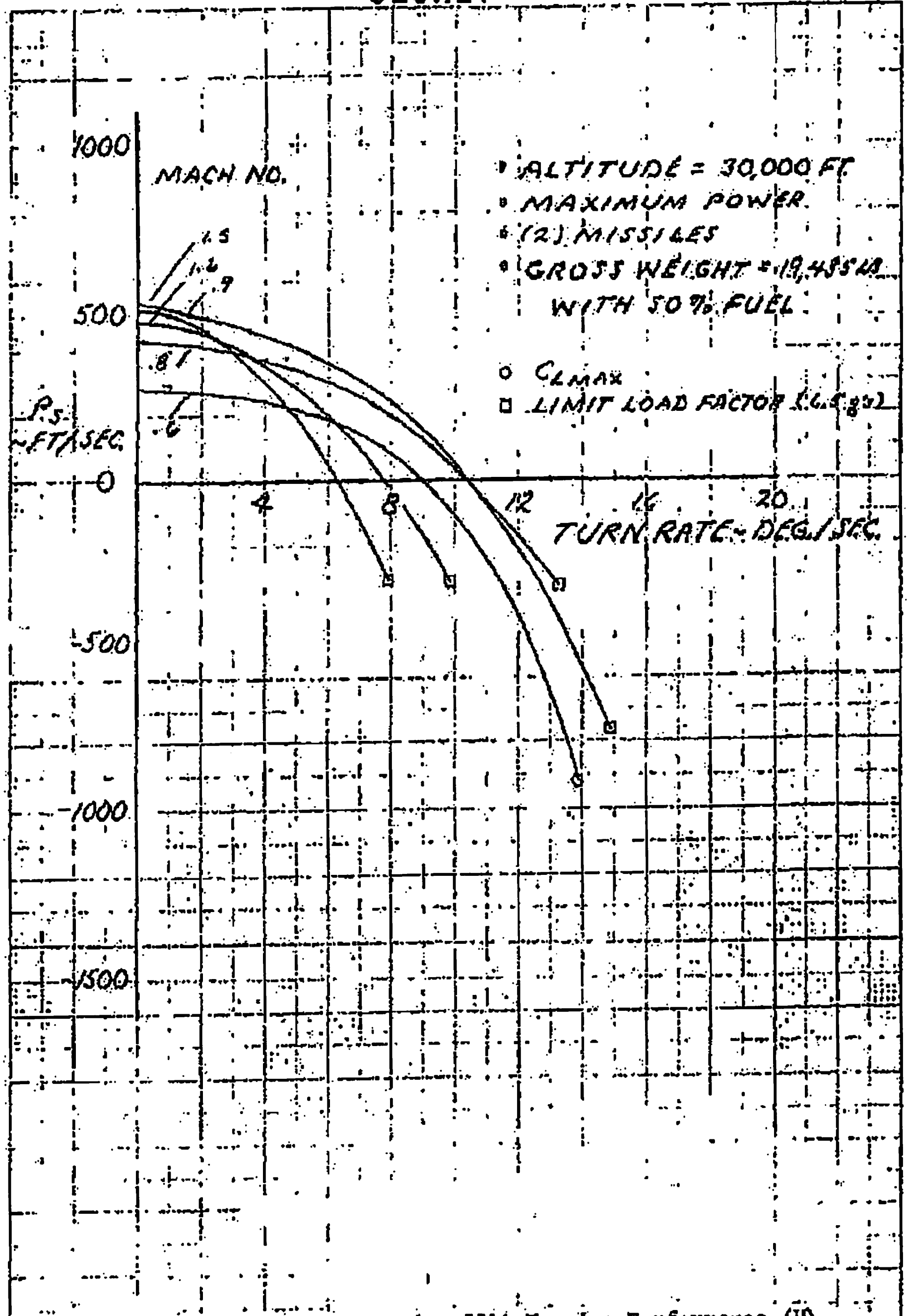
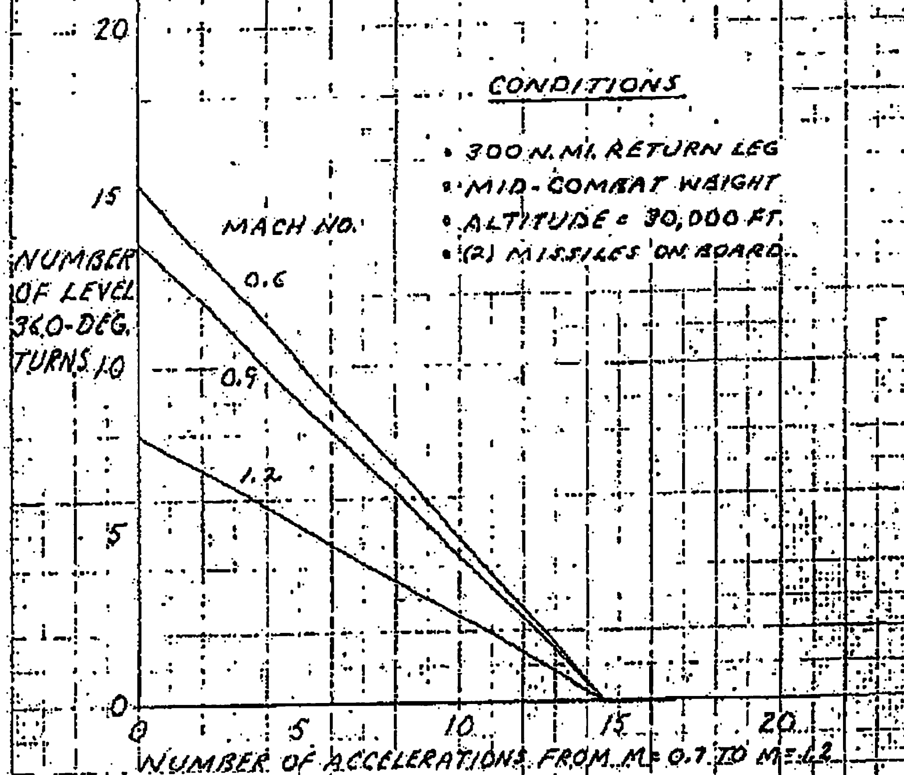


~~(S)~~ Figure 5.2-10 Configuration 501A Turning Performance (U)

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

~~SECRET~~

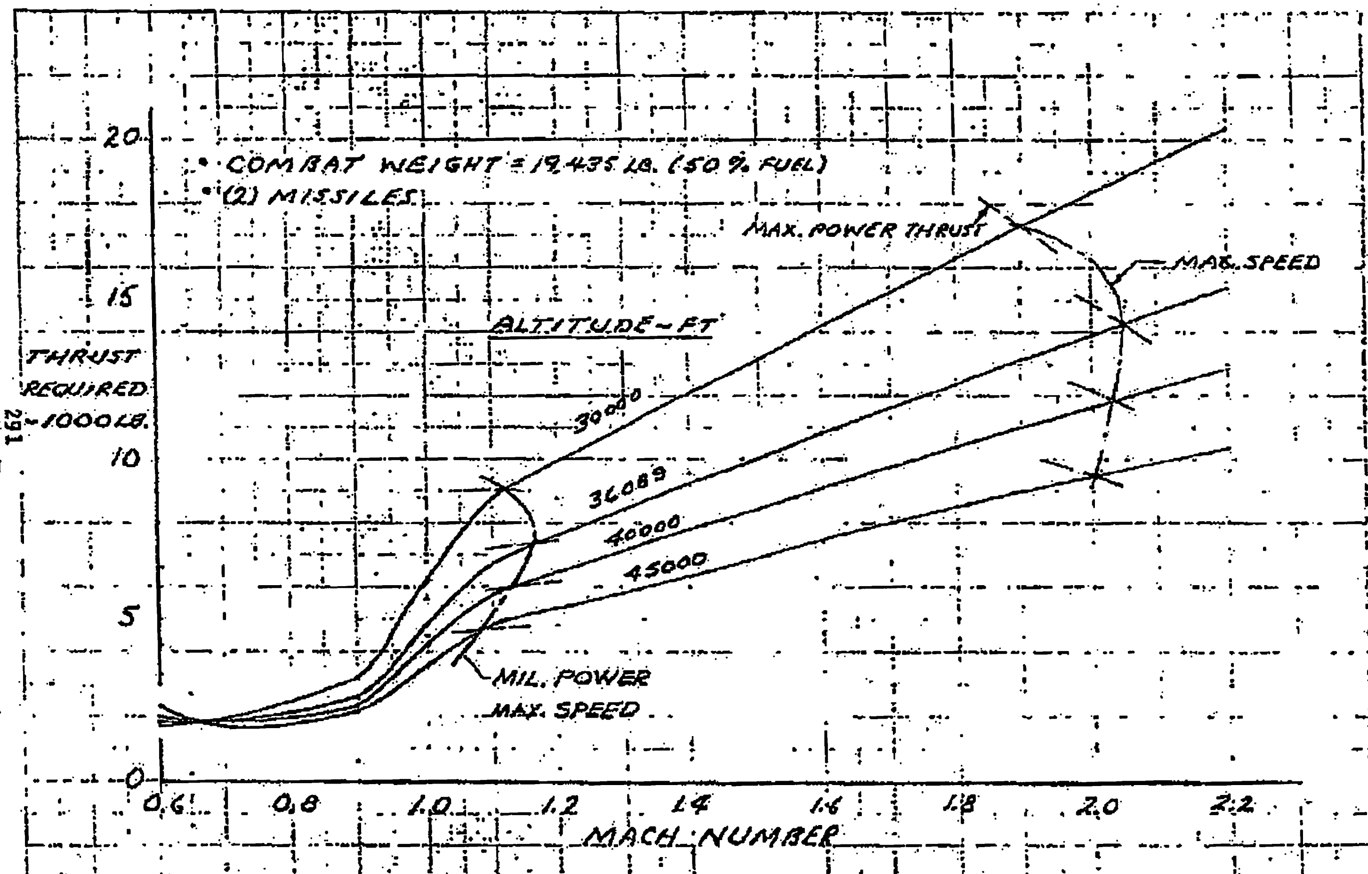


~~(S)~~ Figure 5.2-11 Configuration 501A Persistence Plot (U)

~~SECRET~~

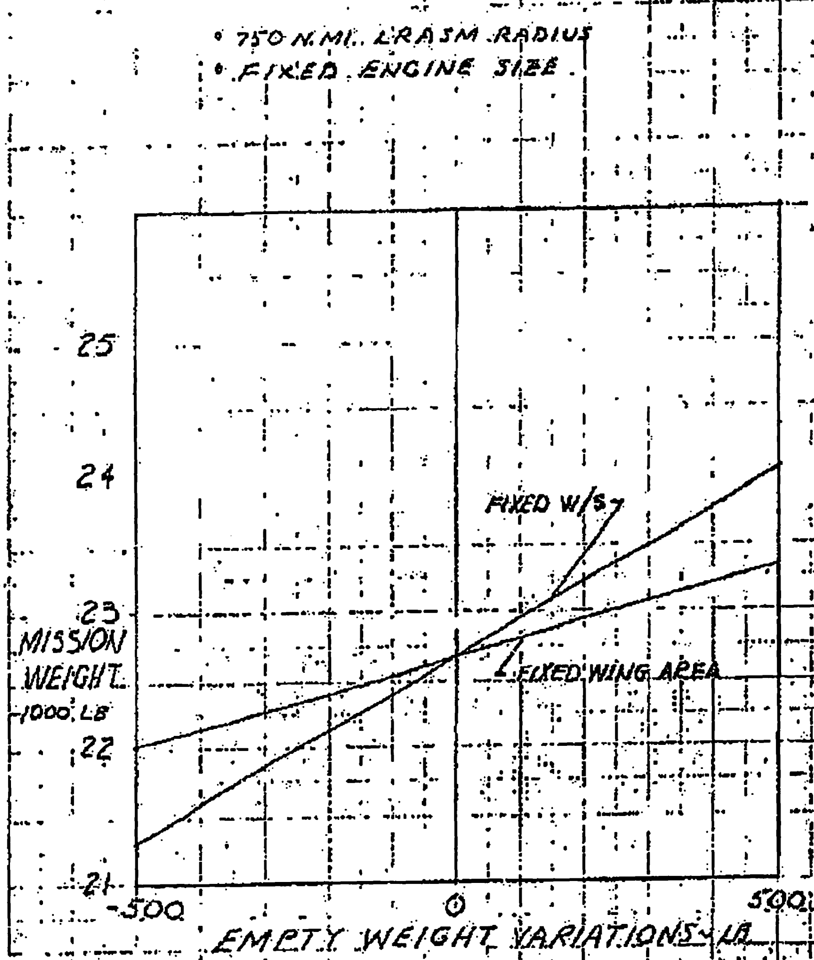
SECRET

291



~~(S)~~ Figure 5.2-12 Configuration 501A Thrust Required (U)

SECRET



~~(S)~~ Figure 5.2-13 Configuration 501A Sensitivity to Weight Variation (U)

5.3 AERODYNAMICS

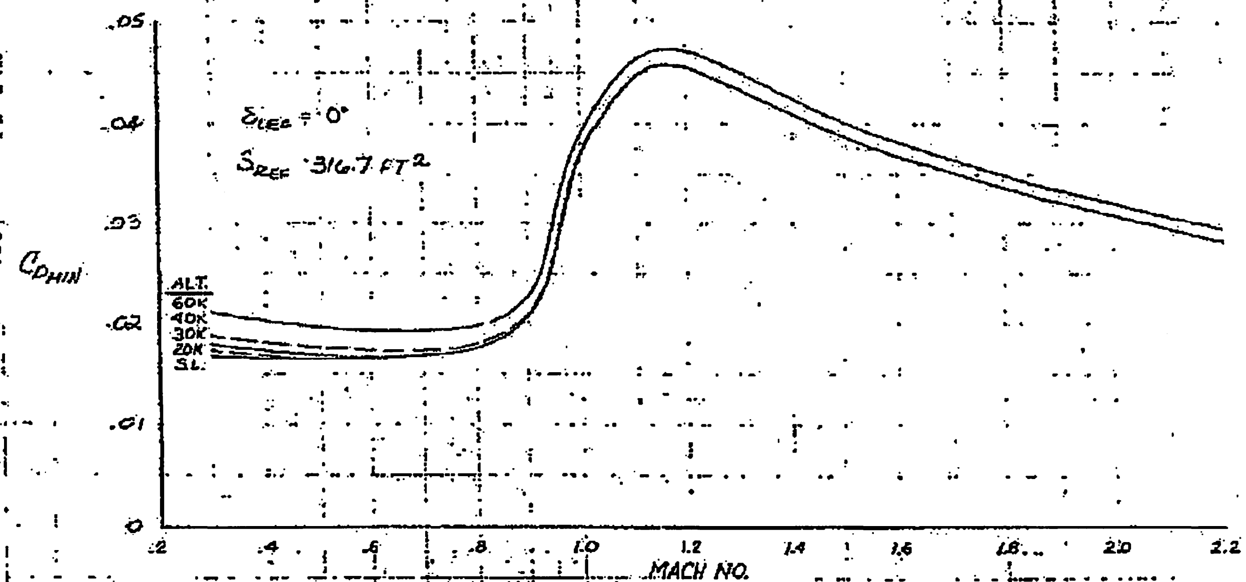
(U) Like Configuration 403, the twin-engine airplane (501A) is geometrically similar to Configuration 401B, and, therefore, the only aerodynamic differences are in the minimum drag.

(U) Again, the methodology and assumptions outlined in Section 3.3 were applied consistently to this configuration. Figures 5.3-1, -2, and -3 summarized the minimum drag data. The most significant difference between Configurations 501A and 401B is in the wave drag - 501A has a coefficient .0054 higher at M = 1.2 and .0034 higher at M = 1.6. This is due to the increased frontal area and steeper aft slopes, as is seen by comparing the normal area distribution curves shown in Figures 3.1-23 and 5.1-16.

(U) The trimmed drag polars and trimmed configuration polars for Configuration 501A are presented in Figures 5.3-4 through 5.3-13. The $(L/D)_{max}$ data are plotted in Figure 5.3-14. A comparison of these data with those of Figure 3.3-25 shows that at subsonic speeds Configurations 501A and 401B are equivalent, but, at Mach 1.2, Configuration 501A has a 6-percent lower $(L/D)_{max}$.

(U) Since the planform and wing loading are the same as for the 401B configuration, the lift curves, buffet boundaries, and control-limit C_L's shown in Figures 3.3-26 through 3.3-31 of Section 3.3 also apply to the 501A configuration.

