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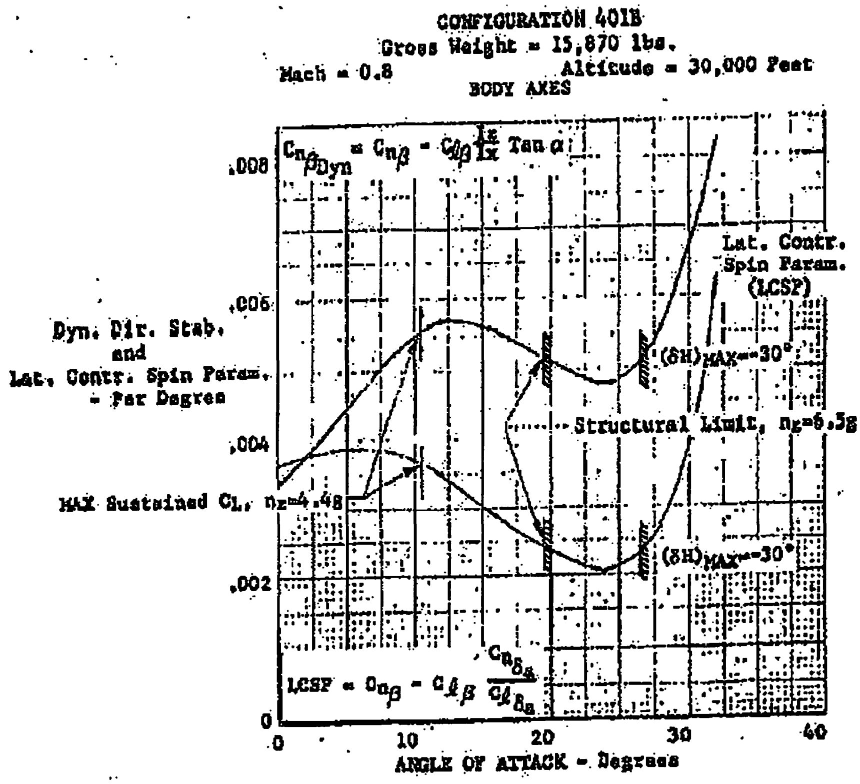

~~(S)~~ Figure 3.4-24 Dynamic Directional Stability and Lateral Control Spin Parameter (U)

3.5 STRUCTURES AND WEIGHTS

3.5.1 Structural Design Rationale

(U) Considerable emphasis has been given to the structural design during the development of the study configuration. One of the key features of the configuration is an expanded wing-root section, which provides the following effects: (1) a reduction of axial forces due to bending as a result of the deeper section; (2) the elimination of potential aileron reversal and other dynamic problems because of the stiffer wing; (3) a reduction of structural weight, and (4) an increase in fuel capacity.

(U) Other structural design features include the following:

1. Relatively deep fuselage rings that provide load paths for the wing carry-through moment and permit control system routing through the frames. Spar caps are attached directly to these frames for continuity of the basic wing load paths.

2. Main landing gear stowage forward of the basic wing box that permits minimum interruption of the basic wing load paths.

3. A relatively deep mid-fuselage that provides for minimum longeron area requirements.

4. A twin-vertical-tail/aft-fuselage-extension configuration that minimizes engine heating and acoustical problems.

5. A relatively low-aspect-ratio wing that results in a reduced wing bending moment because of the shorter span.

6. A relatively low-taper-ratio wing that results in a long root chord which distributes the wing root forces to several ring bulkheads to provide a multi-load path structure.

7. Engine removal from the aft end of the airplane that permits a fixed structure, thereby maintaining continuity of load paths.

8. A 6-percent thickness-to-chord ratio at the roots of the vertical and horizontal tails and a 4-percent ratio at the tips that provide better stiffness characteristics than a constant thickness-to-chord ratio.

(U) These features have evolved through many trade studies and illustrate to some extent the impact of structural design and analysis on the study configurations.

3.5.2 Weight and Balance

(U) The weights for Configuration 401B were calculated through the use of analytical-statistical methods developed over several years under corporate-sponsored Independent Research and Development (IRAD) programs. These methods are documented in Convair Aerospace Division reports ERR-FW-242, "Aircraft Structural Weight Estimating Methods" (Reference 16), and ERR-FW-613, "Aircraft Propulsion and Fixed Equipment Weight Estimating Methods" (Reference 17). These reports are on file at ASD for reference purposes. The detailed weight analyses are not presented as a part of this technical report because the detailed weight calculations as defined in the ERR-FW-242 and ERR-FW-613 reports are quite voluminous in nature. However, these calculations are available for review.

~~(S)~~ Three gross weights were selected for the growth study on Configuration 401B. The points selected for study and the various gross-weight conditions (in pounds) for each point are as follows:

SRASM TOGW	(80% Fuel) Struct DGW	LRASM Overload GW	Ferry Mission Overload GW
15600	14920	20438	25800
16800	15960	21638	27000
18000	17000	23838	28200

~~(S)~~ Input data for the weight equations were derived from the scaling data presented in Section 3.1 together with layouts as required to develop specific area and dimensional data. Considerable emphasis was given to the definition of weighing parameters to assure the validity of the resulting growth curve. A weight summary for the three selected airplanes is presented in Table 3.5-1. It should be noted

~~(S)~~ Table 3.5-1 WEIGHT SUMMARY: CONFIGURATION 401B GROWTH STUDY (pounds) (U)

Item	Airplane Size (Gross Weight)		
	15,600	16,800	18,000
Structure	(5133)	(5426)	(5744)
Wing	1443	1576	1716
Fuselage	2485	2572	2666
Horizontal Tail	318	346	382
Vertical Tail	292	316	344
Landing Gear	595	616	636
Propulsion System	(3459)	(3530)	(3603)
Engine (F100-PW-100)	2737	2737	2737
Air Induction	296	322	349
Fuel System	377	421	467
Engine Controls	21	22	22
Starting System	28	28	28
Systems and Equipment	(2699)	(2751)	(2804)
Surface Controls	566	593	621
Landing Gear Controls	112	115	118
Instruments	94	94	94
Hydraulics and Pneumatics	271	286	302
Electrical	363	370	376
Avionics	460	460	460
Furnishings	238	238	238
Air Conditioning	142	142	142
Armament	453	453	453
Weight Empty	11,291	11,707	12,151
Useful Load	(395)	(400)	(405)
Crew	200	200	200
Unusable Fuel	18	23	28
Engine Oil	17	17	17
Missile Racks and Pylons	124	124	124
Miscellaneous	36	36	36
Basic Operating Weight	11,686	12,107	12,556
Payload	(633)	(633)	(633)
Ammo (500 rounds)	285	285	285
Missiles (2)	348	348	348
Zero Fuel Weight	12,319	12,740	13,189
Fuel	3281	4060	4811
Gross Weight	15,600	16,800	18,000

that the fixed-inlet structure has been coded as air-induction weight under Propulsion System. Since this structure is an integral part of the fuselage, it performs the dual function of resisting inlet pressure loads together with resisting the basic body loads. A plot of weight variation versus mission design weight is shown in Figure 3.5-1. The center-of-gravity and inertia properties are summarized below for the 16,800-pound-gross-weight SRASM configuration.

Properties	Basic Operating Weight	Zero Fuel Weight	Gross Weight
Weight (lb)	12,107	12,740	16,800
Horiz. CG (% MAC)	23.9	23.2	20.5
I_{xx}	4932	5702	6727
I_{yy}	30,130	30,515	31,886
I_{zz}	32,988	34,058	36,228

~~(S)~~ The maximum overload condition is defined by the ferry mission requirements. A weight summary for the LRASM and the ferry mission for the 16,800-pound-design-gross-weight configuration is shown in Table 3.5-2. A center of gravity summary for these conditions is as follows:

Item	LRASM Weight (lb)	LRASM C.G. (% MAC)	Ferry Mission Weight (lb)	Ferry Mission C.G. (% MAC)
Basic Operating Weight	12,955	21.5	13,797	21.5
Zero Fuel Weight	13,588	20.9	14,082	20.5
Gross Weight	21,638	19.9	27,000	20.7

When sized to meet LRASM requirements, the design gross weight of Configuration 401B is 17,115 pounds. There is no significant center-of-gravity difference between the 16,800-pound configuration and the 17,115-pound configuration. A weight summary for this configuration is given in Table 3.5-3.

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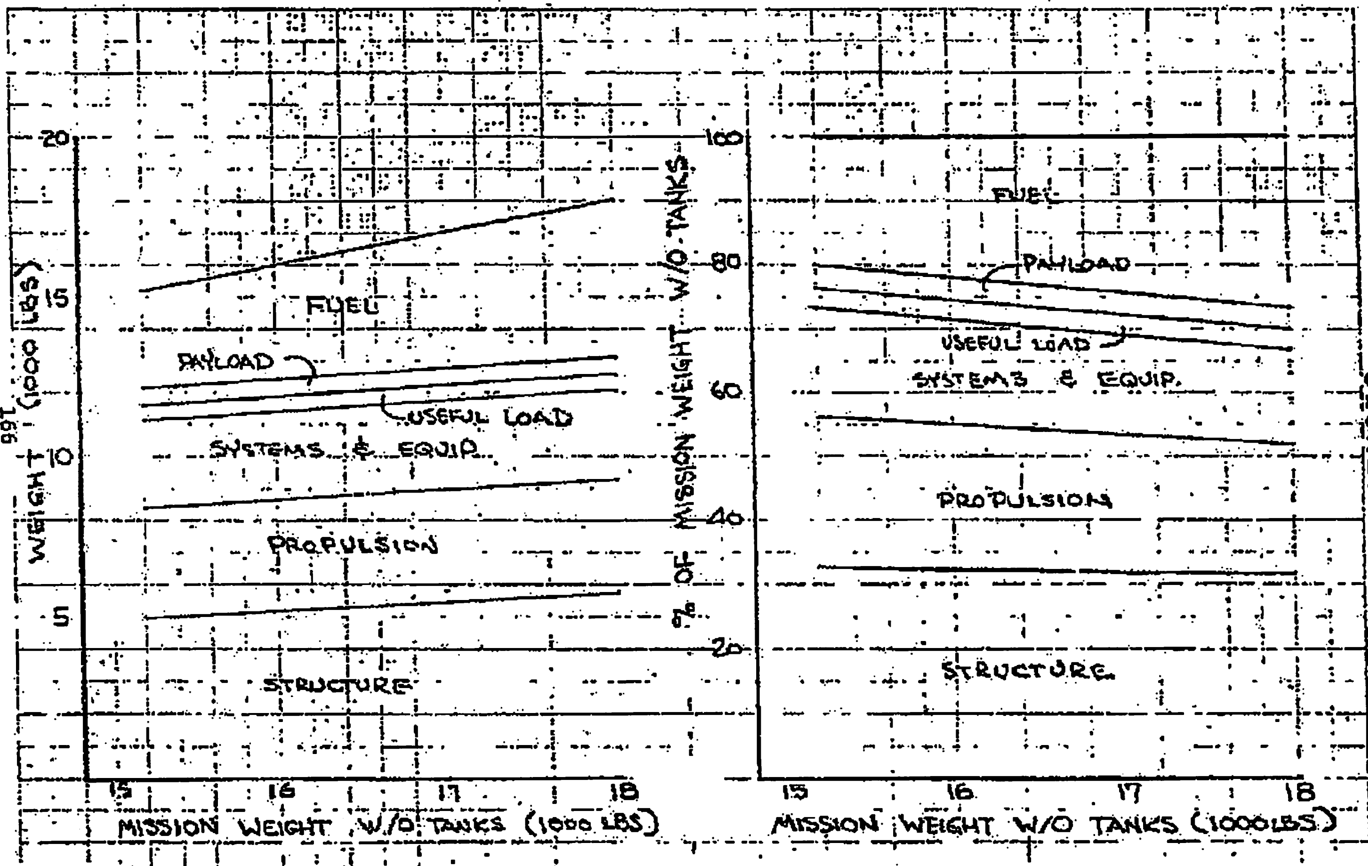

(S) Figure 3.5-1 Weight Variation with Aircraft Size: Configuration 401B (U)

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~~(S)~~ Table 3.5-2 WEIGHT SUMMARY:
CONFIGURATION 401B LRASM AND FERRY MISSION (U)
(pounds)

16,800-lb. AIRPLANE

Item	LRASM Weight	Ferry Mission Weight
Weight Empty	11,707	11,707
Useful Load	(1,248)	(2,090)
Crew	200	200
Unusable Fuel-Internal	23	23
Engine Oil	17	17
Missile Racks & Pylons	124	-
Miscellaneous	36	36
(2) 300-Gal. Tanks	848	-
(1) 150-Gal. Tank	-	308
(2) 600-Gal. Tanks	-	1,506
Basic Operating Weight	12,955	13,797
Payload	(633)	(285)
Ammo (500 rounds)	285	285
(2) AIM 9-X	348	-
Zero Fuel Weight	13,588	14,082
Fuel	(8,050)	(12,918)
Internal	4,060	4,060
External		
(2) 300-Gal. Tanks	3,990	-
(1) 150-Gal. Tank	-	1,016
(2) 600-Gal. Tanks	-	7,842
Gross Weight	21,638	27,000

~~(S)~~ Table 3.5-3 WEIGHT SUMMARY: CONFIGURATION 401B SIZED TO MEET LRASM REQUIREMENTS (U)
(pounds)

Item	Weight
Structure	(5510)
Wing	1612
Fuselage	2600
Horizontal Tail	355
Vertical Tail	322
Landing Gear	621
Propulsion System	(3548)
Engine (F-100-PW-100)	2737
Air Induction	328
Fuel System	433
Engine Controls	22
Starting System	28
Systems and Equipment	(2766)
Surface Controls	601
Landing Gear Controls	116
Instruments	94
Hydraulics and Pneumatics	290
Electrical	372
Avionics	460
Furnishings	238
Air Conditioning System	142
Armament	453
Weight Empty	11,824
Useful Load	(401)
Crew	200
Unuseable Fuel	24
Engine Oil	17
Missile Racks and Pylons	124
Miscellaneous	36
Basic Operating Weight	12,225
Payload	(633)
Ammo (500 rounds)	285
Missiles (2)	348
Zero Fuel Weight	12,858
Fuel	4,257
Gross Weight	17,115

3.6 PROPULSION (401B/F100-PW-100)

(U) The engine installed in Configuration 401B is essentially the F100-PW-100. Certain accessories and attachments unique to the F-15 airplane installation are deleted. The Pratt & Whitney Aircraft designation for this study derivative engine is JTF22A-27 (Reference 18). In this report the engine will be referred to as the F100-PW-100. Engine performance data are furnished by P&WA in their customer computer deck CCD 1025 (Reference 19). A more recent deck was received on 1 April 1971 from P&WA. However, time did not permit revision of the installed-propulsion-system performance data package. The fuel control schedule selected for the engine performance data presented in this report is that which provides near-optimum engine thrust during afterburning (Reference 20), but exhibits an undesirable airflow schedule at some flight conditions. A brief investigation showed that propulsion performance data from the new deck for the F100-PW-100 design airflow are different from those contained in this report only at altitudes above 50,000 feet (maximum thrust reduction of 25% occurs at low supersonic Mach numbers). Performance below intermediate power is not affected.

(U) The engine is located in the aircraft aft fuselage, with primary air flow supplied by a single open-nose inlet located under the forward fuselage. A full description of the inlet is given in Subsection 3.6.2.

(U) The exhaust nozzle is the F100 engine balanced-beam nozzle (BBN), which is exposed aft of the customer connect. The nozzle exhaust area varies slightly during non-afterburning operation and is fully modulating from minimum to maximum afterburning. At Mach number below about 1.1 the nozzle area ratio is approximately 1.3. At about Mach 1.1, the nozzle exit area is shifted open to give an increase area ratio (approximately 1.6) at higher Mach numbers. This increased area ratio is referred to as "high gear". A more detailed description of, and data for, the nozzle is given in Subsection 3.6.3.

(U) A small amount of ventilation air flows through the nacelle. The drag for nacelle ventilation is not included in the engine performance data but is accounted for in the airplane drag (see Subsection 3.6.4)

(U) High-pressure air is bled from the high-pressure-compressor discharge port provided on the engine for operation of the environmental control system. Shaft power is extracted from the high-pressure-compressor rotor to generate electrical and hydraulic power for the airplane.

3.6.1 Propulsion System Performance

(U) The installed thrust specific fuel consumption (TSFCS) and propulsion net thrust (F_{NS}) of the F100-PW-100 are plotted in Figures 3.6-1 through 3.6-14. The data shown comprise a complete package needed for airplane energy-maneuverability analysis. The installed net thrust presented, F_{NS}, accounts for all drag changes that occur with power setting changes. The installed net thrust is defined as follows:

$$F_{NS} = F_N - F_{sp} - F_{noz}$$

where:

- F_{NS} is the installed net thrust of the propulsion system for aircraft performance analysis.
- F_N is the CCD 1025-1.1 computer program net thrust which accounts for (1) inlet pressure recovery (see Subsection 3.6.2), (2) shaft-power extraction and high-pressure-compressor airbleed (see Subsection 3.6.5), and (3) exhaust nozzle internal performance (contained in P&WA CCD 1025-0.1).
- F_{sp} is the inlet spillage drag, which accounts for the inlet drag when capture area ratios are other than 1.0 (see Subsection 3.6.2).
- F_{noz} accounts for drag changes associated with power setting when the nozzle is at other than the maximum open position (see Subsection 3.6.3).

Therefore, airplane drag levels used in conjunction with the installed thrust, F_{NS}, are for the inlet operating at a capture area ratio of 1.0 and the engine exhaust nozzle in the maximum open ("high gear") position.

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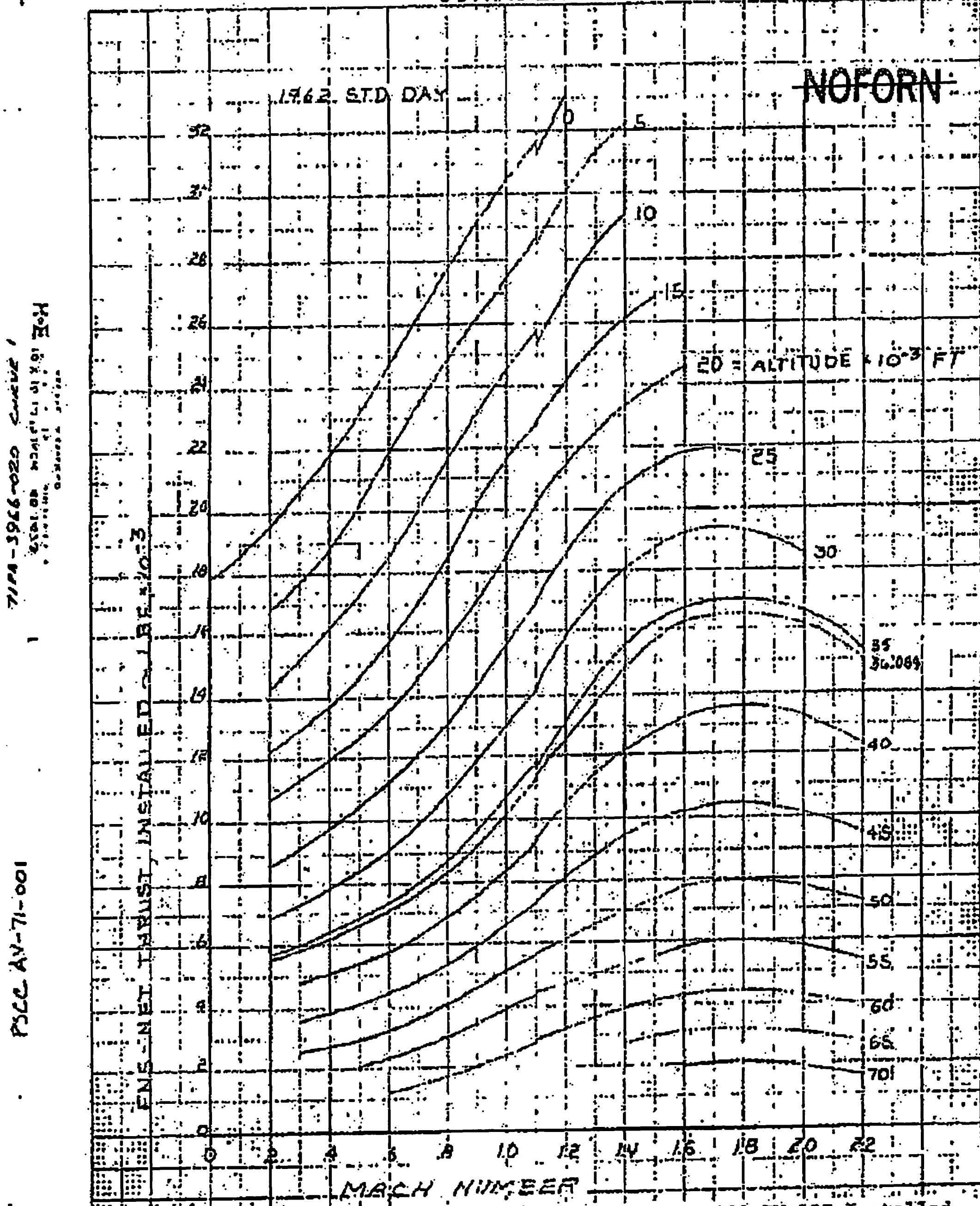

~~(C)~~ Figure 3.6-1 Maximum Afterburning Thrust for the F100-PW-100 Installed in Configuration 401B (U)

