



ESDU PERF EG 8/1

Issued October 1957
With Amendments A and B
June 2010

Estimation of turning performance

Endorsed by
The Royal Aeronautical Society

Copyright Engineering Sciences Data Unit

ESDU DATA ITEMS

Data Items provide validated information in engineering design and analysis for use by, or under the supervision of, professionally qualified engineers. The data are founded on an evaluation of all the relevant information, both published and unpublished, and are invariably supported by original work of ESDU staff engineers or consultants. The whole process is subject to independent review for which crucial support is provided by industrial companies, government research laboratories, universities and others from around the world through the participation of some of their leading experts on ESDU Technical Committees. This process ensures that the results of much valuable work (theoretical, experimental and operational), which may not be widely available or in a readily usable form, can be communicated concisely and accurately to the engineering community.

We are constantly striving to develop new work and review data already issued. Any comments arising out of your use of our data, or any suggestions for new topics or information that might lead to improvements, will help us to provide a better service.

THE PREPARATION OF THIS DATA ITEM

The work of the Engineering Sciences Data Unit on this series is monitored and guided by Technical Committees of the Royal Aeronautical Society. The Committee responsible for this particular Data Item was the Performance Committee, which first met in 1946, and has the following constitution:

Chairman	
Mr C.F. Toms	— Hunting Aircraft Ltd
Members	
Mr D.G. Brown	— de Havilland Aircraft Ltd
Mr J.R. Collingbourne	— Royal Aircraft Establishment
Mr D.W. Kew	— Loughborough University of Technology
Mr P. Robinson	— Hawker Siddeley Aviation Ltd
Mr G.E. Rogerson	— Bristol Aircraft Ltd
Mr R.T. Shields	— Aeroplane and Armament Experimental Establishment
Mr J.C. Stevenson	— Consultant
Mr R.H. Whitby	— British European Airways

The members of staff of the Technical Department of the Royal Aeronautical Society associated with the Performance Committee were Dr A.J. Barrett and Mr J.A. Shaw.

ESTIMATION OF TURNING PERFORMANCE

CONTENTS

	Page
1. NOTATION AND UNITS	1
2. NOTES	2
3. APPROXIMATE FORM FOR THRUST BOUNDARY	3
4. REFERENCES	4
5. EXAMPLES	4
5.1 Example 1	4
5.2 Example 2	6
FIGURE 1	8

ESTIMATION OF TURNING PERFORMANCE

1. NOTATION AND UNITS

Suffix “1” refers to the case of straight and level flight ($n = 1$) and suffixes “*max*” and “*crit*” to values obtained at $C_{L_{max}}$ and $C_{L_{crit}}$ respectively.

A	aspect ratio	—
C_D	total drag coefficient (excluding momentum drag)	—
C_L	total lift coefficient	—
$C_{L_{crit}}$	critical value of C_L at which the value of K changes from K_a to K_b (see Section 2)	—
$C_{L_{max}}$	maximum usable value of C_L	—
D	$D_z + D_i$	lbf
D_i	overall lift-dependent drag (including tail effects of tailplane and of control surface deflections)	lbf
D_M	momentum drag [†] = (mass flow through jet intake or propeller disc) $\times$ $0.05242 \times V$	lbf
D_z	drag at zero-lift	lbf
F	net thrust = resultant of gross thrust and momentum drag	lbf
F_G	gross thrust [†] = (mass flow) $\times$ $0.05242 \times$ (jet or slip stream velocity)	lbf
g	acceleration due to gravity	ft/sec ²
K	overall lift-dependent drag factor [‡] , defined by $\frac{D_i}{0.7pM^2S} = \frac{K}{\pi A} C_L^2$	—
M	Mach number	—
n	ratio of total normal force to weight	—
p	atmospheric pressure	lbf/ft ²
R	radius of horizontal projection of turn	n. mile
S	wing area	ft ²
t	time	sec
V	true airspeed	kn

[†] The factor 0.05242 is the conversion from (lbf $\times$ kn) to (slugs $\times$ ft/sec).

[‡] The factor 0.7 relates to $\frac{1}{2} \times$ (ratio of principal specific heats of air).