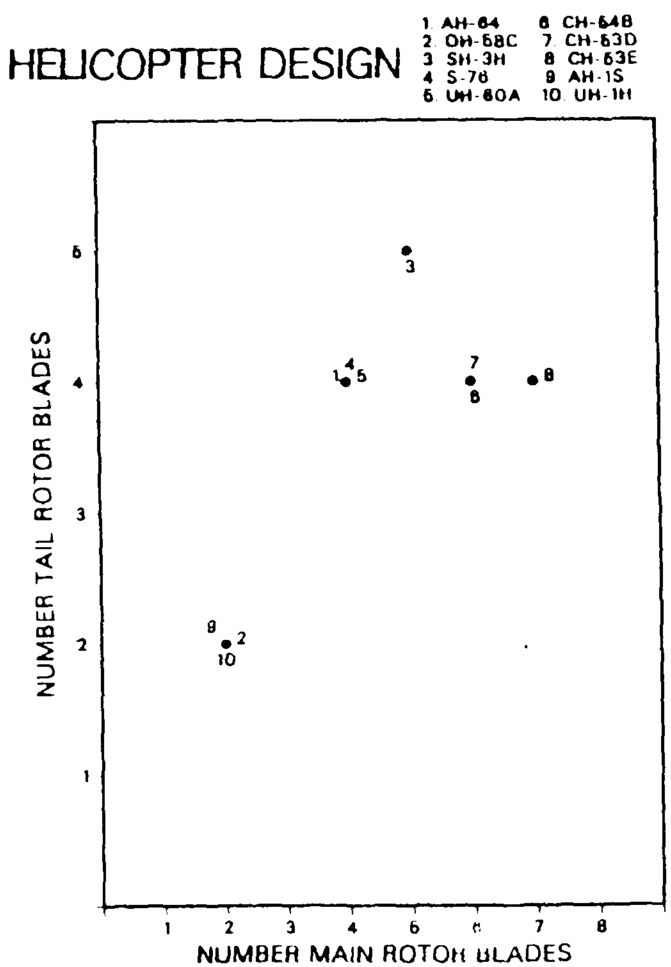


Fig. 3-4a.

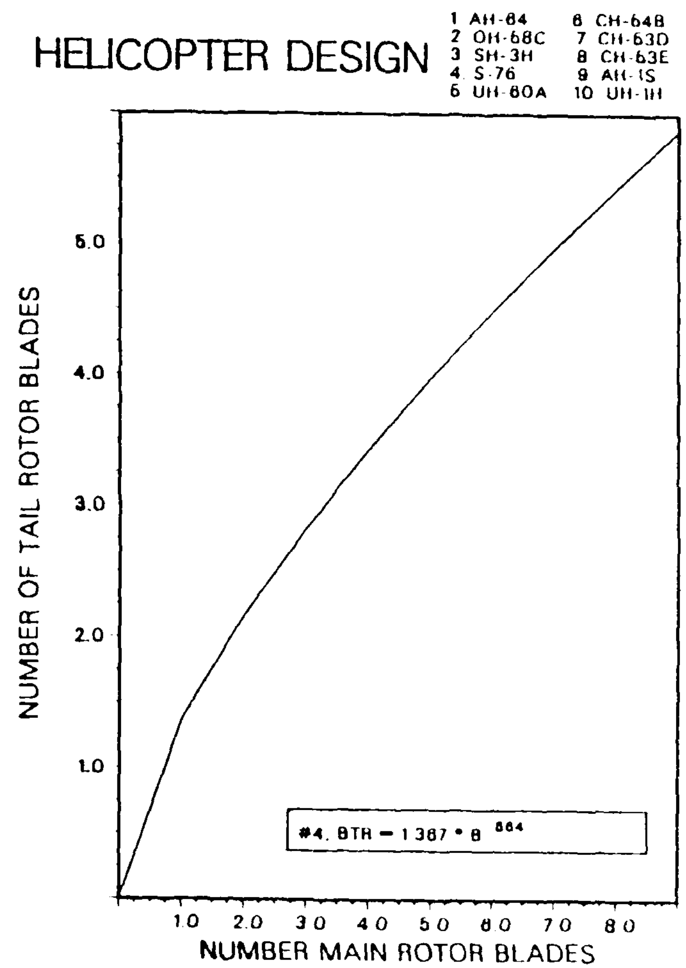


Fig. 3-4b.

Fig. 3-4a and 3-4b.

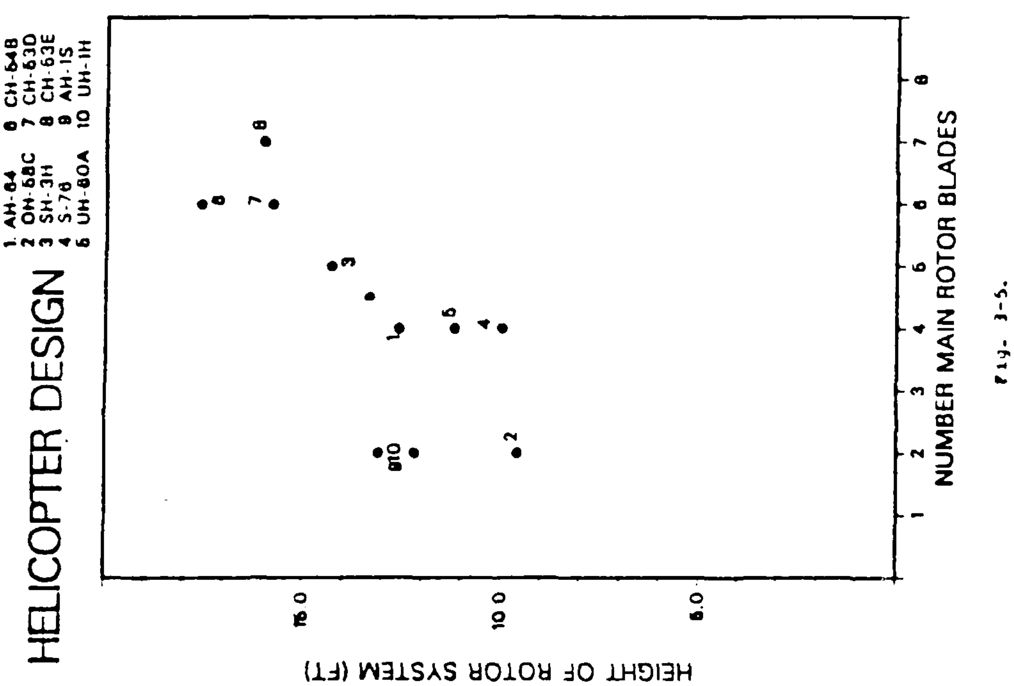

HELICOPTER DESIGN
1 AH-64
2 OH-58C
3 SH-3H
4 S-76
5 UH-60A
6 CH-54B
7 CH-53D
8 CH-53E
9 AH-1S
10 UH-1H
HEIGHT OF ROTOR SYSTEM (FT)
15.0
10.0
5.0
NUMBER MAIN ROTOR BLADES
1
2
3
4
5
6
7
8
Fig. 3-5.

Fig. 3-5.

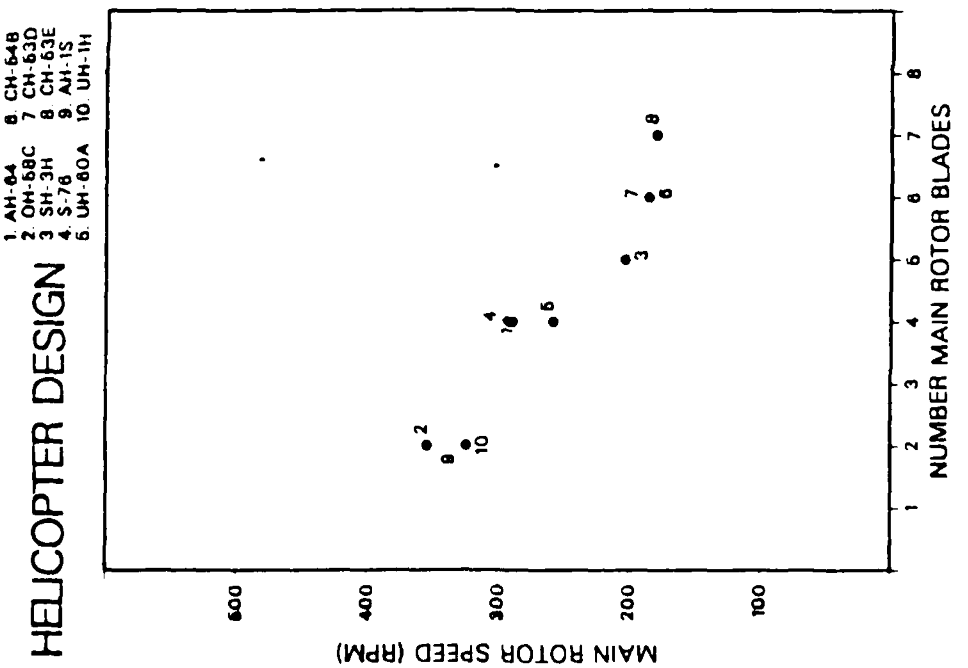


Fig. 3-6a.

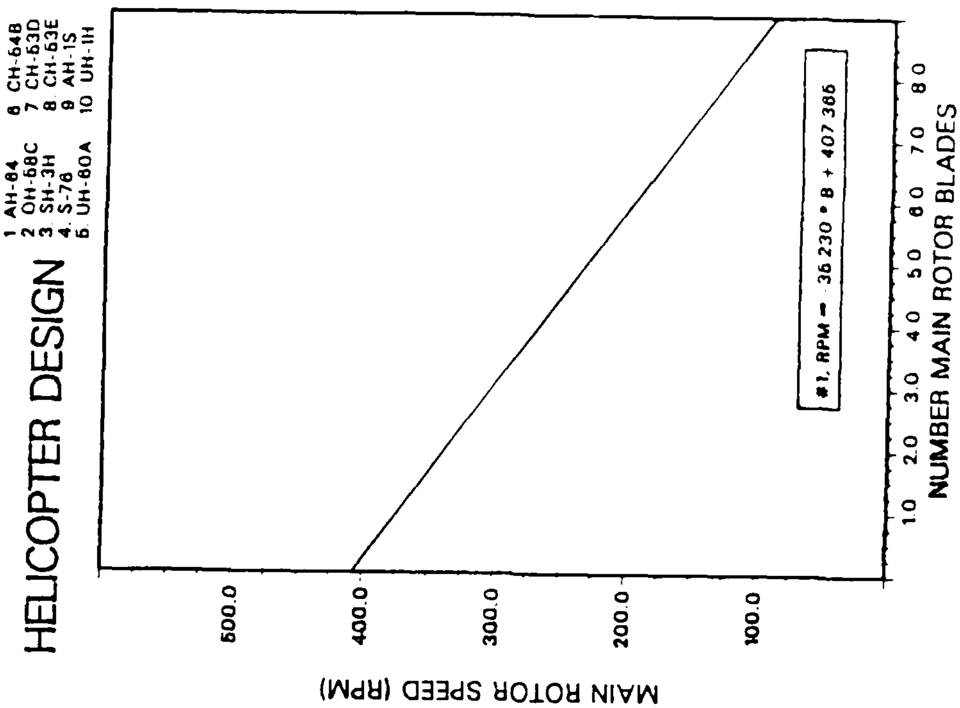
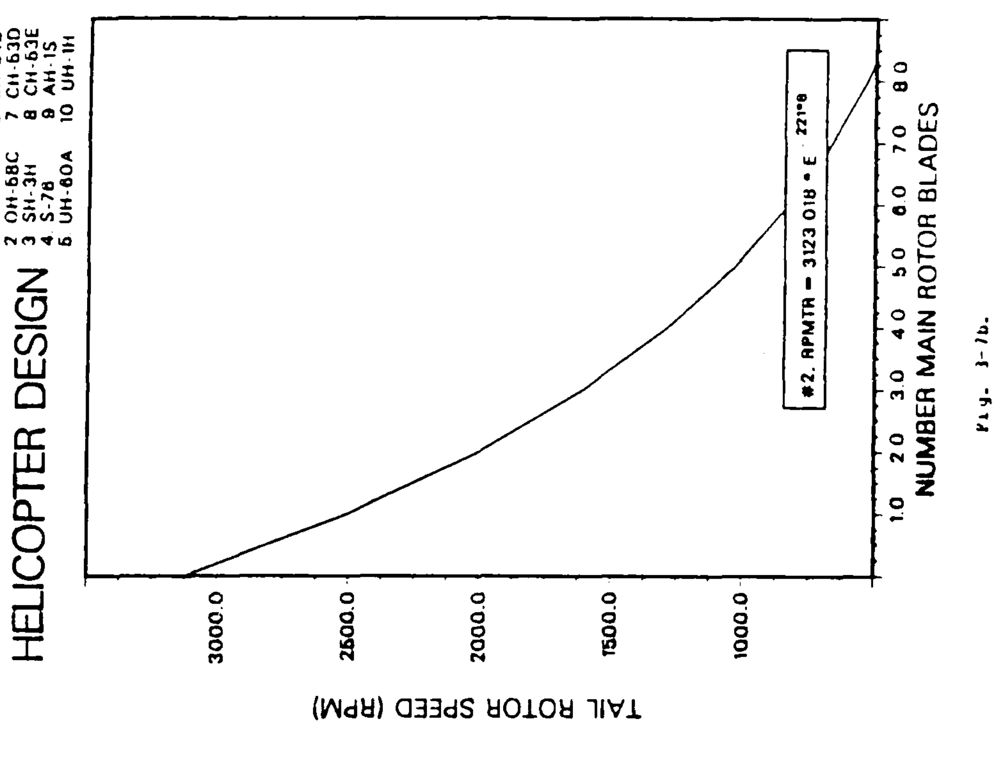


Fig. 3-6b.

Fig. 3-6a and 3-6b.



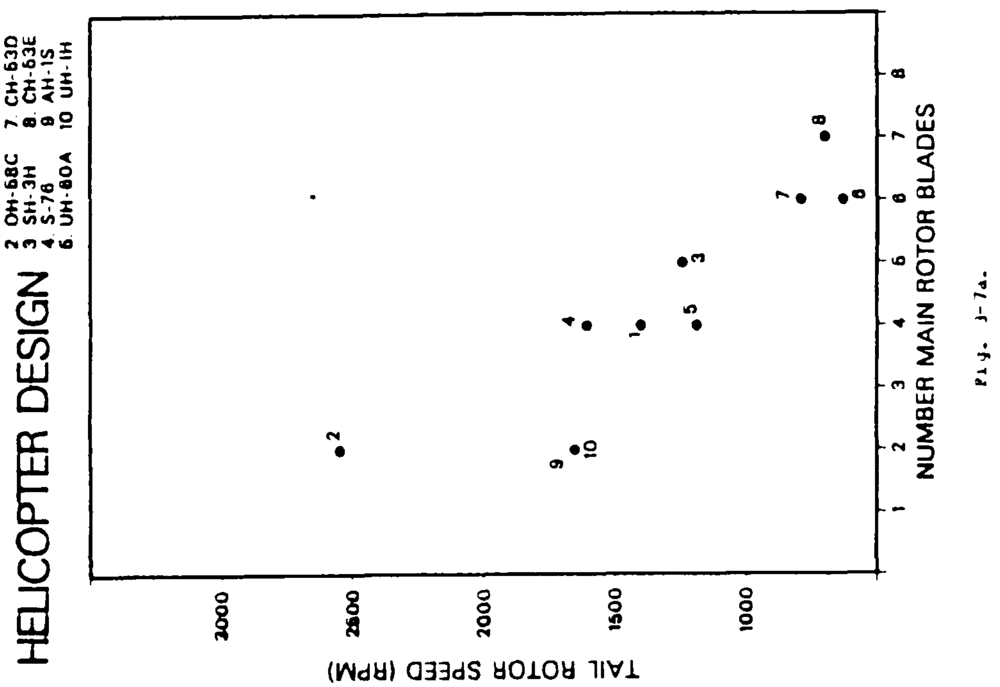


Fig. 3-7a and 3-7b.

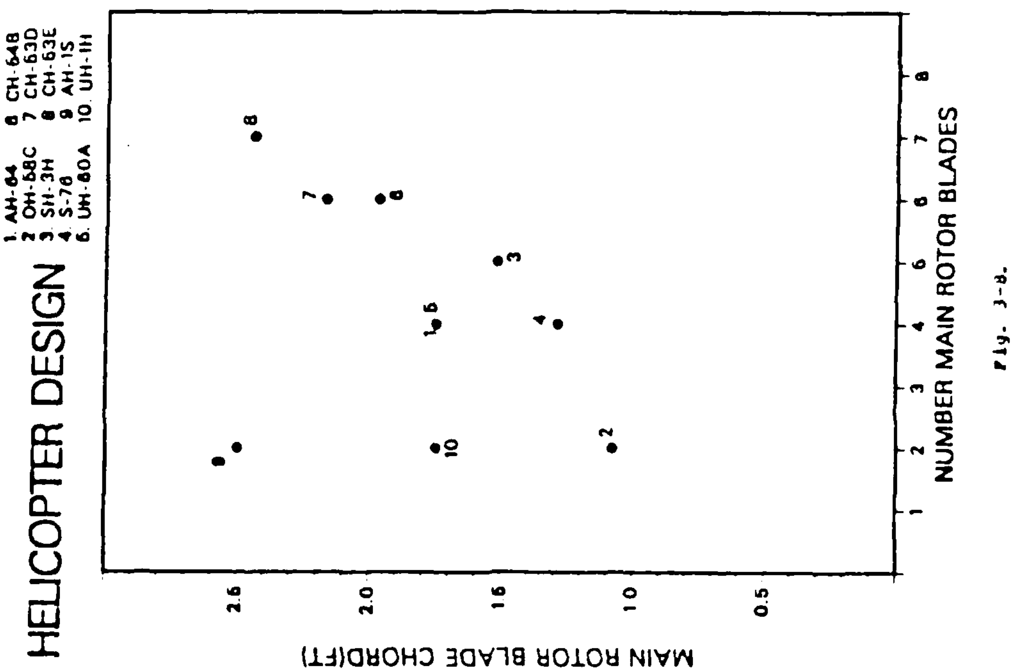

HELICOPTER DESIGN
1. AH-64
2. OH-58C
3. SH-3H
4. S-76
5. UH-60A
6. CH-64B
7. CH-53D
8. CH-53E
9. AH-1S
10. UH-1H
MAIN ROTOR BLADE CHORD(FT)
2.5
2.0
1.5
1.0
0.5
NUMBER MAIN ROTOR BLADES
1
2
3
4
5
6
7
8
Fig. 3-8.

Fig. 3-8.

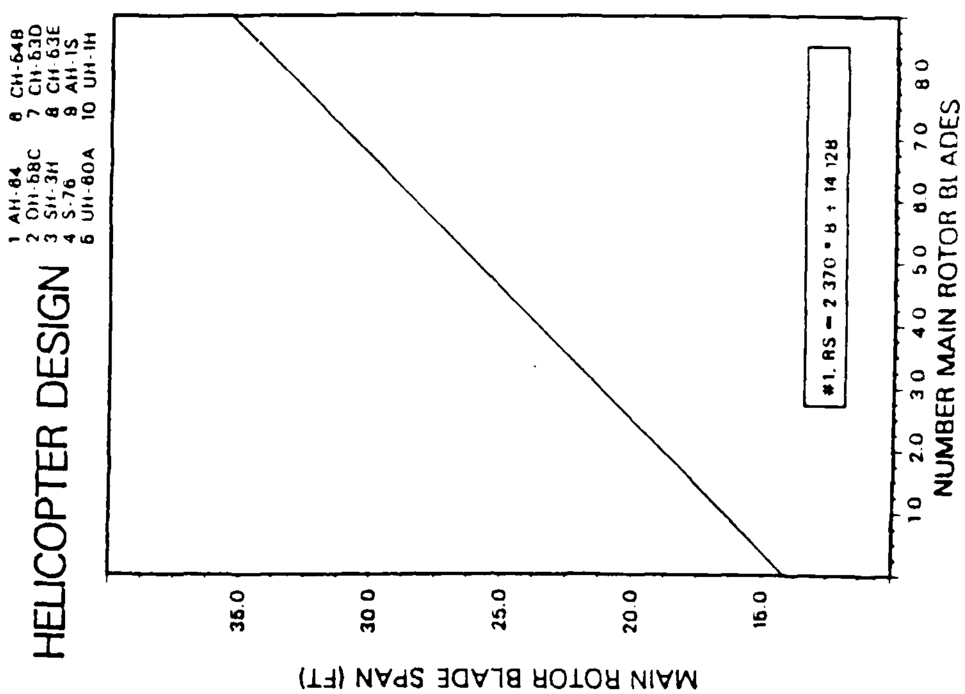


Fig. 3-10b.

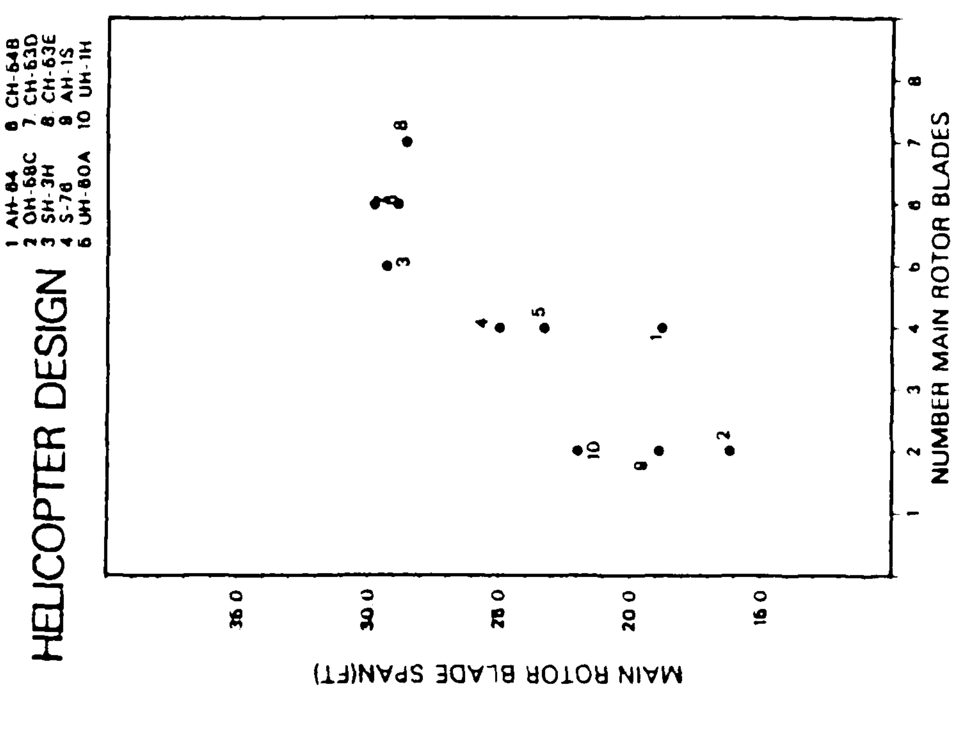


Fig. 3-10a.

Fig. 3-10a and 3-10b.

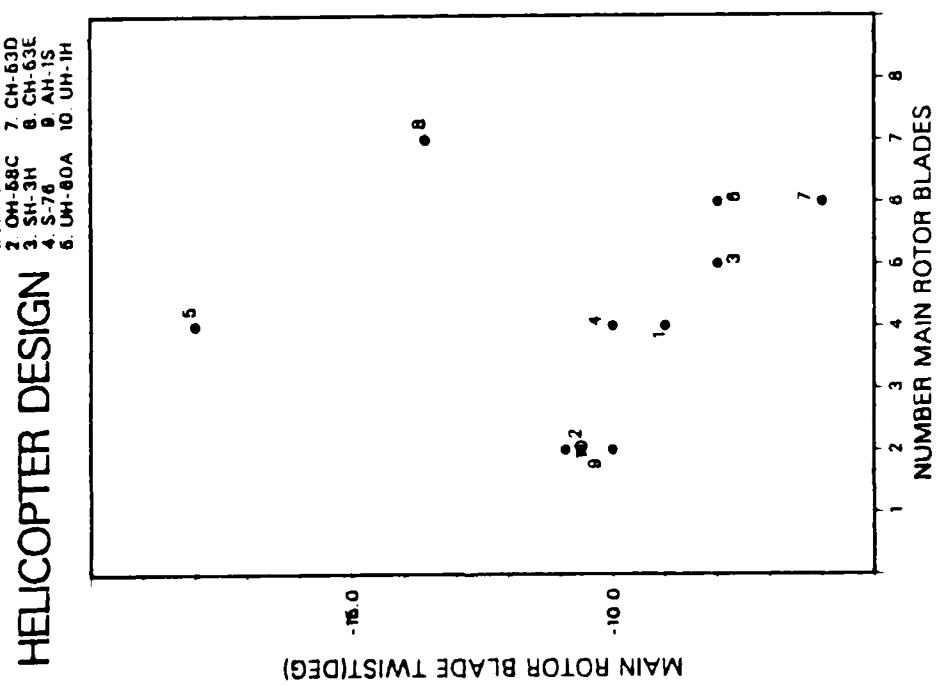


Fig. 3-12.

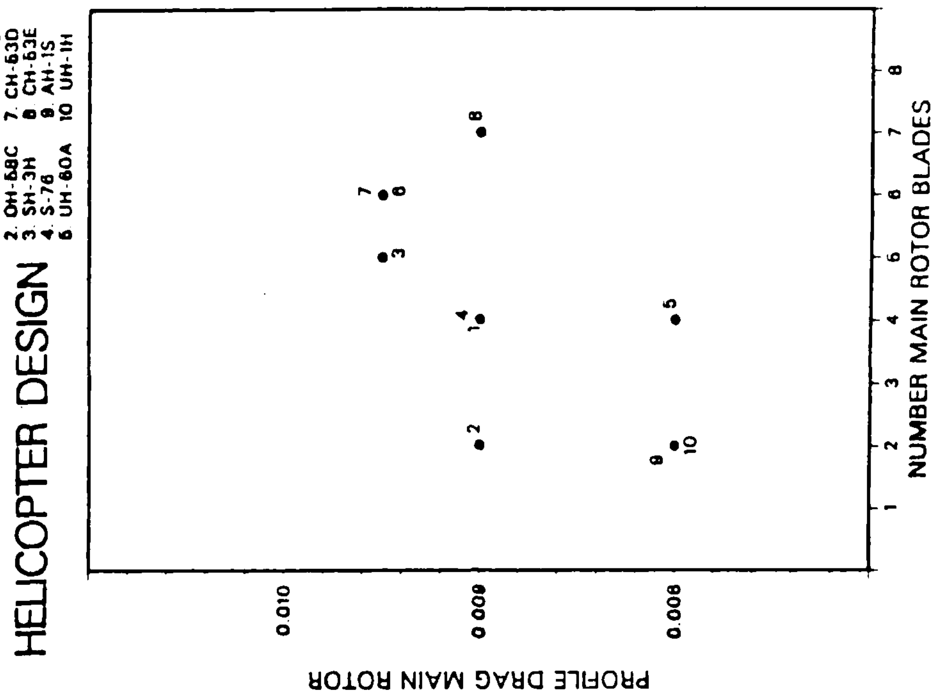


Fig. 3-14.

Fig. 3-12 and 3-14.

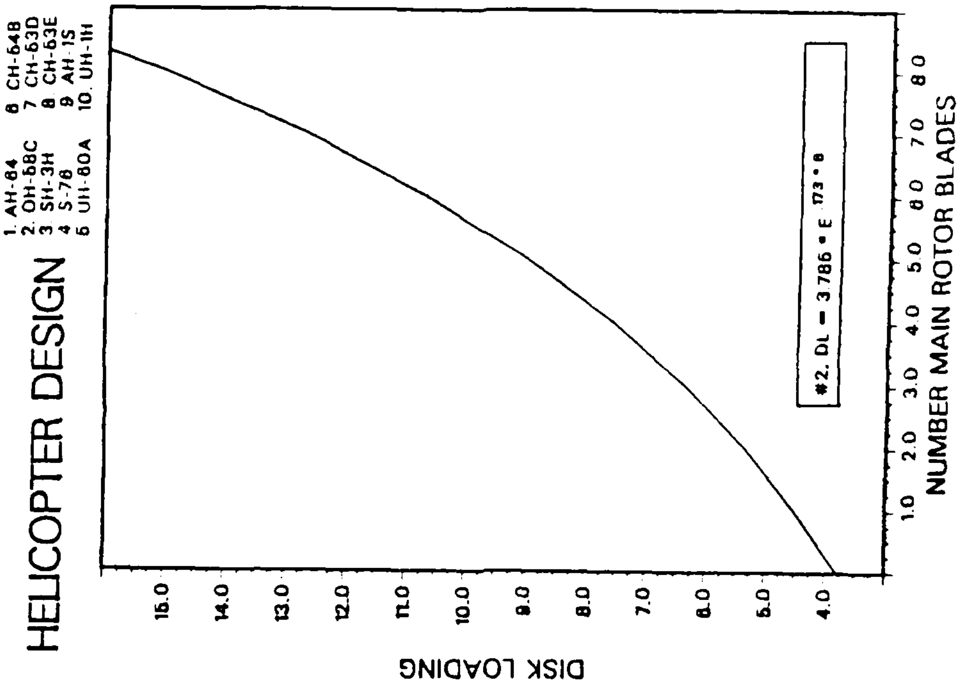


Fig. 3-16b.

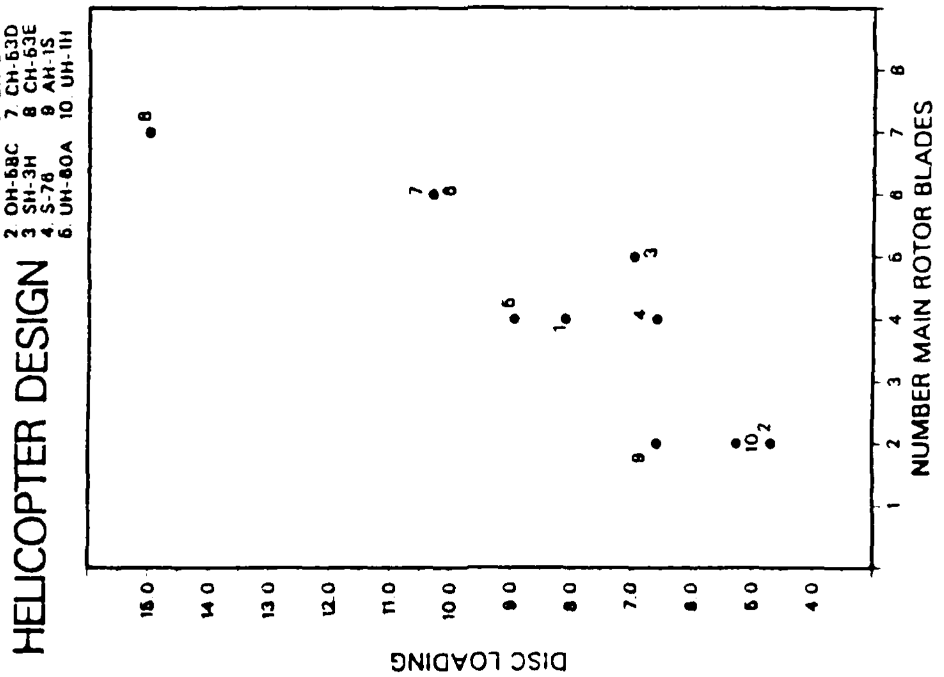


Fig. 3-16a.

Fig. 3-16a and 3-16b.

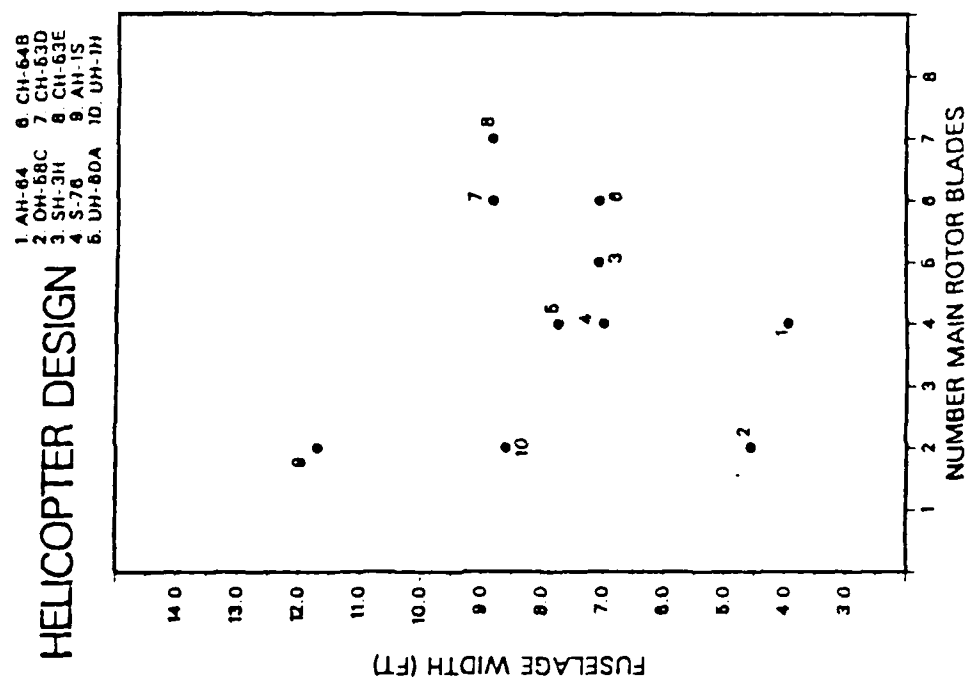

HELICOPTER DESIGN
1. AH-64
2. OH-58C
3. SH-3H
4. S-76
5. UH-60A
6. CH-54B
7. CH-53D
8. CH-53E
9. AH-1S
10. UH-1H
FUSELAGE WIDTH (FT)
14.0
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
NUMBER MAIN ROTOR BLADES
1
2
3
4
5
6
7
8
Fig. 3-17.

Fig. 3-17.

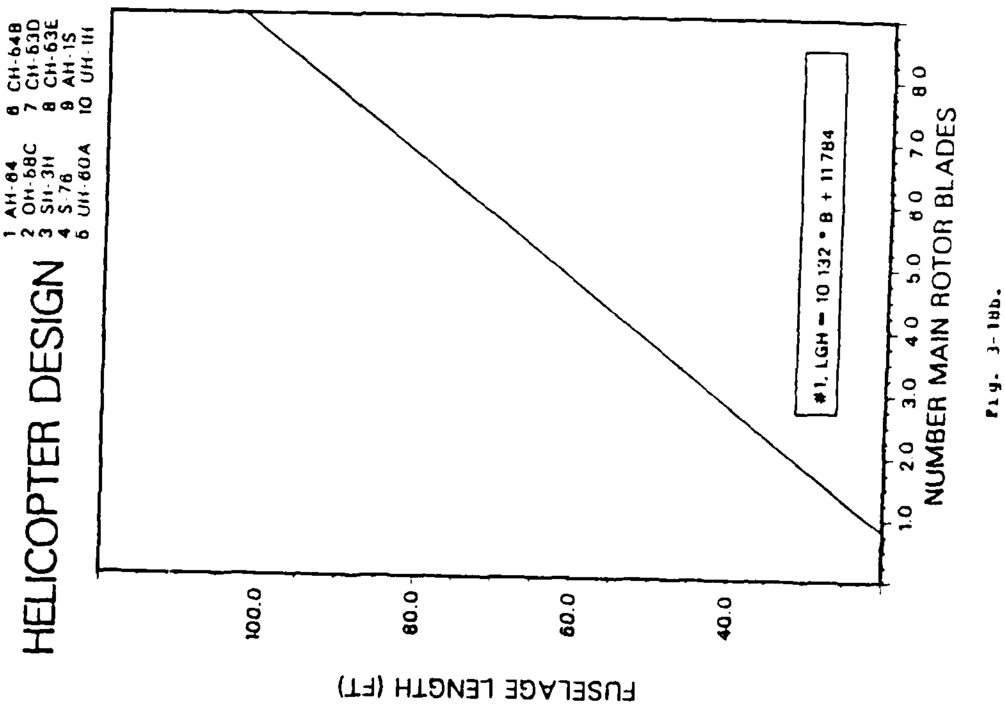


Fig. 3-18b.

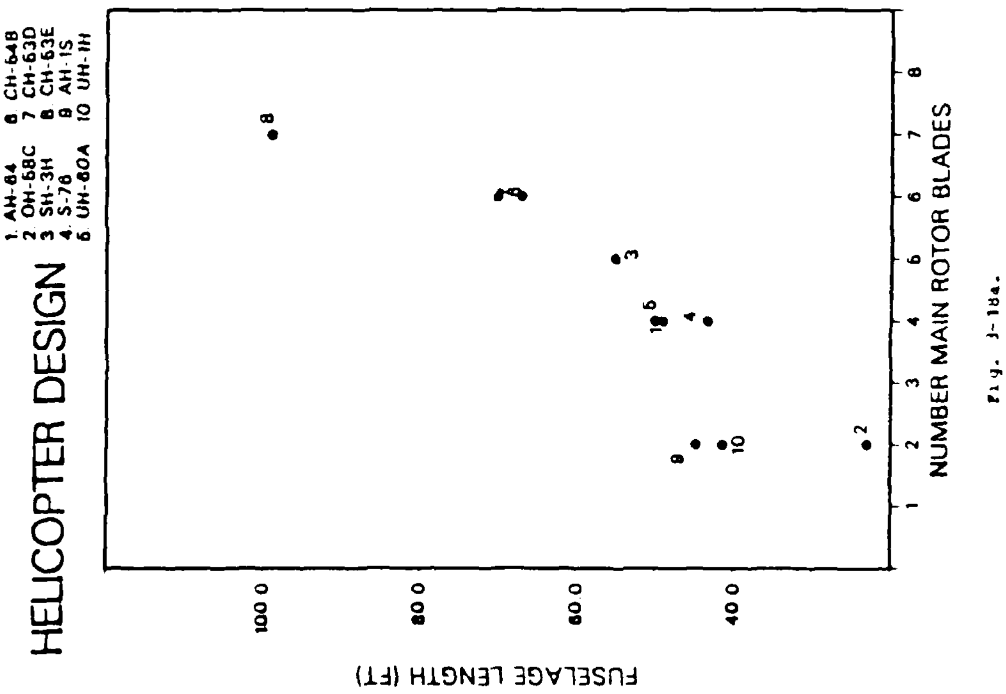
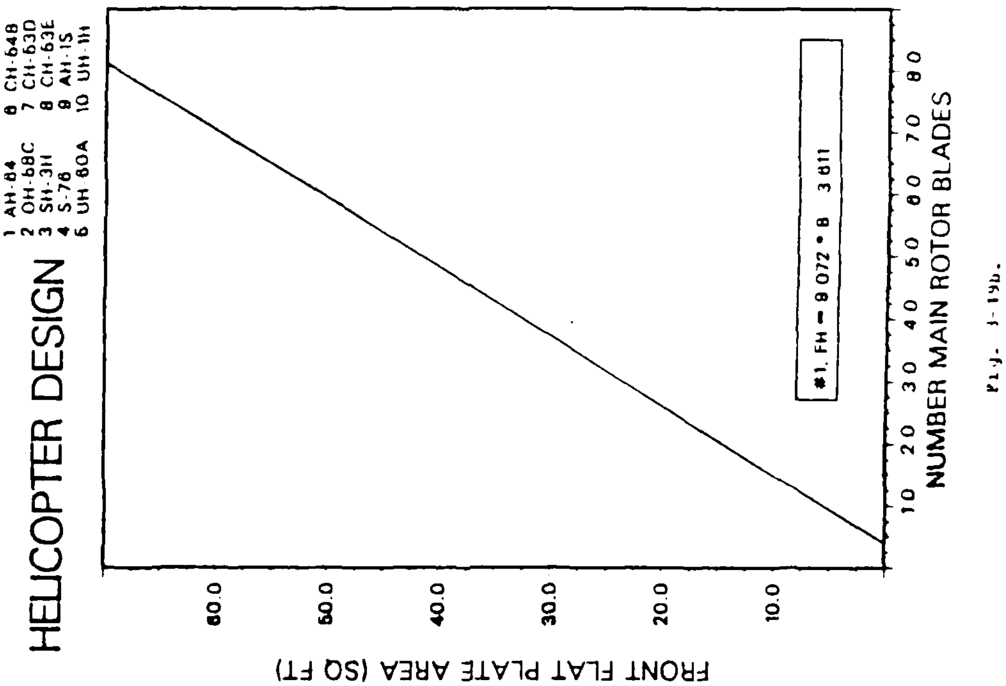


Fig. 3-18a.

Fig. 3-18a and 3-18b.



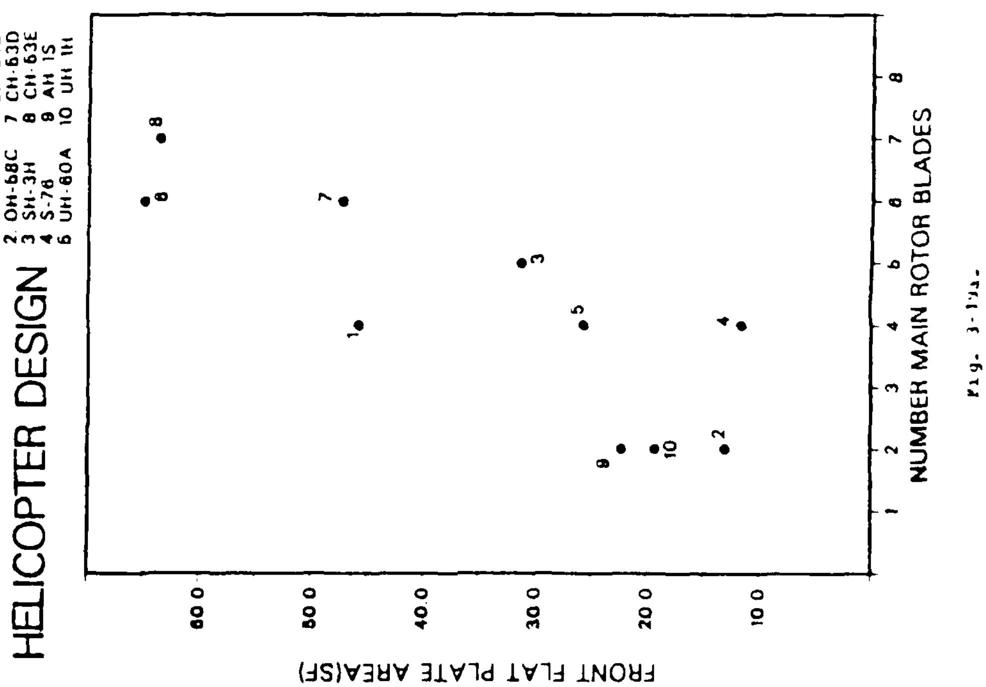


Fig. 3-19a and 3-19b.

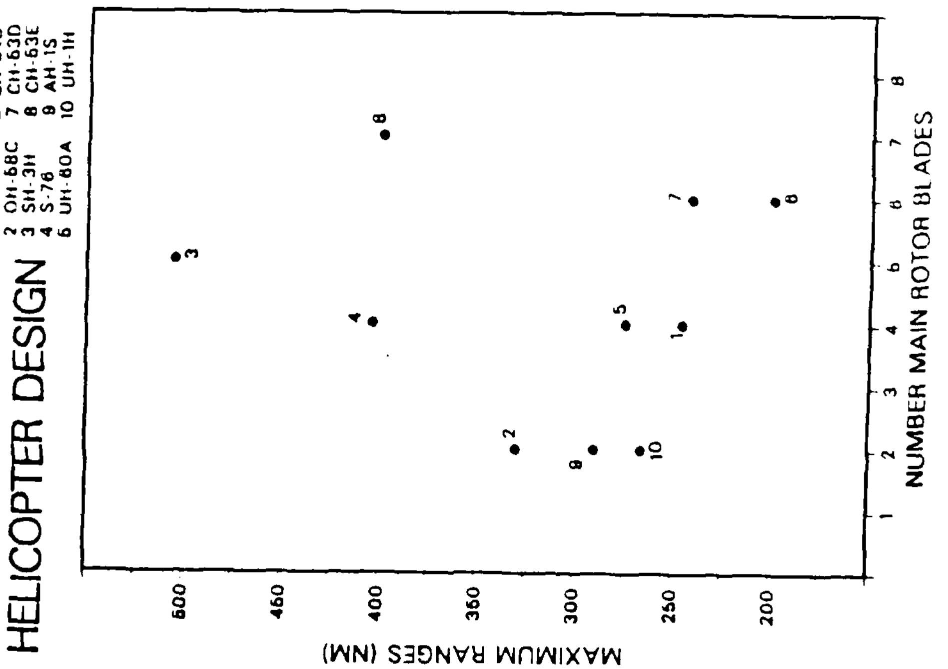


Fig. 3-22.

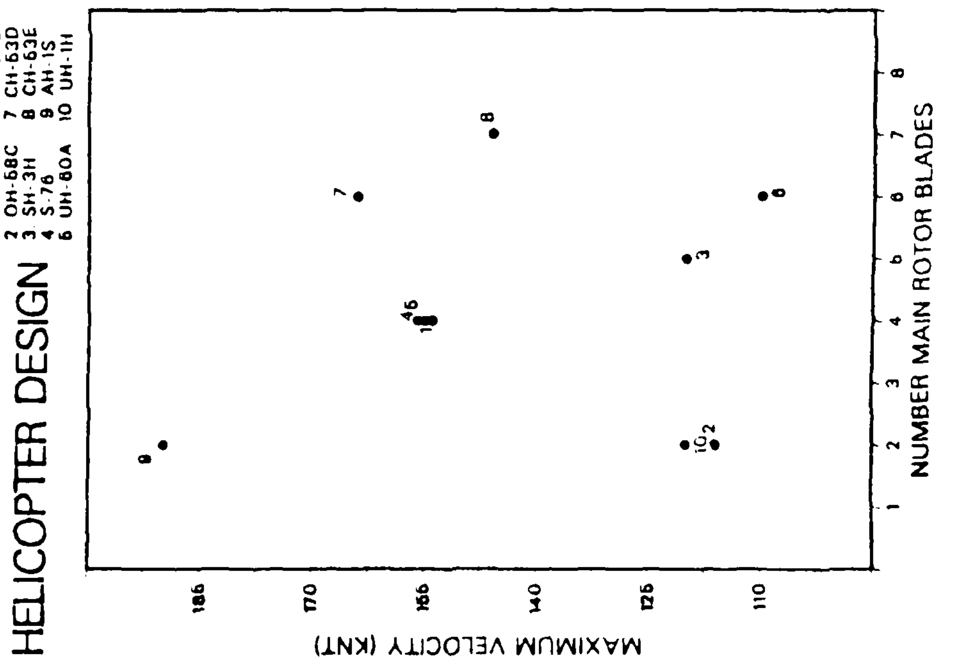


Fig. 3-21.

Fig. 3-21 and 3-22.

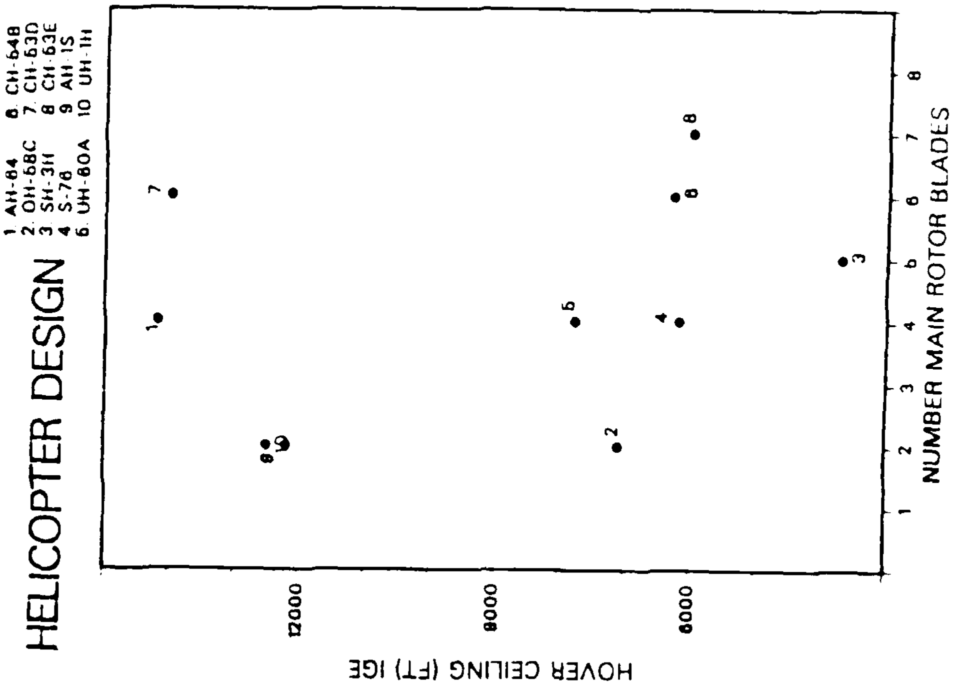


Fig. 3-24.

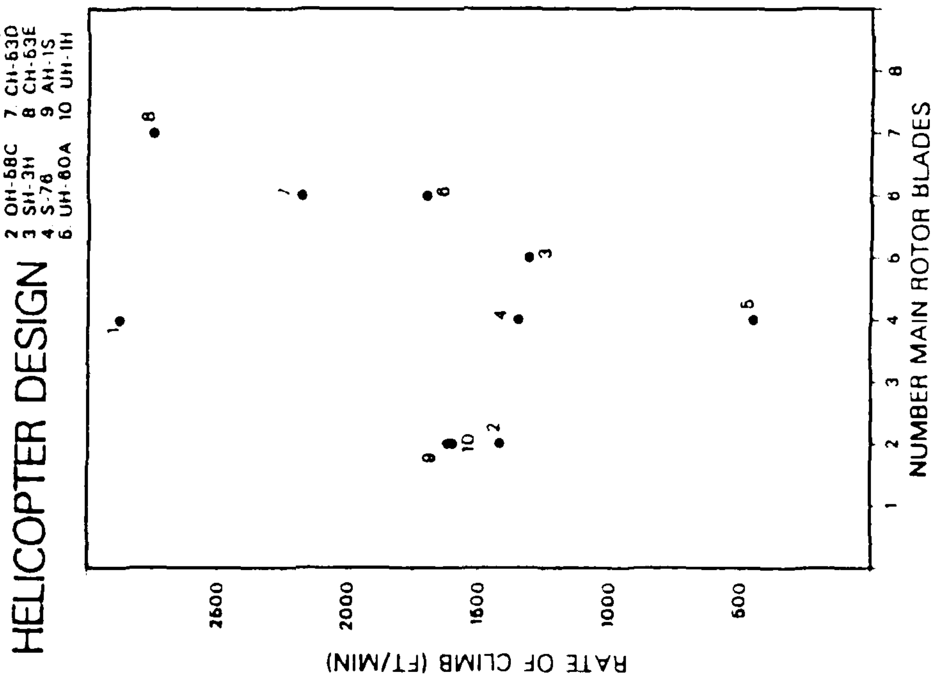


Fig. 3-23.

Fig. 3-23 and 3-24.

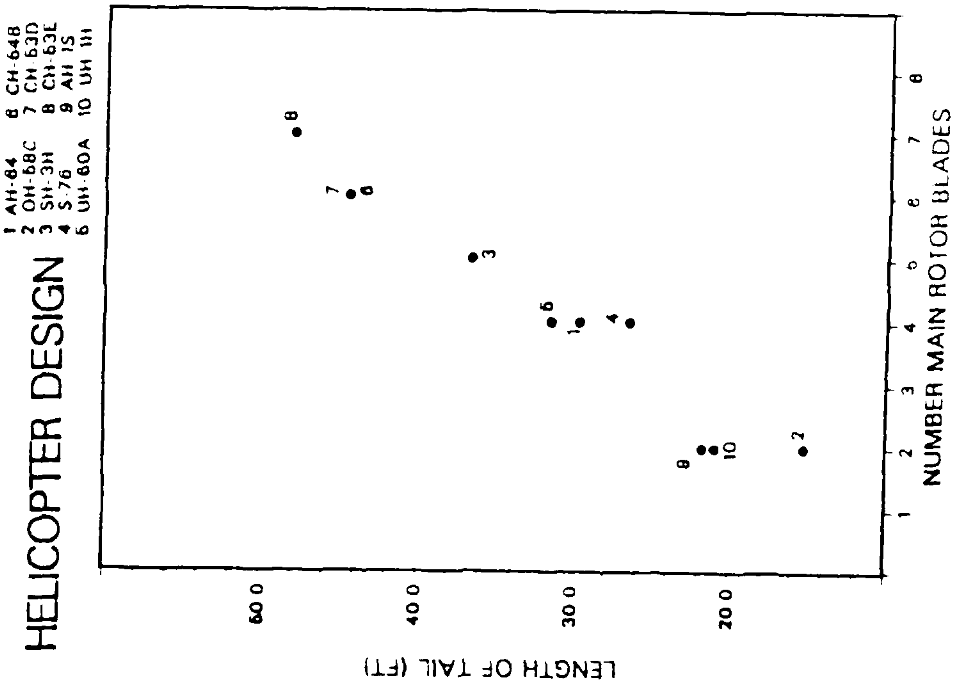


Fig. 3-26.

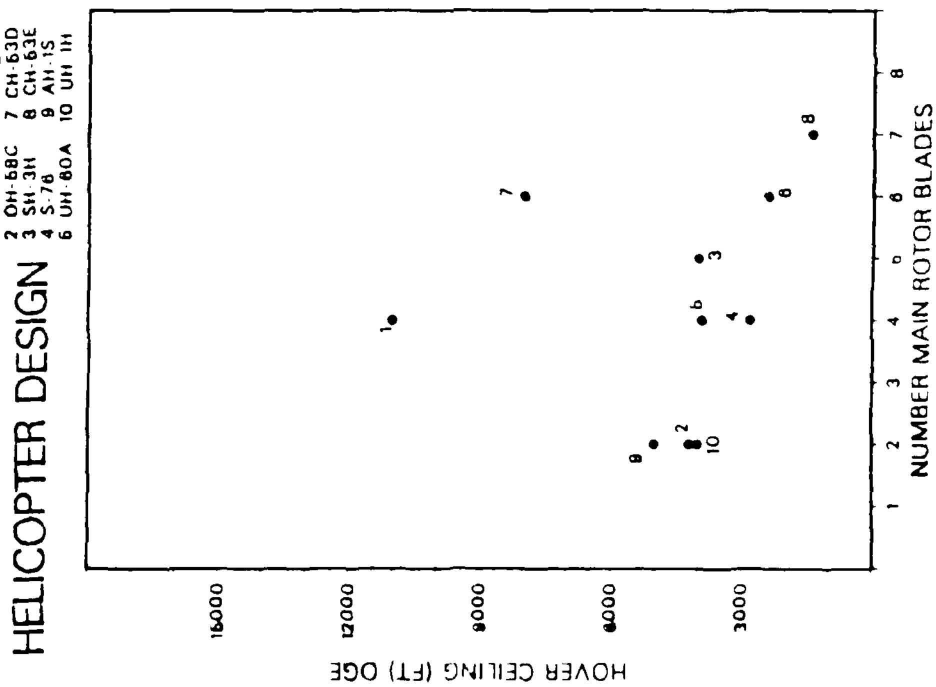
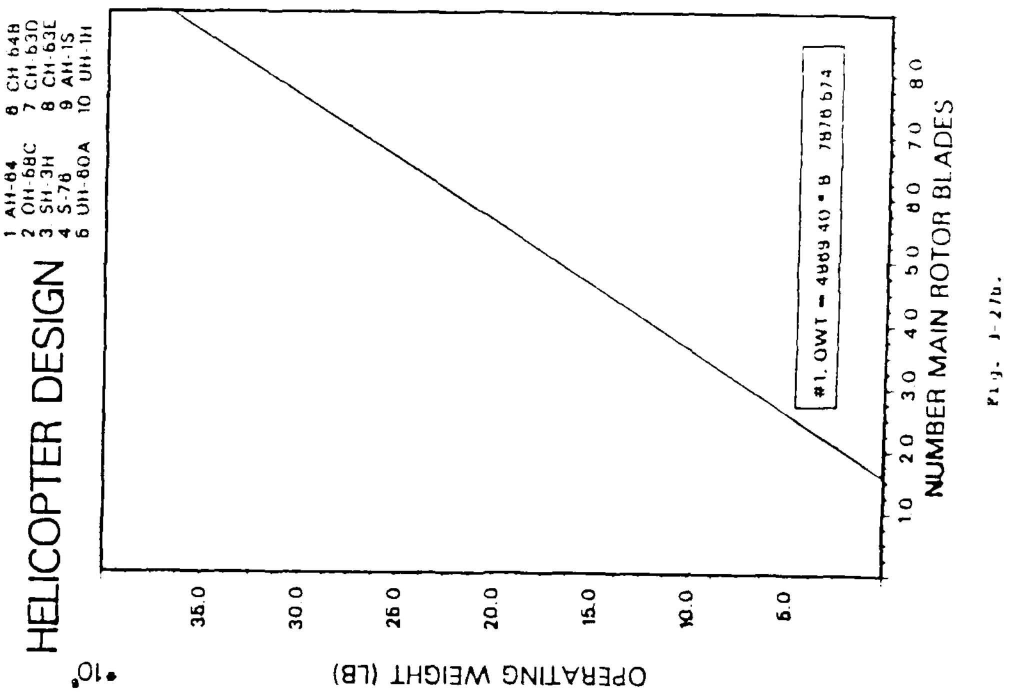


Fig. 3-25.

Fig. 3-25 and 3-26.



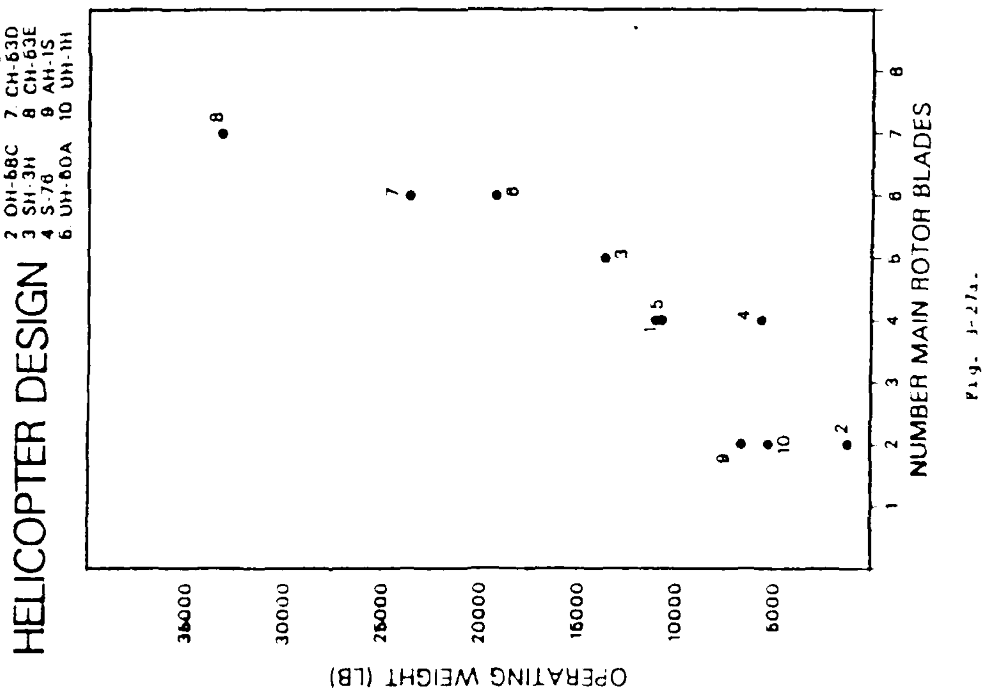


Fig. 3-27a and 3-27b.

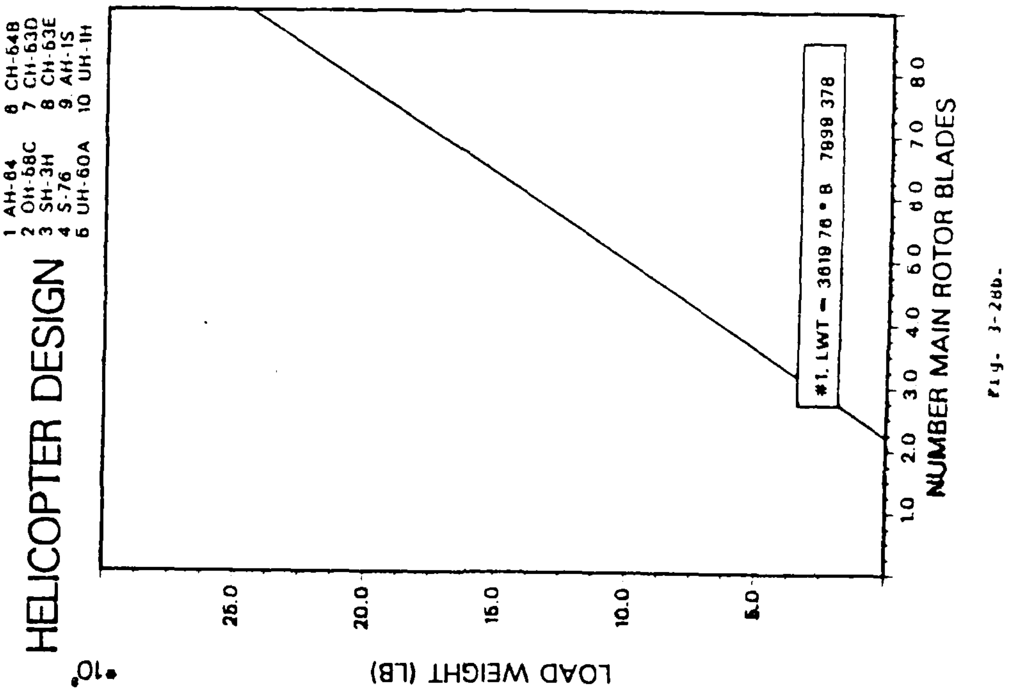


Fig. 3-28a and 3-28b.

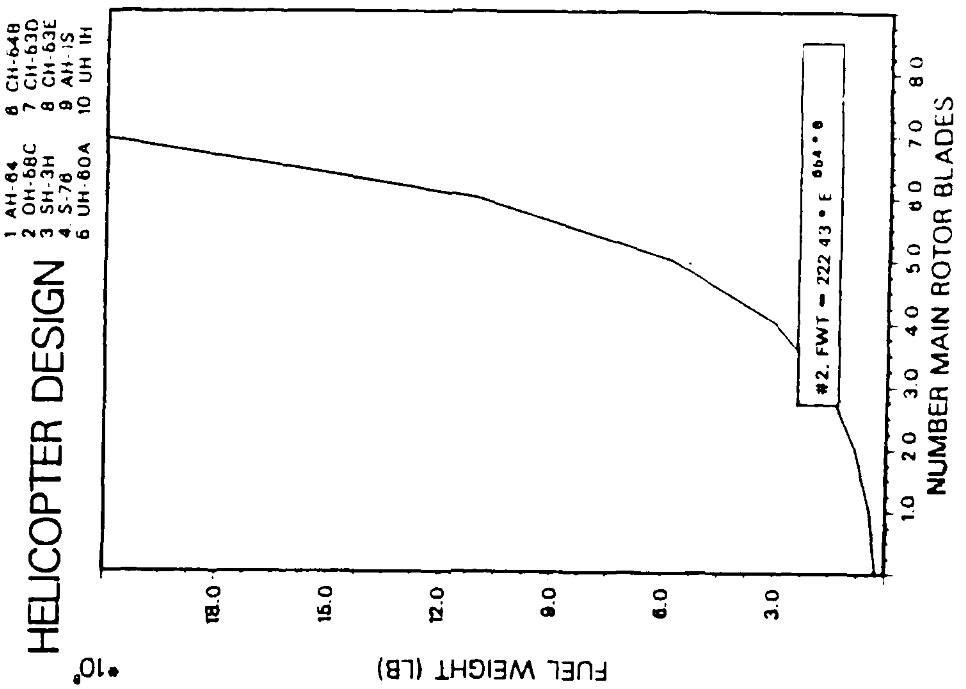


Fig. 3-29b.

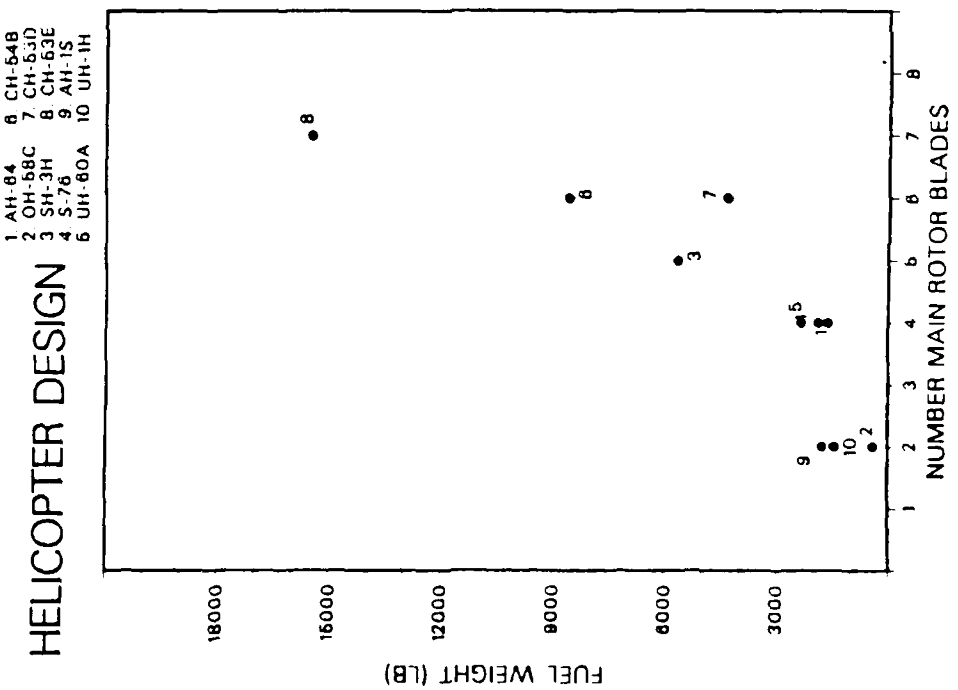
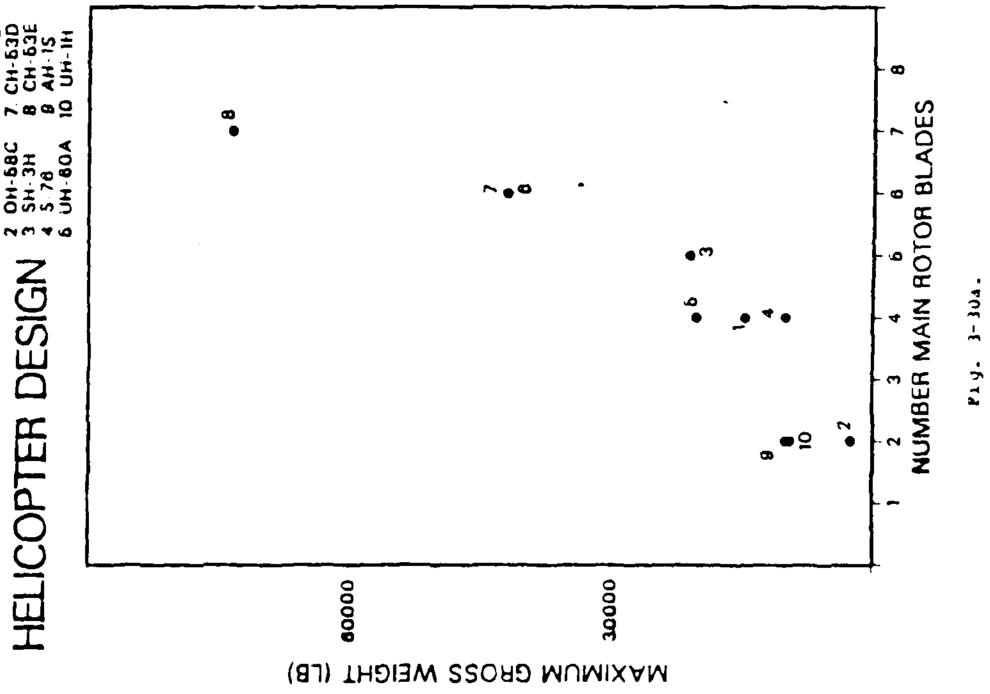


Fig. 3-29a.

Fig. 3-29a and 3-29b.



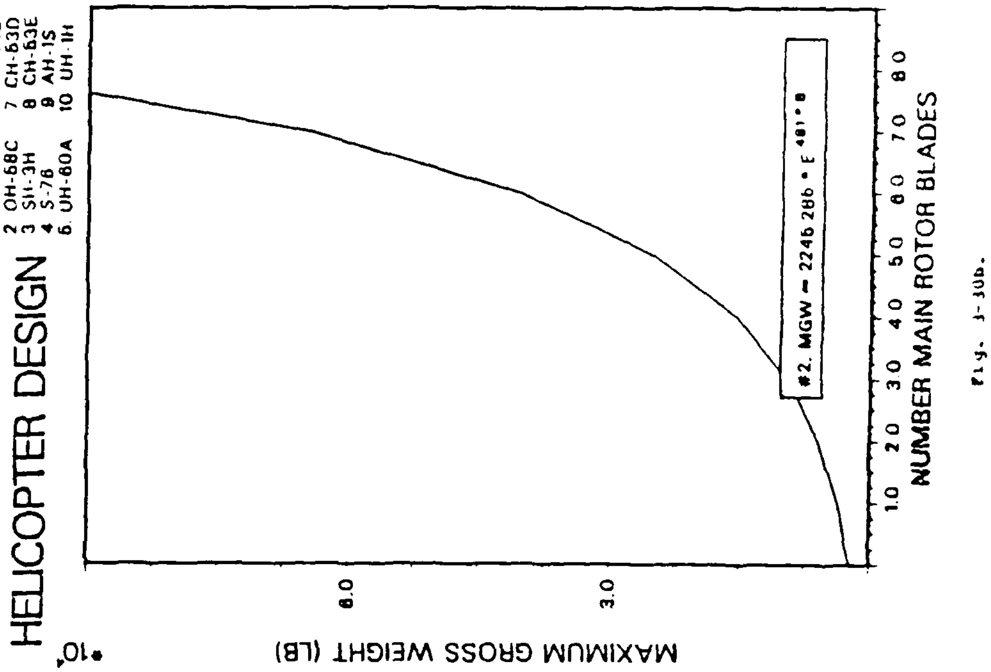


Fig. 3-30a and 3-30b.

Number of Tail Rotor Blades Pairings.

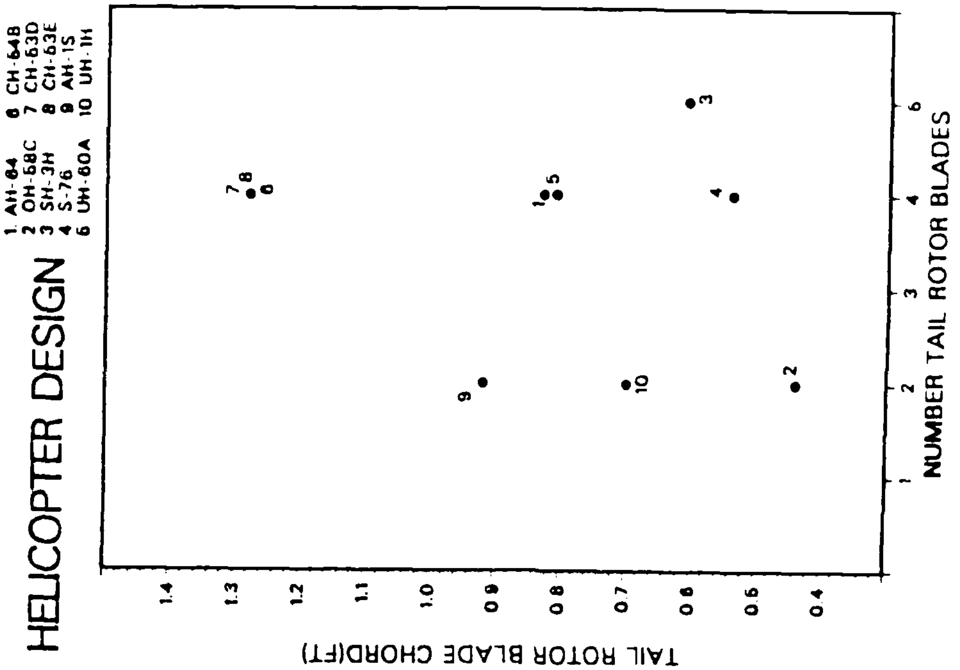


Fig. 4-9.

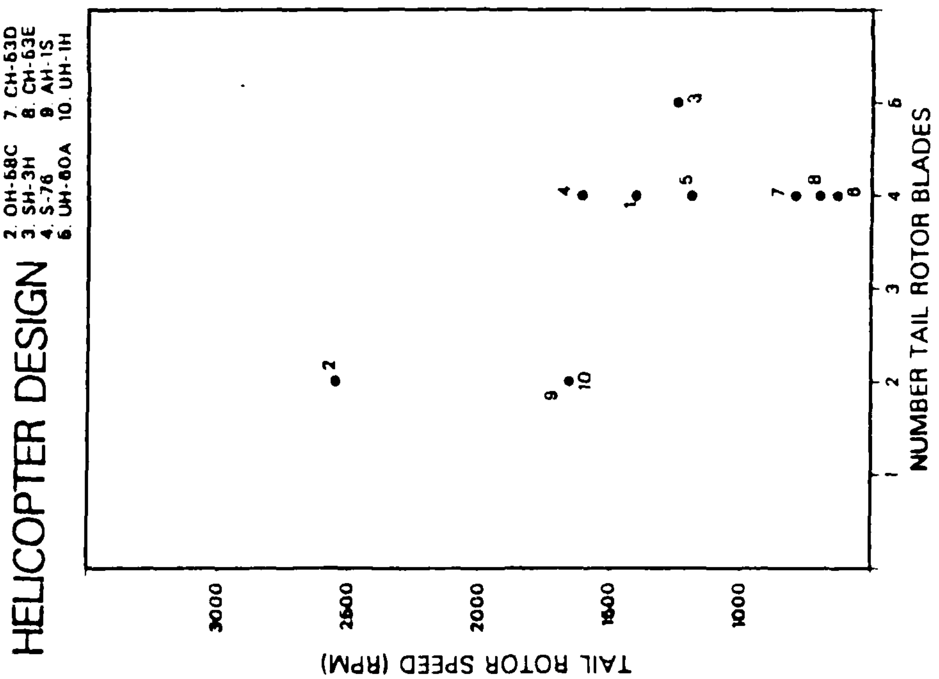


Fig. 4-7.

Fig. 4-7 and 4-9.

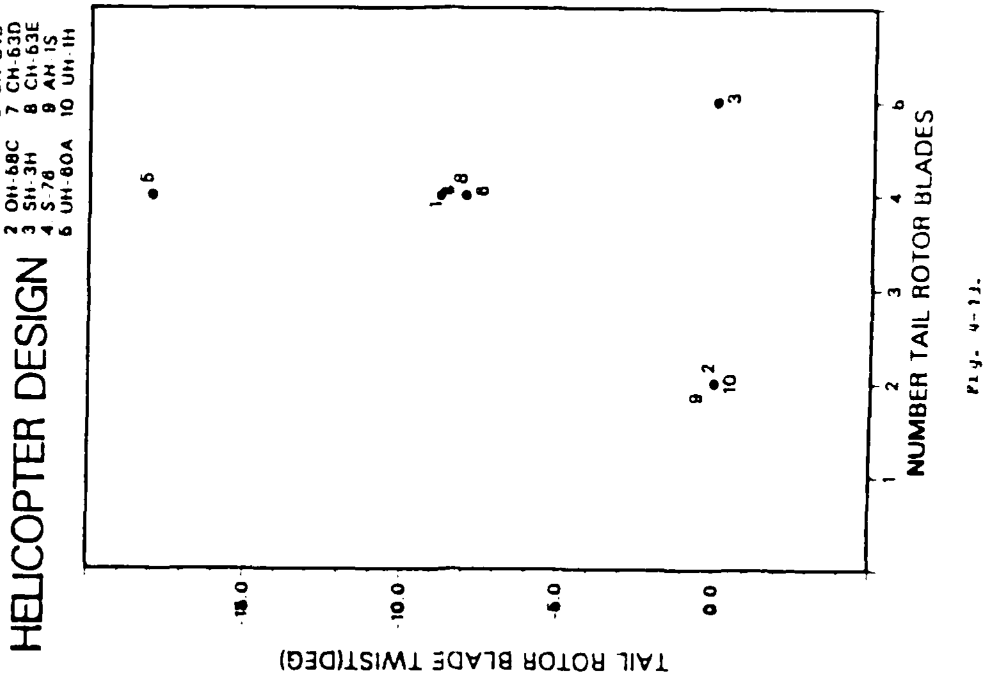


Fig. 4-13.

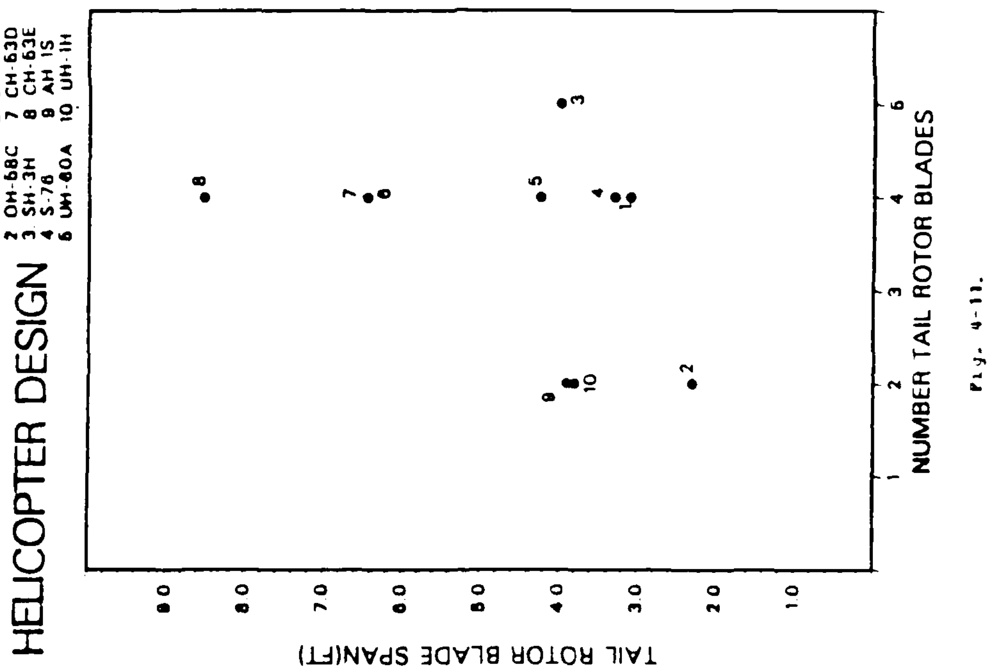


Fig. 4-11.

Fig. 4-11 and 4-13.

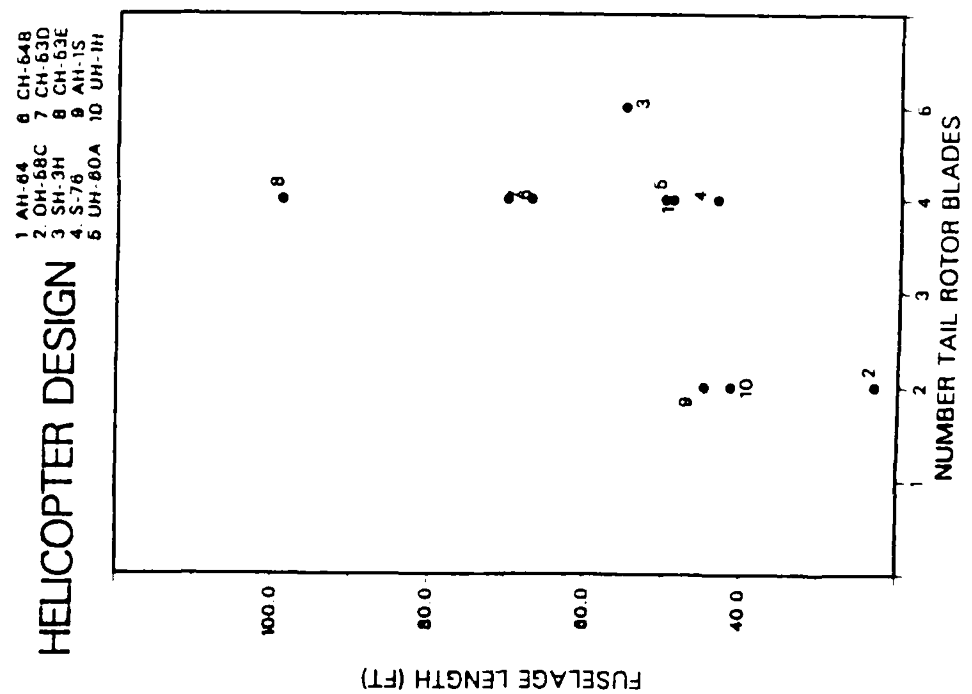


Fig. 4-18.

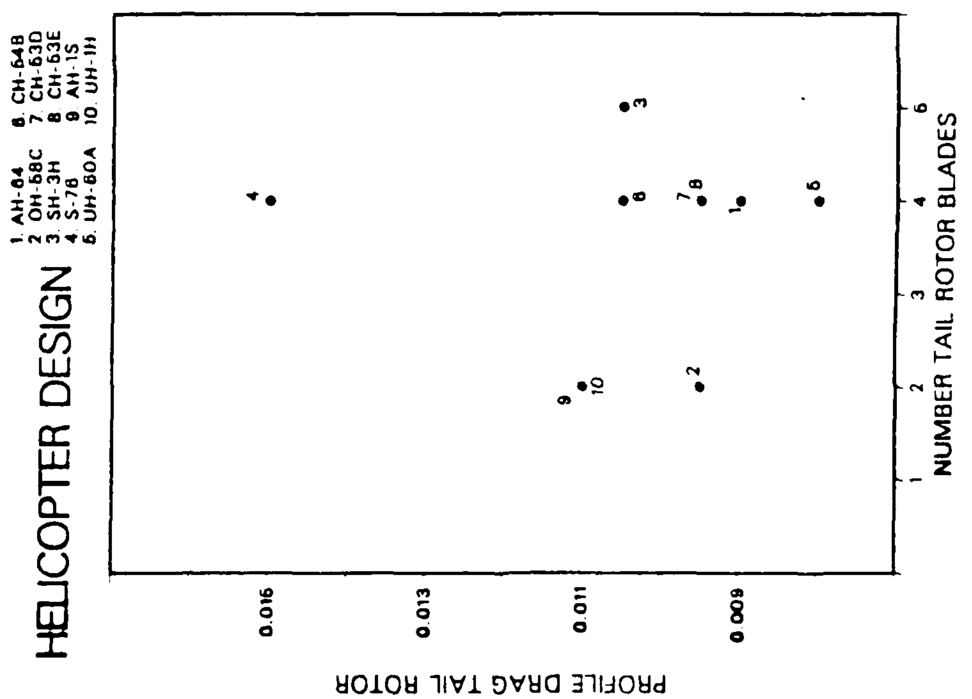
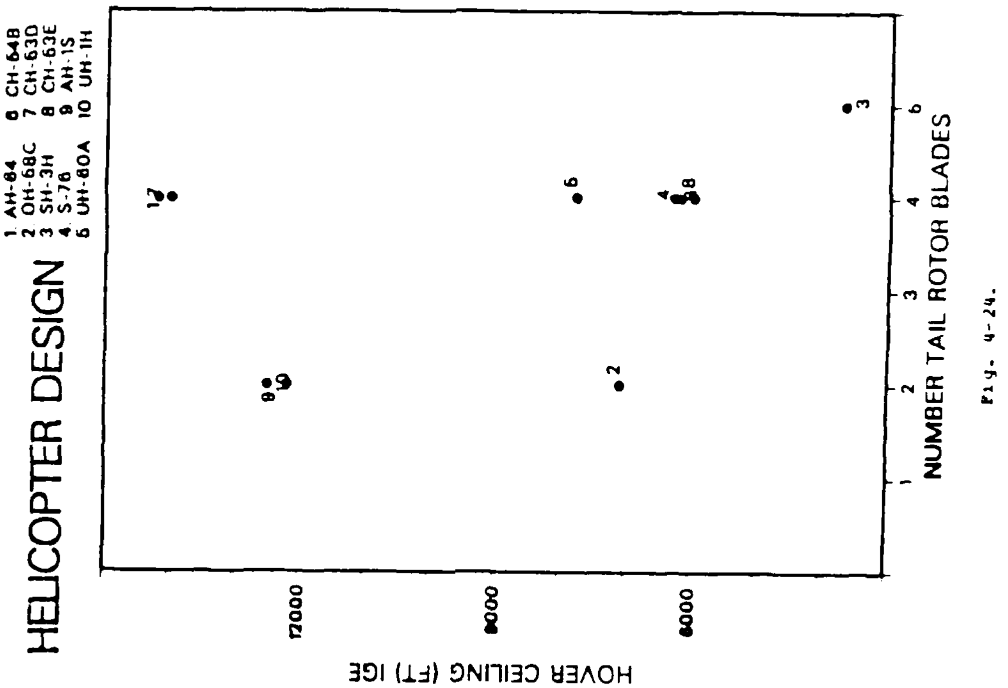


Fig. 4-15.

Fig. 4-15 and 4-18.



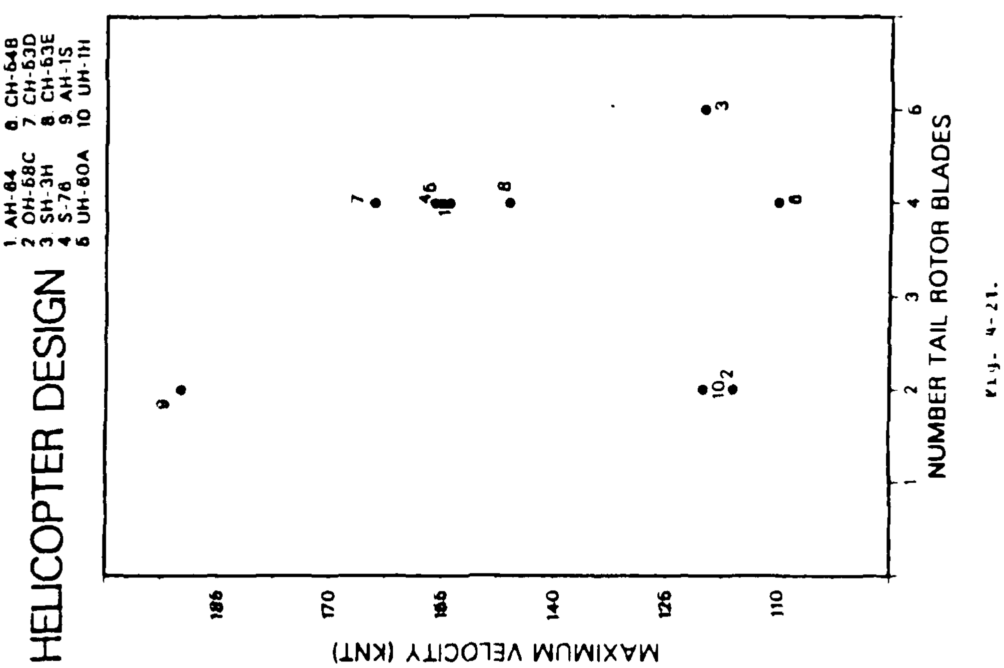


Fig. 4-21 and 4-24.

