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EFFECT OF EMERGING TECHNOLOGY ON A CONVERTIBLE, BUSINESS/INTERCEPTOR, SUPERSONIC-CRUISE JET

F. L. Beissner, Jr., W. A. Lovell, A. Warner Robins, and E. E. Swanson

PRC Kentron, Inc.
Aerospace Technologies Division
Hampton, Virginia 23666

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Space Administration

Langley Research Center
Hampton, Virginia 23665

SUMMARY

This study was initiated to assess the feasibility of an eight-passenger, supersonic-cruise long range business jet aircraft concept that could be converted into a military missile carrying interceptor. The baseline passenger version has a flight crew of two with cabin space for four rows of two passenger seats plus baggage and lavatory room in the aft cabin. The ramp weight is 61,600 pounds with an internal fuel capacity of 30,904 pounds. Utilizing an improved version of a current technology low-bypass ratio turbofan engine, range is 3,622 nautical miles at Mach 2.0 cruise and standard day operating conditions. Balanced field takeoff distance is 6,600 feet and landing distance is 5,170 feet at 44,737 pounds. A typical overland mission of New York to Los Angeles was evaluated and resulted in a ramp weight of 49,702 pounds for the 2,130 nautical mile range. By flying an optimum climb/accelerate profile, sonic boom overpressure would be less than 1.0 psf. In addition, a maximum range subsonic mission was analyzed and resulted in 3,780 nautical miles at Mach 0.95 cruise.

The passenger cabin section from aft of the flight crew station to the aft pressure bulkhead in the cabin was modified for the interceptor version. Internal structural and equipment modifications were made in this area only. Bomb bay type doors were added and volume is sufficient for four advanced air-to-air missiles mounted on a rotary launcher. Missile volume was based on a Phoenix type missile with a weight of 910 pounds per missile for a total payload weight of 3,640 pounds. Structural and equipment weights were adjusted and result in a ramp weight of 63,246 pounds with a fuel load of 30,938 pounds. Based on a typical intercept mission flight profile, the resulting radius is 1,609 nautical miles at a cruise Mach number of 2.0. Takeoff and landing performance for the interceptor version is essentially the same as for the passenger version.

INTRODUCTION

Studies of the application of advanced sustained supersonic cruise aerodynamic technologies have resulted in the concepts reported in references I-1, I-2, II-1, and II-2. From the results of these studies an investigation was initiated, and reported herein, to determine the feasibility of designing a long range supersonic-cruise, eight-passenger executive aircraft that could be converted into a missile carrying, military interceptor type aircraft. The main study constraint was that the external geometry of the concept would be retained so that aerodynamic performance would be the same for both missions. Only those internal structural and equipment changes necessary to convert from a passenger to an internal missile carrying concept would be permitted. For the passenger version, the following constraints and targets were established.

- o Cabin room for eight passengers and baggage plus lavatory.
- o Minimum cruise Mach number 2.0.
- o Two man flight crew.
- o Design range 3,650 nautical miles.
- o Takeoff and landing field length to be a fallout.
- o Improved version of a current technology low-bypass ratio turbofan engine.
- o Standard FAR flight rules for mission analysis to determine range and fuel reserves.

For the missile/interceptor version, internal volume is to be sufficient to carry four Phoenix type missiles and the required electronic and hydraulic provisions and equipment. The ramp weight and mission radius will be based on maximum internal fuel capacity only, and, therefore, radius is a fallout of the performance analysis. The mission profile is a representative but hypothetical mission.

SYMBOLS

A_x	cross-section area
c	wing chord
$\bar{c}$	mean geometric chord
C_D	drag coefficient, $(\frac{Drag}{qS})$
C_L	lift coefficient $(\frac{Lift}{qS})$
g	acceleration due to gravity
h	altitude
L/D	lift-drag ratio (C_L/C_D)
M	Mach number
Δp	sonic-boom overpressure
q	freestream dynamic pressure
S or S_{ref}	wing reference area
W	aircraft weight
x, y, z	Cartesian coordinates
α	angle of attack
δ	deflection angle of movable surface, normal to hinge line

Subscripts:

f	friction
F	wing flap
FIF	full internal fuel
H	horizontal tail
i	induced
LE	leading edge
LEF	leading-edge flap

LET	leading-edge thrust
max	maximum
R	roughness
TE	trailing edge
TEF	trailing-edge flap
W	wave

PART I. - CONFIGURATION DESCRIPTION

E. E. Swanson

This study in this report was initiated to assess the feasibility of an eight passenger, supersonic-cruise long range business jet aircraft concept that could be converted into a missile carrying interceptor. The baseline configuration is similar to those studied and reported in references I-1 and I-2. The primary study objective is to configure an eight passenger two-man flight crew concept with a targeted range of approximately 3,650 nautical miles at a cruise Mach number of 2.0 using a modified version of a low-bypass ratio turbofan engine.For the interceptor conversion, the envelope dimensions and weight provision for four advanced Phoenix type missiles would be provided internally with the cruise range to be a fallout based on maximum fuel available on board. No external line changes for conversion from the passenger version is required. A general arrangement of the concept is shown in figure I-1. Table I-1 lists the geometric characteristics of the study concept.

Figure I-2 shows the interior arrangement comparison for both the passenger and interceptor versions. In the passenger version the main fuselage section contains four rows of two seats with an elliptical cross section as shown in figure I-3. The two place flight crew is located forward of the entrance door with a visor nose provided for improved pilot vision during takeoff and landing. Main landing gear is a two wheel single strut arrangement, wing mounted, and retracts into the fuselage forward of the wing carry-through structure. Nose landing gear is mounted forward of the entrance door and retracts forward below the flight crew compartment. A combined lavatory and baggage area is located in the aft end of the passenger section and provides space for approximately 50 cubic feet of passenger and crew baggage. Environmental control and electrical system space is provided aft of the passenger section pressure bulkhead. Engine accessories and hydraulics are located in the fuselage body below the wing carry-through structure. Accessories are powered by a quill shaft from each under wing mounted engine. The remaining fuselage volume is used for fuel tanks as shown. Wing fuel is located in integral tanks similar to that of reference 1, adjusted in volume to reflect the change in wing area.

For the interceptor conversion, it was assumed that the aircraft would be unchanged aft of the passenger section pressure bulkhead. All structure and subsystems would remain the same. The pressure bulkhead would be moved to a position directly aft of the entrance door. The four Phoenix type missiles would be mounted on a rotary launcher in the passenger/baggage section of the fuselage. This fuselage section could be replaced or provisions designed into the passenger version to permit a bomb bay door to be installed in the lower fuselage. Any additional power requirements, such as electrical or hydraulics, would be provided as part of the missile installation package. Missile related electronic systems are mounted aft of the crew station across from the entrance door. The crew instrument panels and nose mounted radar would be replaced as required to satisfy discrete missile operating systems and requirements.

REFERENCES

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I-2. Beissner, F. L. Jr.; Lovell, W.A.; Robins, A. Warner; and Swanson, E. E.: Effect of Advanced Technology and a Fuel-Efficient Engine on a Supersonic-Cruise Executive Jet with a Small Cabin. NASA CR-172190, August 1983.

TABLE I-I. - GEOMETRIC CHARACTERISTICS

GEOMETRY		WING	HORIZONTAL	VERTICAL
Area (Gross), S	ft^2	1067	71	65.4
Area (Ref), S_{REF}	ft^2	972	71	55.6
Mac (Ref), $\bar{c}_{REF}$	ft^2	28.28	7.034	9.682
Span, b	ft	48.00	11.304	6.094
Aspect Ratio (Ref)		2.370	1.8	.668
Sweep Angle, Λ_{LE}	deg.	74,70,55	60	65
Root Chord, (Ref)	ft	46.674	10.049	13.032
Tip Chord, (Ref)	ft	5.372	2.512	5.213
Root t/c	%	3.0	3.0	4
Tip t/c	%	4.0	3.0	4
Taper Ratio, λ_{REF}		.115	.250	.400

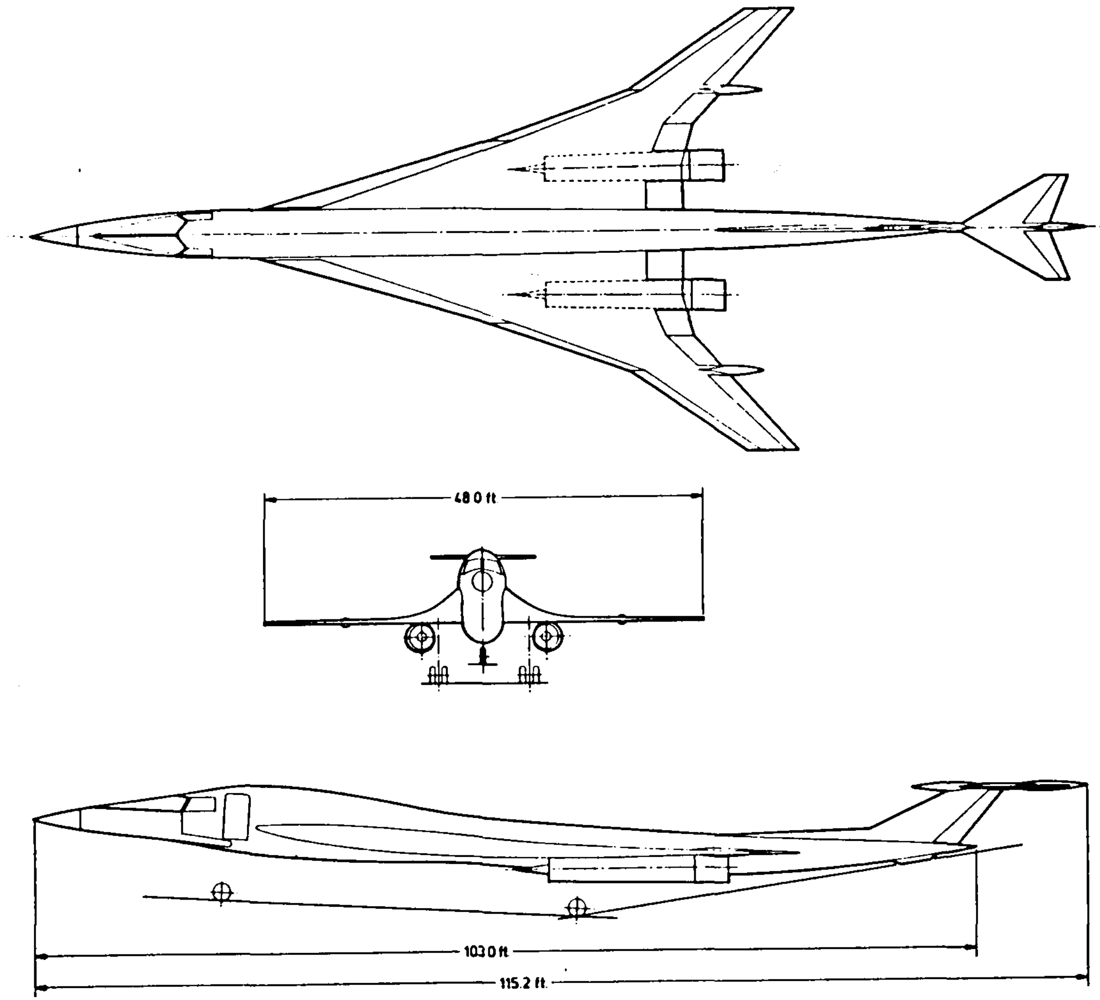

Figure I-1. - Aircraft general arrangement.

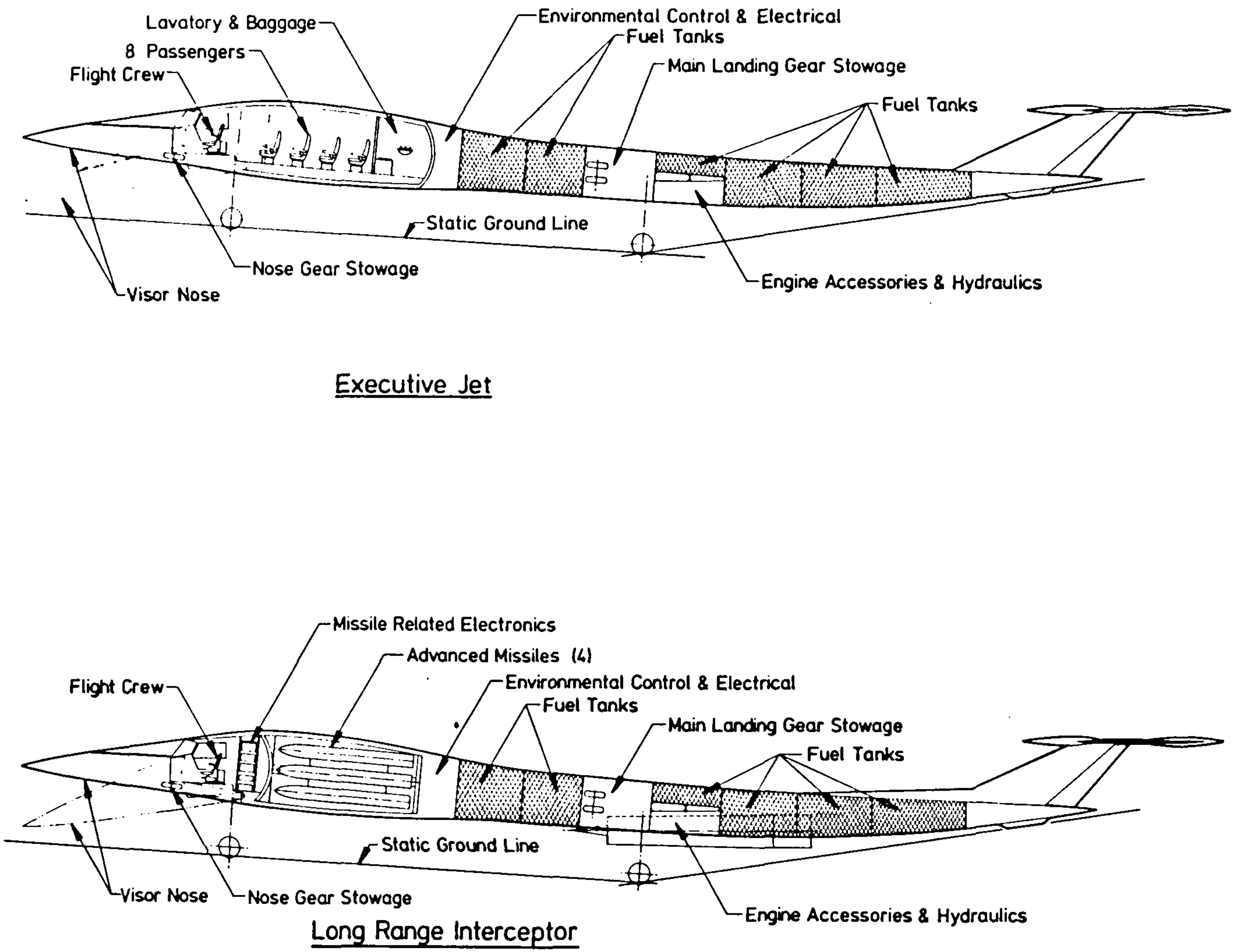

Figure I-2. - Interior arrangement.

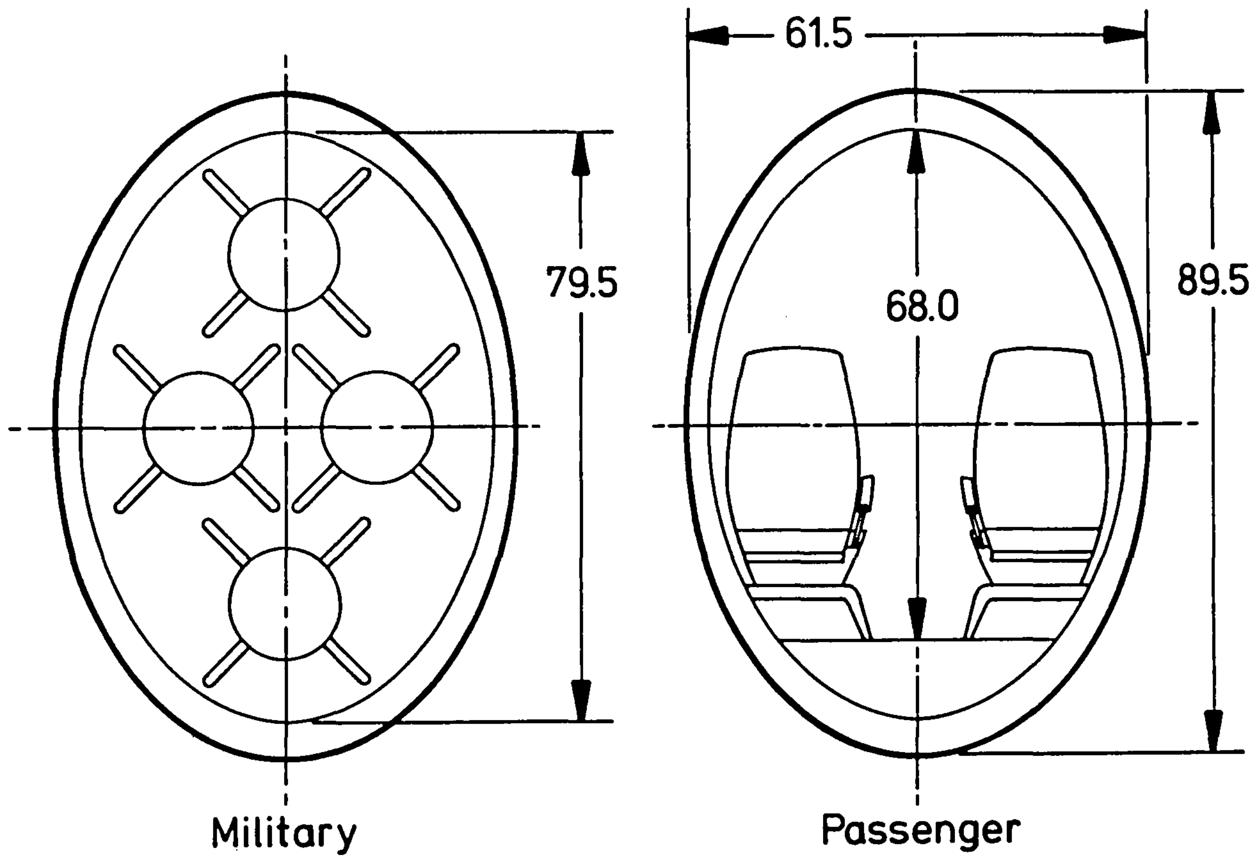

Figure I-3. - Fuselage cross sections.

PART II. - LOW SPEED AERODYNAMIC CHARACTERISTICS

F. L. Beissner, Jr.

The untrimmed low speed aerodynamic characteristics of this aircraft have been estimated for trailing edge flap deflections of 0, 10, 20, and 30 deg with appropriate leading edge flaps. These estimated characteristics are based on experimental data for a supersonic transport using a similar wing as reported in reference II-1. A three view of the model including the flaps and flap nomenclature is shown in figure II-1. A similar three view of the study aircraft is shown in Part I. Corrections were made to the data to account for geometry differences.

The high lift system consists of segmented, plain, leading- and trailing-edge flaps. The leading edge flaps consist of two wing-apex segments and an outboard segment as shown in figure II-1 (from reference II-1). These leading edge flaps are used primarily for improving the pitching moment characteristics by suppressing the leading edge vortex. Deflections are 30 deg at the apex and 45 deg outboard. Because the aircraft leading edge flap is geometrically similar to the model, no corrections were necessary.