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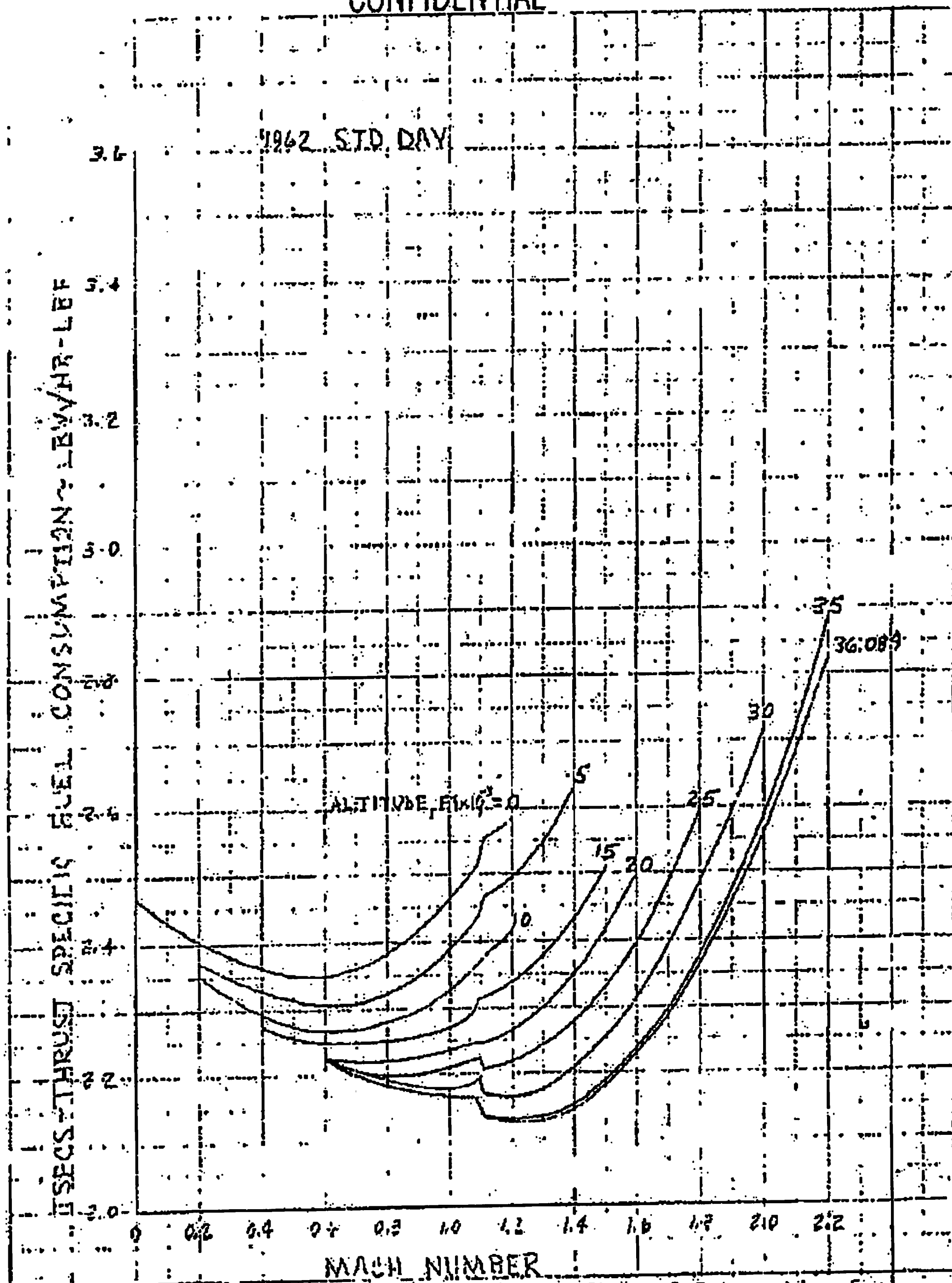
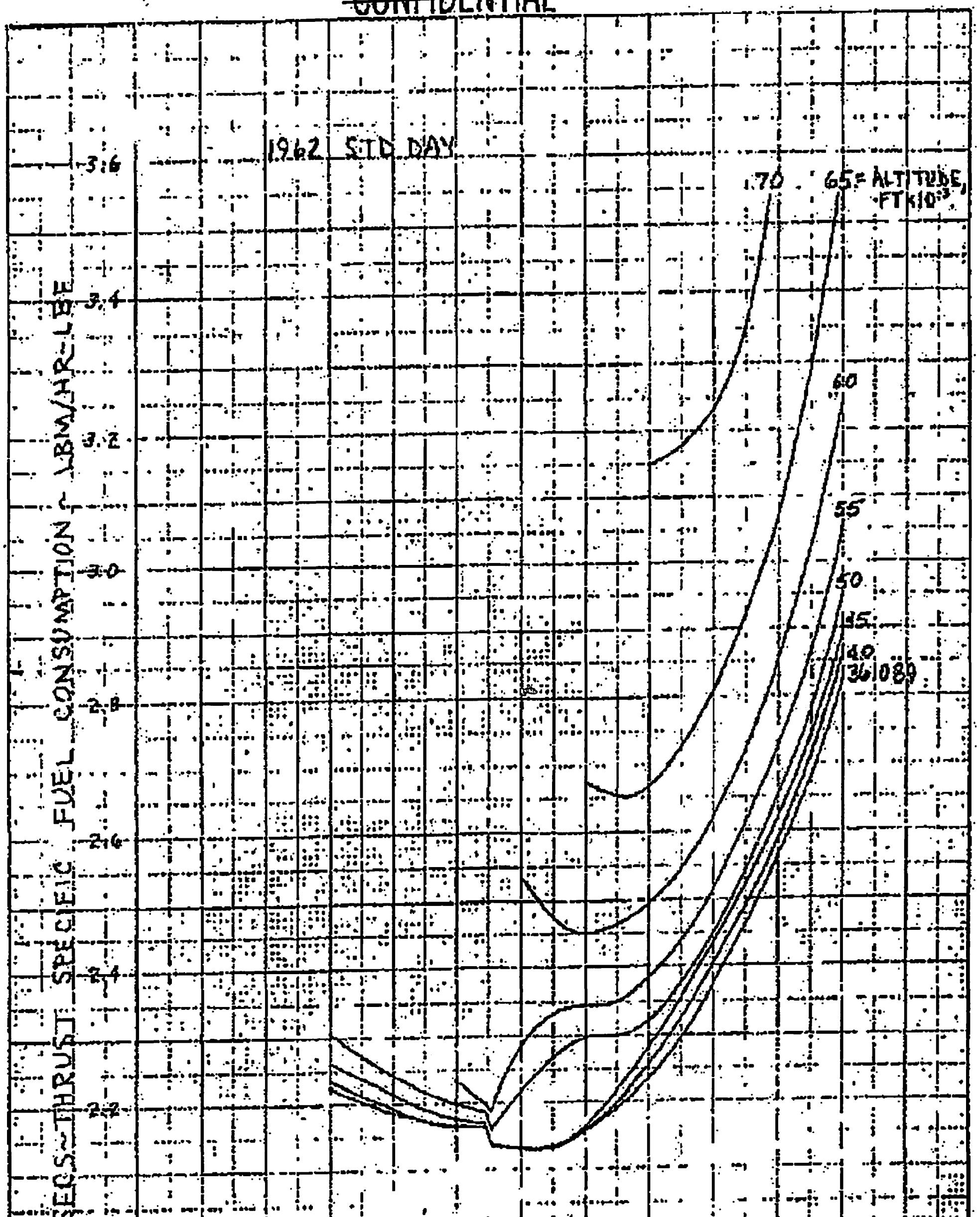


~~(C)~~ Figure 3.6-2 Maximum Afterburning Specific Fuel Consumption for the F100-PW-100 Installed in Configuration 401B, Sea Level to 36,089 feet (U)



~~(C)~~ Figure 3.6-3 Maximum Afterburning Specific Fuel Consumption for the F100-PW-100 Installed in Configuration 401B, 36,089 to 70,000 feet (U)

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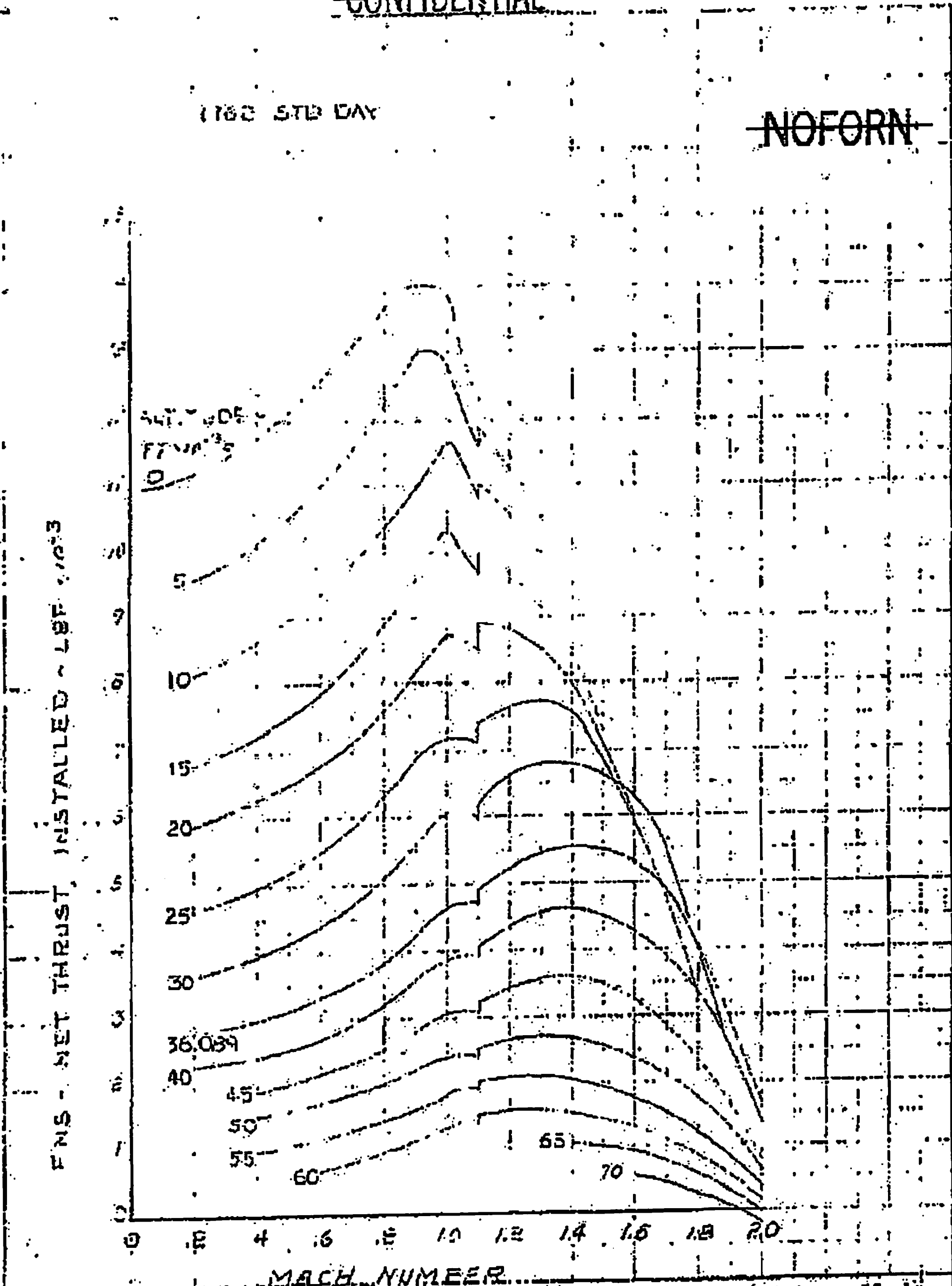
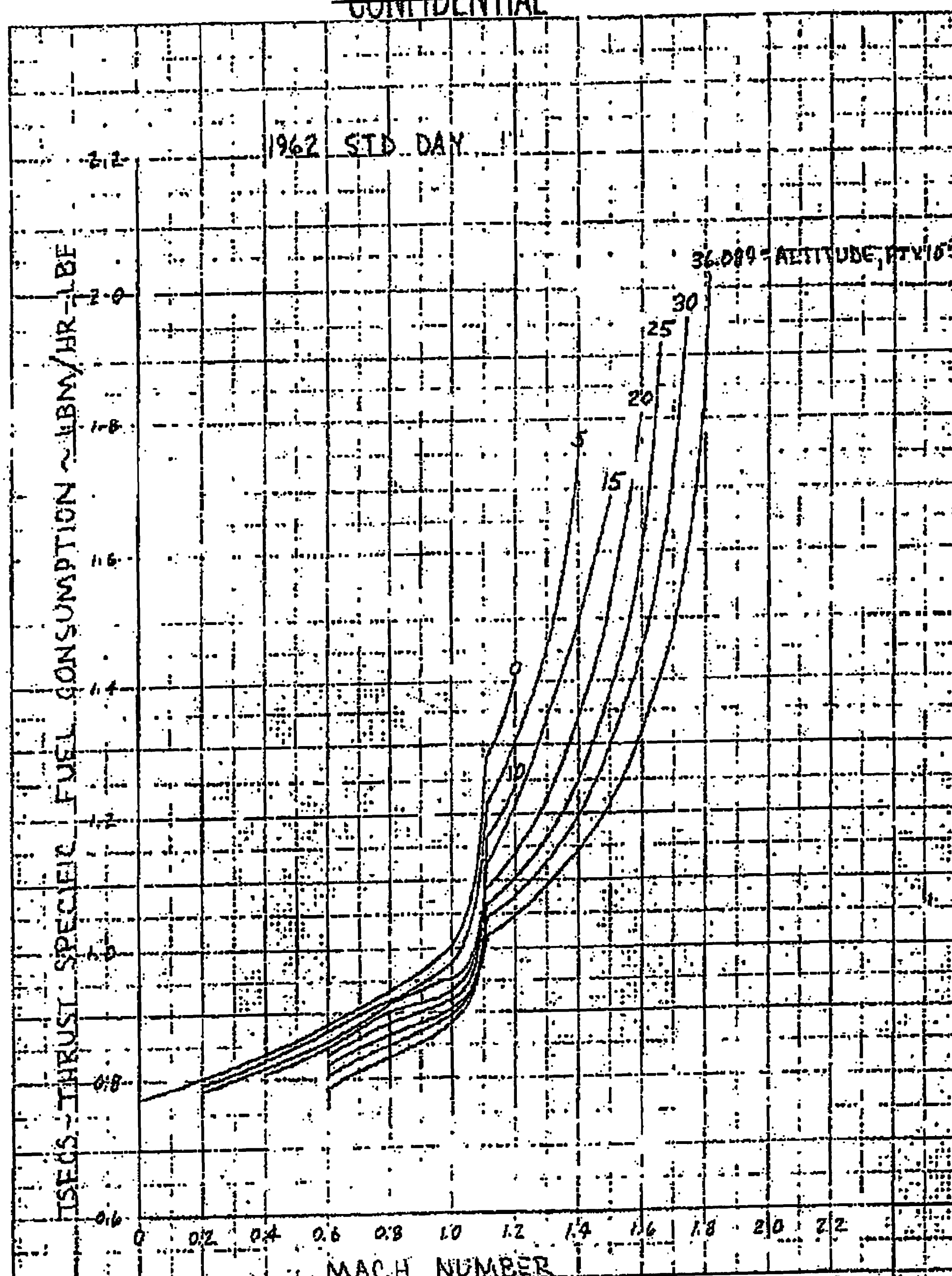


~~(C)~~ Figure 3.6-4 Intermediate Power Thrust for the F100-PW-100 Installed in Configuration 401B (U)



~~(C)~~ Figure 3.6-5 Intermediate Power Specific Fuel Consumption for the F100-PW-100 Installed in Configuration 401B, Sea Level to 36,089 feet (U)

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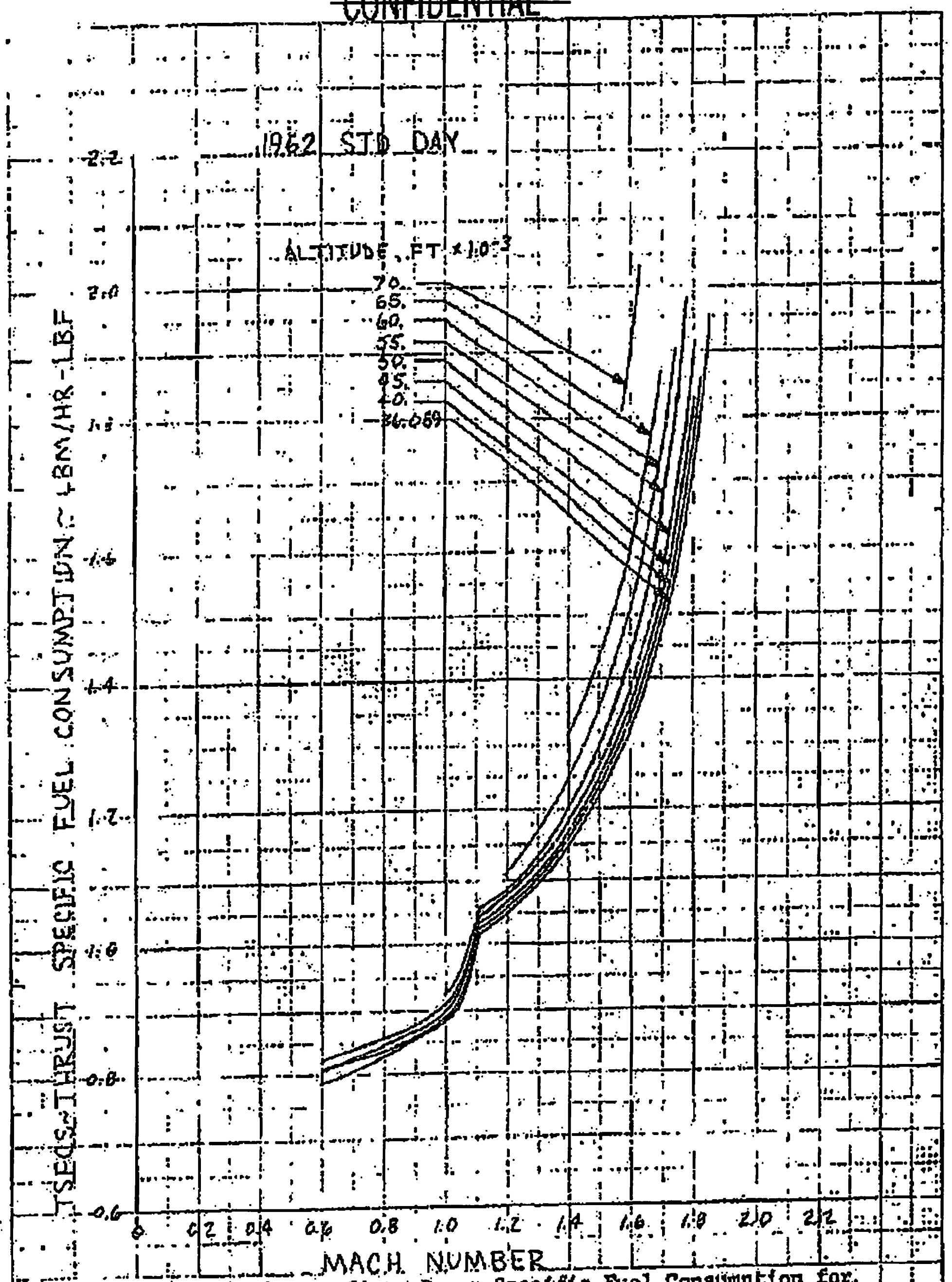

~~(C)~~ Figure 3.6-6 Intermediate Power Specific Fuel Consumption for the F100-PW-100 Installed in Configuration 401B, 36,089 to 70,000 feet (U)

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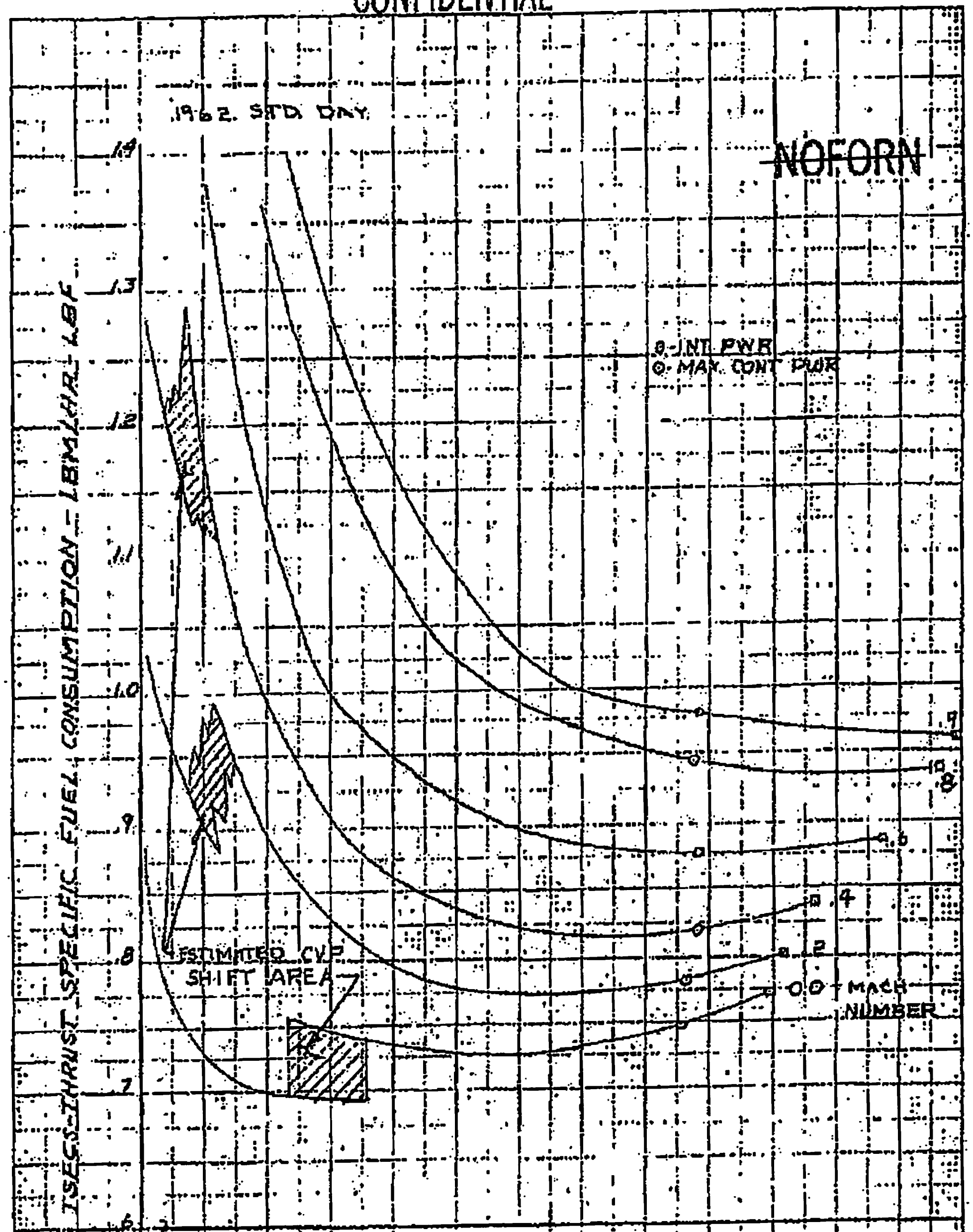
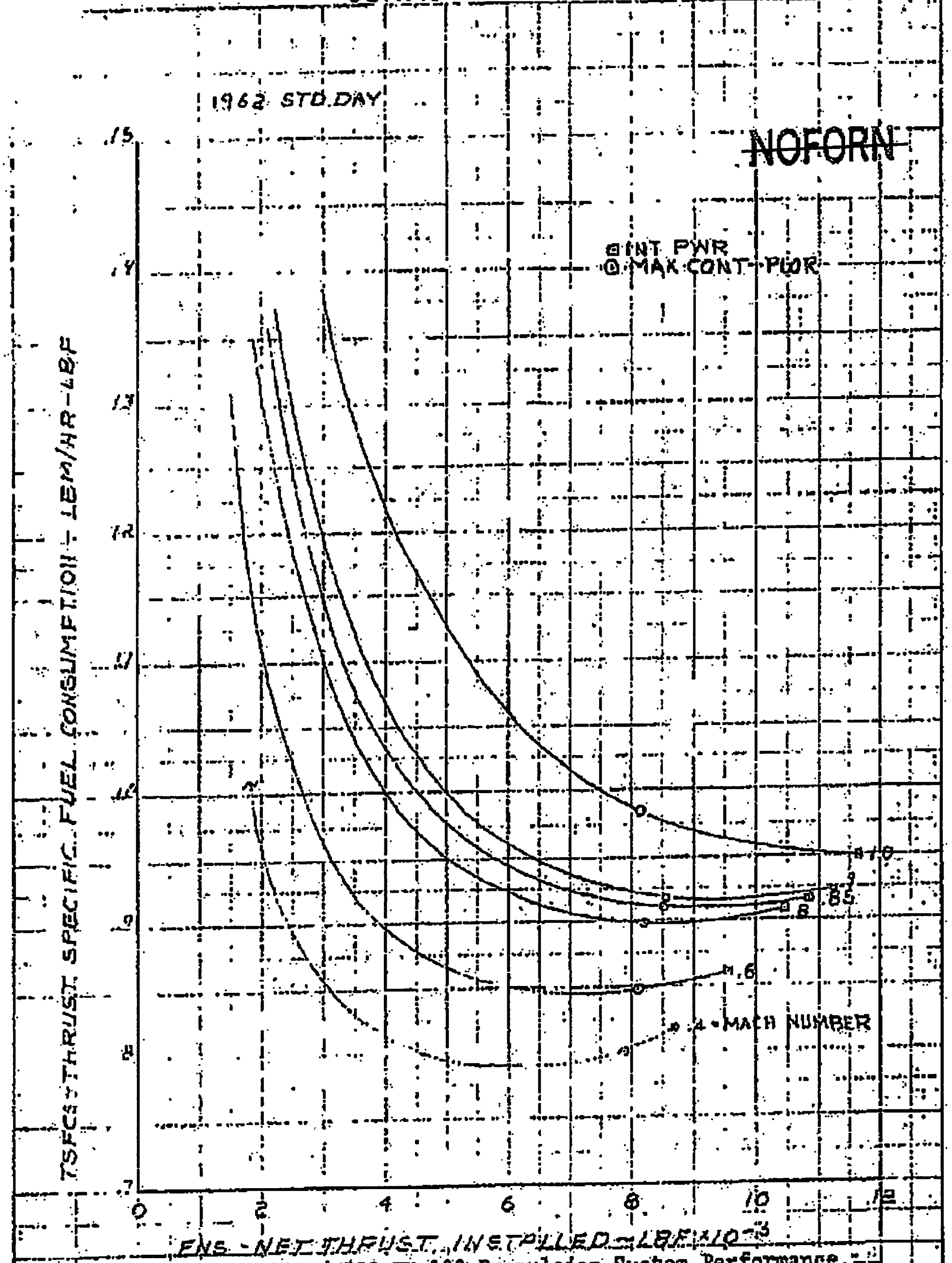


