USAF STABILITY AND CONTROL DATCOM

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FOREWORD

The current volume entitled "USAF Stability and Control Datcom" has been prepared by the Douglas Aircraft Division of the McDonnell Douglas Corporation under Contracts AF33(616)-6460, AF33(615)-1605, F33615-67-C-1156, F33615-68-C-1260, F33615-70-C-1087, F33615-71-C-1298, F33615-72-C-1348, F33615-73-C-3057, F33615-74-C-3021, F33615-75-C-3067, and F33615-76-C-3061. (The term Datcom is a shorthand notation for data compendium.) This effort is sponsored by the Control Criteria Branch of the Flight Control Division, Air Force Flight Dynamics Laboratory, Wright-Patterson Air Force Base, Dayton, Ohio. The Air Force project engineers for this project were J. W. Carlson and D. E. Hoak. The present volume has been published in order to replace the original work and to provide timely stability and flight control data and methods for the design of manned aircraft, missiles, and space vehicles. It is anticipated that this volume will be continuously revised and expanded to maintain its currency and utility. Comments concerning this effort are invited; these should be addressed to the procuring agency.

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SECTION 1

GUIDE TO DATCOM

Fundamentally, the purpose of the Datcom (Data Compendium) is to provide a systematic summary of methods for estimating basic stability and control derivatives. The Datcom is organized in such a way that it is self-sufficient. For any given flight condition and configuration the complete set of derivatives can be determined without resort to outside information. The book is intended to be used for preliminary design purposes before the acquisition of test data. The use of reliable test data in lieu of the Datcom is always recommended. However, there are many cases where the Datcom can be used to advantage in conjunction with test data. For instance, if the lift-curve slope of a wing-body combination is desired, the Datcom recommends that the lift-curve slopes of the isolated wing and body, respectively, be estimated by methods presented and that appropriate wing-body interference factors (also presented) be applied. If wing-alone test data are available, it is obvious that these test data should be substituted in place of the estimated wing-alone characteristics in determining the lift-curve slope of the combination. Also, if test data are available on a configuration similar to a given configuration, the characteristics of the similar configuration can be corrected to those for the given configuration by judiciously using the Datcom material.

The various sections of the Datcom have been numbered with a decimal system, which provides the maximum degree of flexibility. A "section" as referred to in the Datcom contains information on a single specific item, e.g., wing lift-curve slope. Sections can, in general, be deleted, added, or revised with a minimum disturbance to the remainder of the volume. The numbering system used throughout the Datcom follows the scheme outlined below:

Section: An orderly decimal system is used, consisting of numbers having no more than four digits (see Table of Contents). All sections are listed in the Table of Contents although some consist merely of titles. All sections begin at the top of a right-hand page.

Page: The page number consists of the section number followed by a dash number. Example: Page 4.1.3.2-4 is the 4th page of Section 4.1.3.2.

Figures: Figure numbers are the same as the page number. This is a convenient system for referencing purposes. For pages with more than one figure, a lower case letter follows the figure number. Example: Figure 4.1.3.2-50b is the second figure on Page 4.1.3.2-50. Where a related series of figures appears on more than one page, the figure number is the same as the first page on which the series begins. Example: Figure 4.1.3.2-56d may be found on Page 4.1.3.2-57 and is the 4th in a series of charts. Figures are frequently referred to as "charts" in the text.

Tables: Table numbers consist of the section number followed by an upper case dashed letter. Example: Table 4.1.3.2-A is the first table to appear in Section 4.1.3.2.

Equations: Equation numbers consist of the section number followed by a lower case dashed letter. Example: 4.1.3.2-b is the second equation (of importance) appearing in Section 4.1.3.2. Repeated equations are numbered the same as for the first appearance of the equation but are called out as follows: (Equation 4.1.3.2-b).

The major classification of sections in the Datcom is according to type of stability and control parameter. This classification is summarized below:

Section 1. Guide to Datcom and Methods Summary (present discussion including the Methods Summary)

Section 2. General information

Section 3. Reserved for future use

Section 4. Characteristics at angle of attack

Section 5. Characteristics in sideslip

Section 6. Characteristics of high-lift and control devices

Section 7. Dynamic derivatives

Section 8. Mass and inertia

Section 9. Characteristics of VTOL-STOL aircraft

The information in Section 2 consists of a complete listing of notation and definitions used in the Datcom, including the sections in which each symbol is used. It should be noted that definitions are also frequently given in each section where they appear. Insofar as possible, NASA notation has been used. Thus the notation from original source material has frequently been modified for purposes of consistency. Also included in Section 2 is general information used repeatedly by the engineer, such as geometric parameters, airfoil notation, wetted-area charts, etc.

Sections 4 and 5 are for configurations with flaps and control surfaces neutral. Flap and control characteristics are given in Section 6 for both symmetric and asymmetric deflections. Section 4 includes effects of engine power and ground plane on the angle-of-attack parameters.

The Datcom presents less information on the dynamic derivatives (Section 7) than on the static derivatives, primarily because of the relative scarcity of data, but partly because of the complexities of the theories. Furthermore, the dynamic derivatives are frequently less important than the static derivatives and need not be determined to as great a degree of accuracy. However, the Datcom does present test data, from over a hundred sources, for a great variety of configurations (Table 7-A).

If more than preliminary-design information on mass and inertia (Section 8) is needed, a weights-and-balance engineer should be consulted.

Section 9 is a unified section covering aerodynamic characteristics of VTOL-STOL aircraft, with the exception of ground-effect machines and helicopters. The Datcom presents less information in this area than that presented for conventional configurations because of the scarcity of data, the complexities of the theories, and the large number of variables involved. In most cases the Datcom methods of this section are based on theory and/or experimental data such that their use is restricted to first approximations of the aerodynamic characteristics of individual components or simple component combinations. However, the Datcom does present a literature summary from over six hundred sources for a great variety of VTOL-STOL configurations (Table 9-A).

It should be noted that the characteristics predicted by this volume are for rigid airframes only. The effects of aeroelasticity and aerothermoelasticity are considered outside the scope of the Datcom.

The basic approach taken to the estimation of the drag parameters in Section 4 has been found to be satisfactory for preliminary-design stability studies. No attempt is made to provide drag estimation methods suitable for performance estimates.

Each of the major divisions discussed above, notably Sections 4, 5, 6, and 7, is subdivided according to vehicle components. That is, the information is presented as wing, body, wing-body, wing-wing, and wing-body-tail sections. The latter three categories generally utilize component information as presented in the first two categories and add the appropriate aerodynamic interference terms. In some cases, however, estimation methods for combined components as a unit are presented. Each section of the Datcom is organized in a specific manner such that the engineer, once familiar with the system, can easily orient himself in a given section. A typical section is diagramed below:

Section Number and Title

General Introductory Material

A. Subsonic Paragraph
   Introductory Material
   Specific Methods
   Sample Problems

B. Transonic Paragraph
   Introductory Material
   Specific Methods
   Sample Problems

C. Supersonic Paragraph
   Introductory Material
   Specific Methods
   Sample Problems

D. Hypersonic Paragraph
   Introductory Material
   Specific Methods
   Sample Problems

References

Tables

Working Charts

In general, each section is organized according to speed regimes. However, Sections 6.3.1 and 6.3.2 are restricted to the hypersonic speed regime and Section 9 to the low-speed transition-flight regime. In a few sections, where applicable, material is included for the rarefied-gas regime as paragraph E. The material for each speed regime is further subdivided into an introductory discussion of the fundamentals of the problem at hand, a detailed outline of specific methods, and sample problems illustrating the use of the methods presented. In the selection of specific methods, an attempt has been made to survey all known existing generalized methods. All methods that give reasonably accurate results and yet do not require undue labor or automatic computing equipment have been included (at least this is the ultimate goal). Where feasible, the configurations chosen for the sample problems are actual test configurations, and thus some substantiation of the methods is afforded by comparison with the test results.

To facilitate the engineer's orientation to those Datcom sections that use a build-up of wing, wing-body, and wing-body-tail components, a Methods Summary has been included at the end of this section. In addition, the methods of Sections 6.1 and 6.2 are also included in the Methods Summary. The contents of the Methods Summary present the following: (1) the wing, wing-body, and wing-body-tail equations available in each speed regime, (2) the sections where the equation components are obtained, (3) the limitations associated with the equations and their respective components (limitations from design charts are not included), and (4) identification of the parameters that are based on exposed planform geometry that are not specified by the subscript e.

Sometimes the same limitations, such as "linear-lift range," may occur for more than one component in an equation. To avoid repetition, the same limitation is not repeated for each component. The list of limitations should not be construed as effectively replacing the discussion preceding each Datcom method. It remains essential to read the discussion accompanying each derivative to ensure an effective application of each method.

Proper use of the Methods Summary will enable the engineer to organize and plan his approach to minimize the interruptions and the time needed to locate and calculate the independent parameters used in the equation under consideration.

The Datcom methods provide derivatives in a stability-axis system unless otherwise noted. Transformations of stability derivatives from one axis system to another are developed in many standard mathematics and engineering texts. In FDL-TDR-64-70, several coordinate systems are defined and illustrated, and coordinate transformation relations are given.

All material presented in the Datcom has been referenced; plagiarizing has been specifically avoided. In general, material that has not been referenced has been contributed by the authors.

In many of the sections, substantiation tables are presented that show a comparison of test results with results calculated by the methods recommended. Geometric and test variables are also tabulated for convenience in comparing these results. Wherever possible, the limits of applicability for a given method have been determined and are stated in the text.

The working charts are presented on open grid, which in general constitute an inconvenience to the user. However, with a few exceptions, the grids used are of two sizes only: centimeter and half-inch grid sizes. This enables the engineer to use transparent grid paper to read the charts accurately.

Another set of documents similar in intent to the Datcom is the "Royal Aeronautical Society Data

Sheets," available from the Royal Aeronautical Society of Great Britain. These documents are particularly useful from the standpoint that foreign source material is strongly represented in them; whereas the Datcom emphasizes American information.

As stated in the introduction, the work on the Datcom will be expanded and revised over the years to maintain an up-to-date and useful document. In order to help achieve this goal, comments concerning this work are invited and should be directed to the USAF Procuring Agency so that the effort may be properly oriented.

METHODS SUMMARY OUTLINE

DERIVATIVE	PAGES	DERIVATIVE	PAGES
C_{L_α}	1-7 through 1-11	c_{ℓ_δ} , α_δ	**1-49 through 1-50**
C_{m_α}	1-11 through 1-15	$\left(c_{\ell_\alpha}\right)_\delta$	1-50
C_{L_q}	1-15 through 1-18	$\Delta c_{\ell_{max}}$	1-50
C_{m_q}	1-19 through 1-23		
$C_{L_{\dot{\alpha}}}$	1-23 through 1-27	$\left(c_{m_\alpha}\right)_\delta$	1-51
$C_{m_{\dot{\alpha}}}$	1-27 through 1-31	Δc_m	1-51
C_{Y_β}	1-31 through 1-34	c_{h_α}	1-52
C_{l_β}	1-34 through 1-38	c_{h_δ}	1-53
C_{n_β}	1-38 through 1-40	$\left(c_{h_f}\right)_{\delta_t}$	1-53
C_{Y_p}	1-40 through 1-41	C_{L_δ}	1-54 through 1-55
C_{l_p}	1-41 through 1-43	$\left(C_{L_\alpha}\right)_\delta$	1-55
C_{n_p}	1-43 through 1-45	$\Delta C_{L_{max}}$	1-56
C_{Y_r}	1-45	ΔC_m	1-56 through 1-57
C_{l_r}	1-45 through 1-47	C_{h_α}	1-57 through 1-58
C_{n_r}	1-47	C_{h_δ}	1-58

DERIVATIVE	PAGES
C_D	1-59
C_{l_δ}	1-59 through 1-61
C_n	1-61 through 1-62
C_{n_δ}	1-62

METHODS SUMMARY

DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
C_{L_α}	W	SUBSONIC	$\frac{C_{L_\alpha}}{A} = \frac{2\pi}{2+\sqrt{\frac{A^2\beta^2}{\kappa^2}\left(1+\frac{\tan^2\Lambda_{c/2}}{\beta^2}\right)+4}}$ Fig. 4.1.3.2-49	Method 1 1. No curved planforms 2. $M \leqslant 0.8$, $t/c \leqslant 0.1$, if cranked planforms with round LE
			$C_{L_\alpha} = \underbrace{\left(C_{L_\alpha}\right)_{theory}}_{4.1.3.2}\left[\frac{C_{L_\alpha}}{\underbrace{\left(C_{L_\alpha}\right)_{theory}}_{4.1.3.2}}\right]$ Eq. 4.1.3.2-b	Method 2 1. Constant-section, delta or clipped-delta configurations ($\Lambda_{TE} = 0$) 2. $0.58 \leqslant A \leqslant 2.55$ 3. $0 \leqslant \lambda \leqslant 0.3$ 4. $63^\circ \leqslant \Lambda_{LE} \leqslant 80^\circ$ 5. $0.10 \leqslant t/c \leqslant 0.30$ 6. $M = 0.2$
		TRANSONIC	Faired curve between $\left(C_{L_\alpha}\right)_{subsonic}$ and $\left(C_{N_\alpha}\right)_{supersonic}$	1. Symmetric airfoils of conventional thickness distribution 2. $A \leqslant 3$ if composite wings 3. $\alpha = 0$
		SUPERSONIC	Figures 4.1.3.2-56a through -60	1. Straight-tapered wings 2. $M \geqslant 1.4$ 3. Linear-lift range
			$C_{N_\alpha} = \underbrace{K_L}_{4.1.3.2}\left[\underbrace{\left(C_{N_\alpha}\right)_{bw}}_{4.1.3.2}\frac{S_{bw}}{S_W}\underbrace{\left(C_{LE}\right)_{bw}}_{4.1.3.2} + \underbrace{\left(C_{N_\alpha}\right)_g}_{4.1.3.2}\frac{S_g}{S_W}\underbrace{\left(C_{LE}\right)_g}_{4.1.3.2} + \underbrace{\left(C_{N_\alpha}\right)_E}_{4.1.3.2}\frac{S_E}{S_W}\right]$ Eq. 4.1.3.2-h	1. Double-delta and cranked wings 2. Breaks in LE and TE at same spanwise station 3. $1.2 \leqslant M \leqslant 3.0$ 4. Linear-lift range
			$C_{N_\alpha} = \left[\underbrace{\left(\frac{C_{N_\alpha}}{A}\right)}_{4.1.3.2}\left(\frac{1+p}{p}\right)\right] A \frac{p}{1+p}$ Eq. 4.1.3.2-ℓ	1. Curved planforms 2. $1.0 \leqslant M \leqslant 3.0$ 3. Linear-lift range
		HYPERSONIC	Figures 4.1.3.2-56a through -60	1. Straight-tapered wings 2. Conventional wings of zero thickness 3. Two-dimensional slender-airfoil theory 4. $\alpha = 0$
			$\left(C_{N_\alpha}\right)_{\delta=0} = \frac{4}{\beta}\frac{1}{\sqrt{1-\frac{\tan^2\Lambda_{LE}}{\beta^2}}}$ Fig. 4.1.3.2-65	1. Straight-tapered planforms 2. Wedge airfoils 3. Two-dimensional slender-airfoil theory 4. $\alpha = 0$
	WB	SUBSONIC	(a) $\left(C_{L_\alpha}\right)_{WB} = \underbrace{\left[K_N + K_{W(B)} + K_{B(W)}\right]}_{4.3.1.2}\underbrace{\left(C_{L_\alpha}\right)_e}_{4.1.3.2}\frac{S_e}{S_W}$ Fig. 4.3.1.2-a	Method 1 (body diameter)/(wing semispan) $\leqslant 0.8$ (see Sketch (d), 4.3.1.2) (a) Zero wing incidence; wing-body angle of attack varied K_N (based on exposed wing geometry) 1. Bodies of revolution 2. Slender-body theory 3. Linear-lift range $\left(C_{L_\alpha}\right)_e$ 4. No curved planforms 5. $M \leqslant 0.8$, $t/c \leqslant 0.1$, if cranked wings with round LE

METHODS SUMMARY

DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
C_{L_α} (Contd.)	WB (Contd.)	SUBSONIC (Contd.)	(b) $\left(C_{L_i}\right)_{WB} = \underbrace{\left[k_{W(B)} + k_{B(W)}\right]}_{4.3.1.2} \underbrace{\left(C_{L_\alpha}\right)_e}_{4.1.3.2} \dfrac{S_e}{S_W}$ Eq. 4.3.1.2-b	(b) Body angle of attack fixed at zero; wing incidence varied (same limitations as (a) above)
			$\left(C_{L_\alpha}\right)_{WB} = \underbrace{K_{(WB)}}_{4.3.1.2} \underbrace{\left(C_{L_\alpha}\right)_W}_{4.1.3.2}$ Eq. 4.3.1.2-c	Method 2 (body diameter)/(wing span) is large with delta wing extending entire length of body (see Sketch (c), 4.3.1.2) $\left(C_{L_\alpha}\right)_W$ 1. No curved planforms 2. $M \leq 0.8$, $t/c \leq 0.1$, if cranked wings with round LE
		TRANSONIC	(Same as subsonic equations)	Method 1 (body diameter)/(wing span) is small (see Sketch (d), 4.3.1.2) K_N (based on exposed wing geometry) 1. Bodies of revolution 2. Slender-body theory 3. Linear-lift range $K_{B(W)}$ and $k_{W(B)}$ (based on exposed wing geometry) $\left(C_{L_\alpha}\right)_e$ 4. Symmetric airfoils of conventional thickness distribution 5. $A \leq 3$ if composite wings 6. $\alpha = 0$
				Method 2 (body diameter)/(wing span) is large with delta wing extending the entire length of the body (see Sketch (c), 4.3.1.2) $\left(C_{L_\alpha}\right)_W$ 1. Symmetric airfoils of conventional thickness distribution 2. $A \leq 3$ if composite wings 3. $\alpha = 0$
		SUPERSONIC	(Same as subsonic equations)	Method 1 (body diameter)/(wing span) is small (see Sketch (d), 4.3.1.2) K_N (based on exposed wing geometry) 1. Bodies of revolution 2. Slender-body theory 3. Linear-lift range $K_{B(W)}$ and $k_{W(B)}$ (based on exposed wing geometry) $\left(C_{N_\alpha}\right)_e$ 4. Breaks in LE and TE at same spanwise station 5. $M \geq 1.4$ for straight-tapered wings 6. $1.2 \leq M \leq 3$ for composite wings 7. $1.0 \leq M \leq 3$ for curved planforms

METHODS SUMMARY

DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
C_{L_α} (Contd.)	WB (Contd.)	SUPERSONIC (Contd.)		Method 2 (body diameter)/(wing span) is large with delta wing extending entire length of body (see Sketch (c), 4.3.1.2) $\left(C_{N_\alpha}\right)_W$ 1. Breaks in LE and TE at same spanwise station 2. $M \geq 1.4$ for straight-tapered wings 3. $1.2 \leq M \leq 3$ for composite wings 4. $1.0 \leq M \leq 3$ for curved planforms 5. Linear-lift range
	WBT	SUBSONIC	$$C_{L_\alpha} = \underbrace{\left(C_{L_\alpha}\right)_e'}_{4.1.3.2} \underbrace{\left[K_N + K_{W(B)} + K_{B(W)}\right]'}_{4.3.1.2} \frac{S_e'}{S'} + \underbrace{\left(C_{L_\alpha}\right)_e''}_{4.1.3.2} \underbrace{\left[K_{W(B)} + K_{B(W)}\right]''}_{4.3.1.2} \underbrace{\left(1 - \frac{\partial \epsilon}{\partial \alpha}\right)}_{4.4.1} \underbrace{\frac{q''}{q_\infty}}_{4.4.1} \frac{S''}{S'} \frac{S_e''}{S''}$$ Eq. 4.5.1.1-a	Method 1 $b_W/b_H \geq 1.5$ 1. (Body diameter)/(wing semispan) ≤ 0.8 (see Sketch (d), 4.3.1.2) 2. $\alpha \leq \alpha_{stall}$ if high aspect ratio and unswept wings 3. $\alpha << \alpha_{stall}$ if low aspect ratio or swept wings $\left(C_{L_\alpha}\right)_e'$ and $\left(C_{L_\alpha}\right)_e''$ 4. No curved planforms 5. $M \leq 0.8$, $t/c \leq 0.1$, if cranked planforms with round LE K_N (based on exposed wing geometry) 6. Bodies of revolution 7. Slender-body theory 8. Linear-lift range $\frac{\partial \epsilon}{\partial \alpha}$ (depends upon method) 9. Straight-tapered wing 10. Other limitations depend upon $\frac{\partial \epsilon}{\partial \alpha}$ prediction method $\frac{q''}{q_\infty}$ 11. Valid only on the plane of symmetry
			$$C_{L_\alpha} = \underbrace{\left(C_{L_\alpha}\right)_e'}_{4.1.3.2} \underbrace{\left[K_N + K_{W(B)} + K_{B(W)}\right]'}_{4.3.1.2} \frac{S_e'}{S'} + \underbrace{\left(C_{L_\alpha}\right)_e''}_{4.1.3.2} \underbrace{\left[K_{W(B)} + K_{B(W)}\right]''}_{4.3.1.2} \underbrace{\frac{q''}{q_\infty}}_{4.4.1} \frac{S''}{S'} \frac{S_e''}{S''} + \underbrace{\left(C_{L_\alpha}\right)_{W''(v)}}_{4.5.1.1}$$ Eq. 4.5.1.1-b	Method 2 $b_W/b_H < 1.5$ (same limitations as Method 1 above omitting those of $\partial\epsilon/\partial\alpha$) K_N and $\left(C_{L_\alpha}\right)_{W''(v)}$ (based on exposed wing geometry)

METHODS SUMMARY

DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
C_{L_α} (Contd.)	WBT (Contd.)	TRANSONIC	(Same as subsonic equations)	Method 1 $b_W/b_H \geq 1.5$ $\left(C_{L_\alpha}\right)'_e$ and $\left(C_{L_\alpha}\right)''_e$ 1. Symmetric airfoils of conventional thickness distribution 2. $A \leq 3$ if composite planforms 3. $\alpha = 0$ $K_{B(W)}$ (based on exposed wing geometry) K_N (based on exposed wing geometry) 4. Bodies of revolution 5. Slender-body theory 6. Linear-lift range $\frac{\partial\epsilon}{\partial\alpha}$ (depends upon method) 7. Straight-tapered wings 8. Proportional to C_{L_α} $\frac{q''}{q_\infty}$ 9. Conventional trapezoidal planforms 10. Valid only on the plane of symmetry --- Method 2 $b_W/b_H < 1.5$ (same limitations as Method 1 above omitting those of $\partial\epsilon/\partial\alpha$) K_N, $K_{B(W)}$, and $\left(C_{L_\alpha}\right)_{W''(v)}$ (based on exposed wing geometry)
		SUPERSONIC	(Same as subsonic equations)	Method 1 $b_W/b_H \geq 1.5$ $\left(C_{N_\alpha}\right)'_e$ and $\left(C_{N_\alpha}\right)''_e$ 1. Breaks in LE and TE at same spanwise station 2. $M \geq 1.4$ for straight-tapered planforms 3. $1.2 \leq M \leq 3$ for composite planforms 4. $1.0 \leq M \leq 3$ for curved planforms 5. Linear-lift range K_N (based on exposed wing geometry) 6. Bodies of revolution 7. Slender-body theory $K_{B(W)}$ (based on exposed wing geometry) $\frac{\partial\epsilon}{\partial\alpha}$ 8. Straight-tapered wings 9. Other limitations depend upon $\frac{\partial\epsilon}{\partial\alpha}$ prediction method

DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
C_{L_α} (Contd.)	WBT (Contd.)	SUPERSONIC (Contd.)		$\frac{q''}{q_\infty}$ 10. If nonviscous flow field, limited to unswept wings 11. If viscous flow field, valid only on the plane of symmetry Method 2 $b_W/b_H < 1.5$ (same limitations as Method 1 above omitting those of $\partial\epsilon/\partial\alpha$) K_N, $K_{B(W)}$, and $\left(C_{L_\alpha}\right)_{W''(v)}$ (based on exposed wing geometry)
C_{m_α}	W	SUBSONIC	$C_{m_\alpha} = \underbrace{\left(n - \frac{x_{a.c.}}{c_r}\right)}_{4.1.4.2} \frac{c_r}{\bar{c}} \underbrace{C_{L_\alpha}}_{4.1.3.2}$ Eq. 4.1.4.2-d	1. $M \leq 0.6$; however, for swept wings with $t/c \leq 0.04$, application to higher Mach numbers is acceptable 2. Linear-lift range C_{L_α} 3. No curved planforms 4. $M \leq 0.8$, $t/c \leq 0.1$, if cranked planforms with round LE
		TRANSONIC	(Same as subsonic equation)	1. Straight-tapered wings 2. Symmetric airfoil sections 3. Linear-lift range C_{L_α} 4. Conventional thickness distribution 5. $\alpha = 0$
		SUPERSONIC	(Same as subsonic equation)	1. Linear-lift range C_{N_α} 2. Breaks in LE and TE at same spanwise station 3. $M \geq 1.4$ for straight-tapered wings 4. $1.2 \leq M \leq 3$ for composite wings 5. $1.0 \leq M \leq 3$ for curved planforms
		HYPERSONIC	(Same as subsonic equation)	1. $\alpha = 0$ C_{N_α} 2. Straight-tapered wings 3. Conventional wings of zero thickness and wedge airfoils 4. Two-dimensional slender-airfoil theory

METHODS SUMMARY

DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
C_{m_α} (Contd.)	WB	SUBSONIC	$C_{m_\alpha} = \left(n - \underbrace{\frac{x_{a.c.}}{c_r}}_{4.3.2.2}\right) \frac{c_r}{\bar{c}} \underbrace{C_{L_\alpha}}_{4.3.1.2}$ Eq. 4.1.4.2-d	$\frac{x_{a.c.}}{c_r}$ (calculations based on exposed wing geometry) 1. Single wing with body (i.e., no cruciform or other multipanel arrangements) 2. $M \leq 0.6$; however, if swept wing with $t/c \leq 0.04$, application to higher Mach numbers is acceptable 3. Linear-lift range C_{L_α} 4. (Body diameter)/(wing span) ≤ 0.8 5. No curved planforms 6. Bodies of revolution 7. Slender-body theory 8. $M \leq 0.8$, $t/c \leq 0.1$, if swept wing with round LE
		TRANSONIC	(Same as subsonic equation)	$\frac{x_{a.c.}}{c_r}$ (calculations based on exposed wing geometry) 1. Straight-tapered wings 2. Single wing with body (i.e., no cruciform or other multipanel arrangements) 3. Symmetric airfoils of conventional thickness distribution 4. Linear-lift range C_{L_α} 5. Bodies of revolution 6. Slender-body theory 7. $\alpha = 0$
		SUPERSONIC	(Same as subsonic equation)	$\frac{x_{a.c.}}{c_r}$ (calculations based on exposed wing geometry) 1. Single wing with body (i.e., no cruciform or other multipanel arrangements) 2. Linear-lift range C_{N_α} 3. Breaks in LE and TE at same spanwise station 4. Bodies of revolution 5. Slender-body theory 6. $M \geq 1.4$ for straight-tapered wings 7. $1.2 \leq M \leq 3$ for composite wings 8. $1.0 \leq M \leq 3$ for curved planforms

METHODS SUMMARY

DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)		METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
C_{m_α} (Contd.)	WBT	SUBSONIC	$C_{m_\alpha}^* = -\underbrace{\frac{x_{c.g.}-x'}{\bar{c}'}}_{4.5.2.1}\underbrace{\left[K_N + K_{B(W)} + K_{W(B)}\right]'}_{4.3.1.2}\underbrace{\left(C_{L_\alpha}\right)_e'}_{4.1.3.2}\frac{S_e'}{S'}$ $-\underbrace{\frac{x_{c.g.}-x''}{\bar{c}''}}_{4.5.2.1}\underbrace{\left[K_{B(W)} + K_{W(B)}\right]''}_{4.3.1.2}\underbrace{\left(C_{L_\alpha}\right)_e''}_{4.1.3.2}\underbrace{\left(1-\frac{\partial\epsilon}{\partial\alpha}\right)}_{4.4.1}\underbrace{\frac{q''}{q_\infty}}_{4.4.1}\frac{S_e''}{S''}\frac{S''}{S'}\frac{\bar{c}''}{\bar{c}'}$ *Drag and z terms have been omitted, and small-angle assumptions made with respect to angle of attack; equation as given is valid for most configurations	Eq. 4.5.2.1-d'	Method 1 $b_W/b_H \geq 1.5$ 1. (Body diameter)/(wing semispan) ≤ 0.8 (see Sketch (d), 4.3.1.2) 2. Linear-lift range $\frac{x_{c.g.}-x'}{\bar{c}'}$ (calculations based on exposed planform geometry) 3. Single wing with body (i.e., no cruciform or other multipanel arrangements) 4. $M \leq 0.6$; however, for swept wings with $t/c \leq 0.04$, application to higher Mach numbers is acceptable K_N (based on exposed wing geometry) 5. Bodies of revolution 6. Slender-body theory $\left(C_{L_\alpha}\right)_e'$ and $\left(C_{L_\alpha}\right)_e''$ 7. No curved planforms 8. $M \leq 0.8$, $t/c \leq 0.1$ if cranked planforms with round LE $\frac{\partial\epsilon}{\partial\alpha}$ 9. Straight-tapered wing 10. Other limitations depend upon $\frac{\partial\epsilon}{\partial\alpha}$ prediction method $\frac{q''}{q_\infty}$ 11. Valid only on the plane of symmetry
			$C_{m_\alpha} = -\underbrace{\frac{x_{c.g.}-x'}{\bar{c}'}}_{4.5.2.1}\underbrace{\left[K_N + K_{B(W)} + K_{W(B)}\right]'}_{4.3.1.2}\underbrace{\left(C_{L_\alpha}\right)_e'}_{4.1.3.2}\frac{S_e'}{S'}$ $-\underbrace{\frac{x_{c.g.}-x''}{\bar{c}''}}_{4.5.2.1}\left(\frac{\bar{c}''}{\bar{c}'}\right)\left\{\underbrace{\left[K_{W(B)} + K_{B(W)}\right]''}_{4.3.1.2}\underbrace{\left(C_{L_\alpha}\right)_e''}_{4.1.3.2}\frac{S_e''}{S''}\frac{S''}{S'}\underbrace{\frac{q''}{q_\infty}}_{4.4.1}+\underbrace{\left(C_{L_\alpha}\right)_{W''(v)}}_{4.5.1.1}\right\}$	Eq. 4.5.2.1-f'	Method 2 $b_W/b_H < 1.5$ (same limitations as Method 1 above, omitting those for $\partial\epsilon/\partial\alpha$) $\frac{x_{c.g.}-x'}{\bar{c}'}$ (calculations based on exposed planform geometry) K_N and $\left(C_{L_\alpha}\right)_{W''(v)}$ (based on exposed wing geometry)
		TRANSONIC	(Same as subsonic equations)		Method 1 $b_W/b_H \geq 1.5$ $\frac{x_{c.g.}-x'}{\bar{c}'}$ (calculations based on exposed planform geometry) 1. Single wing with body (i.e., no cruciform or other multipanel arrangements) 2. Straight-tapered wings 3. Symmetric airfoils of conventional thickness distribution 4. Linear-lift range

METHODS SUMMARY

DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
C_{m_α} (Contd.)	WBT (Contd.)	TRANSONIC (Contd.)		$K_{B(W)}$ (based on exposed wing geometry) K_N (based on exposed wing geometry) 5. Bodies of revolution 6. Slender-body theory $\left(C_{L_\alpha}\right)_e'$ and $\left(C_{L_\alpha}\right)_e''$ 7. $\alpha = 0$ $\frac{\partial\epsilon}{\partial\alpha}$ 8. Proportional to C_{L_α} $\frac{q''}{q_\infty}$ 9. Conventional trapezoidal planforms 10. Valid only on the plane of symmetry Method 2 $b_W/b_H < 1.5$ (same limitations as Method 1 above, omitting that for $\partial\epsilon/\partial\alpha$) $\frac{x_{c.g.} - x'}{\bar{c}'}$ (calculations based on exposed planform geometry) K_N, $K_{B(W)}$, and $\left(C_{L_\alpha}\right)_{W''(v)}$ (based on exposed wing geometry)
		SUPERSONIC	(Same as subsonic equations)	Method 1 $b_W/b_H \geqslant 1.5$ $\frac{x_{c.g.} \quad x'}{\bar{c}'}$ (calculations based on exposed planform geometry) 1. Single wing with body (i.e., no cruciform or other multipanel arrangements) 2. Linear-lift range K_N (based on exposed wing geometry) 3. Bodies of revolution 4. Slender-body theory $K_{B(W)}$ (based on exposed wing geometry) $\left(C_{N_\alpha}\right)_e'$ and $\left(C_{N_\alpha}\right)_e''$ 5. Breaks in LE and TE at same spanwise station 6. $M \geqslant 1.4$ for straight-tapered planforms 7. $1.2 \leqslant M \leqslant 3$ for composite planforms 8. $1.0 \leqslant M \leqslant 3$ for curved planforms $\frac{\partial\epsilon}{\partial\alpha}$ 9. Straight-tapered wings 10. Other limitations depend upon $\frac{\partial\epsilon}{\partial\alpha}$ prediction method

METHODS SUMMARY

DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
C_{m_α} (Contd.)	WBT (Contd.)	SUPERSONIC (Contd.)		$\frac{q''}{q_\infty}$ 11. If nonviscous flow field, limited to unswept wings 12. If viscous flow field, valid only on plane of symmetry Method 2 $b_W/b_H < 1.5$ (same limitations as Method 1, omitting those of $\partial\epsilon/\partial\alpha$) $\frac{x_{c.g.} - x'}{\bar{c}'}$ (calculation based on exposed planform geometry) K_N, $K_{B(W)}$, and $\left(C_{L_\alpha}\right)_{W''(v)}$ (based on exposed wing geometry)
C_{L_q}	W	SUBSONIC	$C_{L_q} = \left(\frac{1}{2} + 2\underbrace{\frac{\bar{x}}{\bar{c}}}_{4.1.4.2}\right)\underbrace{C_{L_\alpha}}_{4.1.3.2}$ Eq. 7.1.1.1-a	$\frac{\bar{x}}{\bar{c}}$ 1. $M \leq 0.6$; however, for swept wings with $t/c \leq 0.04$, application to higher Mach numbers is acceptable 2. Linear-lift range C_{L_α} 3. No curved planforms 4. $M \leq 0.8$, $t/c \leq 0.1$, if cranked wings with round LE
		TRANSONIC	(Same as subsonic equation)	$\frac{\bar{x}}{\bar{c}}$ 1. Straight-tapered wings 2. No camber C_{L_α} 3. Conventional thickness distribution 4. $\alpha = 0$
		SUPERSONIC	$C_{L_q} = \underbrace{C_{L_q}'}_{7.1.1.1} + 2\underbrace{\left(\frac{\bar{x}}{\bar{c}}\right)}_{4.1.4.2}\underbrace{C_{N_\alpha}}_{4.1.3.2}$ Eq. 7.1.1.1-c	1. Straight-tapered wings C_{L_q}' (a) Subsonic LE ($\beta \cot \Lambda_{LE} < 1$) 2. Mach lines from TE vertex may not intersect LE 3. Wing-tip Mach lines may not intersect on wings nor intersect opposite wing tips (b) Supersonic LE ($\beta \cot \Lambda_{LE} > 1$) 4. Valid only if Mach lines from LE vertex intersect TE 5. Foremost Mach line from either wing tip may not intersect remote half of wing $\frac{\bar{x}}{\bar{c}}$ 6. Linear-lift range

METHODS SUMMARY

DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
C_{L_q} (Contd.)	W (Contd.)	SUPERSONIC (Contd.)		C_{N_α} 7. $M \geq 1.4$
	WB	SUBSONIC	$$\left(C_{L_q}\right)_{WB} = \underbrace{\left[K_{W(B)} + K_{B(W)}\right]}_{4.3.1.2}\left(\frac{S_e}{S}\right)\left(\frac{\bar{c}_e}{\bar{c}}\right)\underbrace{\left(C_{L_q}\right)_e}_{7.1.1.1} + \underbrace{\left(C_{L_q}\right)_B}_{7.2.1.1}\left(\frac{S_b}{S}\right)\left(\frac{\ell_B}{\bar{c}}\right)$$ Eq. 7.3.1.1-a	Method 1 (body diameter)/(wing span) is small (see 4.3.1.2 Sketch (d)) $\left(C_{L_q}\right)_e$ 1. No curved planforms 2. Linear-lift range 3. $M \leq 0.6$; however, for swept wings with $t/c \leq 0.04$, application to higher Mach numbers is acceptable 4. $M \leq 0.8$, $t/c \leq 0.1$, if cranked wing with round LE $\left(C_{L_q}\right)_B$ 5. Bodies of revolution
			$$\left(C_{L_q}\right)_{WB} = \underbrace{K_{(WB)}}_{4.3.1.2}\underbrace{\left(C_{L_q}\right)_W}_{7.1.1.1} + \underbrace{\left(C_{L_q}\right)_B}_{7.2.1.1}\left(\frac{S_b}{S}\right)\left(\frac{\ell_B}{\bar{c}}\right)$$ Eq. 7.3.1.1-b	Method 2 (body diameter)/(wing span) is large, with delta wing extending entire length of body (see 4.3.1.2 Sketch (c)) (same limitations as Method 1 above)
		TRANSONIC	(Same as subsonic equations)	Method 1 (body diameter)/(wing span) is small (see 4.3.1.2 Sketch (d)) $K_{B(W)}$ (based on exposed wing geometry) $\left(C_{L_q}\right)_e$ 1. Straight-tapered wings 2. No camber 3. Conventional thick Distribution 4. $\alpha = 0$ $\left(C_{L_q}\right)_B$ 5. Bodies of revolution
				Method 2 (body diameter)/(wing span) is large, with delta wing extending entire length of body (see 4.3.1.2 Sketch (c)) (same limitations as Method 1 above)
		SUPERSONIC	(Same as subsonic equations)	Method 1 (body diameter)/(wing span) is small (see 4.3.1.2 Sketch (d)) $K_{B(W)}$ (based on exposed wing geometry) $\left(C_{L_q}\right)_e$ 1. Straight-tapered wings 2. $M \geq 1.4$ 3. Linear-lift range

DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
C_{L_q} (Contd.)	WB (Contd.)	SUPERSONIC (Contd.)		(a) Subsonic LE ($\beta \cot \Lambda_{LE} < 1$) 4. Mach lines from TE vertex may not intersect LE 5. Wing tip Mach lines may not intersect on wing nor intersect opposite wing tips (b) Supersonic LE ($\beta \cot \Lambda_{LE} > 1$) 6. Valid only if Mach lines from LE vertex intersect TE 7. Foremost Mach line from either wing tip may not intersect remote half of wing $\left(C_{L_q}\right)_B$ 8. Bodies of revolution
				Method 2 (body diameter)/(wing span) is large, with delta wing extending entire length of body (see 4.3.1.2 Sketch (c)) (same limitations as Method 1 above)
	WBT	SUBSONIC	$C_{L_q} = \underbrace{\left(C_{L_q}\right)_{WB}}_{7.3.1.1} + 2 \underbrace{\left[K_{W(B)} + K_{B(W)}\right]''}_{4.3.1.2} \left(\frac{S_e''}{S'}\right) \underbrace{\left(\frac{x_{c.g.} - x''}{\bar{c}'}\right)}_{4.5.2.1} \underbrace{\left(\frac{q''}{q_\infty}\right)}_{4.4.1} \underbrace{\left(C_{L_\alpha}\right)_e''}_{4.1.3.2}$ Eq. 7.4.1.1-a	Method 1 $b_W/b_H \geqslant 1.5$ 1. Linear-lift range $\left(C_{L_q}\right)_{WB}$ (based on exposed wing geometry) 2. No curved planforms 3. Bodies of revolution 4. $M \leqslant 0.6$; however, for swept wings with $t/c \leqslant 0.04$, application to higher Mach numbers is acceptable 5. $M \leqslant 0.8$, $t/c \leqslant 0.1$, if cranked wings with round LE $\frac{q''}{q_\infty}$ 6. Valid only on the plane of symmetry $\left(C_{L_\alpha}\right)_e''$ 7. Additional tail limitations are identical to Items 2 and 5 immediately above
			$C_{L_q} = \underbrace{\left(C_{L_q}\right)_{WB}}_{7.3.1.1} + 2 \underbrace{\frac{x_{c.g.} - x''}{\bar{c}'}}_{4.5.2.1} \left\{ \underbrace{\left[K_{W(B)} + K_{B(W)}\right]''}_{4.3.1.2} \left(\frac{S_e''}{S'}\right) \underbrace{\left(\frac{q''}{q_\infty}\right)}_{4.4.1} \underbrace{\left(C_{L_\alpha}\right)_e''}_{4.1.3.2} + \underbrace{\left(C_{L_\alpha}\right)_{W''(v)}}_{7.4.1.1} \right\}$ Eq. 7.4.1.1-b	Method 2 $b_W/b_H < 1.5$ (same limitations as Method 1 above) $\left(C_{L_q}\right)_{WB}$ and $\left(C_{L_\alpha}\right)_{W''(v)}$ (based on exposed wing geometry)
		TRANSONIC	(Same as subsonic equations)	Method 1 $b_W/b_H \geqslant 1.5$ $\left(C_{L_q}\right)_{WB}$ (based on exposed wing geometry) 1. Straight-tapered wings 2. No camber 3. Conventional thickness distribution 4. Bodies of revolution

METHODS SUMMARY

DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
C_{L_q} (Contd.)	WBT (Contd.)	TRANSONIC (Contd.)		5. $\alpha = 0$ $K_{B(W)}$ (based on exposed wing geometry) $\frac{q''}{q_\infty}$ 6. Conventional trapezoidal planforms 7. Valid only on the plane of symmetry $\left(C_{L_\alpha}\right)_e''$ 8. Additional tail limitations are identical to Items 2, 3, and 5 immediately above Method 2 $b_W/b_H < 1.5$ (same limitations as Method 1 above) $\left(C_{L_q}\right)_{WB}$, $K_{B(W)}$, and $\left(C_{L_\alpha}\right)_{W''(v)}$ (based on exposed wing geometry)
		SUPERSONIC	(Same as subsonic equations)	Method 1 $b_W/b_H \geqslant 1.5$ 1. Linear-lift range $\left(C_{L_q}\right)_{WB}$ (based on exposed wing geometry) 2. Straight-tapered wings 3. Bodies of revolution 4. $M \geqslant 1.4$ $K_{B(W)}$ (based on exposed wing geometry) (a) Subsonic LE ($\beta \cot \Lambda_{LE} < 1$) 5. Mach line from TE vertex may not intersect LE 6. Wing-tip Mach lines may not intersect on wing nor intersect opposite wing tips (b) Supersonic LE ($\beta \cot \Lambda_{LE} > 1$) 7. Valid only if Mach lines from LE vertex intersect TE 8. Foremost Mach line from either wing tip may not intersect remote half of wing $\frac{q''}{q_\infty}$ 9. If nonviscous flow field, limited to unswept wings 10. If viscous flow field, valid only on plane of symmetry $\left(C_{L_\alpha}\right)_e''$ 11. Additional tail limitations are identical to Items 1 and 4 immediately above Method 2 $b_W/b_H < 1.5$ (same limitations as Method 1 above) $\left(C_{L_q}\right)_{WB}$, $K_{B(W)}$, and $\left(C_{L_\alpha}\right)_{W''(v)}$ (based on exposed wing geometry)

METHODS SUMMARY

DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
C_{m_q}	W	SUBSONIC	$\left(C_{m_q}\right)_{M\approx 0.2} = -0.7\underbrace{c_{l_\alpha}}_{\substack{4.1.1\\4.1.1.2}}\cos\Lambda_{c/4}\left\{\frac{A\left[\frac{1}{2}\overbrace{\frac{\bar{x}}{c}}^{7.1.1.1}+2\overbrace{\left(\frac{\bar{x}}{c}\right)^2}^{7.1.1.1}\right]}{A+2\cos\Lambda_{c/4}}+\frac{1}{24}\left(\frac{A^3\tan^2\Lambda_{c/4}}{A+6\cos\Lambda_{c/4}}\right)+\frac{1}{8}\right\}$ Eq. 7.1.1.2-a $\left(C_{m_q}\right)_{M>0.2} = \left[\frac{\frac{A^3\tan^2\Lambda_{c/4}}{AB+6\cos\Lambda_{c/4}}+\frac{3}{B}}{\frac{A^3\tan^2\Lambda_{c/4}}{A+6\cos\Lambda_{c/4}}+3}\right]\underbrace{\left(C_{m_q}\right)_{M\approx 0.2}}_{7.1.1.2}$ Eq. 7.1.1.2-b	$\frac{\bar{x}}{c}$ 1. $M \leqslant 0.6$; however, for swept wings with $t/c \leqslant 0.04$, application to higher Mach numbers is acceptable 2. Linear-lift range
		TRANSONIC	$C_{m_q} = \frac{\left(C_{L_\alpha}\right)_M-\left(C_{L_\alpha}\right)_{M_{cr}}}{\underbrace{\left(C_{L_\alpha}\right)_{M=1.2}}_{4.1.3.2}-\underbrace{\left(C_{L_\alpha}\right)_{M_{cr}}}_{4.1.3.2}}\left[\underbrace{\left(C_{m_q}\right)_{M=1.2}}_{7.1.1.2}-\underbrace{\left(C_{m_q}\right)_{M_{cr}}}_{7.1.1.2}\right]+\underbrace{\left(C_{m_q}\right)_{M_{cr}}}_{7.1.1.2}$ Eq. 7.1.1.2-c	C_{L_α} 1. Symmetric airfoils of conventional thickness distribution 2. $\alpha = 0$ $\left(C_{m_q}\right)_{M=1.2}$ 3. Straight-tapered wings (a) Subsonic LE ($\beta\cot\Lambda_{LE} < 1$) 4. Mach line from TE vertex may not intersect LE 5. Wing-tip Mach lines may not intersect on wings nor intersect opposite wing tips (b) Supersonic LE ($\beta\cot\Lambda_{LE} > 1$) 6. Valid only if Mach lines from LE vertex intersect TE 7. Foremost Mach line from either wing tip may not intersect remote half of wing
		SUPERSONIC	$C_{m_q} = \underbrace{C'_{m_q}}_{7.1.1.2}-\underbrace{\left(\frac{\bar{x}}{c}\right)}_{7.1.1.1}\underbrace{C_{L_q}}_{7.1.1.1}$ Eq. 7.1.1.2-d	C_{m_q} (a) Subsonic LE ($\beta\cot\Lambda_{LE} < 1$) 1. Mach line from TE vertex may not intersect LE 2. Wing-tip Mach lines may not intersect on wings nor intersect opposite wing tips (b) Supersonic LE ($\beta\cot\Lambda_{LE} > 1$) 3. Valid only if Mach lines from LE vertex intersect TE 4. Foremost Mach line from either wing tip may not intersect remote half of wing C_{L_q} 5. Straight-tapered wings 6. $M \geqslant 1.4$ 7. Linear-lift range