The trailing edge flaps are used to provide increased lift for the takeoff and landing configuration. The configuration adopted, after examining the data and configurations available in reference II-1, was to droop both the outboard flap and the aileron, t_5 and t_6. The amount of droop is 5 degrees. Flap deflection, for the balance of this section, will refer to the deflection of the inboard and mid span flaps, t_1 and t_3 (fig. II-1).

The lift values were adjusted for planform differences by increasing the slope of the experimental lift curve as a direct function of the increase in aspect ratio (AR) from the model value of 1.907 to the aircraft value of 2.370. Flap geometric differences (t_5 and t_6) between model and aircraft were examined by the method of reference II-2. The sum of the flap lift functions were identical. Therefore, no adjustment was required to the flap lift increment.

The experimental drag polars were adjusted for AR differences, model to aircraft, by assuming the same effective span efficiency versus angle of attack variation (where $C_{D_L} = C_L{}^2/\pi ARe$). This was done for each of the flap deflections considered. No adjustments were made due to flap differences because of the reasoning of the preceding paragraphs.

The estimated lift curves and drag polars are shown in figures II-2 and II-3.

REFERENCES

II-1. Smith, Paul M.: Low-Speed Aerodynamic Characteristics from Wind-Tunnel Tests of a Large-Scale Advanced Arrow-Wing Supersonic-Cruise Transport Concept. NASA CR 145280, April 1978.

II-2. Staff of Hampton Technical Center: Advanced Supersonic Technology Concept Study Reference Characteristics. NASA CR 132374, December 1973.

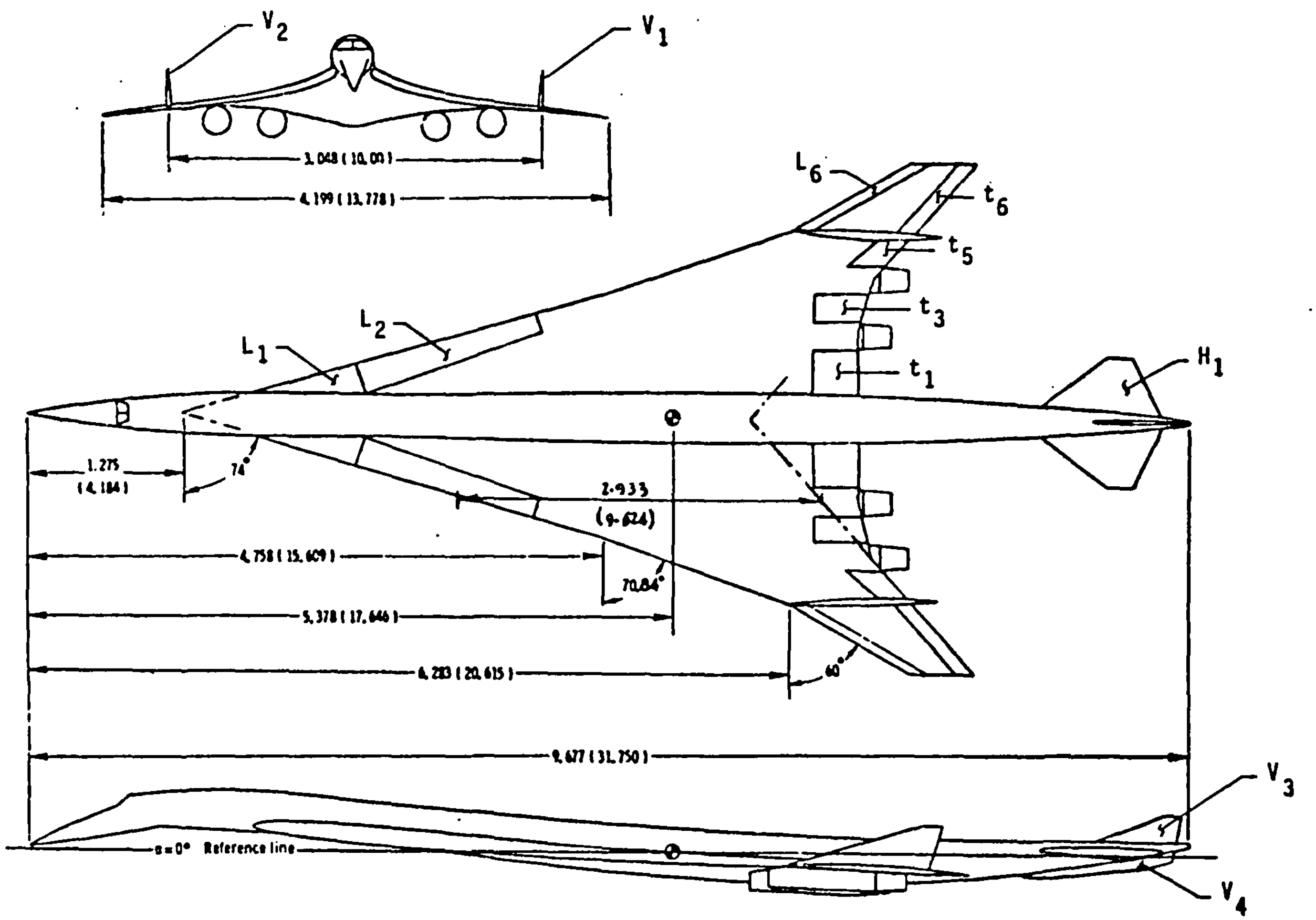

Figure II-1. - Geometric characteristics of model.
Dimensions are in meters (feet).

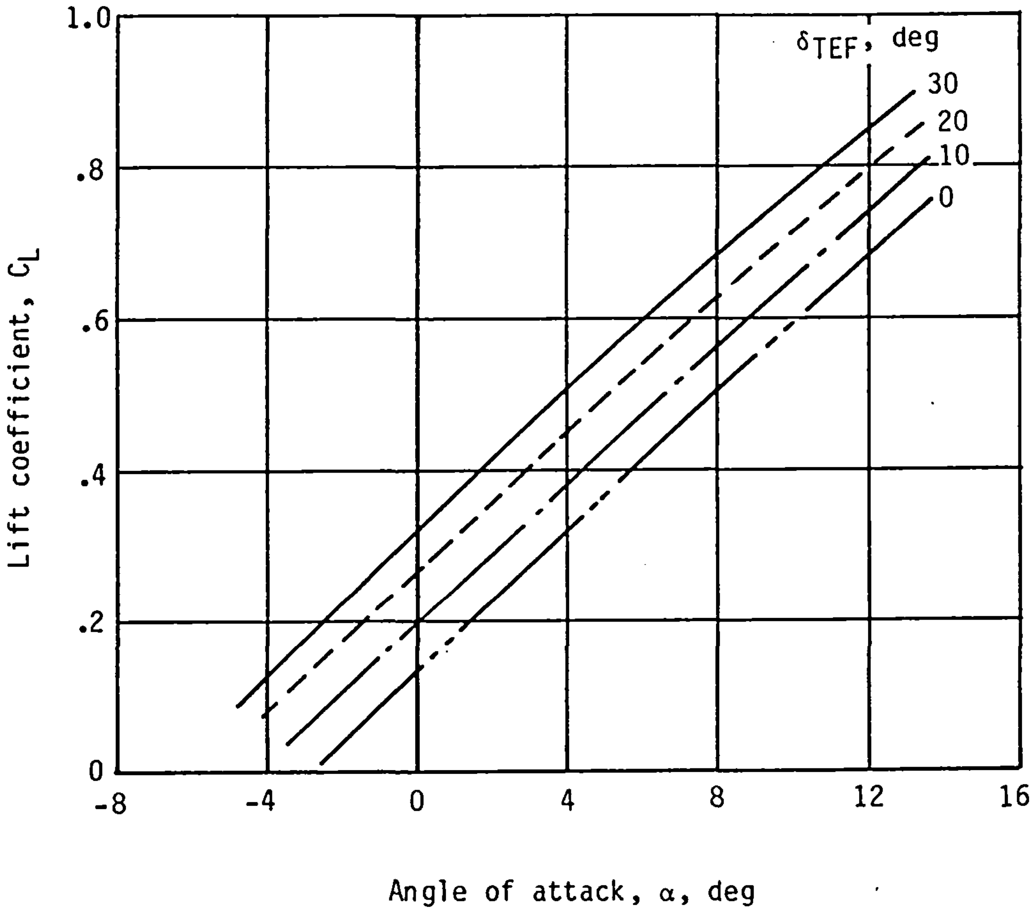

Figure II-2. - Low speed lift curves with various trailing edge flap settings, out of ground effect, untrimmed, $M = 0.3$, $S_{ref} = 972.\ ft^2$. ($\delta_{LEF} = 30/45$ deg, δ_{AIL} & $OUTBD_{TEF} = 5$ deg)

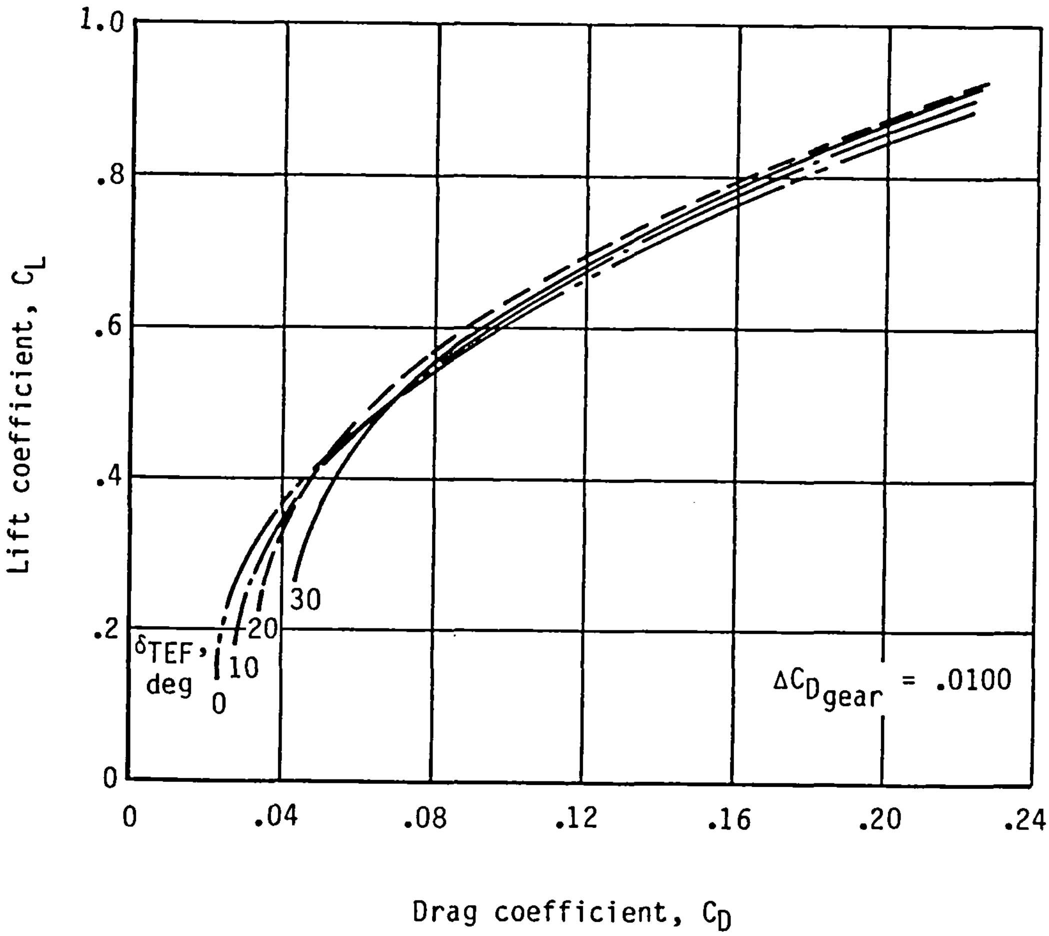

Figure II-3. - Low speed drag polar with various trailing edge flap settings, out of ground effect, untrimmed, $M = 0.3$, $S_{ref} = 972.\ ft^2$. (δ_{LEF} = 30/45 deg, δ_{AIL} & $OUTBD_{TEF}$ = 5 deg)

PART III. - HIGH SPEED AERODYNAMICS

A. Warner Robins

Aerodynamic Development

The wing planform differs from that of reference III-1 only over the wing outermost panel which has been extended 14.37 percent in semispan, retaining tip chord and local trailing-edge sweep. As in the configuration of reference III-1, sufficient trimming moment was provided through camber and twist (using the method of references III-2, III-3, III-4, and III-5), and through center-of-gravity control to allow trimming over the entire supersonic-cruise leg with positive (trailing-edge down) tail deflections. Wing camber-surface shape is shown in figure III-1.

Wing shape having been set, the remaining components were developed and assembled so as to retain the trimming and drag-due-to-lift characteristics of the basic wing at cruise while substantially reducing zero-lift wave drag. The largest-volume component, the fuselage, was integrated into the supersonic lifting system by providing that its rate of change of cross-section area above the wing camber surface be equaled by that of the cross-section area beneath it (see refs. III-6 and III-7). The far-field wave drag method, based on that of reference III-8, was then employed. A feature of this program is an ability to define a least-drag fuselage area-distribution through a set of constraining fuselage stations in a given assembly of components at a given Mach number. This feature was used after careful tailoring was done to alleviate sharp local changes in area development such as at the junctures of the thick upper elements of the vertical tail and the horizontal tail, and at the empennage/body juncture. The empennage pods and dorsal fin are results of such tailoring. The final fuselage area distribution is shown with the specified constraint stations in figure III-2. The Mach 2.0 average-equivalent-body area buildup is shown in figure III-3. The numerical model of the complete configuration in the format of reference III-9 is shown in table III-I. A computer drawing of this modeling is shown as figure III-4.

Performance Aerodynamics

The buildup of zero-lift drag for the complete configuration is shown as a function of Mach number in figure III-5. The values shown correspond to the altitude at the base of the tropopause (h ≈ 36,100 feet). Skin-friction drag values were found by the Sommer and Short T' method of reference III-10. Form drag was found by the subsequent application of geometry-dependent factors of reference III-11, and roughness drag was estimated from previously-developed empirical data. Wave-drag evaluation was, as previously noted, accomplished by a method based on reference III-8.

Supersonic lift-dependent drags (C_{D_i} and $\Delta C_{D_{LET}}$) were evaluated by the modified linear-theory method of references III-2 through III-5. (Angle-of-attack and static longitudinal stability characteristics were also obtained by this method.) Figure III-6 shows lift-dependent drag for the supersonic end-of-cruise point at h = 58,000 feet. The final supersonic drag values differ from the no-leading-edge-thrust polar by an increment, $\Delta C_{D_{LET}}$, which contains not only the leading-edge thrust attainable, but also that portion which manifests itself as vortex lift (see ref. III-12). The drag for the aircraft essentially achieves the ideal full-leading-edge-thrust values in the range of cruise lift-coefficent ($.078 \leq C_L \leq .097$). Complete drag polars for supersonic Mach numbers from 1.2, 1.6, and 2.0 are shown in figure III-7, while maximum lift-drag ratio and those operating lift-drag ratios corresponding to minimum-fuel climb and for beginning and end of cruise are shown in figure III-8.

Subsonic lift-dependent drags, including the effects of leading-edge thrust and vortex lift, were obtained by the method of reference III-13. This method was also used for preliminary design of the outboard leading-edge flaps. These plain flaps are necessary to the achievement of some leading-edge thrust over the sharp-leading-edge outermost wing panel. Figure III-9 compares the Mach number .8 drag polars of the wing-body shown with leading-edge flaps at various flap deflections with the corresponding full-leading-edge-thrust and no-leading-edge-flap polars. Substantial drag reductions from those for the undeflected-flap case are seen. Complete subsonic drag polars reflecting this leading-edge flap treatment are shown for Mach numbers .6, .9, and .95 at an altitude of 36,100 feet in figure III-10.

Sonic Boom

Sonic-boom overpressures were estimated using the simplified process described in reference III-14. Rather than use the simple shape factor charts, however, equivalent cross-section areas due to both volume and lift were combined for six flight conditions to provide the characteristic shape factors for this specific study configuration. The results are shown in figure III-11 in which sonic-boom overpressures are plotted as a function of altitude and aircraft weight for Mach numbers 1.2 and 2.0. The effects of various boom-alleviation profiles on both sonic boom and fuel consumption are shown in the section on aircraft performance.

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III-6. Baals, D. D.; Robins, A. W.; and Harris, R. V., Jr.: Aerodynamic Design Integration of Supersonic Aircraft. J. Airc., Vol. 7, No. 5, Sept.-Oct. 1970, pp. 385-394.

III-7. Dollyhigh, Samuel; and Morris, Odell A.: Experimental Effects of Fuselage Camber on Longitudinal Aerodynamic Characteristics of a Series of Wing-Fuselage Configurations at a Mach Number of 1.41. NASA TM X-3411, 1976.

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III-9. Craidon, Charlotte B.: Description of a Digital Computer Program for Airplane Configuration Plots. NASA TM X-2074, 1970.

III-10. Sommer, Simon C.; and Short, Barbara J.: Free-Flight Measurements of Turbulent-Boundary-Layer Skin Friction in the Presence of Severe Aerodynamic Heating at Mach Numbers from 2.8 to 7.0. NASA TP 1500, 1979.

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III-12. Carlson, Harry W.; Mack, Robert J.; and Barger, Raymond L.: Estimation of Attainable Leading-Edge Thrust for Wings at Subsonic and Supersonic Speeds. NASA TP 1500, October 1979.

III-13. Carlson, Harry W.; and Walkley, Kenneth B.: An Aerodynamic Analysis Computer Program and Design Notes for Low Speed Wing Flap Systems. NASA Contractor Report 3675, March 1983.

III-14. Carlson, Harry W.: Simplified Sonic Boom Prediction. NASA TP 1122, 1978.