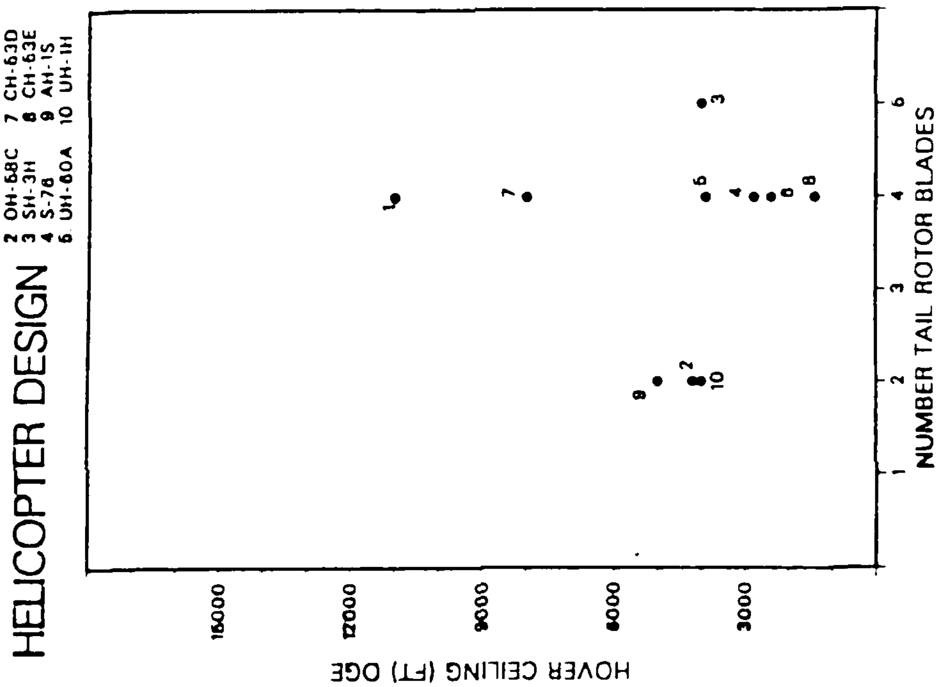
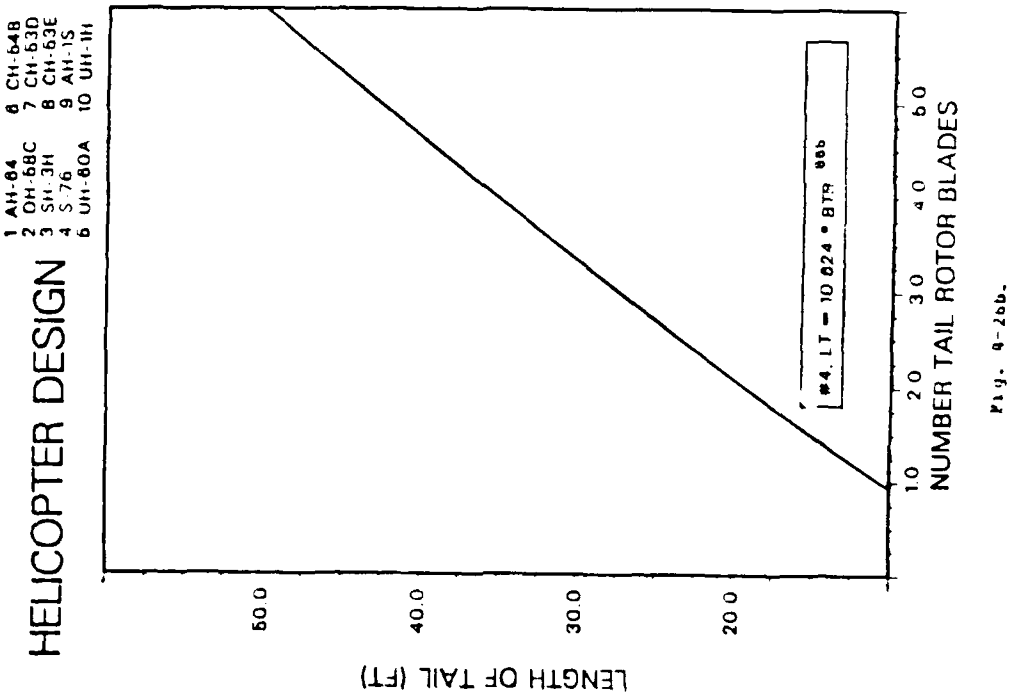


Fig. 4-25.

Fig. 4-25.



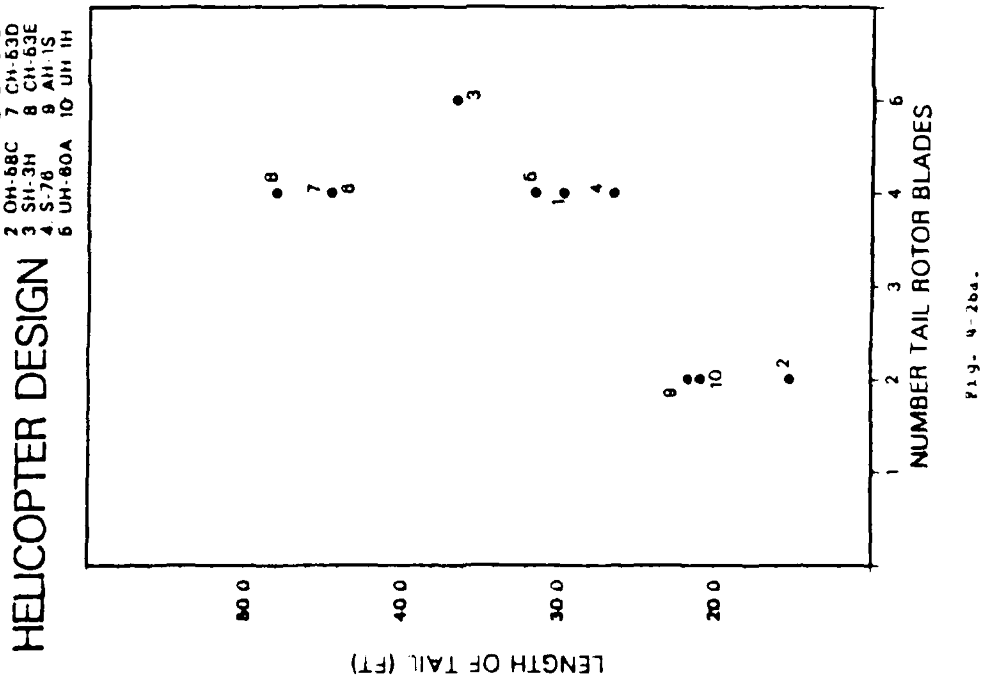
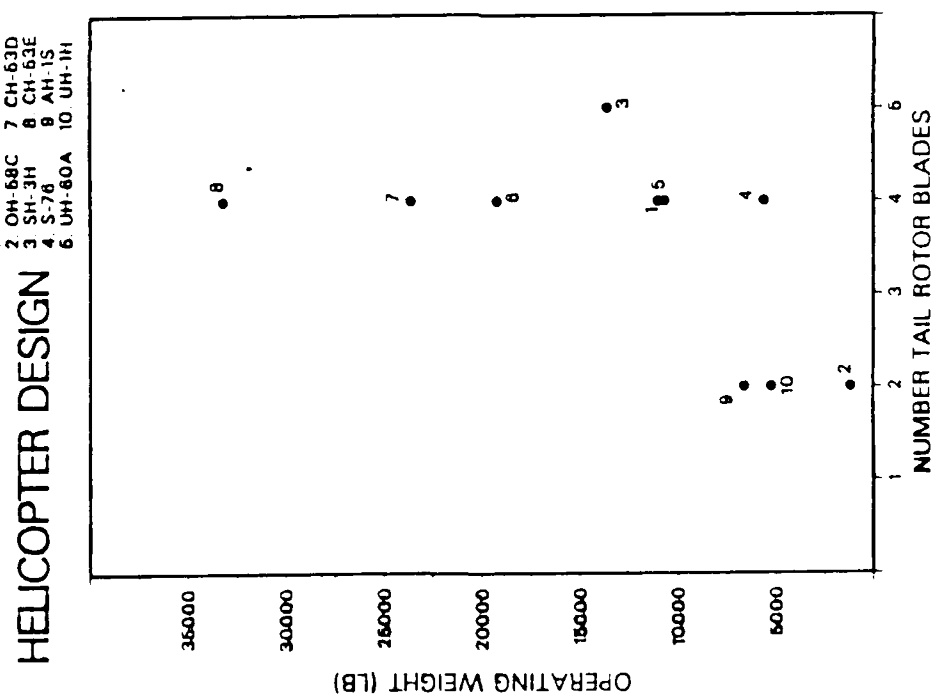


Fig. 4-26a and 4-26b.



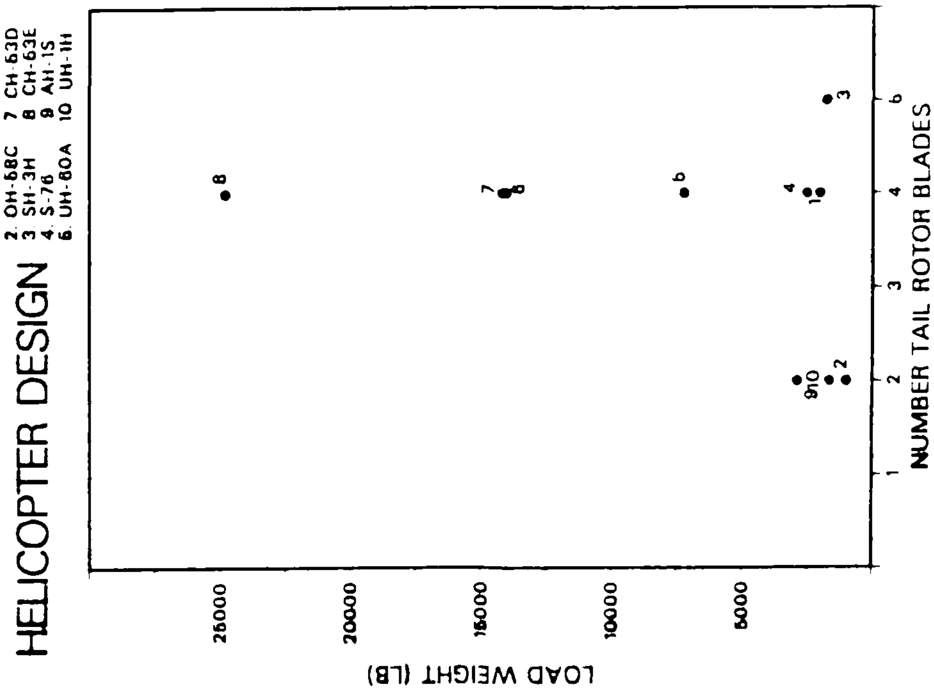


Fig. 4-28.

Fig. 4-27 and 4-28.

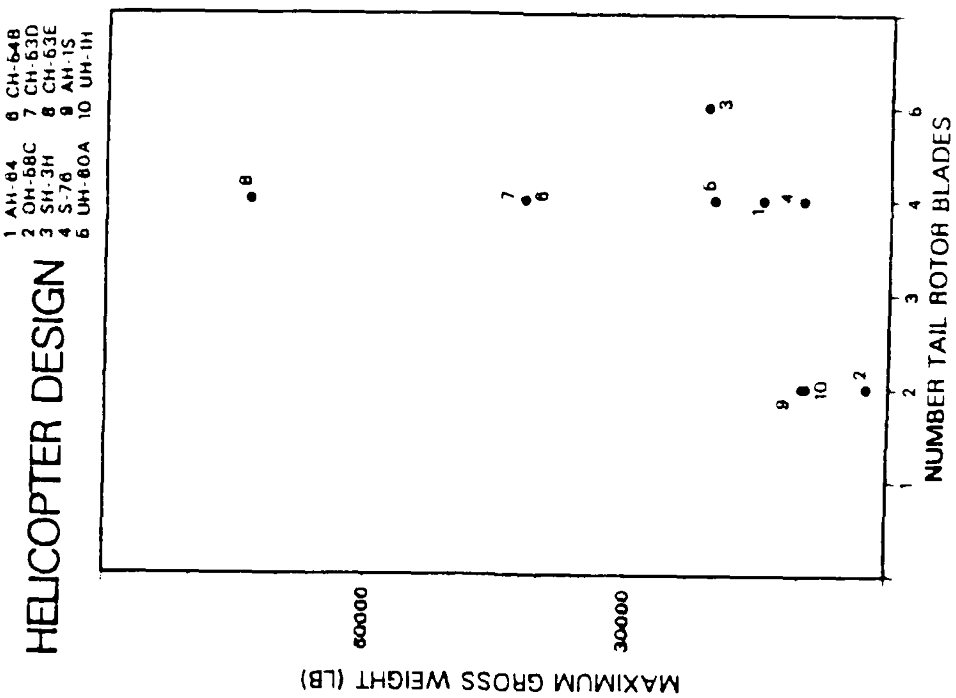


Fig. 4-30.

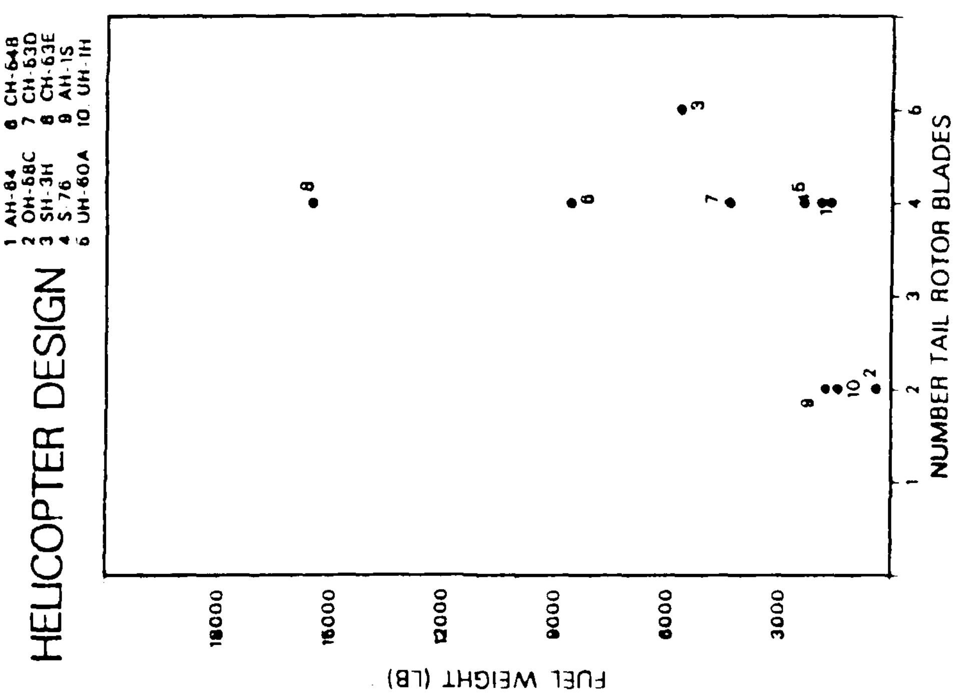


Fig. 4-29.

Fig. 4-29 and 4-30.

Height of Main Rotor System Pairings.

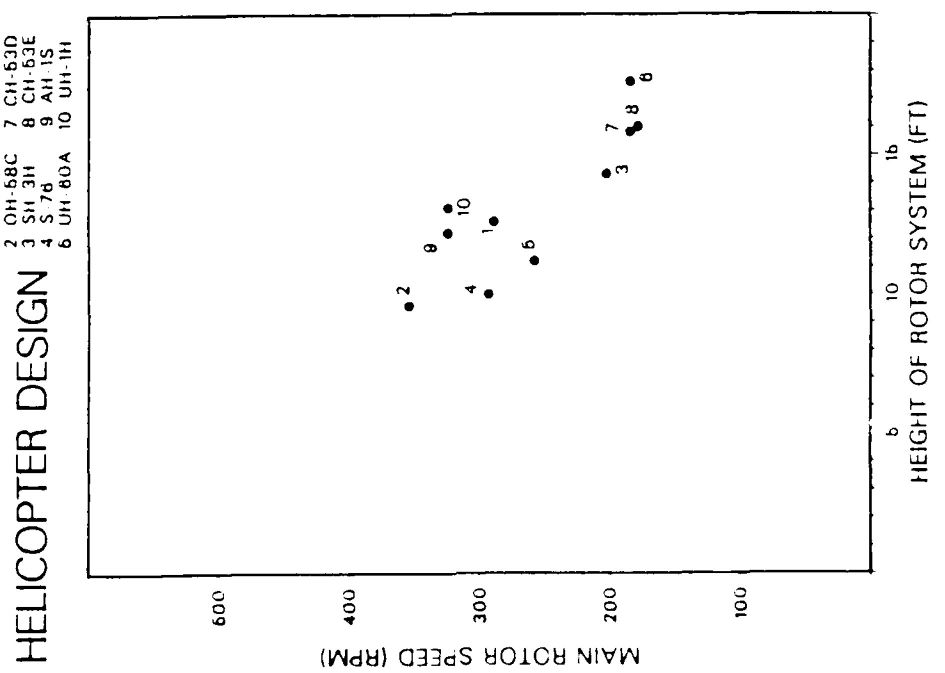


Fig. 5-6a.

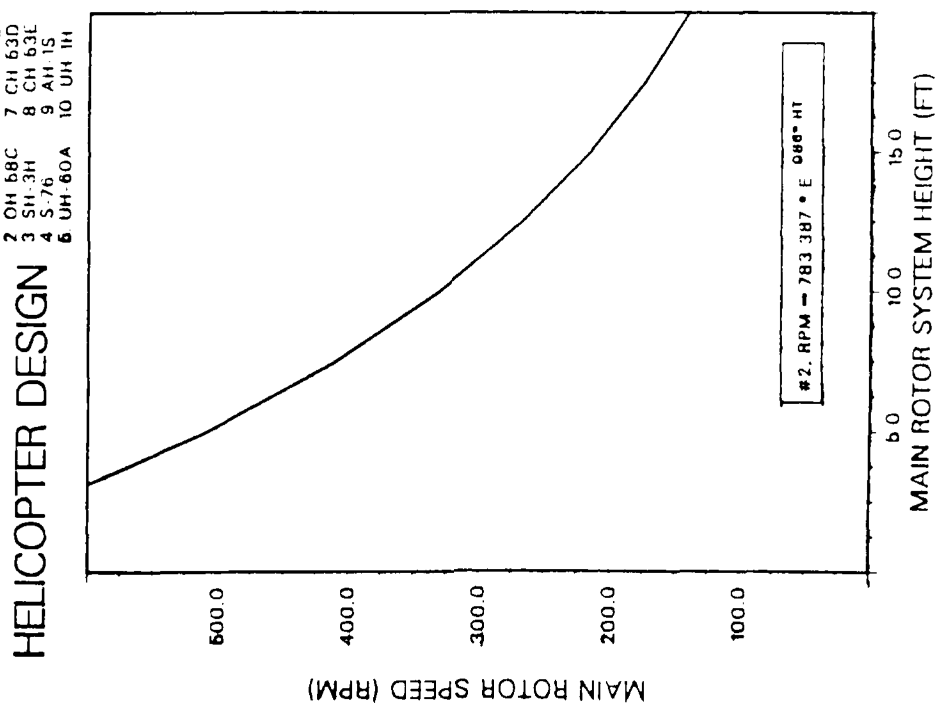


Fig. 5-6b.

Fig. 5-6a and 5-6b.

Fig. 5-8 and 5-14.

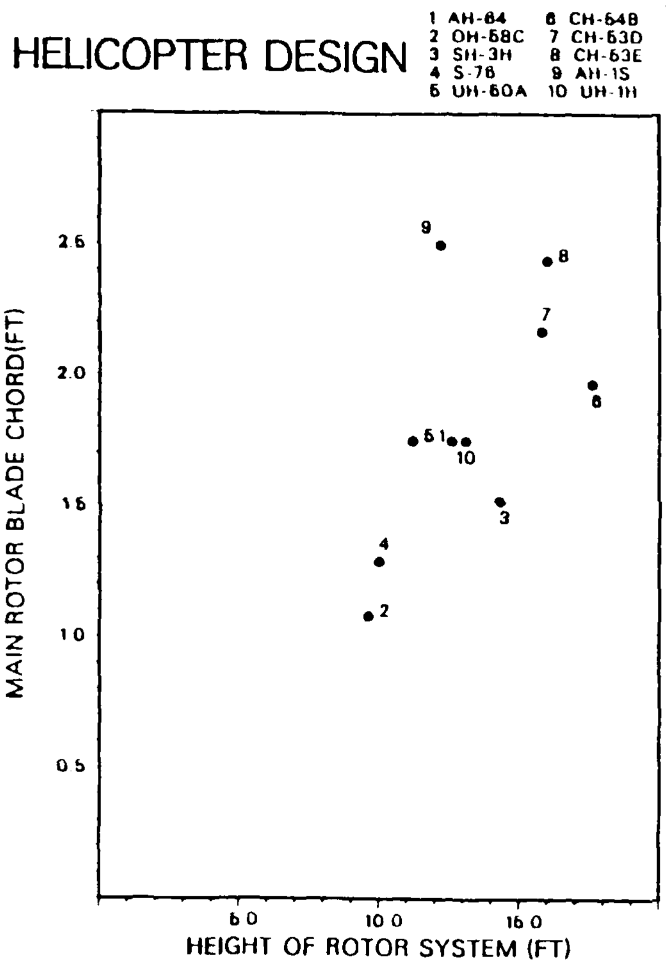


Fig. 5-8.

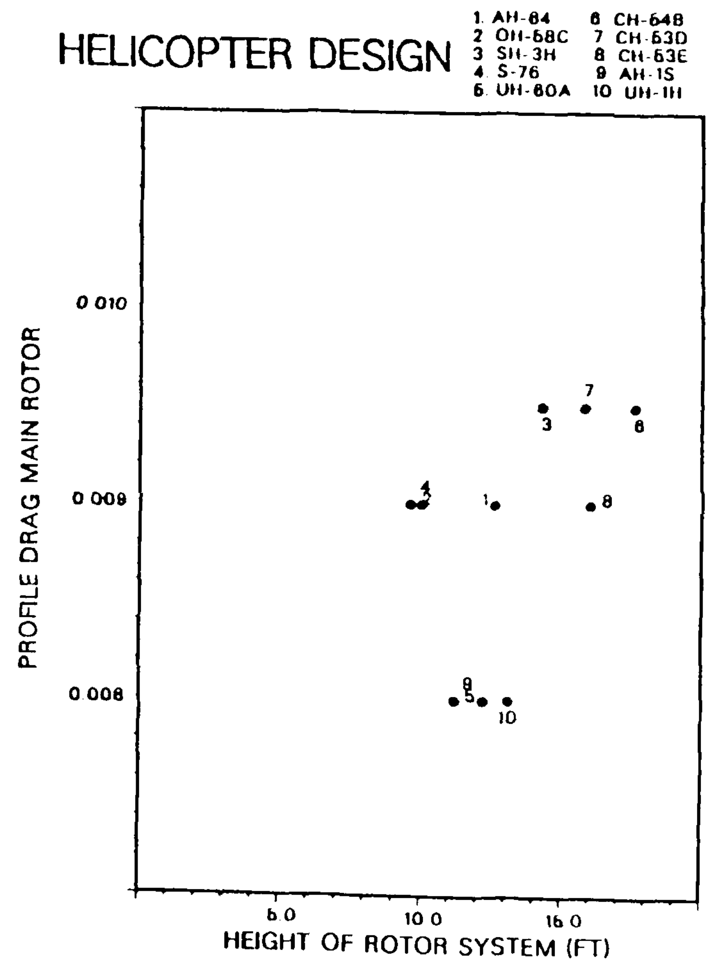


Fig. 5-14.

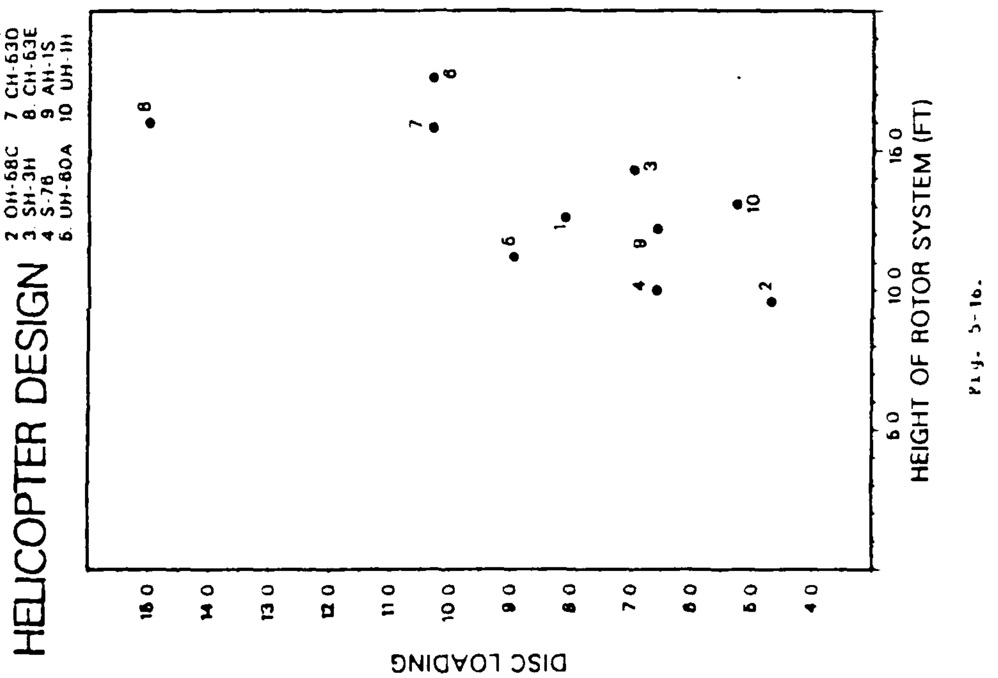


Fig. 5-16.

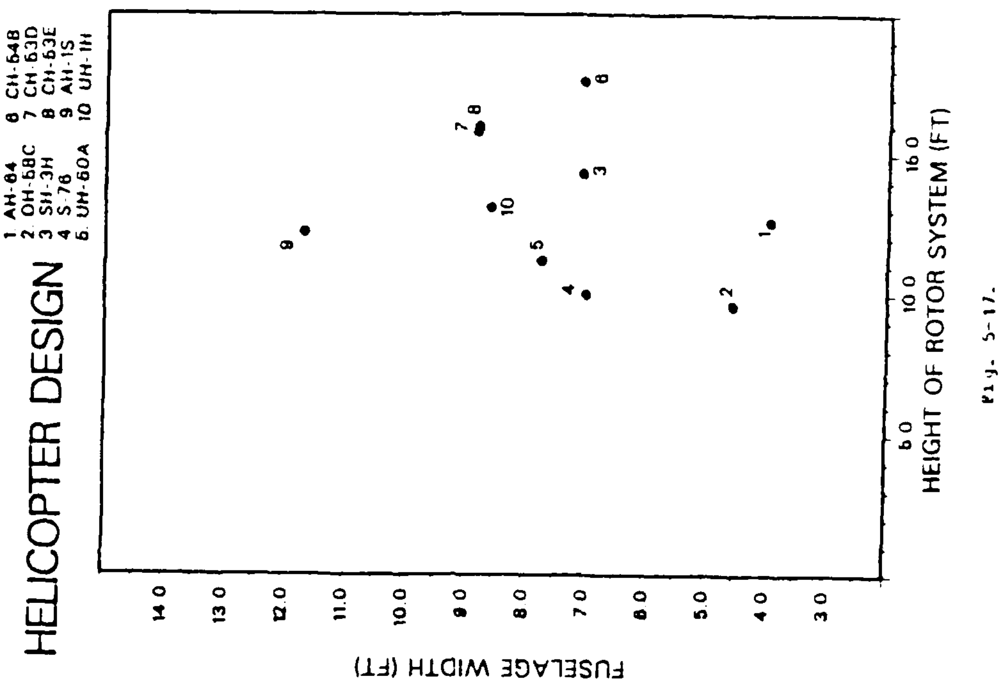
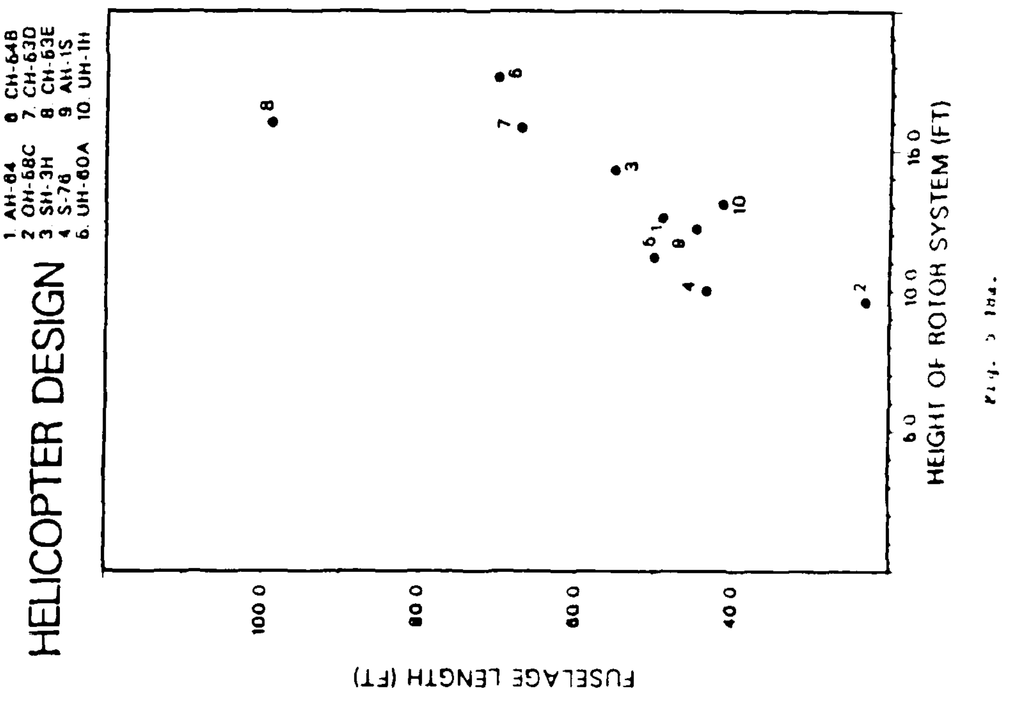


Fig. 5-17.

Fig. 5-16 and 5-17.



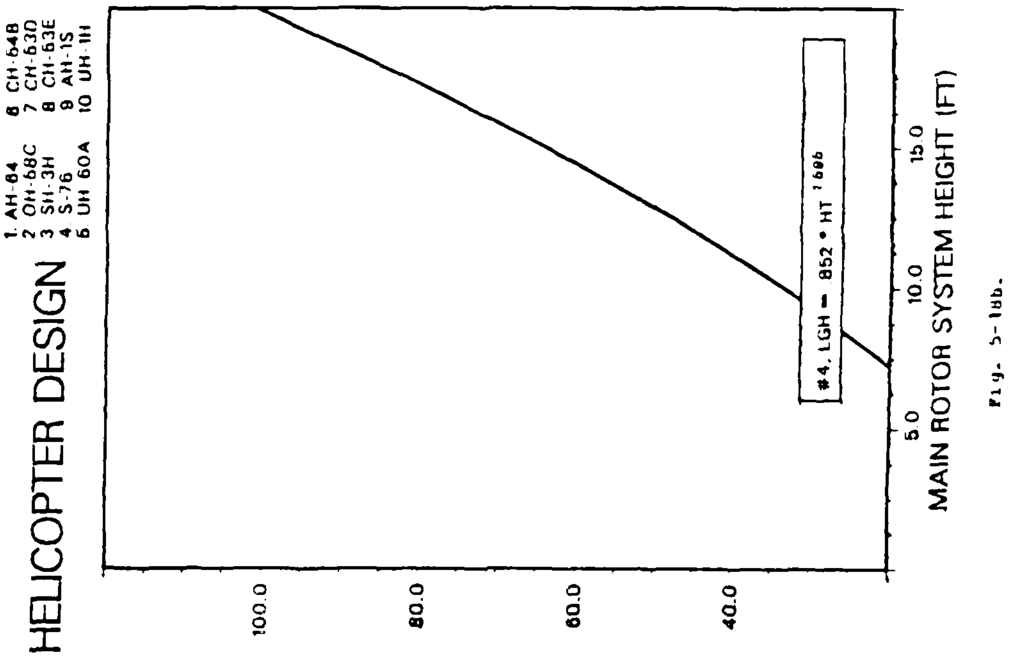
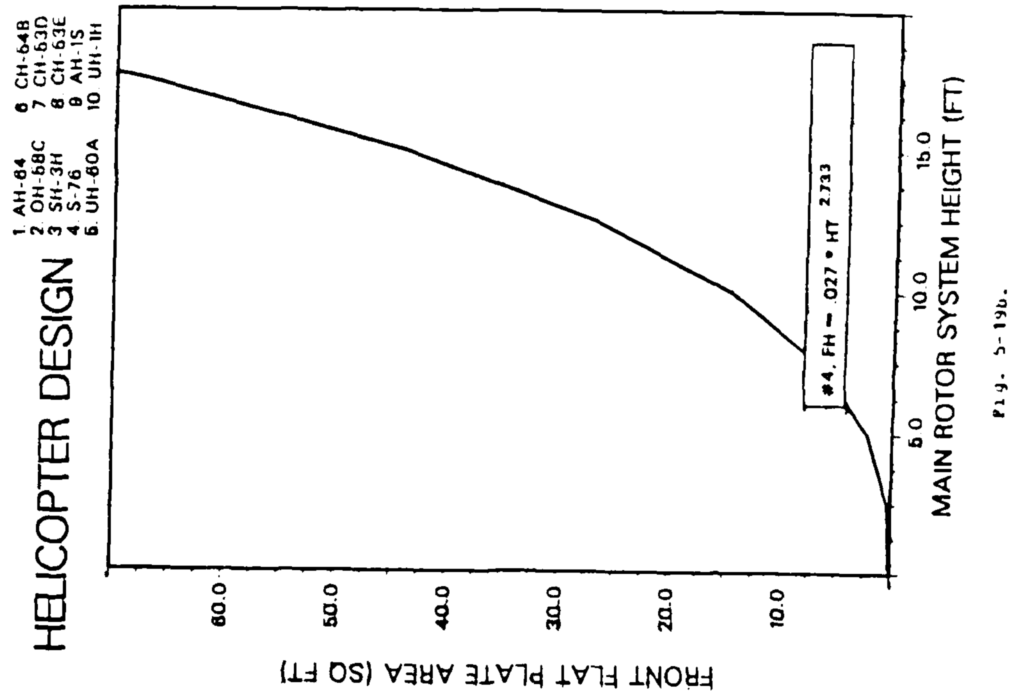


Fig. 5-18a and 5-18b.



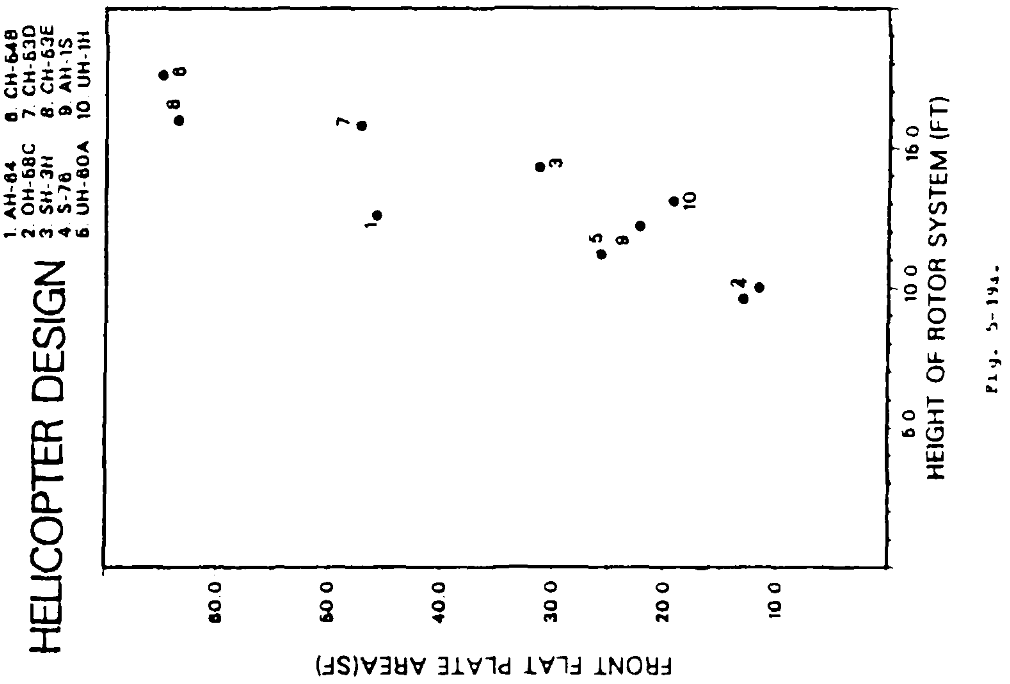
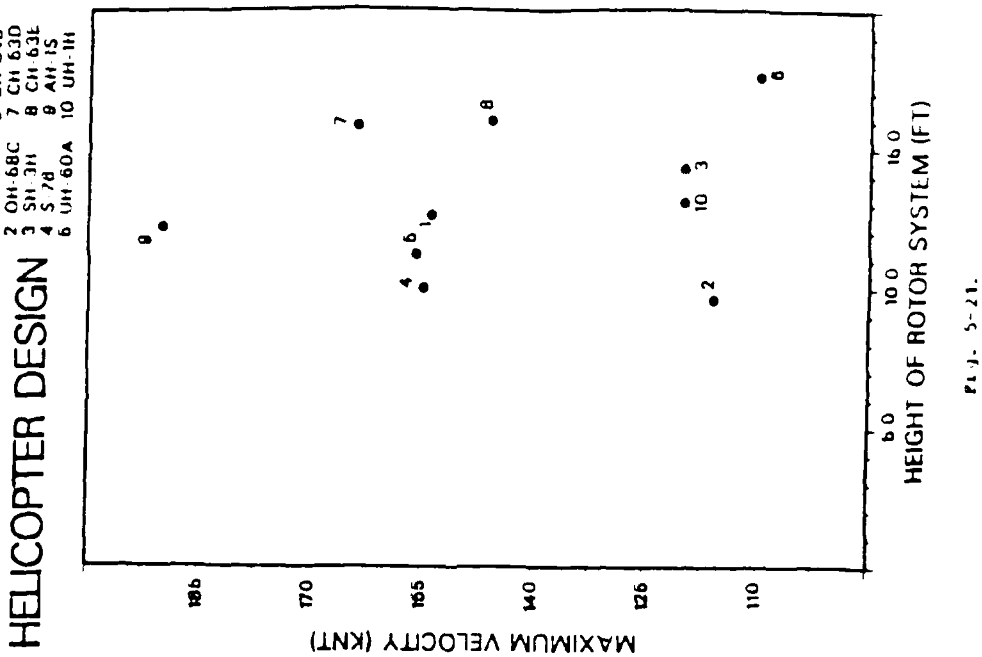


Fig. 5-19a and 5-19b.



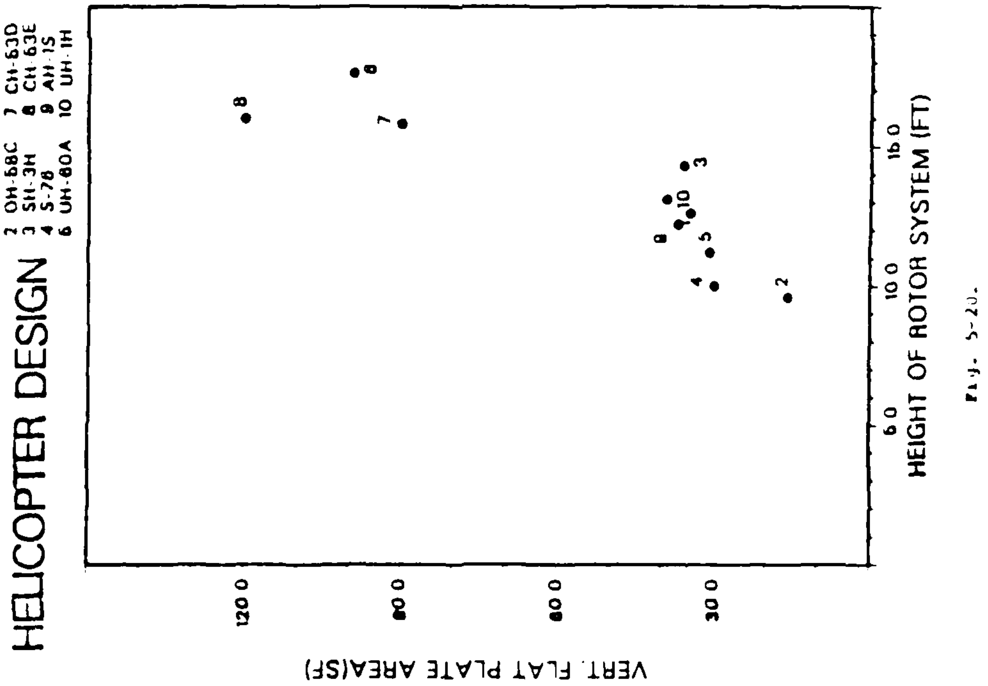


Fig. 5-20 and 5-21.

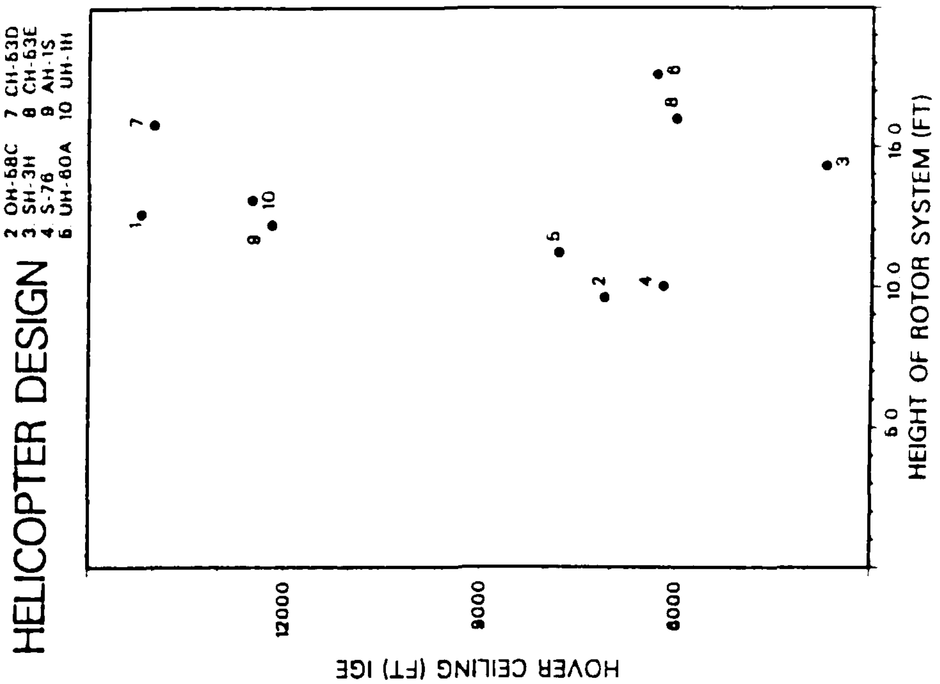


Fig. 5-24.

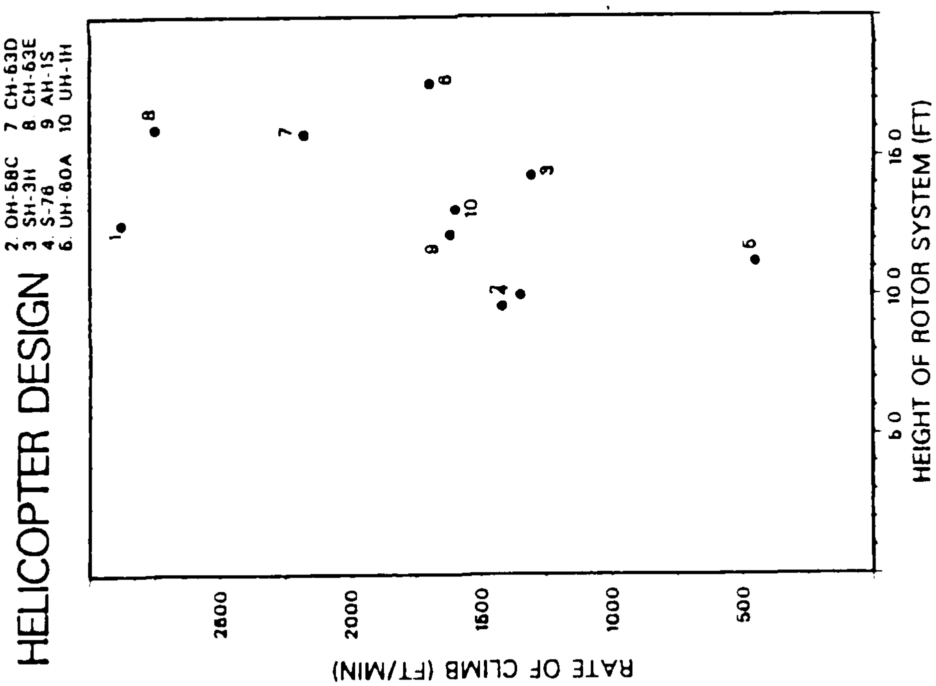


Fig. 5-23.

Fig. 5-23 and 5-24.

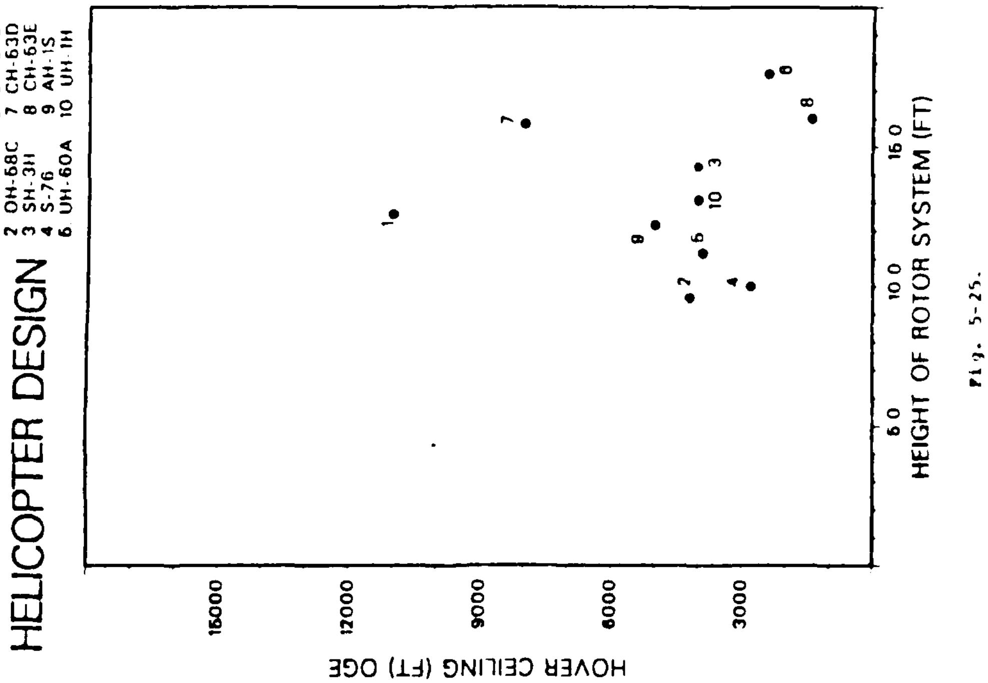
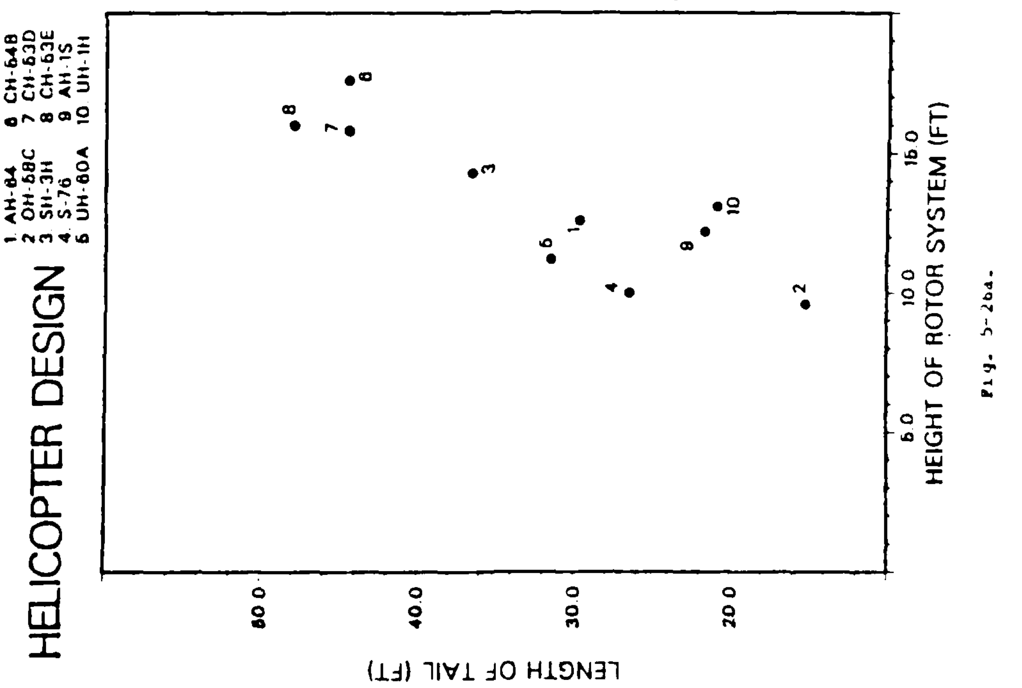

HELICOPTER DESIGN
1 AH-64
2 OH-58C
3 SH-3H
4 S-76
5 UH-60A
6 CH-54B
7 CH-53D
8 CH-53E
9 AH-1S
10 UH-1H
HOVER CEILING (FT) OGE
15000
12000
9000
6000
3000
5.0
10.0
15.0
HEIGHT OF ROTOR SYSTEM (FT)
Fig. 5-25.

Fig. 5-25.



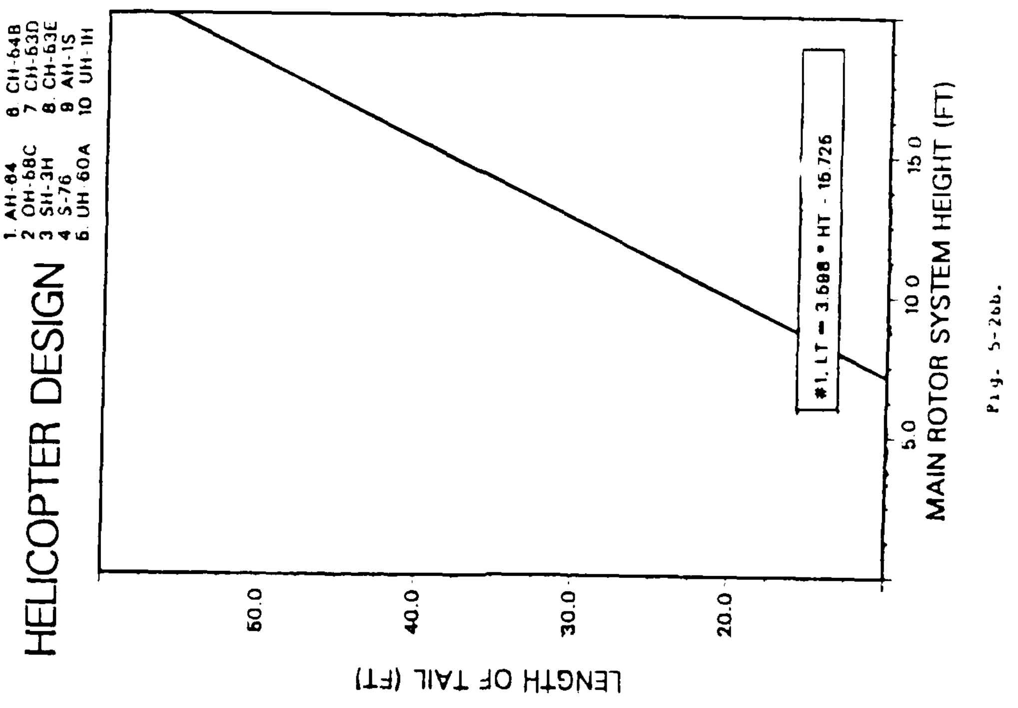


Fig. 5-26a and 5-26b.

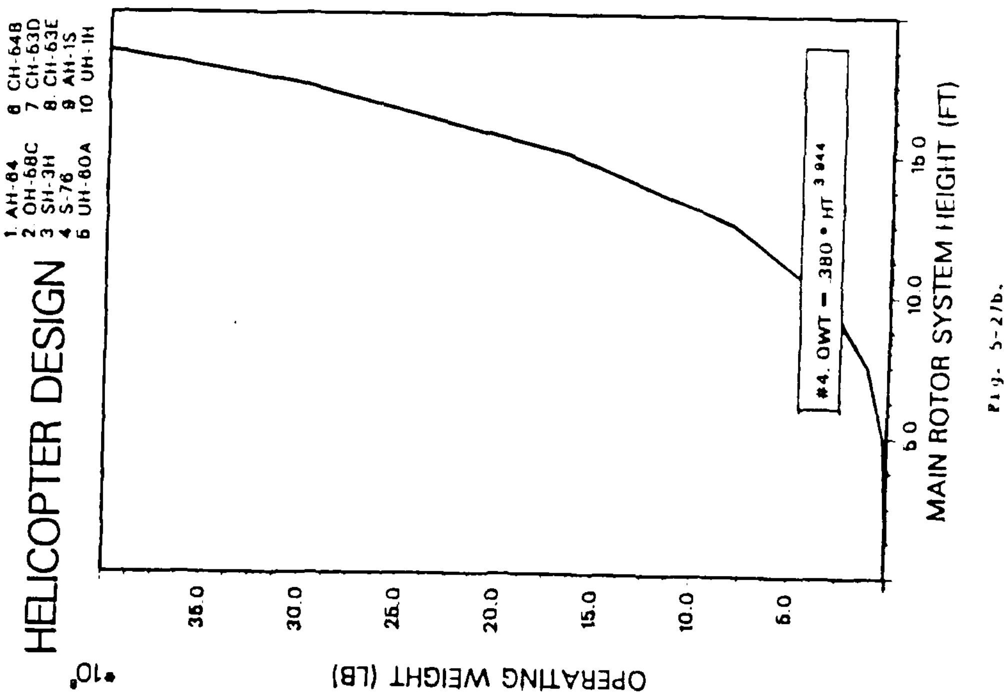


Fig. 5-27b.

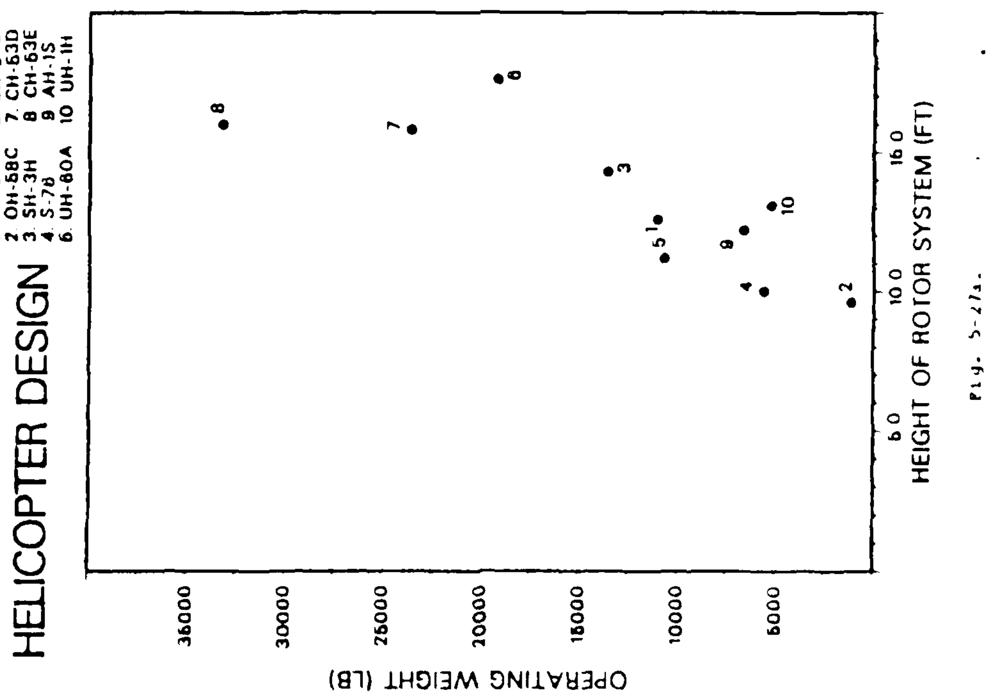


Fig. 5-27a.

Fig. 5-27a and 5-27b.

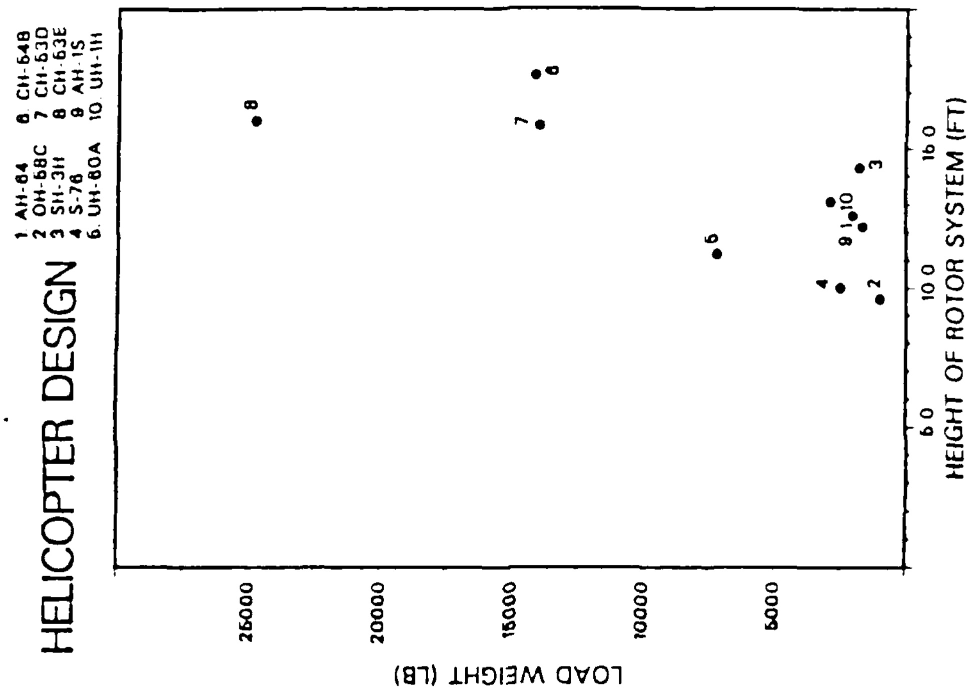


Fig. 5-28.

Fig. 5-28.

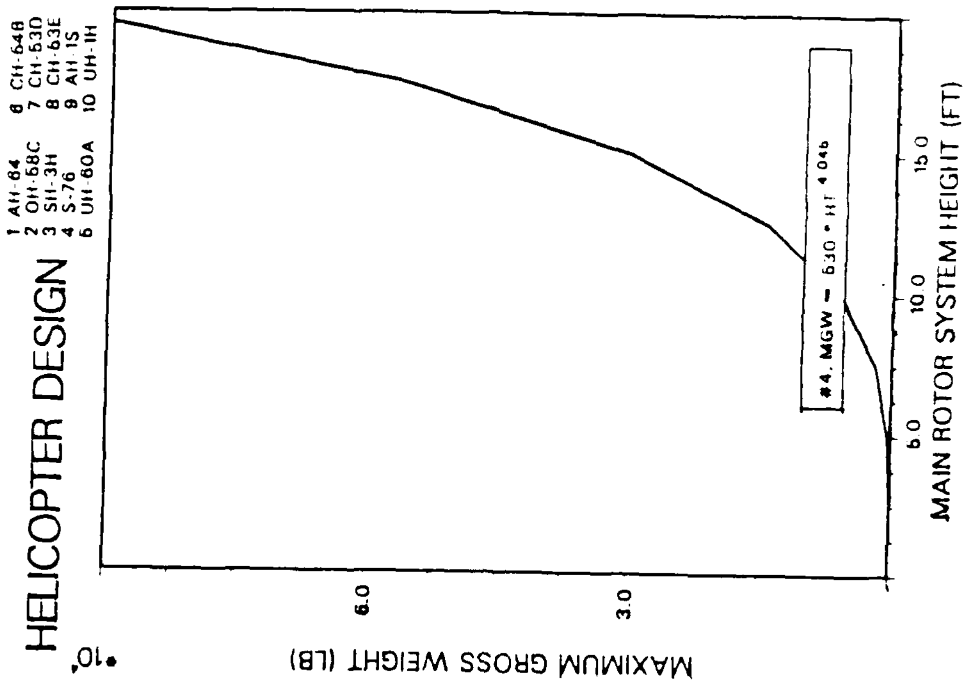


Fig. 5-30b.

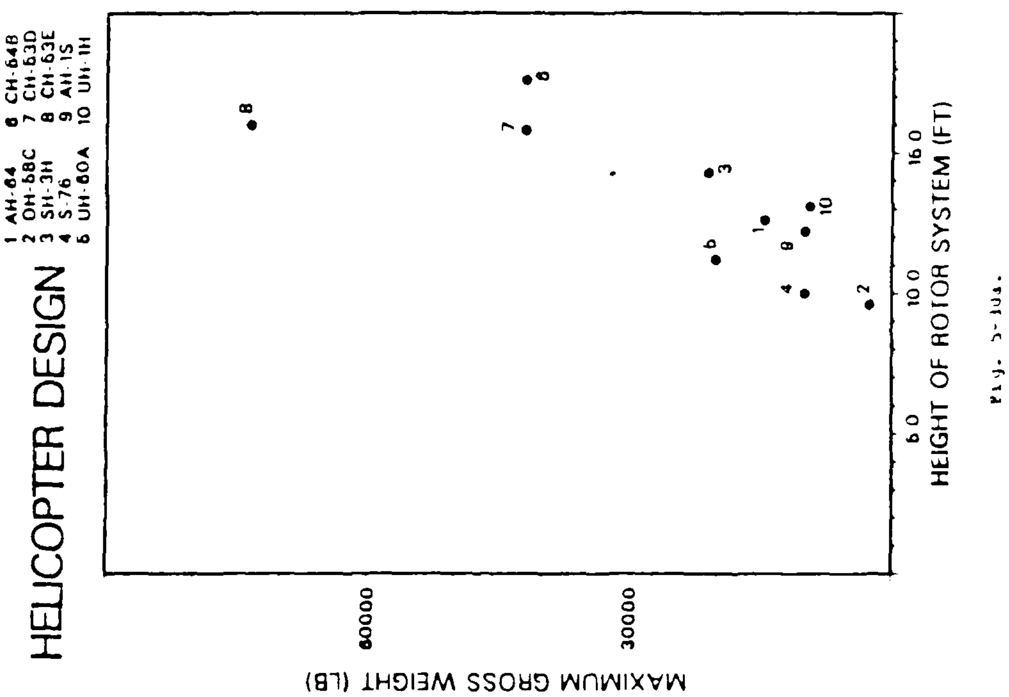


Fig. 5-30a.

Fig. 5-30a and 5-30b.

Speed of Main Rotor Pairings.

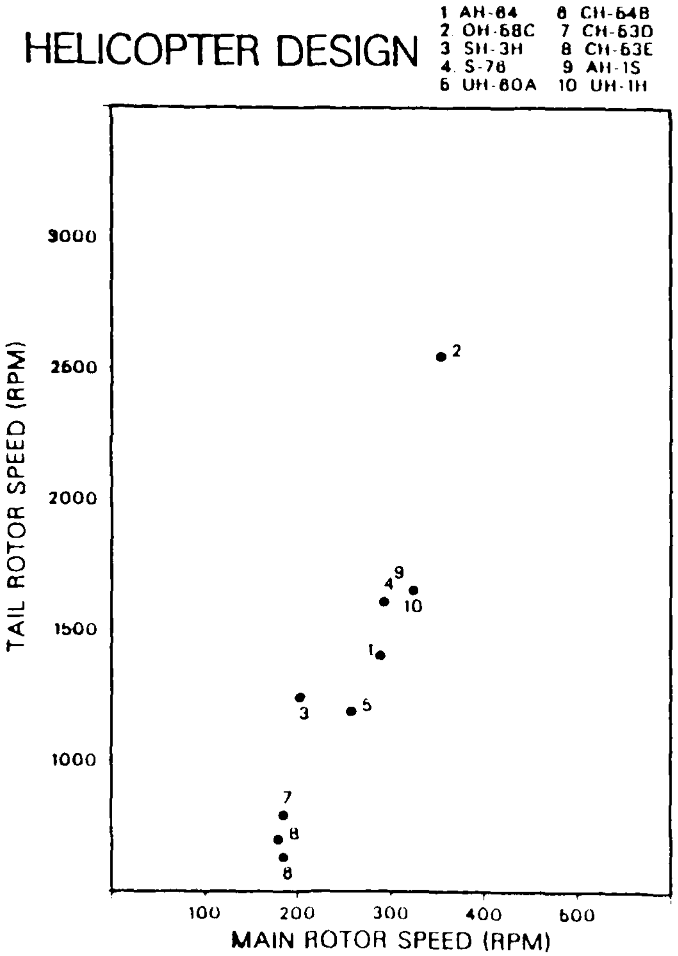


Fig. 6-7a.

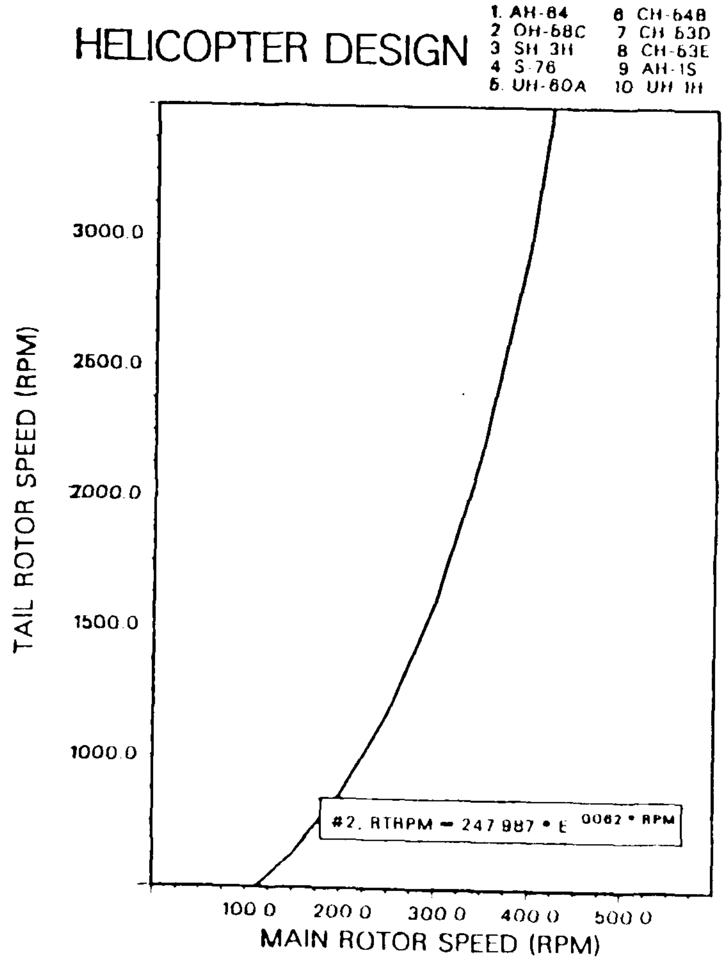


Fig. 6-7b.

Fig. 6-7a and 6-7b.

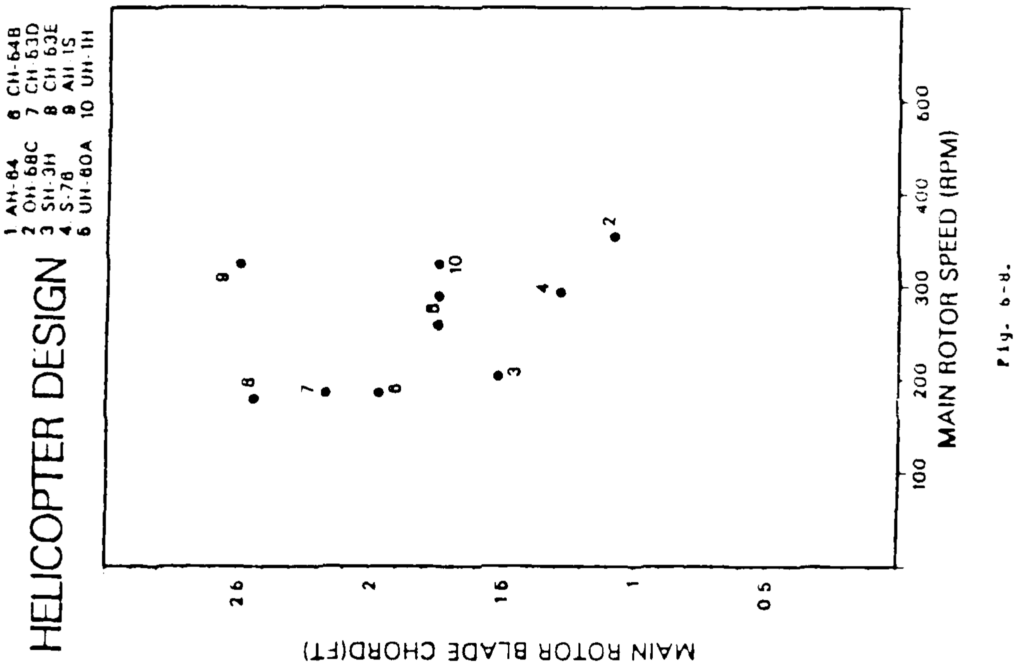

HELICOPTER DESIGN
1 AH-64
2 OH-58C
3 SH-3H
4 S-76
5 UH-60A
6 CH-54B
7 CH-53D
8 CH-53E
9 AH-1S
10 UH-1H
MAIN ROTOR SPEED (RPM)
MAIN ROTOR BLADE CHORD(FT)
Fig. 6-8.

Fig. 6-8.

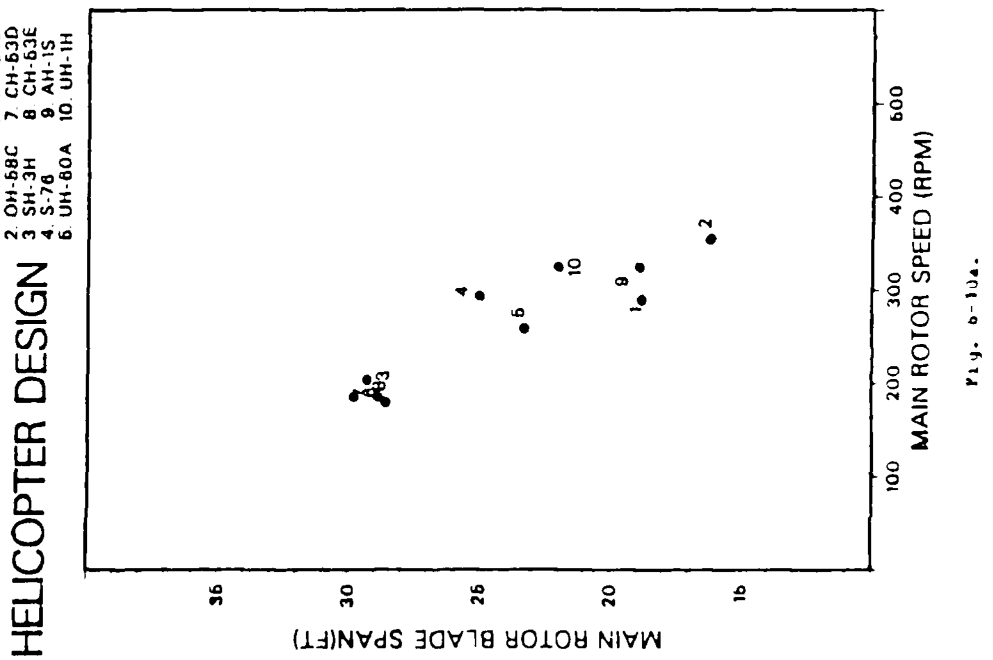


Fig. 6-10a.

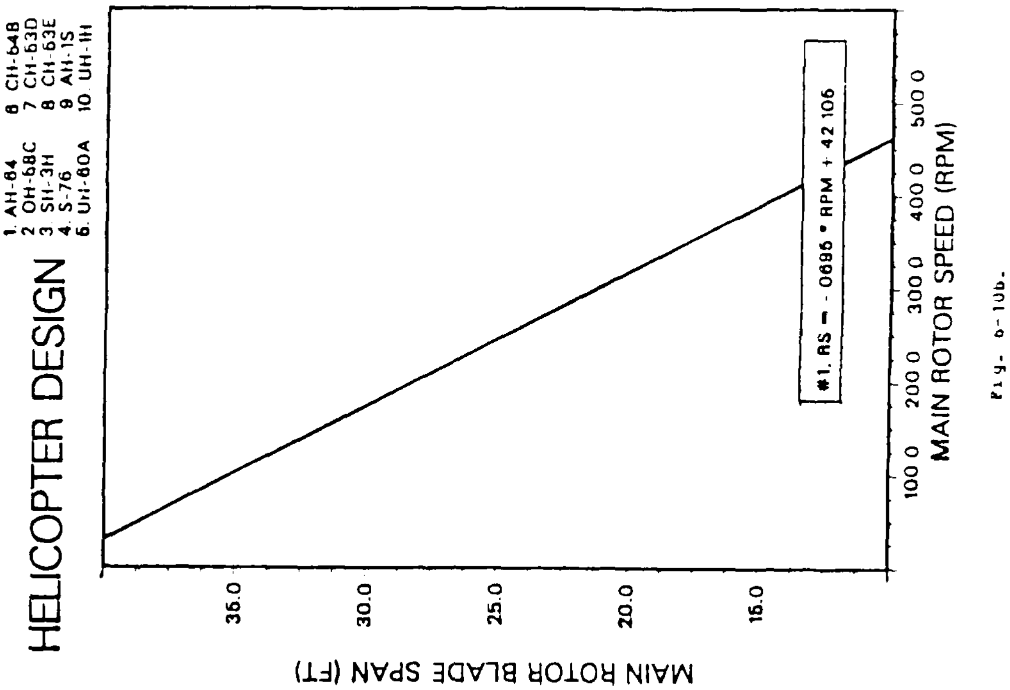


Fig. 6-10b.

Fig. 6-10a and 6-10b.

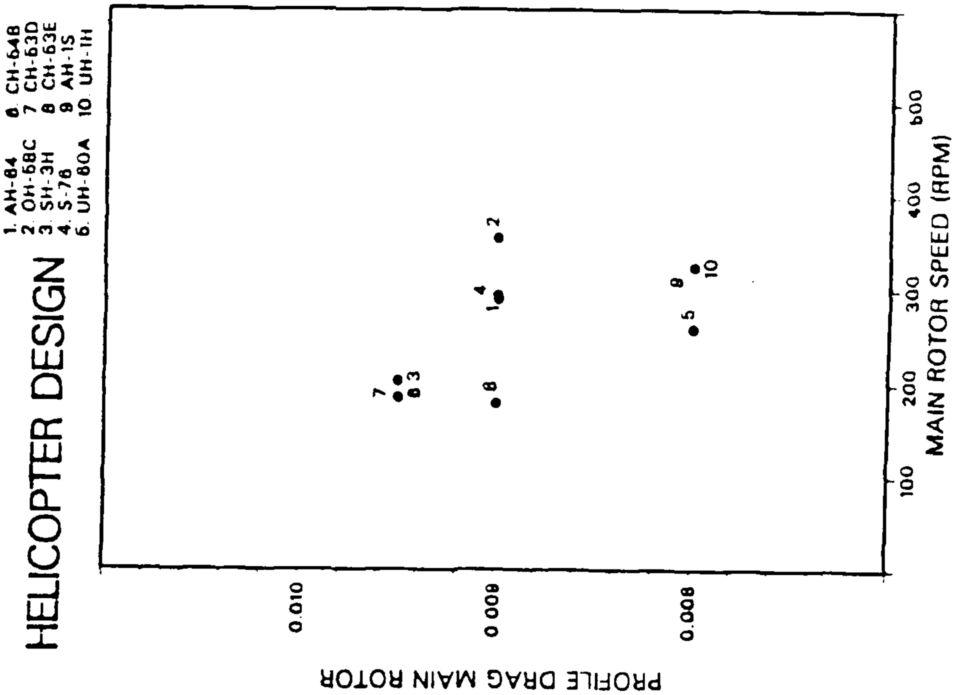


Fig. 6-14.

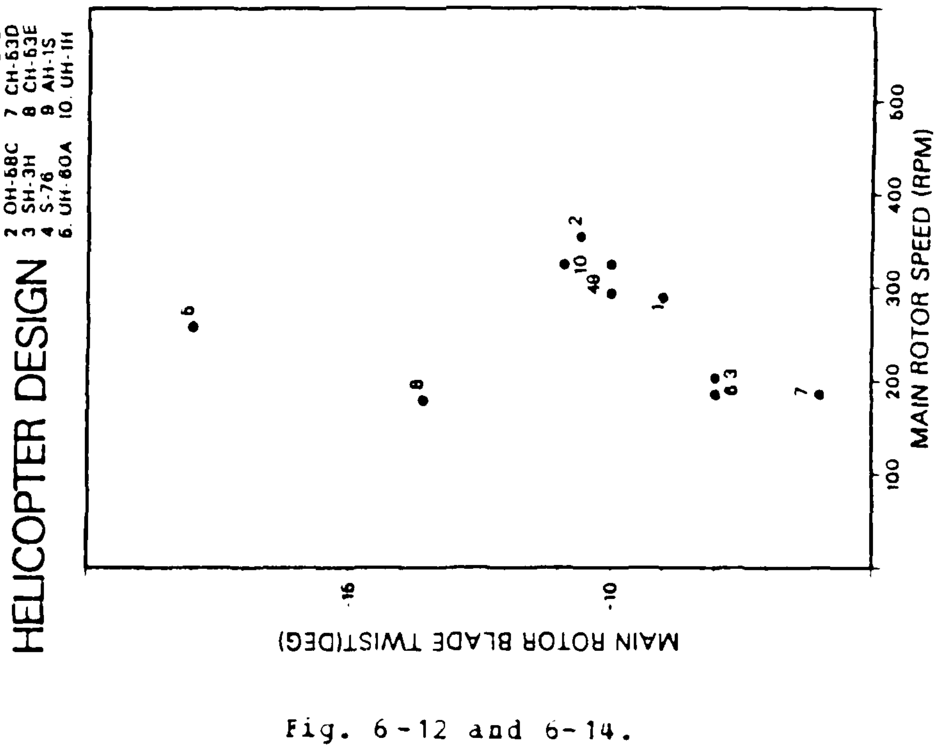
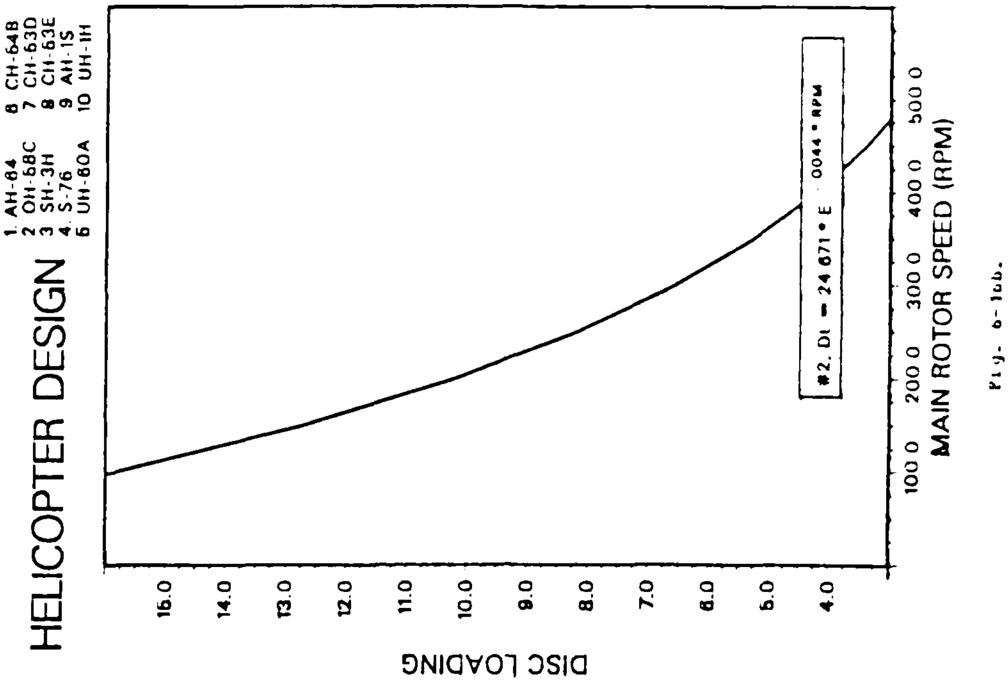


Fig. 6-12.

Fig. 6-12 and 6-14.



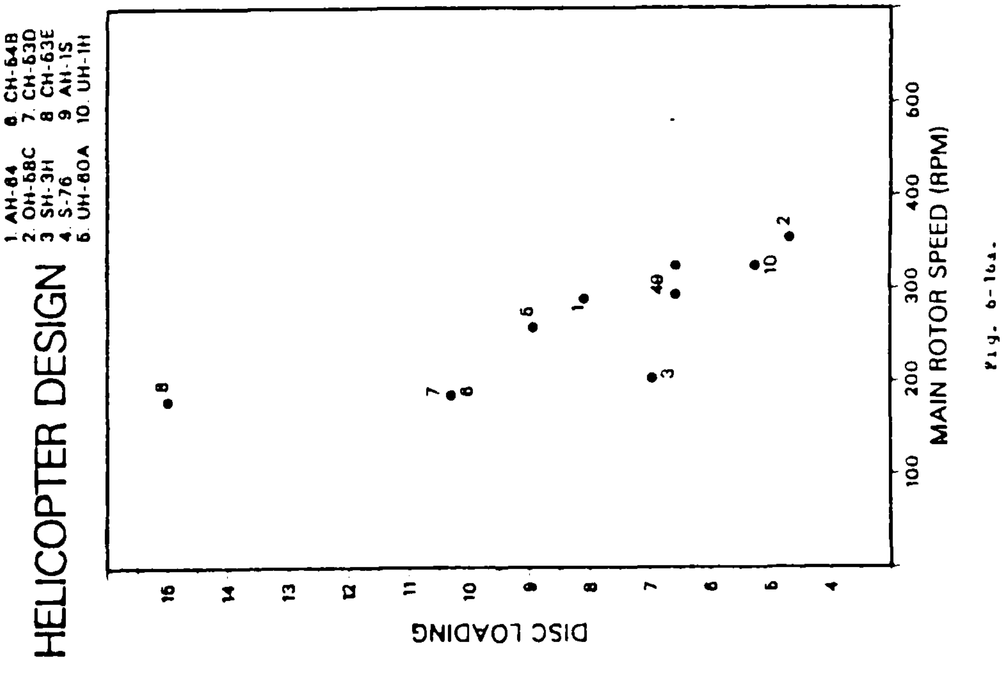
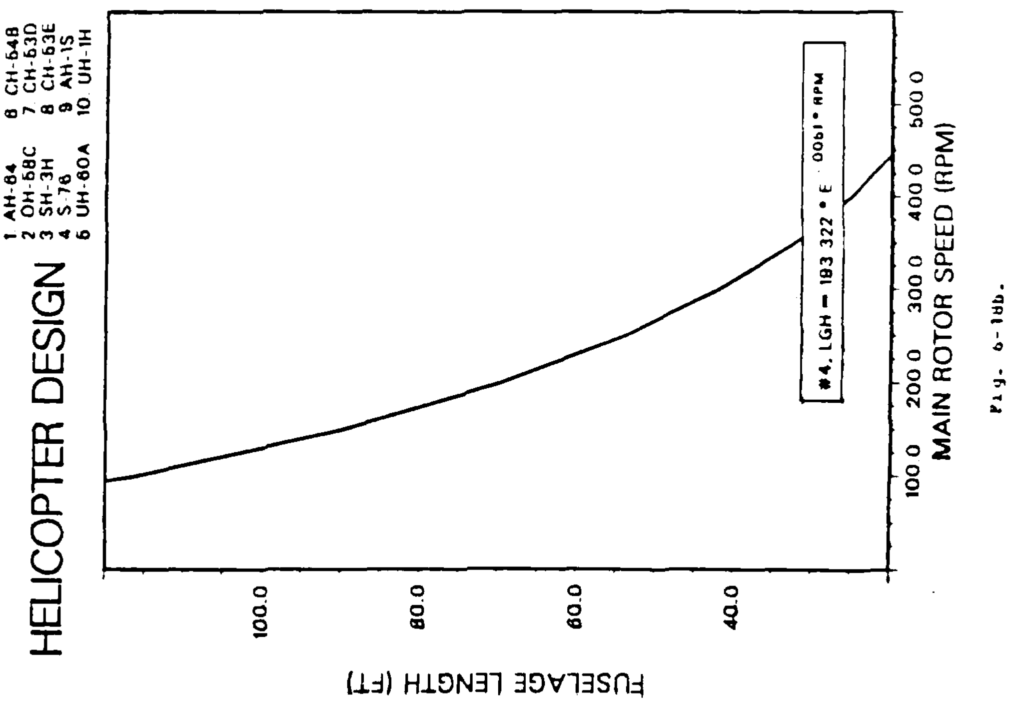


Fig. 6-16a and 6-16b.