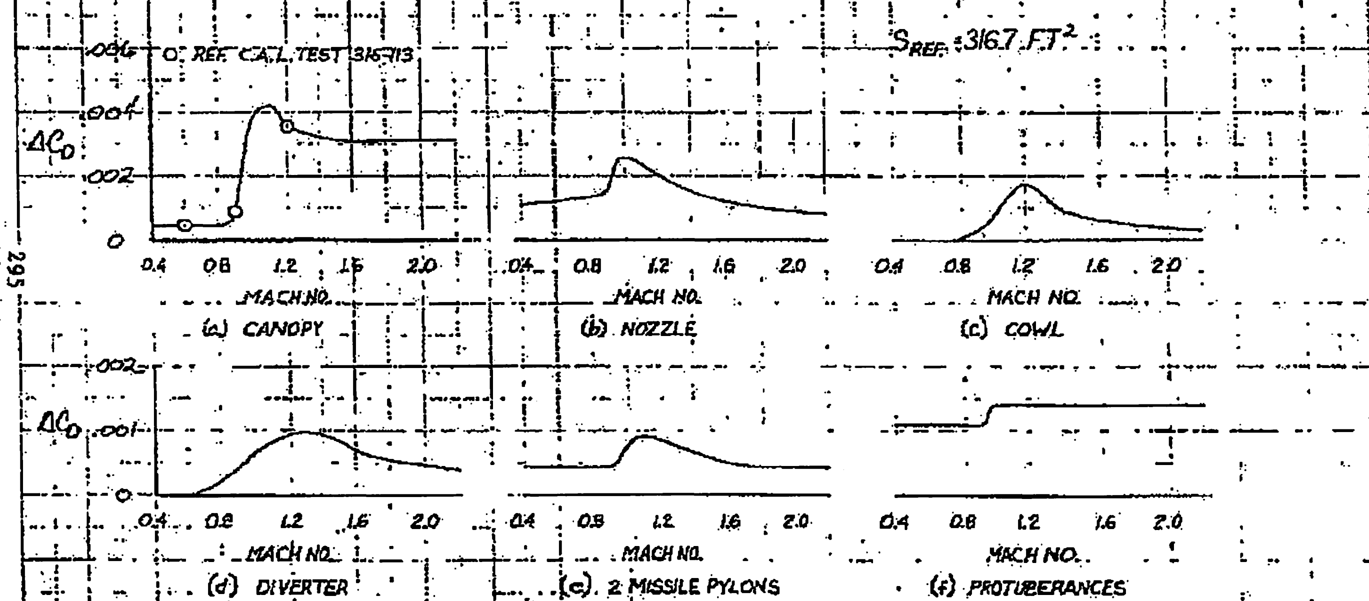
SECRET



~~(S)~~ Figure 5.3-1 Minimum Drag vs Mach Number, Configuration 501A

SECRET

SECRET



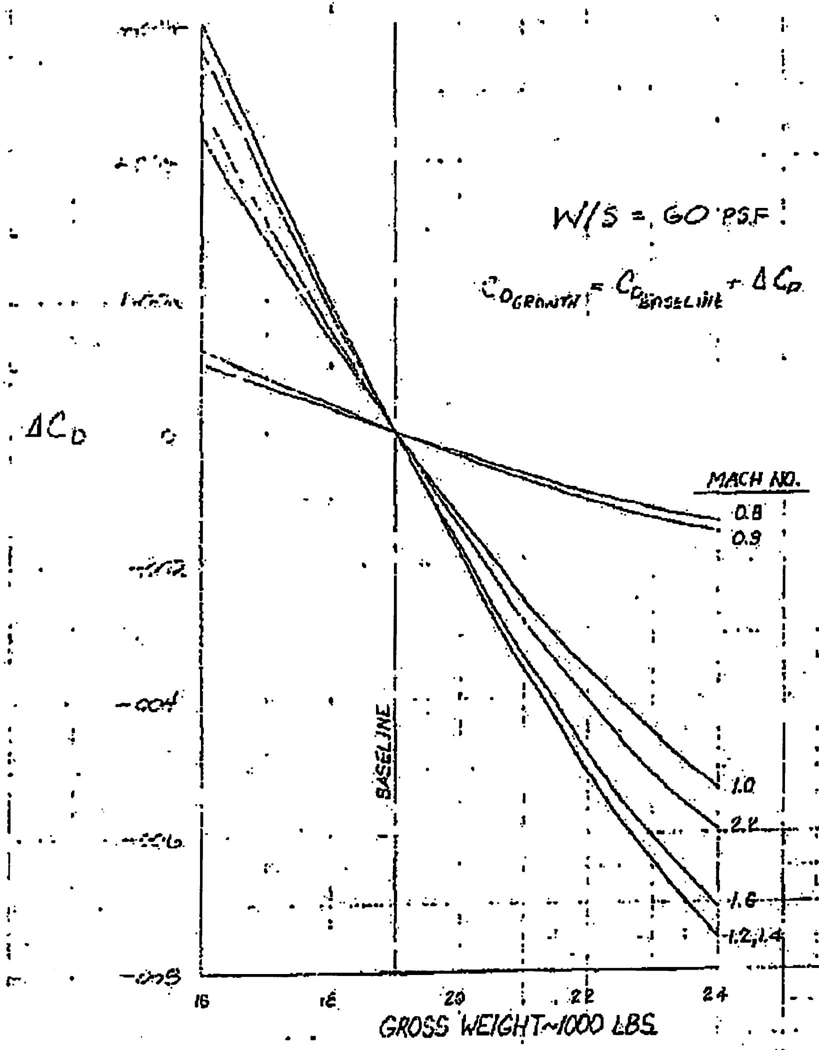
~~(S)~~ Figure 5.3-2 Components Used in Minimum Drag Buildup, Configuration 501A

SECRET

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

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

~~SECRET~~

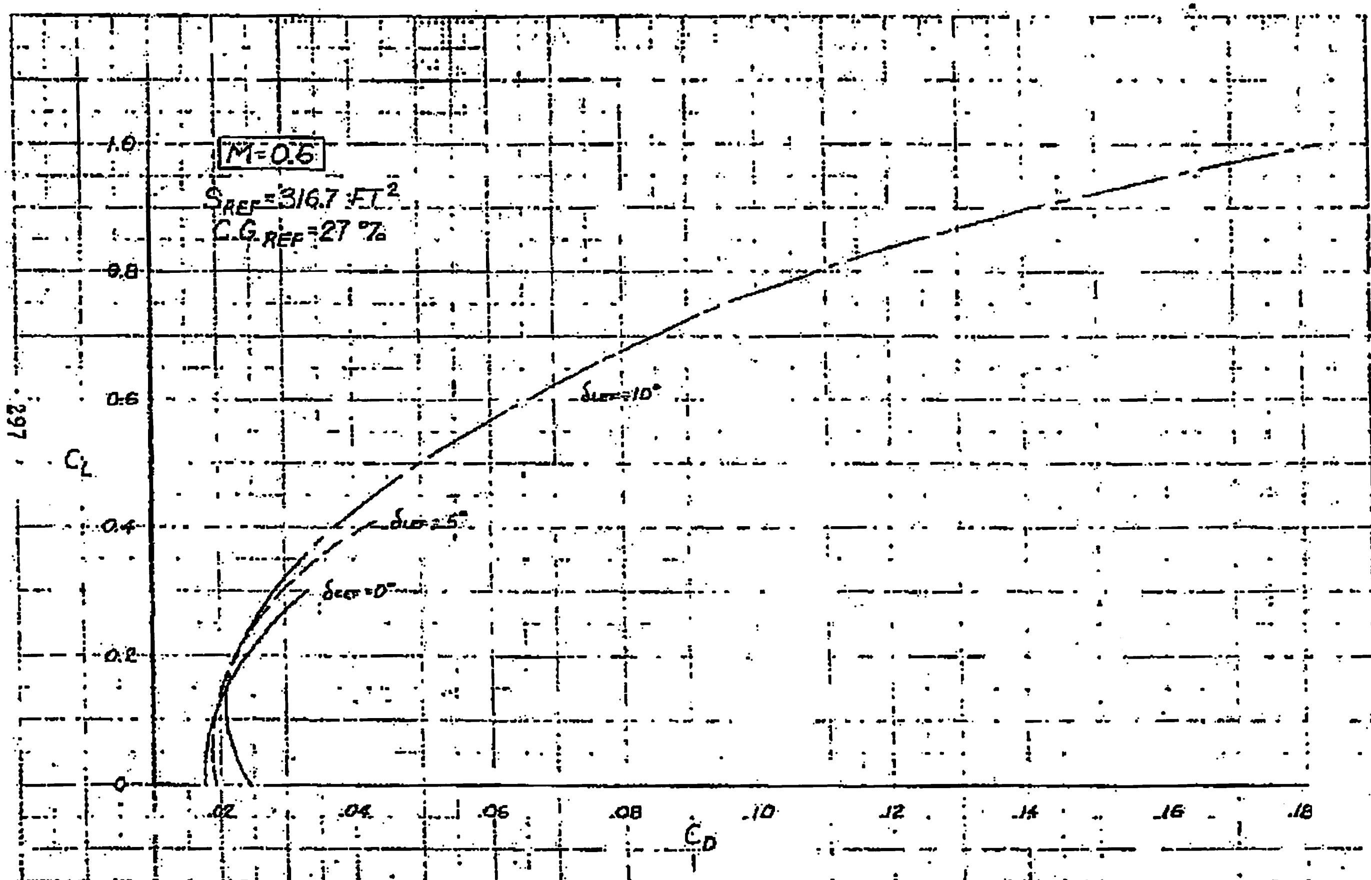


~~(S)~~ Figure 5.3-3 Effect of Aircraft Size on Minimum Drag Coefficient, Configuration 501A (U)

~~SECRET~~

SECRET

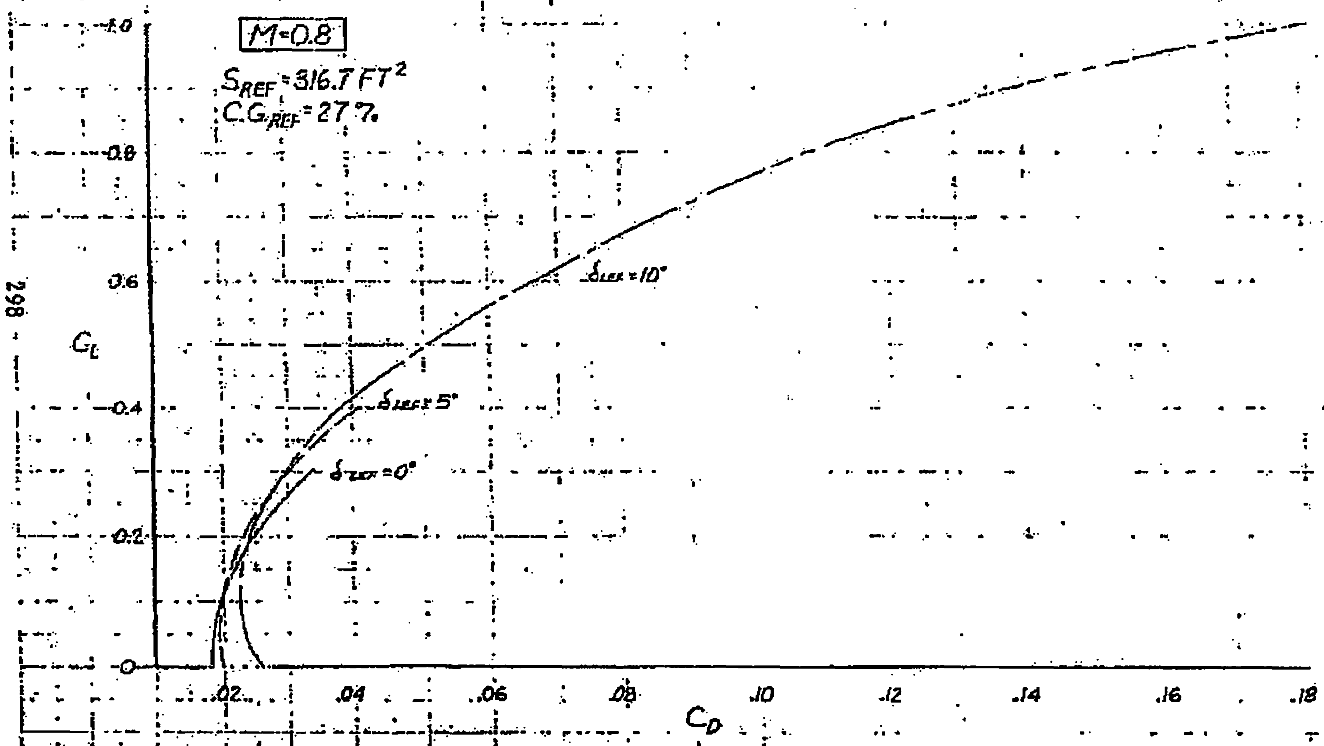
297



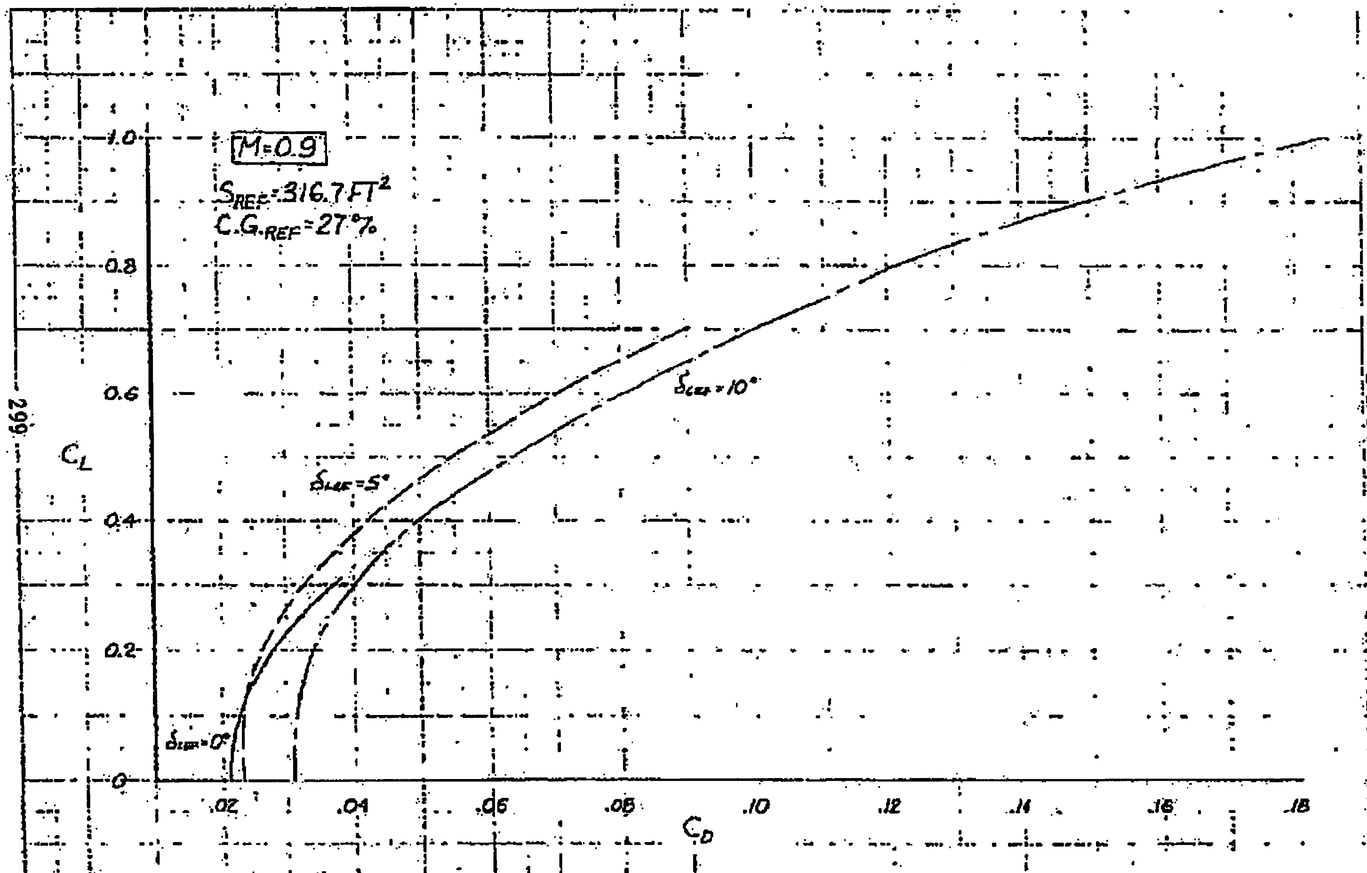
(C) Figure 5.3-4 Trimmed Drag Polars at M=0.6, Configuration 501A