TABLE III-I.- NUMERICAL MODEL OF THE COMPLETE CONFIGURATION.

```
SXJT14A...EXEC.KJET/INTERCEPT...A OPT. CAB...1120M...SPAN=48.0
  1  1 -1  1  1  1      15 20  1 19 30                      3 15 -2 10 -1 10
972.1   28.297 55.000                                                             REFCX
  0.000    .500   1.000   1.500   2.500   5.000  10.000  15.000  20.000  30.000   XAF 10
 40.000  50.000  60.000  70.000  75.000  80.000  85.000  90.000  95.000100.000   XAF 20
24.193 2.418  3.439  47.284                                                       WORG  1
26.737   3.147   2.768 44.725                                                     WORG  2
30.396   4.197   1.969 41.043                                                     WORG  3
34.056   5.246   1.333 37.364                                                     WORG 4
40.192   7.005   0.714 31.188                                                     WORG  5
45.033   8.393   0.385 26.728                                                     WORG  6
50.391   9.931   0.199 21.790                                                     WORG   7
54.948  11.515   0.263 17.665                                                     WORG   8
58.045  12.591   0.180 15.519                                                     WORG   9
61.064  13.640   0.127 13.427                                                     WORG 10
65.642  15.230   0.061 10.256                                                     WORG 11
65.643  15.231   0.061 10.256                                                     WORG 12
69.062  17.605   0.131  8.934                                                     WORG 13
73.665  20.801   0.156  7.154                                                     WORG 14
78.272  24.000   0.141  5.372                                                     WORG  15
  0.000    .002    .003    .005    .002   -.018   -.143   -.321   -.522   -.948   TZ4A.1
 -1.371  -1.765  -2.127  -2.459  -2.615  -2.766  -2.910  -3.046  -3.174  -3.287   TZ4A.2
  0.000    .003    .006    .009    .016    .001   -.093   -.234   -.395   -.742   TZ5.1
 -1.088  -1.417  -1.724  -2.012  -2.151  -2.285  -2.416  -2.541  -2.660  -2.768   TZ5.2
  0.000    .005    .010    .015    .025    .040   -.004   -.088   -.187   -.413   TZ6.1
  -.646   -.877  -1.103  -1.325  -1.437  -1.548  -1.658  -1.766  -1.870  -1.969   TZ6.2
  0.000    .007    .014    .021    .034    .060    .057    .021   -.031   -.163   TZ7.1
  -.310   -.465   -.627   -.796   -.884   -.974  -1.065  -1.156  -1.246  -1.333   TZ7.2
  0.000    .008    .016    .025    .041    .074    .100    .105    .096    .054   TZ8.1
  -.012   -.095   -.194   -.308   -.370   -.436   -.504   -.574   -.644   -.714   TZ8.2
  0.000    .007    .015    .022    .037    .073    .115    .137    .144    .137   TZ9.1
   .107    .059   -.006   -.085   -.130   -.177   -.227   -.279   -.331   -.385   TZ9.2
  0.000    .005    .010    .015    .026    .051    .090    .113    .126    .132   TZ10.1
   .121    .095    .056    .005   -.025   -.057   -.090   -.125   -.162   -.199   TZ10.2
  0.000    .003    .006    .009    .014    .028    .046    .059    .066    .061   TZ11.1
   .044    .015   -.026   -.076   -.104   -.133   -.165   -.197   -.229   -.263   TZ11.2
  0.000    .002    .004    .006    .010    .021    .042    .054    .061    .059   TZ12.1
   .045    .022   -.009   -.046   -.067   -.088   -.110   -.134   -.157   -.180   TZ12.2
  0.000    .002    .004    .005    .009    .018    .036    .043    .050    .050   TZ13.1
   .038    .020   -.005   -.034   -.050   -.065   -.081   -.096   -.112   -.127   TZ13.2
  0.000    .000    .001    .001    .002    .004    .007    .008    .012    .009   TZ14.1
   .002   -.007   -.017   -.029   -.036   -.042   -.046   -.051   -.056   -.061   TZ14.2
  0.000    .000    .001    .001    .002    .004    .007    .008    .012    .009   TZ15.1
   .002   -.007   -.018   -.029   -.036   -.042   -.046   -.051   -.056   -.061   TZ15.2
  0.000   -.001   -.003   -.004   -.007   -.014   -.025   -.032   -.039   -.053   TZ16.1
  -.067   -.079   -.093   -.105   -.110   -.115   -.120   -.124   -.127   -.131   TZ16.2
  0.000   -.002   -.003   -.005   -.008   -.017   -.033   -.049   -.060   -.081   TZ17.1
  -.100   -.118   -.130   -.141   -.144   -.147   -.150   -.152   -.154   -.156   TZ17.2
  0.000   -.001   -.002   -.003   -.006   -.010   -.022   -.032   -.043   -.064   TZ18.1
  -.081   -.097   -.106   -.116   -.121   -.124   -.129   -.132   -.137   -.141   TZ18.2
0.0     .231    .325    .396    .503    .697    .956    1.132   1.264   1.429     WORD 1.1
1.479   1.479   1.477   1.100   .980    .787    .592    .396    .203    0.0       WORD 1.2
0.0     .225    .316    .386    .490    .679    .931    1.103   1.232   1.392     WORD 2.1
1.441   1.441   1.437   1.132   .953    .765    .576    .385    .197    0.0       WORD 2.2
0.0     .216    .304    .370    .470    .651    .894    1.059   1.182   1.336     WORD 3.1
1.383   1.383   1.341   1.056   .889    .714    .537    .360    .184    0.0       WORD 3.2
```

TABLE III-I.- Concluded.

0.0	.208	.294	.358	.455	.631	.866	1.025	1.144	1.293	WORD 4.1
1.338	1.338	1.277	1.006	.848	.681	.512	.343	.175	0.0	WORD 4.2
0.0	.200	.283	.344	.438	.607	.833	.987	1.101	1.244	WORD 5.1
1.287	1.287	1.186	.935	.788	.633	.476	.319	.163	0.0	WORD 5.2
0.0	.198	.280	.341	.435	.602	.827	.979	1.092	1.234	WORD 6.1
1.277	1.277	1.161	.915	.771	.619	.466	.312	.159	0.0	WORD 6.2
0.0	.201	.284	.345	.440	.609	.836	.990	1.105	1.248	WORD 7.1
1.292	1.292	1.149	.906	.763	.613	.461	.309	.156	0.0	WORD 7.2
0.0	.222	.314	.382	.486	.672	.923	1.094	1.221	1.380	WORD 8.1
1.428	1.428	1.238	.976	.822	.661	.497	.333	.170	0.0	WORD 8.2
0.0	.238	.335	.408	.518	.718	.986	1.168	1.303	1.473	WORD 9.1
1.524	1.524	1.321	1.042	.878	.705	.531	.355	.181	0.0	WORD 9.2
0.0	.257	.362	.440	.560	.775	1.064	1.260	1.406	1.590	WORD10.1
1.645	1.645	1.427	1.124	.947	.761	.572	.383	.195	0.0	WORD10.2
0.0	.313	.440	.536	.680	.941	1.292	1.531	1.709	1.932	WORD11.1
2.000	2.000	1.733	1.365	1.149	.923	.695	.465	.237	0.0	WORD11.2
0.0	.040	.079	.118	.195	.380	.720	1.020	1.280	1.680	WORD12.1
1.920	2.000	1.920	1.680	1.500	1.280	1.020	.720	.380	0.0	WORD12.2
0.0	.038	.076	.113	.187	.364	.690	.977	1.226	1.610	WORD13.1
1.840	1.916	1.840	1.610	1.437	1.226	.977	.690	.364	0.0	WORD13.2
0.0	.035	.070	.104	.171	.334	.633	.896	1.125	1.476	WORD14.1
1.687	1.757	1.687	1.476	1.318	1.125	.896	.633	.334	0.0	WORD14.2
0.0	.029	.059	.088	.146	.285	.541	.766	.961	1.261	WORD15.1
1.440	1.500	1.440	1.261	1.126	.961	.766	.541	.285	0.0	WORD15.2
0.0	3.552	7.103	10.655	14.207	17.759	21.310	24.862	28.414	31.966	XFUSE 10
35.517	39.069	42.621	46.172	49.724	53.276	56.828	60.379	63.931	67.483	XFUSE 20
71.035	74.586	78.138	81.690	85.241	88.793	92.345	95.897	99.448	103.000	XFUSE 30
4.409	4.409	4.407	4.399	4.385	4.376	4.319	4.145	3.829	3.464	7FUSE 1
3.074	2.681	2.295	1.924	1.576	1.255	.959	.692	.453	.244	7FUSE 2
.068	-.061	-.145	-.162	-.123	-.044	.070	.210	.360	.508	ZFUSE 3
0.0	2.156	6.015	11.019	15.807	21.292	27.596	29.881	30.028	29.605	AFUS 10
28.116	25.419	22.614	20.827	19.196	18.753	17.688	17.416	16.865	16.173	AFUS 20
14.698	13.773	12.038	10.069	8.336	6.186	3.936	1.901	.674	0.0	AFUS 30
96.100	0.0	7.094								PODORG 1
0.0	2.0	4.0	5.0	5.6	6.3	7.0	7.6	10.2	12.0	XPOD 1-1
13.5	14.7	16.0	17.5	19.1						XPOD 1-2
0.0	.260	.402	.420	.381	.250	.090	.000	.000	.160	PODR 1-1
.320	.400	.400	.240	0.0						PODR 1-2
56.380	6.834	-1.60								NACORG 2
0.0	2.0	3.5	5.5	7.0	8.032	9.164	10.164	11.664	13.007	XPOD 2-1
15.965	17.132	17.664	19.164	19.565						XPOD 2-2
1.347	1.387	1.417	1.457	1.486	1.507	1.521	1.533	1.551	1.568	PODR 2-1
1.604	1.604	1.604	1.604	1.604						PODR 2-2
71.0	15.230	.061								PODORG 3
0.0	1.0	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	XPOD 3.1
6.0	6.5	7.0	8.0	9.0						XPOD 3.2
0.0	.092	.185	.231	.278	.324	.370	.411	.435	.440	PODR 3.1
.418	.370	.296	.148	0.0						PODR 3.2
75.033	0.0	1.00	26.064	91.277	0.0	2.50	11.107			FNORG 1
0.0	10.0	20.0	30.0	40.0	50.0	60.0	70.0	90.0	100.0	XFIN 1
0.0	.230	.430	.588	.697	.748	.749	.749	.532	0.0	FNORD1-1
0.0	.518	.941	1.267	1.498	1.633	1.672	1.555	.719	0.0	FNORD1-2
91.277	0.0	2.50	11.107	101.113	0.0	7.094	5.213			FNORG 2
0.0	10.0	20.0	30.0	40.0	50.0	60.0	70.0	90.0	100.0	XFIN 2
0.0	.518	.941	1.267	1.498	1.633	1.672	1.555	.719	0.0	FNORD2-1
0.0	.918	1.669	2.251	2.667	2.917	3.000	2.814	1.317	0.0	FNORD2-2
101.13	0.0	7.094	10.049	110.92	5.652	7.094	2.512			HTORG
0.0	10.0	20.0	30.0	40.0	50.0	60.0	70.0	90.0	100.0	XHTAIL
0.0	.533	.948	1.264	1.448	1.500	1.448	1.264	.533	0.0	HTORD
0.0	.533	.948	1.264	1.448	1.500	1.448	1.264	.533	0.0	HTORD

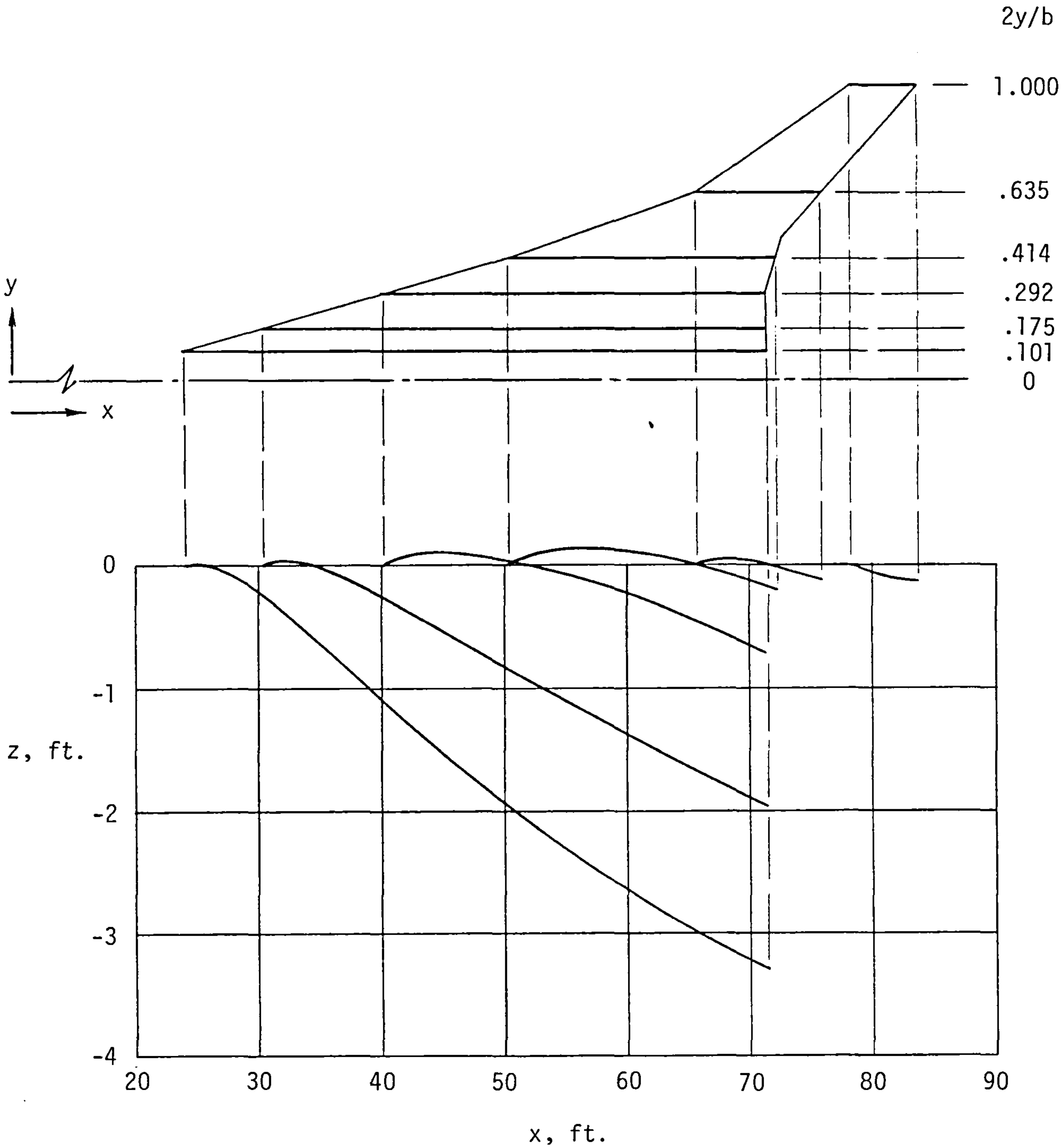


Figure-1.- Camber ordinates of wing with respect to wing leading edge (note that airfoil z-origin values are not at zero on the aircraft configuration).

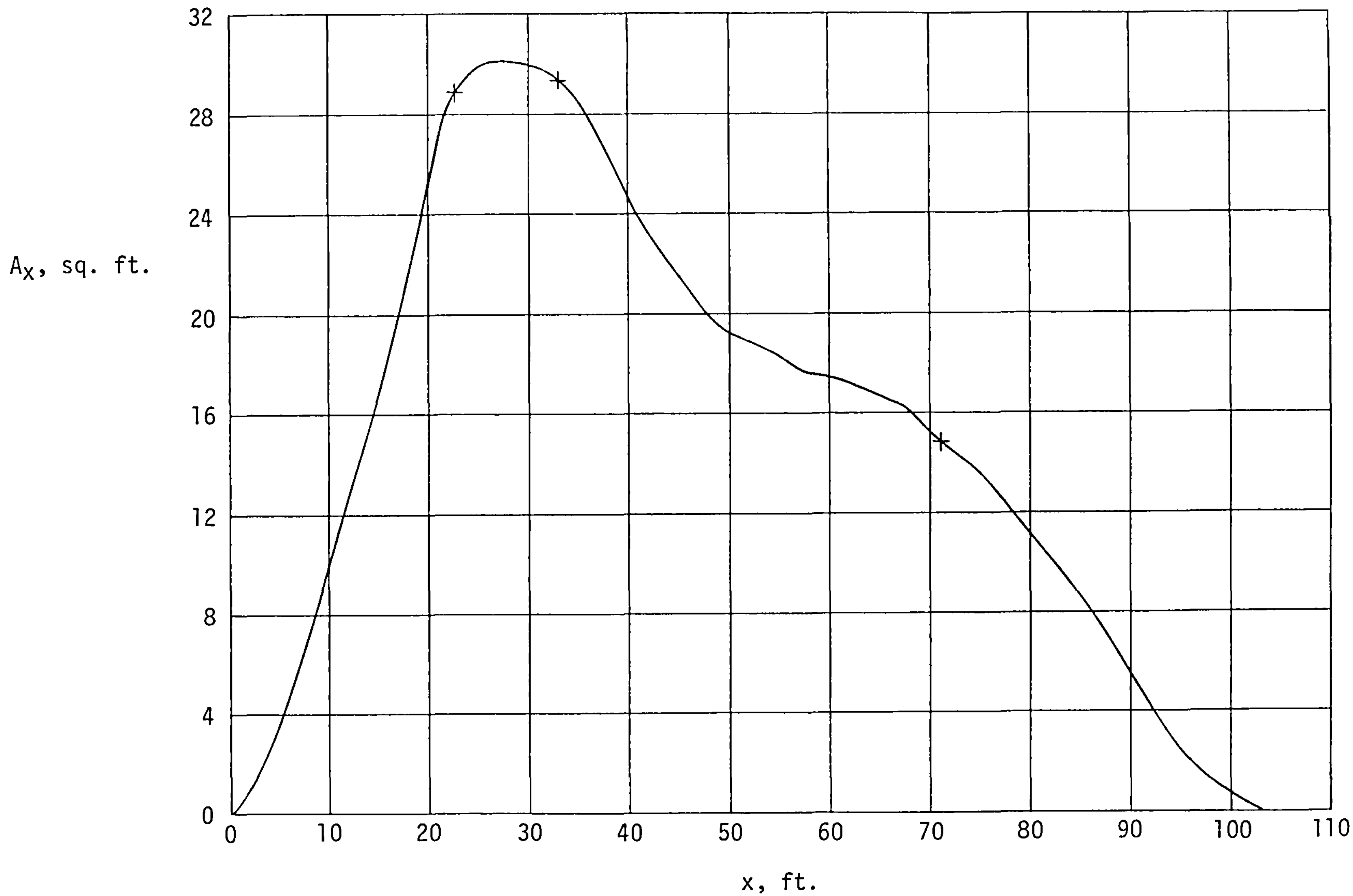


Figure III-2.- Fuselage normal cross-section area distribution optimized for the indicated constraint points and M = 2.0.

