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AERODYNAMIC DESIGN AND ANALYSIS OF THE AST-200 SUPERSONIC TRANSPORT CONFIGURATION CONCEPT

Kenneth B. Walkley and Glenn L. Martin

VOUGHT CORPORATION
HAMPTON TECHNICAL CENTER
Hampton, Virginia 23666

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Hampton, Virginia 23665

SUMMARY

The design and analysis of a supersonic transport configuration has been conducted using linear theory methods in conjunction with appropriate constraints. A configuration which was developed through previous systems studies has been used as the baseline for the present design and analysis. Wing optimization centered on the determination of the required twist and camber and proper integration of the wing and fuselage. Also included in the design are aerodynamic refinements to the baseline wing thickness distribution and nacelle shape. Analysis of the baseline and revised configurations indicated an improvement in lift-to-drag ratio of 0.36 at the Mach 2.7 cruise condition. Validation of the design is planned through supersonic wind tunnel tests.

INTRODUCTION

High-speed aerodynamic performance for NASA-Langley Research Center AST (Advanced Supersonic Technology) concepts of current interest is usually estimated from wind tunnel data obtained during the late 1960's for the NASA SCAT 15F configuration (refs. 1 and 2). The SCAT 15F was designed using the then available linear theory methods, and has demonstrated very high levels of aerodynamic performance at the Mach 2.7 cruise condition. Present AST concepts employ a highly-swept arrow wing similar to the SCAT 15F and are designed for the same Mach 2.7 cruise. As these AST concepts have continued to evolve, however, it has become necessary to apply increasingly larger corrections to the wind tunnel data to account for differences between the model and present study concepts. The availability of more recent wind tunnel data for the McDonnell-Douglas Mach 2.2 AST concept (ref. 3) has not alleviated this data base problem because of significant differences in configuration geometry and design Mach number relative to the NASA AST configurations.

The need to establish an updated experimental data base which is more consistent with current Mach 2.7 AST study concepts is apparent. The purpose of this report is to describe the aerodynamic design of the AST-200 configuration which is typical of concepts currently under study at NASA-Langley.

The development of the AST-200 is centered on determination of the optimum wing twist and camber distribution using linear theory methods which have been significantly expanded and improved since the SCAT 15F design. Other aerodynamic refinements have been identified through various systems studies and are also included. Wind tunnel tests of this updated configuration are planned to validate the design and provide the required data base for future configuration studies.

SYMBOLS

A	fuselage cross-sectional area
$A_1, A_2, \ldots A_9$	coefficients for the component wing loadings
b	wing span
c	wing local chord
$\bar{c}$	wing mean aerodynamic chord
C_D	drag coefficient, $\frac{\text{drag}}{qS}$
C_{D_i}	drag-due-to-lift coefficient, $\frac{\text{drag-due-to-lift}}{qS}$
CG	center-of-gravity
C_L	lift coefficient, $\frac{\text{lift}}{qS}$
C_m	pitching moment coefficient, $\frac{\text{pitching moment}}{qS\bar{c}}$
C_{m_o}	pitching moment at zero lift
C_p	pressure coefficient, $\frac{P-P_\infty}{q}$
$C_{p_{vac}}$	vacuum pressure coefficient, $\frac{-P_\infty}{q}$
C_R	wing root chord (at $y = 0$)

i_T	horizontal tail incidence, degrees
k_E	drag-due-to-lift factor
L/D	lift-to-drag ratio
M_∞	freestream Mach number
P	static pressure
P_∞	freestream static pressure
q	freestream dynamic pressure
S	reference wing area
t/2c	wing half-thickness, percent
X, Y, Z	configuration longitudinal, spanwise, and vertical coordinates
Z_c	camber coordinate
α_{TWIST}	wing section twist angle relative to the horizontal wing reference plane
α_{WRP}	angle of attack of the wing reference plane

DESIGN CONSIDERATIONS

The intent of the present design effort was to define an AST configuration sufficiently typical of concepts currently under study at the NASA-Langley Research Center that planned wind tunnel tests of the design will provide a readily applicable data base for future configuration studies. Improved cruise performance was achieved through application of refined lienar theory design methods and incorporation of additional aerodynamic improvements. Results from previous systems studies (e.g., ref. 4) were used as a guide in applying the linear theory and other aerodynamic improvements. The resulting configuration thus represents a viable concept which meets volume and structural requirements defined through detailed systems studies.

The design of the AST-200 has proceeded from a baseline definition which was developed from previous system studies. Aerodynamic improvements to the baseline wing thickness distribution and nacelle shape were incorporated and an optimum twist and camber distribution was developed. The wing and fuselage were carefully integrated and the fuselage area-ruled for minimum wave drag at the Mach 2.7 cruise condition.

Design conditions and constraints employed in the wing twist and camber optimization included a design lift coefficient of $C_L = 0.10$ at Mach 2.7 with the wing self-trimming for a center-of-gravity (CG) location of $0.49\bar{c}$. Wing upper surface pressure coefficients were constrained to be no more negative than 0.7 $C_{p_{VAC}}$ with gradients less than 0.164 per meter (0.0050 per foot). The wing centerline twist was constrained to maintain an acceptable cabin floor angle.

Aerodynamic design and analysis for the AST-200 is presented below for the full scale configuration.

BASELINE CONFIGURATION DESCRIPTION

The configuration selected as the baseline for this design effort is designated the AST-102 (fig. 1). This configuration is a resized version of the AST-100 described in reference 4 and is a conventional fossil-fueled supersonic cruise transport concept. The AST-102 configuration incorporates a highly swept arrow wing designed for cruise at a Mach number of 2.7. The wing gross area is 866 m^2 (9317 ft^2) and the associated reference area is 785 m^2 (8447 ft^2). Wing twist and camber were developed from the SCAT 15F geometry (refs. 1 and 2), and the wing thickness distribution was designed to meet structural and volume requirements while simultaneously providing low wave drag characteristics. Five abreast seating is provided in the fuselage for 273 passengers. The fuselage is area ruled for optimum cruise performance. Four engine nacelles are located beneath the wing trailing edge in a conventional manner. Vertical wing fins and the vertical and horizontal tails were sized to meet trim, stability, and control criteria consistent with that for the AST-100 (ref. 4).

A standard numerical model description (ref. 5) of the AST-102 is presented as table I. The wing size and planform, fuselage length, and wing fin and empennage geometry defined in this table apply directly to the AST-200. Other geometry revisions developed in the design process are discussed below.

AST-200 DESIGN

The baseline AST-102 configuration described above was redesigned by incorporating several aerodynamic refinements and using an improved linear theory method to optimize the wing twist and camber. This linear theory design and analysis methodology is presented in reference 6 and will be referred to as the Boeing program. Application of this linear theory and incorporation of the other aerodynamic improvements are discussed in the following sections.

Nacelle Revision

The AST-102 nacelle shape incorporated a relatively short conical forebody and a long cylindrical afterbody (fig. 2). Zero-lift wave drag studies using the far-field method (ref. 7) indicated that a wave drag decrease of 1.1 drag counts (.00011) could be achieved by modifying the nacelle geometry to that shown in figure 2 for the AST-200. At lifting conditions, an additional interference drag decrease of 0.8 counts was estimated using the Boeing program (ref. 6). A slight reduction in nacelle wetted area and skin friction also occurred resulting in a total drag decrease of 2.0 counts at the Mach 2.7 cruise condition. The revised nacelle shape resulted in improved cruise performance while providing sufficient volume to house the engine originally defined for the AST-102 baseline.

Wing Thickness Development

A wing thickness distribution which has improved wave drag performance relative to the AST-102 was developed from the NACA 64A series airfoil sections (ref. 8). These airfoil sections have traditionally provided good supersonic performance for subsonic leading edge wings. The maximum thickness for airfoils of this series occurs at the 40 percent chord location, and some modifications are required to adapt these sections to AST configurations which typically require the maximum thickness to be located further aft for structural considerations.

Previous AST-102 configuration studies identified the required maximum thickness and location from wing volume and structural considerations. These same maximum thickness values and locations have been applied to the AST-200, but the basic thickness shape has been modified as follows: As shown in figure 3, a 64A series airfoil section having the required maximum thickness for a given spanwise location on the wing was defined using the data from reference 8. This initial section has its maximum thickness at the 40 percent chord location. The maximum thickness was held constant from this point to the most aft point of maximum thickness taken from the AST-102. A second 64A section was then defined which has a maximum thickness different from the first, but which passes through the most aft point of maximum thickness on the revised section. The resulting airfoil is thus composed of two NACA 64A airfoil sections with a "flat-top" region between them. Typical comparisons of the revised and baseline thickness envelopes are shown in figure 4. Note that the AST-200 sections have somewhat increased depth forward, but reduced depth aft of the rear maximum thickness point. Note also that the wing tip panel which has a supersonic leading edge has been modified to incorporate a circular arc airfoil section with the maximum thickness at the 50 percent chord point. The thickness has been increased to three percent to provide more depth in the tip panel for such items as flap actuators and lights. Figure 5 summarizes the spanwise variation of the maximum thickness location and magnitude.

The revisions to the wing thickness distribution resulted in a nine percent reduction in wing volume for the AST-200. This decrease occurs in the trailing-edge region of the wing where the flaps are located and thus does not penalize the fuel volume capability of the AST-200. The AST-200 wing thickness in the trailing-edge region should be sufficient to house the flap actuators without wing bumps. The increase in wing tip panel thickness resulted in a negligible increase in the far-field wave drag. A net wave drag reduction of 0.5 counts (.00005) was estimated for the wing using the method of reference 7.

Wing Twist and Camber Design

Determination of the optimum wing twist and camber subject to the design constraints previously noted was accomplished using the linear theory methods of reference 6. This methodology incorporates many improvements to the basic theory which have evolved since the SCAT 15F design. Reference 9 presents a discussion of the fundamental details of the computational methods employed in reference 6. The present methodology allows for direct application of various constraints and iterates for the required twist and camber solution.

The loading for determining the twist and camber is optimized from a predefined set of component loadings in conjunction with a series of configuration dependent loadings for fuselage upwash and bouyancy and nacelle bouyancy. Initial design solutions for the AST-200 wing alone indicated that inclusion of the uniform and linear spanwise component loadings produced unmanageable wing root camber. These results were very similar to those obtained in reference 10 for a supersonic cruise fighter wing. The solution to this problem adopted in reference 10 has also been applied to the AST-200 design. The basic component loadings defined in the Boeing program have been replaced with the series of apex loadings defined in reference 10. The configuration dependent loadings have been retained unaltered. Exclusion of the uniform and linear spanwise loadings when using these apex loadings resulted in a more satisfactory camber distribution solution.

Design of the wing in the presence of the fuselage requires modifications to the basic wing upper surface pressure constraints to account for the real flow effects of inboard shock separation. Reference 11 presents a detailed discussion of the inboard shock and provides a method for computing allowable pressure coefficients on the wing. Attempts to design the wing in the presence of the fuselage with these pressure constraints proved unsuccessful. Both unsatisfactory camber shapes and unrealistic drag levels were obtained in all cases. The fuselage was thus not considered in the wing camber design, but was carefully integrated with the final wing as discussed in a later section.

The effects of the nacelles were included directly in the design. As noted in reference 6, two nacelle loadings are available: (1) the nacelle bouyancy loading and (2) a camber-induced loading proportional to the nacelle bouyancy loading. The best overall design was obtained when only the nacelle bouyancy loading was used and the camber-induced loading was omitted. A Z-constraint was ultimately included at the wing root trailing edge to maintain an acceptable cabin floor angle.

Table II summarizes the AST-200 design constraints, loadings, and results. The corresponding camber and twist distributions are compared with the AST-102 baseline in figures 6 and 7, respectively.

The linear theory used in this design does not recognize out-of-plane wing shear and essentially provides a wing with the leading-edge lying in the horizontal reference plane. A shear distribution was developed for the AST-200 which maintains straight, but not necessarily horizontal, trailing-edge flap hinge lines. The AST-102 baseline was used as a guide to define wing anhedral/dihedral angles for the various wing segments. A comparison of the AST-102 baseline and the AST-200 wing leading and trailing edges is presented in figure 8.

Wing-Body Integration

As previously noted, the fuselage induced loadings were excluded from the wing camber surface optimization. The wing and fuselage have been carefully integrated, however, to maintain as closely as possible the optimum wing aerodynamic characteristics. The procedure utilized has been discussed in references 12 and 13 and requires that the change in cross-sectional area with length ($\partial A/\partial x$) above and below the wing camber surface be held equal for each fuselage station. The interactive computer code described in reference 13 was used to perform the integration process. The key station was defined such that a low wing configuration could be established.

The resulting fuselage camber distribution is shown in figure 9. Note that the AST-200 has a circular fuselage.

Wave Drag Optimization

The AST-200 fuselage area distribution was optimized for minimum wave drag at Mach 2.7 subject to a five abreast seating area constraint using the method of reference 7. Figure 10 compares the AST-200 fuselage area distribution with the baseline.

The AST-200 Configuration

A numerical definition (ref. 5) of the AST-200 configuration is presented as table III. The data are for the full scale configuration. Note again that the wing fins and empennage are unchanged from those of AST-102 baseline.

AERODYNAMIC ANALYSIS

The AST-102 baseline and the AST-200 design have been analyzed at Mach numbers of 2.7 and 1.2 to determine the incremental improvements in the aerodynamic performance. The Boeing program (ref. 6) has been used to compute the skin friction and drag-due-to-lift characteristics whereas the method of reference 7 was employed for the wave drag analysis. The fuselage was included in the skin friction and wave drag analyses, but not in the drag-due-to-lift analysis. With the fuselage so excluded, the Boeing program computes the drag-due-to-lift characteristics of the wing-nacelles-horizontal tail combination. Both configurations were trimmed using the horizontal tail at lift coefficients of 0.10 and 0.15 at Mach numbers of 2.7 and 1.2, respectively.

The traditional discrepancies between the design and analysis methods (ref. 9) resulted in predicted aerodynamic characteristics which differ somewhat from the design results. In particular, note that although the AST-200 was designed to be self-trimming at cruise, the analysis results indicate that a small upload on the horizontal tail is required to trim. This small upload is favorable to the overall configuration performance as discussed in reference 14. The effect of the fuselage is to destabilize the configuration and require an additional small horizontal tail upload.

The computed aerodynamic characteristics are presented in figure 11. Of particular interest are the improvements in lift-to-drag ratio obtained by the AST-200 design. An increment of +0.36 in cruise lift-to-drag ratio is estimated.

CONCLUDING REMARKS

The AST-200 is a conventional, circular cross-section fuselage supersonic transort. The aerodynamic design of this configuration using linear theory methods has resulted in improved aerodynamic performance relative to a baseline predecessor.

REFERENCES

1. Morris, Odell A.; Fuller, Dennis E.; and Watson, Carolyn B.: Aerodynamic Characteristics of a Fixed Arrow-Wing Supersonic Cruise Aircraft at Mach Numbers of 2.30, 2.70, and 2.95. NASA TM-78706, August 1978.

2. Decker, John P. and Jacobs, Peter F.: Stability and Performance Characteristics of a Fixed Arrow Wing Supersonic Transport Configuration (SCAT 15F-9898) at Mach Numbers from 0.60 to 1.20. NASA TM-78726, June 1978.

3. Radkey, R. L.; Welge, H. R.; and Felix, J. E.: Aerodynamic Characteristics of a Mach 2.2 Advanced Supersonic Cruise Aircraft Configuration at Mach Numbers from 0.5 to 2.4. NASA CR-145094, February 1977.

4. Baber, Hal T., Jr. and Swanson, E. E.: Advanced Supersonic Technology Concept AST-100 Characteristics Developed in a Baseline Update Study. NASA TM X-72815, January 1976.

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

6. Middleton, W. D.; Lundry, J. L.; and Coleman, R. G.: A Computational System for Aerodynamic Design and Analysis of Supersonic Aircraft. Parts 1, 2, and 3. NASA CR-2715, -2716, and -2717, 1976.

7. Harris, Roy V., Jr.: An Analysis and Correlation of Aircraft Wave Drag. NASA TM X-947, 1964.

8. Patterson, Elizabeth W. and Braslow, Albert L.: Ordinates and Theoretical Pressure-Distribution Data for NACA 6- and 6A-Series Airfoil Sections with Thicknesses from 2 to 21 and from 2 to 15 Percent Chord, Respectively. NASA TR R-84, 1961.

9. Carlson, Harry W. and Miller, David S.: Numerical Methods for the Design and Analysis of Wings at Supersonic Speeds. NASA TN D-7713, 1974.

10. Miller, David S. and Schemensky, Roy T.: Design Study Results of a Supersonic Cruise Fighter Wing. AIAA Paper 79-0062, 1979.

11. Kulfan, R. M. and Sigalla, A.: Real Flow Limitations in Supersonic Airplane Design. AIAA Paper 78-147, 1978.

12. Baals, Donald D.; Robins, A. Warner; and Harris, Roy V., Jr.: Aerodynamic Design Integration of Supersonic Aircraft. AIAA Paper 68-1018, 1968.