(C) Figure 3.6-7 401B/F100-PW-100 Propulsion System Performance, Intermediate and Reduced Power, Sea Level (U)



~~(C)~~ Figure 3.6-8 401B/F100-PW-100 Propulsion System Performance, Intermediate and Reduced Power, 10,000 feet (U)

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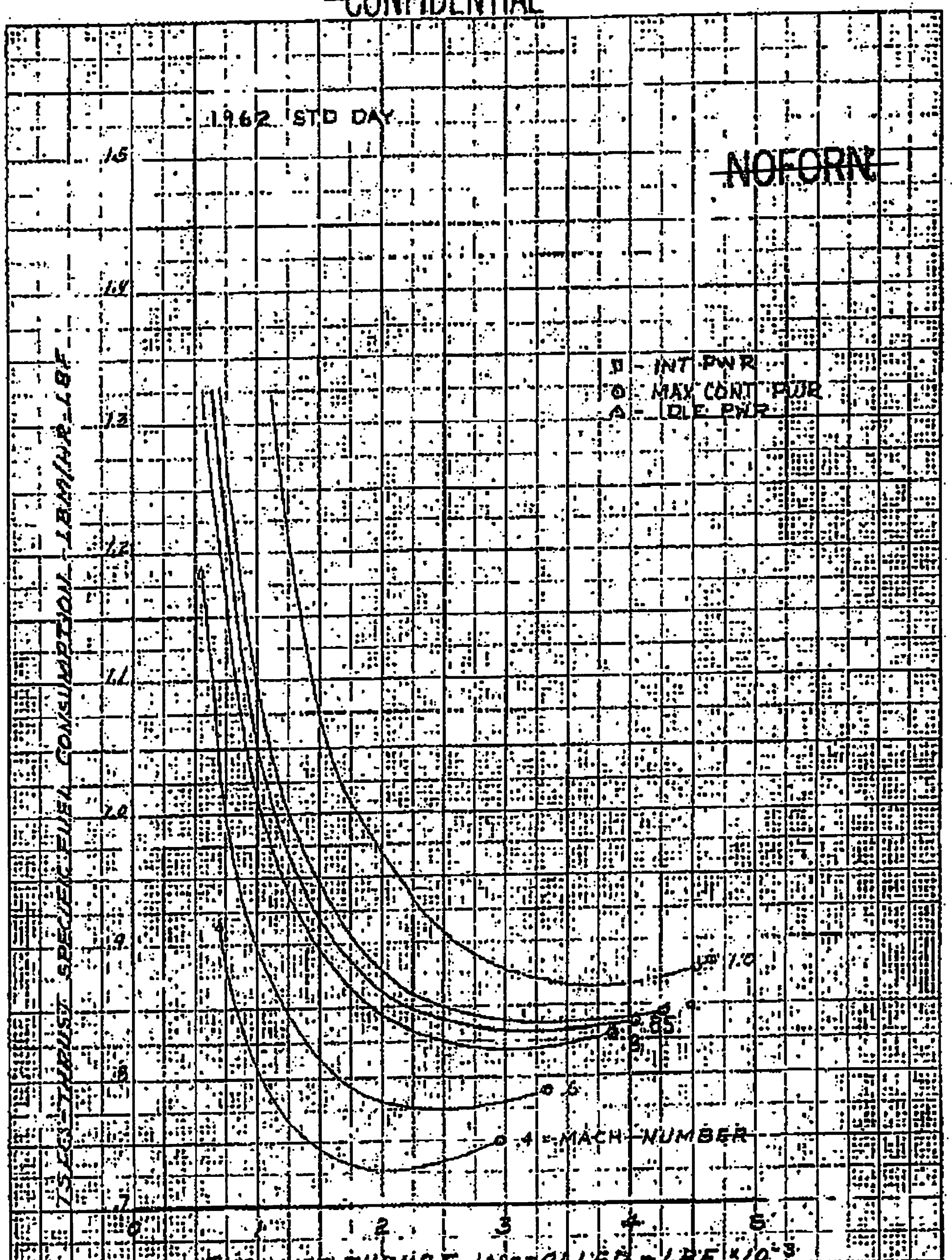

(C) Figure 3.6-9 401B/F100-PW-100 Propulsion System Performance, Intermediate and Reduced Power, 36,089 feet (U)

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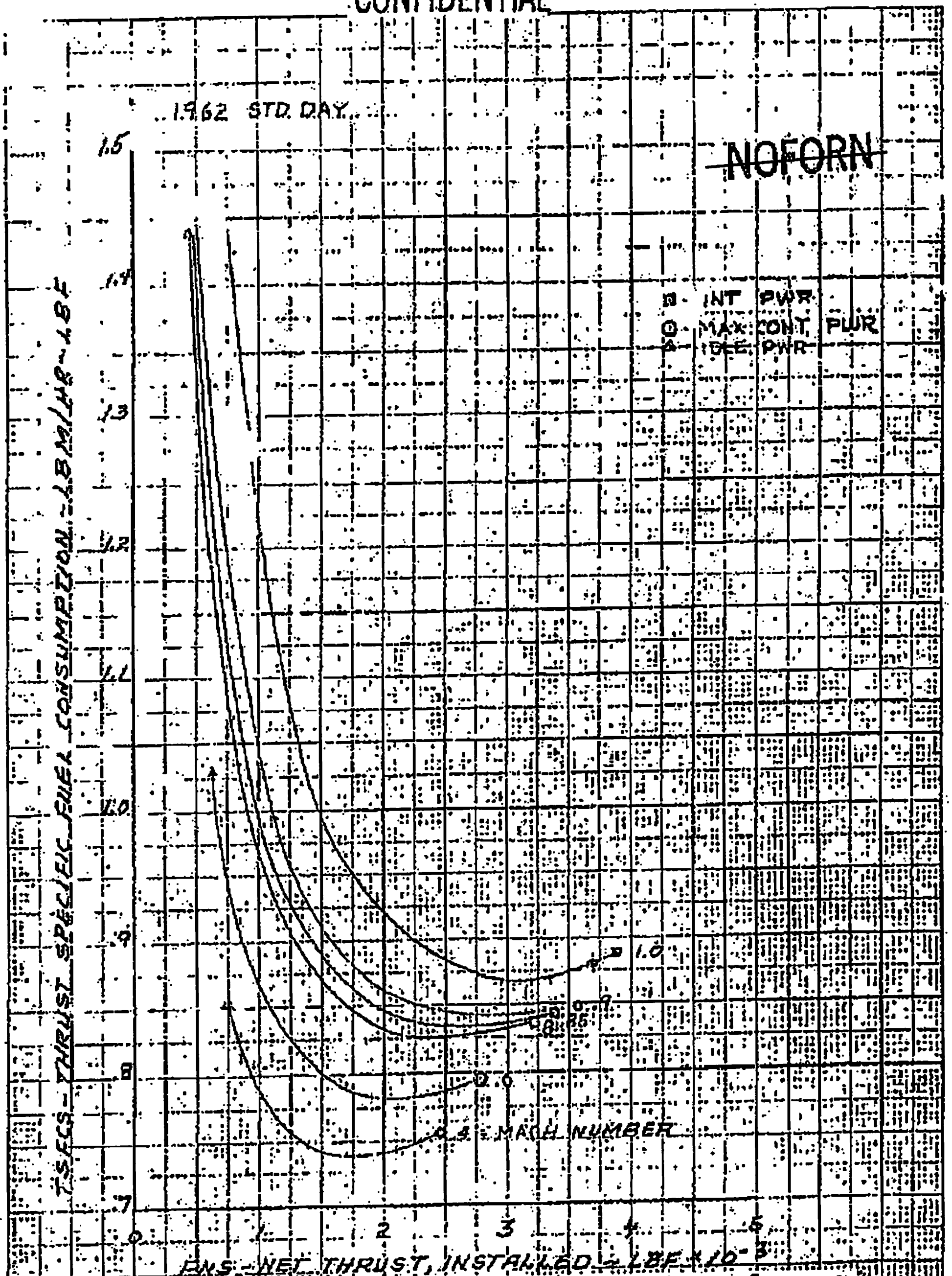

(C) Figure 3.6-10 401B/F100-PW-100 Propulsion System Performance, Intermediate and Reduced Power, 40,000 feet (U)

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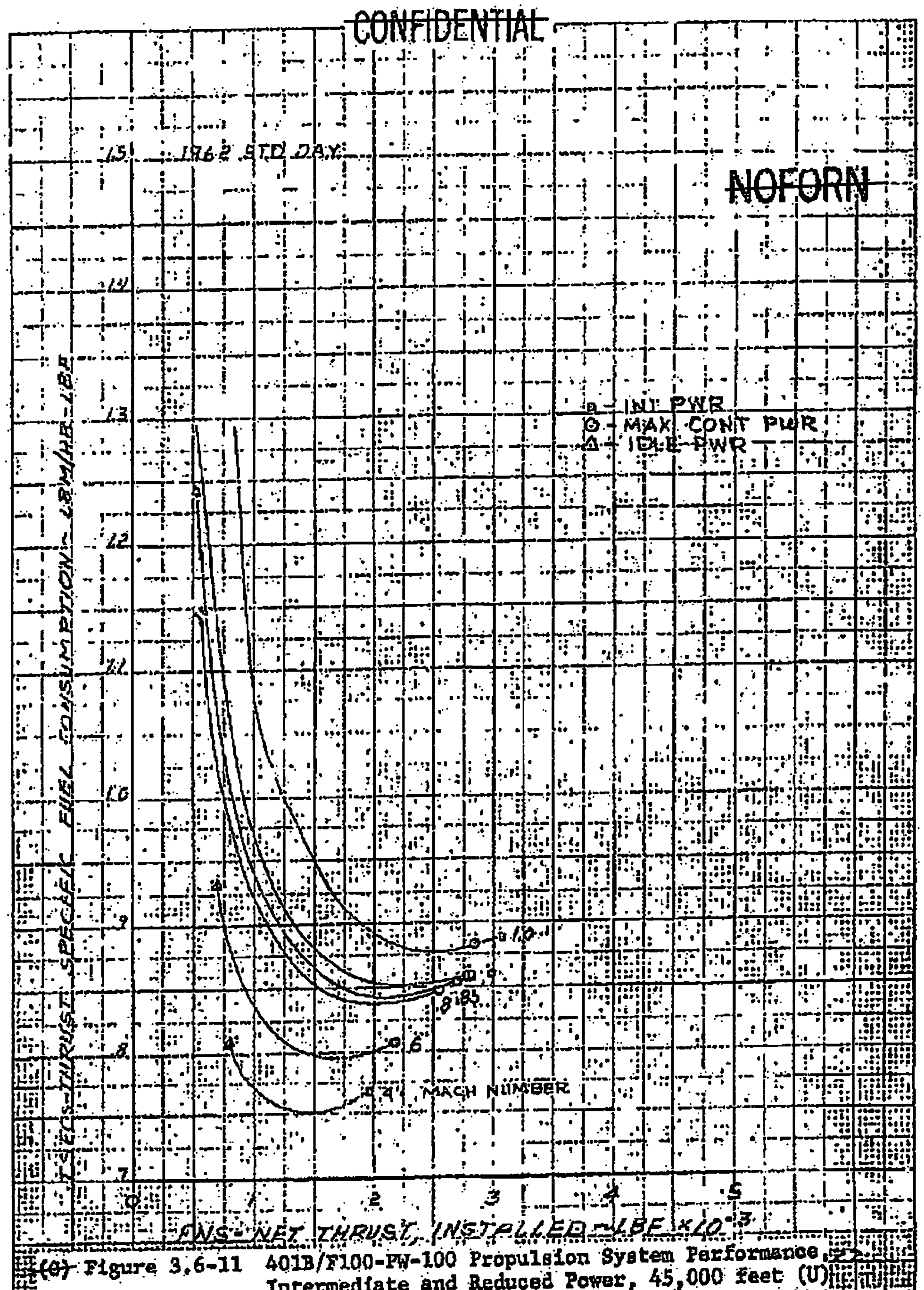

(C) Figure 3.6-11 401B/F100-PW-100 Propulsion System Performance, Intermediate and Reduced Power, 45,000 feet (U)

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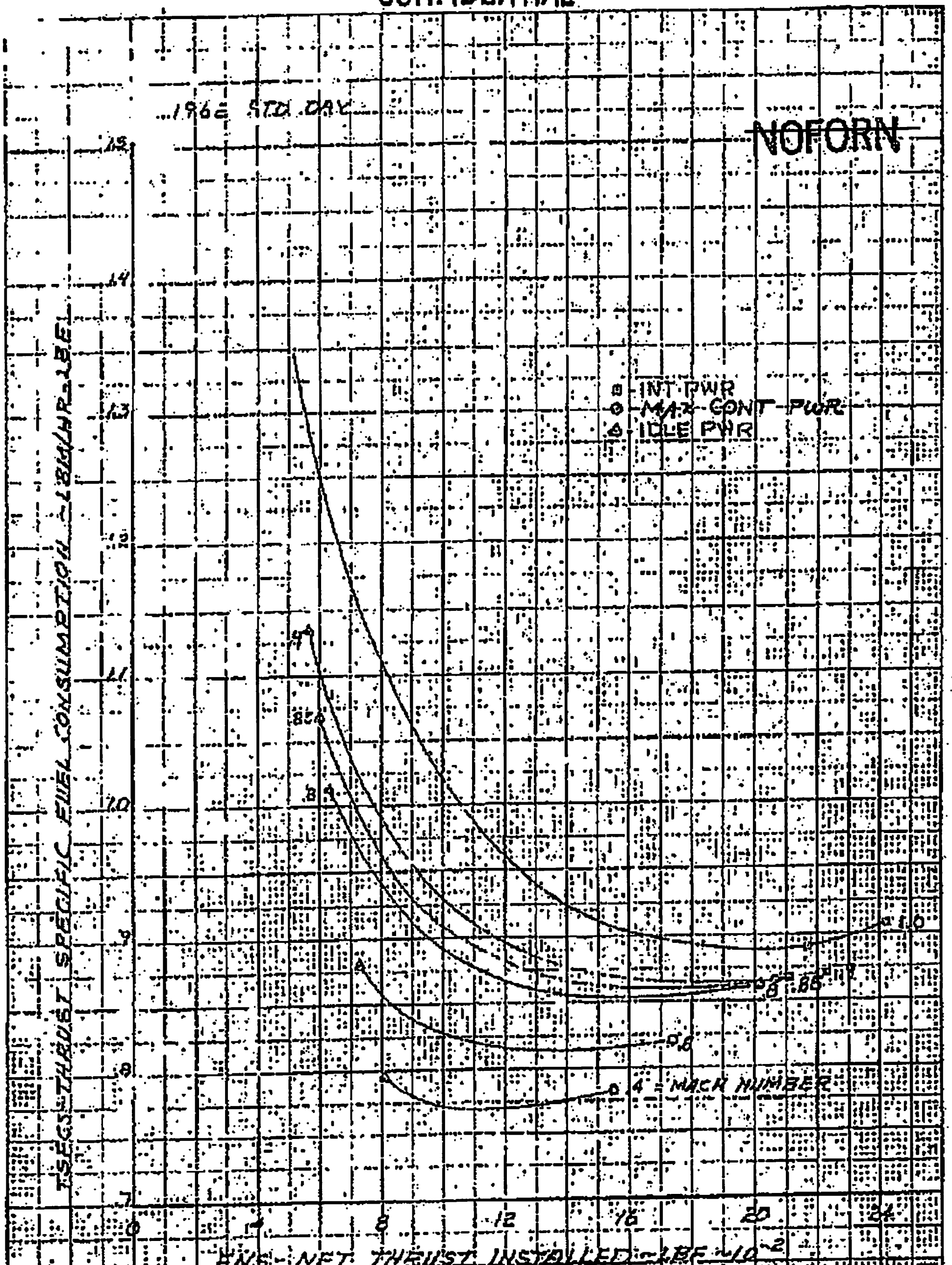

~~(C)~~ Figure 3.6-12 401B/F100-PW-100 Propulsion System Performance, Intermediate and Reduced Power, 50,000 feet (U)

TIPA-3961-D-2 CURVE 5

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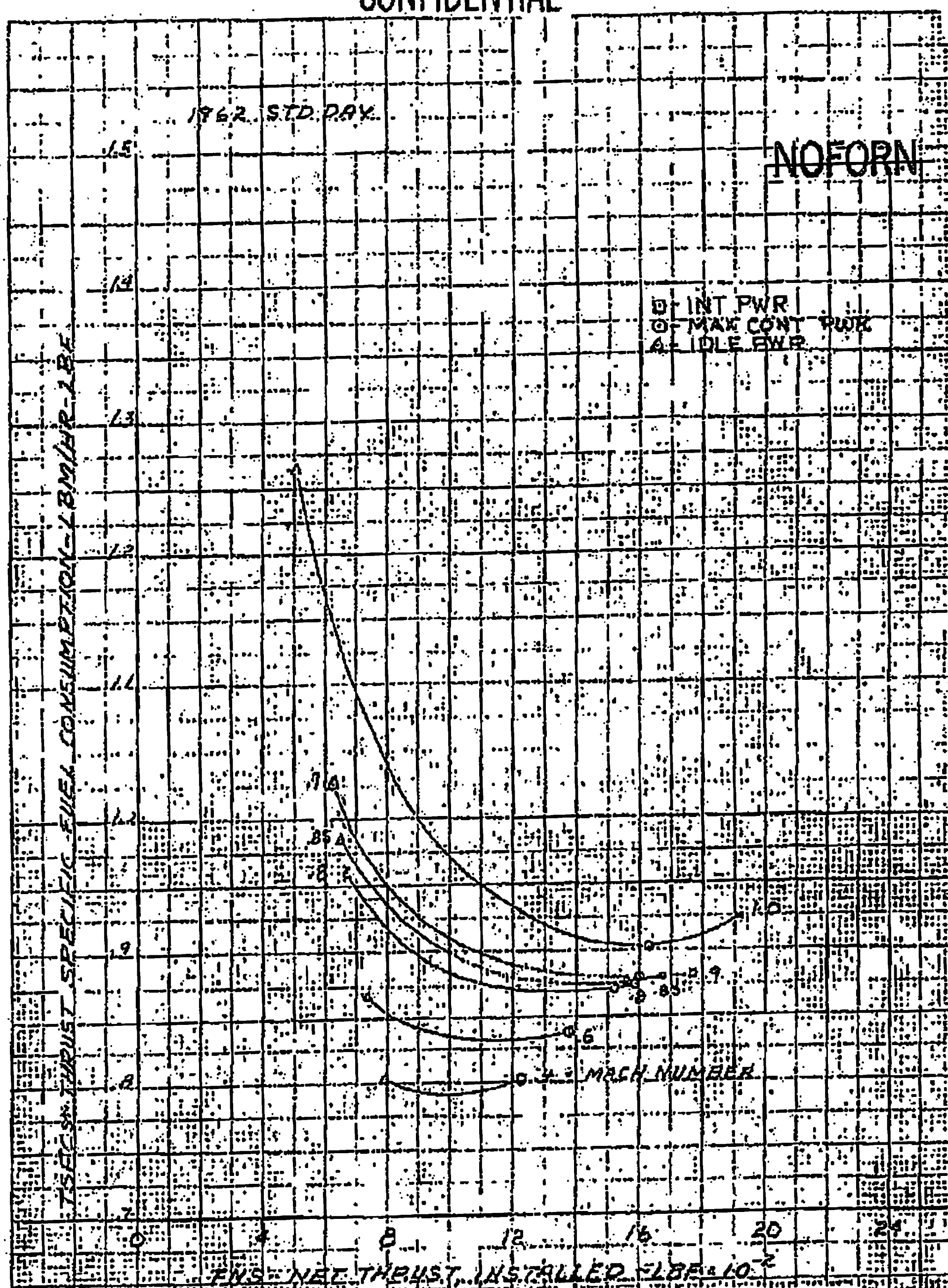

~~(C)~~ Figure 3.6-13 401B/F100-PW-100 Propulsion System Performance, Intermediate and Reduced Power, 55,000 Feet (U)

