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USER MANUAL FOR THE BASE OF AIRCRAFT DATA (BADA) REVISION 3.15

EEC Technical/Scientific Report No. 19/03/18-45

Project BADA

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USER MANUAL FOR THE BASE OF Aircraft DATA (BADA) REVISION 3.15

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Abstract:

The Base of Aircraft Data (BADA) provides a set of ASCII files containing performance and operating procedure coefficients for 1409 different aircraft types. The coefficients include those used to calculate thrust, drag and fuel flow and those used to specify nominal cruise, climb and descent speeds. User Manual for Revision 3.15 of BADA provides definitions of each of the coefficients and then explains the file formats. Instructions for remotely accessing the files via Internet are also given.

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SUMMARY

The Base of Aircraft Data (BADA) provides a set of ASCII files containing performance and operating procedure coefficients for 1409 different aircraft types. The coefficients include those used to calculate thrust, drag and fuel flow and those used to specify nominal cruise, climb and descent speeds. The User Manual for Revision 3.15 of BADA provides definitions of each of the coefficients and then explains the file formats. Instructions for remotely accessing the files via Internet are also given.

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USER MANUAL MODIFICATION HISTORY

Issue Number	Release Date	Comments
Revision 2.1 Issue 1.0	31.05.94	First release of document
Revision 2.2 Issue 1.0	25.01.95	Released with BADA Revision 2.2 - 8 new aircraft models - 2 modified aircraft models - 2 modified equivalences - 6 removed equivalences - 14 new equivalences - modified file formats - additional Synonym File - corrections to formulas in previous version of document - additional description of total-energy and standard atmosphere equations
Revision 2.3 Issue 1.0	08.06.95	Released with BADA Revision 2.3 - document format modified to be consistent with EEC Technical Note standards - new A/C models for B73V and D328 - MD11 changed from equivalence to direct support - generic military fighter model, FGTR, replaces specific fighter models - maximum payload parameter added to all OPF files - Performance Tables Files (*.PTF) introduced - ISA equations used for TAS/CAS conversions instead of approximations (Section 3.2) - use only one formula for correction of speeds at mass values different from reference mass (Section 3.3) - add specification of minimum speed as function of stall speed (Section 3.4) - specification of transition altitude calculated added (Section 4.1) - speed schedules modified for climb (Section 4.1) and descent (Section 4.3) - modify Internet address for remote access and EUROCONTROL contact person (Section 6) - removed Section 7 (General Comments)

Issue Number	Release Date	Comments
Revision 2.4 Issue 1.0	04.01.96	Released with BADA Revision 2.4 - new A/C model for FK70 - C421 changed from equivalence to directly supported - 10 new equivalences - 1 modified equivalence - 3 re-developed models - introduction of dynamic maximum altitude - new temperature correction on thrust - modified max.alt for 4 models - modified minimum weight for 2 models - modified temperature coefficients for 12 models - esf calculation for constant CAS below tropopause changed from binomial approximation to exact formula - cruise Mach numbers changed for 4 models - change in altitude limit for descent speed
Revision 2.5 Issue 1.0	20.01.97	- re-developed models: EA32, B737, B73S, AT42, B767, DC9, BA46, FK10, MD80. - new model: CL65, DH83 - change of minimum speeds - change of climb/descent speed schedules - cruise fuel flow correction - buffeting speed for jet a/c - addition of BADA.GPF file - definition of acceleration limits, bank angles and holding speeds - 38 new equivalences added (SA4, SA5, SweDen 96) - 1 modified equivalence (B74S) - modified climb/cruise speeds (BE90, BE99, E120, PA42, FK50, B73F, B767,B747, B727, DA20) - Format changes in OPF file - Header changes in PTF file - Temperature influence on thrust limitation changed - Unit of Vstall in OPF file changed to KCAS - Correction of typing errors - Correction of APF file format explanation
Revision 2.6 Issue 1.0	01.09.97	- Added non-clean drag and thrust data for: EA32, B73S, MD80, B737, B747, FK10, AT42, B767 and CL65 models - All models mentioned above were re-developed using new clean drag data. - ND16, E120 and FK50 were re-modelled to correct the cruise speed capability. - Change of speed schedule in the take-off / initial climb phase and approach / landing phase

Issue Number	Release Date	Comments
		- Change in descent thrust algorithm - Use of exact formula for density below tropopause instead of approximation. - Addition of formula for pressure above tropopause - Change of buffeting limit to 1.2g (was 1.3g) - Change of OPF file format - Buffeting coefficients for B757 and MD80 were corrected. - Hmo for B747 model was corrected to 45,000 ft - Low altitude descent behaviour corrected for: SW3, PAYE, DA50, DA10, D328, C421, BE99, BE20 and BE90 models - Correction of some minor typing errors - dynamic maximum altitude coefficients changed for B747, B74F, C130 and EA30 - Saab 2000 (SB20) added as equivalent of D328 - Modified algorithm for lift coefficient
Revision 3.0 Issue 1.0	01.03.98	- Climb speed law changed for jet aircraft - Descent speed law changed for jet, turbo and piston - Reduced power climbs - B777, SB20 and B73X models were added - DA01 model was removed - Use of ICAO doc. 8643/25 standard, which resulted in the removal of 4 additional models - B73F and B757 remodelled - MD90 added as equivalence model - Cruise and descent speeds for several turboprops changed - Climb thrust for several a/c changed - Removal of C_{m16} from drag expression
Revision 3.1 Issue 1.0	01.10.98	Released with BADA Revision 3.1 - Descent & cruise speeds for several jet aircraft changed: DC9, BA46, CL60 - Descent, cruise & climb speeds for several turboprops changed: D228, SH36 - Maximum Operating speed for several a/c changed: PA42 - Stalling speed for several a/c changed: DC8, T154 - Removed formula for air density calculation above tropopause - Addition of Appendix D: Solutions for buffeting limit algorithm - Removed Section 3.7.2: Maximum Take-Off Thrust - Description for Cred parameter added - Correction of some minor typing errors

Issue Number	Release Date	Comments
		- Modified PTF File format (Flight Level): Section 6.6 - Cruise CAS schedule for jet & turbo aircraft (Section 4.2)
Revision 3.3 Issue 1.0		Released with BADA Revision 3.3 - Standard atmosphere explanation added - Correction of some typing errors, minor changes in the layout and equations presentation. - Several aircraft types have changed ICAO's designator according to the ICAO doc.8643/27. Aircraft types affected by the RD3 are as follows: A300, ATR, B707, B727, B73A, B73B, B73C, B74A, B74B, B757, B767, B777, CARJ, DC8, DHC8, JSTA, JSTB, P31T, PA28, PA42. That resulted in: modification of the name of the OPF and APF files, addition of new models as synonyms, modification of Synonym.NEW and Synonym.LST files. - B73A, B757, MD80, B73B, F100, B727, CARJ, FA20, FA50, D228, T154 aircraft models have been re-modelled - A319, A321, A306, AT72 models have been added - Climb, cruise and descent speeds changed for several models. - Ground TOL for B73C has been modified. - MD80: Cd0 and Cd2 for IC and TO added, maximum altitude at MTOW, ISA weight gradient on maximum altitude Gw and temperature gradient Gt on maximum altitude have been changed - BA46 maximum altitude at MTOW, ISA weight gradient on maximum altitude Gw have been changed - E145 was added as equivalent of CRJ1 - A478 was added as equivalent of AT72
Revision 3.4 Issue 1.0	June 2002	Released with BADA Revision 3.4 - correction of some typing errors - in chapter 3.5 configuration threshold altitude values replaced with $H_{max,i}$ while the corresponding numbers are listed in chapter 5.6 - Appendix B: a new column is added to the table; providing the information on maximum altitude that an aircraft can reach at MTOW (h_{max}) - FGTN aircraft model added - FGTH aircraft model added - FGTL aircraft model added - FGTR aircraft model removed - DC-9 aircraft model re-modelled - D228 cruise and descent speed modified

Issue Number	Release Date	Comments
		- SH36 cruise and descent speed modified - B738 maximum operational altitude modified - AT72 cruise speed corrected - PA34 minimum mass modified - B734 aircraft model added - B735 aircraft model added - E145 aircraft model added - B737 aircraft model added - AT45 aircraft model added - B762 aircraft model added - B743 aircraft model added - Removal of several existing OPF and APF files due to the change of ICAO aircraft designators according to RD3: A330, A340, BA46, DC9, MD80 - Addition of several new OPF and APF files due to the change of ICAO aircraft designators according to RD3: A333, A343, B461, DC94, MD83 - Addition of new equivalence aircraft types: A332, A342, A345, A346, B461, B462, B463, DC91, DC92, DC93, DC95, MD81, MD82, MD87, MD88, A124, AC80, AC90, AC95, AJET, AMX, AN72, ATLA, B1, B350, B739, B74D, BDOG, BE10, BE40, BE76, BER4, C17, C72R, C77R, C82R, C210, C212, C337, C526, C56X, CRJ7, E135, EUFI, F1, FT2H, F104, G222, GLF5, HAWK, H25A, H25C, IL96, JS1, JS3, JS20, LJ24, M20T, M20P, K35R, N262, P28T, P28B, PA32, PAY4, P68, PA44, SB05, T204, TBM7 - Modification of the value for Maximum bank angles for civil flight during HOLD in BADA.GPF file - Configuration Management of BADA files have been changed; files have been migrated from RCS to Continuus Configuration Management System. That resulted in the modification of the “identification” part of all BADA files given in the header.
Revision 3.5 Issue 1.0	July 2003	Released with BADA Revision 3.5 - correction of some typing errors - B712 aircraft model added - LJ45 aircraft model added - C750 aircraft model added - RJ85 aircraft model added - B736 aircraft model added - B753 aircraft model added

Issue Number	Release Date	Comments
		- A332 aircraft model added - B772 re-modelled - B738 re-modelled - B763 re-modelled - B703 WTC modified - JS41 WTC modified - Addition of new syn. aircraft types: P180, GLEX, C30J, J328, A7, B52, ETAR, F117, L159 - Modification of BADA models for existing synonym aircraft types: C17, GLF3, GLF3, GLF4, GLF5 - SYNONYM_ALL.LST file added.
Revision 3.6 Issue 1.0	July 2004	Released with BADA Revision 3.6 The following models of aircraft added in BADA 3.6: - Dash 8-100: **DH8A** - Boeing MD82: **MD82** - Boeing B767-400: **B764** - Boeing B777-300: **B773** - BAE 146-200: **B462** The following models of aircraft have been re-modelled in BADA 3.6: - Airbus A300B4-203: **A30B** - Airbus A310: **A310** - Airbus A319: **A319** - Airbus A320: **A320** - Airbus A321: **A321** - Airbus A330-301: **A333** - Airbus A340-313: **A343** - Boeing B737-200: **B732** - Boeing B737-300: **B733** - Boeing B747-200: **B742** - Boeing B747-400: **B744** - Boeing B757-200: **B752** Addition of new synonym aircraft types: A3ST, ASTR, B701, C441, GALX, J728, K35A, K35E, L29B, LJ25, LJ60, NIM, PC12, R135, RJ1H, RJ70, P32R, C208, AA5, S76, DC3, BLAS, AEST, EC35, PAY1, PA18, BE55, C170, B461. Correction of syntax errors in BADA files: - Boeing B777-200: **B772** - ATR42-500: **AT45**

Issue Number	Release Date	Comments
Revision 3.7 Issue 1.0	March 2009	Released with BADA Revision 3.7 - Modification of the values for constants g and R in Section 3. - New description of formula 3.1-8 to match its actual use in some models. - Coefficient CVmin, TO is no longer used in climb speed schedule, only in flight envelope determination. - Numbering of several equations changed due to reorganisation of related sections. - Change of descent thrust computation when CTdes,app and CTdes, ld are null in Section 3.7.3. - Clarification of descent fuel flow computation in Section 3.9. - Additional information on climb and descent speed schedules in Section 4. - Update of some Fortran format descriptions in Section 6. - Additional reasons for ROCD discontinuities added in Section 6.6. - Introduction of new PTD file format. - Update of Section 7 to describe the new means of access to the BADA files. - Remodelling of 71 a/c types from BADA 3.6. - Addition of 12 new a/c models for following a/c types: A346, A388, BE58, C510, CRJ2, CRJ9, DA42, DH8D, E135, E170, E190, EA50. - All synonym aircraft have been re-evaluated and some reassigned
Revision 3.8 Issue 1.0	April 2010	Released with BADA Revision 3.8 - Introduction of new revised atmosphere model and relevant corresponding updates throughout the User Manual document - Harmonisation of acronyms for physical constants with the EEC Technical Report No. 2010-001, February 2010 "Revision of Atmosphere Model in BADA Aircraft Performance Model" - Clarification of descent fuel flow computation in Section 3.9. - Information added on whether some BADA model coefficients may or may not be negative. - Missing information about speed schedule in cruise for piston aircraft added (section 4.2) - Additional clarifications provided on use of altitudes in Section 4. - Additional explanatory note provided on data presented in the PTF file. - Correction of error in the solution for buffeting limit algorithm.