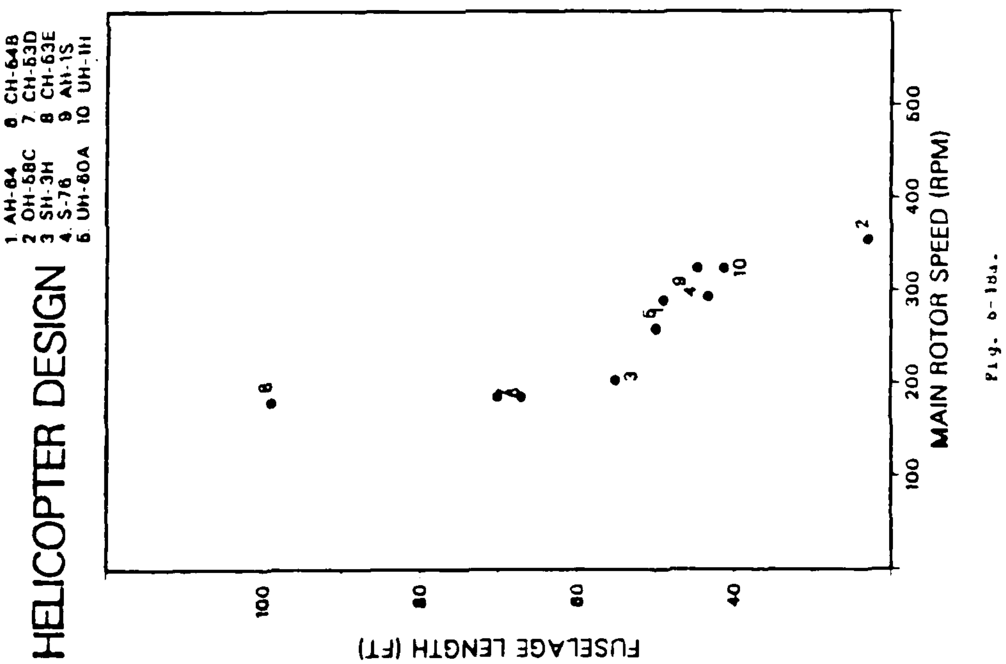


Fig. 6-18a and 6-18b.

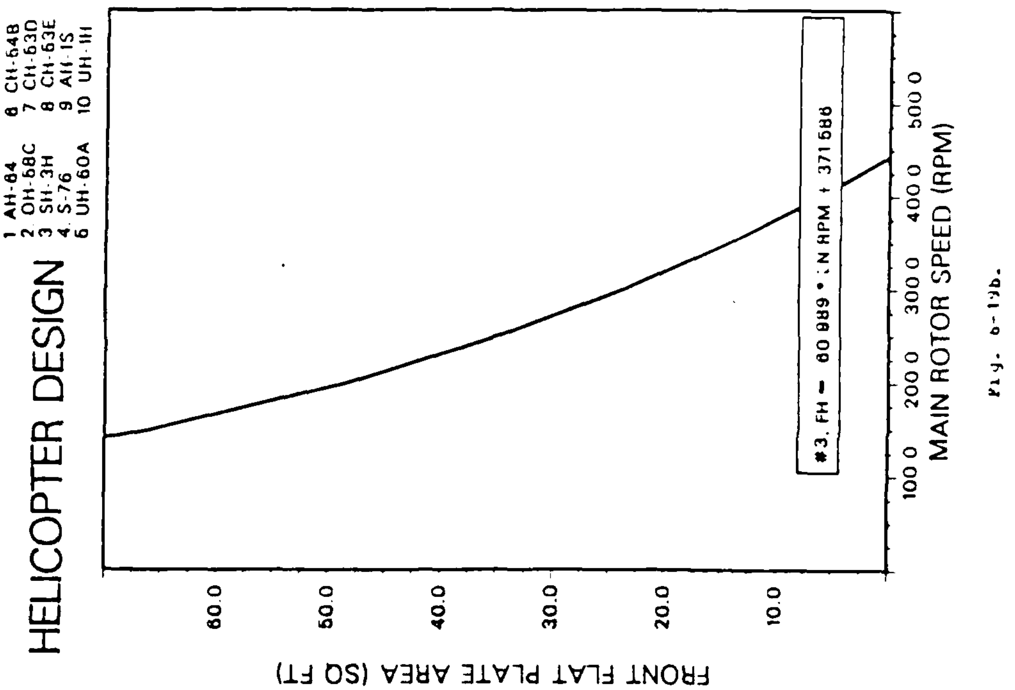


Fig. 6-19b.

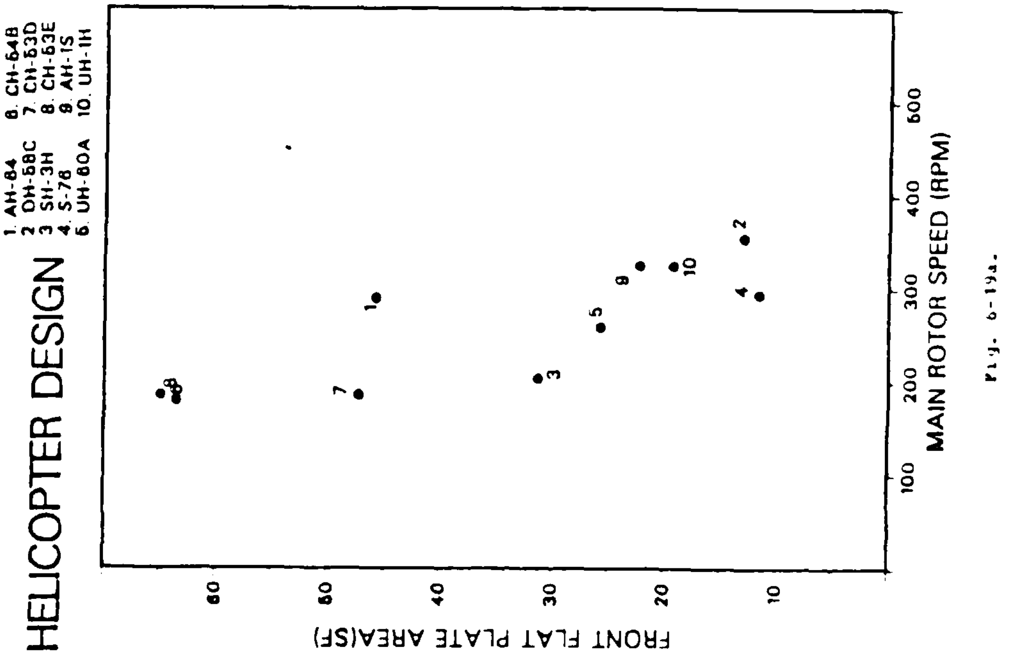


Fig. 6-19a.

Fig. 6-19a and 6-19b.

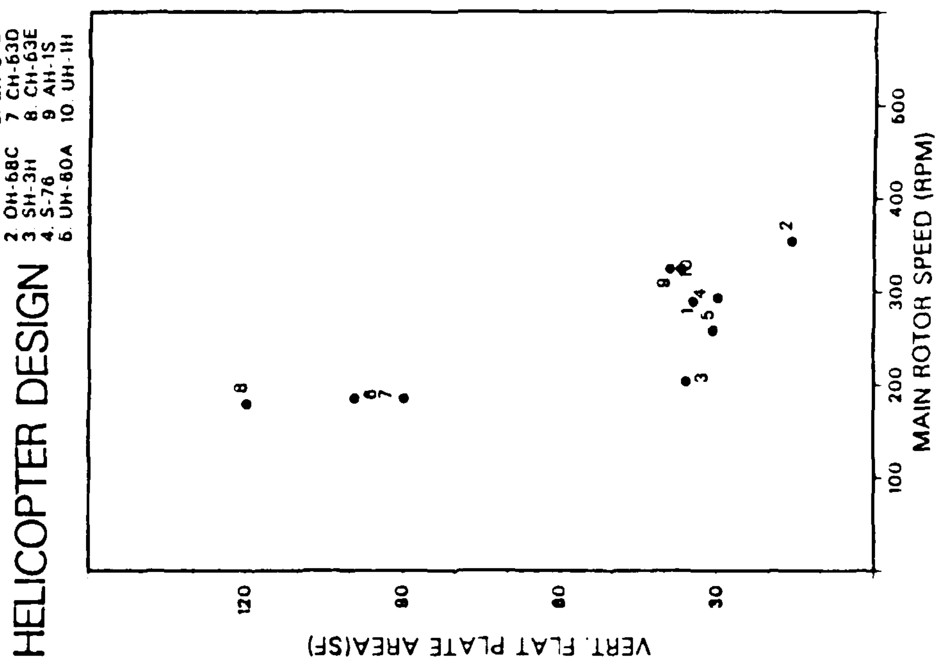


Fig. 6-20.

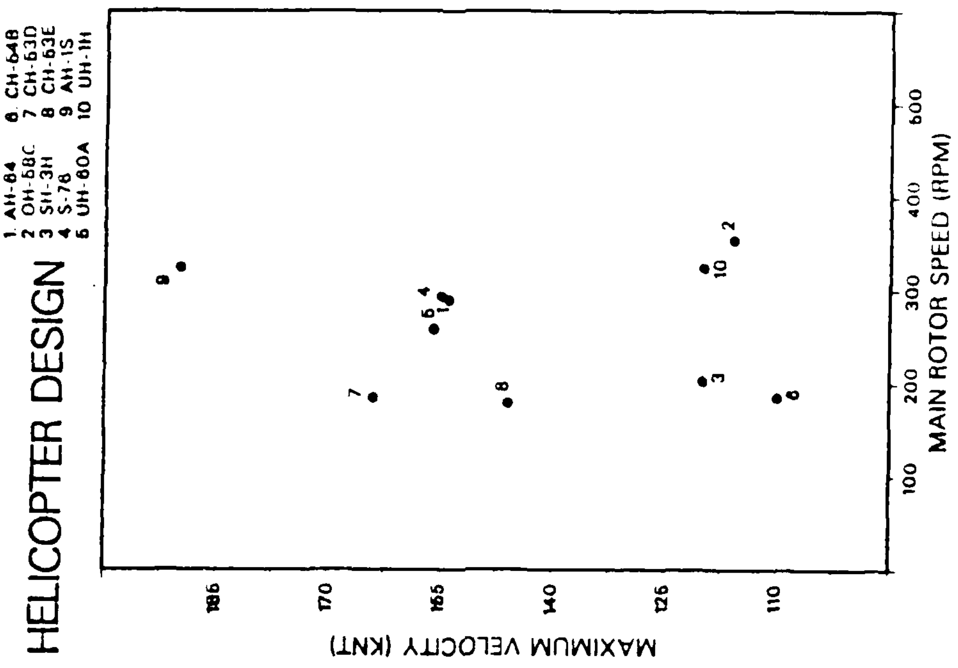
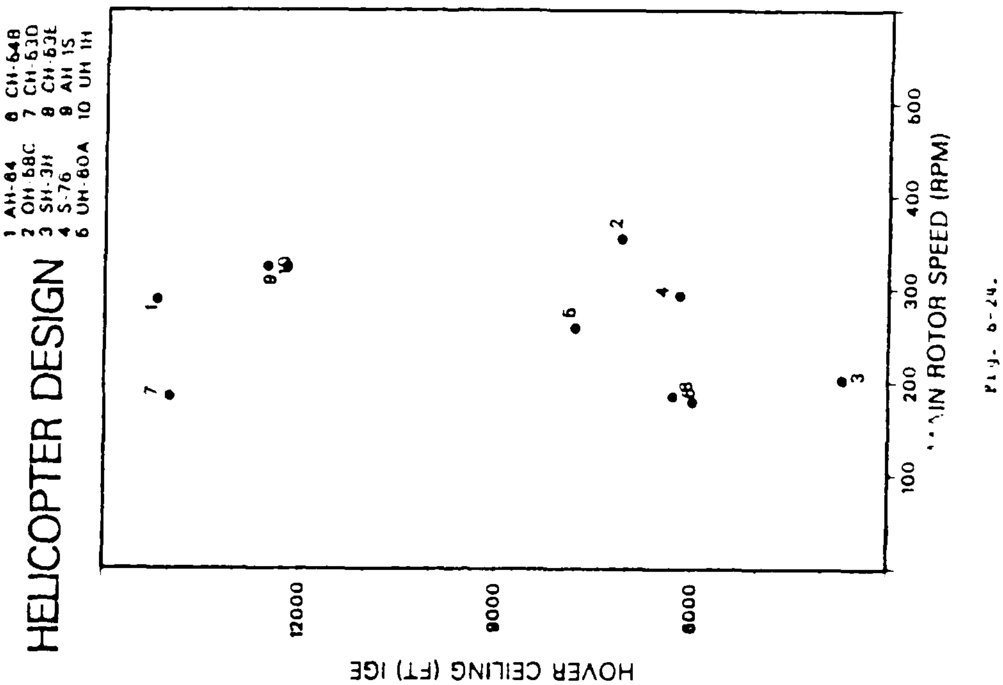


Fig. 6-21.

Fig. 6-20 and 6-21.



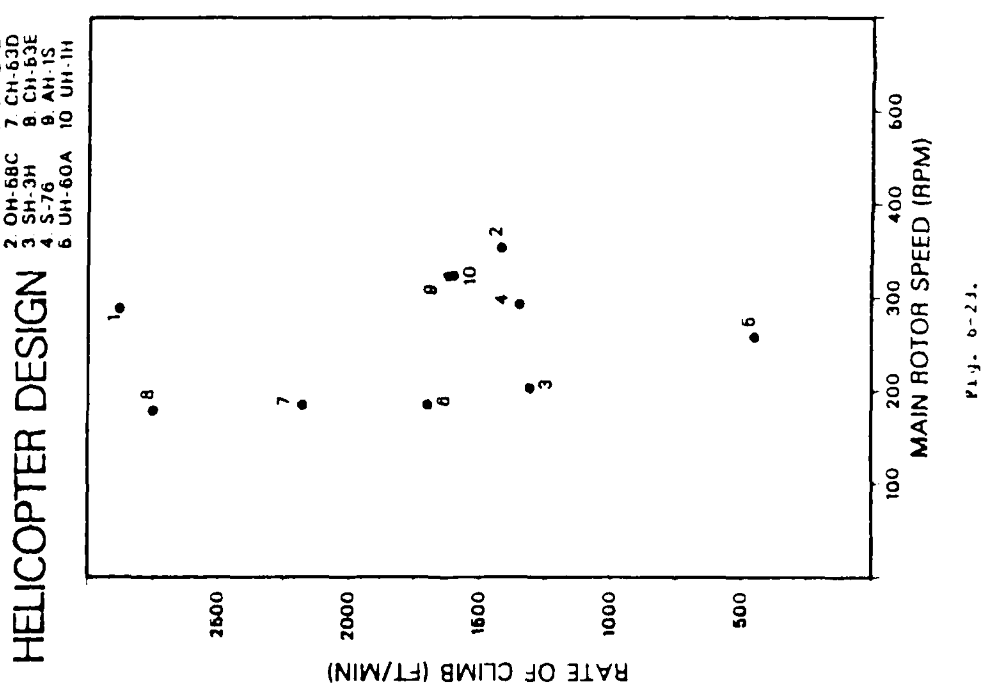


Fig. 6-23 and 6-24.

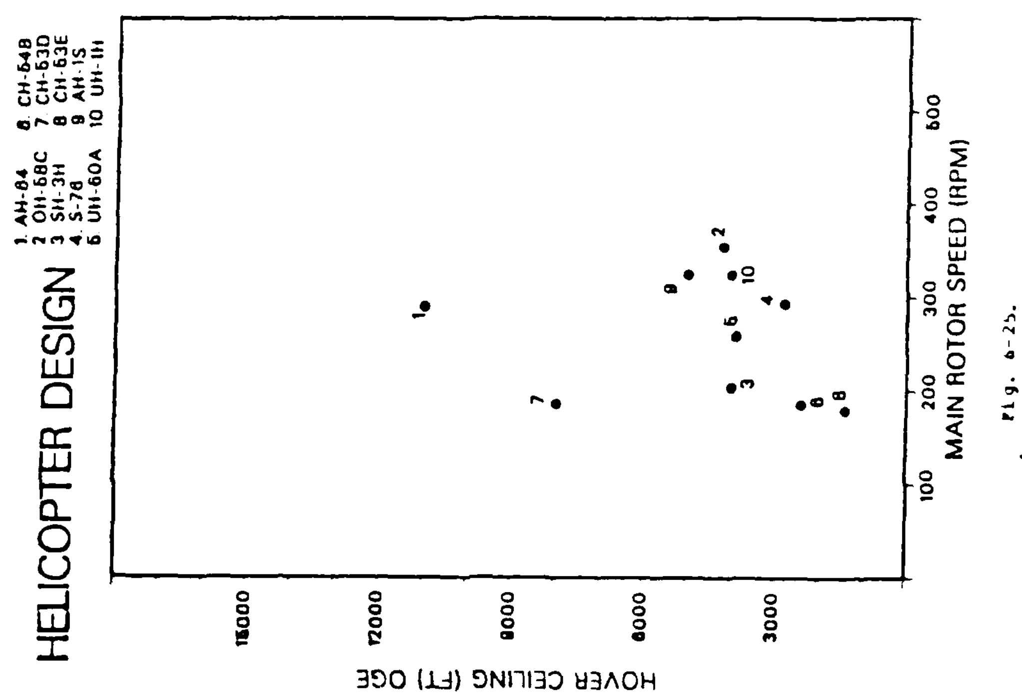

HELICOPTER DESIGN
1 AH-64
2 OH-58C
3 SH-3H
4 S-76
5 UH-60A
6 CH-54B
7 CH-53D
8 CH-53E
9 AH-1S
10 UH-1H
HOVER CEILING (FT) OGE
15000
12000
9000
6000
3000
MAIN ROTOR SPEED (RPM)
100
200
300
400
500
Fig. 6-25.

Fig. 6-25.

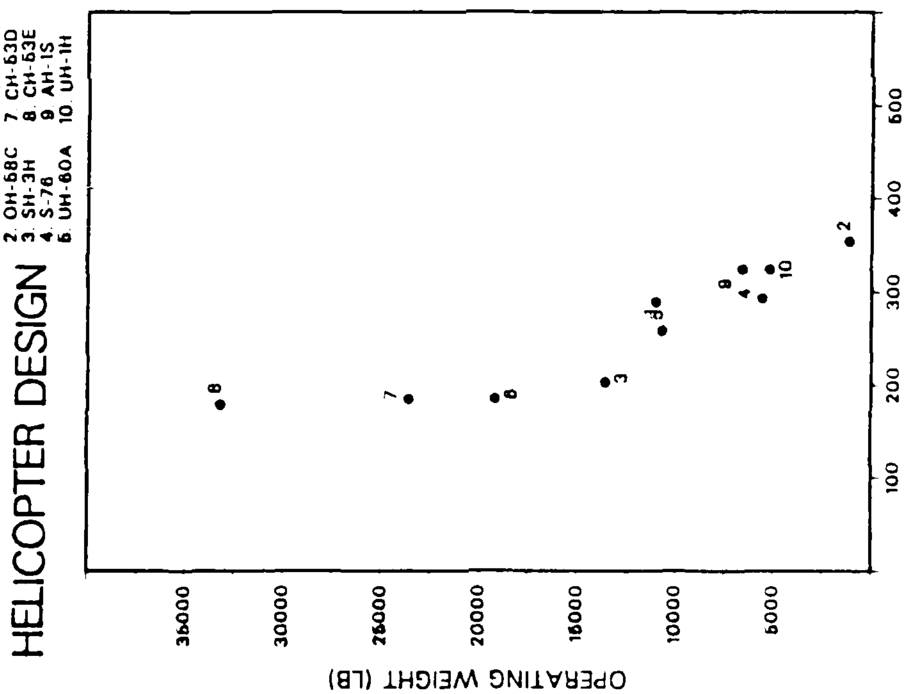


Fig. 6-27a.

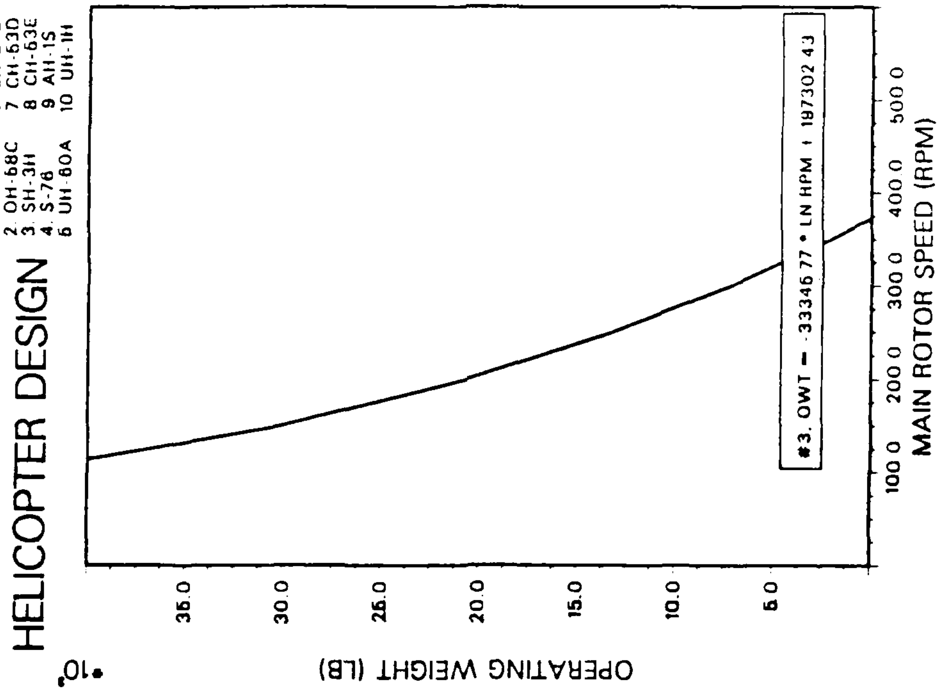


Fig. 6-27b.

Fig. 6-27a and 6-27b.

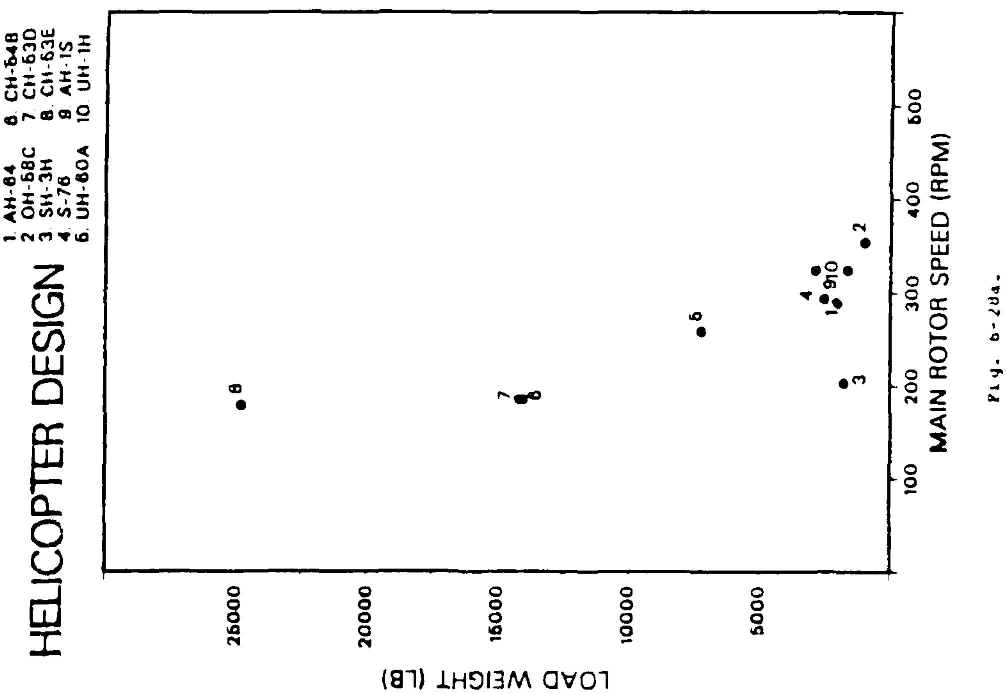


Fig. 6-28a.

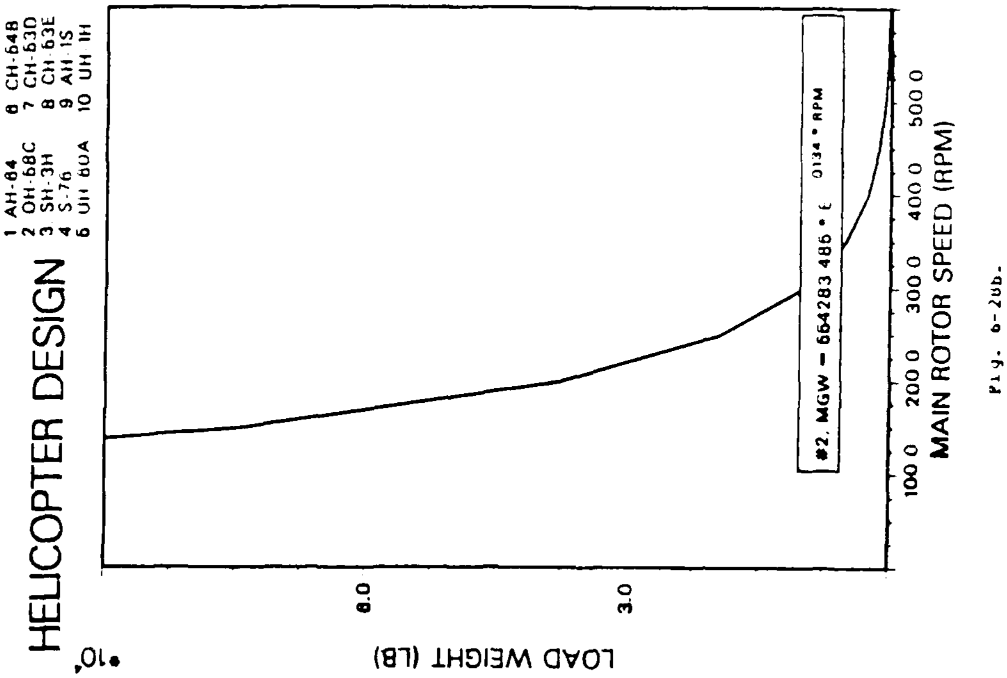
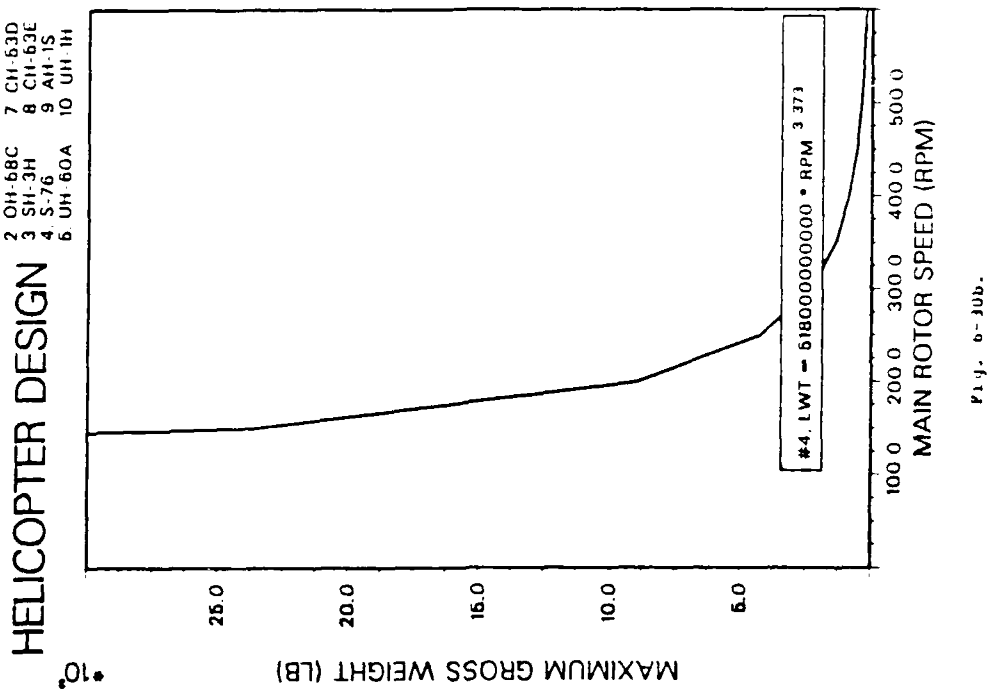


Fig. 6-28b.

Fig. 6-28a and 6-28b.



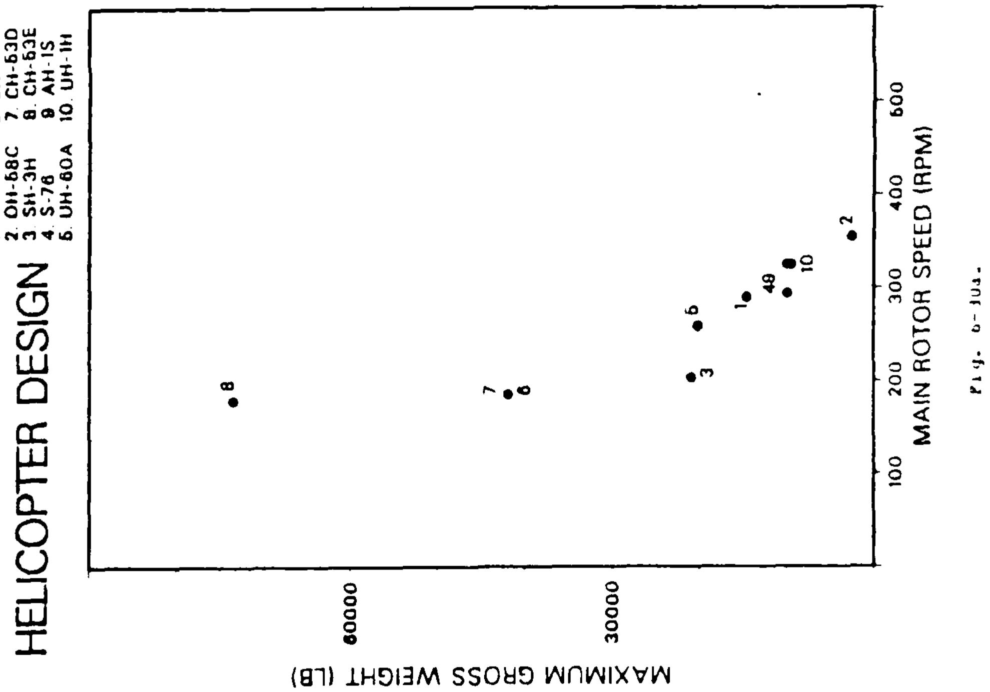


Fig. 6-30a and 6-30b.

Speed of Tail Rotor Radius Pairings.

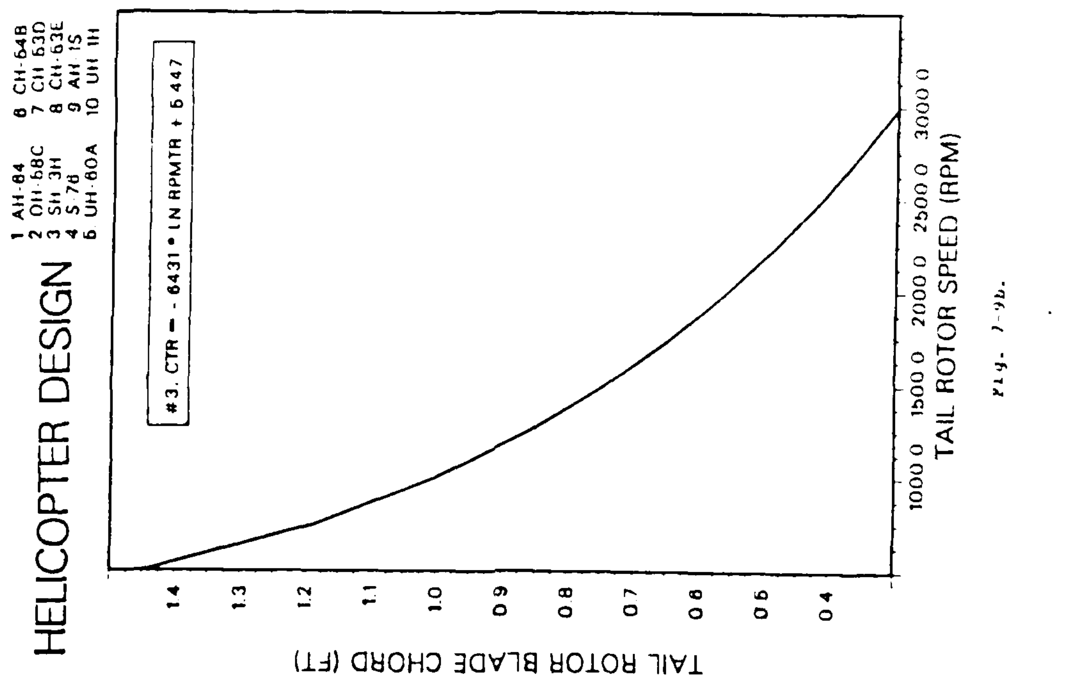


Fig. 7-9b.

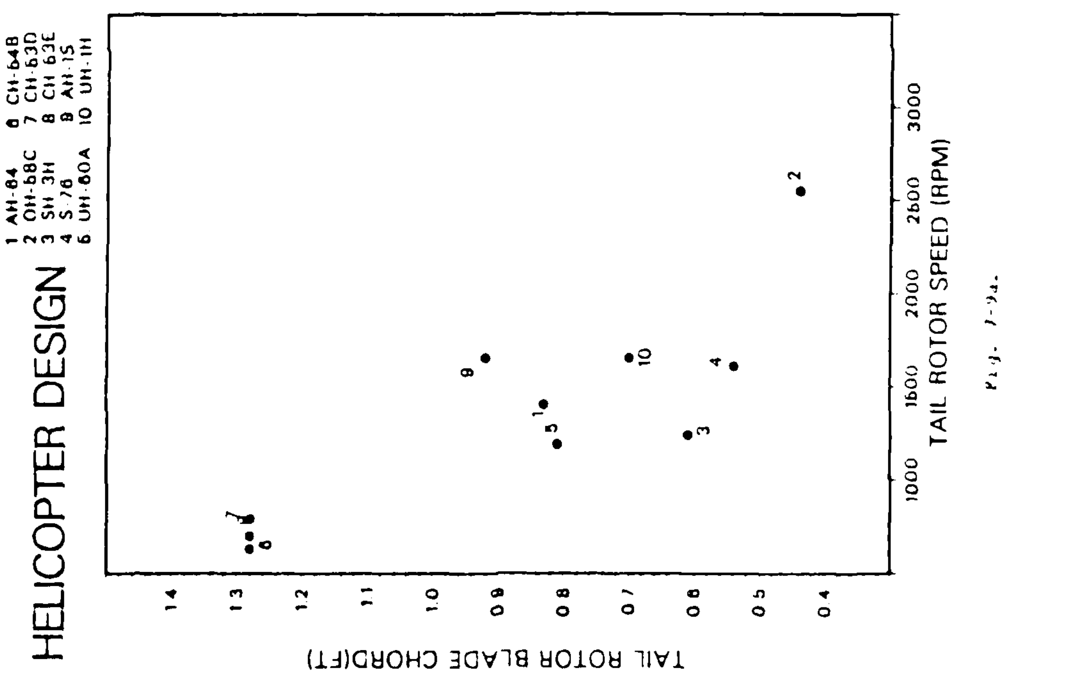
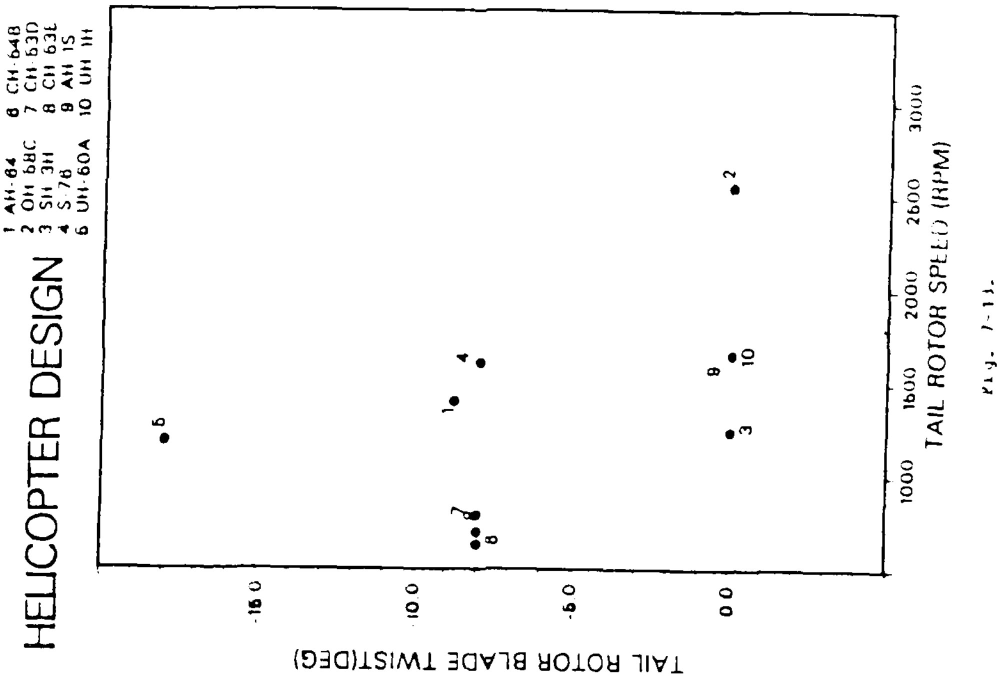


Fig. 7-9a.

Fig. 7-9a and 7-9b.



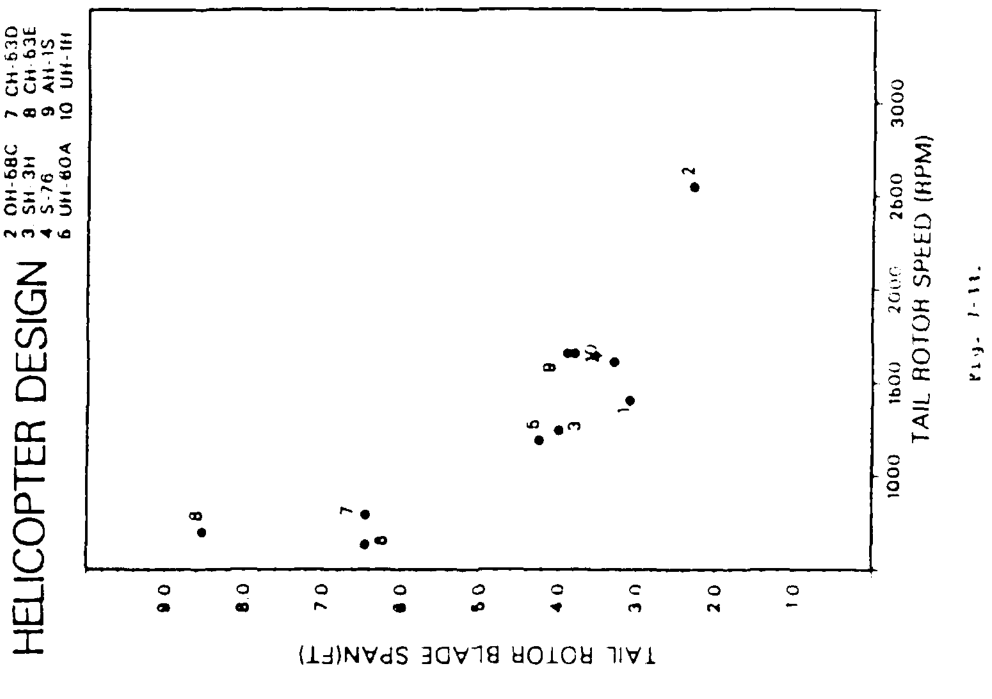


Fig. 7-11 and 7-13.

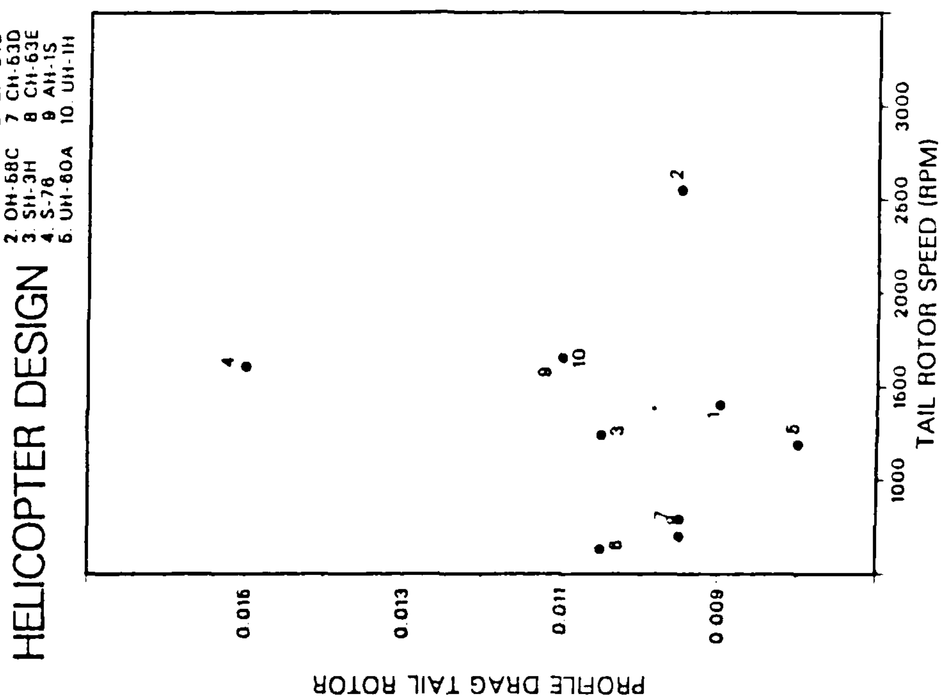

HELICOPTER DESIGN
1. AH-64
2. OH-58C
3. SH-3H
4. S-76
5. UH-60A
6. CH-54B
7. CH-53D
8. CH-53E
9. AH-1S
10. UH-1H
PROFILE DRAG TAIL ROTOR
0.016
0.013
0.011
0.009
TAIL ROTOR SPEED (RPM)
1000
1600
2000
2600
3000

Fig. 7-15.

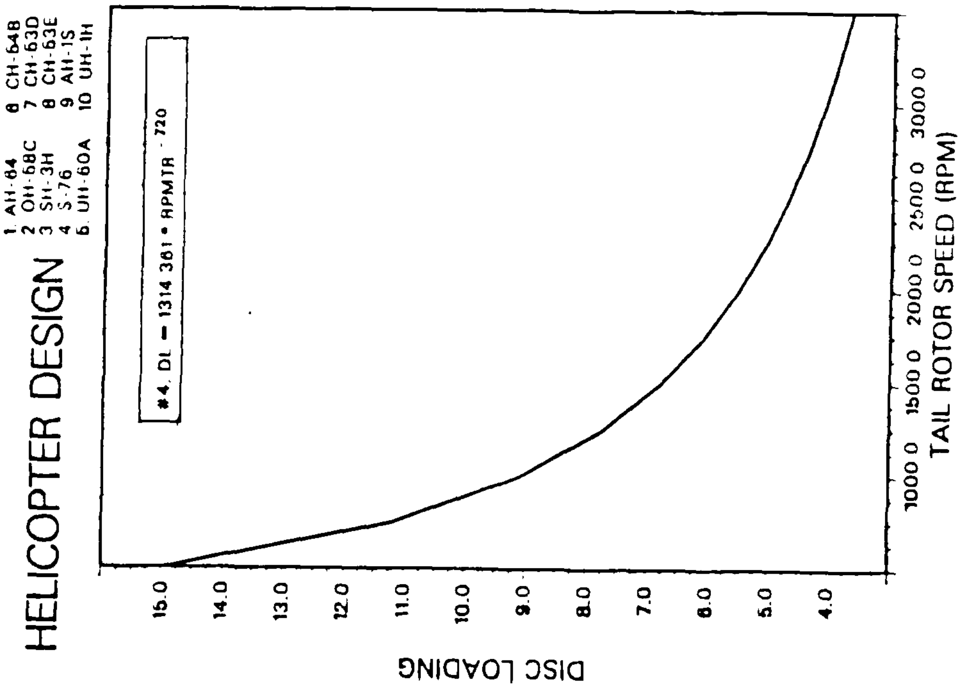


Fig. 7-16b.

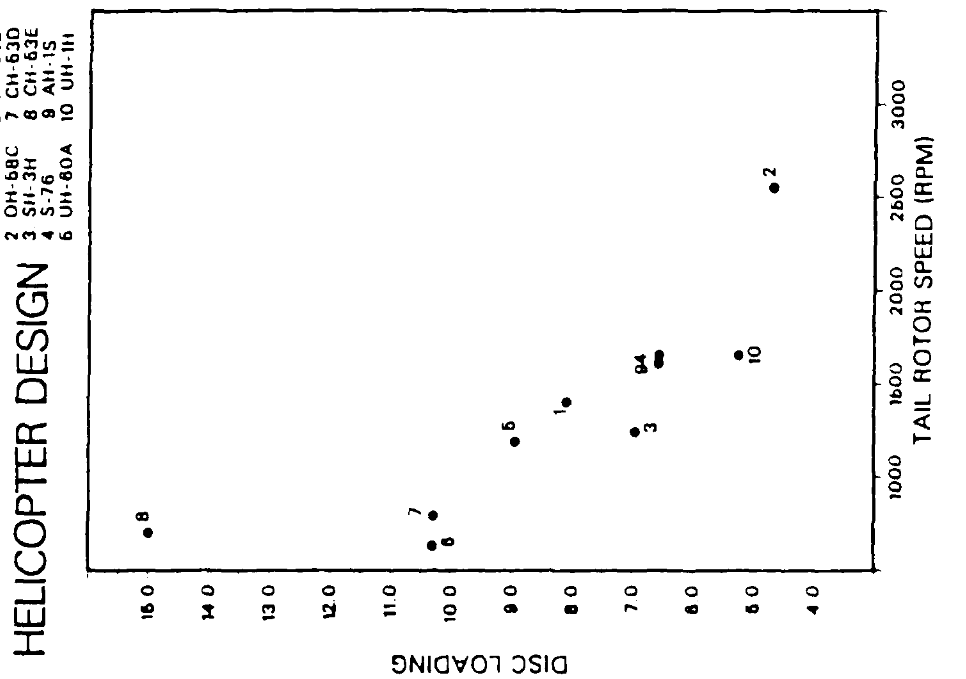
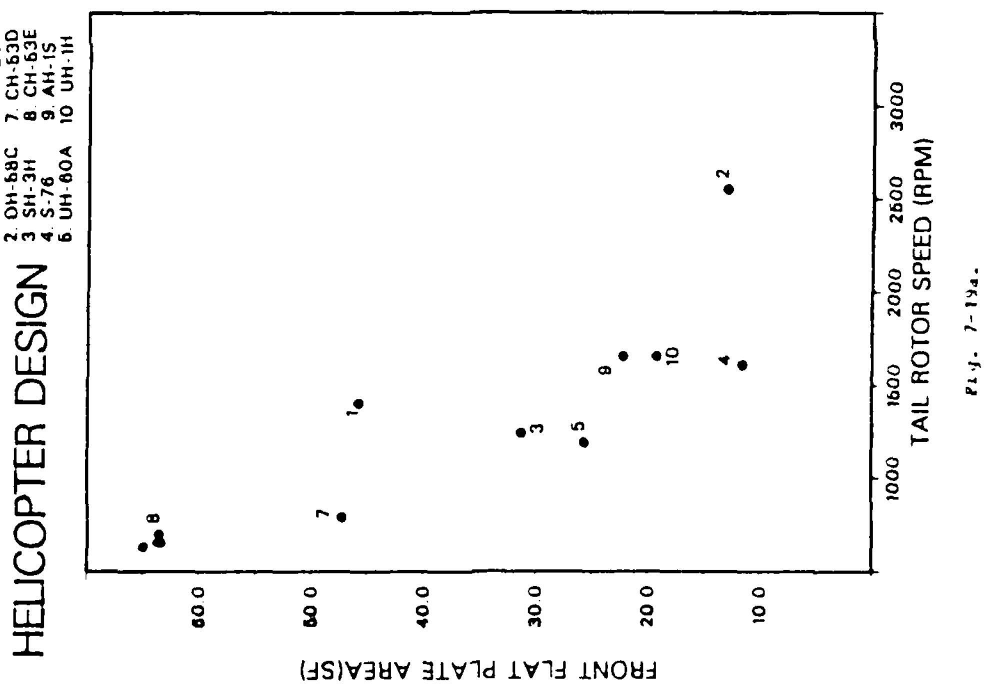


Fig. 7-16a.

Fig. 7-16a and 7-16b.



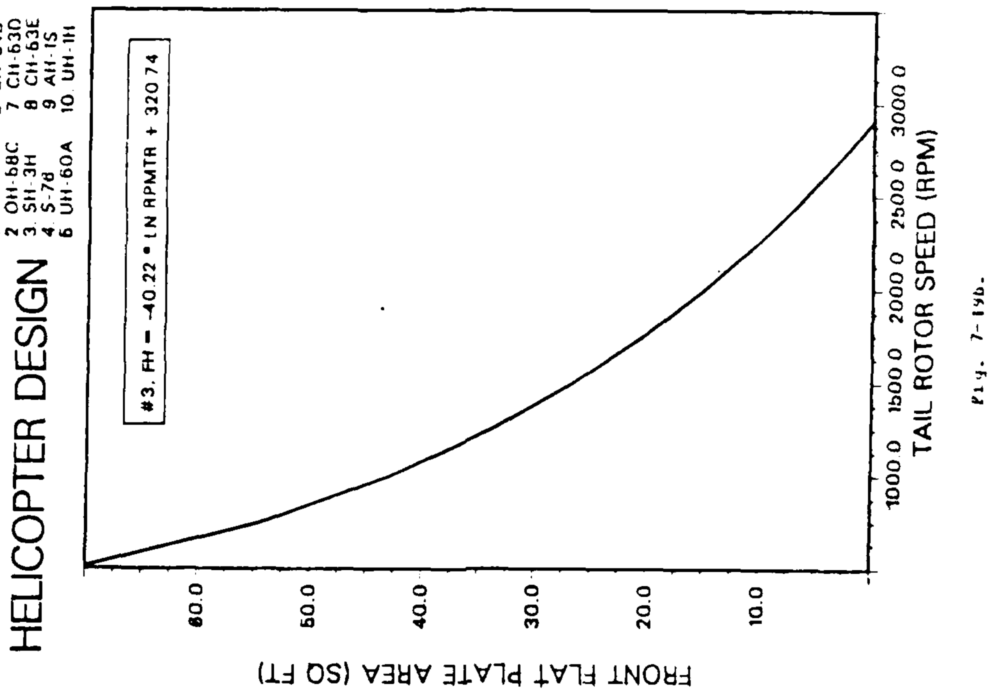


Fig. 7-19a and 7-19b.

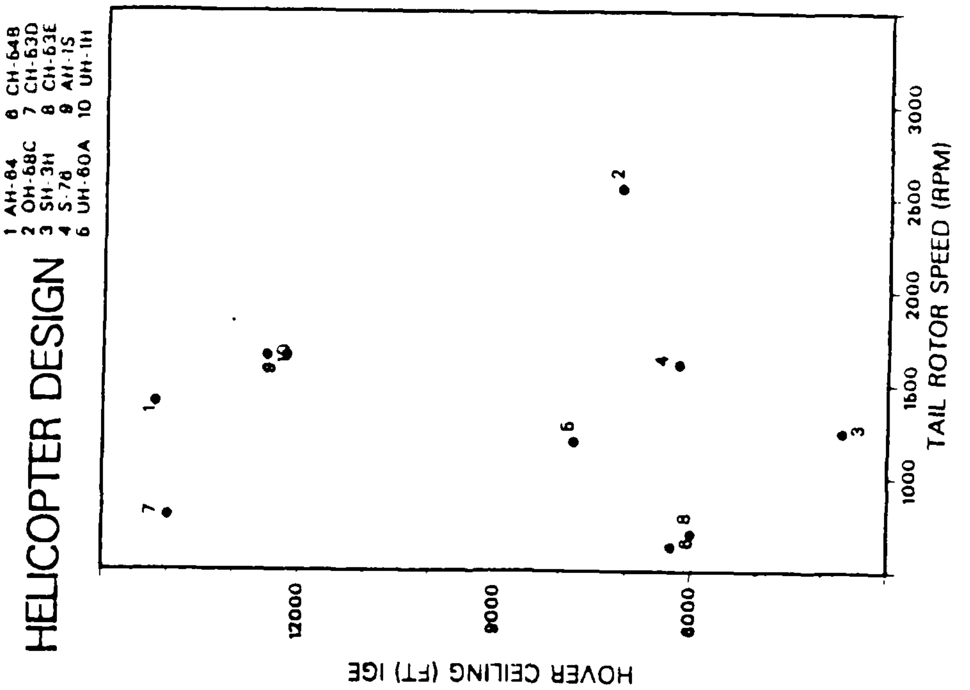


Fig. 7-24.

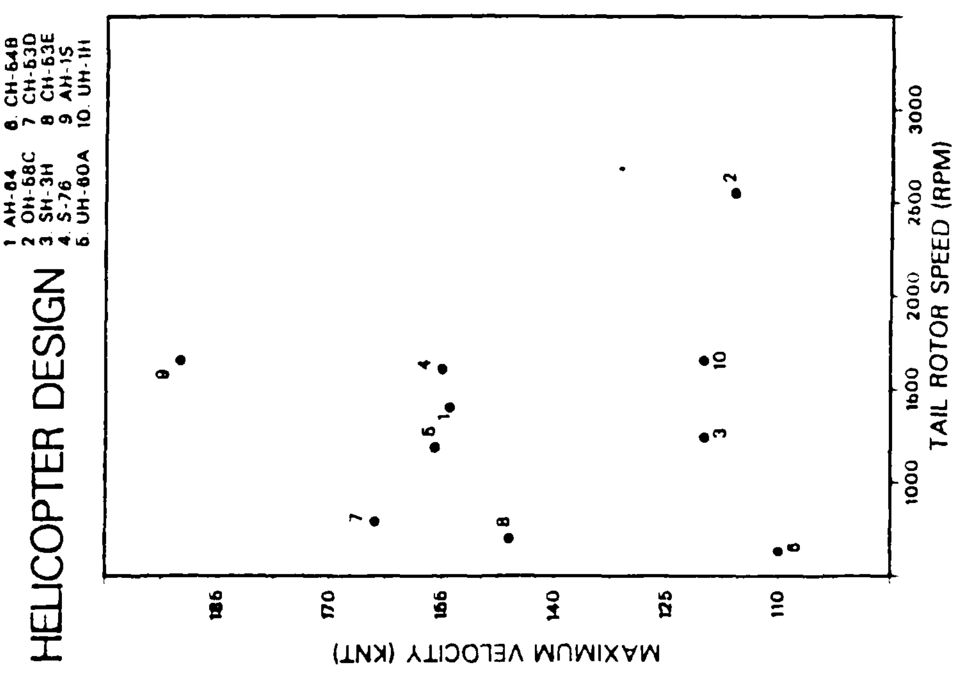


Fig. 7-21.

Fig. 7-21 and 7-24.

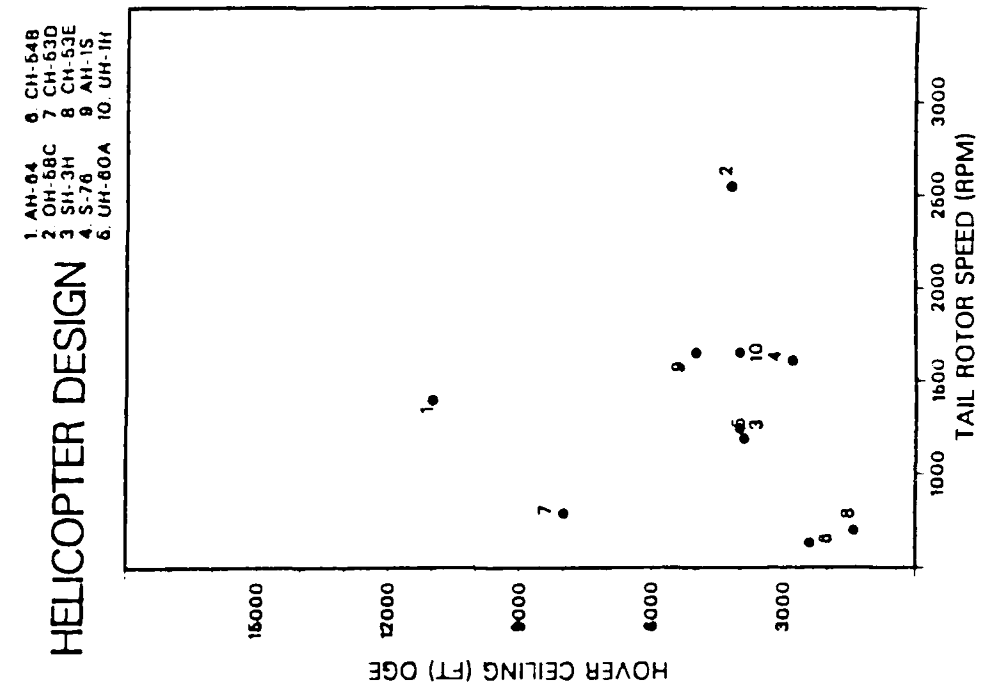


Fig. 7-25.

Fig. 7-25.

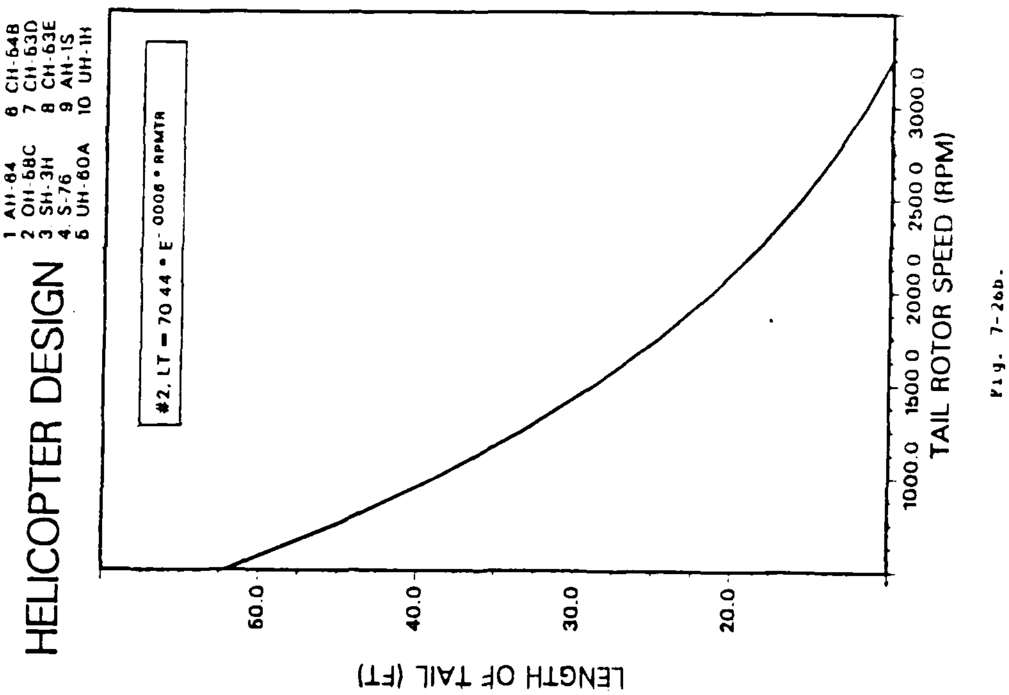


Fig. 7-26b.

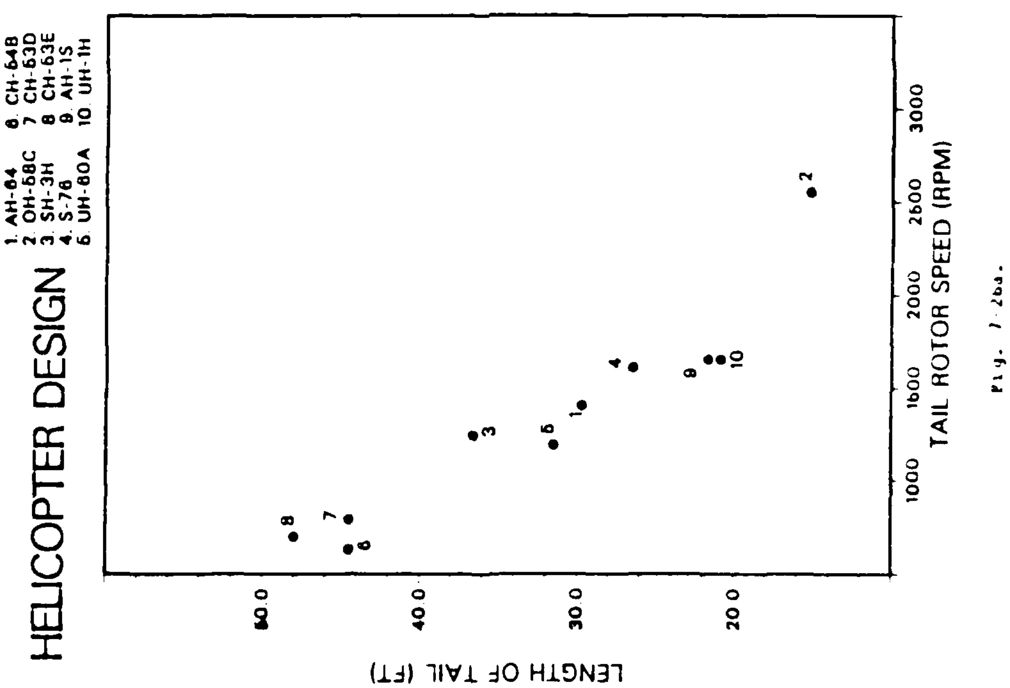


Fig. 7-26a.

Fig. 7-26a and 7-26b.

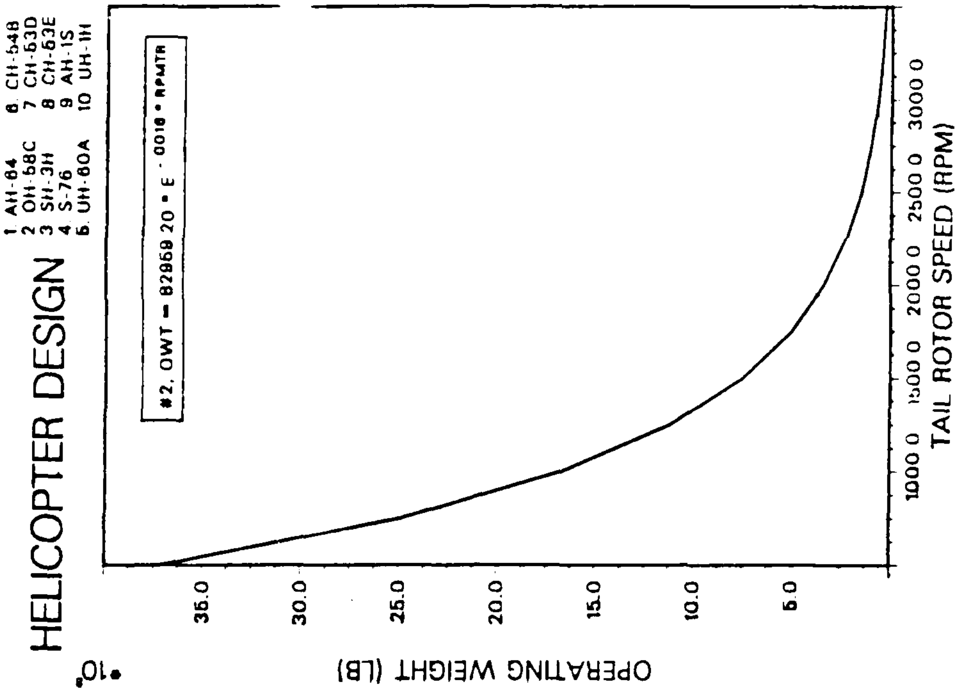


Fig. 7-27b.

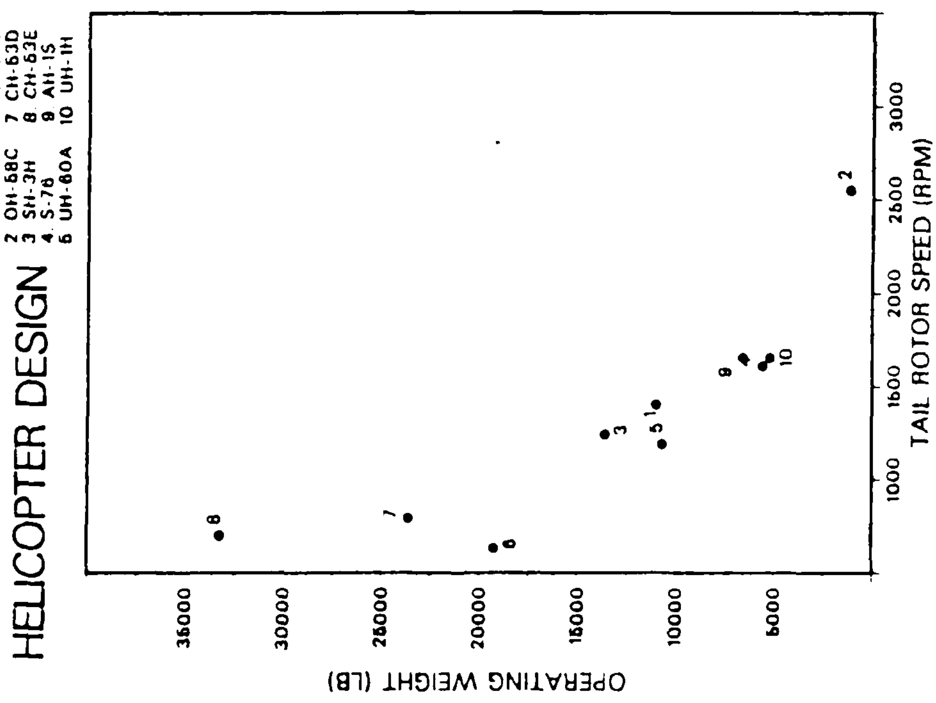
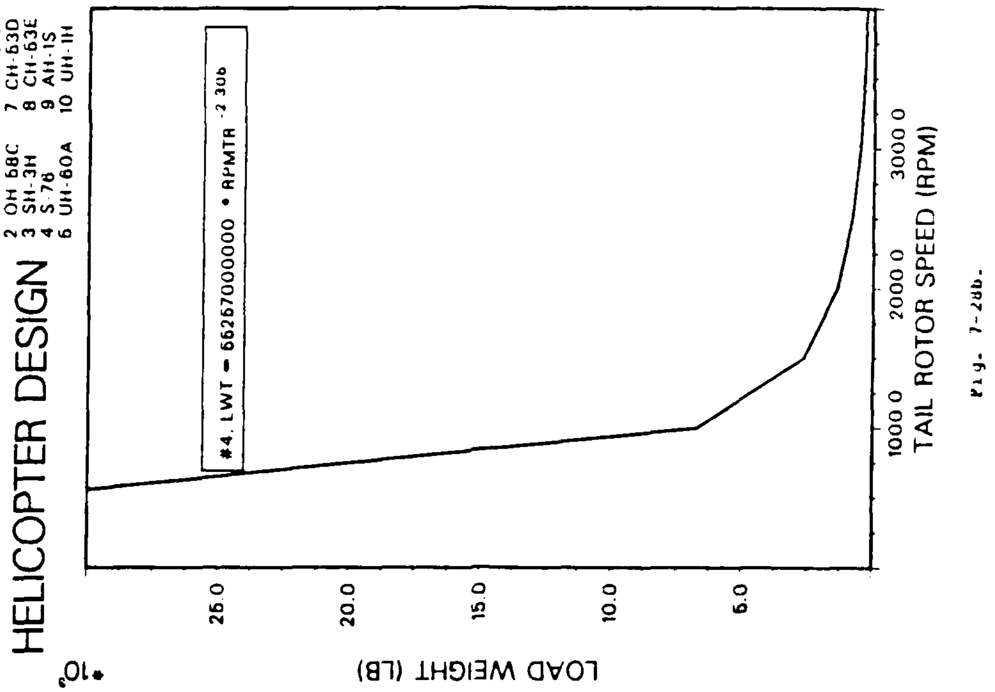


Fig. 7-27a.

Fig. 7-27a and 7-27b.



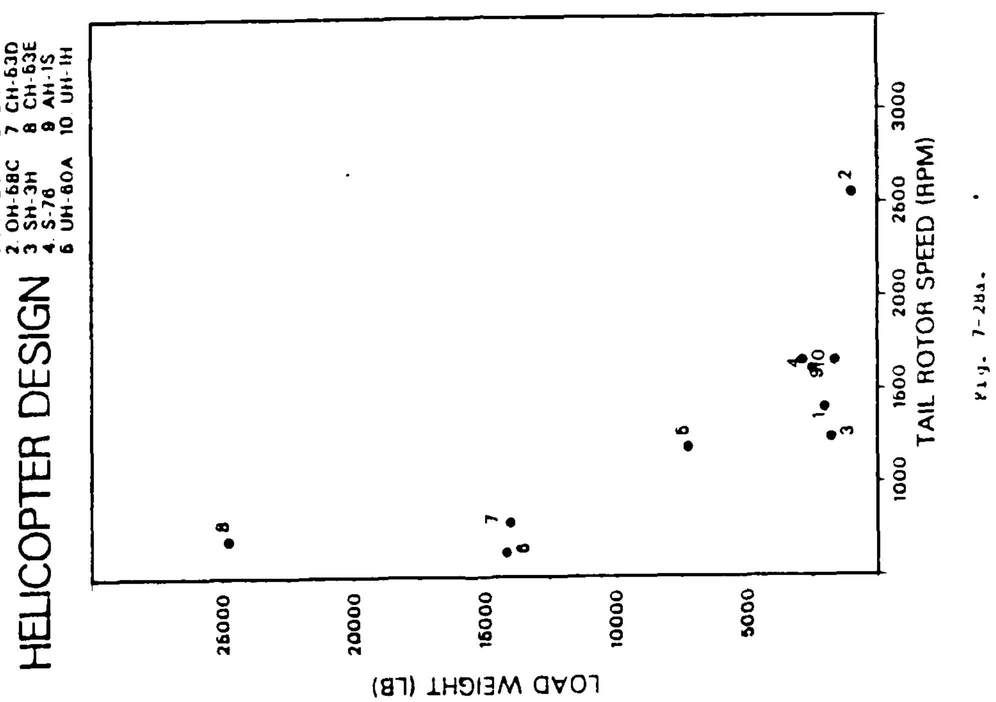


Fig. 7-28a and 7-28b.

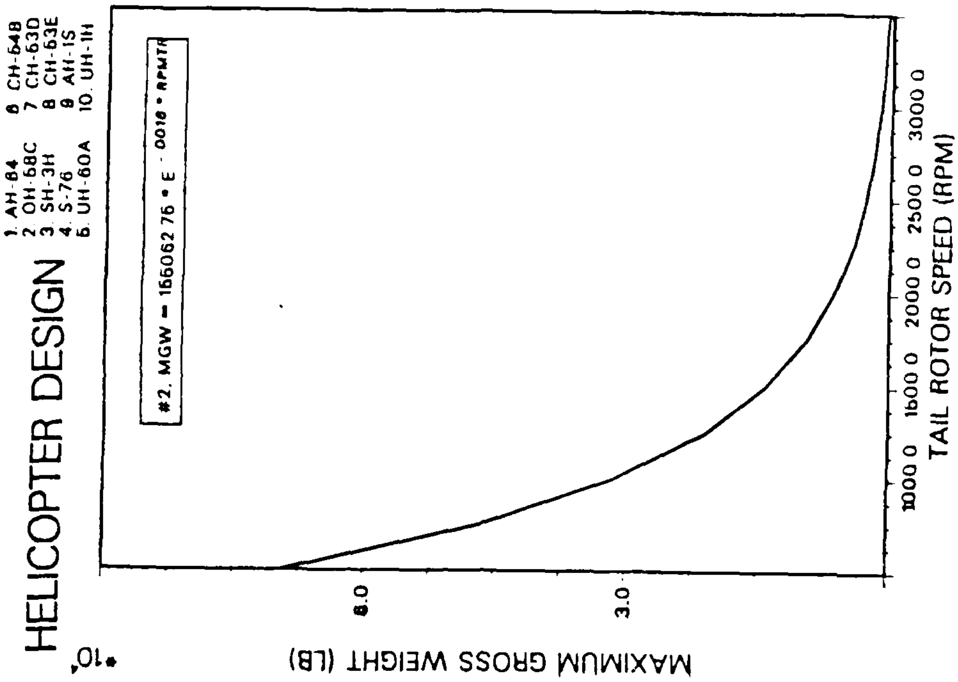


Fig. 7-30b.

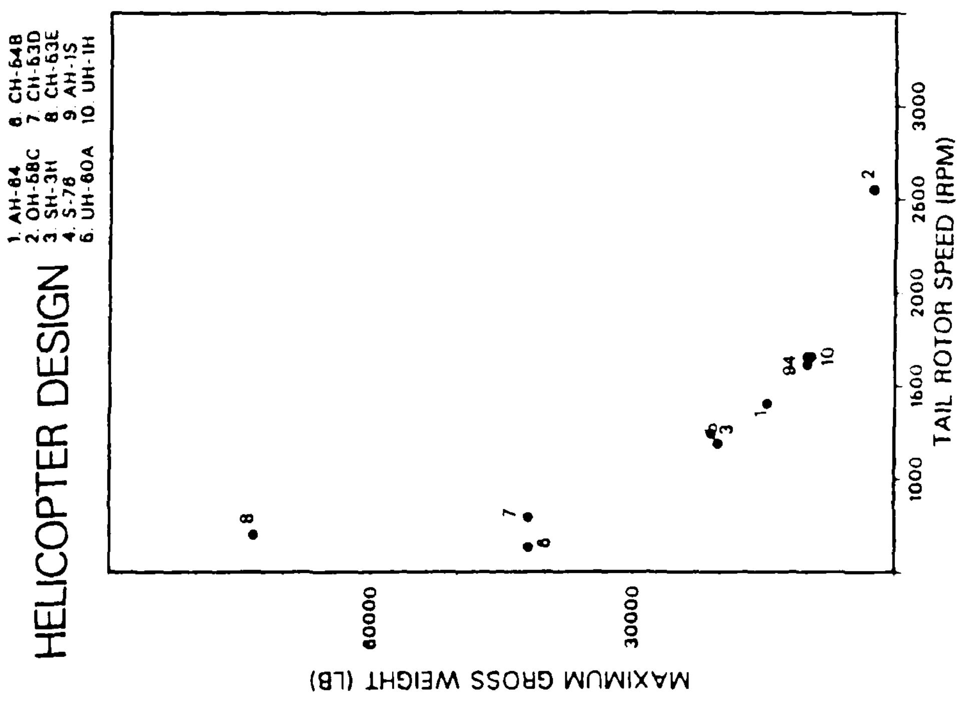


Fig. 7-30a.

Fig. 7-30a and 7-30b.

Chord of Main Rotor Blade Pairings.

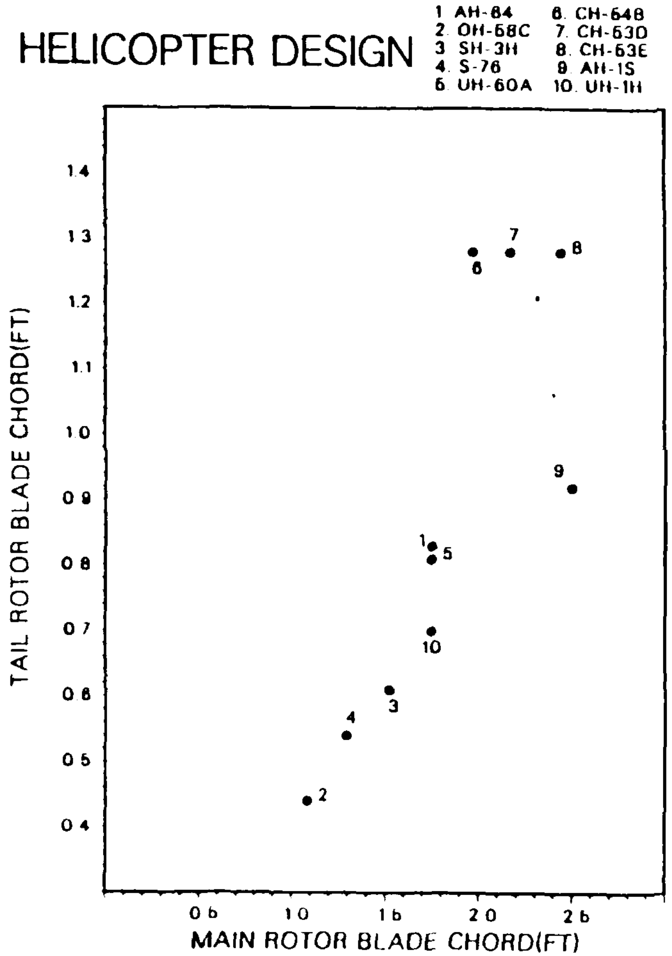


Fig. 8-9a.

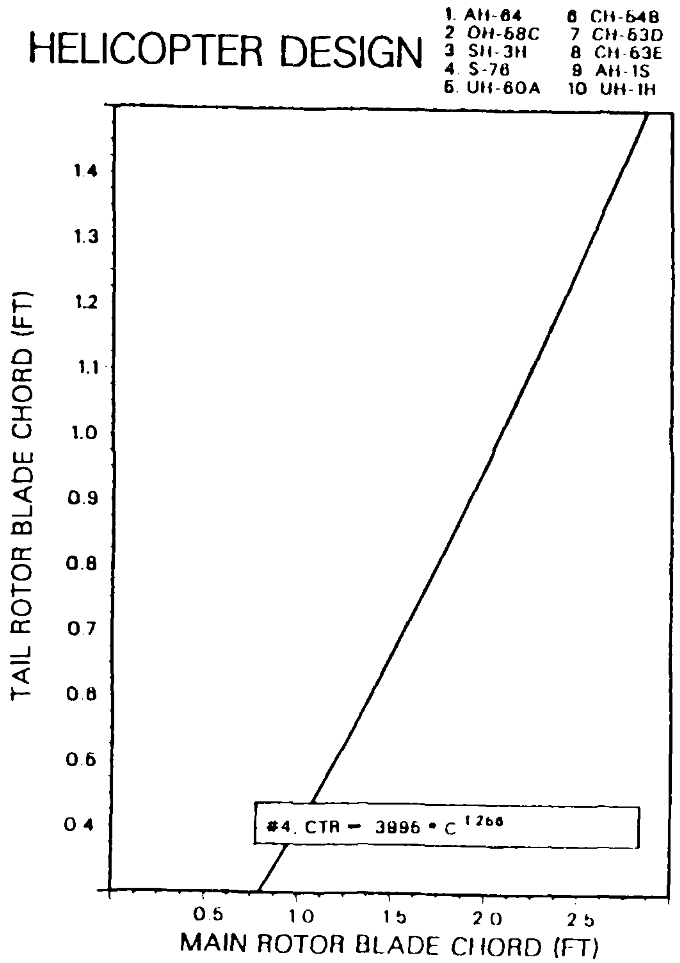


Fig. 8-9b.

Fig. 8-9a and 8-9b.

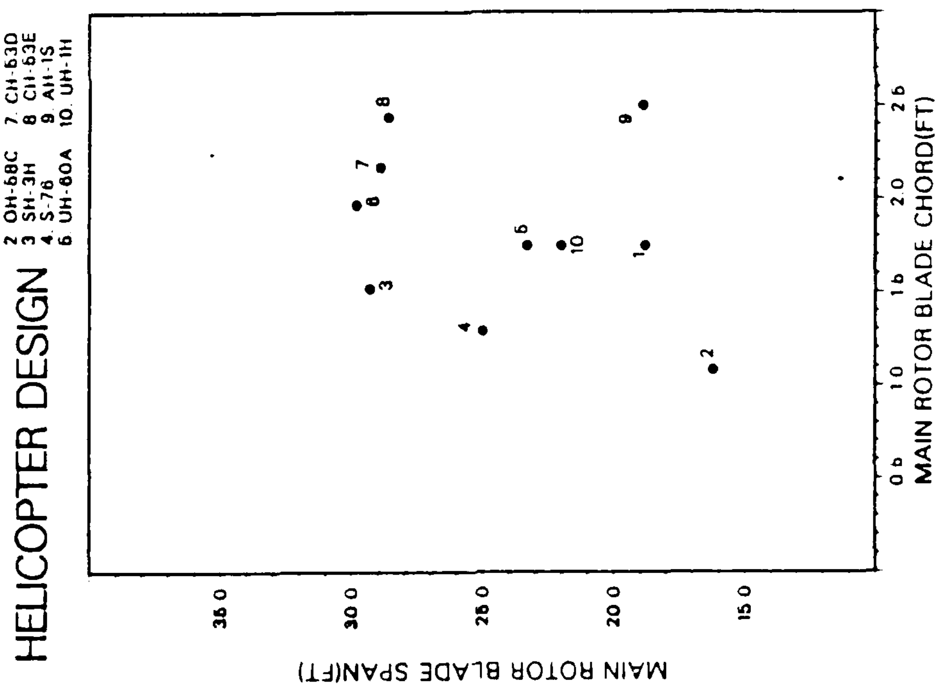


Fig. 8-10.

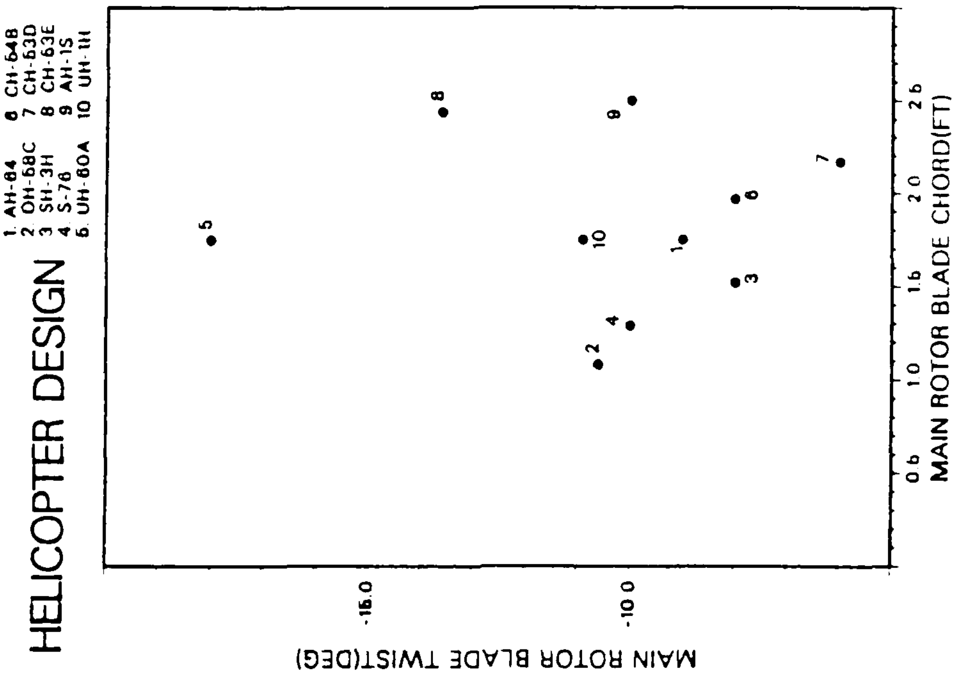
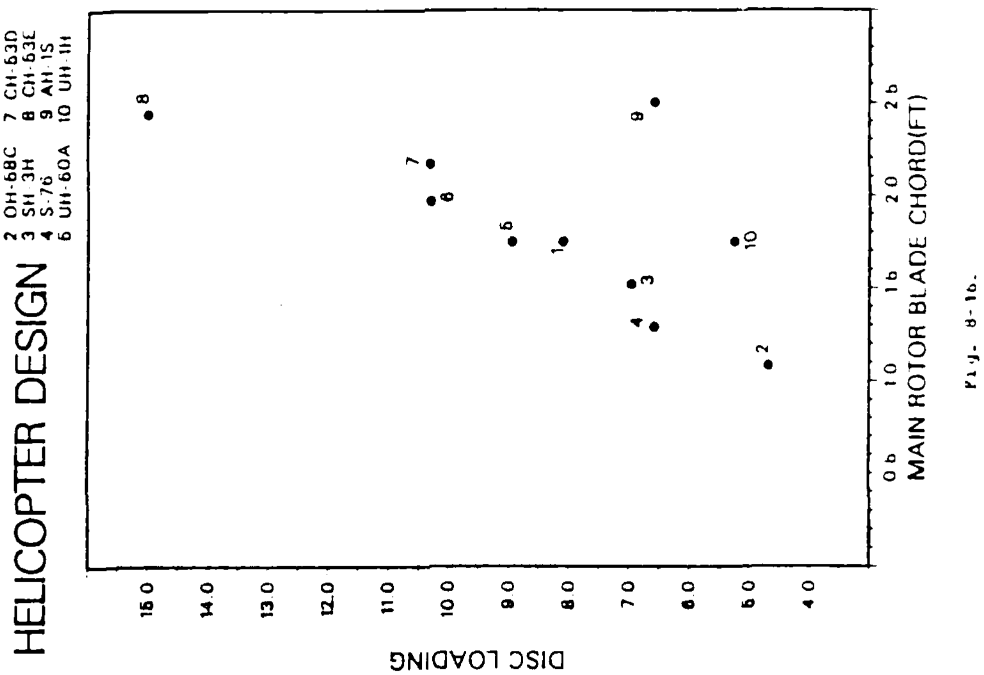


Fig. 8-12.

Fig. 8-10 and 8-12.