SECRET

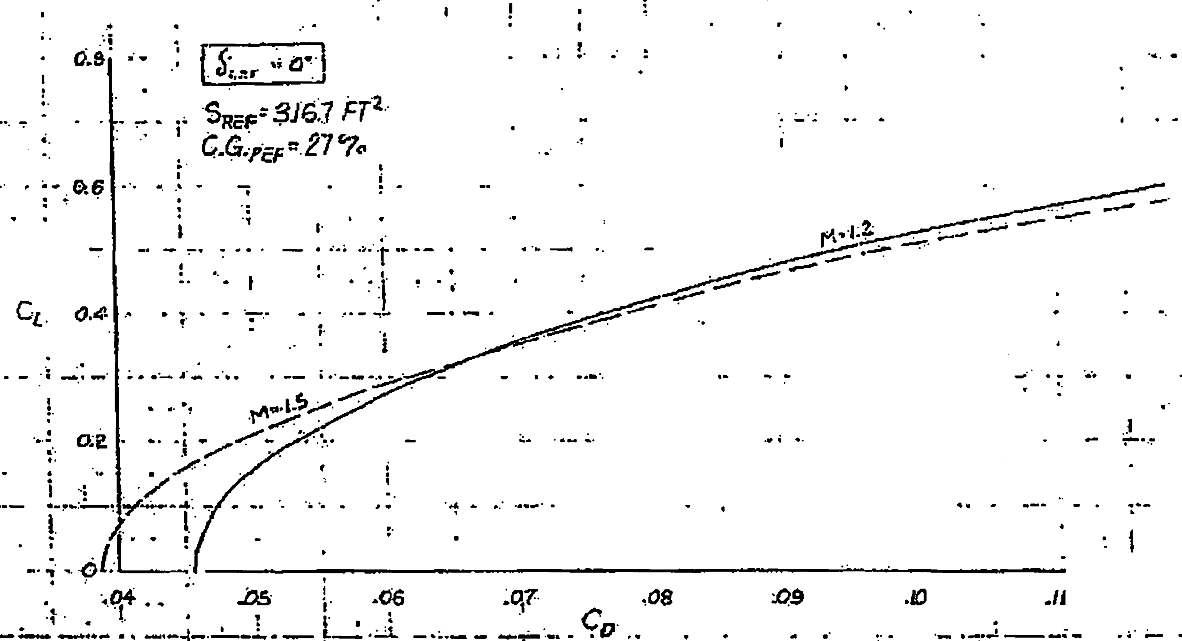
88th ABW/IPI
FOIA (b)(1)
E.O.13526 SEC.
3.3.(b)(4)
1.4. (a)(g)



~~(S)~~ Figure 5.3-5 Trimmed Drag Polars at M=0.8, Configuration 501A

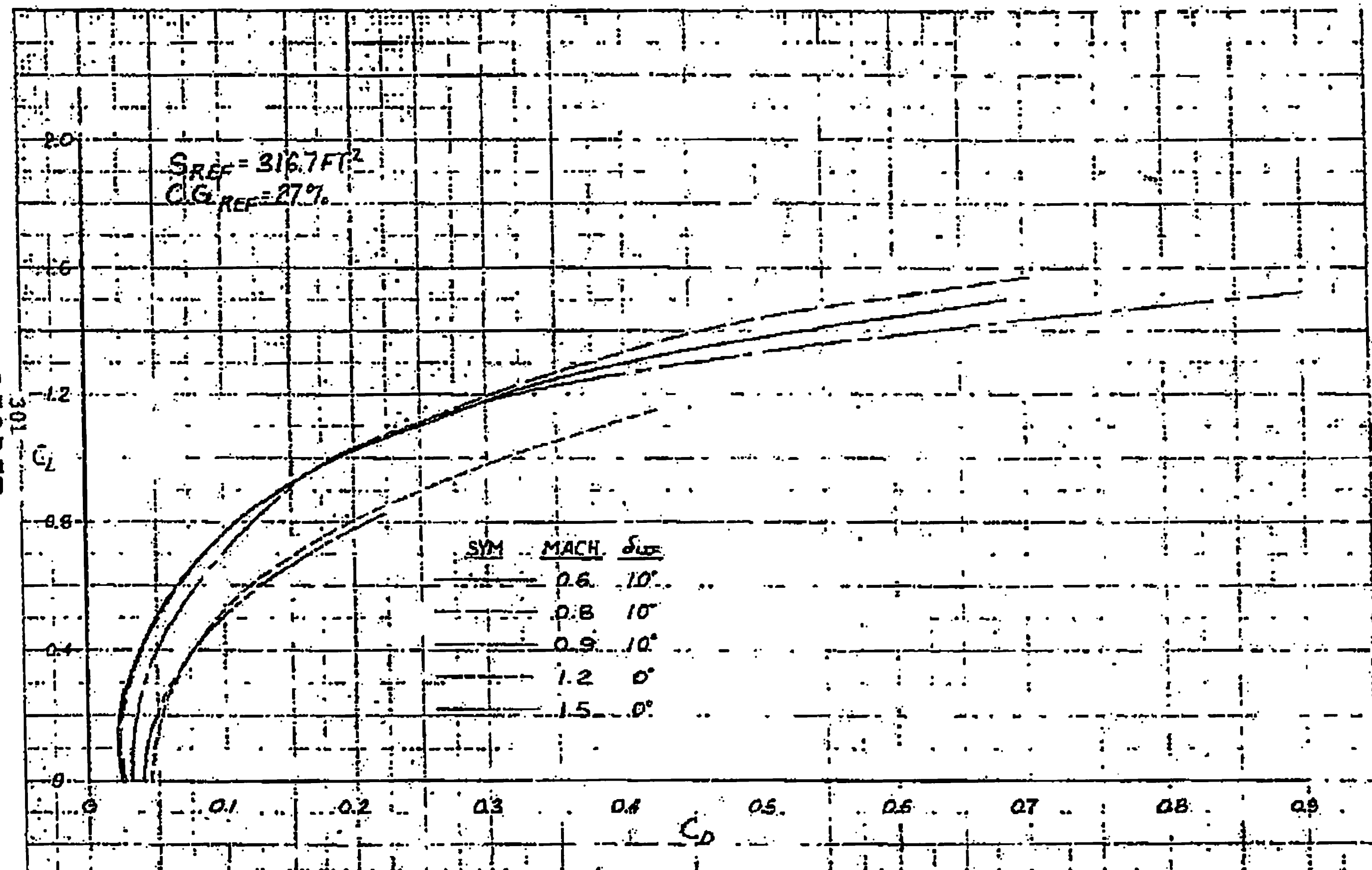


~~(S)~~ Figure 5.3-6 Trimmed Drag Polars at M=0.9, Configuration 501A



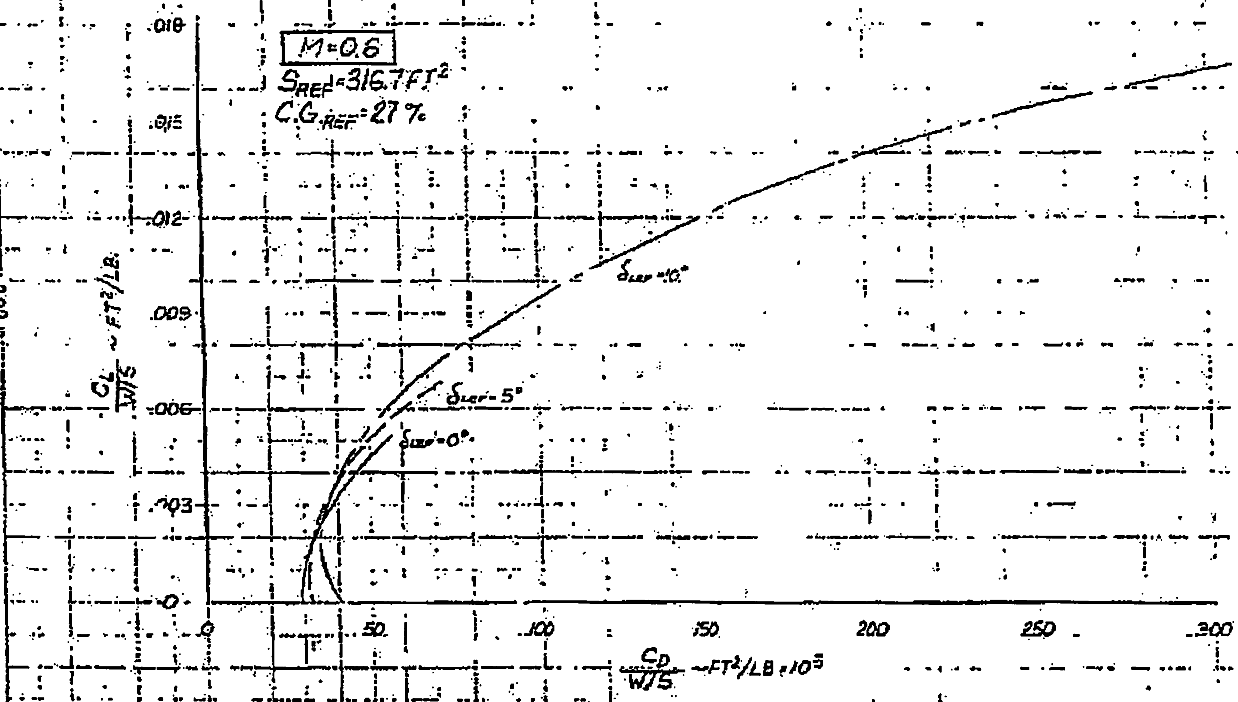
(S) Figure 5.3-7 Trimmed Drag Polars at M=1.2 and 1.5, Configuration 501A

SECRET



(S) Figure 5.3-8 Trimmed Drag Polars at High C_L's, Configuration 501A

SECRET



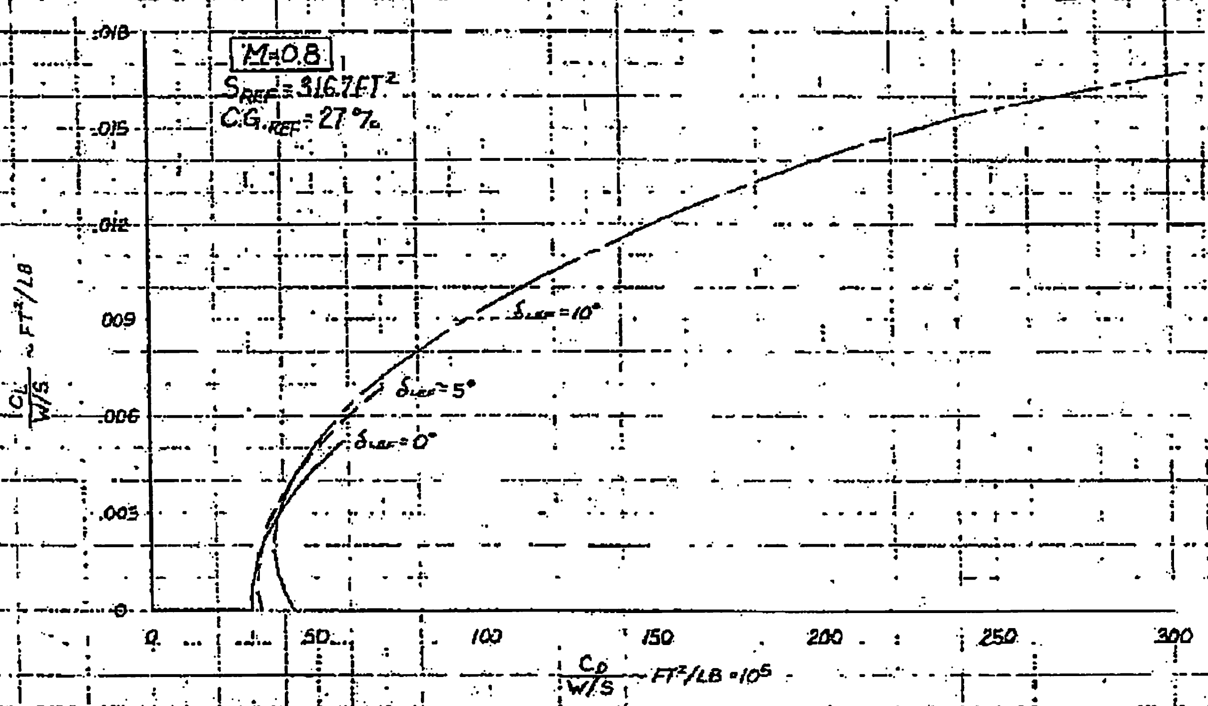
(S) Figure 5.3-9 Trimmed Configuration Polars at M=0.6, Configuration 501A