13. Dollyhigh, Samuel M.; Morris, Odell A.; and Adams, Mary S.: 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.

14. Laitone, E. V.: Ideal Tail Load for Minimum Aircraft Drag. J. Aircraft, Vol. 15, No. 3, March 1978.

Table I. - AST-102 Numerical Model

(a) SI Units (meters)

AST-102 BASELINE FOR AST-200 DESIGN

1 1 -1 1 1 1 12 28 1 19 30 2 4 2 10 1 10

784.75										REFA
0.	.125	.25	.5	.75	1.0	1.5	2.5	5.0	10.	XAF 10
15.	20.	25.	30.	35.	40.	45.	50.	55.	60.	XAF 20
65.	70.	75.	80.	85.	90.	95.	100.			XAF 28
21.726	1.569	-1.551	45.864							WORG 1
22.862	1.894	-1.848	44.720							WORG 2
25.551	2.665	-2.314	42.015							WORG 3
29.470	3.789	-2.737	38.073							WORG 4
36.077	5.684	-3.214	31.427							WORG 5
38.761	6.453	-3.388	28.727							WORG 6
42.683	7.578	-3.627	25.112							WORG 7
48.154	9.146	-3.851	20.070							WORG 8
52.352	10.606	-3.986	16.271							WORG 9
54.543	11.367	-4.076	14.753							WORG 10
62.201	14.028	-4.359	9.446							WORG 11
71.380	19.328	-4.898	4.949							WORG 13
0.000	.000	.000	0.000	-.000	-.001	-.002	-.007	-.037	-.146	TZ 1.1
-.312	-.514	-.742	-.971	-1.215	-1.459	-1.695	-1.947	-2.170	-2.393	TZ 1.2
-2.587	-2.769	-2.940	-3.097	-3.243	-3.375	-3.490	-3.591			TZ 1.3
0.000	.000	.001	.001	.001	.001	.000	-.002	-.012	-.095	TZ 2.1
-.230	-.401	-.596	-.791	-1.010	-1.229	-1.453	-1.678	-1.877	-2.076	TZ 2.2
-2.253	-2.427	-2.592	-2.758	-2.904	-3.039	-3.151	-3.246			TZ 2.3
0.000	.001	.002	.004	.005	.007	.010	.016	.025	.020	TZ 3.1
-.121	-.247	-.400	-.553	-.724	-.895	-1.072	-1.248	-1.418	-1.588	TZ 3.2
-1.742	-1.900	-2.051	-2.194	-2.329	-2.452	-2.564	-2.663			TZ 3.3
0.000	.002	.003	.005	.009	.011	.016	.024	.040	.016	TZ 4.1
-.048	-.134	-.241	-.347	-.470	-.593	-.724	-.854	-.987	-1.119	TZ 4.2
-1.250	-1.379	-1.505	-1.626	-1.744	-1.857	-1.963	-2.063			TZ 4.3
0.000	.002	.003	.006	.009	.013	.020	.031	.058	.069	TZ 5.1
.048	.009	-.048	-.105	-.176	-.249	-.330	-.412	-.499	-.586	TZ 5.2
-.675	-.764	-.854	-.944	-1.032	-1.118	-1.203	-1.286			TZ 5.3

0.000	.002	.004	.008	.012	.016	.024	.040	.076	.097	TZ 6.1
.089	.062	.019	-.023	-.080	-.137	-.203	-.268	-.340	-.411	TZ 6.2
-.486	-.562	-.638	-.714	-.790	-.865	-.938	-1.013			TZ 6.3
0.000	.002	.003	.006	.009	.013	.020	.031	.061	.094	TZ 7.1
.097	.083	.058	.032	-.007	-.045	-.093	-.140	-.192	-.245	TZ 7.2
-.300	-.356	-.415	-.473	-.531	-.591	-.650	-.708			TZ 7.3
0.000	.001	.002	.005	.008	.010	.014	.023	.037	.063	TZ 8.1
.070	.063	.048	.034	.016	-.001	-.030	-.059	-.090	-.121	TZ 8.2
-.154	-.188	-.224	-.261	-.297	-.334	-.372	-.407			TZ 8.3
0.000	.001	.002	.003	.004	.005	.007	.011	.021	.037	TZ 9.1
.048	.051	.046	.042	.032	.021	.007	-.008	-.027	-.045	TZ 9.2
-.065	-.087	-.109	-.133	-.157	-.182	-.208	-.234			TZ 9.3
0.000	.001	.001	.002	.003	.004	.005	.009	.016	.027	TZ 10.1
.034	.037	.034	.032	.024	.017	.005	-.007	-.022	-.037	TZ 10.2
-.054	-.072	-.091	-.111	-.131	-.153	-.175	-.197			TZ 10.3
0.000	0.000	0.000	0.000	.001	.002	.003	.005	.011	.020	TZ 11.1
.027	.028	.026	.023	.017	.011	.003	-.005	-.014	-.023	TZ 11.2
-.034	-.045	-.055	-.067	-.079	-.090	-.103	-.115			TZ 11.3
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	TZ 13.1
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	TZ 13.2
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000			TZ 13.3
0.	.182	.253	.345	.405	.452	.526	.653	.858	1.072	WORD 1.1
1.200	1.287	1.351	1.401	1.441	1.476	1.504	1.524	1.537	1.543	WORD 1.2
1.530	1.492	1.421	1.303	1.104	.766	.393	0.			WORD 1.3
0.	.182	.253	.345	.405	.452	.526	.653	.837	1.035	WORD 2.1
1.162	1.252	1.319	1.372	1.415	1.450	1.476	1.496	1.508	1.513	WORD 2.2
1.497	1.446	1.358	1.220	1.029	.747	.390	0.			WORD 2.3
0.	.182	.253	.345	.405	.452	.526	.653	.824	1.018	WORD 3.1
1.138	1.222	1.282	1.327	1.364	1.393	1.419	1.441	1.456	1.461	WORD 3.2
1.442	1.386	1.287	1.122	.912	.660	.357	0.			WORD 3.3
0.	.182	.253	.345	.405	.452	.526	.653	.801	.972	WORD 4.1
1.088	1.172	1.234	1.283	1.321	1.351	1.373	1.390	1.398	1.395	WORD 4.2
1.366	1.309	1.216	1.075	.872	.615	.316	0.			WORD 4.3
0.	.182	.253	.345	.405	.452	.526	.653	.792	.929	WORD 5.1
1.022	1.090	1.148	1.193	1.229	1.262	1.287	1.303	1.312	1.305	WORD 5.2
1.278	1.226	1.142	1.010	.819	.571	.292	0.			WORD 5.3
0.	.182	.253	.345	.405	.452	.526	.653	.779	.914	WORD 6.1
1.004	1.071	1.127	1.171	1.210	1.241	1.266	1.282	1.287	1.277	WORD 6.2
1.248	1.199	1.121	1.004	.821	.578	.299	0.			WORD 6.3
0.	.182	.253	.345	.405	.452	.526	.653	.773	.904	WORD 7.1
.988	1.053	1.104	1.146	1.183	1.217	1.244	1.262	1.268	1.253	WORD 7.2
1.219	1.162	1.077	.949	.765	.538	.276	0.			WORD 7.3

0.	.182	.253	.345	.405	.452	.526	.653	.794	.958	WORD 8.1
1.062	1.133	1.186	1.226	1.255	1.273	1.285	1.292	1.292	1.283	WORD 8.2
1.258	1.217	1.157	1.070	.952	.781	.504	0.			WORD 8.3
0.	.198	.275	.371	.431	.470	.521	.594	.737	.918	WORD 9.1
1.041	1.128	1.197	1.250	1.288	1.316	1.332	1.342	1.336	1.318	WORD 9.2
1.288	1.238	1.171	1.076	.937	.736	.427	0.			WORD 9.3
0.	.198	.275	.371	.431	.470	.521	.594	.741	.937	WORD10.1
1.067	1.158	1.230	1.283	1.321	1.347	1.364	1.372	1.367	1.353	WORD10.2
1.323	1.277	1.210	1.117	.992	.712	.504	0.			WORD10.3
0.	.198	.275	.371	.431	.470	.521	.594	.741	.937	WORD11.1
1.084	1.206	1.302	1.377	1.432	1.469	1.490	1.500	1.491	1.472	WORD11.2
1.437	1.379	1.300	1.192	1.046	.834	.482	0.			WORD11.3
0.	.05918	.06166	.06663	.07161	.07658	.08652	.10641	.15613	.25558	WORD13.1
.35502	.45446	.55390	.65334	.75279	.85223	.95167	1.051111.150561.25000			WORD13.2
1.236	1.199	1.137	1.046	.914	.727	.437	0.			WORD13.3
0.000	2.503	5.006	10.011	15.017	20.022	22.525	25.028	27.530	30.033	XFUS10
32.536	35.039	37.541	40.044	42.547	45.050	47.552	50.055	52.558	55.061	XFUS20
57.563	60.066	62.569	67.574	72.580	77.586	82.591	87.596	92.602	96.012	XFUS30
0.000	.036	.061	.082	.068	-.145	-.342	-.571	-.821	-1.072	ZFUS10
-1.330	-1.592	-1.852	-2.102	-2.349	-2.576	-2.795	-2.991	-3.153	-3.295	ZFUS20
-3.431	-3.557	-3.674	-3.847	-3.830	-3.654	-3.425	-3.127	-2.688	-2.310	ZFUS30
0.000	.463	1.360	3.670	6.943	9.221	9.498	9.636	9.351	9.148	AFUS10
9.254	9.273	9.341	9.736	9.958	10.302	10.797	10.891	10.894	11.116	AFUS20
11.079	11.131	11.078	10.637	9.698	7.479	5.192	2.520	.744	0.000	AFUS30
59.067	6.453	-5.385								PODORG 1
0.000	3.524	9.639	10.962							XPOD1
.786	.984	.984	.984							RPOD1
60.201	10.606	-5.204								PODORG 2
0.000	3.524	9.639	10.962							XPOD2
.786	.984	.984	.984							RPOD2
62.251	13.888	-4.406	10.718	72.380	13.888	-1.390	1.459			FINORG 1
0.	10.	20.	30.	40.	50.	60.	70.	90.	100.	XFIN
0.	.466	.846	1.138	1.345	1.465	1.498	1.390	.641	0.	FINORD
86.360	0.000	-2.245	9.107	93.783	0.000	.723	2.159			FINORG 2
0.	10.	20.	30.	40.	50.	60.	70.	90.	100.	XFIN
0.	.466	.846	1.138	1.345	1.465	1.498	1.390	.641	0.	FINORD
84.155	.884	-3.133	7.375	90.770	4.605	-4.130	2.210			CANORG
0.	10.	20.	30.	40.	50.	70.	80.	90.	100.	XCAN
0.0	.553	.948	1.264	1.448	1.5	1.264	.948	.553	0.0	CANORD

Table I. - Concluded.

(b) U.S. Customary Units (feet)

```
AST-102 BASELINE FOR AST-200 DESIGN
  1   1 -1  1   1   1     12 28  1 19 30                                   2   4   2 10   1 10
8447.                                                                                          REFA
0.       .125     .25      .5       .75      1.0      1.5      2.5      5.0      10.           XAF 10
15.      20.      25.      30.      35.      40.      45.      50.      55.      60.           XAF 20
65.      70.      75.      80.      85.      90.      95.      100.                             XAF 28
71.278    5.146-5.087 150.471                                                                  WORG 1
75.008    6.215-6.063 146.719                                                                  WORG 2
83.830    8.745-7.591 137.845                                                                  WORG 3
96.686   12.431-8.981 124.912                                                                  WORG 4
118.362 18.647-10.546103.108                                                                   WORG 5
127.167 21.171-11.116 94.250                                                                   WORG 6
140.037 24.862-11.899 82.389                                                                   WORG 7
157.985 30.008-12.635 65.847                                                                   WORG 8
171.757 34.795-13.077 53.383                                                                   WORG 9
178.946 37.293-13.372 48.401                                                                   WORG 10
204.070 46.025-14.301 30.991                                                                   WORG 11
234.186 63.412-16.069 16.237                                                                   WORG 13
  0.000    .001     .001   0.000   -.001   -.002   -.007   -.024   -.120   -.479               TZ 1.1
 -1.022 -1.685  -2.435  -3.185  -3.986  -4.787  -5.560  -6.388  -7.120  -7.852                 TZ 1.2
 -8.487 -9.085  -9.647-10.162-10.641-11.074-11.451-11.782                                      TZ 1.3
  0.000    .001     .002     .003     .003     .003     .001   -.006   -.041   -.313           TZ 2.1
  -.755 -1.316  -1.956  -2.596  -3.314  -4.032  -4.768  -5.505  -6.158  -6.812                 TZ 2.2
 -7.392 -7.962  -8.505  -9.049  -9.527  -9.969-10.337-10.650                                   TZ 2.3
  0.000    .003     .006     .012     .018     .023     .034     .053     .083     .064        TZ 3.1
  -.396   -.810 -1.312  -1.813  -2.375  -2.936  -3.516  -4.096  -4.653  -5.210                 TZ 3.2
 -5.716 -6.232  -6.729  -7.198  -7.640  -8.045  -8.413  -8.736                                 TZ 3.3
  0.000    .005     .009     .018     .028     .036     .051     .078     .130     .053        TZ 4.1
  -.159   -.441   -.791  -1.140  -1.543  -1.946  -2.374  -2.803  -3.237  -3.672                TZ 4.2
 -4.101 -4.523  -4.937  -5.336  -5.722  -6.091  -6.441  -6.768                                 TZ 4.3
  0.000    .005     .009     .020     .031     .042     .064     .102     .191     .227        TZ 5.1
   .158    .031   -.156   -.343   -.579   -.816  -1.083  -1.351  -1.637  -1.922                TZ 5.2
 -2.214 -2.508  -2.803  -3.096  -3.386  -3.669  -3.948  -4.220                                 TZ 5.3
```