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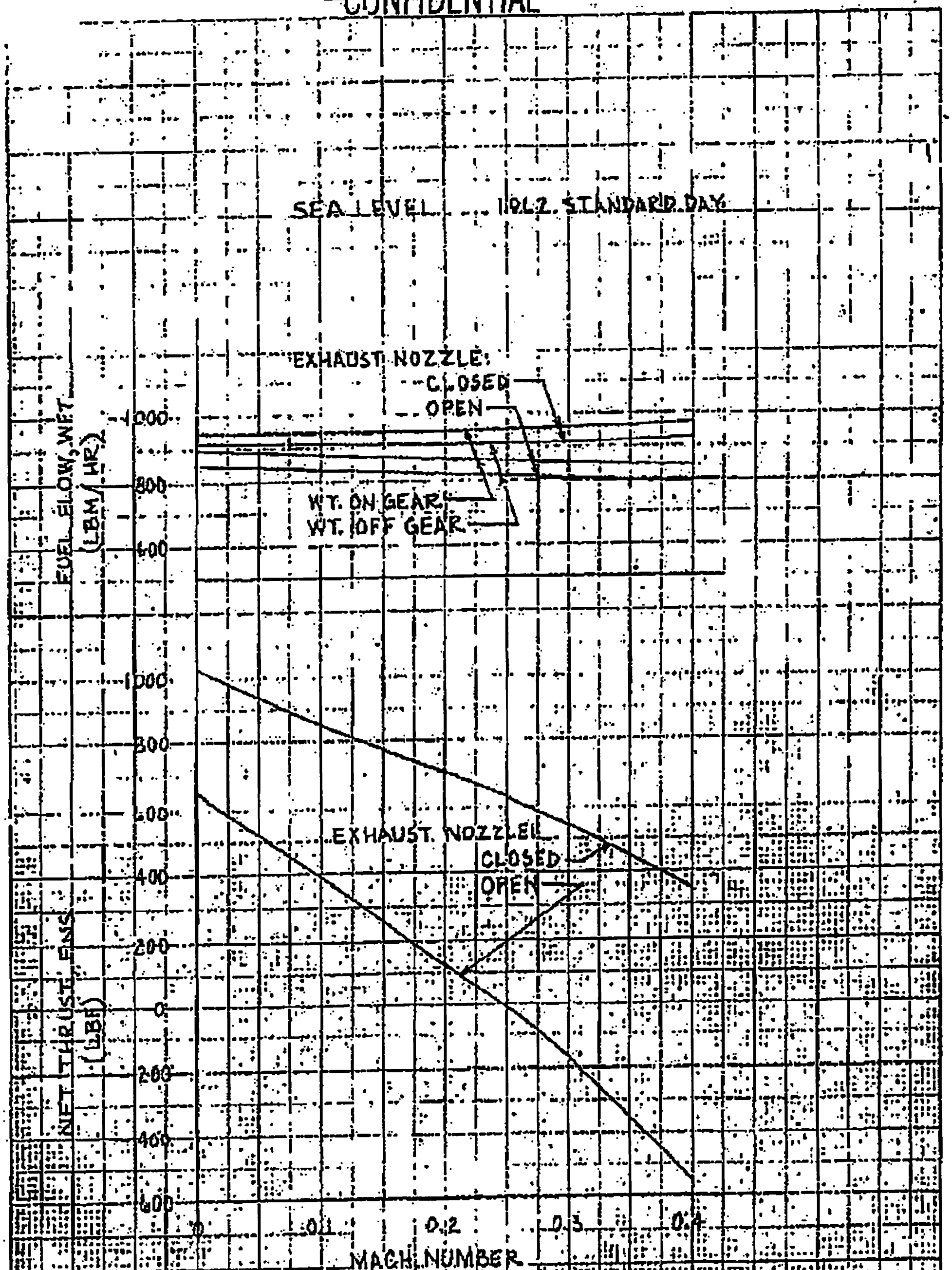

(C) Figure 3.6-14 401B/F100-PW-100 Propulsion System Performance, Idle Power, Sea Level (U)

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(U) The thrust specific fuel consumption, TSFCS, is the ratio of the installed total fuel flow and installed propulsion system net thrust, F_{NS}.

(U) At Mach 1.1 the performance exhibits a slight discontinuity. This effect is from the shift in the exhaust nozzle operating mode, described earlier, from the low- to the high-area-ratio mode of operation (low gear to high gear) above Mach 1.1.

(U) In the data curves of Figure 3.6-7, note the shaded areas defined as "Estimated CVP Shift Area". This variation in performance at the low exhaust-nozzle pressure ratios is obtained from the engine computer deck; the affected parameter is CVP (exhaust nozzle internal gross-thrust coefficient). The change in CVP is caused by flow separation in the nozzle divergent section when the nozzle is operating at low pressure ratios.

3.6.2 Inlet

~~(C)~~ The baseline inlet configuration is of the fixed-geometry open-nose type, initially elliptical in cross section, connected to the engine face by a subsonic duct about 4.05 compressor-face diameters in length. The inlet and engine face centerlines are offset approximately 14.0 inches or 0.10 times the duct length. The minimum separation between the inlet and lower fuselage surface is 1.9 inches so that low-energy fuselage boundary-layer air will not be ingested by the inlet. The inlet upper-lip leading edge is extended 10.0 inches ahead of the lower-lip leading edge to isolate the inlet normal shock from the fuselage boundary layer. The inlet upper-lip leading edge is relatively sharp to preclude shock detachment ahead of the lip. The lower lip is moderately blunt to provide good lip suction characteristics and to reduce internal lip flow separation at low speeds and during high-angle-of-attack operation. The lip bluntness used gives an internal area contraction of 4.0 percent.

~~(C)~~ A minimum amount of upper cowl-lip extension is used to isolate the inlet shock from the fuselage boundary layer; this minimizes boundary-layer buildup on the inlet side of the upper cowl lip. At high supersonic speeds (Mach 1.9 to 2.2), moderate boundary-layer control in the form of vortex generators and/or bleed may be required in the inlet throat

~~(C)~~ to reduce the shock/boundary-layer-induced separation (turbulence) to an acceptable level for engine/inlet compatibility.

~~(C)~~ The inlet is sized to accept maximum engine-corrected airflow (227 lbm/sec) at a throat Mach number of 0.70 based on geometric throat area. The resulting inlet capture area is 740 sq in., with a throat area of 710 sq in.

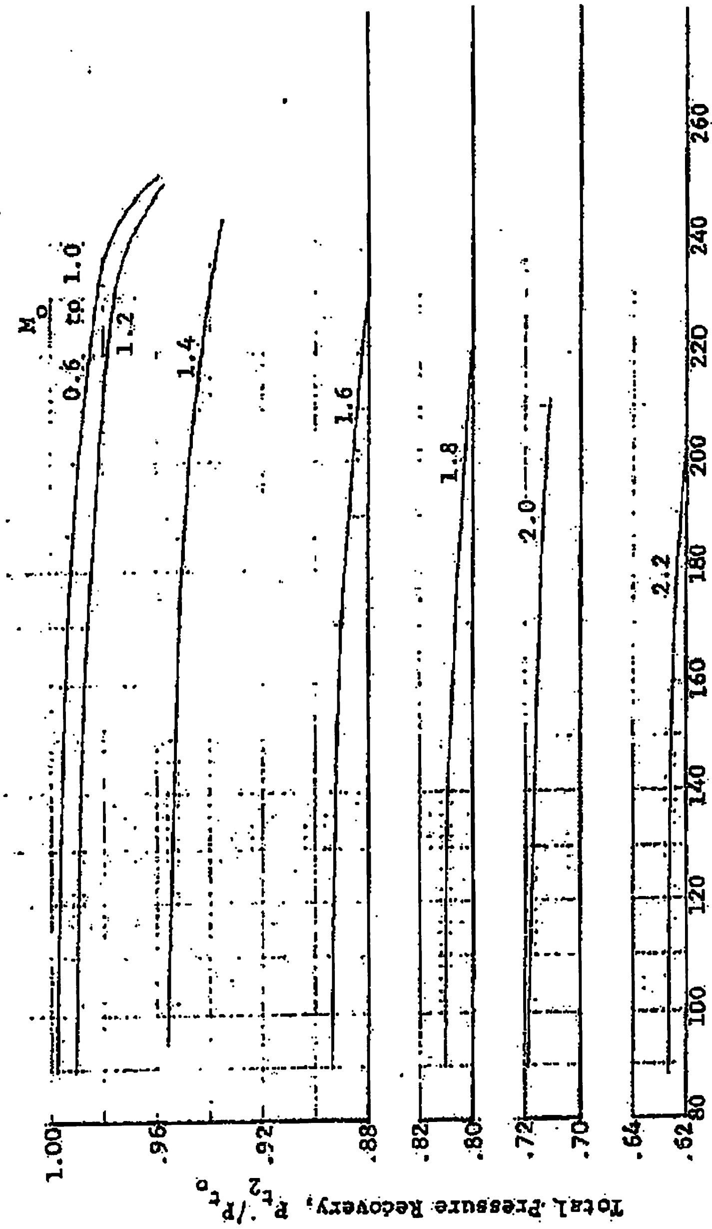
(U) Inlet total pressure recovery for Configuration 401B/F100-PW-100 is presented in Figure 3.6-15. These data are based on normal-shock total pressure recovery and subsonic duct losses correlated as a function of initial boundary-layer displacement thickness, throat Mach number, expansion angle, area ratio (inlet-to-exit), and engine-to-inlet offset. The method of analysis is documented in SEG-TR-67-1 (Reference 21). A revised duct-offset loss factor is used that is based on experimental data reported in AFFDL-TR-69-21 (Reference 22) and recent Convair Aerospace tests (Project Tailor-Mate, Reference 23).

(U) The takeoff and low-speed inlet total pressure recovery is presented in Figure 3.6-16. The method of analysis is from SEG-TR-67-1 in which takeoff and low-speed pressure recovery are correlated in terms of a lip-bluntness parameter and mass flow ratio. No auxiliary inlets are assumed.

(U) Predicted inlet spillage drag data are plotted in Figure 3.6-17. These data are based on open-nose inlet additive drag and the lip suction characteristics plotted in Figure 3.6-18. The technique for predicting lip suction, reported in Reference 24 uses isolated inlet-cowl model test data as a basis and presents cowl efficiency in terms of cowl leading-edge radius, initial cowl slope, external camber, Mach number, and level of additive drag. Factors are included to account for non-axisymmetric geometries.

3.6.3 Nozzle

(U) The selected nozzle is the 1.61/1.1 balance-beam configuration, which is the primary option offered for this engine by P&WA. This is a non-ejector, convergent/divergent nozzle, having modes of operation as shown in the Figure 3.6-19 sketch. The "1.61" refers to the internal expansion-area ratio when the nozzle is in the wide-open position and the "1.1" corresponds to this area-ratio with the nozzle in the minimum-area position.



~~(C)~~ Figure 3.6-15 Open-nose-Inlet Total Pressure Recovery, Mach 0.6 to 2.2

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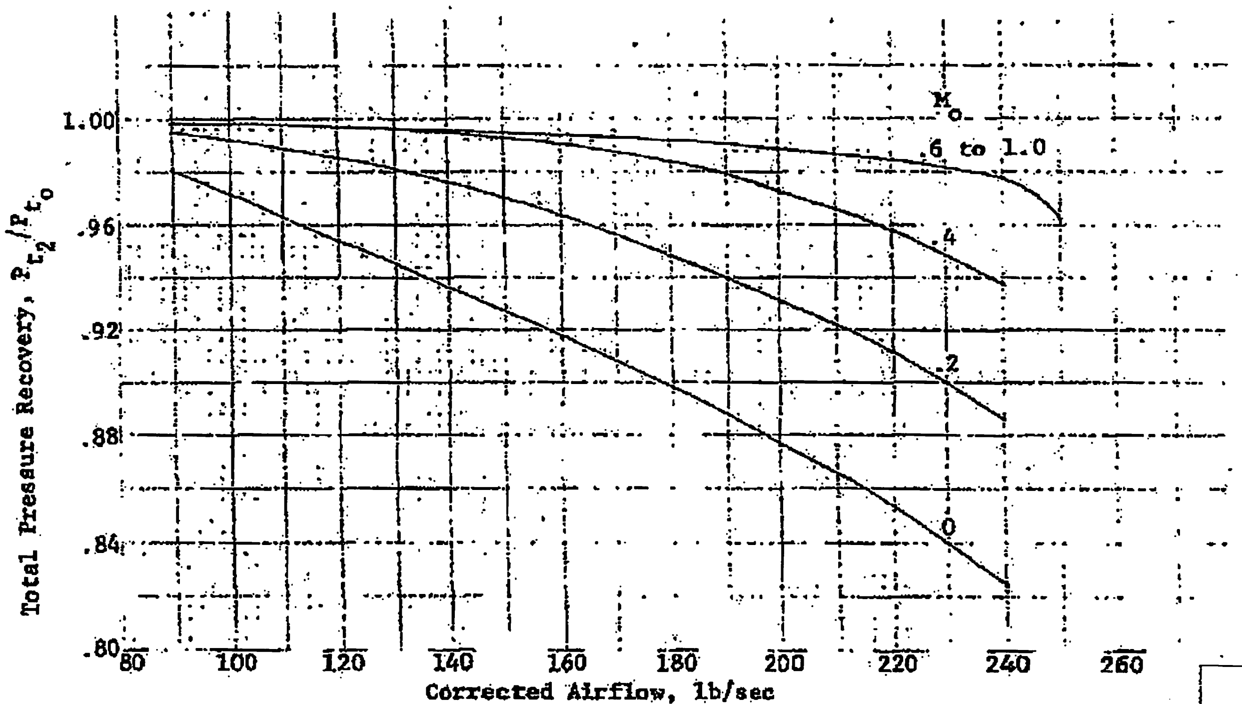

~~(C)~~ Figure 3.6-16 Open-nose-inlet Total Pressure Recovery, Mach 0 to 0.6

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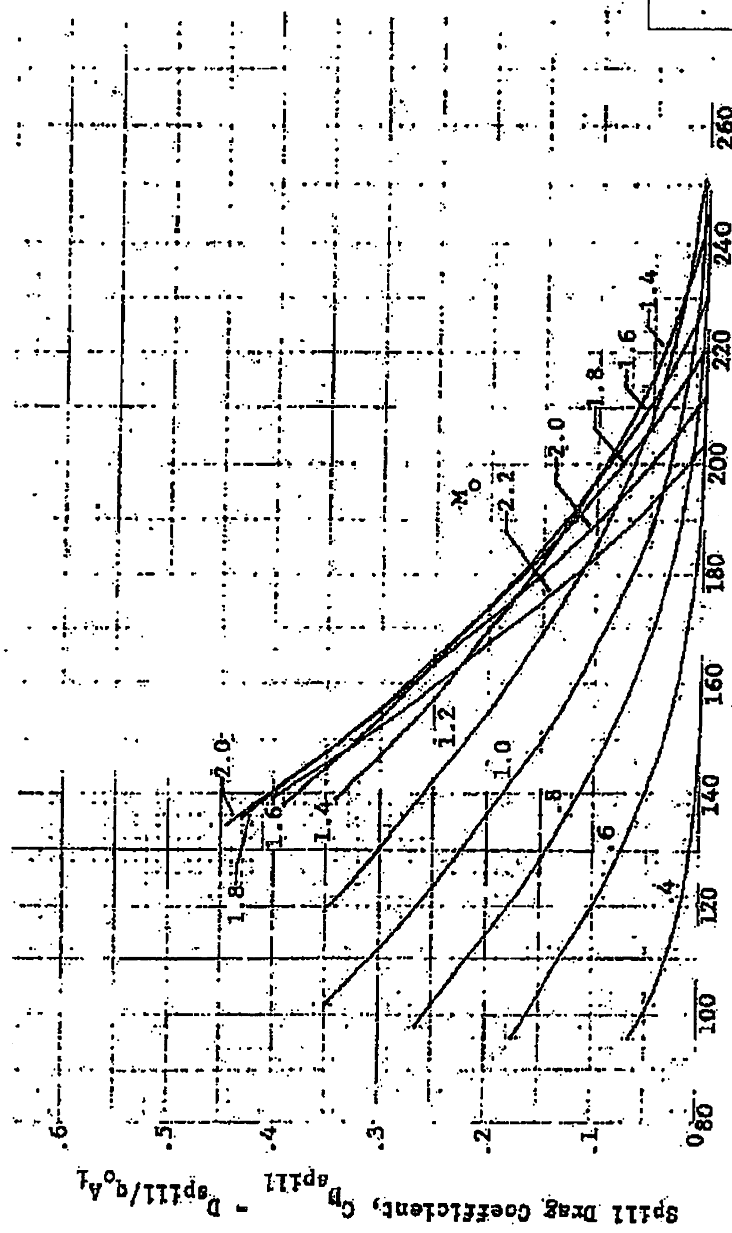
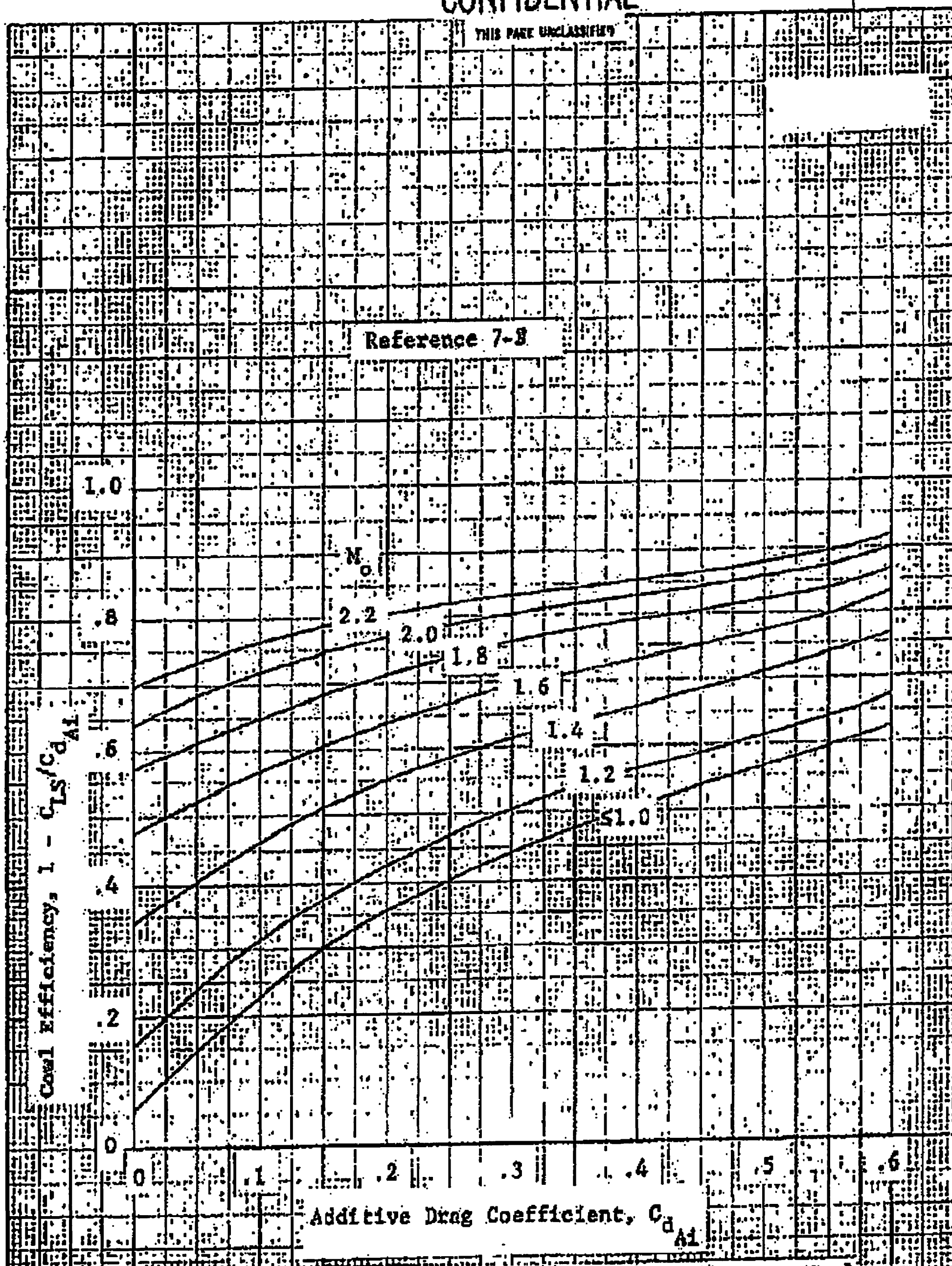
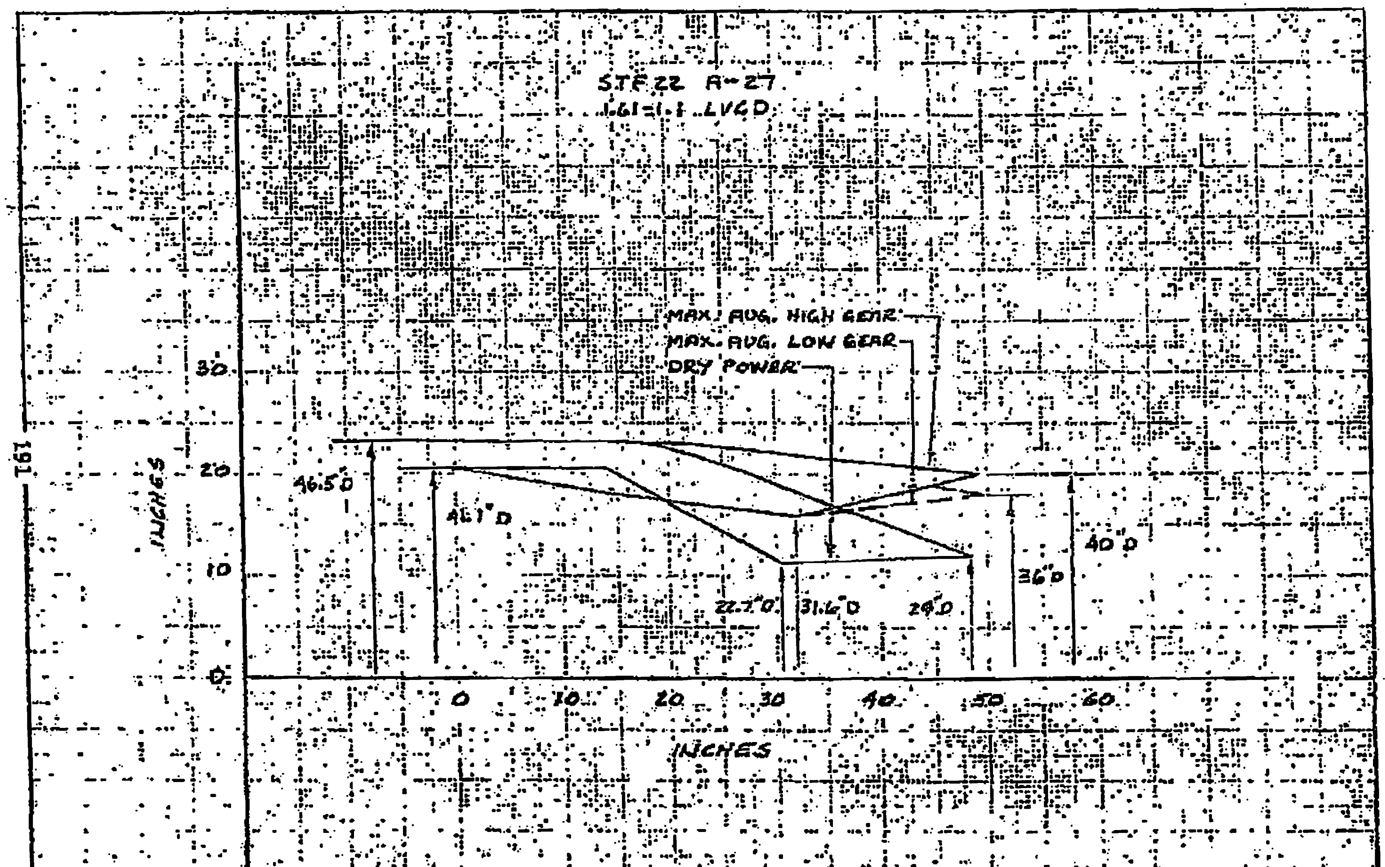


(C) Figure 3.6-17 Open-nose-inlet Spillage Drag



(U) Figure 3.6-18 Open-nose-Inlet Cowl Efficiency (Lip Suction)



(U) Figure 3.6-19 Sketch of the F100-PW-100 Balanced-Beam Nozzle Configuration

(U) A pressure drag analysis was made of the nozzle for each mode of operation; the estimated drags are shown in Figures 3.6-20 through 3.6-23. The nominal values of exit diameter for maximum augmentation and for dry power are shown in Figure 3.6-19. These values are used for estimating the nozzle drag. Also shown in Figure 3.6-19 is the baseline nozzle diameter used to derive the baseline nozzle drag shown in Figure 3.6-20. The baseline configuration is the same as the maximum augmented power configuration at Mach 1.1 and above (referred to as "high gear"). The baseline nozzle pressure ratio is shown in Figure 3.6-24.