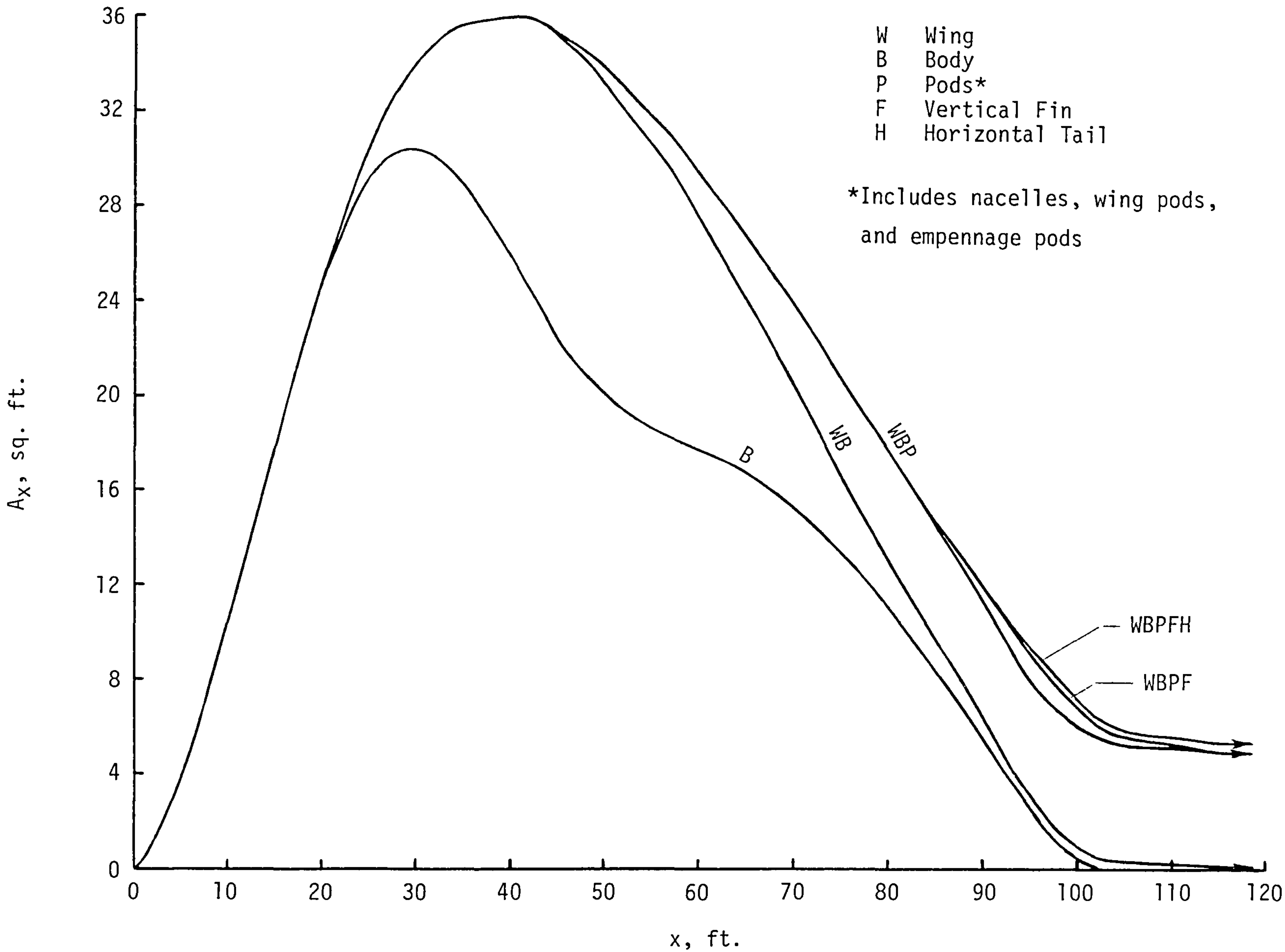


Figure III-3.- Buildup of average equivalent-body area distribution at M = 2.0 condition.

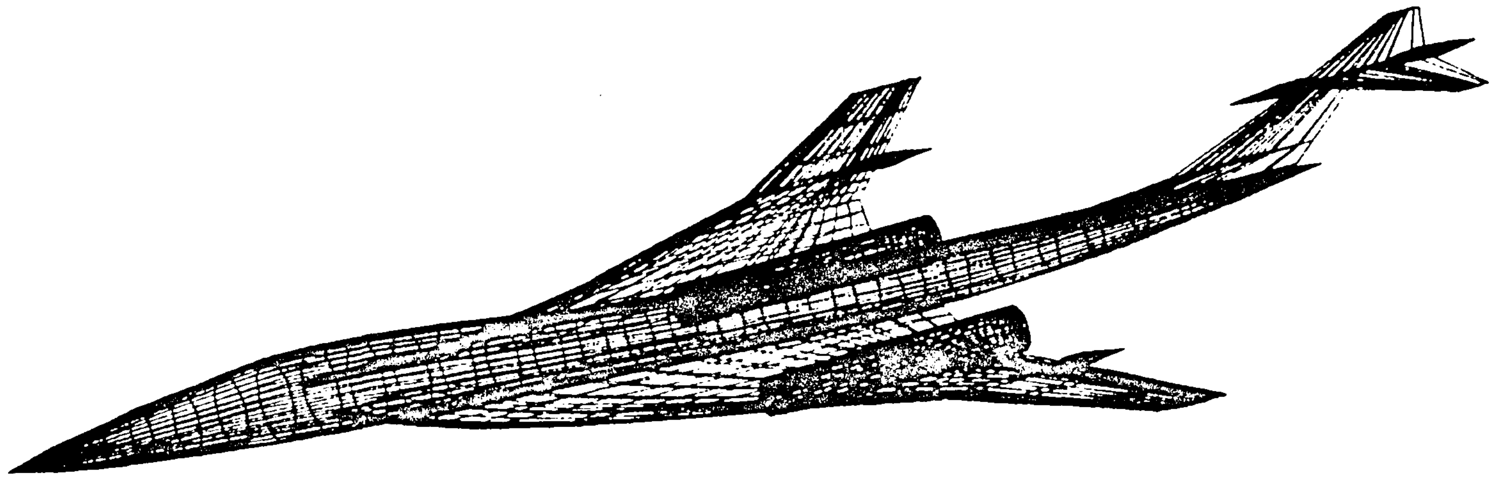


Figure III-4.- Computer drawing from numerical model of complete configuration.

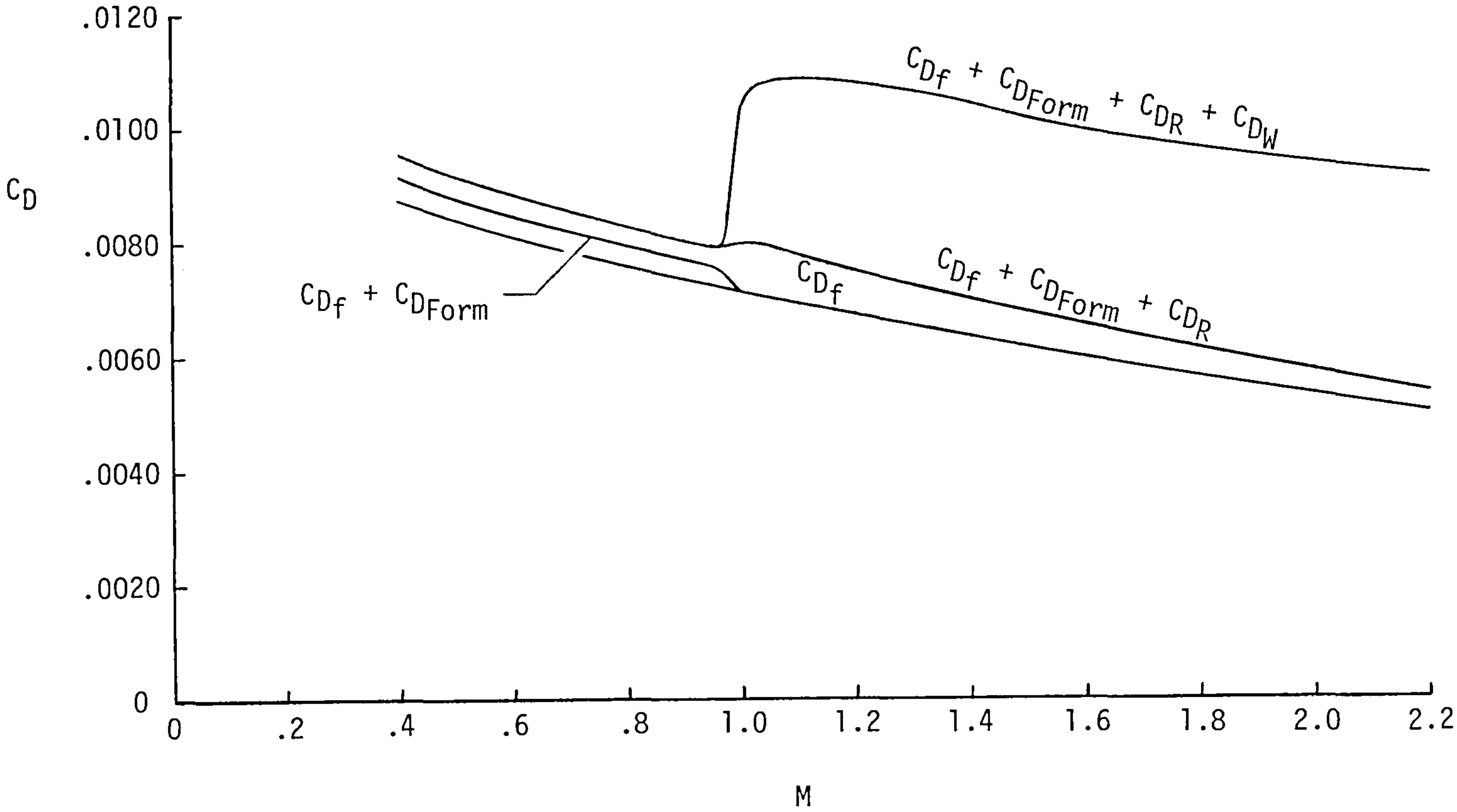


Figure III-5.- Buildup of zero-lift drag coefficient as a function of Mach number. Complete configuration; h = 36100 feet.

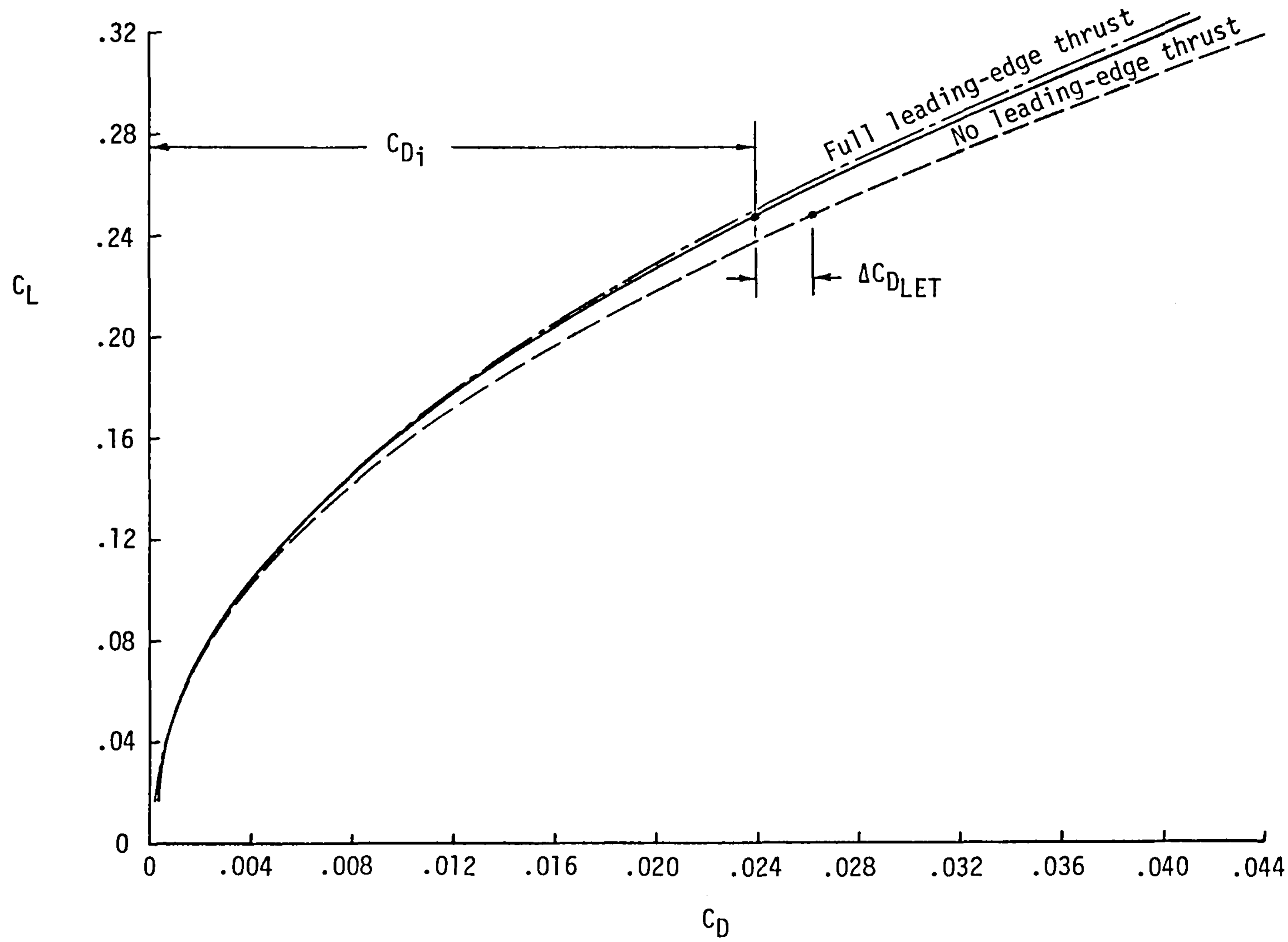


Figure III-6.- Supersonic lift-dependent drag of complete configuration in relation to the full- and no-leading-edge thrust polars. M = 2.0; δ_H = 2.75°; h = 58,200 ft.

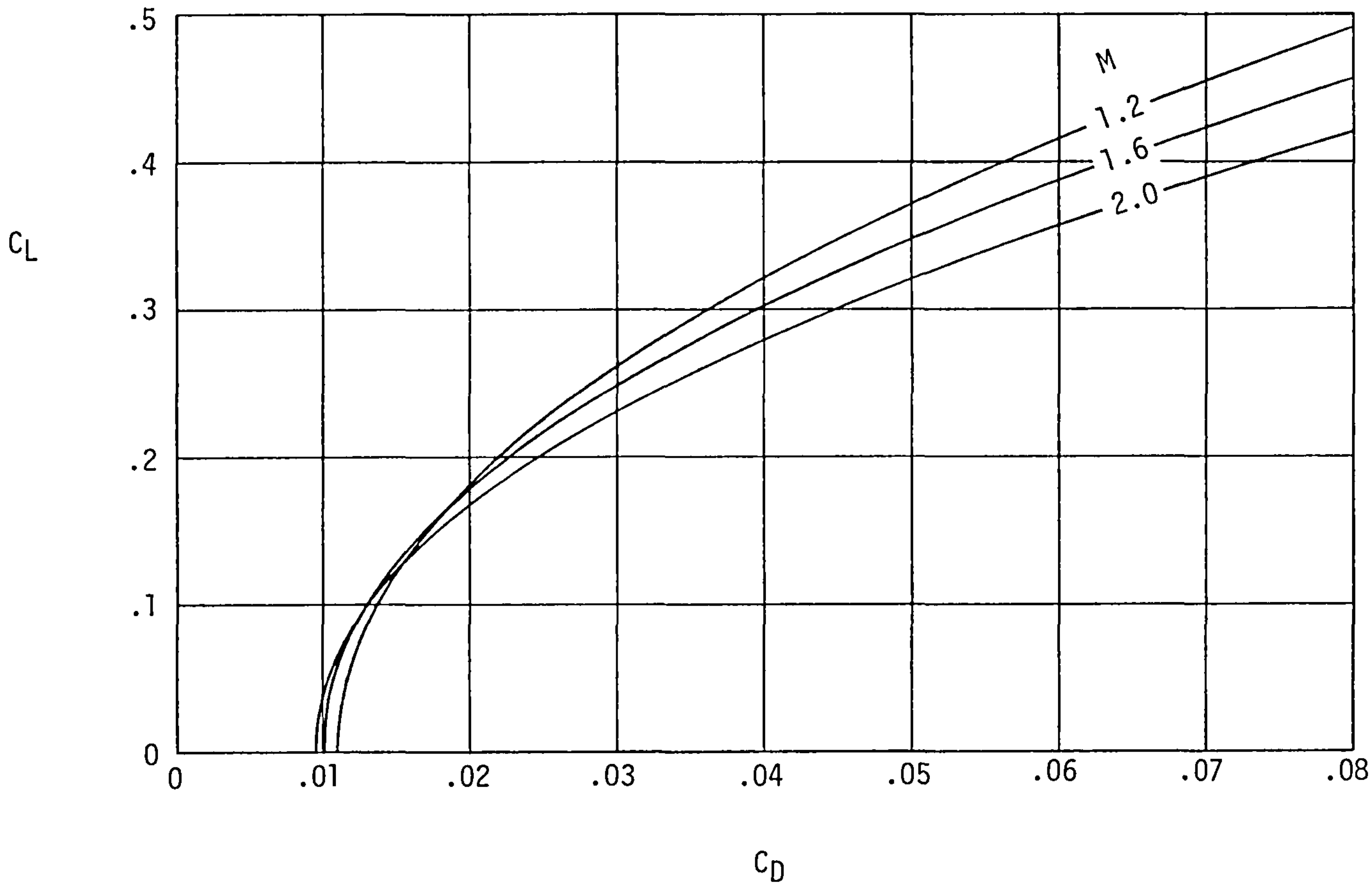


Figure III-7.- Supersonic drag polars for complete configuration at h = 36,100 feet and δ_H = 2.75°.

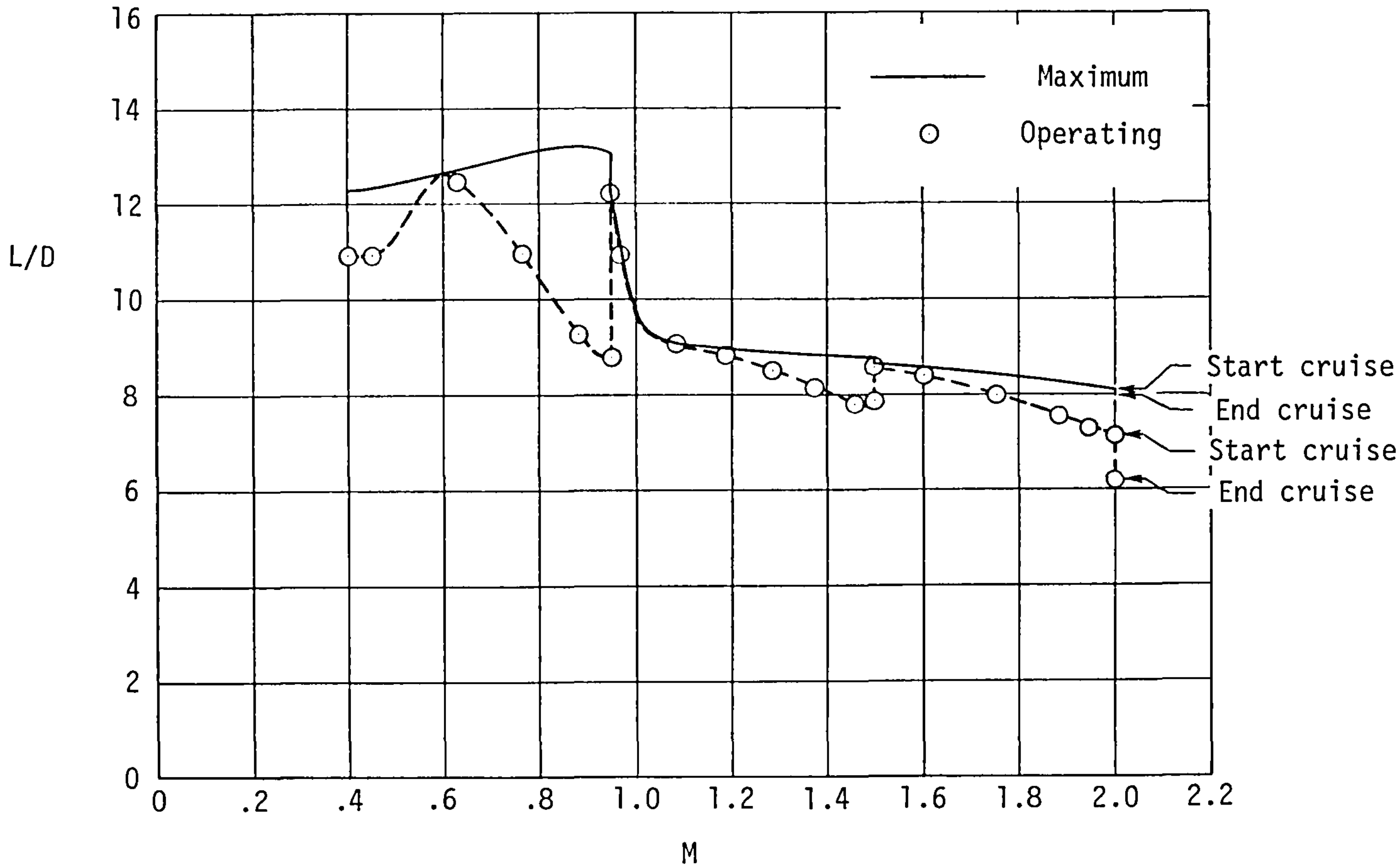


Figure III-8.- Maximum and operating lift-drag ratios along the climb/cruise path of the supersonic executive-jet mission.