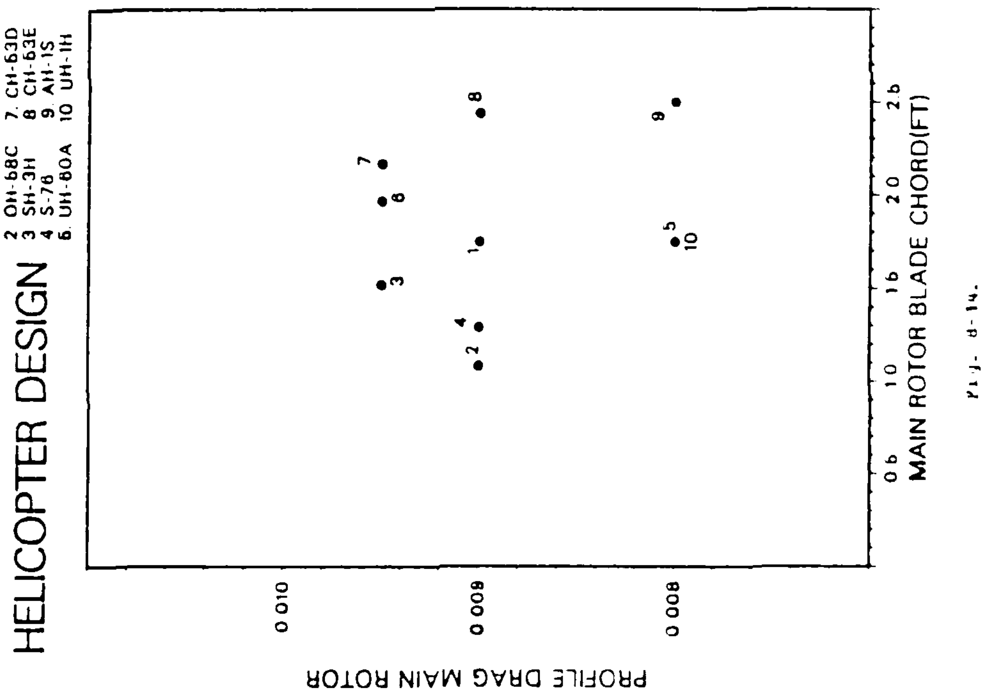
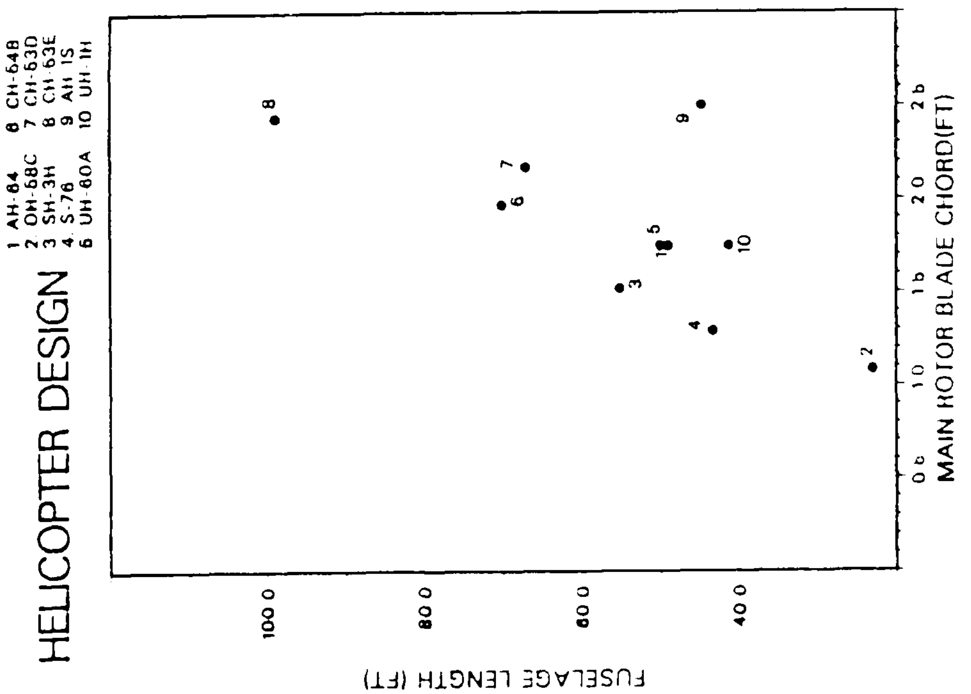


Fig. 8-14 and 8-16.



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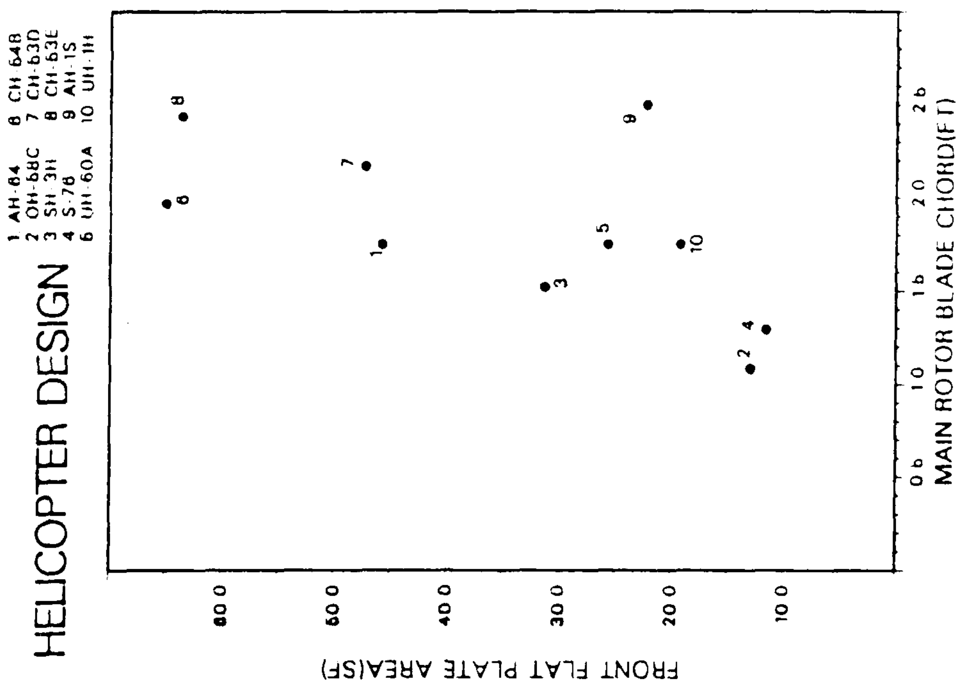


Fig. 8-19.

Fig. 8-18 and 8-19.

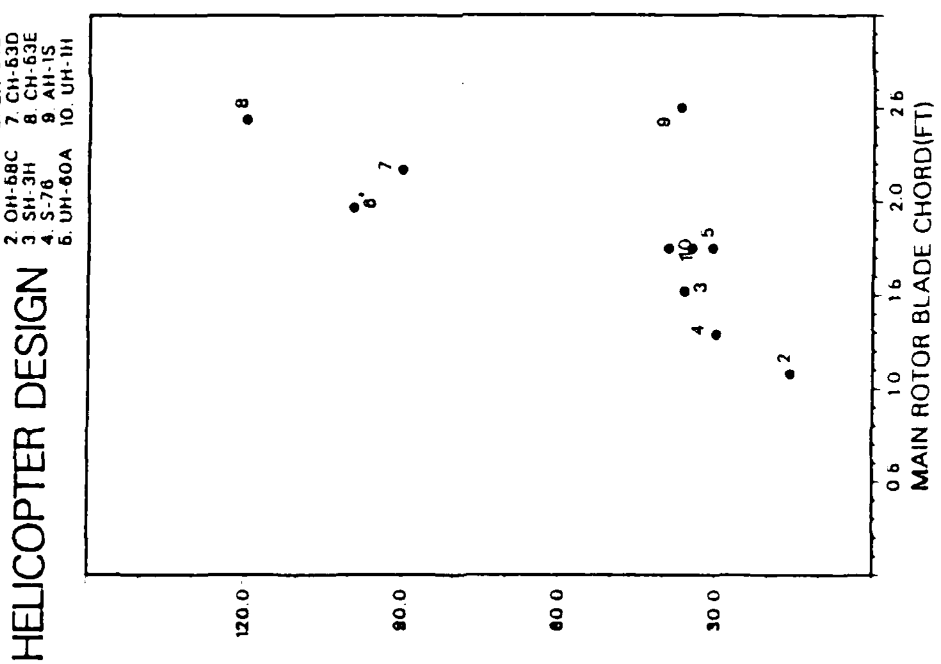


Fig. 8-20.

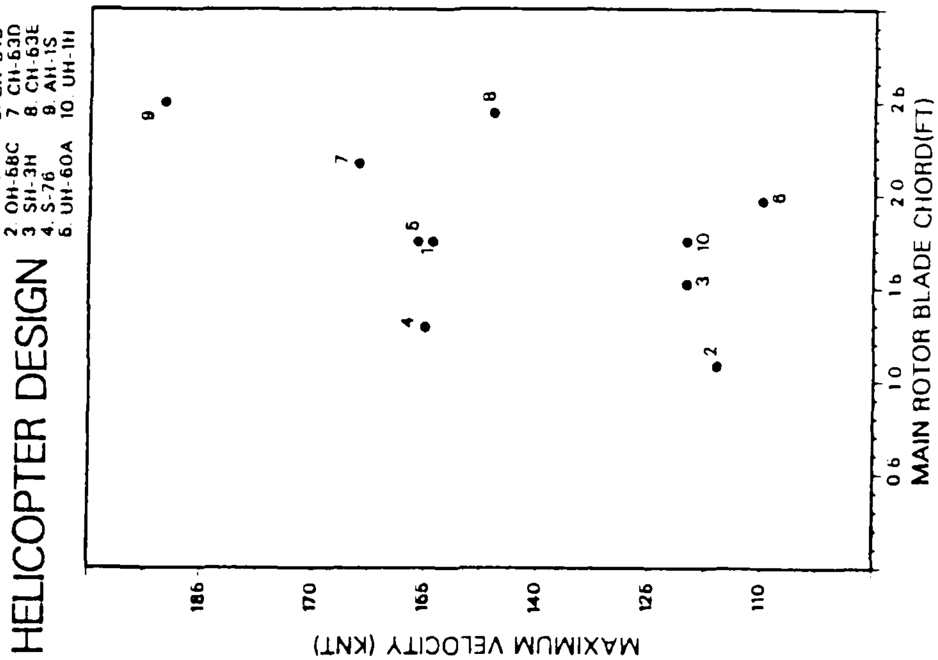


Fig. 8-21.

Fig. 8-20 and 8-21.

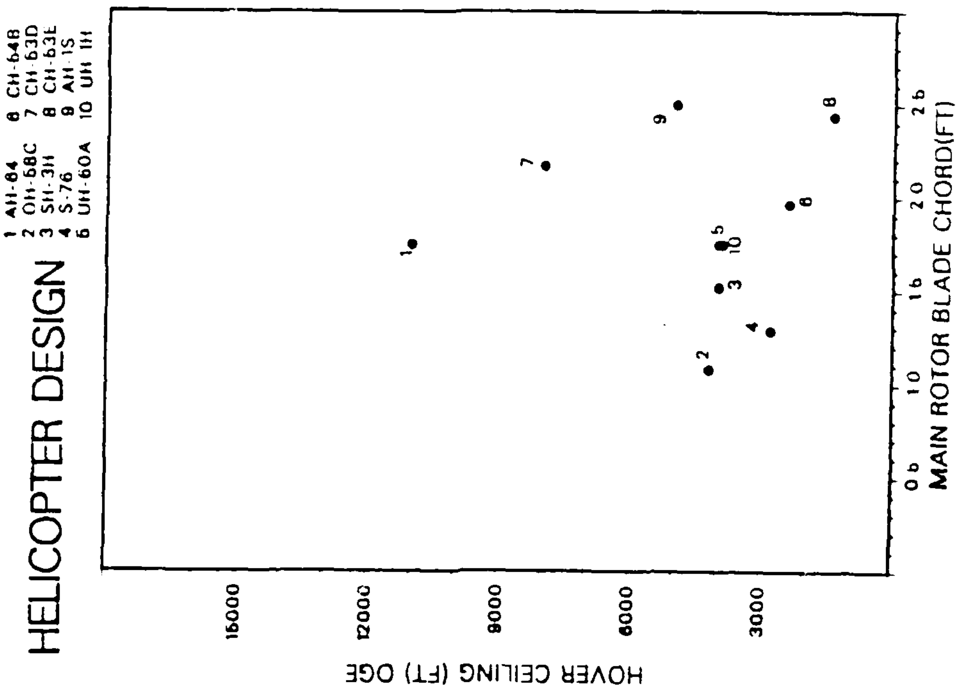


Fig. 8-25.

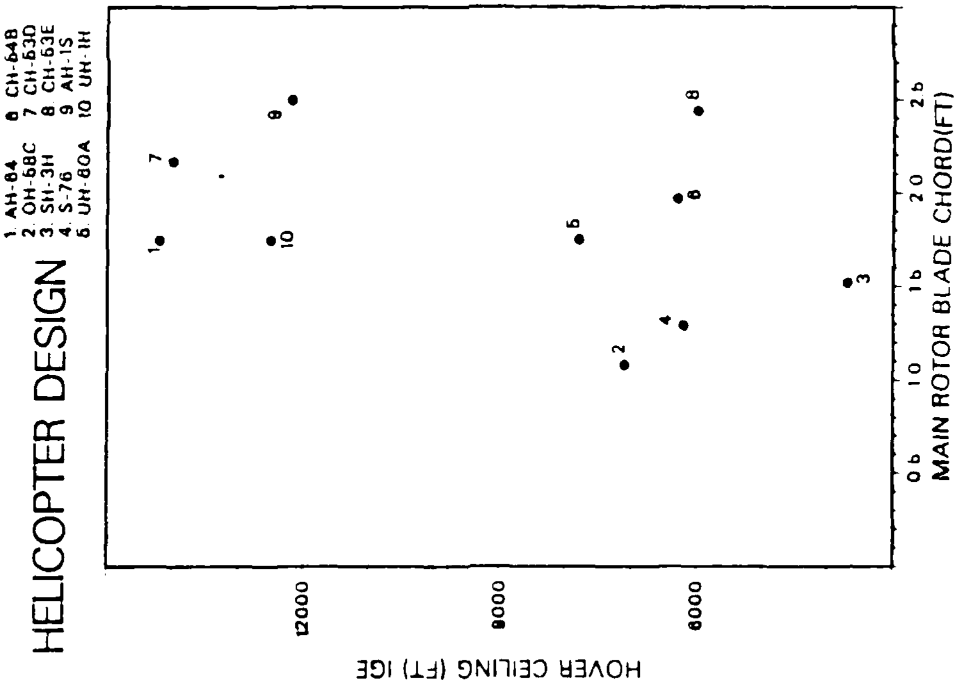
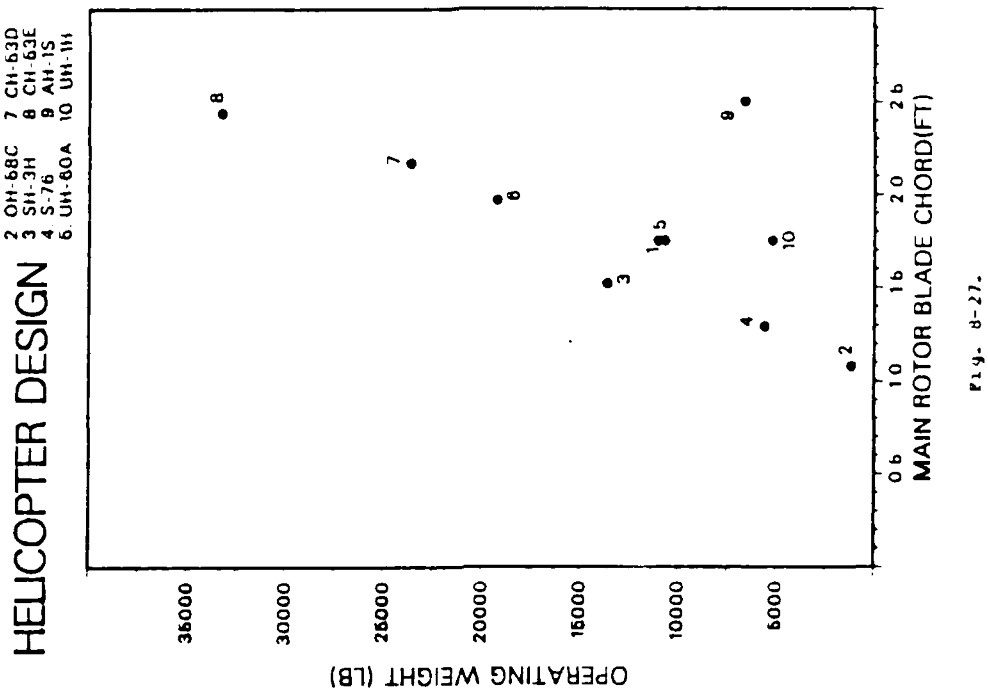


Fig. 8-24.

Fig. 8-24 and 8-25.



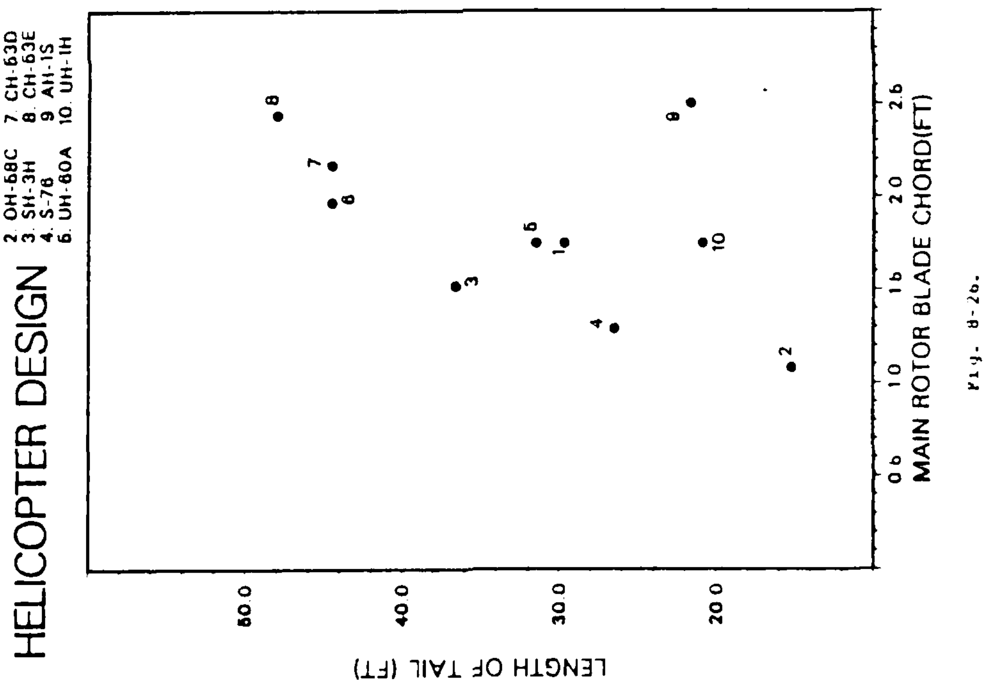


Fig. 8-26 and 8-27.

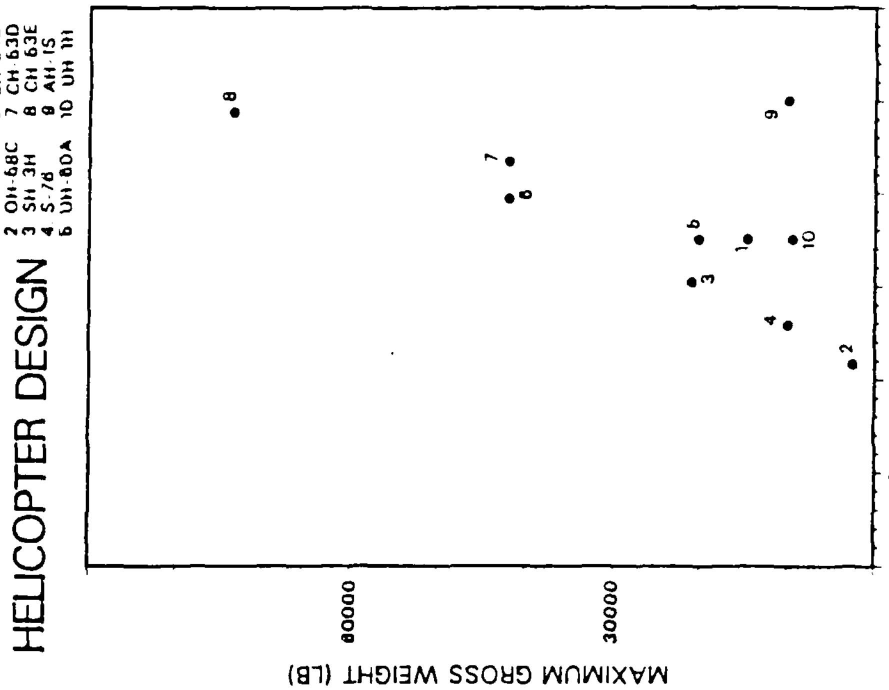


Fig. 8-30.

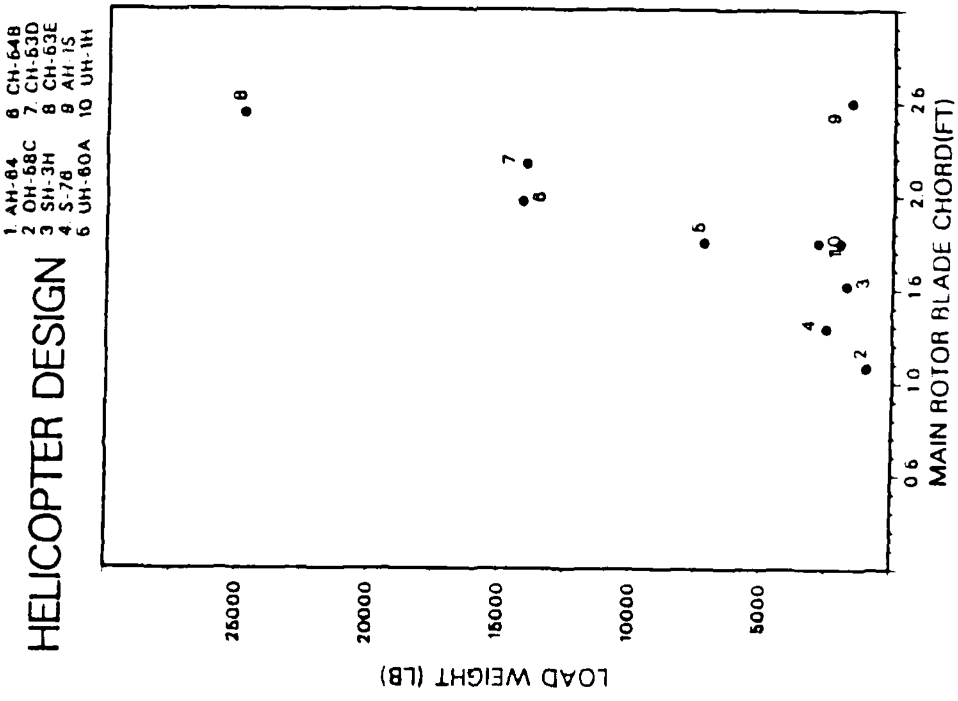


Fig. 8-28.

Fig. 8-28 and 8-30.

Chord of Tail Rotor Blade Pairings.

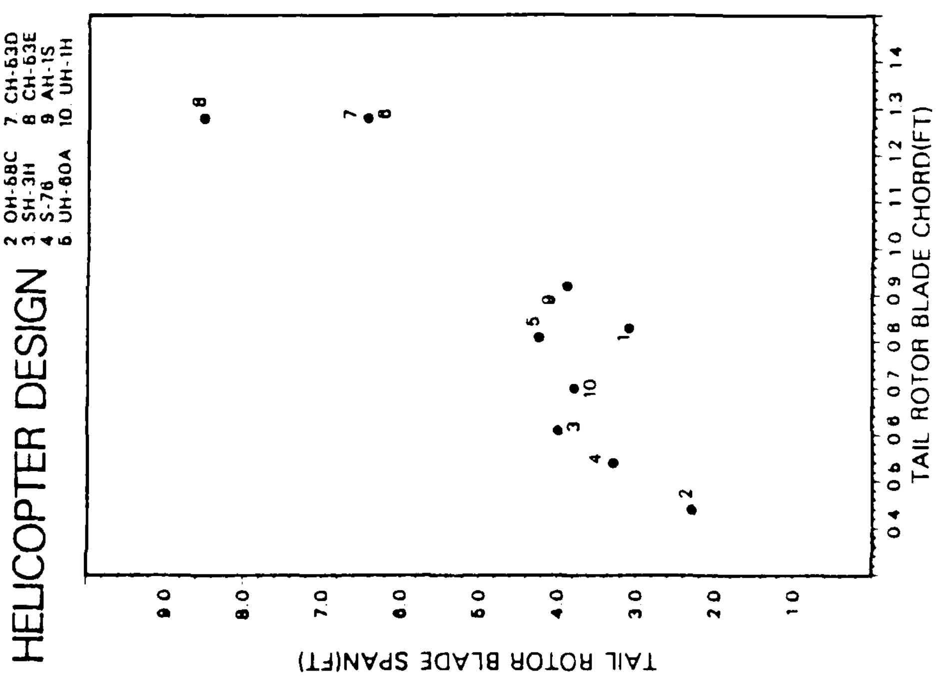


Fig. 9-11a.

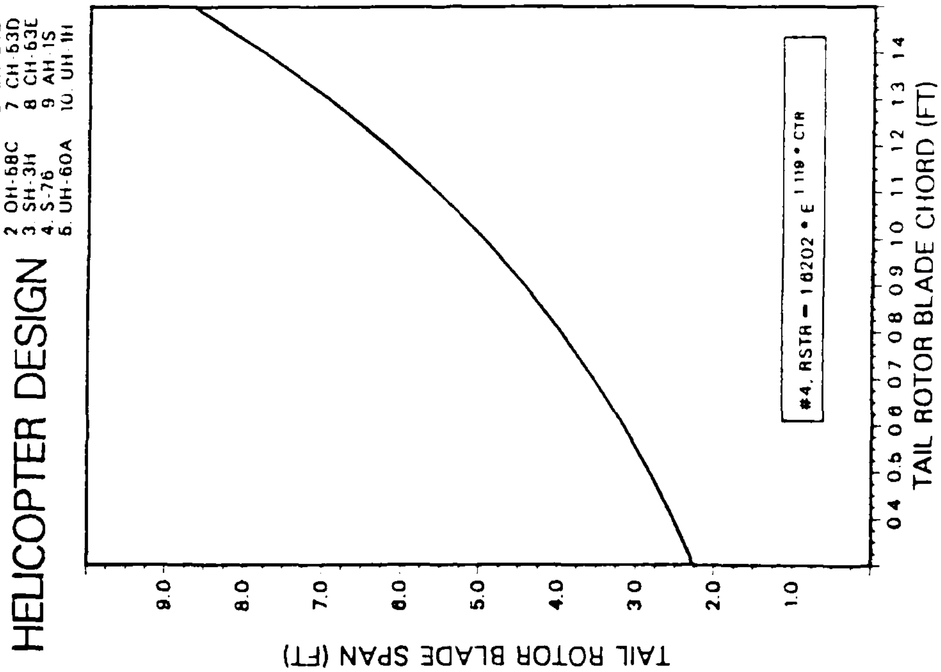


Fig. 9-11b.

Fig. 9-11a and 9-11b.

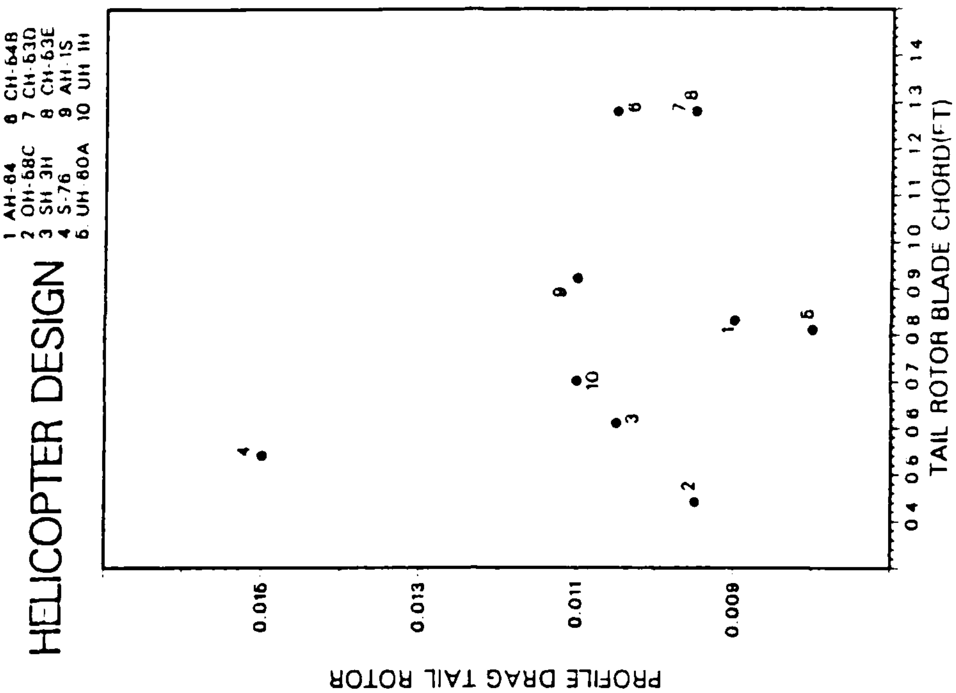


Fig. 9-15.

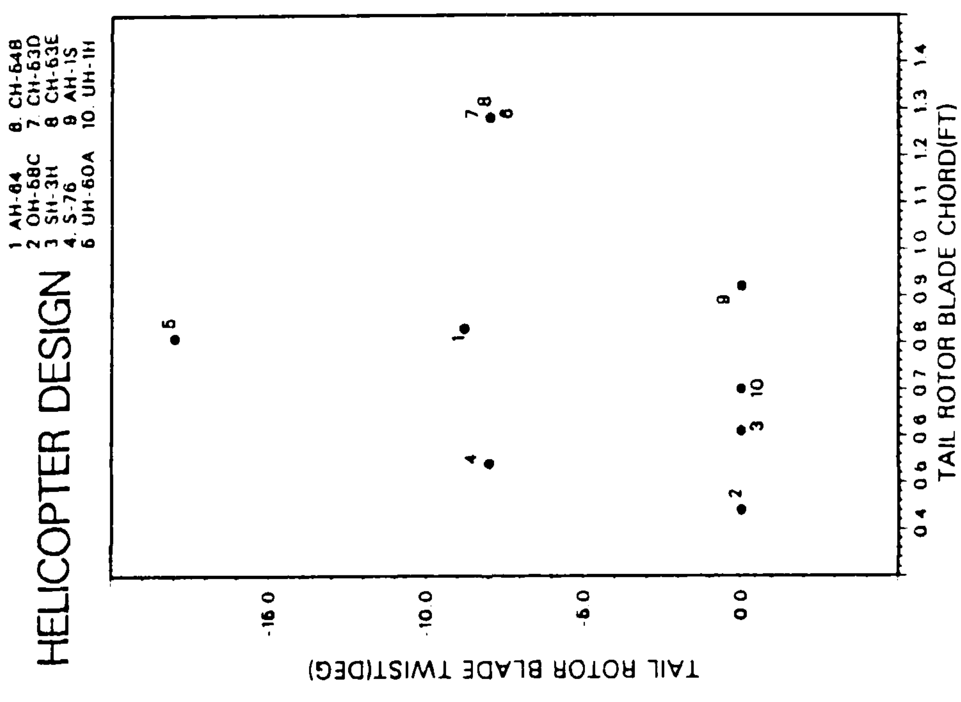


Fig. 9-13.

Fig. 9-13 and 9-15.

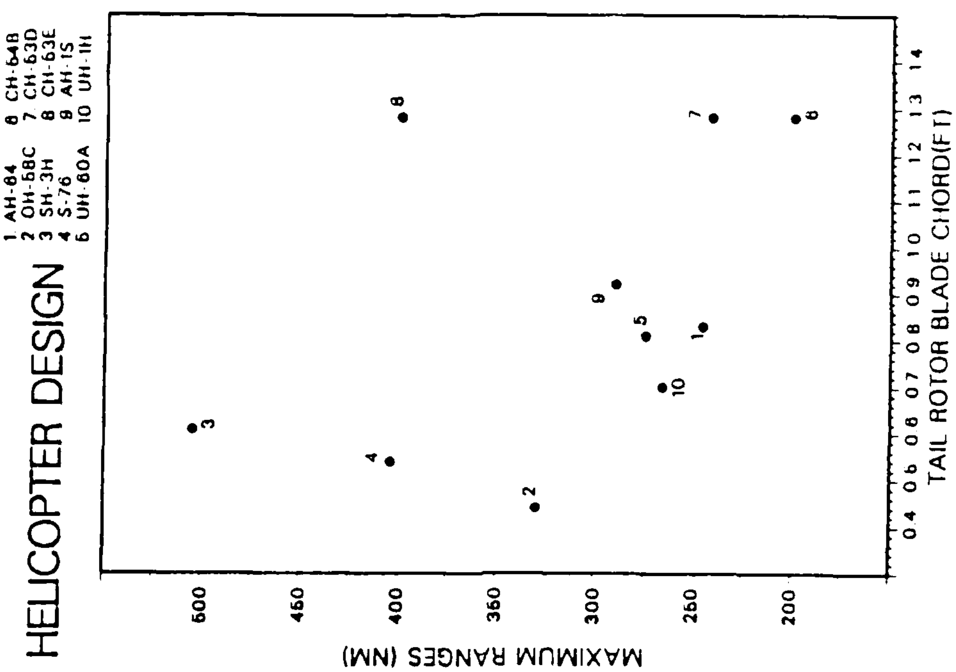


Fig. 9-22.

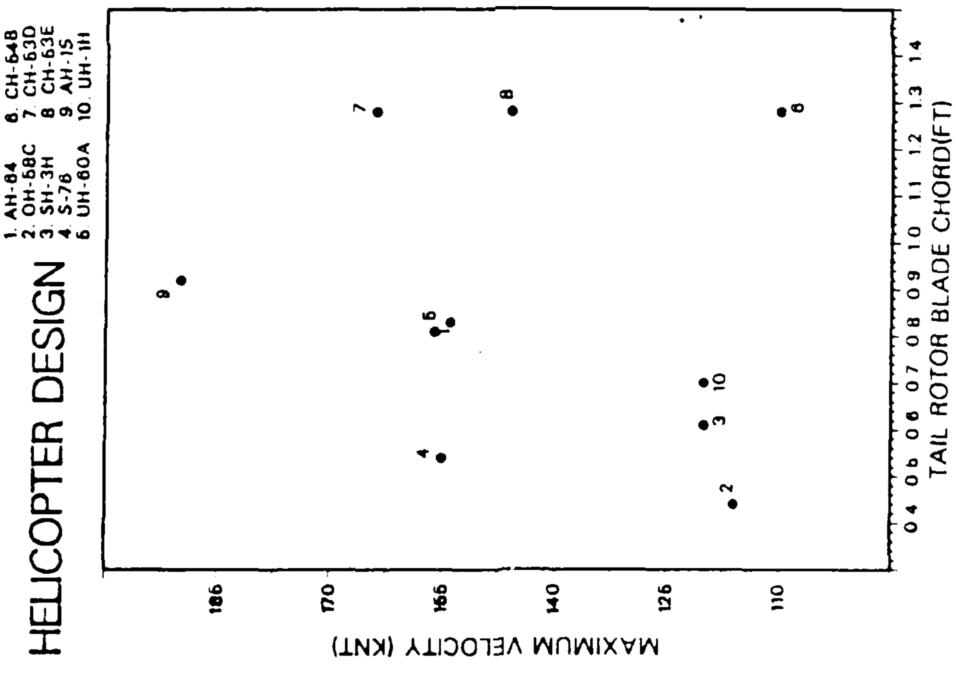
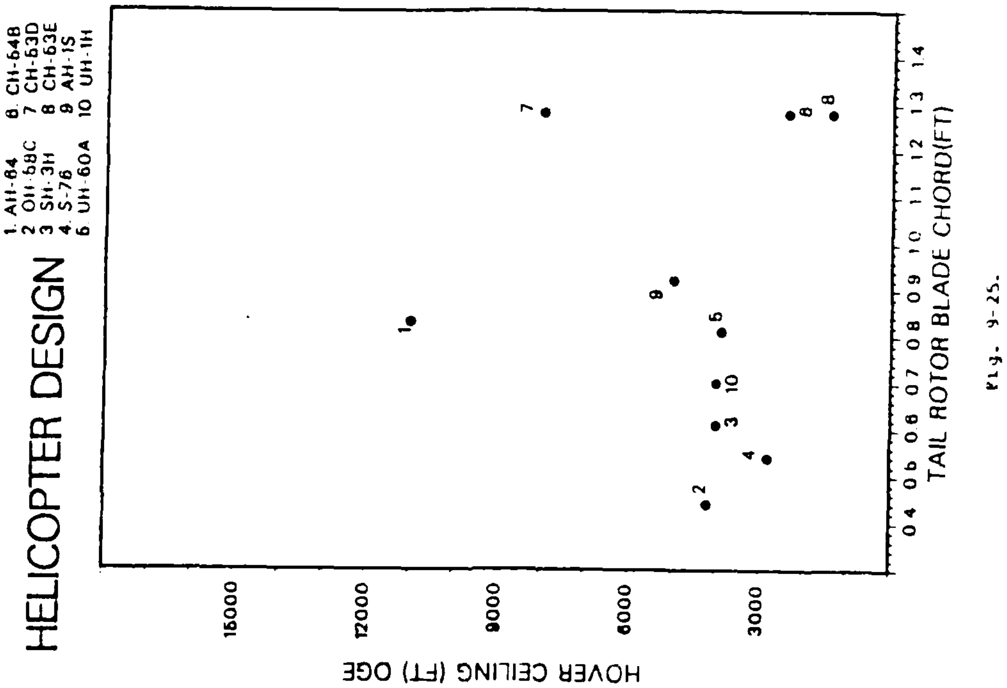


Fig. 9-21.

Fig. 9-21 and 9-22.



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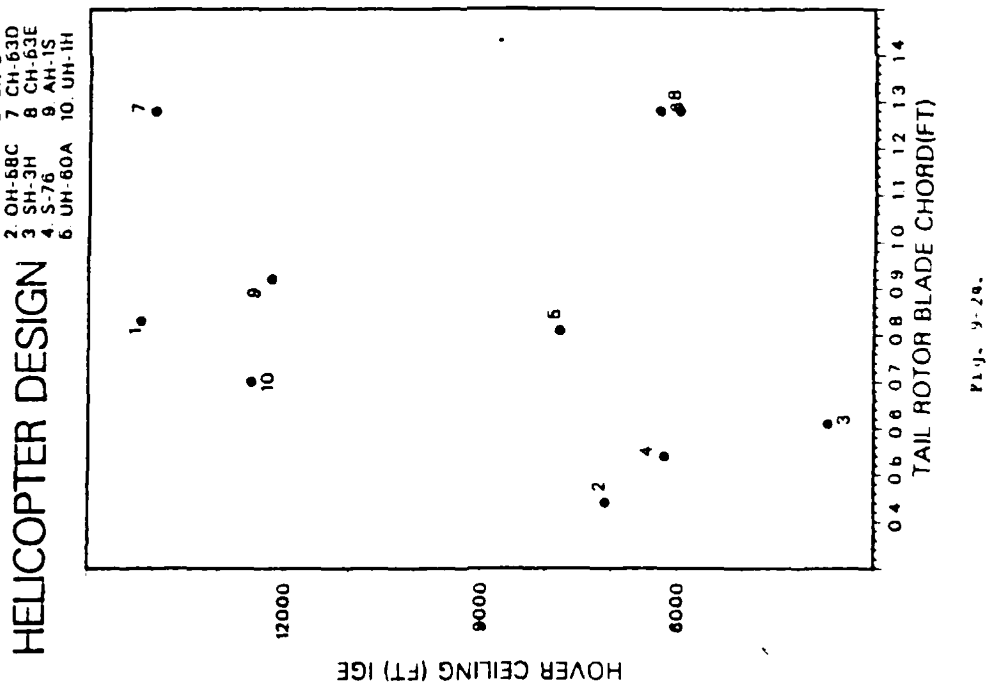


Fig. 9-24.

Fig. 9-24 and 9-25.

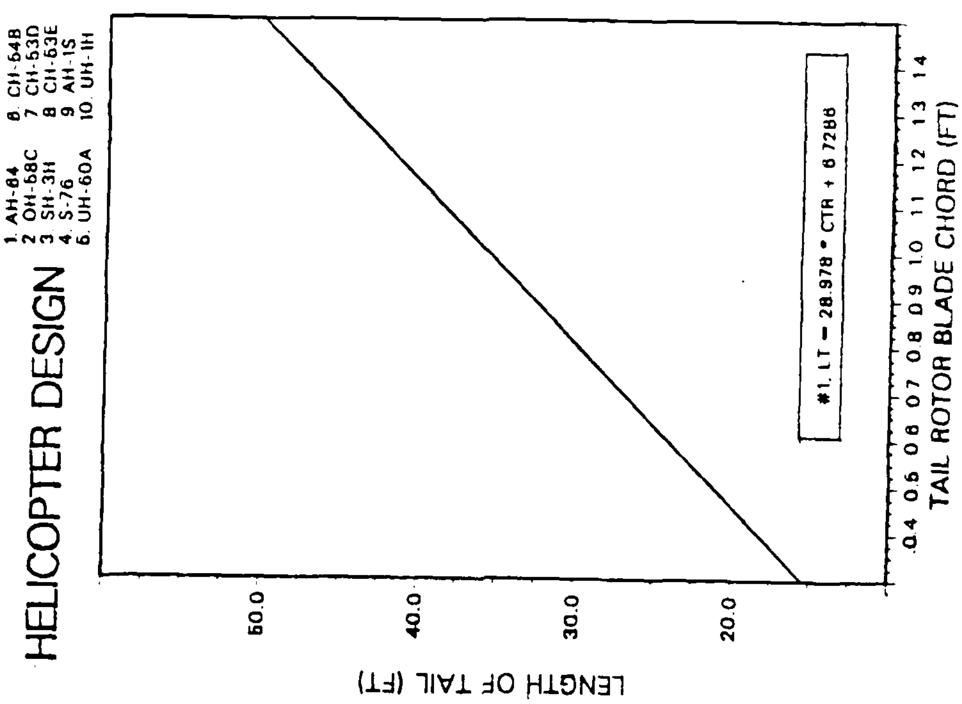


Fig. 9-26b.

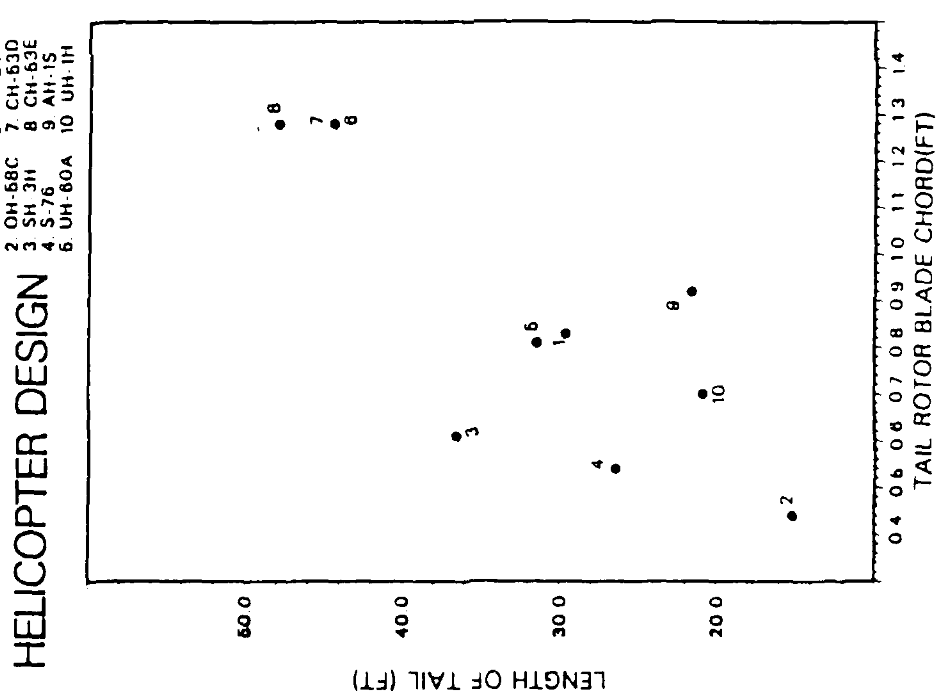


Fig. 9-26a.

Fig. 9-26a and 9-26b.

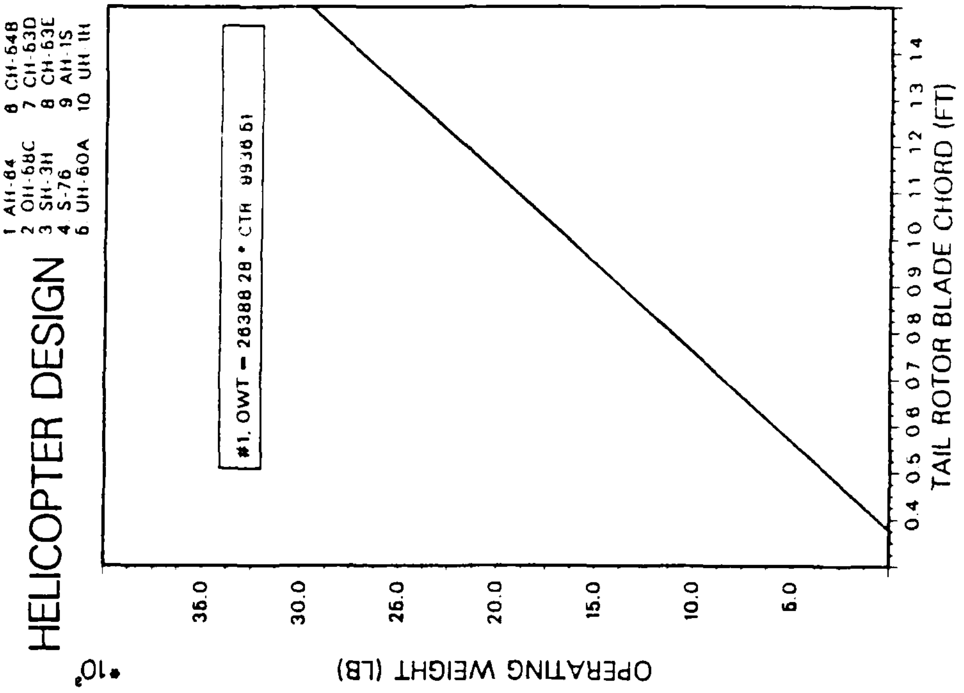


Fig. 9-27b.

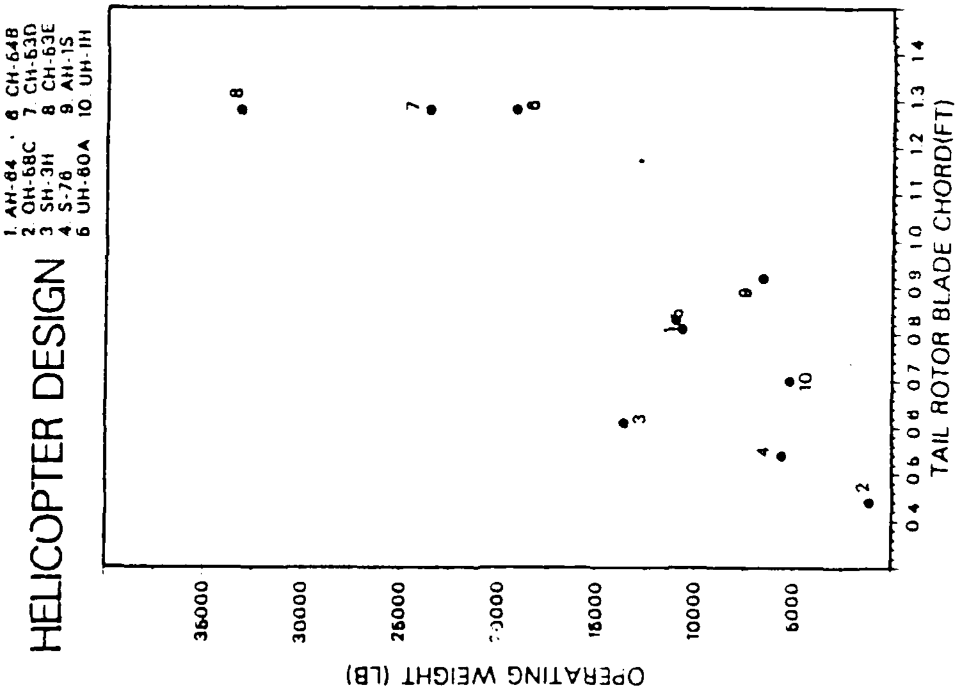


Fig. 9-27a.

Fig. 9-27a and 9-27b.

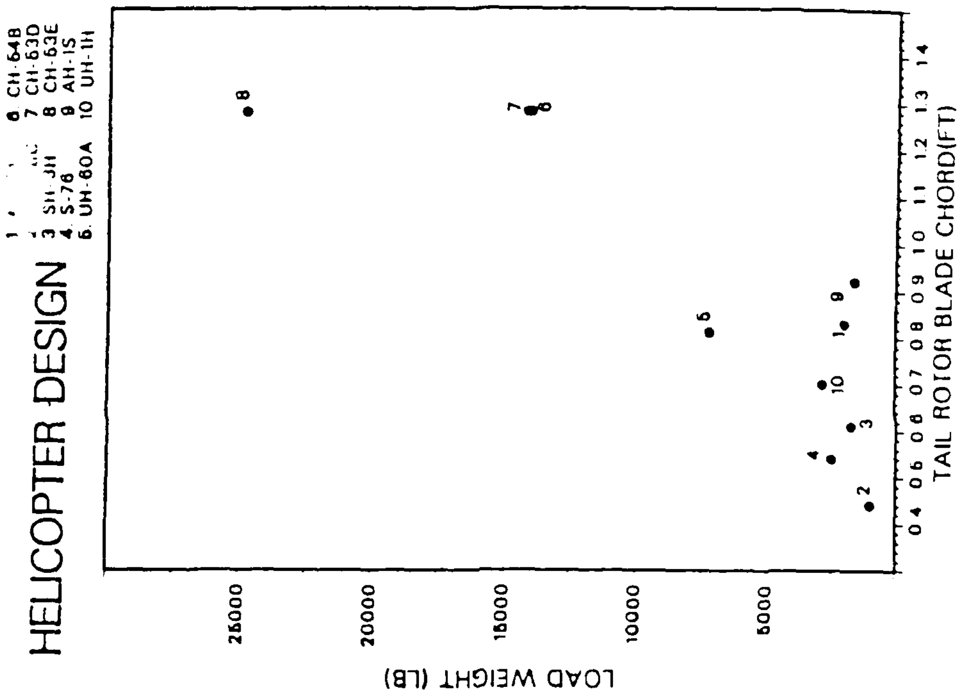


Fig. 9-28.

Fig. 9-28.

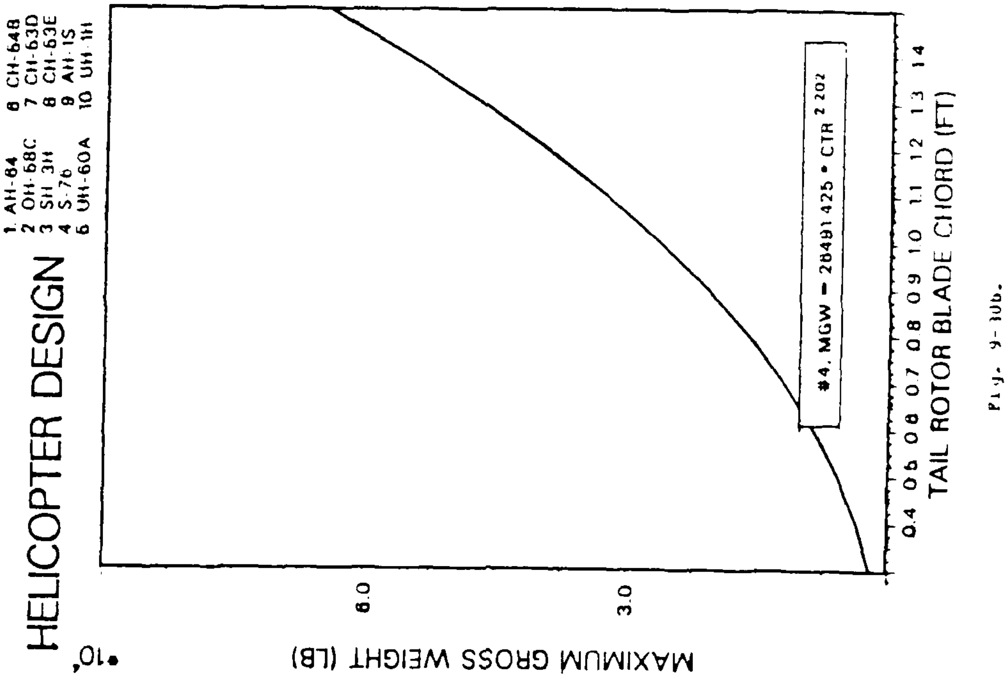


Fig. 9-30b.

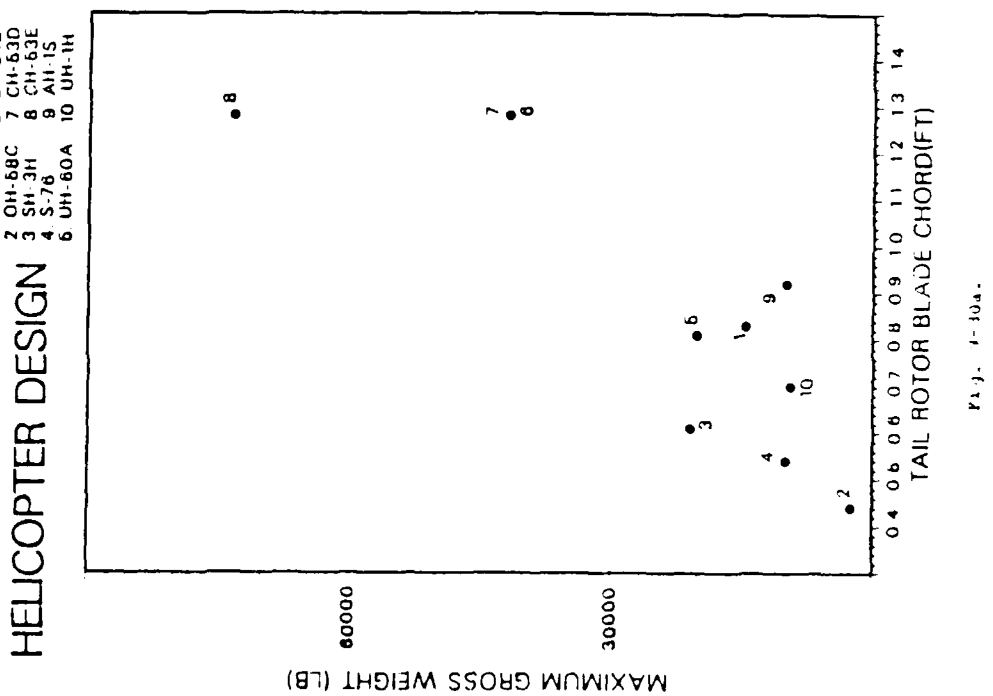


Fig. 9-30a.

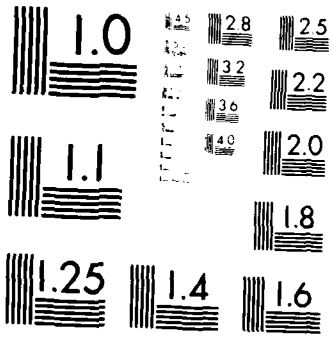
Fig. 9-30a and 9-30b.

Span of Main Rotor Pairings.

AD-A152 034 DETERMINATION OF QUANTITATIVE RELATIONSHIPS BETWEEN SELECTED CRITICAL HELICOPTER DESIGN PARAMETERS(U) NAVAL POSTGRADUATE SCHOOL MONTEREY CA R S PETRICKA SEP 84

3/4

UNCLASSIFIED F/G 1/3 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A

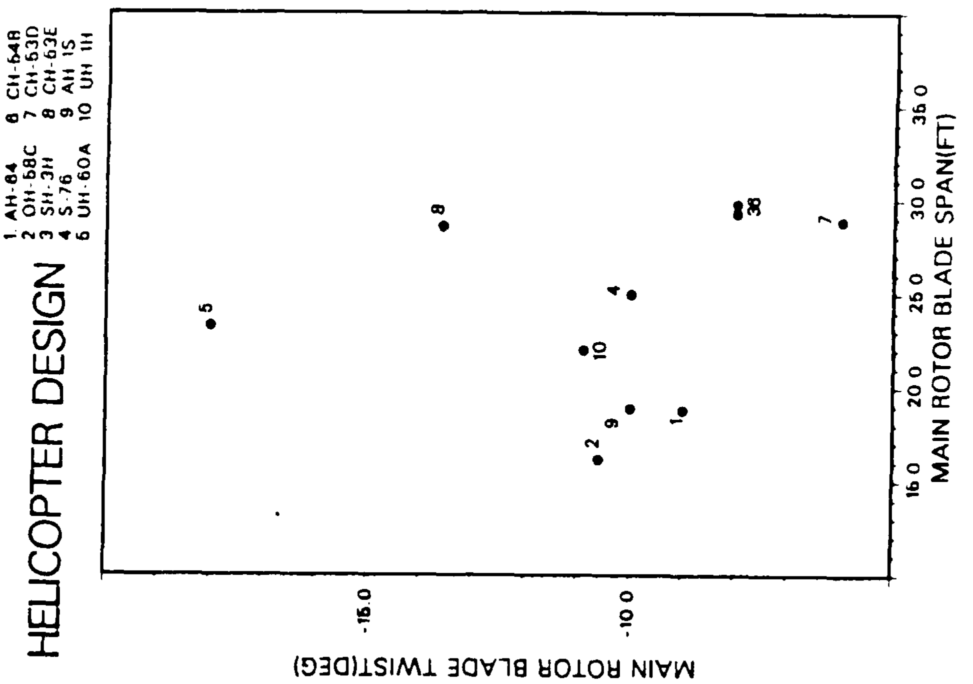


Fig. 10-12.

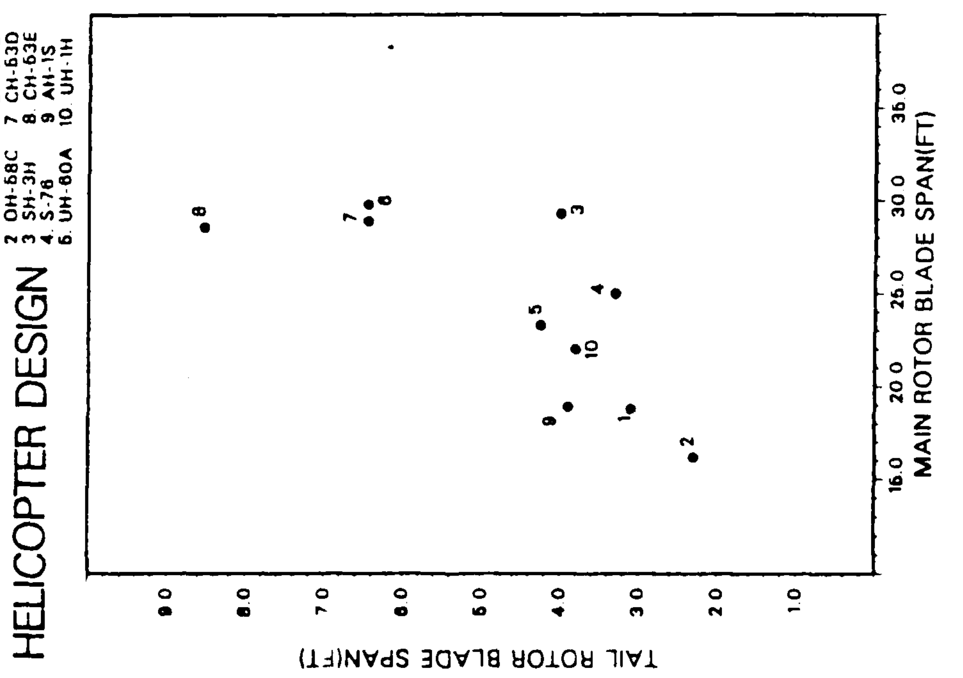


Fig. 10-11.

Fig. 10-11 and 10-12.

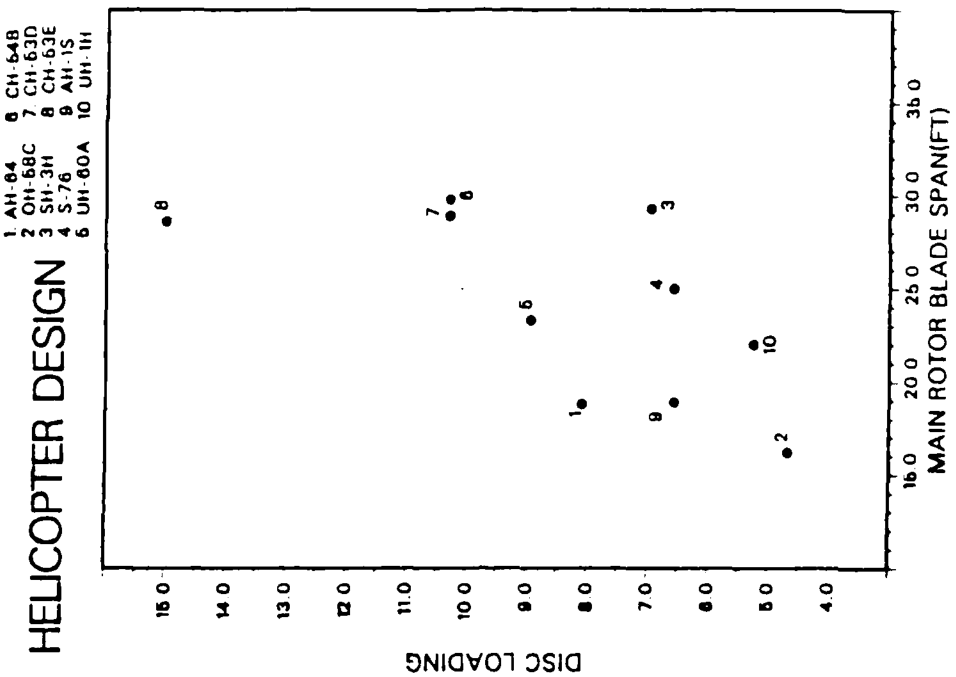


Fig. 10-16.

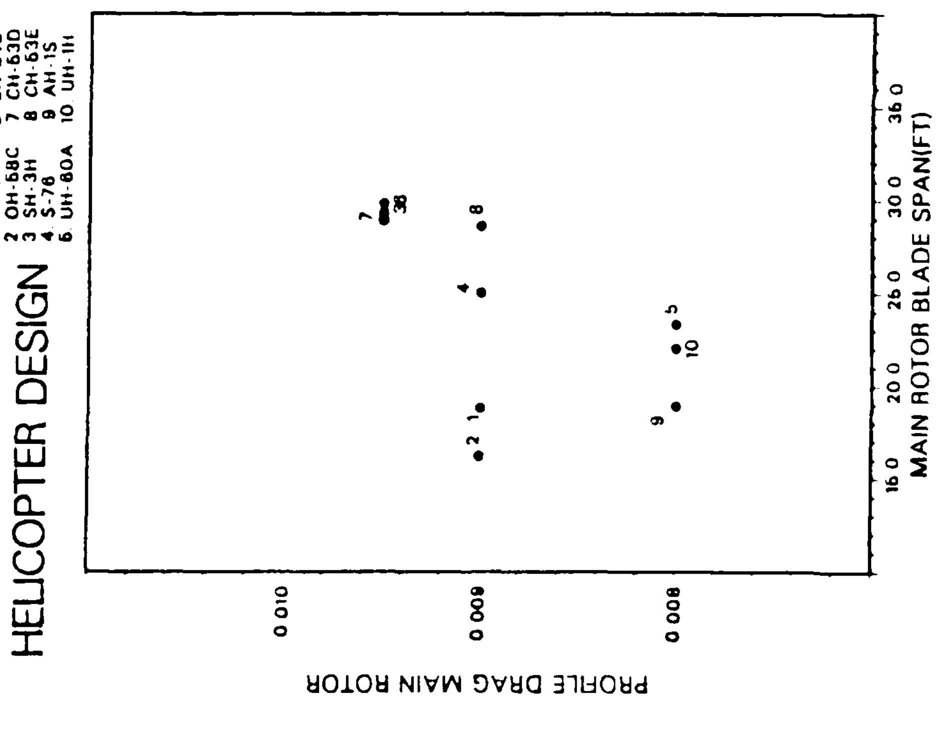


Fig. 10-14.

Fig. 10-14 and 10-16.

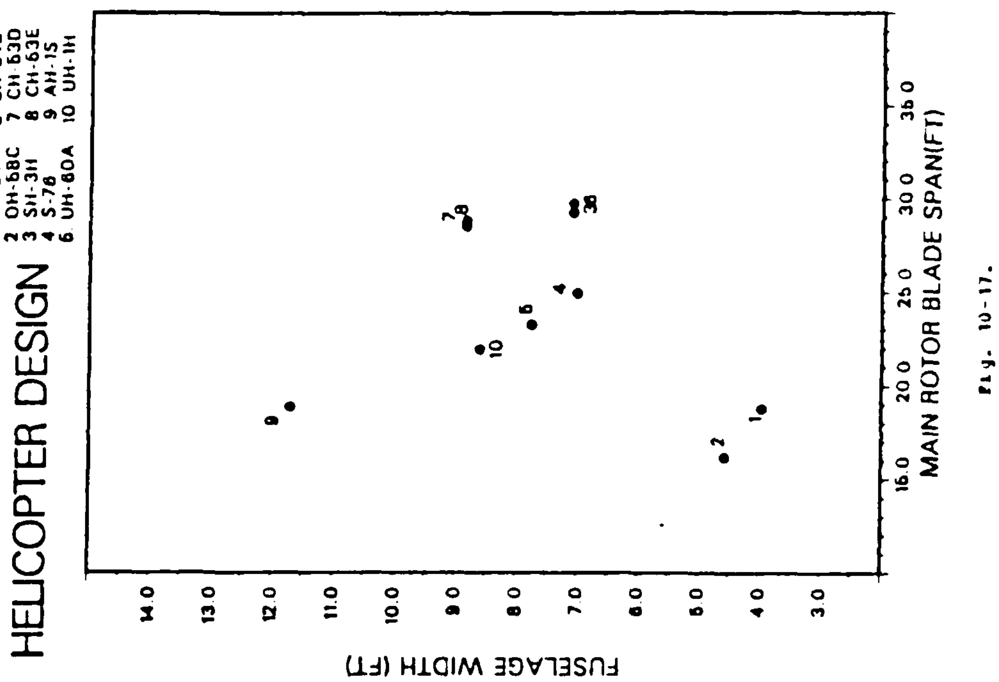
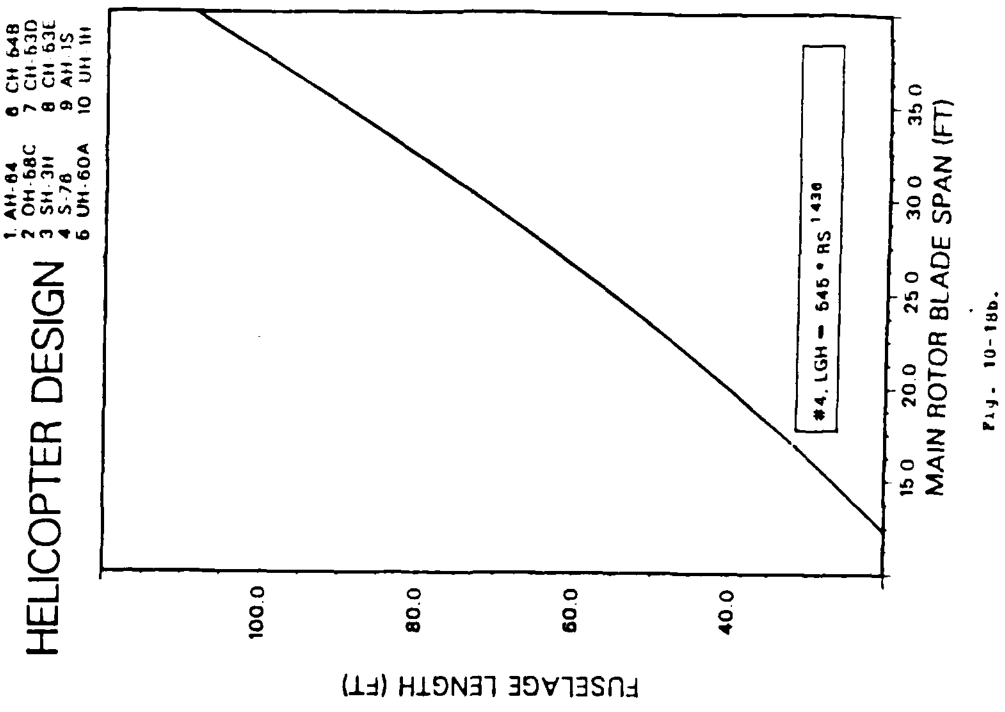

HELICOPTER DESIGN
1 AH-64
2 OH-58C
3 SH-3H
4 S-76
5 UH-60A
6 CH-54B
7 CH-53D
8 CH-53E
9 AH-1S
10 UH-1H
FUSELAGE WIDTH (FT)
14.0
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
MAIN ROTOR BLADE SPAN(FT)
16.0
20.0
25.0
30.0
35.0
Fig. 10-17.

Fig. 10-17.



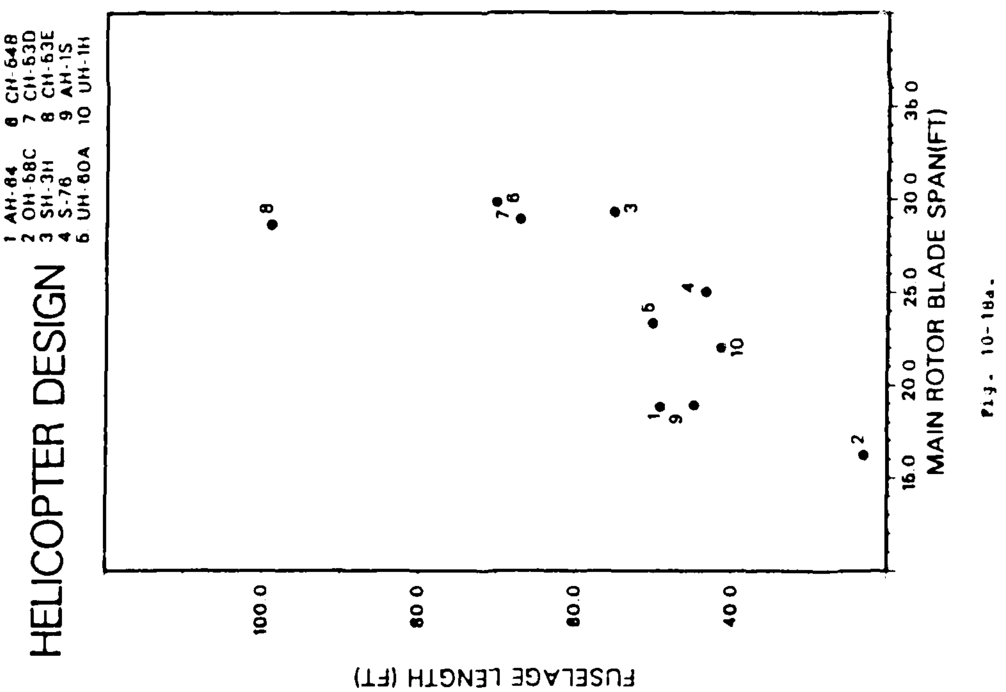


Fig. 10-18a and 10-18b.

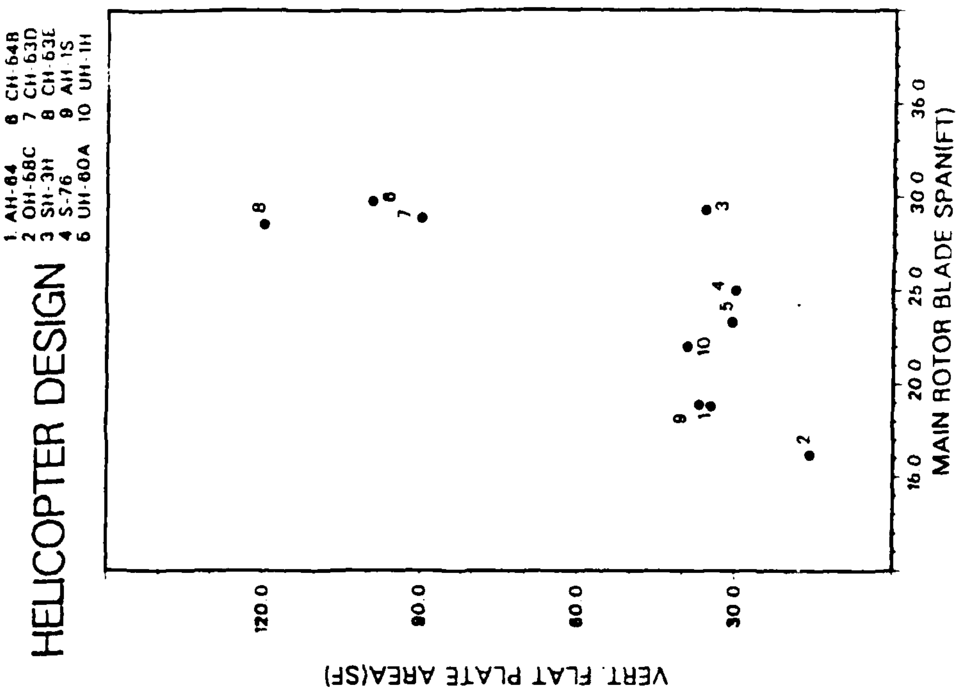


Fig. 10-20.

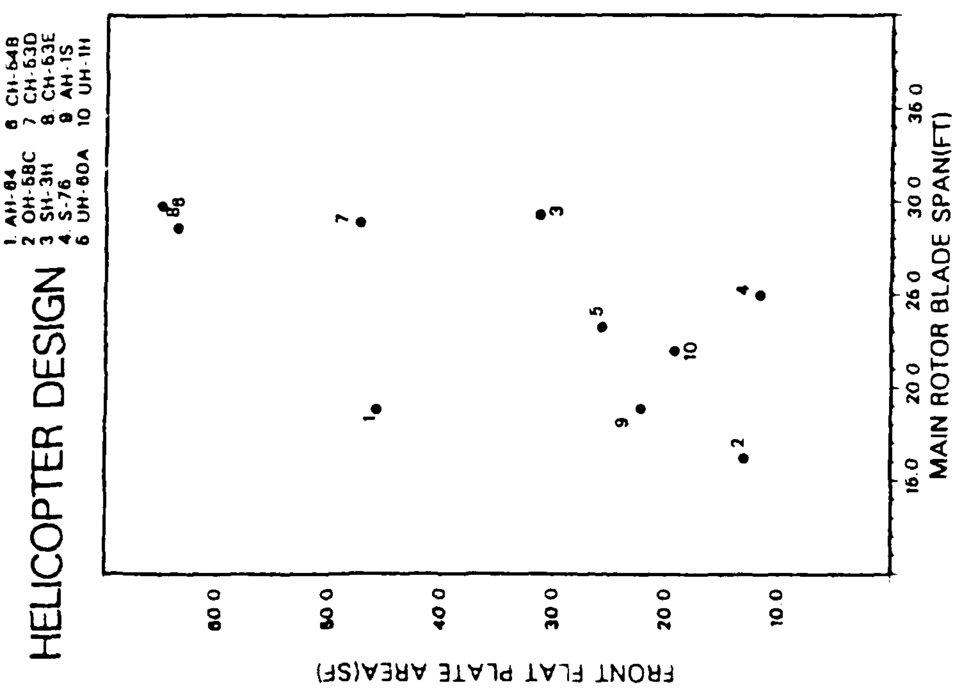


Fig. 10-19.

Fig. 10-19 and 10-20.

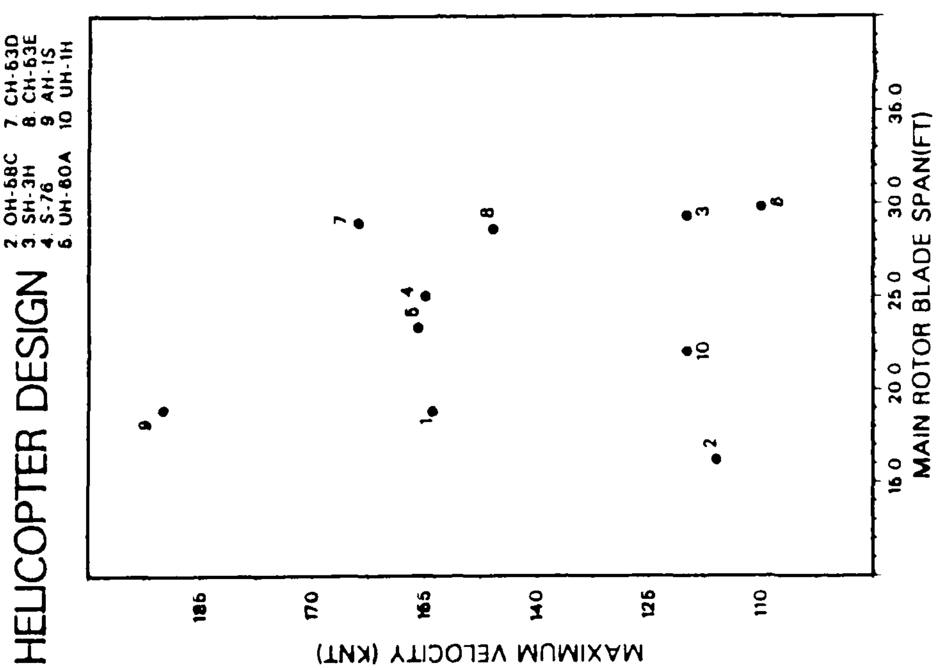


Fig. 10-21.

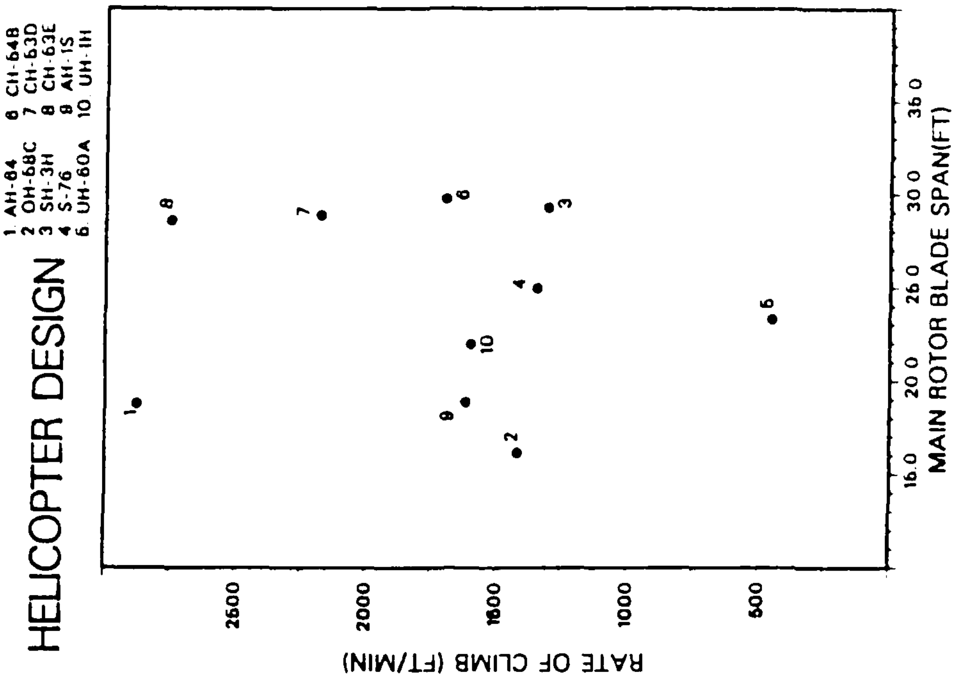
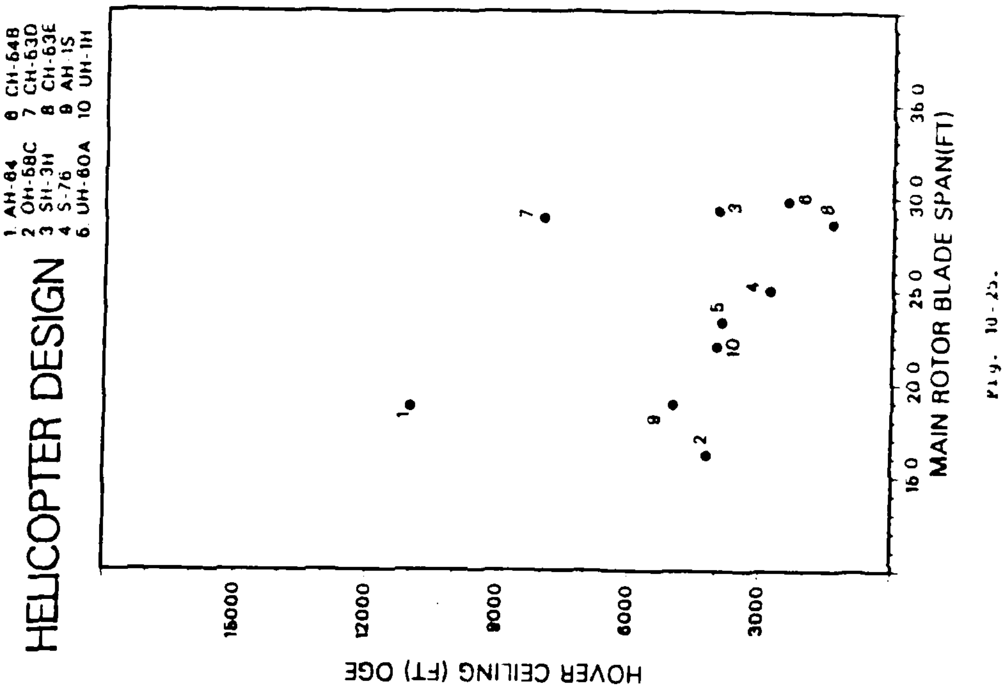


Fig. 10-23.

Fig. 10-21 and 10-23.



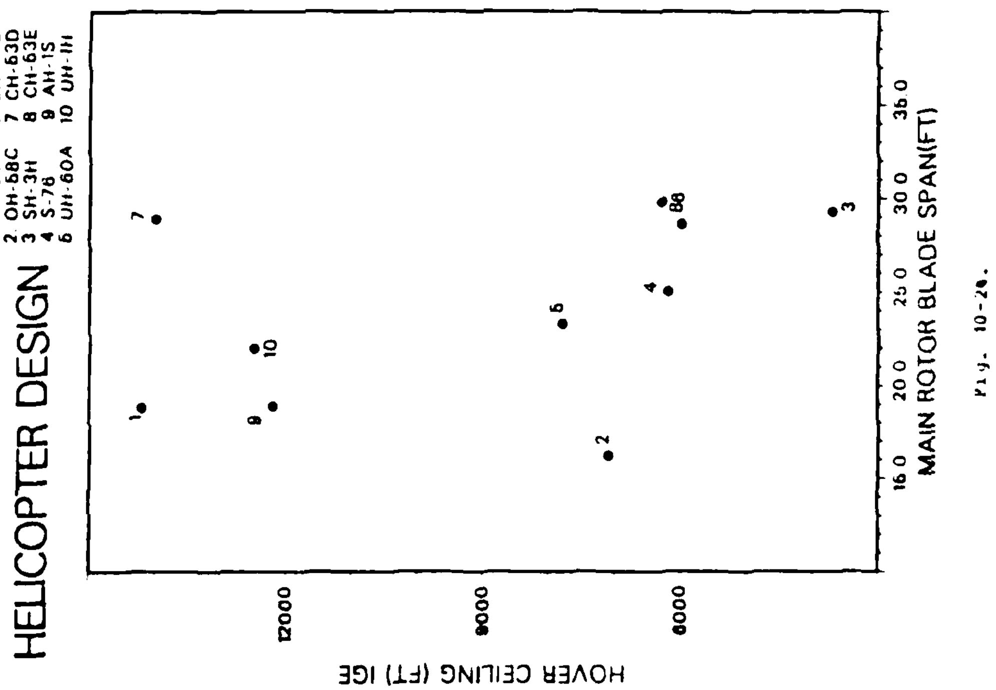
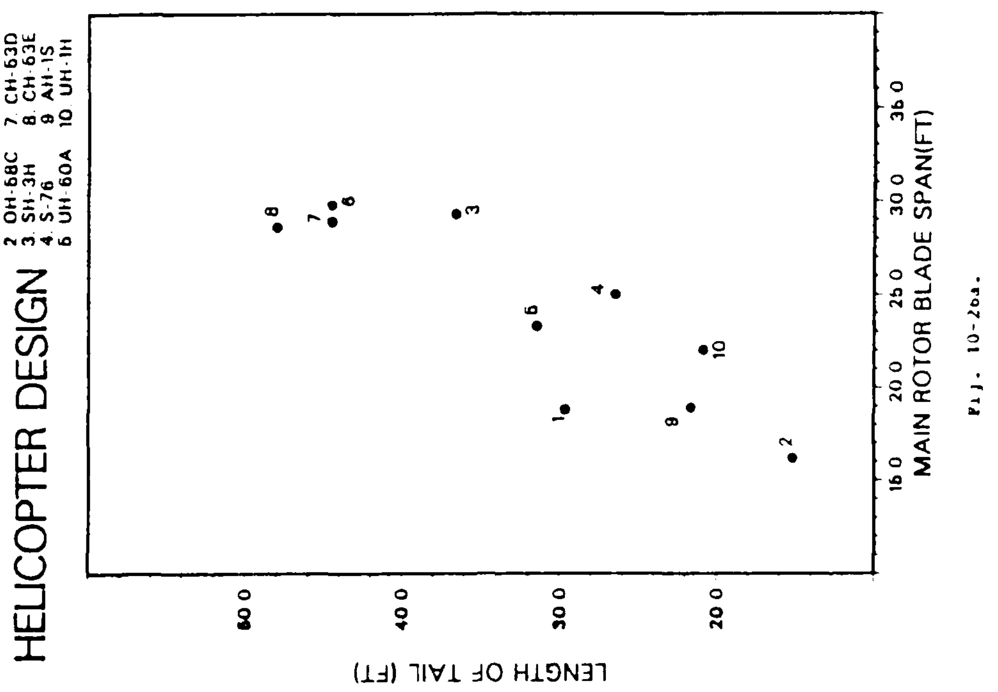


Fig. 10-24 and 10-25.



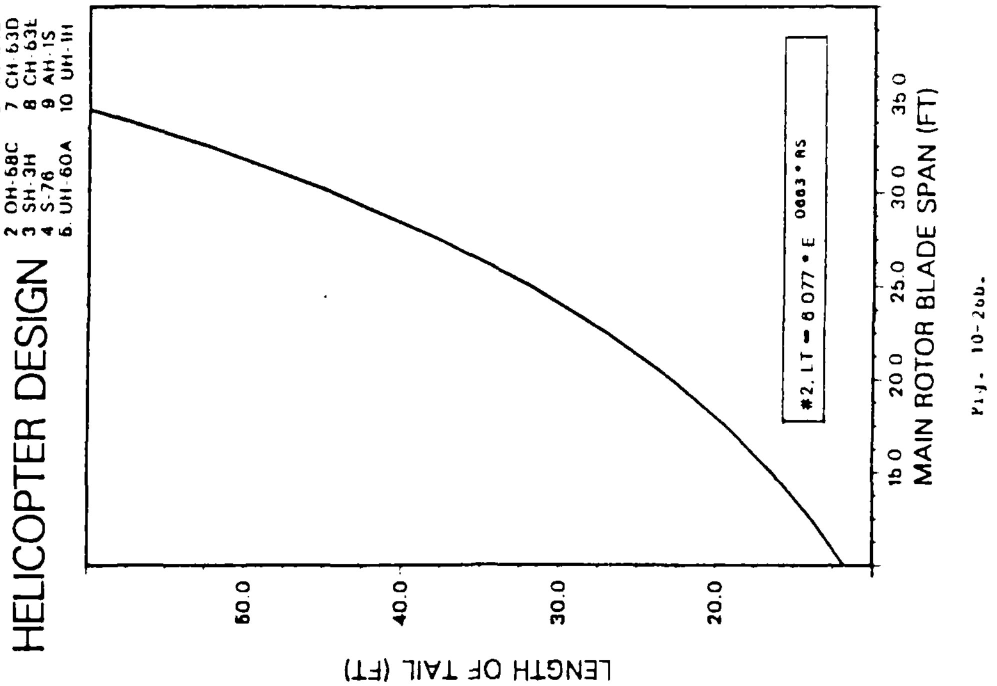


Fig. 10-26a and 10-26b.