(U) The baseline nozzle drag is included in the airplane drag data, and any increment in nozzle drag caused by changing engine power setting, from the baseline, appears in the propulsion data. The maximum augmentation nozzle drags shown in Figure 3.6-21 are included in the propulsion data and are actually the increment in drag between baseline and the true operating conditions (nozzle pressure ratio and nozzle geometry). This increment is zero at Mach 1.1 and above since the baseline reflects the true operating geometry and also is not influenced by changing nozzle pressure ratio.

(U) The dry-power nozzle drags included in the propulsion data are presented in Figures 3.6-22 and -23. These data are increments from the baseline as described above.

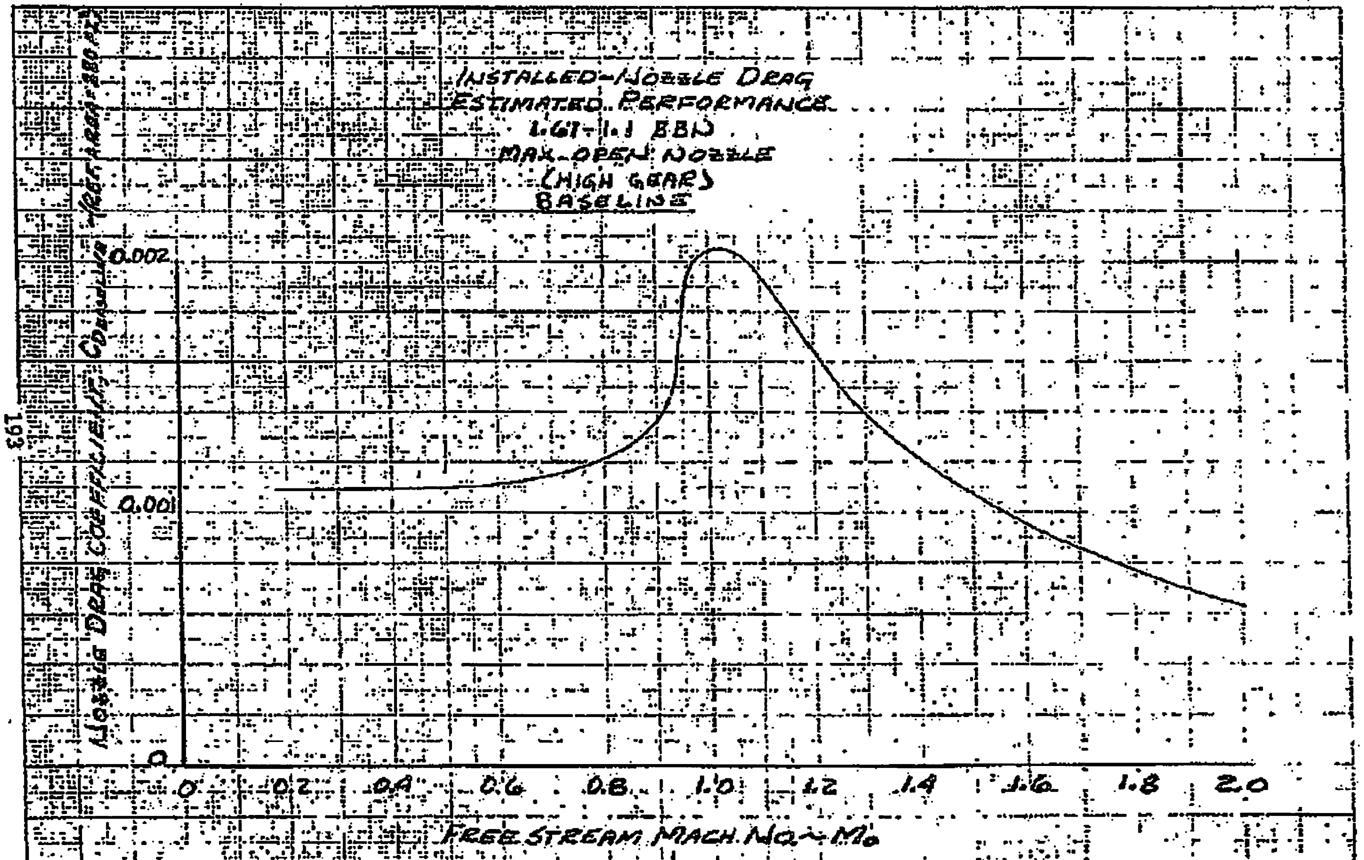
(U) These data, reflecting the specific installation, were used for the vehicle performance analysis rather than the uninstalled-nozzle drag data provided in the engine performance data deck, CCD 1025.

3.6.4 Auxiliary Air

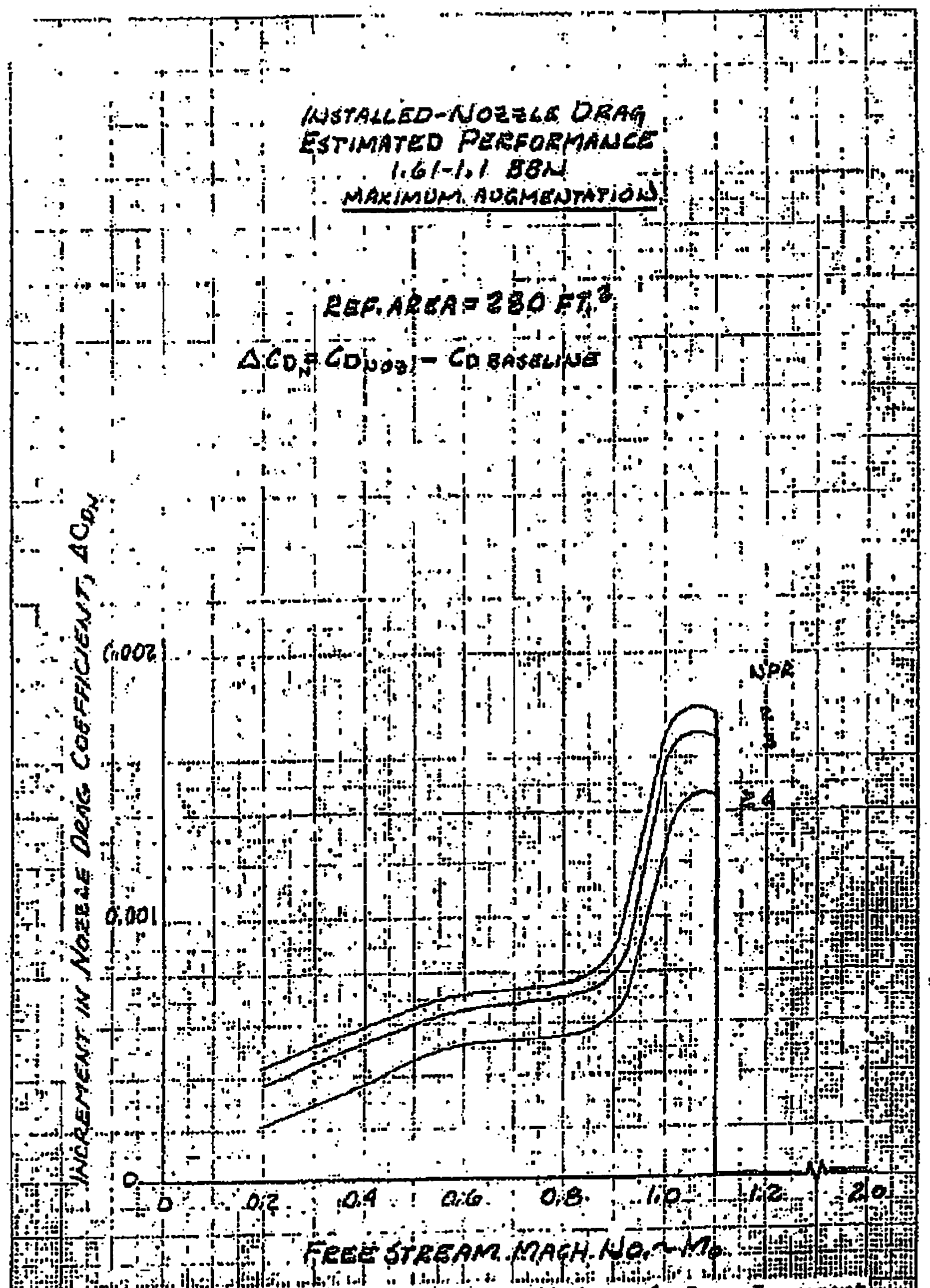
(U) The auxiliary air system serves only to ventilate the nacelle and prevent the accumulation of flammable fluids and vapors. The system consists of a forward-mounted flush inlet (near the engine front-frame) and aft-mounted flush exits (near the nozzle customer-connect). Only a small quantity of air is required to fulfill the system function and the drag penalty is estimated to be 2.5 counts (280-sq ft reference area).

3.6.5 Shaft Power and Compressor Bleed Extraction

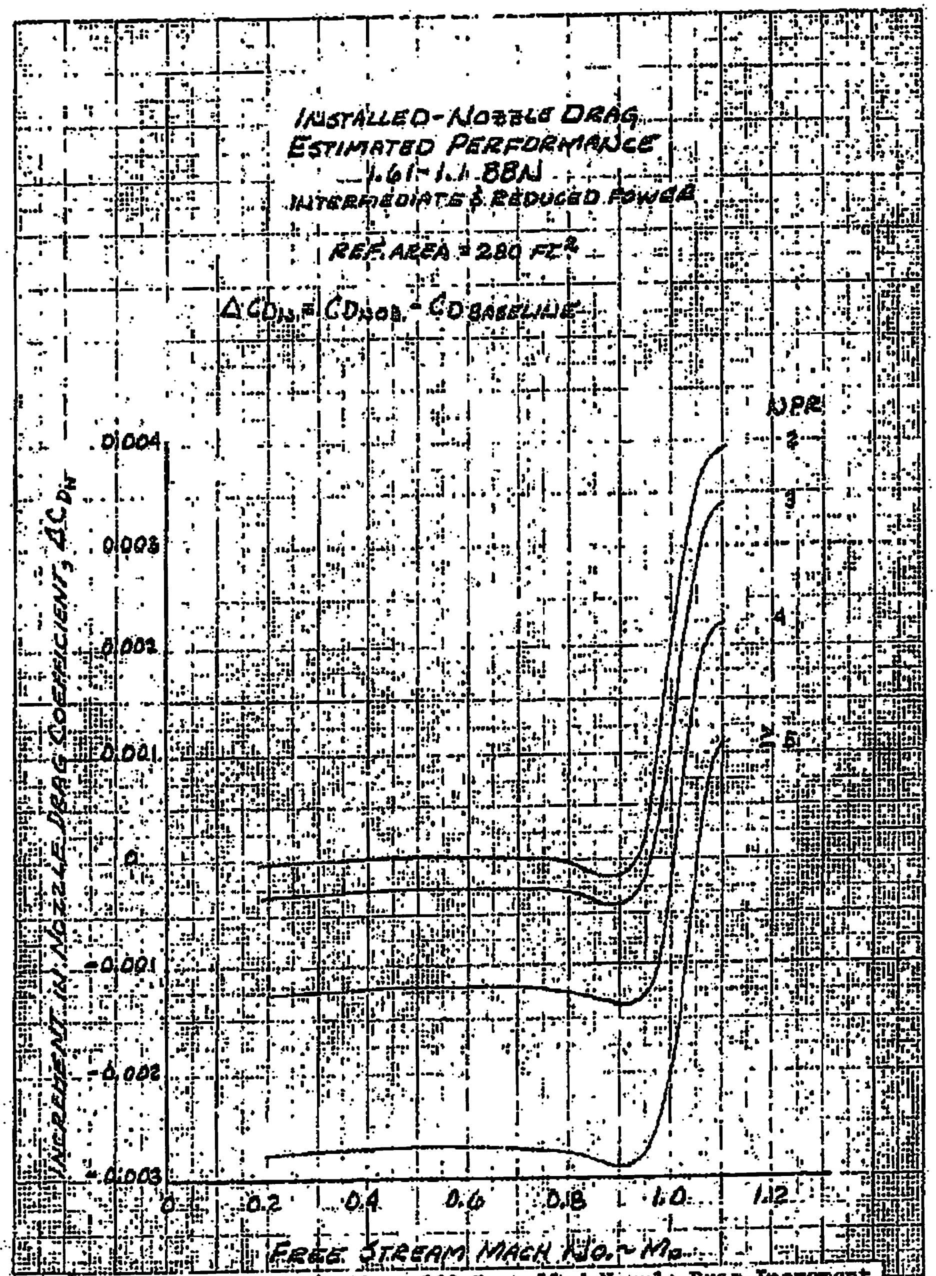
(U) Power is extracted through the engine gear-box power-take-off shaft to drive the airplane electric generator and



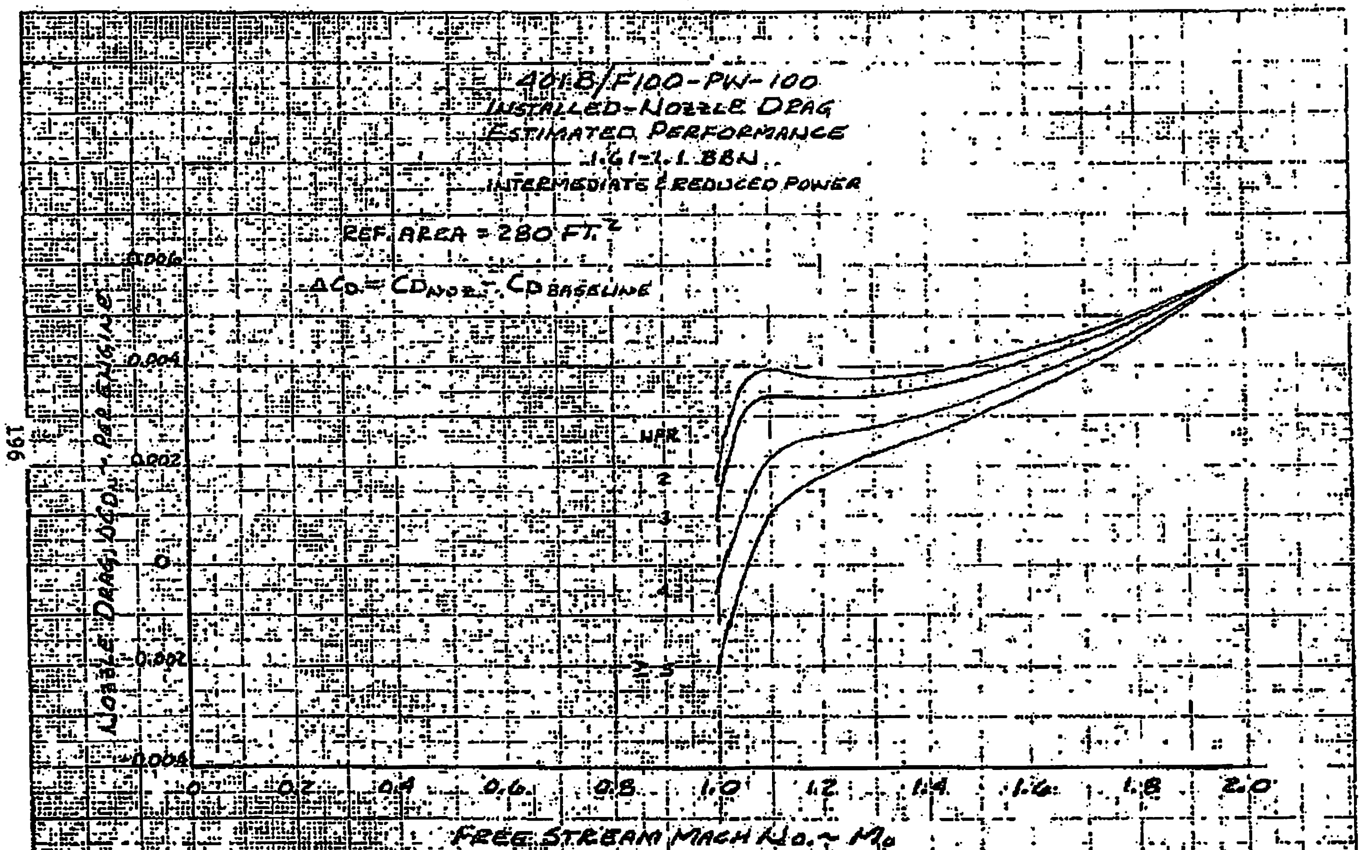
(U) Figure 3.6-20 401B/F100-PW-100 Installed Nozzle Drag, Maximum Open Nozzle (High-Gear Position)



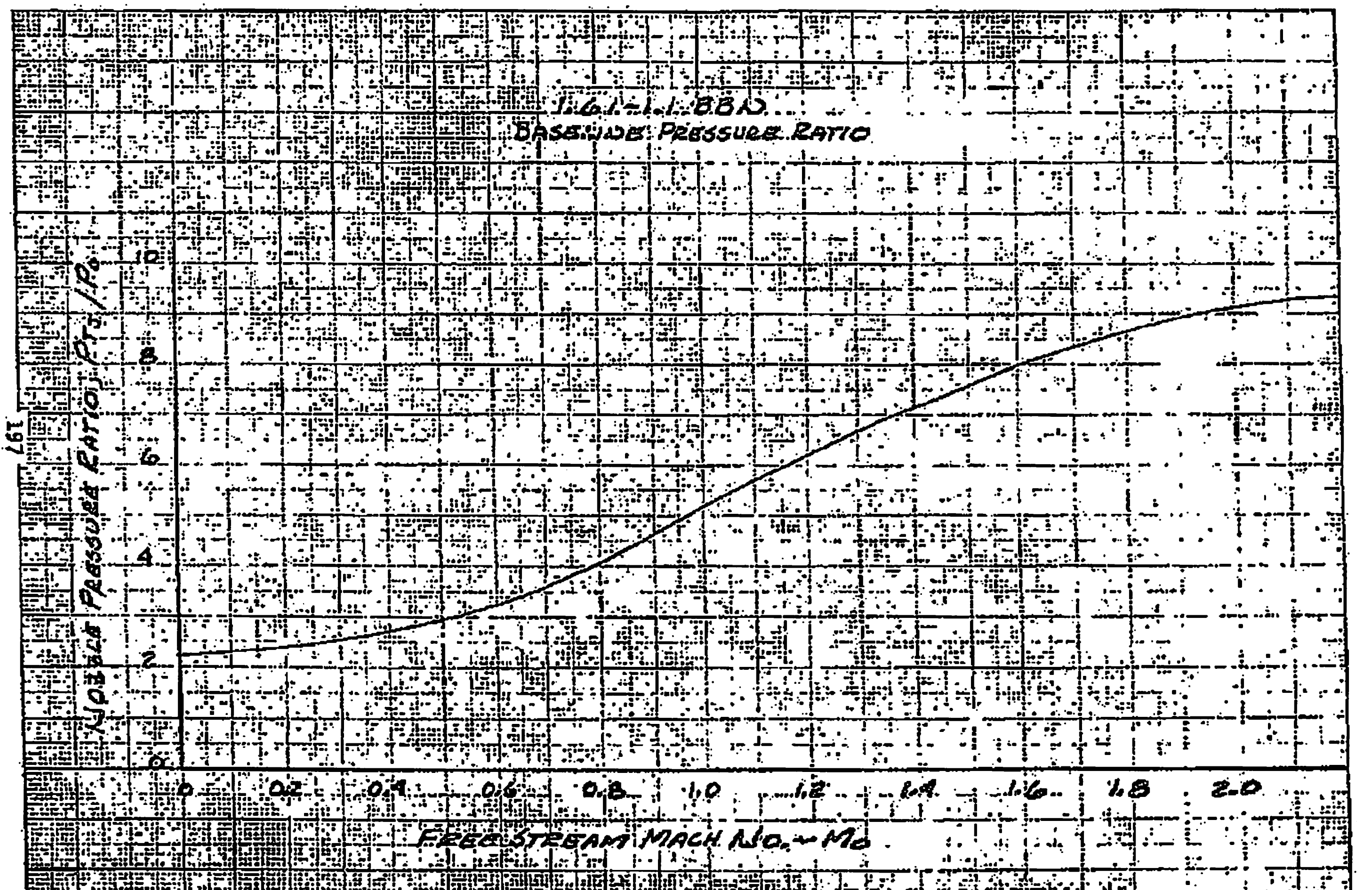
(U) Figure 3.6-21 401B/F100-PW-100 Installed Nozzle Drag Increment during Maximum Afterburning



(U) Figure 3.6-22 401B/F100-PW-100 Installed Nozzle Drag Increment, Intermediate and Reduced Power (Mach numbers less than 1.1)



(U) Figure 3.6-23 401B/F100-PW-100 Installed Nozzle Drag Increment, Intermediate and Reduced Powers (Mach numbers greater than 1.0)



(U) Figure 3.6-24 401B/F100-PW-100 Baseline Nozzle Pressure Ratio hydraulic pumps. An estimated value of the total power extraction is 70 hp. The installed propulsion system performance data accounts for 70 hp at all flight conditions and power settings.

(U) High-pressure bleed air is extracted from the compressor discharge for operating the environmental control system. In flight, the bleed air-flow rate is approximately 0.4 lbm/sec. The installed propulsion system performance data accounts for 0.4 lbm/sec at all flight conditions and power settings.

(U) During ground operation (airplane weight resting on the landing gear), a switch on the landing gear provides signals to valves that direct the flow of high-pressure bleed air to additional systems such as nacelle-ventilation and oil-cooler ejectors. The total airflow for weight-on-gear operation is estimated to be about 1.20 lbm/sec for the airplane. The installed takeoff thrust and fuel flow are corrected for this weight-on-gear bleed flow rate.

