2011-093

13 of 15

88th ABW/IPI
FOIA (b)(1)
E.O. 13526 SEC. 3.3.(b)(4)
1.4. (a)(g)
FOIA (b)(1)
E.O. 13526 SEC 3.3 (b)(4)
SEC 1.4 (a)(g)

~~SECRET~~

WING GEOMETRY MATRIX - A/C G.W.=15,600 lbs.

		AR=3	AR=4	AR=5	AR=6
W/S=45	G.W.	15600	15600	15600	15600
	W/S	45	45	45	45
	S	346.666666	346.666666	346.666666	346.666666
	AR	3.0	4.0	5.0	6.0
	λ	0.2	0.2	0.2	0.2
	b	386.988360	446.855676	499.591028	547.284362
	$b/2$	193.494180	223.427838	249.795514	273.642181
	C_R	214.993536	186.189884	166.533276	152.023352
	C_T	42.998707	37.237977	33.306655	30.404670
	$\bar{c}$	148.106751	128.264209	114.722996	104.727291
	$\bar{c}/4$	37.026687	32.066052	28.680749	26.181822
	$\bar{y}$	75.247692	86.888544	97.144364	106.416370
W/S=50	G.W.	15600	15600	15600	15600
	W/S	50	50	50	50
	S	312.000000	312.000000	312.000000	312.000000
	AR	3.0	4.0	5.0	6.0
	λ	0.2	0.2	0.2	0.2
	b	367.129404	423.924516	473.962026	519.199380
	$b/2$	183.564702	211.962258	236.981013	259.599690
	C_R	203.960772	176.635212	157.987337	144.222048
	C_T	40.792154	35.327042	31.597466	28.844409
	$\bar{c}$	140.506395	121.682112	108.835786	99.353078
	$\bar{c}/4$	35.126599	30.420528	27.208946	24.838257
	$\bar{y}$	71.386224	82.429716	92.159226	100.955276
W/S=55	G.W.	15600	15600	15600	15600
	W/S	55	55	55	55
	S	283.636363	283.636363	283.636363	283.636363
	AR	3.0	4.0	5.0	6.0
	λ	0.2	0.2	0.2	0.2
	b	350.044152	404.196168	451.905048	495.037166
	$b/2$	175.022076	202.098084	225.952524	247.518584
	C_R	194.468964	168.414868	150.635012	137.510356
	C_T	38.893792	33.682973	30.127002	27.502071
	$\bar{c}$	133.967593	116.015347	103.770852	94.729390
	$\bar{c}/4$	33.491898	29.003837	25.942713	23.682347
	$\bar{y}$	68.064096	78.593699	87.870377	96.257172
W/S=60	G.W.	15600	15600	15600	15600
	W/S	60	60	60	60
	S	260.000000	260.000000	260.000000	260.000000
	AR	3.0	4.0	5.0	6.0
	λ	0.2	0.2	0.2	0.2
	b	335.141760	386.988360	432.666154	473.962026
	$b/2$	167.570880	193.494180	216.333077	236.981013
	C_R	186.189884	161.245152	144.222048	131.656116
	C_T	37.237977	32.249030	28.844409	26.331223
	$\bar{c}$	128.264209	111.080063	99.353078	90.696452
	$\bar{c}/4$	32.066052	27.770015	24.838257	22.674113
	$\bar{y}$	65.166406	75.247657	84.129468	92.159226

~~(S)~~ Figure 8.1-4 Wing Geometry Matrix Data - 15,600-lb Aircraft (U)

~~SECRET~~

WING GEOMETRY MATRIX · A/C G.W. = 16,800 lbs.

		AR = 3	AR = 4	AR = 5	AR = 6
W/S = 45	G.W.	16800	16800	16800	16800
	W/S	45	45	45	45
	S	373.333333	373.333333	373.333333	373.333333
	AR	3.0	4.0	5.0	6.0
	λ	0.2	0.2	0.2	0.2
	b	401.596817	463.724052	518.459244	567.943656
	b/2	200.798408	231.862026	259.229622	283.971828
	C_R	223.109340	193.218348	172.819788	157.762128
	C_T	44.621868	38.643669	34.563958	31.552425
	$\bar{c}$	153.697642	133.106057	119.053662	108.680641
	$\bar{c}/4$	38.424410	33.276514	29.763416	27.170160
	$\bar{y}$	78.088274	90.168564	100.811460	110.433488
W/S = 50	G.W.	16800	16800	16800	16800
	W/S	50	50	50	50
	S	336.000000	336.000000	336.000000	336.000000
	AR	3.0	4.0	5.0	6.0
	λ	0.2	0.2	0.2	0.2
	b	380.988180	439.927260	491.853636	538.798664
	b/2	190.494090	219.963630	245.926818	269.399332
	C_R	211.660164	183.303094	163.951212	149.666297
	C_T	42.332033	36.660619	32.790242	29.933259
	$\bar{c}$	145.810765	126.275416	112.944168	103.103451
	$\bar{c}/4$	36.452691	31.568854	28.236042	25.775863
	$\bar{y}$	74.080952	85.541412	95.638207	104.766406
W/S = 55	G.W.	16800	16800	16800	16800
	W/S	55	55	55	55
	S	305.454545	305.454545	305.454545	305.454545
	AR	3.0	4.0	5.0	6.0
	λ	0.2	0.2	0.2	0.2
	b	363.257976	419.454160	468.964032	513.724366
	b/2	181.628988	209.727080	234.482016	256.862184
	C_R	201.809988	174.772672	156.321340	142.701204
	C_T	40.361997	34.954534	31.264268	28.540246
	$\bar{c}$	139.024664	120.398952	107.688167	98.305355
	$\bar{c}/4$	34.756166	30.099738	26.922042	24.576337
	$\bar{y}$	70.633415	81.560464	91.187338	99.890764
W/S = 60	G.W.	16800	16800	16800	16800
	W/S	60	60	60	60
	S	280.000000	280.000000	280.000000	280.000000
	AR	3.0	4.0	5.0	6.0
	λ	0.2	0.2	0.2	0.2
	b	347.793036	401.596817	448.998876	491.853636
	b/2	173.896518	200.798408	224.499438	245.926818
	C_R	193.218348	167.331956	149.666297	136.626010
	C_T	38.643669	33.466399	29.933258	27.325202
	$\bar{c}$	133.106057	115.273227	103.103510	94.120140
	$\bar{c}/4$	33.276514	28.818306	25.775877	23.530035
	$\bar{y}$	67.626364	78.088224	87.305337	95.638207

~~(S)~~ Figure 8.1-5 Wing Geometry Matrix Data - 16,800-lb Aircraft (U)

88th ABW/IPI
FOIA (b)(1)
E.O.13526 SEC 3.3(b)(4)
1.4. (a)(g)
EO13526 SEC 3.3(b)(4)
SEC 1.4(a)(g)

~~SECRET~~

WING GEOMETRY MATRIX - A/C G.W. = 18,000 lbs.

		AR=3	AR=4	AR=5	AR=6
W/S = 45	G.W.	18000	18000	18000	18000
	W/S	45	45	45	45
	S	400.000000	400.000000	400.000000	400.000000
	AR	3.0	4.0	5.0	6.0
	λ	0.2	0.2	0.2	0.2
	b	415.692193	480.000000	536.656308	587.877516
	b/2	207.846096	240.000000	268.328154	293.938784
	C_R	230.940108	199.999992	178.885440	163.299317
	C_T	46.188021	39.999998	35.777088	32.659862
	$\bar{c}$	159.092175	137.777759	123.232270	112.495152
	$\bar{c}/4$	39.773043	34.444464	30.808067	28.123788
	$\bar{y}$	80.828958	93.333276	104.349766	114.309444
W/S = 50	G.W.	18000	18000	18000	18000
	W/S	50	50	50	50
	S	360.000000	360.000000	360.000000	360.000000
	AR	3.0	4.0	5.0	6.0
	λ	0.2	0.2	0.2	0.2
	b	394.361236	455.367977	509.116872	557.709600
	b/2	197.180118	227.683986	254.558436	278.854800
	C_R	219.089016	189.736656	169.705620	154.919328
	C_T	43.817803	37.947331	33.941124	30.983866
	$\bar{c}$	150.928084	130.707556	116.908390	106.722278
	$\bar{c}/4$	37.732021	32.676889	29.227097	26.680567
	$\bar{y}$	76.681104	88.543716	98.994820	108.443460
W/S = 55	G.W.	18000	18000	18000	18000
	W/S	55	55	55	55
	S	327.272727	327.272727	327.272727	327.272727
	AR	3.0	4.0	5.0	6.0
	λ	0.2	0.2	0.2	0.2
	b	376.007736	434.176337	485.423555	531.755272
	b/2	188.003868	217.088166	242.711784	265.877610
	C_R	208.889160	180.906604	161.806564	147.709768
	C_T	41.777836	36.181360	32.361312	29.541957
	$\bar{c}$	143.901481	124.624766	111.466776	101.755656
	$\bar{c}/4$	35.975370	31.156191	27.866694	25.438914
	$\bar{y}$	73.112598	84.423120	94.387520	103.396782
W/S = 60	G.W.	18000	18000	18000	18000
	W/S	60	60	60	60
	S	300.000000	300.000000	300.000000	300.000000
	AR	3.0	4.0	5.0	6.0
	λ	0.2	0.2	0.2	0.2
	b	360.000000	415.692193	464.757996	509.116872
	b/2	180.000000	207.846096	232.378998	254.558436
	C_R	199.999987	173.205077	154.919328	141.421356
	C_T	39.999992	34.641016	30.983866	28.284271
	$\bar{c}$	137.777759	119.319044	106.722278	97.423602
	$\bar{c}/4$	34.444464	29.829761	26.680567	24.355915
	$\bar{y}$	69.999960	80.828958	90.369557	98.994820

~~(S)~~ Figure 8.1-6 Wing Geometry Matrix Data - 18,000-lb Aircraft (U)

~~SECRET~~

88th ABW/IPI
~~FOIA (b)(1)~~
E.O.13526 SEC 3.3(b)(4)
1.4 (a)(g)
FOIA (b)(1)
EO 13526 SEC 3.3(b)(4)
SEC 1.4(a)(g)

~~SECRET~~

SIZING HORIZ. TAIL GEOMETRY MATRIX

		A/C GROSS WEIGHT - LBS		
		15,600	16,800	18,000
WING W/S • 45	$S_{H.T.}$	70.026667	75.413333	80.600000
	AR	3.0	3.0	3.0
	λ	0.2	0.2	0.2
	b	173.929632	180.495312	186.830400
	$b/2$	86.964816	90.247656	93.415200
	C_R	96.627576	100.275168	103.794660
	C_T	19.325515	20.055033	20.758932
	$\bar{c}$	66.565705	69.078492	71.503033
	$\bar{c}/4$	16.641426	17.269623	17.875758
	$\bar{y}$	33.819624	35.096280	36.328104
WING W/S • 50	$S_{H.T.}$	63.024000	67.872000	72.720000
	AR	3.0	3.0	3.0
	λ	0.2	0.2	0.2
	b	165.004140	171.232884	177.242880
	$b/2$	82.502070	85.616442	88.621440
	C_R	91.668972	95.129388	98.468268
	C_T	18.333794	19.025877	19.693653
	$\bar{c}$	63.149776	65.533620	67.833738
	$\bar{c}/4$	15.787444	16.383405	16.958434
	$\bar{y}$	32.084112	33.295260	34.463868
WING W/S • 55	$S_{H.T.}$	57.294545	61.701818	66.109091
	AR	3.0	3.0	3.0
	λ	0.2	0.2	0.2
	b	157.325268	163.264152	168.994452
	$b/2$	78.662634	81.632076	84.497226
	C_R	87.402936	90.702312	93.885804
	C_T	17.480587	18.140462	18.777160
	$\bar{c}$	60.210349	62.483854	64.676928
	$\bar{c}/4$	15.052737	15.620963	16.169232
	$\bar{y}$	30.591000	31.745784	32.860008
WING W/S • 60	$S_{H.T.}$	52.520000	56.560000	60.600000
	AR	3.0	3.0	3.0
	λ	0.2	0.2	0.2
	b	150.627480	156.313524	161.799876
	$b/2$	75.313740	78.156762	80.899938
	C_R	83.681940	86.840844	89.888820
	C_T	16.736388	17.368168	17.977764
	$\bar{c}$	57.647594	59.823730	61.923448
	$\bar{c}/4$	14.411898	14.955932	15.480862
	$\bar{y}$	29.288652	30.394272	31.461060

~~(S)~~ Figure 8.1-7 Sizing Horizontal Geometry Matrix Data (U)

~~SECRET~~

88th ABW/IPI
FOIA (b)(1)
E.O. 13526 SEC 3.3 (b)(4)
1.4 (a)(g) (6)(1)
EO13526 SEC 3.3 (6)(4)
SEC 1.4(a)(g)
pgs 497-507

~~SECRET~~

(U)

VERTICAL TAIL GEOMETRY MATRIX

	A/C GROSS WEIGHT-LBS.		
	15,600	16,800	18,000
S_{VT}	20.338131	22.118055	23.697922
AR	1.326530	1.326530	1.326530
λ	0.4	0.4	0.4
b	62.635452	64.999980	67.281372
$b/2$	31.317726	32.499990	33.640686
C_R	67.453596	70.000008	72.456932
C_T	26.981438	28.000003	28.982764
$\bar{c}$	50.108397	52.000018	53.825147
$\bar{c}/4$	12.527099	13.000004	13.456286
$\bar{y}/2$	13.421868	13.928556	14.417424
$\bar{y}$	26.843736	27.857112	28.834848

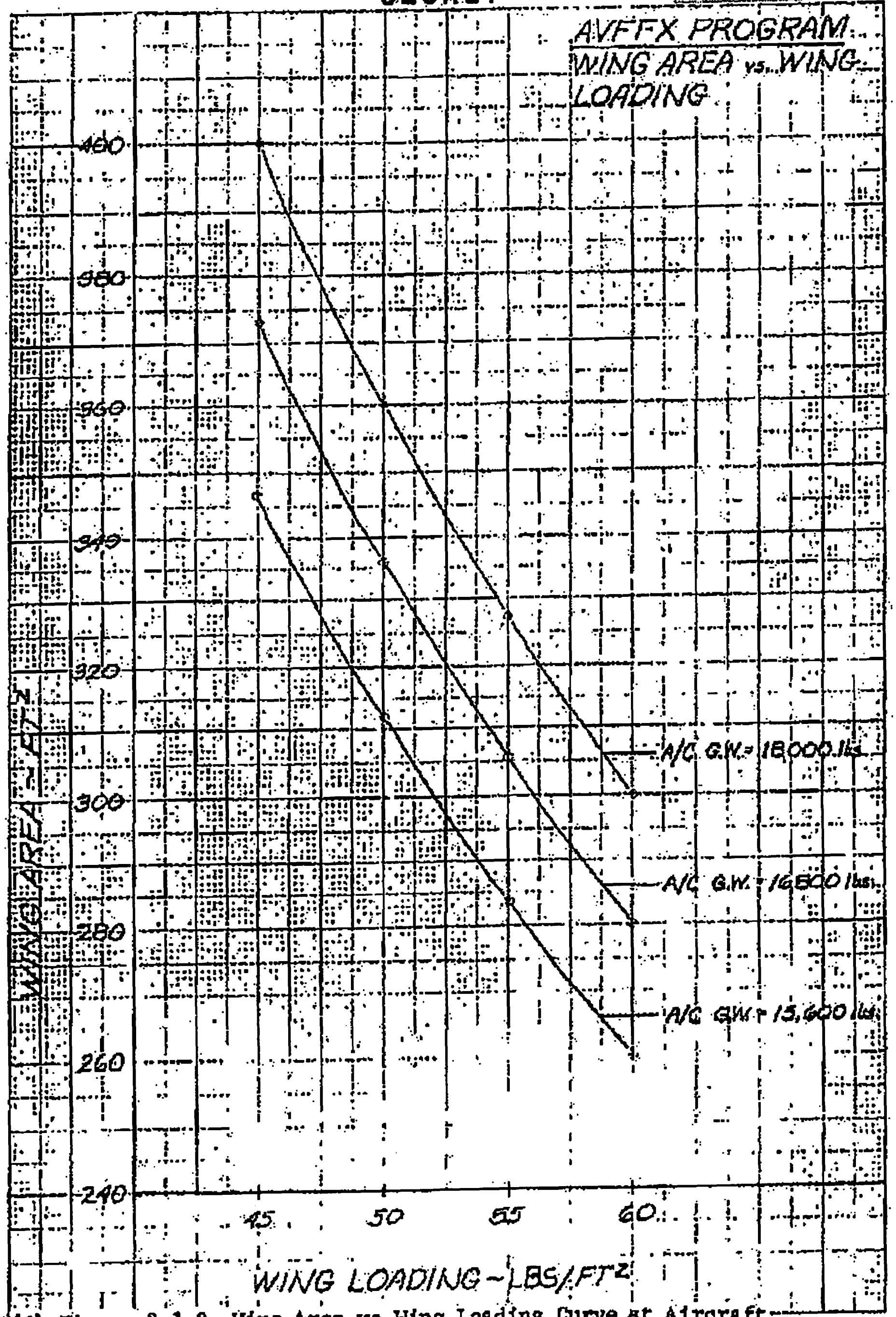
VENTRAL FIN GEOMETRY MATRIX

	A/C GROSS WEIGHT - LBS		
	15,600	16,800	18,000
S_{VF}	3.385406	3.645833	3.906251
AR	0.373333	0.373333	0.373333
λ	0.595744	0.595744	0.595744
b	13.490700	13.999980	14.491368
$b/2$	6.745350	6.999990	7.245684
C_R	45.290316	47.000064	48.649668
C_T	26.981434	28.000006	28.982743
$\bar{c}$	36.908919	38.302262	39.646592
$\bar{c}/4$	9.227229	9.575565	9.911648
$\bar{y}/2$	3.087864	3.204432	3.316908
$\bar{y}$	6.175728	6.408864	6.633816