Issue Number	Release Date	Comments
		- Remodelling of 5 a/c types from BADA 3.7: B763, FA50, F900, RJ85, TRIN - Addition of 8 new a/c models: A318, A3ST, A345, B739, B77L, B77W, F2TH, FA7X. - 23 new synonym aircraft added - Regeneration of all PTF/PTD files
Revision 3.8 Issue 1.1	August 2010	Clarifications only, no impact on BADA implementations: - Overall review of the document to fix formatting and typography problems. - Formula 3.1-19 (approximate value of a constant) removed, formula 3.1-4 added to define $T_{ISA,trop}$, and some formulas reordered in section 3.1
Revision 3.9 Issue 1.0	April 2011	Released with BADA Revision 3.9: - Minor updates in the document - Clarification about speed calculation in Chapter 4.2. Cruise - Remodelling of 4 a/c types from BADA 3.8: A320, BE58, DA42, E135 - Addition of 6 new a/c models: AT72, AT75, C56X, E50P, E55P,TBM7 - 17 new synonym aircraft added and 13 existing synonyms have been revised
Revision 3.10 Issue 1.0	April 2012	Released with BADA Revision 3.10: - Corrected Fortran specification of the PTF file to match actual release files (it would miss the first digit of descent fuel flow in some cases) - Clarification about the impact of speed envelope on speed calculation in Chapters 4.1, 4.2 and 4.3 - Slight change in the description of the buffeting limit algorithm to mention that the discriminant is not “always” but “usually” negative - Addition of 10 new a/c models: A342, B463, B748, B788, C172, C182, P180, RJ1H, SR22, TBM8 - Full remodelling of 9 a/c types: A343, B462, C560, DH8D, F50, PA34, RJ85, SF34, TBM7 - Partial update of 16 a/c types: A3ST, A318, A345, A388, B722, B735, B739, B743, B763, B772, B77L, B77W, BE20, C56X, E190, F100 - Addition of 61 new synonym aircraft and revision of 18 existing synonyms

Issue Number	Release Date	Comments
Revision 3.11 Issue 1.0	May 2013	Released with BADA Revision 3.11: - Addition of 23 new a/c models: A124, A140, A148, AN24, AN28, AN30, AN32, AN38, C25A, C25B, C25C, C525, C680, H25B, IL76, IL86, IL96, P28T, PA44, PA46, T204, YK40, YK42 - Partial update of 4 a/c types: A318, C130, DC10, F70 - Addition of 1 new synonym aircraft and revision of 10 existing synonyms Special thanks to Zlata Belotic (University of Belgrade) for her contribution to this release.
Revision 3.12 Issue 1.0	August 2014	Released with BADA Revision 3.12: - Corrected Fortran specification of the Aircraft Type block in OPF file to match actual release files (section 6.4.2) - Addition of $C_{Tc,1}$ and $C_{Tc,4}$ to the list of coefficients that can be negative (section 3.11) - Pruning of the synonym files: only SYNONYM.NEW will now be maintained. Former SYNONYM.LST can be provided, upon request and with no support, to users of legacy systems. - The content of the last column of the SYNONYM.NEW file has been modified: it now indicates whether a designator is in use according to ICAO Doc 8643 (value “Y”) or not (value “N”). - Addition of 16 new aircraft models: B190, B350, BE30, BE40, C551, C650, DC93, GL5T, GLEX, GLF5, LJ60, P46T, PC12, PRM1, SU95, TB20 - Full remodelling of 6 aircraft types: BE20, BE99, C550, C56X, FGTN, TB21 (formerly TRIN) - Partial update of 2 aircraft models: A319, YK40 - Renaming of 2 aircraft models: P28U (formerly P28T), TB21 (formerly TRIN) - Addition of 31 new synonym aircraft and revision of 33 existing synonyms
Revision 3.13 Issue 1.0	May 2015	Released with BADA Revision 3.13: - Addition of C_{f1} to the list of coefficients that can be negative (section 3.11) - Addition of 24 new aircraft models: AN12, AT76, B789, BE36, BER2, C162, C208, DA40, DIMO, E300, E500, E550, EV97, HA4T, L410, M20P, M20T, MAGC, P06T, P28R, P28T, P750, SF25, SR20

Issue Number	Release Date	Comments
		- Full remodelling of 5 aircraft types: B788, BE58, C182, C550, E135 - Renaming of 4 aircraft models: B58T (formerly BE58), C82S (formerly C182), C55B (formerly C550), E35L (formerly E135) - Addition of 69 new synonym aircraft and revision of many existing synonyms - The nominal bank angle for civil flight during phases other than take-off and landing has been reduced from 35° to 30° (section 5.3)
Revision 3.14 Issue 1.0	June 2017	Released with BADA Revision 3.14: - Correction of the transition altitude formula to manage transition altitudes located above the tropopause (section 3.1.2) - Extension of the low speed buffeting limit and associated coefficients to turboprop aircraft (section 3.6.2) - Addition of 27 new aircraft models: A10, A158, A20N, A359, AJET, C27J, C310, C340, C402, C414, CL30, DA62, E195, E45X, E75L, E75S, F15, F16, F406, G150, G180, HAWK, L39, S22T, SVNH, TEX2, U2 - Full remodelling of 10 aircraft types: A148, B722, C421, C750, E120, E170, E190, MU2, P180, SW4 - Removal of 1 aircraft model: FGTN - Addition of 567 new synonym aircraft and revision of 112 existing synonyms - Update of the definition of the highest altitude used in PTF/PTD files to match actual release files (section 6.6) - Removal of obsolete information in section 6.2 - Removal of section 7 “Remote file access”: information on how to access the BADA release files and documents is now provided in the BADA website User Guides.
Revision 3.15 Issue 1.0	May 2019	Released with BADA Revision 3.15: - Clarification about the aerodynamic configuration to be used in the cruise phase (section 3.5) - Addition of 30 new aircraft models: A21N, A35K, A339, B38M, B39M, B78X, BE76, C30J, C188, C206, C210, CRJX, E290, E545, FLCO, GLF2, HDJT, KODI, LJ25, P1HH, PAY1, Q2, Q4, Q9, S2P, SBR1, SF50, T206, T210, TBM9 - Full remodelling of 5 aircraft types: B789, E135, E145, PAY2, PAY3

Issue Number	Release Date	Comments
		- Addition of 313 new synonym aircraft and revision of 97 existing synonyms

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1. INTRODUCTION

1.1. IDENTIFICATION

This document is the User Manual for the Base of Aircraft Data (BADA) Revision 3.15.

1.2. PURPOSE

BADA is a collection of ASCII files which specifies operation performance parameters, airline procedure parameters and performance summary tables for 1409 aircraft types. This information is designed for use in trajectory simulation and prediction algorithms within the domain of Air Traffic Management (ATM). All files are maintained within a configuration management system at the EUROCONTROL Validation Infrastructure Centre of Expertise located at the EUROCONTROL Experimental Centre (EEC) in Brétigny-sur-Orge, France.

This document describes the mathematical models on which the data are based and specifies the format of the files which contain the data.

1.3. DOCUMENT ORGANISATION

This document consists of six sections including Section 1, the Introduction. A list of referenced documents along with a glossary of acronyms and symbols are included in this section.

Section 2: Revision Summary, summarises the differences between BADA Revision 3.15 and the previous BADA Revision 3.14.

Section 3: Operation Performance Models, defines the set of equations that are used to parameterise aircraft performance. This includes models of aerodynamic drag, engine thrust, and fuel consumption. An atmosphere model is also provided.

Section 4: Airline Procedure Models, defines the set of parameters that is used to characterise standard airline speed procedures for climb, cruise, and descent.

Section 5: Global Aircraft Parameters, defines the set of global aircraft parameters that are valid for all, or a group of, aircraft.

Section 6: File Structure, describes the files in which the BADA aircraft parameters are maintained. Six types of files are identified:

- Synonym File listing the supported aircraft types;
- Operations Performance Files (OPF) containing the performance parameters for a specific aircraft type;
- Airline Procedures Files (APF) containing speed procedure parameters for a specific aircraft type;
- Performance Table Files (PTF) containing summary performance tables of true airspeed, climb/descent rates and fuel consumption at various flight levels for a specific aircraft type;
- Performance Table Data (PTD) containing detailed performance data at various flight levels for a specific aircraft type;
- Global Parameters File (GPF) containing parameters that are valid for all aircraft or a group of aircraft, for instance all turboprops or all military aircraft.

Two appendices are also provided with this document. **Appendix A** provides a list of the aircraft types supported by BADA Revision 3.15 and **Appendix B** gives solutions for a buffeting limit algorithm.

1.4. REFERENCED DOCUMENTS

RD1 User Manual for the Base of Aircraft Data (BADA) Revision 3.14; EEC Technical/Scientific Report No. 17/05/29-143, June 2017.

RD2 Aircraft Type Designators; ICAO Document No. 8643; Edition 47, April 2019, http://www.icao.int/publications/DOC8643/

RD3 Aircraft Modelling Standards for Future ATC Systems; EUROCONTROL Division E1 Document No. 872003, July 1987.

RD4 Manual of the ICAO Standard Atmosphere; ICAO Document No. 7488, 2nd Edition, 1964.

RD5 BADA Product Management Document; EEC Technical Report No. 2009-008 (v1.1), May 2019.

RD6 Base of Aircraft Data (BADA) Aircraft Performance Modelling Manual; EEC Technical Report No. 2009-009, April 2009.

RD7 Memo on the Calculation of Energy Share Factor; EEC/FAS/BYR/95/50; 22 November 1995.

RD8 Revision Summary Document for the Base of Aircraft Data (BADA) Revision 3.15; EEC Technical/Scientific Report No. 19/03/18-46, May 2019.

RD9 Aircraft Performance Summary Tables for the Base of Aircraft Data (BADA) Revision 3.15; EEC Technical/Scientific Report No. 19/03/18-47, May 2019.

RD10 Synonym Aircraft Report for the Base of Aircraft Data (BADA) - Revision 3.15; EEC Technical/Scientific Report No. 19/03/18-49, May 2019.

RD11 Model Accuracy Summary Report for the Base of Aircraft Data (BADA) Revision 3.15: EEC Technical/Scientific Report No. 19/03/18-48, May 2019.

RD12 Revision of Atmosphere Model in BADA Aircraft Performance Model; EEC Technical Report No. 2010-001, February 2010.

RD13 Mathematical Handbook; M.R. Spiegel; 1968; McGraw-Hill book company.

1.5. GLOSSARY OF ACRONYMS

AGL	**A**bove **G**round **L**evel
APF	**A**irlines **P**rocedures **F**ile
ASCII	**A**merican **S**tandard **C**ode for the **I**nterchange of **I**nformation
ATM	**A**ir **T**raffic **M**anagement
BADA	**B**ase of **A**ircraft **Da**ta
CAS	**C**alibrated **A**ir**s**peed
EEC	**E**UROCONTROL **E**xperimental **C**entre
ESF	**E**nergy **S**hare **F**actor
ICAO	**I**nternational **C**ivil **A**viation **O**rganisation
ISA	**I**nternational **S**tandard **A**tmosphere
MLW	**M**aximum **L**anding **W**eight
MSL	**M**ean **S**ea **L**evel
MTOW	**M**aximum **T**ake-**o**ff **W**eight
OPF	**O**perations **P**erformance **F**ile
PTD	**P**erformance **T**able **D**ata
PTF	**P**erformance **T**able **F**ile
RCS	**R**evision **C**ontrol **S**ystem
ROCD	**R**ate of **C**limb or **D**escent
TAS	**T**rue **A**ir**s**peed
TBP	**T**ur**b**o**p**rop
TEM	**T**otal-**E**nergy **M**odel

1.6. GLOSSARY OF SYMBOLS

A list of the symbols used in equations throughout this document is given below along with a description. Where appropriate, the engineering units typically associated with the symbol are also given.

a	speed of sound	[m/s]
d	distance	[nautical miles]
f	fuel flow	[kg/min]
g_0	gravitational acceleration	[m/s^2]
$\frac{dh}{dt}$	vertical speed	[m/s] or [ft/min]
h	geodetic altitude	[metres] or [ft]
H	geopotential altitude	[metres] or [ft]
H_p	geopotential pressure altitude	[metres] or [ft]
C	general coefficient	
D	drag force	[Newtons]
m	aircraft mass	[tonnes] or [kg]
M	Mach number	[-]
p	Actual pressure	[Pa]
p_0	Standard pressure at MSL	[Pa]
R	real gas constant for air	[m^2/(K·s^2)]
ROCD	Rate of Climb or Descent	[m/s] or [ft/min]
S	reference wing surface area	[m^2]
T	temperature	[Kelvin]
Thr	thrust	[N]
V	speed	[m/s] or [knots]
ΔT	temperature difference	[Kelvin]
W	weight	[N]
η	thrust specific fuel flow	[kg/(min·kN)]
ρ	air density	[kg/m^3]

2. REVISION SUMMARY

This section summarises the aircraft types that are supported in BADA Revision 3.15 along with the updates that have been made since the previous release, BADA Revision 3.14 [RD1].

2.1. SUPPORTED AIRCRAFT

BADA Revision 3.15 provides operations and procedures data for a total of 1409 aircraft types. For 250 of these aircraft types, the data are provided directly in specific files. These aircraft types are considered as directly supported, and referred to as aircraft original models. The way they have been identified is described in [RD6]. For the other 1159 aircraft types, the data are specified to be the same as one of the directly supported 250 aircraft types. These aircraft types are considered as 'equivalent' to one of the original aircraft models, and referred to as synonym aircraft. More details on the way they have been identified are given in [RD10].

Each supported aircraft type is identified by a 4-character designation code. This code generally corresponds to the identifier assigned to the aircraft type by the International Civil Aviation Organisation (ICAO) [RD2], at the exception of some BADA generic types (representing military aircraft or helicopters), and decommissioned aircraft types.