METHODS SUMMARY

DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
C_{m_q} (Contd.)	WB	SUBSONIC	$\left(C_{m_q}\right)_{WB} = \underbrace{\left[K_{W(B)} + K_{B(W)}\right]}_{4.3.1.2} \left(\frac{S_e}{S}\right)\left(\frac{\bar{c}_e}{\bar{c}}\right)^2 \underbrace{\left(C_{m_q}\right)_e}_{7.1.1.2} + \underbrace{\left(C_{m_q}\right)_B}_{7.2.1.2} \left(\frac{S_b}{S}\right)\left(\frac{\ell_B}{\bar{c}}\right)^2$ Eq. 7.3.1.2-a	Method 1 (body diameter)/(wing span) is small (see 4.3.1.2 Sketch (d)) 1. Linear-lift range $\left(C_{m_q}\right)_e$ 2. $M \leq 0.6$; however, for swept wings with $t/c \leq 0.04$, application to higher Mach numbers is acceptable $\left(C_{m_q}\right)_B$ 3. Bodies of revolution
			$\left(C_{m_q}\right)_{WB} = \underbrace{K_{(WB)}}_{4.3.1.2} \underbrace{\left(C_{m_q}\right)_W}_{7.1.1.2} + \underbrace{\left(C_{m_q}\right)_B}_{7.2.1.2} \left(\frac{S_b}{S}\right)\left(\frac{\ell_B}{\bar{c}}\right)^2$ Eq. 7.3.1.2-b	Method 2 (body diameter)/(wing span) is large with delta wing extending entire length of body (see 4.3.1.2 Sketch (c)) (same limitations as Method 1 above)
		TRANSONIC	(Same as subsonic equations)	Method 1 (body diameter)/(wing span) is small (see 4.3.1.2 Sketch (d)) 1. Linear-lift range $K_{B(W)}$ (based on exposed wing geometry) $\left(C_{m_q}\right)_e$ 2. Straight-tapered wings 3. Symmetric airfoils of conventional thickness distribution 4. $\alpha = 0$ (a) Subsonic LE ($\beta \cot \Lambda_{LE} < 1$) 5. Mach line from TE vertex may not intersect LE 6. Wing-tip Mach lines may not intersect on wings nor intersect opposite wing tips (b) Supersonic LE ($\beta \cot \Lambda_{LE} > 1$) 7. Valid only if Mach lines from LE vertex intersect TE 8. Foremost Mach line from either wing tip may not interesect remote half of wing $\left(C_{m_q}\right)_B$ 9. Bodies of revolution
				Method 2 (body diameter)/(wing span) is large, with delta wing extending entire length of body (see 4.3.1.2 Sketch (c)) (same limitations as Method 1 above)

METHODS SUMMARY

DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
C_{m_q} (Contd.)	WB (Contd.)	SUPERSONIC	(Same as subsonic equations)	Method 1 (body diameter)/(wing span) is small (see 4.3.1.2 Sketch (d)) 1. Linear-lift range $K_{B(W)}$ (based on exposed wing geometry) $\left(C_{m_q}\right)_e$ 2. Straight-tapered wings 3. $M \geqslant 1.4$ (a) Subsonic LE ($\beta \cot \Lambda_{LE} < 1$) 4. Mach line from TE vertex may not intersect LE 5. Wing-tip Mach lines may not intersect on wings nor intersect opposite wing tips (b) Supersonic LE ($\beta \cot \Lambda_{LE} > 1$) 6. Valid only if Mach lines from LE vertex intersect TE 7. Foremost Mach line from either wing tip may not intersect remote half of wing $\left(C_{m_q}\right)_B$ 8. Bodies of revolution
				Method 2 (body diameter)/(wing span) is large with delta wing extending entire length of body (see Sketch (c) 4.3.1.2) (same limitations as Method 1 above)
	WBT	SUBSONIC	$C_{m_q} = \underbrace{\left(C_{m_q}\right)_{WB}}_{7.3.1.2} - 2\underbrace{\left[K_{W(B)} + K_{B(W)}\right]''}_{4.3.1.2}\left(\frac{S_e''}{S'}\right)\underbrace{\left(\frac{x_{c.g.} - x''}{\bar{c}'}\right)^2}_{4.5.2.1}\underbrace{\left(\frac{q''}{q_\infty}\right)}_{4.4.1}\underbrace{\left(C_{L_\alpha}\right)_e''}_{4.1.3.2}$ Eq. 7.4.1.2-a	Method 1 $b_W/b_H \geqslant 1.5$ $\left(C_{m_q}\right)_{WB}$ (based on exposed wing geometry) 1. Bodies of revolution 2. $M \leqslant 0.6$; however, if a swept wing with $t/c \leqslant 0.04$, application to higher Mach numbers is acceptable 3. Linear-lift range $\frac{q''}{q_\infty}$ 4. Valid only on the plane of symmetry $\left(C_{L_\alpha}\right)_e''$ 5. No curved planforms 6. $M \leqslant 0.8$, $t/c \leqslant 0.10$, if cranked planforms with round LE
			$C_{m_q} = \underbrace{\left(C_{m_q}\right)_{WB}}_{7.3.1.2} - 2\underbrace{\left(\frac{x_{c.g.} - x''}{\bar{c}'}\right)^2}_{4.5.2.1}\left\{\underbrace{\left[K_{W(B)} + K_{B(W)}\right]''}_{4.3.1.2}\left(\frac{S_e''}{S'}\right)\underbrace{\left(\frac{q''}{q_\infty}\right)}_{4.4.1}\underbrace{\left(C_{L_\alpha}\right)_e''}_{4.1.3.2} + \underbrace{\left(C_{L_\alpha}\right)_{W''(v)}}_{4.5.1.1}\right\}$ Eq. 7.4.1.2-b	Method 2 $b_W/b_H < 1.5$ (same limitations as Method 1 above) $\left(C_{m_q}\right)_{WB}$ and $\left(C_{L_\alpha}\right)_{W''(v)}$ (based on exposed wing geometry)

METHODS SUMMARY

DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
C_{m_q} (Contd.)	WBT (Contd.)	TRANSONIC	(Same as subsonic equations)	Method 1 $b_W/b_H \geqslant 1.5$ $\left(C_{m_q}\right)_{WB}$ (based on exposed wing geometry) 1. Straight-tapered wings 2. Symmetric airfoils of conventional thickness distribution 3. Bodies of revolution 4. $\alpha = 0$ (a) Subsonic LE ($\beta \cot \Lambda_{LE} < 1$) 5. Mach line from TE vertex may not intersect LE 6. Wing-tip Mach lines may not intersect on wings nor intersect opposite wing tips (b) Supersonic LE ($\beta \cot \Lambda_{LE} > 1$) 7. Valid only if Mach lines from LE vertex intersect TE 8. Foremost Mach line from either wing tip may not intersect remote half of wing $K_{B(W)}$ (based on exposed wing geometry) $\frac{q''}{q_\infty}$ 9. Conventional trapezoidal planforms 10. Valid only on the plane of symmetry $\left(C_{L_\alpha}\right)_e''$ 11. Additional tail limitations are identical to Items 2 and 4 immediately above Method 2 $b_W/b_H < 1.5$ (same limitations as Method 1 above) $\left(C_{m_q}\right)_{WB}$, $K_{B(W)}$, and $\left(C_{L_\alpha}\right)_{W''(v)}$ (based on exposed wing geometry)
		SUPERSONIC	(Same as subsonic equations)	Method 1 $b_W/b_H \geqslant 1.5$ $\left(C_{m_q}\right)_{WB}$ (based on exposed wing geometry) 1. Straight-tapered wings 2. Bodies of revolution 3. $M \geqslant 1.4$ 4. Linear-lift range $K_{B(W)}$ (based on exposed wing geometry) (a) Subsonic LE ($\beta \cot \Lambda_{LE} < 1$) 5. Mach line from TE vertex may not intersect LE 6. Wing-tip Mach lines may not intersect on wings nor intersect opposite wing tips (b) Supersonic LE ($\beta \cot \Lambda_{LE} > 1$) 7. Valid only if Mach lines from LE vertex intersect TE

METHODS SUMMARY

DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
C_{m_q} (Contd.)	WBT (Contd.)	SUPERSONIC (Contd.)		8. Foremost Mach line from either wing tip may not intersect remote half of wing $\frac{q''}{q_\infty}$ 9. If nonviscous flow field, limited to unswept wings 10. If viscous flow field, valid only on the plane of symmetry $\left(C_{L_\alpha}\right)_e''$ 11. Additional tail limitations are identical to Items 3 and 4 immediately above Method 2 $b_W/b_H < 1.5$ (same limitations as Method 1 above) $\left(C_{m_q}\right)_{WB}$, $K_{B(W)}$, and $\left(C_{L_\alpha}\right)_{W''(v)}$ (based on exposed wing geometry)
$C_{L_{\dot\alpha}}$	W	SUBSONIC	$C_{L_{\dot\alpha}} = 1.5 \underbrace{\left(\frac{x_{a.c.}}{c_r}\right)}_{4.1.4.2} \underbrace{C_{L_\alpha}}_{4.1.3.2} + 3 \underbrace{C_L(g)}_{7.1.4.1}$ Eq. 7.1.4.1-a	1. Triangular planforms 2. Linear-lift range $\frac{x_{a.c.}}{c_r}$ 3. $M \leq 0.6$; however, if swept wing with $t/c \leq 0.04$, application to higher Mach numbers is acceptable $C_L(g)$ 4. $0 < \beta A < 4$
		TRANSONIC	(Same as subsonic equation)	1. Triangular planforms 2. $M_{cr} \leq M \leq 1.0$ 3. Linear-lift range $\frac{x_{a.c.}}{c_r}$ 4. No camber C_{L_α} 5. Symmetric airfoils of conventional thickness distribution 6. $\alpha = 0$ $C_L(g)$ 7. $0 < \beta A < 4$
		SUPERSONIC	$C_{L_{\dot\alpha}} = -\frac{\pi A M^2}{2\beta^2}\left[-3\underbrace{G(\beta C)}_{7.1.1.1}\underbrace{F_3(N)}_{7.1.4.1} + 2\underbrace{E''(\beta C)}_{7.1.1.1}\underbrace{F_2(N)}_{7.1.4.1} + \frac{1}{M^2}\underbrace{E''(\beta C)}_{7.1.1.1}\underbrace{F_1(N)}_{7.1.4.1}\right]$ Eq. 7.1.4.1-b	Method 1 1. Straight-tapered wings 2. $\lambda = 0$ 3. Subsonic LE ($\beta \cot \Lambda_{LE} < 1$) 4. Mach line from TE vertex may not intersect LE

METHODS SUMMARY

DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
$C_{L_{\dot{\alpha}}}$ (Contd.)	W (Contd.)	SUPERSONIC (Contd.)		5. Wing-tip Mach lines may not intersect on wings nor intersect opposite wing tips 6. Linear-lift range
			$C_{L_{\dot{\alpha}}} = \frac{M^2}{\beta^2} \underbrace{(C_{L_{\dot{\alpha}}})_1}_{7.1.4.1} - \frac{1}{\beta^2} \underbrace{(C_{L_{\dot{\alpha}}})_2}_{7.1.4.1}$ Eq. 7.1.4.1-c	Method 2 1. Straight-tapered wings 2. Linear-lift range (a) Subsonic LE ($\beta \cot \Lambda_{LE} < 1$) 3. $0.25 \leqslant \lambda \leqslant 1.0$ 4. Mach line from TE vertex may not intersect LE 5. Wing-tip Mach lines may not intersect on wings nor intersect opposite wing tips (b) Supersonic LE ($\beta \cot \Lambda_{LE} > 1$) 6. Valid only if Mach lines from LE vertex intersect TE 7. Foremost Mach line from either wing tip may not intersect the remote half-wing
	WB	SUBSONIC	$(C_{L_{\dot{\alpha}}})_{WB} = \underbrace{\left[K_{W(B)} + K_{B(W)}\right]}_{4.3.1.2} \left(\frac{S_e}{S}\right)\left(\frac{\bar{c}_e}{\bar{c}}\right) \underbrace{(C_{L_{\dot{\alpha}}})_e}_{7.1.4.1} + \underbrace{(C_{L_{\dot{\alpha}}})_B}_{7.2.2.1} \left(\frac{S_b}{S}\right)\left(\frac{\ell_B}{\bar{c}}\right)$ Eq. 7.3.4.1-a	Method 1 (body diameter)/(wing span) is small (see sketch (d) 4.3.1.2) 1. Linear-lift range $(C_{L_{\dot{\alpha}}})_e$ 2. Triangular planforms 3. $0 < \beta A < 4$ 4. $M \leqslant 0.6$; however, if swept wing with $t/c \leqslant 0.04$, application to higher Mach numbers is acceptable $(C_{L_{\dot{\alpha}}})_B$ 5. Bodies of revolution
			$(C_{L_{\dot{\alpha}}})_{WB} = \underbrace{K_{(WB)}}_{4.3.1.2} \underbrace{(C_{L_{\dot{\alpha}}})_W}_{7.1.4.1} + \underbrace{(C_{L_{\dot{\alpha}}})_B}_{7.2.2.1} \left(\frac{S_b}{S}\right)\left(\frac{\ell_B}{\bar{c}}\right)$ Eq. 7.3.4.1-b	Method 2 (body diameter)/(wing span) is large with delta wing extending entire length of body (see Sketch (c) 4.3.1.2) (same limitations as Method 1 above)
		TRANSONIC	(Same as subsonic equations)	Method 1 (body diameter)/(wing span) is small (see Sketch (d) 4.3.1.2) 1. Linear-lift range $K_{B(W)}$ (based on exposed wing geometry) $(C_{L_{\dot{\alpha}}})_e$ 2. Triangular planforms 3. Symmetric airfoils with conventional thickness distribution 4. $0 < \beta A < 4$ 5. $M_{cr} \leqslant M \leqslant 1.0$

METHODS SUMMARY

DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
$C_{L_{\dot{\alpha}}}$ (Contd.)	WB (Contd.)	TRANSONIC (Contd.)		$\left(C_{L_{\dot{\alpha}}}\right)_B$ 6. Bodies of revolution Method 2 (body diameter)/(wing span) is large with delta wing extending entire length of body (see Sketch (c) 4.3.1.2) (same limitations as Method 1 above)
		SUPERSONIC	(Same as subsonic equations)	Method 1 (body diameter)/(wing span) is small (see Sketch (d) 4.3.1.2) 1. Straight-tapered wing 2. Linear-lift range $K_{B(W)}$ (based on exposed wing geometry) $\left(C_{L_{\dot{\alpha}}}\right)_e$ (a) Subsonic LE ($\beta \cot \Lambda_{LE} < 1$) 3. Mach line from TE vertex may not intersect LE 4. Wing-tip Mach lines may not intersect on wings nor intersect opposite wing tips (b) Supersonic LE ($\beta \cot \Lambda_{LE} > 1$) 5. Valid only if Mach lines from LE vertex intersect TE 6. Foremost Mach line from either wing tip may not intersect remote half-wing $\left(C_{L_{\dot{\alpha}}}\right)_B$ 7. Bodies of revolution Method 2 (body diameter)/(wing span) is large with delta wing extending entire length of body (see Sketch (c) 4.3.1.2)(limitations of Method 1)
	WBT	SUBSONIC	$C_{L_{\dot{\alpha}}} = \underbrace{\left(C_{L_{\dot{\alpha}}}\right)_{WB}}_{7.3.4.1} + 2\underbrace{\left[K_{W(B)} + K_{B(W)}\right]''}_{4.3.1.2}\left(\frac{S_e''}{S'}\right)\underbrace{\left(\frac{x_{c.g.} - x''}{\bar{c}'}\right)}_{4.5.2.1}\underbrace{\left(\frac{q''}{q_\infty}\right)}_{4.4.1}\underbrace{\left(\frac{\partial\epsilon}{\partial\alpha}\right)}_{4.4.1}\underbrace{\left(C_{L_\alpha}\right)_e''}_{4.1.3.2}$ Eq. 7.4.4.1-a	Method 1 $b_W/b_H \geqslant 1.5$ 1. Linear-lift range $\left(C_{L_{\dot{\alpha}}}\right)_{WB}$ (based on exposed wing geometry) 2. Triangular planforms 3. $0 < \beta A < 4$ 4. Bodies of revolution 5. $M \leqslant 0.6$; however, if swept wing with $t/c \leqslant 0.04$, application to higher Mach numbers is acceptable $\frac{q''}{q_\infty}$ 6. Valid only on the plane of symmetry $\frac{\partial\epsilon}{\partial\alpha}$ 7. Limitations depend upon $\frac{\partial\epsilon}{\partial\alpha}$ prediction method

METHODS SUMMARY

DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
$C_{L_{\dot{\alpha}}}$ (Contd.)	WBT (Contd.)	SUBSONIC (Contd.)	$C_{L_{\dot{\alpha}}} = \underbrace{\left(C_{L_{\dot{\alpha}}}\right)_{WB}}_{7.3.4.1} - 2\underbrace{\left(\frac{x_{c.g.} - x''}{\bar{c}'}\right)}_{4.5.2.1}\underbrace{\left(C_{L_\alpha}\right)_{W''(v)}}_{4.5.1.1}$ Eq. 7.4.4.1-b	Method 2 $b_W/b_H < 1.5$ (same limitations as Items 1 through 5 immediately above) $\left(C_{L_{\dot{\alpha}}}\right)_{WB}$ and $\left(C_{L_\alpha}\right)_{W''(v)}$ (based on exposed wing geometry)
		TRANSONIC	(Same as subsonic equations)	Method 1 $b_W/b_H \geq 1.5$ 1. Linear-lift range $\left(C_{L_{\dot{\alpha}}}\right)_{WB}$ (based on exposed wing geometry) 2. Triangular planforms 3. Symmetric airfoils with conventional thickness distribution 4. $0 < \beta A < 4$ 5. Bodies of revolution 6. $M_{cr} \leq M \leq 1.0$ $K_{B(W)}$ (based on exposed wing geometry) $\frac{q''}{q_\infty}$ 7. Conventional trapezoidal planforms 8. Valid only on the plane of symmetry $\frac{\partial\epsilon}{\partial\alpha}$ 9. Proportional to C_L $\left(C_{L_\alpha}\right)_e''$ 10. $\alpha = 0$ 11. Additional tail limitation is identical to Item 3 immediately above — — — — — — — — — Method 2 $b_W/b_H < 1.5$ (same limitations as Items 1 through 6 immediately above) $\left(C_{L_{\dot{\alpha}}}\right)_{WB}$ and $\left(C_{L_\alpha}\right)_{W''(v)}$ (based on exposed wing geometry)
		SUPERSONIC	(Same as subsonic equations)	Method 1 $b_W/b_H \geq 1.5$ 1. Straight-tapered wing 2. Linear-lift range $K_{B(W)}$ (based on exposed wing geometry) $\left(C_{L_{\dot{\alpha}}}\right)_{WB}$ (based on exposed wing geometry) 3. Bodies of revolution (a) Subsonic LE ($\beta \cot \Lambda_{LE} < 1$) 4. Mach line from TE vertex may not intersect LE 5. Wing-tip Mach lines may not intersect on wings nor intersect opposite wing tips

METHODS SUMMARY

DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
$C_{L_{\dot{\alpha}}}$ (Contd.)	WBT (Contd.)	SUPERSONIC (Contd.)		(b) Supersonic LE ($\beta \cot \Lambda_{LE} > 1$) 6. Valid only if Mach lines from LE vertex intersect TE 7. Foremost Mach line from either wing tip may not intersect remote half-wing $K_{B(W)}$ (based on exposed wing geometry) $\frac{q''}{q_\infty}$ 8. If nonviscous flow field, limited to unswept wings 9. If viscous flow field, valid only on the plane of symmetry $\frac{\partial \epsilon}{\partial \alpha}$ 10. Straight-tapered wings 11. Other limitations depend upon $\frac{\partial \epsilon}{\partial \alpha}$ prediction method $\left(C_{L_\alpha}\right)_e''$ 12. $M \geqslant 1.4$ Method 2 $b_W/b_H < 1.5$ (same limitations as Items 1 through 7 immediately above) $\left(C_{L_{\dot{\alpha}}}\right)_{WB}$ and $\left(C_{L_\alpha}\right)_{W''(v)}$ (based on exposed wing geometry)
$C_{m_{\dot{\alpha}}}$	W	SUBSONIC	$C_{m_{\dot{\alpha}}} = \underbrace{C_{m_{\dot{\alpha}}}''}_{7.1.4.2} + \left(\frac{x_{c.g.}}{\bar{c}}\right) \underbrace{C_{L_{\dot{\alpha}}}}_{7.1.4.1}$ Eq. 7.1.4.2-a	$C_{L_{\dot{\alpha}}}$ 1. Triangular planforms 2. $0 < \beta A < 4$ 3. $M \leqslant 0.6$; however, if swept wing with $t/c \leqslant 0.04$, application to higher Mach numbers is acceptable 4. Linear-lift range
		TRANSONIC	(Same as subsonic equation)	$C_{L_{\dot{\alpha}}}$ 1. Triangular planforms 2. Symmetric airfoils of conventional thickness distribution 3. $0 < \beta A < 4$ 4. $M_{cr} \leqslant M \leqslant 1.0$ 5. Linear-lift range
		SUPERSONIC	(Same as subsonic equation)	$C_{m_{\dot{\alpha}}}''$ (a) Subsonic LE ($\beta \cot \Lambda_{LE} < 1$) 1. Mach line from TE vertex may not intersect LE 2. Wing-tip Mach lines may not intersect on wings nor intersect opposite wing tips