~~(S)~~ Figure 8.1-8 Vertical Tail and Ventral Fin Geometry Matrix Data (U)

88th ABW/IPI
FOIA (b)(1)
E.O.13526 SEC. 3.3.(b)(4)
1.4. (a)(g)

~~SECRET~~

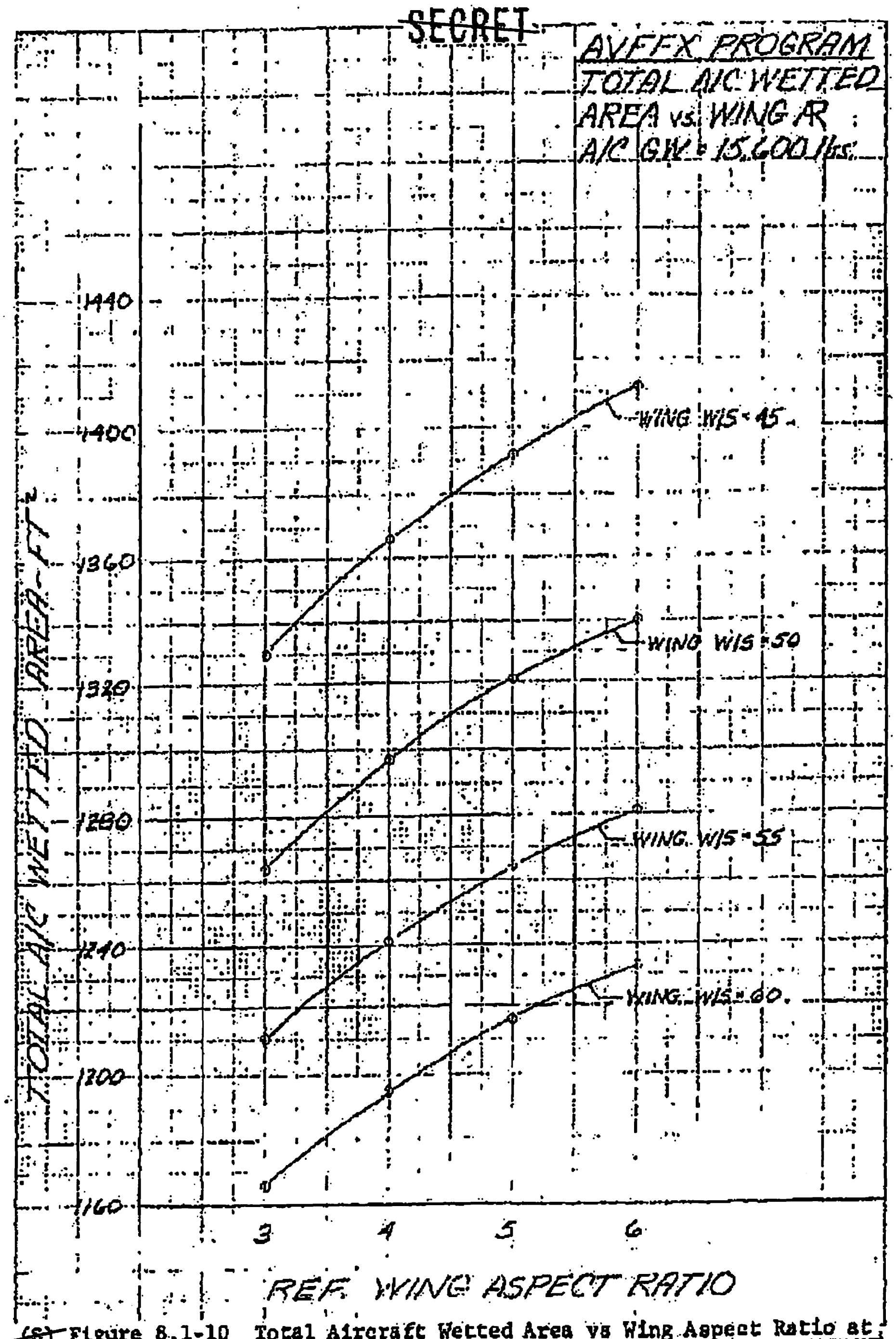


~~(S)~~ Figure 8.1-9 Wing Area vs Wing Loading Curve at Aircraft Mission Weights (U)

~~SECRET~~

88th ABW/IPI
FOIA (b)(1)
E.O.13526 SEC. 3.3.(b)(4)
1.4. (a)(g)

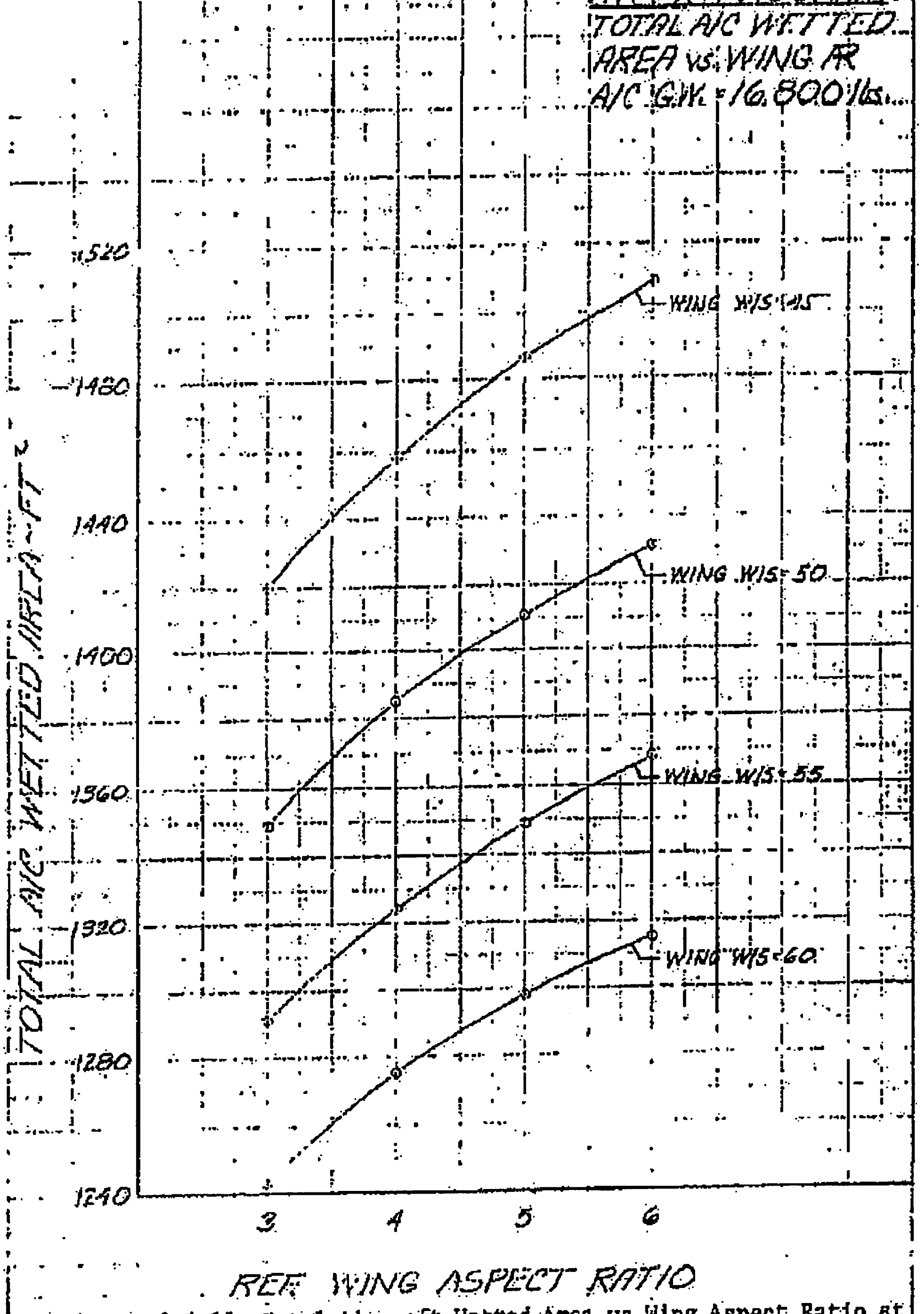
~~SECRET~~



~~(S)~~ Figure 8.1-10 Total Aircraft Wetted Area vs Wing Aspect Ratio at Variable Wing Loadings for a 15,600-lb Aircraft (U)

~~SECRET~~

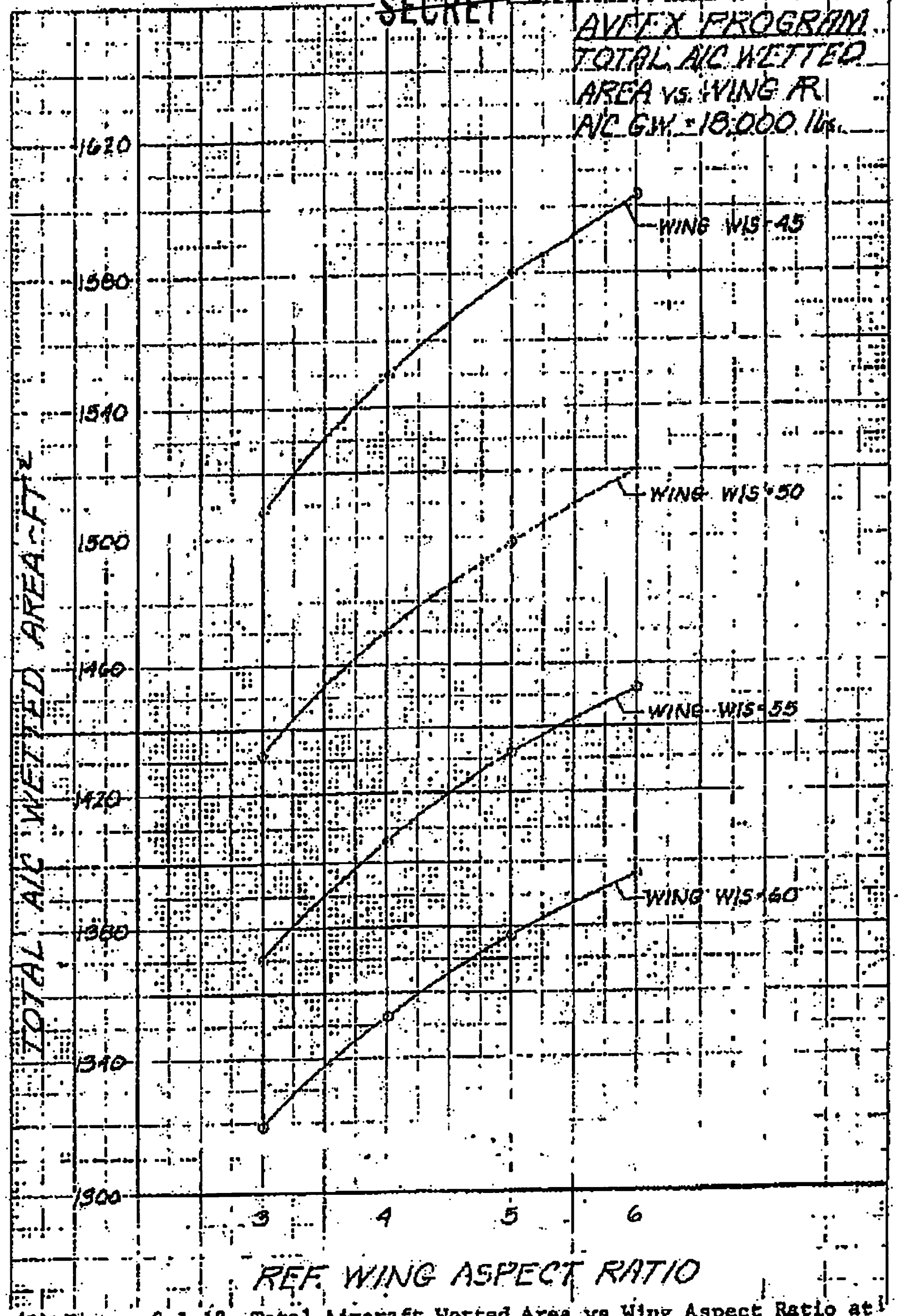
88th ABW/IPI
FOIA (b)(1)
E.O.13526 SEC. 3.3.(b)(4)
1.4. (a)(g)



~~(S)~~ Figure 8.1-11 Total Aircraft Wetted Area vs Wing Aspect Ratio at Variable Wing Loadings for a 16,800-lb Aircraft (U)

88th ABW/IPI
FOIA (b)(1)
E.O.13526 SEC. 3.3.(b)(4)
~~1.4. (a)(g)~~

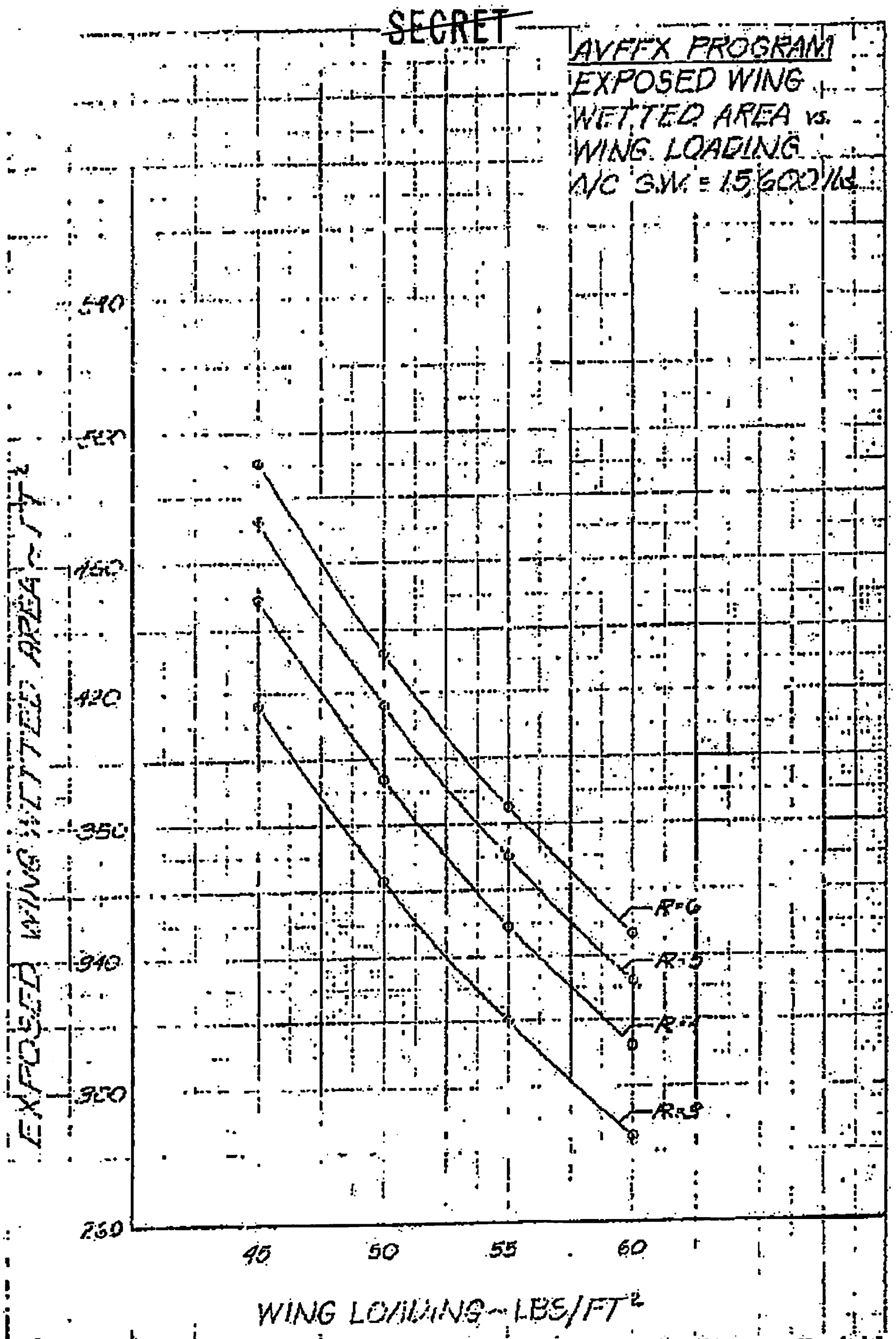
SECRET



~~(S)~~ Figure 8.1-12 Total Aircraft Wetted Area vs Wing Aspect Ratio at Variable Wing Loadings for a 18,000-lb Aircraft (U)