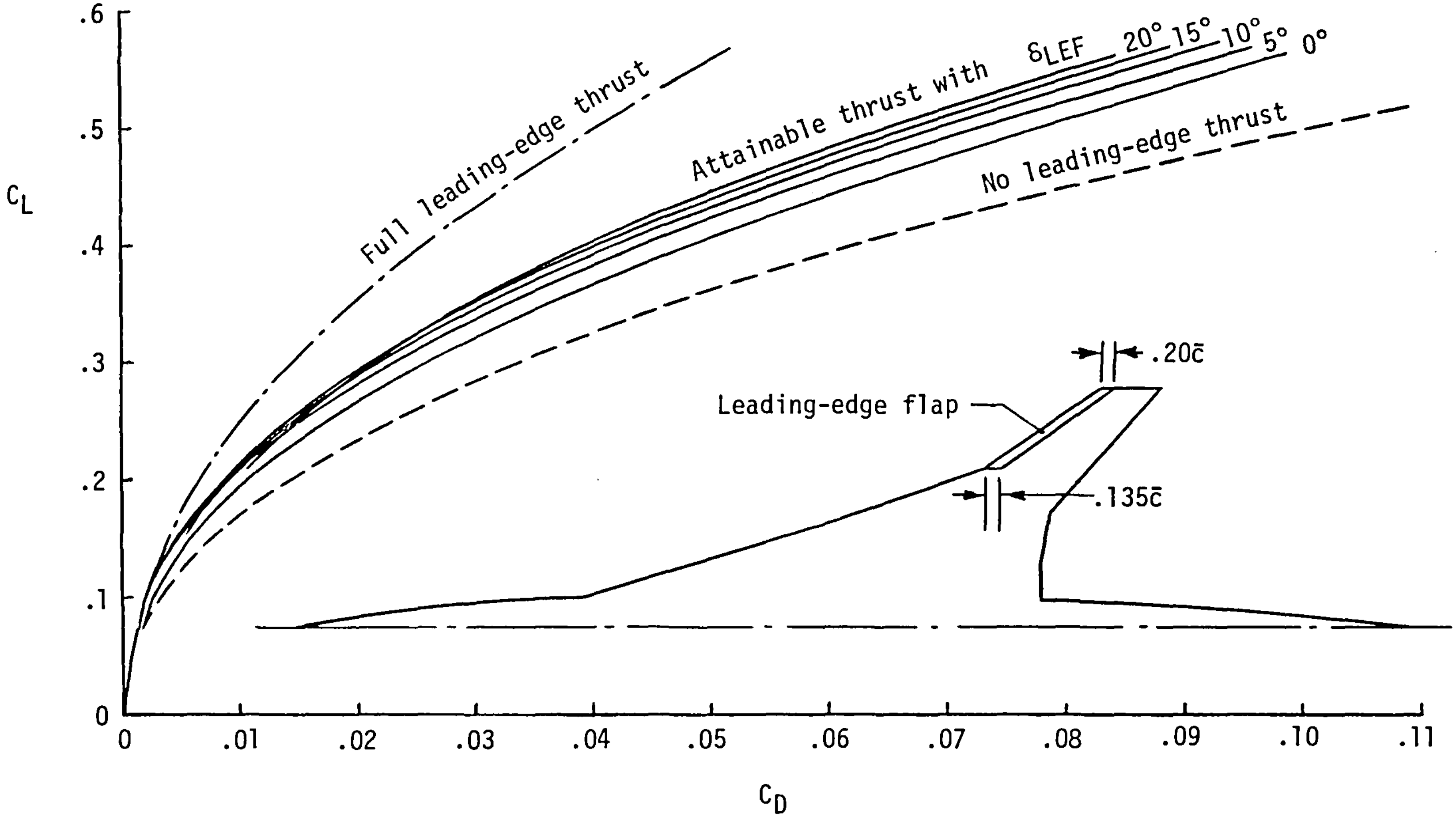


Figure III-9.- Effect of plain outboard leading-edge flaps on the subsonic drag polar of the configuration without horizontal tail. M = .8 and h = 30,000 feet.

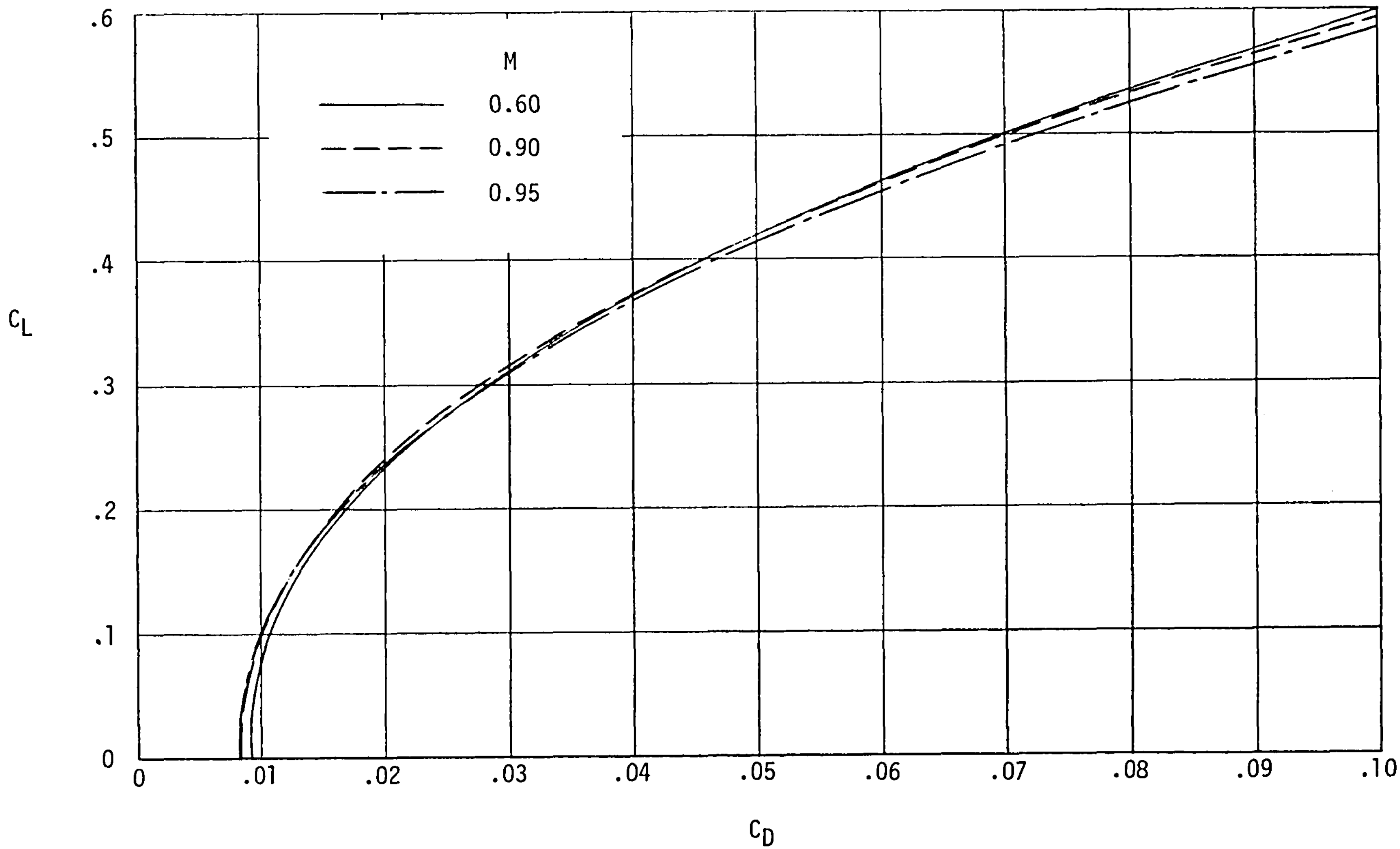


Figure III-10.- Subsonic drag polars for the complete configuration at h = 36,100 feet.

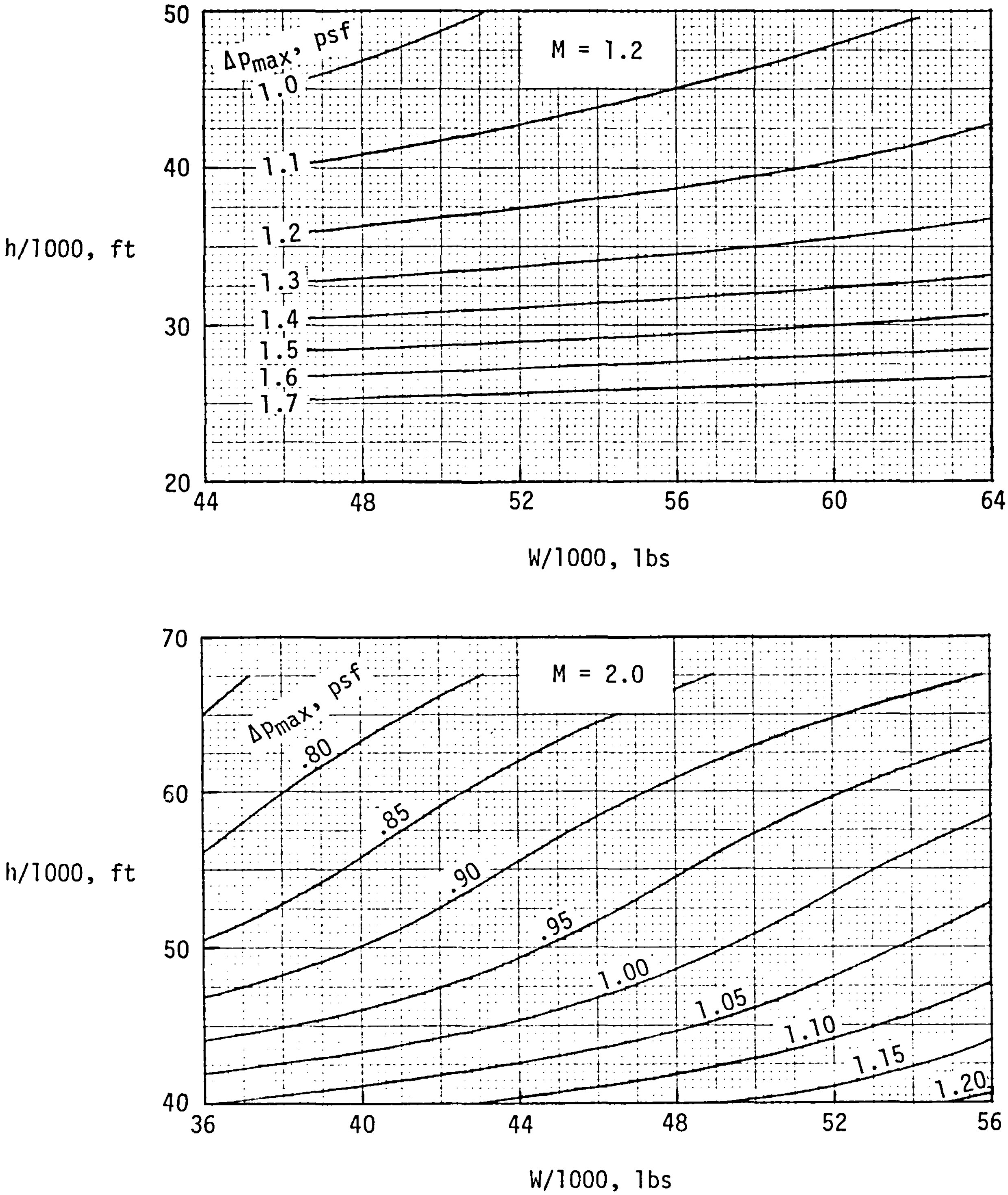


Figure III-11.- Transonic and supersonic-cruise sonic-boom overpressures as a function of altitude and aircraft weight.

PART - IV. - PROPULSION

W. A. LOVELL

The engine used in this study is based on a current technology engine and was assumed to have an upper operational limit of Mach 2.4 at an altitude of 70000 feet at standard day atmospheric conditions.

The current technology was modified based on anticipated technology advances and the potential for improving the supersonic performance, by modification of the fan and low pressure turbine for high supersonic propulsive efficiency. These modifications were estimated, based on existing supersonic cruise engines, to have the potential to reduce the supersonic specific fuel consumption by about 20%. The engine weight was assumed to be 3% less than existing current technology engines. Engine performance has been adjusted for the effects of Military specification inlet pressure recovery, however, installation drag, power extraction and service airbleed have not been accounted for. This data is, therefore, somewhat optimistic as used in this study.

BASELINE ENGINE

The baseline (current technology) engine as designed, is a two-spool low-bypass ratio augmented turbojet engine. It has a 3-stage low compressor, 1-stage low rotor, 10-stage compressor and a 2-stage turbine high rotor. A full annular duct surrounds the basic gas generator and supplies cooling air to the augmentor and nozzle. The inlet guide vanes, located ahead of the low compressor, have a movable trailing edge to achieve variable airfoil camber. This improves the inlet distortion tolerance, low compressor efficiency and enhances the engine acceleration characteristics. The high compressor has variable stators to improve starting and high Mach number characteristics.

The engine's exhaust nozzle is a variable throat area balanced flap convergent-divergent design. Nozzle area ratio varies as a function of nozzle throat area, so that both the throat and exit areas are simultaneously near optimum throughout the operating range.

Baseline engine performance is based on the 1962 U. S. Standard Atmosphere and Military specification inlet recovery (MIL-E-5008C). Since no other installation effects were considered, the performance used in this study is optimistic.

Baseline (as designed) engine characteristics at maximum power (with augmentation), sea level static and standard day atmospheric conditions are tabulated below:

Total engine corrected airflow rate	178 lbm/sec
Fuel lower heating value	18,400 Btu/lbm
Net thrust	21,000 lbf
Net specific fuel consumption	1.82 lbm/hr/lbf
Bypass ratio	0.155
Weight (including nozzle but no thrust reverser)	2,840 lbf
Maximum envelope diameter	38.5 in
Length of engine plus nozzle	161.8 in

STUDY ENGINE

Based on projected advanced technology, the baseline engine was modified as follows:

- Net thrust (gross thrust-ram drag) levels have been increased by 20 percent at all Mach numbers above 1.4
- No change in fuel flow rate for thrust increase.
- Engine weight (including nozzle but no thrust reverser) has been reduced by 3 percent.
- No change in the exterior engine geometry.

These changes would necessitate a modification to the low pressure spool of the engine. That is, one of the three stages of the low pressure compressor would be eliminated and the remaining two stages reduced in diameter to reduce the bypass ratio. Associated with these modifications would be the requirement to modify the low pressure turbine to achieve the proper work balance between the turbine and compressor. Subsonic performance of the engine would also be affected by this modification. However, it has been assumed (optimistically) that subsonic performance decrements could be offset by incorporating a turbine bypass in the engine. On the basis of these modifications, the baseline engine weight of 2,840 lbf is reduced to 2,755 lbf including the nozzle but not a thrust reverser.

To estimate the nacelle drag and weight of a nacelle for the study engine, the engine was fitted with a NASA/Ames "P" inlet sized to match the engine. This inlet is a typical axisymmetric mixed compression design with a translating center-body sized for supersonic cruise conditions. A nacelle concept layout to house the engine incorporating a NASA/Ames "P" inlet and a variable throat area balanced flap convergent-divergent nozzle is shown in Figure IV-1.

Estimated standard day engine performance, adequate for preliminary aircraft mission performance analysis is presented on figures IV-2 through IV-6 for maximum augmented power, maximum non-augmented power and maximum and part power ratings.

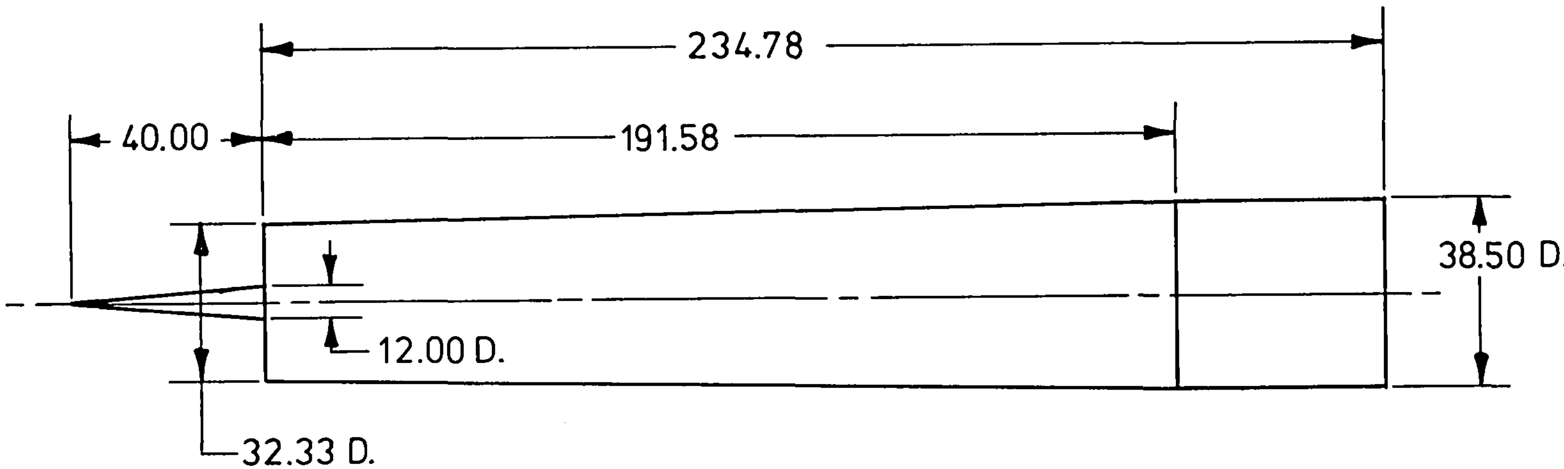


Figure IV-1. - Engine nacelle geometry.