SECRET

302

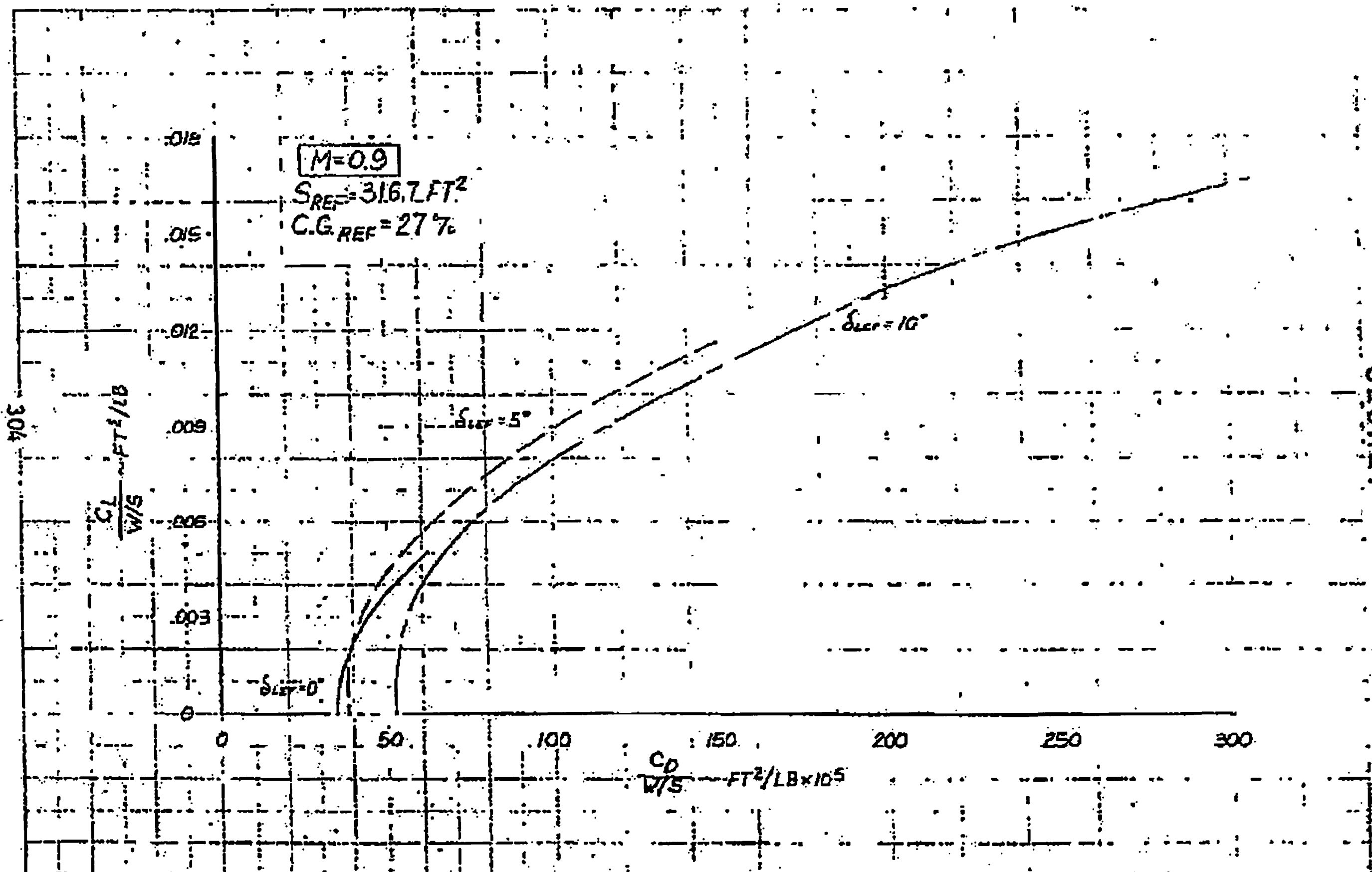
SECRET

SECRET



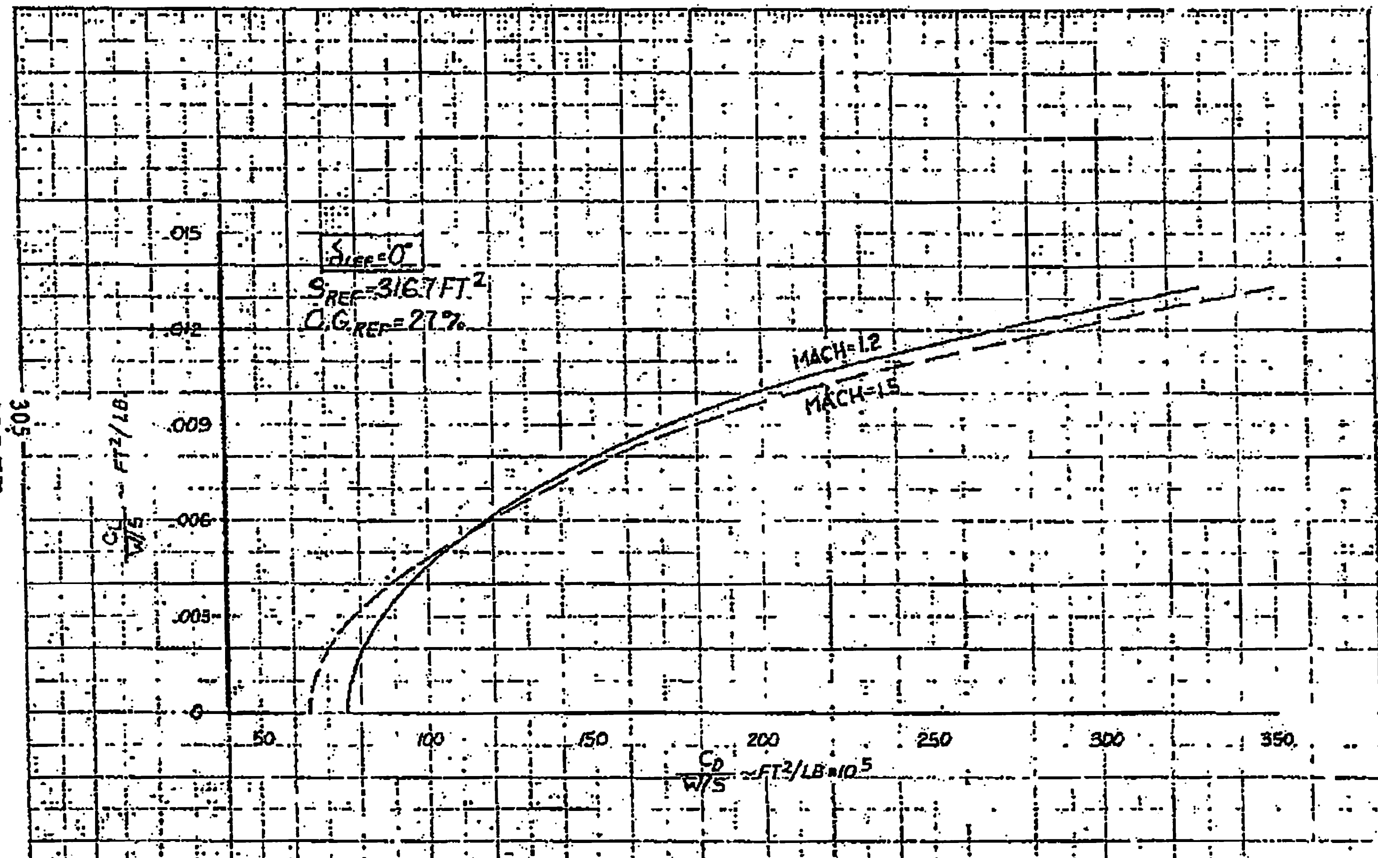
(S) Figure 5.3-10 Trimmed Configuration Polars at M=0.8, Configuration 501A

SECRET



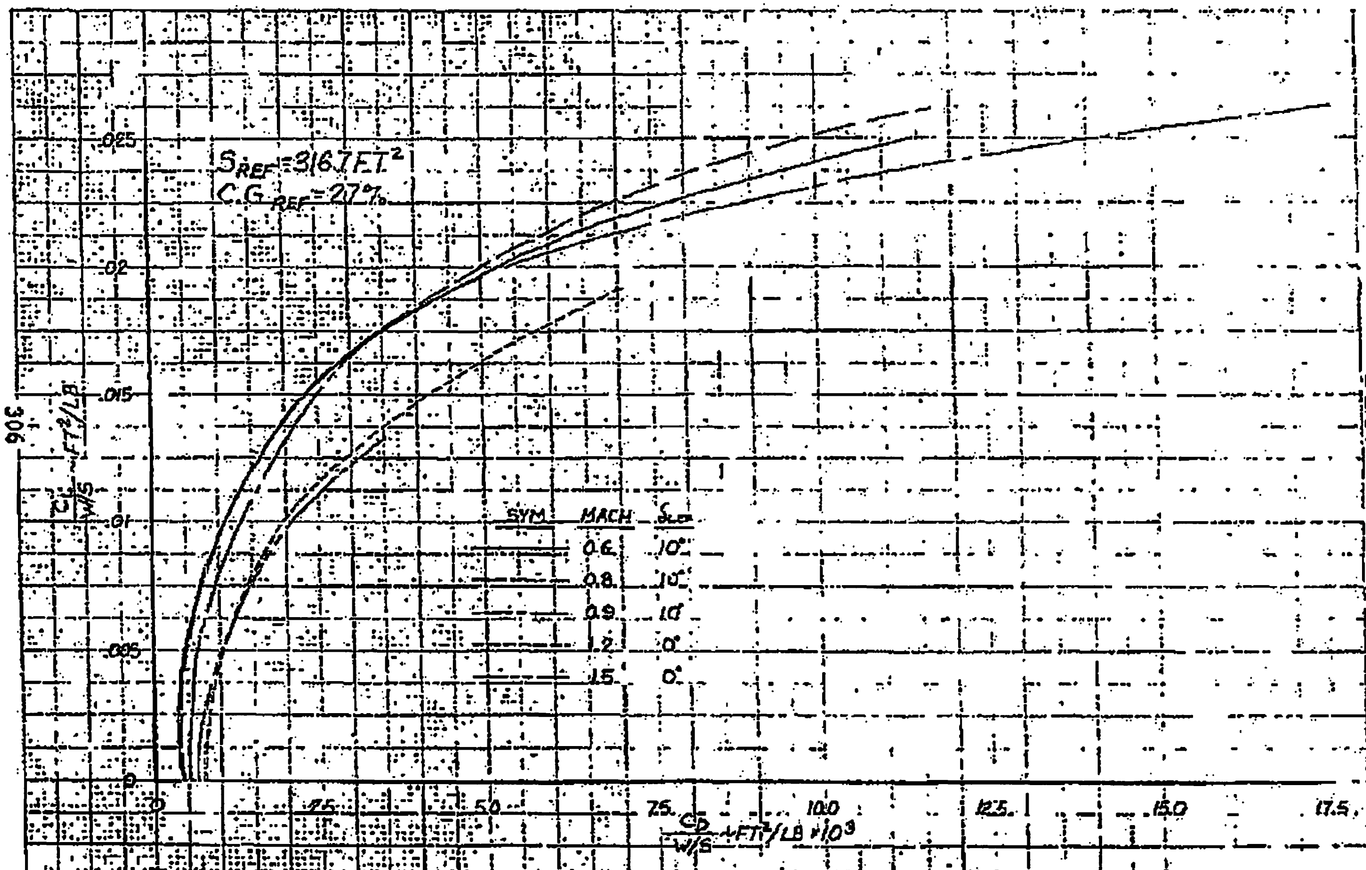
~~(S)~~ Figure 5.3-11 Trimmed Configuration Polars at M=0.9, Configuration 501A

SECRET



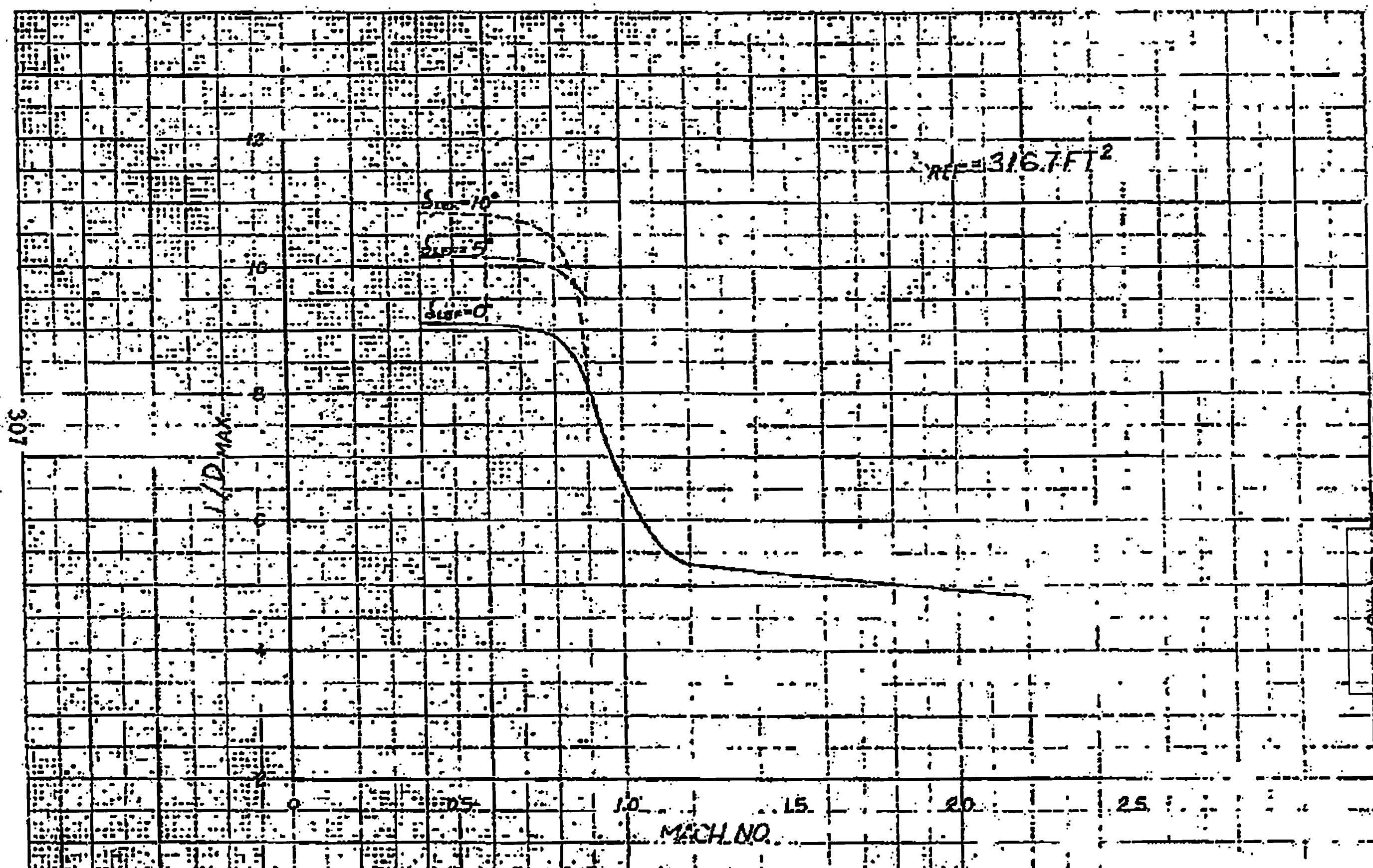
~~(S)~~ Figure 5.3-12 Trimmed Configuration Polars at M=1.2 and 1.5, Configuration 501A

SECRET



(S) Figure 5.3-13 Trimmed Configuration Polars at High C_L's, Configuration 501A

SECRET

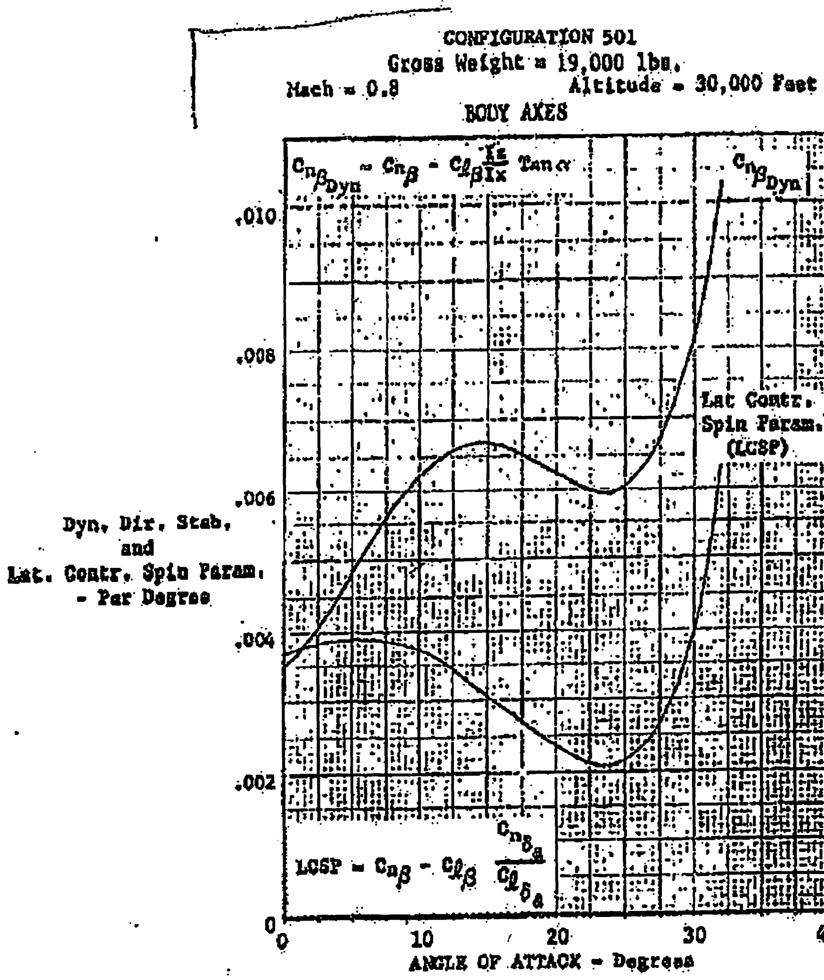


(S) Figure 5.3-14 Trimmed $(L/D)_{max}$ vs Mach Number, Configuration 501A

SECRET

5.4 STABILITY, CONTROL, AND HANDLING QUALITIES

(U) The same basic stability and control and handling qualities design philosophy previously reported for the single-engine 401B configuration has been followed in development of the large twin-engine concept 501A configuration. Overall, the basic configurations are similar since the respective tail volume coefficients have been kept equivalent for the 401B single-engine and the 501A two engine design. The stability and control characteristics of the 501A will be basically the same as those presented for the 401B in Subsection 3.4.3. In general, no major difference can be expected in the handling qualities between the two designs as a result of the higher moment of inertias of the larger two-engine configuration. The dynamic directional stability parameter for Configuration 501A is plotted in Figure 5.4-1 along with the lateral-control spin parameter. When compared with similar curves for the 401B configuration (Figure 3.4-24), the 501A exhibits higher dynamic directional stability and, hence, higher spin resistance than the 401B. The higher spin resistance of configuration 501A is attributed to the higher ratio of yawing moment of inertia to rolling moment of inertia.



~~(S)~~ Figure 5.4-1 Dynamic Directional Stability and Lateral Control Spin Parameter (U)

5.5 STRUCTURES AND WEIGHTS

~~(S)~~ Weight analysis for the Configuration 501A growth curve was performed in the same manner as for the Configuration 401B growth curve. Four airplanes were selected for analysis at design gross weights (in pounds) as shown below.

SRASM TOGW	(80% Fuel) Struct DGW	Ferry Mission Overload GW
16,800	15,940	27,000
19,000	18,100	29,200
22,000	21,040	32,200
24,000	23,000	34,200

(U) Input data for weight equations were derived from scaling data presented in Section 5.1 together with layouts as required to develop specific area and dimensional data.

~~(S)~~ A weight summary for each of the four selected airplanes is presented in Table 5.5-1. A plot of weight variation versus gross weight is shown in Figure 5.5-1. The center-of-gravity and inertia properties are summarized below for the 19,000-pound-gross-weight SRASM configuration.