~~SECRET~~

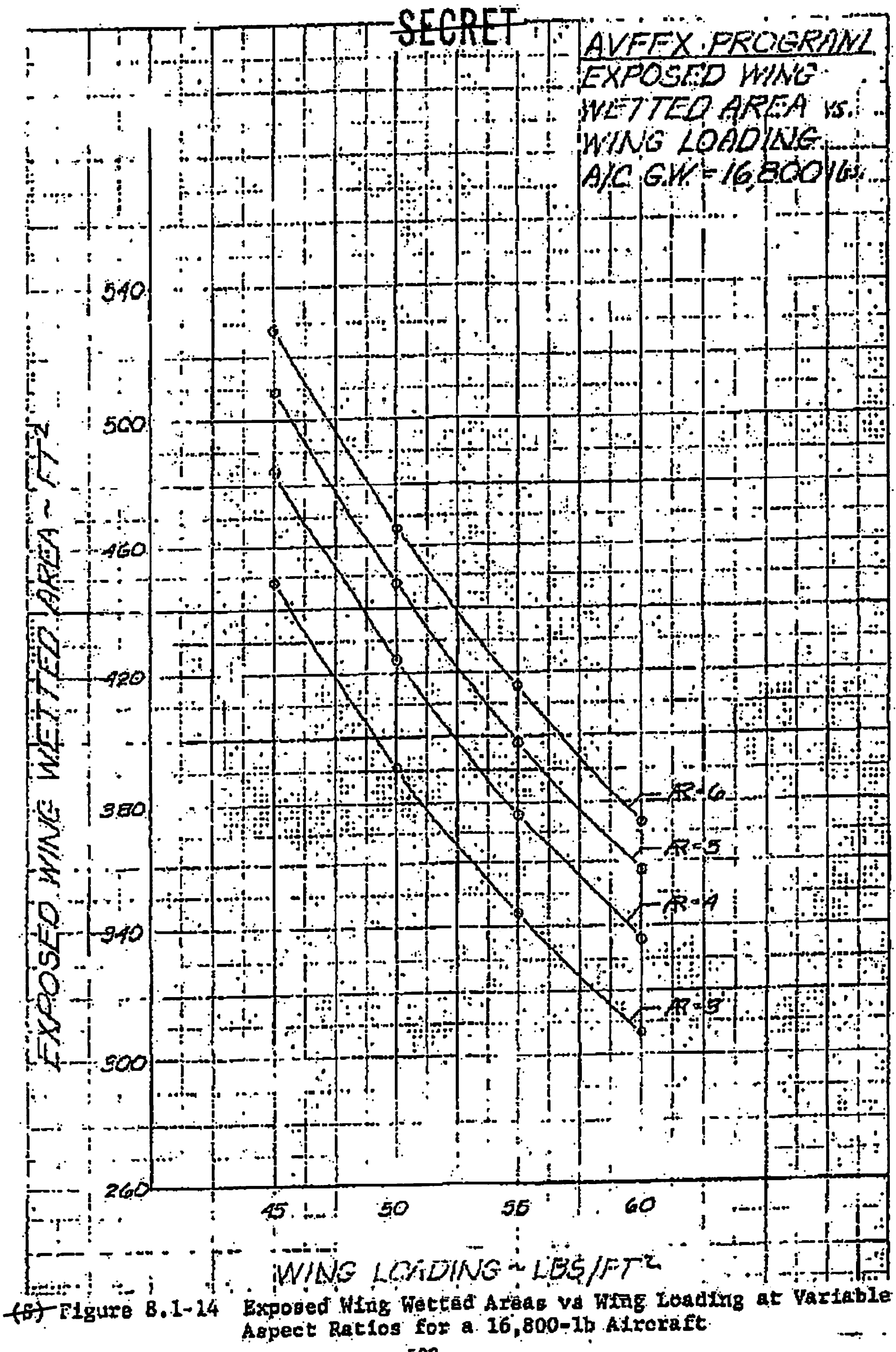
~~SECRET~~



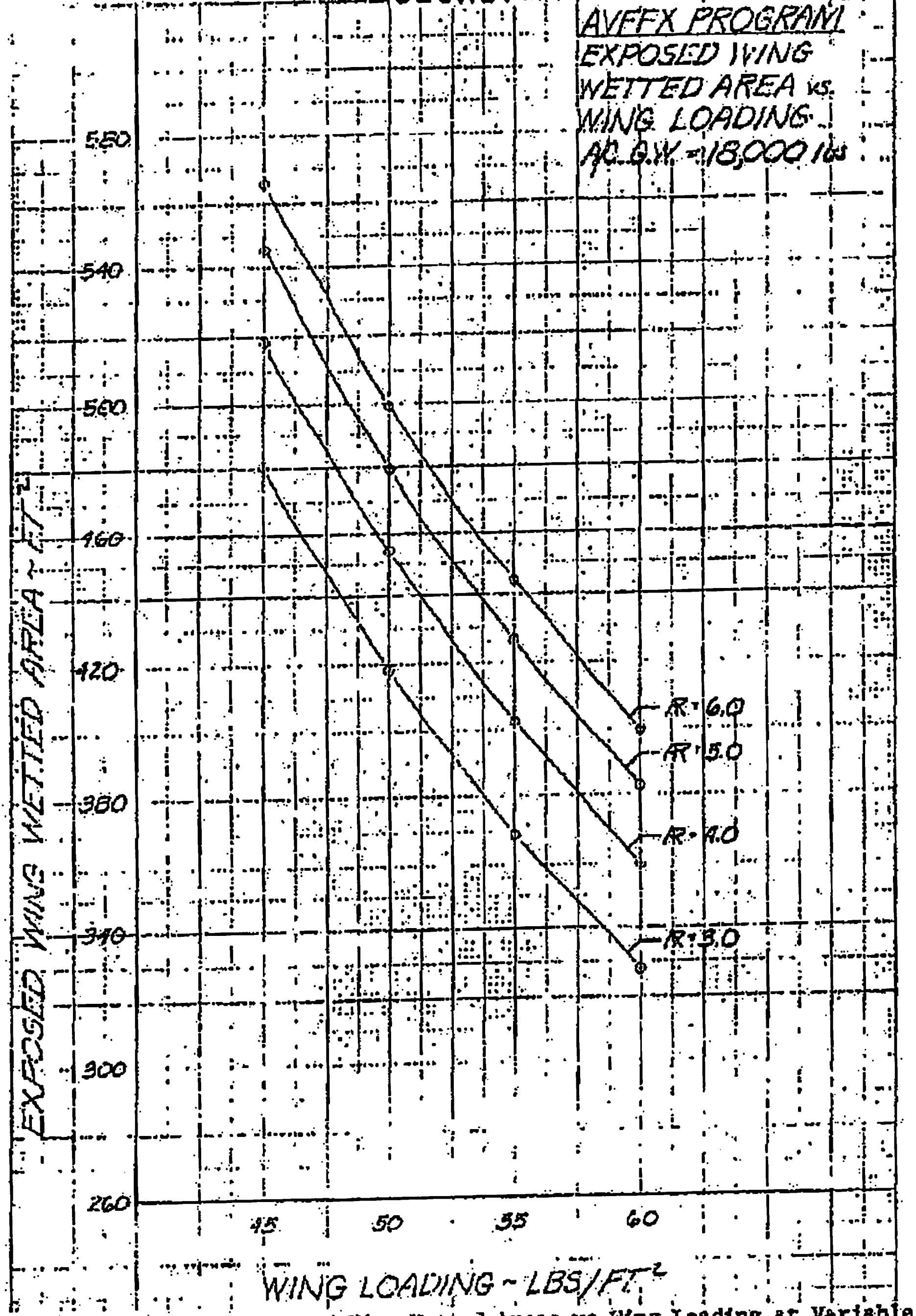
~~(S)~~ Figure 8.1-13 Exposed Wing Wetted Areas vs Wing Loading at Variable Aspect Ratios for a 15,600-lb Aircraft (U)

~~SECRET~~

88th ABW/IPI
FOIA (b)(1)
E.O.13526
SEC. 3.3.(b)(4)
1.4.(a)(g)

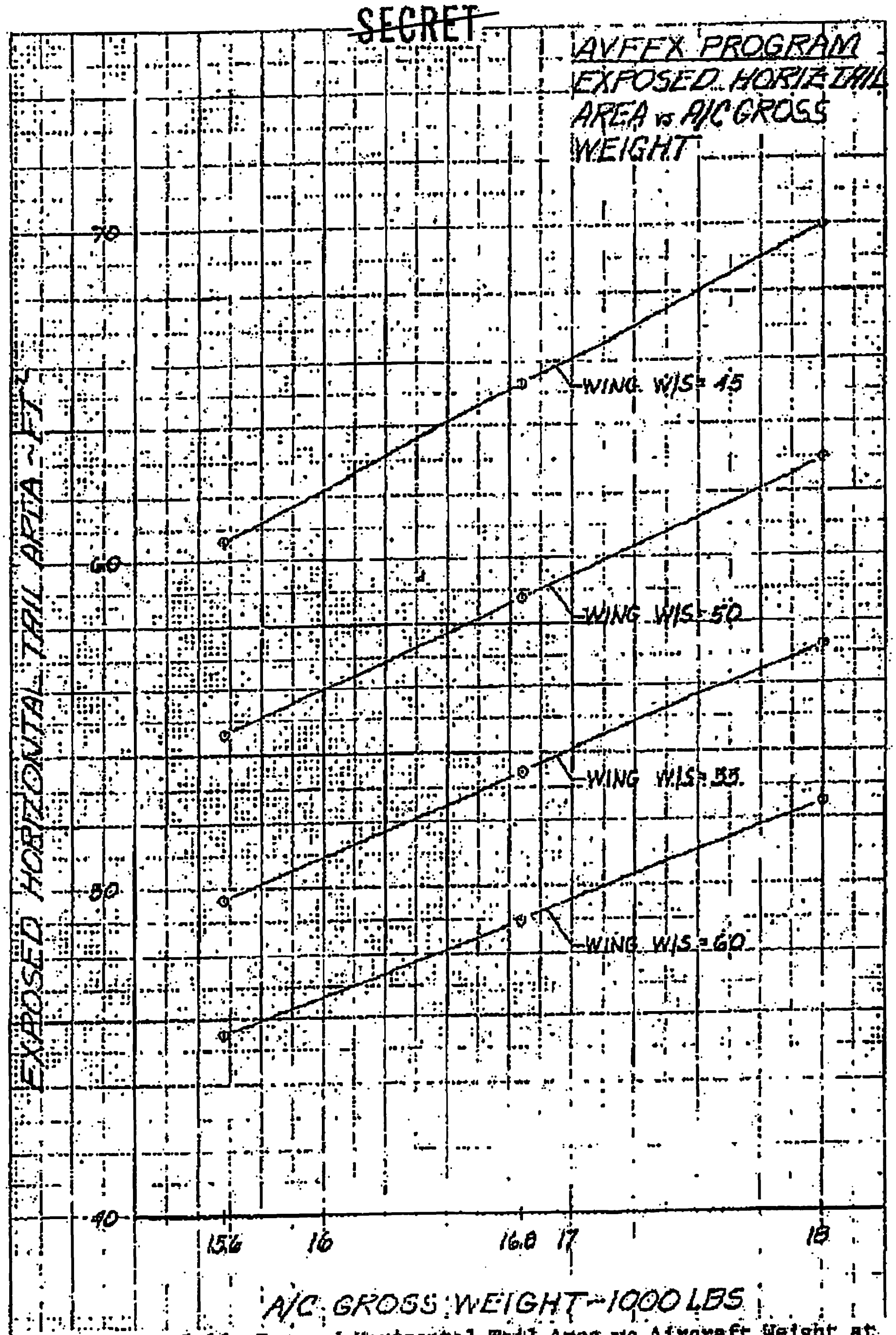


~~(S)~~ Figure 8.1-14 Exposed Wing Wetted Areas vs Wing Loading at Variable Aspect Ratios for a 16,800-lb Aircraft



~~(S)~~ Figure 8.1-15 Exposed Wing Wetted Areas vs Wing Loading at Variable Aspect Ratios for a 18,000-lb Aircraft

88th ABW/IPI
FOIA (b)(1)
E.O.13526 SEC.
3.3.(b)(4)
1.4. (a)(g)



~~(S)~~ Figure 8.1-16 Exposed Horizontal Tail Area vs Aircraft Weight at Variable Wing Loadings

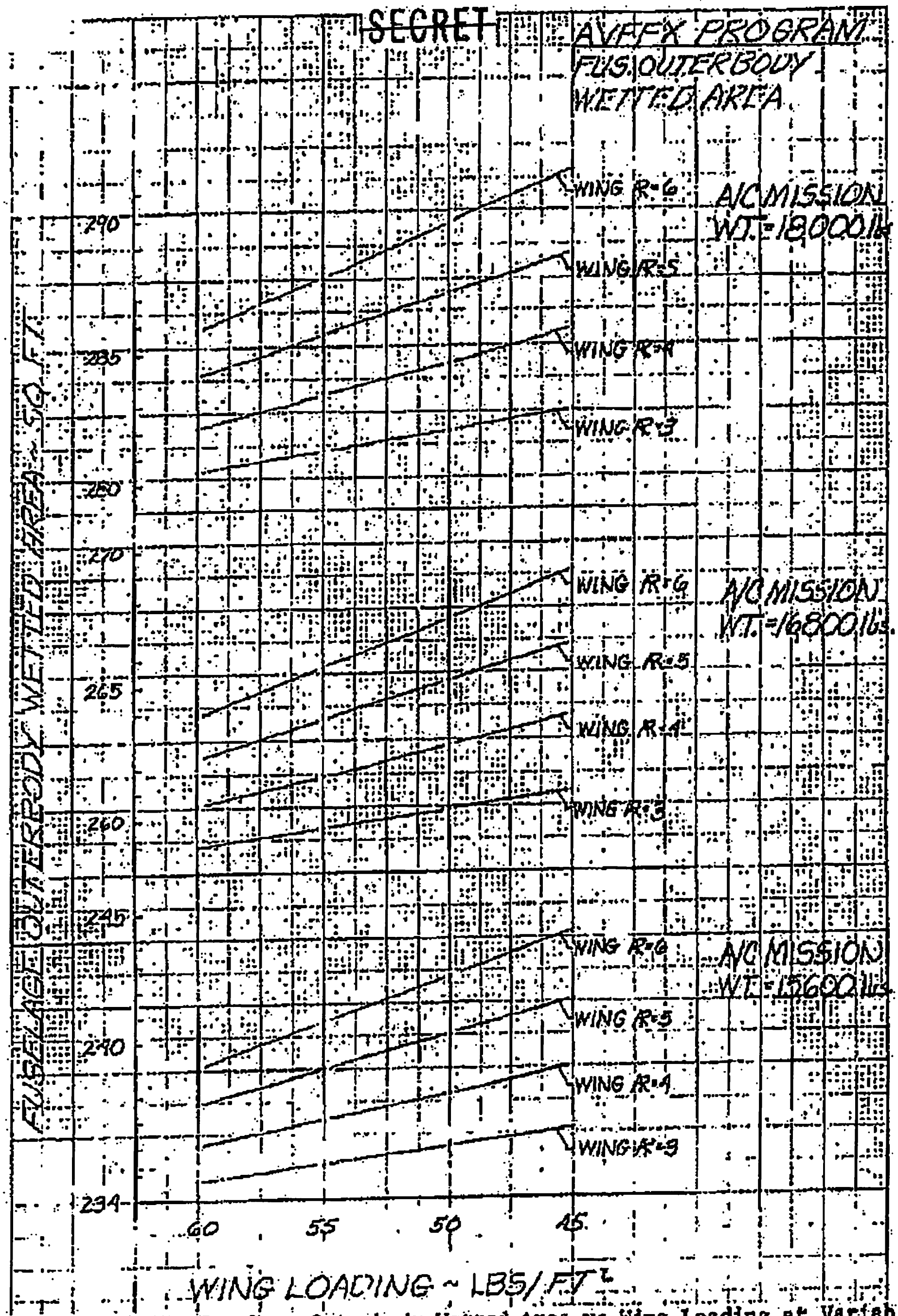
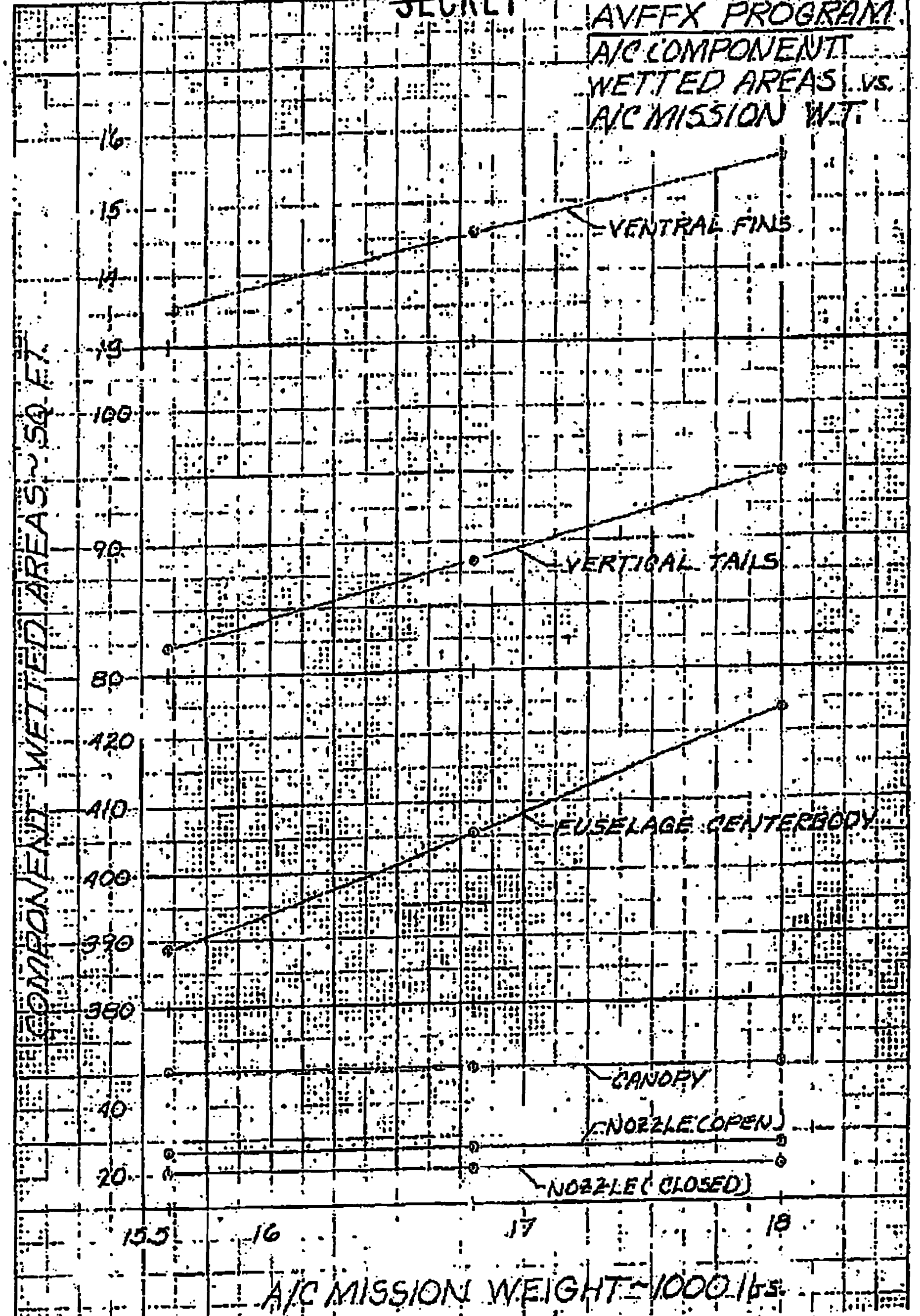


Figure 8.1-17 Fuselage Outerbody Wetted Area vs Wing Loading at Variable Wing Aspect Ratios for 15,600-, 16,800-, and 18,000-lb Aircraft (U)

88th ABW/IPI
FOIA (b)(1)
E.O.13526 SEC.
3.3.(b)(4)
1.4. (a)(g)

~~SECRET~~



~~(S)~~ Figure 8.1-18 Aircraft Surfaces and Body Component Wetted Areas vs Aircraft Mission Weights (U)

~~SECRET~~

8.2 PERFORMANCE

~~(S)~~ Long-range air-superiority missions (LRASM) were computed for all the combinations of aspect ratio, wing loading, mission weights, and composite content - a total of 192 configurations. For each configuration, [a mission weight was determined to yield the desired 750-n.mi LRASM radius. For each composite content, the aspect-ratio/wing-loading combinations were optimized to give the maximum turn rate at Mach 0.8, 30,000 feet.]