0.000	.006	.014	.026	.040	.053	.079	.132	.249	.318	TZ 6.1
.292	.202	.063	-.075	-.261	-.448	-.665	-.880	-1.115	-1.350	TZ 6.2
-1.596	-1.844	-2.092	-2.342	-2.591	-2.838	-3.079	-3.322			TZ 6.3
0.000	.005	.011	.020	.031	.042	.064	.102	.200	.307	TZ 7.1
.317	.273	.190	.106	-.022	-.149	-.304	-.458	-.631	-.804	TZ 7.2
-.985	-1.169	-1.360	-1.551	-1.743	-1.938	-2.132	-2.324			TZ 7.3
0.000	.004	.007	.017	.026	.032	.046	.074	.120	.207	TZ 8.1
.230	.207	.159	.110	.054	-.003	-.098	-.193	-.295	-.396	TZ 8.2
-.506	-.617	-.736	-.856	-.976	-1.097	-1.220	-1.335			TZ 8.3
0.000	.003	.005	.009	.013	.016	.023	.036	.069	.121	TZ 9.1
.158	.166	.152	.139	.104	.070	.022	-.027	-.087	-.146	TZ 9.2
-.214	-.284	-.358	-.435	-.515	-.597	-.682	-.768			TZ 9.3
0.000	.002	.003	.006	.009	.012	.017	.028	.051	.087	TZ 10.1
.112	.121	.113	.106	.080	.055	.016	-.022	-.072	-.122	TZ 10.2
-.178	-.236	-.298	-.364	-.431	-.501	-.573	-.647			TZ 10.3
0.000	0.000	0.000	0.000	.002	.005	.009	.018	.037	.066	TZ 11.1
.087	.092	.084	.076	.056	.037	.010	-.017	-.047	-.077	TZ 11.2
-.110	-.146	-.182	-.219	-.258	-.296	-.338	-.377			TZ 11.3
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	TZ 13.1
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	TZ 13.2
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000			TZ 13.3
0.	.182	.253	.345	.405	.452	.526	.653	.858	1.072	WORD 1.1
1.200	1.287	1.351	1.401	1.441	1.476	1.504	1.524	1.537	1.543	WORD 1.2
1.530	1.492	1.421	1.303	1.104	.766	.393	0.			WORD 1.3
0.	.182	.253	.345	.405	.452	.526	.653	.837	1.035	WORD 2.1
1.162	1.252	1.319	1.372	1.415	1.450	1.476	1.496	1.508	1.513	WORD 2.2
1.497	1.446	1.358	1.220	1.029	.747	.390	0.			WORD 2.3
0.	.182	.253	.345	.405	.452	.526	.653	.824	1.018	WORD 3.1
1.138	1.222	1.282	1.327	1.364	1.393	1.419	1.441	1.456	1.461	WORD 3.2
1.442	1.386	1.287	1.122	.912	.660	.357	0.			WORD 3.3
0.	.182	.253	.345	.405	.452	.526	.653	.801	.972	WORD 4.1
1.088	1.172	1.234	1.283	1.321	1.351	1.373	1.390	1.398	1.395	WORD 4.2
1.366	1.309	1.216	1.075	.872	.615	.316	0.			WORD 4.3
0.	.182	.253	.345	.405	.452	.526	.653	.792	.929	WORD 5.1
1.022	1.090	1.148	1.193	1.229	1.262	1.287	1.303	1.312	1.305	WORD 5.2
1.278	1.226	1.142	1.010	.819	.571	.292	0.			WORD 5.3
0.	.182	.253	.345	.405	.452	.526	.653	.779	.914	WORD 6.1
1.004	1.071	1.127	1.171	1.210	1.241	1.266	1.282	1.287	1.277	WORD 6.2
1.248	1.199	1.121	1.004	.821	.578	.299	0.			WORD 6.3
0.	.182	.253	.345	.405	.452	.526	.653	.773	.904	WORD 7.1
.988	1.053	1.104	1.146	1.183	1.217	1.244	1.262	1.268	1.253	WORD 7.2
1.219	1.162	1.077	.949	.765	.538	.276	0.			WORD 7.3

```
0.        .182      .253      .345      .405      .452      .526      .653      .794      .958       WORD 8.1
1.062     1.133     1.186     1.226     1.255     1.273     1.285     1.292     1.292     1.283      WORD 8.2
1.258     1.217     1.157     1.070     .952      .781      .504      0.                             WORD 8.3
0.        .198      .275      .371      .431      .470      .521      .594      .737      .918       WORD 9.1
1.041     1.128     1.197     1.250     1.288     1.316     1.332     1.342     1.336     1.318      WORD 9.2
1.288     1.238     1.171     1.076     .937      .736      .427      0.                             WORD 9.3
0.        .198      .275      .371      .431      .470      .521      .594      .741      .937       WORD10.1
1.067     1.158     1.230     1.283     1.321     1.347     1.364     1.372     1.367     1.353      WORD10.2
1.323     1.277     1.210     1.117     .992      .712      .504      0.                             WORD10.3
0.        .198      .275      .371      .431      .470      .521      .594      .741      .937       WORD11.1
1.084     1.206     1.302     1.377     1.432     1.469     1.490     1.500     1.491     1.472      WORD11.2
1.437     1.379     1.300     1.192     1.046     .834      .482      0.                             WORD11.3
0.        .05918    .06166    .06663    .07161    .07658    .08652    .10641    .15613    .25558     WORD13.1
.35502    .45446    .55390    .65334    .75279    .85223    .95167    1.051111.150561.25000          WORD13.2
1.236     1.199     1.137     1.046     .914      .727      .437      0.                             WORD13.3
0.        8.2111    16.422332.844649.266965.689173.900382.111490.322698.5337                         XFUS10
106.745114.956123.167131.378139.589147.801156.012164.223172.434180.645                               XFUS20
188.856197.067205.279221.701238.123254.546270.968287.390303.812315.                                  XFUS30
0.        .1191     .1987     .2685     .2227     -.4765    -1.1216-1.8726-2.6924-3.5163             ZFUS10
-4.3621-5.2241-6.0757-6.8973-7.7063-8.4501-9.1687-9.8124-10.344-10.812                               ZFUS20
-11.258-11.670-12.053-12.623-12.564-11.988-11.236-10.260-8.8204-7.580                                ZFUS30
0.        4.9889    14.638239.508074.730899.2493102.241103.726100.65698.4643                          AFUS10
99.609199.8158100.545104.793107.185110.889116.214117.232117.261119.653                               AFUS20
119.249119.809119.245114.500104.38880.502155.886427.12248.0117 0.                                    AFUS30
193.78821.171   -17.667                                                                              PODORG 1
0.        11.563    31.624    35.963                                                                 XPOD1
2.578     3.229     3.229     3.229                                                                  RPOD1
197.51134.795   -17.074                                                                              PODORG 2
0.        11.563    31.624    35.963                                                                 XPOD2
2.578     3.229     3.229     3.229                                                                  RPOD2
204.23745.565   -14.45635.163   237.46745.565   -4.561    4.787                                      FINORG 1
0.        10.       20.       30.       40.       50.       60.       70.       90.       100.       XFIN
0.        .466      .846      1.138     1.345     1.465     1.498     1.390     .641      0.         FINORD
283.3330.       -7.367    29.877    307.6870.           2.373     7.082                              FINORG 2
0.        10.       20.       30.       40.       50.       60.       70.       90.       100.       XFIN
0.        .466      .846      1.138     1.345     1.465     1.498     1.390     .641      0.         FINORD
276.1002.900    -10.27824.196   297.80315.1095-13.5507.252                                           CANORG
0.        10.       20.       30.       40.       50.       70.       80.       90.       100.       XCAN
0.0       .553      .948      1.264     1.448     1.5       1.264     .948      .553      0.0        CANORD
```

TABLE II. - AST-200 WING DESIGN SUMMARY

- CONSTRAINTS
  - $M_\infty = 2.7$
  - $C_L = 0.10$
  - $C_m = 0.$ for CG at $0.49\bar{c}$ at $C_L = 0.10$
  - $C_p \geq 0.7\ C_{p_{vac}}$ on wing upper surface
  - $\frac{dC_p}{dx} \leq .0164$ per meter (.0050 per foot)
  - $Z = -0.095\ C_R$ at wing root trailing edge
  - Wing-nacelle geometry only
- LOADINGS
  - Linear Chordwise, A_1x
  - Quadratic Chordwise, A_2x^2
  - Cubic Chordwise, A_3x^3
  - Quartic Chordwise, A_4x^4
  - Quadratic Spanwise, A_6y^2
  - Cubic Spanwise, A_7y^3
  - Quartic Spanwise, A_8y^4
  - Elliptical, $A_9\sqrt{1 - 2y/b}/c$
  - Nacelle Bouyancy
- DESIGN CHARACTERISTICS (WING + NACELLES)
  - $C_L = 0.10$
  - $C_{D_i} = .004773$
  - $C_m = 0.$
  - $C_{m_o} = 0.0136$
  - $k_E = 0.477302$

Table III. - AST-200 Numerical Model

(a) SI Units (meters)

AST-200 CONFIGURATION

1 1 -1 1 1 1 19 28 1 19 30 2 20 2 10 1 10

784.75										REFA
0.	.125	.25	.5	.75	1.0	1.5	2.5	5.0	10.	XAF 10
15.	20.	25.	30.	35.	40.	45.	50.	55.	60.	XAF 20
65.	70.	75.	80.	85.	90.	95.	100.			XAF 28
16.256	0.000	-.984	51.366							WORG 1
17.941	.483	-.936	49.671							WORG 2
19.627	.967	-1.193	47.976							WORG 3
22.013	1.651	-1.566	45.579							WORG 3A
22.996	1.933	-1.722	44.585							WORG 4
26.367	2.899	-2.328	41.195							WORG 5
29.736	3.865	-2.858	37.804							WORG 6
33.107	4.832	-3.289	34.415							WORG 7
38.761	6.453	-3.847	28.727							WORG 8
43.218	7.731	-4.238	24.620							WORG 9
48.154	9.146	-4.588	20.070							WORG 10
52.352	10.606	-4.663	16.271							WORG 11
55.203	11.597	-4.641	14.294							WORG 12
57.984	12.563	-4.706	12.368							WORG 13
62.201	14.028	-4.768	9.446							WORG 14
62.201	14.029	-4.768	9.446							WORG 15
64.684	15.463	-4.784	8.229							WORG 16
68.031	17.395	-4.955	6.589							WORG 17
71.380	19.328	-5.228	4.949							WORG 18
0.000	-.000	-.000	-.001	-.001	-.002	-.002	-.004	-.044	-.197	TZ 1.1
-.430	-.719	-1.046	-1.392	-1.748	-2.101	-2.445	-2.774	-3.083	-3.370	TZ 1.2
-3.636	-3.880	-4.101	-4.300	-4.478	-4.635	-4.770	-4.880			TZ 1.3
0.000	-.001	-.002	-.003	-.005	-.006	-.009	-.026	-.085	-.275	TZ 2.1
-.532	-.835	-1.165	-1.509	-1.857	-2.201	-2.534	-2.851	-3.151	-3.430	TZ 2.2
-3.690	-3.928	-4.146	-4.344	-4.522	-4.681	-4.819	-4.936			TZ 2.3
0.000	-.002	-.003	-.006	-.009	-.012	-.018	-.030	-.086	-.273	TZ 3.1
-.522	-.807	-1.115	-1.433	-1.754	-2.068	-2.373	-2.663	-2.937	-3.193	TZ 3.2
-3.431	-3.651	-3.854	-4.038	-4.206	-4.357	-4.489	-4.602			TZ 3.3

0.000	-.001	-.001	-.002	-.003	-.004	-.007	-.016	-.059	-.223	TZ 3A.1
-.444	-.698	-.969	-1.248	-1.529	-1.805	-2.073	-2.328	-2.571	-2.801	TZ 3A.2
-3.015	-3.216	-3.403	-3.577	-3.737	-3.883	-4.015	-4.132			TZ 3A.3
0.000	-.000	-.000	-.001	-.001	-.001	-.002	-.011	-.047	-.202	TZ 4.1
-.412	-.653	-.909	-1.172	-1.437	-1.697	-1.949	-2.191	-2.421	-2.639	TZ 4.2
-2.844	-3.037	-3.218	-3.386	-3.543	-3.688	-3.820	-3.938			TZ 4.3
0.000	.001	.001	.002	.004	.005	.008	.008	-.012	-.124	TZ 5.1
-.280	-.462	-.658	-.860	-1.065	-1.268	-1.466	-1.659	-1.846	-2.024	TZ 5.2
-2.195	-2.360	-2.517	-2.667	-2.810	-2.946	-3.074	-3.193			TZ 5.3
0.000	.001	.002	.005	.008	.010	.015	.026	.018	-.047	TZ 6.1
-.153	-.281	-.422	-.572	-.724	-.877	-1.031	-1.181	-1.329	-1.474	TZ 6.2
-1.616	-1.755	-1.891	-2.025	-2.155	-2.282	-2.405	-2.523			TZ 6.3
0.000	.002	.003	.006	.009	.012	.019	.031	.050	.022	TZ 7.1
-.043	-.127	-.224	-.328	-.438	-.551	-.666	-.782	-.899	-1.016	TZ 7.2
-1.133	-1.250	-1.367	-1.485	-1.602	-1.718	-1.833	-1.947			TZ 7.3
0.000	.002	.004	.007	.011	.014	.021	.036	.066	.085	TZ 8.1
.073	.041	-.001	-.054	-.111	-.174	-.241	-.313	-.387	-.465	TZ 8.2
-.547	-.630	-.716	-.805	-.895	-.988	-1.082	-1.177			TZ 8.3
0.000	.002	.004	.008	.012	.016	.023	.039	.070	.101	TZ 9.1
.109	.103	.086	.062	.030	-.007	-.050	-.096	-.146	-.200	TZ 9.2
-.257	-.317	-.381	-.447	-.517	-.589	-.663	-.740			TZ 9.3
0.000	.002	.003	.005	.008	.011	.017	.028	.055	.091	TZ 10.1
.108	.114	.113	.107	.095	.079	.059	.036	.009	-.021	TZ 10.2
-.054	-.090	-.128	-.170	-.214	-.261	-.309	-.359			TZ 10.3
0.000	.001	.002	.003	.004	.006	.009	.015	.030	.056	TZ 11.1
.068	.074	.076	.070	.062	.051	.035	.018	-.002	-.026	TZ 11.2
-.051	-.077	-.108	-.140	-.173	-.208	-.246	-.284			TZ 11.3
0.000	.001	.001	.002	.004	.005	.007	.012	.025	.045	TZ 12.1
.057	.063	.067	.062	.056	.048	.037	.023	.007	-.010	TZ 12.2
-.031	-.052	-.075	-.100	-.126	-.154	-.183	-.213			TZ 12.3
0.000	.001	.001	.002	.003	.004	.006	.010	.020	.035	TZ 13.1
.048	.055	.059	.059	.057	.052	.047	.037	.028	.016	TZ 13.2
.003	-.012	-.028	-.045	-.062	-.080	-.098	-.118			TZ 13.3
0.000	.000	.000	.001	.001	.001	.002	.003	.006	.015	TZ 14.1
.025	.031	.034	.036	.036	.036	.035	.034	.032	.029	TZ 14.2
.027	.023	.020	.017	.013	.009	.005	0.000			TZ 14.3
0.000	.000	.000	.001	.001	.001	.002	.003	.006	.015	TZ 15.1
.025	.031	.034	.036	.036	.036	.035	.034	.032	.029	TZ 15.2
.027	.023	.020	.017	.013	.009	.005	0.000			TZ 15.3
0.000	-.000	-.001	-.002	-.002	-.003	-.004	-.007	-.014	-.028	TZ 16.1
-.042	-.051	-.056	-.062	-.068	-.073	-.079	-.085	-.091	-.097	TZ 16.2

-.103	-.108	-.114	-.119	-.125	-.130	-.136	-.141			TZ 16.3
0.000	-.000	-.001	-.002	-.002	-.003	-.004	-.007	-.015	-.029	TZ 17.1
-.044	-.058	-.073	-.083	-.092	-.102	-.112	-.118	-.125	-.132	TZ 17.2
-.139	-.144	-.150	-.156	-.161	-.166	-.171	-.176			TZ 17.3
0.000	-.000	-.001	-.002	-.002	-.003	-.004	-.007	-.014	-.028	TZ 18.1
-.042	-.048	-.055	-.061	-.067	-.073	-.075	-.077	-.079	-.082	TZ 18.2
-.083	-.082	-.080	-.080	-.078	-.076	-.071	-.067			TZ 18.3
0.	.137	.180	.242	.298	.339	.413	.521	.726	.996	WORD1.1
1.181	1.318	1.419	1.490	1.532	1.543	1.543	1.543	1.543	1.543	WORD1.2
1.388	1.213	1.021	.819	.615	.413	.212	0.			WORD1.3
0.	.137	.180	.242	.298	.339	.413	.521	.726	.996	WORD2.1
1.181	1.318	1.419	1.490	1.532	1.543	1.543	1.543	1.543	1.543	WORD2.2
1.388	1.213	1.021	.819	.615	.413	.212	0.			WORD2.3
0.	.137	.180	.242	.298	.339	.413	.521	.726	.996	WORD3.1
1.181	1.318	1.419	1.490	1.532	1.543	1.543	1.543	1.543	1.543	WORD3.2
1.388	1.213	1.021	.819	.615	.413	.212	0.			WORD3.3
0.	.137	.179	.241	.297	.339	.412	.523	.724	.994	WORD3A.1
1.177	1.315	1.416	1.487	1.528	1.539	1.539	1.539	1.539	1.539	WORD3A.2
1.384	1.210	1.018	.817	.614	.412	.211	0.			WORD3A.3
0.	.136	.178	.237	.291	.333	.405	.514	.712	.978	WORD4.1
1.157	1.292	1.391	1.461	1.501	1.512	1.512	1.512	1.512	1.512	WORD4.2
1.363	1.192	1.003	.806	.606	.406	.208	0.			WORD4.3
0.	.128	.168	.225	.277	.316	.386	.490	.679	.931	WORD5.1
1.103	1.232	1.326	1.392	1.430	1.441	1.441	1.441	1.441	1.437	WORD5.2
1.294	1.132	.953	.765	.576	.385	.197	0.			WORD5.3
0.	.118	.160	.216	.266	.304	.370	.470	.651	.894	WORD6.1
1.059	1.182	1.273	1.336	1.373	1.383	1.383	1.383	1.383	1.341	WORD6.2
1.208	1.056	.889	.714	.537	.360	.184	0.			WORD6.3
0.	.110	.153	.208	.257	.294	.358	.455	.631	.866	WORD7.1
1.025	1.144	1.231	1.293	1.328	1.338	1.338	1.338	1.338	1.277	WORD7.2
1.151	1.006	.848	.681	.512	.343	.175	0.			WORD7.3
0.	.101	.145	.200	.247	.283	.344	.438	.607	.833	WORD8.1
.987	1.101	1.184	1.244	1.278	1.287	1.287	1.287	1.287	1.186	WORD8.2
1.069	.935	.788	.633	.476	.319	.163	0.			WORD8.3
0.	.100	.144	.198	.245	.280	.341	.435	.602	.827	WORD9.1
.979	1.092	1.175	1.234	1.268	1.277	1.277	1.277	1.260	1.161	WORD9.2
1.046	.915	.771	.619	.466	.312	.159	0.			WORD9.3
0.	.102	.146	.201	.248	.284	.345	.440	.609	.836	WORD10.1
.990	1.105	1.189	1.248	1.283	1.292	1.292	1.292	1.247	1.149	WORD10.2
1.035	.906	.763	.613	.461	.309	.156	0.			WORD10.3