Properties	Basic Operating Weight	Zero Fuel Weight	Gross Weight
Weight (lb)	14,107	14,740	19,000
Horiz. C.G. (% MAC)	22.7	21.2	20.6
I_{xx} (slug ft^2)	7543	8044	9104
I_{yy} (slug ft^2)	49,021	50,317	53,953
I_{zz} (slug ft^2)	53,676	55,444	59,952

~~(S)~~ A summary of the center-of-gravity conditions for the LRASM and ferry mission for the 19,000-pound-gross-weight configuration is as follows:

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

(S)

Item	LRASM Weight (lb)	LRASM C.G. (% MAC)	Ferry Mission Weight (lb)	Ferry Mission C.G. (% MAC)
Basic Operating Weight	14,955	22.3	15,797	21.8
Zero Fuel Weight	15,588	20.9	16,082	20.0
Gross Weight	23,838	19.8	29,200	18.8

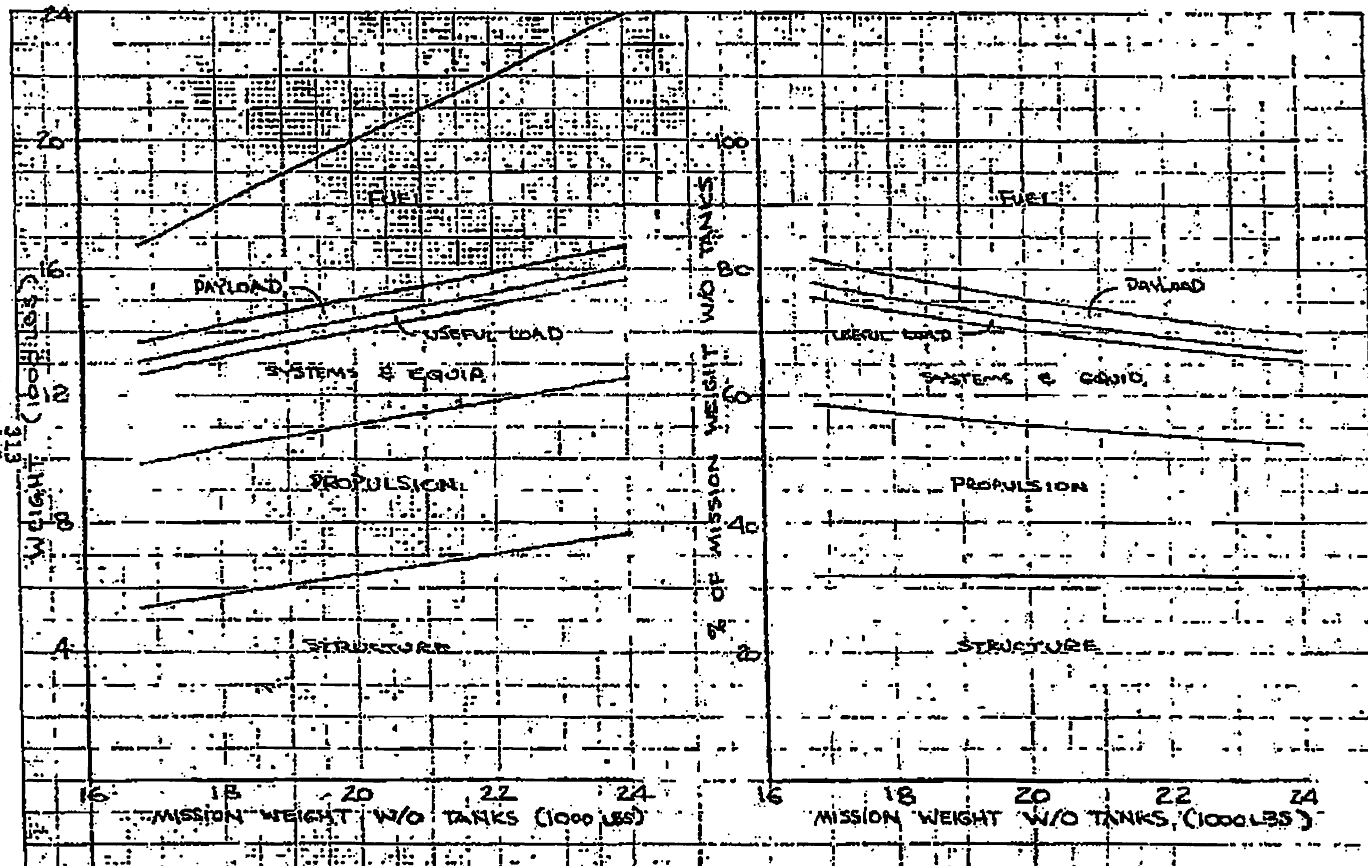
Based on mission requirements, the airplane has been sized at a SRASM gross weight of 22,680 pounds. A weight summary for this configuration is presented in Table 5.5-2. The center-of-gravity conditions for this weight level are not included since they will not differ significantly from the center-of-gravity conditions shown above.

SECRET

(S) Table 5.5-1 WEIGHT SUMMARY: CONFIGURATION 501A GROWTH STUDY (U)
(pounds)

Item	Airplane Sizes			
	16,800GW	19,000GW	22,000GW	24,000GW
Structure	(5,404)	(6,075)	(6,992)	(7,657)
Wing	1,474	1,725	2,058	2,303
Fuselage	2,604	2,832	3,152	3,381
Horizontal Tail	372	438	538	606
Vertical Tail	334	380	448	496
Landing Gear	620	700	796	871
Propulsion System	(4,458)	(4,617)	(4,792)	(4,881)
Engines (2) (J101-GE-100)	3,580	3,580	3,580	3,580
Air Induction	438	501	580	625
Fuel System	364	458	552	595
Engine Controls	36	38	40	41
Starting System	40	40	40	40
Systems and Equipment	(2,820)	(2,933)	(3,072)	(3,158)
Surface Controls	613	661	724	762
Landing Gear Controls	116	128	143	154
Instruments	109	109	109	109
Hydraulics & Pneumatics	296	327	368	395
Electrical	386	408	428	438
Avionics	460	460	460	460
Furnishings	245	245	245	245
Air Conditioning	142	142	142	142
Armament	453	453	453	453
Weight Empty	12,682	13,625	14,856	15,696
Useful Load	(389)	(396)	(406)	(410)
Crew	200	200	200	200
Unusable Fuel	15	22	32	36
Engine Oil	20	20	20	20
Missile Racks and Pylons	124	124	124	124
Miscellaneous	30	30	30	30
Basic Operating Weight	13,071	14,021	15,262	16,106
Payload	(633)	(633)	(633)	(633)
Ammo (500 rounds)	285	285	285	285
Missiles (2)	348	348	348	348
Zero Fuel Weight	13,704	14,654	15,895	16,739
Fuel	3,096	4,346	6,105	7,261
Gross Weight	16,800	19,000	22,000	24,000

SECRET



(S) Figure 5.5-1 Weight Variation with Aircraft Size: Configuration 501A (U)

~~(S)~~ Table 5.5-2 WEIGHT SUMMARY: CONFIGURATION 501A SIZED TO MEET LRASM REQUIREMENTS (pounds) (U)

Item	Weight
Structure	(7209)
Wing	2145
Fuselage	3233
Horizontal Tail	545
Vertical Tail	463
Landing Gear	823
Propulsion System	(4822)
Engine (2) (J101-GE-100)	3580
Air Induction	595
Fuel System	567
Engine Controls	40
Starting System	40
Systems and Equipment	(3112)
Surface Controls	740
Landing Gear Controls	145
Instruments	109
Hydraulics and Pneumatics	380
Electrical	438
Avionics	460
Furnishings	245
Air Conditioning System	142
Armament	453
Weight Empty	15,143
Useful Load	(406)
Crew	200
Unusable	32
Engine Oil	20
Missile Racks and Pylons	124
Miscellaneous	30
Basic Operating Weight	15,549
Payload	(633)
Ammo (500 rounds)	285
Missiles (2)	348
Zero Fuel Weight	16,182
Fuel	6498
Gross Weight	22,680

5.6 PROPULSION (501A/J101-GE-100)

(U) Two General Electric continuous-bleed turbojets, J101-GE-100, are installed in the Configuration 501 airplane. This is geometrically the same engine, including the exhaust nozzle, that is installed in the Configuration 403 airplane (see Section 4.6). However, the engine performance data furnished by General Electric are more recent than those used in the analysis of Configuration 403.

(U) In this section, the J101-GE-100 propulsion system performance data are presented for the engines installed in the airplane. The effects of installation are accounted for in the data explained below.

(U) Subsequent to the analysis of the J101-GE-100, General Electric described a lower-weight J101 having a revised cycle (referred to as the 7/23 cycle). The thrust is increased and the specific fuel consumption is reduced. The new weight is 4.8% lower, and the sea-level-static rated thrust is 4.3% higher. Cruise TSFC is about 4% lower. Since this information only became known at the end of the reporting period, time did not permit evaluation of the 7/23 cycle.

(U) The engines are located side by side in the aircraft aft fuselage, with primary airflow delivered to each engine by an open-nose inlet. The airplane has two independent inlets and ducts, one for each engine.

(U) A small amount of ventilation air flows into and out of the nacelles in a manner similar to that of the single-engine configuration. The drag for this airflow is assumed to be the same as that for the single-engine configuration and is accounted for in the airplane drag.

5.6.1 Propulsion System Performance

(U) The installed thrust specific fuel consumption, TSFCS, and propulsion system net thrust, F_{NS}, are presented in Figures 5.6-1 through 5.6-13 for each engine of the Configuration 501 airplane. The data shown comprise a complete package needed for airplane energy-maneuverability analysis.

(U) The definition of F_{NS} is the same as that given in Subsection 3.6.1, except for the sources of the data employed.

(U) The installed net-thrust values, F_N, are taken from data supplied by GE in References 27 and 28. The GE data takes into account the inlet pressure recovery, compressor bleed for ECS, and power extraction specified by Convair. The exhaust nozzle drag, per engine, is assumed to be the same as that for the Configuration 403 airplane. (see Subsection 4.6.3)

5.6.2 Inlet

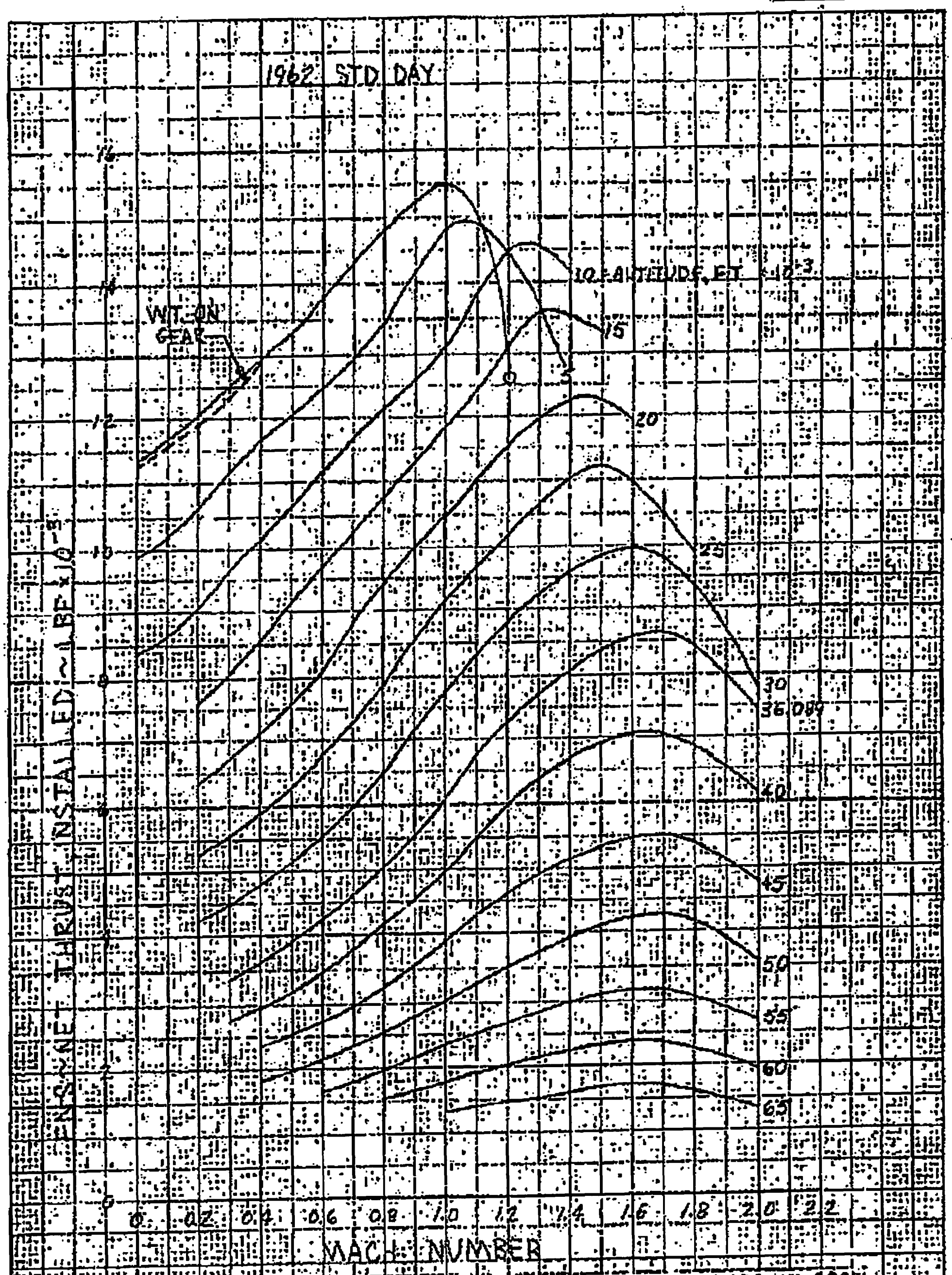
(U) The Configuration 501 inlet system consists of two separate inlets located on either side of the fuselage with separate ducts to each engine. The inlet sizing criteria and performance data are the same as described in Subsection 4.6.2 for Configuration 403/J101-GE-100. The inlet design rationale is essentially the same as for Configuration 401B/F100-PW-100 (Subsection 3.6.2). D-shaped inlets were chosen for Configuration 501 (as opposed to elliptical) to minimize the boundary-layer diverter.

5.6.3 Shaft Power and Compressor Bleed Extraction

(U) Power is extracted through the engine gear-box power-take-off shaft to drive the airplane electric generator and hydraulic pumps. The estimated value of total power extraction is 70 hp for the airplane, or 35 hp from each engine. The installed propulsion system performance data (each engine) accounts for 35 hp at all flight conditions and power settings.

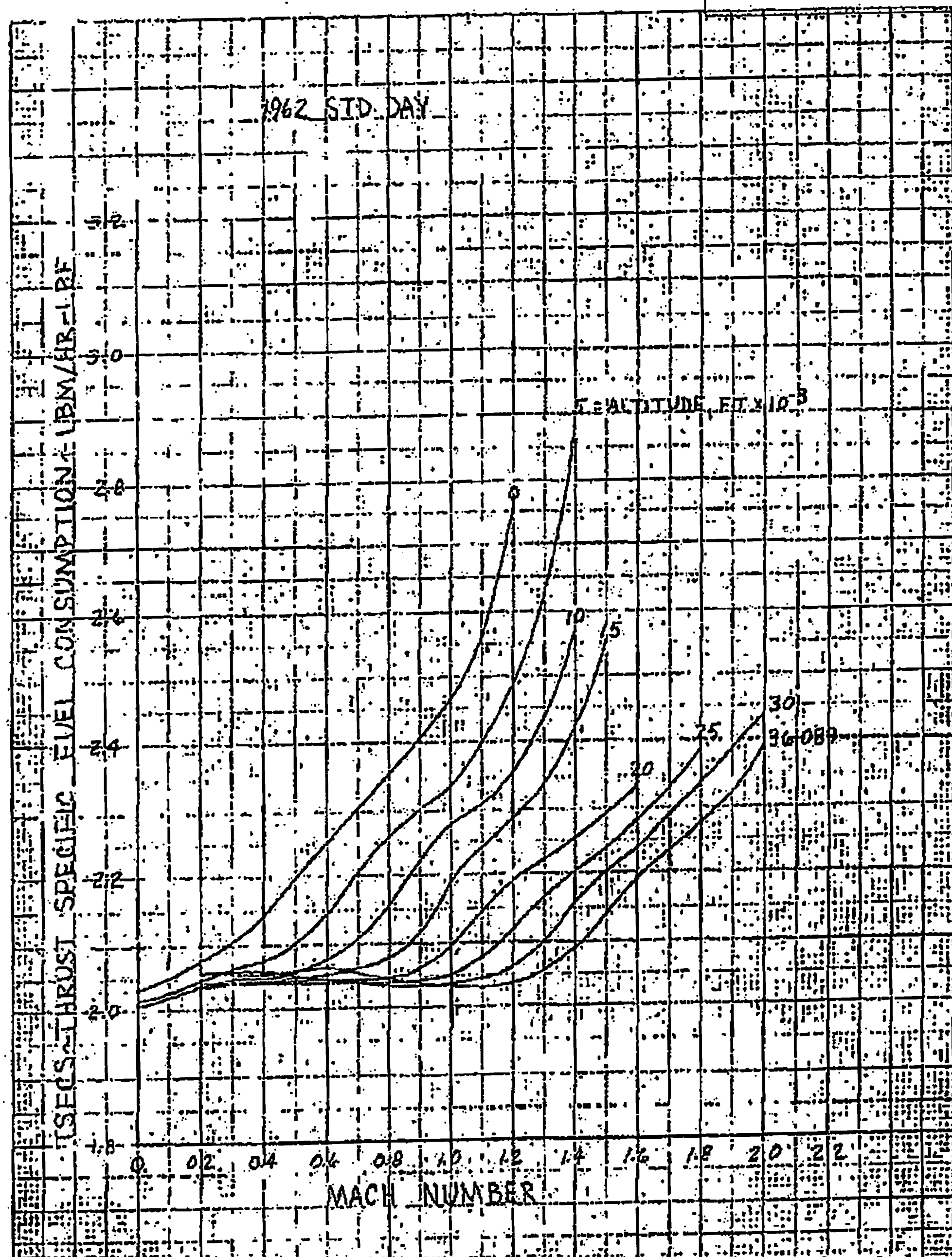
(U) High-pressure bleed air is extracted from the compressors for operating the environmental control system. The bleed air-flow rate is estimated to be 0.4 lbm/sec for the airplane, or 0.2 lbm/sec from each engine. The installed propulsion system performance data (each engine) accounts for 0.2 lbm/sec at all flight conditions and power settings.