METHODS SUMMARY

DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
$C_{m_{\dot\alpha}}$ (Contd.)	W (Contd.)	SUPERSONIC (Contd.)		(b) Supersonic LE ($\beta \cot \Lambda_{LE} > 1$) 3. Valid only if Mach lines from LE vertex intersect TE 4. Foremost Mach line from either wing tip may not intersect remote half-wing $C_{L_{\dot\alpha}}$ 5. Straight-tapered wings 6. Linear-lift range
	WB	SUBSONIC	$\left(C_{m_{\dot\alpha}}\right)_{WB} = \underbrace{\left[K_{W(B)} + K_{B(W)}\right]}_{4.3.1.2}\left(\frac{S_e}{S}\right)\left(\frac{\bar{c}_e}{\bar{c}}\right)^2 \underbrace{\left(C_{m_{\dot\alpha}}\right)_e}_{7.1.4.2} + \underbrace{\left(C_{m_{\dot\alpha}}\right)_B}_{7.2.2.2}\left(\frac{S_b}{S}\right)\left(\frac{\ell_B}{\bar{c}}\right)^2$ Eq. 7.3.4.2-a	Method 1 (body diameter)/(wing span) is small (see 4.3.1.2 Sketch (d)) 1. Linear-lift range $\left(C_{m_{\dot\alpha}}\right)_e$ 2. Triangular planforms $\left[\text{due to } \left(C_{L_{\dot\alpha}}\right)_e\right]$ 3. $0 < \beta A < 4$ 4. $M \leqslant 0.6$; however, if swept wing with $t/c \leqslant 0.04$, application to higher Mach numbers is acceptable $\left(C_{m_{\dot\alpha}}\right)_B$ 5. Bodies of revolution
			$\left(C_{m_{\dot\alpha}}\right)_{WB} = \underbrace{K_{(WB)}}_{4.3.1.2} \underbrace{\left(C_{m_{\dot\alpha}}\right)_W}_{7.1.4.2} + \underbrace{\left(C_{m_{\dot\alpha}}\right)_B}_{7.2.2.2}\left(\frac{S_b}{S}\right)\left(\frac{\ell_B}{\bar{c}}\right)^2$ Eq. 7.3.4.2-b	Method 2 (body diameter)/(wing span) is large, with delta wing extending over entire length of body (see 4.3.1.2 Sketch (c)) (same limitations as Method 1 above)
		TRANSONIC	(Same as subsonic equations)	Method 1 (body diameter)/(wing span) is small (see 4.3.1.2 Sketch (d)) 1. Linear-lift range $K_{B(W)}$ (based on exposed wing geometry) $\left(C_{m_{\dot\alpha}}\right)_e$ 2. Triangular planforms $\left[\text{due to } \left(C_{L_{\dot\alpha}}\right)_e\right]$ 3. Symmetric airfoils of conventional thickness distribution 4. $0 < \beta A < 4$ 5. $M_{cr} \leqslant M \leqslant 1.0$ $\left(C_{m_{\dot\alpha}}\right)_B$ 6. Bodies of revolution
				Method 2 (body diameter)/(wing span) is large, with delta wing extending entire length of body (see 4.3.1.2 Sketch (c)) (same limitations as Method 1 above)
		SUPERSONIC	(Same as subsonic equations)	Method 1 (body diameter)/(wing span) is small (see 4.3.1.2 Sketch (d)) 1. Straight-tapered wings 2. Linear-lift range

METHODS SUMMARY

DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
$C_{m_{\dot\alpha}}$ (Contd.)	WB (Contd.)	SUPERSONIC (Contd.)		$K_{B(W)}$ (based on exposed wing geometry) $(C_{m_{\dot\alpha}})_e$ (a) Subsonic LE ($\beta \cot \Lambda_{LE} < 1$) 3. Mach line from TE vertex may not intersect LE 4. Wing-tip Mach lines may not intersect on wings nor intersect opposite wing tips (b) Supersonic LE ($\beta \cot \Lambda_{LE} > 1$) 5. Valid only if Mach lines from LE vertex intersect TE 6. Foremost Mach line from either wing tip may not intersect remote half-wing $(C_{m_{\dot\alpha}})_B$ 7. Bodies of revolution
				Method 2 (body diameter)/(wing span) is large, with delta wing extending entire length of body (see 4.3.1.2 Sketch (c)) (same limitations as Method 1 above)
	WBT	SUBSONIC	$C_{m_{\dot\alpha}} = \underbrace{\left(C_{m_{\dot\alpha}}\right)_{WB}}_{7.3.4.2} - 2\underbrace{\left[K_{W(B)} + K_{B(W)}\right]''}_{4.3.1.2}\left(\frac{S''_e}{S'}\right)\underbrace{\left(\frac{x_{c.g.} - x''}{\bar{c}'}\right)^2}_{4.5.2.1}\underbrace{\left(\frac{q''}{q_\infty}\right)}_{4.4.1}\underbrace{\left(\frac{\partial\epsilon}{\partial\alpha}\right)}_{4.4.1}\underbrace{\left(C_{L_\alpha}\right)''_e}_{4.1.3.2}$ Eq. 7.4.4.2-a	Method 1 $b_W/b_H \geq 1.5$ 1. Linear-lift range $(C_{m_{\dot\alpha}})_{WB}$ (based on exposed wing geometry) 2. Triangular planforms [due to $(C_{L_{\dot\alpha}})_e$] 3. $0 < \beta A < 4$ 4. Bodies of revolution 5. $M \leq 0.6$; however, if swept wing with $t/c \leq 0.04$, application to higher Mach numbers is acceptable $\frac{q''}{q_\infty}$ 6. Valid only on the plane of symmetry $\frac{\partial\epsilon}{\partial\alpha}$ 7. Limitations depend upon $\frac{\partial\epsilon}{\partial\alpha}$ prediction method
			$C_{m_{\dot\alpha}} = \underbrace{\left(C_{m_{\dot\alpha}}\right)_{WB}}_{7.3.4.2} + 2\underbrace{\left(\frac{x_{c.g.} - x''}{\bar{c}'}\right)^2}_{4.5.2.1}\underbrace{\left(C_{L_\alpha}\right)_{W''(v)}}_{4.5.1.1}$ Eq. 7.4.4.2-b	Method 2 $b_W/b_H < 1.5$ (same limitations as Items 1 through 5 immediately above) $(C_{m_{\dot\alpha}})_{WB}$ and $(C_{L_\alpha})_{W''(v)}$ (based on exposed wing geometry)
		TRANSONIC	(Same as subsonic equations)	Method 1 $b_W/b_H \geq 1.5$ 1. Linear-lift range

METHODS SUMMARY

DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
$C_{m_{\dot{\alpha}}}$ (Contd.)	WBT (Contd.)	TRANSONIC (Contd.)		$\left(C_{m_{\dot{\alpha}}}\right)_{WB}$ (based on exposed wing geometry) 2. Triangular planforms $\left[\text{due to } \left(C_{L_{\dot{\alpha}}}\right)_e\right]$ 3. Symmetric airfoils of conventional thickness distribution 4. $0 < \beta A < 1.0$ 5. Bodies of revolution 6. $M_{cr} \leqslant M \leqslant 1.0$ $K_{B(W)}$ (based on exposed wing geometry) $\frac{q''}{q_\infty}$ 7. Conventional trapezoidal planforms 8. Valid only on the plane of symmetry $\frac{\partial\epsilon}{\partial\alpha}$ 9. Proportional to C_{L_α} $\left(C_{L_\alpha}\right)_e''$ 10. $\alpha = 0$ 11. Additional tail limitation is identical to Item 3 immediately above - - - - - - - - - - Method 2 $b_W/b_H < 1.5$ (same limitations as Items 1 through 6 immediately above) $\left(C_{m_{\dot{\alpha}}}\right)_{WB}$ and $\left(C_{L_\alpha}\right)_{W''(v)}$ (based on exposed wing geometry)
		SUPERSONIC	(Same as subsonic equations)	Method 1 $b_W/b_H \geqslant 1.5$ 1. Straight-tapered wings 2. Linear-lift range $\left(C_{m_{\dot{\alpha}}}\right)_{WB}$ (based on exposed wing geometry) 3. Bodies of revolution (a) Subsonic LE ($\beta \cot \Lambda_{LE} < 1$) 4. Mach line from TE vertex may not intersect LE 5. Wing-tip Mach lines may not intersect on wings nor intersect opposite wing tips (b) Supersonic LE ($\beta \cot \Lambda_{LE} > 1$) 6. Valid only if Mach lines from LE vertex intersect TE 7. Foremost Mach line from either wing tip may not intersect the remote half-wing $K_{B(W)}$ (based on exposed wing geometry) $\frac{q''}{q_\infty}$ 8. If nonviscous flow field, limited to unswept wings 9. If viscous flow field, valid only on the plane of symmetry

METHODS SUMMARY

DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
$C_{m_{\dot\alpha}}$ (Contd.)	WBT (Contd.)	SUPERSONIC (Contd.)		$\frac{\partial\epsilon}{\partial\alpha}$ 10. Limitations depend upon $\frac{\partial\epsilon}{\partial\alpha}$ prediction method $\left(C_{N_\alpha}\right)''_e$ 11. $M \geq 1.4$ Method 2 $b_W/b_H \leq 1.5$ (same limitations as Items 1 through 7 immediately above) $\left(C_{m_{\dot\alpha}}\right)_{WB}$ and $\left(C_{L_\alpha}\right)_{W''(v)}$ (based on exposed wing geometry)
C_{Y_β}	W	SUBSONIC (Low Speed)	$C_{Y_\beta} = C_L^2 \left[\frac{6 \tan \Lambda_{c/4} \sin \Lambda_{c/4}}{\pi A (A + 4 \cos \Lambda_{c/4})}\right] \frac{1}{57.3} - 0.0001 \lvert\Gamma\rvert$ Eq. 5.1.1.1-a	1. Constant-chord swept wings 2. Linear-lift range
		(Subcritical)	$\left(\frac{C_{Y_\beta}}{C_L}\right)_M = \frac{A + 4 \cos \Lambda_{c/4}}{AB + 4 \cos \Lambda_{c/4}} \underbrace{\left(\frac{C_{Y_\beta}}{C_L}\right)_{\substack{low\\speed}}}_{5.1.1.1}$ Eq. 5.1.1.1-c	
		TRANSONIC	(No method)	
		SUPERSONIC	$\frac{C_{Y_\beta}}{\alpha^2} = -\frac{8M^2}{\pi A \beta^2} \frac{1}{57.3} - \frac{0.0001 \lvert\Gamma\rvert}{\alpha^2}$ Eq. 5.1.1.1-d, -b	1. Rectangular planforms 2. Mach number and aspect ratio greater than that for which the Mach line from LE of tip section intersects TE of opposite tip section $(A\sqrt{M^2 - 1} \geq 1)$
			$\frac{C_{Y_\beta}}{\alpha^2} = -\frac{\pi}{4} AM^2 \underbrace{Q(\beta C)}_{5.1.1.1} \frac{1}{57.3} - \frac{0.0001 \lvert\Gamma\rvert}{\alpha^2}$ Eq. 5.1.1.1-e, -b	1. Sweptback planforms 2. $\lambda = 0$ 3. Wing is contained within Mach cones springing from apex and TE at center of wing $(\sqrt{M^2 - 1} \cot \Lambda_{LE} \leq 1.0)$
	WB	SUBSONIC	$\left(C_{Y_\beta}\right)_{WB} = \underbrace{K_i}_{5.2.1.1} \underbrace{\left(C_{Y_\beta}\right)_B}_{4.2.1.1} \left(\frac{\text{Body Reference Area}}{S_W}\right) + \underbrace{\left(\Delta C_{Y_\beta}\right)_\Gamma}_{5.1.1.1}$ Eq. 5.2.1.1-a	$\left(C_{Y_\beta}\right)_B$ 1. Bodies of revolution 2. Linear-lift range
		TRANSONIC	(Same as subsonic equation)	(same limitations as subsonic above)
		SUPERSONIC	(Same as subsonic equation)	(same limitations as subsonic above)

METHODS SUMMARY

DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
C_{Y_β} (Contd.)	TB	SUBSONIC	$\left(\Delta C_{Y_\beta}\right)_{V(WBH)} = \underbrace{-k}_{5.3.1.1} \underbrace{\left(C_{L_\alpha}\right)_V}_{4.1.3.2} \underbrace{\left(1+\frac{\partial\sigma}{\partial\beta}\right)\frac{q_V}{q_\infty}}_{5.4.1} \frac{S_V}{S_W}$ Eq. 5.3.1.1-b	Method 1 (vertical panels on plane of symmetry) $\left(C_{L_\alpha}\right)_V$ 1. Straight-tapered planforms
			$\left(\Delta C_{Y_\beta}\right)_{V(WBH)} = -\frac{\left(C_{Y_\beta}\right)_{V(WBH)}}{\underbrace{\left(C_{Y_\beta}\right)_{V_{eff}}}_{5.3.1.1}} \underbrace{\left(C_{Y_\beta}\right)_{V_{eff}}}_{5.3.1.1} \frac{2S_V}{S_W}$ Eq. 5.3.1.1-c	Method 2 (twin vertical panels)
			(a) $\left(\Delta C_{Y_\beta}\right)_p = -\underbrace{K}_{5.3.1.1} \underbrace{\left(C_{L_\alpha}\right)_p}_{4.1.3.2} \frac{S_{P_e}}{S_W}$ Eq. 5.3.1.1-d (b) $\left(\Delta C_{Y_\beta}\right)_{H(B)} = \underbrace{K_{H(B)}}_{5.3.1.1} \underbrace{\left(C_{Y_\beta}\right)_B}_{4.2.1.1} \frac{S_{B_{ref}}}{S_W}$ Eq. 5.3.1.1-e	Method 3 (horizontal tail mounted on body or no horizontal tail) (a) Contribution of vertical panel $\left(C_{L_\alpha}\right)_p$ (based on exposed vertical-tail geometry) 1. No curved planforms 2. $M \leq 0.8$, $t/c \leq 0.1$, if cranked planforms with round LE (b) Contribution of horizontal tail $\left(C_{Y_\beta}\right)_B$ 3. Bodies of revolution 4. Linear-lift range
		TRANSONIC	(No method)	
		SUPERSONIC	(a) $\left(\Delta C_{Y_\beta}\right)_p = -\underbrace{K'}_{5.3.1.1} \underbrace{\left(C_{N_\alpha}\right)_p}_{4.1.3.2} \frac{S_{P_e}}{S_W}$ Eq. 5.3.1.1-f (b) $\left(\Delta C_{Y_\beta}\right)_{H(B)} = \underbrace{K_{H(B)}}_{5.3.1.1} \underbrace{\left(C_{Y_\beta}\right)_B}_{4.2.1.1} \frac{S_{act}}{S_{ext}} \frac{S_{B_{ref}}}{S_W}$ Eq. 5.3.1.1-g	1. Horizontal tail mounted on body, or no horizontal tail 2. Linear-lift range (a) Vertical-tail contribution K' (based on exposed vertical-tail geometry) $\left(C_{N_\alpha}\right)_p$ (based on exposed vertical-tail geometry) 3. Breaks in LE and TE at same spanwise station 4. $M \geq 1.4$ for straight-tapered planforms 5. $1.2 \leq M \leq 3$ for composite planforms 6. $1.0 \leq M \leq 3$ for curved planforms (b) Horizontal-tail contribution $\left(C_{Y_\beta}\right)_B$ 7. Bodies of revolution
		HYPERSONIC		Method 1 1. Horizontal tail mounted on a body 2. Not substantiated above $M = 7$ 3. Linear-lift range

METHODS SUMMARY

DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)		METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
C_{Y_β} (Contd.)	TB (Contd.)	HYPERSONIC (Contd.)	(a) $(\Delta C_{Y_\beta})_p = \underbrace{-K'}_{5.3.1.1}\ \underbrace{(C_{N_\alpha})_p}_{4.1.3.2}\ \frac{S_{P_e}}{S_W}$	Eq. 5.3.1.1-f	(a) Vertical-tail contribution K′ (based on exposed vertical-tail geometry) $(C_{N_\alpha})_p$ 4. M > 3
			(b) $(\Delta C_{Y_\beta})_{H(B)} = \underbrace{K_{H(B)}}_{5.3.1.1}\ \underbrace{(C_{Y_\beta})_B}_{4.2.1.1}\ \frac{S_{act}}{S_{ext}}\ \frac{S_{B_{ref}}}{S_W}$	Eq. 5.3.1.1-g	(b) Horizontal-tail contribution $(C_{Y_\beta})_B$ 5. Bodies of revolution
			$C_p = (\beta \pm \delta)^2 \left(\frac{\gamma + 1}{2} \pm \sqrt{\frac{(\gamma + 1)^2}{4} + \frac{4}{(M^2 - 1)(\beta \pm \delta)^2}}\right)$	Eq. 5.3.1.1-h	Method 2 1. Sharp-edged sections 2. $\delta << 1$
	WBT	SUBSONIC	$C_{Y_\beta} = \underbrace{(C_{Y_\beta})_{WB}}_{5.2.1.1} + \underbrace{(\Delta C_{Y_\beta})_{V(WBH)}}_{5.3.1.1}$	Eq. 5.6.1.1-a	Method 1 (single vertical stabilizer, and horizontal tail at any height or no horizontal tail) 1. Linear-lift range $(C_{Y_\beta})_{WB}$ 2. Bodies of revolution $(\Delta C_{Y_\beta})_{V(WBH)}$ 3. Straight-tapered planforms
			$C_{Y_\beta} = \underbrace{(C_{Y_\beta})_{WB}}_{5.2.1.1} + \underbrace{(\Delta C_{Y_\beta})_{V(WBH)}}_{5.3.1.1}$	Eq. 5.6.1.1-a	Method 2 (twin vertical panels) 1. Linear-lift range $(C_{Y_\beta})_{WB}$ 2. Bodies of revolution
			$C_{Y_\beta} = \underbrace{(C_{Y_\beta})_{WB}}_{5.2.1.1} + \sum_p \underbrace{(\Delta C_{Y_\beta})_p}_{5.3.1.1}$	Eq. 5.6.1.1-b	Method 3 (horizontal tail mounted on body or no horizontal tail) 1. Linear-lift range $(C_{Y_\beta})_{WB}$ 2. Bodies of revolution $(\Delta C_{Y_\beta})_p$ (based on exposed vertical-tail geometry) 3. No curved planforms 4. $M \leq 0.8$, $t/c \leq 0.1$, if cranked planforms with round LE
		TRANSONIC	(No method)		

METHODS SUMMARY

DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
C_{Y_β} (Contd.)	WBT (Contd.)	SUPERSONIC	$C_{Y_\beta} = \underbrace{\left(C_{Y_\beta}\right)_{WB}}_{5.2.1.1} + \sum_p \underbrace{\left(\Delta C_{Y_\beta}\right)_p}_{5.3.1.1}$ Eq. 5.6.1.1-b	1. Horizontal tail mounted on body or no horizontal tail 2. Linear-lift range $\left(C_{Y_\beta}\right)_{WB}$ 3. Bodies of revolution $\left(\Delta C_{Y_\beta}\right)_p$ (based on exposed vertical-tail geometry) 4. Breaks in LE and TE at same spanwise station 5. $M \geq 1.4$ for straight-tapered planforms 6. $1.2 \leq M \leq 3$ for composite planforms 7. $1.0 \leq M \leq 3$ for curved planforms
C_{l_β}	W	SUBSONIC	$C_{l_\beta} = C_L\left[\underbrace{\left(\frac{C_{l_\beta}}{C_L}\right)_{\Lambda_{c/2}}}_{5.1.2.1} \underbrace{K_{M_\Lambda}}_{5.1.2.1} + \underbrace{\left(\frac{C_{l_\beta}}{C_L}\right)_A}_{5.1.2.1}\right] + \Gamma\left(\underbrace{\frac{C_{l_\beta}}{\Gamma}}_{5.1.2.1} \underbrace{K_{M_\Gamma}}_{5.1.2.1}\right) + \theta \tan \Lambda_{c/4} \underbrace{\frac{\Delta C_{l_\beta}}{\theta \tan \Lambda_{c/4}}}_{5.1.2.1}$ Eq. 5.1.2.1-a	1. Straight-tapered wings 2. $A \geq 1.0$ 3. Uniform dihedral (alternate form is available to account for dihedral) 4. $M \leq 0.6$ 5. $-5° \leq \beta \leq +5°$ 6. Linear-lift range
			$C_{l_\beta} = C_L\left[-\frac{1}{57.3}\,\frac{2}{3}\,\frac{1}{A}\right] - \Gamma\left(\frac{A}{6}\right)$ Eq. 5.1.2.1-a'	1. Straight-tapered wings 2. $A < 1.0$ 3. Uniform dihedral 4. $M \leq 0.6$ 5. $-5° \leq \beta \leq +5°$ 6. Linear-lift range
			$\frac{C_{l_\beta}}{C_L} = \underbrace{\frac{1}{\left(C_{L_\alpha}\right)_{total}}}_{5.1.2.1}\left\{\underbrace{\left(C_{L_\alpha}\right)_i}_{4.1.3.2} \frac{S_i}{S_W}\left[\underbrace{\left(\frac{C_{l_\beta}}{C_L}\right)_{\Lambda_{c/2_i}}}_{5.1.2.1} \underbrace{K_{M_{\Lambda_i}}}_{5.1.2.1} + \underbrace{\left(\frac{C_{l_\beta}}{C_L}\right)_{A_i}}_{5.1.2.1}\right]\frac{b_i}{b_W} + \underbrace{\left(C_{L_\alpha}\right)'_o}_{4.1.3.2} \frac{S'_o}{S_W}\left[\underbrace{\left(\frac{C_{l_\beta}}{C_L}\right)_{\Lambda'_{c/2_o}}}_{5.1.2.1} \underbrace{K_{M_{\Lambda'_o}}}_{5.1.2.1} + \underbrace{\left(\frac{C_{l_\beta}}{C_L}\right)_{A'_o}}_{5.1.2.1}\right]\right\}$ Eq. 5.1.2.1-b	1. Double-delta and cranked wings 2. A_i and $A'_o \geq 1.0$ 3. No twist 4. No dihedral 5. $M \leq 0.6$ 6. $-5° \leq \beta \leq +5°$ 7. Linear-lift range $\left(C_{L_\alpha}\right)_i$ and $\left(C_{L_\alpha}\right)'_o$ 8. $t/c \leq 0.10$ if cranked wings with round LE
			$\frac{C_{l_\beta}}{C_L} = \underbrace{\left(\frac{1}{C_{L_\alpha}}\right)_{total}}_{5.1.2.1}\left\{\underbrace{\left(C_{L_\alpha}\right)_i}_{4.1.3.2} \frac{S_i}{S_W}\left[-\frac{1}{57.3}\,\frac{2}{3}\,\frac{1}{A_i}\right]\frac{b_i}{b_W} + \underbrace{\left(C_{L_\alpha}\right)'_o}_{4.1.3.2} \frac{S'_o}{S_W}\left[\underbrace{\left(\frac{C_{l_\beta}}{C_L}\right)_{\Lambda'_{c/2_o}}}_{5.1.2.1} \underbrace{K_{M_{\Lambda'_o}}}_{5.1.2.1} + \underbrace{\left(\frac{C_{l_\beta}}{C_L}\right)_{A'_o}}_{5.1.2.1}\right]\right\}$ Eq. 5.1.2.1-b	1. Dougle-delta and cranked wings 2. A_i and $A'_o < 1.0$ 3. No twist 4. No dihedral 5. $M \leq 0.6$ 6. $-5° \leq \beta \leq +5°$ 7. Linear-lift range $\left(C_{L_\alpha}\right)_i$ and $\left(C_{L_\alpha}\right)'_o$ 8. $t/c \leq 0.1$ if cranked wings with round LE