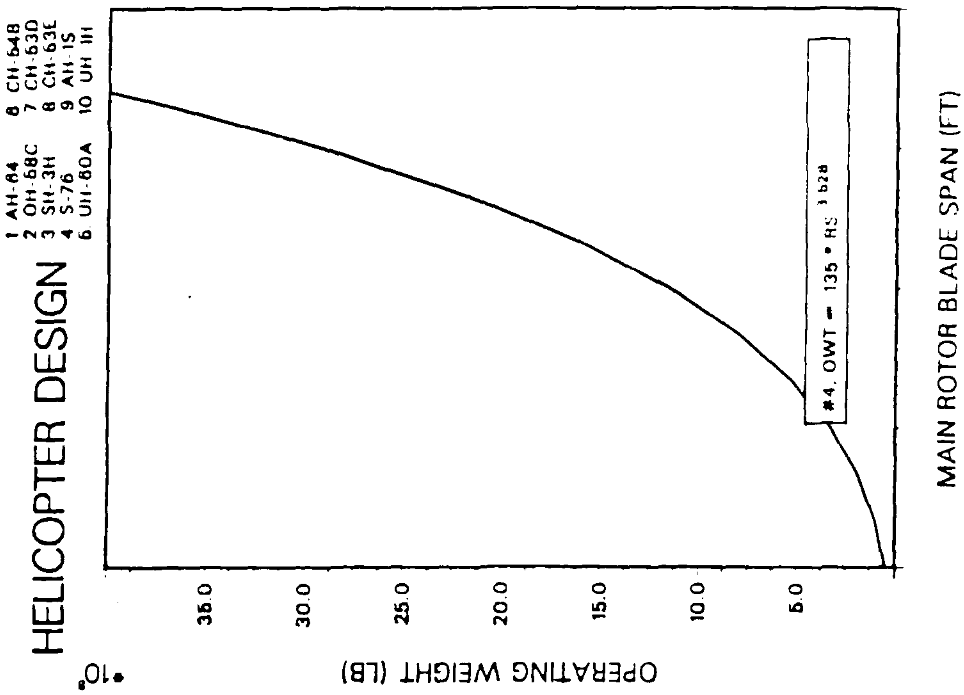


Fig. 10-27b.

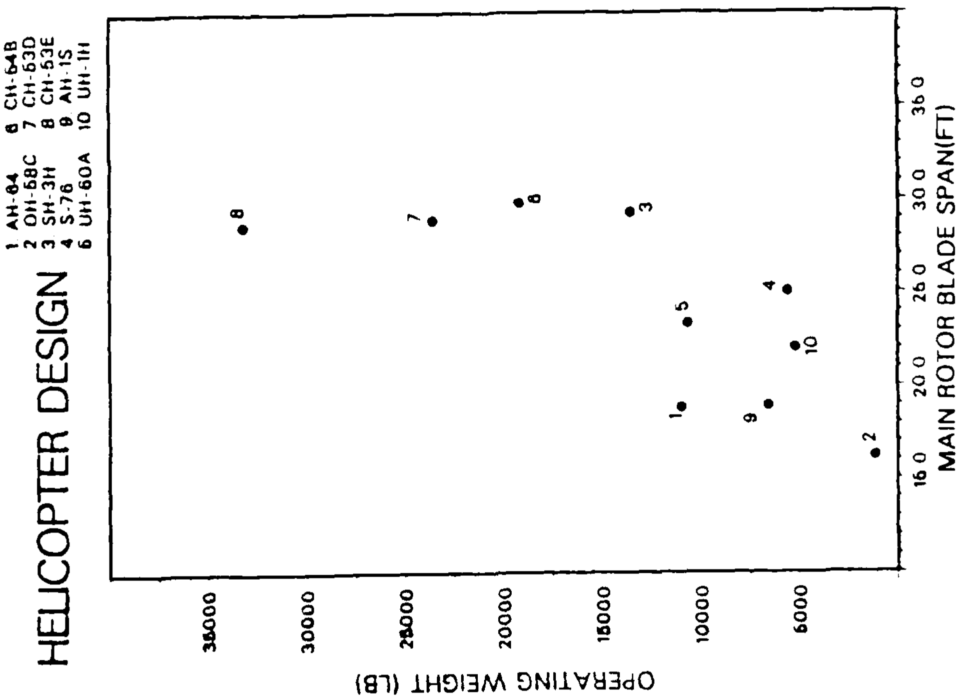


Fig. 10-27a.

Fig. 10-27a and 10-27b.

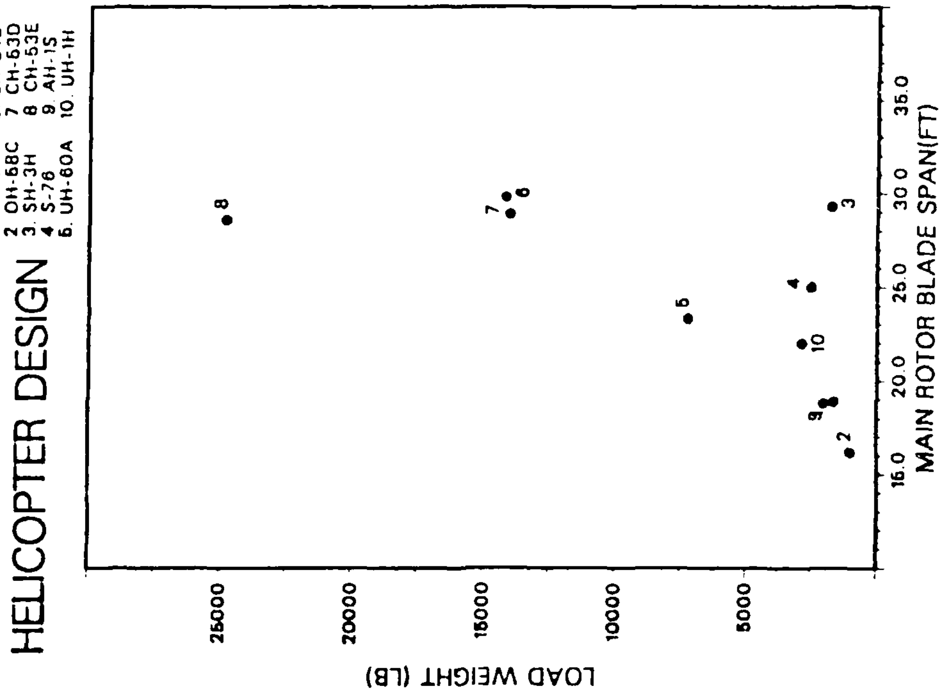


Fig. 10-28.

Fig. 10-28.

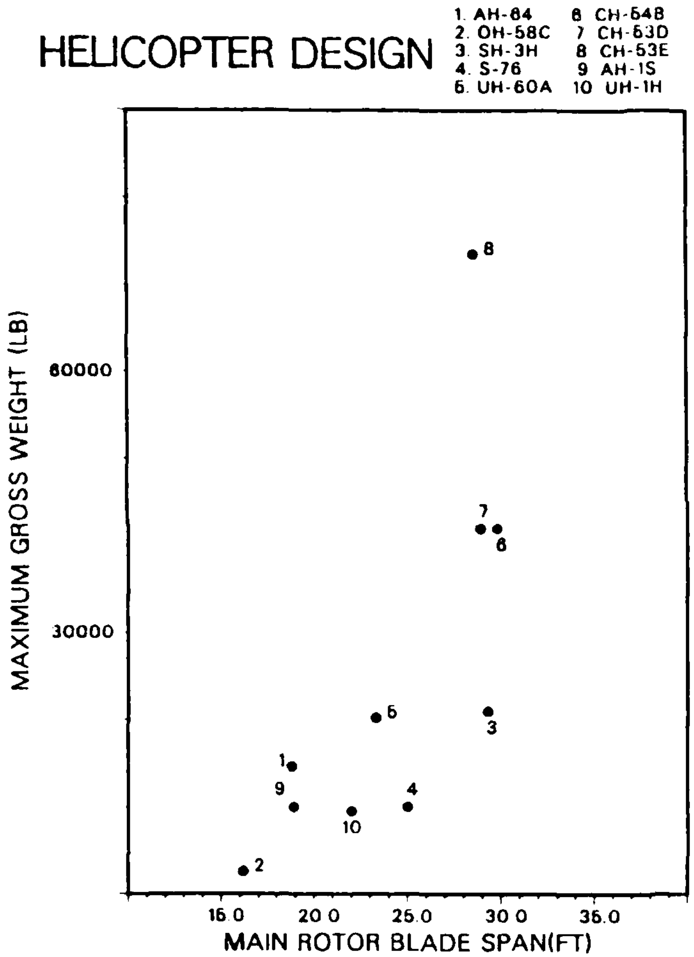


Fig. 10-30a.

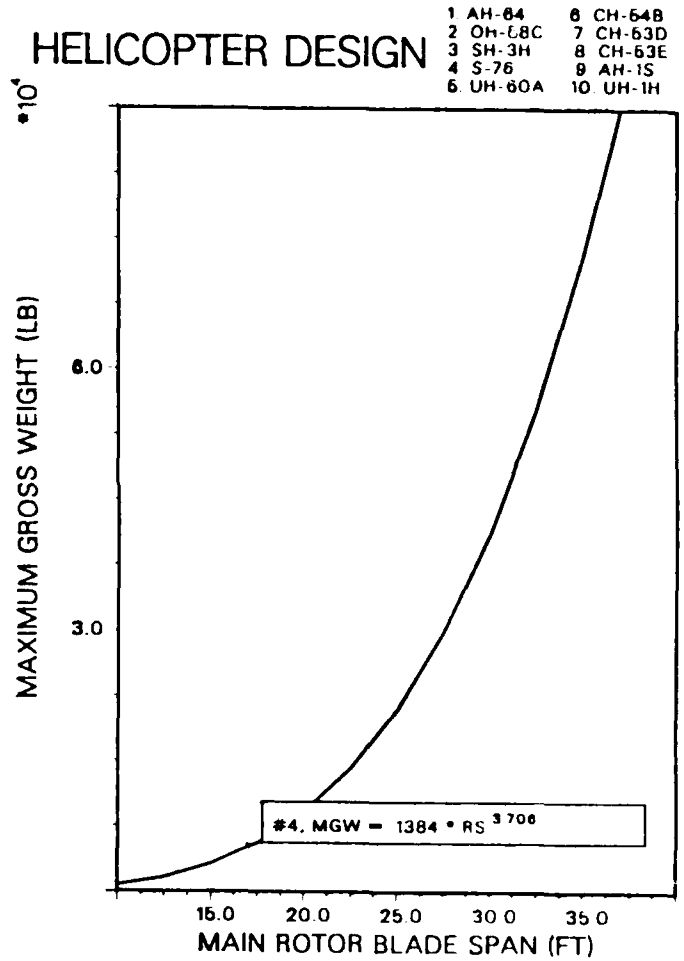


Fig. 10-30b.

Fig. 10-30a and 10-30b.

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Span of Tail Rotor Pairings.

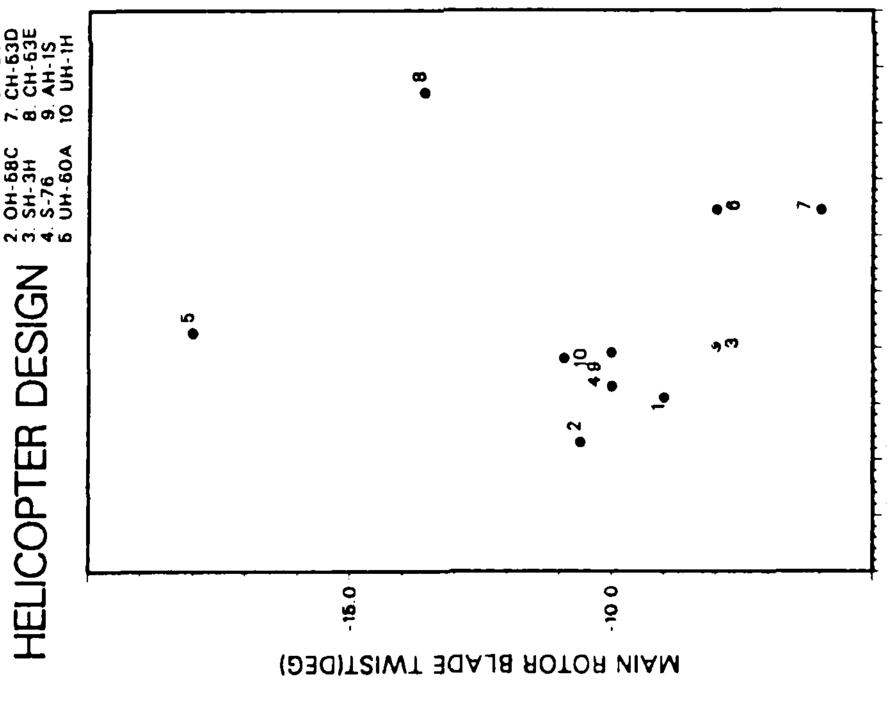


Fig. 11-12.

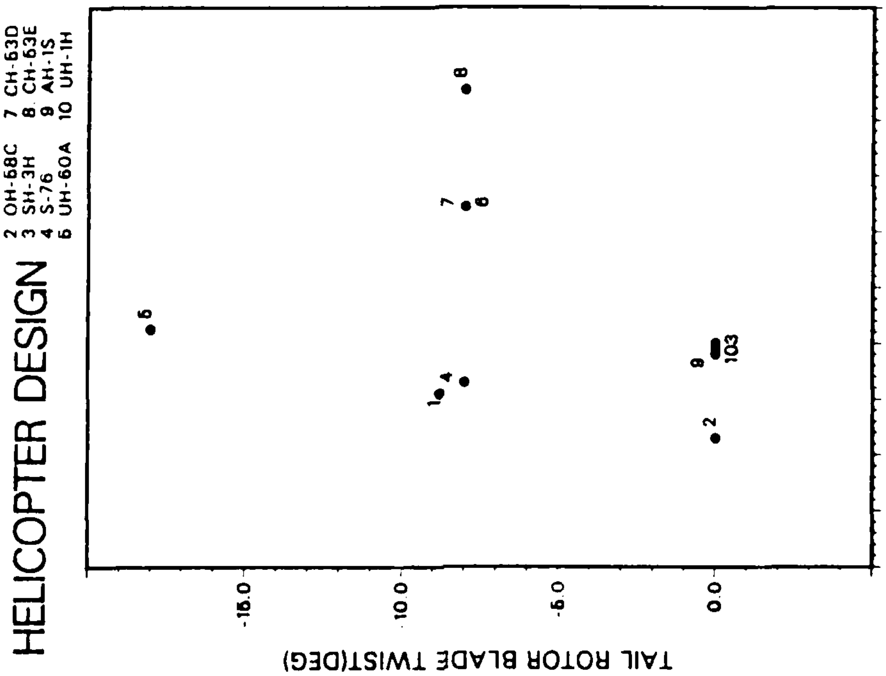


Fig. 11-13.

Fig. 11-12 and 11-13.

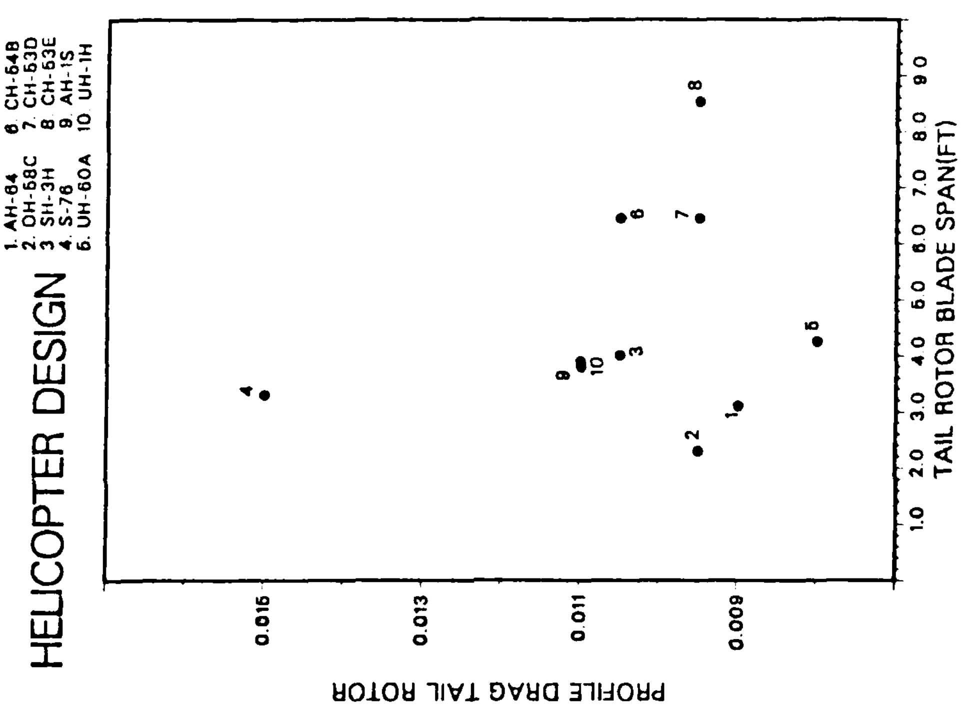
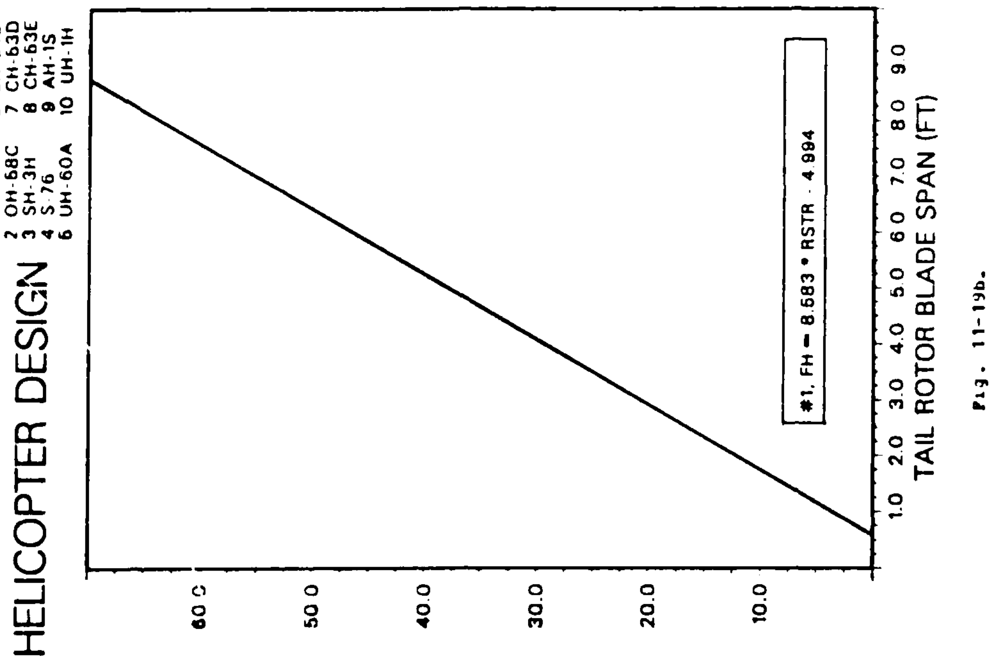


Fig. 11-15.

Fig. 11-15.



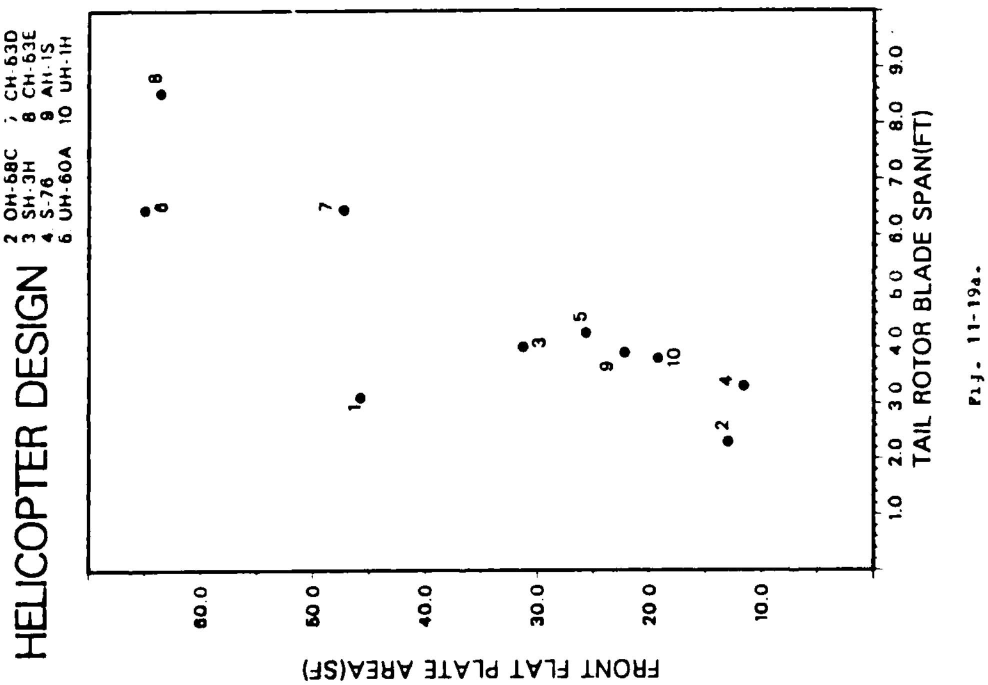


Fig. 11-19a and 11-19b.

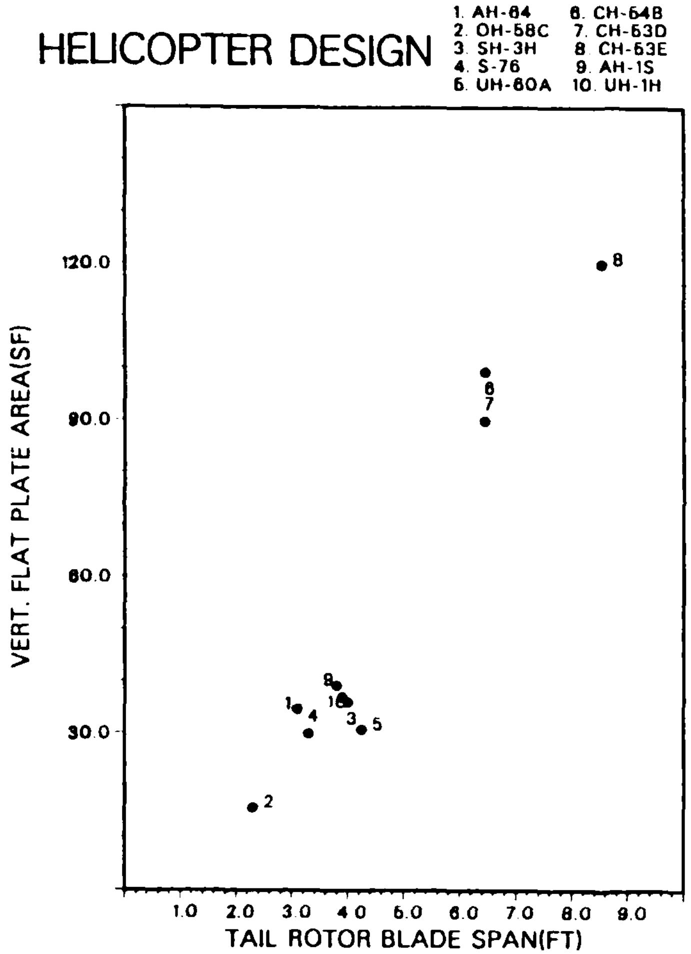


Fig. 11-20.

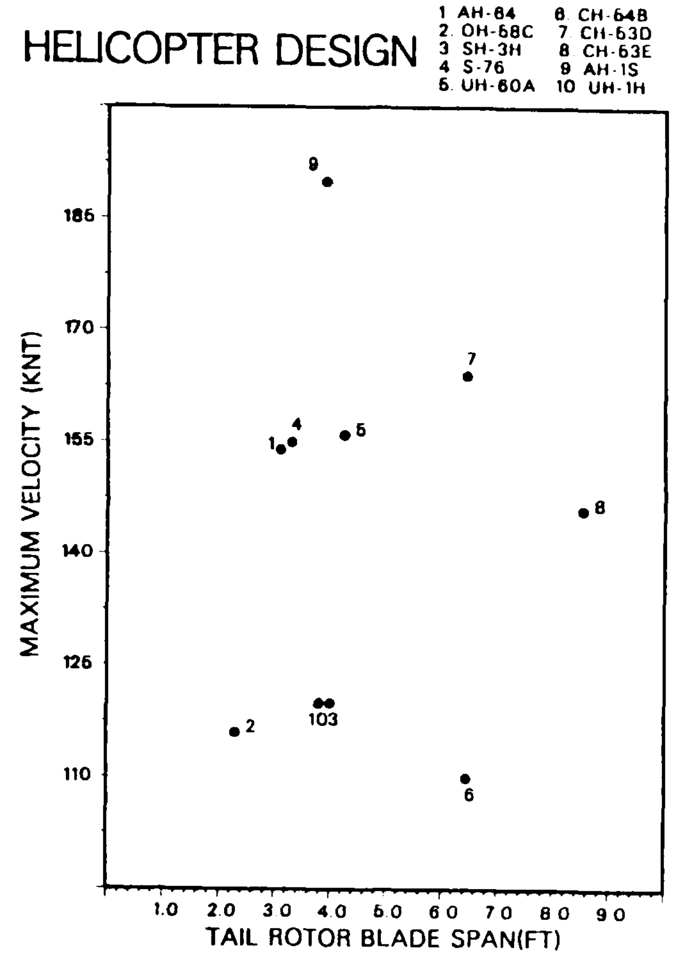


Fig. 11-21.

Fig. 11-20 and 11-21.

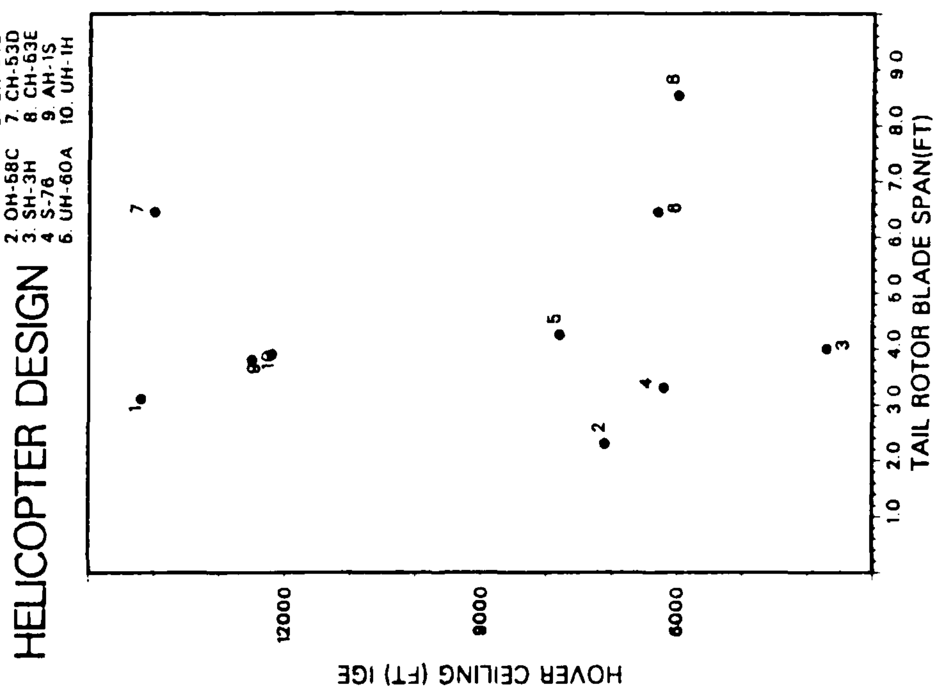


Fig. 11-24.

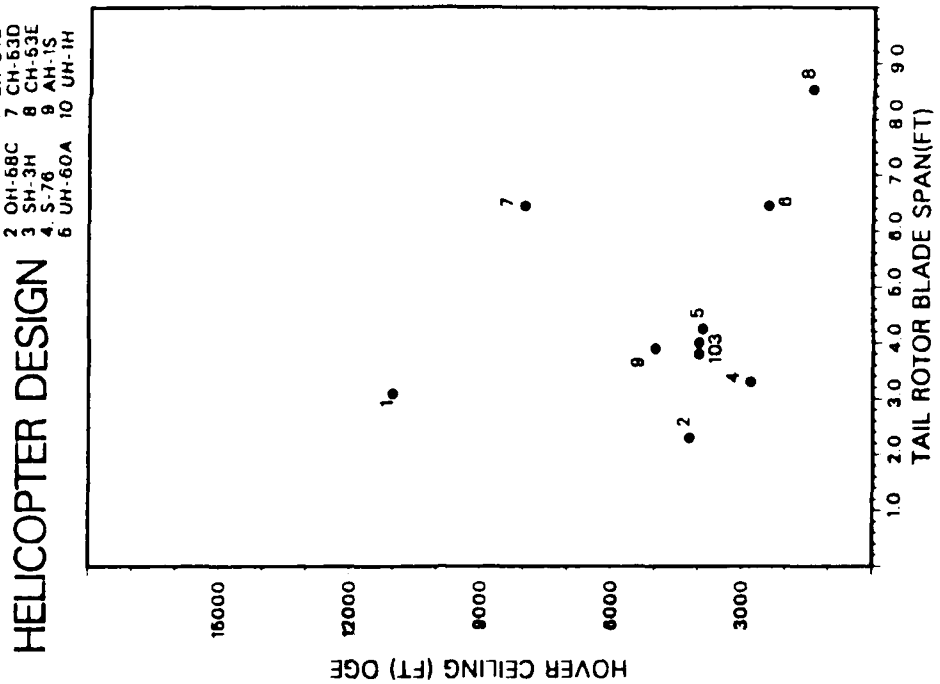


Fig. 11-25.

Fig. 11-24 and 11-25.

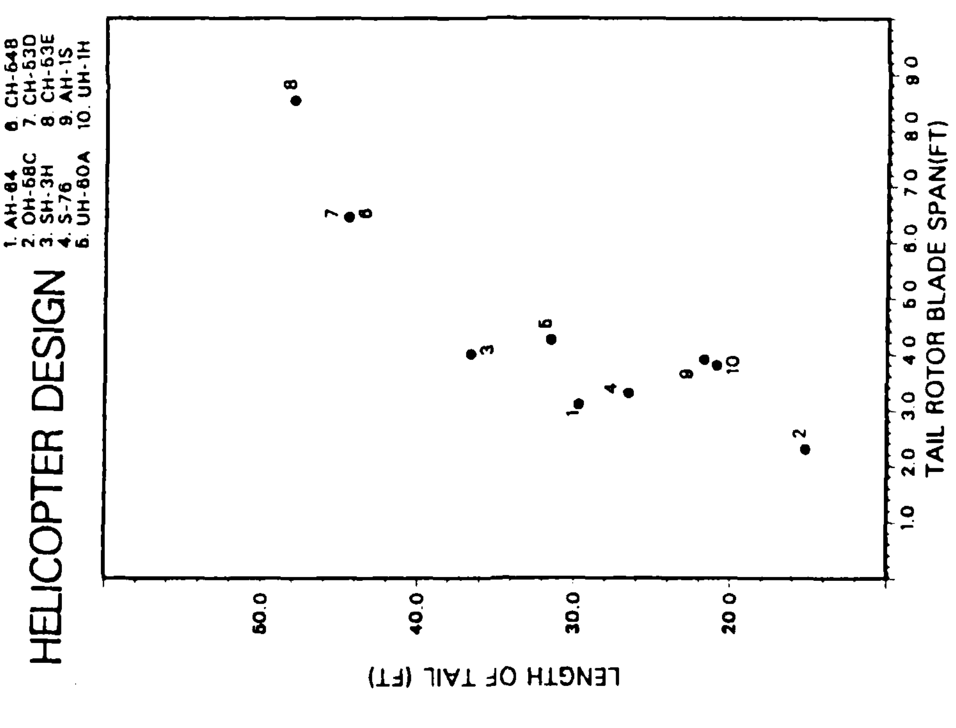


Fig. 11-2ba.

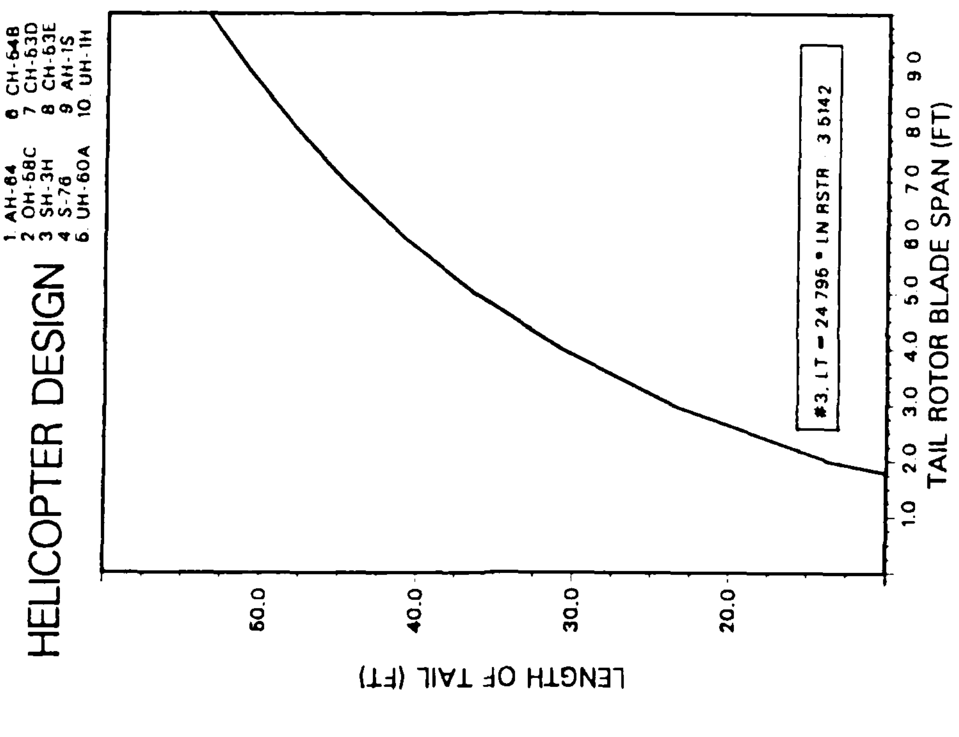


Fig. 11-2bb.

Fig. 11-2ca and 11-2cb.

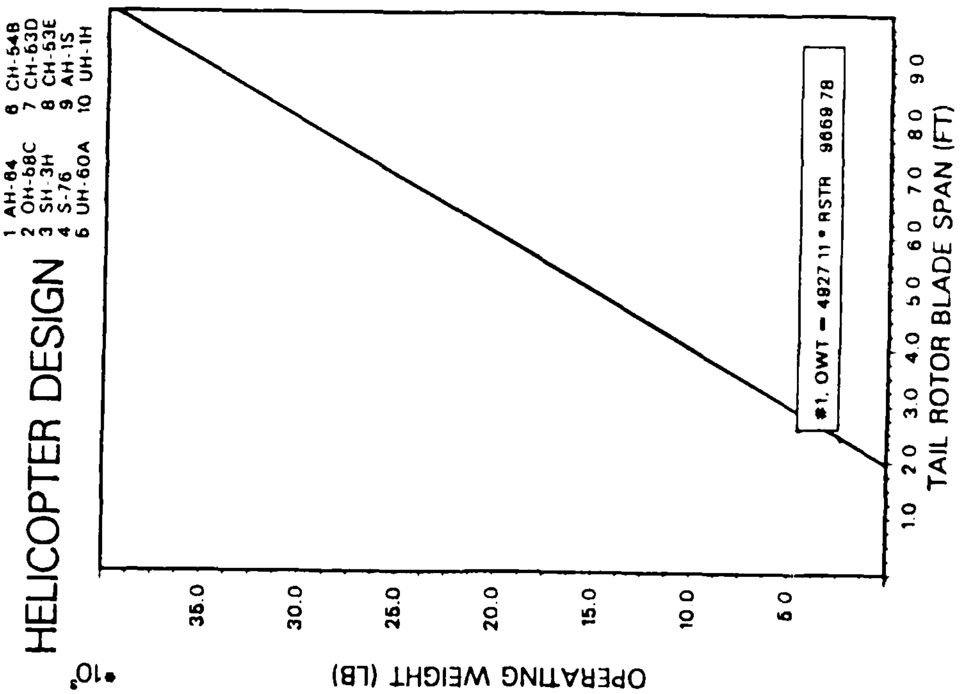


Fig. 11-27b.

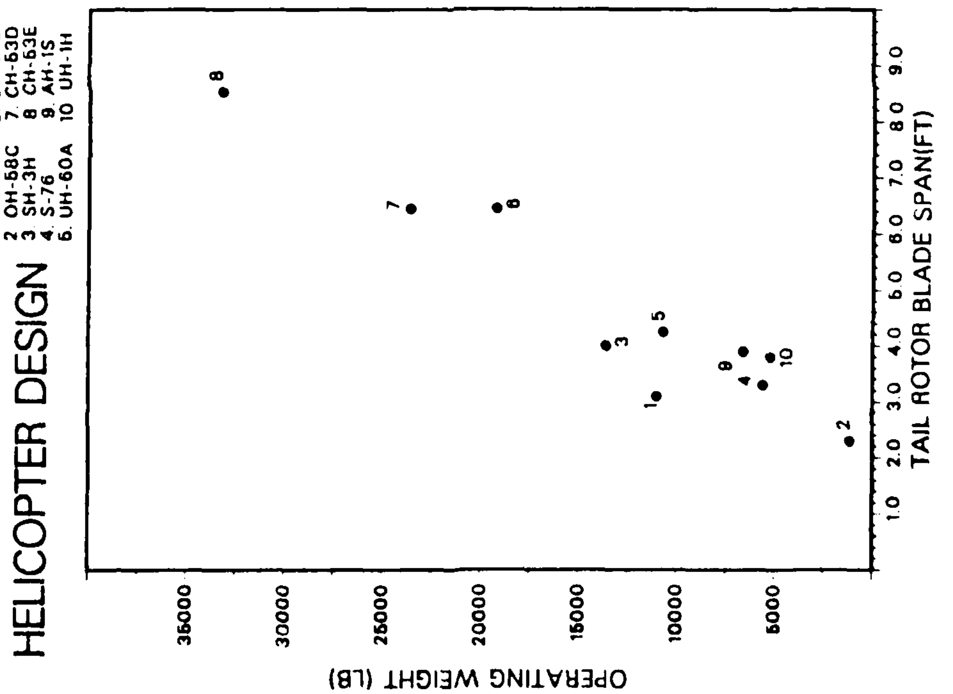


Fig. 11-27a.

Fig. 11-27a and 11-27b.

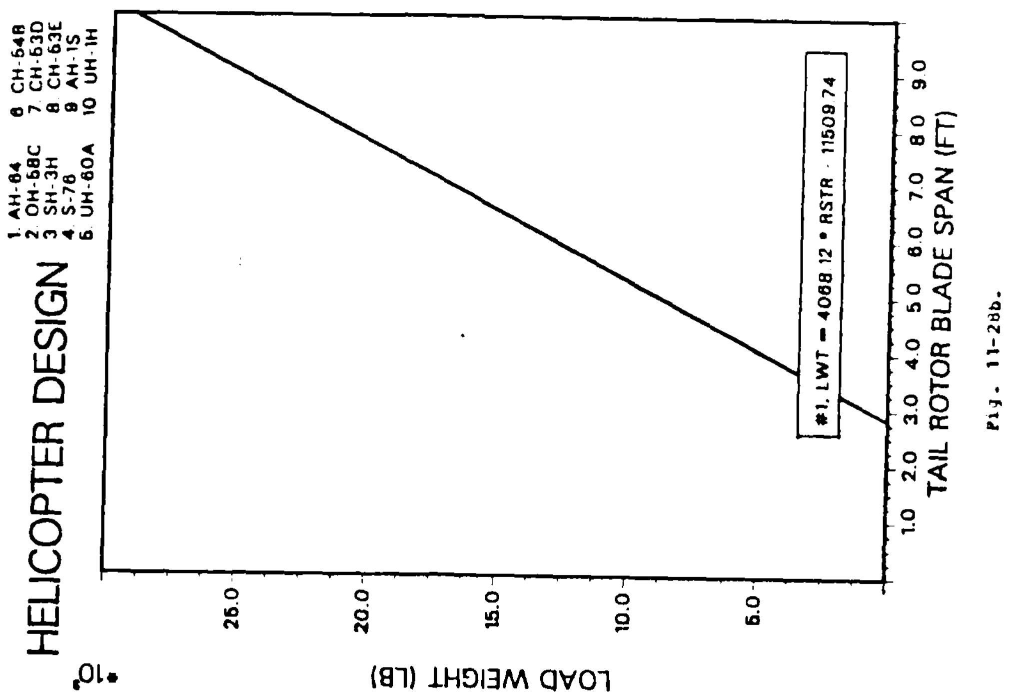


Fig. 11-28b.

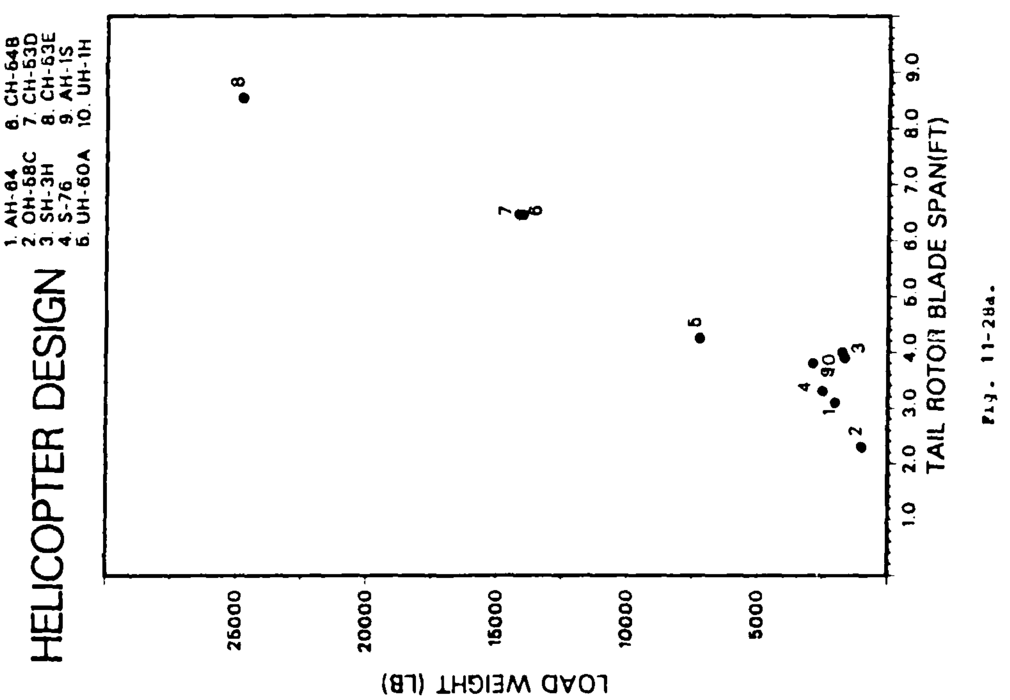


Fig. 11-28a.

Fig. 11-28a and 11-28b.

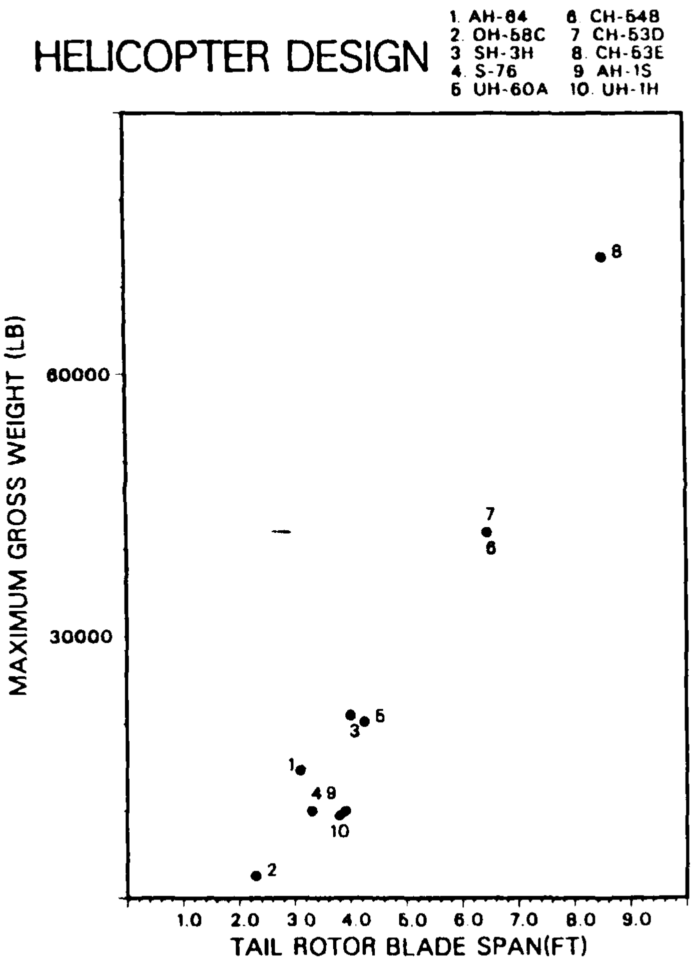


Fig. 11-30a.

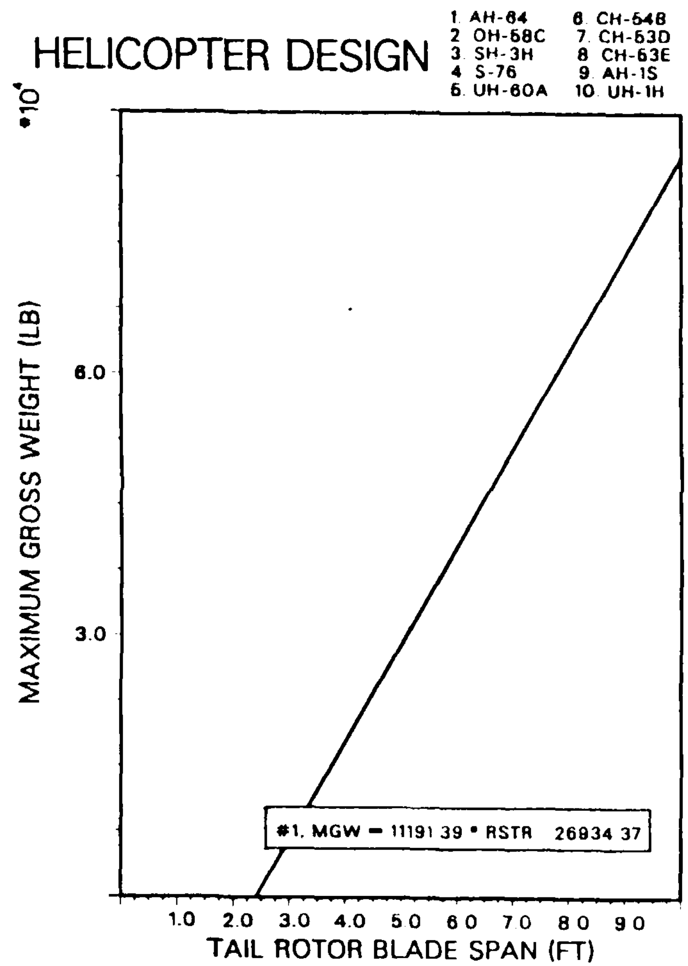


Fig. 11-30b.

Fig. 11-30a and 11-30b.

Twist of Main Rotor Blade Pairings.

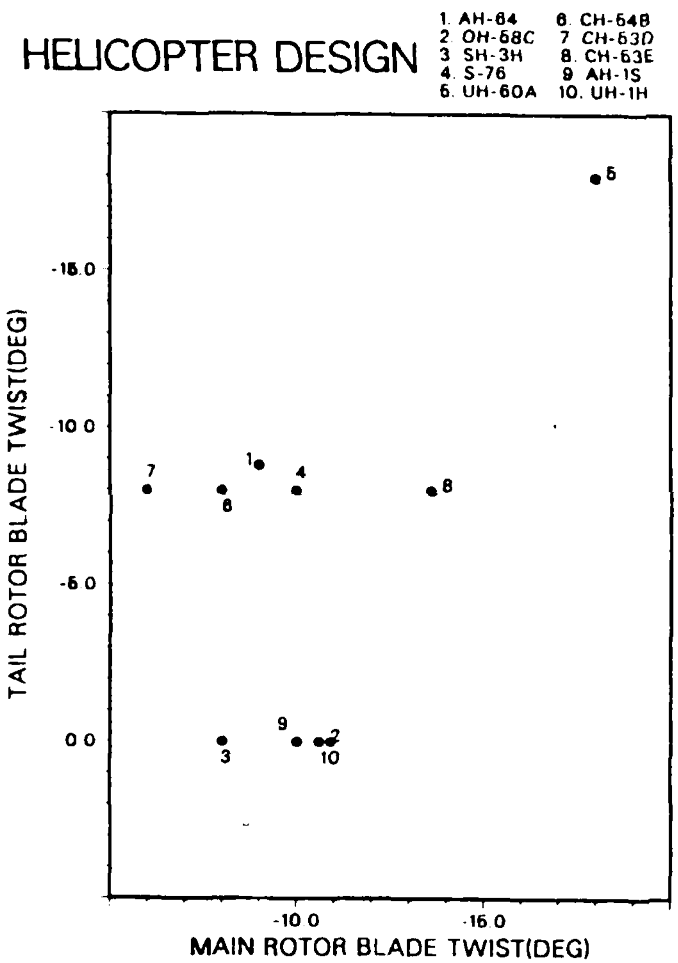


Fig. 12-13.

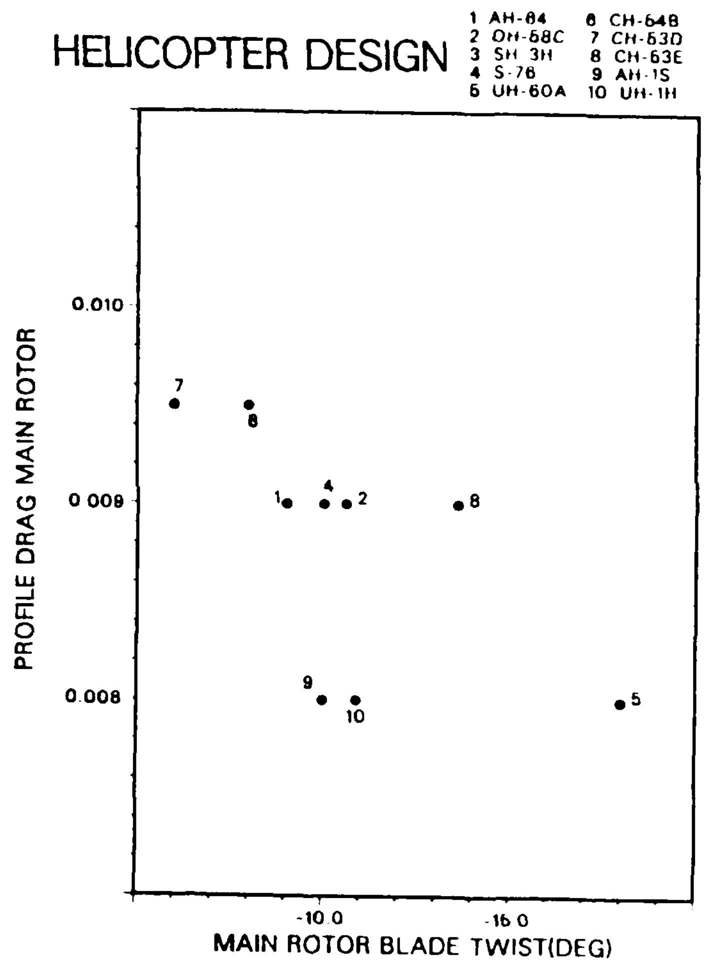


Fig. 12-14.

Fig. 12-13 and 12-14.

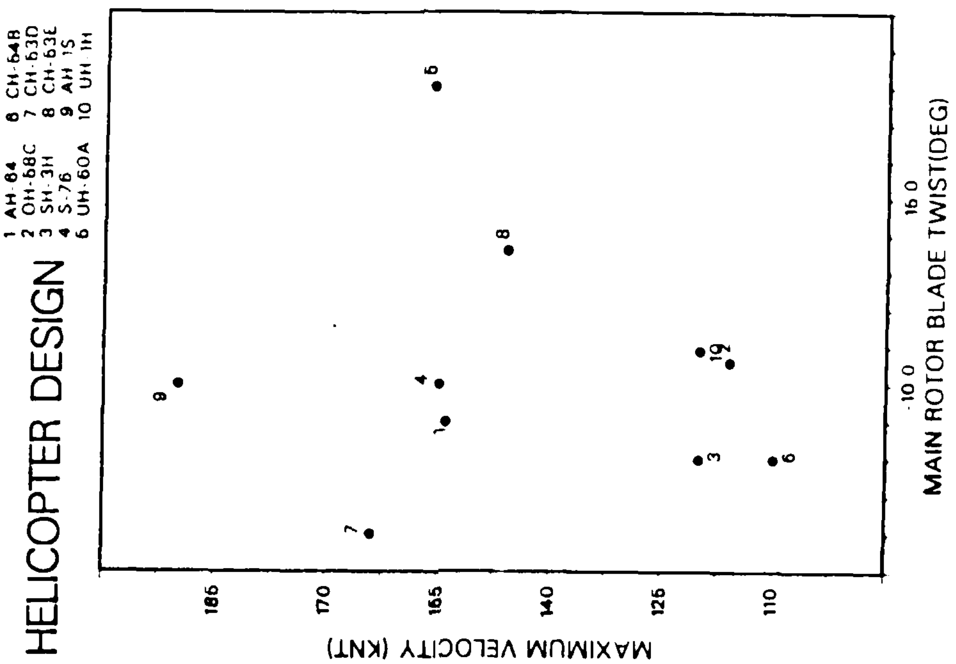


Fig. 12-21.

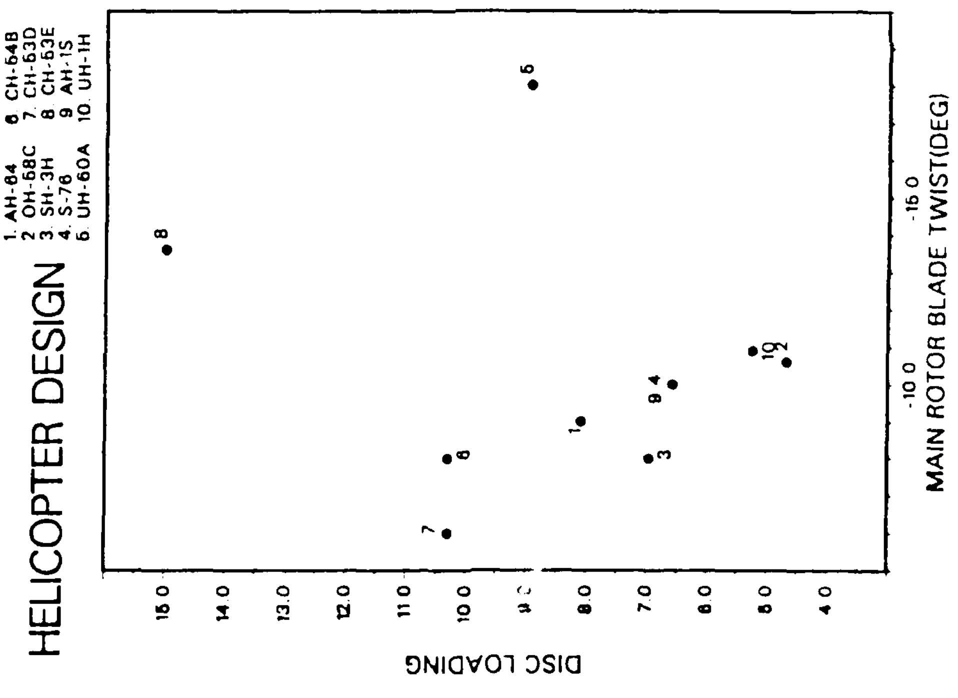


Fig. 12-16.

Fig. 12-16 and 12-21.

Twist of Tail Rotor Blade Pairings.

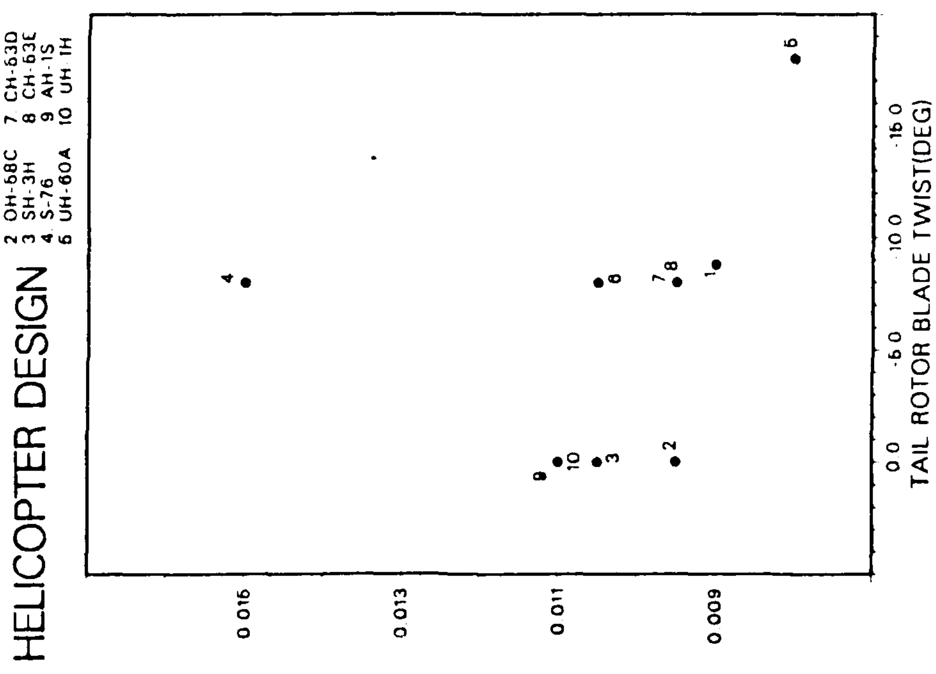


Fig. 13-15.

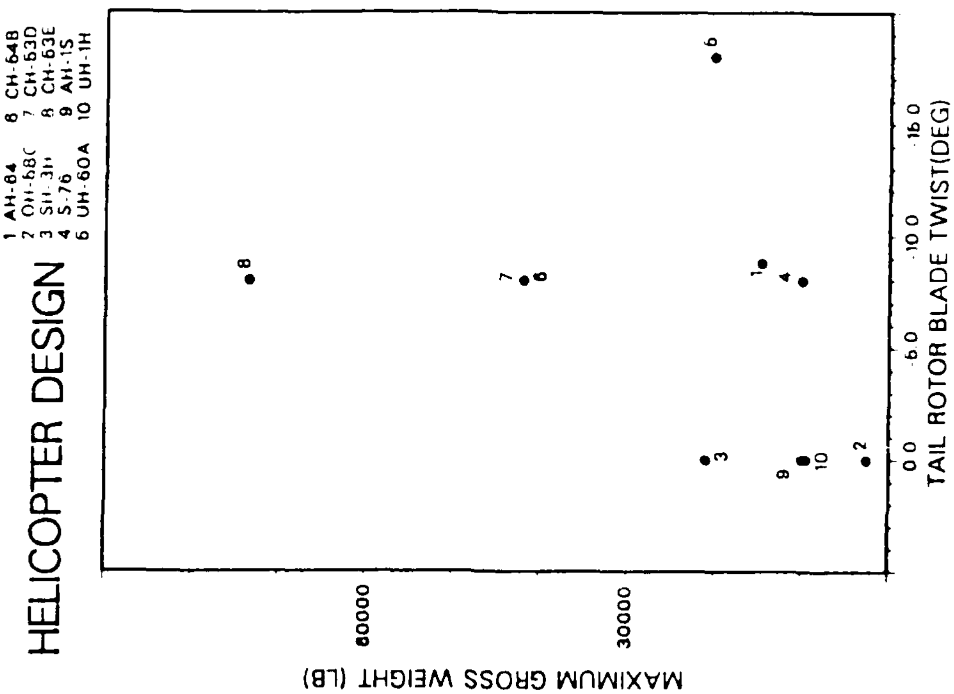


Fig. 13-30.

Fig. 13-15 and 13-30.

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Profile Drag of Main Rotor Blade Pairings.

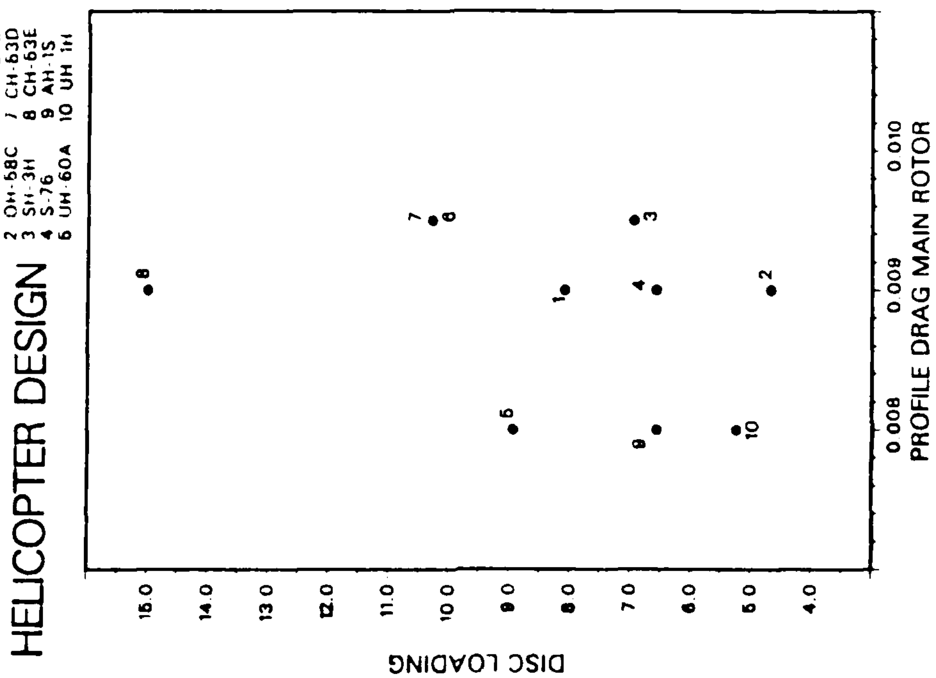


Fig. 14-16.

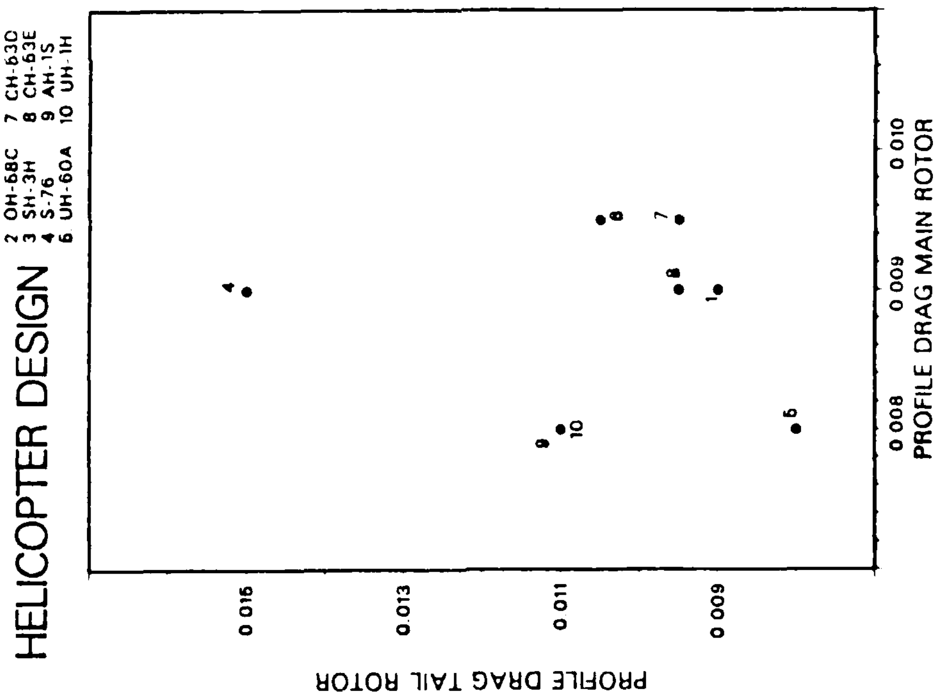


Fig. 14-15.

Fig. 14-15 and 14-16.

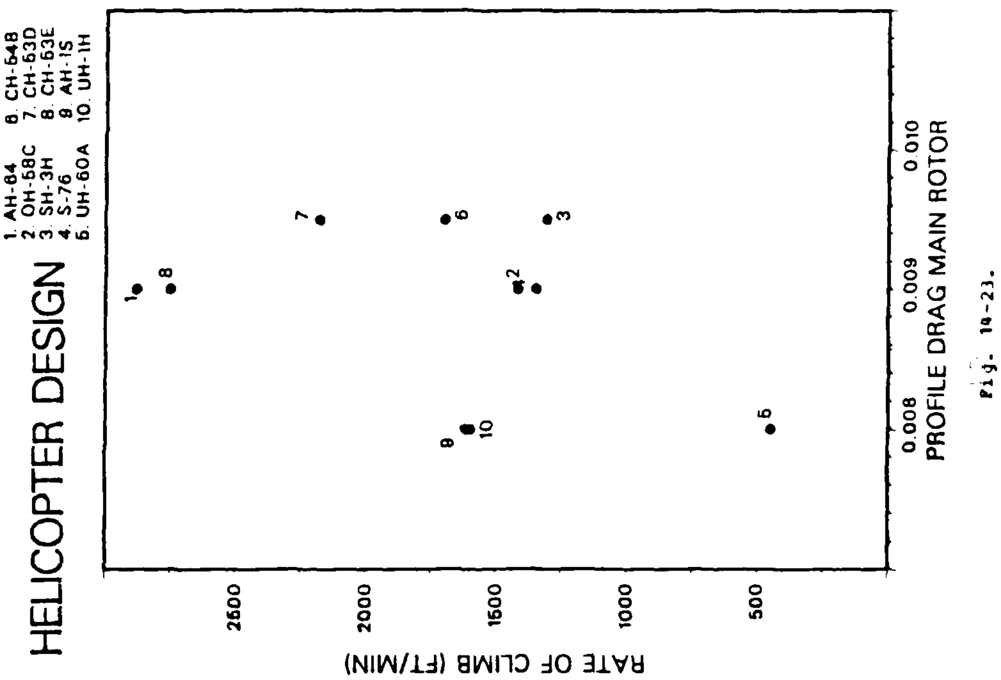


Fig. 14-23.

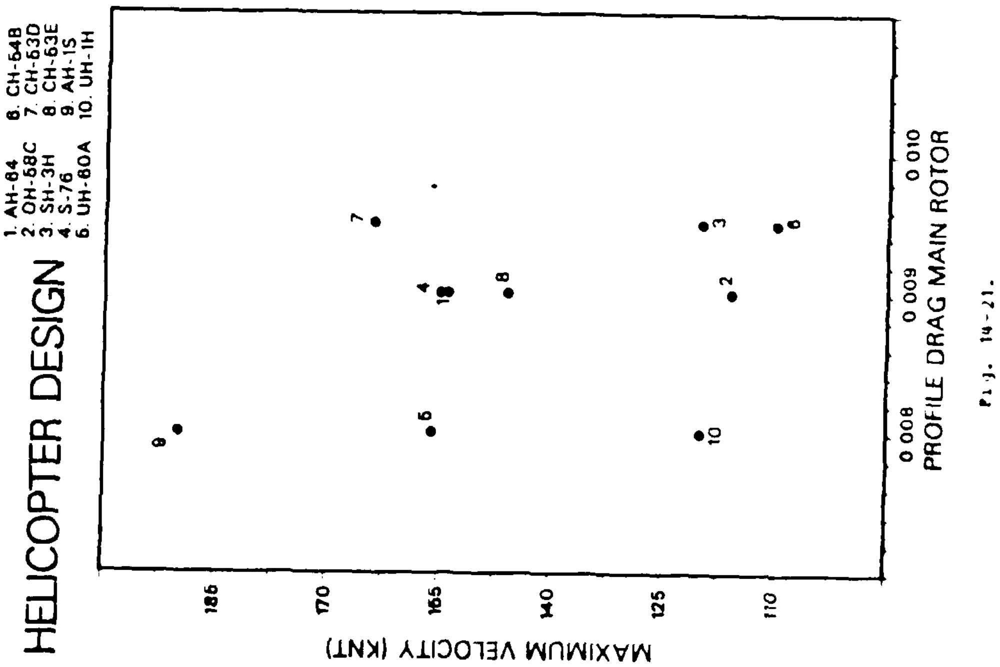


Fig. 14-21.

Fig. 14-21 and 14-23.

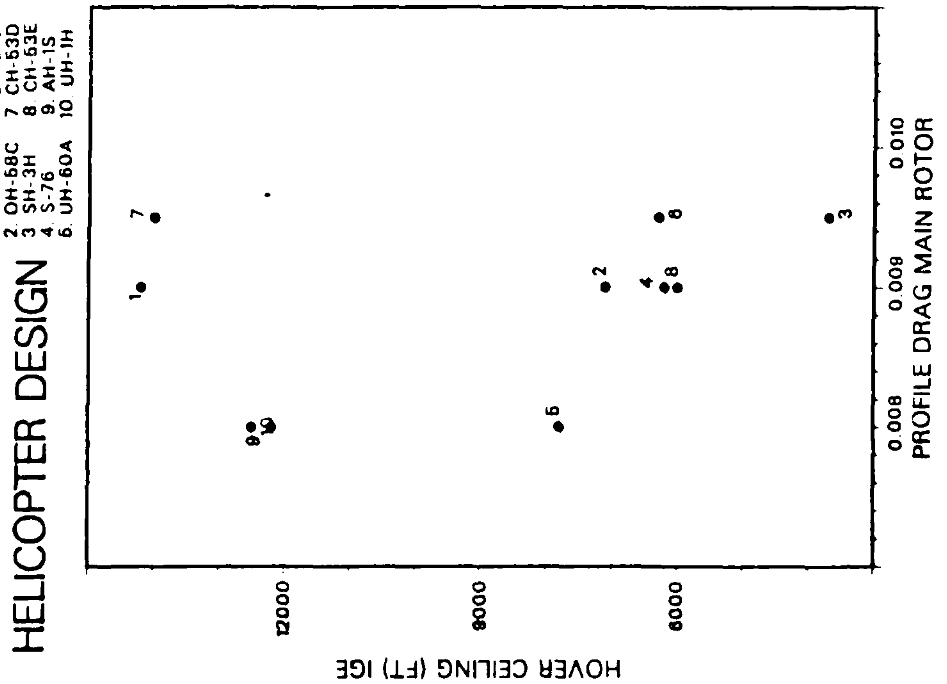


Fig. 14-24.

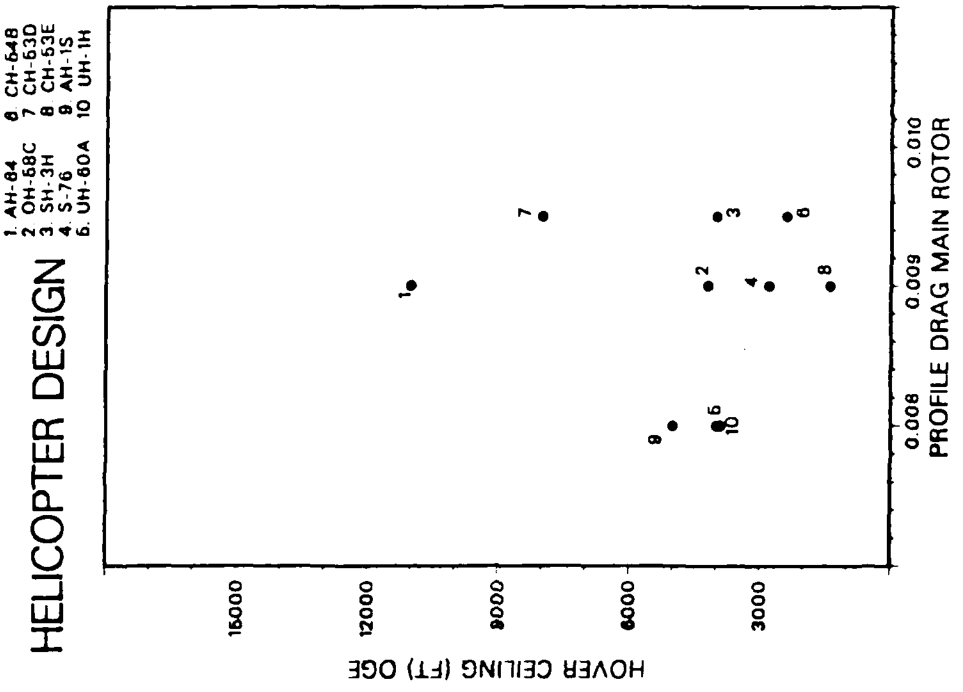


Fig. 14-25.

Fig. 14-24 and 14-25.

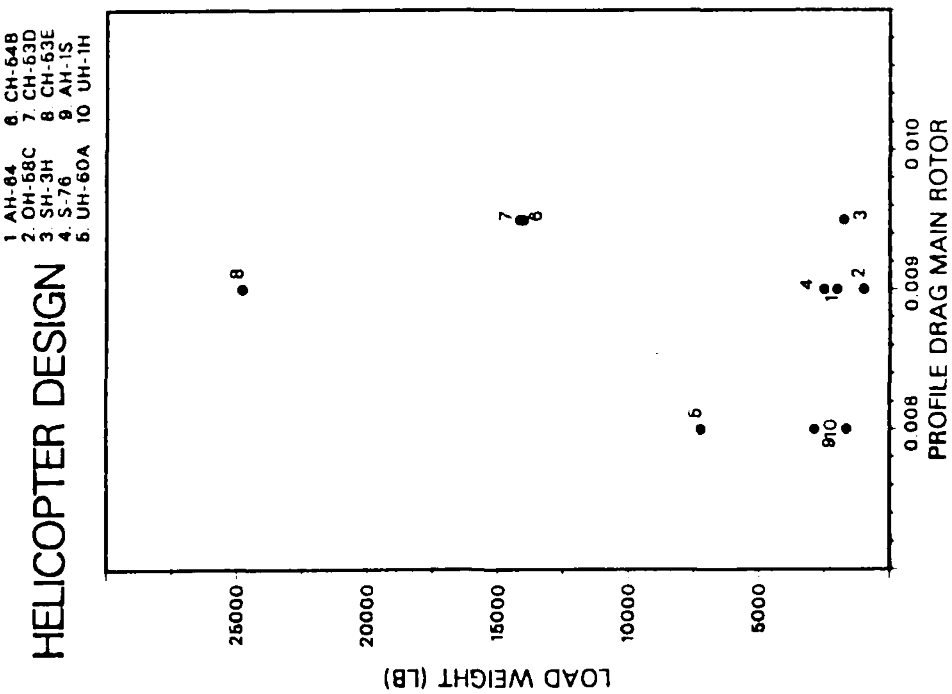


Fig. 14-28.

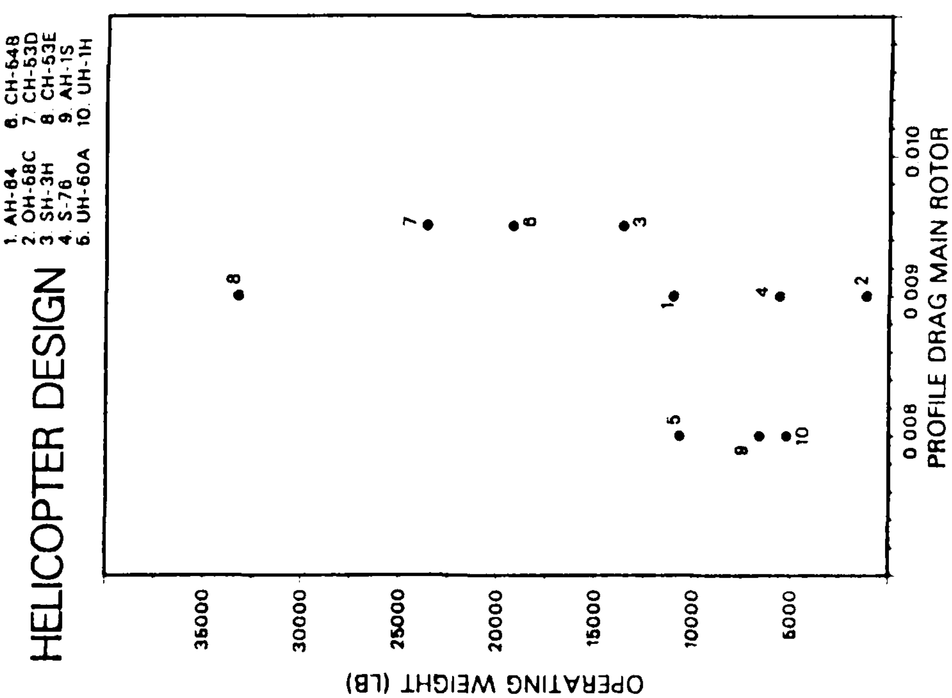


Fig. 14-27.

Fig. 14-27 and 14-28.

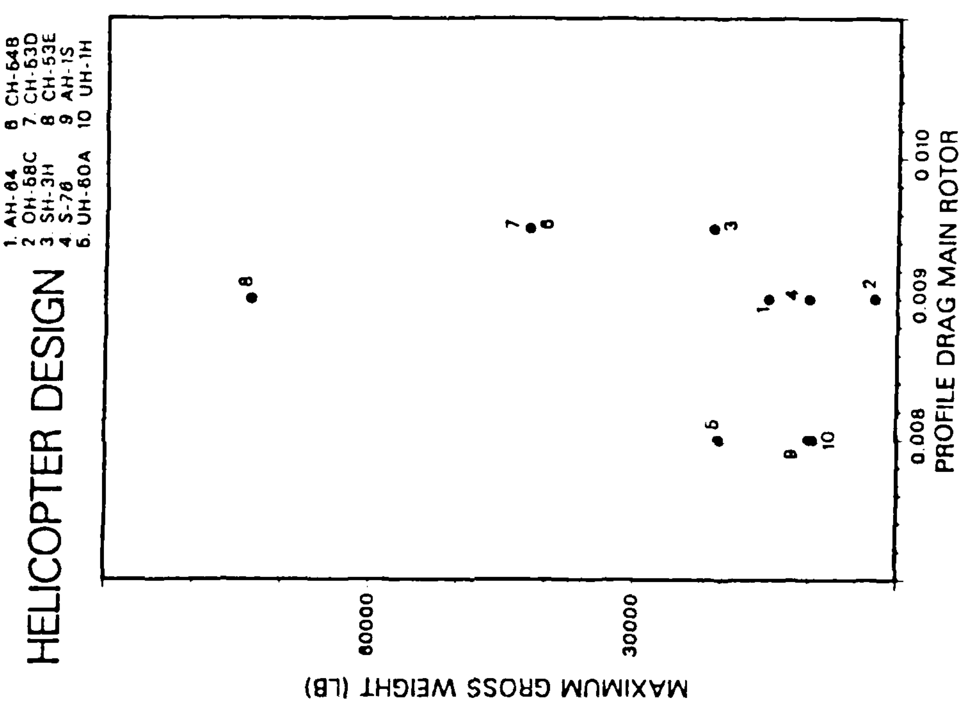


Fig. 14-30.

Fig. 14-30.

Profile Drag of Tail Rotor Blade Pairings.

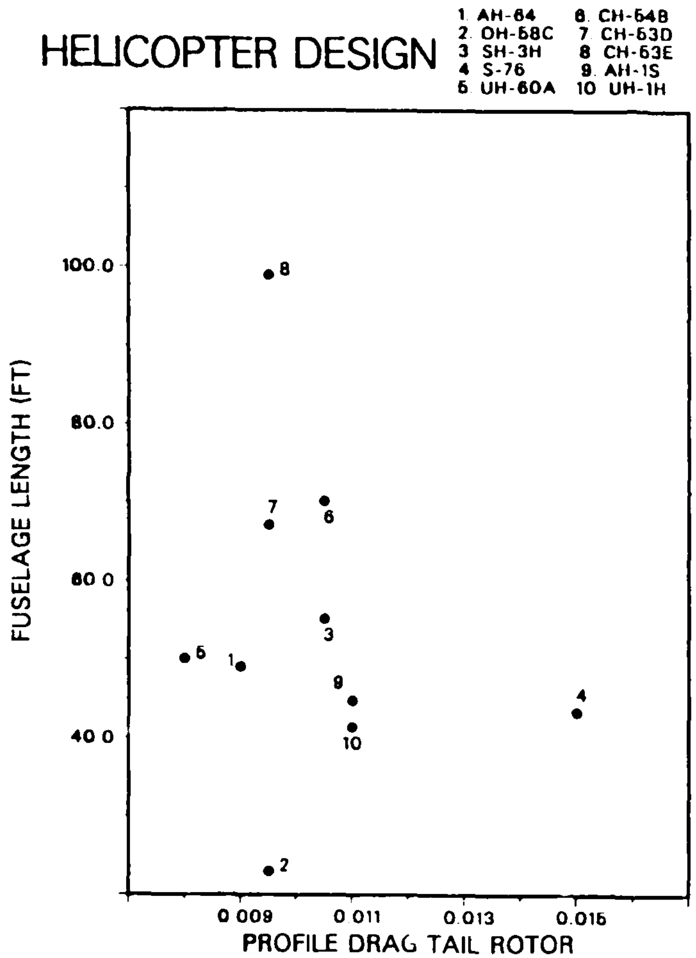


Fig. 15-18.

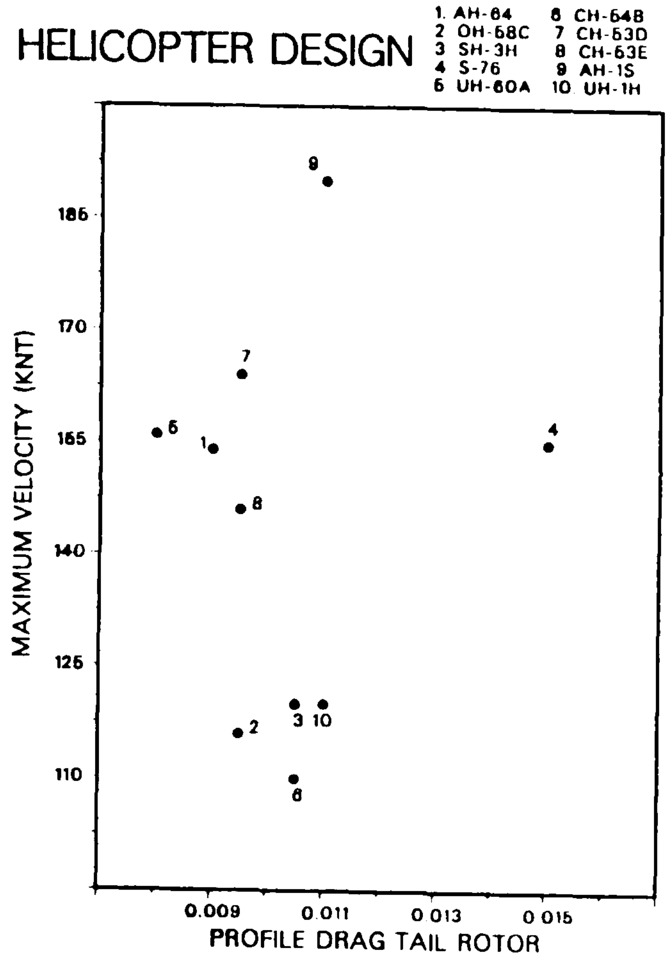


Fig. 15-21.

Fig. 15-18 and 15-21.

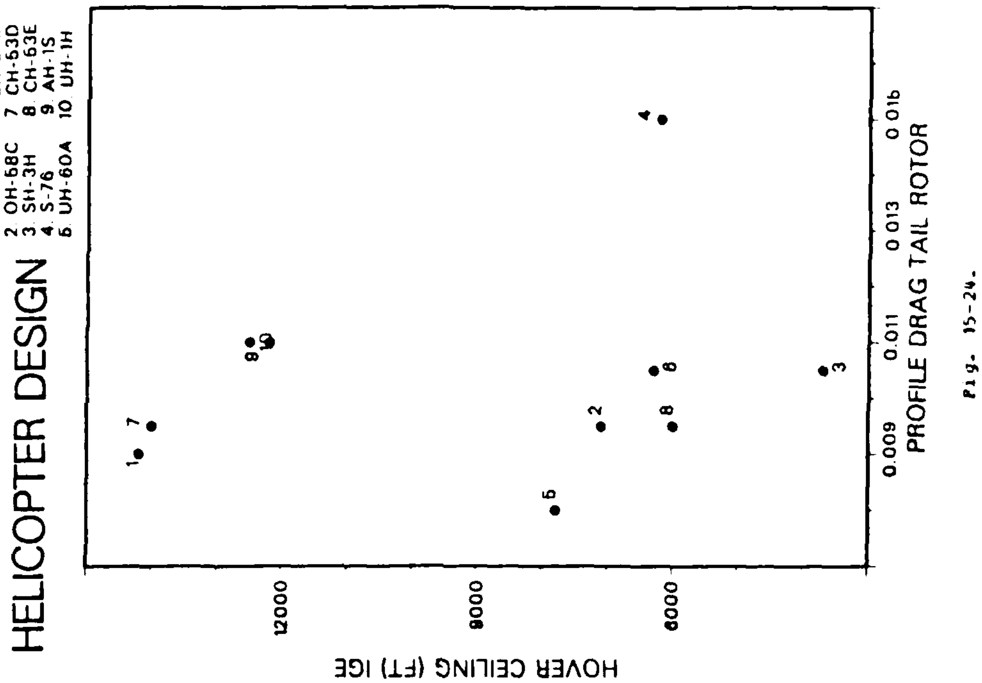


Fig. 15-24.