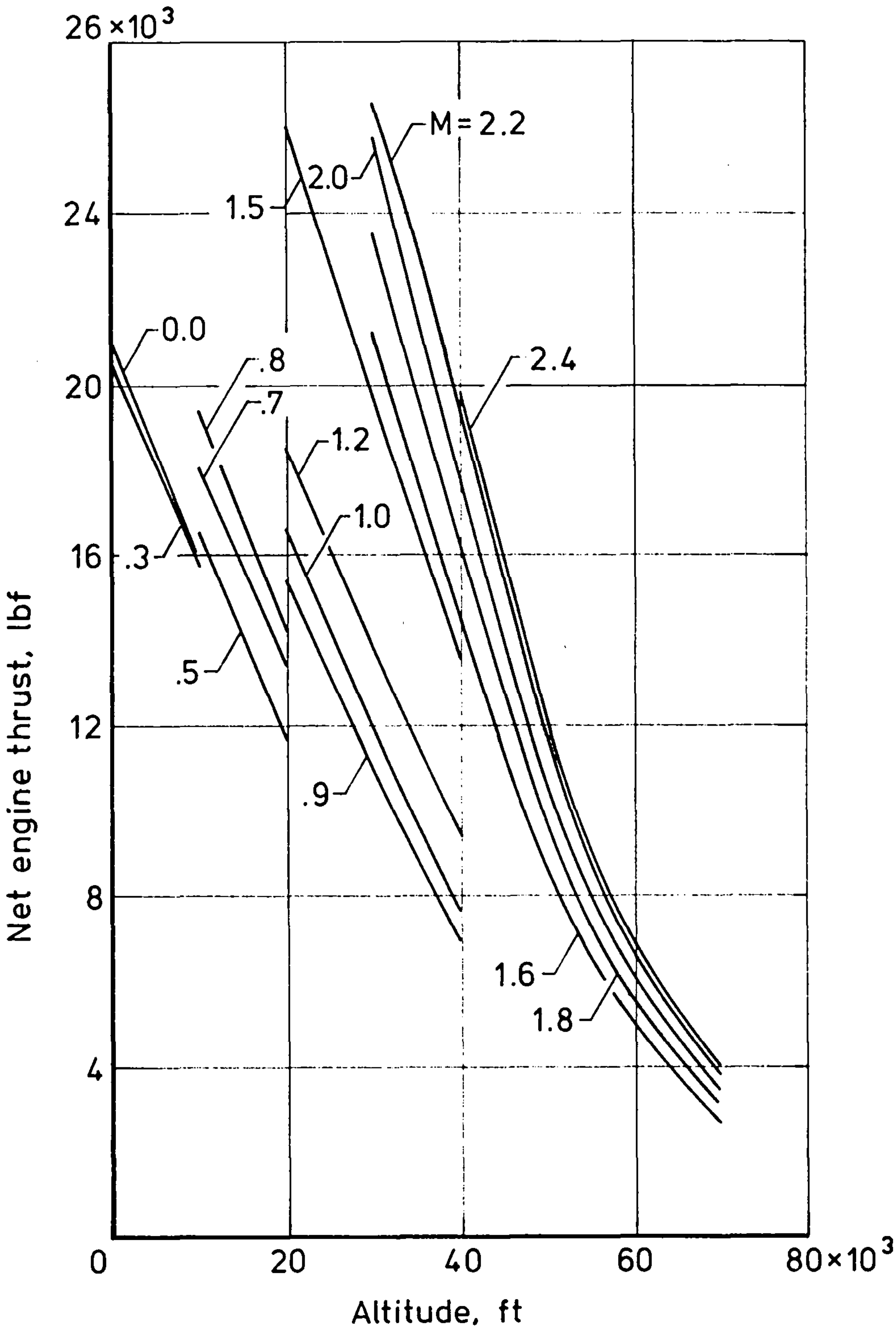


Figure IV-2. - Installed net engine maximum thrust. Standard day conditions.

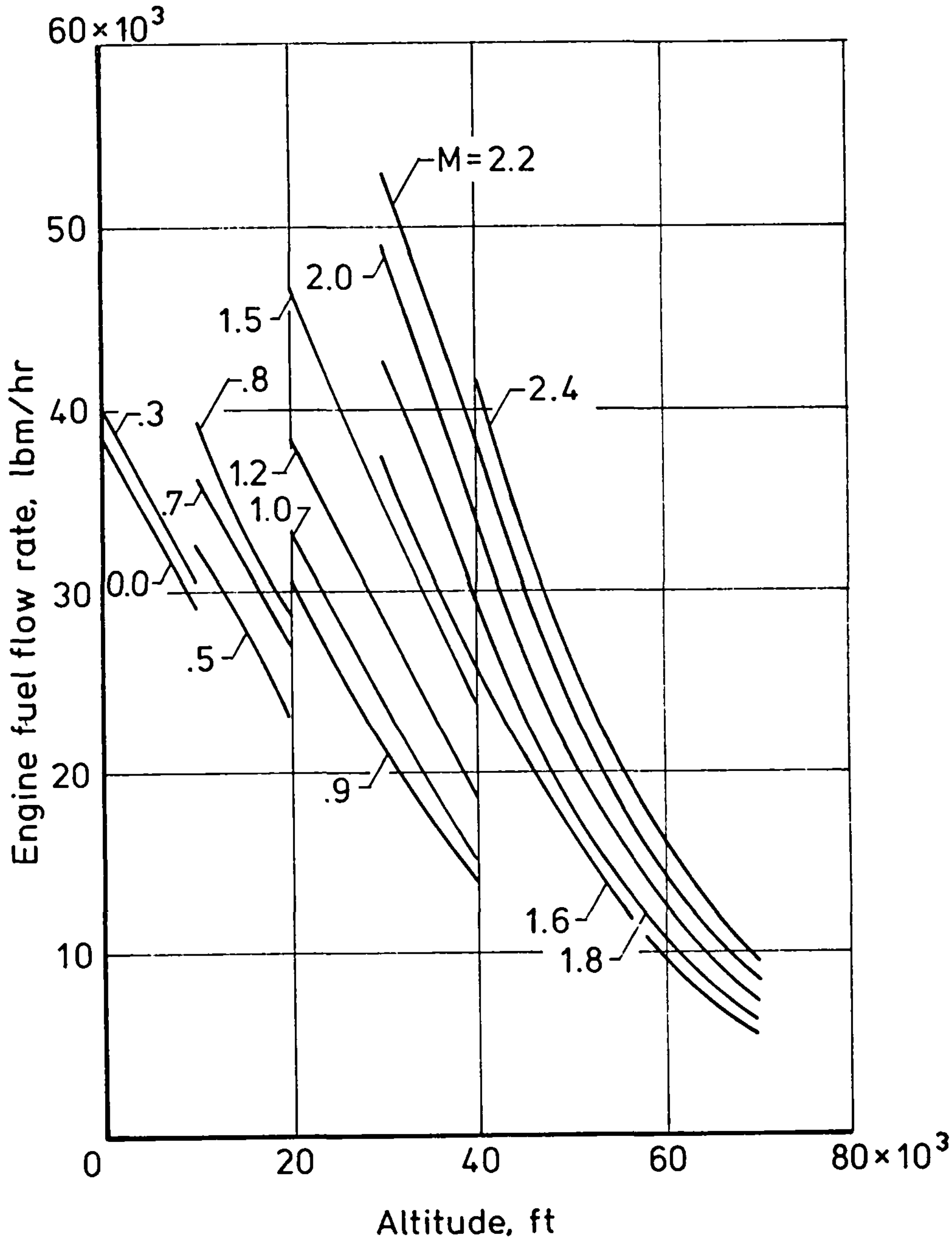


Figure IV-3. - Engine fuel flow rate at maximum thrust. Standard day conditions.

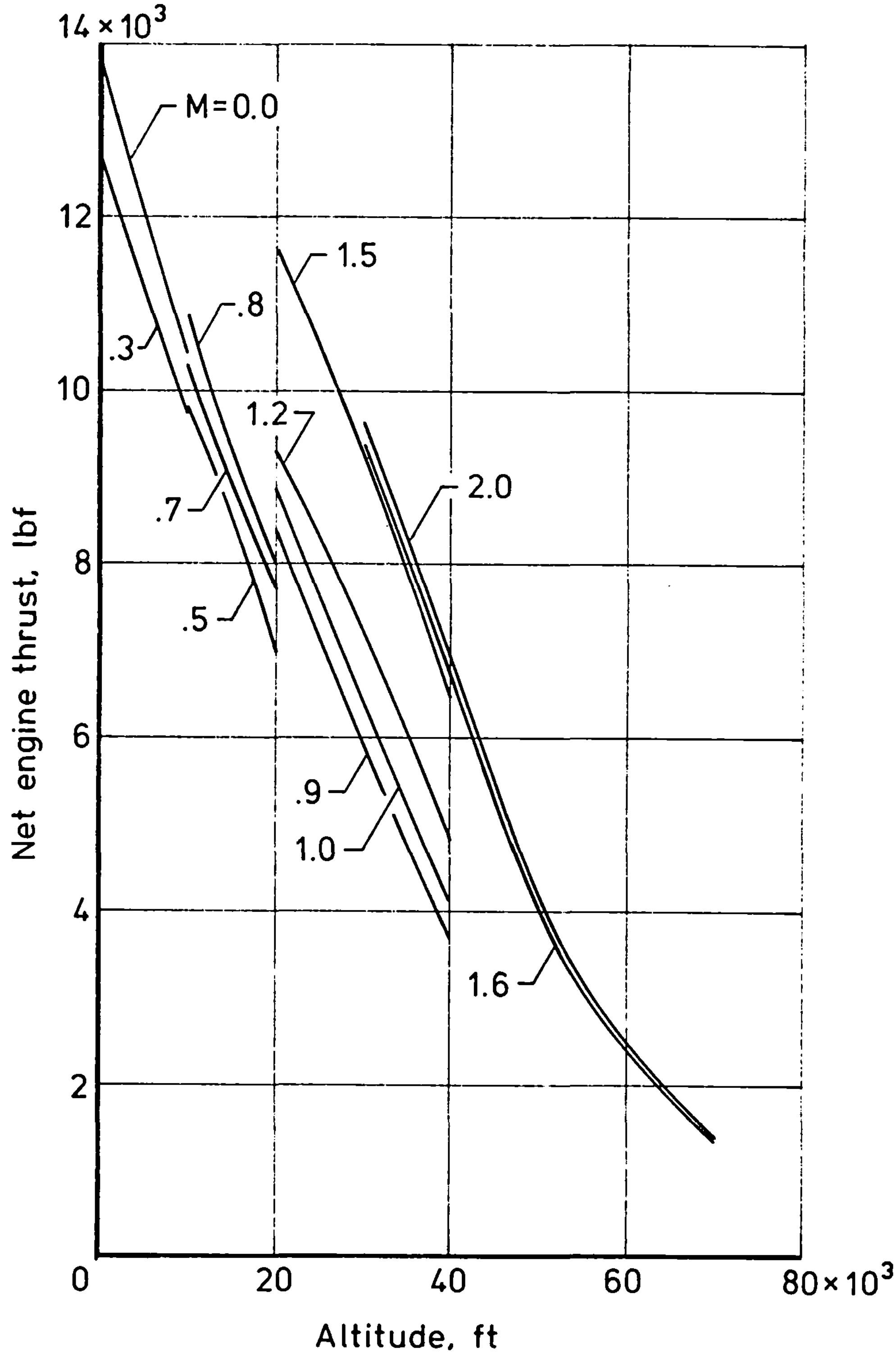


Figure IV-4. - Installed net engine intermediate thrust. Standard day conditions.

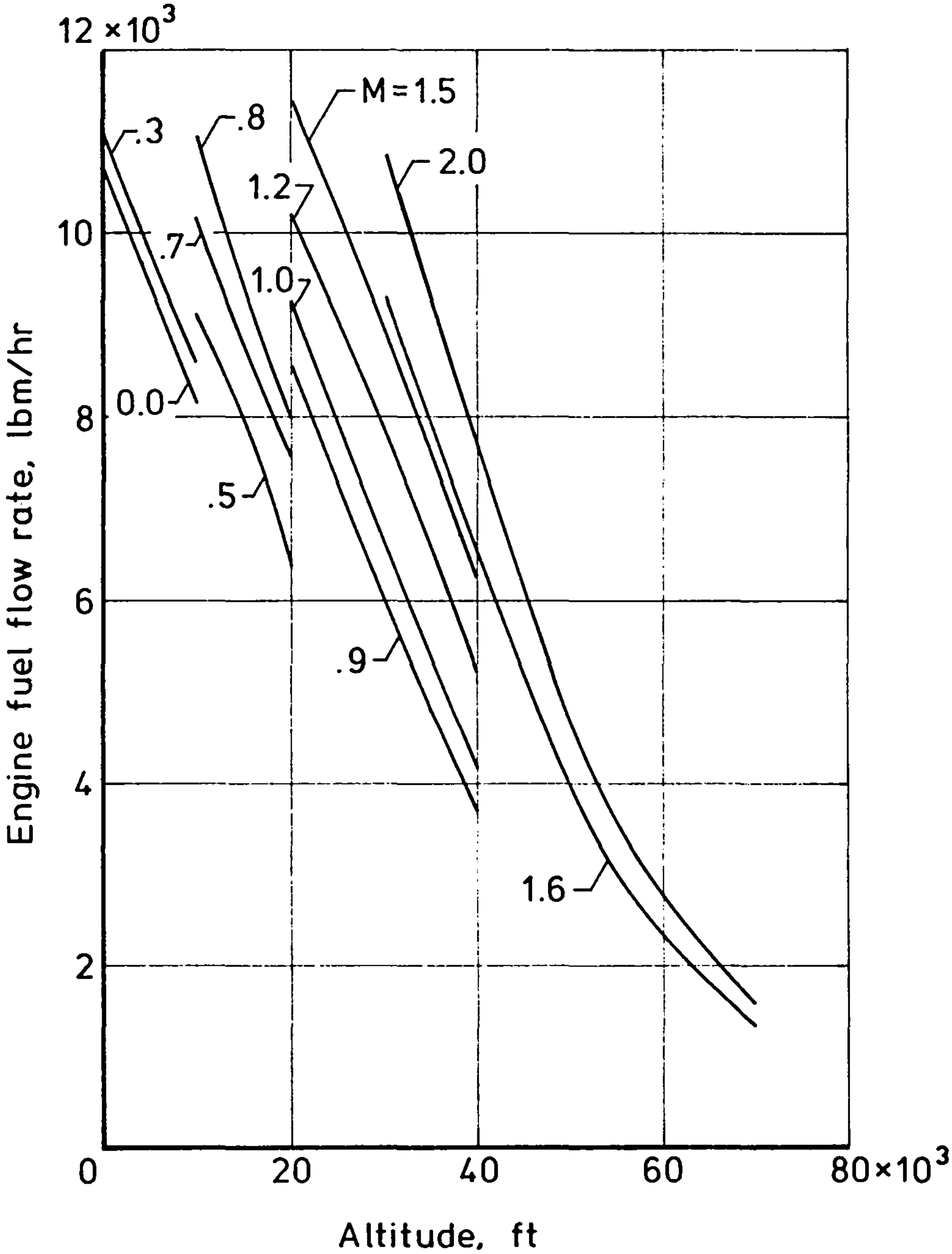


Figure IV-5. - Engine fuel flow rate at intermediate thrust. Standard day conditions.

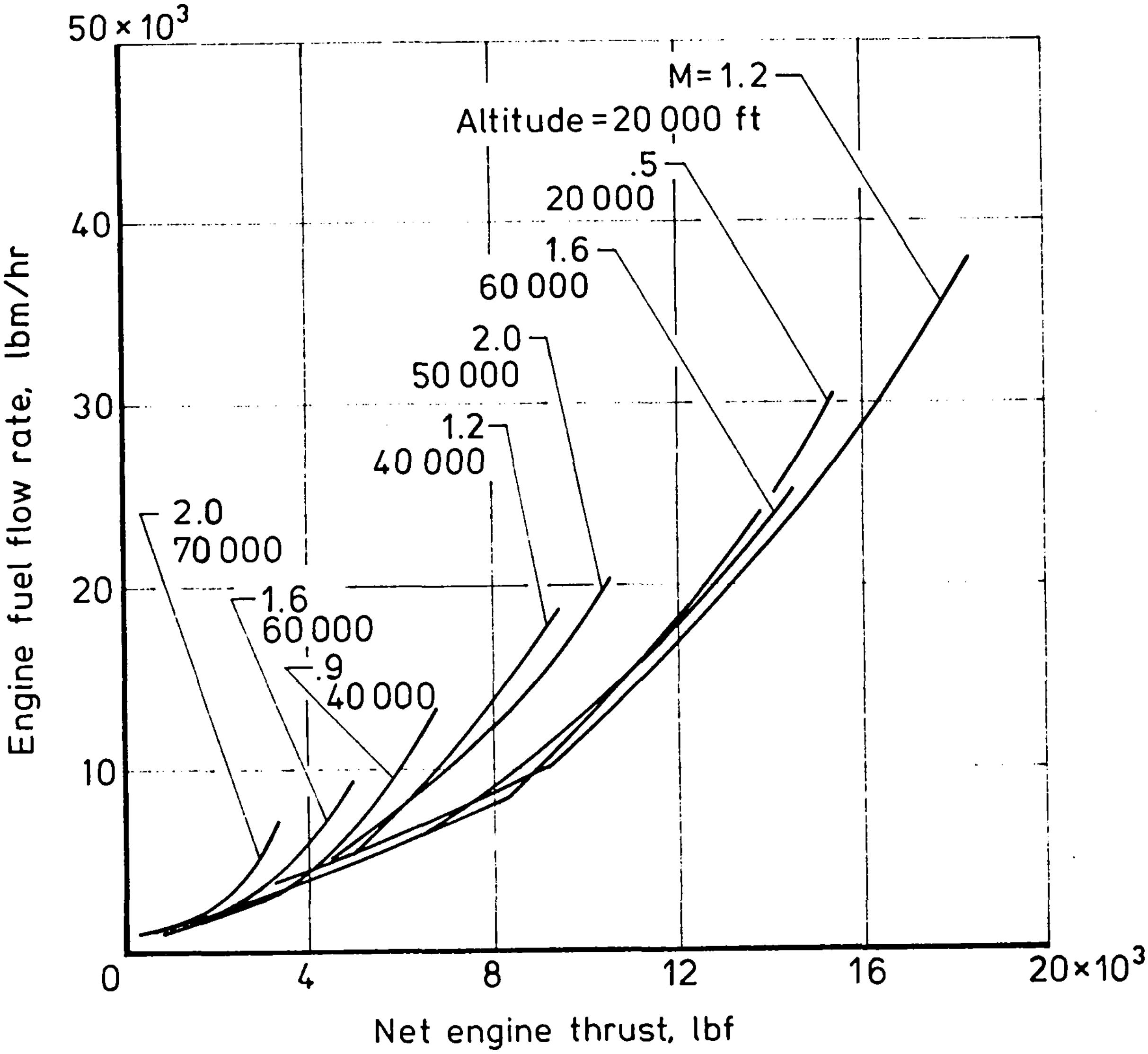


Figure IV-6. - Installed engine fuel flow rate for maximum acceleration and part power thrust. Standard day conditions.

PART V. - MASS PROPERTIES

E. E. Swanson

Mass properties analysis for this study was conducted using the weight analysis method in the Flight Optimization System (FLOPS) computer program described in reference V-I. Conventional titanium structure was assumed with no improvements in material or manufacturing technology applied. Table V-I lists a weight breakdown by subsystem for the baseline passenger version. The interceptor version is shown in table V-II. For this concept, furnishings and equipment, along with passengers and passenger services, have been removed. The fuselage weight has been increased to reflect the installation of the missile rotary launcher and bomb bay doors. Since one of the objectives of the convertible concept was to maintain maximum commonality, the intercept mission was defined as takeoff, cruise supersonically to intercept, deliver payload and return. Therefore, no structural weight penalty was assessed for maneuvering load factors. Additional weight has been provided for missile related avionics and systems. It was assumed that each missile would weigh 910 pounds for a total disposable payload weight of 3,640 pounds.