(U) During ground operation the bleed flow is estimated to be 1.2 lbm/sec for the airplane. The installed propulsion system performance data during takeoff accounts for 0.6 lbm/sec from each engine.

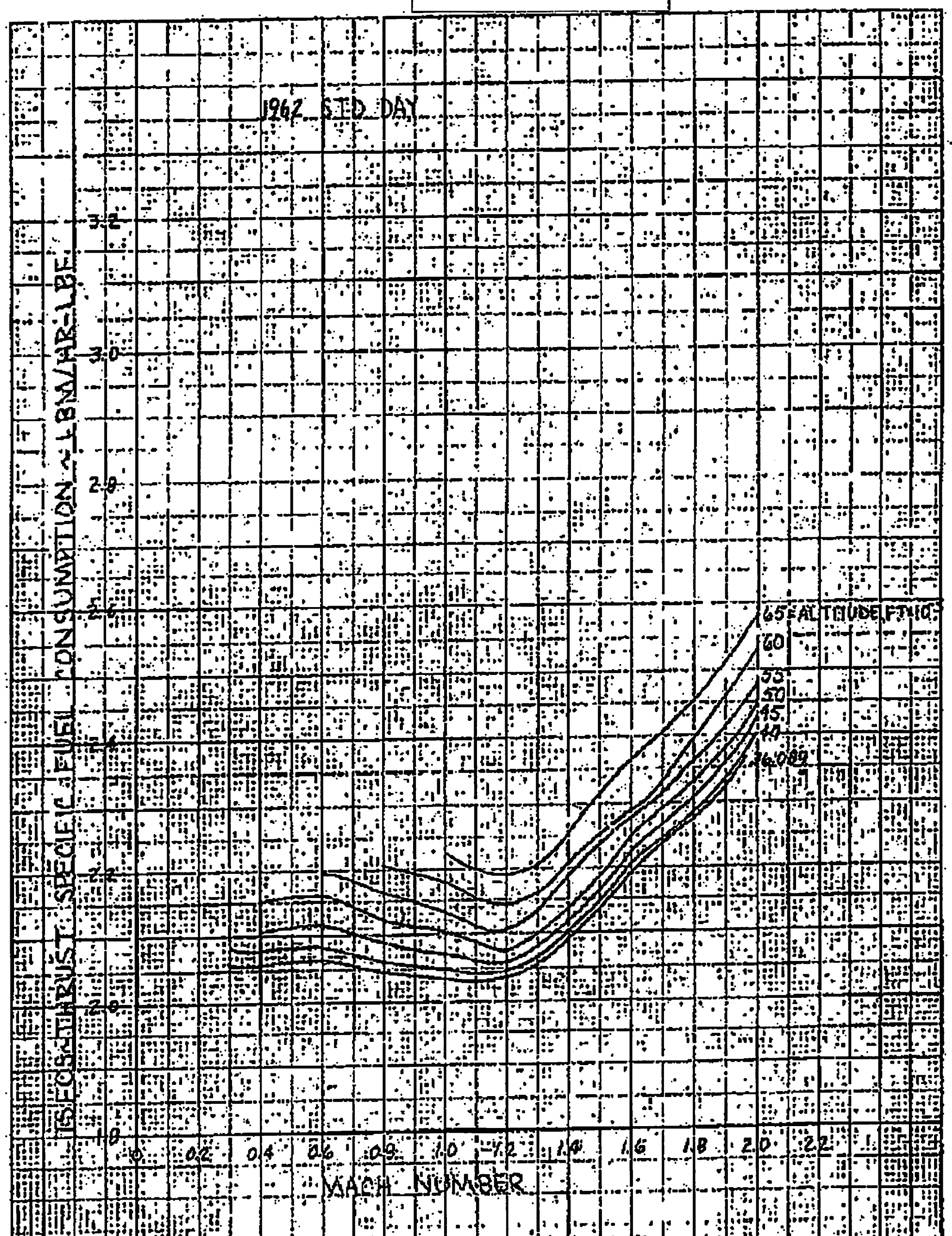


(U) Figure 5.6-1 Maximum Afterburning Thrust for the J101-GE-100 Installed in Configuration 501

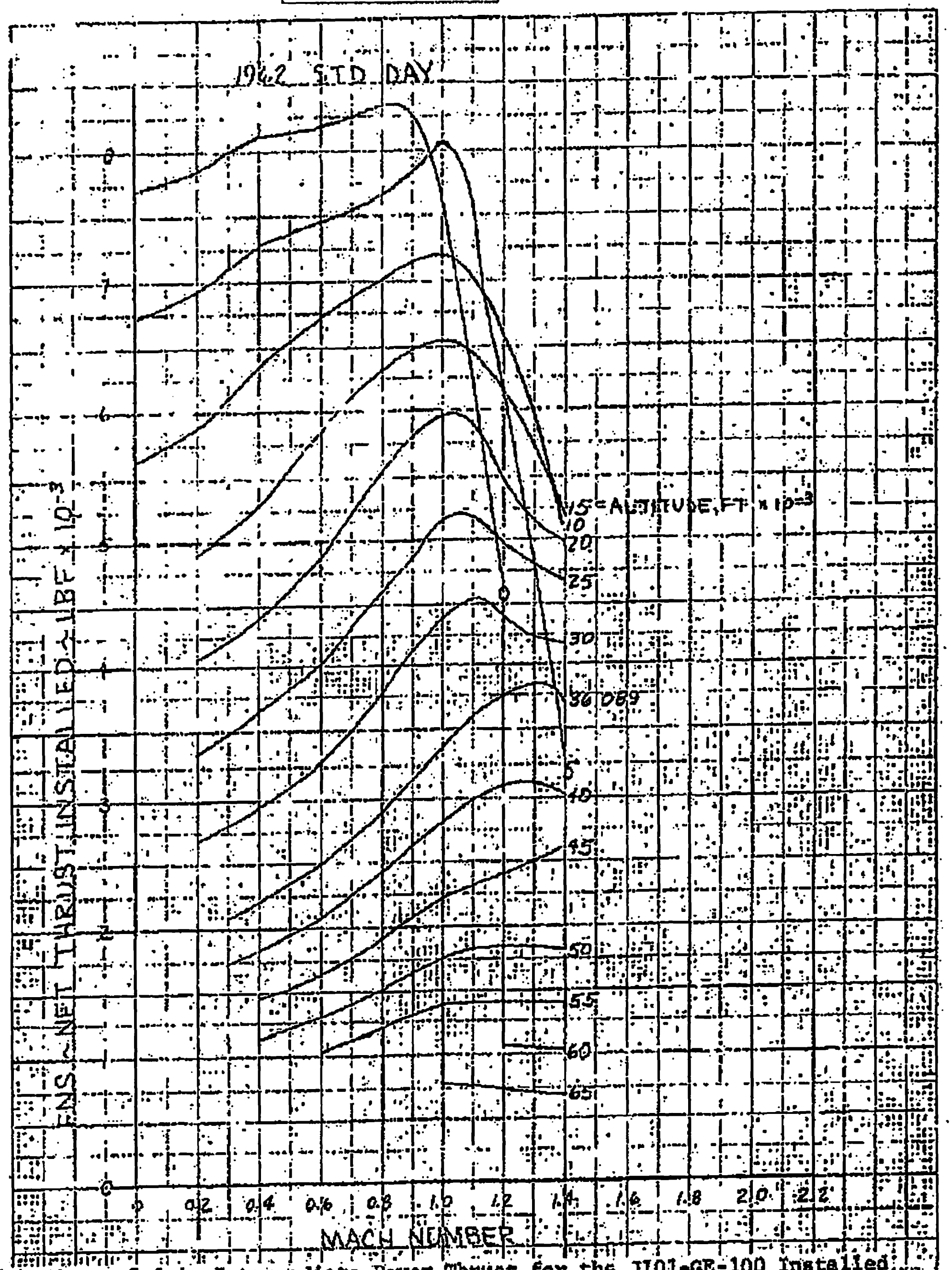
PGS 318-329



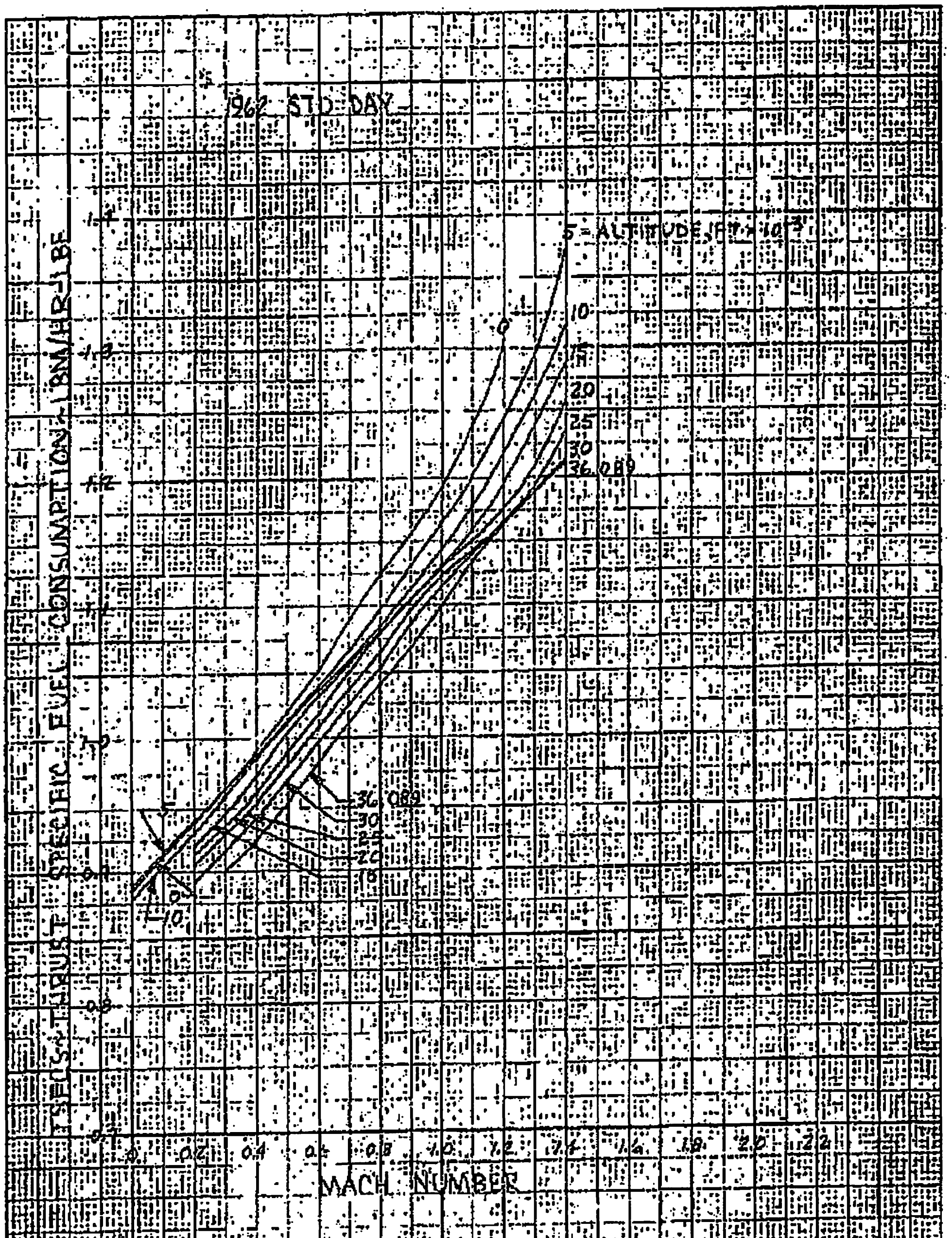
(U) Figure 5.6-2 Maximum Afterburning Specific Fuel Consumption for the J101-GE-100 Installed in Configuration 501, Sea Level to 36,089 feet



(U) Figure 5.6-3 Maximum Afterburning Specific Fuel Consumption for the J101-GE-100 Installed in Configuration 501, 36,089 to 65,000 feet

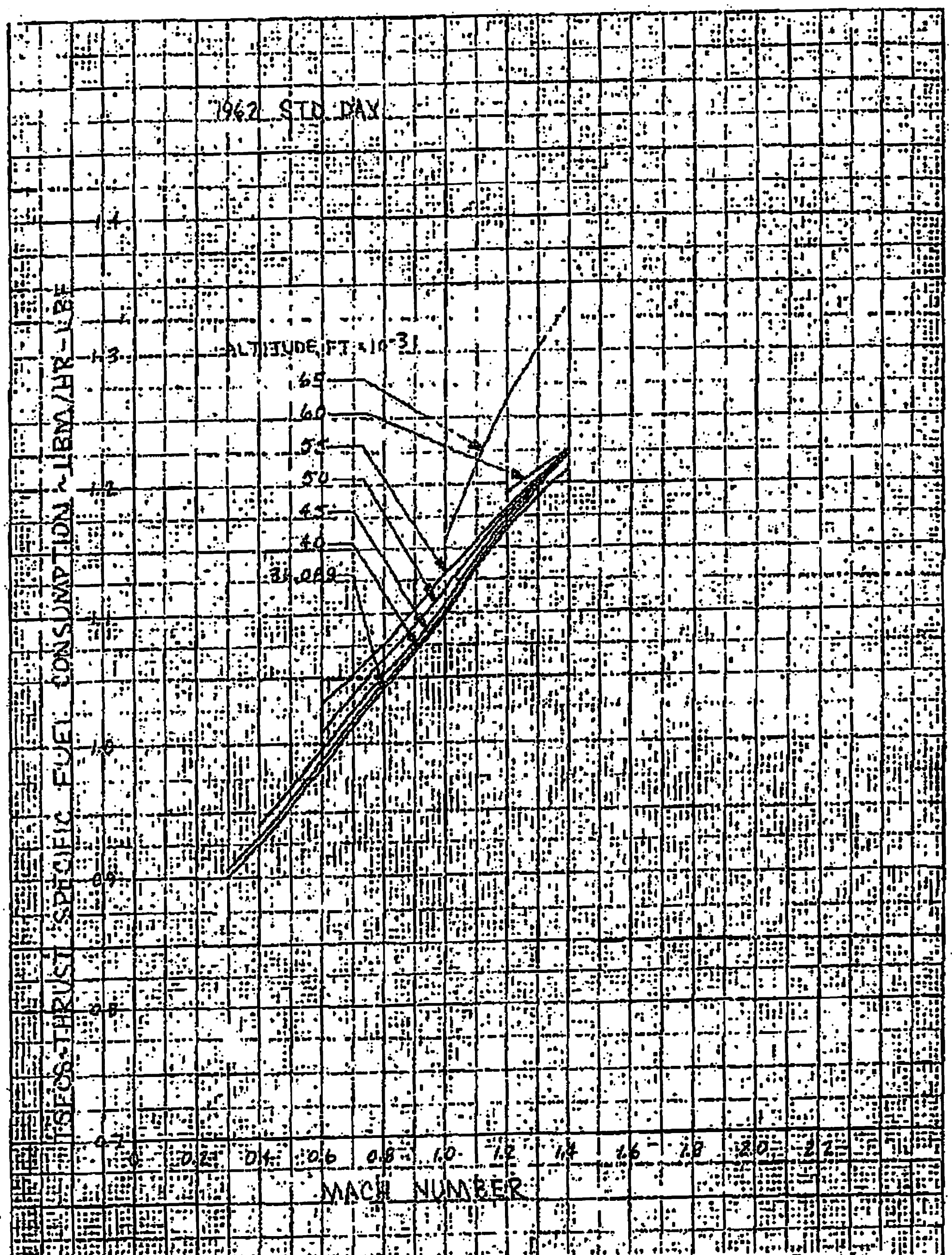


(U) Figure 5.6-4 Intermediate Power Thrust for the J101-GE-100 Installed in Configuration 501