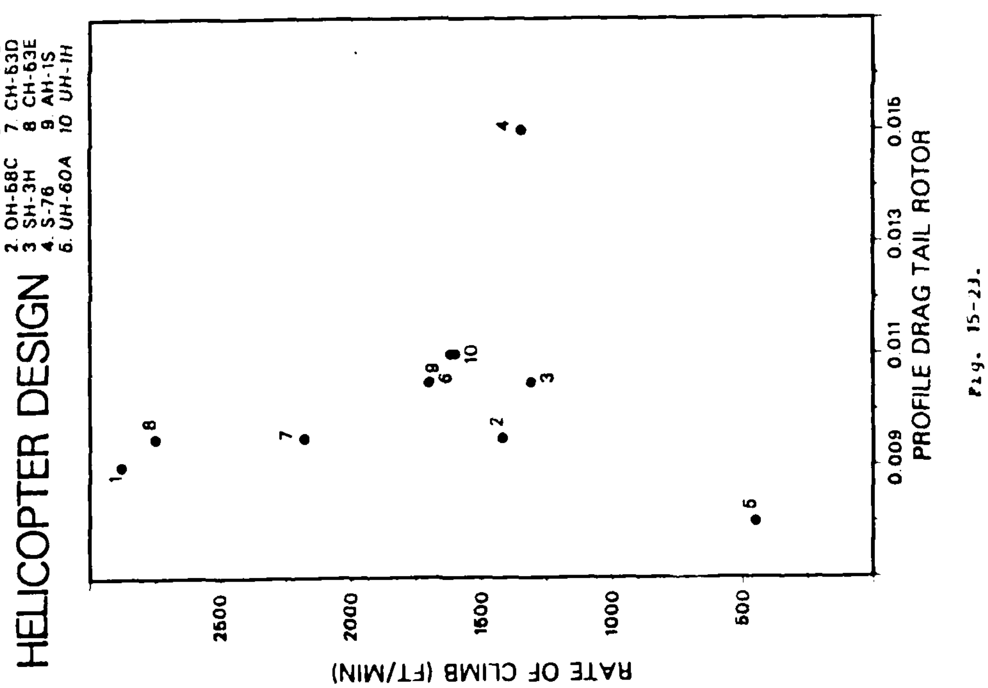


Fig. 15-23.

Fig. 15-23 and 15-24.

Fig. 15-25 and 15-26.

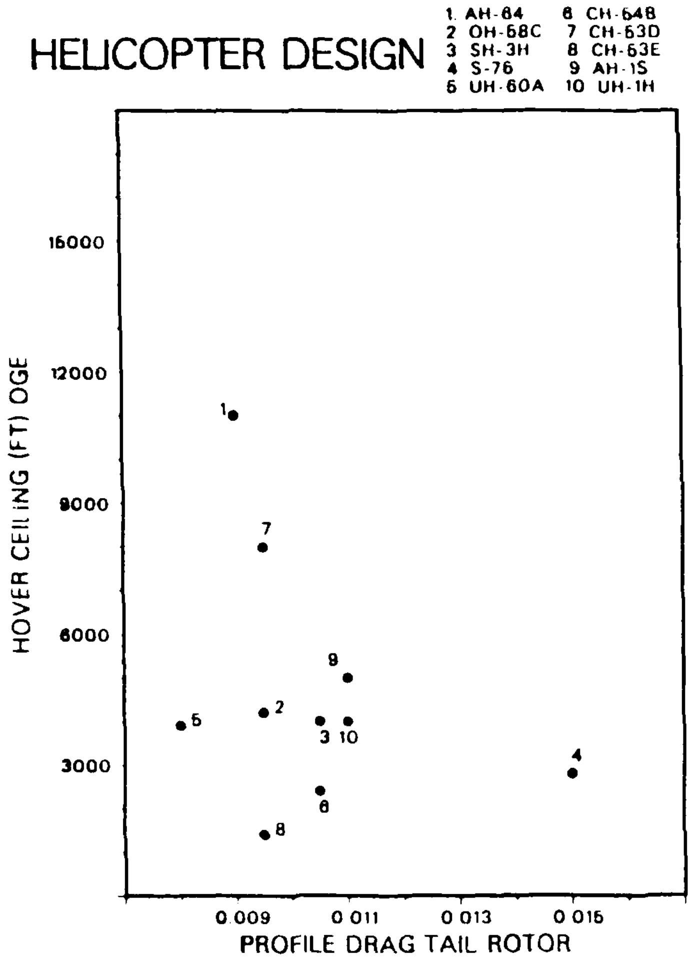


Fig. 15-25.

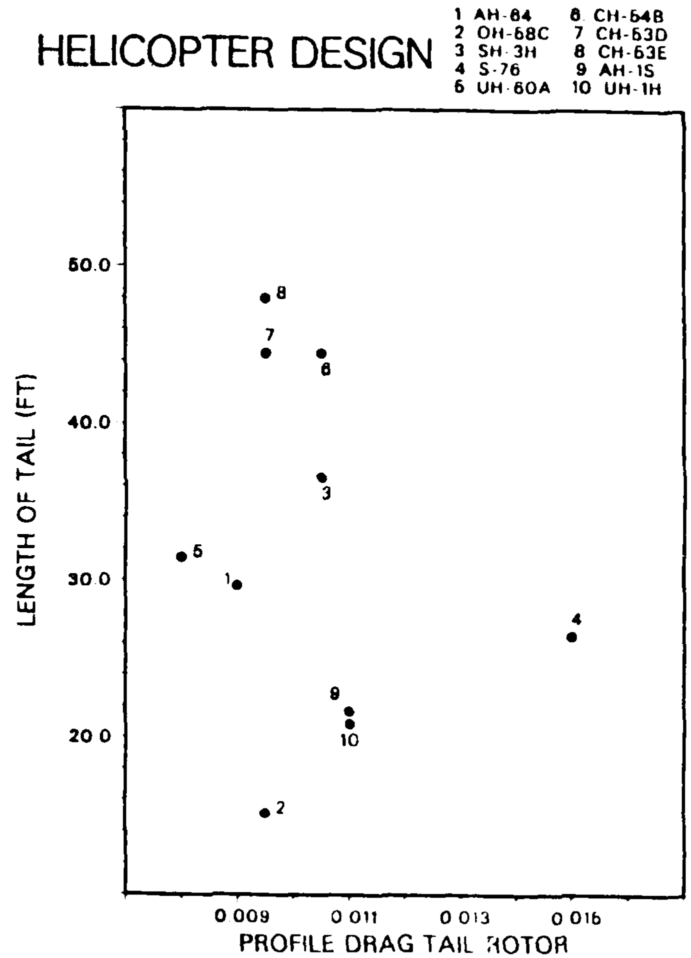


Fig. 15-26.

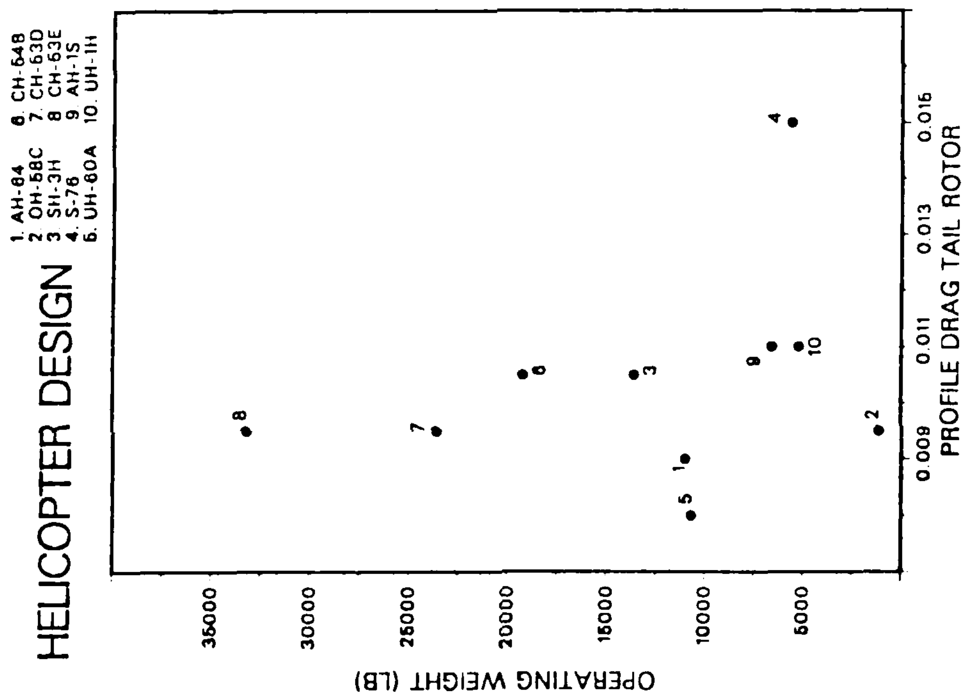


Fig. 15-27.

Fig. 15-27.

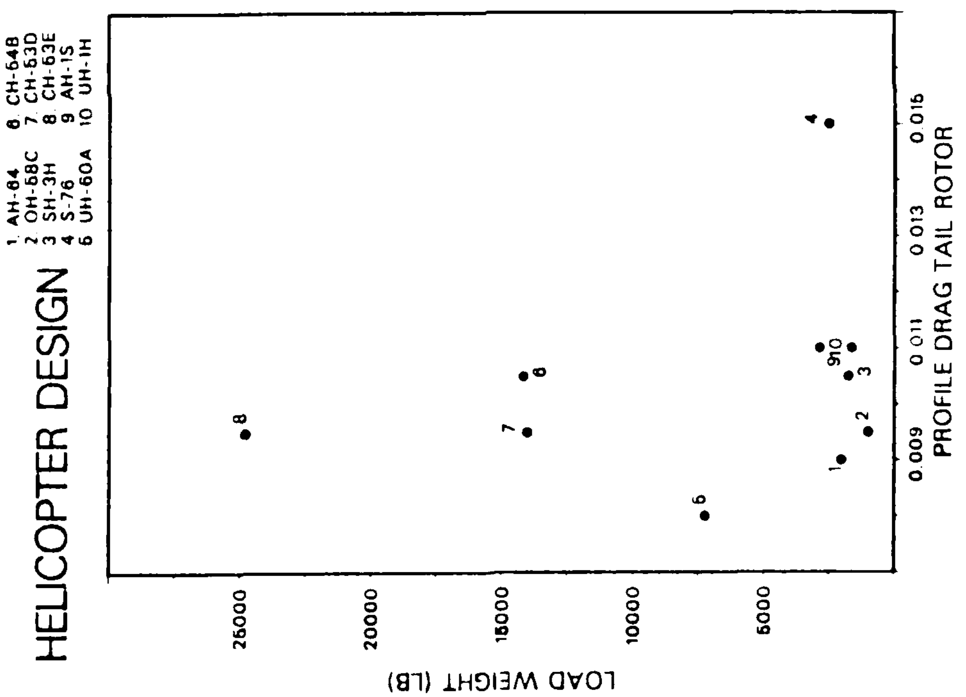


Fig. 15-28a.

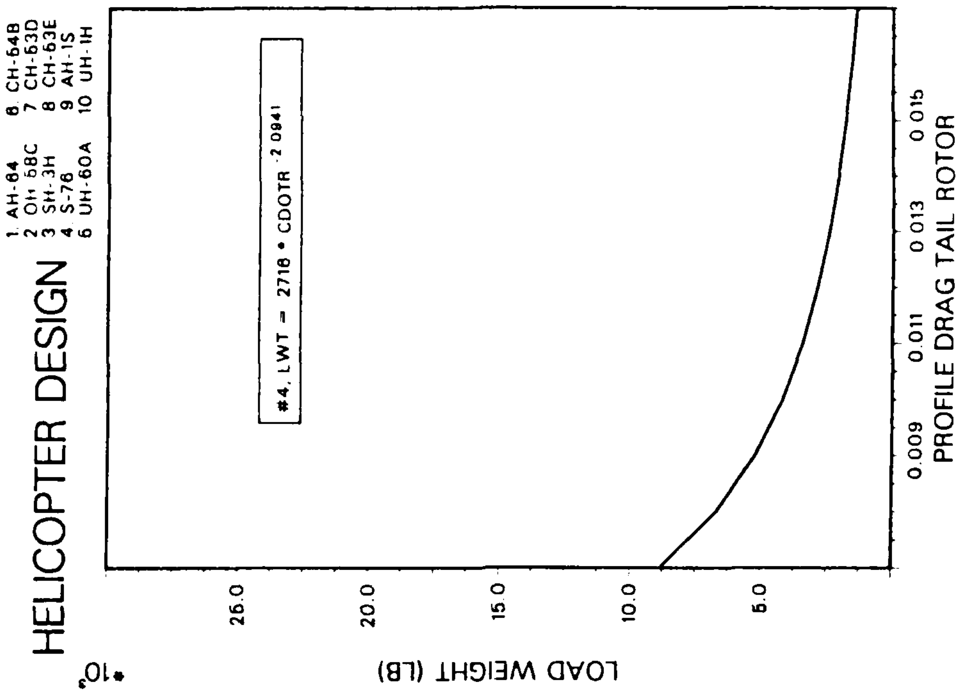


Fig. 15-28b.

Fig. 15-28a and 15-28b.

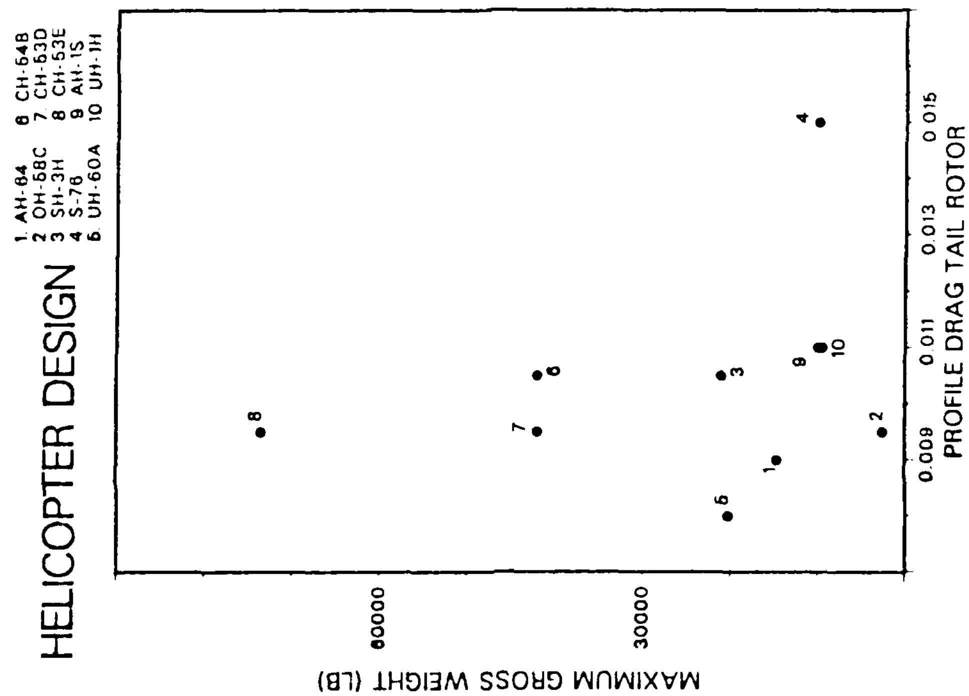


Fig. 15-30.

Fig. 15-30.

Disc Loading of the Main Rotor System Pairings.

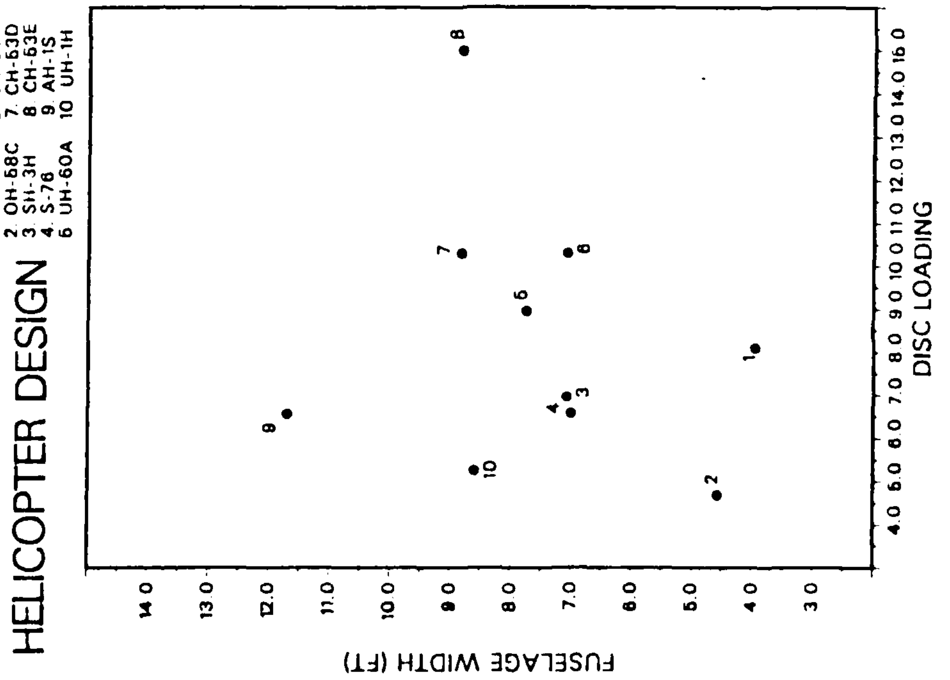


Fig. 16-17.

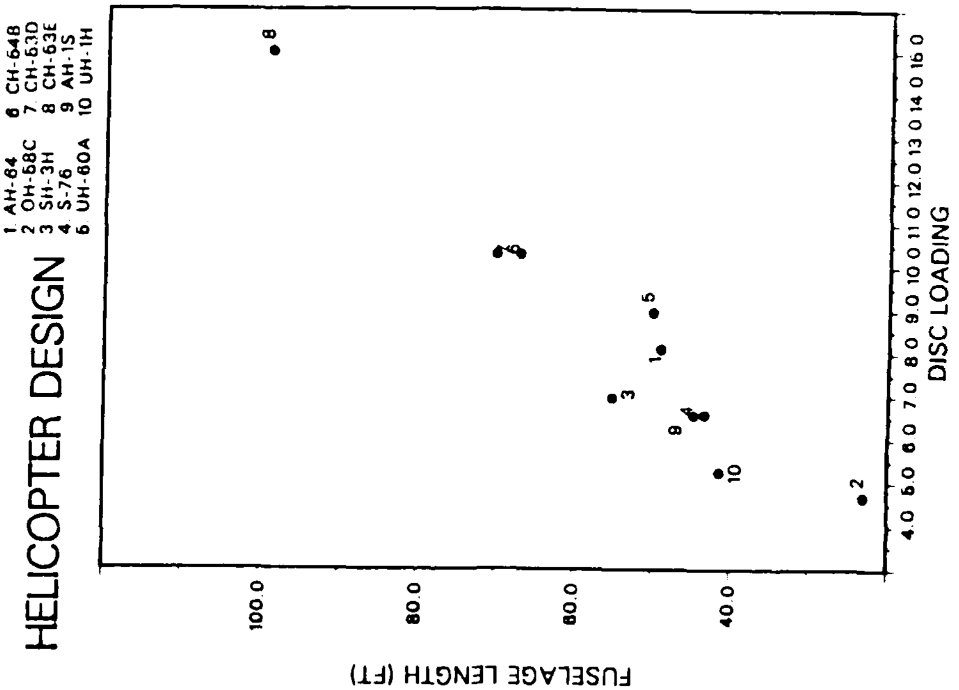


Fig. 16-18.

Fig. 16-17 and 16-18.

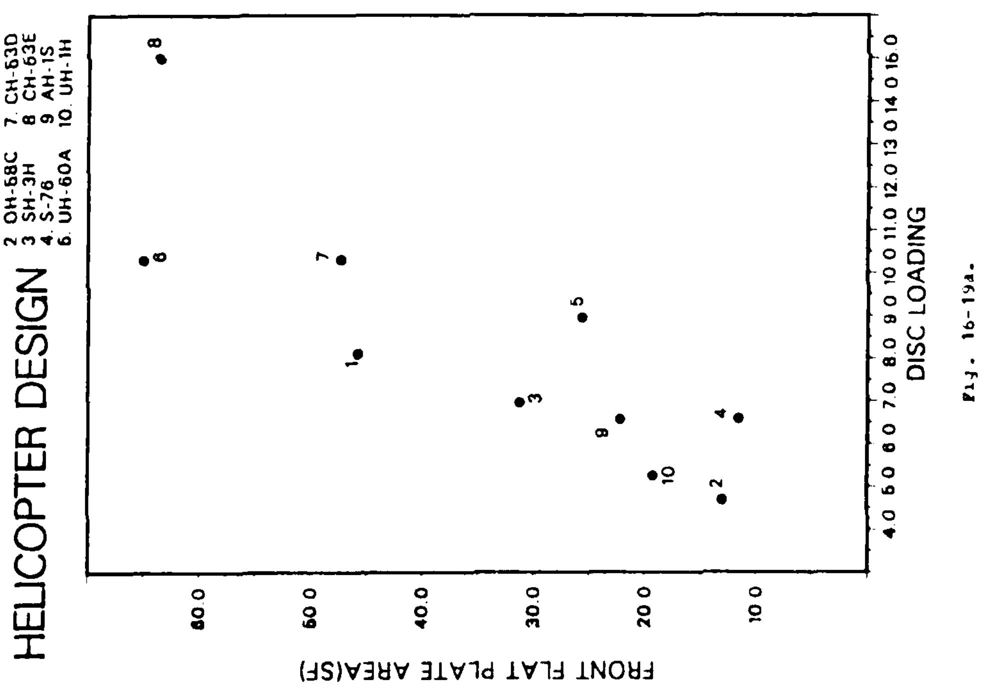


Fig. 16-19a.

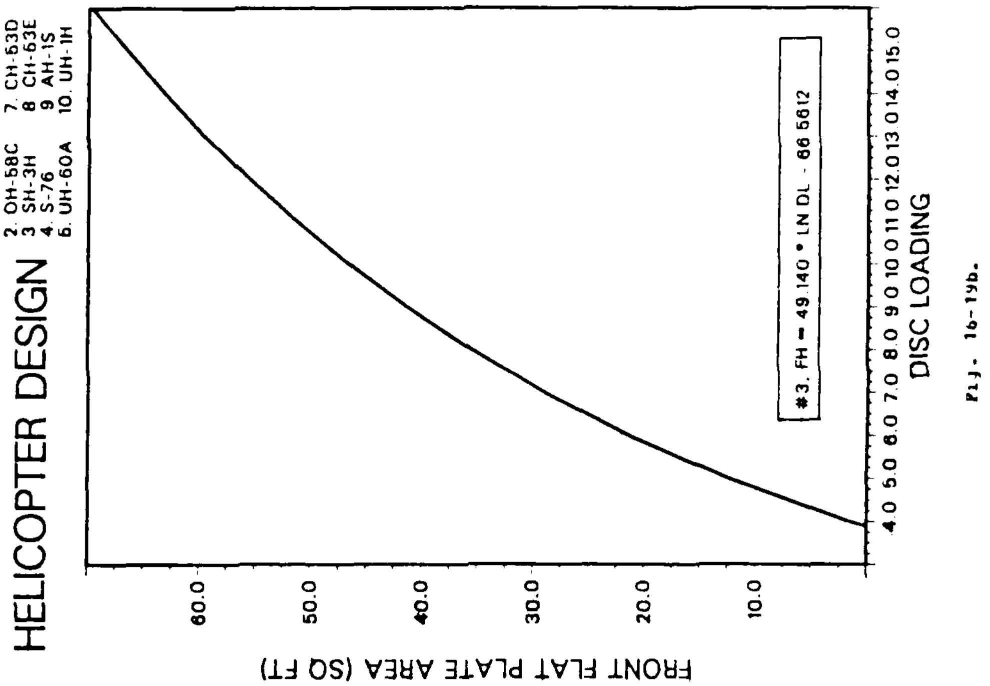


Fig. 16-19b.

Fig. 16-19a and 16-19b.

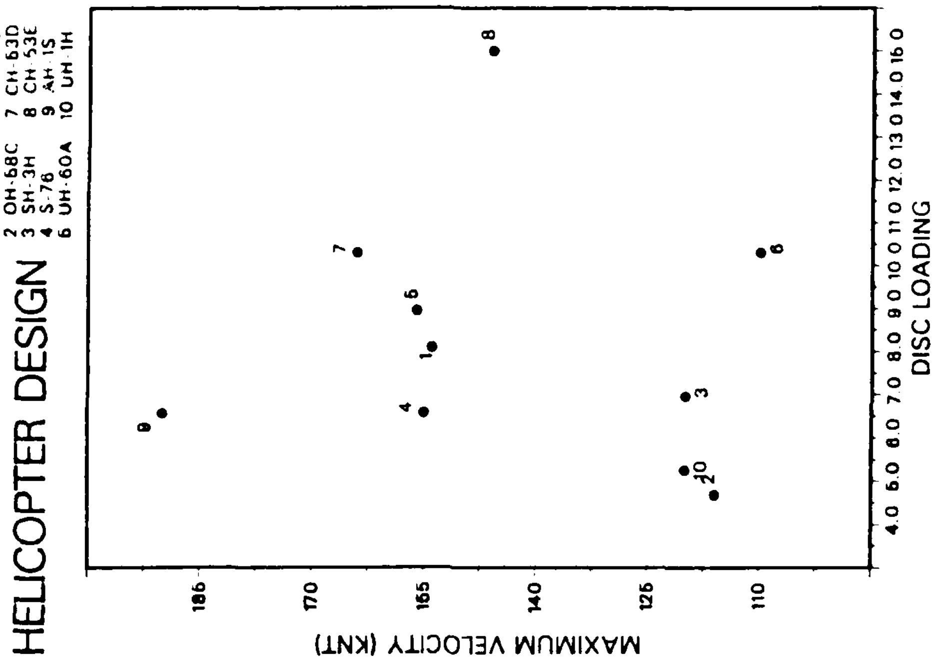


Fig. 16-21.

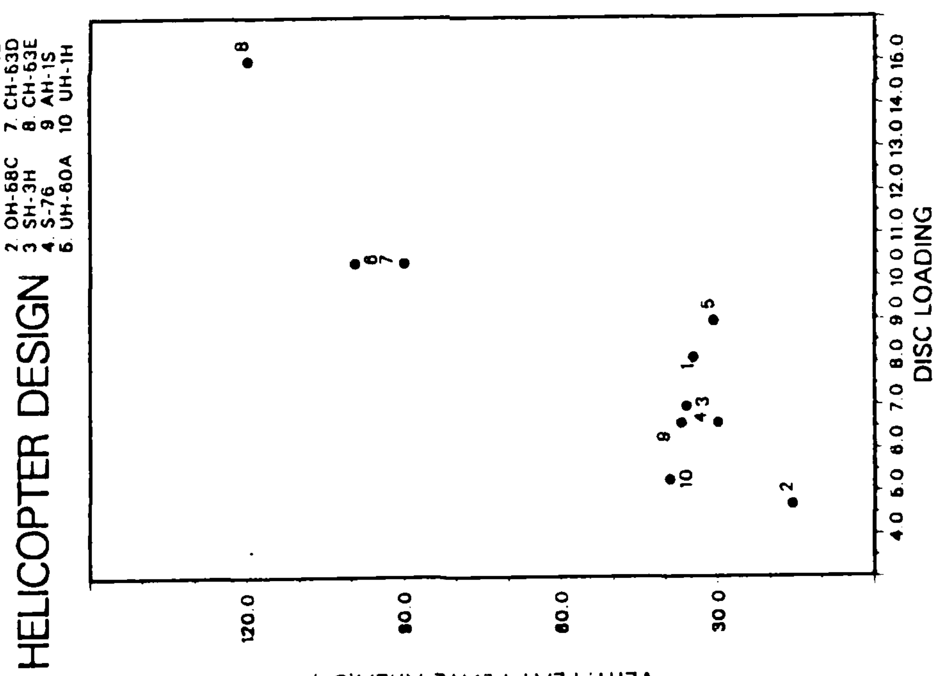


Fig. 16-20.

Fig. 16-20 and 16-21.

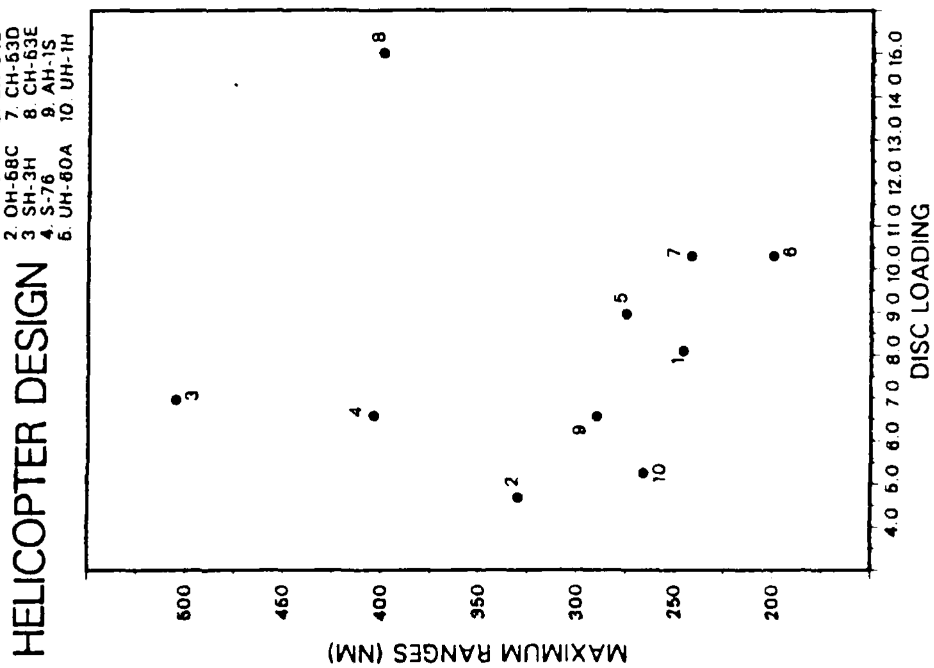


Fig. 16-22.

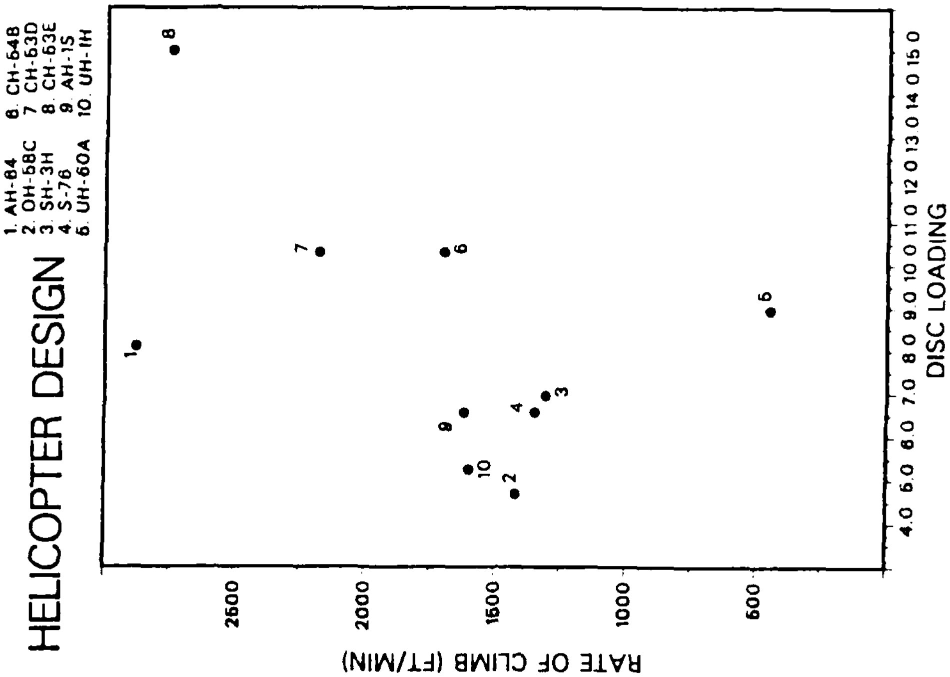


Fig. 16-23.

Fig. 16-22 and 16-23.

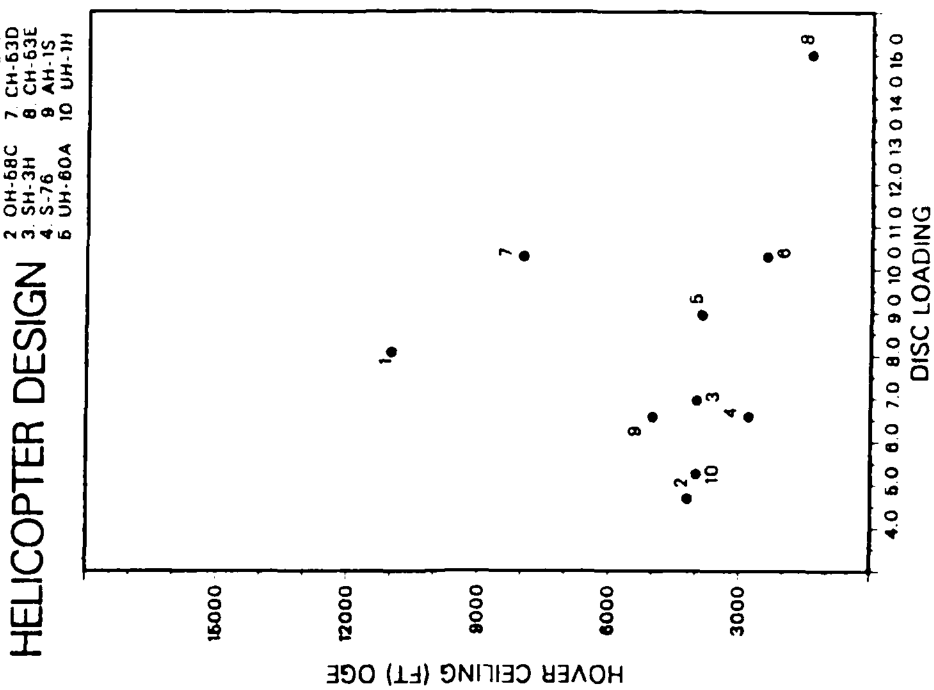


Fig. 16-25.

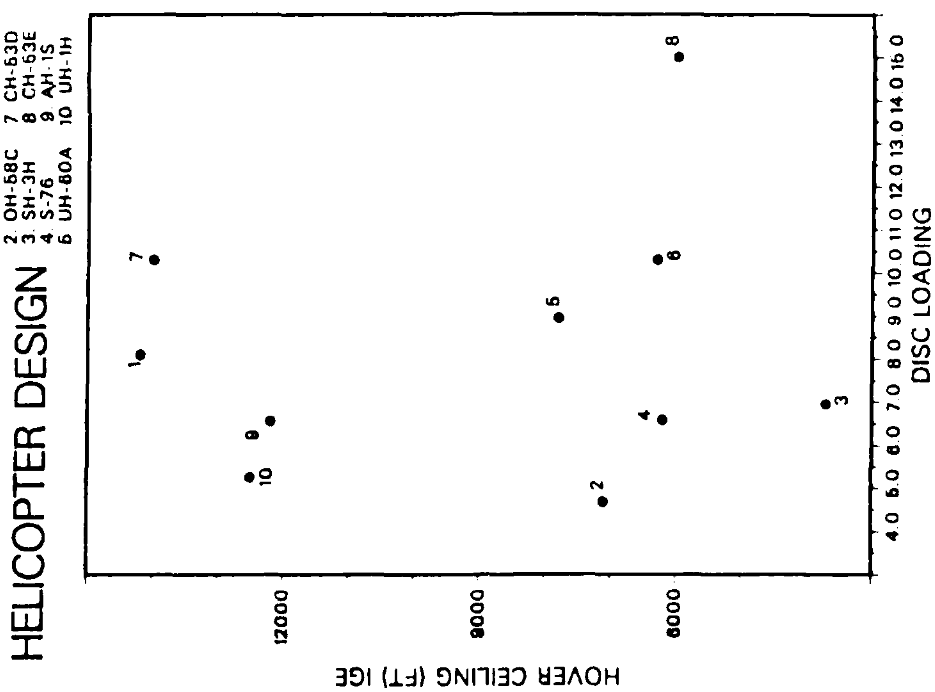


Fig. 16-24.

Fig. 16-24 and 16-25.

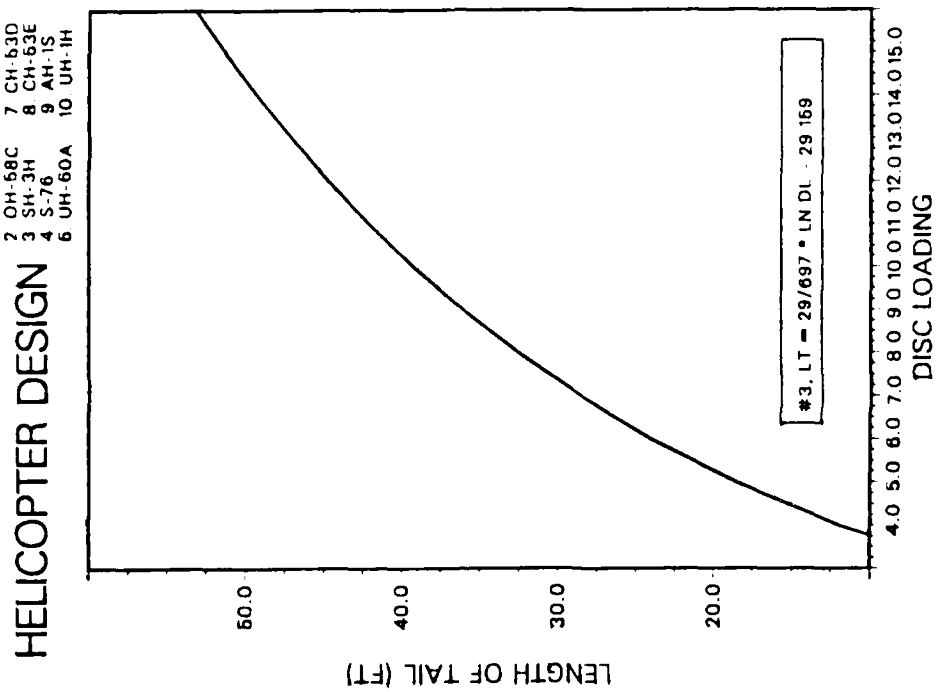


Fig. 16-26b.

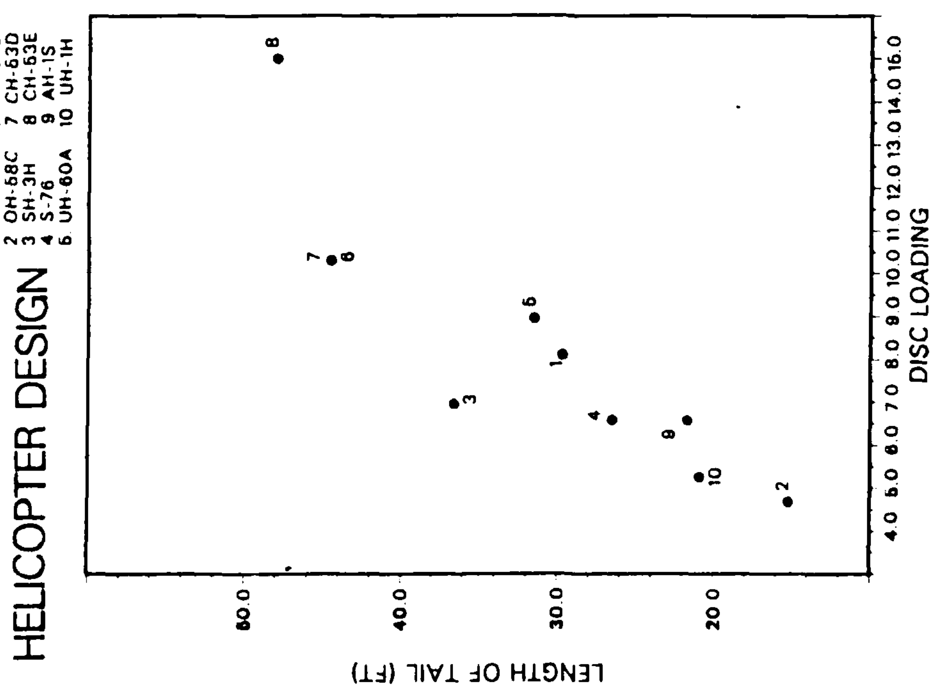
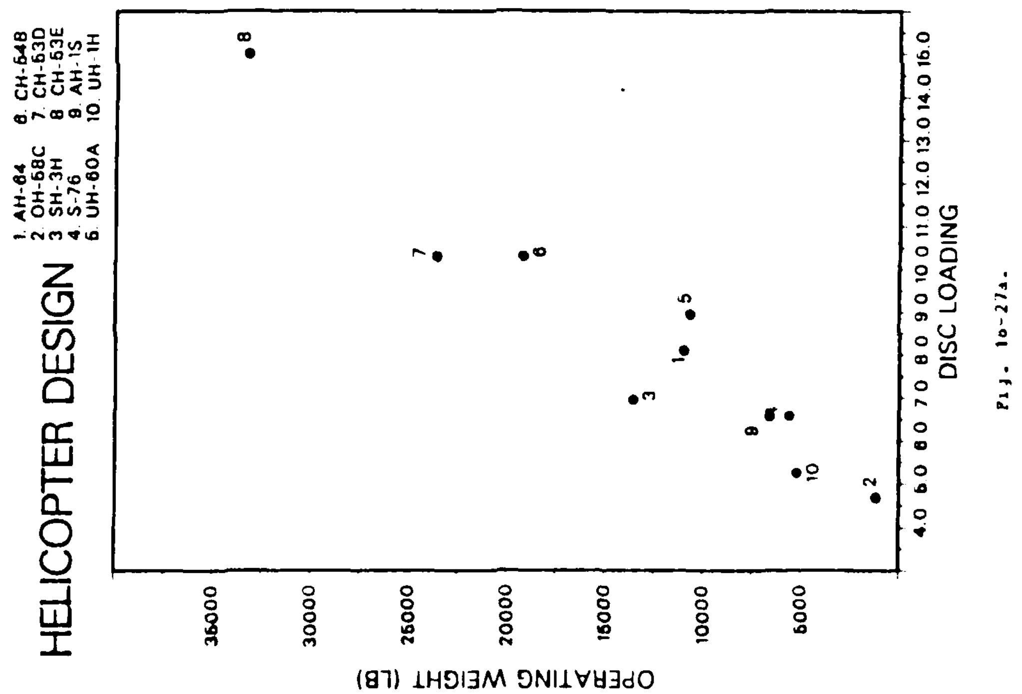


Fig. 16-26a.

Fig. 16-26a and 16-26b.



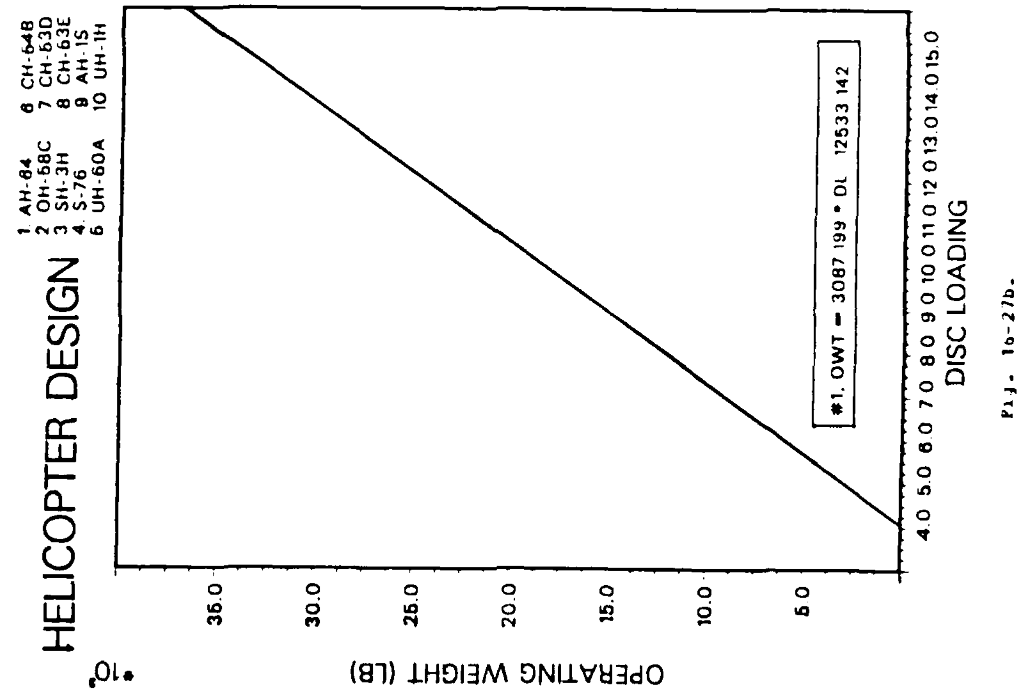


Fig. 1b-27a and 1b-27b.

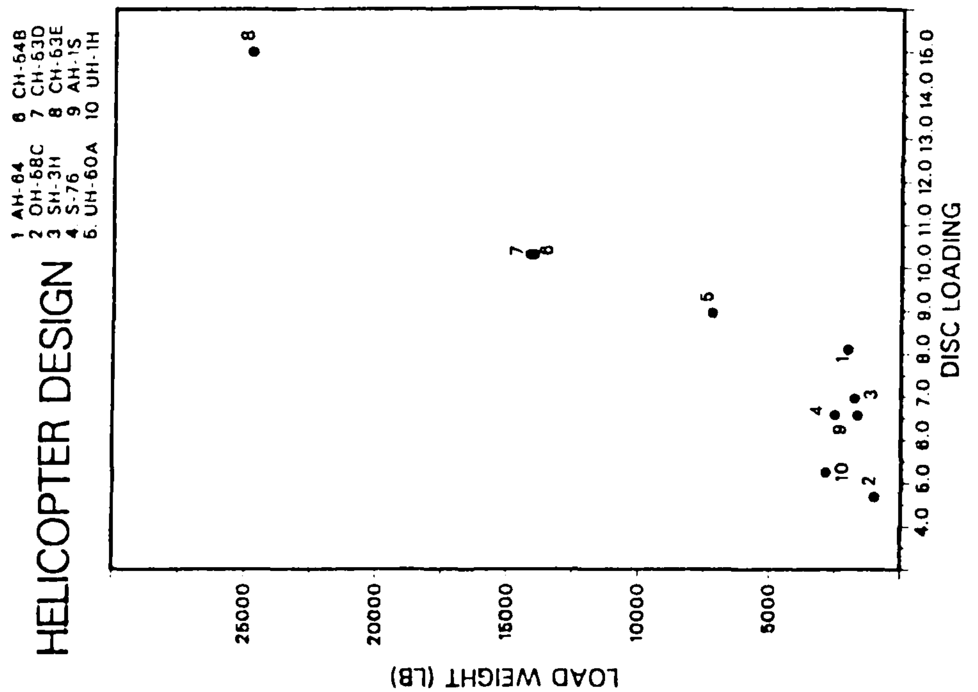
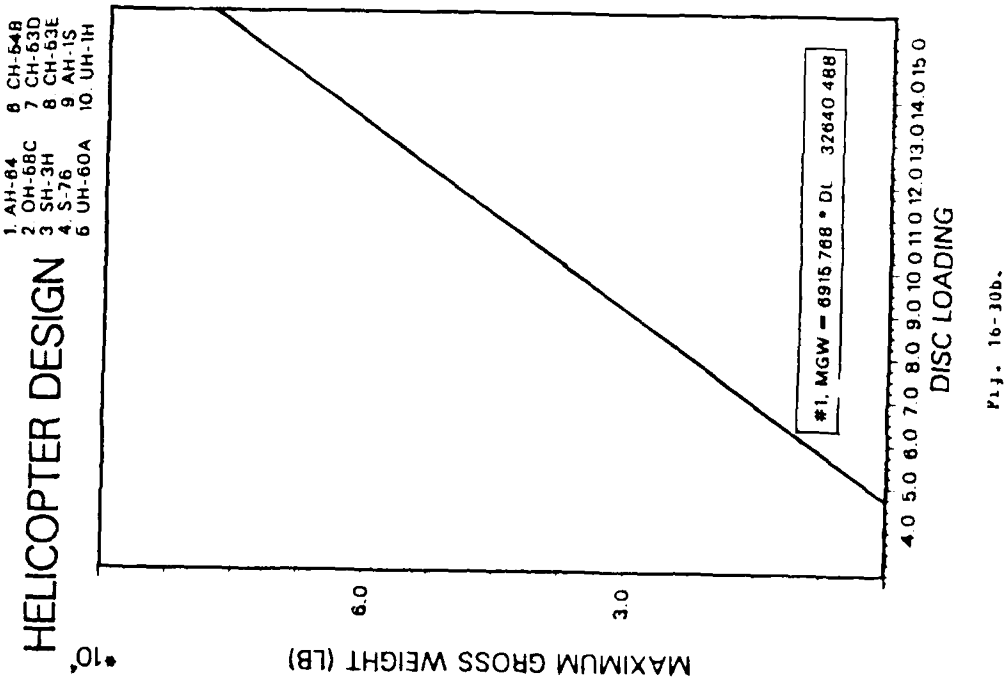

HELICOPTER DESIGN
1 AH-64
2 OH-58C
3 SH-3H
4 S-76
5 UH-60A
6 CH-54B
7 CH-53D
8 CH-53E
9 AH-1S
10 UH-1H
LOAD WEIGHT (LB)
25000
20000
15000
10000
5000
DISC LOADING
4.0 5.0 6.0 7.0 8.0 9.0 10.0 11.0 12.0 13.0 14.0 15.0

Fig. 16-28.



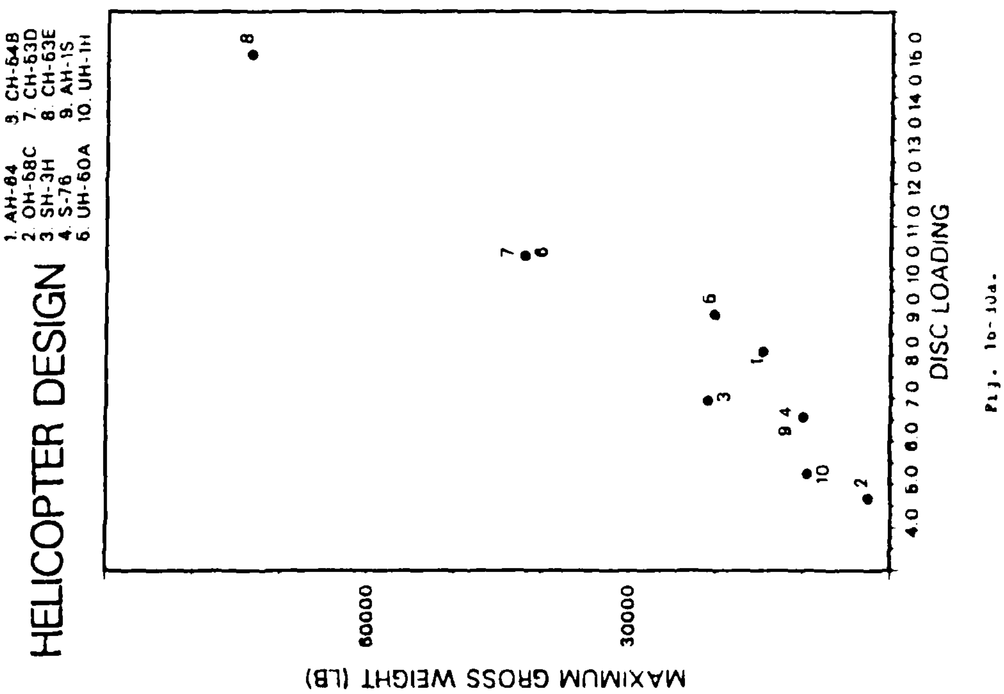


Fig. 16-30a and 16-30b.

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Width of the Fuselage Pairings.

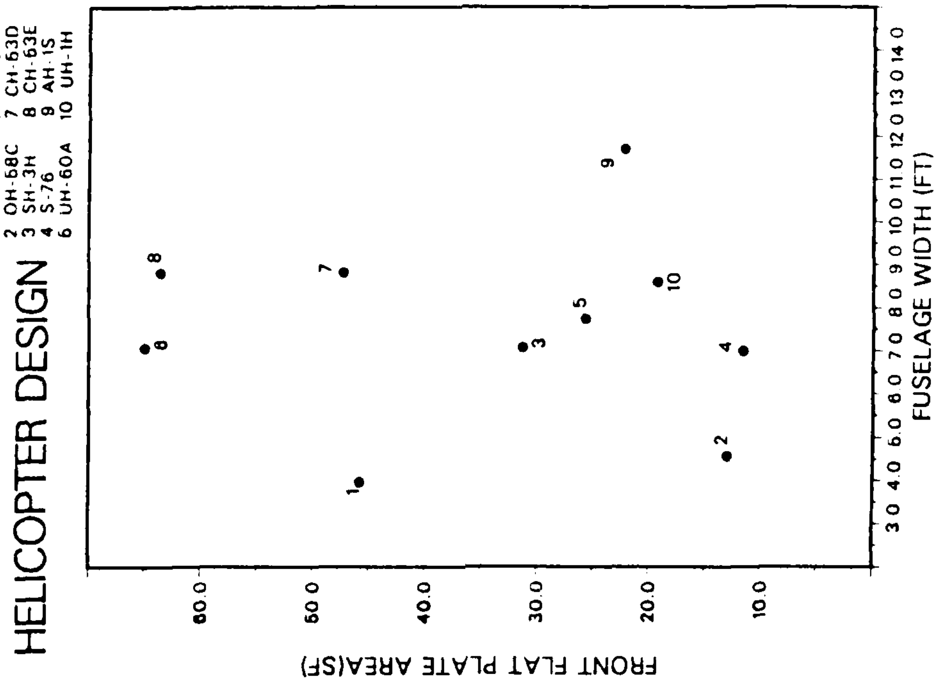


Fig. 17-19.

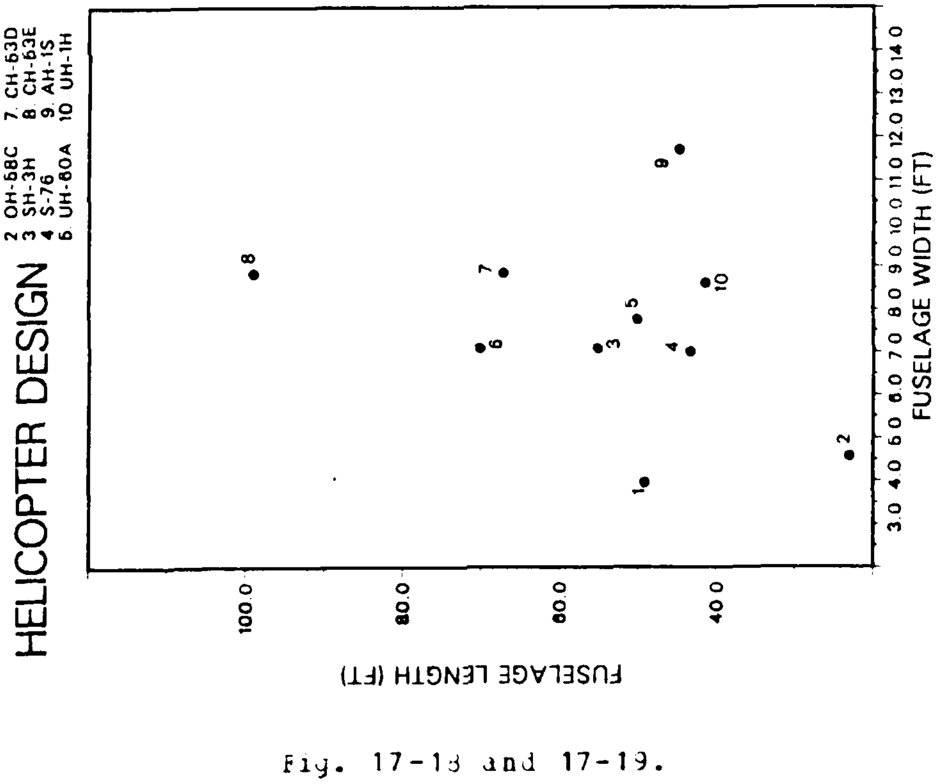


Fig. 17-18.

Fig. 17-18 and 17-19.

Fig. 17-20 and 17-21.

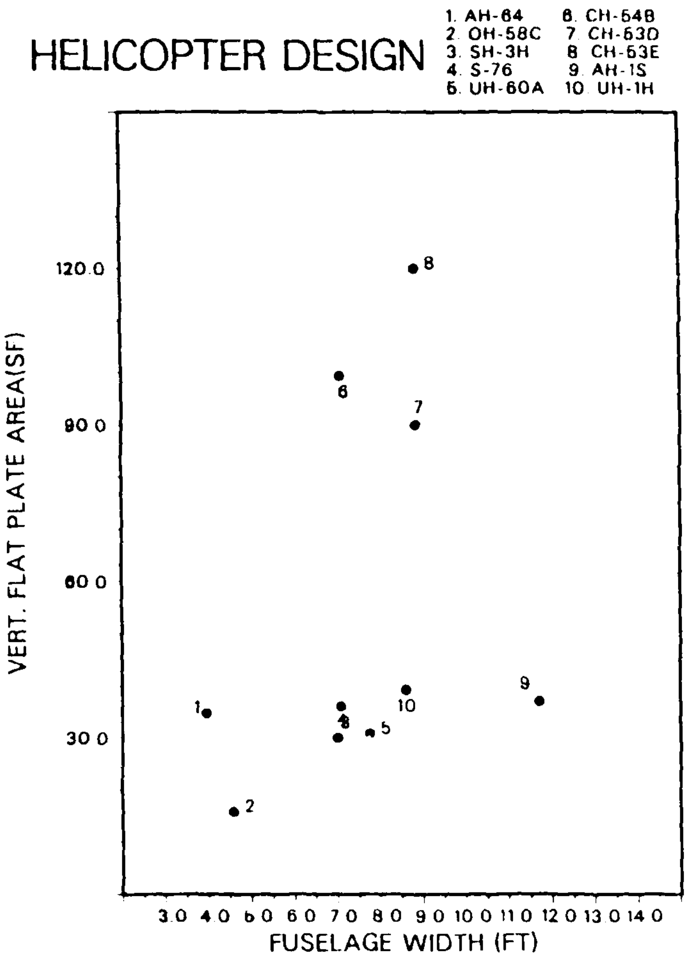


Fig. 17-20.

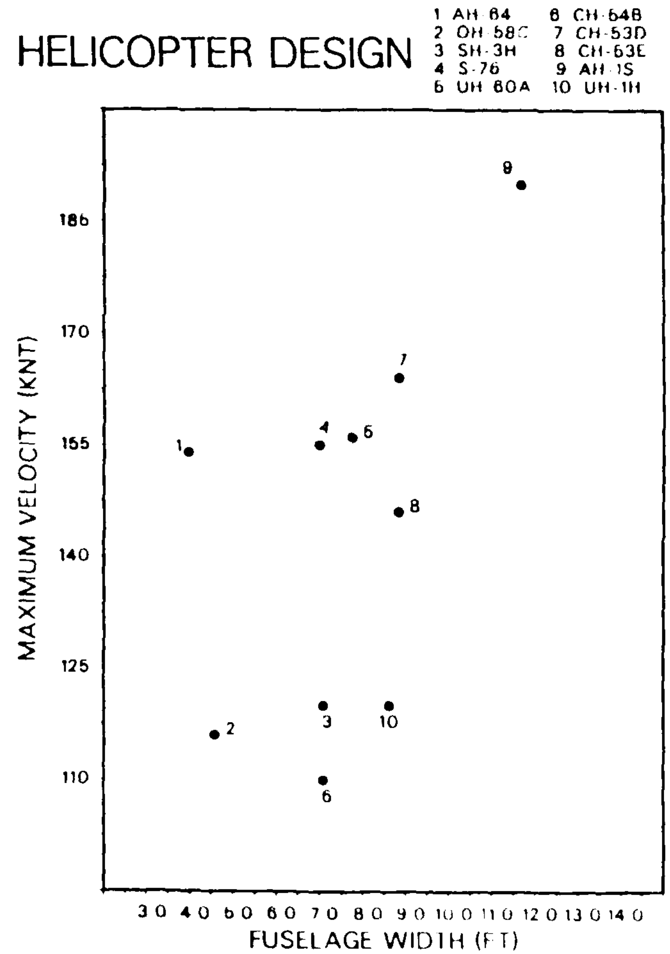


Fig. 17-21.

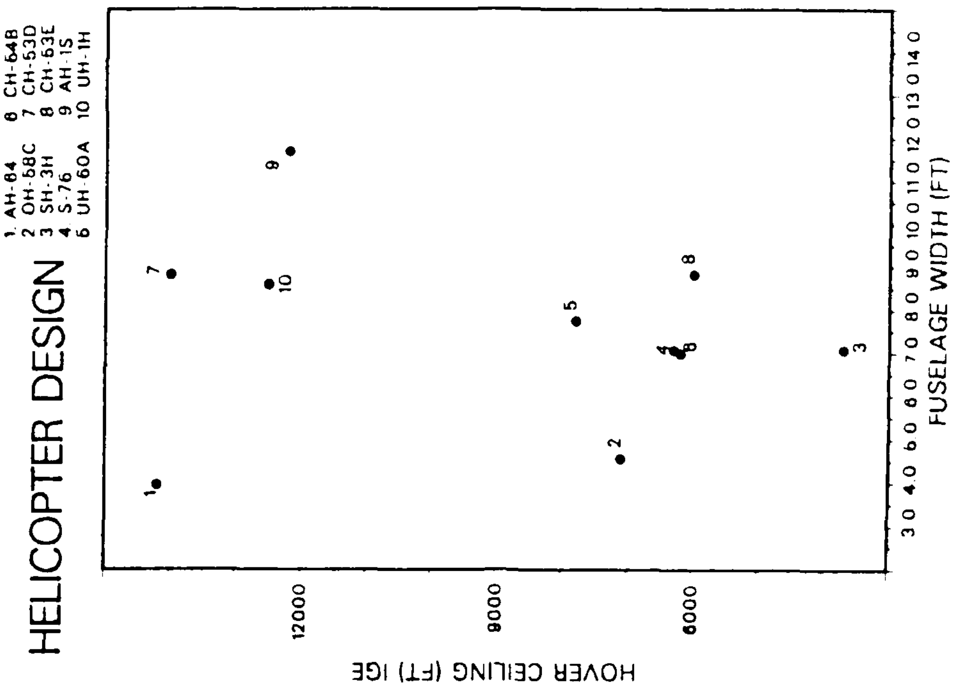


Fig. 17-24.

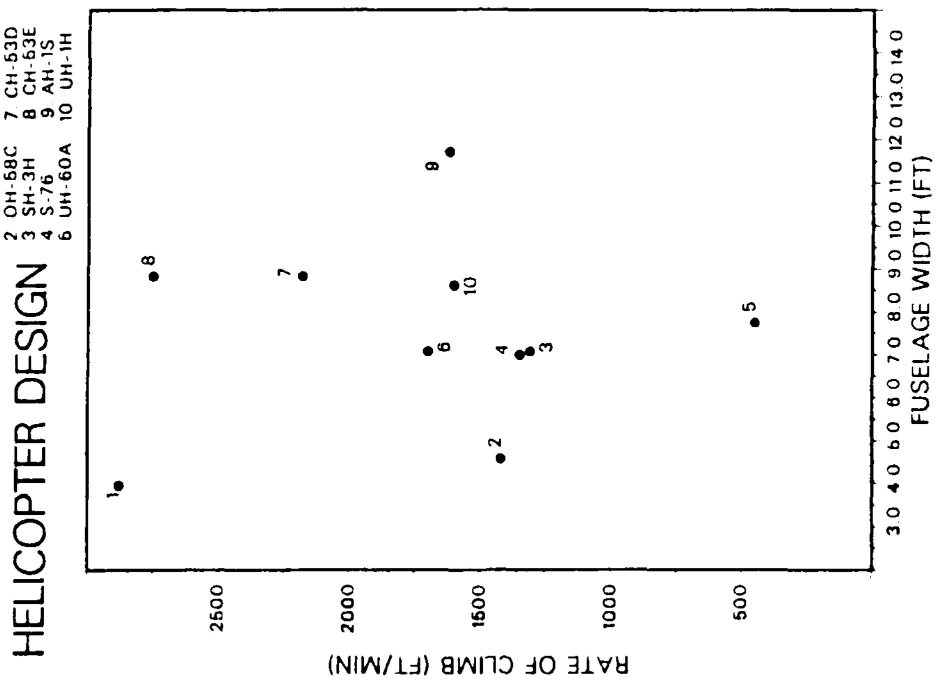


Fig. 17-23.

Fig. 17-23 and 17-24.

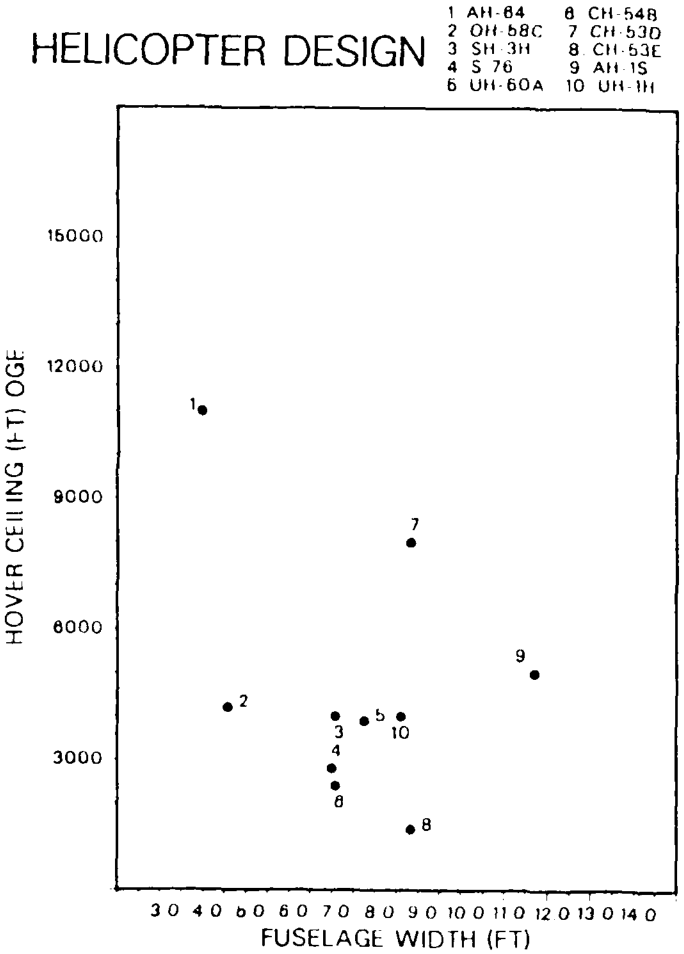


Fig. 17-25.

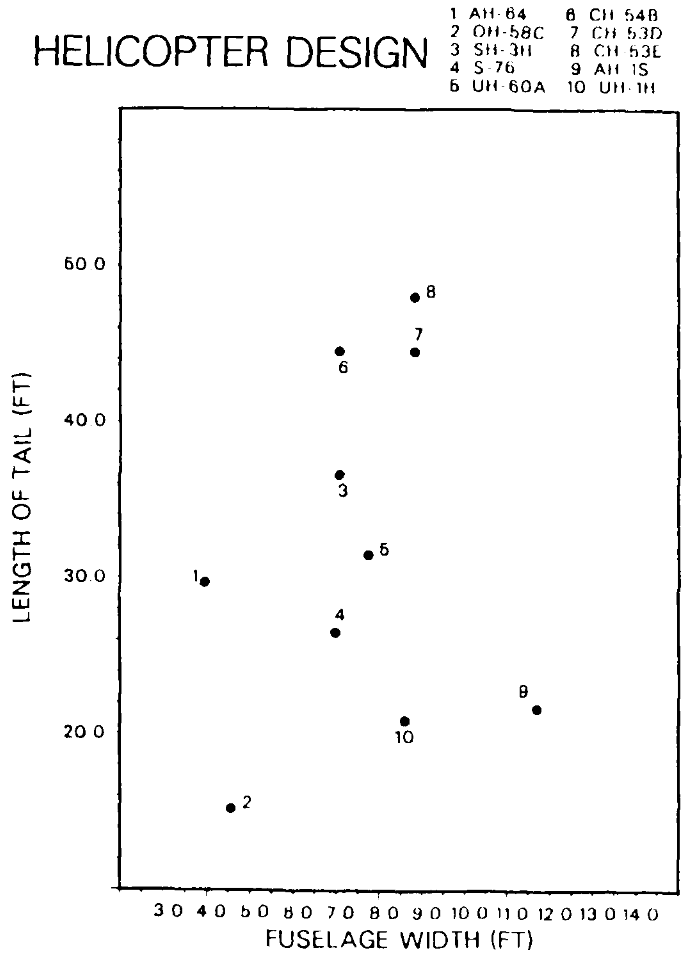


Fig. 17-26.

Fig. 17-25 and 17-26.

Fig. 17-27 and 17-28.

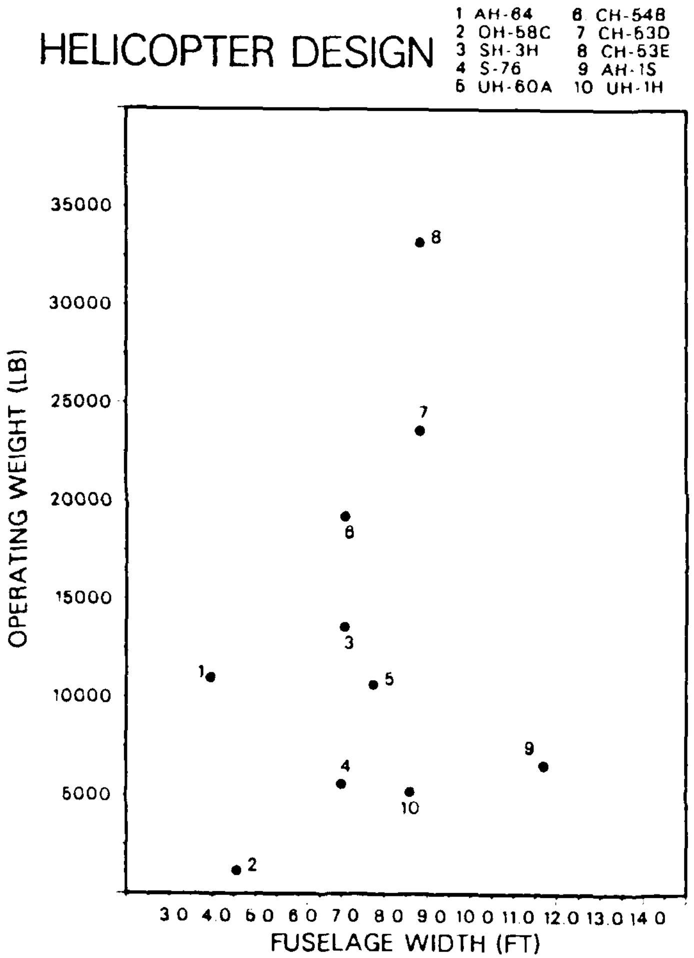


Fig. 17-27.

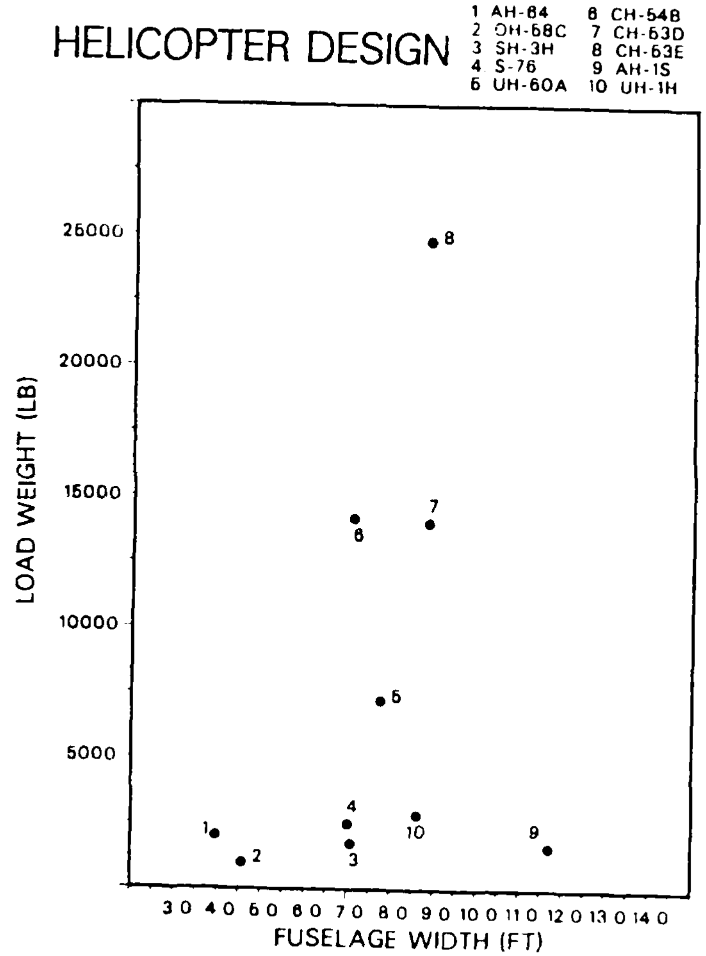


Fig. 17-28.

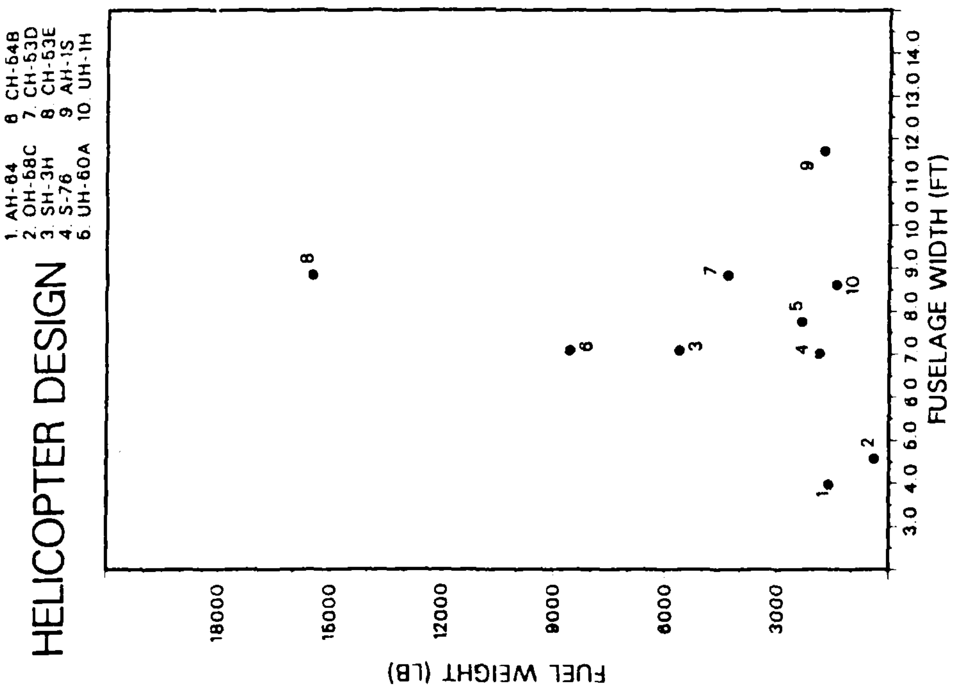


Fig. 17-29.

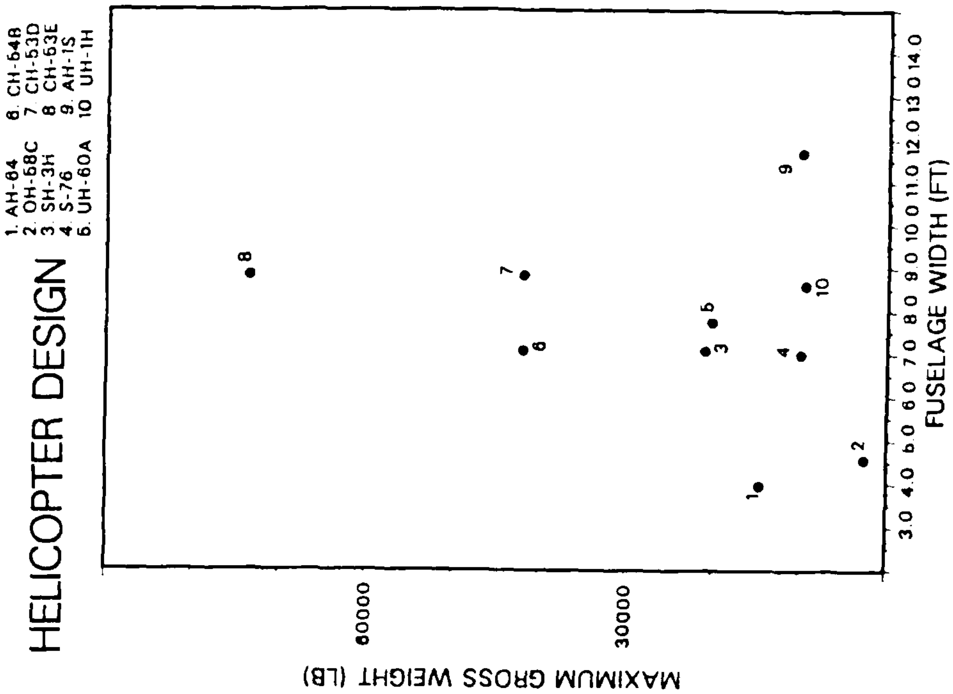


Fig. 17-30.

Fig. 17-29 and 17-30.

Length of Fuselage Pairings.

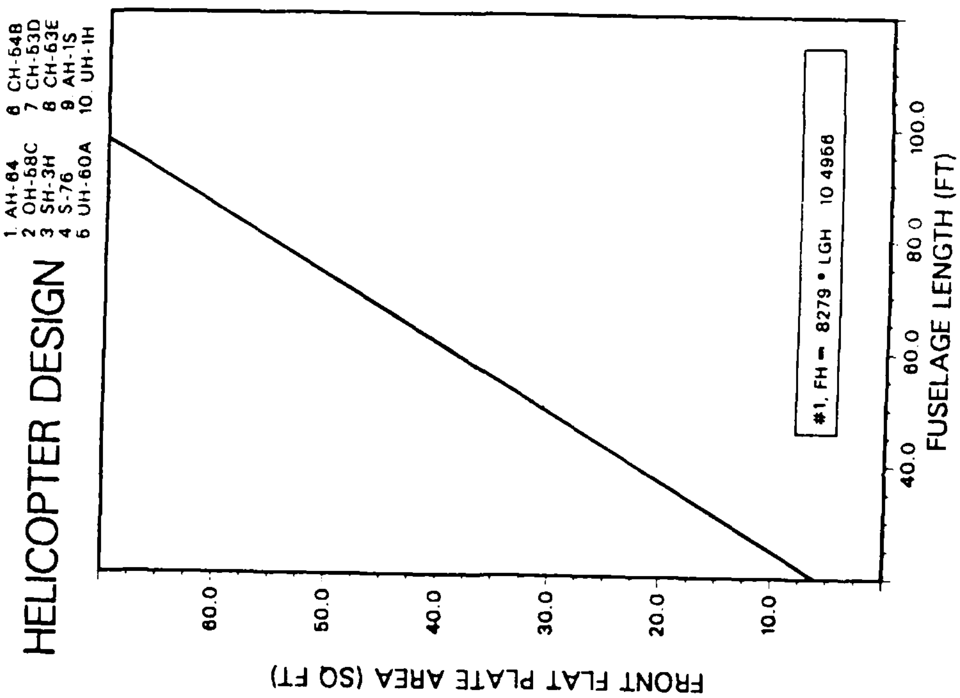


Fig. 18-19b.

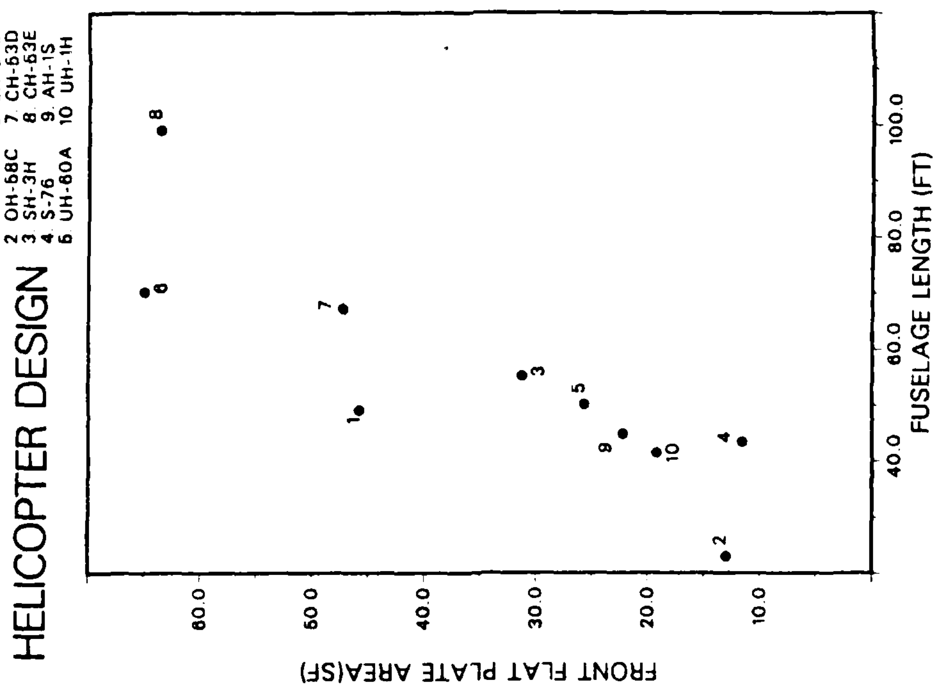


Fig. 18-19a.

Fig. 18-19a and 18-19b.

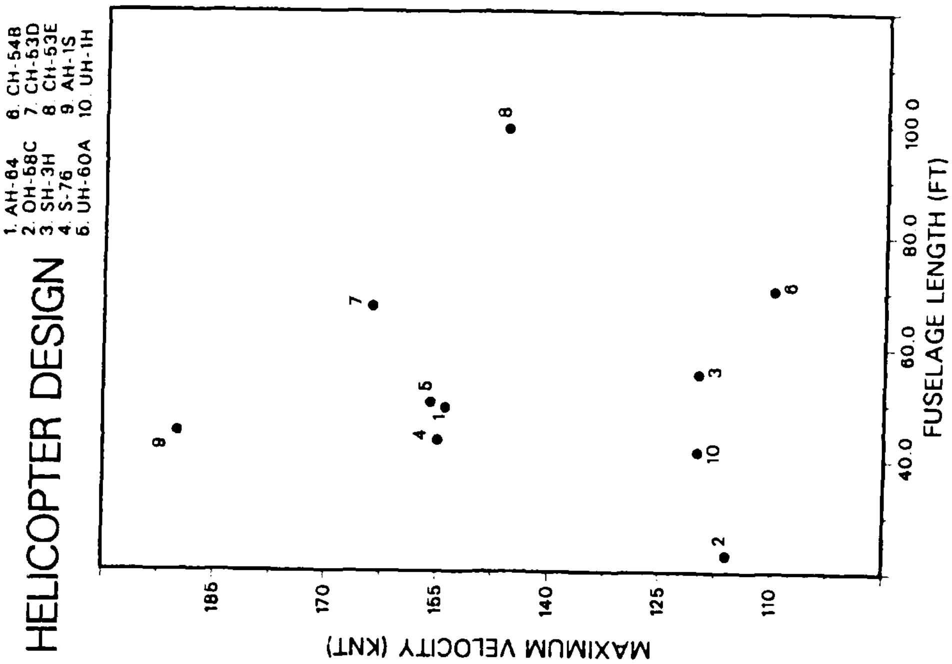


Fig. 18-21.

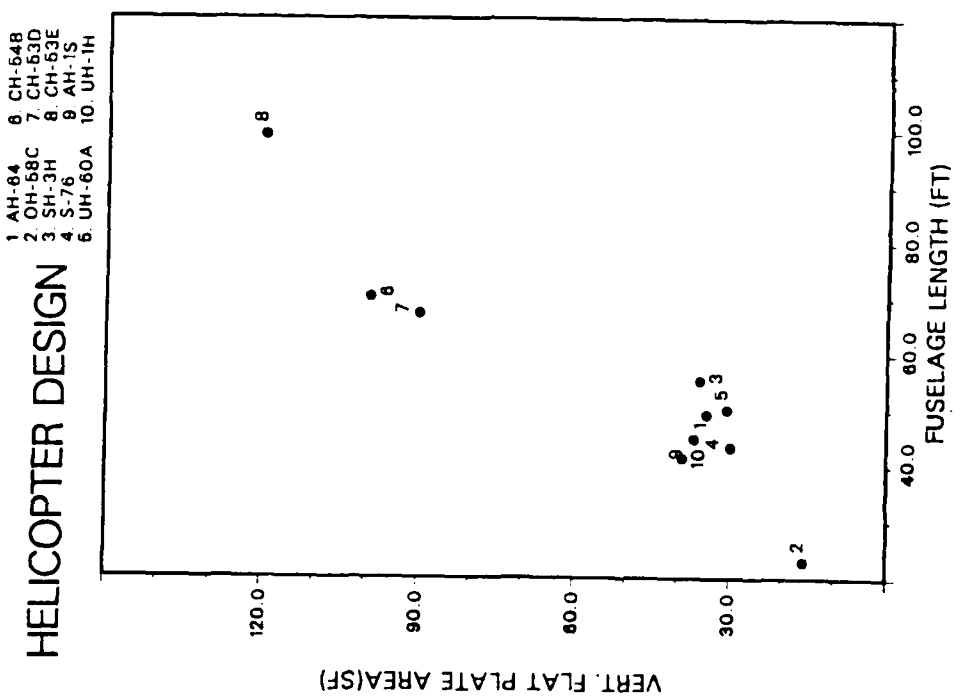


Fig. 18-20.

Fig. 18-20 and 18-21.

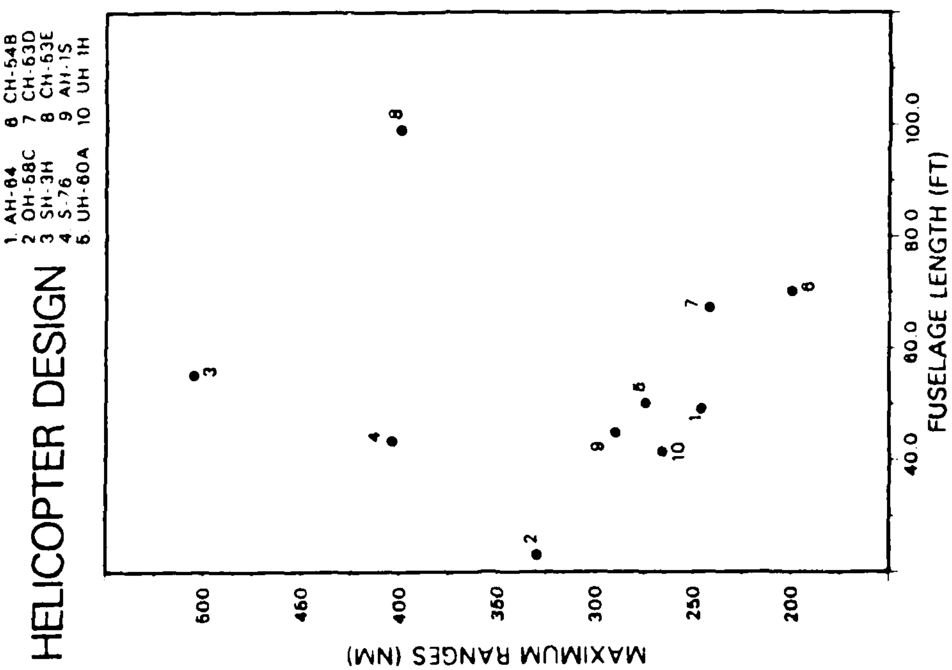


Fig. 18-22.