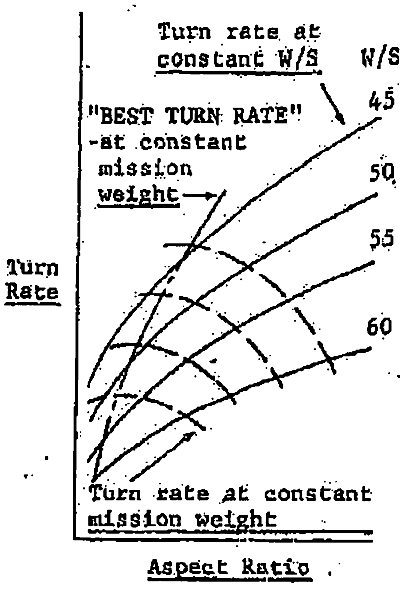
88th ABW/IPF
FOIA (b)(1)
E.O 13526 SEC. 3.3.
(b)(4)
1.4. (a)(g)

~~(S)~~ In Figures 8.2-1 through 8.2-4, the variation of LRASM radius with mission weight is plotted for each wing-loading/composite-content combination for each aspect ratio. The mission weight for the 750-n.mi LRASM radius for each configuration was determined from these curves.

~~(S)~~ [In Figures 8.2-5 and 8.2-6, the turn rate at Mach 0.8, 30,000 feet and acceleration time from Mach 0.9 to 1.5 at 30,000 ft are presented. The mission weights for the 750-n.mi LRASM radius are marked for each configuration of apsect ratio, wing loading, and composite content.]

88th ABW/IPF
FOIA (b)(1)
E.O 13526 SEC. 3.3(b)
(4)
1.4. (a)(g)

(U) The mission weights determined from Figures 8.2-1 through 8.2-4 and the turn rates and acceleration times determined from Figures 8.2-5 and 8.2-5 are presented in Figures 8.2-7 through 8.2-10 for each level of composite content. A combination of aspect radio, wing loading, and mission weight for best turn rate was determined by plotting lines of constant mission weight on the aspect-ratio-vs-turn-rate chart and picking the peak value of turn rate for each mission weight, as illustrated in the sketch on the right. The best combination is noted by a line labeled "BEST TURN RATE" on each of Figures 8.2-7 through 8.2-10.



88th ABW/IPF
FOIA (b)(1)

88th ABW/IP
FOIA (b)(1)
E.O. 13526 SEC. 3.3 (b)(4)
1.4 (a)(g)

~~(S)~~ [The configurations for best turn rate at each level of composite content are presented in Figure 8.2-11. This figure presents wing loading, aspect ratio, and mission weight for best turn rate versus the resulting acceleration times for each composite content series. The chart of turn rate versus acceleration time shows increasing time to accelerate for increase in turn rate for each composite content series. As turn rate is increased, the mission weight and aspect ratio increase and wing loading decreases. Comparing composite content series at a selected acceleration time shows an increasing turn rate, mission weight, and aspect ratio with decreasing wing loading. For example, at a 35.5-second acceleration time, a comparison of the all-aluminum and all-composite configurations is as follows:

	Aluminum	Composite	% Change
Turn Rate, deg/sec	9.9	13.5	+ 36.3
Mission Weight, lb	17,115	15,600	- 8.8
Aspect Ratio	3.0	3.8	+ 26.7
W/S, psf	60	45	- 25.0]

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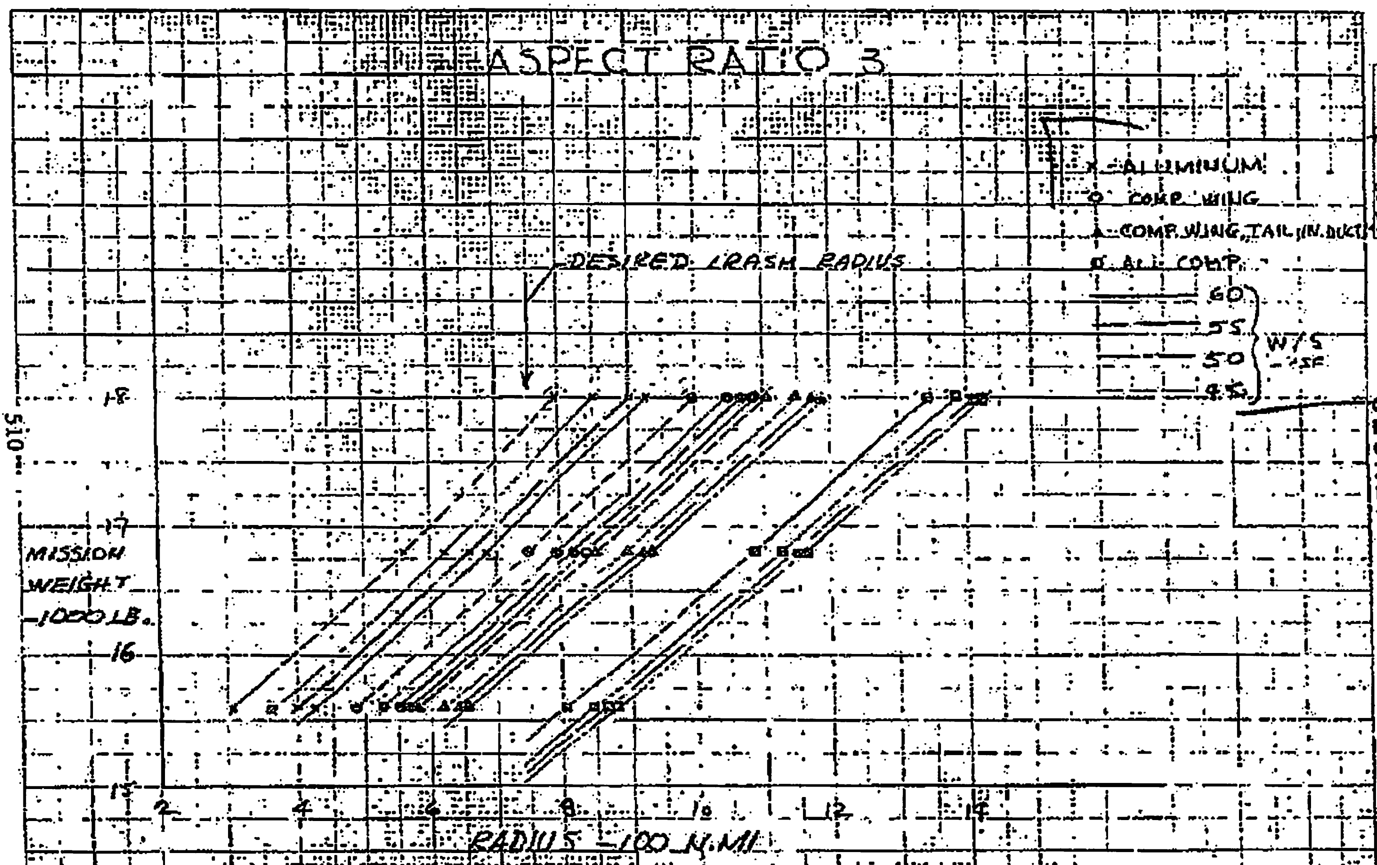

(S) Figure 8.2-1 LRASM Growth Curves for Configuration 401B with Aspect Ratio 3.0 Wing (U)

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88th ABW/IP
FOIA (b)(1)
E.O 13526 SEC.
3.3(b)(4) 2G
1.4 (a)(g) (5)(4)
5E 1.4(a)(g)

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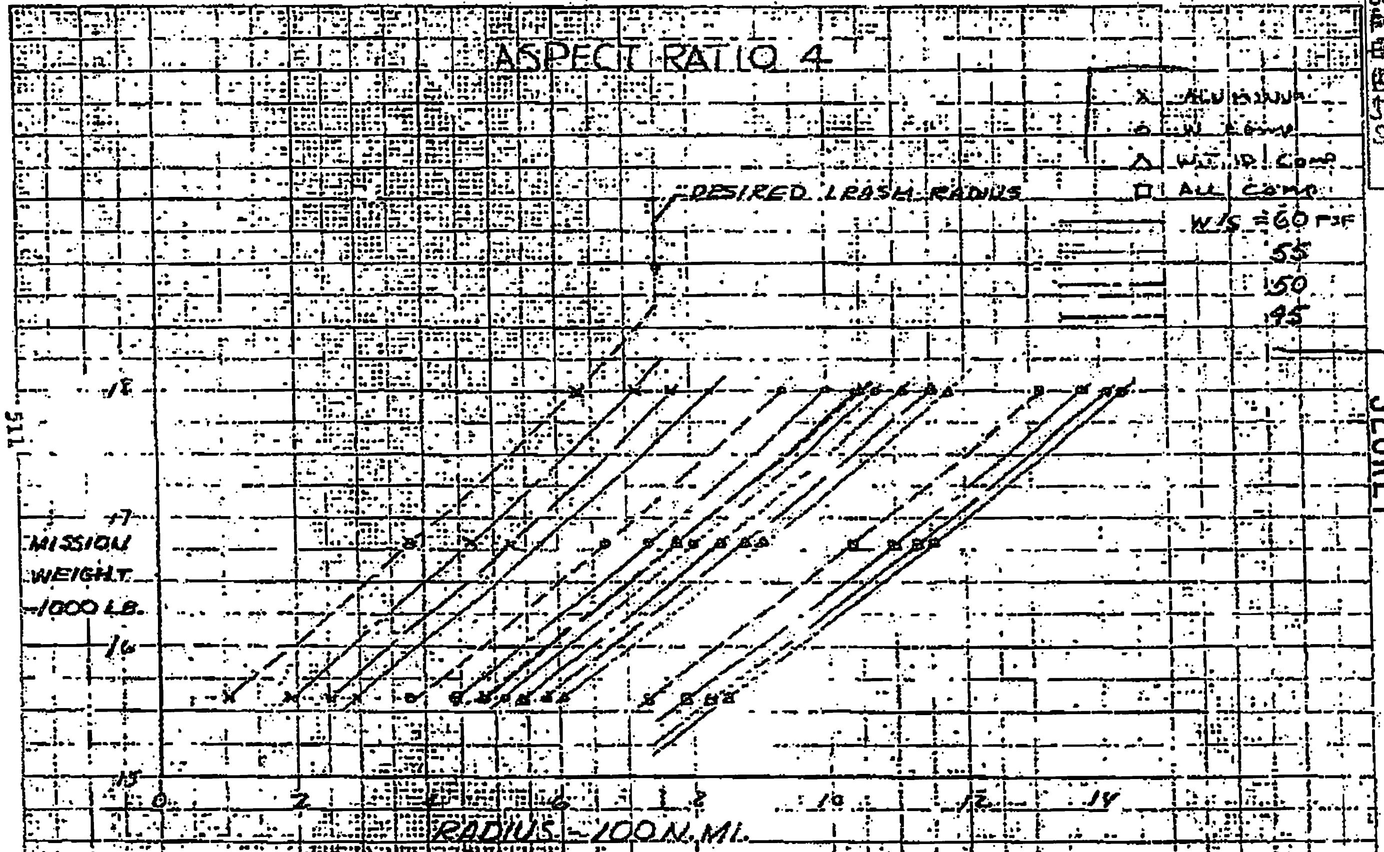
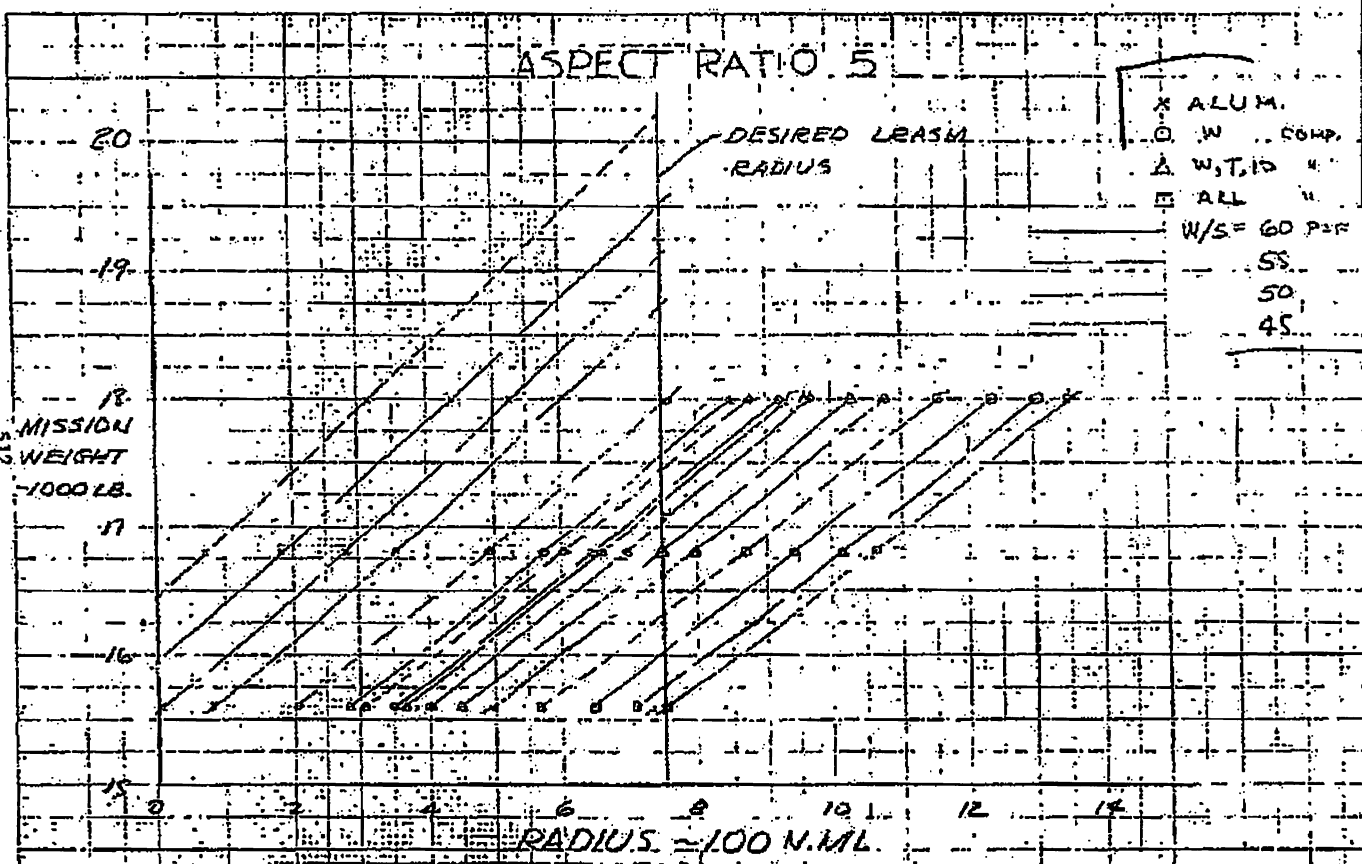


(S) Figure 8.2-2 LRASM Growth Curves for Configuration 401B with Aspect Ratio 4.0 Wing (U)

SECRET

88th ABW/IPI
FOIA (b)(1)
E.O. 13526 SEC
3.3(b)(4)
1.4(a)(g)
SEC 3.3(b)(
SEC 1.4(a)(

SECRET



(S) Figure 8.2-3 LRASM Growth Curves for Configuration 401B with Aspect Ratio 5.0 Wing (U)

SECRET

88th ABW/IPI
FOIA (b)(1)
E.O 13526 SEC 3.3 (b)(4)
1.4 (a)(g)
EO 13526
SEC 3.3 (b)(4)
SEC 1.4 (a)(g)