SECTION 4

SMALL SINGLE-ENGINE CONCEPT

(403/J101-GE-100)

4.1 VEHICLE DESIGN

(U) In this subsection a description is presented of the small single-engine concept, a brief explanation is given of the overall configuration rationale, and the configuration growth data that were generated for aircraft sizing purposes are summarized.

4.1.1 Vehicle Description

~~(S)~~ The small single-engine fighter concept (Concept 2), designated Configuration 403, is presented in Figures 4.1-1 and 4.1-2, which show the general arrangement and basic lines arrangement respectively. This design was developed as one of a family of three configurations generated to establish growth data for the airplane powered by the small GE15-1/J1A5 engine (USAF designation J101-GE-100).

~~(S)~~ Configuration 403 is essentially the same as the Configuration 401B concept (see Subsection 3.1.1) except for its scaled-down size and changes in some internal relationships which result from the variation in engine-to-airplane proportions brought about by the engine differences. The 403 design shown in Figures 4.1-1 and 4.1-2 has a gross weight of 13,000 pounds [a wing loading of 60 psf, and a thrust-to-weight ratio of 1.01 (uninstalled).]

88th ABW/IPI
FOIA (b)(1)
E.O. 13526 SEC 3.3 (b)(6)

~~(S)~~ Since an aircraft could not be properly sized for the design mission in this case, an example 403 type at the 13,000-lb mission weight is presented. Further explanation concerning aircraft sizing is given in the performance discussion of Subsection 4.2.

4.1.2 Design Rationale

(U) The rationale for Configuration 403 is the same as that of the 401B concept (see Subsection 3.1.2).

4.1.3 Growth Data

(U) The aircraft sizing approach is outlined and the design data developed for the growth study are summarized in the following paragraphs.

Three data points were investigated to supply the necessary design information to develop the growth curves. A complete layout was made of the 403 configuration (13,000-lb mission weight), which served as a focal point of the growth family. A small 10,000-pound configuration layout was also developed along with a 16,800-pound design that was defined by modification of the original 401B configuration to a small-engine version. A family of airplane data was thus generated in which the data from the two layouts and the modified 401B information were utilized to provide growth data curves for the gross-weight range from 10,000 pounds to 16,800 pounds. Weight and balance considerations and internal fuel requirements for this wider range of gross weight combined to alter the fuselage scaling factors from those utilized in the original 401B growth study. However, virtually all other scaling parameters such as surface area ratios, tail volume coefficients, aspect ratios, taper ratios, etc., remained intact. The basic landing gear dimensions and tire sizes were varied for the main gear but remained the same for the nose gear.

(U) The variation of airplane wetted area with airplane size (mission weight) is shown in Figure 4.1-3. A breakout of wetted area versus mission weight for the various major airplane components is given in Figure 4.1-4. The variation of several key configuration characteristic dimensions is plotted as a function of mission weight in Figures 4.1-5 and 4.1-6 for the fuselage and surfaces, respectively. In Figures 4.1-7 through 4.1-12, data sheets are presented on which friction drag design data and basic geometric descriptions are tabulated for airplanes at each of the three selected gross-weight data points. A normal-area distribution curve and fuel distribution plot are presented for the 403 configuration (13,000-lb mission weight) in Figures 4.1-13 and 4.1-14, respectively.

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

~~SECRET~~

WING (REFERENCE)

AREA	216.67 SQ FT
ASPECT RATIO	3.0
TAPER RATIO	0.2
SPAN	25 FT 59.4 IN
SWEEP-LEADING EDGE	35°
ROOT CHORD	169.97 IN
TIP CHORD	33.99 IN
MAC	117.01 IN
AIRFOIL SECTION	4% BICONVEX
INCIDENCE	2°
DIHEDRAL	0°

MANEUVER FLAP

TYPE	PLAIN
TOTAL AREA	19.73 SQ FT
SPAN-PER SIDE	82.69 IN
ROOT CHORD	23.15 IN
TIP CHORD	11.44 IN
DEFLECTION	25°
HINGE LINE	
ROOT	18%
TIP	30%

FLAPS

TYPE	PLAIN
TOTAL AREA-INCLUDING FLAPERON	21.82 SQ FT
ROOT CHORD	24.63 IN
TIP CHORD	8.8 IN
FLAPERON	
TOTAL AREA	11.61 IN
SPAN-PER SIDE	58.74 IN
ROOT CHORD	19.35 IN
TIP CHORD	8.8 IN
DEFLECTION	+20°, -30°
FLAP DEFLECTION-MAX	30°
FLAP HINGE	80%

VERTICAL TAIL

AREA-TOTAL	35.2 SQ FT
ASPECT RATIO	1.33
TAPER RATIO	0.4
SPAN	58.06 IN
SWEEP-LEADING EDGE	45°
ROOT CHORD	62.36 IN
TIP CHORD	21.11 IN
AIRFOIL SECTION	6% ROOT, 4% TIP BICONVEX

RUDDER

AREA TOTAL	8.8 SQ FT
SPAN	39.06 IN
ROOT CHORD	15.51 IN
TIP CHORD	6.24 IN
DEFLECTION	±30°

VENTRAL FINS

AREA TOTAL	3.8 SQ FT
ASPECT RATIO	0.3733
TAPER RATIO	0.5957
SPAN	12.49 IN
SWEEP-LEADING EDGE	45°
ROOT CHORD	41.92 IN
TIP CHORD	24.97 IN
AIRFOIL SECTION	6% BICONVEX

HORIZONTAL TAIL (ALL MOVABLE)

AREA	43.77 SQ FT
ASPECT RATIO	3.0
TAPER RATIO	0.2
SPAN-EXPOSED	137.31 IN
SWEEP LEADING EDGE	35°
ROOT CHORD	76.91 IN
TIP CHORD	15.38 IN
MAC	52.63 IN
INCIDENCE	2°
AIRFOIL SECTION	6% AT BL 44.2, 4% TIP BICONVEX
DIHEDRAL	[illegible]
DEFLECTION	LE UP 15°, DWN 30°

POWERPLANT
GENERAL ELECTRIC GE 15-1/J79A3 ENGINE

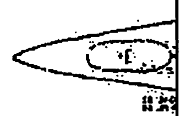
LANDING GEAR

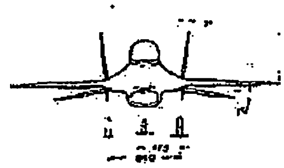
MAIN GEAR TIRE	22×5.5
NOSE GEAR TIRE	15×4.5

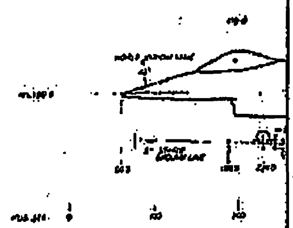
TAIL LENGTHS

C/4 WING TO C/4 VERT TAIL	11.61 FT
C/4 WING TO C/4 HORIZ TAIL	12.56 FT

MISSION WEIGHT - 13000 LB







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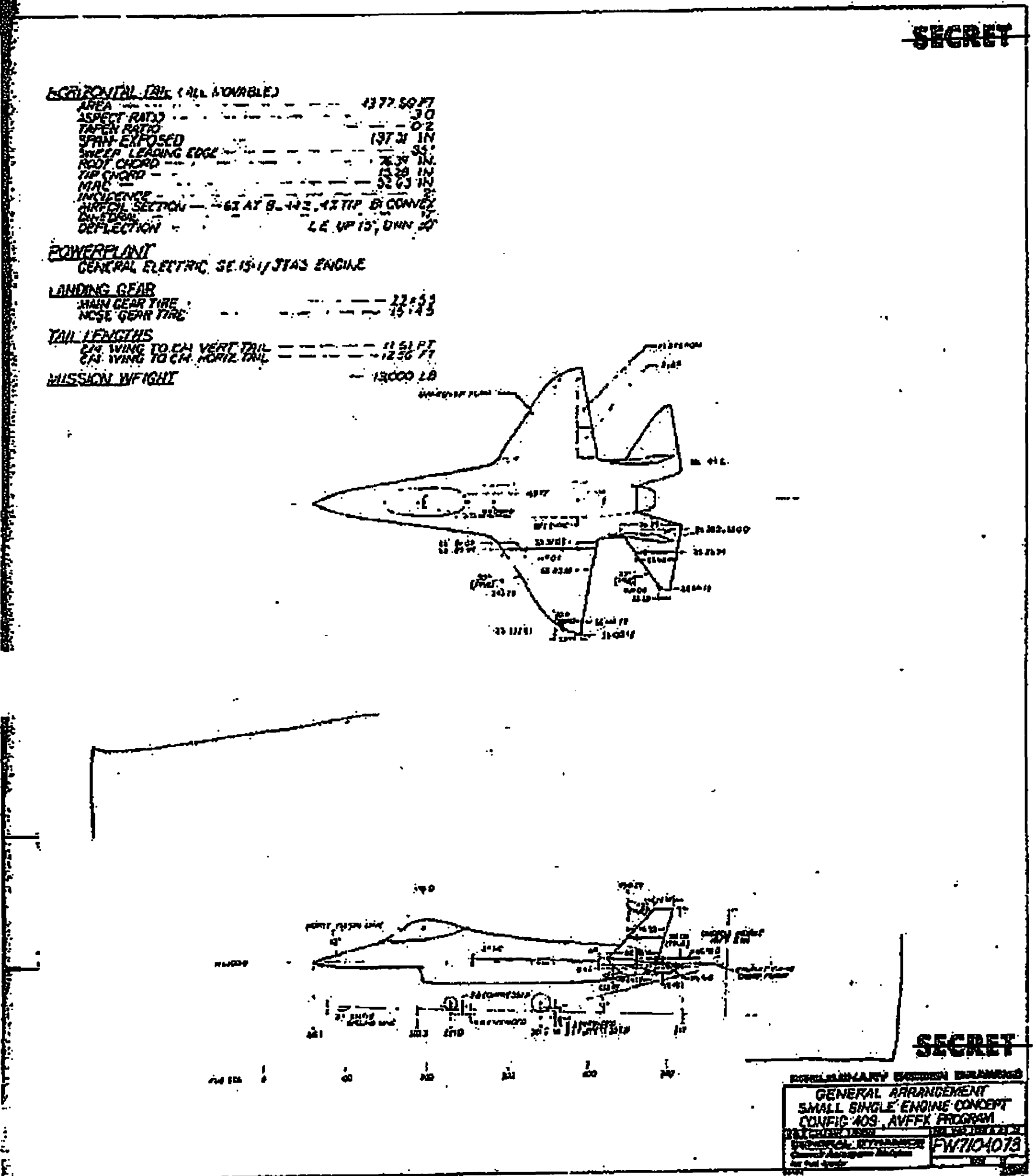
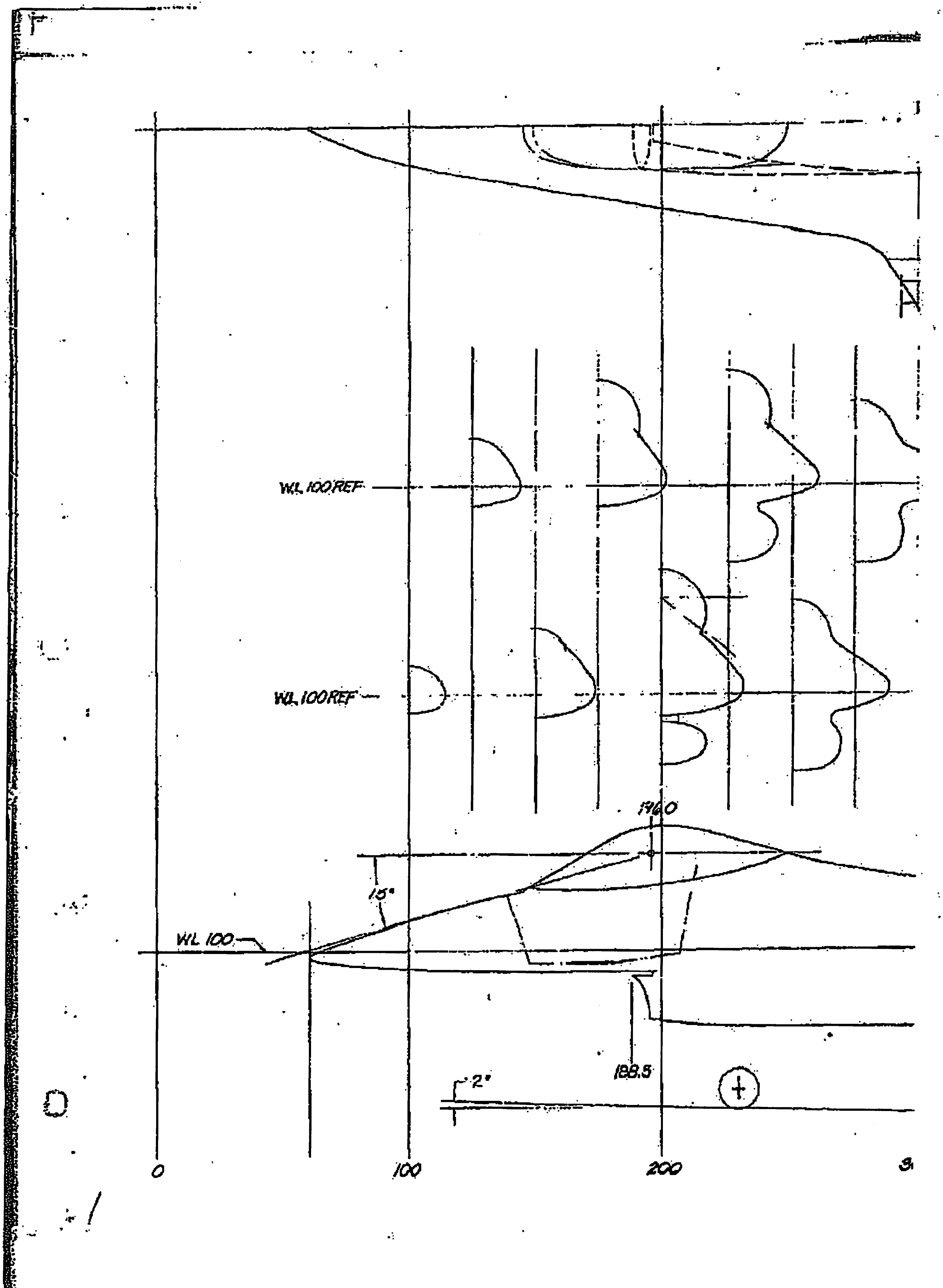
~~(S)~~ Fi

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

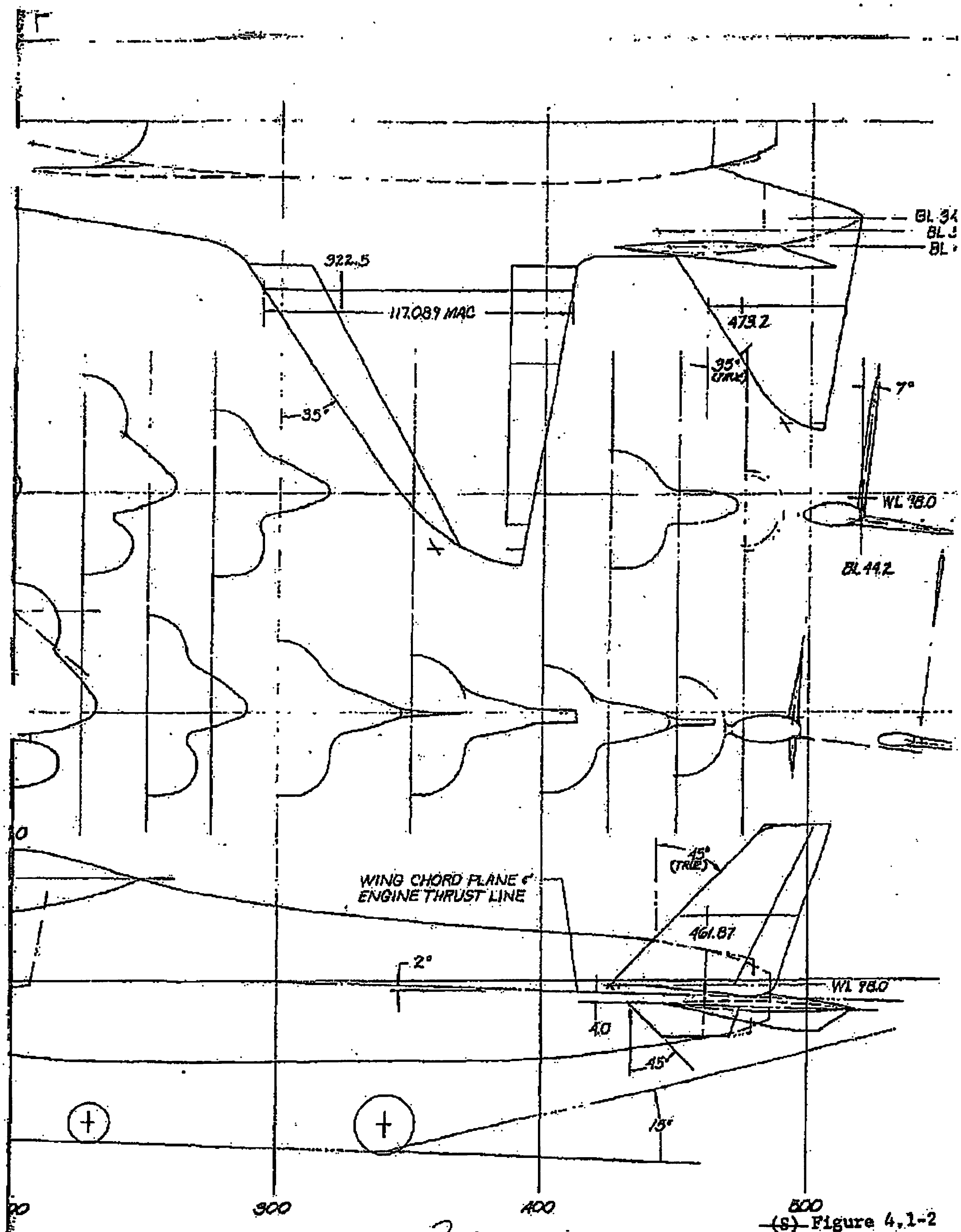


~~(S)~~ Figure 4.1-1 General Arrangement Small Single-Engine Concept Configuration 403 (U) 201/202

2



WL 100 REF
WL 100 REF
146.0
15°
WL 100
188.5
2"
0
100
200



(S) Figure 4.1-2

2

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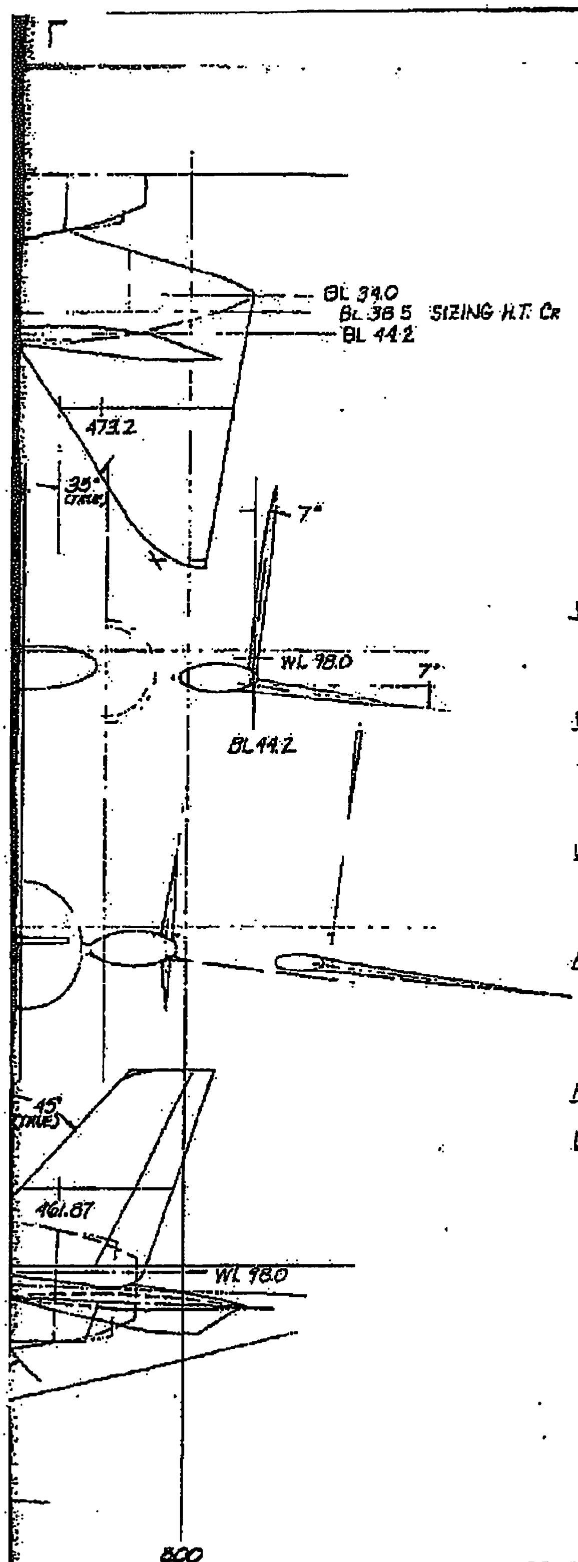

BASIC DATA

WING		
REF. AREA		216.67 SQ.FT.
ASPECT RATIO		3.0
TAPER RATIO		0.2
AIRFOIL SECTION		4% BI-CONVEX
VERTICAL TAIL		
AREA (PER TAIL)		17.6 SQ.FT.
ASPECT RATIO		1.33
TAPER RATIO		0.4
AIRFOIL SECTION	ROOT	6% BI-CONVEX
	TIP	4% BI-CONVEX
VENTRAL FIN		
AREA (PER FIN)		2.9 SQ.FT.
ASPECT RATIO		0.3735
TAPER RATIO		0.59574
AIRFOIL SECTION		6% BI-CONVEX
HORIZONTAL TAIL		
SIZING AREA		43.77 SQ.FT.
ASPECT RATIO		3.0
TAPER RATIO		0.2
AIRFOIL SECTION	TIP	4% BI-CONVEX
	BL 44.2	6% BI-CONVEX
POWERPLANT		
GENERAL ELECTRIC GE 15-1/J1A5 ENGINE		
DESIGN GROSS WEIGHT		19,000 LBS

~~SECRET~~

PRELIMINARY DESIGN DRAWING

— LINES LAYOUT —
SMALL SINGLE ENGINE CONCEPT
CONFIG. 403. AVFFX PROGRAM

R.J. CSASZAR	APPROVED	SCALE 1/20	DATE 6-18-71
GENERAL DYNAMICS Convair Aerospace Division Fort Worth Operation		FW7104067	SHEET

~~(S)~~ Figure 4.1-2 Lines - Small Single-Engine Concept Configuration 403 (U)