The list of aircraft types supported by BADA Revision 3.15 is given in Appendix A. In this Appendix, the supported aircraft types are listed alphabetically by their designation code. For each aircraft type, the aircraft name and type of BADA support (either original or synonym) is specified. Also, for each synonym aircraft, which is supported through equivalence, the corresponding equivalent aircraft type is specified.

2.2. UPDATES FOR BADA REVISION 3.15

The main updates made to BADA Revision 3.15 from the previous Revision 3.14 are listed below:

(a) Addition of 30 new aircraft models.

(b) Full remodelling of 5 aircraft types.

(c) Addition of new synonym aircraft and revision of existing ones.

(d) Updates of existing documentation.

A more complete overview of all changes can be found in [RD8].

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3. OPERATIONS PERFORMANCE MODEL

This section defines the various equations and coefficients used by the BADA operations performance model.

The first two subsections describe the equations for atmospheric properties and the Total-Energy Model (TEM) equations respectively.

The remaining eight subsections define the aircraft model in terms of the eight categories listed below:

- aircraft type,
- mass,
- flight envelope,
- aerodynamics,
- engine thrust,
- reduced power,
- fuel consumption,
- ground movement.

3.1. ATMOSPHERE MODEL

This section provides expressions for the atmospheric properties (pressure, temperature, density and speed of sound) as a function of altitude which are required for calculation of aircraft performances and movements[1]. Conversions from CAS to TAS and Mach number also require the determination of several atmospheric properties as a function of altitude.

The most important equations for atmospheric properties used by BADA and CAS/TAS conversion are summarised in this chapter, while other expressions and more details are provided in [RD12].

3.1.1. Definitions

Mean Sea Level (MSL) Standard atmosphere conditions are those that occur in the International Standard Atmosphere (ISA) at the point where the geopotential pressure altitude H_p[2] is zero. They are denoted as T_0, p_0, ρ_0 and a_0 with the values listed below:

Standard atmospheric temperature at MSL:	T_0	=	288.15	[K]
Standard atmospheric pressure at MSL:	p_0	=	101325	[Pa]
Standard atmospheric density at MSL:	ρ_0	=	1.225	[kg/m^3]
Speed of sound:	a_0	=	340.294	[m/s]

[1] These equations are based on the International Standard Atmosphere (ISA) [RD4].

[2] Geopotential pressure altitude H_p is the geopotential altitude H that occurs in the ISA atmospheric conditions [RD12].

Mean Sea Level (MSL) atmosphere conditions are those that occur in a non-ISA atmosphere. They are identified by the sub-index MSL and differ from (T_0, p_0, ρ_0, a_0) in non-ISA conditions.

Non-ISA atmospheres are those that follow the same hypotheses as the ISA atmosphere but differ from it in that one or both of the following parameters is not zero:

1. **ΔT**. Temperature differential at MSL. It is the difference in atmospheric temperature at MSL between a given non-standard atmosphere and ISA.

2. **Δp**. Pressure differential at MSL. It is the difference in atmospheric pressure at MSL between a given non-standard atmosphere and ISA.

The values of these two parameters uniquely identify any non-ISA atmosphere. Thus, a non-ISA atmosphere provides expressions for the atmospheric pressure, temperature and density as functions of the geopotential altitude H[3] and its two differentials. [RD12] provides more details on the corresponding analytical expressions.

3.1.2. Expressions

The relationships linking the atmospheric pressure p, temperature T, geopotential pressure altitude H_p and geopotential altitude H for any ISA[4] and non-ISA atmosphere are provided below.

Physical constants which are used throughout this chapter are listed below:

Adiabatic index of air:	κ	=	1.4	
Real gas constant for air:	R	=	287.05287	$[m^2/(K \cdot s^2)]$
Gravitational acceleration:	g_0	=	9.80665	$[m/s^2]$
ISA temperature gradient with altitude below the tropopause:	$\beta_{T,<}$	=	- 0.0065	[K/m]

Note that subindex < denotes values below and at the tropopause and subindex > denotes values above the tropopause (as defined by 3.1-11).

Standard Mean Sea Level (subindex $H_p = 0$)

The temperature differential ΔT sets the value of the real temperature T in non-standard atmospheres.

$$H_{p,Hp=0} = 0 \qquad (3.1\text{-}1)$$

[3] Geopotential altitude H is that which under the standard constant gravitational field provides the same differential work performed by the standard acceleration of free fall when displacing the unit of mass a distance dH along the line of force, as that performed by the geopotential acceleration when displacing the unit of mass a geodetic distance dh [RD12].

[4] By replacing ΔT and Δp parameters with zeros the expressions are made applicable to the case of the standard atmosphere.

$$p_{Hp=0} = p_0 \tag{3.1-2}$$

$$T_{ISA,Hp=0} = T_0 \tag{3.1-3}$$

$$T_{Hp=0} = T_0 + \Delta T \tag{3.1-4}$$

$$H_{Hp=0} = \frac{1}{\beta_{T,<}}\left[T_0 - T_{ISA,MSL} + \Delta T \cdot Ln\left(\frac{T_0}{T_{ISA,MSL}}\right)\right] \tag{3.1-5}$$

where T_{ISA} is the standard atmospheric temperature that occurs in the ISA atmosphere. It is a function of the geopotential pressure altitude H_p.

Mean Sea Level (subindex MSL)

The pressure differential Δp sets the value of the atmospheric pressure p.

$$H_{MSL}=0$$ (3.1-6)[5]

$$p_{MSL} = p_0 + \Delta p \tag{3.1-7}$$

$$H_{p,MSL} = \frac{T_0}{\beta_{T,<}}\left[\left(\frac{p_{MSL}}{p_0}\right)^{-\frac{\beta_{T,<}R}{g_0}} - 1\right] \tag{3.1-8}$$

$$T_{ISA,MSL} = T_0 + \beta_{T,<} H_{p,MSL} \tag{3.1-9}$$

$$T_{MSL} = T_0 + \Delta T + \beta_{T,<} H_{p,MSL} \tag{3.1-10}$$

Tropopause

Tropopause is the separation between two different layers: the troposphere, which stands below it, and the stratosphere, which is placed above. Its altitude $H_{p,trop}$ is constant when expressed in terms of geopotential pressure altitude:

$$H_{p,trop} = 11000 \text{ [m]} \tag{3.1-11}$$

[5] In order to simplify the expressions, this document assumes that the geopotential altitude at mean sea level is always zero.

a) Determination of Temperature

$$T = f\,(H_p,\ \Delta T) \tag{3.1-12}$$

$$T_< = T_0 + \Delta T + \beta_{T,<}\,H_{p,<} \tag{3.1-13}$$

$$T_{ISA,trop} = T_0 + \beta_{T,<}\,H_{p,trop} \tag{3.1-14}$$

$$T_{trop} = T_0 + \Delta T + \beta_{T,<}\,H_{p,trop} \tag{3.1-15}$$

$$T_> = T_{trop} \tag{3.1-16}$$

b) Determination of Air Pressure

$$p = f\,(T,\ \Delta T) \tag{3.1-17}$$

$$p_< = p_0\left(\frac{T_< - \Delta T}{T_0}\right)^{-\frac{g_0}{\beta_{T,<}R}} \tag{3.1-18}$$

$$p_{trop} = p_0\left(\frac{T_{trop} - \Delta T}{T_0}\right)^{-\frac{g_0}{\beta_{T,<}R}} \tag{3.1-19}$$

$T_> = T_{trop}$, so $p_>$ does not directly depend on temperature $T_>$. For altitudes above the tropopause, the following formula should be used:

$$p_> = p_{trop}\,\exp\left[-\frac{g_0}{R\,T_{ISA,trop}}\left(H_{p,>} - H_{p,trop}\right)\right] \tag{3.1-20}$$

where altitudes $H_{p,>}$ and $H_{p,trop}$ are expressed in metres.

c) Determination of Air Density

The air density, ρ, in kg/m^3, is calculated from the pressure p and the temperature T at altitude using the perfect gas law:

$$\rho = \frac{p}{R\,T} \tag{3.1-21}$$

d) Determination of Speed of Sound

The speed of sound, a, is the speed at which the pressure waves travel through a fluid and it is given by the expression:

$$a = \sqrt{\kappa R T} \tag{3.1-22}$$

e) CAS/TAS Conversion

The true airspeed, V_{TAS}, is calculated as a function of the calibrated air speed, V_{CAS}, as follows:

$$V_{TAS} = \left[\frac{2}{\mu} \frac{p}{\rho} \left\{ \left(1 + \frac{p_0}{p} \left[\left(1 + \frac{\mu}{2} \frac{\rho_0}{p_0} V_{CAS}^2 \right)^{\frac{1}{\mu}} - 1 \right] \right)^{\mu} - 1 \right\} \right]^{\frac{1}{2}} \tag{3.1-23}$$

Similarly, V_{CAS} is calculated as a function of V_{TAS} as follows:

$$V_{CAS} = \left[\frac{2}{\mu} \frac{p_0}{\rho_0} \left\{ \left(1 + \frac{p}{p_0} \left[\left(1 + \frac{\mu}{2} \frac{\rho}{p} V_{TAS}^2 \right)^{\frac{1}{\mu}} - 1 \right] \right)^{\mu} - 1 \right\} \right]^{\frac{1}{2}} \tag{3.1-24}$$

where symbols not previously defined are explained below:

$$\mu = \frac{\kappa - 1}{\kappa} \qquad \left(\mu = \frac{1}{3.5} \text{ if } \kappa = 1.4 \right) \tag{3.1-25}$$

Note that for these conversion formulas above, the speeds V_{TAS} and V_{CAS} must be specified in m/s.

f) Mach/TAS conversion

The true airspeed, V_{TAS} [m/s], is calculated as a function of the Mach number, M, as follows:

$$V_{TAS} = M \times \sqrt{\kappa R T} \tag{3.1-26}$$

g) Mach/CAS transition altitude

The transition altitude (also called crossover altitude), $H_{p,trans}$ [m], between a given CAS, V_{CAS} [m/s], and a Mach number, M, is defined to be the geopotential pressure altitude at which V_{CAS} and M represent the same TAS value, and can be calculated as follows:

$$H_{p,trans} = \begin{cases} \dfrac{T_0}{\beta_{T,<}} \cdot \left[\left(\dfrac{p_{trans}}{p_0} \right)^{-\frac{\beta_{T,<} R}{g_0}} - 1 \right] & \text{when } p_{trans} \geq p_{trop} \\ H_{P,trop} - \dfrac{R \cdot T_{ISA,trop}}{g_0} \cdot Ln \left(\dfrac{p_{trans}}{p_{trop}} \right) & \text{when } p_{trans} < p_{trop} \end{cases} \qquad (3.1\text{-}27)$$

where p_{trans} is the pressure at the transition altitude,

$$p_{trans} = p_0 \cdot \frac{\left[1 + \left(\dfrac{\kappa - 1}{2} \right) \left(\dfrac{V_{CAS}}{a_0} \right)^2 \right]^{\frac{\kappa}{\kappa - 1}} - 1}{\left[1 + \dfrac{\kappa - 1}{2} M^2 \right]^{\frac{\kappa}{\kappa - 1}} - 1} \qquad (3.1\text{-}28)$$

3.2. TOTAL-ENERGY MODEL

The Total-Energy Model equates the rate of work done by forces acting on the aircraft to the rate of increase in potential and kinetic energy, that is:

$$(Thr - D) \cdot V_{TAS} = mg_0 \frac{dh}{dt} + mV_{TAS} \frac{dV_{TAS}}{dt} \qquad (3.2\text{-}1)$$

The symbols are defined below with metric units specified:

Thr	-	thrust acting parallel to the aircraft velocity vector	[Newtons]
D	-	aerodynamic drag	[Newtons]
m	-	aircraft mass	[kilograms]
h	-	geodetic altitude	[m]
g_0	-	gravitational acceleration	[9.80665 m/s^2]
V_{TAS}	-	true airspeed	[m/s]
$\frac{d}{dt}$	-	time derivative	[s^{-1}]

Note that true airspeed is often calculated in knots and altitude calculated in feet thus requiring the appropriate conversion factors.

Without considering the use of devices such as spoilers, leading-edge slats or trailing-edge flaps, there are two independent control inputs available for affecting the aircraft trajectory in the vertical plane. These are the throttle and the elevator.

These inputs allow any two of the three variables of thrust, speed, or rate of climb or descent (ROCD) to be controlled. The other variable is then determined by equation 3.2-1. The three resulting control possibilities are elaborated on below.

(a) Speed and Throttle Controlled - Calculation of Rate of Climb or Descent

Assuming that velocity and thrust are independently controlled, then equation 3.2-1 is used to calculate the resulting rate of climb or descent (ROCD). This is a fairly common case for climbs and descents in which the throttle is set to some fixed position (maximum climb thrust or idle for descent) and the speed is maintained at some constant value of calibrated airspeed (CAS) or Mach number.

(b) ROCD and Throttle Controlled - Calculation of Speed

Assuming that the ROCD and thrust are independently controlled, then equation 3.2-1 is used to calculate the resulting speed.

(c) Speed and ROCD Controlled - Calculation of Thrust

Assuming that both ROCD and speed are controlled, then equation 3.2-1 can be used to calculate the necessary thrust. This thrust must be within the available limits for the desired ROCD and speed to be maintained.