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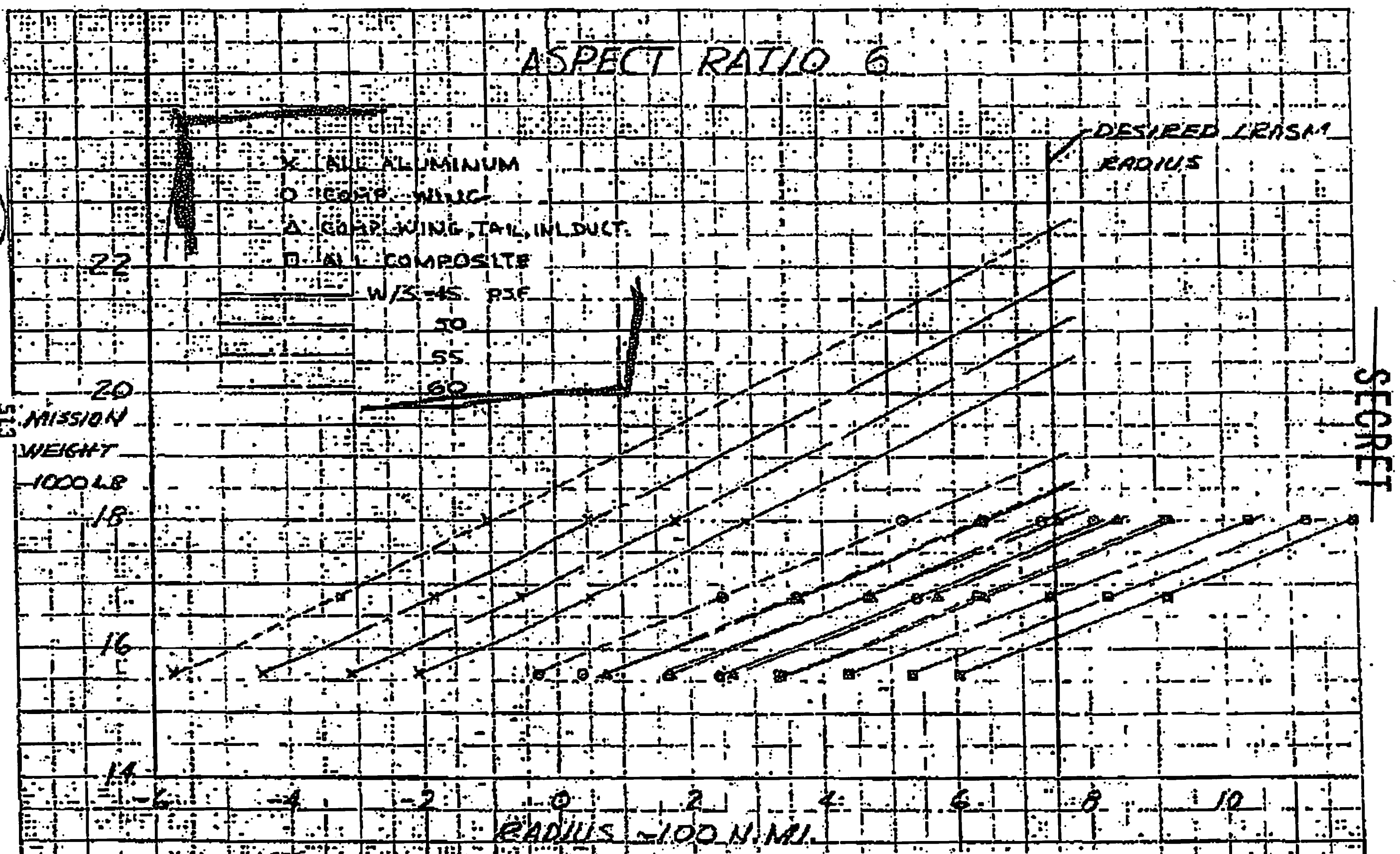

(S) Figure 8.2-4 LRASM Growth Curves for Configuration 4013 with Aspect Ratio 6.0 Wing (U)

SECRET

88th ABW/IPI
FOIA (b)(1)
E.O 13526 SEC 3.3(b)(4)
1.4 (a)(g)

88 ABW/IPI
FOIA (b)(1)
EO 13526 SEC 3.3(b)(4)
SEC 1.4(a)(g)

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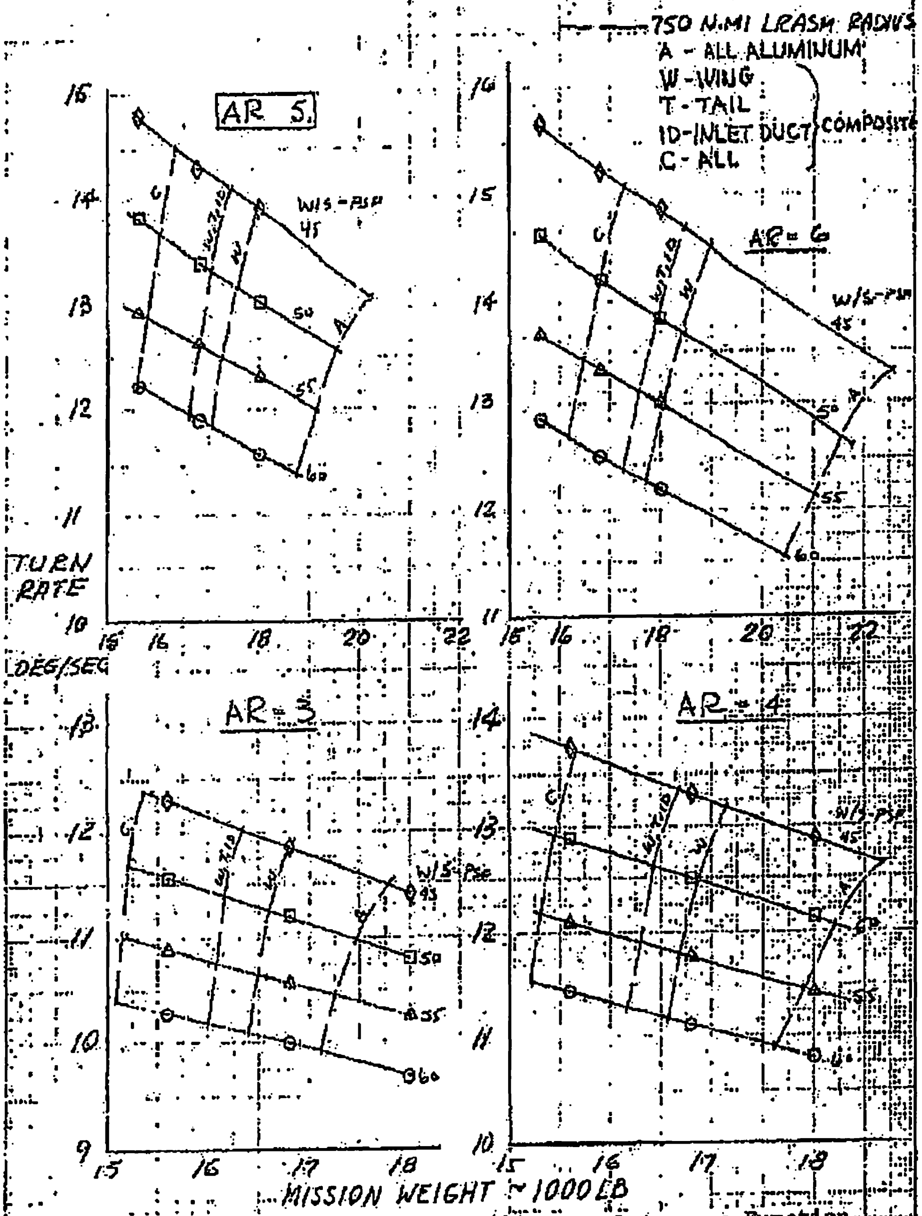
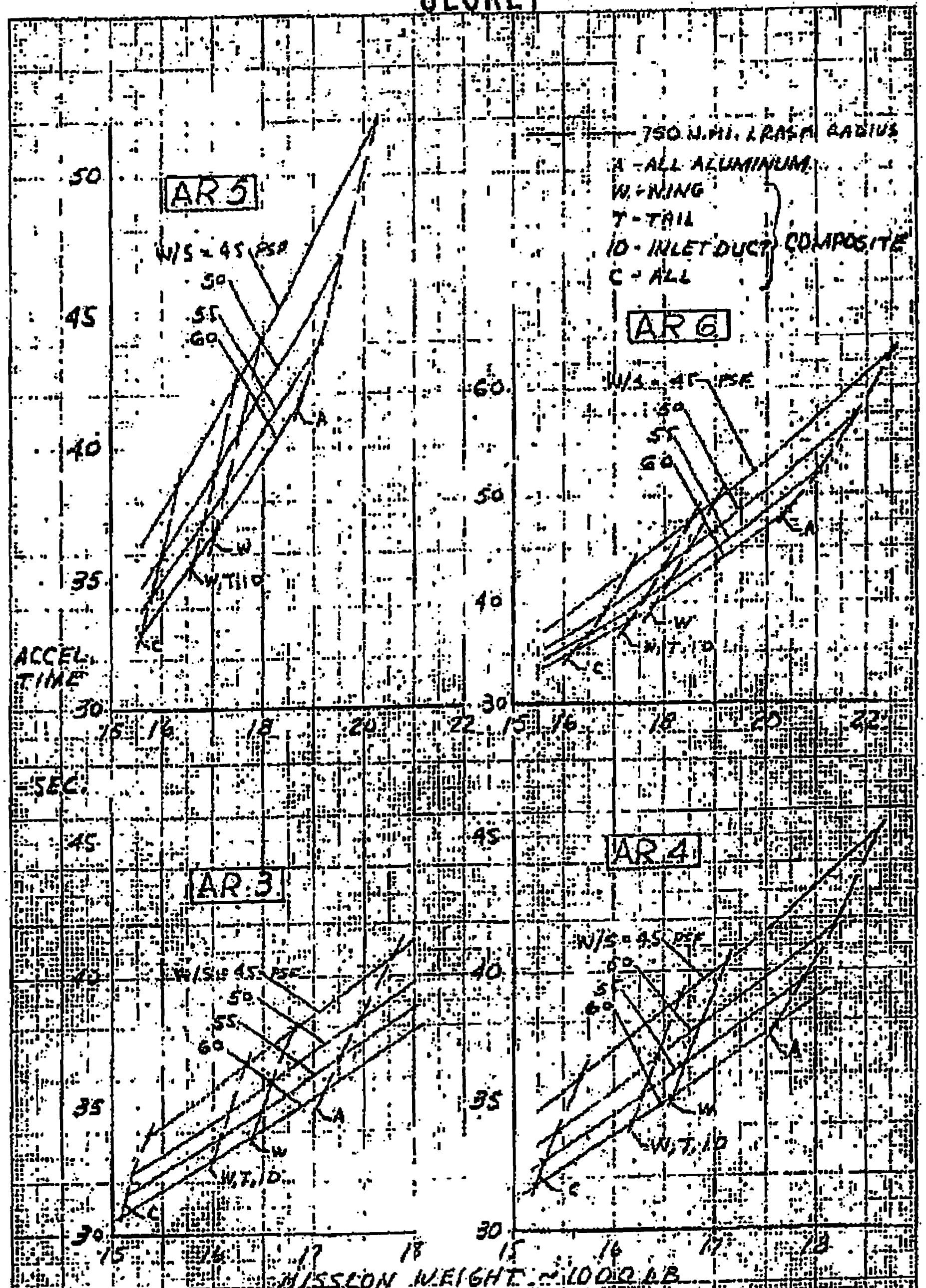
514-520



~~(S)~~ Figure 8.2-5 Configuration 401B Turn Rate as a Function of Aspect Ratio and Wing Loading ~~(U)~~



~~(S)~~ Figure 8.2-6 Configuration 401B Acceleration Time as a Function of Aspect Ratio and Wing Loading (U)

88th ABW/IPI
FOIA (b)(1)
E.O.13526 SEC. 3.3.
(b)(4)
1.4. (a)(g)

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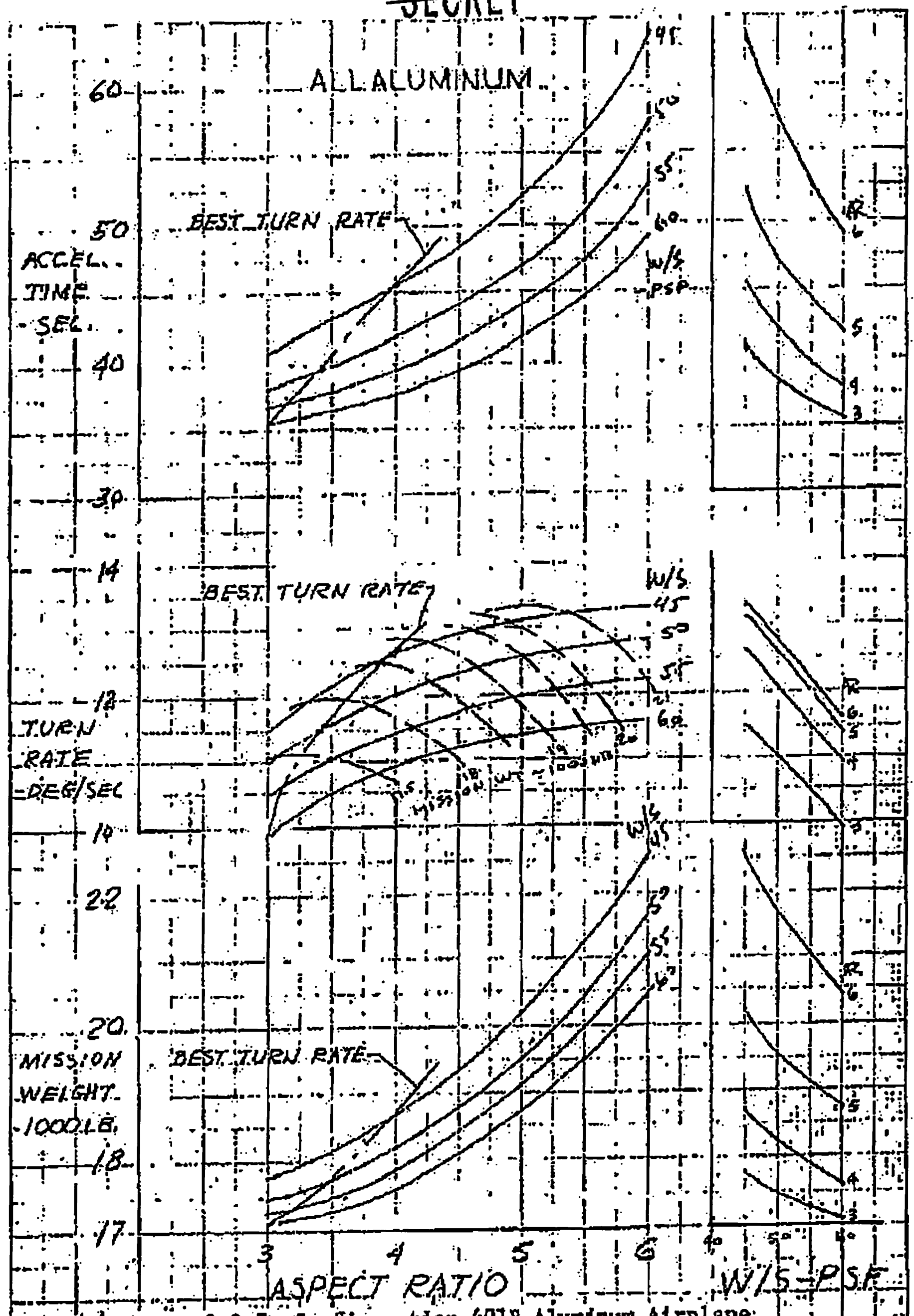

~~(S)~~ Figure 8.2-7 Configuration 4018 Aluminum Airplane LRASM Performance Trades (U)