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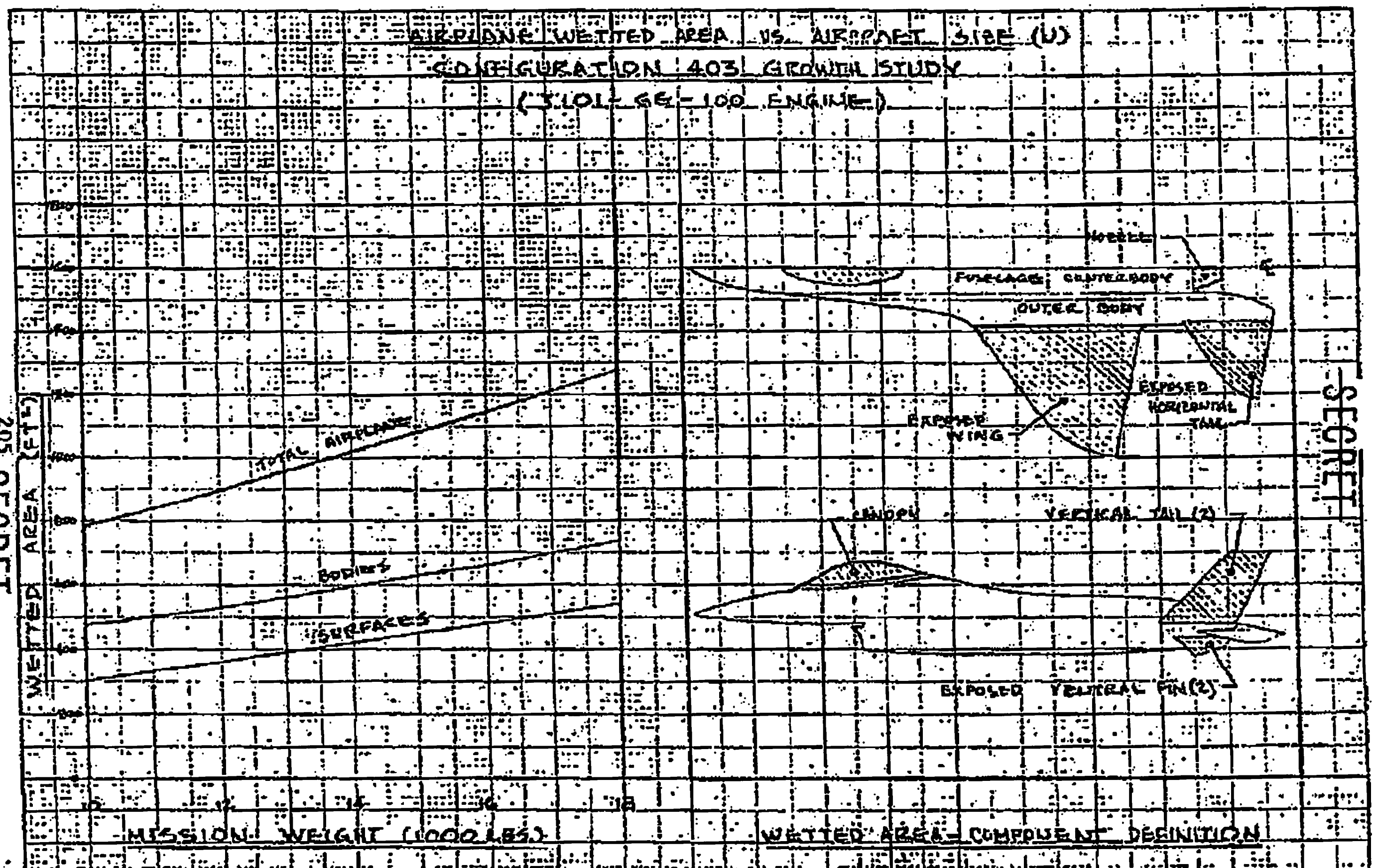

(S) Figure 4.1-3 Aircraft Wetted Area vs. Aircraft Size - Small Single-Engine Concept (U)

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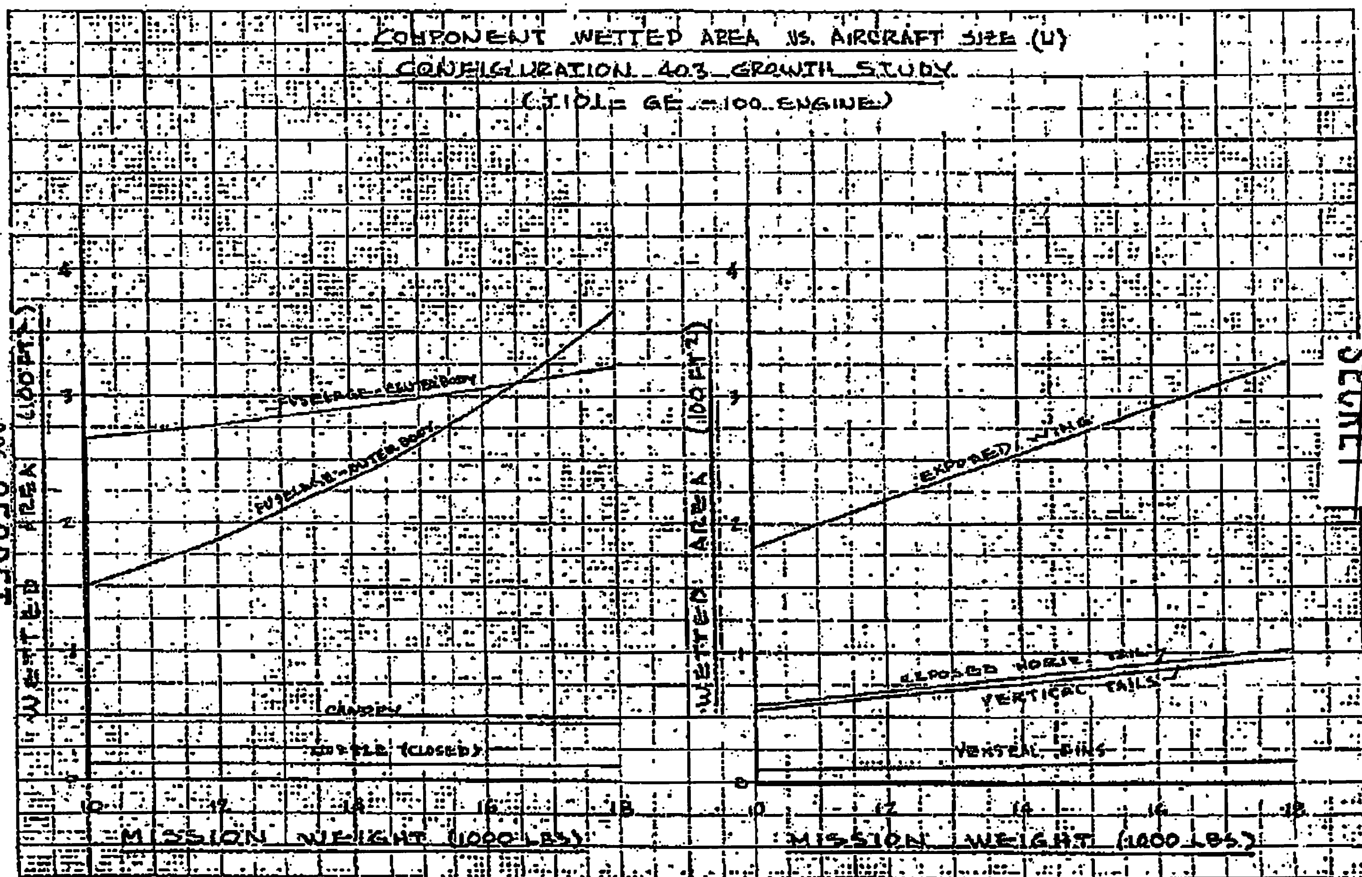
SECRET

206



(S) Figure 4.1-4 Aircraft Component Wetted Area vs. Aircraft Size - Small Single-Engine Concept (U)

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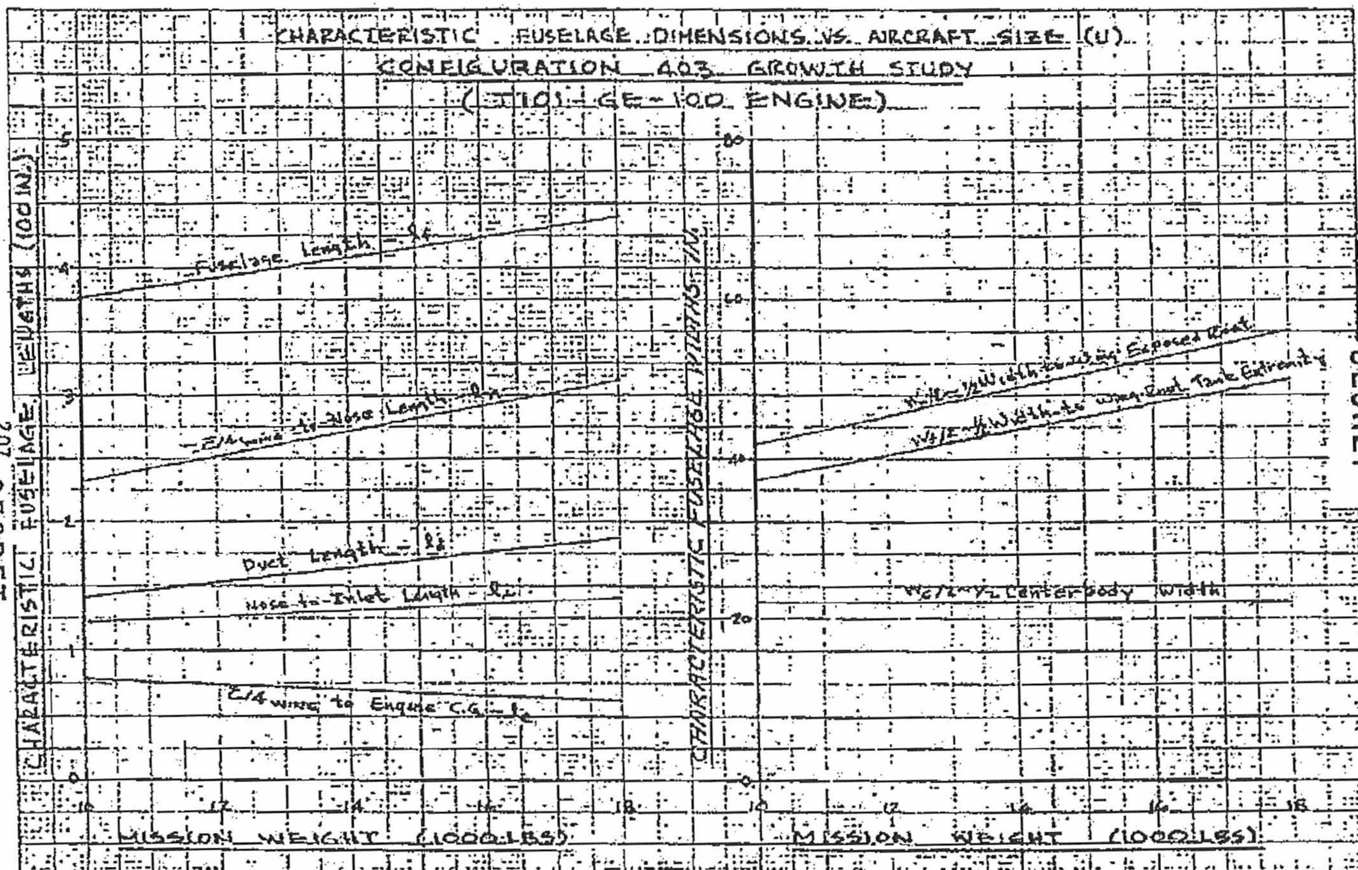

(S) Figure 4.1-5 Aircraft Fuselage Dimensions vs. Aircraft Size - Small Single-Engine Concept (U)

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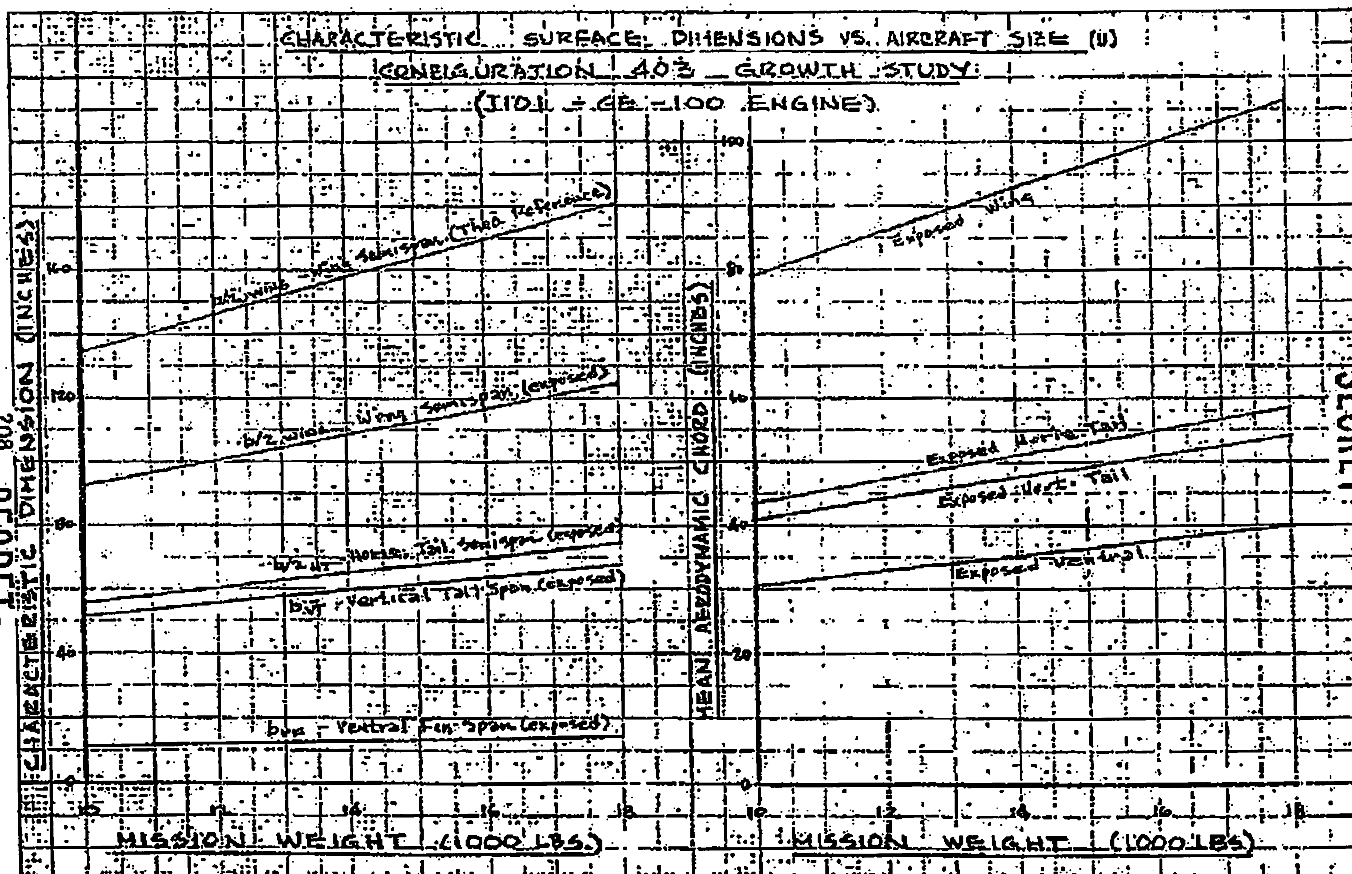

(S) Figure 4.1-6 Aircraft Surface Dimensions vs. Aircraft Size - Small Single-Engine Concept (U)

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BASIC DESCRIPTION ~~SECRET~~

G.W. = 10,000 LBS.
W/S = 60 LBS./FT²
T/W = 1.4295 (UNINSTALLED)
ENGINE ~ GE J1A5
~ A.F. Designation J101-GE-100)

BODIES

	LENGTH (IN.)	X (IN.)	Y (IN.)	Z (IN.)
FUSELAGE ~~Centerbody~~ Wo/Canopy	396.0	0	0	0
Fuselage Outerbody	342.0	63.0	±30	0
Canopy	130.0	85.0	0	+39.0

WING REF. AREA (IN²)
24000.48

SURFACES

	WING (NOMINAL) 0° incidence	HORIZ. TAIL 3° incidence	VERT. TAIL (Per side)	VENTRAL (Per side)
AREA (FT²)	166.67	72.84	13.69	2.26
AR - ASPECT RATIO	3.00	3.41	1.33	0.3733
λ - TAPER RATIO	0.20	0.137	0.40	0.5957
E_1 (L.E.)	+ 55°	+55°	+ 45°	+ 45°
E_2	+10°41'	+10°41'	−19°22'	−19°22'
a - CUTOUT = $\frac{\tan E_2}{\tan(90-E_1)}$				
C_R - ROOT CHORD (IN.)	149.071	97.493	55.00	37.01
C_T - TIP CHORD (IN.)	29.814	13.400	22.00	22.05
b - SPAN (IN.)	268.328	189.184	51.20	11.02
AIRFOIL	4% BICONVEX	6% @ root (exp) 4% @ tip BICONVEX	6% @ root 4% @ tip BICONVEX	6% BICONVEX
d (IN.)	41.70	39.29	0	0
x (IN.)	199.00	339.0	322.0	328.5
y (IN.)	0	0	±41.68	±39.0
z (IN.)	−4.50	−15.14	−9.00	−16.00
	0° DIHEDRAL	15° NEG. DIHEDRAL	[illegible] CANT	5° CANT

d = Average buried semi-span
x = Distance aft from fuselage nose to body nose or surface fuselage intersection point.
y = Distance outbd from fuselage ref. line to body ref. line or vertical surface chord line.
z = Distance up (+) or down (−) from fuselage ref. line (WL100) to body or surface ref line.

8061-31

~~(S)~~ Figure 4.1-7 Basic Description Data Sheet - Configuration 403 Type at 10,000-lb Mission Weight (U)

~~SECRET~~

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

BASIC DESCRIPTION ~~SECRET~~

G.W. = 13,000 LBS.
W/S = 60 LBS/FT²
T/W = 1.0996 (uninstalled)
Engine = Gen. Elec. J1A5
AF Designation J10FGE-100

BODIES

	LENGTH (IN.)	X (IN.)	Y (IN.)	Z (IN.)
FUSELAGE CENTERBODY (w/o canopy)	* 418.5	0	0	0
Fuselage Outer body	316.5	82.0	± 34	0
Canopy	130.0	85.0	0	+39.0

(* length includes nozzle in open position)

WING REF. AREA (IN²)
31,200.48

Note: Dimensions shown in chord plane of surface.

SURFACES

	2° incidence WING (nominal)	2° incidence HORIZ TAIL (nominal)	(Per Side) Vert Tail	(Per Side) VENTRAL FIN
AREA (FT²)	216.67	94.26	17.60	2.90
AR - ASPECT RATIO	3.00	3.41	1.33	0.3733
λ - TAPER RATIO	0.20	0.1378	0.40	0.59574
L.E. E_1	+ 55°	+55°	+ 45°	+ 45°
T.E. E_2	+10°41'	+10°41'	-19°22'	+19°22'
a - CUTOUT = $\frac{\tan E_2}{\tan(90-E_1)}$				
C_R - ROOT CHORD (IN.)	169.967	110.907	62.361	41.920
C_T - TIP CHORD (IN.)	33.993	15.279	24.944	24.973
b - SPAN (IN.)	305.941	215.152	58.058	12.486
AIRFOIL	4% Biconvex	6% @ exposed root 4% @ tip Biconvex	6% @ root 4% @ tip Biconvex	6% Biconvex
d (IN.)	47.5	44.53	0	0
x (IN.)	224.5	385.0	364.9	371.9
y (IN.)	0	0	± 47.23	± 44.2
z (IN.)	0	- 11.0	0	- 7.0
	0° DIHEDRAL	1° NEG. DIHEDRAL	7° OUTBD CANT	0° CANT

d = Average buried semi-span
x = Distance aft from fuselage nose to body nose or surface fuselage intersection point.
y = Distance outbd from fuselage ref. line to body ref. line or vertical surface chord line. (WL 99.0 Reference line)
z = Distance up (+) or down (-) from fuselage ref. line to body or surface ref line.

8061-14

~~(S)~~ Figure 4.1-8 Basic Description Data Sheet - Configuration 403 Type at 13,000-lb Mission Weight (U)

~~SECRET~~

BASIC DESCRIPTION ~~SECRET~~

G.W. = 16,800 LBS
W/S = 60 LBS/FT²
T/W = 0.85089
Engine ~ GE J1A5
(AF Designation J101-GE-100

BODIES

	LENGTH (IN.)	X (IN.)	Y (IN.)	Z (IN.)
FUSELAGE CENTERBODY W/O CANOPY	452.0	0	0	0
FUSELAGE OUTER BODY	449.0	74.0	±40.0	0
CANOPY	130.0	85.0	0	+39.0

WING REF. AREA (IN²): 40,320

SURFACES

	3° INCIDENCE WING (GROSS)	5° INCIDENCE (DN) HORIZ. TAIL	(PER SIDE) VERT. TAIL	(PER SIDE) VENTRAL
AREA (FT²)	280.00	123.14	22.12	3.646
AR - ASPECT RATIO	3.00	3.415	1.33	0.3733
λ - TAPER RATIO	0.20	0.137	0.40	0.59574
L.E. E_1 (+)	+55°	+55°	+45°	+45°
T.E. E_2 (+)	+10°41'	+10°41'	-19°22'	+19°22'
a - CUTOUT = $\frac{\tan E_2}{\tan(90-E_1)}$				
C_R - ROOT CHORD (IN.)	193.218	126.74	70	47.03
C_T - TIP CHORD (IN.)	38.644	17.37	28	28.02
b - SPAN (IN.)	347.793	246.09	65	14.01
AIRFOIL	4% BICONVEX	6% Biconv. @ exposed root, 4% Biconv. @ tip, exposed @ BL 51.5	6% Biconv. @ root, 4% Biconv @ tip, root @ WL 92.0	6% BICONVEX
d (IN.)	54.00	51.99	0	0
x (IN.)	257.50	440.00	419.50	429.50
y (IN.)	0	0	±54.40	51.00
z (IN.)	0	-13.90	-2.00	-13.00
	0° DIHEDRAL	7° NEG DIHEDRAL	7° OUTBD CANT	0° CANT

d = Average buried semi-span
x = Distance aft from fuselage nose to body nose or surface fuselage intersection point.
y = Distance outbd from fuselage ref. line to body ref. line or vertical surface chord line.
z = Distance up (+) or down (-) from fuselage ref. line WL 92.0 to body or surface ref line.