Case (a), above, is the most common such that equation 3.2-1 is most often used to calculate the rate of climb or descent. To facilitate this calculation, equation 3.2-1 can be rearranged as follows:

$$(Thr - D) \cdot V_{TAS} = mg_0 \frac{dh}{dt} + m\, V_{TAS} \left(\frac{dV_{TAS}}{dh}\right)\left(\frac{dh}{dt}\right) \qquad (3.2\text{-}2)$$

Isolating the vertical speed on the left hand side gives:

$$\frac{dh}{dt} = \frac{(Thr - D) \cdot V_{TAS}}{mg_0}\left[1 + \left(\frac{V_{TAS}}{g_0}\right)\left(\frac{dV_{TAS}}{dh}\right)\right]^{-1} \qquad (3.2\text{-}3)$$

Vertical speed is defined as the variation with time of the aircraft geodetic altitude h. The assumption of a standard constant gravity field derives in identical geodetic and geopotential altitudes H [RD12].

The ROCD is defined as the variation with time of the aircraft geopotential pressure altitude H_p. It is the preferred way of presenting the performances of an aircraft as it eliminates possible variations caused by the atmospheric conditions:

$$ROCD = \frac{dH_p}{dt} = \frac{T - \Delta T}{T} \frac{(Thr - D) \cdot V_{TAS}}{mg_0}\left[1 + \left(\frac{V_{TAS}}{g_0}\right)\left(\frac{dV_{TAS}}{dh}\right)\right]^{-1} \qquad (3.2\text{-}4)$$

where:

T	-	atmosphere temperature [K];
ΔT	-	temperature differential [K].

It has been shown by Renteux [RD3] that the last term can be replaced by an energy share factor as a function of Mach number, f{M}:

$$f\{M\} = \left[1 + \left(\frac{V_{TAS}}{g_0}\right) \cdot \left(\frac{dV_{TAS}}{dh}\right)\right]^{-1} \qquad (3.2\text{-}5)$$

This leads to:

$$\frac{dh}{dt} = \left[\frac{(Thr - D) \cdot V_{TAS}}{mg_0}\right] f\{M\} \qquad (3.2\text{-}6)$$

$$ROCD = \frac{dH_P}{dt} = \frac{T - \Delta T}{T}\left[\frac{(Thr - D) \cdot V_{TAS}}{mg_0}\right] f\{M\} \qquad (3.2\text{-}7)$$

This energy share factor f{M} specifies how much of the available power is allocated to climb as opposed to acceleration while following a selected speed profile during climb.

For several common flight conditions, equation 3.2-5 can be rewritten as is done below. A more comprehensive description of this process can be found in [RD7]:

(a) Constant Mach number in stratosphere (i.e. above tropopause)

$$f\{M\} = 1.0 \tag{3.2-8}$$

Note that above the tropopause the air temperature and the speed of sound are constant. Maintaining a constant Mach number therefore requires no acceleration and all available power can be allocated to a change in altitude.

(b) Constant Mach number below tropopause:

$$f\{M\} = \left[1 + \frac{\kappa R \beta_{T,<}}{2 g_0} M^2 \frac{T - \Delta T}{T}\right]^{-1} \tag{3.2-9}$$

In this case, for a typical Mach number of 0.8 the energy share factor allocated to climb is 1.09.

This number is greater than 1 because below the tropopause, the temperature and thus, speed of sound decreases with altitude. Maintaining a constant Mach number during climb thus means that the true airspeed decreases with altitude. Consequently, the rate of climb benefits from not only all the available power but also a transfer of kinetic energy to potential energy.

(c) Constant Calibrated Airspeed (CAS) below tropopause

$$f\{M\} = \left\{1 + \frac{\kappa R \beta_{T,<}}{2 g_0} M^2 \frac{T - \Delta T}{T} + \left(1 + \frac{\kappa - 1}{2} M^2\right)^{\frac{-1}{\kappa - 1}} \left\{\left(1 + \frac{\kappa - 1}{2} M^2\right)^{\frac{\kappa}{\kappa - 1}} - 1\right\}\right\}^{-1} \tag{3.2-10}$$

In this case the energy share factor is less than one. A Mach number of 0.6 for example yields an energy share factor of 0.85.

This number is less than 1 because as density decreases with altitude, maintaining a constant CAS during climb requires maintaining a continual increase in true airspeed. Thus, some of the available power needs to be allocated to acceleration leaving the remainder for climb.

(d) Constant Calibrated Airspeed (CAS) above tropopause.

$$f\{M\} = \left\{1 + \left(1 + \frac{\kappa - 1}{2} M^2\right)^{\frac{-1}{\kappa - 1}} \left\{\left(1 + \frac{\kappa - 1}{2} M^2\right)^{\frac{\kappa}{\kappa - 1}} - 1\right\}\right\}^{-1} \tag{3.2-11}$$

This formula is identical to (3.2-10), except that β_T is now null since we are above the tropopause.

The energy share factors given above apply equally well to descent as to climb. The difference being that the available power is negative for descent.

In cases where neither constant Mach number nor constant CAS is maintained, the following energy share factors are used:

- acceleration in climb: f{M} = 0.3
- deceleration in descent: f{M} = 0.3
- deceleration in climb: f{M} = 1.7
- acceleration in descent: f{M} = 1.7

Note that, for the cases of acceleration in climb or deceleration in descent, the majority of the available power is devoted to a change in speed.

For the cases of deceleration in climb or acceleration in descent, the energy share factor is greater than 1 since the change of altitude benefits from a transfer of kinetic energy.

3.3. AIRCRAFT TYPE

Three values are specified for aircraft type, these being the number of engines, n_{eng}, the engine type and the wake category.

The engine type can be one of three values:

- Jet
- Turboprop
- Piston

The wake category can also be one of four values:

- J : jumbo
- H : heavy
- M: medium
- L : light

Note that ICAO associates a wake category with each aircraft type designator [RD2].

3.4. MASS

Four mass values are specified for each aircraft in tonnes:

m_{min} - minimum mass
m_{max} - maximum mass
m_{ref} - reference mass
m_{pyld} - maximum payload mass

Note that the specified mass limits are taken from aircraft performance reference data which is available in the BADA library. In function of specific aircraft certified limitations, a particular aircraft version of a given aircraft type (model) may have different limits. More details on the way the mass limits are selected in BADA are provided in [RD6].

Aircraft operating speeds vary with the aircraft mass. This variation is calculated according to the formula below:

$$V = V_{ref} \times \sqrt{\frac{m}{m_{ref}}} \qquad (3.4\text{-}1)$$

In this formula, the aircraft reference speed V_{ref} is given for the reference mass m_{ref}. The speed at another mass, m, is then calculated as V.

An example of an aircraft speed which can be calculated via this formula is the stall speed, V_{stall}.

3.5. FLIGHT ENVELOPE

(a) Maximum Speed and Altitude

The maximum speed and altitude for an aircraft are expressed in terms of the following six parameters:

V_{MO}	-	maximum operating speed (CAS) [kt]
M_{MO}	-	maximum operational Mach number
h_{MO}	-	maximum operating altitude [ft] above standard MSL
h_{max}	-	maximum altitude [ft] above standard MSL at MTOW under ISA conditions (allowing about 300 ft/min of residual rate of climb)
G_w	-	mass gradient on h_{max} [ft/kg]
G_t	-	temperature gradient on h_{max} [ft/K]

The maximum altitude for any given mass is:

$$h_{max/act} = MIN\left[h_{MO}, h_{max} + G_t \times (\Delta T - C_{Tc,4}) + G_w \times (m_{max} - m_{act})\right] \qquad (3.5\text{-}1)$$

where: ΔT is the temperature deviation from ISA [K]
m_{act} is the actual aircraft mass [kg]

with: $G_w \geq 0$

$G_t \leq 0$

if $(\Delta T - C_{Tc,4}) < 0$, then: $(\Delta T - C_{Tc,4}) = 0$

Formula 3.5-1 should not be executed when the h_{max} value in the OPF file is set to 0 (zero). In that case the maximum altitude is always h_{MO}.

Note that the given speed and altitude limits are taken from available reference data: depending upon specific certifications, a particular aircraft of a given type may present different limits.

(b) Minimum Speed

The minimum speed for the aircraft is in function of aircraft stall speed and specified as follows:

$$V_{min} = C_{Vmin,TO} \times V_{stall} \qquad \text{if in take-off} \qquad (3.5\text{-}2)$$

$$V_{min} = C_{Vmin} \times V_{stall} \qquad \text{otherwise} \qquad (3.5\text{-}3)$$

Note: See Section 3.6.2 for minimum speed at high altitude for jet aircraft and Section 5.7 for the values of the minimum speed coefficients.

Here the speeds are specified in terms of CAS. The stall speed depends upon the configuration.

Specifically, five different configurations are specified with a stall speed, $(V_{stall})_i$, and configuration threshold altitude, $H_{max,i}$, given for each:

TO - take-off configuration (in climb up to $H_{max,TO}$ AGL)	$(V_{stall})_{TO}$
IC - initial climb configuration (in climb between $H_{max,TO}$ and $H_{max,IC}$ AGL)	$(V_{stall})_{IC}$
CR - cruise (clean) configuration (in climb above $H_{max,IC}$ AGL, in cruise, in descent above $H_{max,AP}$ AGL, in descent below $H_{max,AP}$ AGL when $V \geq V_{min,cruise} + 10$ kt)	$(V_{stall})_{CR}$
AP - approach configuration (in descent between $H_{max,AP}$ AGL and $H_{max,LD}$ AGL when $V < V_{min,cruise} + 10$ kt, in descent below $H_{max,LD}$ AGL when $V_{min,cruise} + 10 \text{ kt} > V \geq V_{min,approach} + 10$ kt)	$(V_{stall})_{AP}$
LD - landing configuration (in descent below $H_{max,LD}$ AGL when $V < V_{min,approach} + 10$ kt)	$(V_{stall})_{LD}$

The threshold altitudes are expressed in terms of geopotential pressure altitude. However, when aircraft operations close to the ground are considered, one has to account for airport/runway elevation[6]. The pressure altitude thresholds provided above correspond to geopotential pressure altitude Above Ground Level (AGL).

The stall speeds correspond to a minimum stall speed and not a 1-g stall speed. Also, the BADA model assumes that for any aircraft these stall speeds have the following relationship:

$$(V_{stall})_{CR} \geq (V_{stall})_{IC} \geq (V_{stall})_{TO} \geq (V_{stall})_{AP} \geq (V_{stall})_{LD}$$

The configuration specific values are listed in Section 5.6. The speeds V used during the descent, approach and landing phases are defined in Section 4.3.

[6] Measured from Mean Sea Level (MSL).

3.6. AERODYNAMICS

3.6.1. Aerodynamic Drag

The lift coefficient, C_L, is determined assuming that the flight path angle is zero. However, a correction for a bank angle ϕ is made.

$$C_L = \frac{2 \cdot m \cdot g_0}{\rho \cdot V_{TAS}{}^2 \cdot S \cdot \cos\phi} \tag{3.6-1}$$

Under nominal conditions, the drag coefficient, C_D is specified as a function of the lift coefficient C_L as follows:

$$C_D = C_{D0,CR} + C_{D2,CR} \times (C_L)^2 \tag{3.6-2}$$

Formula 3.6-2 is valid for all situations except for the approach and landing where other drag coefficients are to be used.

In the approach configuration (as defined in Section 3.5) a different flap setting is used, and formula 3.6-3 should be applied:

$$C_D = C_{D0,AP} + C_{D2,AP} \times (C_L)^2 \tag{3.6-3}$$

In the landing configuration (as defined in Section 3.5) a different flap setting is used, and formula 3.6-4 should be applied:

$$C_D = C_{D0,LDG} + C_{D0,\Delta LDG} + C_{D2,LDG} \times (C_L)^2 \tag{3.6-4}$$

The value of $C_{D0,\Delta LDG}$ represents drag increase due to the landing gear. The values of $C_{D0,LD}$ in the OPF files were all determined for the landing flap setting mentioned in the OPF file.

The drag force [Newtons] is then determined from the drag coefficient in the standard manner:

$$D = \frac{C_D \cdot \rho \cdot V_{TAS}{}^2 \cdot S}{2} \tag{3.6-5}$$

Where:

ρ is the air density [kg/m^3]

S is the wing reference area [m^2]

V_{TAS} is the true airspeed [m/s].

Note that the air density is a function of altitude as described in Section 3.1.

The above equations thus result in eight coefficients for the specification of drag:

S	
$C_{D0,CR}$	$C_{D2,CR}$
$C_{D0,AP}$	$C_{D2,AP}$
$C_{D0,LD}$	$C_{D2,LD}$
$C_{D0,\Delta LDG}$	

In case the $C_{D0,AP}$, $C_{D2,AP}$, $C_{D0,LD}$, $C_{D2,LD}$ and $C_{D0,\Delta LDG}$ coefficients (referred to as "non-clean" data in this document) are set to 0 (zero) in the OPF file, expression 3.6-2 will be used in all cases.

3.6.2. Low Speed Buffeting Limit

For jet and turboprop aircraft, a low speed buffeting limit has been introduced. This buffeting limit is expressed as a Mach number and can be determined using the following equation:

$$k \times M^3 - C_{Lbo\,(M=0)} \times M^2 + \frac{W}{S \cdot p \cdot 0.583} = 0 \qquad (3.6\text{-}6)$$

where:

k is lift coefficient gradient

$C_{Lbo\,(M=0)}$ is initial buffet onset lift coefficient for M=0

p is actual pressure [Pa]

M is Mach number

S is the wing reference area [m^2]

W is aircraft weight [N]

Note that the factor of 0.583 gives a 0.2 g margin.