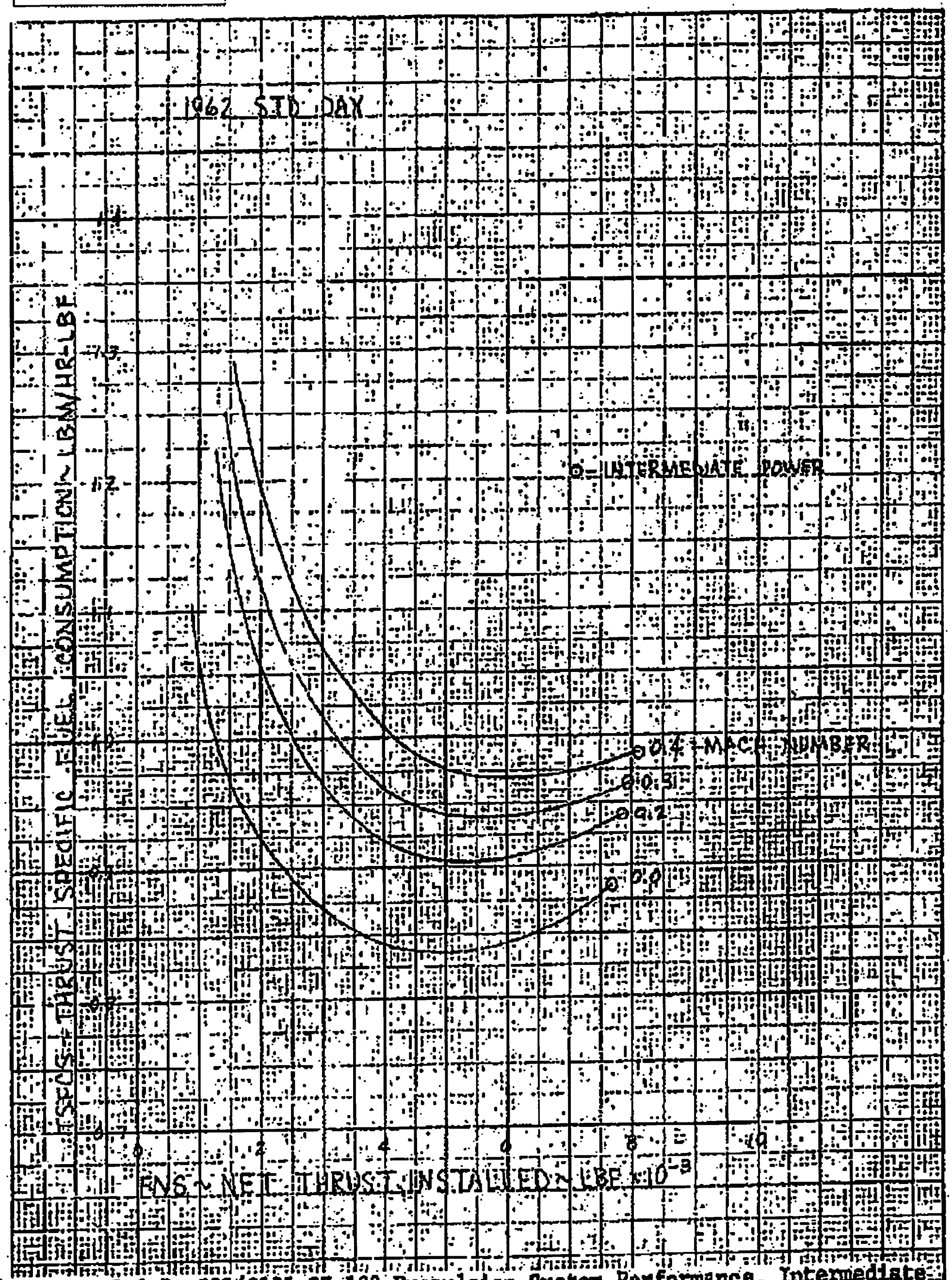


(U) Figure 5.6-5 Intermediate Power Specific Fuel Consumption for the J101-GE-100 Installed in Configuration 501, Sea Level to 36,089 feet

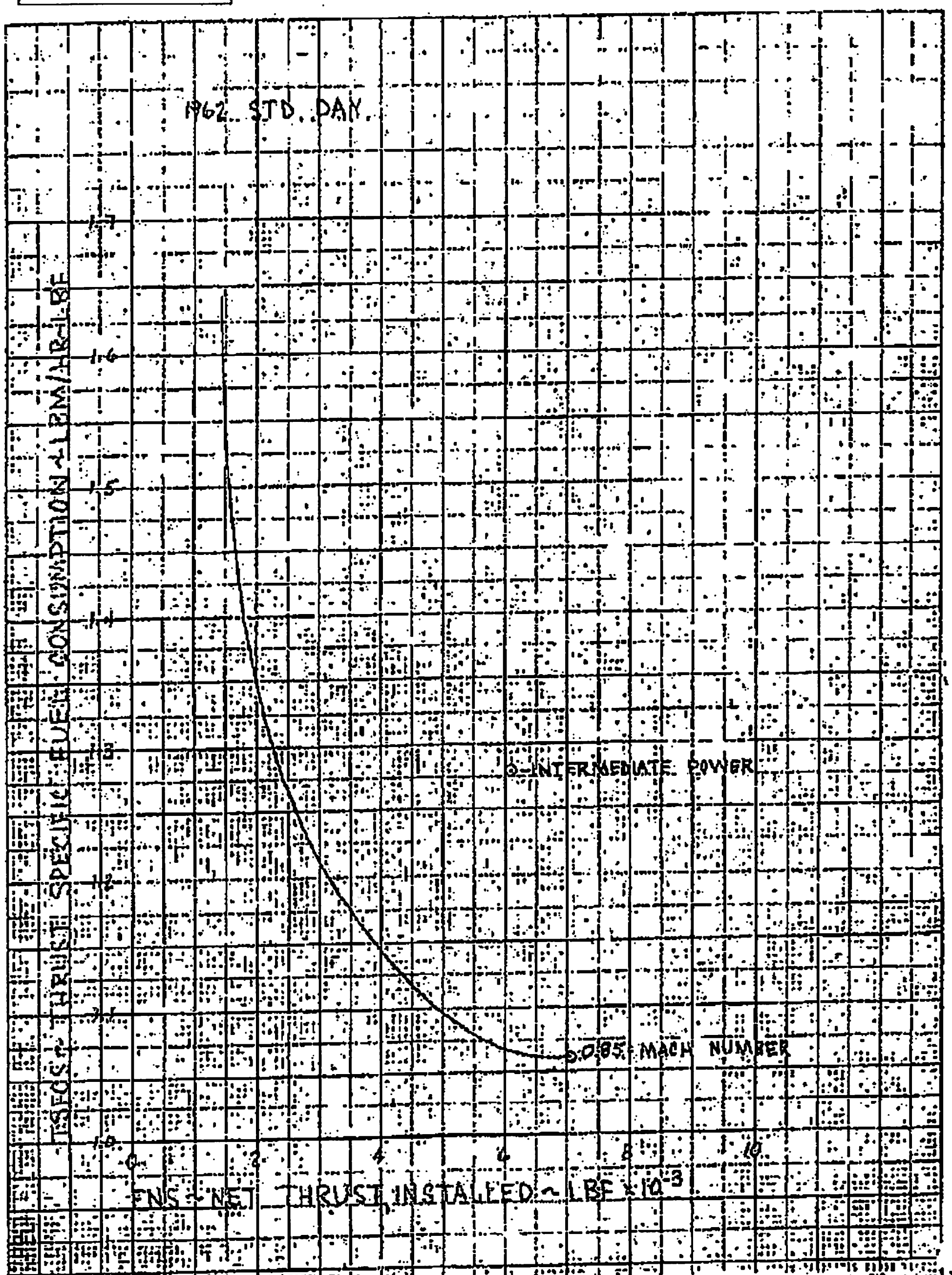
88th ABW/IP[
FOIA (b)(1)
~~E.O.13526 SEC.~~
3.3.(b)(4)
1.4. (a)(g)



(U) Figure 5.6-6 Intermediate Power Specific Fuel Consumption for the J101-GE-100 Installed in Configuration 501, 36,089 to 65,000 feet



(U) Figure 5.6-7 501/J101-GE-100 Propulsion System Performance, Intermediate and Reduced Power, Sea Level

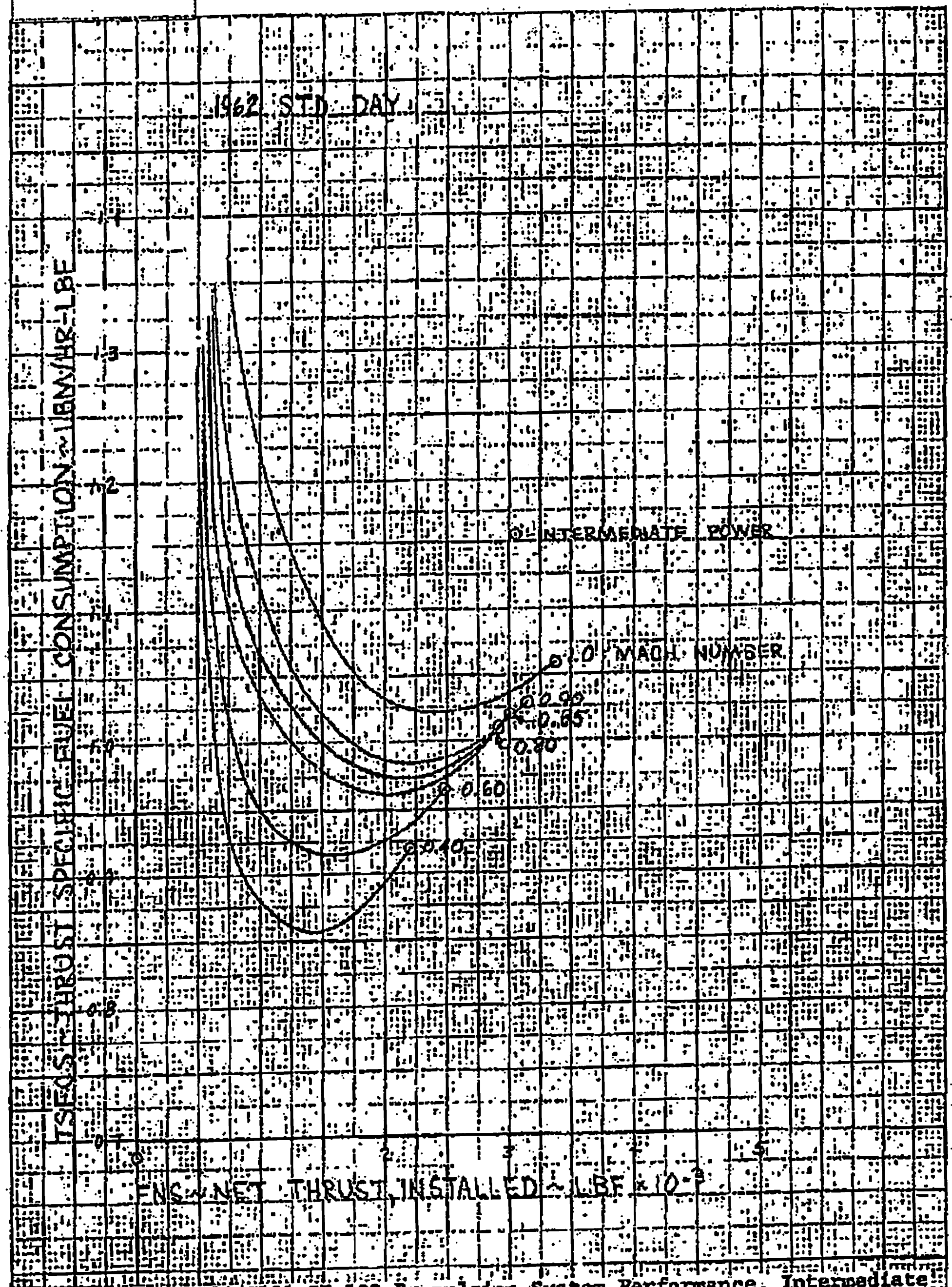


(U) Figure 5.6-8 501/J101-GE-100 Propulsion System Performance, Intermediate and Reduced Powers, 10,000 feet

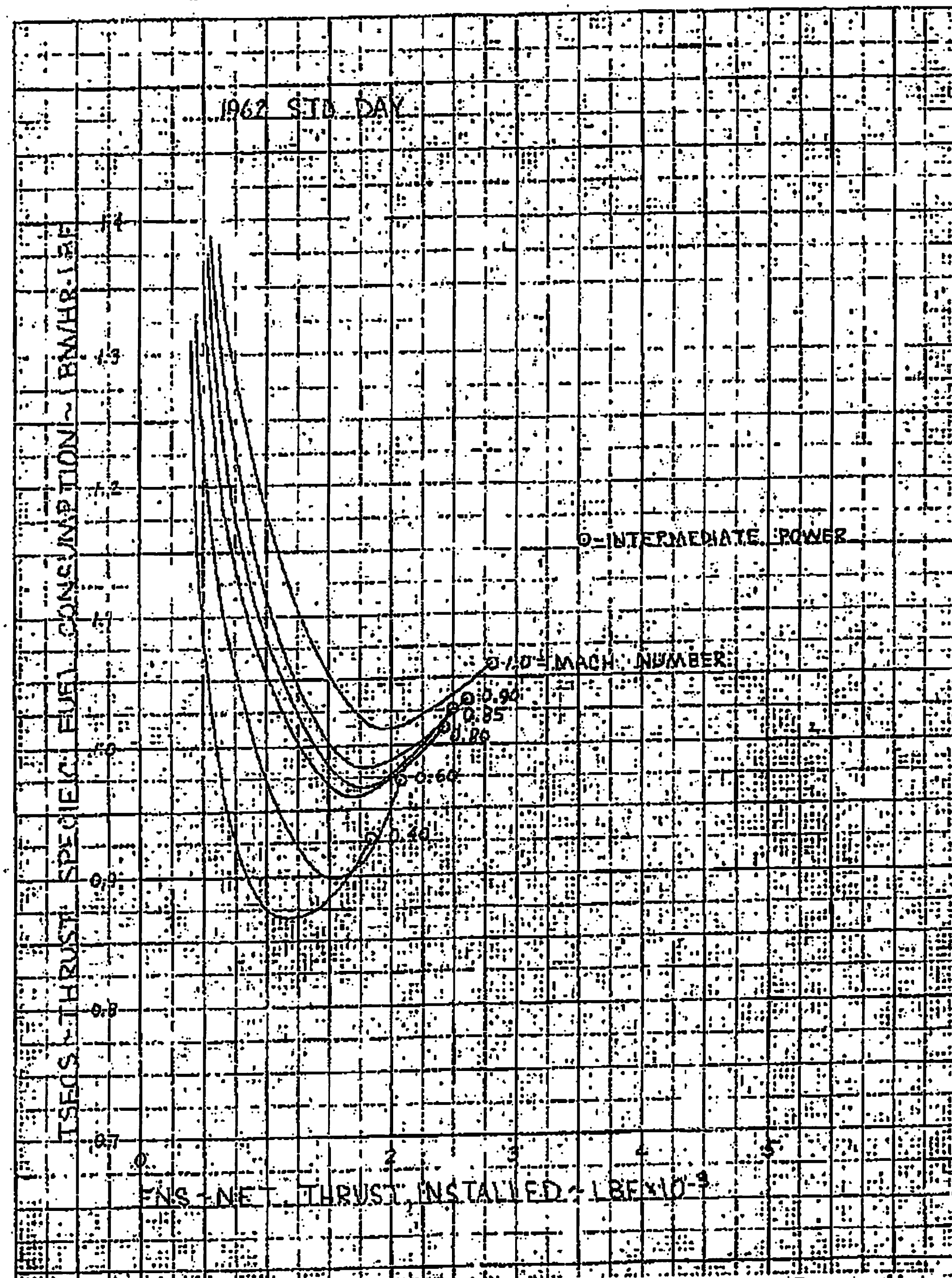
88th ABW/IPI
FOIA (b)(1)
E.O.13526 SEC.
3.3.(b)(4)
1.4. (a)(g)