METHODS SUMMARY

DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
C_{l_β} (Contd.)	W (Contd.)	TRANSONIC	$\frac{C_{l_\beta}}{C_L} = \left\{\left[\frac{\overbrace{\left(\frac{C_{l_\beta}}{C_N}\right)_{M=1.4}}^{5.1.2.1}}{\underbrace{\left(C_{N_\alpha}^2\right)_{M=1.4}}_{4.1.3.2}} - \frac{\overbrace{\left(\frac{C_{l_\beta}}{C_L}\right)_{M=0.6}}^{5.1.2.1}}{\underbrace{\left(C_{L_\alpha}^2\right)_{M=0.6}}_{4.1.3.2}}\right]\left(\frac{M-0.6}{0.8}\right) + \frac{\overbrace{\left(\frac{C_{l_\beta}}{C_L}\right)_{M=0.6}}^{5.1.2.1}}{\underbrace{\left(C_{L_\alpha}^2\right)_{M=0.6}}_{4.1.3.2}}\right\}\underbrace{\left(C_{L_\alpha}^2\right)}_{4.1.3.2}$ Eq. 5.1.2.1-c	1. Straight-tapered wings 2. $-5° \leq \beta \leq +5°$ 3. Linear-lift range $\left(\frac{C_{l_\beta}}{C_N}\right)_{M=1.4}$ 4. Wing tips parallel to free stream 5. No twist 6. Uniform dihedral 7. Foremost Mach line from wing tip may not intersect remote half-wing
		SUPERSONIC	$C_{l_\beta} = -0.061\, C_N \underbrace{\frac{C_{N_\alpha}}{57.3}}_{4.1.3.2}\left[1 + \lambda\left(1 + \Lambda_{LE}\right)\right]\left(1 + \frac{\Lambda_{LE}}{2}\right)\frac{\tan \Lambda_{LE}}{\beta}\left[\frac{M^2 \cos^2 \Lambda_{LE}}{A} + \left(\frac{\tan \Lambda_{LE}}{4}\right)^{4/3}\right]$ $+\, \Gamma \underbrace{\left(\frac{C_{l_\beta}}{\Gamma}\right)}_{5.1.2.1}$ Eq. 5.1.2.1-e	1. Straight-tapered wings 2. No twist 3. Uniform dihedral 4. Linear-lift range C_{N_α} 5. $M \geq 1.4$ $\frac{C_{l_\beta}}{\Gamma}$ 6. Wing tips parallel to free stream 7. Foremost Mach line from wing tip may not intersect remote half-wing
			$\frac{C_{l_\beta}}{C_N} = -0.061\left[\frac{K_L \overbrace{\left(C_{N_\alpha}\right)_g}^{4.1.3.2}\left(\frac{S_g}{S_W}\right)}{57.3}\right]\left(1 + \frac{\Lambda_{LE_g}}{2}\right)\left(\frac{\tan \Lambda_{LE_g}}{\beta}\right)\left[\frac{M^2 \cos^2 \Lambda_{LE_g}}{A_g} + \left(\frac{\tan \Lambda_{LE_g}}{4}\right)^{4/3}\right]\frac{b_g}{b_W}$ $-0.061\left[\frac{\overbrace{K_L}^{4.1.3.2}\ \overbrace{\left(C_{N_\alpha}\right)_{bw}}^{4.1.3.2}\ \frac{S_{bw}}{S_W}}{57.3}\right]\left[1 + \lambda_{bw}\left(1 + \Lambda_{LE_{bw}}\right)\right]$ $\left(1 + \frac{\Lambda_{LE_{bw}}}{2}\right)\left(\frac{\tan \Lambda_{LE_{bw}}}{\beta}\right)\left[\frac{M^2 \cos^2 \Lambda_{LE_{bw}}}{A_{bw}} + \left(\frac{\tan \Lambda_{LE_{bw}}}{4}\right)^{4/3}\right]$ Eq. 5.1.2.1-f	1. Double-delta and cranked wings 2. No twist 3. No dihedral 4. Straight trailing edge 5. Low angles of sideslip 6. Linear-lift range $\left(C_{N_\alpha}\right)_g$ and $\left(C_{N_\alpha}\right)_{bw}$ 7. $1.2 \leq M \leq 3$ 8. $M > 1.4$, if $\Lambda_o > \Lambda_i$ 9. $\Lambda_g < 80°$, if $\Lambda_o > \Lambda_i$
	WB	SUBSONIC	$C_{l_\beta} = C_L\left[\underbrace{\left(\frac{C_{l_\beta}}{C_L}\right)_{\Lambda_{c/2}}}_{5.1.2.1}\underbrace{K_{M_\Lambda}}_{5.1.2.1}\ \underbrace{K_f}_{5.2.2.1} + \underbrace{\left(\frac{C_{l_\beta}}{C_L}\right)_A}_{5.1.2.1}\right] + \Gamma\left[\underbrace{\frac{C_{l_\beta}}{\Gamma}}_{5.1.2.1}\ \underbrace{K_{M_\Gamma}}_{5.1.2.1} + \underbrace{\frac{\Delta C_{l_\beta}}{\Gamma}}_{5.2.2.1}\right] + \underbrace{\left(\Delta C_{l_\beta}\right)_{z_W}}_{5.2.2.1} + \theta \tan \Lambda_{c/4}\underbrace{\left(\frac{\Delta C_{l_\beta}}{\theta \tan \Lambda_{c/4}}\right)}_{5.1.2.1}$ Eq. 5.2.2.1-a	1. Straight-tapered wings 2. Uniform dihedral 3. $M \leq M_{fb}$ 4. $-5° \leq \beta \leq +5°$ 5. Linear-lift range

METHODS SUMMARY

DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
C_{l_β} (Contd.)	WB (Contd.)	SUBSONIC (Contd.)		$\frac{C_{l_\beta}}{C_L}$ 6. $M \leqslant 0.6$
		TRANSONIC	$\frac{C_{l_\beta}}{C_L} = \left\{\left[\frac{\overbrace{\left(\frac{C_{l_\beta}}{C_N}\right)_{M=1.4}}^{5.2.2.1}}{\underbrace{\left(C_{N_\alpha}^{2}\right)_{M=1.4}}_{4.1.3.2}} - \frac{\overbrace{\left(\frac{C_{l_\beta}}{C_L}\right)_{M_{fb}}}^{5.2.2.1}}{\underbrace{\left(C_{L_\alpha}^{2}\right)_{M_{fb}}}_{4.1.3.2}}\right]\left(\frac{M - M_{fb}}{\underbrace{1.4 - M_{fb}}_{4.1.3.2}}\right) + \frac{\overbrace{\left(\frac{C_{l_\beta}}{C_L}\right)_{M_{fb}}}^{5.2.2.1}}{\underbrace{\left(C_{L_\alpha}^{2}\right)_{M_{fb}}}_{4.1.3.2}}\right\}\underbrace{\left(C_{L_\alpha}^{2}\right)_M}_{4.1.3.2}$ Eq. 5.2.2.1-d	1. Straight-tapered wings 2. $M_{fb} \leqslant M \leqslant 1.4$ 3. $-5° \leqslant \beta \leqslant +5°$ $\left(\frac{C_{l_\beta}}{C_N}\right)_{M=1.4}$ 4. Wing tips parallel to free stream 5. Foremost Mach line from wing tip may not intersect remote half-wing $\left(\frac{C_{l_\beta}}{C_L}\right)_{M_{fb}}$ 6. Uniform dihedral 7. Linear-lift range $\left(C_{L_\alpha}\right)_{M_{fb}}$ and $\left(C_{L_\alpha}\right)_M$ 8. Symmetric airfoils of conventional thickness distribution 9. $\alpha \doteq 0$
		SUPERSONIC	$C_{l_\beta} = -0.061\, C_N \underbrace{\frac{C_{N_\alpha}}{57.3}}_{4.1.3.2}\left[1 + \lambda\left(1 + \Lambda_{LE}\right)\right]\left(1 + \frac{\Lambda_{LE}}{2}\right)\left(\frac{\tan \Lambda_{LE}}{\beta}\right)\left[\frac{M^2 \cos^2 \Lambda_{LE}}{A} + \left(\frac{\tan \Lambda_{LE}}{4}\right)^{4/3}\right]$ $+ \Gamma\left[\underbrace{\frac{C_{l_\beta}}{\Gamma}}_{5.1.2.1} + \underbrace{\frac{\Delta C_{l_\beta}}{\Gamma}}_{5.2.2.1}\right] + \underbrace{\left(\Delta C_{l_\beta}\right)_{z_W}}_{5.2.2.1}$ Eq. 5.2.2.1-e	1. Straight-tapered wings 2. $M \geqslant 1.4$ 3. Linear-lift range $\frac{C_{l_\beta}}{\Gamma}$ 4. Wing tips parallel to free stream 5. Foremost Mach line from wing tip may not intersect remote half-wing 6. Supersonic TE
	TB	SUBSONIC	$\left(\Delta C_{l_\beta}\right)_p = \underbrace{\left(\Delta C_{Y_\beta}\right)_p}_{5.3.1.1} \frac{z_p \cos \alpha - \ell_p \sin \alpha}{b_W}$ Eq. 5.3.2.1-a	$\left(\Delta C_{Y_\beta}\right)_p$ (based on exposed vertical-tail geometry for $\left(\Delta C_{Y_\beta}\right)_p$ Method 3) 1. Limitations depend upon $\left(\Delta C_{Y_\beta}\right)_p$ prediction method
		TRANSONIC	(No method)	
		SUPERSONIC	(Same as subsonic equation)	1. Horizontal tail mounted on body or no horizontal tail $\left(\Delta C_{Y_\beta}\right)_p$ (based on exposed vertical-tail geometry) 2. Breaks in LE and TE must be at same spanwise station

METHODS SUMMARY

DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
C_{l_β} (Contd.)	TB (Contd.)	SUPERSONIC (Contd.)		3. Bodies of revolution 4. $M \geq 1.4$ for straight-tapered planforms 5. $1.2 \leq M \leq 3$ for composite planforms 6. $1.0 \leq M \leq 3$ for curved planforms 7. Linear-lift range
		HYPERSONIC	$\left(\Delta C_{l_\beta}\right)_p = \underbrace{\left(\Delta C_{Y_\beta}\right)_p}_{5.3.1.1} \dfrac{z_p \cos\alpha - \ell_p \sin\alpha}{b_W}$ Eq. 5.3.2.1-a	Method 1 1. Horizontal tail mounted on body or no horizontal tail 2. $M < 7$ $\left(\Delta C_{Y_\beta}\right)_p$ (based on exposed vertical-panel geometry) 3. $M \geq 1.4$ for straight-tapered planforms 4. $1.2 \leq M \leq 3$ for composite planforms 5. $1.0 \leq M \leq 3$ for curved planforms 6. Linear-lift range z_p and ℓ_p (based on exposed vertical-panel geometry) Method 2 1. Horizontal tail mounted on body or no horizontal tail $\left(\Delta C_{Y_\beta}\right)_p$ (based on exposed vertical-panel geometry) 2. Sharp-edge sections 3. $\delta << 1$ z_p and ℓ_p (based on exposed vertical-panel geometry) Method 3 1. Horizontal tail mounted on body or no horizontal tail 2. Upper range of hypersonic Mach numbers $\left(\Delta C_{Y_\beta}\right)_p$ (based on exposed vertical-panel geometry) z_p and ℓ_p (based on exposed vertical-panel geometry)
	WBT	SUBSONIC	$C_{l_\beta} = \underbrace{\left(C_{l_\beta}\right)_{WB}}_{5.2.2.1} + \sum_p \left\{ \underbrace{\left(\Delta C_{Y_\beta}\right)_p}_{5.3.1.1} \left[\dfrac{z_p \cos\alpha - \ell_p \sin\alpha}{b_W}\right] \right\}$ Eq. 5.6.2.1-a	1. Linear-lift range $\left(C_{l_\beta}\right)_{WB}$ 2. Straight-tapered wings 3. Uniform dihedral 4. $M \leq M_{fb}$ 5. $M \leq 0.6$ 6. $-5° \leq \beta \leq +5°$ $\left(\Delta C_{Y_\beta}\right)_p$ (based on exposed vertical-tail geometry for $\left(\Delta C_{Y_\beta}\right)_p$ Method 3)
		TRANSONIC	(No method)	

METHODS SUMMARY

DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
C_{l_β} (Contd.)	WBT (Contd.)	SUPERSONIC	(Same as subsonic equation)	1. Linear-lift range $\left(C_{l_\beta}\right)_{WB}$ 2. Straight-tapered wings 3. Wing tips parallel to free stream 4. Foremost Mach line from wing tip may not intersect remote half-wing 5 $M \geqslant 1.4$ $\left(C_{Y_\beta}\right)_p$ (based on exposed vertical-tail geometry) 6. Additional tail limitation is identical to Item 5 immediately above
C_{n_β}	W	SUBSONIC (Low Speed)	$\frac{C_{n_\beta}}{C_L^2} = \frac{1}{57.3}\left[\frac{1}{4\pi A} - \frac{\tan \Lambda_{c/4}}{\pi A(A + 4\cos\Lambda_{c/4})}\left(\cos\Lambda_{c/4} - \frac{A}{2} - \frac{A^2}{8\cos\Lambda_{c/4}} + 6\,\frac{\bar{x}}{\bar{c}}\,\frac{\sin\Lambda_{c/4}}{A}\right)\right]$ Eq. 5.1.3.1-a	1. Linear-lift range
		(Subcritical)	$\left(\frac{C_{n_\beta}}{C_L^2}\right)_M = \left(\frac{A + 4\cos\Lambda_{c/4}}{AB + 4\cos\Lambda_{c/4}}\right)\left(\frac{A^2B^2 + 4AB\cos\Lambda_{c/4} - 8\cos^2\Lambda_{c/4}}{A^2 + 4A\cos\Lambda_{c/4} - 8\cos^2\Lambda_{c/4}}\right)\underbrace{\left(\frac{C_{n_\beta}}{C_L^2}\right)_{\substack{\text{low}\\\text{speed}}}}_{5.1.3.1}$ Eq. 5.1.3.1-b	
		TRANSONIC	(No method)	
		SUPERSONIC	$\frac{C_{n_\beta}}{\alpha^2} = \frac{1}{\pi A^2\beta^2}\left[\frac{4M^2}{3} + 8M^2\,\frac{x}{\bar{c}} - \pi\left\{\frac{A(1-\beta^2)}{\beta}\;\frac{3+\beta^2}{3\beta^2}\right\}\right]\frac{1}{57.3}$ Eq. 5.1.3.1-c	1. Rectangular planform 2. $A\sqrt{M^2 - 1} \geqslant 1.0$ (Mach number and aspect ratio greater than those for which Mach line from LE of tip section intersects TE of opposite tip section)
			$\frac{C_{n_\beta}}{\alpha^2} = \frac{\pi}{3}\left[\underbrace{E''(\beta C)}_{7.1.1.1}\;\underbrace{F_9(N)}_{5.1.3.1} + \left(\frac{A^2}{16}\;\underbrace{F_{11}(N)}_{7.1.1.2} + \frac{x}{\bar{c}}\right)M^2\;\underbrace{Q(\beta C)}_{5.1.1.1}\right]\frac{1}{57.3}$ Eq. 5.1.3.1-d	1. $\lambda = 0$ 2. $\sqrt{M^2 - 1}\cot\Lambda_{LE} \leqslant 1.0$ (Mach number and aspect ratio for which wing lies within Mach cones springing from apex and TE at center of wing)
	WB	ALL SPEEDS	$\left(C_{n_\beta}\right)_{WB} = -\underbrace{K_N}_{5.2.3.1}\;\underbrace{K_{R_l}}_{5.2.3.1}\;\frac{S_{B_S}}{S_W}\;\frac{l_B}{b}$ Eq. 5.2.3.1-a	1. Linear-lift range
	TB	SUBSONIC	$\left(\Delta C_{n_\beta}\right)_p = -\underbrace{\left(\Delta C_{Y_\beta}\right)_p}_{5.3.1.1}\;\frac{l_p}{b_W}$ Eq. 5.3.3.1-a	Method 1 $\left(\Delta C_{Y_\beta}\right)_p$ (based on exposed vertical-tail geometry for $\left(\Delta C_{Y_\beta}\right)_p$ Method 3) 1. Limitations depend upon $\left(\Delta C_{Y_\beta}\right)_p$ prediction method

METHODS SUMMARY

DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
C_{n_β} (Contd.)	TB (Contd.)	SUBSONIC (Contd.)	$\left(\Delta C_{n_\beta}\right)_p = -\underbrace{\left(\Delta C_{Y_\beta}\right)_p}_{5.3.1.1} \dfrac{\ell_p + \overbrace{(x_{a.c.})_p}^{4.1.4.2}}{b_W}$ Eq. 5.3.3.1-b	Method 2 $\left(\Delta C_{Y_\beta}\right)_p$ (based on exposed vertical-tail geometry for $\left(\Delta C_{Y_\beta}\right)_p$ Method 3) 1. Limitations depend upon $\left(\Delta C_{Y_\beta}\right)_p$ prediction method $(x_{a.c.})_p$ 2. $M \leqslant 0.6$; however, if swept planforms with $t/c \leqslant 0.04$, application to higher Mach numbers is acceptable 3. Linear-lift range
		TRANSONIC	(No method)	
		SUPERSONIC	(Same as subsonic equations)	Method 1 1. Horizontal tail mounted on body, or no horizontal tail $\left(\Delta C_{Y_\beta}\right)_p$ (based on exposed vertical-tail geometry) 2. Breaks in LE and TE at same spanwise station 3. Bodies of revolution 4. $M \geqslant 1.4$ for straight-tapered planforms 5. $1.2 \leqslant M \leqslant 3$ for composite planforms 6. $1.0 \leqslant M \leqslant 3$ for curved planforms 7. Linear-lift range Method 2 (same limitations as Method 1 above) $\left(\Delta C_{Y_\beta}\right)_p$ (based on exposed vertical-tail geometry)
	WBT	SUBSONIC	$C_{n_\beta} = \underbrace{\left(C_{n_\beta}\right)_{WB}}_{5.2.3.1} + \sum_p \left[-\underbrace{\left(\Delta C_{Y_\beta}\right)_p}_{5.3.1.1} \dfrac{\ell_p}{b_w}\right]$ Eq. 5.6.3.1-a	Method 1 $\left(C_{n_\beta}\right)_{WB}$ 1. Linear-lift range $\left(\Delta C_{Y_\beta}\right)_p$ (based on exposed vertical-tail geometry for $\left(\Delta C_{Y_\beta}\right)_p$ Method 3) 2. Limitations depend upon $\left(\Delta C_{Y_\beta}\right)_p$ prediction method
			$C_{n_\beta} = \underbrace{\left(C_{n_\beta}\right)_{WB}}_{5.2.3.1} + \sum_p \left[-\underbrace{\left(\Delta C_{Y_\beta}\right)_p}_{5.3.1.1} \left(\dfrac{\ell_p + (x_{a.c.})_p}{b_W}\right)\right]$ Eq. 5.6.3.1-b	Method 2 $\left(C_{n_\beta}\right)_{WB}$ 1. Linear-lift range $\left(\Delta C_{Y_\beta}\right)_p$ (based on exposed vertical-tail geometry for $\left(\Delta C_{Y_\beta}\right)_p$ Method 3) 2. Limitations depend upon $\left(\Delta C_{Y_\beta}\right)_p$ prediction method

METHODS SUMMARY

DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
C_{n_β} (Contd.)	WBT (Contd.)	SUBSONIC (Contd.)		$(x_{a.c.})_p$ 3. $M \leq 0.6$; however, if swept planforms with $t/c \leq 0.04$, application to higher Mach numbers is acceptable 4. Linear-lift range
		TRANSONIC	(No method)	
		SUPERSONIC	(Same as subsonic equations)	Method 1 1. Horizontal tail mounted on body or no horizontal tail $\left(C_{n_\beta}\right)_{WB}$ 2. Linear-lift range $\left(\Delta C_{Y_\beta}\right)_p$ (based on exposed vertical-tail geometry) 3. Breaks in LE and TE at same spanwise station 4. Bodies of revolution 5. $M \geq 1.4$ for straight-tapered planforms 6. $1.2 \leq M \leq 3$ for composite planforms 7. $1.0 \leq M \leq 3$ for curved planforms 8. Linear-lift range Method 2 (same limitations as Method 1 above) $\left(\Delta C_{Y_\beta}\right)_p$ (based on vertical-tail geometry)
C_{Y_p}	W	SUBSONIC	$C_{Y_p} = \underbrace{K}_{7.1.2.1} \left[\underbrace{\left(\frac{C_{Y_p}}{C_L}\right)_{\substack{C_L=0\\M}}}_{7.1.2.1} C_L \right] + \underbrace{\left(\Delta C_{Y_p}\right)_\Gamma}_{7.1.2.1}$ Eq. 7.1.2.1-a	1. $\alpha \leq \alpha_{stall}$ K 2. Test data for lift and drag $\left(\frac{C_{Y_p}}{C_L}\right)_{\substack{C_L=0\\M}}$ 3. $M \leq M_{cr}$
		TRANSONIC	(No method)	
		SUPERSONIC	Figure 7.1.2.1-10	1. Thin, sweptback, tapered wings with streamwise tips 2. Low lift coefficients
	WB	SUBSONIC	$C_{Y_p} = \underbrace{K}_{7.1.2.1} \left[\underbrace{\left(\frac{C_{Y_p}}{C_L}\right)_{\substack{C_L=0\\M}}}_{7.1.2.1} C_L \right] + \underbrace{\left(\Delta C_{Y_p}\right)_\Gamma}_{7.1.2.1}$ Eq. 7.1.2.1-a	1. (Body diameter)/(wing span) ≤ 0.3 2. $\alpha \leq \alpha_{stall}$ K 3. Test data for lift and drag