The k and $C_{Lbo\,(M=0)}$ parameters have been determined for many jet aircraft and one turboprop aircraft in BADA Revision 3.15. If the k and $C_{Lbo\,(M=0)}$ parameters in the OPF file are set to 0 (zero), the minimum speed is given by expressions 3.5-2 and 3.5-3. Otherwise, the solution for M in Formula 3.6-6 can be obtained using the method given in Appendix B. The buffeting limit should be applied as a minimum speed in the following way:

- If ($H_p \geq 15{,}000$ ft) then: $V_{min} = MAX(V_{min,stall}, M_b)$

- If ($H_p < 15{,}000$ ft) then: $V_{min} = V_{min,stall}$

where: H_p is the geopotential pressure altitude

M_b is the lowest positive solution of expression 3.6-6

$V_{min,stall}$ is given by expressions 3.5-2 and 3.5-3

Note that the units of the two values $V_{min,stall}$ and M_b inside the MAX() expression should be the same.

3.7. ENGINE THRUST

The BADA model provides coefficients that allow the calculation of the following thrust levels:

- maximum climb and take-off,
- maximum cruise,
- descent.

The thrust is calculated in Newtons and includes the contribution from all engines. The subsections below provide the equations for each of the thrust conditions.

3.7.1. Maximum Climb and Take-Off Thrust

The maximum climb thrust at standard atmosphere conditions, $(Thr_{max\ climb})_{ISA}$, is calculated in Newtons as a function of the following information:

- engine type: either Jet, Turboprop or Piston;
- geopotential pressure altitude, H_p [ft];
- true airspeed, V_{TAS} [kt];
- temperature deviation from standard atmosphere, ΔT [K].

The equations corresponding to the three engine types are given below.

Jet: $$(Thr_{max\,climb})_{ISA} = C_{Tc,1} \times \left(1 - \frac{H_p}{C_{Tc,2}} + C_{Tc,3} \times H_p^{\,2}\right) \tag{3.7-1}$$

Turboprop: $$(Thr_{max\,climb})_{ISA} = \frac{C_{Tc,1}}{V_{TAS}} \times \left(1 - \frac{H_p}{C_{Tc,2}}\right) + C_{Tc,3} \tag{3.7-2}$$

Piston: $$(Thr_{max\,climb})_{ISA} = C_{Tc,1} \times \left(1 - \frac{H_p}{C_{Tc,2}}\right) + \frac{C_{Tc,3}}{V_{TAS}} \tag{3.7-3}$$

For all engine types, the maximum climb thrust is corrected for temperature deviations from standard atmosphere, ΔT, in the following manner:

$$Thr_{max\,climb} = (Thr_{max\,climb})_{ISA} \times \left(1 - C_{Tc,5} \cdot \Delta T_{eff}\right) \tag{3.7-4}$$

Where:

$$\Delta T_{eff} = \Delta T - C_{Tc,4} \tag{3.7-5}$$

with the limits:

$$0.0 \leq \Delta T_{eff} \text{ x } C_{Tc,5} \leq 0.4 \tag{3.7-6}$$

and:

$$C_{Tc,5} \geq 0.0 \tag{3.7-7}$$

This maximum climb thrust is used for both take-off and climb phases.

3.7.2. Maximum Cruise Thrust

The normal cruise thrust is by definition set equal to drag (Thr = D). However, the maximum amount of thrust available in cruise situation is limited. The maximum cruise thrust is calculated as a ratio of the maximum climb thrust given by expression 3.7-4, that is:

$$(Thr_{cruise})_{MAX} = C_{Tcr} \times Thr_{max\,climb} \tag{3.7-8}$$

The coefficient C_{Tcr} is currently uniformly set for all aircraft (see Section 5.5).

3.7.3. Descent Thrust

Descent thrust is calculated as a ratio of the maximum climb thrust given by expression 3.7-4, with different correction factors used for high and low altitudes, and approach and landing configurations (see Section 3.5), that is:

if $H_p > H_{p,des}$:

$$Thr_{des,high} = C_{Tdes,high} \times Thr_{max\,climb} \tag{3.7-9}$$

if $H_p \leq H_{p,des}$:

Cruise configuration: $$Thr_{des,low} = C_{Tdes,low} \times Thr_{max\,climb} \tag{3.7-10}$$

Approach configuration: $$Thr_{des,app} = C_{Tdes,app} \times Thr_{max\,climb} \tag{3.7-11}$$

Landing configuration: $$Thr_{des,ld} = C_{Tdes,ld} \times Thr_{max\,climb} \tag{3.7-12}$$

Note that for those models where “non-clean” data (see Section 3.6.1) is available, $H_{p,des}$ cannot be below $H_{max,AP}$.

3.8. REDUCED CLIMB POWER

The reduced climb power has been introduced to allow the simulation of climbs using less than the maximum climb setting. In day-to-day operations, many aircraft use a reduced setting during climb in order to extend engine life and save cost. The correction factors that are used to calculate the reduction in power have been obtained in an empirical way and have been validated with the help of air traffic controllers.

In BADA, climbs that are performed using the full climb power will result in profiles that match the reference data that is found in the Flight Manual of the aircraft. Climbs with reduced power will give a realistic profile.

$$C_{pow,red} = 1 - C_{red} \times \frac{m_{max} - m_{act}}{m_{max} - m_{min}} \qquad (3.8\text{-}1)$$

The value of C_{red} is a function of the aircraft type and is given in Section 5.11.

Nevertheless:

If $H_p < (0.8 \cdot h_{max})$:

$C_{red} = f$ (aircraft type) (see Section 5.11)

Else

$C_{red} = 0$ [dimensionless]

where h_{max} is given by expression 3.5-1.

The power reduction $C_{pow,red}$ is to be applied during the climb phase in expression 3.2-7, which becomes:

$$ROCD = \frac{dH_p}{dt} = \frac{T - \Delta T}{T} \frac{(Thr_{max\,climb} - D) \cdot V_{TAS} \cdot C_{pow,red}}{m \cdot g_0} \cdot f\{M\} \qquad \text{(in climb)} \qquad (3.8\text{-}2)$$

3.9. FUEL CONSUMPTION

3.9.1. Jet and Turboprop Engines

For the jet and turboprop engines, the thrust specific fuel consumption, η [kg/(min·kN)], is specified as a function of the true airspeed, V_{TAS} [kt]:

jet: $$\eta = C_{f1} \times \left(1 + \frac{V_{TAS}}{C_{f2}}\right) \qquad (3.9\text{-}1)$$

turboprop: $$\eta = C_{f1} \times \left(1 - \frac{V_{TAS}}{C_{f2}}\right) \times \left(\frac{V_{TAS}}{1000}\right) \qquad (3.9\text{-}2)$$

The nominal fuel flow, f_{nom} [kg/min], can then be calculated using the thrust, Thr:

jet/turboprop: $$f_{nom} = \eta \times Thr \qquad (3.9\text{-}3)$$

These expressions are used in all flight phases except during idle descent and cruise, where the following expressions are to be used.

The minimum fuel flow, f_{min} [kg/min], corresponding to idle thrust descent conditions for both jet and turboprop engines, is specified as a function of the geopotential pressure altitude, H_p [ft], that is:

jet/turboprop: $$f_{min} = C_{f3}\left(1 - \frac{H_P}{C_{f4}}\right) \qquad (3.9\text{-}4)$$

Note that for both jet and turboprop engines, the idle thrust part of the descent stops when the aircraft switches to approach and landing configuration (see Section 3.5), at which point thrust is generally increased. Hence, the calculation of fuel flow during approach and landing phases shall be based on the nominal fuel flow (expressions 3.7-11, 3.7-12 and 3.9-3), and limited to the minimum fuel flow (expression 3.9-4) if necessary:

jet/turboprop: $$f_{ap/ld} = \text{MAX}\,(f_{nom}, f_{min}) \qquad (3.9\text{-}5)$$

The cruise fuel flow, f_{cr} [kg/min], is calculated using the thrust specific fuel consumption η, the thrust Thr, and a cruise fuel flow factor, C_{fcr}:

jet/turboprop: $$f_{cr} = \eta \times Thr \times C_{fcr} \qquad (3.9\text{-}6)$$

For the moment the cruise fuel flow correction factor has been established for a number of aircraft types whenever the reference data for cruise fuel consumption is available. This factor has been set to 1 (one) for all the other aircraft models.

3.9.2. Piston Engines

For piston engines, the nominal fuel flow, f_{nom} [kg/min], is specified to be a constant, that is:

$$f_{nom} = C_{f1} \tag{3.9-7}$$

This expression is used in all flight phases except during descent and cruise, where the following expressions are to be used.

The minimum fuel flow, f_{min} [kg/min], corresponding to descent conditions for piston engines, is specified to be a constant:

$$f_{min} = C_{f3} \tag{3.9-8}$$

The cruise fuel flow, f_{cr} [kg/min], is calculated using a cruise fuel flow factor, C_{fcr}:

$$f_{cr} = C_{f1} \times C_{fcr} \tag{3.9-9}$$

For the moment the cruise fuel flow correction factor has been established for a number of aircraft types whenever the reference data for cruise fuel consumption is available. This factor has been set to 1 (one) for all the other aircraft models.

3.10. GROUND MOVEMENT

Four values are specified that can be of use when simulating ground movements. These parameters are:

- TOL: FAR Take-Off Length [m] with MTOW on a dry, hard, level runway under ISA conditions and no wind.
- LDL: FAR Landing Length [m] with MLW on a dry, hard, level runway under ISA conditions and no wind.
- span: aircraft wingspan [m]
- length: aircraft length [m]

Note that currently the value of the MLW is not provided in BADA. Apart from these model specific parameters, there are also a number of ground speeds defined as general parameters in Section 5.10.

3.11. SUMMARY OF OPERATIONS PERFORMANCE PARAMETERS

A summary of the parameters specified by the BADA operations performance model is supplied in Table 3-1 below. This table excludes those parameters that have been set to zero.

Detailed information on how these parameters have been obtained during the process of BADA aircraft model identification using the aircraft performance reference documents is provided in [RD6].

Important notice: Parameters listed in bold in the Table 3-1 below should not be modified by the user as such modifications may impact the validity of the data provided in [RD11].

Table 3-1: BADA Operations Performance Parameter Summary

Model Category	Symbols	Units	Description
Aircraft type (3 values)	$\mathbf{n_{eng}}$ **engine type** **wake category**	dimensionless string string	**number of engines** **either Jet, Turboprop or Piston** **either J, H, M or L**
Mass (4 values)	$\mathbf{m_{ref}}$ $\mathbf{m_{min}}$ $\mathbf{m_{max}}$ $\mathbf{m_{pyld}}$	tonnes tonnes tonnes tonnes	**reference mass** **minimum mass** **maximum mass** **maximum payload mass**
Flight envelope (6 values)	$\mathbf{V_{MO}}$ $\mathbf{M_{MO}}$ $\mathbf{h_{MO}}$ $\mathbf{h_{max}}$ $\mathbf{G_w}$ $\mathbf{G_t}$	knots (CAS) dimensionless feet feet feet/kg feet/K	**maximum operating speed** **maximum operating Mach number** **maximum operating altitude** **max. altitude at MTOW and ISA** **weight gradient on max. altitude** **temperature gradient on max. altitude**
Aerodynamics (15 values for Jet & TBP aircraft, 13 values for others)	$\mathbf{S}$ $\mathbf{C_{D0,CR}}$ $\mathbf{C_{D2,CR}}$ $\mathbf{C_{D0,AP}}$ $\mathbf{C_{D2,AP}}$ $\mathbf{C_{D0,LD}}$ $\mathbf{C_{D2,LD}}$ $\mathbf{C_{D0,\Delta LDG}}$ $\mathbf{(V_{stall})_i}$ $\mathbf{C_{Lbo\,(M=0)}}$ $\mathbf{k}$	m^2 dimensionless dimensionless dimensionless dimensionless dimensionless dimensionless dimensionless knots (CAS) dimensionless dimensionless	**reference wing surface area** **parasitic drag coefficient (cruise)** **induced drag coefficient (cruise)** **parasitic drag coefficient (approach)** **induced drag coefficient (approach)** **parasitic drag coefficient (landing)** **induced drag coefficient (landing)** **parasite drag coef. (landing gear)** **stall speed [TO, IC, CR, AP, LD]** **buffet onset lift coef. (Jet & TBP only)** **buffeting gradient (Jet & TBP only)**

Model Category	Symbols	Units	Description
Engine thrust (12 values)	$C_{Tc,1}$	Newton (jet/piston) knot-Newton (turboprop)	**1st max. climb thrust coefficient**
	$C_{Tc,2}$	feet	**2nd max climb thrust coefficient**
	$C_{Tc,3}$	1/feet^2 (jet) Newton (turboprop) knot-Newton (piston)	**3rd max. climb thrust coefficient**
	$C_{Tc,4}$	K	**1st thrust temperature coefficient**
	$C_{Tc,5}$	1/K	**2nd thrust temperature coefficient**
	$C_{Tdes,low}$	dimensionless	**low altitude descent thrust coefficient**
	$C_{Tdes,high}$	dimensionless	**high altitude descent thrust coefficient**
	$H_{p,des}$	feet	**transition altitude for calculation of descent thrust**
	$C_{Tdes,app}$	dimensionless	**approach thrust coefficient**
	$C_{Tdes,ld}$	dimensionless	**landing thrust coefficient**
	$V_{des,ref}$	knots (CAS)	reference descent speed
	$M_{des,ref}$	dimensionless	reference descent Mach number
Fuel flow (5 values)	C_{f1}	kg/(min·kN) (jet) kg/(min·kN·knot) (turboprop) kg/min (piston)	**1st thrust specific fuel consumption coefficient**
	C_{f2}	knots	**2nd thrust specific fuel consumption coefficient**
	C_{f3}	kg/min	**1st descent fuel flow coefficient**
	C_{f4}	feet	**2nd descent fuel flow coefficient**
	C_{fcr}	dimensionless	**cruise fuel flow correction coefficient**
Ground movement (4 values)	TOL	m	take-off length
	LDL	m	landing length
	span	m	wingspan
	length	m	length

Note that the following coefficients can have negative values:
K, G_t, $C_{Tc,1}$, $C_{Tc,2}$, $C_{Tc,3}$, $C_{Tc,4}$, $C_{Tdes,low}$, $C_{Tdes,high}$, C_{f1}, C_{f2}, C_{f4}.