Figures V-1 and V-2 show the center-of-gravity envelope for each of the study versions. No aircraft inertia calculations were performed during this study.

REFERENCES

V-1. McCullers, L. A.: Aircraft Configuration Optimization Including Optimized Flight Profiles. Recent Experiences in Multi-disciplinary Analysis and Optimization, NASA CP 2327, April, 1984.

TABLE V-I. - GROUP WEIGHT SUMMARY
INTERCEPTOR VERSION

	lbf
WING	6,936.
HORIZONTAL TAIL	658.
VERTICAL TAIL	596.
FUSELAGE	4,735.
LANDING GEAR	1,771.
NACELLE	1,890.
STRUCTURE TOTAL	(16,586.)
ENGINES	5,680.
MISCELLANEOUS SYSTEMS	353.
FUEL SYSTEM-TANKS AND PLUMBING	705.
PROPULSION TOTAL	(6,738.)
SURFACE CONTROLS	872.
INSTRUMENTS	234.
HYDRAULICS	521.
ELECTRICAL	1,133.
AVIONICS	950.
FURNISHINGS AND EQUIPMENT	250.
AIR CONDITIONING	321.
ANTI-ICING	147.
SYSTEMS AND EQUIPMENT TOTAL	(4,426.)
WEIGHT EMPTY	27,750.
CREW AND BAGGAGE - FLIGHT, 2	450.
UNUSABLE FUEL	371.
ENGINE OIL	131.
OPERATING WEIGHT	28,702.
CARGO	3,640.
ZERO FUEL WEIGHT	32,342.
MISSION FUEL	30,904.
RAMP (GROSS) WEIGHT	63,246.

TABLE V-II. - GROUP WEIGHT SUMMARY
PASSENGER VERSION

	lbf
WING	6,936.
HORIZONTAL TAIL	658.
VERTICAL TAIL	596.
FUSELAGE	4,294.
LANDING GEAR	1,771.
NACELLE	1,890.
STRUCTURE TOTAL	(16,145.)
ENGINES	5,680.
MISCELLANEOUS SYSTEMS	353.
FUEL SYSTEM-TANKS AND PLUMBING	705.
PROPULSION TOTAL	(6,738.)
SURFACE CONTROLS	872.
INSTRUMENTS	234.
HYDRAULICS	521.
ELECTRICAL	1,133.
AVIONICS	500.
FURNISHINGS AND EQUIPMENT	1,350.
AIR CONDITIONING	330.
ANTI-ICING	147.
SYSTEMS AND EQUIPMENT TOTAL	(5,086.)
WEIGHT EMPTY	27,969.
CREW AND BAGGAGE - FLIGHT, 2	450.
UNUSABLE FUEL	371.
ENGINE OIL	131.
PASSENGER SERVICE	103.
OPERATING WEIGHT	29,024.
PASSENGERS, 8	1,320.
PASSENGER BAGGAGE	352.
ZERO FUEL WEIGHT	30,696.
MISSION FUEL	30,904.
RAMP (GROSS) WEIGHT	61,600.

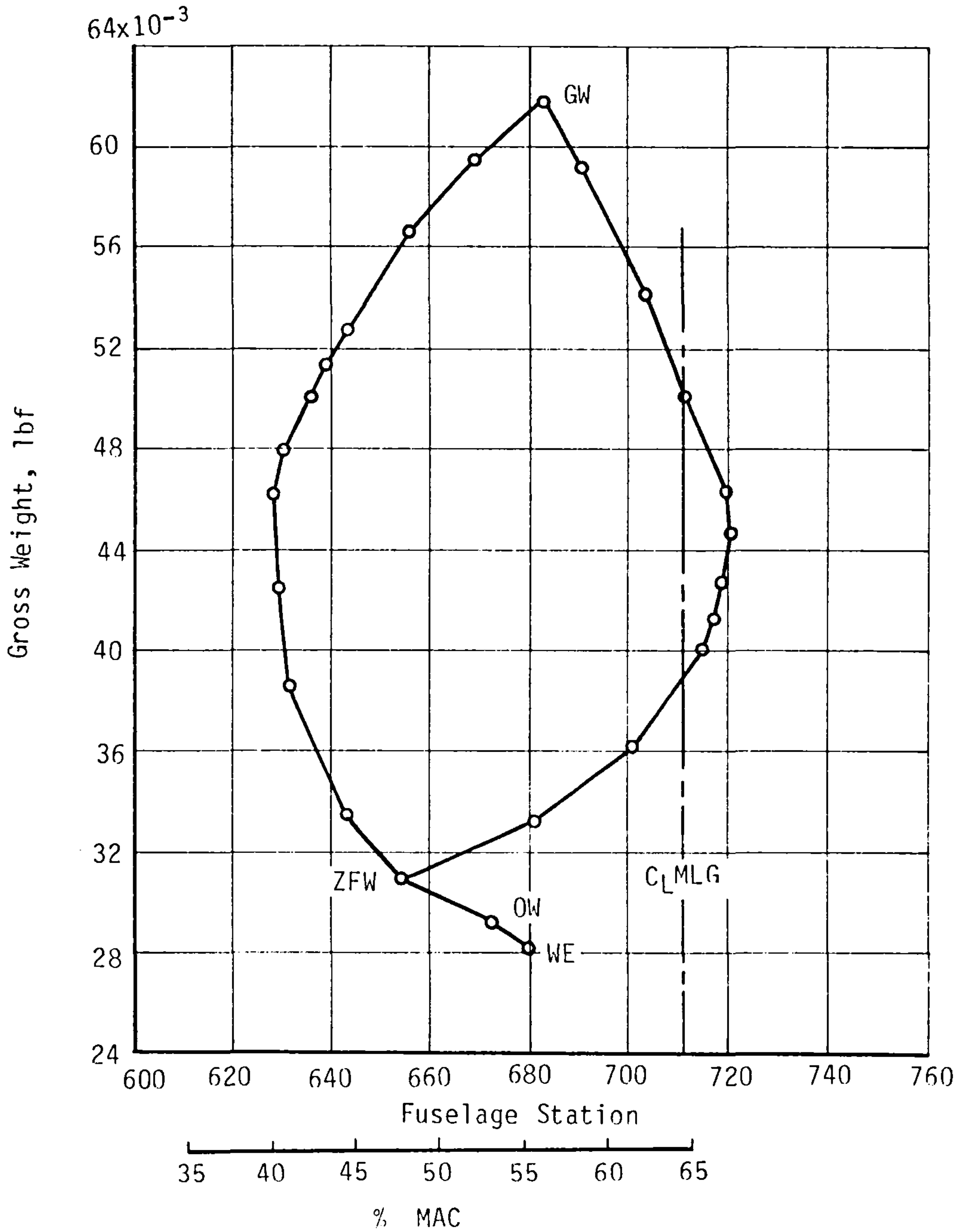


Figure V. - 1. - Center-of-gravity envelope.
Passenger Version

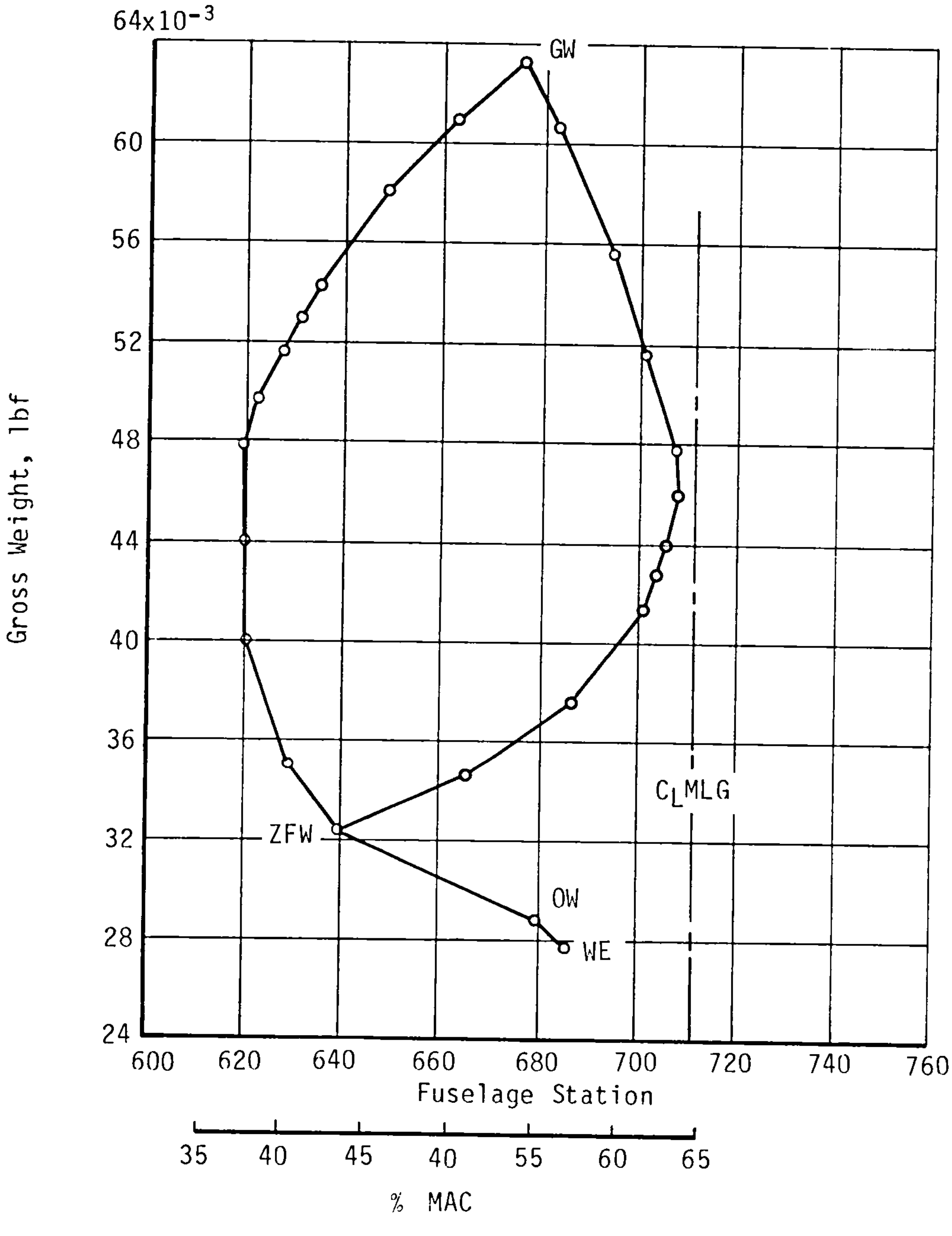


Figure V. - 2. - Center-of-gravity envelope.
Interceptor version

PART VI. - PERFORMANCE

F. L. Beissner, Jr.

The study of a dual purpose supersonic cruise aircraft resulted in an aircraft which could have an executive transport and a military interceptor capability. The range characteristics are considerable in either role, and the missions are quite diverse. The modifications required for change from one mission configuration to the other are minimal. The external lines are identical.

The aircraft is capable of a 3,622 n.mi. ($M = 2.0$ cruise) flight with the full payload of 8 passengers and crew of 2 on a full internal fuel load of 30,904 lb of fuel. The resulting ramp weight is 61,600 lb. The mission performance summary is shown in table VI-I. In the interceptor role, table VI-II shows the radius capability of 1,638 n.mi. with the same fuel load but with a payload of 4 Advanced Long Range Air to Air Missiles. Again, there is a crew of 2 with a totally different mission and the ramp weight is now 63,246 lb with the new payload. The two mission profiles are shown in figures VI-1 and VI-2.

Table VI-III is included to show the performance differences in a side by side comparison of this aircraft as it is employed in these two different missions. The primary difference in the mission execution of the aircraft in each of the two roles is the type of climb/acceleration that is performed. The transport is flown on a climb/acceleration that minimizes the fuel for the total mission (distance). It must also meet the FAA climb requirement, $V \leq 250$ KCAS below 10,000 ft altitude. The purpose of the interceptor is quite different, highly specialized, and is a military mission, not subject to the FAA climb restraint. The interceptor climb/acceleration minimizes the time to distance in order to achieve the intercept as quickly as possible. (This minimum time to distance climb/acceleration also achieves the alternate interceptor objective of intercepting inbound hostile aircraft, bogies, at the maximum distance out.) The aircraft is limited to $M \leq 2.0$ and maximum dynamic pressure of 1,500 lb/ft^2 at all times. Figures VI-3 and VI-4 compare the climb/acceleration schedules and flight paths in these two different missions. The other differences in missions involve, for the interceptor, a combat allowance ($M = 2.0$, 55,000 ft, 2g sustained turn of 540°, no distance credit), ordnance delivery, and return to home base.

Mission performance includes taxi-out and takeoff allowances (10 min fuel flow at idle power setting and 1 min fuel flow at takeoff power setting, nonaugmented in this case) followed by the selected climb/acceleration to cruise speed and altitude. Continue along M = 2.0 optimum cruise climb (combat and ordnance delivery for the interceptor, then continue) and descent to destination. Reserves are included which provide for flight continuation to the alternate airport including missed approach allowance (1 min fuel flow at takeoff power setting) climb and subsonic cruise at 30,000 ft, hold for 30 min and descent to the airport. The alternate airport is located 250 n.mi from the destination. The performance is calculated by the Flight Optimization System (FLOPS) computer program described in reference VI-1. All performance in this study is for standard day, no wind conditions.

One apparent operational anomaly in the mission rules just stated is the use of nonaugmented power setting for the military interceptor configuration. Referring to table VI-II, the taxi-out allowance of ten minutes idle requires 371 lb of fuel and the takeoff consumes 357 lbs (1 min). At full internal fuel weight, the maximum augmented takeoff run requires 16.11 seconds to the obstacle which requires 350 lb of fuel.

An alternate mission from New York to Los Angeles for the transport configuration was analyzed to determine the fuel required and the associated ramp weight. This 2,130 n.mi. overland flight requires fueling the aircraft with 18,881 lb of fuel to a ramp weight of 49,557 lb. The sonic boom overpressure during acceleration for this mission for minimum fuel and reduced overpressure is presented in table VI-IV. The increase in fuel/takeoff weight to 49,702 lb is inconsequential.

A maximum subsonic range mission at Mach 0.95 for the transport configurations also analyzed. Using the same basic mission rules for the transport configuration, the maximum subsonic range is 3,780 miles, as shown in table VI-V. This is only slightly better than the M = 2.0 range capability, but could be used to stretch the aircraft's range capability if desired.

Emergency loss of an engine in this aircraft presents no range problem. Operation would be restricted to subsonic speed. The worst possible case of engine loss at mid mission (subsonic) would require emergency use of some of the planned reserves to reach the destination.

Airfield performance for the study aircraft includes a balanced field length of 6,600 ft for the fully fueled transport aircraft. Normal two engine takeoff distance over a 35 ft obstacle is 4,640 ft. Maximum nonaugmented power is the takeoff power setting. Landing field length over a 50 ft obstacle is 5,170 ft at 44,737 lb. All airfield performance is computed at sea level standard day conditions with no additional conservatism. The trailing edge flap deflection of 20 degrees for takeoff was selected on the basis of minimum balanced field length. The landing configuration has a 30 degree flap deflection.

REFERENCES

VI-1. McCullers, L. A.: Aircraft Configuration Optimization Including Optimized Flight Profiles. Recent Experiences in Multi-disciplinary Analysis and Optimization, NASA CP 2327, April, 1984.

TABLE VI-I. - MISSION PERFORMMANCE SUMMARY

TRANSPORT DESIGN MISSION

	WEIGHT (LB)	FUEL (LB)	DISTANCE (N.MI.)	TIME (MIN.)	ALTITUDE (FT)	L/D	WT/SREF (LB/FT2)
RAMP WEIGHT	61,600.						
TAXI OUT		371.		10.0			
TAKEOFF WEIGHT	61,229.						63.0
TAKEOFF		357.		1.0			
START CLIMB WEIGHT	60,872.						
CLIMB		4,942.	328.4	26.5			
START CRUISE WEIGHT	55,930.				52,973.	7.18	57.5
CRUISE		20,890.	3,155.9	165.1			
END CRUISE WEIGHT	35,040.				58,204.	6.24	36.1
DESCENT		324.	138.4	15.4			
END DESCENT WEIGHT	34,717.						35.7
RESERVE		4,021.					
ZERO FUEL WEIGHT	30,696.						
TAXI IN		371.		10.0			
TOTAL FUEL		30,904.					
DESIGN RANGE			3,622.8				
FLIGHT TIME				270.0			

BLOCK TIME = 3.80 HOURS
BLOCK FUEL = 27,254. POUNDS

TABLE VI-II. - MISSION PERFORMMANCE SUMMARY

INTERCEPT DESIGN MISSION

	WEIGHT (LB)	FUEL (LB)	DISTANCE (N.MI.)	TIME (MIN.)	ALTITUDE (FT)	L/D	WT/SREF (LB/FT2)
RAMP WEIGHT	63,246.						
TAXI OUT		371.					
TAKEOFF WEIGHT	62,875.						
TAKEOFF		357.					
START CLIMB WEIGHT	62,518.						
CLIMB		3,760.	34.1	2.6			
START M=2.0 INTERCEPT	58,757.				52,304.	7.25	60.4
FLY IN		12,040.	1,603.9	83.9			
START COMBAT	46,717.				55,182.	6.87	48.1
COMBAT		1,593.	1,638.0	86.5			
END COMBAT	45,124.						
DELIVER ORDINANCE	(3,640)						
START M=2.0 RETURN	41,484.				56,506	6.62	42.7
FLY OUT		8,528.	1,481.8	(77.5)			
END RETURN CRUISE	32,955.				58,723.	6.08	33.9
DESCENT		390.	198.1	(17.6)			
END DESCENT	32,565.						
RESERVE		3,863.					
ZERO FUEL	28,702.						
TAXI IN		371.					
TOTAL FUEL		30,904.					
DESIGN RADIUS AND TIME TO INTERCEPT			1,638.0	86.5			

TABLE VI-III. - PASSENGER/INTERCEPTOR COMPARISON

CONFIGURATION	PASSENGER	INTERCEPTOR
PAYLOAD		
8 PASSENGERS, LB	1,672	
4 MISSILES, LB		3,640
WING AREA (REF) SQ FT	972.1	972.1
TAKE OFF GROSS WEIGHT (FIF), LB	61,600	63,246
FUEL WEIGHT (FIF), LB	30,904	30,904
MISSION RANGE*	3,622	
RADIUS*		1,638
CLIMB/ACCELERATION DESCRIPTION	MIN FUEL	MIN TIME
FLIGHT TIME TO COMMON POINT (500 N.MI.) MIN	35.1	27.0
FLIGHT FUEL TO COMMON POINT (500 N.MI.) MIN	6,286	7,517

*MRT TAKEOFF AND TAXI ALLOWANCE INCLUDED. SAME RESERVE RULES.

TABLE VI-IV.