METHODS SUMMARY

DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
C_{Y_p} (Contd.)	WB (Contd.)	SUBSONIC (Contd.)		$\left(\frac{C_{Y_p}}{C_L}\right)_{C_L=0}$ M 4. $M \leq M_{cr}$
		TRANSONIC	(No method)	
		SUPERSONIC	Figure 7.1.2.1-10	1. Thin, sweptback, tapered wings with streamwise tips 2. (Body diameter)/(wing span) ≤ 0.3 3. Low lift coefficients
	WBT	SUBSONIC	$C_{Y_p} = \underbrace{\left(C_{Y_p}\right)_{WB}}_{7.3.2.1} + 2\left[\frac{z - z_p}{b_W}\right]\underbrace{\left(\Delta C_{Y_\beta}\right)_{V(WBH)}}_{5.3.1.1}$ Eq. 7.4.2.1-a	Method 1 (conventionally located vertical tails) $\left(C_{Y_p}\right)_{WB}$ 1. (body diameter)/(wing span) ≤ 0.3 2. $\alpha \leq \alpha_{stall}$ 3. Test data for lift and drag 4. $M \leq M_{cr}$ $\left(\Delta C_{Y_\beta}\right)_{V(WBH)}$ 5. Additional or identical tail limitations depend on $\left(\Delta C_{Y_\beta}\right)_{V(WBH)}$ prediction method
			$C_{Y_p} = \underbrace{\left(C_{Y_p}\right)_{WB}}_{7.3.2.1} + \left[\frac{2z - z_p}{b_W}\right]\underbrace{\left(\Delta C_{Y_\beta}\right)_{V(WBH)}}_{5.3.1.1}$ Eq. 7.4.2.1-c	Method 2 (vertical tail directly above, or above and slightly behind wing) (same limitations as Method 1 above)
		TRANSONIC	(No method)	
		SUPERSONIC	(No method)	
C_{l_p}	W	SUBSONIC	$C_{l_p} = \underbrace{\left(\frac{\beta C_{l_p}}{\kappa}\right)_{C_L=0}}_{7.1.2.2}\underbrace{\left(\frac{\kappa}{\beta}\right)}_{4.1.1.2}\frac{\overbrace{\left(C_{L_\alpha}\right)_{C_L}}^{4.1.3.3}}{\underbrace{\left(C_{L_\alpha}\right)_{C_L=0}}_{4.1.3.2}}\frac{\left(C_{l_p}\right)_\Gamma}{\underbrace{\left(C_{l_p}\right)_{\Gamma=0}}_{7.1.2.2}} + \underbrace{\left(\Delta C_{l_p}\right)_{drag}}_{7.1.2.2}$ Eq. 7.1.2.2-a	1. $M \leq M_{cr}$ $\left(C_{L_\alpha}\right)_{C_L}$ 2. Symmetric airfoils 3. $1 \times 10^6 \leq R_\ell \leq 15 \times 10^6$ based on MAC $\left(C_{L_\alpha}\right)_{C_L=0}$ 4. Straight-tapered wings
		TRANSONIC	(No method)	

METHODS SUMMARY

DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
C_{l_p} (Contd.)	W (Contd.)	SUPERSONIC	$C_{l_p} = \underbrace{\left[\frac{(C_{l_p})_{theory}}{A}\right]}_{7.1.2.2} A \underbrace{\frac{C_{l_p}}{(C_{l_p})_{theory}}}_{7.1.2.2}$ Eq. 7.1.2.2-d	1. Straight-tapered wings 2. Wing tips parallel to free stream 3. Foremost Mach line from tip may not intersect remote half-wing 4. Supersonic TE
	WB	SUBSONIC	$C_{l_p} = \underbrace{\left(\frac{\beta C_{l_p}}{\kappa}\right)_{C_L=0}}_{7.1.2.2} \underbrace{\left(\frac{\kappa}{\beta}\right)}_{4.1.1.2} \underbrace{\frac{\overbrace{(C_{L_\alpha})_{C_L}}^{4.1.3.3}}{(C_{L_\alpha})_{C_L=0}}}_{4.1.3.2} \underbrace{\frac{(C_{l_p})_\Gamma}{(C_{l_p})_{\Gamma=0}}}_{7.1.2.2} + \underbrace{(\Delta C_{l_p})_{drag}}_{7.1.2.2}$ Eq. 7.1.2.2-a	1. (Body diameter)/(wing span) $\leqslant$ 0.3 2. $M \leqslant M_{cr}$ $(C_{L_\alpha})_{C_L}$ 3. Symmetric airfoils 4. $1 \times 10^6 \leqslant R_\ell \leqslant 15 \times 10^6$ based on MAC $(C_{L_\alpha})_{C_L=0}$ 5. Straight-tapered wings
		TRANSONIC	(No method)	
		SUPERSONIC	$(C_{l_p})_{WB} = \underbrace{(C_{l_p})_W}_{7.1.2.2} \underbrace{\frac{C_{l_p}}{(C_{l_p})_{d/b=0}}}_{7.3.2.2}$ Eq. 7.3.2.2-a	1. Straight-tapered wings. If (body diameter)/(wing span) > 0.3, valid only for triangular wings) 2. Cylindrical or nearly cylindrical bodies $(C_{l_p})_W$ 3. Wing tips parallel to free stream 4. Foremost Mach line from tip may not intersect remote half-wing 5. Supersonic TE
	WBT	SUBSONIC	$C_{l_p} = \underbrace{(C_{l_p})_{WB}}_{7.1.2.2} + 0.5 \underbrace{(C_{l_p})_H}_{7.1.2.2} \left(\frac{S_H}{S_W}\right)\left(\frac{b_H}{b_W}\right)^2 + \left\lvert 2\left(\frac{z}{b_W}\right)\left[\frac{z - z_p}{b_W}\right]\right\rvert \underbrace{(\Delta C_{Y_\beta})_{V(WBH)}}_{5.3.1.1}$ Eq. 7.4.2.2-a	Method 1 (conventionally located vertical tails) $(C_{l_p})_{WB}$ and $(C_{l_p})_H$ 1. Straight-tapered planforms 2. Symmetric airfoils 3. (Body diameter)/(wing span) $\leqslant$ 0.3 4. $M \leqslant M_{cr}$ 5. $1 \times 10^6 \leqslant R_\ell \leqslant 15 \times 10^6$ based on MAC $(\Delta C_{Y_\beta})_{V(WBH)}$ 6. Additional or identical tail limitations depend on $(\Delta C_{Y_\beta})_{V(WBH)}$ prediction method

METHODS SUMMARY

DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
C_{l_p} (Contd.)	WBT (Contd.)	SUBSONIC (Contd.)	$C_{l_p} = \underbrace{\left(C_{l_p}\right)_{WB}}_{7.1.2.2} + 0.5\underbrace{\left(C_{l_p}\right)_H}_{7.1.2.2}\left(\frac{S_H}{S_W}\right)\left(\frac{b_H}{b_W}\right)^2 + \left\lvert\frac{z}{b_W}\left[\frac{2z - z_p}{b_W}\right]\right\rvert\underbrace{\left(\Delta C_{Y_\beta}\right)_{V(WBH)}}_{5.3.1.1}$ Eq. 7.4.2.2-b	Method 2 (vertical tail located directly above, or above and slightly behind wing) (same limitations as Method 1 above)
		TRANSONIC	(No method)	
		SUPERSONIC	(No method)	
C_{n_p}	W	SUBSONIC	$C_{n_p} = -\underbrace{C_{l_p}}_{7.1.2.2}\tan\alpha - \underbrace{K}_{7.1.2.3}\left[-\underbrace{C_{l_p}}_{7.1.2.2}\tan\alpha - \underbrace{\left(\frac{C_{n_p}}{C_L}\right)_{\substack{C_L=0\\M}}}_{7.1.2.3}C_L\right] + \underbrace{\left(\frac{\Delta C_{n_p}}{\theta}\right)}_{7.1.2.3}\theta + \underbrace{\left[\frac{\Delta C_{n_p}}{\left(\frac{\partial\alpha}{\partial\delta}\right)_f\delta_f}\right]}_{7.1.2.3}\underbrace{\left(\frac{\partial\alpha}{\partial\delta}\right)_f}_{6.1.1.1}\delta_f$ Eq. 7.1.2.3-a	1. $M \leq M_{cr}$ 2. Lift coefficients up to stall (if reliable lift and drag data are available) C_{l_p} 3. Straight-tapered wings 4. Symmetric airfoils 5. $1 \times 10^6 \leq R_\ell \leq 15 \times 10^6$ based on MAC
		TRANSONIC	(No method)	
		SUPERSONIC	$\frac{C_{n_p}}{\alpha} = \underbrace{\left(\frac{C_{n_p}}{\alpha}\right)_{\substack{\text{body}\\\text{axis}}}}_{7.1.2.3} + \frac{2x_{c.g.}}{A(1+\lambda)}\underbrace{\left(\frac{C_{Y_p}}{\alpha}\right)}_{7.1.2.1} - \left(\underbrace{C_{l_p}}_{7.1.2.2} - \underbrace{C_{n_r}}_{7.1.3.3}\right)$ Eq. 7.1.2.3-e	Method 1 Subsonic leading edges ($\beta \cot \Lambda_{LE} < 1$) 1. Straight-tapered wings 2. Streamwise wing tips 3. Low lift coefficients C_{l_p} 4. Foremost Mach line from tip may not intersect remote half-wing 5. Supersonic TE
			$\frac{C_{n_p}}{\alpha} = \underbrace{\left(\frac{C_{n_p}}{\alpha}\right)_{\substack{\text{body}\\\text{axis}}}}_{7.1.2.3} + \left[\frac{2x_{c.g.}}{A(1+\lambda)} - \frac{1}{2}\tan\Lambda_{LE}\right]\underbrace{\frac{C_{Y_p}}{\alpha}}_{7.1.2.1} - \underbrace{C_{l_p}}_{7.1.2.2}$ Eq. 7.1.2.3-g	Method 2 Supersonic leading edges ($\beta \cot \Lambda_{LE} > 1$) (same limitations as Method 1 above)
	WB	SUBSONIC	$C_{n_p} = -\underbrace{C_{l_p}}_{7.1.2.2}\tan\alpha - \underbrace{K}_{7.1.2.3}\left[-\underbrace{C_{l_p}}_{7.1.2.2}\tan\alpha - \underbrace{\left(\frac{C_{n_p}}{C_L}\right)_{\substack{C_L=0\\M}}}_{7.1.2.3}C_L\right]$ Eq. 7.1.2.3-a $+\underbrace{\left(\frac{\Delta C_{n_p}}{\theta}\right)}_{7.1.2.3}\theta + \underbrace{\left[\frac{\Delta C_{n_p}}{\left(\frac{\partial\alpha}{\partial\delta}\right)_f\delta_f}\right]}_{7.1.2.3}\underbrace{\left(\frac{\partial\alpha}{\partial\delta}\right)_f}_{6.1.1.1}\delta_f$	1. (Body diameter)/(wing span) ≤ 0.3 2. $M \leq M_{cr}$ 3. Lift coefficients up to stall (if reliable lift and drag data are available) C_{l_p} 4. Straight-tapered wings 5. Symmetric airfoils 6. $1 \times 10^6 \leq R_\ell \leq 15 \times 10^6$ based on MAC

METHODS SUMMARY

DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
C_{n_p} (Contd.)	WB (Contd.)	TRANSONIC	(No method)	
		SUPERSONIC	$\frac{C_{n_p}}{\alpha} = \underbrace{\left(\frac{C_{n_p}}{\alpha}\right)_{\substack{body\\axis}}}_{7.1.2.3} + \frac{2x_{c.g.}}{A(1+\lambda)}\underbrace{\left(\frac{C_{Y_p}}{\alpha}\right)}_{7.1.2.1} - \left(\underbrace{C_{l_p}}_{7.1.2.2} - \underbrace{C_{n_r}}_{7.1.3.3}\right)$ Eq. 7.1.2.3-e	Method 1 Subsonic leading edges ($\beta \cot \Lambda_{LE} < 1$) 1. Straight-tapered wings 2. Streamwise wing tips 3. (Body diameter)/(wing span) ≤ 0.3 4. Lift coefficients where C_{n_p} varies linearly with C_L C_{l_p} 5. Foremost Mach line from tip may not intersect remote half-wing 6. Supersonic TE
			$\frac{C_{n_p}}{\alpha} = \underbrace{\left(\frac{C_{n_p}}{\alpha}\right)_{\substack{body\\axis}}}_{7.1.2.3} + \left[\frac{2x_{c.g.}}{A(1+\lambda)} - \frac{1}{2}\tan\Lambda_{LE}\right]\underbrace{\frac{C_{Y_p}}{\alpha}}_{7.1.2.1} - \underbrace{C_{l_p}}_{7.1.2.2}$ Eq. 7.1.2.3-g	Method 2 Supersonic leading edges ($\beta \cot \Lambda_{LE} > 1$) (same limitations as Method 1 above)
	WBT	SUBSONIC	$C_{n_p} = \underbrace{\left(C_{n_p}\right)_{WB}}_{7.3.2.3} - \frac{2}{b_W}\left(\ell_p \cos\alpha + z_p \sin\alpha\right)\left[\frac{z - z_p}{b_W}\right]\underbrace{\left(\Delta C_{Y_\beta}\right)_{V(WBH)}}_{5.3.1.1}$ Eq. 7.4.2.3-a	Method 1 (conventionally located vertical tails) $\left(C_{n_p}\right)_{WB}$ 1. Straight-tapered wings 2. Symmetric airfoils 3. (Body diameter)/(wing span) ≤ 0.3 4. $M \leq M_{cr}$ 5. $1 \times 10^6 \leq R_\ell \leq 15 \times 10^6$ based on MAC 6. Lift coefficients up to stall (if reliable lift and drag data are available) $\left(\Delta C_{Y_\beta}\right)_{V(WBH)}$ 7. Additional or identical tail limitations depend on $\left(\Delta C_{Y_\beta}\right)_{V(WBH)}$ prediction method
			$C_{n_p} = \underbrace{\left(C_{n_p}\right)_{WB}}_{7.3.2.3} + 2\left[\frac{z - z_p}{b_W}\right]\left(\Delta C_{n_\beta}\right)_p$ Eq. 7.4.2.3-b	(same limitations as for Eq. 7.4.2.3-a above) $\left(\Delta C_{n_\beta}\right)_p$ 1. Test data
			$C_{n_p} = \underbrace{\left(C_{n_p}\right)_{WB}}_{7.3.2.3} - \left[\frac{\ell_p \cos\alpha + z_p \sin\alpha}{b_W}\right]\left[\frac{2z - z_p}{b_W}\right]\underbrace{\left(\Delta C_{Y_\beta}\right)_{V(WBH)}}_{5.3.1.1}$ Eq. 7.4.2.3-c	Method 2 (vertical tails located directly above, or above and slightly behind wing) (same limitations as for Eq. 7.4.2.3-a above)
			$C_{n_p} = \underbrace{\left(C_{n_p}\right)_{WB}}_{7.3.2.3} + \left[\frac{2z - z_p}{b_W}\right]\left(\Delta C_{n_\beta}\right)_p$ Eq. 7.4.2.3-d	(same limitations as Method 1 above)

METHODS SUMMARY

DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
C_{n_p} (Contd.)	WBT (Contd.)	TRANSONIC	(No method)	
		SUPERSONIC	(No method)	
C_{Y_r}	W	SUBSONIC	(No method)	
		TRANSONIC	(No method)	
		SUPERSONIC	(No method)	
	WB	SUBSONIC	(No method)	
		TRANSONIC	(No method)	
		SUPERSONIC	(No method)	
	WBT	SUBSONIC	$C_{Y_r} = \left(C_{Y_r}\right)_{WB} - \frac{2}{b_w}\left(\ell_p \cos\alpha + z_p \sin\alpha\right)\underbrace{\left(\Delta C_{Y_\beta}\right)_{V(WBH)}}_{5.3.1.1}$ Eq. 7.4.3.1-a	$\left(C_{Y_r}\right)_{WB}$ 1. Aperiodic mode only $\left(\Delta C_{Y_\beta}\right)_{V(WBH)}$ 2. Test data 3. Additional tail limitations depend on $\left(\Delta C_{Y_\beta}\right)_{V(WBH)}$ prediction method
			$C_{Y_r} = \left(C_{Y_r}\right)_{WB} + 2\left(\Delta C_{n_\beta}\right)_p$ Eq. 7.4.3.1-b	$\left(C_{Y_r}\right)_{WB}$ and $\left(\Delta C_{n_\beta}\right)_p$ 1. Test data
		TRANSONIC	(No method)	
		SUPERSONIC	(No method)	
C_{l_r}	W	SUBSONIC	$C_{l_r} = C_L \underbrace{\left(\frac{C_{l_r}}{C_L}\right)_{\substack{C_L=0\\M}}}_{7.1.3.2} + \underbrace{\left(\Delta C_{l_r}\right)_{C_L}}_{7.1.3.2} + \underbrace{\left(\frac{\Delta C_{l_r}}{\Gamma}\right)}_{7.1.3.2}\Gamma + \underbrace{\left(\frac{\Delta C_{l_r}}{\theta}\right)}_{7.1.3.2}\theta + \underbrace{\left[\frac{\Delta C_{l_r}}{\left(\frac{\partial\alpha}{\partial\delta}\right)_f \delta_f}\right]}_{7.1.3.2}\underbrace{\left(\frac{\partial\alpha}{\partial\delta}\right)_f}_{6.1.1.1}\delta_f$ Eq. 7.1.3.2-a	1. $M \leq M_{cr}$ $\left(\Delta C_{l_r}\right)_{C_L}$ 2. No curved planforms 3. No twist or dihedral, if non-straight-tapered wings 4. $t/c \leq 0.1$ if cranked wing with round LE 5. $M \leq 0.6$ 6. Linear-lift range 7. $-5^\circ \leq \beta \leq +5^\circ$
		TRANSONIC	(No method)	
		SUPERSONIC	(No method)	

METHODS SUMMARY

DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
C_{l_r} (Contd.)	WB	SUBSONIC	$C_{l_r} = \underbrace{C_L \left(\frac{C_{l_r}}{C_L}\right)_{\substack{C_L=0\\M}}}_{7.1.3.2} + \underbrace{\left(\Delta C_{l_r}\right)_{C_L}}_{7.1.3.2} + \underbrace{\left(\frac{\Delta C_{l_r}}{\Gamma}\right)}_{7.1.3.2}\Gamma + \underbrace{\left(\frac{\Delta C_{l_r}}{\theta}\right)}_{7.1.3.2}\theta + \underbrace{\left[\frac{\Delta C_{l_r}}{\left(\frac{\partial\alpha}{\partial\delta}\right)_f \delta_f}\right]}_{7.1.3.2}\underbrace{\left(\frac{\partial\alpha}{\partial\delta}\right)_f}_{6.1.1.1}\delta_f$ Eq. 7.1.3.2-a	1. (Body diameter)/(wing span) ≤ 0.3 2. $M \leq M_{cr}$ $\left(\Delta C_{l_r}\right)_{C_L}$ 3. No curved planforms 4. No twist or dihedral, if non-straight-tapered wing 5. $t/c \leq 0.1$ if cranked wing with round LE 6. $M \leq 0.6$ 7. Linear-lift range 8. $-5^\circ \leq \beta \leq +5^\circ$
		TRANSONIC	(No method)	
		SUPERSONIC	(No method)	
	WBT	SUBSONIC	$C_{l_r} = \underbrace{\left(C_{l_r}\right)_{WB}}_{7.3.3.2} - \frac{2}{b_W^2}\left(\ell_p \cos\alpha + z_p \sin\alpha\right)\left(z_p \cos\alpha - \ell_p \sin\alpha\right)\underbrace{\left(\Delta C_{Y_\beta}\right)_{V(WBH)}}_{5.3.1.1}$ Eq. 7.4.3.2-a	$\left(C_{l_r}\right)_{WB}$ 1. No curved planforms 2. No twist or dihedral, if non-straight-tapered wing 3. $t/c \leq 0.1$ if cranked wing with round LE 4. (Body diameter)/(wing span) ≤ 0.3 5. $M \leq 0.6$ 6. $M \leq M_{cr}$ 7. Linear-lift range 8. $-5^\circ \leq \beta \leq +5^\circ$ $\left(\Delta C_{Y_\beta}\right)_{V(WBH)}$ 9. Additional or identical tail limitations depend on $\left(\Delta C_{Y_\beta}\right)_{V(WBH)}$ prediction method
			$C_{l_r} = \underbrace{\left(C_{l_r}\right)_{WB}}_{7.3.3.2} - \frac{2}{b_W}\left(\ell_p \cos\alpha + z_p \sin\alpha\right)\left(\Delta C_{l_\beta}\right)_p$ Eq. 7.4.3.2-b	$\left(C_{l_r}\right)_{WB}$ (same limitations as for Eq. 7.4.3.2-a) $\left(\Delta C_{l_\beta}\right)_p$ 1. Test data
			$C_{l_r} = \underbrace{\left(C_{l_r}\right)_{WB}}_{7.3.3.2} + 2\,\frac{\left(\Delta C_{n_\beta}\right)_p}{\underbrace{\left(\Delta C_{Y_\beta}\right)_{V(WBH)}}_{5.3.1.1}}\left(\Delta C_{l_\beta}\right)_p$ Eq. 7.4.3.2-c	$\left(C_{l_r}\right)_{WB}$ (same limitations as for Eq. 7.4.3.2-a) $\left(\Delta C_{n_\beta}\right)_p$, $\left(\Delta C_{Y_\beta}\right)_{V(WBH)}$, and $\left(\Delta C_{l_\beta}\right)_p$ 1. Test data
		TRANSONIC	(No method)	