4. AIRLINE PROCEDURE MODELS

This section defines the standard airline procedures, which are parameterised by the BADA airline procedure models. Definition of the standard airline procedures in BADA is driven by a requirement to provide means of simulating standard or nominal aircraft operations using different simulation and modelling tools for various ATM applications.

The BADA airline procedure model is provided for three separate flight phases: climb, cruise and descent. For each of these phases and each aircraft model, the BADA airline procedure model requires the following information to determine aircraft speed schedule:

1. BADA airline procedure default speeds provided in Airline Procedure File (APF):

   V_1 - standard CAS [knots] below 10,000 ft;

   V_2 - standard CAS [knots] between 10,000 ft and Mach transition altitude;

   M - standard Mach number above Mach transition altitude;

   where the Mach transition altitude is defined in Section 3.1 (g).
2. Stall speeds for take-off and landing configurations provided in Operations Performance File (OPF)
3. Coefficients provided in the Section 5.7 and 5.8

The process of definition of the BADA airline procedure default speeds and choice of aircraft configurations in function of flight phase is described in [RD6]. The airline procedure model below 10,000 ft with corresponding coefficients (mentioned under item 3 above) have been defined taking into account aircraft manufacturer's performance reference data and aircraft operational data available at EUROCONTROL.

The fact that the way aircraft is operated varies significantly in function of specific airspace procedures and operating policies of locally dominant airlines is widely recognised. It is for that reason that the resulting speed schedules of the BADA standard airline procedure model may differ from a geographical location or of an aerospace's specific aircraft operation.

To account for the local aircraft operation characteristics and improve conformance of the simulated aircraft behaviour with real operations, the user of BADA is given a possibility to modify the BADA default speeds (as provided in APF file). The change of speed related APF parameters should be done in accordance with the BADA modelling procedure described in the Chapter 2.2.3 of [RD6].

However, the stall speeds (as provided in OPF file) and coefficients detailed in Section 5.7 and 5.8 are not subject to modification. The BADA User should not modify them.

The altitude levels, used for determination of CAS speed schedules and provided in the following chapters, are expressed in terms of geopotential pressure altitude. However, different reference datums for altitude measurement[7] may be applied in function of the user application and its functional design choices.

The BADA Airline Procedure Model only identifies the possibility to introduce notion of different altitude altimetry for calculation of the CAS speed schedules in the user application. The implementation decision is left to the application owner.

[7] Such as use of standard operational pressure settings used in aviation: QNH for MSL pressure, QFE for pressure at the airport reference point or QNE corresponding to standard MSL1013 hPa.These can be selected through the altimeter's pressure setting knob in the aircraft.

4.1. CLIMB

The following parameters are defined for each aircraft type to characterise the climb phase:

$V_{cl,1}$	-	standard climb CAS [knots] between 1,500/6,000 and 10,000 ft
$V_{cl,2}$	-	standard climb CAS [knots] between 10,000 ft and Mach transition altitude
M_{cl}	-	standard climb Mach number above Mach transition altitude

- For jet aircraft the following CAS schedule is assumed, based on the parameters mentioned above and the take-off stall speed:

from 0 to 1,499 ft	$C_{Vmin} \cdot (V_{stall})_{TO} + Vd_{CL,1}$	(4.1-1)
from 1,500 to 2,999 ft	$C_{Vmin} \cdot (V_{stall})_{TO} + Vd_{CL,2}$	(4.1-2)
from 3,000 to 3,999 ft	$C_{Vmin} \cdot (V_{stall})_{TO} + Vd_{CL,3}$	(4.1-3)
from 4,000 to 4,999 ft	$C_{Vmin} \cdot (V_{stall})_{TO} + Vd_{CL,4}$	(4.1-4)
from 5,000 to 5,999 ft	$C_{Vmin} \cdot (V_{stall})_{TO} + Vd_{CL,5}$	(4.1-5)
from 6,000 to 9,999 ft	min ($V_{cl,1}$, 250 kt)	
from 10,000 ft to Mach transition altitude	$V_{cl,2}$	
above Mach transition altitude	M_{cl}	

- For turboprop and piston aircraft the following CAS schedule is assumed:

from 0 to 499 ft	$C_{Vmin} \cdot (V_{stall})_{TO} + Vd_{CL,6}$	(4.1-6)
from 500 to 999 ft	$C_{Vmin} \cdot (V_{stall})_{TO} + Vd_{CL,7}$	(4.1-7)
from 1,000 to 1,499 ft	$C_{Vmin} \cdot (V_{stall})_{TO} + Vd_{CL,8}$	(4.1-8)
from 1,500 to 9,999 ft	min ($V_{cl,1}$, 250 kt)	
from 10,000 ft to Mach transition altitude	$V_{cl,2}$	
above Mach transition altitude	M_{cl}	

Note 1: The take-off stall speed, $(V_{stall})_{TO}$, must be corrected for the difference in aircraft mass from the reference mass using formula 3.4-1. The values for $Vd_{CL,i}$ can be found in Section 5.

Note 2: The climb speed schedule shall determine an increasing speed from take-off to $V_{cl,1}$. To ensure that monotony, it is recommended to determine the speed schedule from the highest altitude to the lowest one, and to use at each step the speed of the higher altitude range as a ceiling value for the lower altitude range.

Note 3: Any speed from the schedule described above that would be lower (resp. higher) than the minimum (resp. maximum) speed determined for the same conditions using Section 3.5 (b) (resp. Section 3.5 (a)) shall be overriden by this minimum (resp. maximum) speed.

4.2. CRUISE

The following parameters are defined for each aircraft type to characterise the cruise phase:

$V_{cr,1}$	-	standard cruise CAS [knots] between 3,000 and 10,000 ft
$V_{cr,2}$	-	standard cruise CAS [knots] between 10,000 ft and Mach transition altitude
M_{cr}	-	standard cruise Mach number above Mach transition altitude

- For jet aircraft the following CAS schedule is assumed:

from 0 to 2,999 ft	min ($V_{cr,1}$, 170 kt)
from 3,000 to 5,999 ft	min ($V_{cr,1}$, 220 kt)
from 6,000 to 13,999 ft	min ($V_{cr,1}$, 250 kt)
from 14,000 ft to Mach transition altitude	$V_{cr,2}$
above Mach transition altitude	M_{cr}

- For turboprop and piston aircraft the following CAS schedule is assumed:

from 0 to 2,999 ft	min ($V_{cr,1}$, 150 kt)
from 3,000 to 5,999 ft	min ($V_{cr,1}$, 180 kt)
from 6,000 to 9,999 ft	min ($V_{cr,1}$, 250 kt)
from 10,000 ft to Mach transition altitude	$V_{cr,2}$
above Mach transition altitude	M_{cr}

Note: Any speed from the schedule described above that would be lower (resp. higher) than the minimum (resp. maximum) speed determined for the same conditions using Section 3.5 (b) (resp. Section 3.5 (a)) shall be overriden by this minimum (resp. maximum) speed.

4.3. DESCENT

The following parameters are defined for each aircraft type to characterise the descent phase:

$V_{des,1}$ - standard descent CAS [knots] between 3,000/6,000 and 10,000 ft

$V_{des,2}$ - standard descent CAS [knots] between 10,000 ft and Mach transition altitude

M_{des} - standard descent Mach number above Mach transition altitude

- For jet and turboprop aircraft the following CAS schedule is assumed, based on the above parameters and the landing stall speed:

from 0 to 999 ft	$C_{Vmin} \cdot (V_{stall})_{LD} + Vd_{DES,1}$	(4.3-1)
from 1,000 to 1,499 ft	$C_{Vmin} \cdot (V_{stall})_{LD} + Vd_{DES,2}$	(4.3-2)
from 1,500 to 1,999 ft	$C_{Vmin} \cdot (V_{stall})_{LD} + Vd_{DES,3}$	(4.3-3)
from 2,000 to 2,999 ft	$C_{Vmin} \cdot (V_{stall})_{LD} + Vd_{DES,4}$	(4.3-4)
from 3,000 to 5,999 ft	min ($V_{des,1}$, 220)	
from 6,000 to 9,999 ft	min ($V_{des,1}$, 250)	
from 10,000 ft to Mach transition altitude	$V_{des,2}$	
above Mach transition altitude	M_{des}	

- For piston aircraft the following CAS schedule is assumed:

from 0 to 499 ft	$C_{Vmin} \cdot (V_{stall})_{LD} + Vd_{DES,5}$	(4.3-5)
from 500 to 999 ft	$C_{Vmin} \cdot (V_{stall})_{LD} + Vd_{DES,6}$	(4.3-6)
from 1000 to 1,499 ft	$C_{Vmin} \cdot (V_{stall})_{LD} + Vd_{DES,7}$	(4.3-7)
from 1,500 to 9,999 ft	$V_{des,1}$	
from 10,000 ft to Mach transition altitude	$V_{des,2}$	
above Mach transition altitude	M_{des}	

Note 1: The landing stall speed, $(V_{stall})_{LD}$, must be corrected for the difference in aircraft mass from the reference mass using formula 3.4-1. The values for $Vd_{DES,i}$ can be found in Section 5.

Note 2: The descent speed schedule shall determine a decreasing speed from $V_{des,1}$ to landing. To ensure that monotony, it is recommended to evaluate the speed schedule from the highest altitude to the lowest one, and to use at each step the speed of the higher altitude range as a ceiling value for the lower altitude range.

Note 3: Any speed from the schedule described above that would be lower (resp. higher) than the minimum (resp. maximum) speed determined for the same conditions using Section 3.5 (b) (resp. Section 3.5 (a)) shall be overriden by this minimum (resp. maximum) speed.

5. GLOBAL AIRCRAFT PARAMETERS

5.1. INTRODUCTION

A number of parameters that have been described in Section 3 (Operations Performance Model) and Section 4 (Airline Procedure Model) have values that are independent of the aircraft type or model for which they are used. The values of these and other parameters which have general use, have been put in the Global Parameters File (BADA.GPF). This increases the flexibility and allows an easier evaluation of the values that are used.

The next section gives an overview of the parameters that are defined in the Global Parameters File. If relevant, it also indicates the formula in which the parameter should be used.

5.2. MAXIMUM ACCELERATION

Maximum acceleration parameters are used to limit the increment in TAS (longitudinal) or ROCD (normal). Two parameters are defined:

Name:	**Description:**	**Value [ft/s^2]:**
$a_{l,max\,(civ)}$	maximum longitudinal acceleration for civil flights	2.0
$a_{n,max\,(civ)}$	maximum normal acceleration for civil flights	5.0

The two acceleration limits are to be used in the following way:

- longitudinal acceleration: $$\left| V_k - V_{k-1} \right| \leq a_{l,max\,(civ)}\, \Delta t \qquad (5.2\text{-}1)$$
- normal acceleration: $$\left| \gamma_k - \gamma_{k-1} \right| \leq \frac{a_{n,max\,(civ)}\, \Delta t}{V} \qquad (5.2\text{-}2)$$

where,

$$\gamma = \sin^{-1}\left(\frac{\dot{h}}{V}\right) \qquad (5.2\text{-}3)$$

and,

γ	is the climb/descent angle,
V	is the true airspeed [ft/s],
k, k-1	indicate values at update intervals k and k-1,
Δt	is the time interval between k and k-1 [s]

The values for the maximum longitudinal acceleration for military flights, $a_{l,max\ (mil)}$, and for the maximum normal acceleration for military flights, $a_{n,max\ (mil)}$, are currently undefined.

5.3. BANK ANGLES

Nominal and maximum bank angles are defined separately for military and civil flights. These bank angles can be used to calculate nominal and maximum rate of turns.

Name:	Description:	Value [deg]:
$\phi_{nom,civ\ (TO,LD)}$	Nominal bank angles for civil flight during TO and LD	15
$\phi_{nom,civ\ (OTHERS)}$	Nominal bank angles for civil flight during all other phases	30
$\phi_{nom,mil}$	Nominal bank angles for military flight (all phases)	50
$\phi_{max,civ\ (TO,LD)}$	Maximum bank angles for civil flight during TO and LD	25
$\phi_{max,civ\ (HOLD)}$	Maximum bank angles for civil flight during HOLD	35
$\phi_{max,civ\ (OTHERS)}$	Maximum bank angles for civil flight during all other phases	45
$\phi_{max,mil}$	Maximum bank angles for military flight (all phases)	70

The rate of turn, $\dot{\varphi}$, is calculated as a function of the bank angle:

$$\dot{\varphi} = \frac{g_0}{V_{TAS}} \times \tan(\phi) \qquad (5.3\text{-}1)$$

5.4. EXPEDITED DESCENT

The expedited descent factor is to be used as a drag multiplication factor during expedited descents in order to simulate use of spoilers:

Name:	Description:	Value [-]:
$C_{des,exp}$	Expedited descent factor	1.6

The drag during an expedited descent is calculated using the nominal drag (see Section 3.6.1):

$$D_{des,exp} = C_{des,exp} \cdot D_{nom} \qquad (5.4\text{-}1)$$

5.5. THRUST FACTORS

Maximum take-off and maximum cruise thrust factors have been specified. The $C_{Th,TO}$ factor is no longer used since BADA 3.0. The C_{Tcr} factor is to be used in expression 3.7-8.