PSCC-AV-71-005

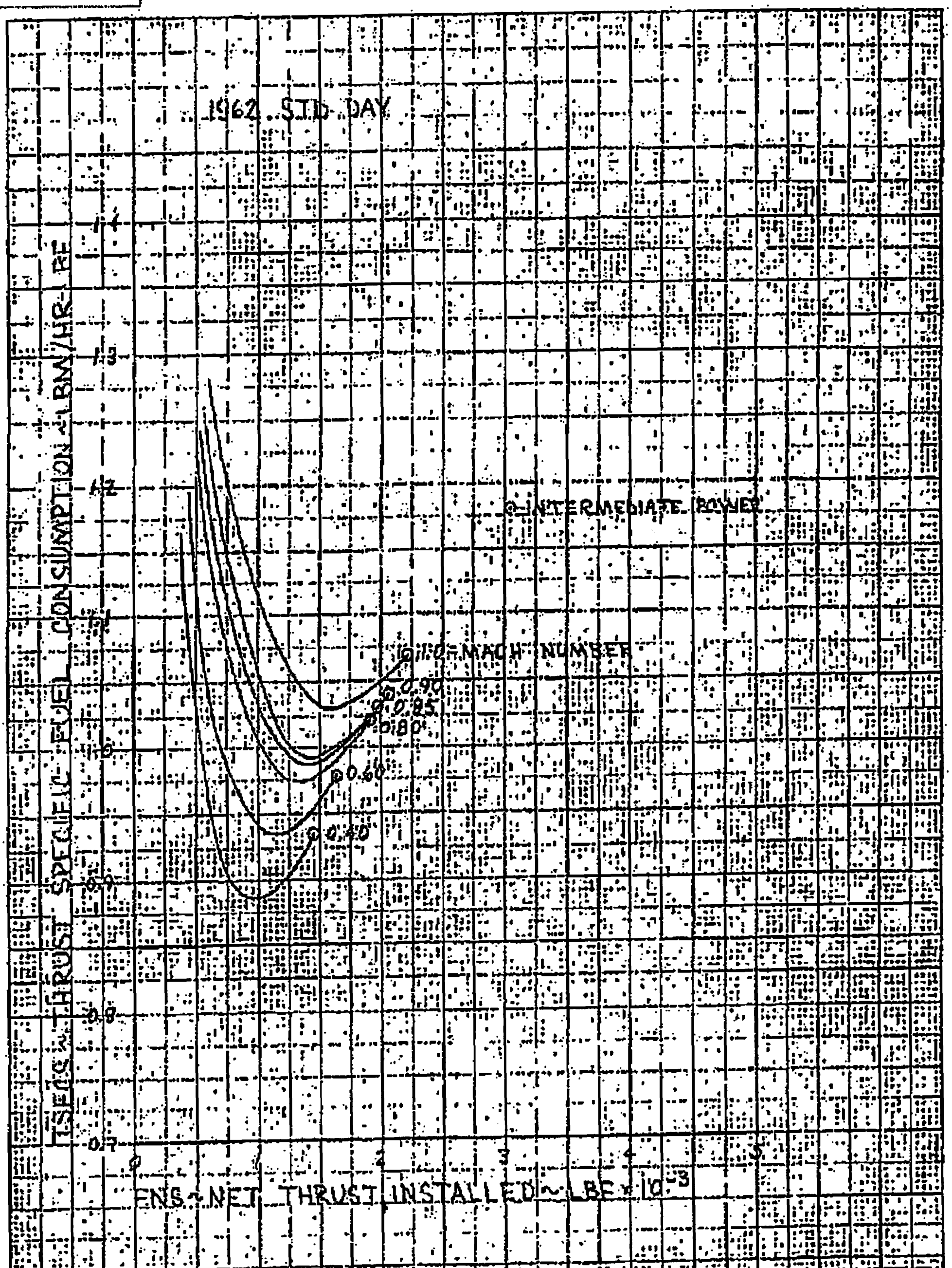
71 PA-2383-016 9-3-71



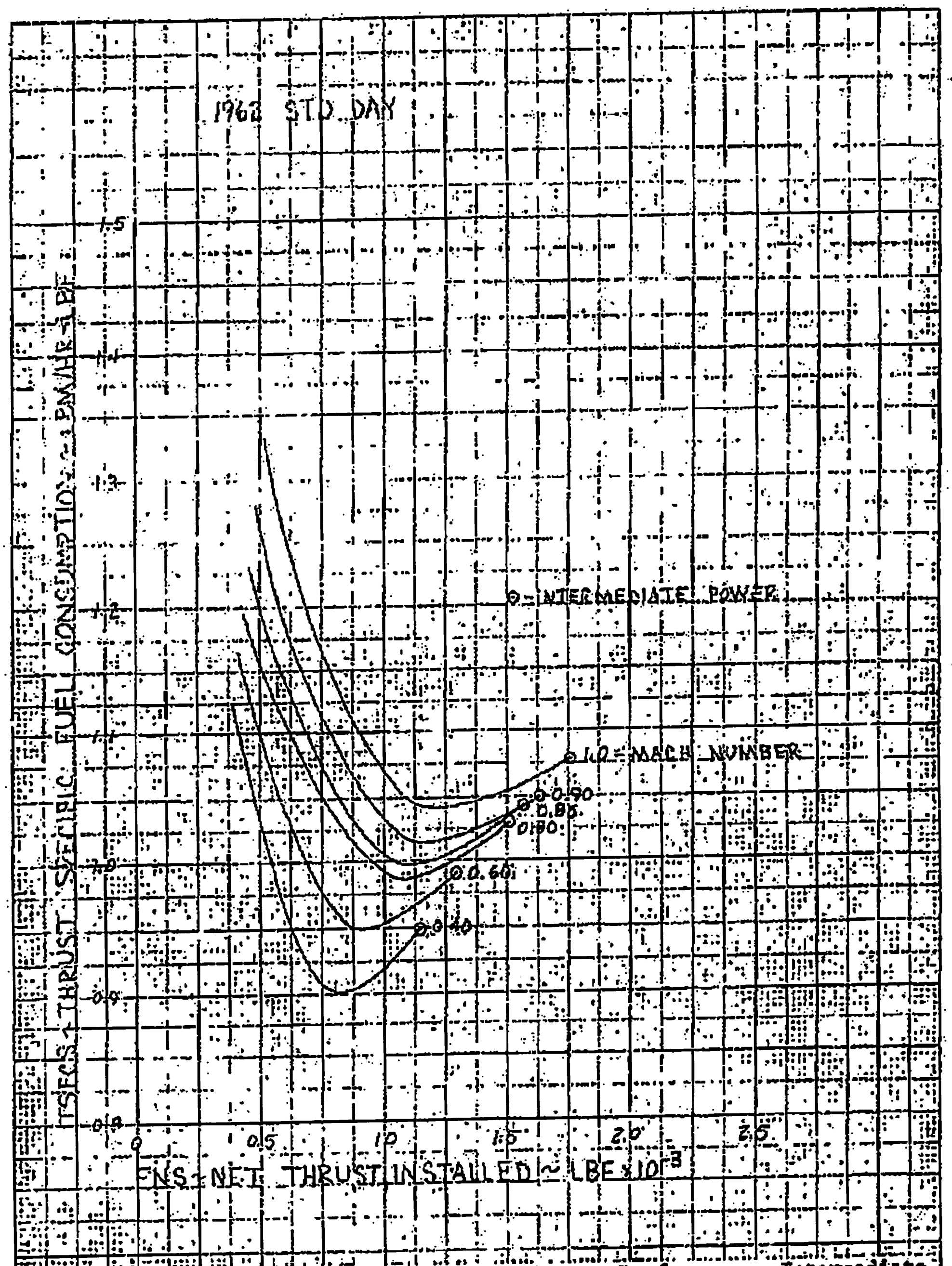
(U) Figure 5.6-9 501/J101-GE-100 Propulsion System Performance, Intermediate and Reduced Powers, 36,089 feet



(U) Figure 5.6-10 501/J101-GE-100 Propulsion System Performance, Intermediate and Reduced Powers, 40,000 feet



(U) Figure 5.6-11 501/J101-GE-100 Propulsion System Performance, Intermediate and Reduced Powers, 45,000 feet



(U) Figure 5.6-12 501/J101-GE-100 Propulsion System Performance, Intermediate and Reduced Powers, 50,000 feet

SECTION 6

0.4 TAPER RATIO WING ON 401B

6.1 VEHICLE DESIGN

~~(S)~~ The Concept 1 aircraft (the large single-engine 401B concept) was also designed with a contract-specified wing geometry: [wing loading of 60 psf, aspect ratio of 3.0, taper ratio of 0.4, thickness/chord ratio of 4 percent, fixed leading-edge sweep of 35 degrees, straight leading and trailing edges, and manually selectable single-hinge leading-edge high-lift devices. This wing differs from the selected wing used on the Concept 1, 2, and 3 designs in two respects: taper ratio of 0.4 versus 0.20, and squared rather than rounded wing tips.]

~~(S)~~ A version of the large single-engine airplane concept (401B) with the Statement of Work (S.O.W) wing planform is presented in the general arrangement drawing of Figure 6.1-1. In the drawing, an example aircraft is shown at a mission weight of 16,800 pounds, which was one of the data points used in generating the growth curves. The point-design mission weight of the airplane with the S.O.W. [wing was determined by the performance analysis to be 17,735 pounds. The final point-design arrangement is not presented since the changes in dimensions are very small and can be determined by applying the appropriate scale factors described in Section 3.]

(U) This configuration is the same as 401B externally except for the wing planform, wing thickness distribution, and horizontal tail size. Internal structure is slightly rearranged to accommodate the change in wing box structural geometry, but the subsystem arrangement remains essentially unchanged.

6.1.1 Design Rationale

~~(S)~~ The rationale for the S.O.W. wing installation is essentially identical to that of the basic 401B concept. [Primary differences involve design of the wing and horizontal tail. The wing is located longitudinally at the same

SECRET

WING

AREA	280 SQ FT
ASPECT RATIO	3.0
TAPER RATIO	0.4
SPAN	28 FT 1/8 IN
SWEEP - LEADING EDGE	34°
ROOT CHORD	163.616 IN
TIP CHORD	65.246 IN
M.A.C.	123.029 IN
AIRFOIL SECTION	6% AT BICONVEX
INCIDENCE	0°
DIHEDRAL	0°

MANEUVER FLAP

TYPE	PLAIN
TOTAL AREA	32.3 SQ FT
SPAN - PER SIDE	115.9 IN
ROOT CHORD	26.5 IN
TIP CHORD	19.9 IN
DEFLECTION	25°
HINGE LINE	
ROOT	18%
TIP	30%

FLAPS

TYPE	PLAIN
TOTAL AREA - INCLUDING FLAPERON	30.28 SQ FT
ROOT CHORD	26.5 IN
TIP CHORD	22.0 IN
FLAPERON	
TOTAL AREA	12.18 FT
SPAN - PER SIDE	68.0 IN
ROOT CHORD	22.0 IN
TIP CHORD	14.27 IN
DEFLECTION	-20°, -30°
FLAP DEFLECTION - MAX	30°
FLAP HINGE	60%

VERTICAL TAIL

AREA - TOTAL	44.20 SQ FT
ASPECT RATIO	1.3765
TAPER RATIO	0.4
SPAN	93.0 IN
SWEEP - LEADING EDGE	45°
ROOT CHORD	70.0 IN
TIP CHORD	28.0 IN
AIRFOIL SECTION	6% ROOT, 4% TIP - BICONVEX

RUDDER

AREA - TOTAL	10.53 SQ FT
SPAN	51.0 IN
ROOT CHORD	37.3 IN
TIP CHORD	7.63 IN
DEFLECTION	±30°

VENTRAL FINS

AREA - TOTAL	2.79 SQ FT
ASPECT RATIO	0.3733
TAPER RATIO	0.3951
SPAN	14.0 IN
SWEEP - LEADING EDGE	65°
ROOT CHORD	47.0 IN
TIP CHORD	28.0 IN
AIRFOIL SECTION	6% ROOT, 4% TIP - BICONVEX

HORIZONTAL TAIL (ALL MOVABLE)

AREA	
ASPECT RATIO	
TAPER RATIO	
SPAN - EXPOSED	
SWEEP - LEADING EDGE	
ROOT CHORD	
TIP CHORD	
M.A.C.	
INCIDENCE - NOMINAL	
AIRFOIL SECTION	6% AT BL 345,4
DIHEDRAL	
DEFLECTION	NOSE

POWER PLANT

PCW JTF 776-27 TURBOFAN ENGINE

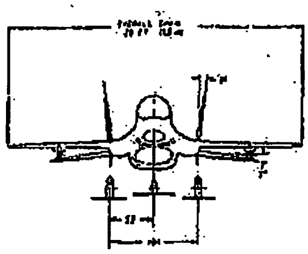
LANDING GEAR

MAIN GEAR TIRE	
NOSE GEAR TIRE	

TAIL LENGTHS

¼ WING TO ¼ VERT TAIL	
¼ WING TO ¼ HORIZ TAIL	

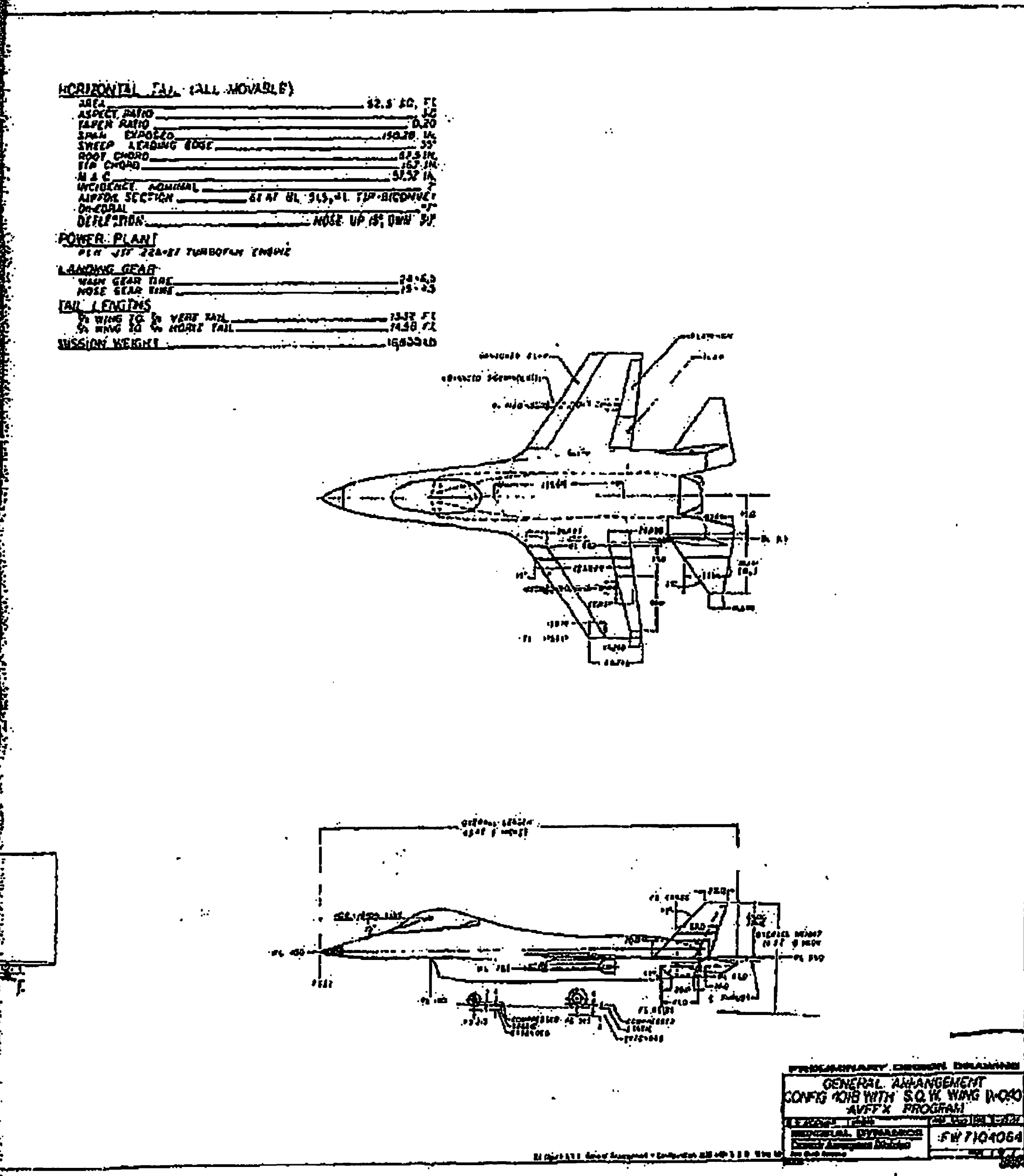
MISSION WEIGHT



SECRET

88th ABW/IPI
FOIA (b)(1)(3) / IDT
E.O 13526 SEC 3.3 (b)(4)
1.4 (a)(g)
EO 13526 SEC 3.3 (b)(4)
SEC 1.4 (a)(g)

SECRET



(S) Figure 6.1-1 General Arrangement Configuration 401B with S.O.W. Wing (U)

SECRET

2