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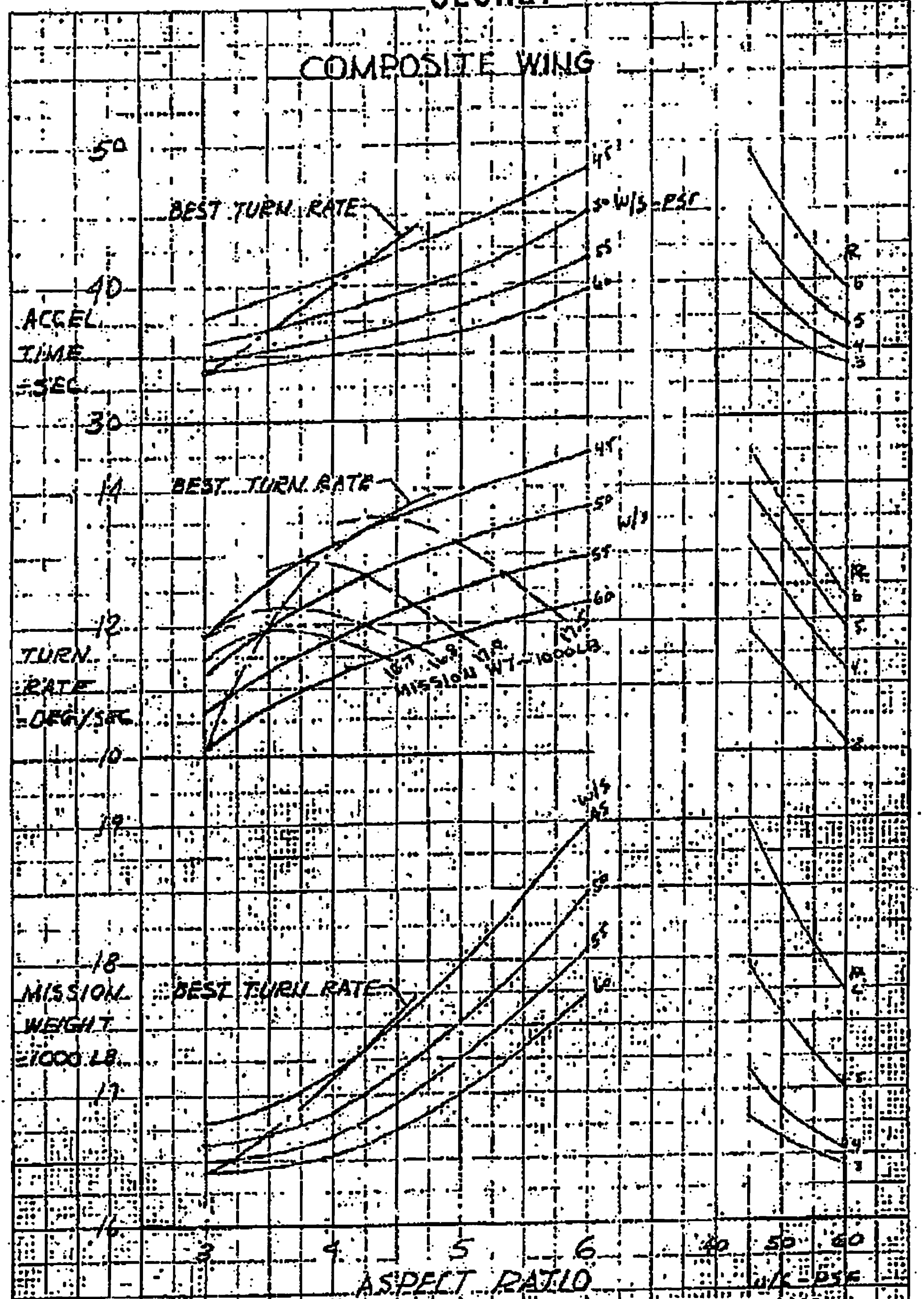
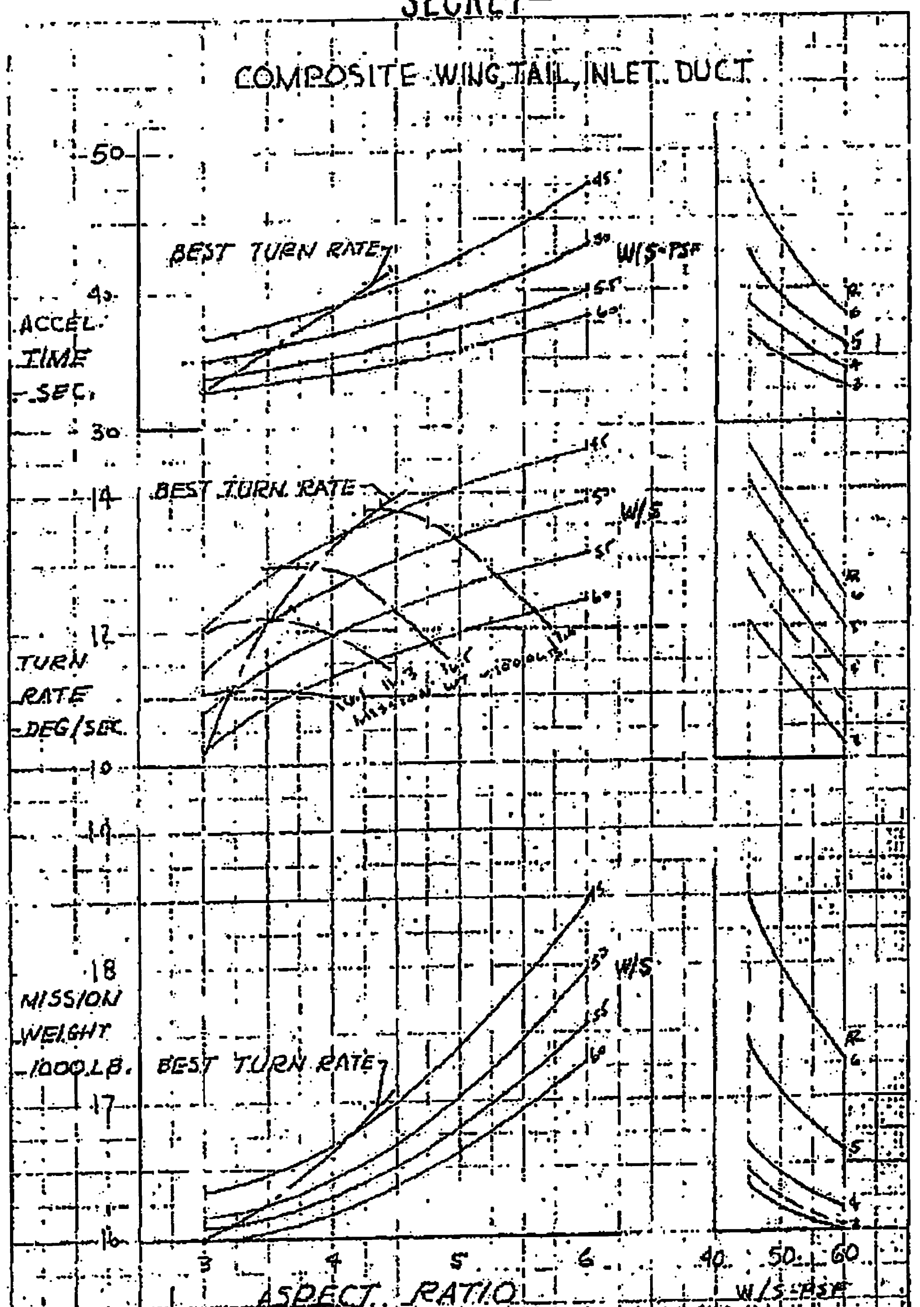
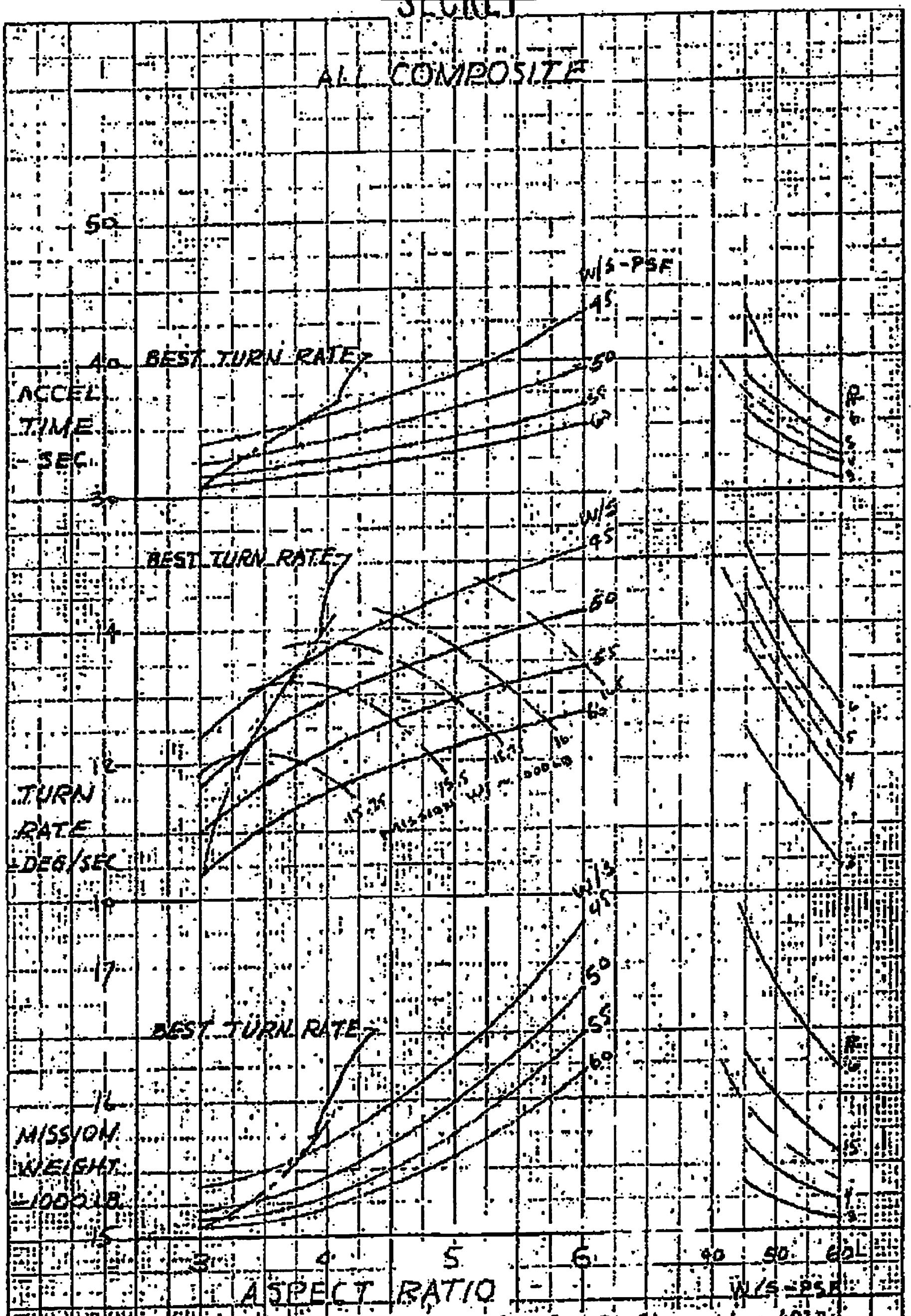


(S) Figure 8.2-8 LRASM Performance Trades for Configuration 401B with Composite Material Wing (U)

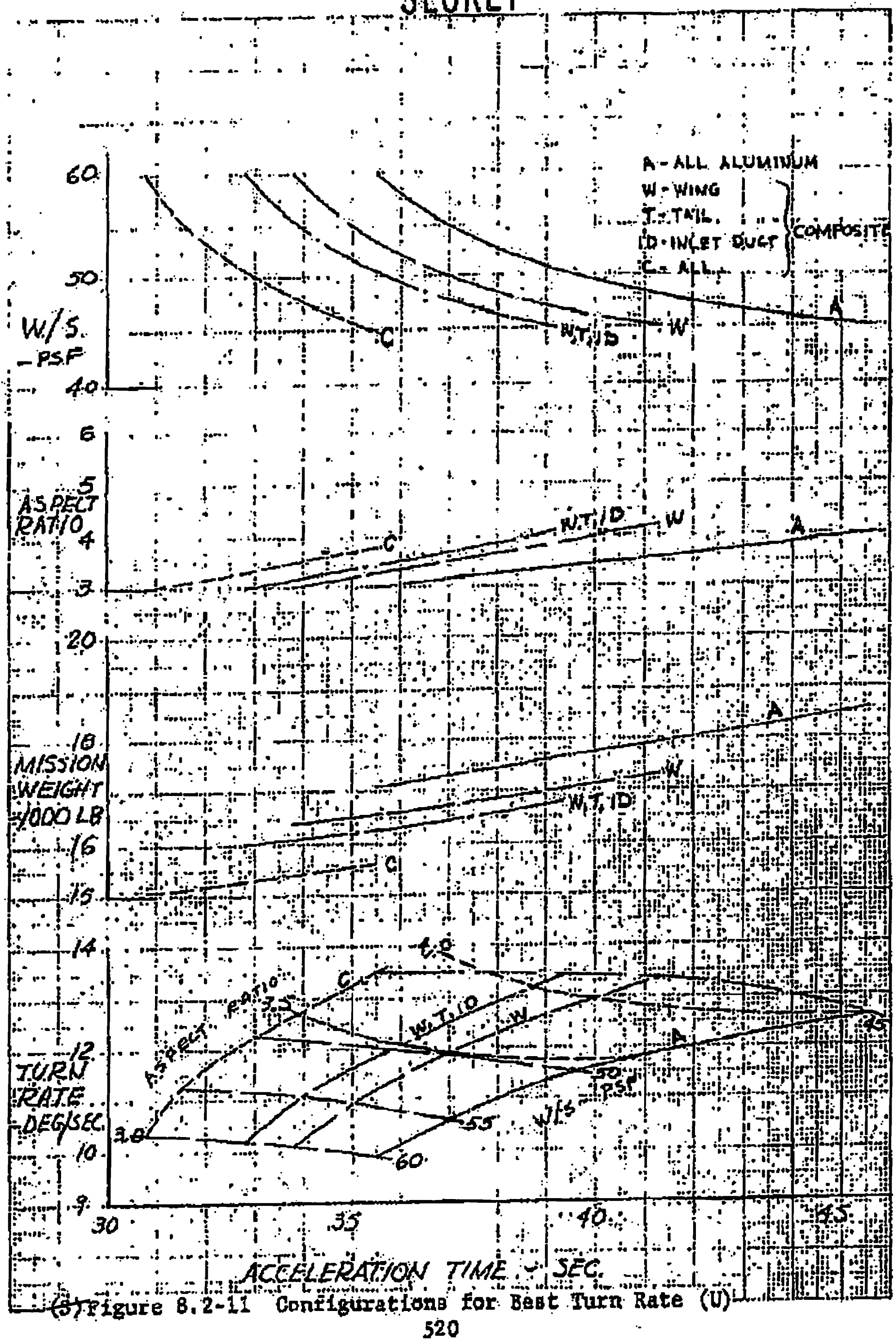


~~(S)~~ Figure 8.2-9 LRASM Performance Trades for Configuration 401B with Composite Material Wing, Tail, and Inlet Duct (U)

88th ABW/IPI
FOIA (b)(1)
E.O.13526 SEC.
3.3.(b)(4)
1.4. (a)(g)



~~(S)~~ Figure 8.2-10 LRASM Performance Trades for Configuration 401B All-Composite Material Airplane (U)



(S) Figure 8.2-11 Configurations for Best Turn Rate (U)

8.3 AERODYNAMICS

(U) With respect to aerodynamics there is a matrix of 48 aircraft configurations:

AR = 3.0, 4.0, 5.0, 6.0

W/S = 45, 50, 55, and 60 psf

G.W. = 15,600, 16,800, and 18,000 lb

The approach is to generate complete aerodynamics data for each of the aspect ratios at a reference gross weight and wing loading. Variations in gross weight and wing loading from the reference are then given as increments in minimum drag. The fundamental assumption here is that, to a first-order analysis, changes in airplane size or wing loading do not affect the induced-drag coefficient.

(U) The reference gross weight and wing loading are 16,800 lb and 60 psf respectively. The reference AR = 3.0 data is that of the 401B Configuration discussed in Section 3. All planforms have curved tips similar to the 401B airplane; therefore, the true aspect ratios are 3.2, 4.27, 5.33, and 6.4.

8.3.1 Minimum Drag

(U) In Figure 8.3-1, $C_{D_{min}}$ versus Mach number is plotted for the reference configurations at sea level. The methods and procedures are the same as those described in Section 3.3. The area-rule procedure (K35) was used to compute wave drag for each of the configurations shown. The minimum-drag coefficient at other altitudes may be incremented by the amounts shown in Figure 3.3-1 of Section 3.3.

(U) The variation in minimum drag as a function of gross weight and wing loading is plotted in Figure 8.3-2. The increments shown are from the reference 60-psf wing loading and 16,800-lb gross weight and are applicable to all aspect ratios.

8.3.2 Drag Due to Lift

(U) The drag due to lift for the AR = 4.0, 5.0, and 6.0 wings was obtained by applying aspect-ratio corrections to the drag due to lift of the Configuration 401B airplane (AR = 3.0). At subsonic speeds, the correction is simply

$$C_{D_{L_{AR_1}}} = (C_{D_L})_{401B} \times \frac{3.0}{AR_1}$$

(U) At supersonic speeds, the induced drag factor, K $(= C_{D_L}/C_L^2)$, is predicted by the method given in the USAF Stability and Control Datcom (Reference 9). This method is also given in Reference 1. The ratio of the induced-drag factor is applied to the 401B drag-due-to-lift data given in Section 3.3:

$$C_{D_{L_{AR_1}}} = C_{D_{L_{401B}}} \times \frac{K_{401B}}{K_{AR_1}}$$

8.3.3 Trim Drag

(U) Since trim drag is largely a function of tail load required to trim and wing-span efficiency, it is assumed that trim drag is proportional to induced drag. The same ratios applied to the induced drag are also applied to the baseline trim drag.

8.3.4 Trimmed Drag Polars

(U) The subsonic and supersonic drag polars for the aspect ratio 4.0, 5.0, and 6.0 wings at the reference gross weight and wing loading are presented in Figures 8.3-3 through 8.3-8.