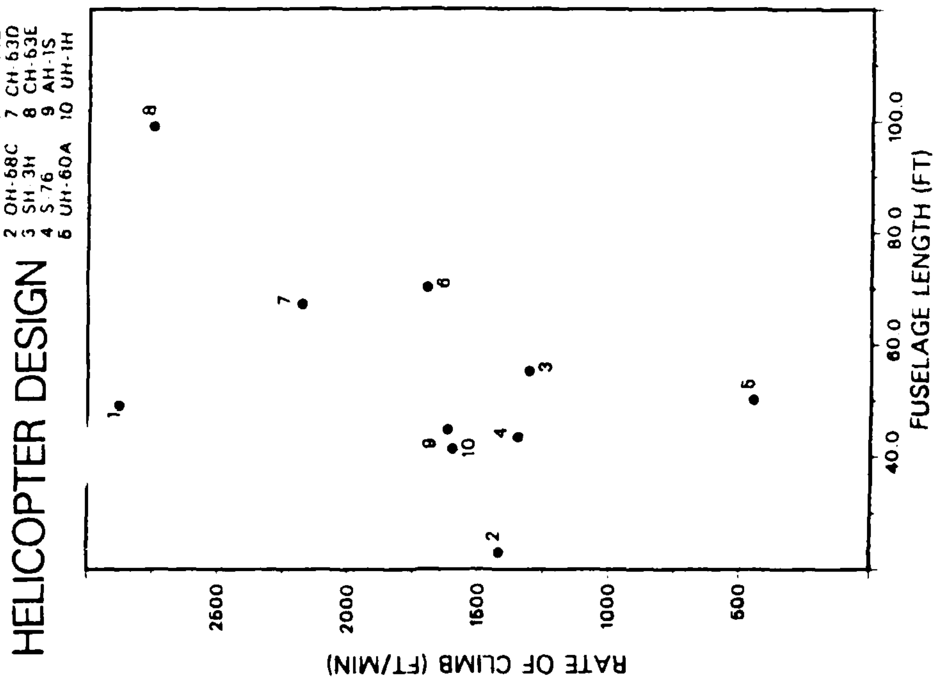


Fig. 18-23.

Fig. 18-22 and 18-23.

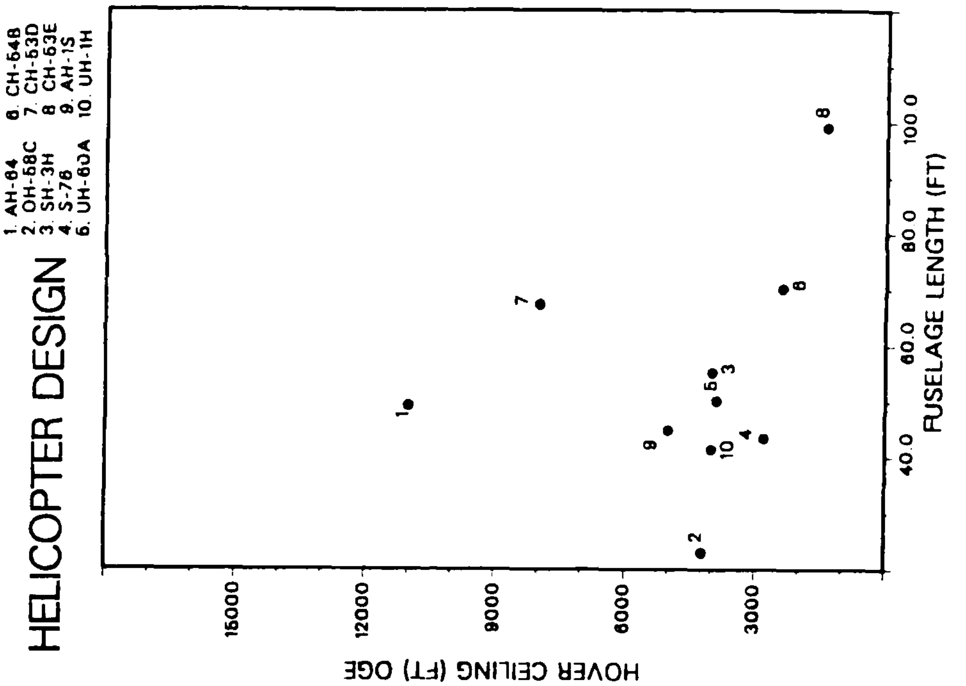


Fig. 18-25.

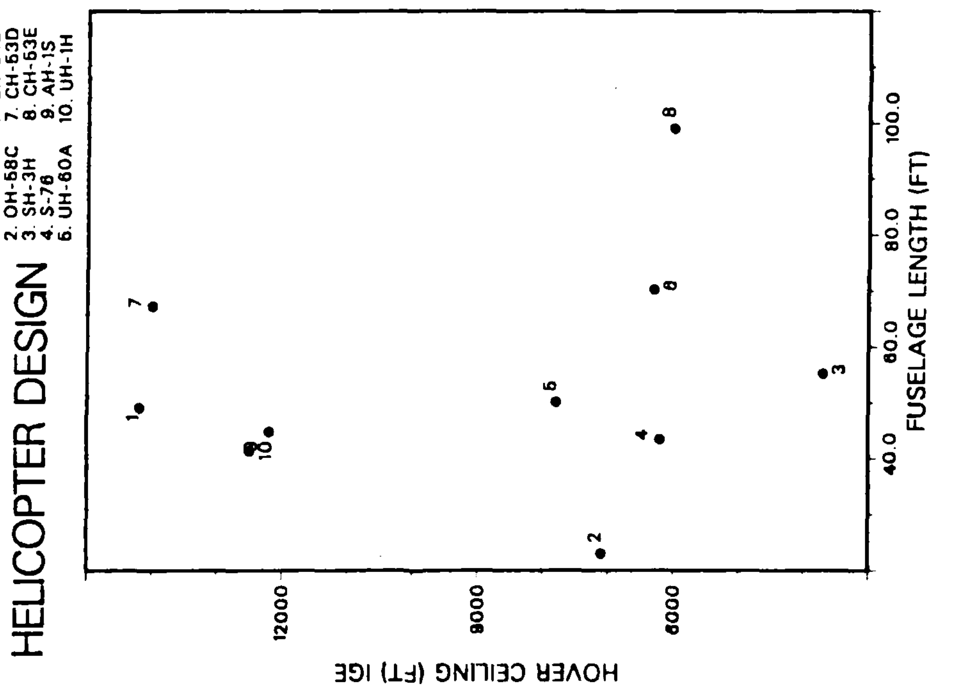
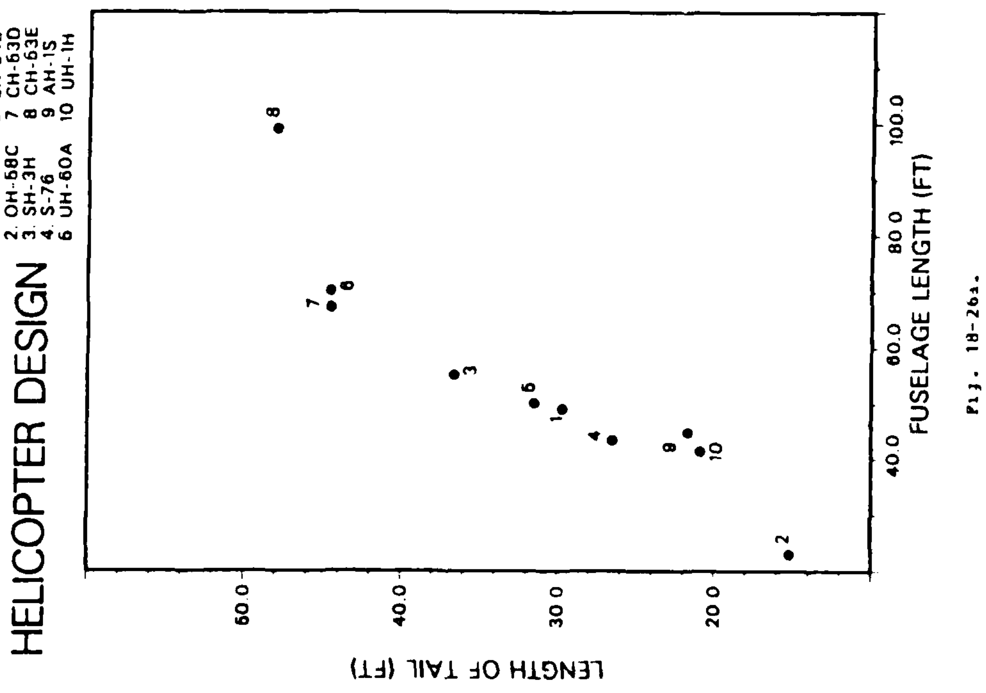


Fig. 18-24.

Fig. 18-24 and 18-25.



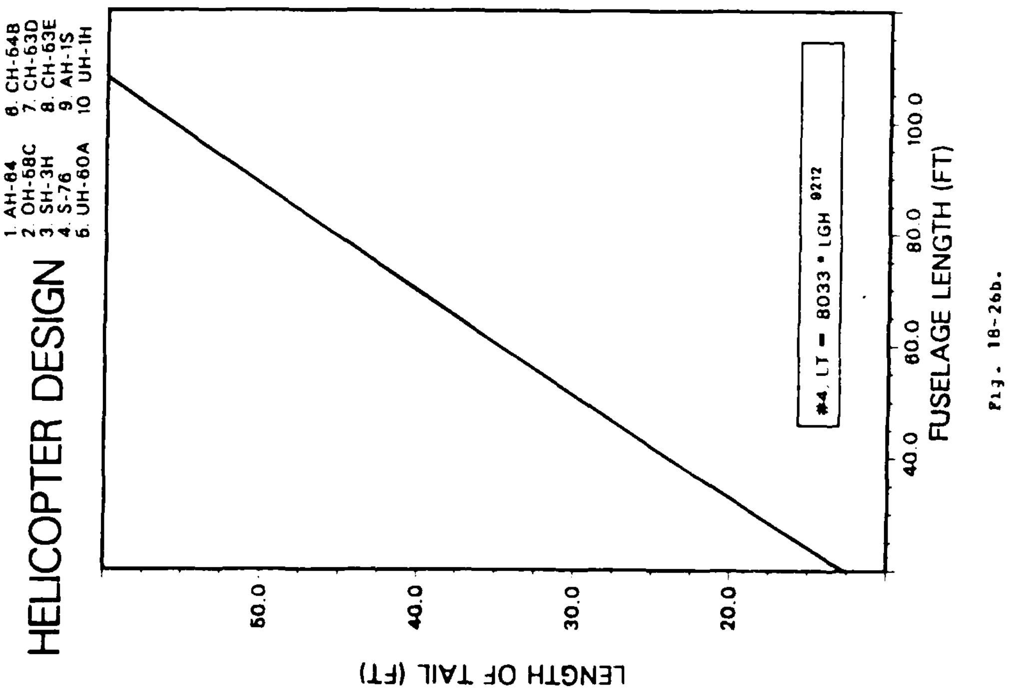


Fig. 18-26a and 18-26b.

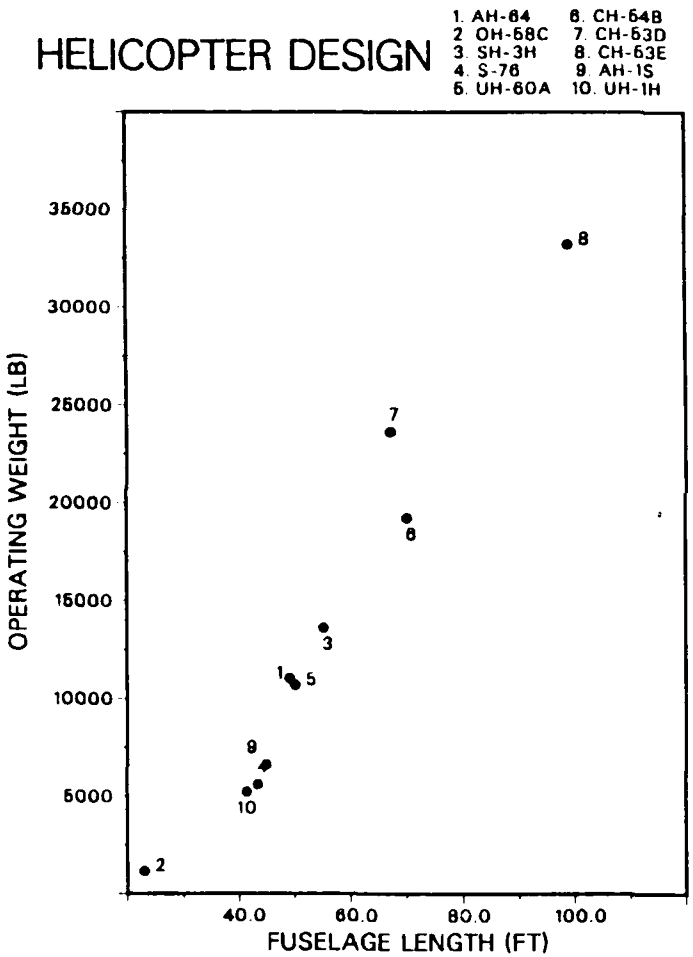


Fig. 18-27a.

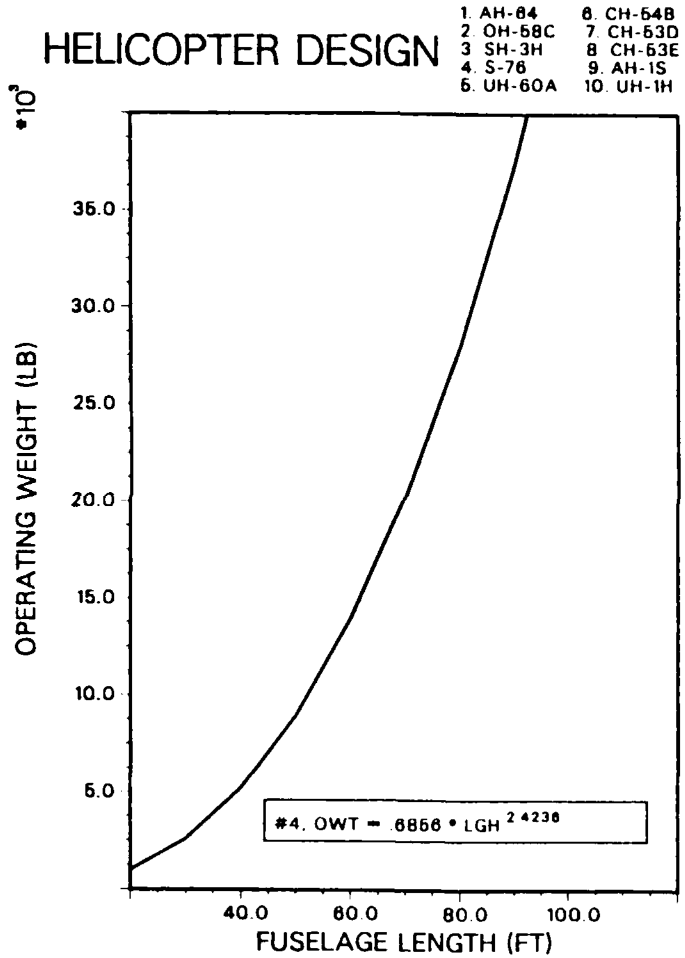


Fig. 18-27b.

Fig. 18-27a and 18-27b.

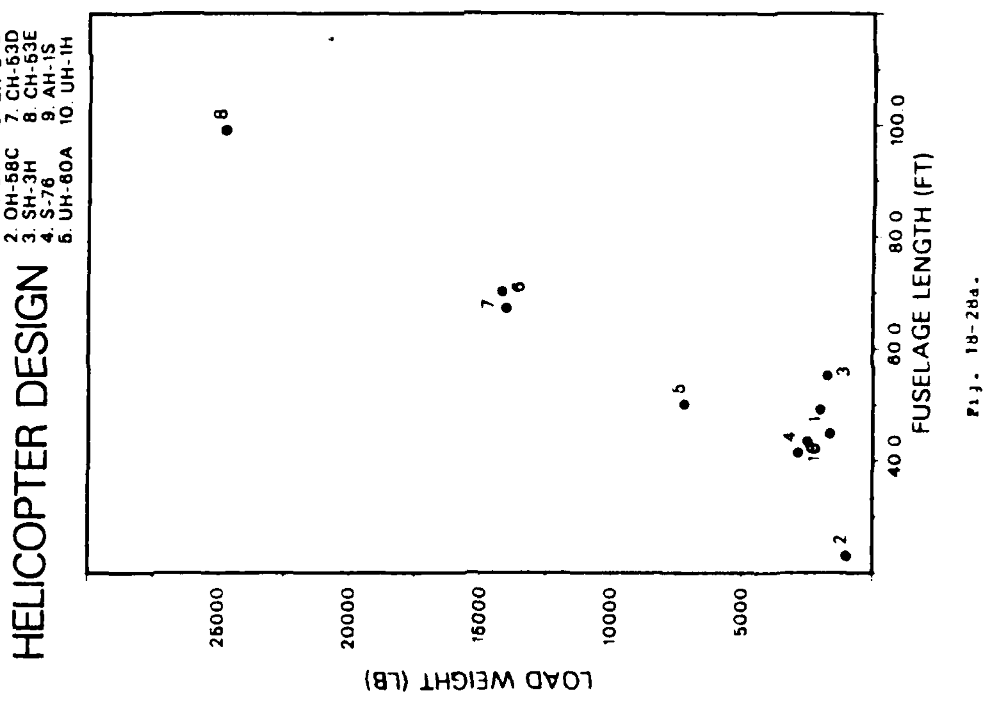


Fig. 18-28a.

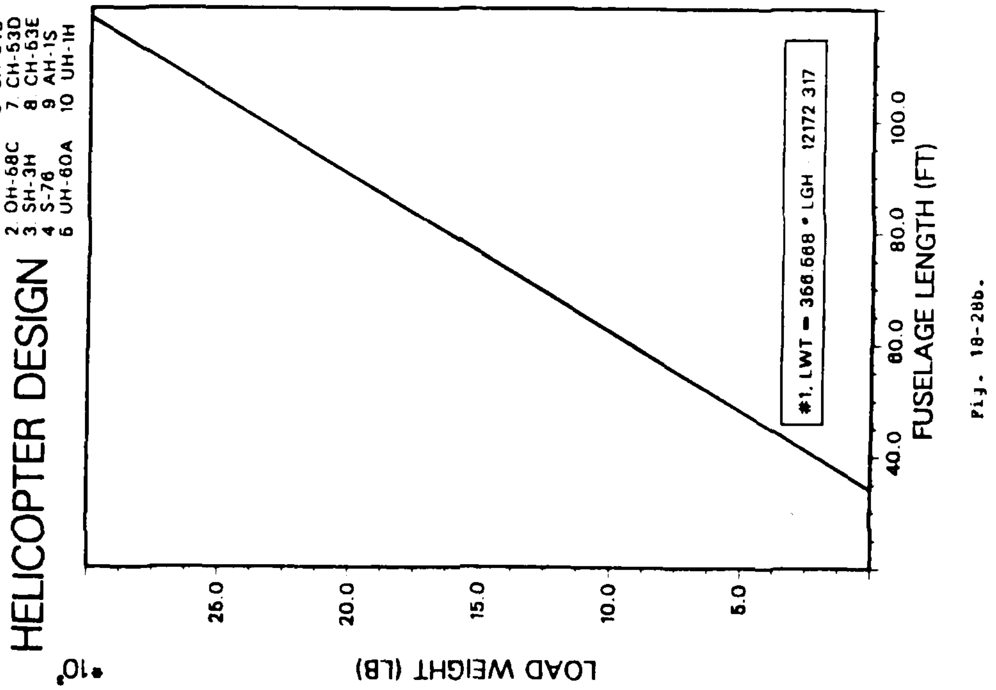


Fig. 18-28b.

Fig. 18-28a and 18-28b.

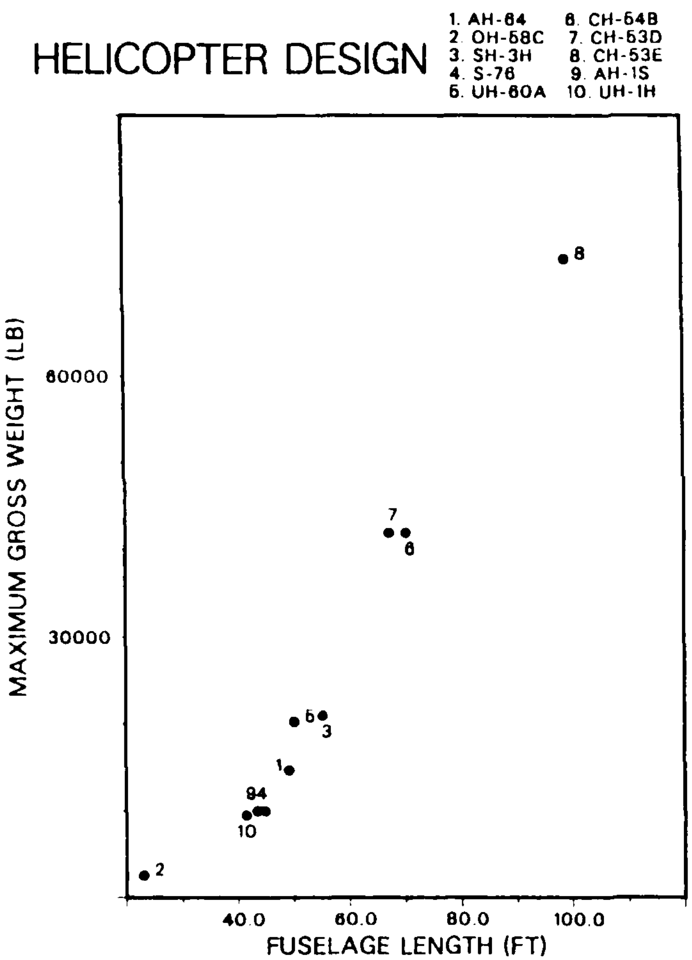


Fig. 18-30a.

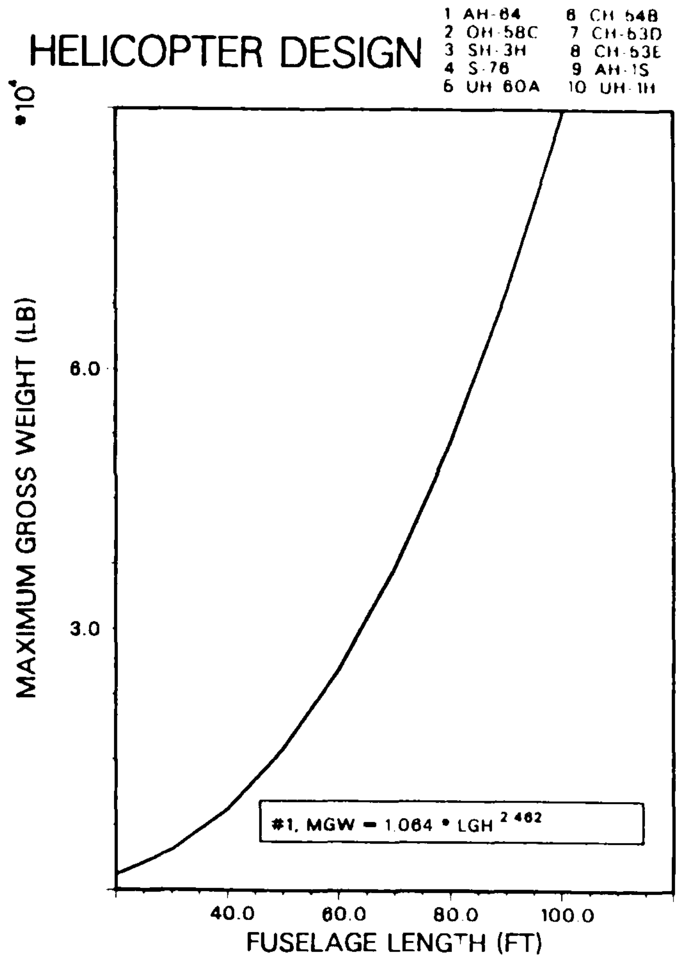


Fig. 18-30b.

Fig. 18-30a and 18-30b.

Frontal Horizontal Flat Plate Area Pairings.

HELICOPTER DESIGN

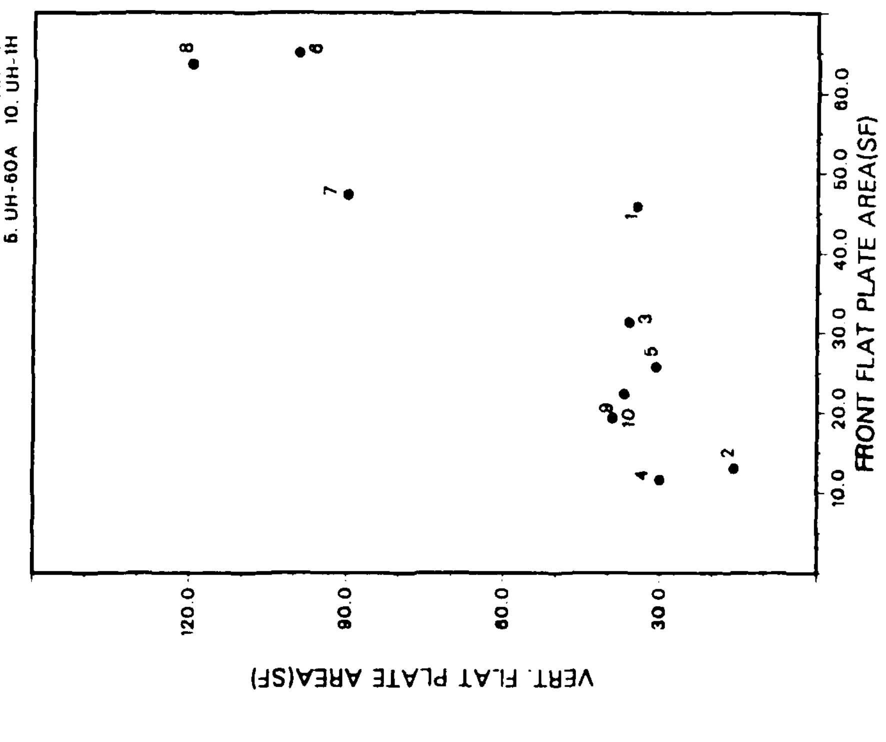


Fig. 19-20.

HELICOPTER DESIGN

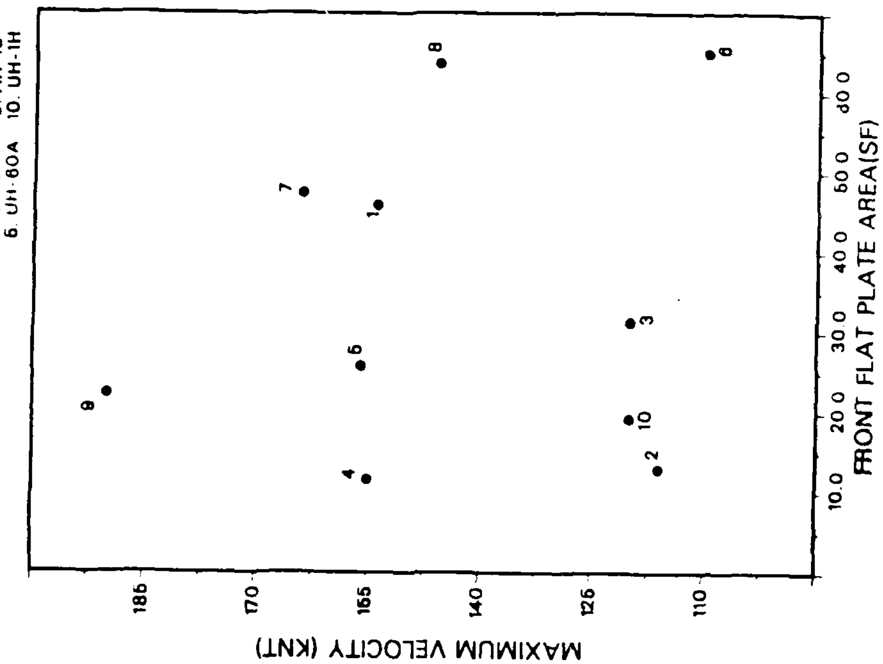


Fig. 19-21.

Fig. 19-20 and 19-21.

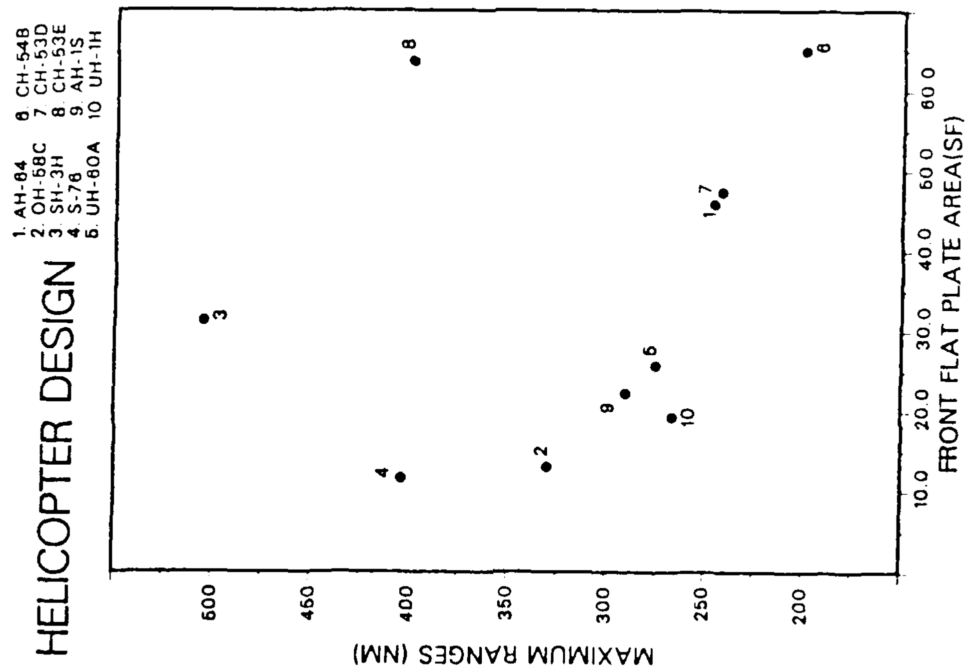


Fig. 19-22.

Fig. 19-22.

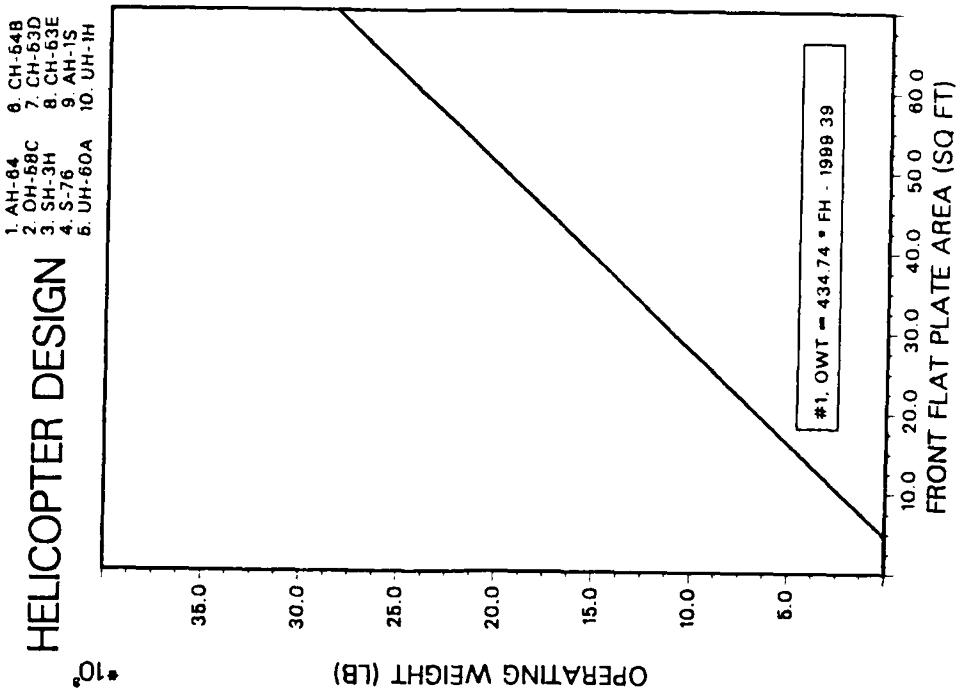


Fig. 19-27b.

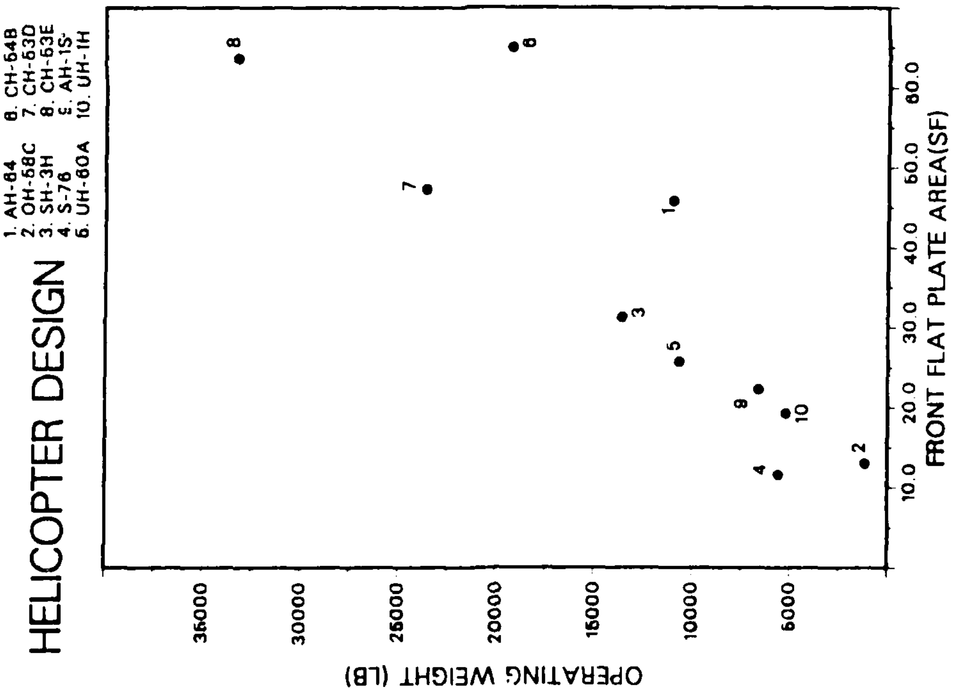


Fig. 19-27a.

Fig. 19-27a and 19-27b.

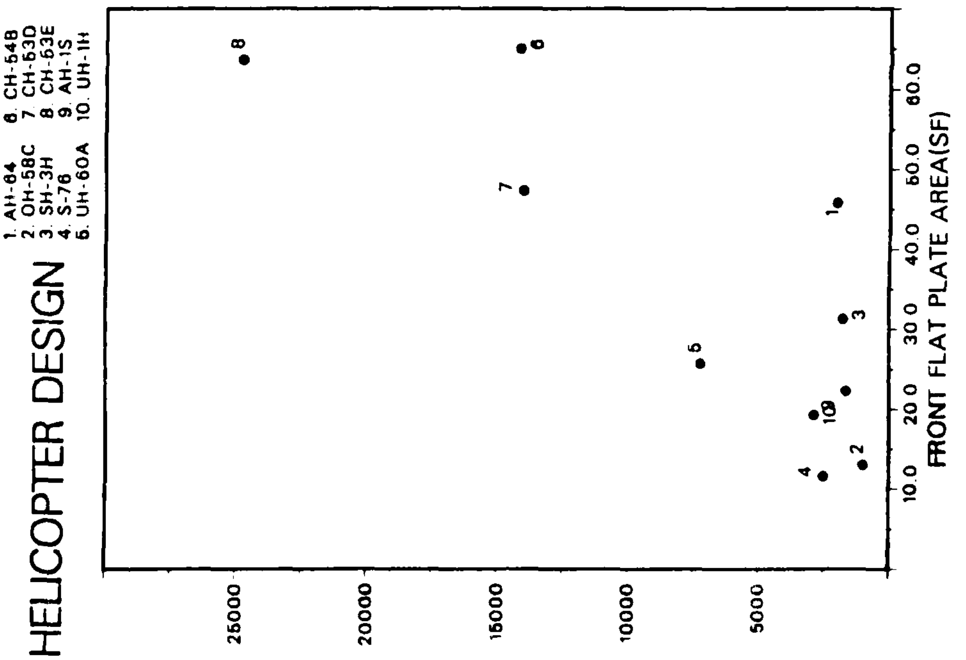


Fig. 19-28a.

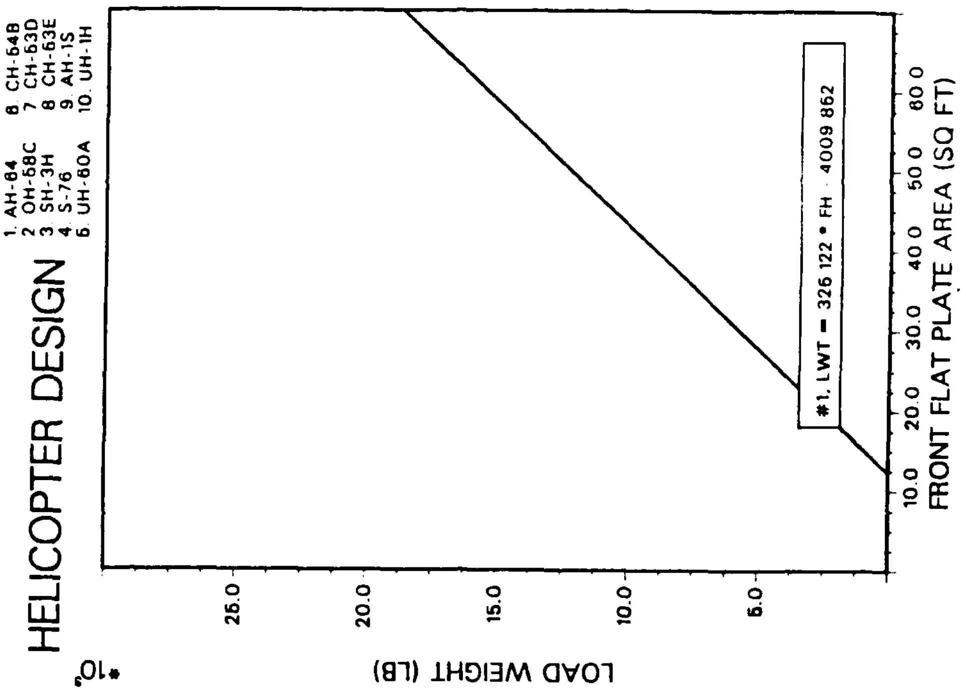


Fig. 19-28b.

Fig. 19-28a and 19-28b.

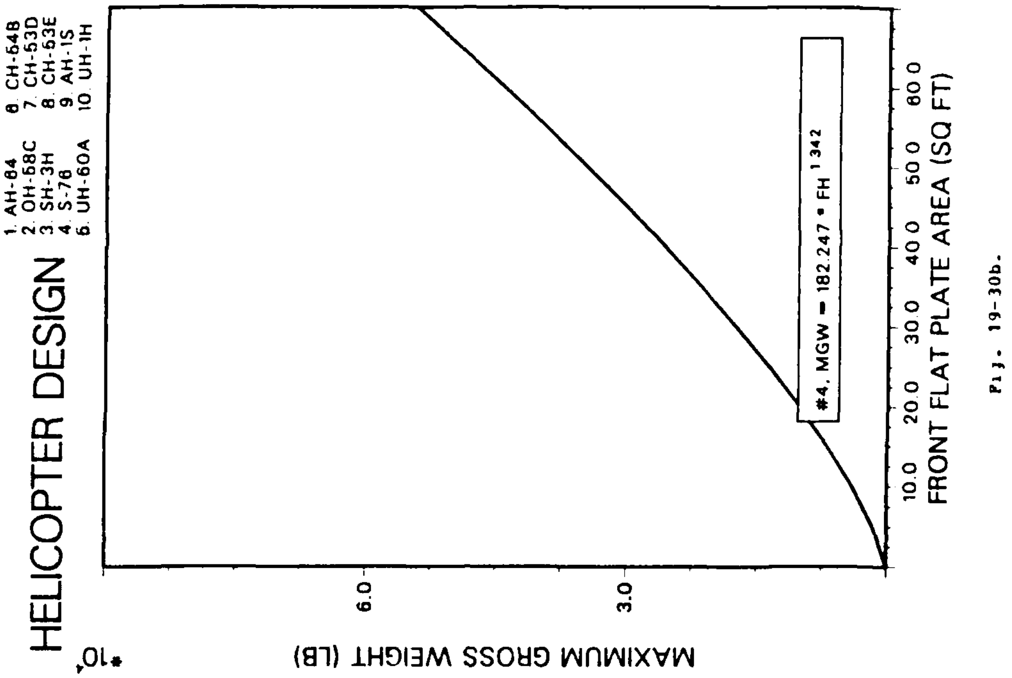


Fig. 19-30b.

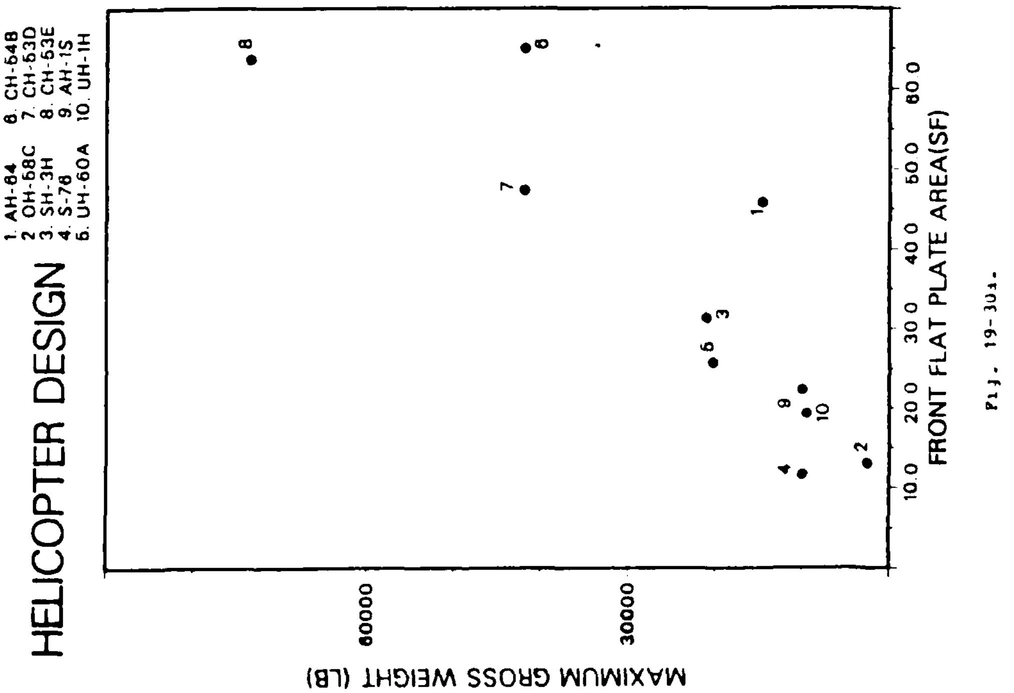


Fig. 19-30a.

Fig. 19-30a and 19-30b.

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Frontal Vertical Flat Plate Area Pairings.

Fig. 20-23 and 20-24.

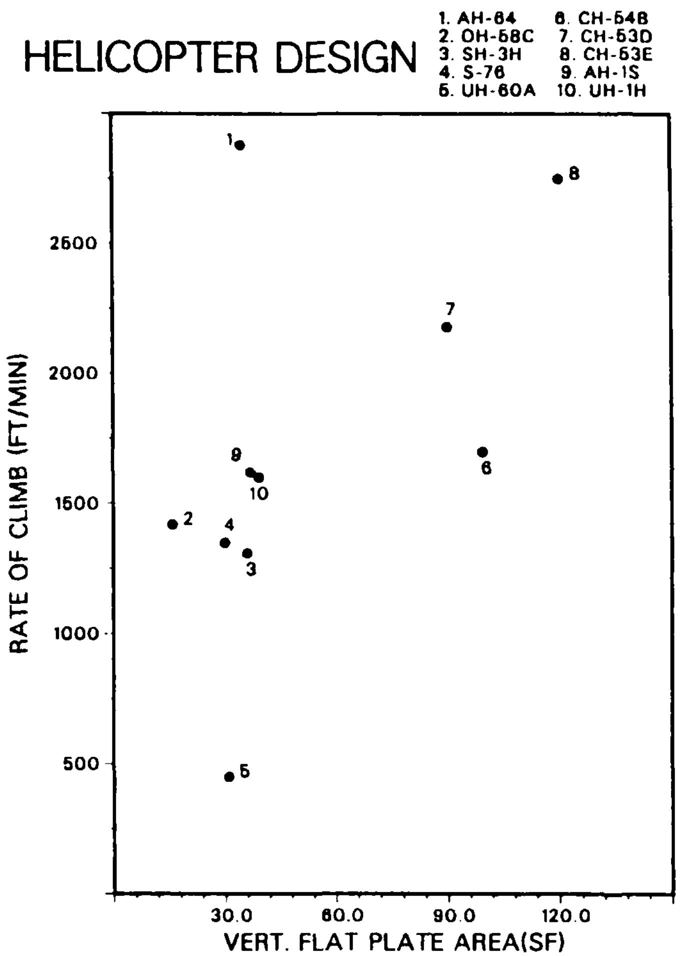


Fig. 20-23.

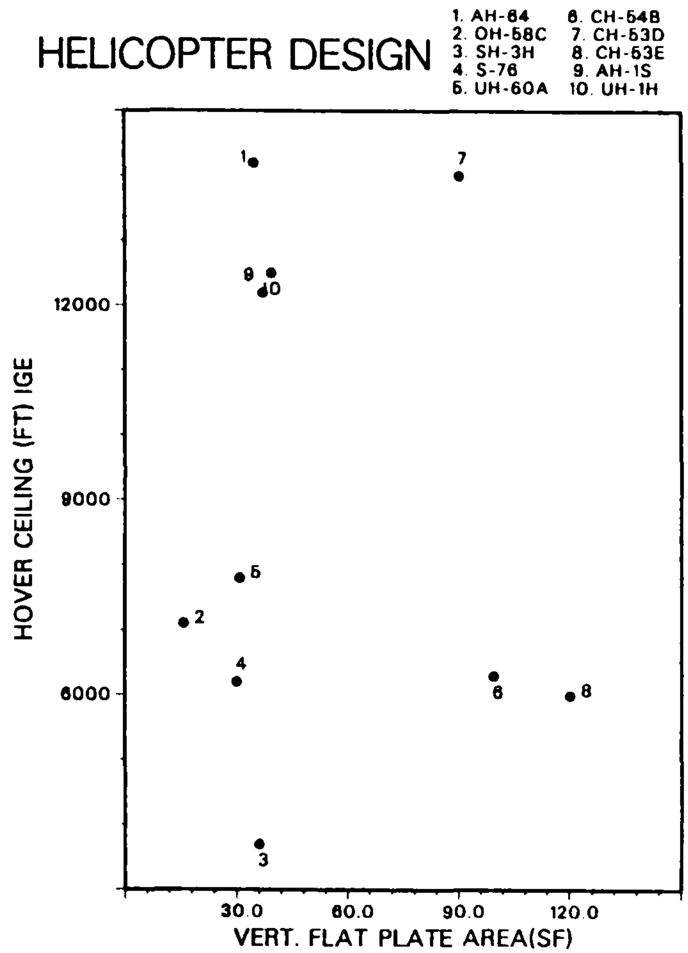


Fig. 20-24.

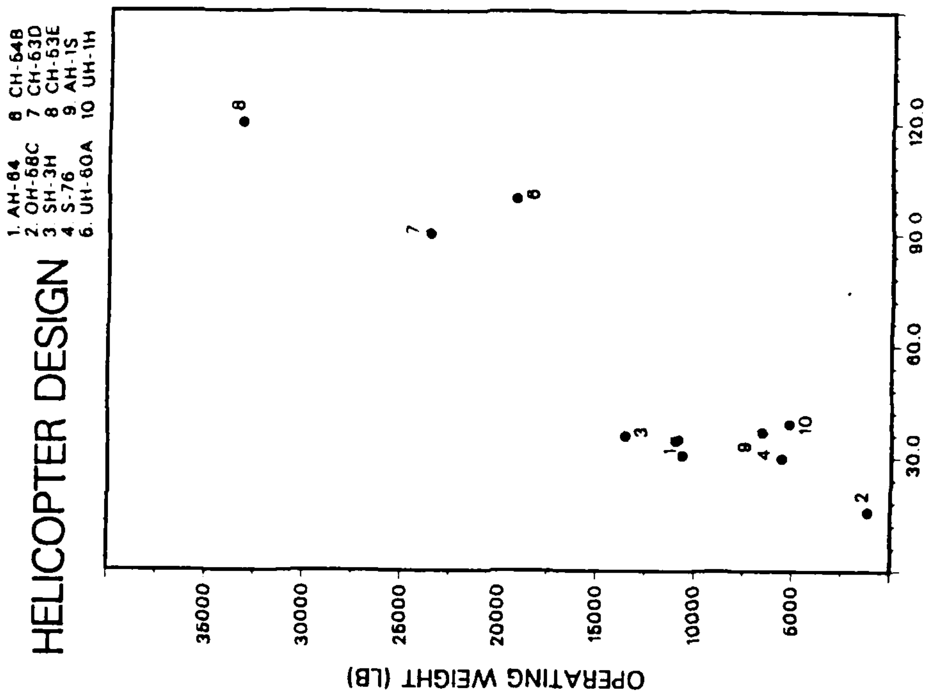


Fig. 20-27.

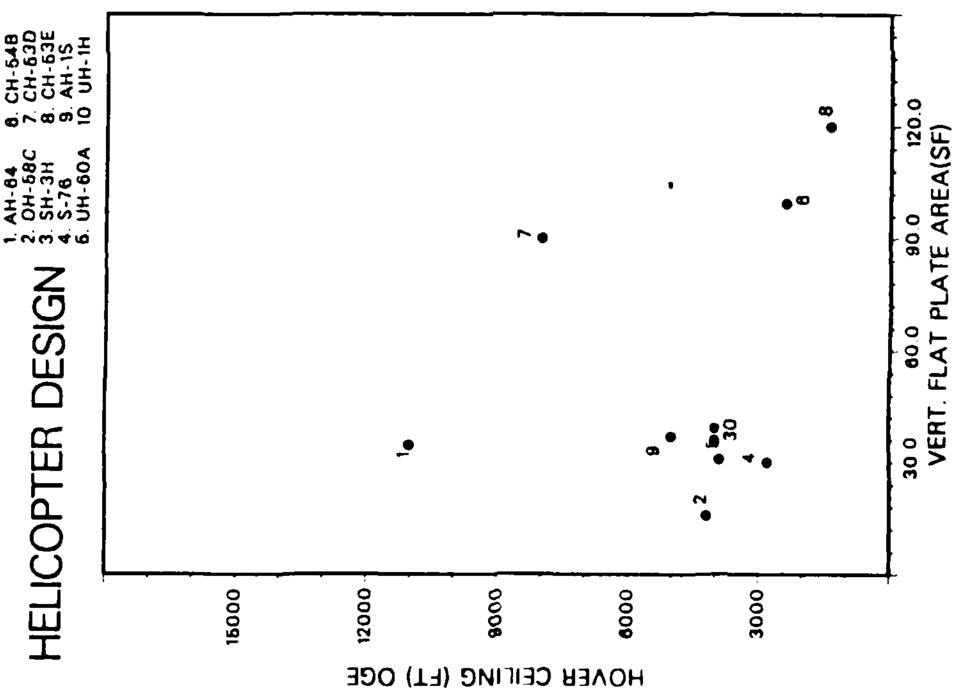


Fig. 20-25.

Fig. 20-25 and 20-27.

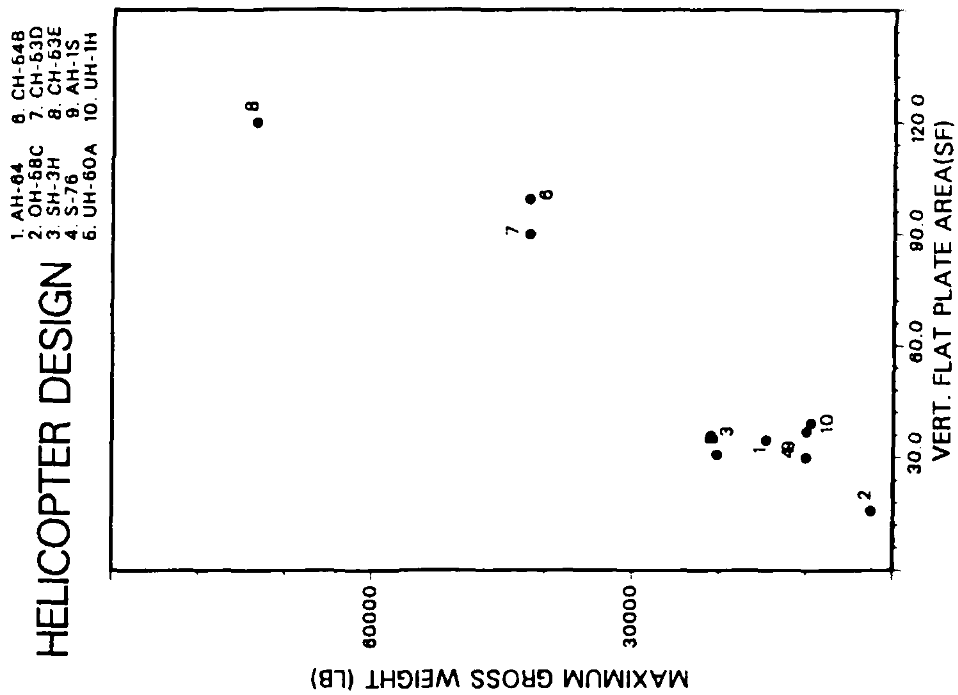


Fig. 20-30.

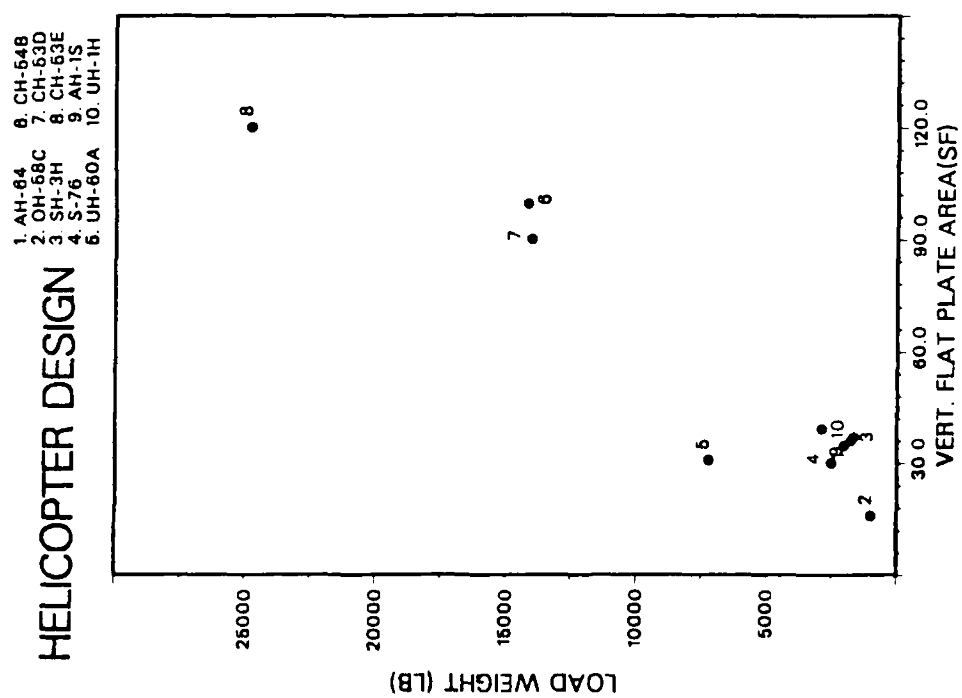


Fig. 20-28.

Fig. 20-28 and 20-30.

1294

Maximum Forward Velocity Pairings.

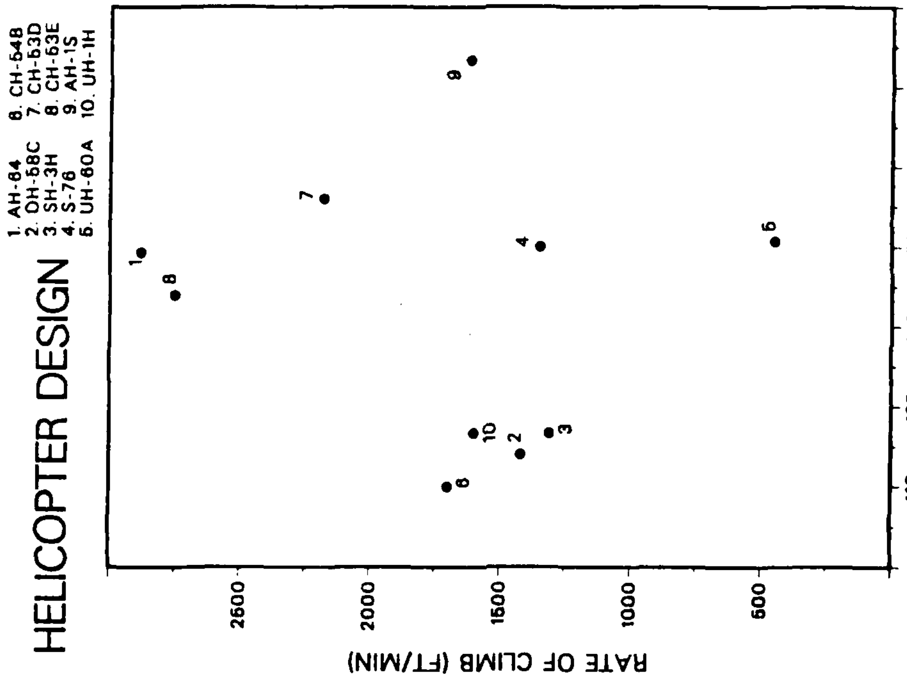


Fig. 21-23.

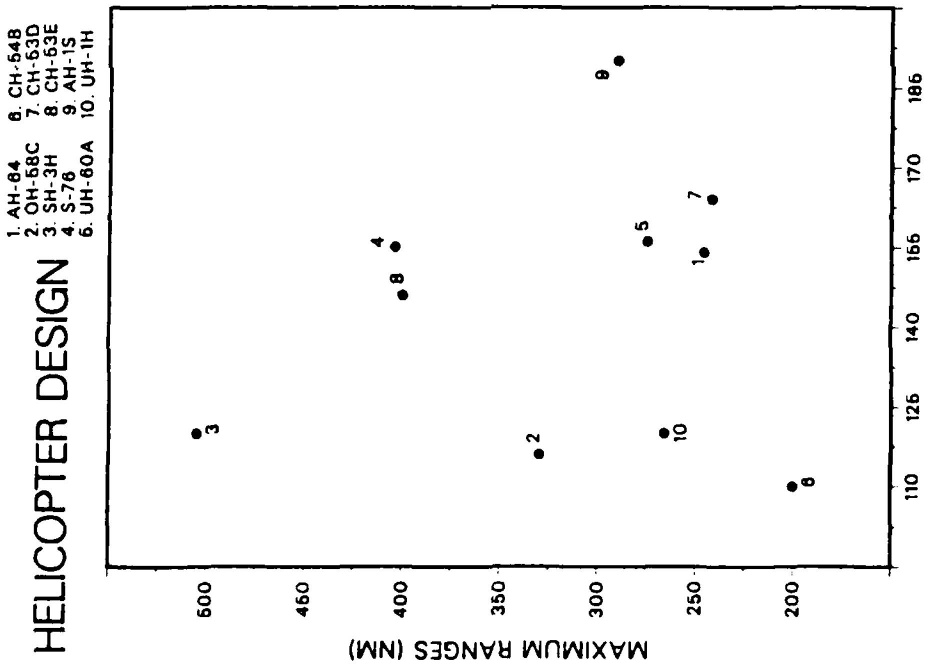


Fig. 21-22.

Fig. 21-22 and 21-23.

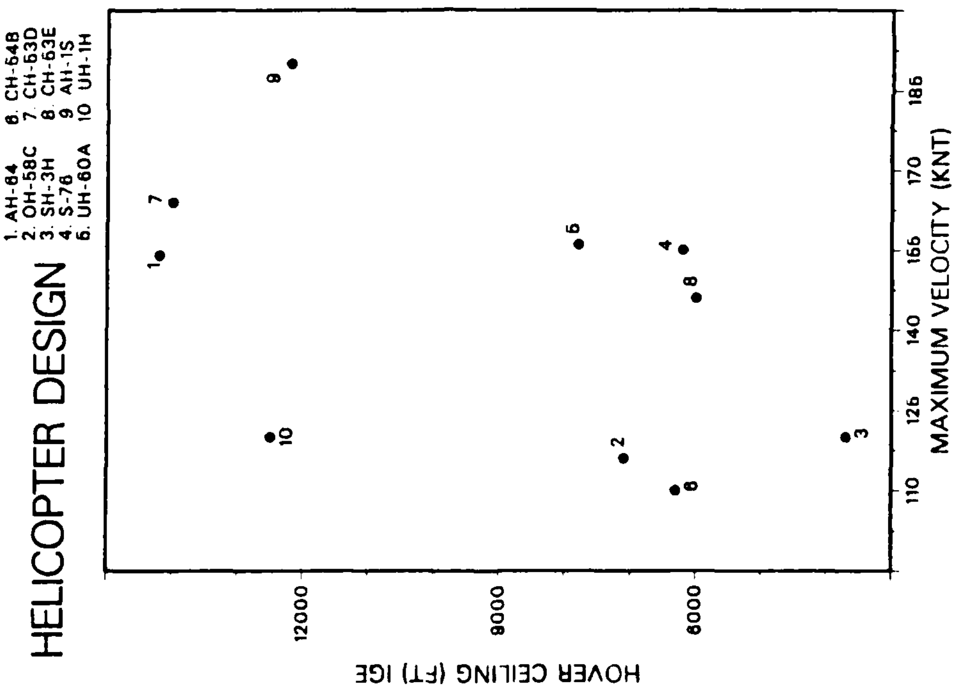


Fig. 21-24.

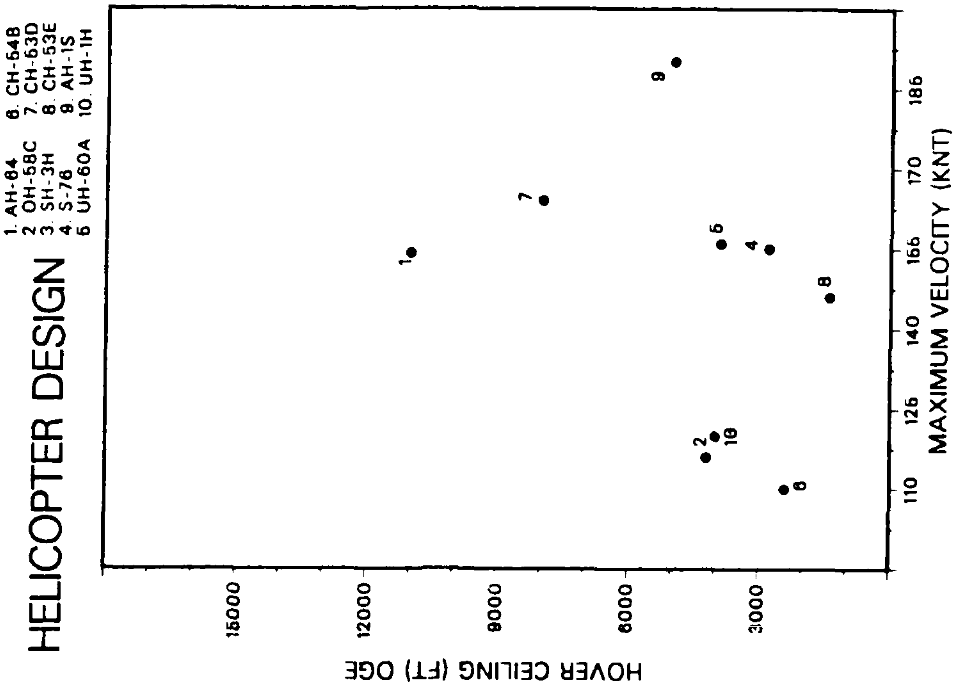


Fig. 21-25.

Fig. 21-24 and 21-25.

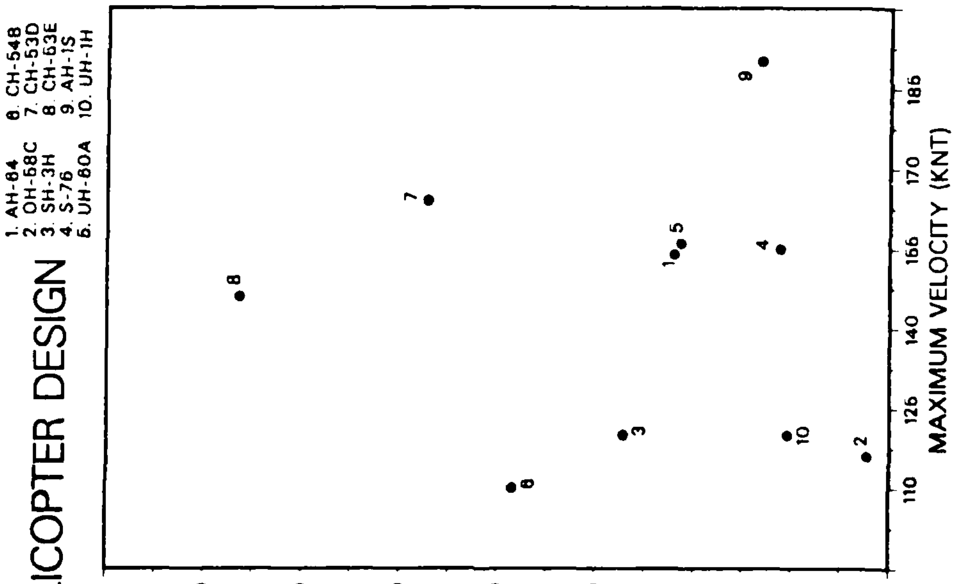


Fig. 21-27.

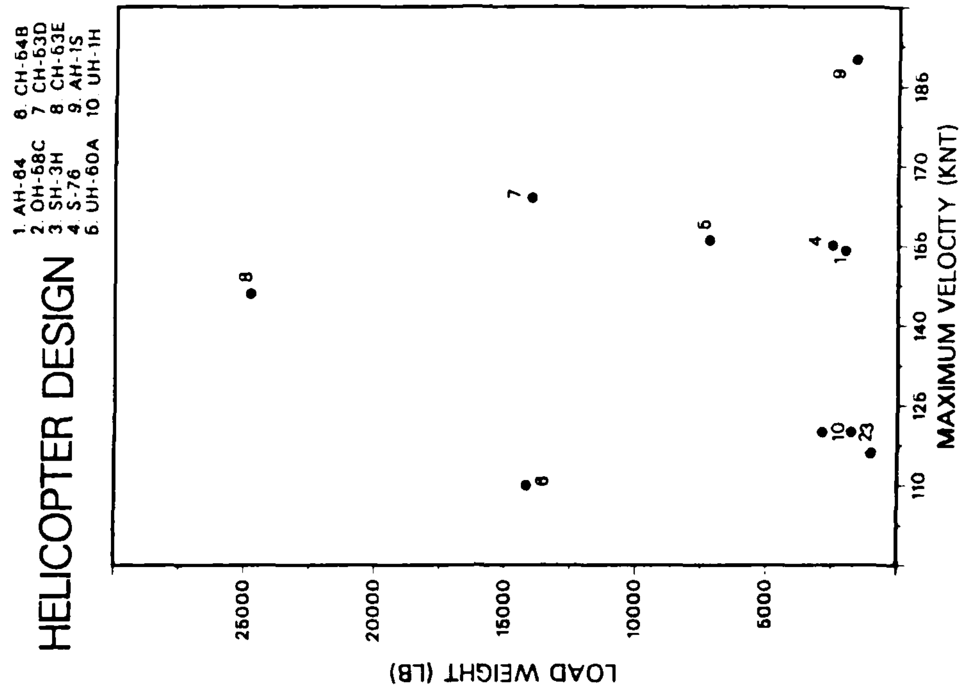


Fig. 21-28.

Fig. 21-27 and 21-28.

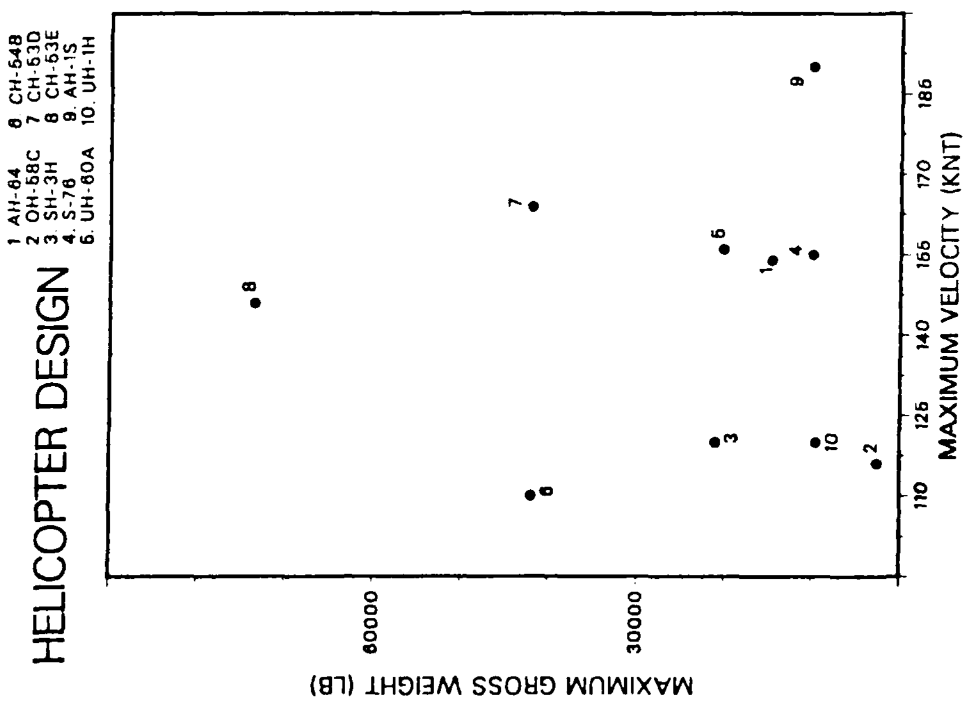


Fig. 21-30.

Fig. 21-30.

Maximum Range Pairings.

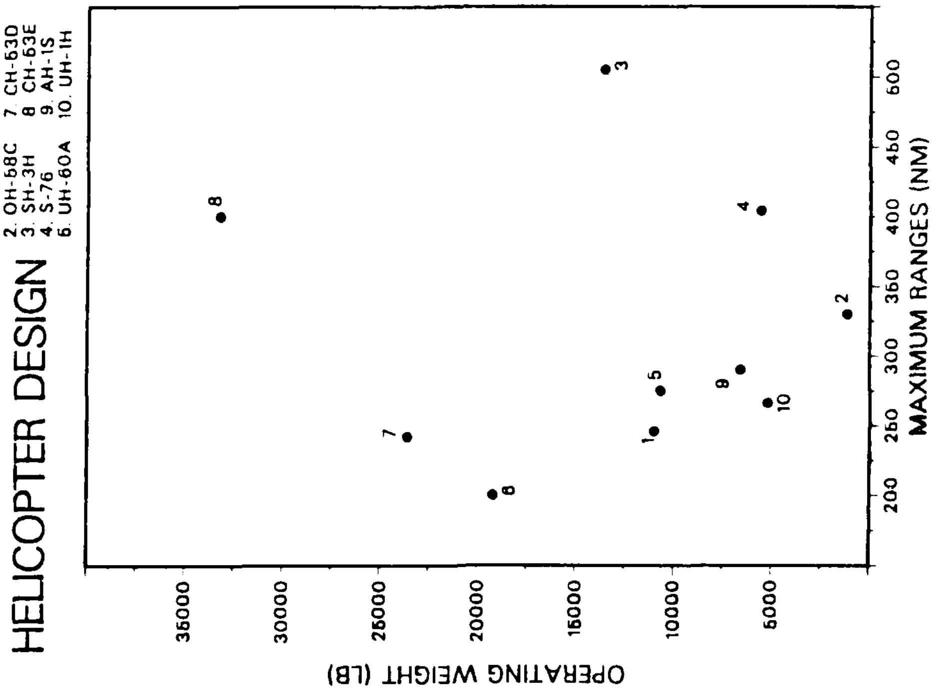


Fig. 22-27.

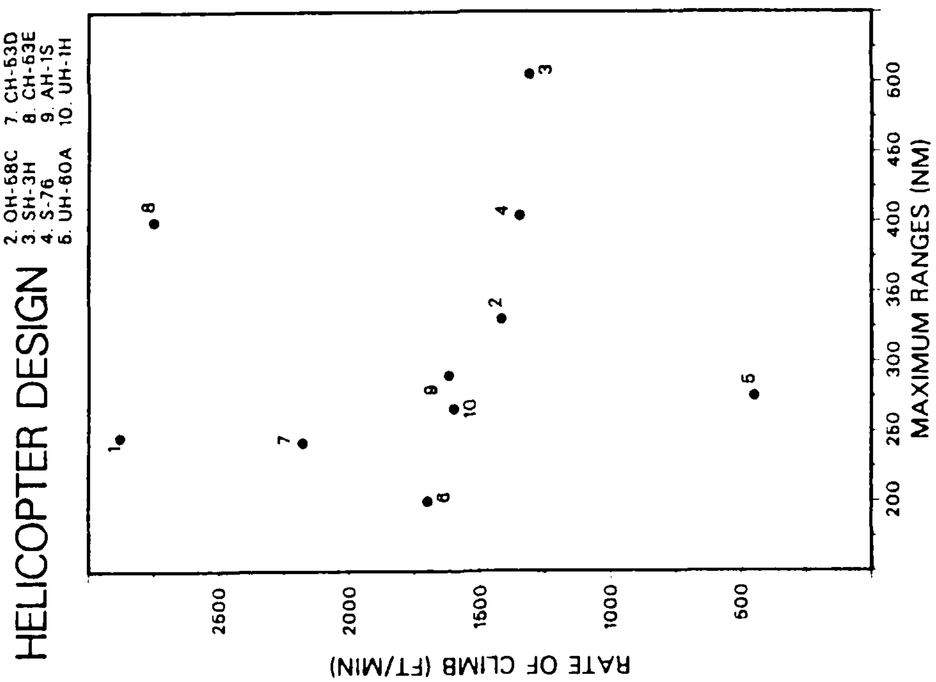


Fig. 22-23.

Fig. 22-23 and 22-27.

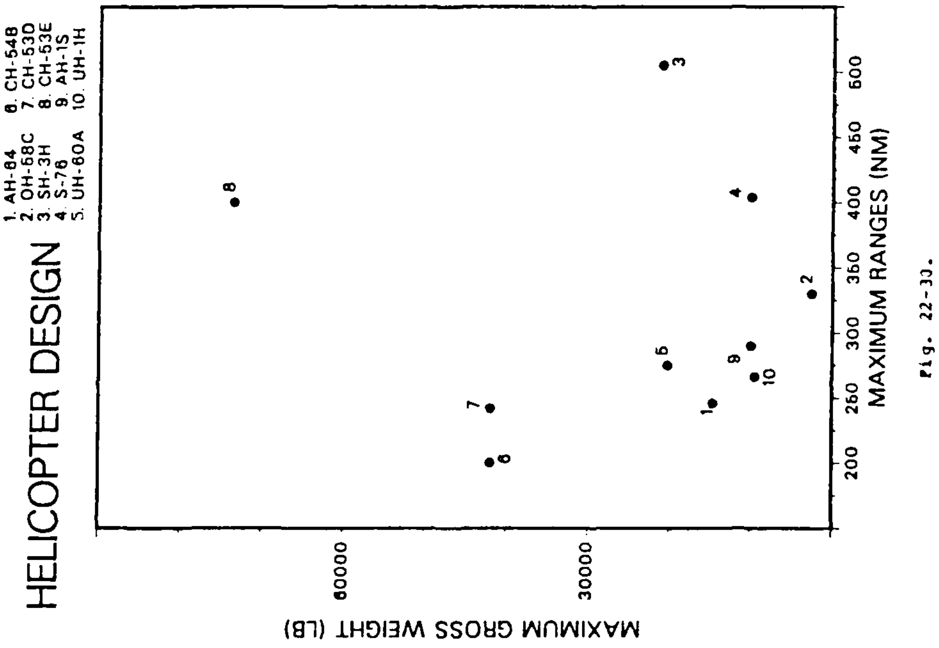

HELICOPTER DESIGN
1. AH-64
2. OH-58C
3. SH-3H
4. S-76
5. UH-60A
6. CH-54B
7. CH-53D
8. CH-53E
9. AH-1S
10. UH-1H
MAXIMUM GROSS WEIGHT (LB)
30000
60000
MAXIMUM RANGES (NM)
200
250
300
350
400
450
500
Fig. 22-30.

Fig. 22-30.

Rate of Climb Pairings.

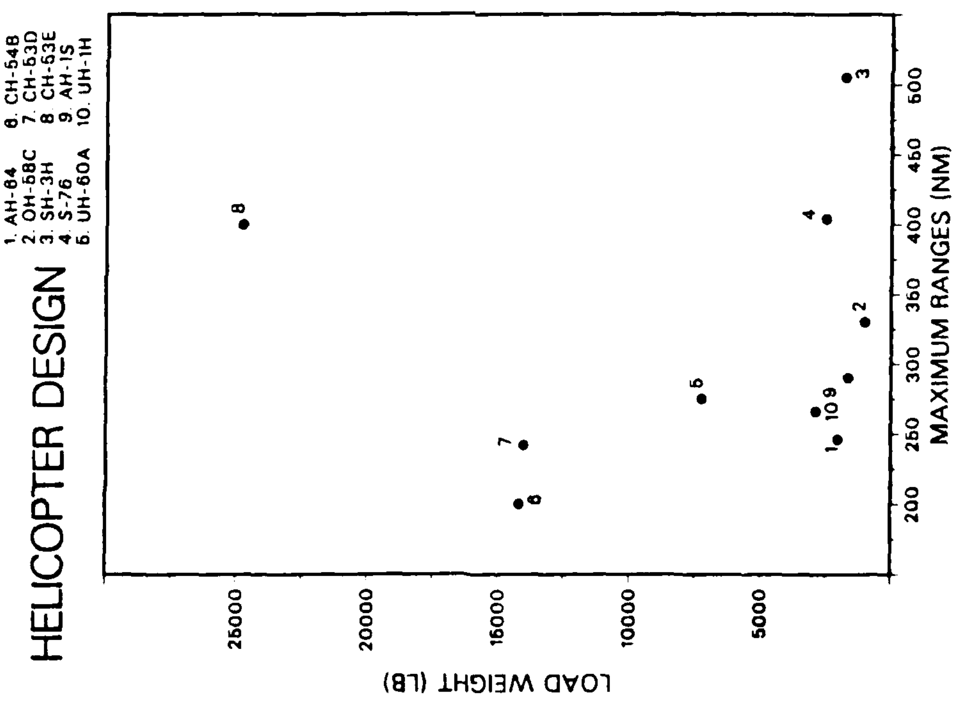


Fig. 22-28.

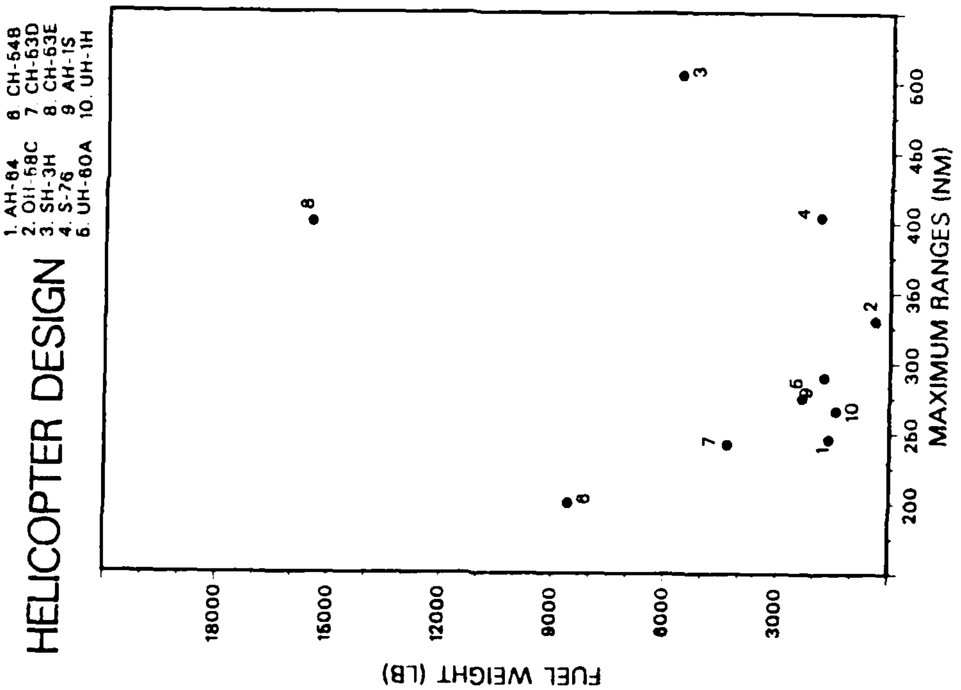


Fig. 22-29.

Fig. 22-28 and 22-29.

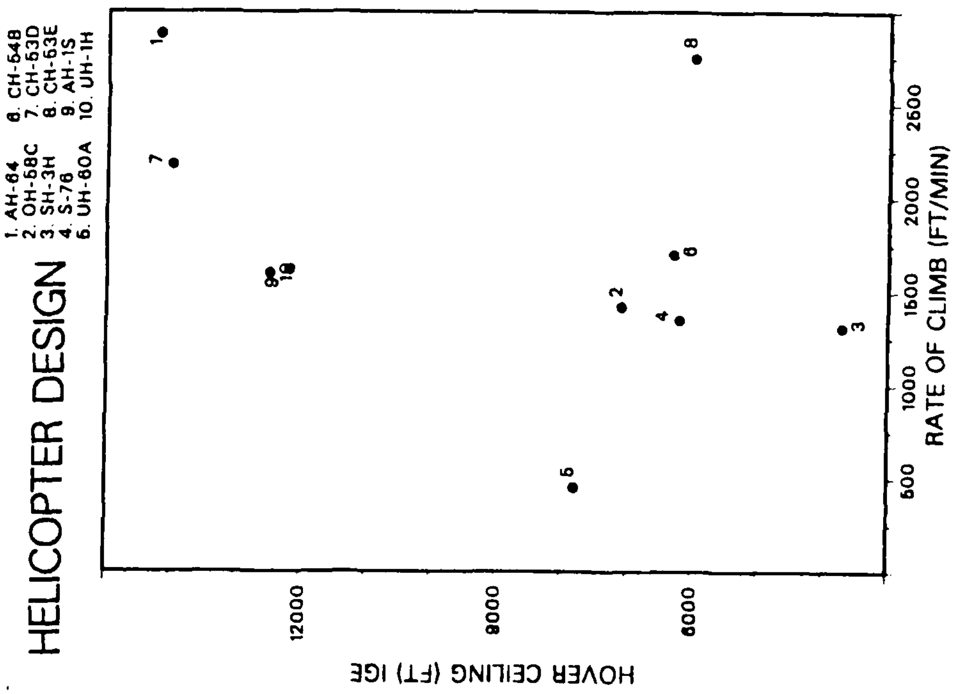


Fig. 23-24.

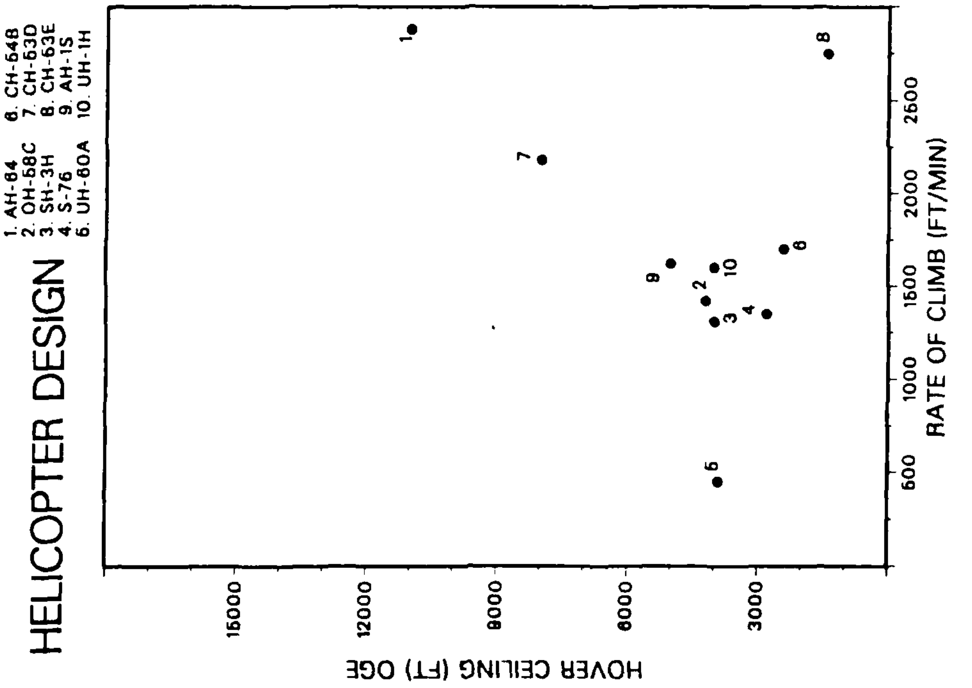


Fig. 23-25.

Fig. 23-24 and 23-25.