Name:	Description:	Value [-]:
$C_{Th,TO}$	Take-off thrust coefficient	1.2
C_{Tcr}	Maximum cruise thrust coefficient	0.95

5.6. CONFIGURATION ALTITUDE THRESHOLD

For 4 configurations, altitude thresholds have been specified in BADA: take-off (TO), initial climb (IC), approach (AP) and landing (LD). Note that the selection of the take-off and initial climb configurations is defined only with the altitude. The selection of the approach and landing configurations is done through the use of air speed and altitude (see Section 3.5), while the altitudes at which the configuration change takes place should not be higher than the ones given below. The altitude values are expressed in terms of geopotential pressure altitude.

Name:	Description:	Value [ft]:
$H_{max,TO}$	Maximum altitude threshold for take-off	400
$H_{max,IC}$	Maximum altitude threshold for initial climb	2,000
$H_{max,AP}$	Maximum altitude threshold for approach	8,000
$H_{max,LD}$	Maximum altitude threshold for landing	3,000

5.7. MINIMUM SPEED COEFFICIENTS

Two minimum speed coefficients are specified, which are to be used in expressions 3.5-2 and 3.5-3 and (for C_{Vmin} only) in Section 4.1 and 4.3:

Name:	Description:	Value [-]:
$C_{Vmin,TO}$	Minimum speed coefficient for take-off	1.2
C_{Vmin}	Minimum speed coefficient (all other phases)	1.3

5.8. SPEED SCHEDULES

The speed schedules applicable below FL100 for climb and descent are based on a factored stall speed plus increment valid for a specified geopotential pressure altitude range.

Name:	Description:	Value [KCAS]:
$Vd_{CL,1}$	Climb speed increment below 1500 ft (jet)	5
$Vd_{CL,2}$	Climb speed increment below 3000 ft (jet)	10
$Vd_{CL,3}$	Climb speed increment below 4000 ft (jet)	30
$Vd_{CL,4}$	Climb speed increment below 5000 ft (jet)	60
$Vd_{CL,5}$	Climb speed increment below 6000 ft (jet)	80
$Vd_{CL,6}$	Climb speed increment below 500 ft (turbo/piston)	20
$Vd_{CL,7}$	Climb speed increment below 1000 ft (turbo/piston)	30
$Vd_{CL,8}$	Climb speed increment below 1500 ft (turbo/piston)	35
$Vd_{DES,1}$	Descent speed increment below 1000 ft (jet/turboprop)	5
$Vd_{DES,2}$	Descent speed increment below 1500 ft (jet/turboprop)	10
$Vd_{DES,3}$	Descent speed increment below 2000 ft (jet/turboprop)	20
$Vd_{DES,4}$	Descent speed increment below 3000 ft (jet/turboprop)	50
$Vd_{DES,5}$	Descent speed increment below 500 ft (piston)	5

$Vd_{DES,6}$	Descent speed increment below 1000 ft (piston)	10
$Vd_{DES,7}$	Descent speed increment below 1500 ft (piston)	20

These values are to be used in the expressions in Section 4.1 and 4.3.

5.9. HOLDING SPEEDS

The holding speeds that are to be used to calculate holding areas are defined according to the ICAO standards:

Name:	Description:	Value [KCAS]:
$V_{hold,1}$	Holding speed below FL140	230
$V_{hold,2}$	Holding speed between FL140 and FL200	240
$V_{hold,3}$	Holding speed between FL200 and FL340	265
$V_{hold,4}$	Holding speed above FL340 [Mach]	0.83

Note that the holding speeds that are used by individual aircraft may vary between types.

5.10. GROUND SPEEDS

A number of ground speeds are defined for the simulation of ground movement. For the moment, no distinction between aircraft type or engine type is made. The following speeds have been defined:

Name:	Description:	Value [KCAS]:
$V_{backtrack}$	Runway backtrack speed	35
V_{taxi}	Taxi speed	15
V_{apron}	Apron speed	10
V_{gate}	Gate speed	5

The runway backtrack speed is the speed the aircraft will maintain when it backtracks across the runway. The taxi speed is used anywhere between the runway and the apron area. The apron speed is used in the apron area while the gate speed is used for all manoeuvring between the gate position and the apron.

5.11. REDUCED POWER COEFFICIENT

The reduced power coefficients are defined for the three different engine types. It is stressed that the values given below were found in an empirical way and have been validated with the help of air traffic controllers:

Name:	Description:	Value [-]:
$C_{red,turbo}$	Maximum reduction in power for turboprops	0.25
$C_{red,piston}$	Maximum reduction in power for pistons	0.0
$C_{red,jet}$	Maximum reduction in power for jets	0.15

The coefficients should be used in Formula 3.8-1.

6. FILE STRUCTURE

6.1. FILE TYPES

All data provided by BADA Revision 3.15 are organised into six types of files:

- one Synonym File,
- a set of Operations Performance Files,
- a set of Airline Procedure Files,
- a set of Performance Table Files,
- a set of Performance Table Data,
- a Global Parameter File.

- The Synonym File, named SYNONYM.NEW, provides a list of all the aircraft types which are supported by BADA and indicates whether the aircraft type is supported directly (through provision of parameters in other files) or supported by equivalence (through indicating an equivalent aircraft type that is supported directly). In addition, the file indicates whether the aircraft type is recognised by ICAO in [RD2]. The format of the file is described in Section 6.3.
- There is one Operations Performance File (OPF) provided for each aircraft type which is directly supported. This file specifies parameter values for the mass, flight envelope, drag, engine thrust and fuel consumption that are described in Section 3. Details on the format of the OPF file are given in Section 6.4.
- There is one Airline Procedures File (APF) for each directly supported aircraft type. This file specifies the nominal manoeuvre speeds that are described in Section 4. Details on the format of the APF file are given in Section 6.5.
- There is one Performance Table File (PTF) for each directly supported aircraft type. This file contains a summary table of speeds, climb/descent rates and fuel consumption at various flight levels. Details on the format of the PTF file are given in Section 6.6.
- There is one Performance Table Data (PTD) file for each directly supported aircraft type. This file contains a detailed table of computed performance values at various flight levels. Details on the format of the PTD file are given in Section 6.7.
- Finally there is one Global Parameter File which is named BADA.GPF. This file contains parameters that are described in Section 5 and are valid for all aircraft or a group of aircraft (for instance all civil flights or all jet aircraft). Details on the format of the GPF file are given in Section 6.8.

The names of the OPF, APF, PTF and PTD files are based on the ICAO designation code for the aircraft type. With only the exception of the generic military fighter aircraft types (FGTH, FGTL), this code is the same as the International Civil Aviation Organisation (ICAO) designator code for the aircraft type [RD2]. That is:

Operations Performance File name:	<ICAO_code>__.OPF
Airline Procedures File name:	<ICAO_code>__.APF
Performance Table File name:	<ICAO_code>__.PTF
Performance Table Data name:	<ICAO_code>__.PTD

Note that there are at least two underscore characters between the ICAO code and the file extension such that the length of the file name without the extension is six characters. Most ICAO codes are four characters in length and thus have two underscore characters. Some ICAO codes, however, can be shorter (e.g. F50) and thus require more underscore characters. For example, an Airbus 310 which has the ICAO code of A310 is represented in BADA by the following files:

Operations Performance File:	A310__.OPF
Airline Procedures File:	A310__.APF
Performance Table File:	A310__.PTF
Performance Table Data:	A310__.PTD

The Fokker 50, which has the ICAO code of F50, is represented in BADA by the following files:

Operations Performance File:	F50___.OPF
Airline Procedures File:	F50___.APF
Performance Table File:	F50___.PTF
Performance Table Data:	F50___.PTD

6.2. RELEASE SUMMARY FILE

The ReleaseSummary file provides a list of all files delivered as part of the BADA release. It lists, for each BADA file, the file name and BADA release identification, which is the BADA release in which the file was last modified.

6.3. SYNONYM FILE FORMAT

The SYNONYM.NEW file is an ASCII file, which lists all aircraft types supported by the BADA revision. All supported aircraft are listed alphabetically in the file whether they are supported directly or by equivalence. An example of the SYNONYM.NEW file is given below (partial listing).

```
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC SYNONYM.NEW CCCCCCCCCCCCCCC/
CC                                                                    /
CC                  BADA SYNONYM FILE                                 /
CC                                                                    /
CC                                                                    /
CC        File_name: SYNONYM.NEW                                      /
CC                                                                    /
CC        Creation_date: Apr 30 2002                                  /
CC                                                                    /
CC        Modification_date: Aug 25 2014                              /
CC                                                                    /
CC                                                                    /
CC====== Aircraft List ===============================================/
CC                                                                    /
CC   A/C    MANUFACTURER        NAME OR MODEL              FILE   ICAO /
CC   CODE                                                             /
CC                                                                    /
CD * A10    FAIRCHILD           THUNDERBOLT II            FGTN__  Y    /
CD - A124   ANTONOV             AN-124 RUSLAN             A124__  Y    /
CD - A140   ANTONOV             AN-140                    A140__  Y    /
CD - A148   ANTONOV             AN-148-100B               A148__  Y    /
CD - A306   AIRBUS              A300B4-600                A306__  Y    /
CD - A30B   AIRBUS              A300B4-200                A30B__  Y    /
CD - A310   AIRBUS              A310                      A310__  Y    /
CD - A318   AIRBUS              A318                      A318__  Y    /
CD - A319   AIRBUS              A319                      A319__  Y    /
CD - A320   AIRBUS              A320                      A320__  Y    /
CD - A321   AIRBUS              A321                      A321__  Y    /
CD - A332   AIRBUS              A330-200                  A332__  Y    /
CD - A333   AIRBUS              A330-300                  A333__  Y    /
CD - A342   AIRBUS              A340-200                  A342__  Y    /
CD - A343   AIRBUS              A340-300                  A343__  Y    /
CD - A345   AIRBUS              A340-500                  A345__  Y    /
CD - A346   AIRBUS              A340-600                  A346__  Y    /
CD * A359   AIRBUS              A350-900 WXB              B772__  Y    /
CD - A388   AIRBUS              A380-800                  A388__  Y    /
CD - A3ST   AIRBUS              A-300ST Beluga            A3ST__  Y    /
CD * A4     DOUGLAS             SUPER SKYHAWK             FGTN__  Y    /
CD * A400   AIRBUS              A-400M                    A3ST__  Y    /
CD * A6     GRUMMAN             INTRUDER                  FGTN__  Y    /
CD * A660   THRUSH              660 TURBO THRUSH          AN28__  Y    /
CD * A7     VOUGHT              CORSAIR II A7             FGTN__  Y    /
CD * A748   AVRO                AVRO 748                  ATP___  Y    /
```

There are three types of lines in the SYNONYM.NEW file with the line type identified by the first two characters in the line. These line types with their associated two leading characters are listed below.

CC	comment line
CD	data line
FI	end-of-file line

The data is organised into two blocks separated by a comment line consisting of the block name and equal signs "=":

- file identification block
- aircraft list block

Each of these blocks is described in the subsections below.

6.3.1.1. File Identification Block

The file identification block provides information on the file name, creation and modification date. The block consists of 12 comment lines as shown below.

```
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC SYNONYM.NEW CCCCCCCCCCCCCCC/
CC                                                                    /
CC                  BADA SYNONYM FILE                                 /
CC                                                                    /
CC                                                                    /
CC       File_name: SYNONYM.NEW                                       /
CC                                                                    /
CC       Creation_date: Apr 30 2002                                   /
CC                                                                    /
CC       Modification_date: Aug 25 2014                               /
CC                                                                    /
CC                                                                    /
```

The comment lines specify the file name along with the creation and last modification date. The creation date indicates the date when the file was created for the first time. The modification date indicates when the contents of the file were last modified.

6.3.1.2. Aircraft Listing Block

The aircraft listing block consists of 5 comment lines and at least one data line for each aircraft supported by the BADA revision. A partial listing of this block is shown below.

```
CC====== Aircraft List ===============================================/
CC                                                                    /
CC   A/C    MANUFACTURER        NAME OR MODEL             FILE   ICAO /
CC   CODE                                                             /
CC                                                                    /
CD * A10    FAIRCHILD           THUNDERBOLT II           FGTN__   Y    /
CD - A124   ANTONOV             AN-124 RUSLAN            A124__   Y    /
CD - A140   ANTONOV             AN-140                   A140__   Y    /
CD - A148   ANTONOV             AN-148-100B              A148__   Y    /
CD - A306   AIRBUS              A300B4-600               A306__   Y    /
CD - A30B   AIRBUS              A300B4-200               A30B__   Y    /
```

Each data line consists of 6 fields as described below:

(a) Support Type Field

This field is one character in length being one of the following two values:

"-" to indicate an aircraft type directly supported, and,

"*" to indicate an aircraft type supported by equivalence with another directly supported aircraft

(b) Aircraft Code Field

This field identifies the aircraft type. It consists of a three or four-character ICAO code.