88th ABW/IPI
~~FOIA (b)(1)~~
E.O 13526 ~~SEC 3.3(b)(4)~~
1.4. (a)(g)
+FOIA (b)(1)
E013526 SEC 3.3(b)(4)
SEC 1.4(a)(g)
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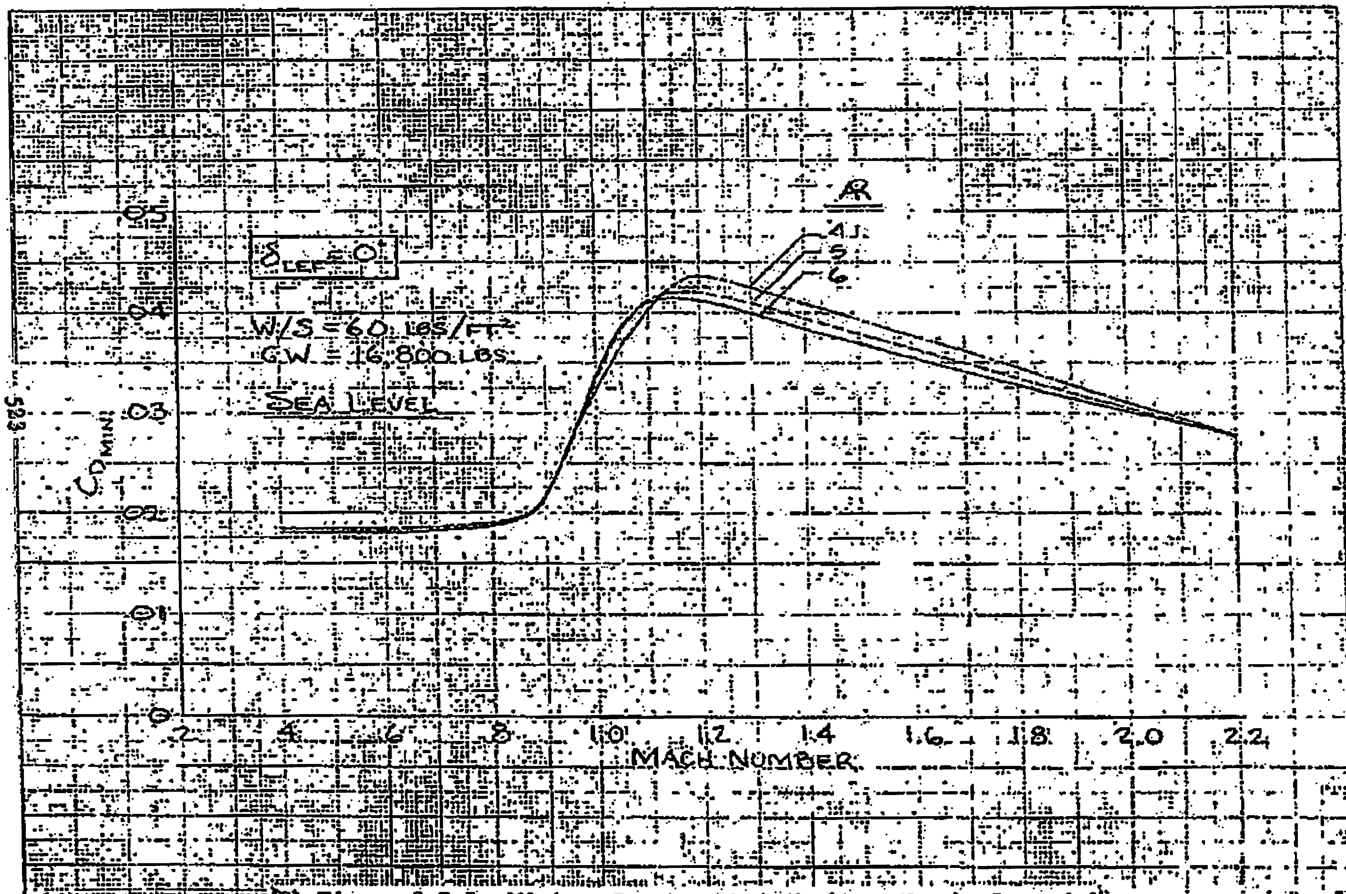

~~(S)~~ Figure 8.3-1 Minimum Drag vs Mach Number, AR = 4, 5, and 6

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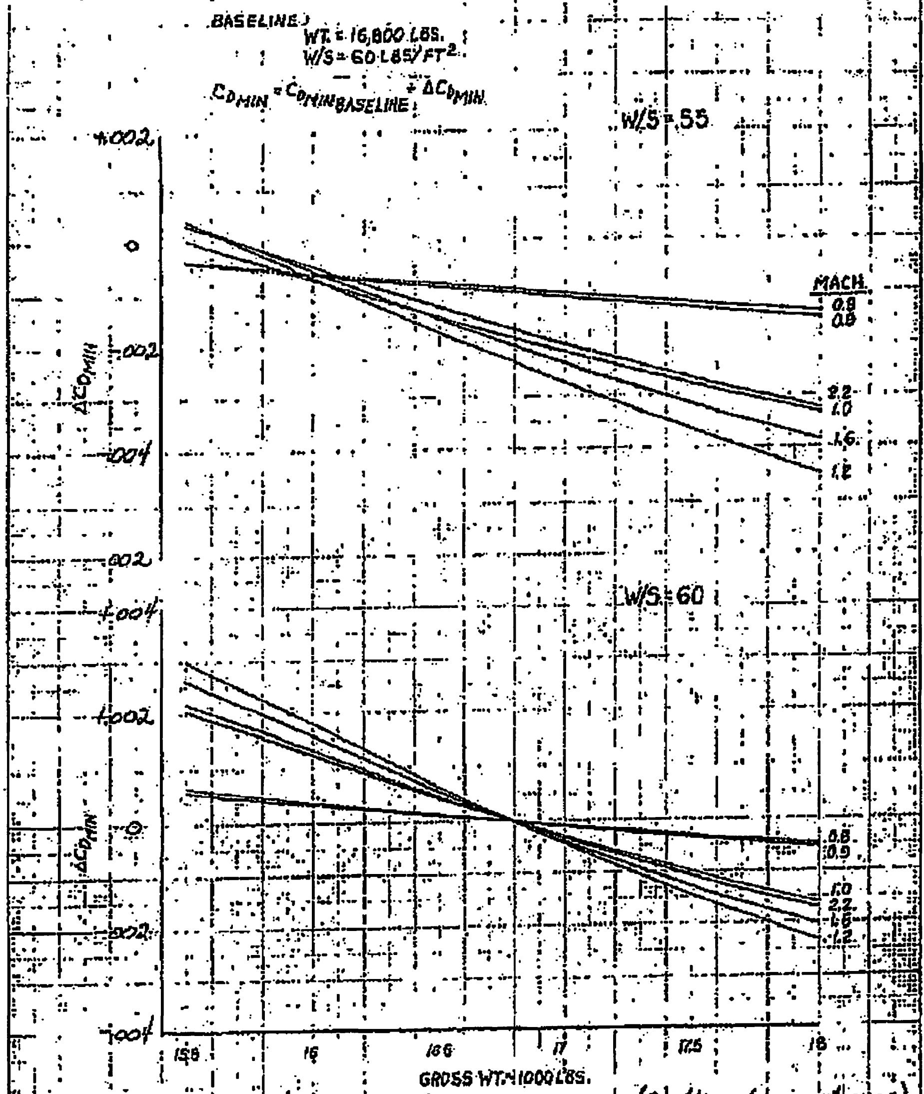
88th ABW/IPI
FOIA (b)(1)
E.O.13526 SEC. 3.3.(b)(4)
1.4. (a)(g)



(Continued on next page)

~~(S)~~ Figure 8.3-2 Aircraft Growth and Wing Loading Effect (U)

88th ABW/IPI
~~FOIA (b)(1)~~
E.O.13526 SEC. 3.3.
(b)(4)
1.4. (a)(g)

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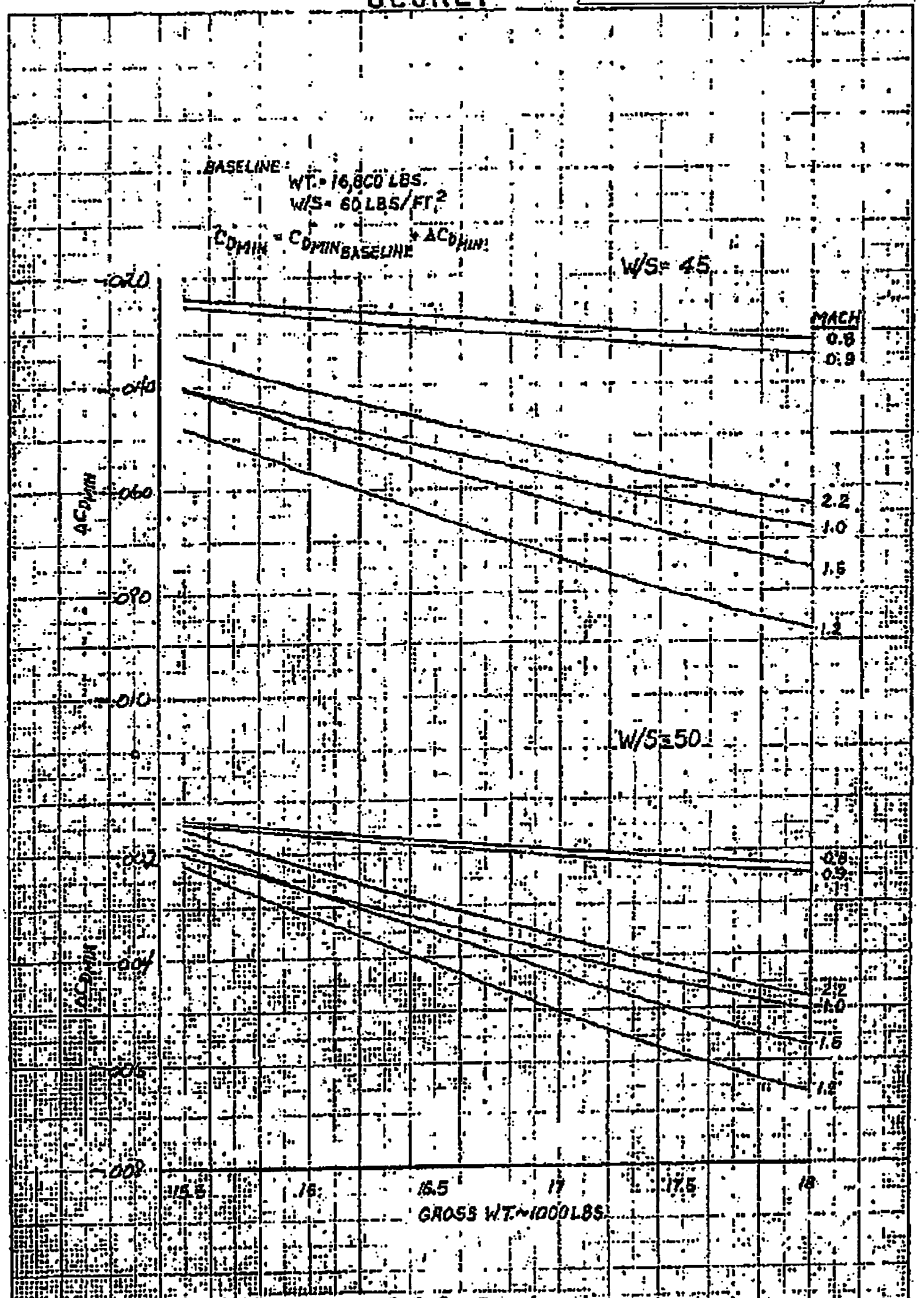

~~(S)~~ Figure 8.3-2 Continued

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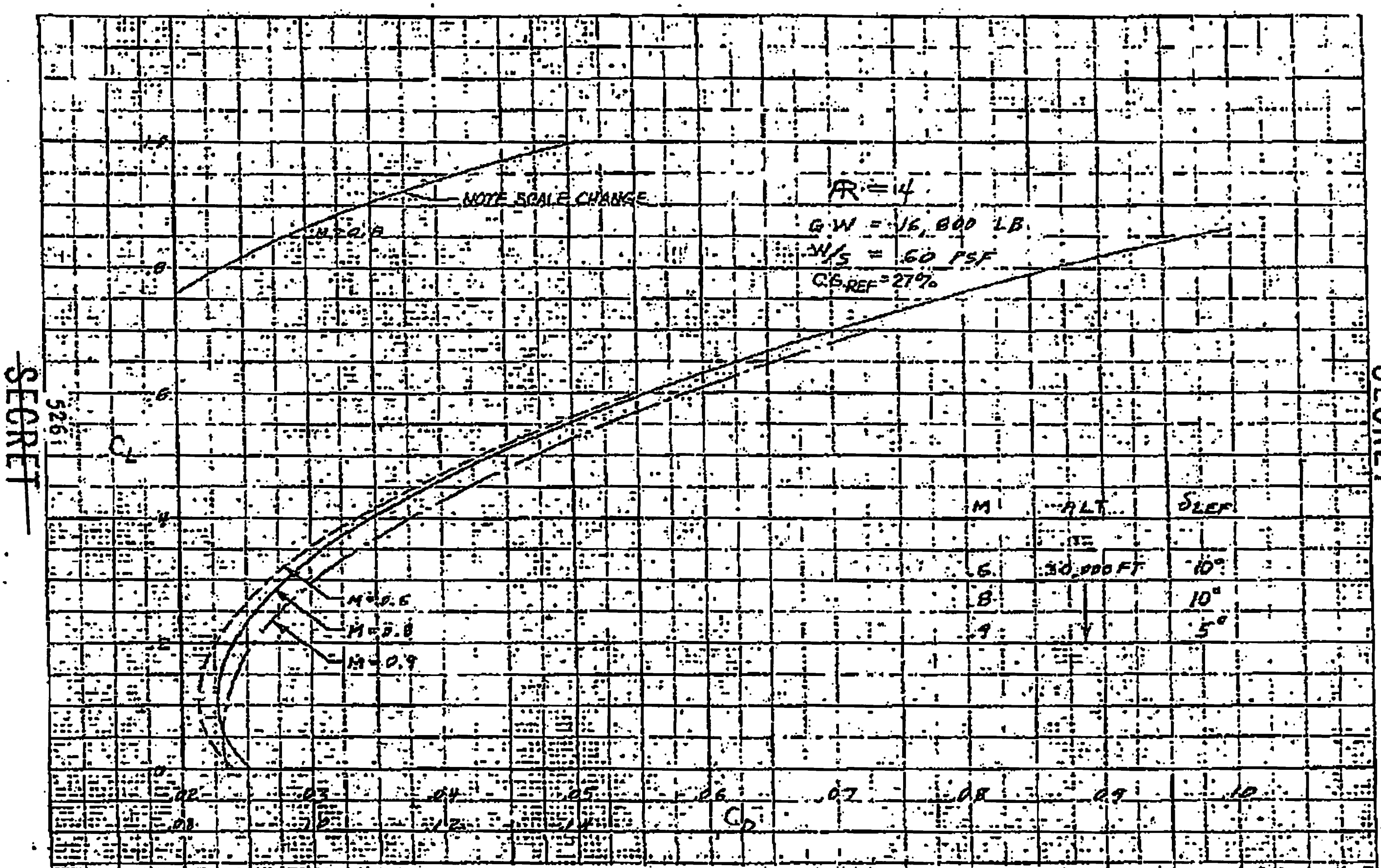

~~(S)~~ Figure 8.3-3 Trimmed Subsonic Drag Polars, AR= 4

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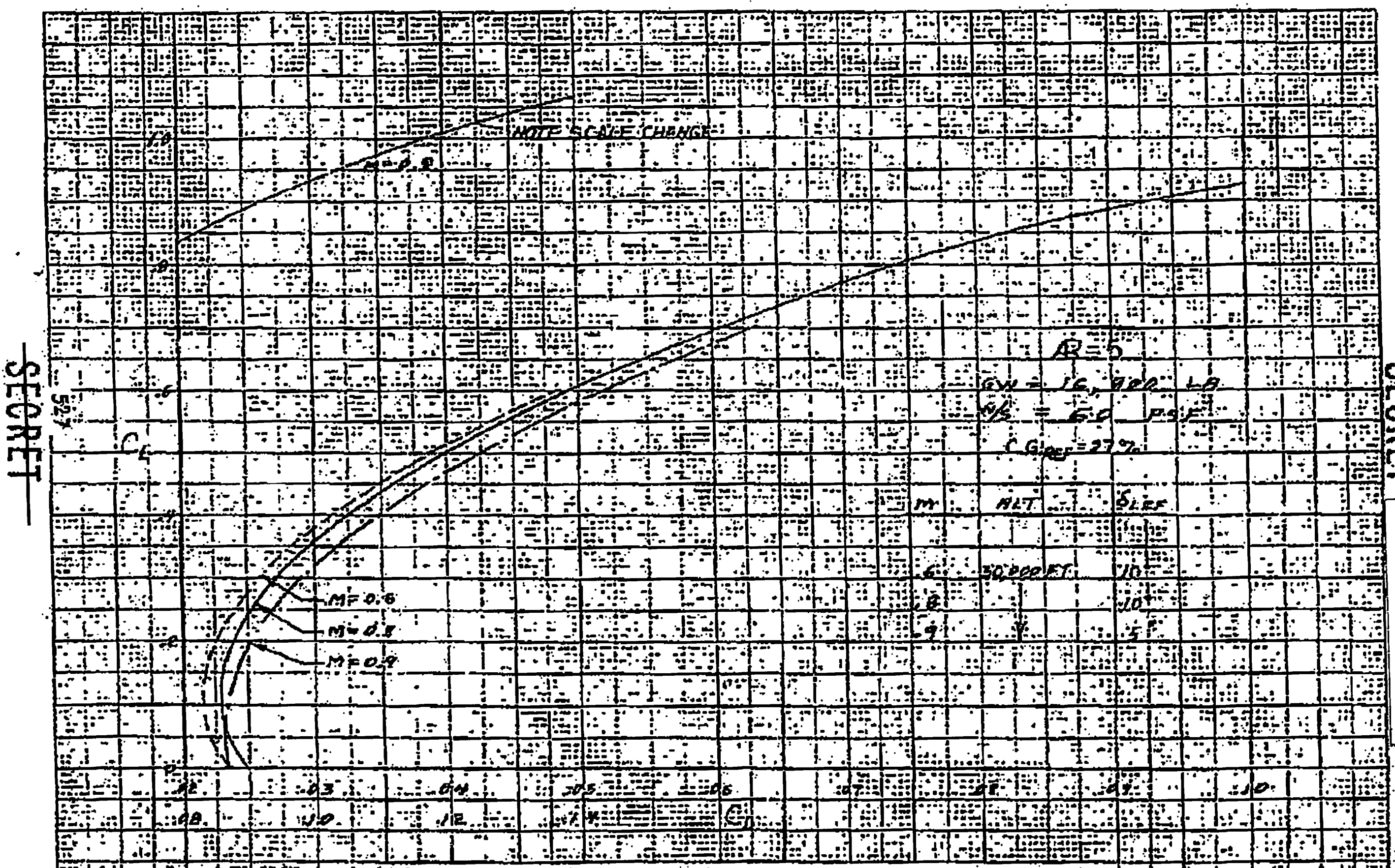
88th ABW/IPI
FOIA (b)(1)
E.O.13526 SEC. 3.3.
(b)(4)
1.4. (a)(g)



~~(S)~~ Figure 8.3-4 Trimmed Subsonic Drag Polars, AR= 5

88th ABW/IPI
FOIA (b)(1)
E.O. 13526 SEC. 3.3.
(b)(4)
1.4. (a)(g)