0.	.111	.154	.209	.258	.295	.359	.457	.632	.868	WORD11.1
1.028	1.148	1.235	1.297	1.330	1.342	1.342	1.342	1.263	1.164	WORD11.2
1.049	.917	.773	.621	.467	.313	.160	0.			WORD11.3
0.	.118	.160	.216	.266	.304	.370	.470	.651	.894	WORD12.1
1.059	1.181	1.272	1.335	1.372	1.382	1.382	1.382	1.300	1.198	WORD12.2
1.080	.945	.796	.639	.481	.322	.164	0.			WORD12.3
0.	.125	.166	.222	.274	.313	.381	.484	.670	.920	WORD13.1
1.090	1.216	1.309	1.375	1.413	1.423	1.423	1.423	1.339	1.234	WORD13.2
1.112	.972	.819	.658	.495	.331	.169	0.			WORD13.3
0.	.138	.177	.235	.289	.330	.402	.510	.706	.969	WORD14.1
1.148	1.282	1.380	1.449	1.489	1.500	1.500	1.500	1.411	1.300	WORD14.2
1.171	1.024	.862	.692	.521	.349	.178	0.			WORD14.3
0.	.0069	.0144	.0294	.0440	.0590	.0884	.1462	.2853	.541	WORD15.1
.766	.961	1.126	1.261	1.365	1.440	1.485	1.500	1.485	1.440	WORD15.2
1.365	1.261	1.126	.961	.766	.541	.285	0.			WORD15.3
0.	.0069	.0144	.0294	.0440	.0590	.0884	.1462	.2853	.541	WORD16.1
.766	.961	1.126	1.261	1.365	1.440	1.485	1.500	1.485	1.440	WORD16.2
1.365	1.261	1.126	.961	.766	.541	.285	0.			WORD16.3
0.	.0069	.0144	.0294	.0440	.0590	.0884	.1462	.2853	.541	WORD17.1
.766	.961	1.126	1.261	1.365	1.440	1.485	1.500	1.485	1.440	WORD17.2
1.365	1.261	1.126	.961	.766	.541	.285	0.			WORD17.3
0.	.0069	.0144	.0294	.0440	.0590	.0884	.1462	.2853	.541	WORD18.1
.766	.961	1.126	1.261	1.365	1.440	1.485	1.500	1.485	1.440	WORD18.2
1.365	1.261	1.126	.961	.766	.541	.285	0.			WORD18.3
0.000	3.048	6.096	9.144	12.192	15.240	18.288	21.336	24.384	27.432	XFUS 10
30.480	33.528	36.576	39.624	42.672	45.720	48.768	51.816	54.864	57.912	XFUS 20
60.960	64.008	67.056	70.104	73.152	76.200	79.248	85.344	91.440	96.012	XFUS 30
0.000	0.000	0.000	0.000	0.000	-.061	-.144	-.340	-.585	-.930	ZFUS 10
-1.324	-1.729	-2.129	-2.512	-2.875	-3.207	-3.520	-3.801	-4.069	-4.309	ZFUS 20
-4.521	-4.709	-4.876	-4.999	-5.044	-5.014	-4.907	-4.557	-4.023	-3.536	ZFUS 30
0.000	.660	1.839	3.298	5.045	7.061	9.021	10.043	10.294	9.838	AFUS 10
9.216	9.188	9.346	9.569	9.866	10.247	10.702	10.990	11.074	11.148	AFUS 20
11.130	10.981	10.591	9.968	9.114	7.887	6.550	3.252	.929	0.000	AFUS 30
59.067	6.453	-6.004								PODORG 1
0.000	.610	1.219	1.829	2.438	3.048	3.658	4.267	4.877	5.486	XPOD
6.096	6.706	7.315	7.925	8.534	9.144	9.639	9.754	10.363	10.962	XPOD
.786	.798	.811	.824	.836	.849	.861	.874	.886	.899	RPOD
.911	.924	.936	.949	.961	.974	.984	.984	.984	.984	RPOD

60.201	10.606	-5.906								PODORG 2
0.000	.610	1.219	1.829	2.438	3.048	3.658	4.267	4.877	5.486	XPOD
6.096	6.706	7.315	7.925	8.534	9.144	9.639	9.754	10.363	10.962	XPOD
.786	.798	.811	.824	.836	.849	.861	.874	.886	.899	RPOD
.911	.924	.936	.949	.961	.974	.984	.984	.984	.984	RPOD
62.251	14.029	-4.768	10.718	72.380	14.029	-1.752	1.459			V FIN
0.	10.	20.	30.	40.	50.	60.	70.	90.	100.	XFIN
0.	.466	.846	1.138	1.345	1.465	1.498	1.390	.641	0.	FINORD
86.359	0.000	-3.475	9.107	93.783	0.000	-.506	2.159			V TAIL
0.	10.	20.	30.	40.	50.	60.	70.	90.	100.	XVTAIL
0.	.466	.846	1.138	1.345	1.465	1.498	1.390	.641	0.	TVTAIL
84.155	.884	-4.237	7.375	90.770	4.606	-5.234	2.210			H TAIL
0.	10.	20.	30.	40.	50.	70.	80.	90.	100.	XHTAIL
0.0	.553	.948	1.264	1.448	1.5	1.264	.948	.553	0.0	THTAIL

Table III. - Concluded.

(b) U.S. Customary Units (feet)

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AST-200 CONFIGURATION
 1  1 -1  1  1  1    19 28  1 19 30                         2 20  2 10  1 10
8447.                                                                           REFA
0.      .125    .25     .5      .75     1.0     1.5     2.5     5.0     10.     XAF 10
 15.     20.     25.     30.     35.     40.     45.     50.     55.     60.    XAF 20
65.     70.     75.     80.     85.     90.     95.     100.                    XAF 28
53.333 0.      -3.227 168.524                                                   WORG 1
58.861 1.585   -3.070 162.963                                                   WORG 2
64.392 3.171   -3.914 157.401                                                   WORG 3
72.221 5.416   -5.137 149.537                                                   WORG 3A
75.447 6.341   -5.650 146.276                                                   WORG 4
86.505 9.512   -7.639 135.155                                                   WORG 5
97.560 12.682  -9.376 124.030                                                   WORG 6
108.61915.853 -10.790112.909                                                    WORG 7
127.16721.171 -12.62094.250                                                     WORG 8
141.79125.365 -13.90480.773                                                     WORG 9
157.98530.008 -15.05165.847                                                     WORG 10
171.75734.795 -15.29753.383                                                     WORG 11
181.11338.047 -15.22646.897                                                     WORG 12
190.23741.218 -15.43840.576                                                     WORG 13
204.07046.025 -15.64430.991                                                     WORG 14
204.07046.026 -15.64430.991                                                     WORG 15
212.21750.730 -15.69526.999                                                     WORG 16
223.20057.071 -16.25621.618                                                     WORG 17
234.18663.412 -17.15216.237                                                     WORG 18
0.      -.001   -.001   -.002   -.003   -.005   -.007   -.012   -.144   -.647   TZ 1.1
-1.410 -2.359 -3.431 -4.568 -5.734 -6.894 -8.022 -9.100 -10.114-11.058          TZ 1.2
-11.930-12.729-13.454-14.109-14.693-15.207-15.649-16.010                        TZ 1.3
0.      -.002   -.005   -.010   -.015   -.020   -.030   -.085   -.278   -.901   TZ 2.1
-1.745 -2.738 -3.821 -4.950 -6.093 -7.221 -8.313 -9.355 -10.337-11.254          TZ 2.2
-12.105-12.888-13.602-14.252-14.836-15.357-15.811-16.193                        TZ 2.3
0.      -.005   -.010   -.019   -.029   -.039   -.058   -.097   -.282   -.897   TZ 3.1
-1.711 -2.647 -3.658 -4.703 -5.753 -6.785 -7.784 -8.736 -9.635 -10.476          TZ 3.2
-11.257-11.979-12.643-13.249-13.799-14.293-14.728-15.098                        TZ 3.3
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0.	-.002	-.004	-.007	-.011	-.014	-.023	-.054	-.192	-.731	TZ 3A.1
-1.456	-2.290	-3.180	-4.096	-5.016	-5.922	-6.800	-7.639	-8.436	-9.188	TZ 3A.2
-9.893	-10.552	-11.166	-11.734	-12.259	-12.739	-13.173	-13.555			TZ 3A.3
0.	-.001	-.001	-.002	-.003	-.004	-.008	-.036	-.155	-.662	TZ 4.1
-1.351	-2.143	-2.983	-3.846	-4.713	-5.566	-6.394	-7.187	-7.942	-8.657	TZ 4.2
-9.331	-9.964	-10.557	-11.110	-11.625	-12.099	-12.532	-12.919			TZ 4.3
0.	.002	.004	.008	.012	.017	.025	.027	-.041	-.406	TZ 5.1
-.918	-1.516	-2.158	-2.822	-3.494	-4.160	-4.810	-5.443	-6.055	-6.640	TZ 5.2
-7.202	-7.742	-8.257	-8.749	-9.219	-9.665	-10.084	-10.475			TZ 5.3
0.	.004	.008	.017	.025	.034	.050	.084	.059	-.154	TZ 6.1
-.503	-.921	-1.385	-1.877	-2.376	-2.878	-3.381	-3.874	-4.360	-4.836	TZ 6.2
-5.302	-5.759	-6.205	-6.643	-7.070	-7.487	-7.889	-8.277			TZ 6.3
0.	.005	.010	.021	.031	.041	.062	.103	.163	.071	TZ 7.1
-.141	-.418	-.735	-1.076	-1.438	-1.809	-2.186	-2.567	-2.948	-3.333	TZ 7.2
-3.716	-4.100	-4.486	-4.871	-5.255	-5.638	-6.015	-6.388			TZ 7.3
0.	.006	.012	.023	.035	.047	.070	.117	.216	.280	TZ 8.1
.241	.135	-.002	-.176	-.364	-.570	-.792	-1.026	-1.270	-1.527	TZ 8.2
-1.793	-2.067	-2.350	-2.640	-2.937	-3.242	-3.550	-3.862			TZ 8.3
0.	.006	.013	.025	.038	.051	.076	.127	.229	.330	TZ 9.1
.356	.339	.283	.205	.098	-.024	-.164	-.315	-.480	-.655	TZ 9.2
-.843	-1.041	-1.250	-1.468	-1.697	-1.933	-2.176	-2.427			TZ 9.3
0.	.005	.009	.018	.027	.037	.056	.092	.182	.299	TZ 10.1
.354	.374	.370	.350	.311	.259	.194	.118	.030	-.068	TZ 10.2
-.177	-.295	-.421	-.558	-.703	-.855	-1.013	-1.179			TZ 10.3
0.	.002	.005	.010	.014	.019	.029	.048	.097	.184	TZ 11.1
.223	.244	.248	.230	.202	.167	.116	.058	-.007	-.084	TZ 11.2
-.166	-.254	-.354	-.458	-.567	-.683	-.806	-.932			TZ 11.3
0.	.002	.004	.008	.012	.016	.024	.041	.081	.147	TZ 12.1
.187	.207	.219	.203	.184	.158	.120	.074	.022	-.034	TZ 12.2
-.101	-.172	-.246	-.329	-.415	-.505	-.599	-.698			TZ 12.3
0.	.002	.003	.007	.010	.013	.020	.034	.067	.116	TZ 13.1
.158	.179	.194	.193	.187	.171	.153	.123	.092	.052	TZ 13.2
.011	-.040	-.092	-.148	-.204	-.263	-.322	-.387			TZ 13.3
0.	.001	.001	.002	.003	.004	.006	.010	.020	.049	TZ 14.1
.081	.101	.112	.118	.118	.117	.115	.111	.104	.096	TZ 14.2
.087	.077	.066	.055	.043	.029	.015	0.			TZ 14.3
0.	.001	.001	.002	.003	.004	.006	.010	.020	.049	TZ 15.1
.081	.101	.112	.118	.118	.117	.115	.111	.104	.096	TZ 15.2
.087	.077	.066	.055	.043	.029	.015	0.			TZ 15.3
0.	-.001	-.002	-.005	-.007	-.009	-.014	-.023	-.046	-.092	TZ 16.1
-.139	-.166	-.184	-.203	-.222	-.241	-.260	-.279	-.299	-.318	TZ 16.2

-.337	-.355	-.374	-.392	-.409	-.427	-.446	-.464			TZ 16.3
0.	-.001	-.002	-.005	-.007	-.010	-.014	-.024	-.048	-.095	TZ 17.1
-.143	-.190	-.238	-.271	-.303	-.336	-.366	-.388	-.411	-.434	TZ 17.2
-.455	-.474	-.493	-.513	-.529	-.545	-.562	-.577			TZ 17.3
0.	-.001	-.002	-.005	-.007	-.009	-.014	-.023	-.047	-.093	TZ 18.1
-.138	-.159	-.179	-.200	-.220	-.238	-.246	-.253	-.260	-.268	TZ 18.2
-.272	-.268	-.264	-.261	-.257	-.249	-.234	-.219			TZ 18.3
0.	.137	.180	.242	.298	.339	.413	.521	.726	.996	WORD1.1
1.181	1.318	1.419	1.490	1.532	1.543	1.543	1.543	1.543	1.543	WORD1.2
1.388	1.213	1.021	.819	.615	.413	.212	0.			WORD1.3
0.	.137	.180	.242	.298	.339	.413	.521	.726	.996	WORD2.1
1.181	1.318	1.419	1.490	1.532	1.543	1.543	1.543	1.543	1.543	WORD2.2
1.388	1.213	1.021	.819	.615	.413	.212	0.			WORD2.3
0.	.137	.180	.242	.298	.339	.413	.521	.726	.996	WORD3.1
1.181	1.318	1.419	1.490	1.532	1.543	1.543	1.543	1.543	1.543	WORD3.2
1.388	1.213	1.021	.819	.615	.413	.212	0.			WORD3.3
0.	.137	.179	.241	.297	.339	.412	.523	.724	.994	WORD3A.1
1.177	1.315	1.416	1.487	1.528	1.539	1.539	1.539	1.539	1.539	WORD3A.2
1.384	1.210	1.018	.817	.614	.412	.211	0.			WORD3A.3
0.	.136	.178	.237	.291	.333	.405	.514	.712	.978	WORD4.1
1.157	1.292	1.391	1.461	1.501	1.512	1.512	1.512	1.512	1.512	WORD4.2
1.363	1.192	1.003	.806	.606	.406	.208	0.			WORD4.3
0.	.128	.168	.225	.277	.316	.386	.490	.679	.931	WORD5.1
1.103	1.232	1.326	1.392	1.430	1.441	1.441	1.441	1.441	1.437	WORD5.2
1.294	1.132	.953	.765	.576	.385	.197	0.			WORD5.3
0.	.118	.160	.216	.266	.304	.370	.470	.651	.894	WORD6.1
1.059	1.182	1.273	1.336	1.373	1.383	1.383	1.383	1.383	1.341	WORD6.2
1.208	1.056	.889	.714	.537	.360	.184	0.			WORD6.3
0.	.110	.153	.208	.257	.294	.358	.455	.631	.866	WORD7.1
1.025	1.144	1.231	1.293	1.328	1.338	1.338	1.338	1.338	1.277	WORD7.2
1.151	1.006	.848	.681	.512	.343	.175	0.			WORD7.3
0.	.101	.145	.200	.247	.283	.344	.438	.607	.833	WORD8.1
.987	1.101	1.184	1.244	1.278	1.287	1.287	1.287	1.287	1.186	WORD8.2
1.069	.935	.788	.633	.476	.319	.163	0.			WORD8.3
0.	.100	.144	.198	.245	.280	.341	.435	.602	.827	WORD9.1
.979	1.092	1.175	1.234	1.268	1.277	1.277	1.277	1.260	1.161	WORD9.2
1.046	.915	.771	.619	.466	.312	.159	0.			WORD9.3
0.	.102	.146	.201	.248	.284	.345	.440	.609	.836	WORD10.1
.990	1.105	1.189	1.248	1.283	1.292	1.292	1.292	1.247	1.149	WORD10.2
1.035	.906	.763	.613	.461	.309	.156	0.			WORD10.3