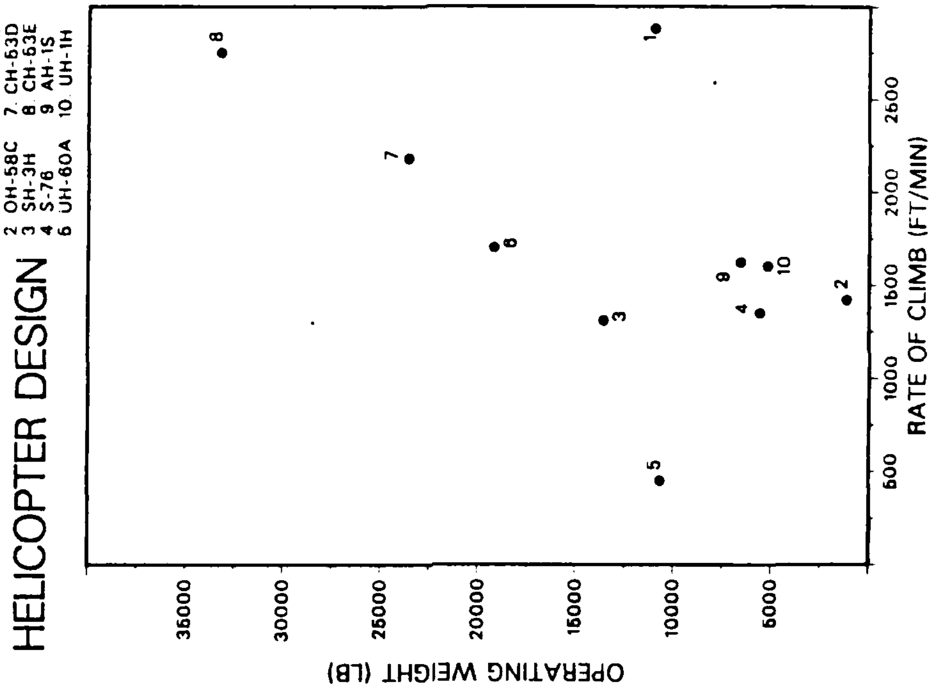


Fig. 23-27.

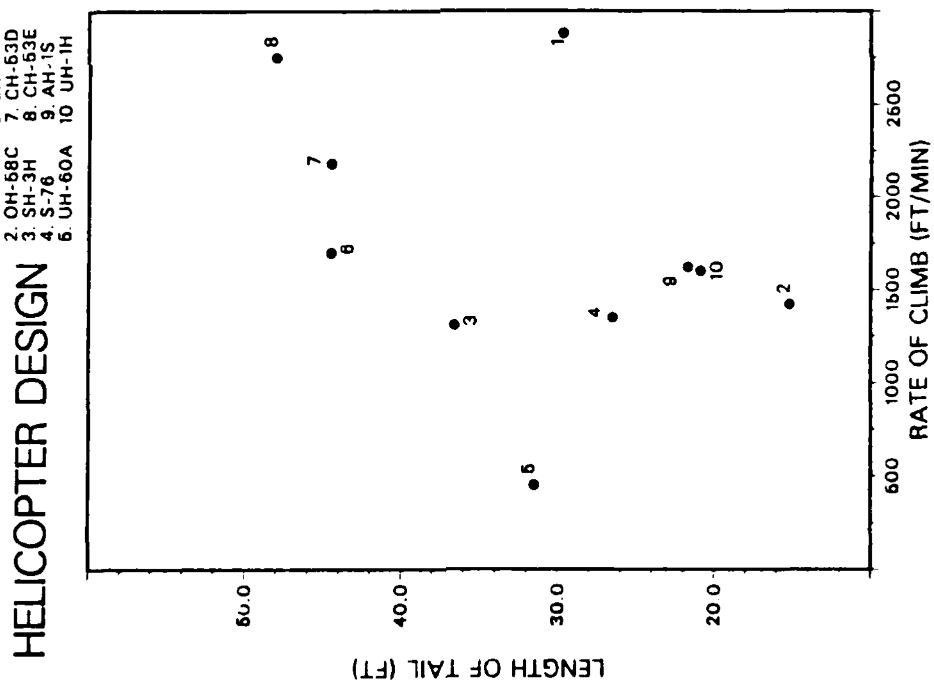


Fig. 23-26.

Fig. 23-26 and 23-27.

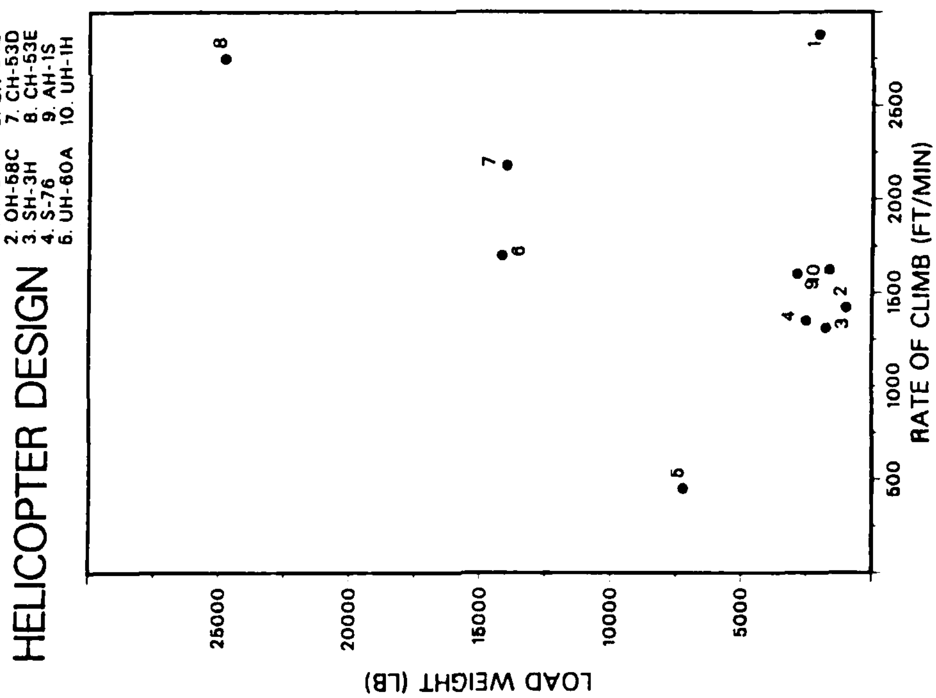


Fig. 23-28.

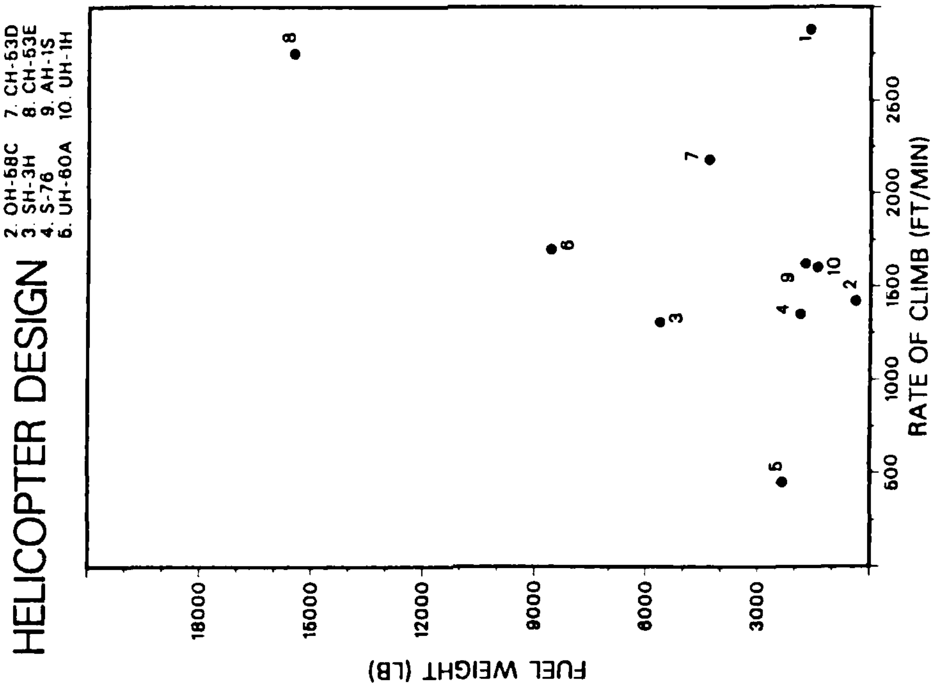


Fig. 23-29.

Fig. 23-28 and 23-29.

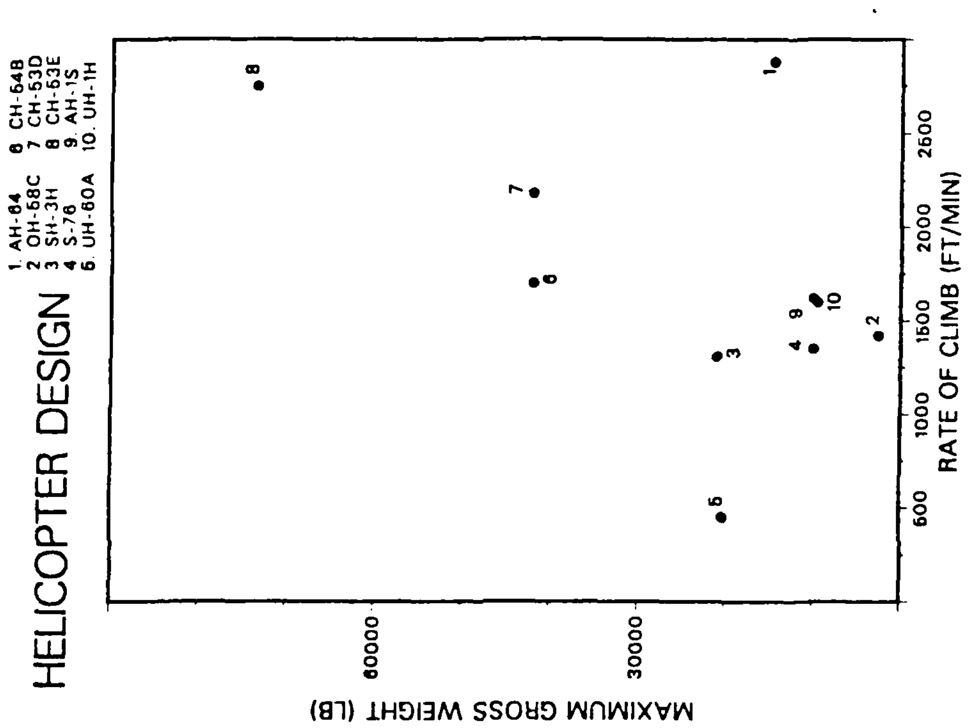


Fig. 23-30.

Fig. 23-30.

Hover Ceiling (IGE) Pairings.

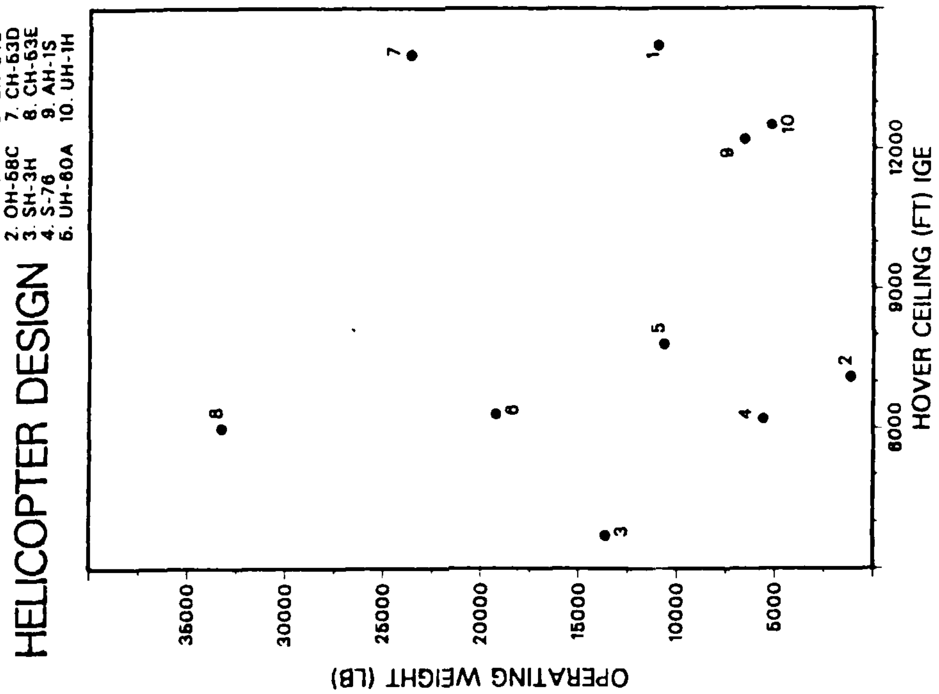


Fig. 24-27.

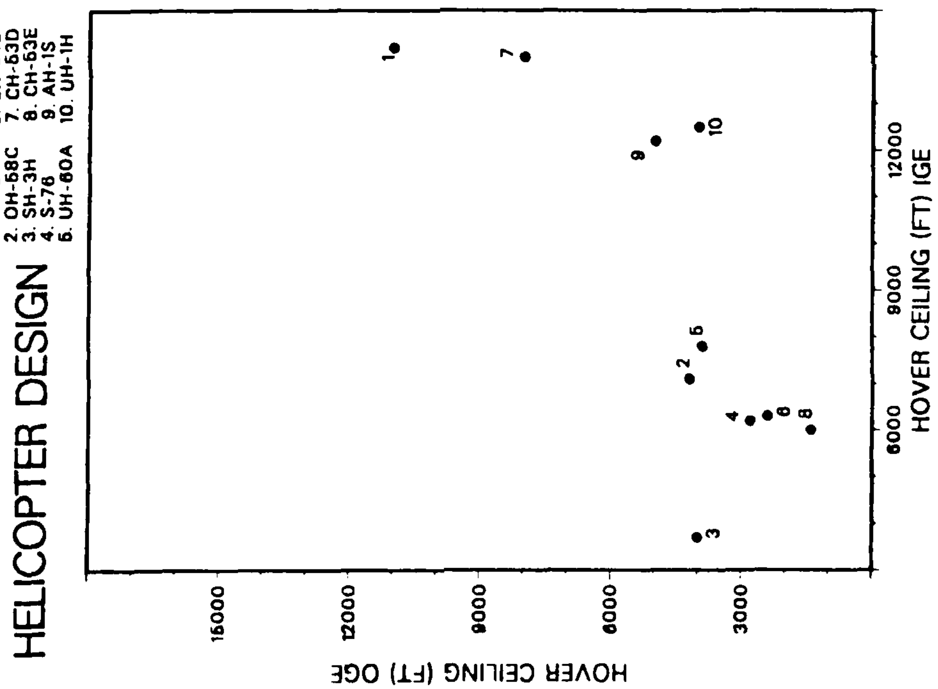


Fig. 24-25.

Fig. 24-25 and 24-27.

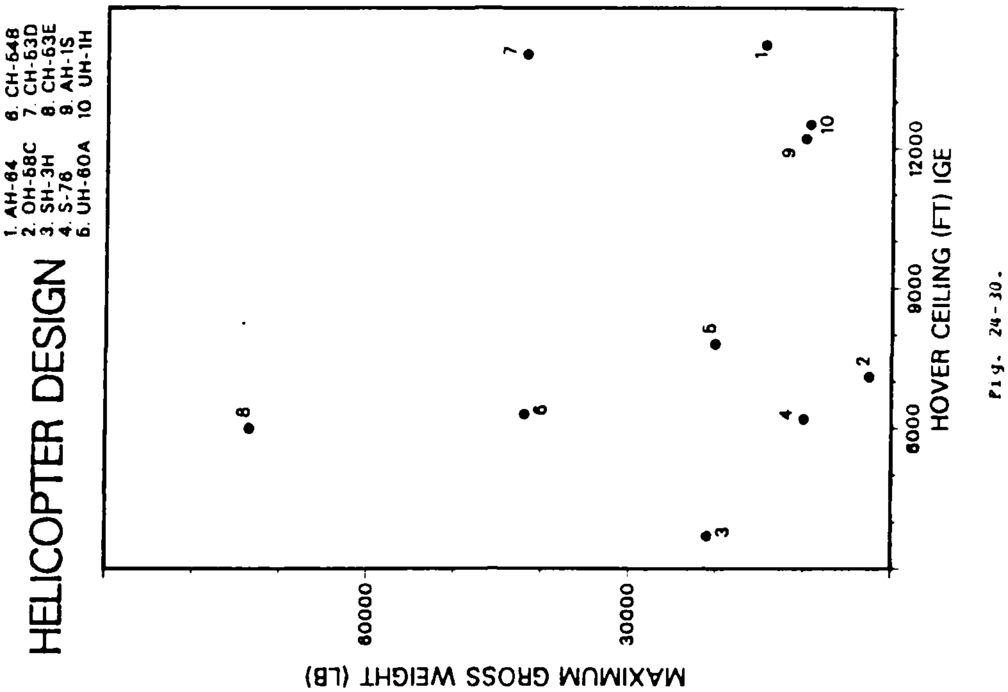


Fig. 24-30.

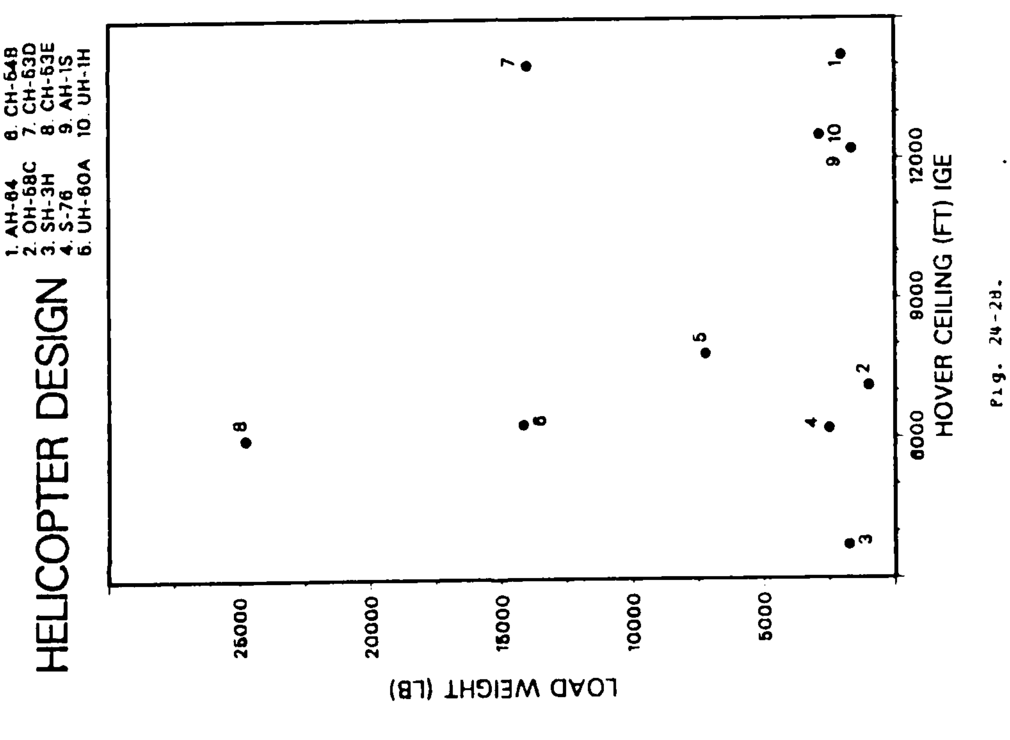


Fig. 24-28.

Fig. 24-28 and 24-30.

Hover Ceiling (OGE) Pairings.

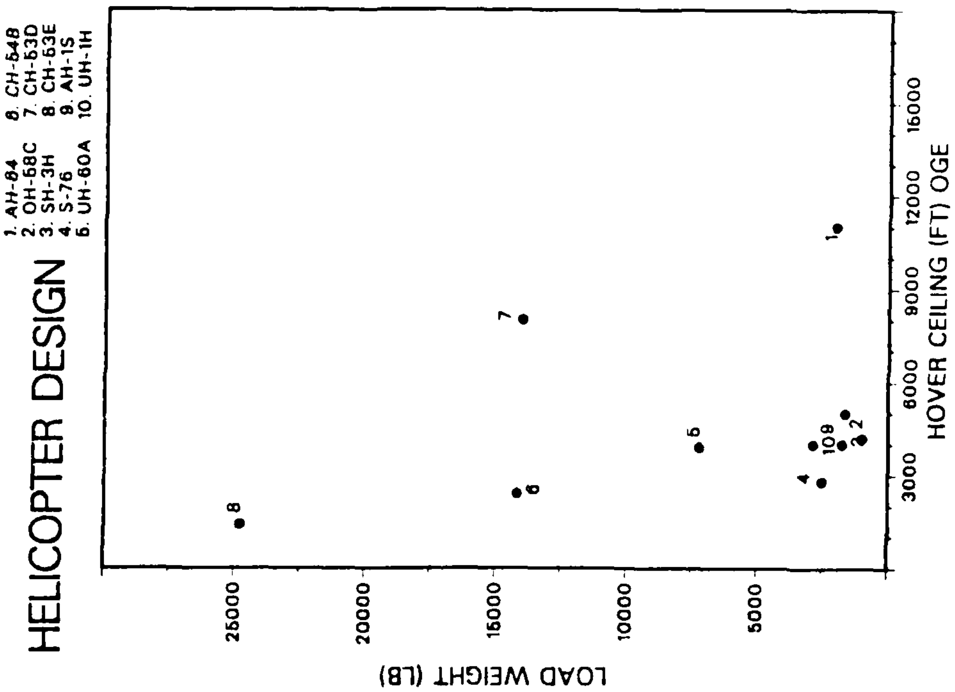


Fig. 25-28.

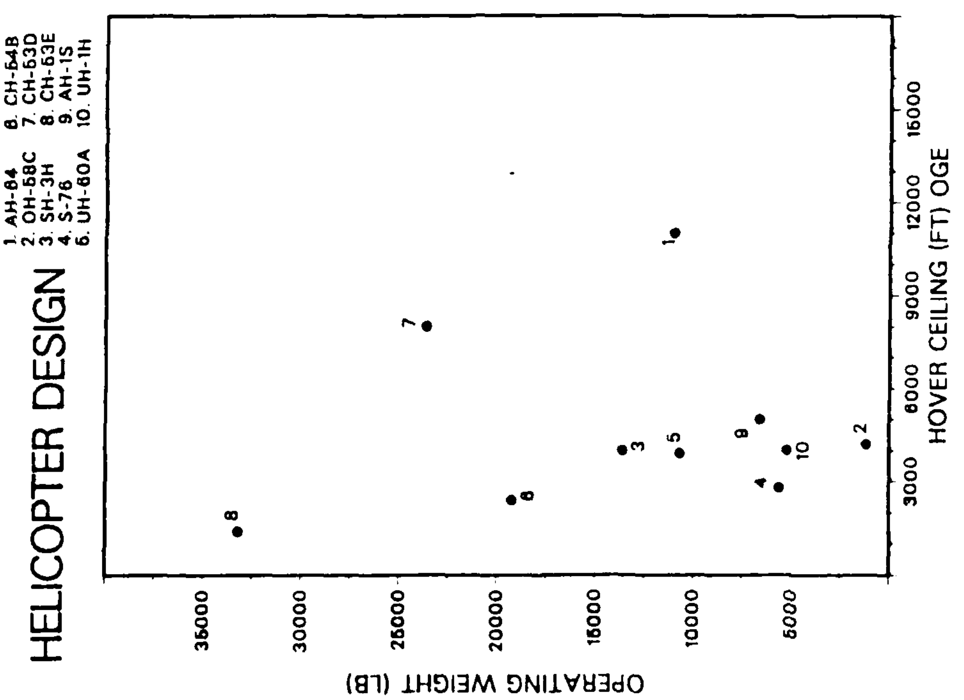


Fig. 25-27.

Fig. 25-27 and 25-28.

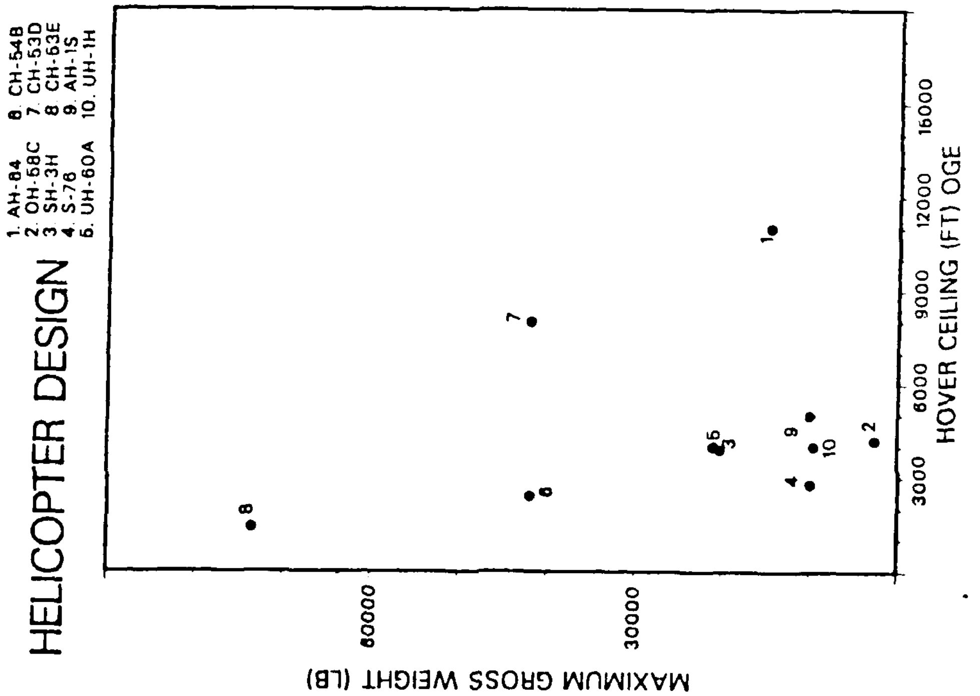


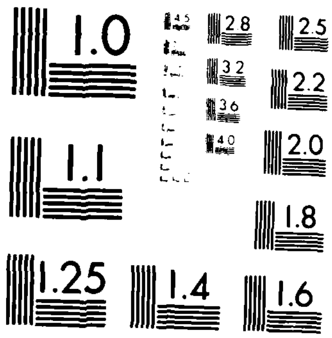
Fig. 25-30.

Fig. 25-30.

Length of Tail Pairings.

AD-A152 034 DETERMINATION OF QUANTITATIVE RELATIONSHIPS BETWEEN SELECTED CRITICAL HELICOPTER DESIGN PARAMETERS(U) NAVAL POSTGRADUATE SCHOOL MONTEREY CA R S PETRICKA SEP 84 4/4

UNCLASSIFIED F/G 1/3 NL



MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

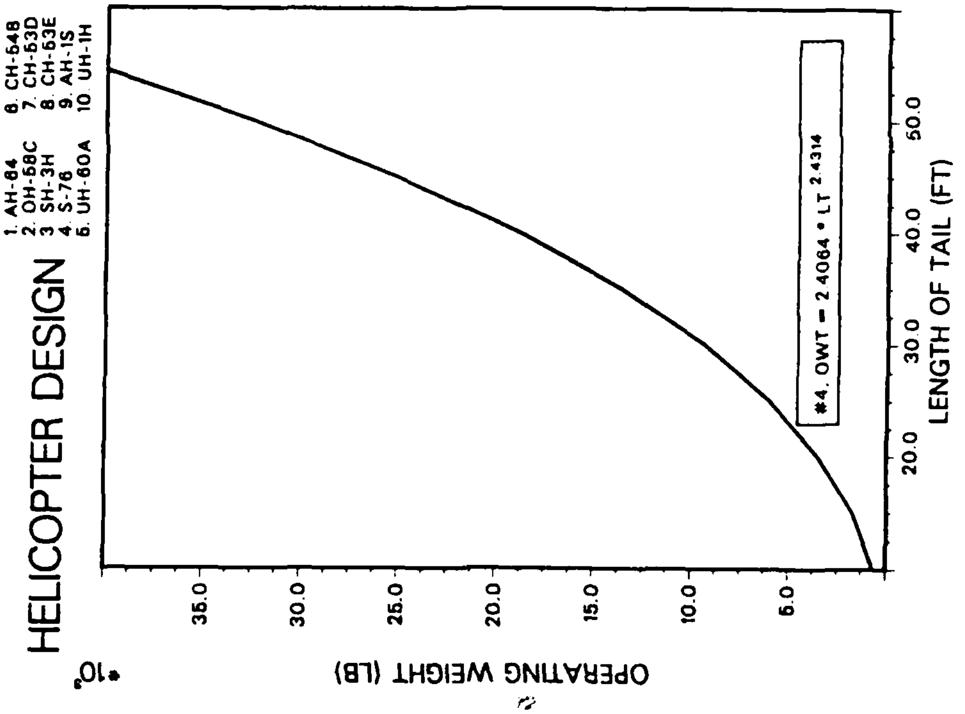


Fig. 26-27b.

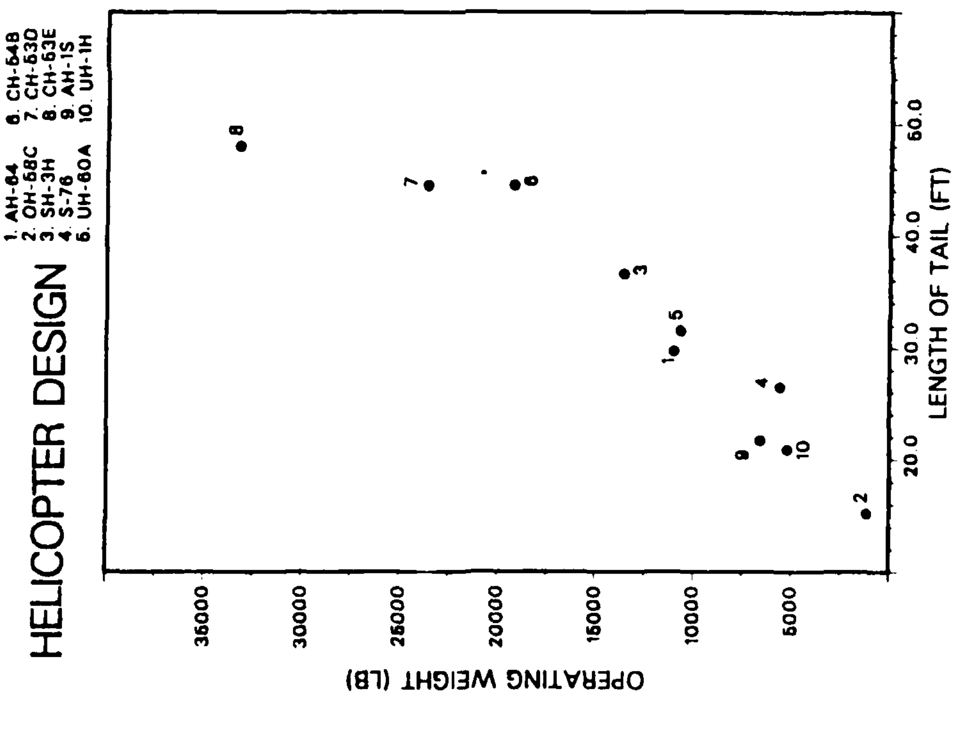


Fig. 26-27a.

Fig. 26-27a and 26-27b.

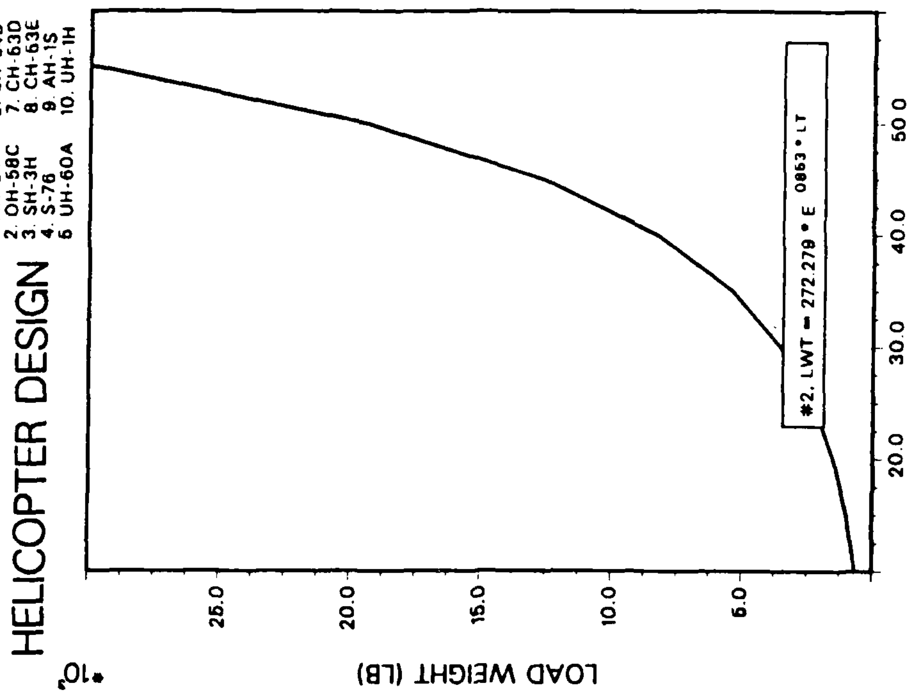


Fig. 26-28b.

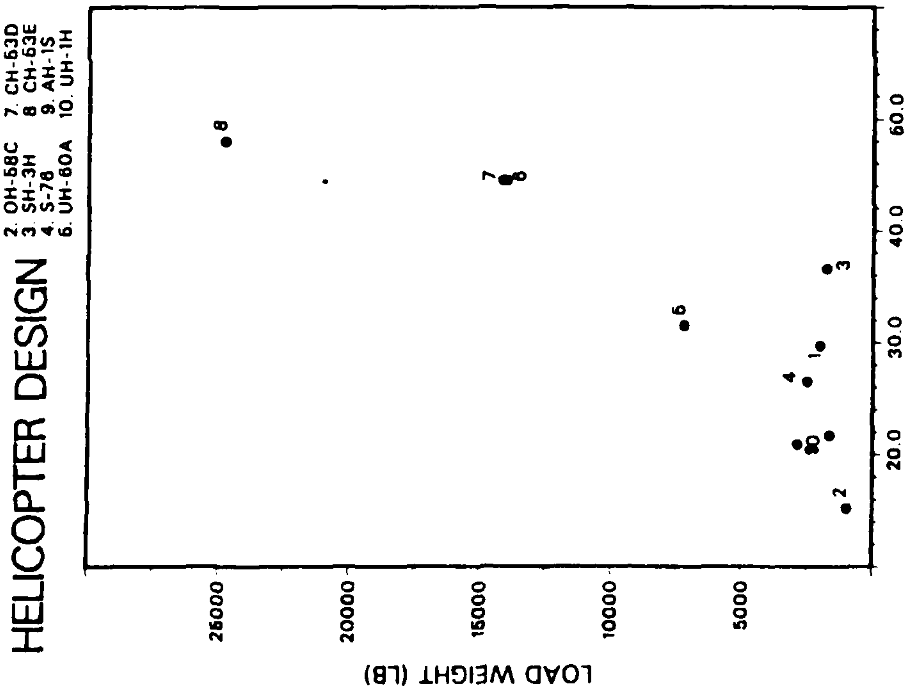


Fig. 26-28a.

Fig. 26-28a and 26-28b.

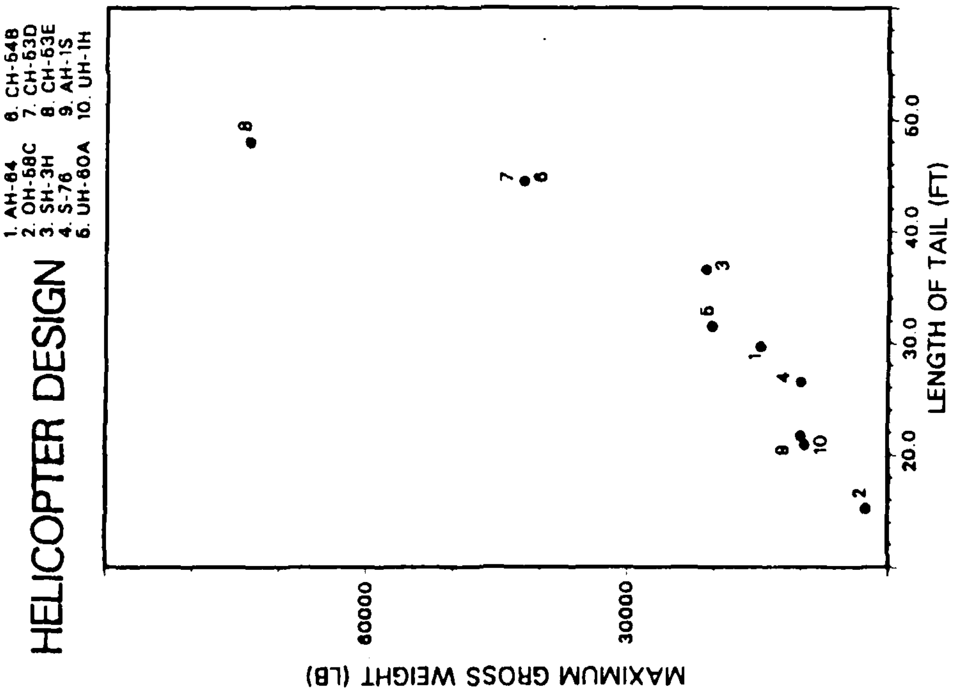


Fig. 26-30a.

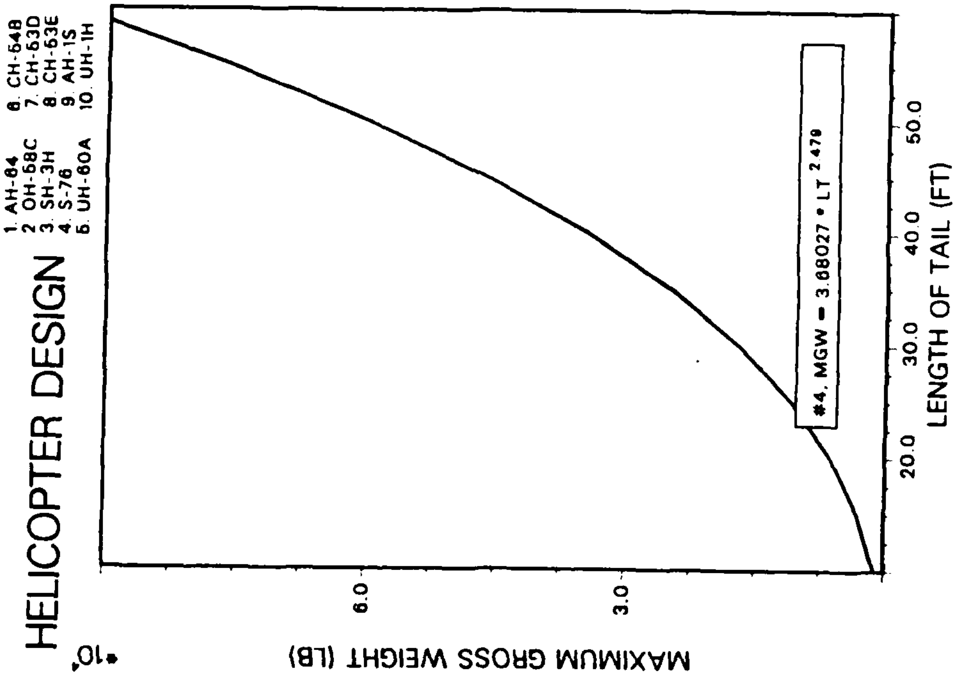


Fig. 26-30b.

Fig. 26-30a and 26-30b.

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Operating Weight Pairings.

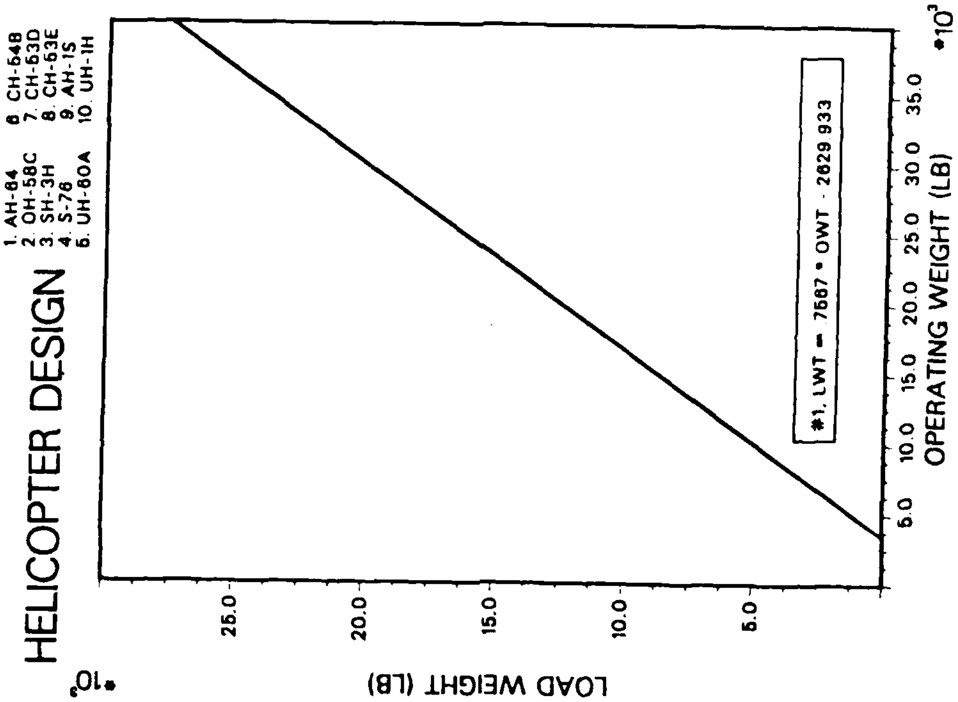


Fig. 27-28b.

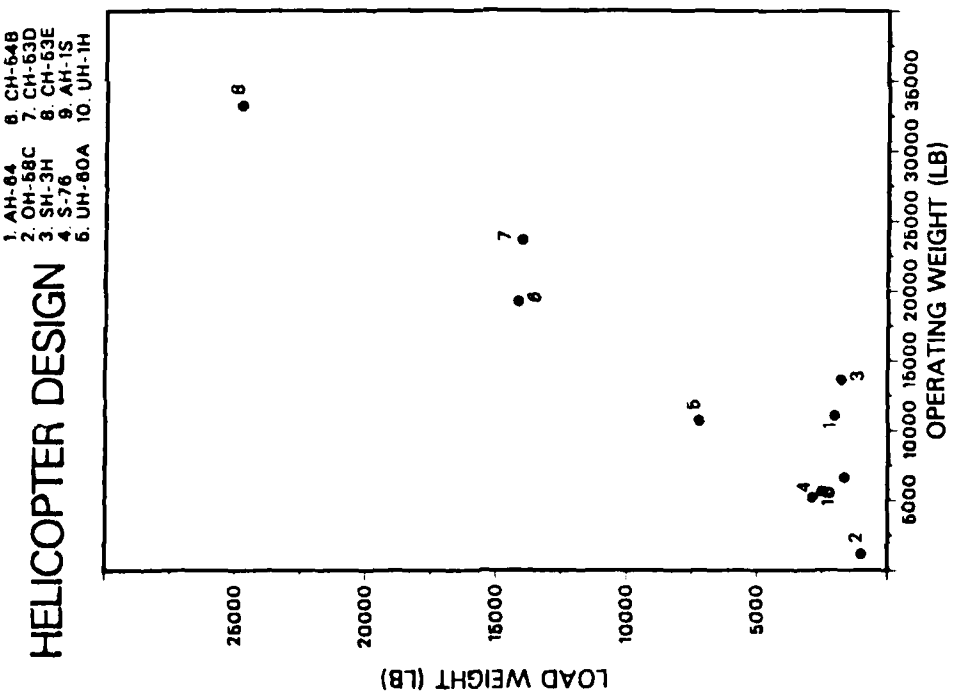


Fig. 27-28a.

Fig. 27-28a and 27-28b.

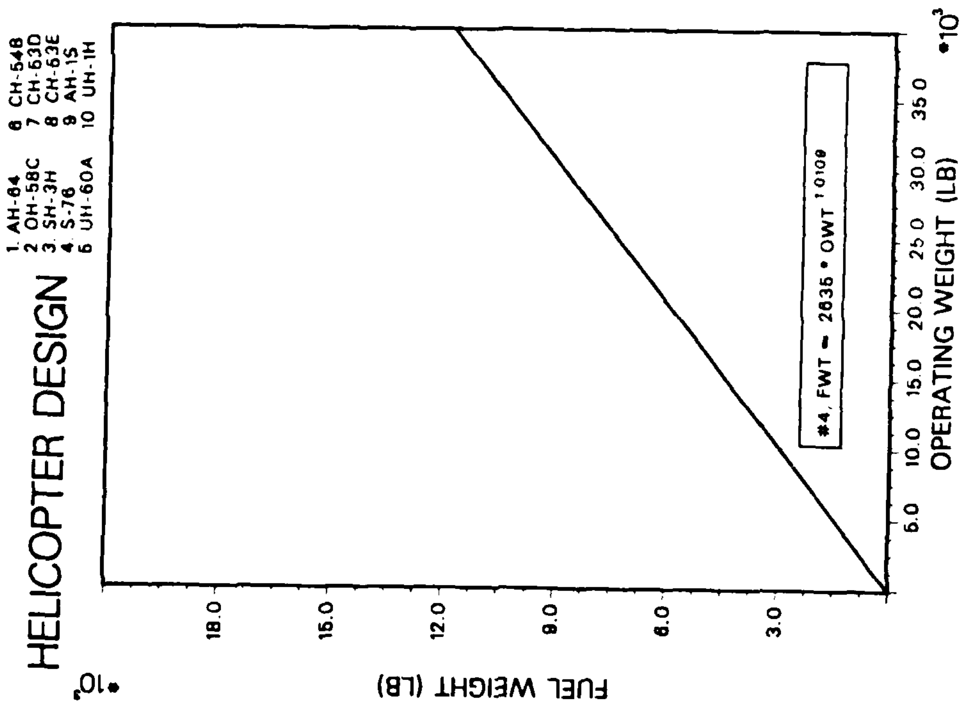


Fig. 27-29b.

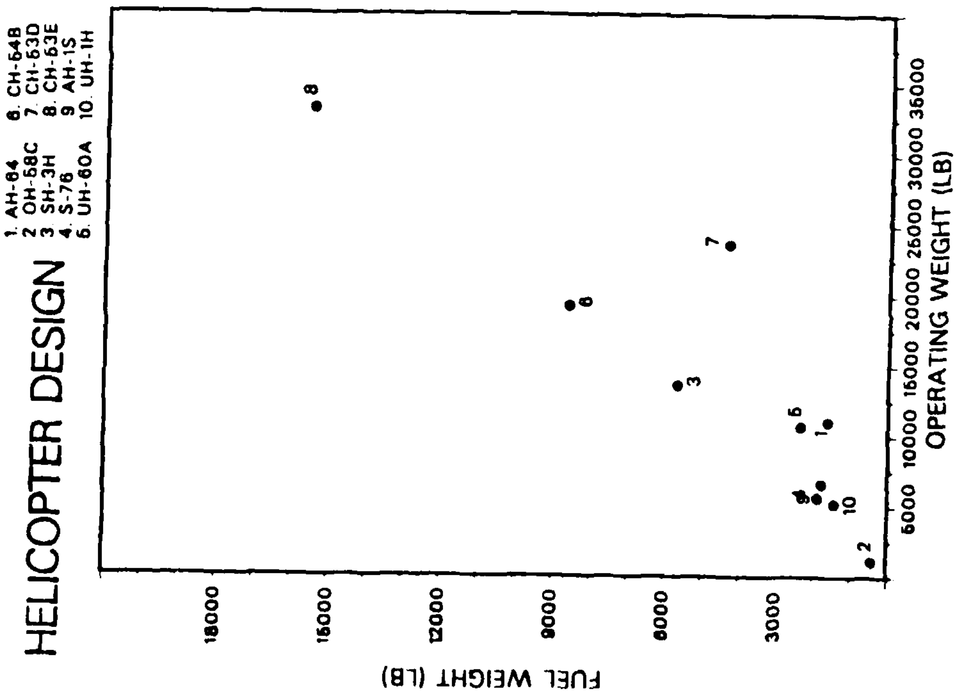


Fig. 27-29a.

Fig. 27-29a and 27-29b.

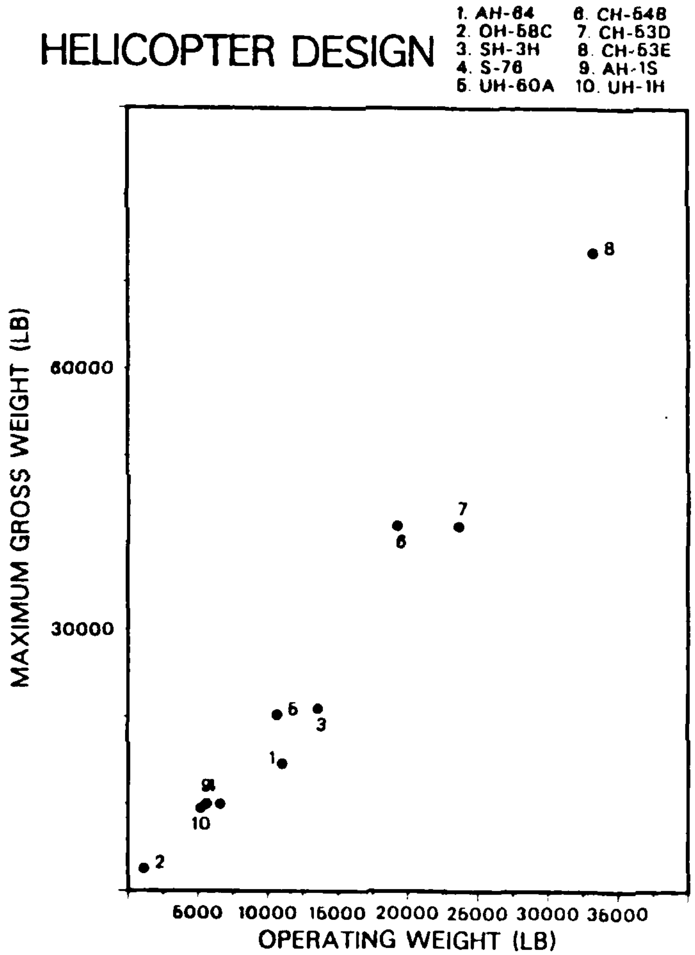


Fig. 27-30a.

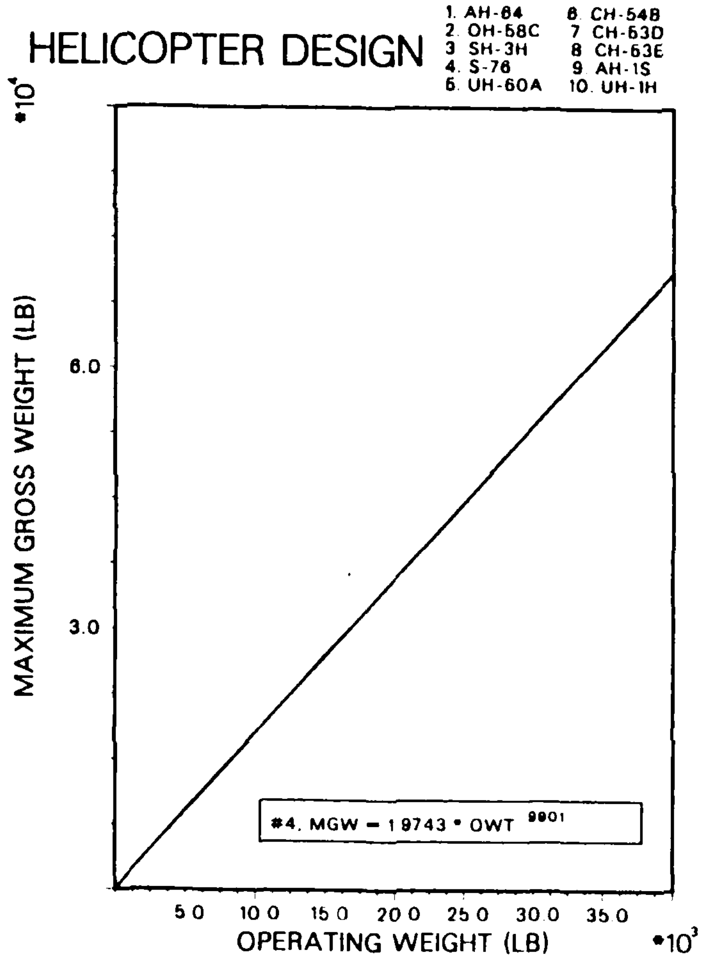
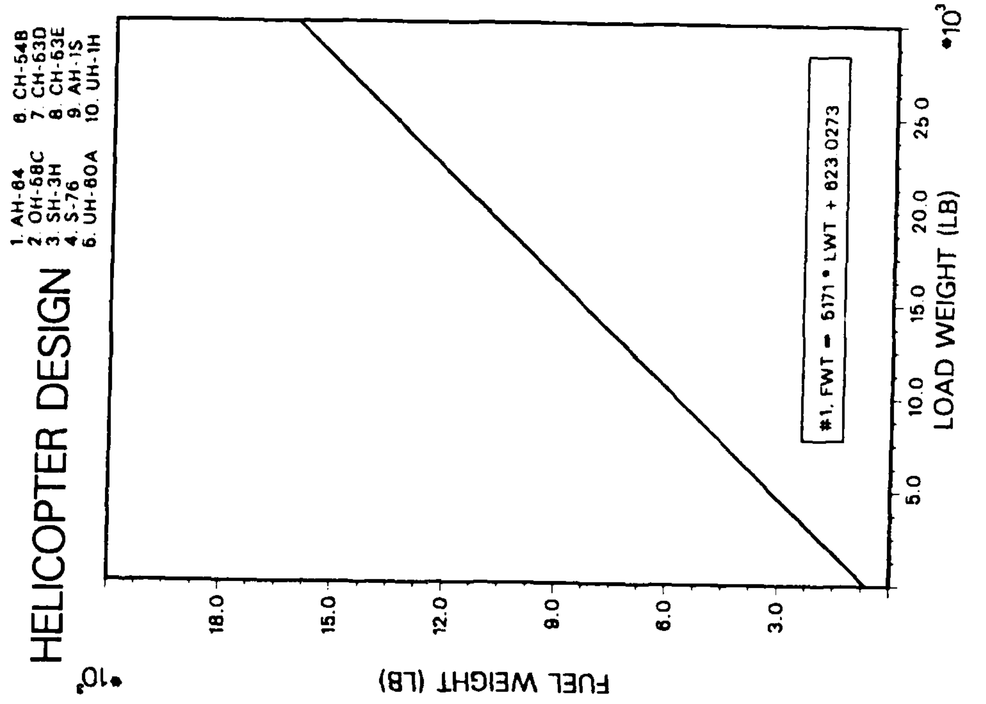


Fig. 27-30b.

Fig. 27-30a and 27-30b.

1332

Load Weight Pairings.



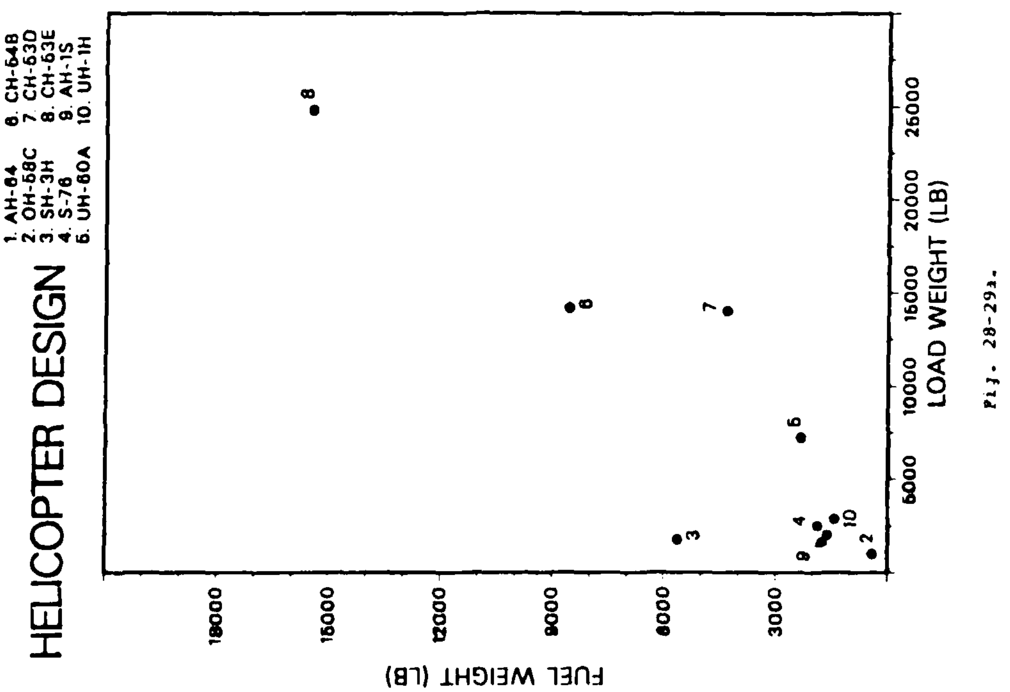


Fig. 28-29a and 28-29b.

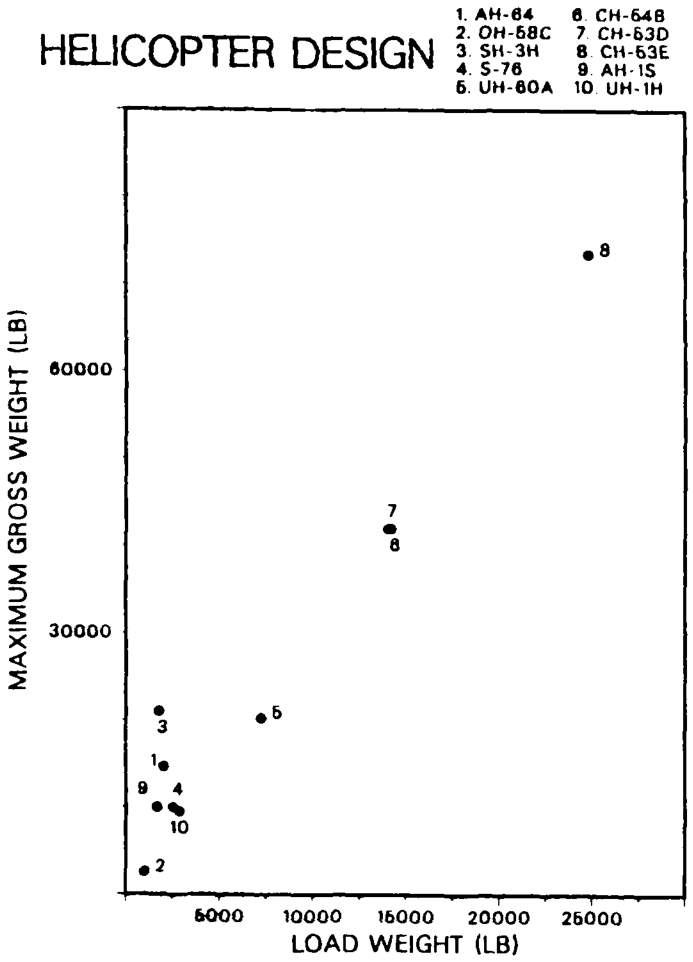


Fig. 28-30a.

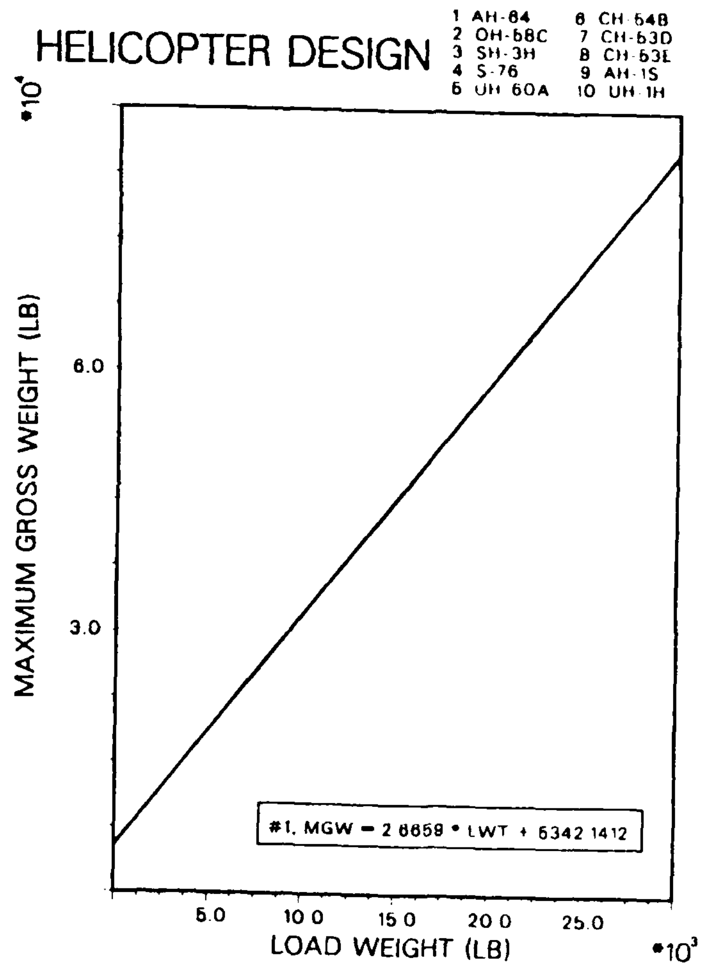


Fig. 28-30b.

Fig. 28-30a and 28-30b.

Fuel Weight Pairings.

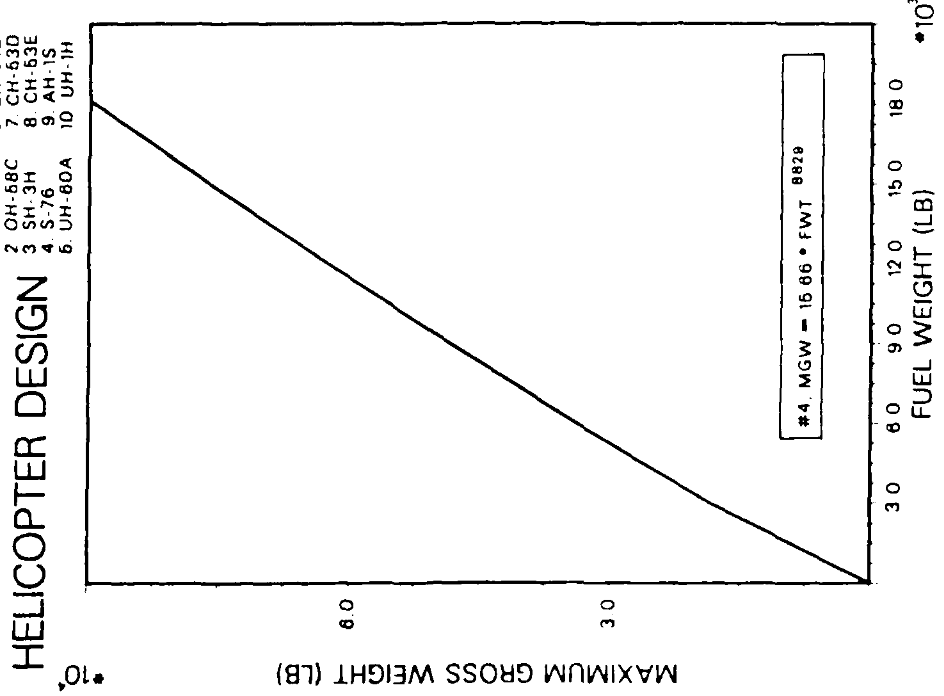


Fig. 29-30b.

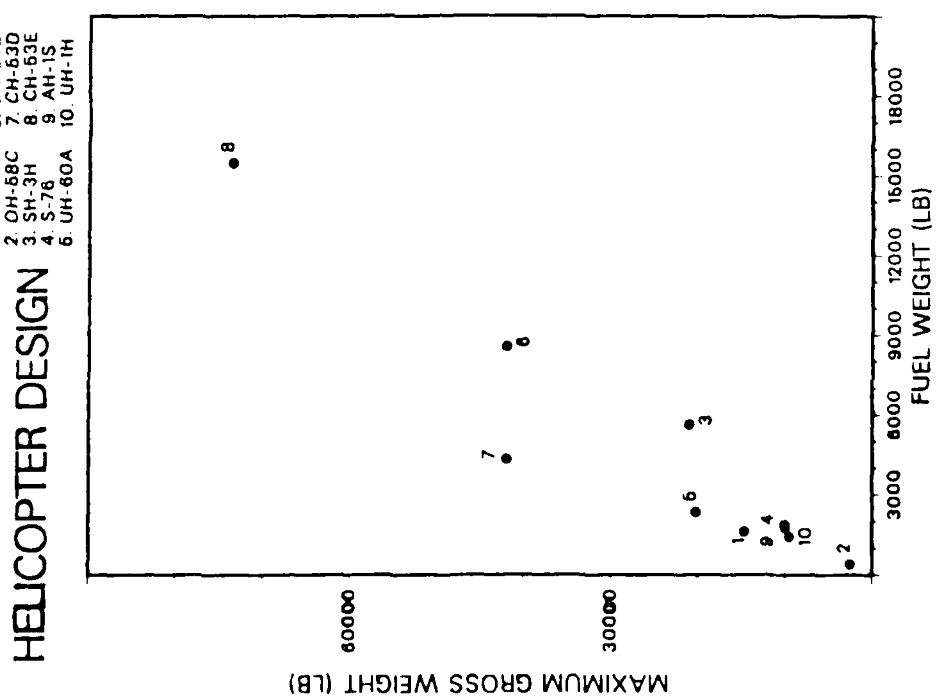


Fig. 29-30a.

Fig. 29-30a and 29-30b.

APPENDIX D

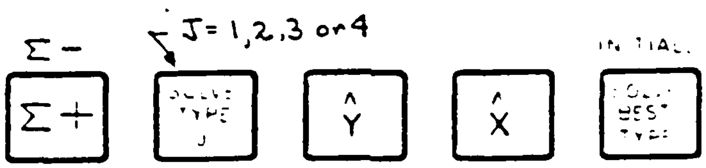
FORTRAN AND HEWLETT PACKARD COMPUTER PROGRAMS

A. 'CRVFIT' (DETERMINATION OF CURVE FIT EQUATIONS) HP PROGRAM

This program will determine a curve of best fit to a set of data points. The four standard curve types the program handles are:

1. Linear $y = b*x + a$
2. Exponential $y = a*e^{bx}$ $(a>0)$
3. Logarithmic $y = b*Ln(x) + a$
4. Power $y = a*x^{b}$ $(a>0)$

The program will compute the coefficients a and b in the equation of one of the above four curve types as well as compute a value r^2 called the coefficient of determination which is a measure of the goodness of fit. Once a set of data has been fit to a given curve type, a prediction may be made for the y-value given a new x-value, or a prediction may be made for the x-value given a new y-value. The functions available on the top row of keys on the keyboard are indicated in the following diagram.



These same functions are referenced in the examples and instructions by enclosing the name of the function on the key in square brackets [ ].

Example 1: Find the straight line which best fits the following data:
(1.1, 5.2), (4.5, 12.6), (8.0, 20.0),
(10.0, 23.0), (15.6, 34.0)
Then predict y when x=20 and predict x when y=25.

LOAD "CVF" PROG. Into the 41C and SIZE 027. GTO "CVF" and go into USER mode. This puts the program counter in ROM and makes the curve fit functions available on the top row of keys. Pressing [INITIALIZE] will initialize the program. This clears registers R11 thru R24 so that a new set of data may be entered. In this example the 5 data points will be entered using the [Σ+] key. Key in each pair as x ENTER↑ y and push [Σ+].

Do:		See:
[INITIALIZE]		1.0000
1.1 ENTER↑ 5.2	[Σ+]	2.0000
4.5 ENTER↑ 12.6	[Σ+]	3.0000
8.0 ENTER↑ 20.0	[Σ+]	4.0000
10.0 ENTER↑ 23.0	[Σ+]	5.0000
15.6 ENTER↑ 34.0	[Σ+]	6.0000

All the data has now been entered and the parameters for the curve will be computed next. Since in this example we are interested in a straight line we key 1 (j=1) and push [SOLVE TYPE J]. When execution stops the values a, b, and r are available in the stack as:

Z: r	and are also stored as	R08: b
Y: a		R09: a
X: b		R10: r

For this example:

Z: r=0.999035140.
Y: a=3.499147270
X: b=1.972047542

The value r ranges between -1 and +1 and is a measure of how well the data fits the given curve type. The sign of r indicates whether the data is positively or negatively skewed. The closer r is to one of the extremes ±1 the better the fit. For this example the line has positive slope and the fit is extremely good (all sample problems seem to work well).

Having computed the values b and a (these remain stored in R08 & R09 until new data is input) we can determine new points along the line. Key in 20 and push [$\hat{y}$] for the predicted y-value. y=42.94009811 when x=20. Key in 25 and push [$\hat{x}$] for the predicted x-value. x=10.90280649 when y=25.

COMPLETE INSTRUCTIONS FOR "CVF"

(Keyboard Operation)

1) Key GTO "   , SIZE 027 and go into USER mode. The keyboard functions should now be now available on the top row of keys.

2) Press [INITIALIZE] to initialize the program. This step clears data registers R11 thru R24 inclusive. These registers will be used to accumulate the data for all four curve types. The display will show 1.

3) Key in the next data pair (x,y) as x ENTER↑ y and push [Σ+]. Repeat this step for all data pairs. The display will stop with a count of the number of the next data pair to be entered. This feature makes it possible to enter only the y-values when the x-values are consecutive integers which start counting from 1. In this case the display provides the x-values which need not be entered. If an improper data pair has just been input with the [Σ+] key, then immediately pressing R/S will delete the pair. Otherwise an improper or undesired data pair can be deleted by re-entering both x and y and pressing [Σ-].

4) As data pairs are entered it is possible that some x or y value is negative or zero. In these cases only one or two of the four curve types may be applied to the data. The four curve types and their respective equations are as follows:

Type J	Name	Equation
1	Linear	$y = b*x + a$
2	Exponential	$y = a*e^{bx}$ (a>0)
3	Logarithmic	$y = b*Ln(x) + a$
4	Power -	$y = a*x^{b}$ (a>0)

If any x-values are negative or zero then only types 1 & 2 are feasible curves. If any y-values are negative or zero then only types 1 & 3 are feasible curves. If in any data pair both x and y are negative or zero then type 1 is the only feasible curve. The a coefficient must be positive for curve types 2 and 4.

5) After all data pairs have been input the next step is to select the desired curve type. This step can be accomplished in one of two ways. Under either option, the 41C should not be interrupted or else there is a possibility that the data registers will not be returned with their normal contents.

a) To fit a particular curve type, key in the number 1-4 for that type and press [SOLVE TYPE J]. The stack returns with:

Z: r	and these parameters	R07: J=curve type
Y: a	remain stored in	R08: b
X: b		R09: a
		R10: r

Step a) may be repeated at any time for any of the four curve types.

b) If all data input is positive then pressing [SOLVE BEST] will automatically choose the curve of best fit according to the curve type with largest absolute value of r. In this case the stack returns with:

T: r	and these parameters	R07: J=curve type
Z: a	remain stored in	R08: b
Y: b		R09: a
X: J=best curve type		R10: r

6) Predictions for new x or y values may be made only after step 5) has been completed. Predictions for new values are based on the settings of flags F08 and F09 which are automatically set during the fit process in step 5). The status of flags 8 and 9 for the four curve types are as follows.

		Flag 8	Flag 9
1	Linear	clear	clear
2	Exponential	set	clear
3	Logarithmic	clear	set
4	Power	set	set

In general the user need not be concerned with these flag settings, and F08 and F09 are not avalible for other use and must not be disturbed. To predict y given x, key in x and press [$\hat{y}$]. To predict x given y, key in y and press [$\hat{x}$]. In both cases the predicted value is left in the X-register.

7) New data may be added or deleted at any time via the [Σ+] or [Σ-] keys. However, step 5) must be performed after updating the data before any new predictions can be made using step 6). The parameters a and b are automatically destroyed after input of new data.

```
01•LBL "CVF"
02 XEQ e
03 GTO IND 06
04•LBL A
05•LBL 01
06 CF 10
07•LBL 06
08 STO 09
09 X<>Y
10 STO 08
11 ΣREG 13
12 FC? 10
13 Σ+
14 FS? 10
15 Σ-
16 RDN
17 RCL 08
18 ENTER↑
19 X>0?
20 LN
21 ST* Z
22 RCL 09
23 X>0?
24 LN
25 ST* Z
26 X<>Y
27 ΣREG 19
28 FC? 10
29 Σ+
30 FS? 10
31 Σ-
32 R↑
33 FS? 10
34 CHS
35 ST+ 12
36 R↑
37 FS? 10
38 CHS
39 ST+ 11
40 X<> Z
41 SIGN
42 ST+ L
43 RCL 08
44 RCL 09
45 X<> L
46 RTN
47 RCL 08
48 RCL 09
49•LBL a
50 SF 10
51 GTO 06
52•LBL B
53•LBL 02
54 CF 08
55 CF 09
56 STO 07
57 2
58 X<Y?
59 SF 09
60 /
61 FRC
62 X=0?
63 SF 08
64 8
65 ST+ 07
66 XEQ IND 07
67 RCL 17
68 RCL 13
69 RCL 15
70 STO 09
71 *
72 RCL 18
73 /
74 -
75 STO 10
76 RCL 14
77 RCL 13
78 X↑2
79 RCL 18
80 /
81 -
82 STO Z
83 /
84 STO 08
85 RCL 13
86 *
87 ST- 09
88 X<>Y
89 RCL 16
90 RCL 15
91 X↑2
92 RCL 18
93 ST/ 09
94 /
95 -
96 *
97 SQRT
98 ST/ 10
99 XEQ IND 07
100 8
101 ST- 07
102 RCL 10
103 RCL 09
104 FS? 08
105 E↑X
106 STO 09
107 RCL 08
108 RTN
109•LBL 10
110 RCL 11
111 X<> 17
112 STO 11
113•LBL 13
114 RCL 21
115 X<> 15
116 STO 21
117 RCL 22
118 X<> 16
119 STO 22
120•LBL 09
121 RTN
122•LBL 11
123 RCL 12
124 X<> 17
125 STO 12
126•LBL 14
127 RCL 19
128 X<> 13
129 STO 19
130 RCL 20
131 X<> 14
132 STO 20
133 RTN
134•LBL 12
135 RCL 23
136 X<> 17
137 STO 23
138 XEQ 14
139 GTO 13
140•LBL C
141•LBL 03
142 FS? 09
143 LN
144 RCL 08
145 *
146 RCL 09
147 FS? 08
148 LN
149 +
150 FS? 08
151 E↑X
152 RTN
153•LBL D
154•LBL 04
155 FS? 08
156 LN
157 RCL 09
158 FS? 08
159 LN
160 -
161 RCL 08
162 /
163 FS? 09
164 E↑X
165 RTN
166•LBL e
167•LBL 00
168 CLRG
169 SF 27
170 E
171 RTN
172•LBL E
173•LBL 05
174 .
175 STO 25
176 4
177 STO 07
178•LBL 07
179 RCL 07
180 XEQ B
181 RCL 25
182 RCL 10
183 ABS
184 X<=Y?
185 GTO 15
186 STO 25
187 RCL 07
188 STO 26
189•LBL 15
190 DSE 07
191 GTO 07
192 RCL 26
193 XEQ 02
194 RCL 26
195 .END.
```

B. 'CRVFIT' (GRAPHING OF CURVE FITS) FORTRAN PROGRAM

```
C
C     ****** PROGRAM TO GENERATE DATA POINTS AND PRODUCE ***
C     ****** GRAPHS REPRESENTING CURVE-FITTED DATA *********
C     ***************************************************
C
      INTEGER I,KINDS(200),J,R
      REAL X(17),Y(17)
C     CALL TEK618
      CALL COMPRS
      DO 900 J=1,16
      R=FLOAT(J)
      CALL HWSCAL('SCREEN')
      CALL SWISSL
      CALL SETCLR('BLACK')
      CALL HEIGHT(.1)
C
C     ***************************************************
C     *** APPLY HEADINGS AND UPPER LEGEND ***
C     ***************************************************
C
      CALL LINES('1. AH-64        6. CH-54B$',KINDS,1)
      CALL LINES('2. OH-58C      7. CH-53D$',KINDS,2)
      CALL LINES('3. SH-3H        8. CH-53E$',KINDS,3)
      CALL LINES('4. S-76           9. AH-1S$',KINDS,4)
      CALL LINES('5. UH-60A    10. UH-1H$',KINDS,5)
      CALL RESET('HEIGHT')
      CALL HEIGHT(.25)
      CALL SHDCHR(90.,1,0.002,1)
      CALL PAGE(8.5,11.)
      CALL PHYSOR(2.45,2.25)
      CALL HWROT('AUTO')
      CALL GRACE(0.0)
C     CALL NOCHEK
      CALL AREA2D(4.65,6.5)
      CALL MESSAG('HELICOPTER DESIGN$',-100,-.7,6.85)
      CALL LSTORY(KINDS,5,2.75,6.65)
      CALL FRAME
      CALL XAXEND('NOENDS')
      CALL YAXEND('NOENDS')
      CALL RESET('HEIGHT')
      CALL HEIGHT(.15)
C
C     ***************************************************
C     *** APPLY AXIS LABELS ***
C     ***************************************************
C
      GO TO(11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26),R
   11 CALL YNAME('TAIL ROTOR RADIUS (FT)$',100)
```

```
      GO TO 100
12    CALL YNAME('NUMBER OF MAIN ROTOR BLADES$',100)
      GO TO 100
13    CALL YNAME('MAIN ROTOR SPEED (RPM)$',100)
      GO TO 100
14    CALL YNAME('TAIL ROTOR SPEED (RPM)$',100)
      GO TO 100
15    CALL YNAME('MAIN ROTOR BLADE CHORD (FT)$',100)
      GO TO 100
16    CALL YNAME('TAIL ROTOR BLADE CHORD (FT)$',100)
      GO TO 100
17    CALL YNAME('MAIN ROTOR BLADE SPAN (FT)$',100)
      GO TO 100
18    CALL YNAME('TAIL ROTOR BLADE SPAN (FT)$',100)
      GO TO 100
19    CALL YNAME('DISK LOADING$',100)
      GO TO 100
20    CALL YNAME('FUSELAGE LENGTH (FT)$',100)
      GO TO 100
21    CALL YNAME('FRONT FLAT PLATE AREA (SQ FT)$',100)
      GO TO 100
22    CALL YNAME('LENGTH OF TAIL (FT)$',100)
      GO TO 100
23    CALL YNAME('OPERATING WEIGHT (LB)$',100)
      GO TO 100
24    CALL YNAME('LOAD WEIGHT (LB)$',100)
      GO TO 100
25    CALL YNAME('FUEL WEIGHT (LB)$',100)
      GO TO 100
26    CALL YNAME('MAXIMUM GROSS WEIGHT (LB)$',100)
      GO TO 100
100   CONTINUE
      CALL XNAME('MAIN ROTOR RADIUS (FT)$',100)
      CALL YAXANG(0.0)
      CALL XTICKS(4)
      CALL YTICKS(4)
C
C     ****************************************************
C     *****   GENERATE DATA POINTS FOR CURVES   *****
C     ****************************************************
C
      X(1)=15.
      GO TO(31,32,33,34,35,36,37,38,39,40,41,42,43,44,45,46),K
31    Y(1)=(.0360)*X(1)**(1.512)
      GO TO 200
32    Y(1)=.234*X(1) - 2.309
      GO TO 200
33    Y(1)=691.291*(EXP(-.036*(X(1))))
```

```
      GO TO 200
34    Y(1)=283577.28*X(1)**(-1.650)
      GO TO 200
35    Y(1)=.210*(X(1))**.647
      GO TO 200
36    Y(1)=.037*X(1)-.169
      GO TO 200
37    Y(1)=17.370*ALOG(X(1))-33.177
      GO TO 200
38    Y(1)=1.015*(EXP(.052*(X(1))))
      GO TO 200
39    Y(1)=2.3938*(EXP(.043*(X(1))))
      GO TO 200
40    Y(1)=.501*(X(1))**1.402
      GO TO 200
41    Y(1)=2.396*(X(1))-32.198
      GO TO 200
42    Y(1)=1.533*(X(1))-10.740
      GO TO 200
43    Y(1)=1298.244*(X(1))-23135.238
      GO TO 200
44    Y(1)=51.799*(EXP(.137*X(1)))
      GO TO 200
45    Y(1)=.0094*(X(1))**3.816
      GO TO 200
46    Y(1)=.1132*(X(1))**3.615
      GO TO 200
200   CONTINUE
      DO 731 I=1,16
        X(I+1)=X(I)+2.0
        GO TO(27,28,29,30,47,48,49,50,67,68,69,70,87,88,89,90),K
27      Y(I+1)=(.0360)*X(I+1)**(1.512)
       GO TO 300
28    Y(I+1)=.234*X(I+1) - 2.309
      GO TO 300
29    Y(I+1)=691.291*(EXP(-.036*(X(I+1))))
      GO TO 300
30    Y(I+1)=283577.28*X(I+1)**(-1.650)
      GO TO 300
47    Y(I+1)=.210*(X(I+1))**.647
      GO TO 300
48    Y(I+1)=.037*X(I+1)-.169
      GO TO 300
49    Y(I+1)=17.370*ALOG(X(I+1))-33.177
      GO TO 300
50    Y(I+1)=1.015*(EXP(.052*(X(I+1))))
      GO TO 300
67    Y(I+1)=2.3938*(EXP(.043*(X(I+1))))
```

```
      GO TO 300
   68 Y(I+1)=.5013*(X(I+1))**1.402
      GO TO 300
   69 Y(I+1)=2.396*(X(I+1))-32.198
      GO TO 300
   70 Y(I+1)=1.533*(X(I+1))-10.740
      GO TO 300
   87 Y(I+1)=1298.244*(X(I+1))-23135.238
      GO TO 300
   88 Y(I+1)=91.799*(EXP(.137*X(I+1)))
      GO TO 300
   89 Y(I+1)=.0094*(X(I+1))**3.816
      GO TO 300
   90 Y(I+1)=.1132*(X(I+1))**3.615
      GO TO 300
  300 CONTINUE
  301 CONTINUE
      GO TO(51,52,53,54,55,56,57,58,59,60,61,62,63,64,65,66),F
   51 CALL GRAF(15.,5.0,45.,0.0,2.0,12.)
        GO TO 400
   52 CALL GRAF(15.,5.0,45.,0.0,1.0,9.0)
      GO TO 400
   53 CALL GRAF(15.,5.,45.,0.,100.,600.)
      GO TO 400
   54 CALL GRAF(15.,5.0,45.,500.,500.,3500.)
      GO TO 400
   55 CALL GRAF(15.,5.0,45.,0.0,.5,3.0)
      GO TO 400
   56 CALL GRAF(15.,5.0,45.,0.3,0.1,1.5)
      GO TO 400
   57 CALL GRAF(15.,5.0,45.,10.,5.0,40.)
      GO TO 400
   58 CALL GRAF(15.,5.0,45.,0.0,1.0,10.)
      GO TO 400
   59 CALL GRAF(15.,5.0,45.,3.0,1.0,16.)
      GO TO 400
   60 CALL GRAF(15.,5.0,45.,20.,20.,120.)
      GO TO 400
   61 CALL GRAF(15.,5.0,45.,0.0,10.,70.)
      GO TO 400
   62 CALL GRAF(15.,5.0,45.,10.,10.,60.)
      GO TO 400
   63 CALL GRAF(15.,5.0,45.,0.0,5000.,40000.)
      GO TO 400
   64 CALL GRAF(15.,5.0,45.,0.0,5000.,30000.)
      GO TO 400
   65 CALL GRAF(15.,5.0,45.,0.0,3000.,21000.)
      GO TO 400
```

```
 66   CALL GRAF(15.,5.0,45.,0.0,30000.,50000.)
      GO TO 400
400   CONTINUE
      CALL RESET('HEIGHT')
      CALL HEIGHT(.10)
C
C     **************************************************************
C     ***   WRITE LEGEND TO IDENTIFY THE RESULTING
C     ***     CURVE AND DERIVED CONSTANTS
C     **************************************************************
C
      CALL MIXALF('INSTRU')
      GO TO(71,72,73,74,75,76,77,78,79,80,81,82,83,84,85,86),H
 71   CALL MESSAG('#4, KTR = .0360   R (EH.8)1.521(EXHX)$',100,1.5,0.5)
      GO TO 500
 72   CALL MESSAG('#1, E = .0360   R - 2.309$',100,1.5,0.5)
      GO TO 500
 73   CALL MESSAG('#2, RRM = 691.291   E (EH.8)-.036 R(EXHX)$',100,1.5
     ,0.5)
      GO TO 500
 74   CALL MESSAG('#4, RRM = 2835771   R (EH.8)-1.650(EXHX)$',100,1.5
     ,0.5)
      GO TO 500
 75   CALL MESSAG('#4, C = .210   R (EH.8).647(EXHX)$',100,1.5,0.5)
      GO TO 500
 76   CALL MESSAG('#1, CTR = .037   R - .169$',100,1.5,0.5)
      GO TO 500
 77   CALL MESSAG('#3, RS = 17.370   LN R -33.177$',100,1.5,0.5)
      GO TO 500
 78   CALL MESSAG('#2, RSTR = 1.0150   E (EH.8).052 R(EXHX)$',100,1.5,
     0.5)
      GO TO 500
 79   CALL MESSAG('#2, EL = 2.3938   E (EH.8).043 R(EXHX)$',100,1.5,0.5)
      GO TO 500
 80   CALL MESSAG('#4, LCH = .501   R (EH.8)1.402(EXHX)$',100,1.5,0.5)
      GO TO 500
 81   CALL MESSAG('#1, FH = 2.396   R - 32.198$',100,1.5,0.5)
      GO TO 500
 82   CALL MESSAG('#1, LT = 1.533   R - 10.740$',100,1.5,0.5)
      GO TO 500
 83   CALL MESSAG('#1, CWT = 1298.244   R - 23135.238$',100,1.7,0.5)
      GO TO 500
 84   CALL MESSAG('#2, LWT = 91.799   E (EH.8).137 R(EXHX)$',100,1.7,0.5
     )
      GO TO 500
 85   CALL MESSAG('#4, FWT = .0094   R (EH.8)3.816(EXHX)$',100,1.7,0.5)
      GO TO 500
 86   CALL MESSAG('#4, MGW = .1132   R (EH.8)3.615(EXHX)$',100,1.7,0.5)
```

```
      GO TO 900
  800 CONTINUE
      CALL RESET('MIXALF')
      CALL BLREC(1.4,0.4,3.0,.35,.015)
C
C
C         PLOT CURVE
C
C
      CALL THKCRV(.02)
      CALL CURVE(X,Y,16,0)
      CALL RESET('THKCRV')
      CALL ENDPL(0)
  900 CONTINUE
      CALL DONEPL
      STOP
      END
```

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3. Layton, Professor Donald M., AE 4306 Helicopter Design Manual, Naval Postgraduate School, Monterey, California, 1983.

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