METHODS SUMMARY

DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
C_{l_r} (Contd.)	WBT (Contd.)	SUPERSONIC	(No method)	
C_{n_r}	W	SUBSONIC	$C_{n_r} = \underbrace{\left(\frac{C_{n_r}}{C_L^2}\right)}_{7.1.3.3} C_L^2 + \underbrace{\left(\frac{C_{n_r}}{C_{D_0}}\right)}_{7.1.3.3} C_{D_0}$ Eq. 7.1.3.3-a	1. No twist nor dihedral 2. Lift-coefficient range for which C_{n_r} varies linearly with C_L
		TRANSONIC	(No method)	
		SUPERSONIC	(No method)	
	WB	SUBSONIC	$C_{n_r} = \underbrace{\left(\frac{C_{n_r}}{C_L^2}\right)}_{7.1.3.3} C_L^2 + \underbrace{\left(\frac{C_{n_r}}{C_{D_0}}\right)}_{7.1.3.3}$ Eq. 7.1.3.3-a	1. No twist nor dihedral 2. Lift coefficient range for which C_{n_r} varies linearly with C_L
		TRANSONIC	(No method)	
		SUPERSONIC	(No method)	
	WBT	SUBSONIC	$C_{n_r} = \underbrace{\left(C_{n_r}\right)_{WB}}_{7.3.3.3} + \frac{2}{b_W^2}\left(\ell_p \cos\alpha + z_p \sin\alpha\right)^2 \underbrace{\left(\Delta C_{Y_\beta}\right)_{V(WBH)}}_{5.3.1.1}$ Eq. 7.4.3.3-a	$\left(C_{n_r}\right)_{WB}$ 1. Aperiodic mode only 2. No twist nor dihedral 3. Lift-coefficient range for which C_{n_r} varies linearly with C_L $\left(\Delta C_{Y_\beta}\right)_{V(WBH)}$ 4. Additional tail limitations depend upon $\left(\Delta C_{Y_\beta}\right)_{V(WBH)}$ prediction method
			$C_{n_r} = \underbrace{\left(C_{n_r}\right)_{WB}}_{7.3.3.3} + 2\frac{\left(\Delta C_{n_\beta}\right)_p^2}{\underbrace{\left(\Delta C_{Y_\beta}\right)_{V(WBH)}}_{5.3.1.1}}$ Eq. 7.4.3.3-b	(same limitations as for Eq. 7.4.3.3-a above) $\left(\Delta C_{n_\beta}\right)_p$ 1. Test data
		TRANSONIC	(No method)	
		SUPERSONIC	(No method)	

METHODS SUMMARY

DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
c_{ℓ_δ} and α_δ	W (two dim)	SUBSONIC	$c_{\ell_\delta} = \left(\frac{\partial c_\ell}{\partial \delta}\right)_\alpha$ Eq. 6.1.1.1-a	1. Linear-lift range 2. Other limitations depend upon type of flap (see Equations -c through -j below)
			$\alpha_\delta = -\frac{(c_{\ell_\delta})_\alpha}{(c_{\ell_\alpha})_\delta}$ Eq. 6.1.1.1-b	1. Linear-lift range 2. Other limitations depend upon type of flap (see Equations -c through -j below)
			$\Delta c_\ell = \delta_f \underbrace{\left[\frac{c_{\ell_\delta}}{(c_{\ell_\delta})_{theory}}\right]}_{6.1.1.1} \underbrace{(c_{\ell_\delta})_{theory}}_{6.1.1.1} \underbrace{K'}_{6.1.1.1}$ Eq. 6.1.1.1-c	1. Plain trailing-edge flaps with sealed gaps 2. No beveled trailing edges 3. No compressibility effects
			$\Delta c_\ell = \underbrace{-c_{\ell_\alpha}}_{\text{test data}} \underbrace{\alpha_\delta}_{6.1.1.1} \delta_f$ Eq. 6.1.1.1-d	(a) Single-slotted flaps (b) Fowler flaps 1. Near fully extended position 2. Slot properly developed
			$\Delta c_\ell = \underbrace{c_{\ell_\delta}}_{6.1.1.1} \delta_f \underbrace{\eta_1}_{6.1.1.1} \frac{c'}{c}$ Eq. 6.1.1.1-e	(a) Single-slotted flaps (b) Fowler flaps
			$\Delta c_\ell = \underbrace{\eta_1}_{6.1.1.1} \underbrace{c_{\ell_{\delta_{f_1}}}}_{6.1.1.1} \delta_{f_1} \left(\frac{c + c_1}{c}\right) + \underbrace{\eta_2}_{6.1.1.1} \underbrace{c_{\ell_{\delta_{f_2}}}}_{6.1.1.1} \left(\delta_{f_1} + \delta_{f_2}\right) \frac{c'}{c}$ Eq. 6.1.1.1-h	1. Double-slotted flaps 2. Ratio of forward-flap chord to aft-flap chord ≤ 0.60
			$\Delta c_\ell = \underbrace{\eta_1}_{6.1.1.1} \underbrace{c_{\ell_{\delta_{f_1}}}}_{6.1.1.1} \delta_{f_1} \left(\frac{c'_a}{c}\right) + \underbrace{\eta_2}_{6.1.1.1} \underbrace{\eta_t}_{6.1.1.1} \underbrace{c_{\ell_{\delta_{f_2}}}}_{6.1.1.1} \delta_{f_2} \left(1 + \frac{c' - c'_a}{c}\right)$ Eq. 6.1.1.1-i	1. Double-slotted flaps 2. Ratio of forward-flap chord to aft-flap chord $\simeq 1.0$
			$\Delta c_\ell = \underbrace{-c_{\ell_\alpha}}_{4.1.1.2} \underbrace{\alpha_\delta}_{6.1.1.1} \delta_f$ Eq. 6.1.1.1-j	1. Split flaps
			$\Delta c_\ell = \left\{\left[1 + \underbrace{k_t}_{6.1.1.1}\left(\frac{t}{c'}\right)\right] \delta_f \left(\underbrace{c_{\ell_{\delta_f}}}_{6.1.1.1} - \underbrace{C'_\mu}_{6.1.1.1}\right) + \underbrace{C'_\mu}_{6.1.1.1} \delta_f + \left[1 + \underbrace{k_t}_{6.1.1.1}\left(\frac{t}{c'}\right)\right] \delta_j \left(\underbrace{c_{\ell_{\delta_j}}}_{6.1.1.1} - \underbrace{C'_\mu}_{6.1.1.1}\right) + \underbrace{C'_\mu}_{6.1.1.1} \delta_j\right\} \frac{c'}{c}$ Eq. 6.1.1.1-k	1. Jet flaps (first approximation for multislotted flaps) 2. Linearized thin-airfoil theory 3. No trailing-edge separation 4. No augmentor-wing concept 5. Not valid for low values of C_μ

DERIVATIVE	CONFIG	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
c_{ℓ_δ} and α_δ (Contd.)	W (two dim) (Contd.)	SUBSONIC (Contd.)	$\Delta c_\ell = \underbrace{c_{\ell_\delta}}_{6.1.1.1} \delta_f$ Eq. 6.1.1.1-ℓ	1. Leading-edge flaps 2. Thin-airfoil theory
			$\Delta c_\ell = \underbrace{c_{\ell_\delta}}_{6.1.1.1} \delta_f \frac{c'}{c}$ Eq. 6.1.1.1-m	1. Thin-airfoil theory (a) Krueger flaps (b) Leading-edge slats
			$\Delta c_\ell = \underbrace{-c_{\ell_\alpha}}_{4.1.1.2} \underbrace{\Delta\alpha'_s}_{6.1.1.1}$ Eq. 6.1.1.1-n	1. Plug or flap spoiler 2. Zero-lift region
$(c_{\ell_\alpha})_\delta$	W (two dim)	SUBSONIC	$(c_{\ell_\alpha})_\delta = \underbrace{(c_{\ell_\alpha})_{\delta=0}}_{4.1.1.2}$ (same as that for flap-retracted section – see Section 6.1.1.2)	1. Fixed-hinge trailing- and leading-edge flaps 2. $\delta_f \leq 20°$ for plain flaps 3. $\delta_f \leq 30°$ for single-slotted and Fowler flaps 4. $\delta_f \leq 60°$ for double-slotted flaps 5. $\delta_f \leq 45°$ for split flaps 6. No separated flow
			$\left(c_{\ell_\alpha}\right)_\delta = \frac{c'}{c} \underbrace{\left(c_{\ell_\alpha}\right)_{\delta=0}}_{4.1.1.2}$ Eq. 6.1.1.2-a	1 Translating trailing-edge flaps and leading-edge slats
			$c_{\ell_\alpha} = \left\{\left[1 + \underbrace{k_t}_{6.1.1.2}\left(\frac{t}{c'}\right)\right] (\underbrace{c'_{\ell_\alpha}}_{6.1.1.1} - C'_\mu) + C'_\mu\right\}\frac{c'}{c}$ Eq. 6.1.1.2-b	1. Jet flaps (first approximation for multislotted flaps) 2. Linearized thin-airfoil theory 3. No trailing-edge separation 4. No augmentor-wing concept 5. Not valid for low values of C_μ
			$\left(c_{\ell_\alpha}\right)_s = \left(c_{\ell_\alpha}\right)_{\delta=0}$ (same as basic airfoil)	1. Spoilers 2. $\alpha > 0$ 3. $c_\ell < 0$
$\Delta c_{\ell_{max}}$	W (two dim)	SUBSONIC	$\Delta c_{\ell_{max}} = \underbrace{k_1}_{6.1.1.3} \underbrace{k_2}_{6.1.1.3} \underbrace{k_3}_{6.1.1.3} \underbrace{\left(\Delta c_{\ell_{max}}\right)_{base}}_{6.1.1.3}$ Eq. 6.1.1.3-a	1. Trailing-edge flaps
			$\Delta c_\ell = \underbrace{c_{\ell_{\delta_{max}}}}_{6.1.1.3} \underbrace{\eta_{max}}_{6.1.1.3} \underbrace{\eta_\delta}_{6.1.1.3} \delta_f \frac{c'}{c}$ Eq. 6.1.1.3-b	1. Thin-airfoil theory (a) Leading-edge flaps 2. No Krueger flaps 3. $\delta_f < 30°$ (b) Leading-edge slats 4. $\delta_s < 20°$

METHODS SUMMARY

DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
Δc_m	W (two-dim)	SUBSONIC	$\Delta c_m = \underbrace{\Delta c_\ell}_{6.1.1.1} \left[\frac{x_{ref}}{c} - \underbrace{\left(\frac{x_{c.p.}}{c'}\right)}_{6.1.2.1}\left(\frac{c'}{c}\right)\right]$ Eq. 6.1.2.1-a	Method 1 1. Plain, split, and multislotted trailing-edge flaps 2. Linear-lift range Δc_ℓ (depends upon type of flap)
			Figure 6.1.2.1 -35b	Method 2 1. Plain trailing-edge flaps 2. Subcritical Mach numbers 3. Linear-lift range
			$\Delta c_{m_{LE}} = \underbrace{c'_{m_{\delta_{LE}}}}_{6.1.2.1}\left(\frac{c'}{c}\right)^2 \delta_{f_{LE}} + \left(\frac{x_{ref}}{c} + \frac{c'-c}{c}\right)\underbrace{\Delta c_\ell}_{6.1.1.1} + \underbrace{c_m}_{4.1.2.1}\left[\left(\frac{c'}{c}\right)^2 - 1\right] + 0.75 \underbrace{c_\ell}_{4.1.1.1,\ 4.1.1.2}\left(\frac{c'}{c}\right)\left(\frac{c'}{c} - 1\right)$ Eq. 6.1.2.1-b	1. Small leading-edge devices 2. Thin-airfoil theory Δc_ℓ (depends upon type of flap)
			$\Delta c_m = \underbrace{(\Delta c_m)_{\delta_{f_{LE}}}}_{6.1.2.1} + \underbrace{\Delta c_{m_\alpha}}_{6.1.2.1} + \underbrace{(\Delta c_m)_{\delta_f}}_{6.1.2.1} + \underbrace{(\Delta c_m)_{\delta_j}}_{6.1.2.1}$ Eq. 6.1.2.1-c	1. Jet flaps (first approximation for multislotted flaps) 2. Linearized thin-airfoil theory 3. No trailing-edge separation 4. No augmentor-wing concept 5. Not valid for low values of C_μ
$(c_{m_\alpha})_\delta$	W (two dim)	SUBSONIC	$(c_{m_\alpha})_\delta = (c_{m_\alpha})_{\delta=0}$ (same as that for flap-retracted sections)	1. Leading- and trailing-edge mechanical flaps 2. No separated flow
			$(\Delta c_m)_\alpha = \underbrace{\Delta c_4 x_2}_{6.1.2.1} + \underbrace{\Delta c_{m_4}}_{6.1.2.1}$ Eq. 6.1.2.1-k	1. Jet flaps (first approximation for multislotted flaps) 2. Linearized thin-airfoil theory 3. No trailing-edge separation 4. No augmentor-wing concept 5. Not valid for low values of C_μ
Δc_m	W (two dim)	SUBSONIC	Figure 6.1.2.3-3	1. Portion of $c_{m_{c_\ell}}$ curve below the moment break Δc_ℓ (depends upon type of flap)

METHODS SUMMARY

DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
c_{h_α}	W (two dim)	SUBSONIC	$c'_{h_\alpha} = \underbrace{\left[\frac{c'_{h_\alpha}}{(c_{h_\alpha})_{theory}}\right]}_{6.1.3.1} \underbrace{(c_{l_\alpha})_{theory}}_{6.1.3.1}$ Eq. 6.1.3.1-a	1. Radius-nose, sealed, trailing-edge flaps 2. Tangent of half the trailing-edge angle = t/c 3. No separated flow 4. Low speeds
			$c''_{h_\alpha} = \underbrace{c'_{h_\alpha}}_{6.1.3.1} + 2\underbrace{(c_{l_\alpha})_{theory}}_{4.1.1.2}\left[1 - \frac{c_{l_\alpha}}{\underbrace{(c_{l_\alpha})_{theory}}_{4.1.1.2}}\right]\left(\tan\frac{\phi''_{TE}}{2} - \frac{t}{c}\right)$ Eq. 6.1.3.1-b	c'_{h_α} 1. Radius-nose, sealed, trailing-edge flaps 2. Tangent of half the trailing-edge angle $\neq$ t/c 3. No separated flow 4. Low speeds
			$(c_{h_\alpha})_{balance} = \underbrace{c''_{h_\alpha}}_{6.1.3.1}\underbrace{\left[\frac{(c_{h_\alpha})_{balance}}{c''_{h_\alpha}}\right]}_{6.1.3.1}$ Eq. 6.1.3.1-c	1. Control with nose balance c''_{h_α} 2. Radius-nose, sealed, trailing-edge flaps 3. No separated flow 4. Low speeds
		TRANSONIC	(No method)	
		SUPERSONIC	$c_{h_\alpha} = \underbrace{-C_1}_{6.1.3.1} + \underbrace{C_2\,\phi_{TE}}_{6.1.3.1}$ Eq. 6.1.3.1-e	1. Airfoils with sharp leading and trailing edges 2. Symmetric, straight-sided flaps 3. $c_f/c < 0.5$ 4. Small flap deflections 5. Small angles of attack 6. Flow field supersonic and inviscid 7. No separated flow
			$c_{h_\alpha} = \underbrace{-C_1}_{6.1.3.1} + \underbrace{\left(\frac{\Delta c_{h_\alpha}}{t/c}\right)}_{6.1.3.1}\frac{t}{c}$ Eq. 6.1.3.1-f	1. Airfoils with sharp leading and trailing edges 2. Symmetric, circular-arc airfoils 3. $c_f/c < 0.5$ 4. Small flap deflections 5. Small angles of attack 6. Flow field supersonic and inviscid 7. No separated flow

METHODS SUMMARY

DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
c_{h_δ}	W (two dim)	SUBSONIC	$c'_{h_\delta} = \underbrace{\left[\frac{c'_{h_\delta}}{(c_{h_\delta})_{theory}}\right]}_{6.1.3.2} \underbrace{(c_{h_\delta})_{theory}}_{6.1.3.2}$ Eq. 6.1.3.2-a	1. Radius-nose, sealed, trailing-edge flaps 2. Tangent of half the trailing-edge angle = t/c 3. No separated flow 4. Low speeds
			$c''_{h_\delta} = \underbrace{c'_{h_\delta}}_{6.1.3.2} + 2\underbrace{(c_{\ell_\delta})_{theory}}_{6.1.1.1}\left[1 - \frac{c_{\ell_\delta}}{\underbrace{(c_{\ell_\delta})_{theory}}_{6.1.1.1}}\right]\left(\tan\frac{\phi''_{TE}}{2} - \frac{t}{c}\right)$ Eq. 6.1.3.2-b	1. Radius-nose, sealed, trailing-edge flaps 2. Tangent of half the trailing-edge angle ≠ t/c 3. No separated flow 4. Low speeds
			$(c_{h_\delta})_{balance} = \underbrace{c''_{h_\delta}}_{6.1.3.2}\underbrace{\left[\frac{(c_{h_\delta})_{balance}}{c''_{h_\delta}}\right]}_{6.1.3.2}$ Eq. 6.1.3.2-c	1. Control with nose balance c''_{h_δ} 2. Radius-nose, sealed, trailing-edge flaps 3. No separated flow 4. Low speeds
		TRANSONIC	(No method)	
		SUPERSONIC	$c_{h_\delta} = \underbrace{-C_1}_{6.1.3.2} + \underbrace{C_2\,\phi_{TE}}_{6.1.3.2}$ Eq. 6.1.3.2-d	1. Airfoils with sharp leading and trailing edges 2. Symmetric, straight-sided flap 3. $c_f/c < 0.5$ 4. Small flap deflections 5. Small angles of attack 6. Flow field supersonic and inviscid 7. No separated flow
			$c_{h_\delta} = \underbrace{-C_1}_{6.1.3.2} + \underbrace{\left(\frac{\Delta c_{h_\delta}}{t/c}\right)}_{6.1.3.1}\frac{t}{c}$ Eq. 6.1.3.2-e	1. Airfoils with sharp leading and trailing edges 2. Symmetric, circular-arc airfoil 3. $c_f/c \leqslant 0.5$ 4. Small flap deflections 5. Small angles of attack 6. Flow field supersonic and inviscid 7. No separated flow
$(c_{h_f})_{\delta_t}$	W (two dim)	SUBSONIC	$\left(\frac{\partial c_{h_f}}{\partial \delta_t}\right)_{\alpha,\delta_f} = \left(\frac{\partial c_{h_f}}{\partial \delta_t}\right)_{c_\ell,\delta_f} - \left(\frac{\partial c_{h_f}}{\partial c_\ell}\right)_{\delta_t,\delta_f}\left(\frac{\partial c_\ell}{\partial \alpha}\right)_{\delta_t,\delta_f}\left(\frac{\partial \alpha}{\partial \delta_t}\right)_{c_\ell,\delta_f}$ Eq. 6.1.3.3-a	1. $-18° \leqslant \delta_t \leqslant 18°$ 2. Does not account for effects of airfoil thickness, control-surface gaps, control nose balance, and TE angle 3. Low speeds 4. Linear hinge-moment range

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DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
$(c_{h_t})_{\delta_f}$	W (two dim)	SUBSONIC	$\left(\frac{\partial c_{h_t}}{\partial \delta_f}\right)_{\alpha,\delta_t} = \left(\frac{\partial c_{h_t}}{\partial \delta_f}\right)_{c_\ell,\delta_t} - \left(\frac{\partial c_{h_t}}{\partial c_\ell}\right)_{\delta_f,\delta_t}\left(\frac{\partial c_\ell}{\partial \alpha}\right)_{\delta_f,\delta_t}\left(\frac{\partial \alpha}{\partial \delta_f}\right)_{c_\ell,\delta_t}$ Eq. 6.1.3.4-a	1. $-18^o \leqslant \delta_f \leqslant 18^o$ 2. Does not account for effects of airfoil thickness, control-surface gaps, control nose balance, and TE angle 3. Low speeds 4. Linear hinge-moment range
C_{L_δ}	W	SUBSONIC	$\Delta C_L = \underbrace{\Delta c_\ell}_{6.1.1.1}\overbrace{\underbrace{\left(\frac{C_{L_\alpha}}{c_{\ell_\alpha}}\right)}_{4.1.1.2}}^{4.1.3.2}\underbrace{\left[\frac{(\alpha_\delta)_{C_L}}{(\alpha_\delta)_{c_\ell}}\right]}_{6.1.4.1}\underbrace{K_b}_{6.1.4.1}$ Eq. 6.1.4.1-a	Δc_ℓ (depends upon type of flap) C_{L_α} 1. Mechanical flaps 2. Straight-tapered wings
			$\Delta C_L = \underbrace{\Delta c_\ell}_{6.1.1.1}\left[\frac{A_t + \frac{2C_J'}{\pi}}{A_t + 2 + 0.604(C_J')^{1/2} + 0.876\, C_J'}\right]\frac{S_{W_f}}{S_W}$ Eq. 6.1.4.1-b	1. Jet flap IBF configuration 2. Small angles of attack 3. Linearized thin-airfoil theory 4. No trailing-edge separation 5. No augmentor-wing concept 6. Not valid for low values of C_J
			$\Delta C_L = 4\pi d_o\left[\frac{\pi A_t + 2C_J'}{\pi A_t + \underbrace{c'_{\ell_\alpha}}_{6.1.1.1} + 2.01\, C_J'}\right]\frac{\overbrace{\delta_{j_{eff}}}^{6.1.4.1}}{57.3}\frac{S_{W_f}}{S_W}$ Eq. 6.1.4.1-c	1. Jet flap EBF configuration 2. Small angles of attack 3. Linearized thin-airfoil theory 4. No trailing-edge separation 5. No augmentor-wing concept 6. Not valid for low values of C_J
		TRANSONIC	$C_{L_\delta} = \underbrace{C_{L_{\delta_{M=0.6}}}}_{6.1.4.1}\underbrace{\left(\frac{C_{l_\delta}}{C_{l_{\delta_{M=0.6}}}}\right)}_{6.2.1.1}$ Eq. 6.1.4.1-e	$C_{L_{\delta_{M=0.6}}}$ 1. Straight-tapered wings $C_{l_{\delta_{M=0.6}}}$ 2. Plain trailing-edge flaps 3. $\beta A \geqslant 2$ 4. $\Lambda_\beta < 60^o$ 5. No beveled trailing edges 6. No compressibility effects C_{l_δ} 7. Symmetric airfoils of conventional thickness distribution 8. $\alpha = 0$