0.	.111	.154	.209	.258	.295	.359	.457	.632	.868	WORD11.1
1.028	1.148	1.235	1.297	1.330	1.342	1.342	1.342	1.263	1.164	WORD11.2
1.049	.917	.773	.621	.467	.313	.160	0.			WORD11.3
0.	.118	.160	.216	.266	.304	.370	.470	.651	.894	WORD12.1
1.059	1.181	1.272	1.335	1.372	1.382	1.382	1.382	1.300	1.198	WORD12.2
1.080	.945	.796	.639	.481	.322	.164	0.			WORD12.3
0.	.125	.166	.222	.274	.313	.381	.484	.670	.920	WORD13.1
1.090	1.216	1.309	1.375	1.413	1.423	1.423	1.423	1.339	1.234	WORD13.2
1.112	.972	.819	.658	.495	.331	.169	0.			WORD13.3
0.	.138	.177	.235	.289	.330	.402	.510	.706	.969	WORD14.1
1.148	1.282	1.380	1.449	1.489	1.500	1.500	1.500	1.411	1.300	WORD14.2
1.171	1.024	.862	.692	.521	.349	.178	0.			WORD14.3
0.	.0069	.0144	.0294	.0440	.0590	.0884	.1462	.2853	.541	WORD15.1
.766	.961	1.126	1.261	1.365	1.440	1.485	1.500	1.485	1.440	WORD15.2
1.365	1.261	1.126	.961	.766	.541	.285	0.			WORD15.3
0.	.0069	.0144	.0294	.0440	.0590	.0884	.1462	.2853	.541	WORD16.1
.766	.961	1.126	1.261	1.365	1.440	1.485	1.500	1.485	1.440	WORD16.2
1.365	1.261	1.126	.961	.766	.541	.285	0.			WORD16.3
0.	.0069	.0144	.0294	.0440	.0590	.0884	.1462	.2853	.541	WORD17.1
.766	.961	1.126	1.261	1.365	1.440	1.485	1.500	1.485	1.440	WORD17.2
1.365	1.261	1.126	.961	.766	.541	.285	0.			WORD17.3
0.	.0069	.0144	.0294	.0440	.0590	.0884	.1462	.2853	.541	WORD18.1
.766	.961	1.126	1.261	1.365	1.440	1.485	1.500	1.485	1.440	WORD18.2
1.365	1.261	1.126	.961	.766	.541	.285	0.			WORD18.3
0.	10.	20.	30.	40.	50.	60.	70.	80.	90.	XFUS 10
100.	110.	120.	130.	140.	150.	160.	170.	180.	190.	XFUS 20
200.	210.	220.	230.	240.	250.	260.	280.	300.	315.	XFUS 30