TRANSPORT AIRCRAFT, NEW YORK TO LOS ANGELES ROUTE, M = 2.0 CRUISE

SAME RESERVES

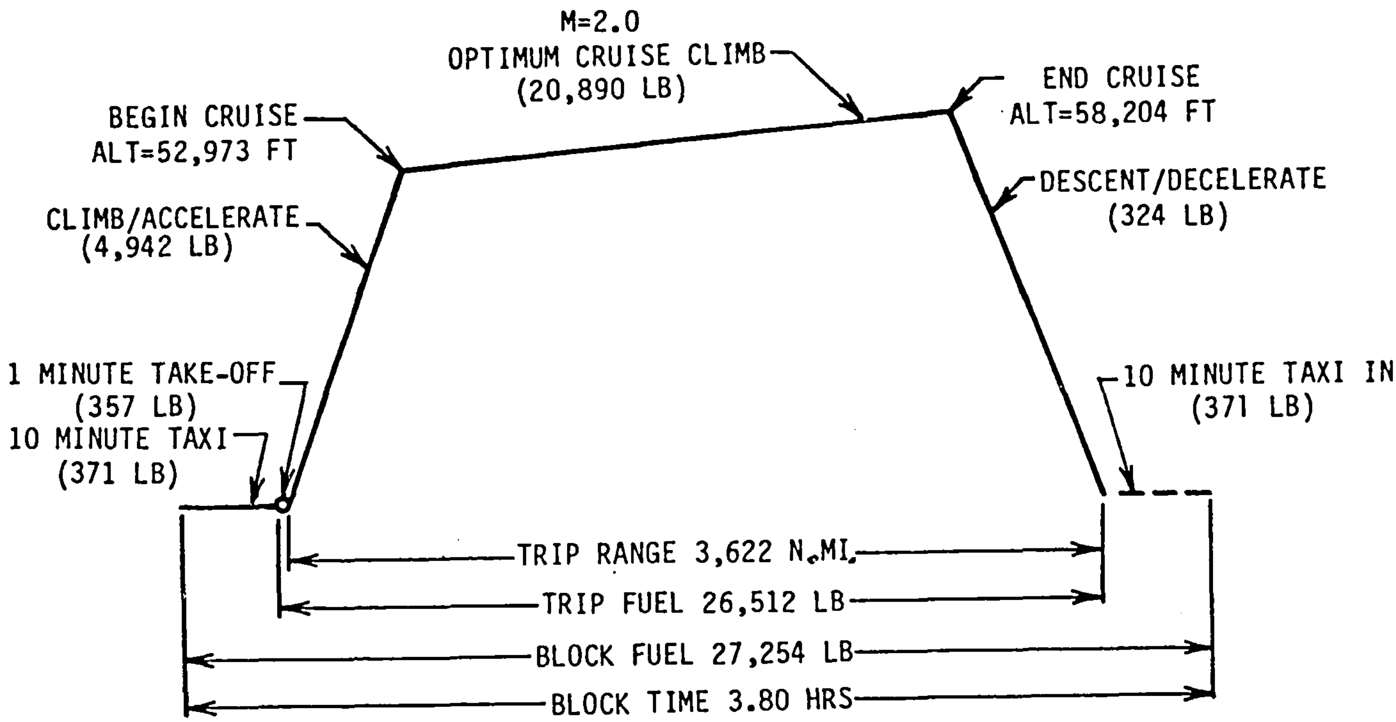
MISSION TYPE	MINIMUM FUEL	REDUCED BOOM
RAMP WEIGHT, LB	49,577	49,702
FUEL WEIGHT, LB	18,881	19,006
RANGE, N.MI.	2,130	2,130
ACCELERATION (M = 1.2)		
ALTITUDE, FT	43,150	46,000
WEIGHT, LB	47,100	46,950
OVERPRESSURE, PSF	1.05	1.00
START CRUISE (M = 2.0)		
ALTITUDE, FT	55,920	55,948
WEIGHT, LB	43,866	43,759
OVERPRESSURE, PSF	.90	.90

TABLE VI-V. - MISSION PERFORMANCE SUMMARY

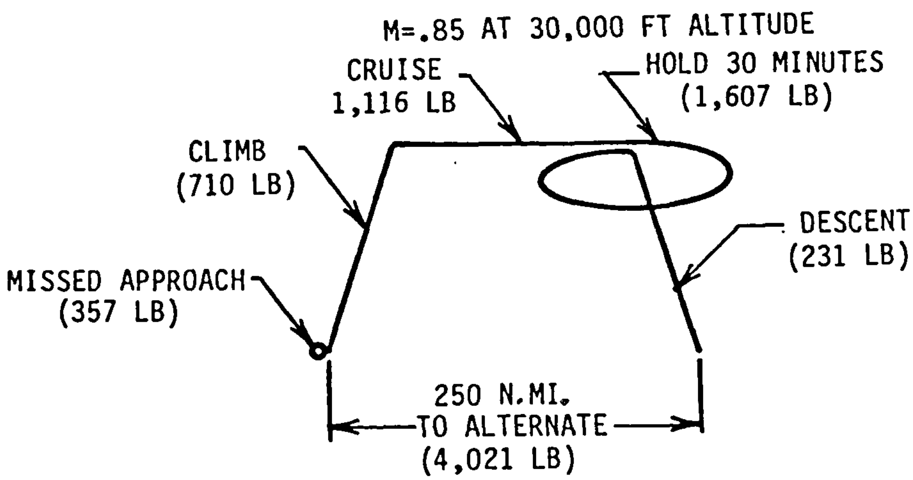
SUBSONIC MISSION - TRANSPORT VERSION

	WEIGHT (LB)	FUEL (LB)	DISTANCE (N.MI.)	TIME (MIN.)	ALTITUDE (FT)	L/D	WT/SREF (LB/FT2)
RAMP WEIGHT	61,600.						
TAXI OUT		371.		10.0			
TAKEOFF WEIGHT	61,229.						63.0
TAKEOFF		357.		1.0			
START CLIMB WEIGHT	60,872.						
CLIMB		1,552.	36.0	5.1			
START CRUISE WEIGHT	59,320.				33,951.	12.27	61.0
CRUISE		24,312.	3,648.6	401.4			
END CRUISE WEIGHT	35,007.				44,173.	11.85	36.0
DESCENT		296.	95.4	12.4			
END DESCENT WEIGHT	34,711.						
RESERVE		4,015.					
ZERO FUEL WEIGHT	30,696.						
TAXI IN		371.					
TOTAL FUEL		30,904.					
DESIGN RANGE			3,780.0				
FLIGHT TIME				418.9			

BLOCK TIME = 7.33 HOURS
BLOCK FUEL = 27,260. POUNDS

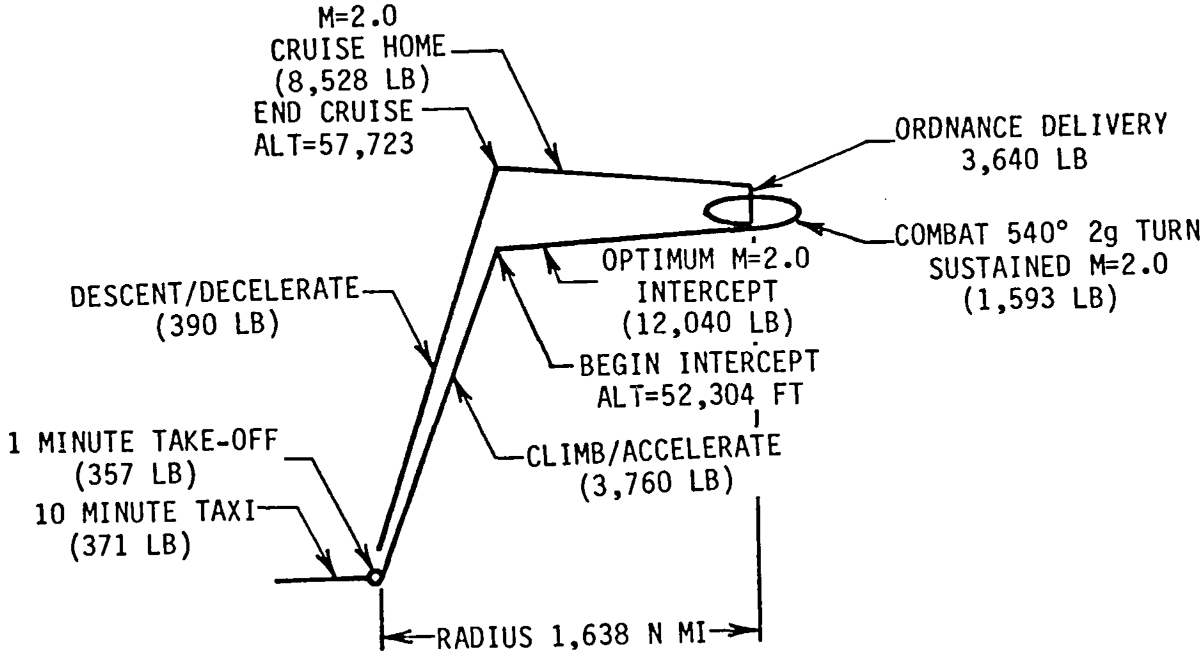


A. Main Segment.

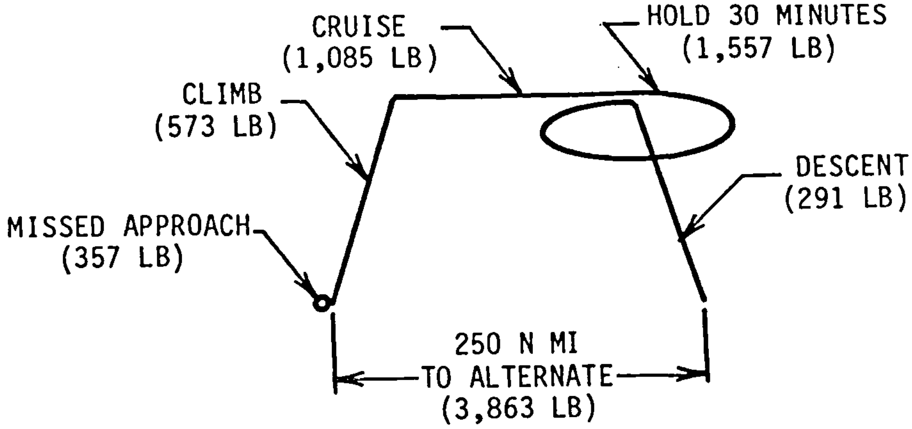


B. Reserve Segment.

Figure VI-1. Transport design mission profile, M=2.0 cruise, full internal fuel.



A. Main Segment.



B. Reserve Segment.

Figure VI-2. Interceptor mission profile, M=2.0, full internal fuel.

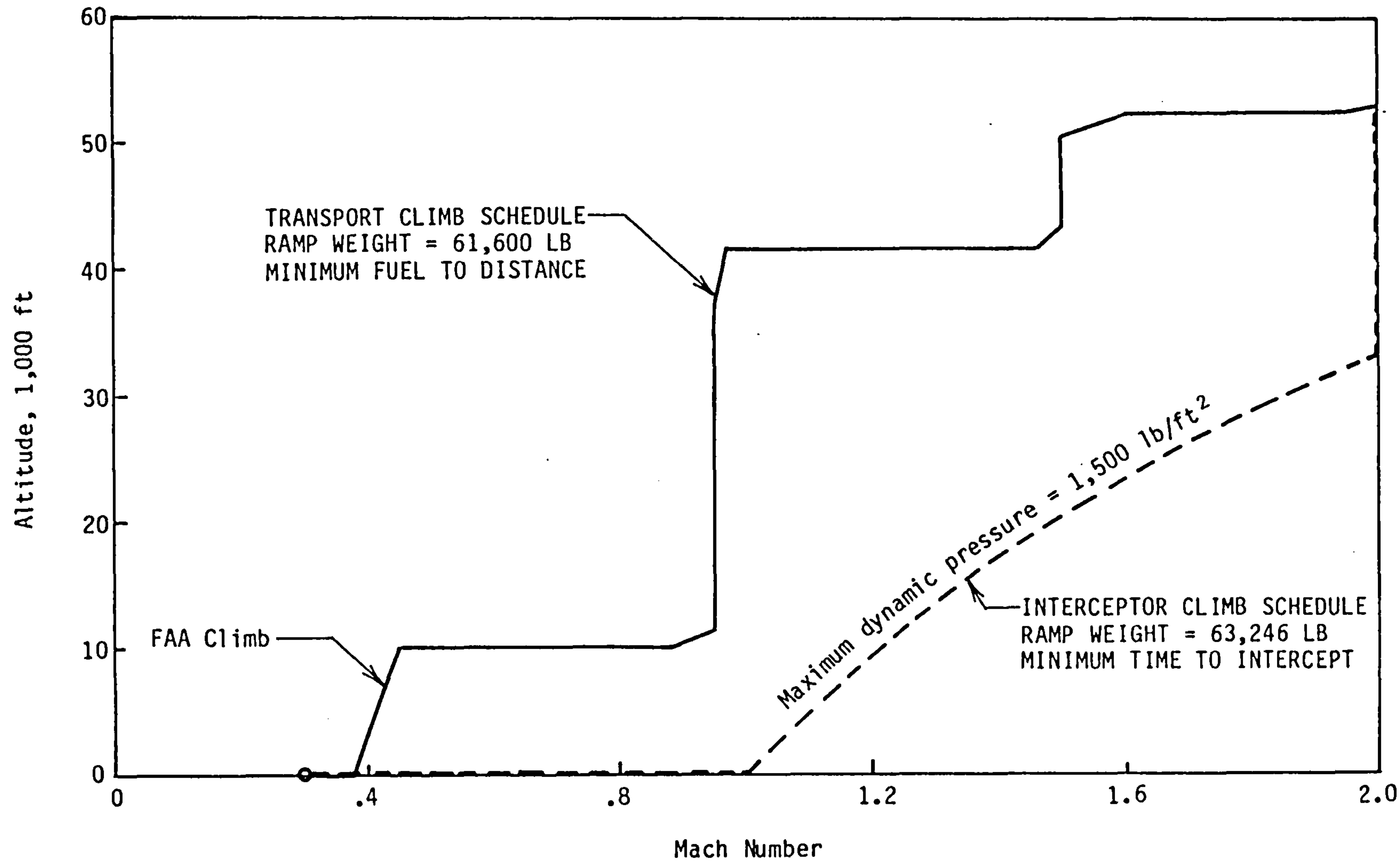


Figure VI-3. Climb/acceleration schedule comparison, transport versus interceptor.

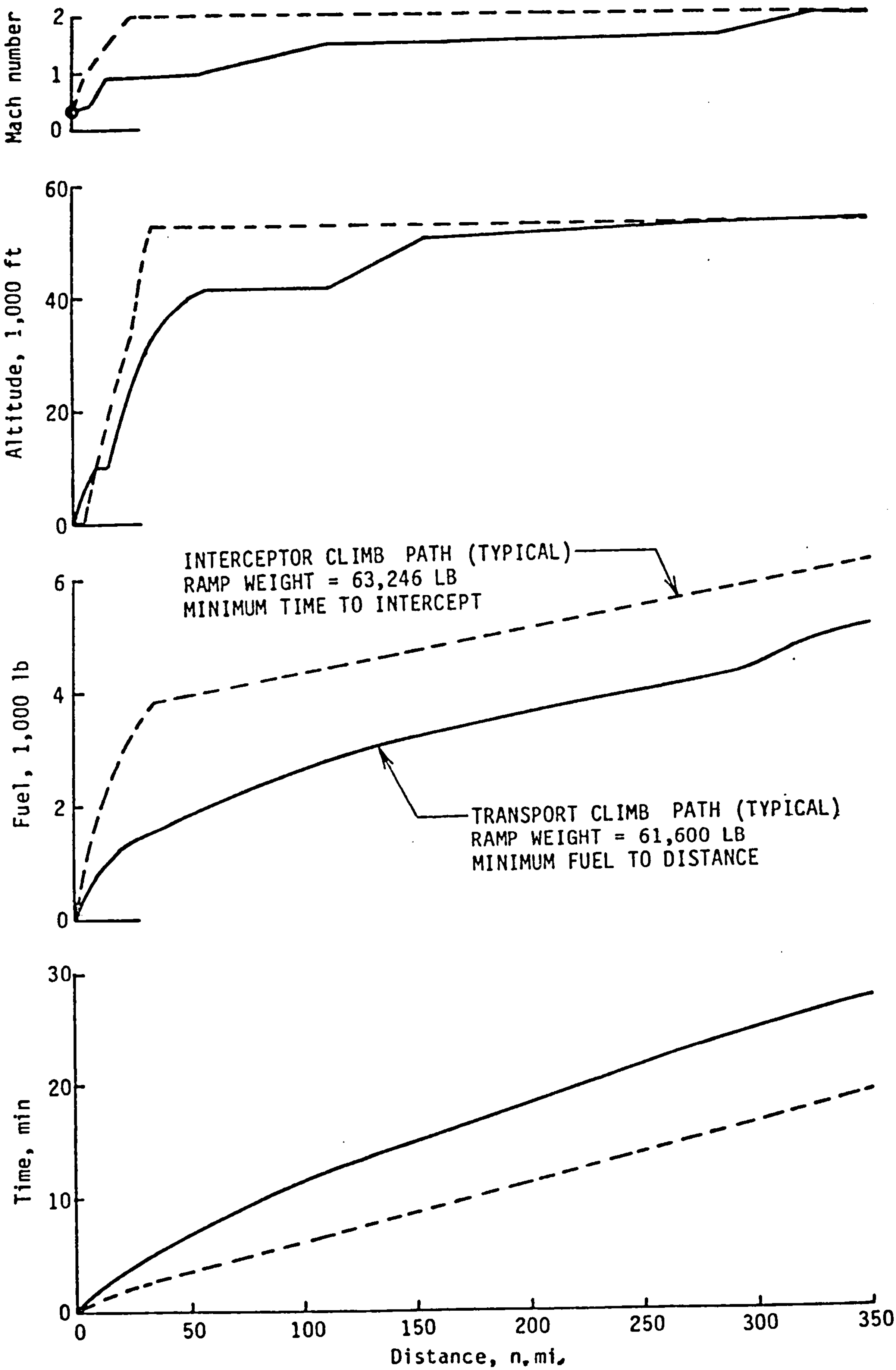


Figure VI-4. Effect of two different climb/acceleration schedules on flight path performance, transport versus interceptor, both full internal fuel and including payload.

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F. L. Beissner, Jr., W. A. Lovell, A. Warner Robins, and E. E. Swanson

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16. Abstract
This study was initiated to assess the feasibility of an eight-passenger, supersonic-cruise long range business jet aircraft that could be converted into a military missile carrying interceptor. The baseline passenger version has a flight crew of two with cabin space for four rows of two passenger seats plus baggage and lavatory room in the aft cabin. The ramp weight is 61,600 pounds with an internal fuel capacity of 30,904 pounds. Utilizing an improved version of a current technology low-bypass ratio turbofan engine, range is 3,622 nautical miles at Mach 2.0 cruise and standard day operating conditions. Balanced field takeoff distance is 6,600 feet and landing distance is 5,170 feet at 44,737 pounds. The passenger section from aft of the flight crew station to the aft pressure bulkhead in the cabin was modified for the interceptor version. Bomb bay type doors were added and volume is sufficient for four advanced air-to-air missiles mounted on a rotary launcher. Missile volume was based on a Phoenix type missile with a weight of 910 pounds per missile for a total payload weight of 3,640 pounds. Structural and equipment weights were adjusted and result in a ramp weight of 63,246 pounds with a fuel load of 30,938 pounds. Based on a typical intercept mission flight profile, the resulting radius is 1,609 nautical miles at a cruise Mach number of 2.0.

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