METHODS SUMMARY

DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
C_{L_δ} (Contd.)	W (Contd.)	SUPERSONIC	$C_{L_\delta} = \left(1 - \underbrace{\frac{C_2}{C_1}}_{6.1.4.1} \phi_{TE}\right) \underbrace{C'_{L_\delta}}_{6.1.4.1} \frac{S_f}{S_W}$ Eq. 6.1.4.1-f	1. Leading and trailing edges of the control surface are swept ahead of Mach lines from the deflected controls 2. Control root and tip chords are parallel to the plane of symmetry 3. Controls are located either at the wing tip or far enough inboard so that the outermost Mach lines from the deflected controls do not cross the wing tip 4. Innermost Mach lines from deflected controls do not cross the wing root chord 5. Wing planform has leading edges swept ahead of Mach lines and has streamwise tips 6. Controls are not influenced by tip conical flow from the opposite wing panel or by the interaction of the wing-root Mach cone with the wing tip C'_{L_δ} 7. Symmetric, straight-sided flaps
$\left(C_{L_\alpha}\right)_\delta$	W	SUBSONIC	$\left(C_{L_\alpha}\right)_\delta = \underbrace{\left(C_{L_\alpha}\right)_{\delta=0}}_{4.1.3.2}$ (same as for unflapped wings)	1. Nontranslating leading- and trailing-edge flaps 2. No separated flow on wings and flaps $\left(C_{L_\alpha}\right)_{\delta=0}$ 3. No curved planforms 4. $M \leqslant 0.80$, $t/c \leqslant 0.1$, if cranked planform with round LE
			$\left(C_{L_\alpha}\right)_\delta = \left[\left(\frac{c'}{c} - 1\right) \frac{S_{W_f}}{S_W}\right] \underbrace{\left(C_{L_\alpha}\right)_{\delta=0}}_{4.1.3.2} + \underbrace{\left(C_{L_\alpha}\right)_{\delta=0}}_{4.1.3.2}$ Eq. 6.1.4.2-a	1. Translating leading- and trailing-edge flaps 2. No separated flow on wings and flaps $\left(C_{L_\alpha}\right)_{\delta=0}$ 3. No curved planforms 4. $M \leqslant 0.80$, $t/c \leqslant 0.1$, if cranked planform with round LE
			$C_{L_\alpha} = \underbrace{\left(C_{L_\alpha}\right)_\delta}_{6.1.4.2} \left\{\left[\underbrace{K(A_t, C'_J)}_{6.1.4.2} - 1\right] \underbrace{K_b}_{6.1.4.1} + 1.0\right\} + \frac{C_J(\cos \overbrace{\delta_{J_{eff}}}^{6.1.4.1} - 1)}{57.3}$ Eq. 6.1.4.2-b	1. Jet flaps 2. $A \geqslant 5$ $\left(C_{L_\alpha}\right)_\delta$ 3. No separated flow on wings and flaps 4. No curved planforms 5. $M \leqslant 0.80$, $t/c \leqslant 0.1$, if cranked planform with round LE

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DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
$\Delta C_{L_{max}}$	W	SUBSONIC	$\Delta C_{L_{max}} = \underbrace{\Delta c_{\ell_{max}}}_{6.1.1.3} \dfrac{S_{W_f}}{S_W} \underbrace{K_\Lambda}_{6.1.4.3}$ Eq. 6.1.4.3-a	1. Mechanical trailing-edge flaps
			$\Delta C_{L_{max}} = 1.28 \left(\dfrac{c_f/c}{0.18}\right)\left(\dfrac{b_{slat}}{b_e}\right)^2 \cos^2 \Lambda_{c/4}$ Eq. 6.1.4.3-b	1. Slats (first-order approximation)
			Figure 6.1.4.3-12	1. First-order approximation for EBF configuration
ΔC_m	W	SUBSONIC	$\Delta C_{m_f} = \underbrace{\Delta C_m}_{6.1.5.1} + \underbrace{K_\Lambda}_{6.1.5.1} \left(\dfrac{A}{1.5}\right) \underbrace{\Delta C_L}_{6.1.4.1} \tan \Lambda_{c/4}$ Eq. 6.1.5.1-a	1. Linear-lift range 2. $\Lambda_{c/4} < 45^\circ$ ΔC_L (depends upon type of flap) 3. Mechanical flaps 4. Straight-tapered wings
			$\Delta C_{m_f} = \int_0^{1.0} -\left[\underbrace{c_{\ell_\Lambda}}_{6.1.5.1} \dfrac{c}{c_{av}} \underbrace{\left(\dfrac{x}{\bar{c}}\right)}_{6.1.5.1}\right] d\eta$ Eq. 6.1.5.1-k	1. Linear aerodynamic control characteristic region C_{ℓ_Λ} (depends upon type of flap) $x/\bar{c}$ 2. Linear-lift range 3. Subcritical Mach numbers
			$\Delta C_m = \left[\underbrace{c_{m_{\delta'_{LE}}}}_{6.1.2.1} \left(\dfrac{\bar{c}'}{c}\right) + \left(\dfrac{x_m}{\bar{c}} - \dfrac{x_{LE}}{\bar{c}}\right) \underbrace{c'_{\ell_\delta}}_{6.1.1.1}\right] \dfrac{S_{W_f}}{S_W} \delta_f + \left\{\underbrace{C_m}_{\text{test data}} \left[\left(\dfrac{\bar{c}'}{c}\right)^2 - 1\right] + 0.75 \underbrace{C_L}_{\text{test data}} \left(\dfrac{\bar{c}'}{c}\right)\left(\dfrac{\bar{c}' - c}{c}\right)\right\} \Delta\eta$ Eq. 6.1.5.1-ℓ	1. Mechanical leading-edge devices 2. Constant flap-chord-to-wing-chord ratio 3. Thin-airfoil theory
			$\Delta C_m = \underbrace{C_{m_m}}_{6.1.5.1} + \underbrace{\eta_t}_{6.1.4.3} \overbrace{C_J}^{6.1.4.1} \underbrace{\dfrac{\Delta z}{\bar{c}}}_{6.1.5.1} + \sum_{k=1}^{p} \left\{\left[\underbrace{C_\mu}_{6.1.5.1} \overbrace{\dfrac{\alpha_L}{57.3}}^{6.1.5.1} \overbrace{\dfrac{S_K}{S_W}}^{6.1.5.1} - \underbrace{C_{\lambda_k}}_{6.1.5.1}\right] \underbrace{\dfrac{\Delta x_k}{\bar{c}}}_{6.1.5.1}\right\}$ Eq. 6.1.5.1-u	1. Jet flaps (first approximation for multislotted flaps) 2. Linearized thin-airfoil theory 3. No trailing-edge separation 4. No augmentor-wing concept 5. Not valid for low values of C_μ
C_{m_δ}	W	TRANSONIC	$C_{m_\delta} = \underbrace{-C_{L_\delta}}_{6.1.4.1} \underbrace{\left(\dfrac{x}{\bar{c}}\right)}_{6.1.5.1}$ Eq. 6.1.5.1-w	1. Linear aerodynamic control characteristic region C_{L_δ} 2. Straight-tapered wings 3. Plain trailing-edge flaps with sealed gap 4. No beveled trailing edges 5. $\beta A \geqslant 2$ 6. $\Lambda_\beta < 60^\circ$ 7. Symmetric airfoils with conventional thickness distribution 8. No compressibility effects 9. $\alpha = 0$

DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
C_{m_δ} (Contd)	W (Contd.)	SUPERSONIC	$C_{m_\delta} = \underbrace{K_1}_{6.1.5.1} \frac{1}{3} \frac{b_f}{\bar{c}} \frac{c_{r_f}}{S_W} \underbrace{C'_{m_\delta}}_{6.1.5.1} - \underbrace{K_2}_{6.1.5.1} \frac{1}{2} \frac{b_f}{\bar{c}} \frac{S_f}{S_W} \underbrace{C'_{l_\delta}}_{6.2.1.1} - \underbrace{K_3}_{6.1.5.1} \frac{x_f}{\bar{c}} \frac{S_f}{S_W} \underbrace{C'_{L_\delta}}_{6.1.4.1}$ Eq. 6.1.5.1-q	1. Linear aerodynamic control characteristic region 2. Symmetric straight-sided controls 3. Leading and trailing edges of the control surface are swept ahead of Mach lines from the deflected controls. 4. Control root and tip chords are parallel to the plane of symmetry 5. Controls are located either at the wing tip or far enough inboard so that outermost Mach lines from the deflected controls do not cross the wing tip 6. Innermost Mach lines from deflected controls do not cross the wing root chord 7. Wing planform has leading edges swept ahead of Mach lines and has streamwise tips 8. Controls are not influenced by tip conical flow from the opposite wing panel or by the interaction of the wing-root Mach cone with the wing tip. C'_{l_δ} 9. Plain trailing-edge flaps 10. Thin wings
C_{h_α}	W	SUBSONIC	$C_{h_\alpha} = \frac{A \cos \Lambda_{c/4}}{A + 2 \cos \Lambda_{c/4}} \underbrace{\left(c_{h_\alpha}\right)_{\text{balance}}}_{6.1.3.1} + \underbrace{\Delta C_{h_\alpha}}_{6.1.6.1}$ Eq. 6.1.6.1-a	1. High aspect ratios (A > 3) 2. Ends of control surfaces parallel to plane of symmetry 3. Neglects subcritical Mach-number effects 4. Sealed, plain trailing-edge controls c_{h_α} 5. No separated flow 6. Low speeds
		TRANSONIC	(No method)	
		SUPERSONIC	$\left(C_{h_\alpha}\right)_{t/c} = \left(1 - \underbrace{\frac{C_2}{C_1}}_{6.1.6.1} \phi_{TE}\right) \underbrace{\left(C_{h_\alpha}\right)_{t/c\,=\,0}}_{6.1.6.1}$ Eq. 6.1.6.1-b	1. Symmetric, straight-sided controls 2. Control root and tip chords are parallel to the plane of symmetry 3. Wing planform has leading edges swept ahead of Mach lines and has streamwise tips 4. Controls are not influenced by tip conical flow from the opposite wing panel or by interaction of the wing-root Mach cone with the wing tip.

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DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
C_{h_α} (Contd)	W (Contd.)	SUPERSONIC (Contd.)	$\left(C_{h_\alpha}\right)_{t/c} = \left\{1 - \frac{2\overbrace{C_2}^{6.1.6.1}\left(\frac{t}{c}\right)'}{3\underbrace{C_1\,(1+k)}_{6.1.6.1}\cos\left(\Lambda_{LE}-\Lambda_{HL}\right)}\left\{2\left[1+2\left(\frac{x_h}{c}\right)'\right] - \underbrace{k}_{6.1.6.1}\left[1-\left(\frac{x_h}{c}\right)'\right]^2\right\}\right\}\underbrace{\left(C_{h_\alpha}\right)_{t/c=0}}_{6.1.6.1}$ Eq. 6.1.6.1-b with different correction factor	1. Symmetric biconvex airfoil 2. Other limitations identical to Items 2 through 4 immediately above
C_{h_δ}	W	SUBSONIC	$C_{h_\delta} = \cos\Lambda_{c/4}\cos\Lambda_{HL}\left[\underbrace{\left(c_{h_\delta}\right)_{balance}}_{6.1.3.2} + \underbrace{\alpha_\delta}_{6.1.1.1}\underbrace{\left(c_{h_\alpha}\right)_{balance}}_{6.1.3.1}\frac{2\cos\Lambda_{c/4}}{A+2\cos\Lambda_{c/4}}\right] + \underbrace{\Delta C_{h_\delta}}_{6.1.6.2}$ Eq. 6.1.6.2-a	1. High aspect ratios ($A > 3$) 2. Ends of control surfaces parallel to plane of symmetry 3. Neglects subcritical Mach-number effects 4. Sealed, plain trailing-edge flaps c_{h_δ} 5. No separated flow 6. Low speeds
		TRANSONIC	(No method)	
		SUPERSONIC	$C_{h_\delta} = \frac{1}{\beta}\left(1 - \underbrace{\frac{C_2}{C_1}}_{6.1.6.2}\phi_{TE}\right)\beta\underbrace{C'_{h_\delta}}_{6.1.6.2}$ Eq. 6.1.6.2-b	1. Symmetric, straight-sided controls 2. Leading and trailing edges of the control surface are swept ahead of Mach lines from the deflected controls 3. Control root and tip chords are parallel to the plane of symmetry 4. Controls are located either at the wing tip or far enough inboard so that outermost Mach lines from deflected controls do not cross the wing tip 5. Innermost Mach lines from deflected controls do not cross the wing root chord 6. The wing planform has leading edges swept ahead of Mach lines and has streamwise tips 7. Controls are not influenced by tip conical flow from the opposite wing panel or by interaction of the wing-root Mach cone with the wing tip
			$C_{h_\delta} = \frac{1}{\beta}\left\{1 - \frac{4}{3}\underbrace{\frac{C_2}{C_1}}_{6.1.6.2}\left(\frac{t}{c}\right)'\left[1+2\left(\frac{x_h}{c}\right)'\right]\right\}\beta\underbrace{C'_{h_\delta}}_{6.1.6.2}$ Eq. 6.1.6.2-b with different correction factor	1. Symmetric biconvex airfoil 2. Other limitations identical to Items 2 through 7 immediately above

DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
C_D	W	SUBSONIC	$$C_{D_i} = \frac{\pi A}{m+1}\Bigg[\underbrace{G_k}_{6.1.7}\Big\{\underbrace{b_{kk}}_{6.1.7}\ \underbrace{G_k}_{6.1.7} - \sum_{n=1}^{k}\underbrace{(1-\delta_{vn})}_{6.1.7}\ \underbrace{B_{kn}}_{6.1.7}\ \underbrace{G_n}_{6.1.7}\Big\} + 2\sum_{v=1}^{k-1}\underbrace{G_v}_{6.1.7}\Big\{\underbrace{b_{vv}}_{6.1.7}\ \underbrace{G_v}_{6.1.7} - \sum_{n=1}^{k}\underbrace{(1-\delta_{vn})}_{6.1.7}\ \underbrace{B_{vn}}_{6.1.7}\ \underbrace{G_n}_{6.1.7}\Big\}\sin\phi_v\Bigg]$$ Eq. 6.1.7-c	1. No separated flow over control surface 2. Induced drag due to control deflection G_k, G_n, G_v (depends upon type of flap)
			$$\Delta C_{D_{min}} = \underbrace{\Delta c_{d_f}}_{6.1.7}\ \underbrace{K_b}_{6.1.4.1} + \underbrace{K'}_{6.1.7}\ \frac{\left(\overbrace{\Delta C_{L_f}}^{6.1.4.1}\right)^2}{\pi A}$$ Eq. 6.1.7-p	1. No separated flow over control surface 2. Profile drag due to control deflection ΔC_{L_f} (depends upon type of flap)
		TRANSONIC	(No method)	
		SUPERSONIC	$$\Delta C_{D_{wave}} = \left[\frac{C_{D_{wave}}}{\underbrace{\left(C_{D_{wave}}\right)_{\delta=0}}_{6.1.7}} - 1\right]\underbrace{\left(C_{D_{wave}}\right)_{\delta=0}}_{4.1.5.1}$$ Eq. 6.1.7-q	
C_{l_δ}	W	SUBSONIC	$$C_{l_\delta} = \underbrace{\lvert\alpha_\delta\rvert}_{6.1.1.1}\ \underbrace{C'_{l_\delta}}_{6.2.1.1}$$ Eq. 6.2.1.1-b	1. Plain trailing-edge flaps 2. $\beta A \geqslant 2$ 3. $\Lambda_\beta < 60°$ 4. $M \leqslant 0.6$ 5. No separated flow α_δ 6. No beveled trailing edges 7. No compressibility effects
			$$C_l = \underbrace{\frac{C'_{l_\delta}}{2}}_{6.2.1.1}\ \underbrace{\Delta\alpha'_s}_{6.1.1.1}$$ Eq. 6.2.1.1-c	1. Plug or flap-type spoilers 2. No separated flow C'_{l_δ} 3. Other limitations identical to Items 1 through 4 immediately above
			$$(C_l)_{\text{spoiler-slot-deflector}} = \underbrace{K}_{6.2.1.1}\ \underbrace{(C_l)_{\text{plain spoiler}}}_{6.2.1.1}$$ Eq. 6.2.1.1-f	1. Spoiler-slot-deflector 2. $\beta A \geqslant 2$ 3. $\Lambda_\beta < 60°$ 4. $M \leqslant 0.6$ 5. No separated flow $(C_l)_{\text{plain spoiler}}$ 6. Plain flap-type spoiler

METHODS SUMMARY

DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
C_{l_δ} (Contd)	W (Contd.)	TRANSONIC	$C_l = \underbrace{(C_l)_{M=0.6}}_{6.2.1.1} \; \underbrace{\frac{C_{L_\alpha}}{(C_{L_\alpha})_{M=0.6}}}_{4.1.3.2}$ Eq. 6.2.1.1-g	$(C_l)_{M=0.6}$ (depends upon type of control) C_{L_α} 1. Symmetric airfoils of conventional thickness distribution 2. $A \leq 3$ if composite wing 3. $\alpha = 0$ $(C_{L_\alpha})_{M=0.6}$ 4. No curved planform 5. $t/c \leq 0.10$, if cranked planform with round LE
		SUPERSONIC	$C_{l_\delta} = \left(1 - \underbrace{\frac{C_2}{C_1}}_{6.2.1.1} \phi_{TE}\right) \underbrace{C'_{L_\delta}}_{6.1.4.1} \frac{S_f}{S_W} \frac{1}{2}\left[\frac{y_i}{b_W} + \left(\frac{b_f}{2b_W}\right)\frac{\overbrace{C'_{l_\delta}}^{6.2.1.1}}{\underbrace{C'_{L_\delta}}_{6.1.4.1}}\right]$ Eq. 6.2.1.1-h	1. Plain trailing-edge flaps 2. Leading (hinge line) and trailing edges of control surfaces are supersonic (swept ahead of Mach lines) 3. Control surfaces are located at wing tip or far enough inboard to prevent outermost Mach lines from control surfaces from crossing wing tip 4. Innermost Mach lines from deflected control surfaces do not cross root chord 5. Root and tip chords of control surfaces are streamwise 6. Controls are not influenced by tip conical flow from opposite wing panel or by interaction of wing-root Mach cone with the wing tip C'_{l_δ} 7. Thin wings C'_{L_δ} 8. Symmetric, straight-sided controls
			Figure 6.2.1.1-30	1. Plug or flap-type spoilers
		SUBSONIC	$C_{l_\delta} = \frac{1}{2}\left[\left(1 - \frac{\pi A_W}{57.3} \underbrace{\frac{\partial\bar{\epsilon}}{\partial\alpha}}_{4.4.1}\right) + \underbrace{i_{v_{B(H)}}}_{4.3.1.3} \underbrace{\left(\frac{\Gamma}{2\pi\alpha V r}\right)}_{4.3.1.3}\left(\frac{r}{b_{H_e}/2}\right)\right] \underbrace{\eta\left(\frac{q_H}{q}\right)}_{6.2.1.2} \frac{\bar{y}_H}{b_W}\frac{S_{H_e}}{S_W} \underbrace{\left(C_{L_{\alpha_H}}\right)_e}_{4.1.3.2}$ Eq. 6.2.1.2-a	1. Differentially deflected horizontal stabilizer 2. Horizontal tail mounted on body 3. No separated flow on horizontal tail $\frac{\partial\bar{\epsilon}}{\partial\alpha}$ 4. Straight-tapered wing 5. Other limitations depend upon $\frac{\partial\bar{\epsilon}}{\partial\alpha}$ prediction method $\left(C_{L_{\alpha_H}}\right)_e$ 6. No curved planforms 7. $M \leq 0.8$, $t/c \leq 0.10$, if cranked planform with round LE

DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
C_{l_δ} (Contd.)	T (Contd.)	TRANSONIC	(Same as subsonic equation)	1. Differentially deflected horizontal stabilizer 2. $M < 1.0$ 3. Body-mounted horizontal tail 4. No separated flow on horizontal tail $\frac{\partial\bar{\epsilon}}{\partial\alpha}$ 5. Straight-tapered wing 6. Proportional to C_{L_α} $\left(C_{L_{\alpha_H}}\right)_e$ 7. Symmetric airfoils of conventional thickness distribution 8. $A \leqslant 3$ if composite wing 9. $\alpha = 0$
			(Same as supersonic equation)	1. $M > 1.0$ (Same limitations as for $M < 1.0$ above except those of $\partial\bar{\epsilon}/\partial\alpha$)
		SUPERSONIC	$C_{l_\delta} = 0.35 \left[\underbrace{i_{v_{B(H)}}}_{4.3.1.3} \underbrace{\left(\frac{\Gamma}{2\pi\alpha\, V_r}\right)}_{4.3.1.3}\left(\frac{r}{b_{H_e}/2}\right) + \underbrace{\left(k_{H(B)} + k_{B(H)}\right)}_{4.3.1.2}\right] \underbrace{\left(C_{N_{\alpha_H}}\right)_e}_{4.1.3.2} \frac{\bar{y}_H\, S_{H_e}}{b_W\, S_W}$ Eq. 6.2.1.2-c	1. Differentially deflected horizontal stabilizer 2. Body-mounted horizontal tail 3. No separated flow on horizontal tail $\left(C_{N_{\alpha_H}}\right)_e$ 4. Breaks in LE and TE at same spanwise station 5. $M \geqslant 1.4$ for straight-tapered planforms 6. $1.2 \leqslant M \leqslant 3$ for double-delta planforms 7. $1.0 \leqslant M \leqslant 3$ for curved planforms
C_n	W	SUBSONIC	$C_n = \underbrace{K}_{6.2.2.1}\ C_L\ \underbrace{C_{l_\delta}}_{6.2.1.1} \frac{(\delta_L - \delta_R)}{2}$ Eq. 6.2.2.1-a	1. Aileron-type controls 2. No separated flow 3. Neglects contributions due to profile drag C_{l_δ} 4. $\beta A \geqslant 2$ 5. $\Lambda_\beta < 60°$ 6. No beveled TE 7. No compressibility effect 8. $M \leqslant 0.6$
			Figures 6.2.2.1-10, 6.2.2.1-11	1. Plug and flap-type spoilers 2. $0.02 \leqslant \delta_s/c \leqslant 0.10$ 3. $\alpha = 0$
			$(C_n)_{\text{spoiler-slot-deflector}} = \underbrace{K}_{6.2.2.1} \underbrace{(C_n)_{\text{plain spoiler}}}_{6.2.2.1}$ Eq. 6.2.2.1-b	1. Spoiler-slot-deflector 2. $\alpha = 0$ 3. $\delta_s/\delta_d = 1.0$ $(C_n)_{\text{plain spoiler}}$ 4. Plain, flap-type spoiler

METHODS SUMMARY

DERIVATIVE	CONFIG.	SPEED REGIME	EQUATIONS FOR DERIVATIVE ESTIMATION (Datcom section for components indicated)	METHOD LIMITATIONS ASSOCIATED WITH EQUATION COMPONENTS
C_n (Contd.)	W (Contd.)	TRANSONIC	$C_n = \underbrace{(C_n)_{M=0.6}}_{6.2.2.1} \dfrac{C_{L_\alpha}}{\underbrace{\left(C_{L_\alpha}\right)_{M=0.6}}_{4.1.3.2}}$ Eq. 6.2.2.1-c	$(C_n)_{M=0.6}$ 1. Aileron-type controls 2. $\beta A \geqslant 2$ 3. $\Lambda_\beta < 60°$ 4. No beveled TE 5. No separated flow 6. No compressibility effects 7. Neglects contributions due to profile drag $\left(C_{L_\alpha}\right)_{M=0.6}$ 8. Straight-tapered wings C_{L_α} 9. Symmetric airfoils of conventional thickness distribution 10. $\alpha = 0$
		SUPERSONIC	Figure 6.2.2.1-13	1. Aileron-type controls 2. Neglects contributions due to profile drag
			Figure 6.2.2.1-14	1. Plug and flap-type spoilers
C_{n_δ}	T	ALL SPEEDS	(No method)	