0.	0.	0.	0.	0.	-.200	-.471	-1.117	-1.920	-3.050	ZFUS 10
-4.345	-5.671	-6.986	-8.240	-9.434	-10.522	-11.548	-12.471	-13.349	-14.136	ZFUS 20
-14.834	-15.451	-15.999	-16.400	-16.550	-16.450	-16.100	-14.950	-13.200	-11.600	ZFUS 30
0.0	7.1	19.8	35.5	54.3	76.0	97.1	108.1	110.8	105.9	AFUS 10
99.2	98.9	100.6	103.0	106.2	110.3	115.2	118.3	119.2	120.0	AFUS 20
119.8	118.2	114.0	107.3	98.1	84.9	70.5	35.0	10.0	0.0	AFUS 30
193.788	21.171	-19.698								PODORG 1
0.	2.	4.	6.	8.	10.	12.	14.	16.	18.	XPOD
20.	22.	24.	26.	28.	30.	31.624	32.	34.	35.963	XPOD
2.578	2.619	2.660	2.702	2.743	2.784	2.825	2.866	2.907	2.949	RPOD
2.990	3.031	3.072	3.113	3.154	3.196	3.229	3.229	3.229	3.229	RPOD

```
197.51134.795 -19.375                                                                    PODORG 2
0.        2.        4.        6.        8.        10.       12.       14.       16.       18.        XPOD
20.       22.       24.       26.       28.       30.       31.624    32.       34.       35.963     XPOD
2.578     2.619     2.660     2.702     2.743     2.784     2.825     2.866     2.907     2.949      RPOD
2.990     3.031     3.072     3.113     3.154     3.196     3.229     3.229     3.229     3.229      RPOD
204.23746.0255-15.64435.163 237.46746.0255-5.749 4.787                                           V FIN
0.        10.       20.       30.       40.       50.       60.       70.       90.       100.       XFIN
0.        .466      .846      1.138     1.345     1.465     1.498     1.390     .641      0.         FINORD
283.3300.           -11.40029.877 307.6870.               -1.660 7.082                               V TAIL