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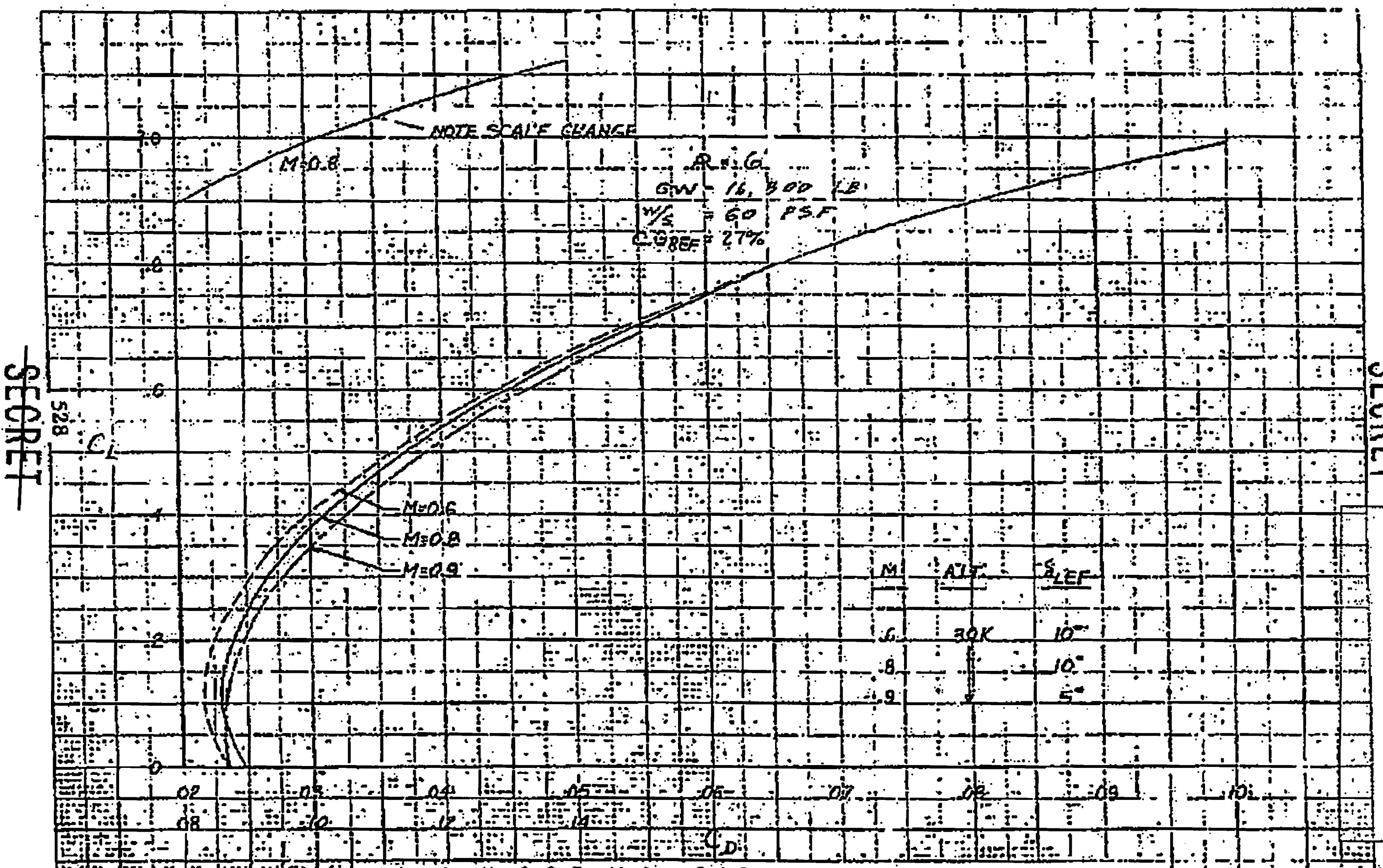

(S) Figure 8.3-5 Trimmed Subsonic Drag Polars, Æ = 6

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88th ABW/IPI
FOIA (b)(1)
E.O.13526 SEC. 3.3.(b)
(4)
1.4. (a)(g)

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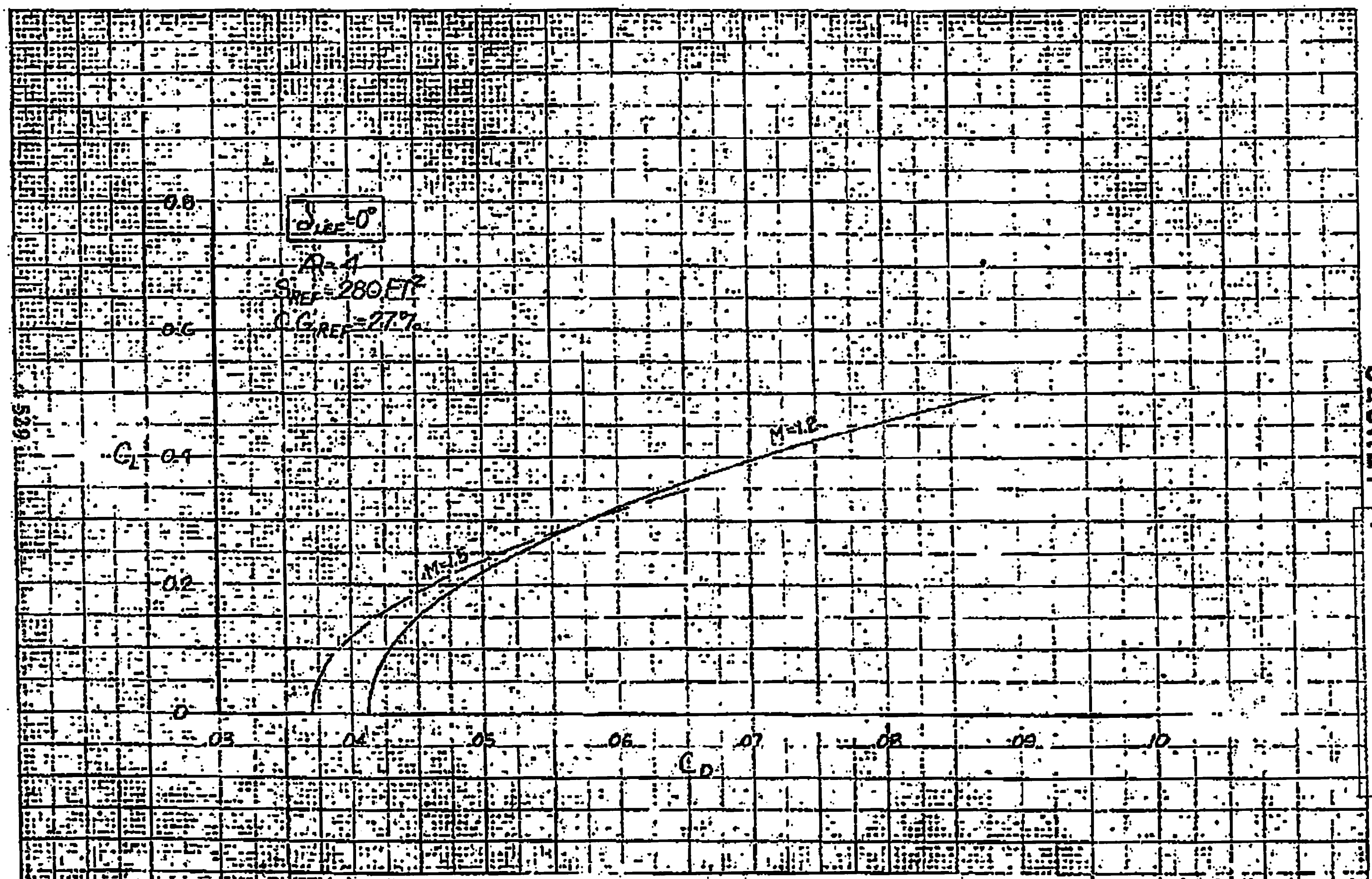

(S) Figure 8.3-6 Trimmed Supersonic Drag Polars, $AR=4$

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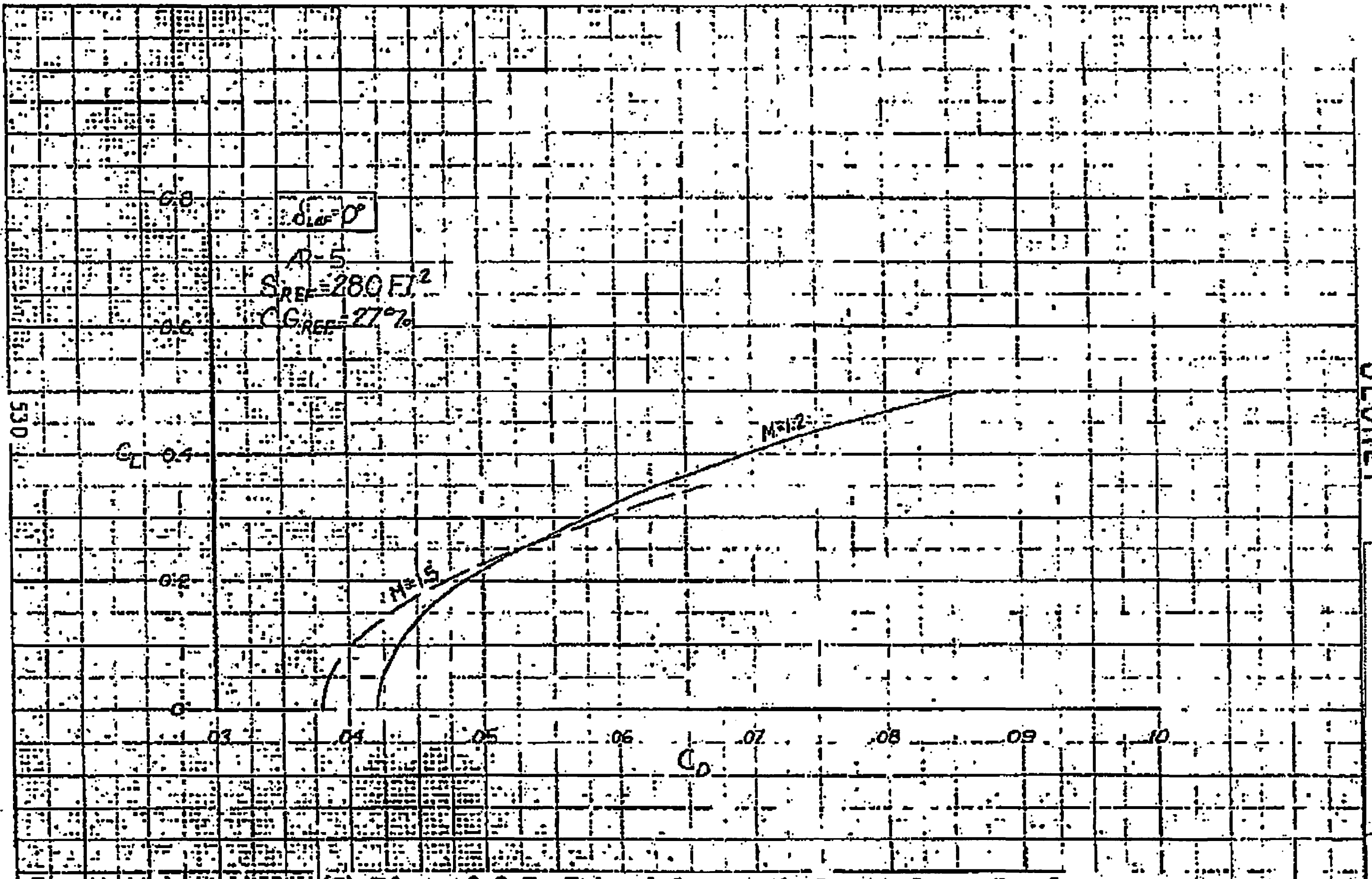

~~(S)~~ Figure 8.3-7 Trimmed Supersonic Drag Polars, AR = 5

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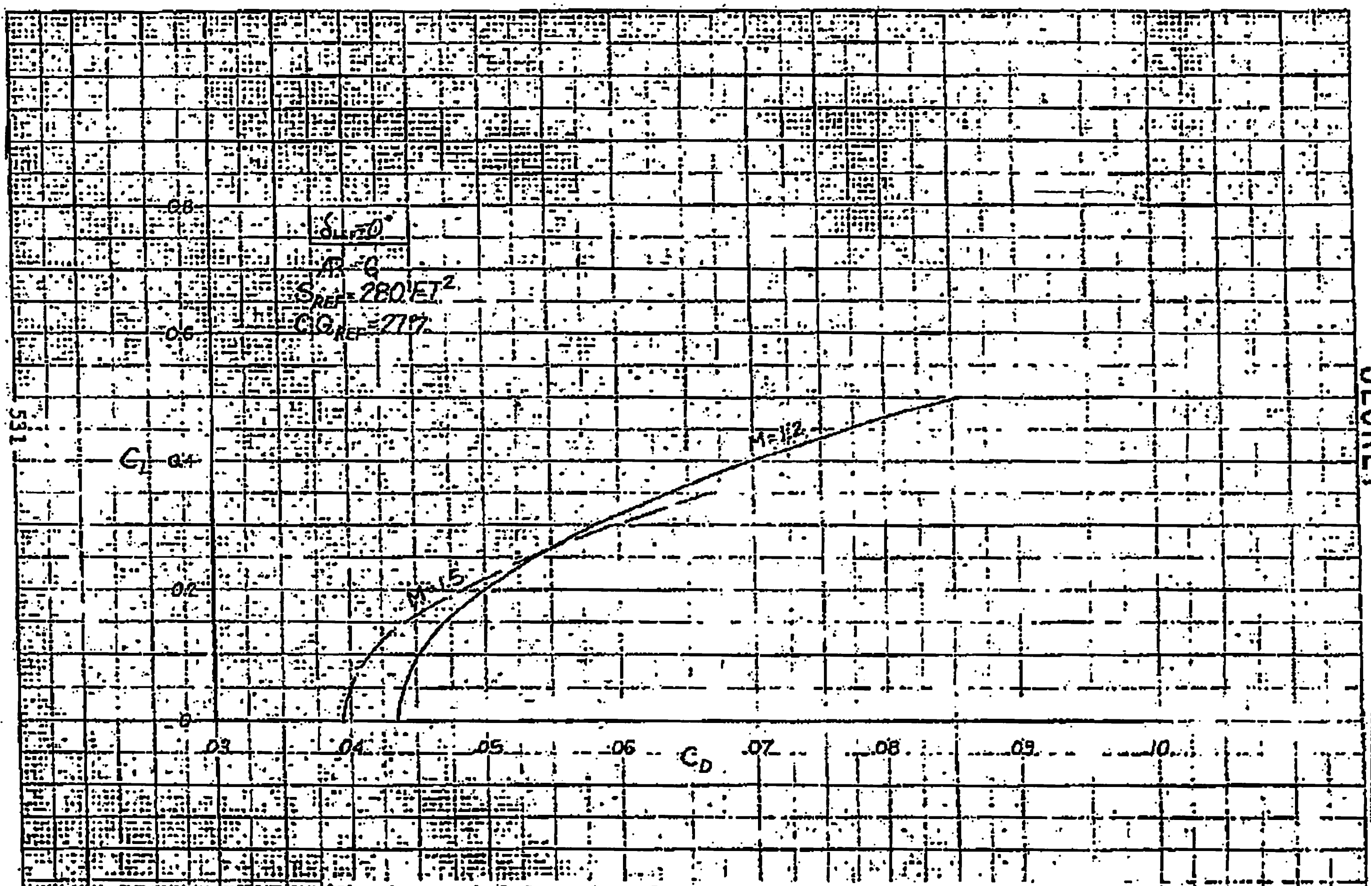
88th ABW/IPI
FOIA (b)(1)
E.O. 13526 SEC. 3.3(b)(4)
1.4. (a)(g)



~~(S)~~ Figure 8.3-8 Trimmed Supersonic Drag Polars, Æ= 6

88th ABW/IPI
FOIA (b)(1)
~~E.O.13526 SEC. 3.3.(b)(4)~~
1.4. (a)(g)

8.4 STABILITY, CONTROL, AND HANDLING QUALITIES

(U) For the composite-material aircraft matrix study, similar general guidelines were given for realistic sizing of the horizontal and vertical stabilizing surfaces as was done for the supercritical wing parametric study (Section 7.5). Ground rules followed in sizing the tails are specified in Subsection 8.1.2. No specific stability and control parameters were generated for this study.

8.5 STRUCTURES AND WEIGHTS

~~(S)~~ For the composite materials study, a matrix of 48 airplanes was selected with the variables of gross weight, aspect ratio, and wing loading. The 3 x 4 x 4 matrix for the study is shown below:

GW	AR	W/S
15600	3	45
16800	4	50
18000	5	55
	6	60

(U) Weight analyses were performed for all airplanes, with aluminum serving as the basic structural material to provide a baseline. The aluminum weights were calculated by the analytical-statistical methods previously described (see Section 3.1). Weights were developed for three levels of composite usage:

1. All composite
2. Composite wing only
3. Composite wing, tails, and inlet duct.

(U) In the study, all of the structural material was not changed to composite in the individual components. In regions of high-load introduction and high-load interaction such as the wing-fuselage interaction, landing gear bulkheads, and gun support structure, there was no attempt to use composites.

(U) Conversion factors were developed from data generated during composite materials research conducted over the past decade. The boron-epoxy and graphite-epoxy systems have advanced from basic materials testing through flight test and limited production in certain applications. With the data from these studies, an assessment of realistic weight savings was made, and weight conversion factors were derived. The factors were then applied to the various structural items of the aluminum component weights to determine the composite weights.

~~(S)~~ The fuselage weight saving is based on the engineering analysis for the F-5 composite fuselage presently being fabricated by Convair Aerospace. The horizontal tail data were obtained from the F-111A composite production tail. Several previous studies were used as a basis for the vertical tail factors. Strength-density factors were applied to the theoretical skins of the wing structural box, and savings on secondary structure were based on existing hardware. No composite savings were attempted for the landing gear.

(U) Weight summaries for the various levels of composite usage and for the aluminum baseline are given in Tables 8.5-1 through 8.5-4. The resulting zero-fuel-weight-vs-aspect-ratio curves are shown in Figures 8.5-1 through 8.5-3.