



Computer program for calculation of aerodynamic centre of wing-fuselage-nacelle combinations

Associated software: ESDUpac A1309



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THE PREPARATION OF THIS DATA ITEM

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COMPUTER PROGRAM FOR CALCULATION OF AERODYNAMIC CENTRE OF WING-FUSELAGE-NACELLE COMBINATIONS

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COMPUTER PROGRAM FOR CALCULATION OF AERODYNAMIC CENTRE OF WING-FUSELAGE-NACELLE COMBINATIONS

1. NOTATION AND UNITS

This Data Item makes direct use of three Data Items, ESDU 76015, 77012 and 78013 (Derivations 2, 3 and 4). To avoid repetition, the Notation given here is limited to the quantities appearing in Sketches 1.1 to 1.5 and the input and output files for the ESDUpac.

		SI	British
A	aspect ratio of equivalent wing planform, b^2/S , see Equation (3.12) of ESDU 76015		
a	lift-curve slope of equivalent wing planform, see ESDU 70011 (Derivation 1)	radian ⁻¹	radian ⁻¹
a_n	lift-curve slope of nacelle in isolation, based on area wl , see Figure 1 of ESDU 77012 for wing pylon-mounted nacelles or see Figure 1 of ESDU 78013 for rear-fuselage pylon-mounted nacelles	radian ⁻¹	radian ⁻¹
b	span of equivalent wing planform, see Sketch 1.1	m	ft
$\bar{c}$	standard (or geometric) mean chord of equivalent wing planform, see Equation (3.9) of ESDU 76015	m	ft
$\bar{c}$	aerodynamic mean chord of equivalent wing planform, see Equation (3.10) of ESDU 76015	m	ft
c_f	root chord of true wing planform at side of projected fuselage planform, see Sketch 1.1	m	ft
c_r	root chord of equivalent wing planform, see Sketch 1.1	m	ft
c_{ref}	general reference chord for stability calculations	m	ft
c_t	tip chord of equivalent wing planform, see Sketch 1.1	m	ft
c_0	centre-line chord of equivalent wing planform, see Sketch 1.1	m	ft
d	width of fuselage at leading edge of root chord of equivalent wing planform, see ESDU 76015	m	ft
F	parameter used in estimating effect of fuselage on aerodynamic centre position, see Equation (2.2) and Figure 1 of ESDU 76015		
G	parameter used in estimating effect of fuselage on aerodynamic centre position, see Equation (2.2) and Figure 2 of ESDU 76015		
H	downwash parameter, see Equation (2.3) of ESDU 78013	radian	radian

h	height of fuselage at leading edge of root chord of equivalent wing planform, see ESDU 76015	m	ft
K_1	parameter used in estimating effect of fuselage on aerodynamic centre position, see Equation (2.2) and Figure 3 of ESDU 76015		
K_2	parameter used in estimating effect of fuselage on aerodynamic centre position, see Equation (2.2) and Figure 4 of ESDU 76015		
l	length of nacelle forward cowl or overall length of single cowl nacelle, see Sketch 1.3 (or Figure 1 of ESDU 77012) for wing pylon-mounted nacelles or see Sketch 1.4 (or Figure 1 of ESDU 78013) for rear-fuselage pylon-mounted nacelles	m	ft
l_f	overall fuselage length, see Sketch 1.1	m	ft
M	free-stream Mach number		
MARKER	integer specifying nacelle location: 1 = wing pylon-mounted nacelles 2 = rear-fuselage pylon-mounted nacelles		
m	fuselage length forward of leading edge of root chord of equivalent wing planform, see Sketch 1.1	m	ft
N	number of cranks in leading edge of true semi-wing planform		
$NNAC$	total number of nacelles		
n	fuselage length aft of trailing edge of root chord of equivalent wing planform, see Sketch 1.1	m	ft
R	distance of centre of nacelle inlet from wing local quarter-chord point, $(r'^2 + z_n^2)^{1/2}$, see Sketch 1.3	m	ft
r	for wing pylon-mounted nacelles, chordwise distance of nacelle lip forward of aerodynamic centre of wing-fuselage combination, see Sketch 1.3 <i>or alternatively,</i> for rear-fuselage pylon-mounted nacelles, distance of nacelle inlet aft of wing-fuselage aerodynamic centre, see Sketch 1.4	m	ft
r_{te}	for rear-fuselage pylon-mounted nacelles, nacelle inlet distance aft of wing trailing-edge, measured from centre of nacelle inlet, see Sketch 1.4	m	ft
r'	for wing pylon-mounted nacelles, chordwise distance of nacelle lip forward of wing local quarter-chord point, see Sketch 1.3 <i>or alternatively,</i> for rear-fuselage pylon-mounted nacelles, distance of nacelle inlet aft of quarter-chord point of centre-line chord of equivalent wing planform, see ESDU 78013	m	ft

r''	chordwise distance of nacelle lip (or inlet) from leading edge of aerodynamic mean chord of equivalent wing planform, measured positive forward for wing-mounted nacelles (see Sketch 1.3) and positive aft for rear-fuselage pylon-mounted nacelles (see Sketch 1.4)	m	ft
S	area of equivalent wing planform, see Equation (3.11) of ESDU 76015	m ²	ft ²
s	semi-span of wing planform, $b/2$, see Sketch 1.1	m	ft
$s_{l,0}$	spanwise distance to side of fuselage at point where leading edge of root chord of true wing planform meets side of projected fuselage planform, see Sketches 1.1 and 1.2	m	ft
$s_{l,i}$	spanwise distance to crank i in leading edge of planform of true wing for $i = 1, 2, \dots, N$, see Sketch 1.1	m	ft
s_n	for wing pylon-mounted nacelles, spanwise distance from fuselage centre-line to nacelle centre-line, see Sketch 1.3	m	ft
w	for wing pylon-mounted nacelles, maximum spanwise width of nacelle, see Sketch 1.3 or Figure 1 of ESDU 77012 or alternatively, for rear-fuselage pylon-mounted nacelles, maximum spanwise width of single-engine nacelle; half-width of nacelle containing two engines, see Sketches 1.4 and 1.5 or Figure 1 of ESDU 78013	m	ft
$\bar{x}$	chordwise location of aerodynamic centre of equivalent wing planform, measured positive aft from leading edge of aerodynamic mean chord of equivalent wing planform, see Sketch 1.3	m	ft
$\bar{x}$	chordwise location of leading edge of aerodynamic mean chord of equivalent wing planform, measured positive aft from apex of equivalent wing planform	m	ft
x_f	chordwise location of leading edge of c_f measured positive aft from fuselage nose, see Sketch 1.1	m	ft
x_h	chordwise location of aerodynamic centre of wing-fuselage combination, measured positive aft from leading edge of aerodynamic mean chord of equivalent wing planform, see Sketches 1.3 or 1.4	m	ft
$\Delta x_h / \bar{c}$	forward shift in chordwise location of aerodynamic centre due to presence of fuselage, non-dimensionalised by $\bar{c}$		
$\Delta x_h / \bar{\bar{c}}$	forward shift in chordwise location of aerodynamic centre due to presence of fuselage, non-dimensionalised by $\bar{\bar{c}}$, see Equation (2.2) of ESDU 76015		
x_{hnos}	chordwise distance of aerodynamic centre of wing-fuselage combination, measured positive aft from fuselage nose, see Sketch 1.2	m	ft