0.        10.       20.       30.       40.       50.       60.       70.       90.       100.       XVTAIL
0.        .466      .846      1.138     1.345     1.465     1.498     1.390     .641      0.         TVTAIL
276.1002.900        -13.90024.196 297.80315.110 -17.1727.252                                     H TAIL
0.        10.       20.       30.       40.       50.       70.       80.       90.       100.       XHTAIL
0.0       .553      .948      1.264     1.448     1.5       1.264     .948      .553      0.0        THTAIL
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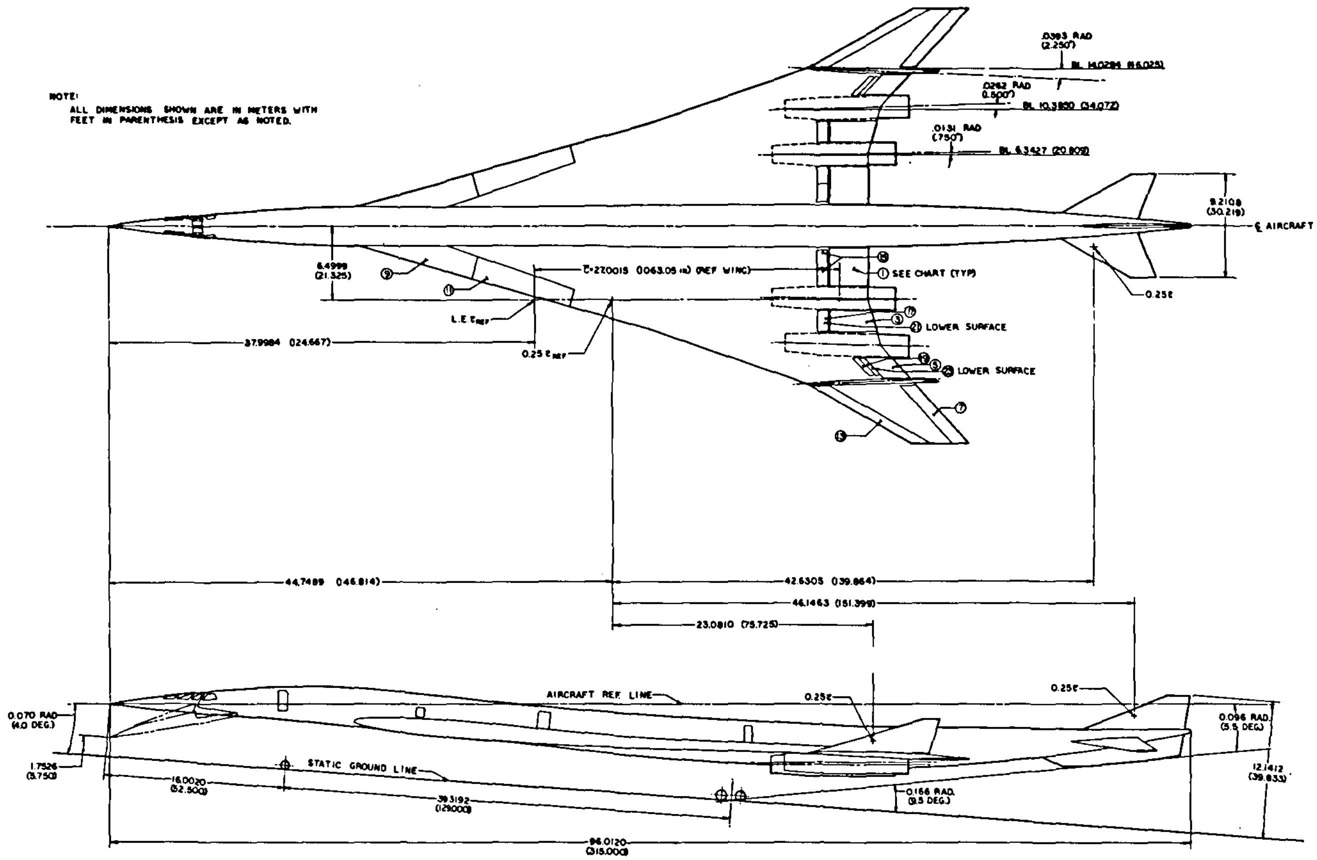


Figure 1. AST-102 baseline configuration.

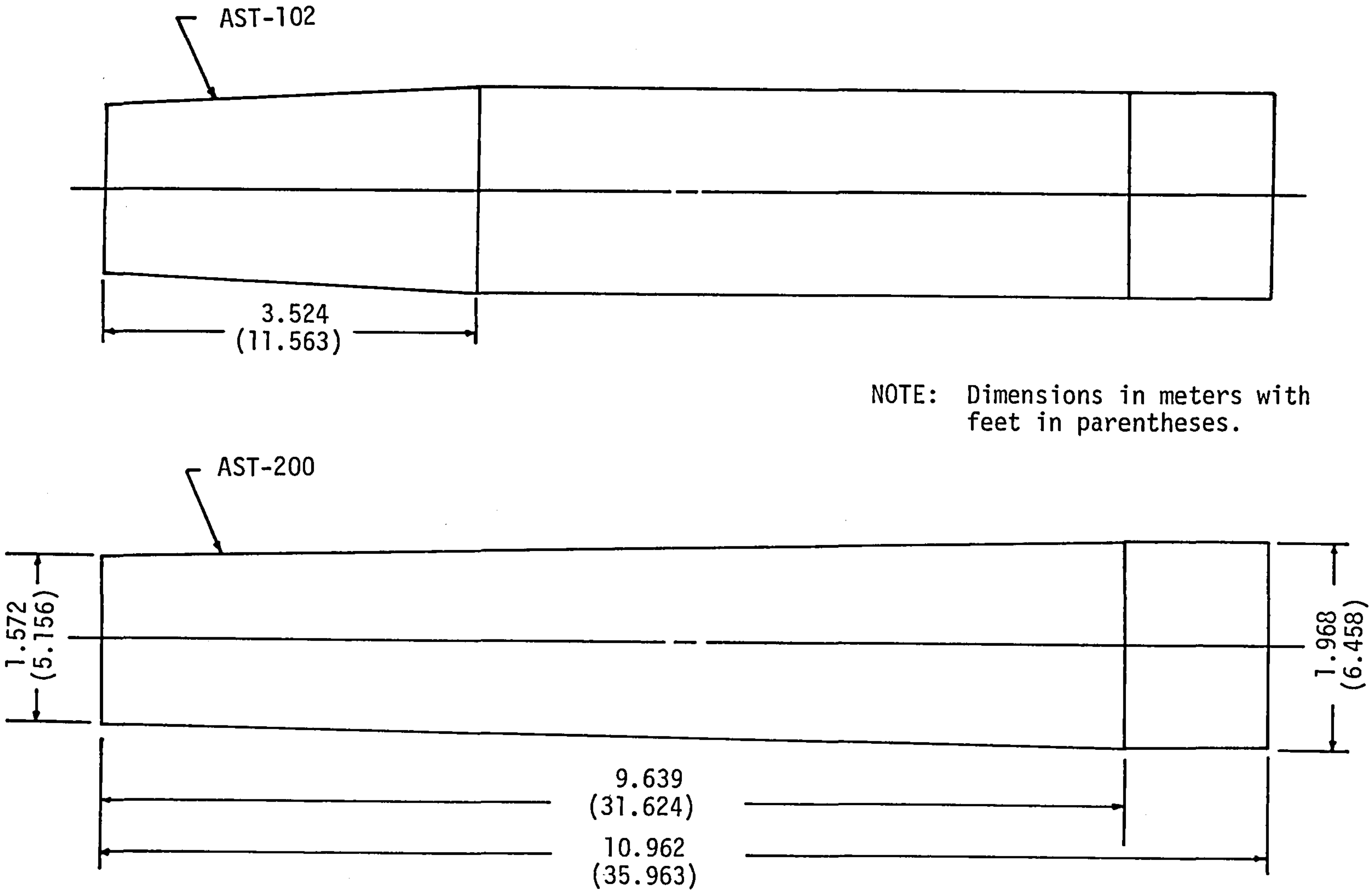


Figure 2. - Nacelle revision.

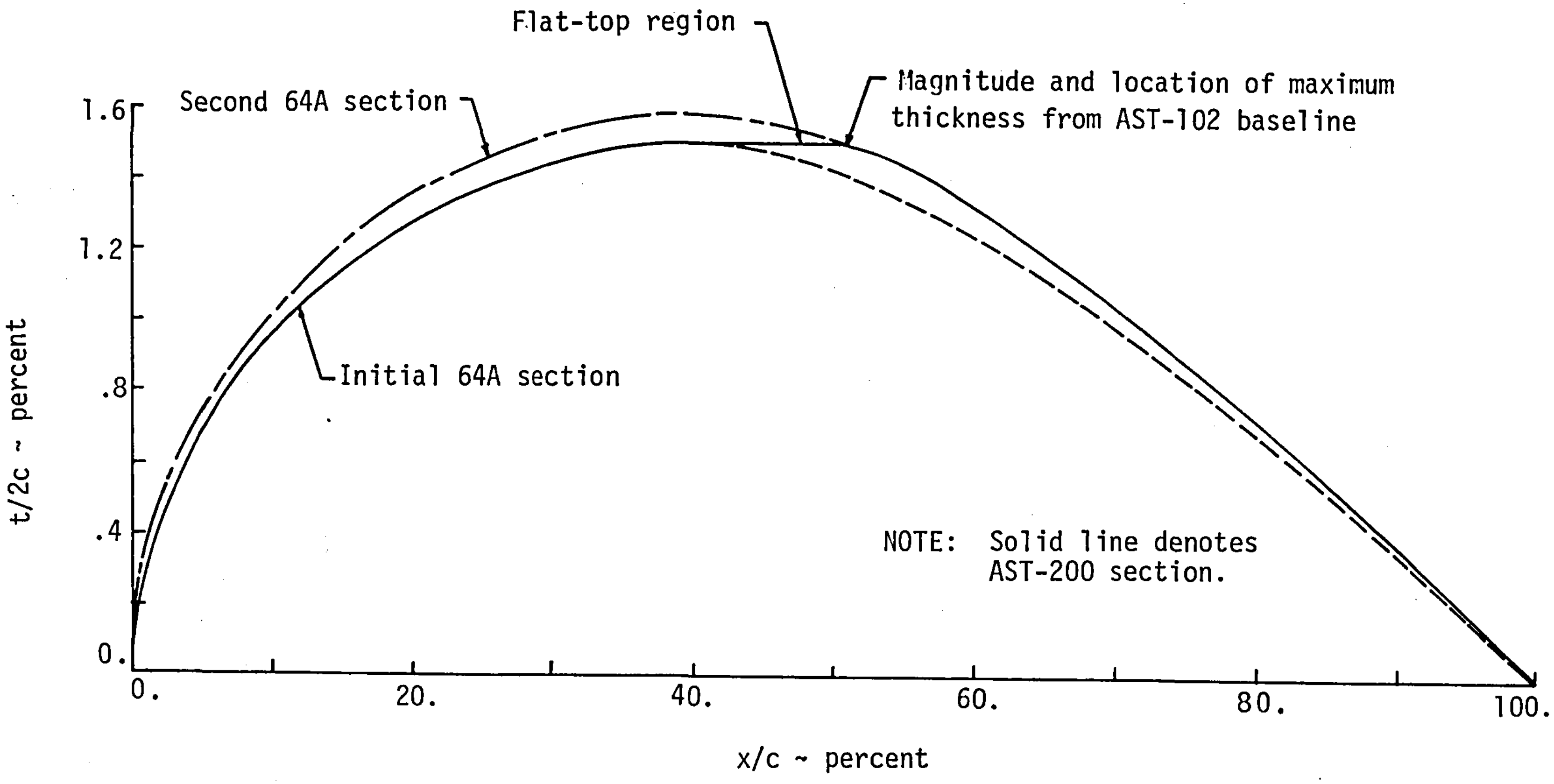
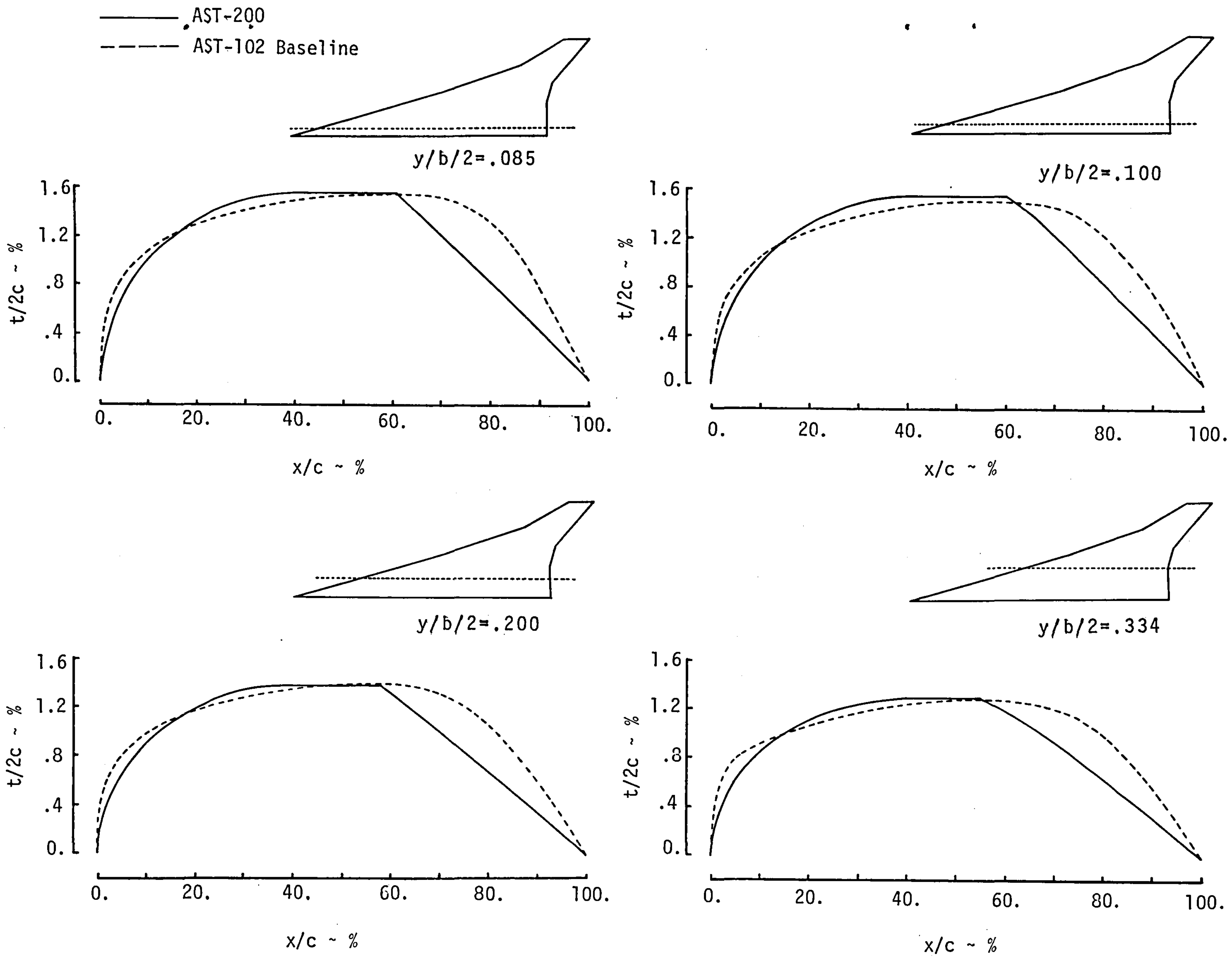
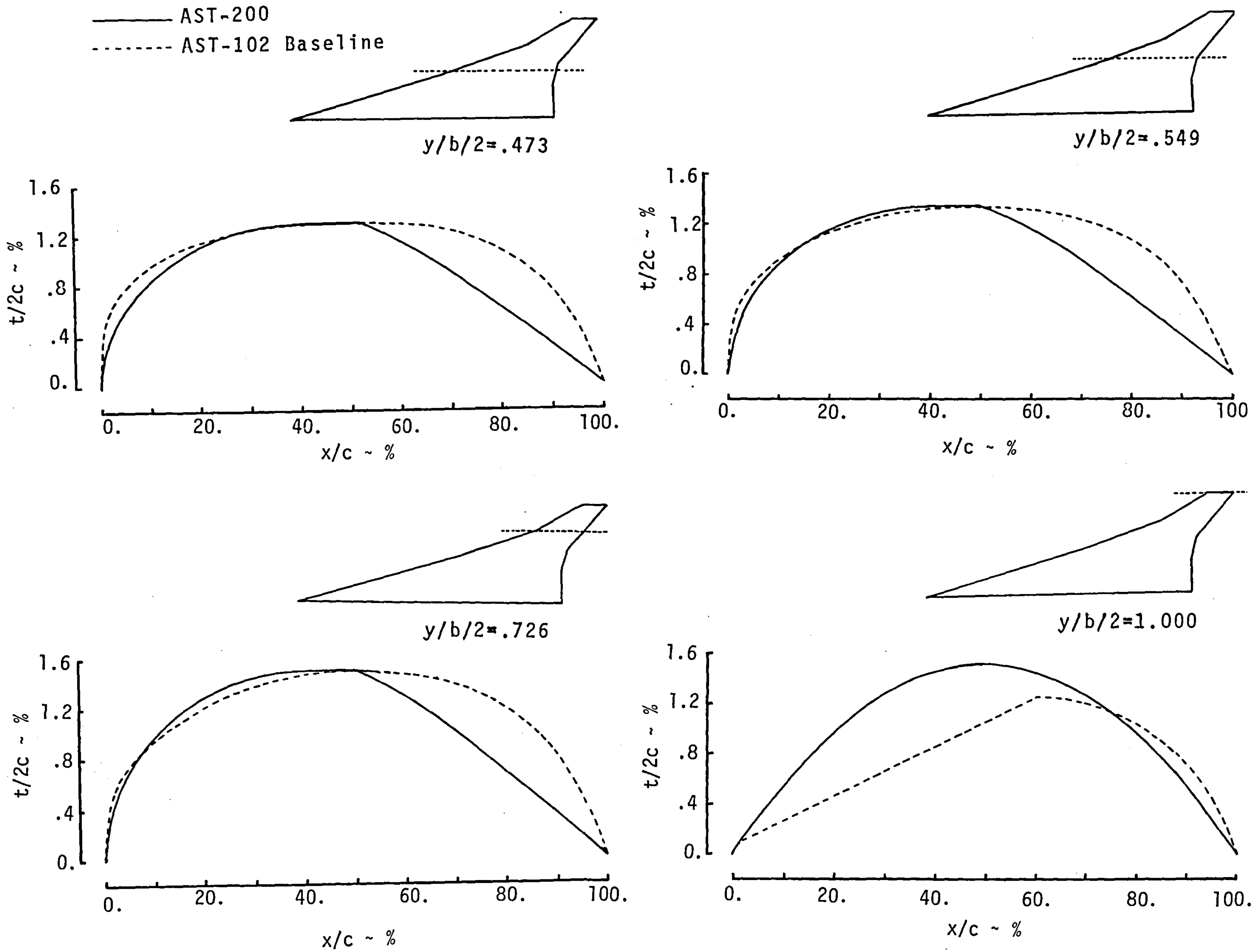


Figure 3. - Typical AST-200 wing section development.



(a) Inboard sections.

Figure 4. - Typical comparison of baseline and revised wing thickness distributions.



(b) Outboard sections.

Figure 4. - Concluded.

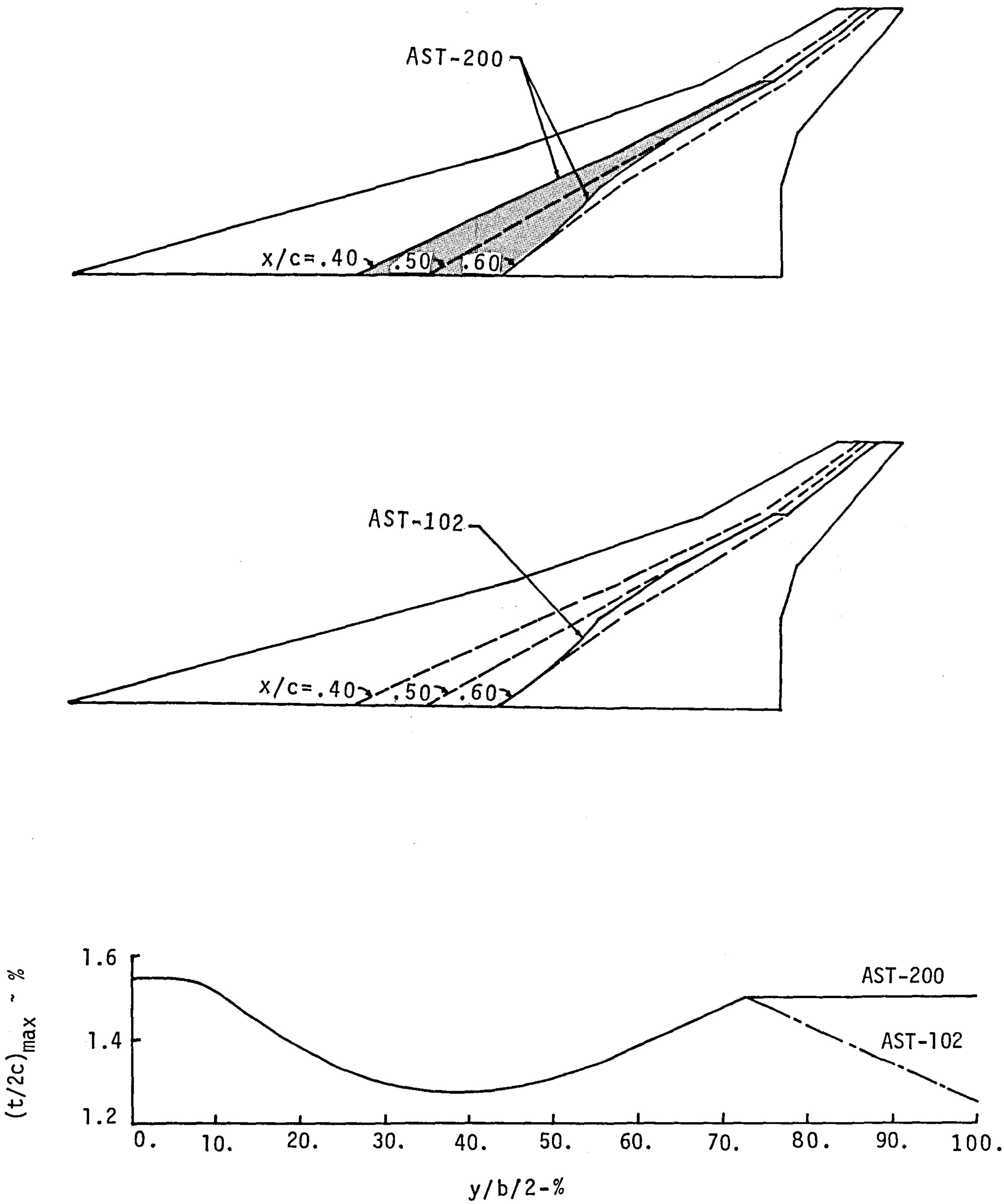
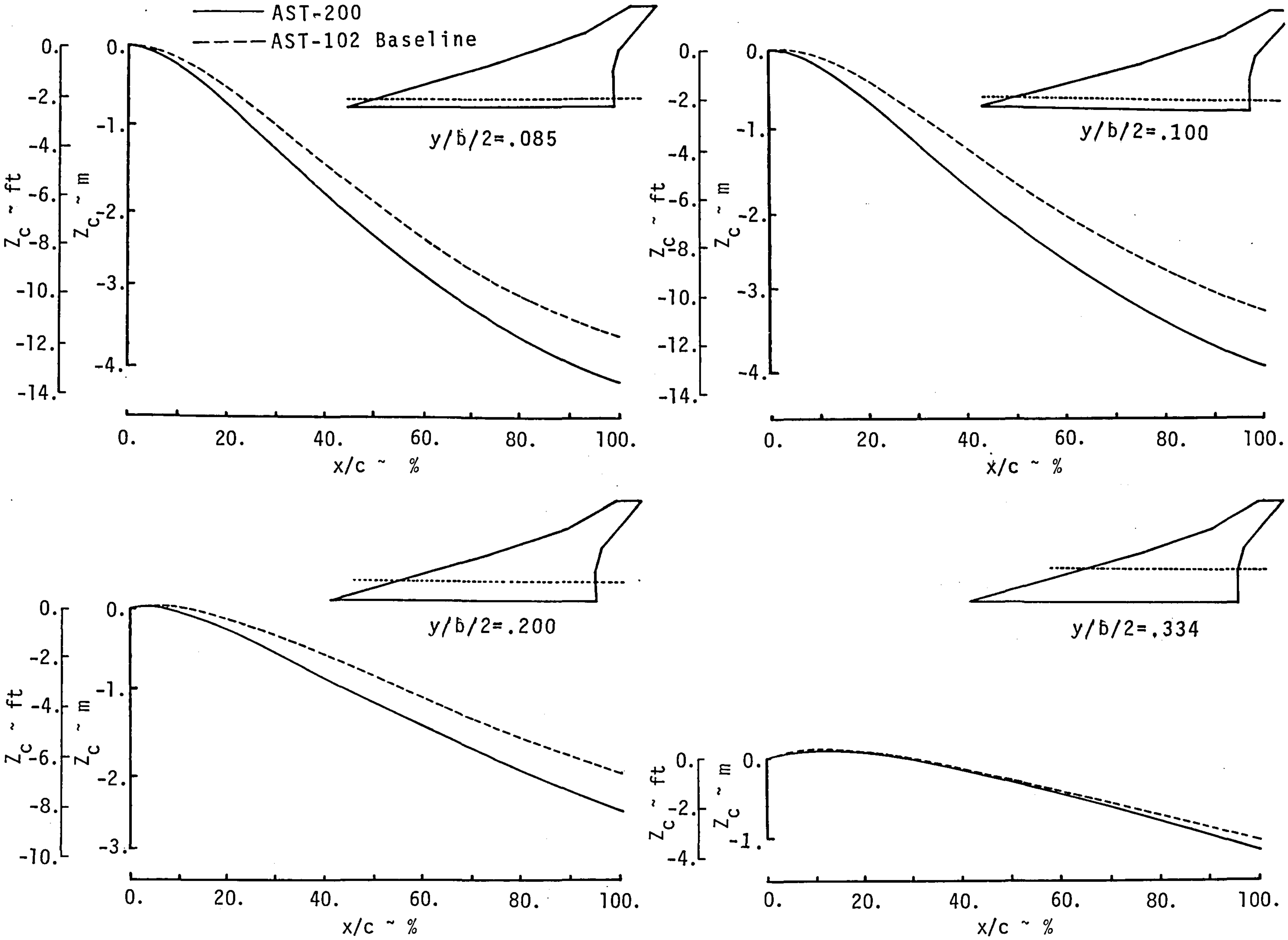
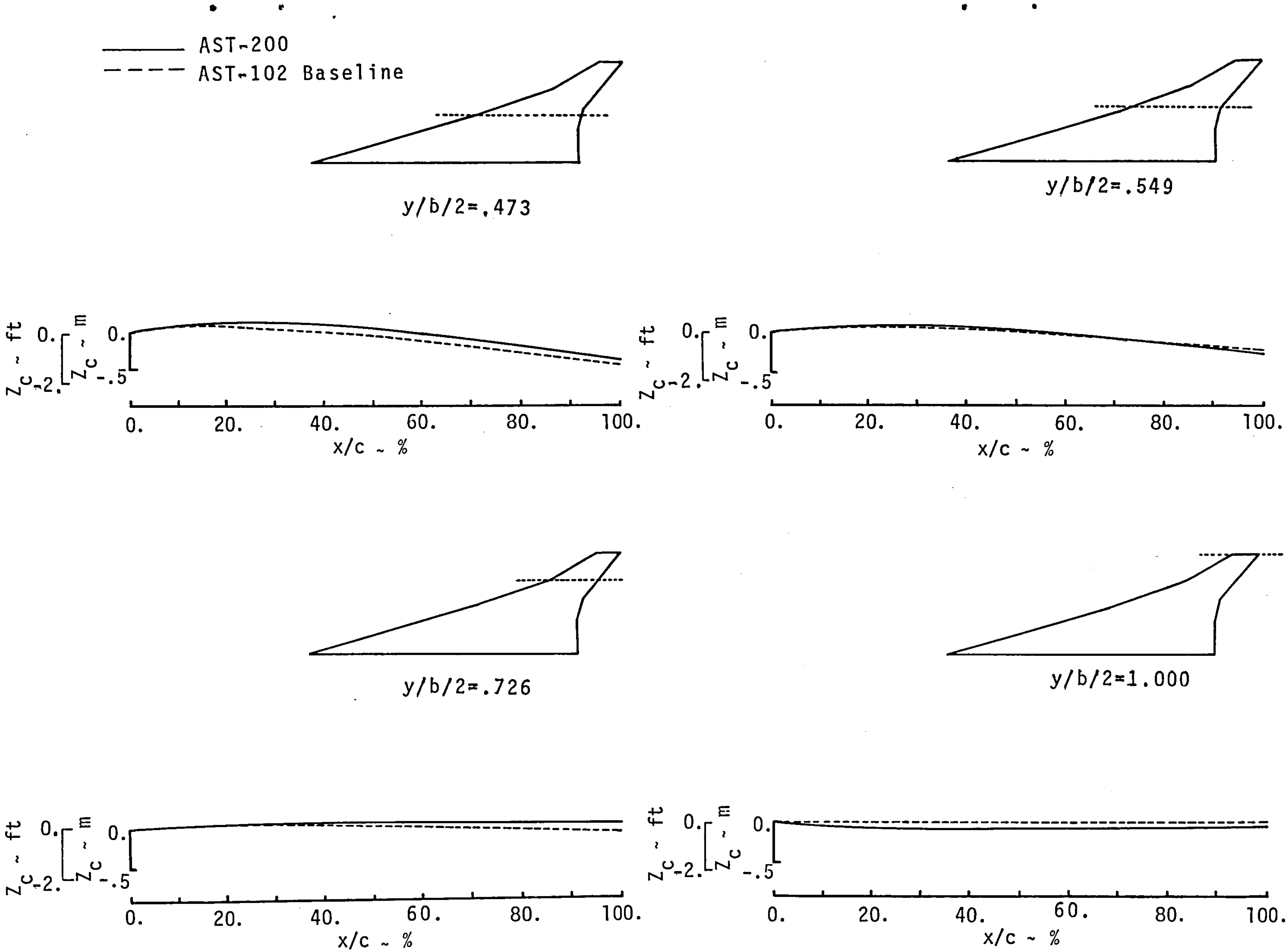


Figure 5. - Spanwise variation of maximum thickness.



(a) Inboard sections.

Figure 6. - Comparison of AST-102 baseline and AST-200 wing camber distributions.



(b) Outboard sections.

Figure 6. - Concluded.

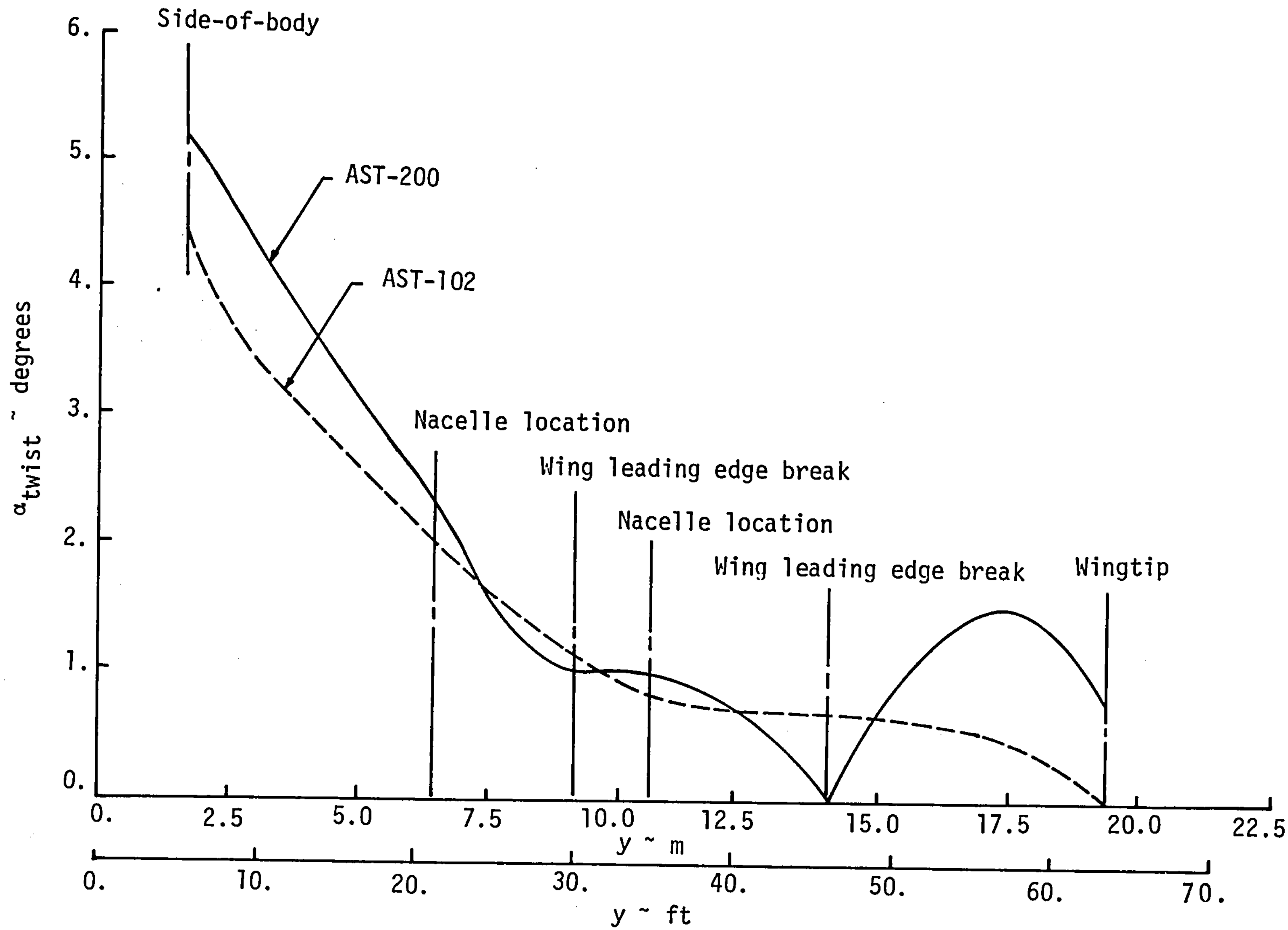


Figure 7. - Comparison of AST-102 baseline and AST-200 wing twist distributions.