8061-1h

~~(S)~~ Figure 4.1-9 Basic Description Data Sheet - Configuration 403 Type at 16,800-lb Mission Weight (U)

~~SECRET~~

FRICTION DRAG DATA
G.W. = 10,000 LBS.
W/S = 60 LBS/FT²
T/W = 1.4295 (UNINSTALLED)
ENGINE — GE J1A5 (AF Desig. J101-GE-100)

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

BODIES

BODY	WETTED AREA (FT^2)		LENGTH (IN)	WIDTH (IN)	HEIGHT (IN)
Fuselage Centerbody		266.0	* 402.0	44.0	63.0
Fuselage Outerbody		152.1	346.0	22.0	[illegible]
Canopy (incl fairing)		44.4	130.0	34.0	16.0
Nozzle - Closed		12.6	25.05	32.4 DIA.	[illegible] DIA.
Nozzle - Open	12.0		19.50	32.4 DIA.	32.4 DIA.
BODY TOTAL		475.1			

* Length includes nozzle closed (Δwet for nozzle shown separately)

SURFACES

SURFACE	WETTED AREA (FT^2)		EXPOSED MAC LENGTH (IN)	MAX. THICKNESS SWEEP (DEG.)	AIRFOIL
WING		182.1	78.85	14° 30'	4% Biconvex
HORIZ. TAIL		58.3	43.28	14° 30'	[illegible] Biconvex
VERT. TAIL (2)		54.8	40.86	34° 15'	[illegible]
VENTRAL FIN (2)		9.0	30.16	[illegible]°45'	6% Biconvex
SURFACE TOTAL		304.2			
AIRPLANE TOTAL		779.3			

BASIC WING GEOMETRY:

	TRAPEZOIDAL SHAPE BASIC REFERENCE WING	TRAPEZOIDAL SHAPE FOR CLIPPED TIP WING
AREA (FT^2)	166.67	168.666
ASPECT RATIO	3.00	3.20
TAPER RATIO	0.20	0.1695
LEADING EDGE SWEEP (DEG.)	35.0	35.0

$\Delta A_{wet} = 4.4 ft^2$

~~SECRET~~

8061-13

~~(S)~~ Figure 4.1-10 Friction Drag Data Sheet - Configuration 403 Type at 10,000-lb Mission Weight (U)

~~SECRET~~

FRICTION DRAG DATA
G.W. = 13,000 LBS
W/S = 60.0 LBS/FT²
T/W = 1.0996 (UNINSTALLED)
ENGINE - GE, J1A5 Engine
BODIES (AF Designation J-101-GE-100)

BODY	WETTED AREA (FT^2)		LENGTH (IN)	MAX. WIDTH (IN)	MAX. HEIGHT (IN)
(BL 72 inbd) Fuselage Centerbody		284.0	* 425.0	44.0	63.0
(BL 72-485) Fuselage Outerbody		218.0	376.5	25.5	21.5
Canopy (incl fairing)		44.4	130.0	34.0	16.0
Nozzle - Closed		12.6	25.05	32.4 DIA	32.4 DIA
Nozzle - Open	12.0	—	19.50	32.4 DIA	32.4 DIA
BODY TOTAL		559.0	*length includes nozzle closed (Awet for nozzle shown separately)		

SURFACES

SURFACE	WETTED AREA (FT^2)		EXPOSED MAC LENGTH (IN)	MAX. THICKNESS SWEEP (DEG.)	AIRFOIL
WING		236.9	89.93	14°30'	4% Biconvex
HORIZ. TAIL		75.8	49.34	14°30'	6% Biconvex @ root, 4% Biconvex @ tip
VERT. TAIL (2)		70.4	46.33	34°15'	6% Biconvex @ root, 4% Biconvex @ tip
VENTRAL FIN (2)		11.6	34.16	17°45'	6% Biconvex
SURFACE TOTAL		394.7			
AIRPLANE TOTAL		953.7			

88th ABW/IPI
FOIA (b)(1)
E.O. 13526 SEO:
3.3 (b)(4)
1.4 (a)(g)
3.3(b)(4)
1.4(A)(G)

BASIC WING GEOMETRY:

	TRAPEZOID SHAPE BASIC REFERENCE WING	TRAPEZOID SHAPE FOR CURVED TIP WING
AREA (FT^2)	216.67	219.265
ASPECT RATIO	3.00	3.20
TAPER RATIO	0.20	0.1685
LEADING EDGE SWEEP (DEG.)	35.0	35.0

← ΔAwet = 5.2 ft²

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~~(S)~~ Figure 4.1-11 Friction Drag Data Sheet - Configuration 403 Type at 13,000-lb Mission Weight (U)

~~SECRET~~

FRICTION DRAG DATA
GW = 16,400 LBS
W/S = 60 LBS / FT²
T/W = 0.85039

ENGINE ~ GE 31A5 (AF Propulsion J-101-GE-100)

BODIES

BODY	WETTED AREA (FT²)		LENGTH (IN)	MAX. WIDTH (IN)	MAX. HEIGHT (IN)
Fuselage Centerbody		312.5	* 457.0	44.0	63.0
Fuselage Outerbody		323.6	449.0	32.0	18.0
Canopy (incl. Fairing)		44.4	130.0	34.0	16.0
Nozzle-Closed		12.6	25.05	32.4 DIA	32.4 DIA
Nozzle-Open	12.0	—	19.50	32.4 DIA	32.4 DIA
BODY TOTAL		693.1			

* Length includes nozzle closed (Awet for nozzle shown separately)

SURFACES

SURFACE	WETTED AREA (FT²)		EXPOSED MAC LENGTH (IN)	MAX. THICKNESS SWEEP (DEG.)	AIRFOIL
WING		306.2	107.2	14° 30'	4% BICONVEX
HORIZ. TAIL		98.0	56.1	14° 30'	6% BICONV - ROOT, 4% BICONV - TIP } exp.
VERT. TAIL (2)		88.5	52.0	34° 15'	6% BICONV - ROOT, 4% BICONV - TIP
VENTRAL FIN (2)		14.6	38.3	17° 45'	6% BICONVEX
SURFACE TOTAL		507.3			
AIRPLANE TOTAL		1200.4			

BASIC WING GEOMETRY:

	Trapezoid Shape Basic Reference Wing	Trapezoid Shape for Curved Tip Wing
AREA (FT²)	280	293.353
ASPECT RATIO	3.0	3.20
TAPER RATIO	0.20	0.1689
LEADING EDGE SWEEP (DEG.)	35.0	35.0

Δ Awet = + 6.7 ft²

~~SECRET~~

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~~(S)~~ Figure 4.1-12 Friction Drag Data Sheet - Configuration 403 Type at 16,800-lb Mission Weight (U)

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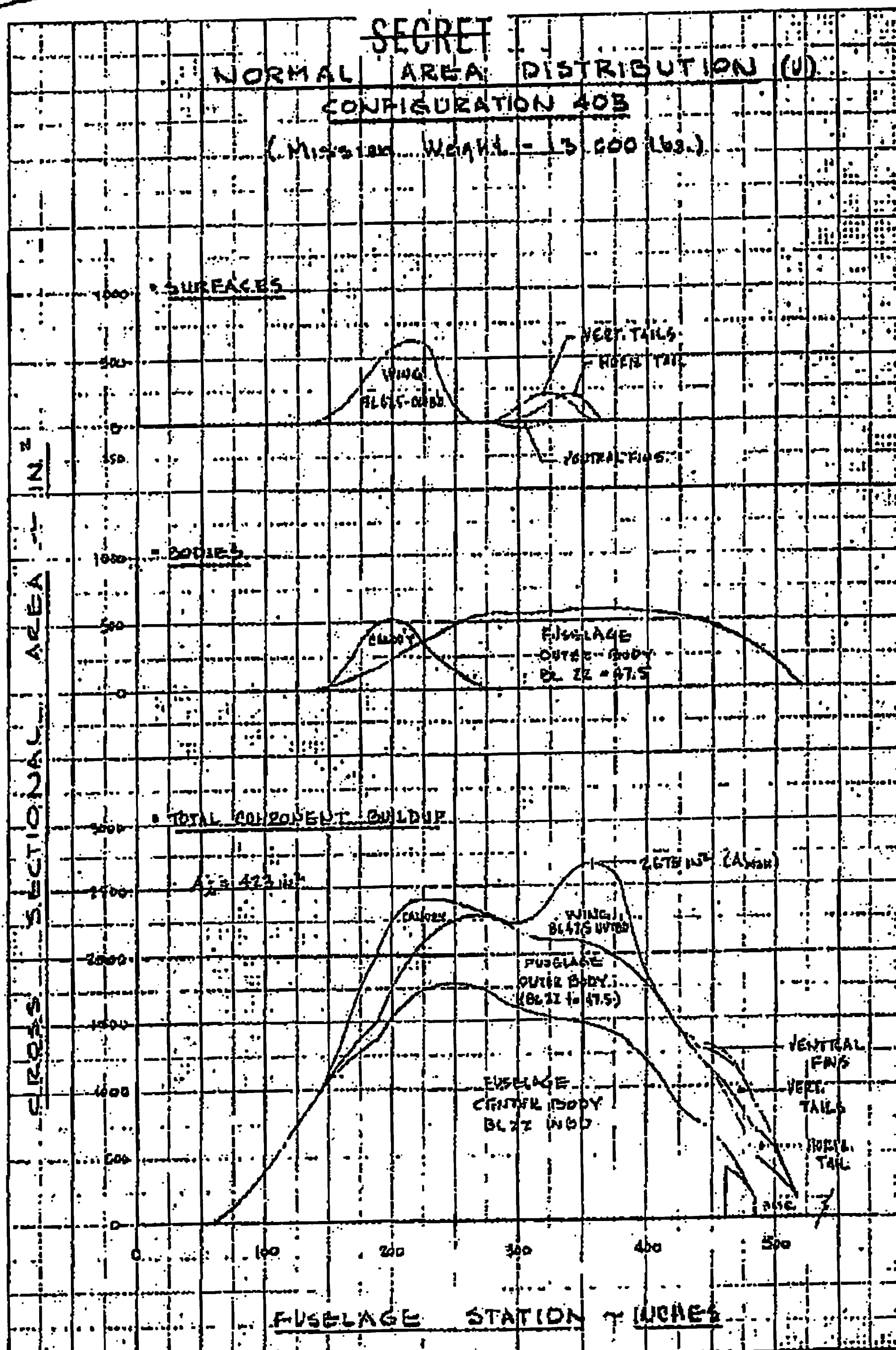
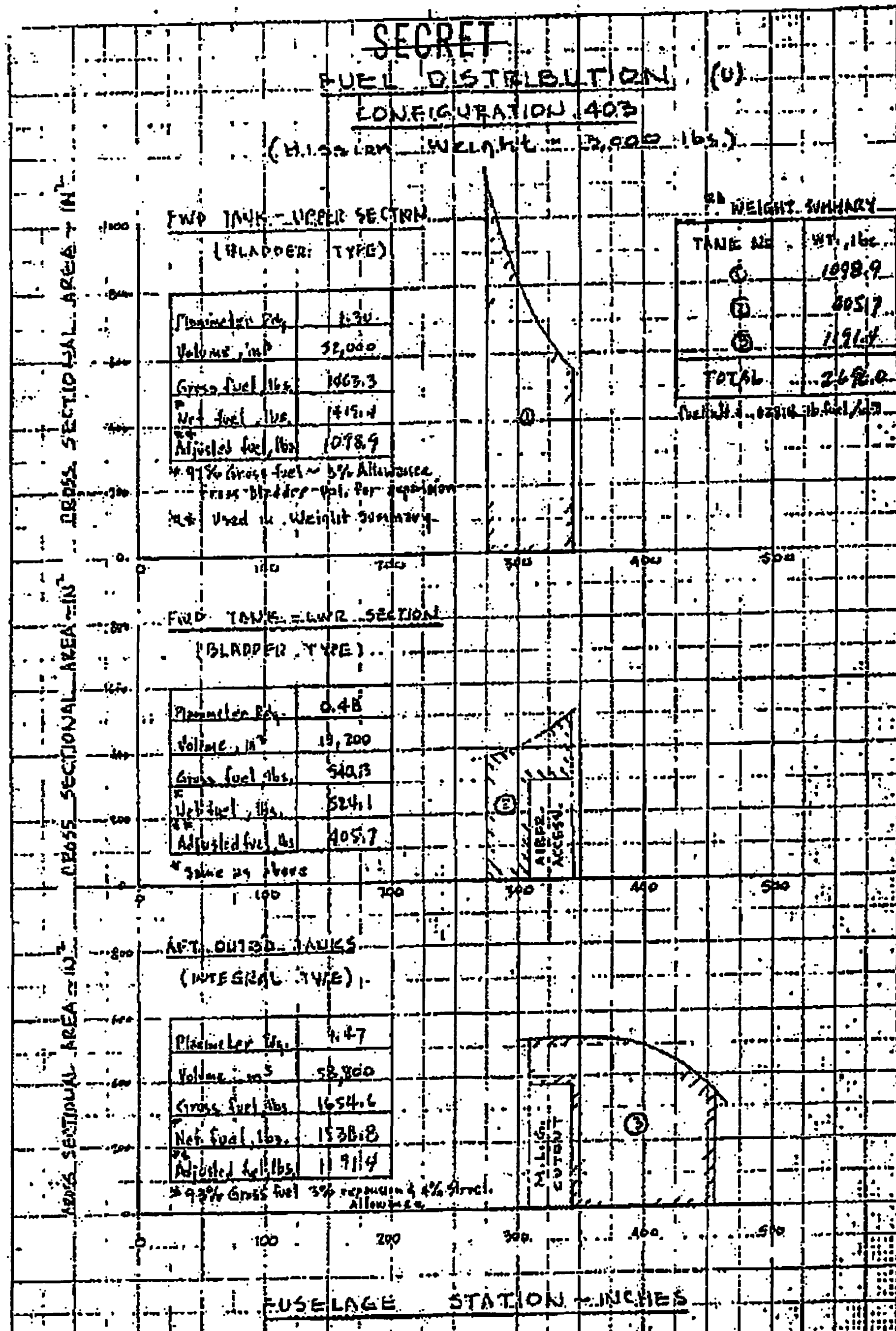


~~(S)~~ Figure 4.1-13 Area Distribution Curve - Small Single-Engine Concept Configuration 403 (U)



~~(S)~~ Figure 4.1-14 Fuel Distribution Curve - Small Single-Engine Concept Configuration 403 (U)

88th ABW/IP
FOIA (b)(1) (b)(3)
E.O. 13526 SEC. 3.3(b)(4) & (6)
1.4 (a)(g)(b)(4)
1.4 (A)(G)

~~SECRET~~

4.2 PERFORMANCE

(S) Basic performance data computed for the small single-engine concept, Configuration 403, are based on the same mission definitions and performance rules as presented in Section 3.2 for Configuration 401B. Calculations were made on aircraft of three sizes. These were a 13,000-lb size used for the design layout and two growth versions discussed in Section 4.1. The basic data used in the performance calculations are presented in Sections 4.3 through 4.6.

(S) The mission performance capabilities of Configuration 403 at 13,000 lb are summarized in Figure 4.2-1. The performance of Configuration 403 at 13,000 lb is far from satisfactory. The LRASM radius is only 146 n.mi., and the SRASM is not possible under the existing ground rules because the fuel allowances for takeoff, climb, combat, and landing exceed the fuel capacity. Even growing the aircraft, as shown in Figure 4.2-2, will not accomplish the desired mission radius for either the LRASM or the SRASM. The problem with the larger-sized aircraft is the small thrust excess during acceleration. Growing the airplane in size (without increasing engine size) results in lower acceleration capabilities, which require more time and fuel for the acceleration portion of the combat allowance. When the aircraft is grown to approximately 18,500 lb it is incapable of accelerating to Mach 1.5 and cannot perform the mission.

(U) The small single-engine concept was dropped from further consideration.

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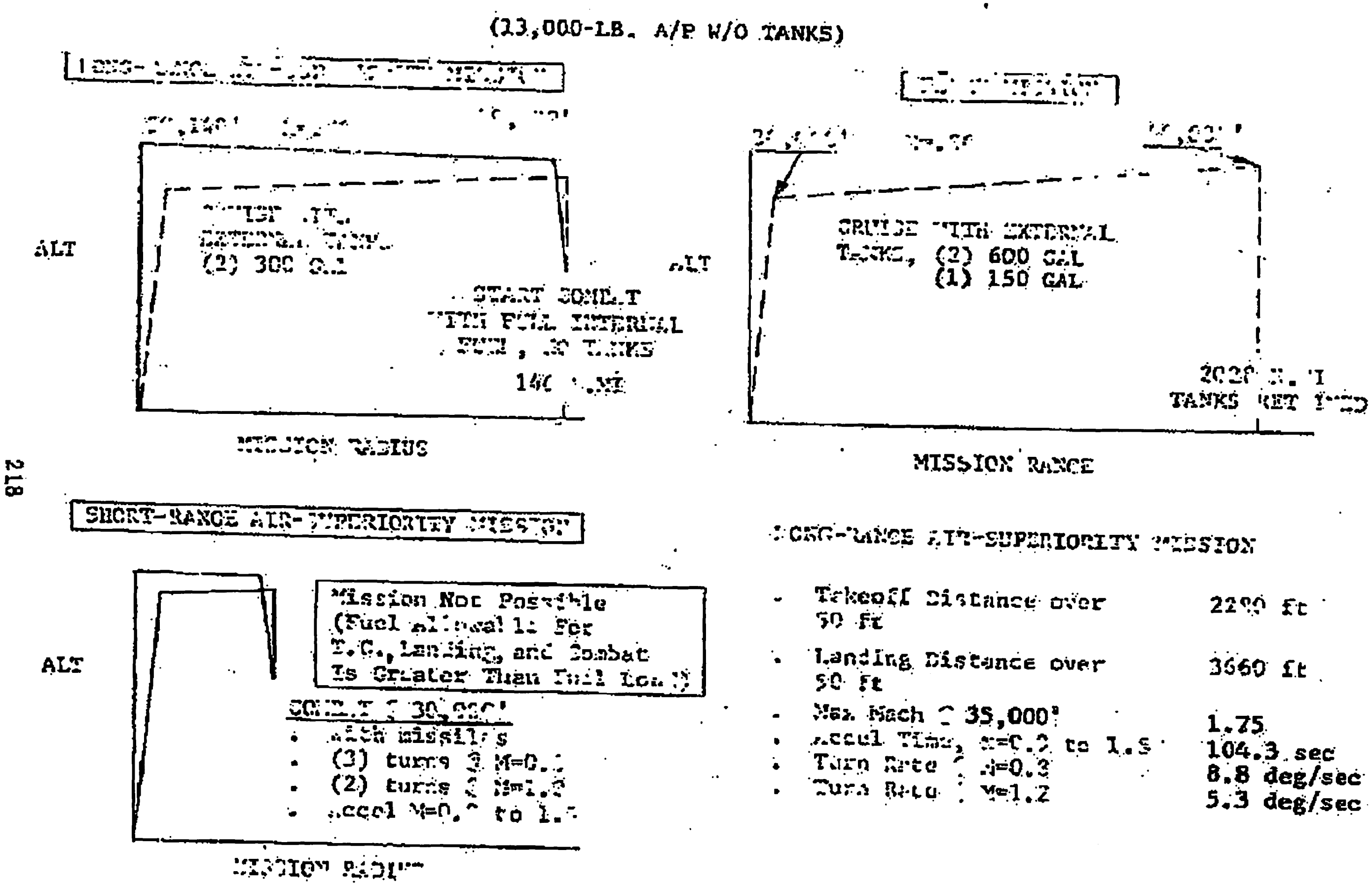

~~(S)~~ Figure 4.2-1 Configuration 403 Mission Performance Summary (U)

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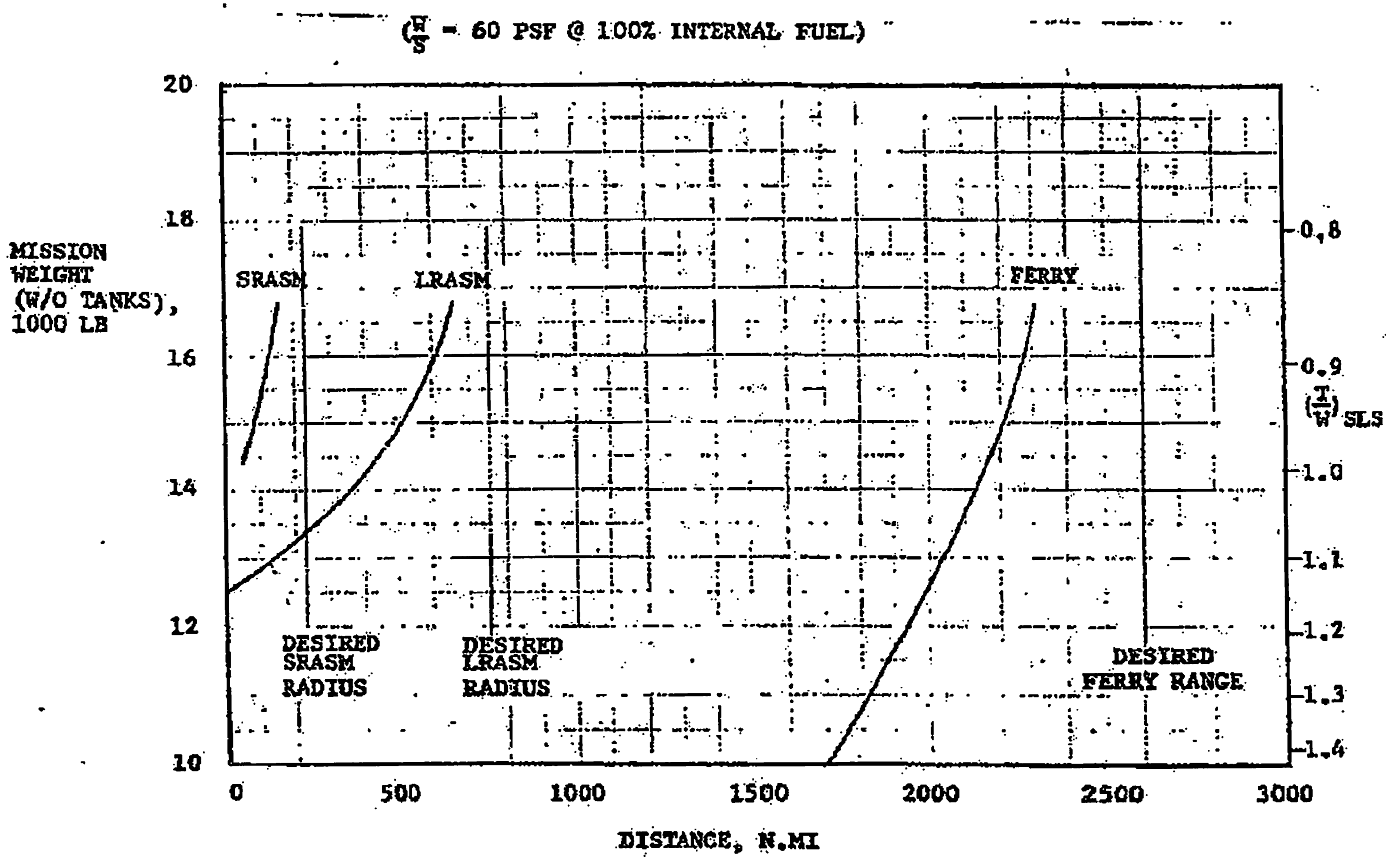
219



~~(S)~~ Figure 4.2-2 Configuration 403 Growth Curve (U)

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