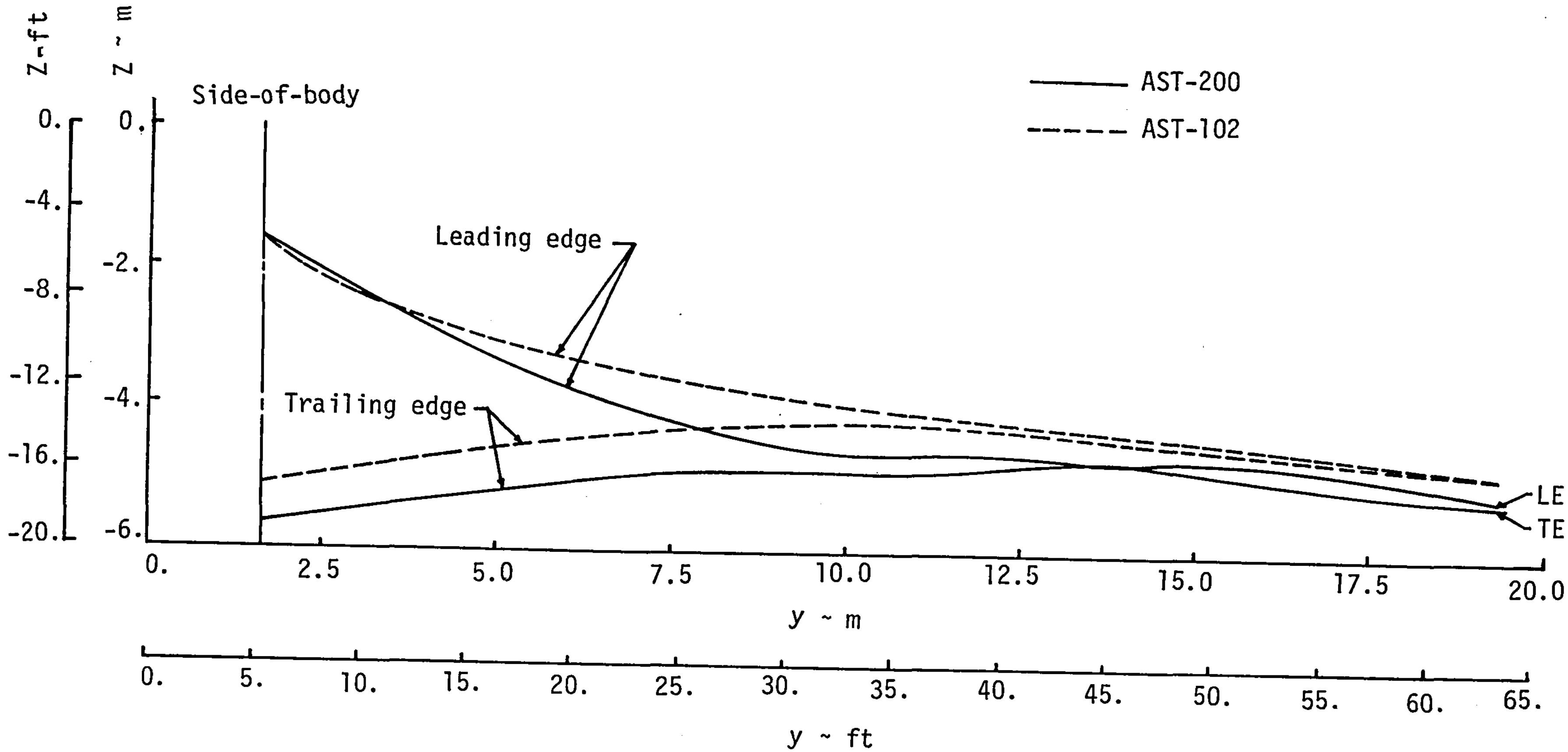


Figure 8. Wing shear distribution comparison.

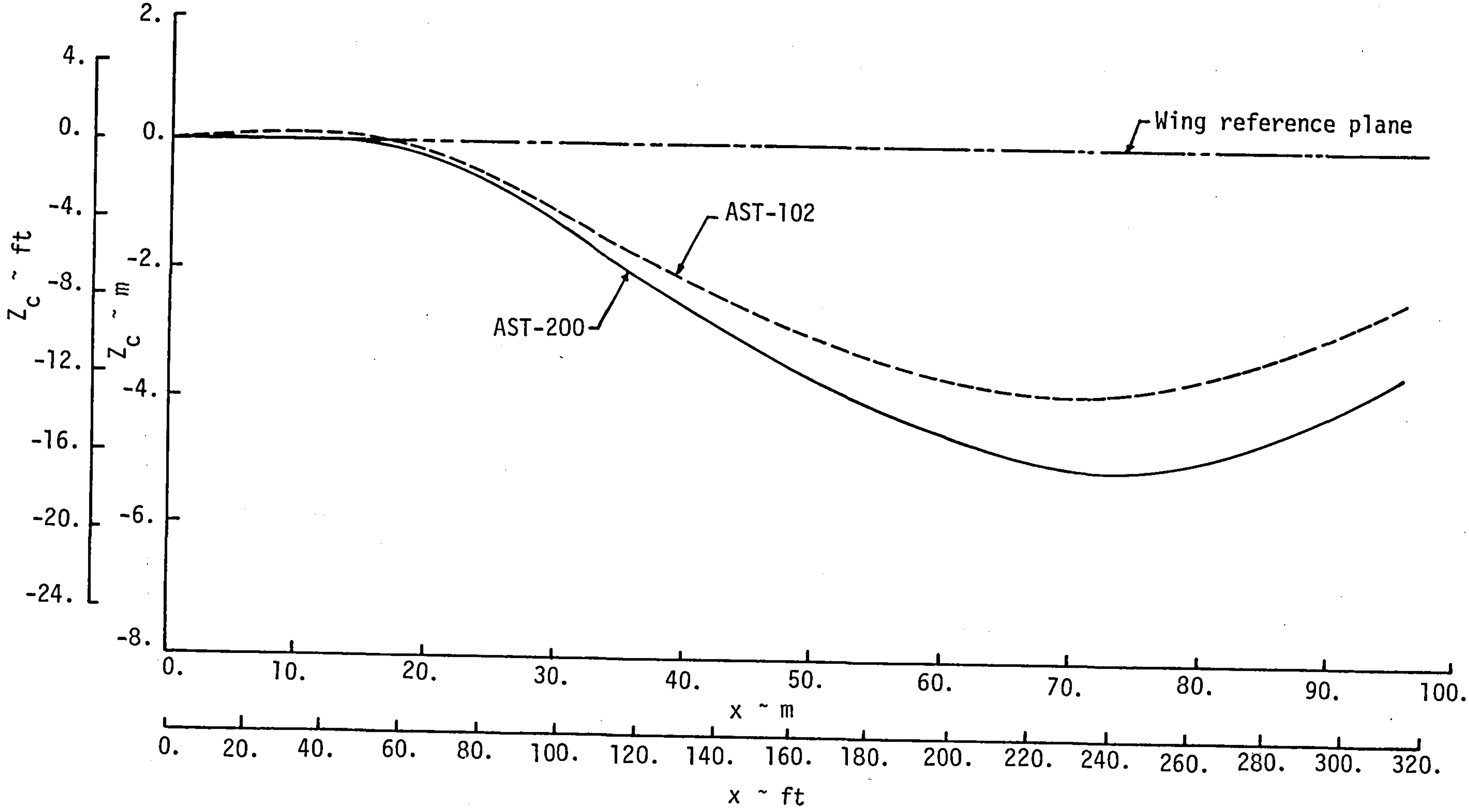


Figure 9. - Fuselage camber comparison.

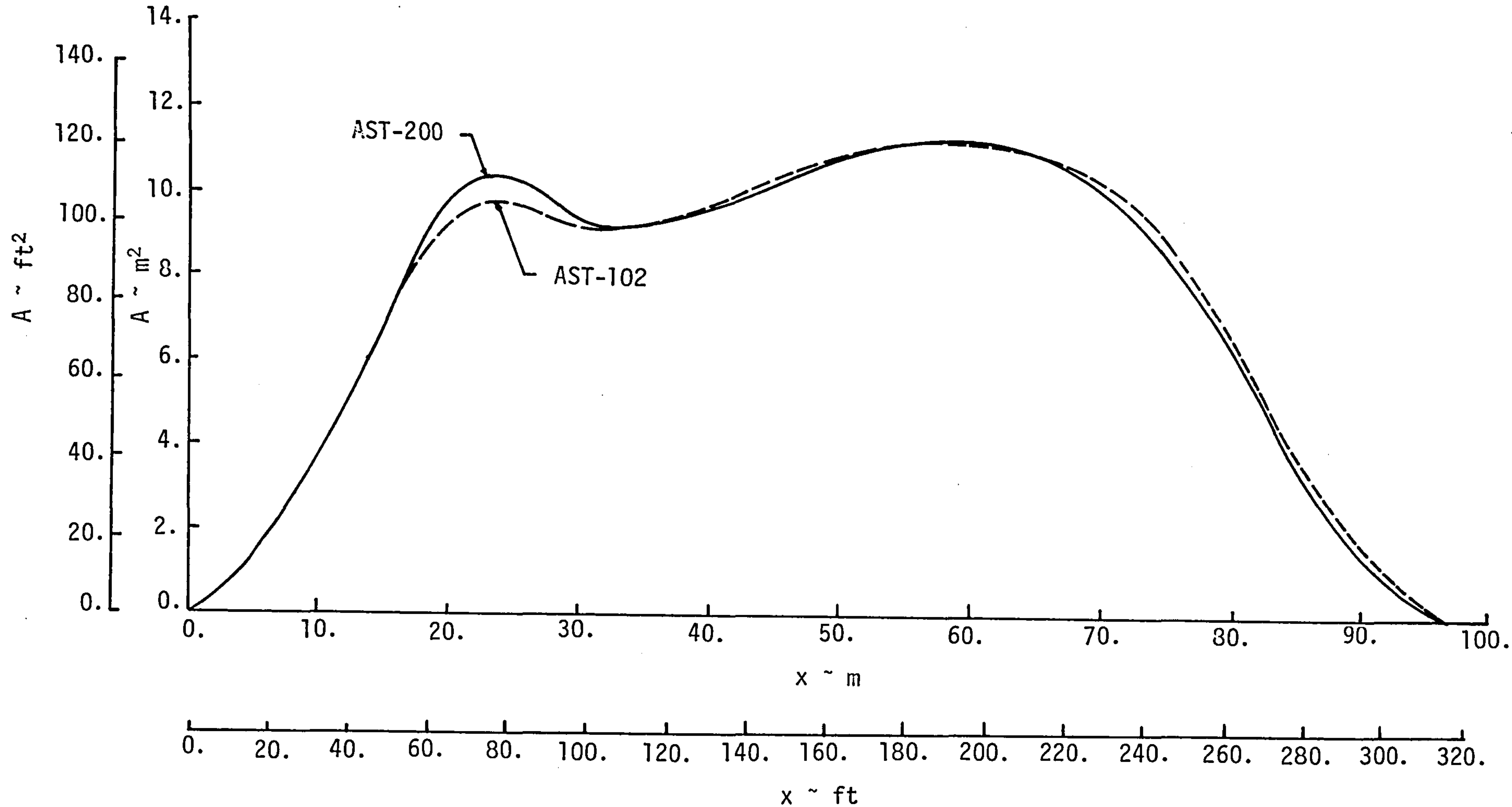
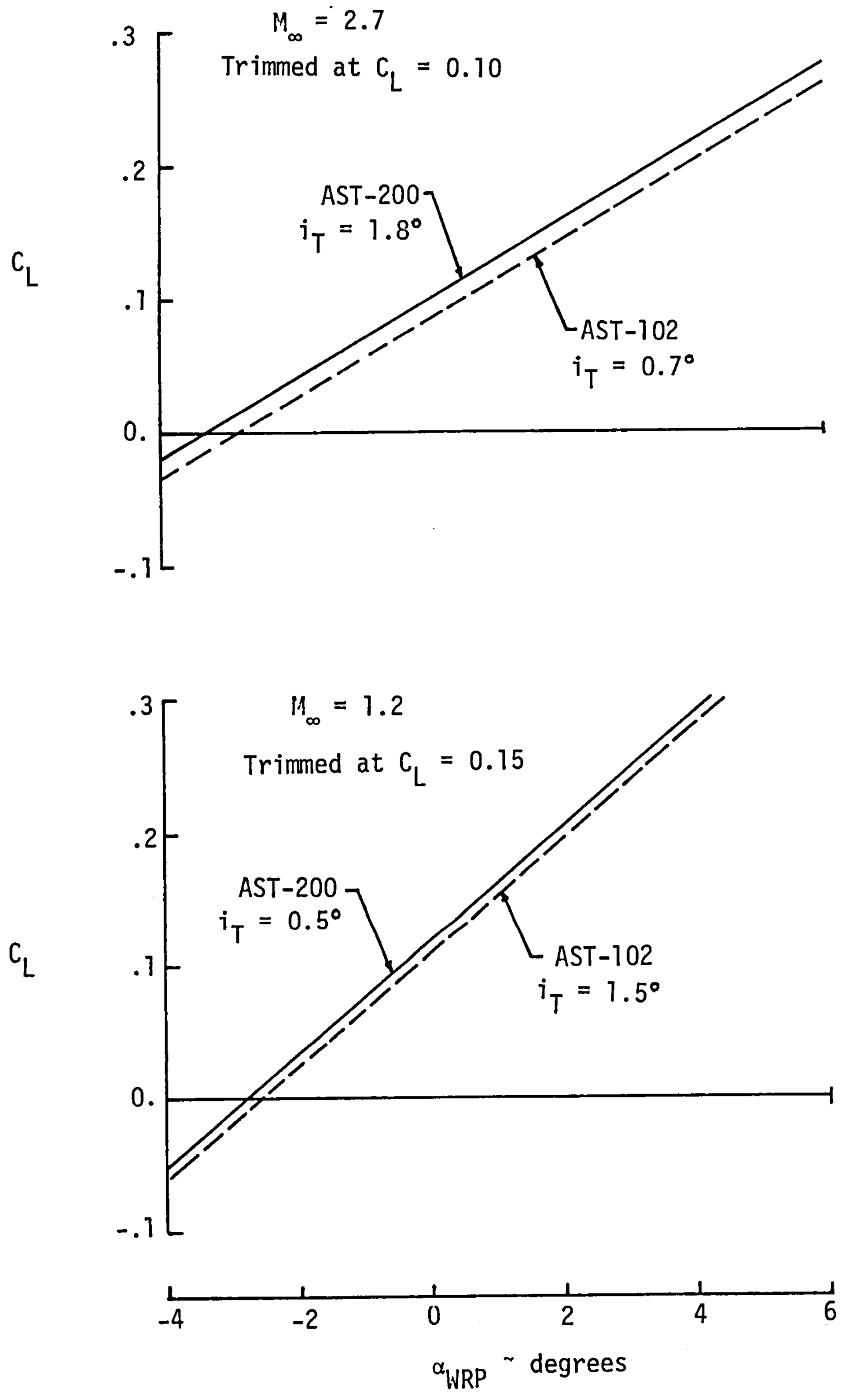
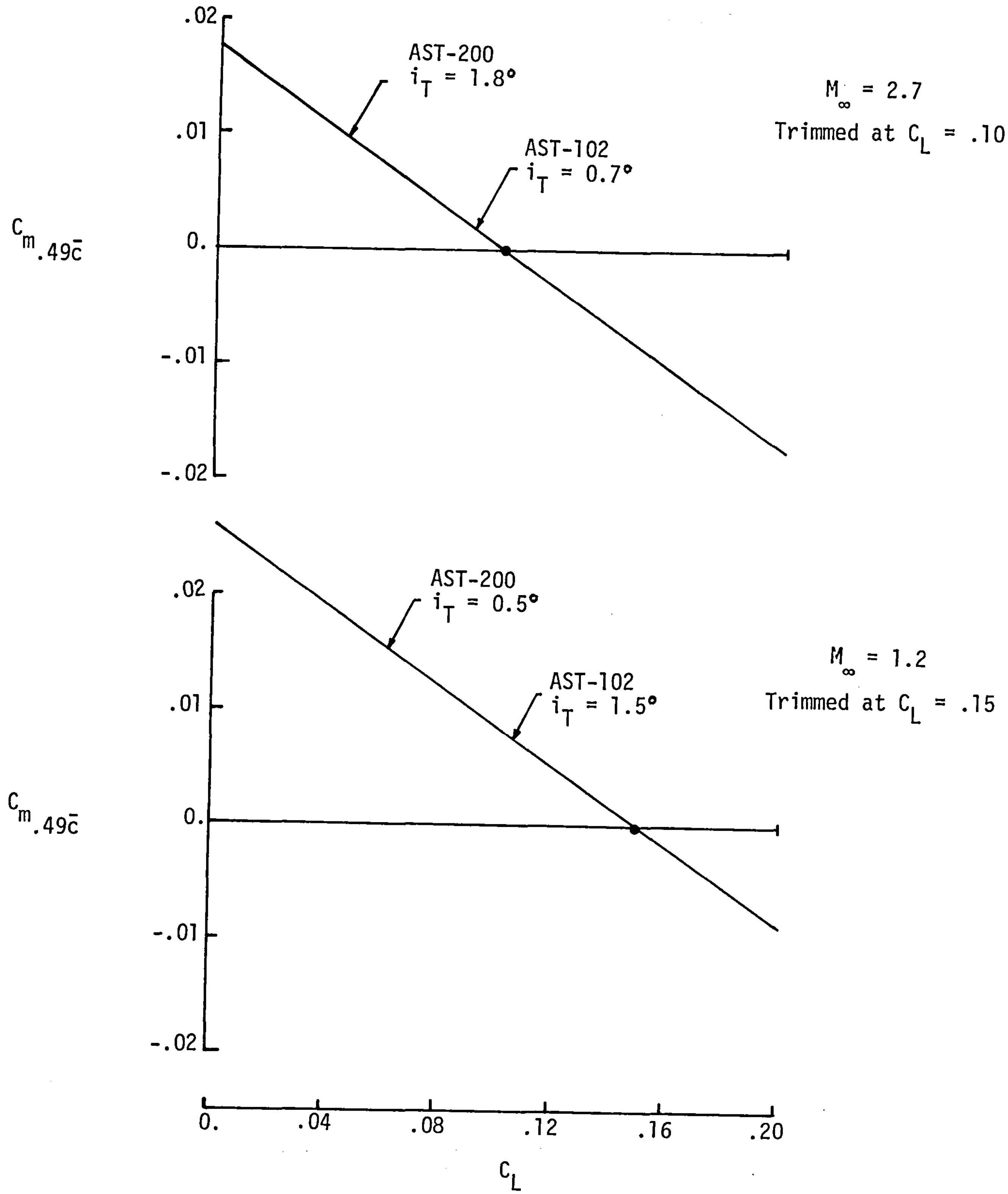


Figure 10. - Fuselage area distribution comparison.



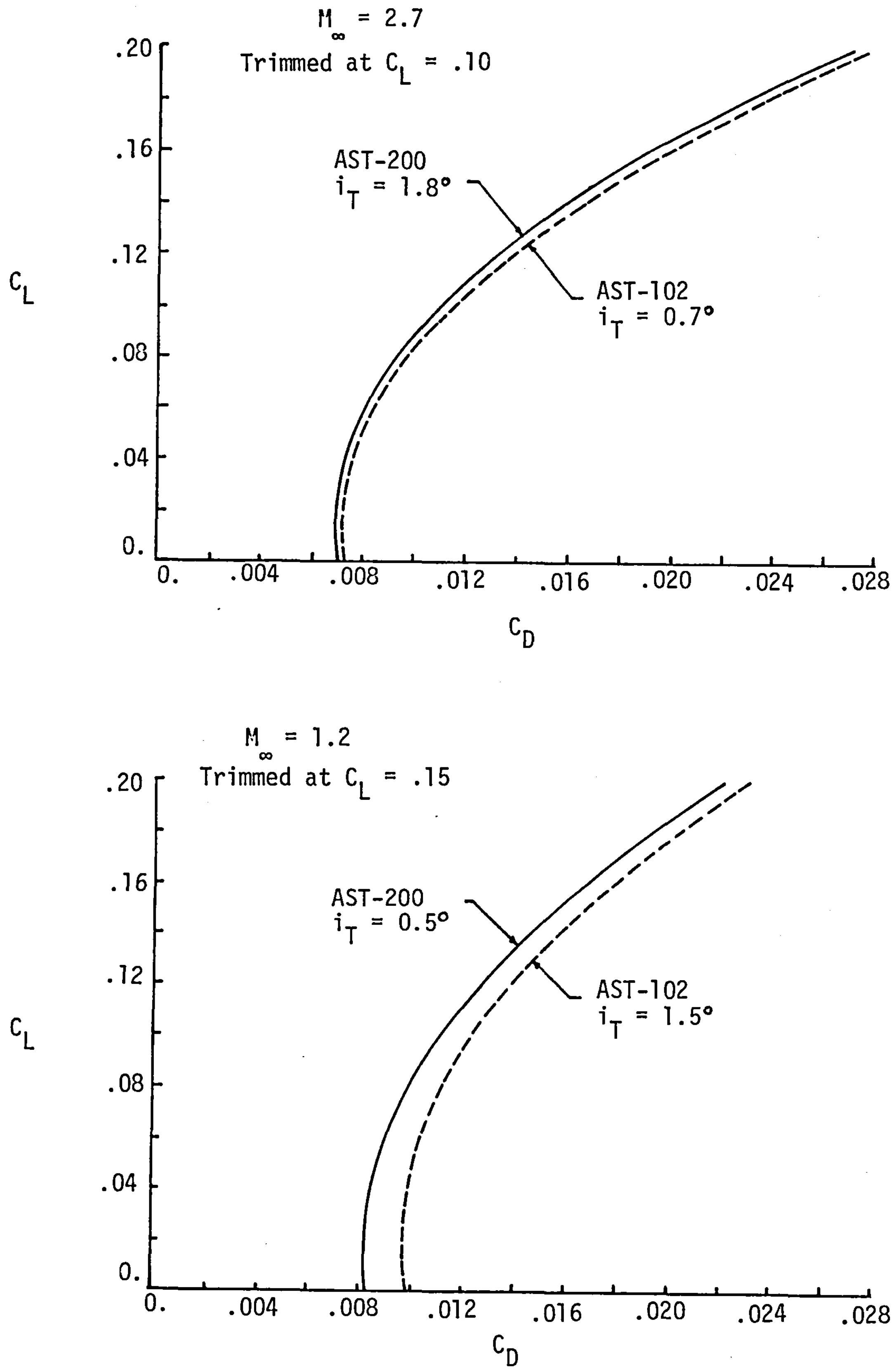
(a) Lift comparison.

Figure 11. - Aerodynamic performance.



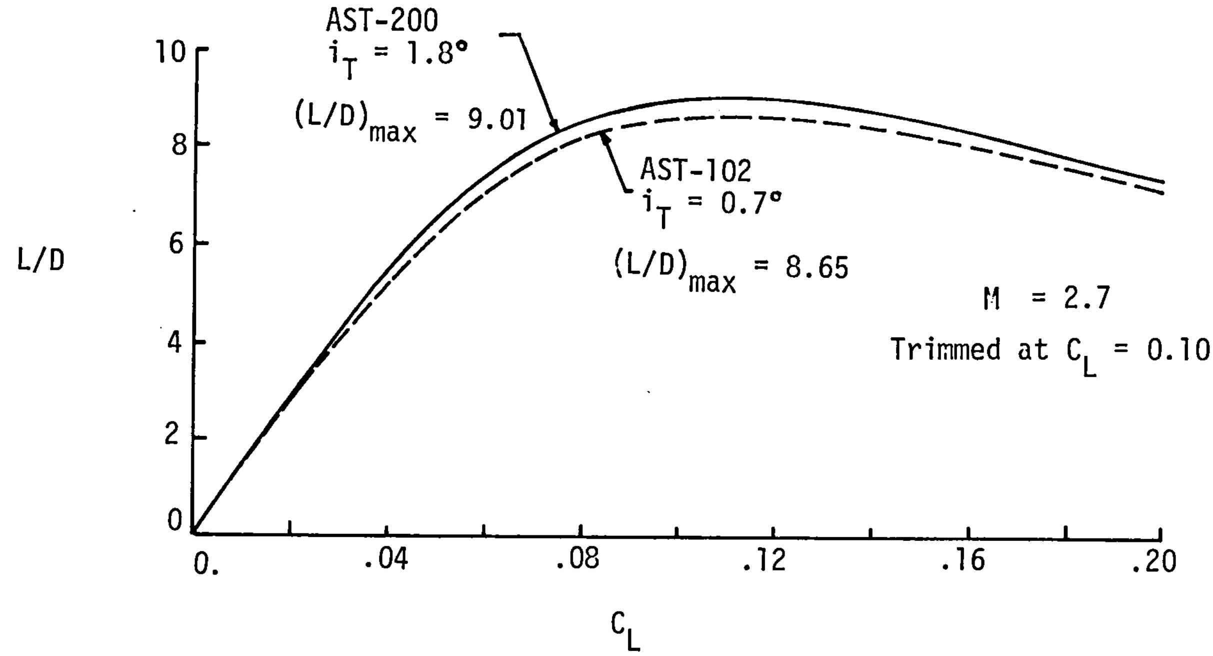
(b) Pitching moment comparison.

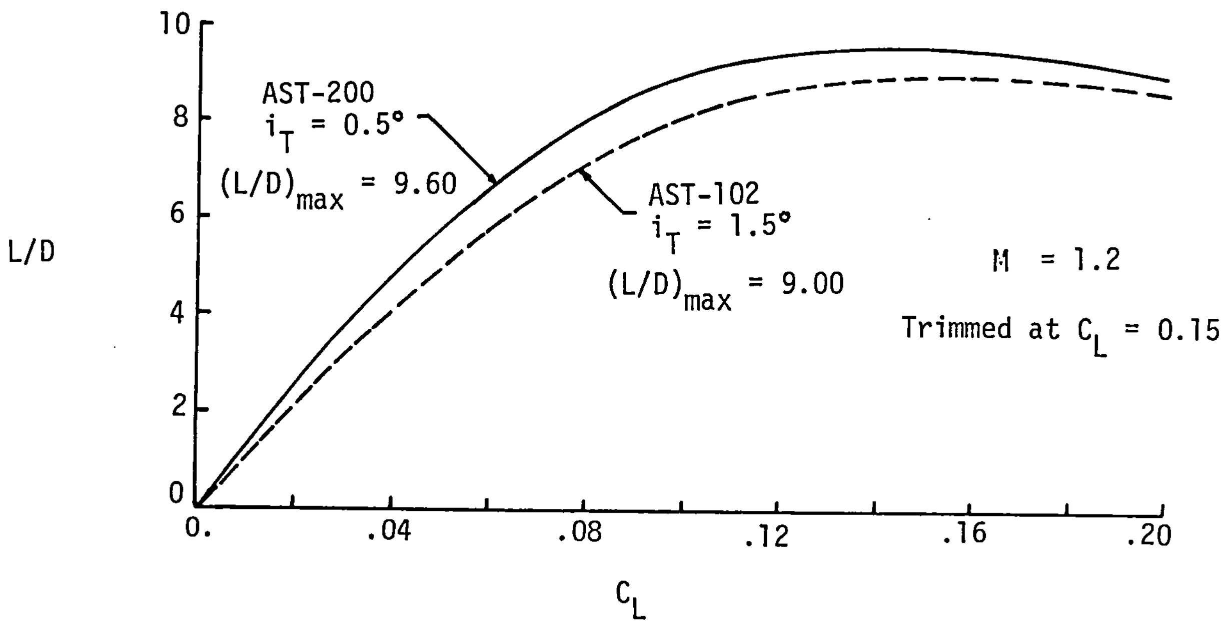
Figure 11. - Continued.



(c) Drag comparison.

Figure 11. - Continued.





(d) L/D comparison.

Figure 11. - Concluded.

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16. Abstract

The design and analysis of a supersonic transport configuration has been conducted using linear theory methods in conjunction with appropriate constraints. A configuration which was developed through previous systems studies has been used as the baseline for the present design and analysis. Wing optimization centered on the determination of the required twist and camber and proper integration of the wing and fuselage. Also included in the design are aerodynamic refinements to the baseline wing thickness distribution and nacelle shape. Analysis to the baseline and revised configurations indicated an improvement in lift-to-drag ratio of 0.36 at the Mach 2.7 cruise condition. Validation of the design is planned through supersonic wing tunnel tests.

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