(c) Manufacturer Field

This field identifies the manufacturer of the aircraft. Examples are Boeing, Airbus or Fokker.

(d) Name or Model Field

This field identifies the name or model for the aircraft type. Examples are the 747-400 series or Learjet 35.

(e) File Field

This field indicates the name of the OPF, APF, PTF or PTD file, which contains the parameters for the aircraft type (minus the file extension).

For an aircraft type which is directly supported this file name will be the same as the ICAO code with an additional two or more underscore characters to form a string of six characters in length. For example, the file name corresponding to the A333 will be A333__. This indicates an OPF file A333__.OPF, an APF file A333__.APF, a PTF file A333__.PTF and a PTD file A333__.PTD. For the Fokker F-27 with an ICAO code of F27, the file names include three underscore characters, that is, F27___.OPF, F27___.APF, F27___.PTF and F27___.PTD.

For an aircraft type which is supported through equivalence the file name will indicate the file for the equivalent aircraft type which should be used. As an example, the Boeing KC-135E (K35E) is equivalent to the Boeing 707-300 (B703). Thus the files B703__.OPF, B703__.APF, B703__.PTF and B703__.PTD should be used.

(f) ICAO Field

This field indicates whether the designator for this aircraft type is in use according to ICAO Doc 8643 [RD2] (value “Y”) or not (value “N”). This allows the BADA user to either conform to the latest ICAO Doc 8643, or maintain compatibility with legacy data. Aircraft types associated with the “N” value include generic BADA models whose names are not official ICAO designators, such as FGTL or HELI, and decommissioned aircraft types, such as MIR4 or NIM.

The above fields are specified in the following fixed format (Fortran notation):

'CD', 1X, A1, 1X, A4, 3X, A18, 1X, A25, 1X, A6, 2X, A1

6.4. OPF FILE FORMAT

The Operations Performance File (OPF) is an ASCII file, which for a particular aircraft type specifies the operations performance parameters described in Section 3. An example of an OPF file for the A306 (Airbus 300B4-600) aircraft is shown below.

```
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCC A306__.OPF CCCCCCCCCCCCCCCCCCCCCCCCCCCC/
CC                                                                    /
CC                AIRCRAFT PERFORMANCE OPERATIONAL FILE               /
CC                                                                    /
CC                                                                    /
CC       File_name: A306__.OPF                                        /
CC                                                                    /
CC       Creation_date: Apr 30 2002                                   /
CC                                                                    /
CC       Modification_date: Sep 05 2008                               /
CC                                                                    /
CC                                                                    /
CC====== Actype ======================================================/
CD    A306__         2 engines    Jet                       H         /
CC   A300B4-622    with PW4158 engines                     wake       /
CC                                                                    /
CC====== Mass (t) ====================================================/
CC     reference      minimum      maximum     max payload  mass grad  /
CD      .14000E+03   .87000E+02   .17170E+03   .39000E+02   .15103E+00 /
CC====== Flight envelope =============================================/
CC      VMO(KCAS)       MMO         Max.Alt       Hmax       temp grad  /
CD      .33500E+03   .82000E+00   .41000E+05   .32378E+05   -.2716E+02 /
CC====== Aerodynamics ================================================/
CC Wing Area and Buffet coefficients (SIM)                            /
CCndrst Surf(m2)      Clbo(M=0)       k          CM16                 /
CD 5    .26000E+03   .13150E+01   .84080E+00   .00000E+00             /
CC    Configuration characteristics                                   /
CC n Phase  Name     Vstall(KCAS)   CD0         CD2         unused    /
CD 1 CR    Clean     .15100E+03   .20591E-01   .51977E-01   .00000E+00 /
CD 2 IC    S15F00    .11700E+03   .33057E-01   .45362E-01   .00000E+00 /
CD 3 TO    S15F00    .11700E+03   .33057E-01   .45362E-01   .00000E+00 /
CD 4 AP    S15F15    .10900E+03   .38031E-01   .44932E-01   .00000E+00 /
CD 5 LD    S30F40    .97000E+02   .78935E-01   .44822E-01   .00000E+00 /
CC    Spoiler                                                         /
CD 1       RET                                                        /
CD 2       EXT                                 .00000E+00   .00000E+00 /
CC    Gear                                                            /
CD 1       UP                                                         /
CD 2       DOWN                   .22500E-01   .00000E+00   .00000E+00 /
CC    Brakes                                                          /
CD 1       OFF                                                        /
CD 2       ON                                  .00000E+00   .00000E+00 /
CC====== Engine Thrust ===============================================/
CC          Max climb thrust coefficients (SIM)                       /
CD      .29716E+06   .51306E+05   .56296E-10   .84814E+01   .44597E-02 /
CC      Desc(low)    Desc(high)   Desc level   Desc(app)     Desc(ld)  /
CD      .32012E-01   .40310E-01   .15161E+05   .13124E+00   .39136E+00 /
CC      Desc CAS     Desc Mach     unused       unused       unused    /
CD      .30000E+03   .78000E+00   .00000E+00   .00000E+00   .00000E+00 /
CC====== Fuel Consumption ============================================/
CC    Thrust Specific Fuel Consumption Coefficients                   /
CD      .63936E+00   .10047E+04                                       /
CC    Descent Fuel Flow Coefficients                                  /
CD      .21196E+02   .67071E+05                                       /
CC    Cruise Corr.    unused       unused       unused       unused    /
CD      .98852E+00   .00000E+00   .00000E+00   .00000E+00   .00000E+00 /
CC====== Ground ======================================================/
CC         TOL          LDL         span        length       unused    /
CD      .23620E+04   .15550E+04   .44840E+02   .54080E+02   .00000E+00 /
CC====================================================================/
FI                                                                    /
```

There are three types of lines in the OPF file with the line type identified by the first two characters in the line. These line types with their associated two leading characters are listed below.

CC comment line

CD data line

FI end-of-file line

The comment lines are provided solely for the purpose of improving the readability of the file. All coefficients are contained within the CD lines in a fixed format. The end-of-file line is included as the last line in the file in order to facilitate the reading of the file in certain computing environments.

The data is organised into a total of eight blocks with each block separated by a comment line containing the block name and equal signs "=". These blocks are listed below and are described in further detail in the subsections below.

- file identification block
- aircraft type block
- mass block
- flight envelope block
- aerodynamics block
- engine thrust block,
- fuel consumption block
- ground movements block

6.4.1. File Identification Block

The file identification block provides information on the file name, creation date and modification date. The block consists of 11 comment lines. An example of the file identification block for the A306__.OPF file is shown below.

```
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCC A306__.OPF CCCCCCCCCCCCCCCCCCCCCCCCCCCC/
CC                                                                    /
CC                 AIRCRAFT PERFORMANCE OPERATIONAL FILE              /
CC                                                                    /
CC                                                                    /
CC       File_name: A306__.OPF                                        /
CC                                                                    /
CC       Creation_date: Apr 30 2002                                   /
CC                                                                    /
CC       Modification_date: Sep 05 2008                               /
CC                                                                    /
```

The comment lines specify the file name along with the creation date and last modification date. The creation date indicates the date when the file was created for the first time. The modification date indicates when the contents of the file were last modified.

6.4.2. Aircraft Type Block

The OPF aircraft type block consists of 1 data line with 3 comment lines for a total of 4 lines. An example of the aircraft type block is given below.

```
       CC====== Actype ======================================================/
1 ->    CD    A306__         2 engines    Jet                      H          /
       CC   A300B4-622    with PW4158 engines                      wake       /
       CC                                                                     /
```

The data line specifies the following aircraft type parameters:

- ICAO aircraft code (followed by 2 or more underscore characters as required to form a six character string)
- number of engines, n_{eng}
- engine type
- wake category

The engine type can be one of the following three values: Jet, Turboprop or Piston. The wake category can be one of the four values J (jumbo), H (heavy), M (medium) or L (light).

The four values are specified in the following fixed format (Fortran notation)

'CD', 3X, A6, 9X, I1, 12X, A9, 17X, A1

The comment lines typically indicate the engine manufacturer's designation and the source of the performance coefficients.

6.4.3. Mass Block

The OPF mass block consists of 1 data line with 2 comment lines for a total of 3 lines.

An example of the mass block is given below.

```
            CC====== Mass (t) ================================================/
            CC     reference      minimum      maximum     max payload  mass grad  /
      1 ->  CD      .14000E+03    .87000E+02    .17170E+03    .39000E+02    .15103E+00 /
```

The data line specifies the following BADA mass model parameters:

m_{ref} m_{min} m_{max} m_{pyld} G_w

These parameters are specified in the following fixed format (Fortran notation)

'CD', 2X, 5 (3X, E10.5)

6.4.4. Flight Envelope Block

The OPF flight envelope block consists of 1 data line with 2 comment lines for a total of 3 lines. An example of the flight envelope block is given below.

```
            CC====== Flight envelope =============================================/
            CC      VMO(KCAS)      MMO         Max.Alt        Hmax        temp grad  /
      1 ->  CD      .33500E+03    .82000E+00    .41000E+05    .32378E+05    -.2716E+02 /
```

The date line specifies the following BADA speed envelope parameters:

V_{MO} M_{MO} h_{MO} h_{max} G_t

Note that all altitudes are expressed in feet.

These parameters are specified in the following fixed format (Fortran notation):

'CD', 2X, 5 (3X, E10.5)

6.4.5. Aerodynamics Block

The OPF aerodynamics block consists of 12 data lines and 8 comment lines for a total of 20 lines. An example of the aerodynamics block is given below.

```
          CC====== Aerodynamics ================================================/
          CC Wing Area and Buffet coefficients (SIM)                            /
          CCndrst Surf(m2)     Clbo(M=0)       k          CM16                  /
1 ->      CD 5    .26000E+03   .13150E+01   .84080E+00   .00000E+00             /
          CC   Configuration characteristics                                    /
          CC n Phase  Name     Vstall(KCAS)    CD0          CD2        unused   /
2 ->      CD 1 CR     Clean    .15100E+03   .20591E-01   .51977E-01   .00000E+00 /
3 ->      CD 2 IC     S15F00   .11700E+03   .33057E-01   .45362E-01   .00000E+00 /
4 ->      CD 3 TO     S15F00   .11700E+03   .33057E-01   .45362E-01   .00000E+00 /
5 ->      CD 4 AP     S15F15   .10900E+03   .38031E-01   .44932E-01   .00000E+00 /
6 ->      CD 5 LD     S30F40   .97000E+02   .78935E-01   .44822E-01   .00000E+00 /
          CC   Spoiler                                                          /
7 ->      CD 1        RET                                                       /
8 ->      CD 2        EXT                                .00000E+00   .00000E+00 /
          CC   Gear                                                             /
9 ->      CD 1        UP                                                        /
10 ->     CD 2        DOWN                  .2250E-01    .00000E+00   .00000E+00 /
          CC   Brakes                                                           /
12 ->     CD 1        OFF                                                       /
13 ->     CD 2        ON                                 .00000E+00   .00000E+00 /
```

The first data line specifies the following BADA aerodynamic model parameters:

S $\qquad C_{lbo(M=0)}$ $\qquad k$ $\qquad C_{M16}$

These parameters are specified in the following fixed format (Fortran notation):

'CD', 2X, 4 (3X, E10.5)

Note that the "5" under the header "ndrst" stands for the five drag settings. Currently this is not used but is left in for compatibility requirements.

The next line holds besides the stall speed and flap setting for cruise as well as the values for the two drag coefficients for this configuration:

$(V_{stall})_{CR}$ $\qquad C_{D0}$ $\qquad C_{D2}$

These parameters are specified in the following fixed format (Fortran notation):

'CD', 15X, 3 (3X, E10.5)

The next four data lines have the same format and correspond to the other configurations. The configurations are specified in the following order, corresponding to a semi-monotonically decreasing stall speed:

IC initial climb

TO take-off

AP approach

LD landing

The stall speed, $(V_{stall})_i$, is specified for each configuration, and C_{D0} and C_{D2} are given if available in the following fixed format (Fortran notation):

'CD', 15X, 3 (3X, E10.5)

In case the IC configuration is equal to the CR configuration, the values for C_{D0} and C_{D2} are mentioned only in the CR dataline. Note that C_{D0} and C_{D2} coefficients for IC and TO configurations are not used but are included for the reason of compatibility with previous versions.

The data lines 7 through 9 are not used but are included for the reason of compatibility with previous versions.

Dataline 10 holds the drag increment for landing gear down:

$C_{D0,\Delta LDG}$

The format of this line is:

'CD', 31X, E10.5

Datalines 11 and 12 are not used but are included for the reason of compatibility with previous versions.

6.4.6. Engine Thrust Block

The OPF engine thrust block consists of 3 data lines with 4 comment lines for a total of 7 lines. An example of the engine thrust block is given below.

```
        CC====== Engine Thrust =============================================/
        CC          Max climb thrust coefficients (SIM)                     /
1 ->    CD      .29716E+06   .51306E+05   .56296E-10   .84814E+01   .44597E-02 /
        CC      Desc(low)    Desc(high)   Desc level   Desc(app)     Desc(ld)  /
2 ->    CD      .32012E-01   .40310E-01   .15161E+05   .13124E+00   .39136E+00 /
        CC      Desc CAS     Desc Mach     unused       unused       unused    /
3 ->    CD      .30000E+03   .78000E+00   .00000E+00   .00000E+00   .00000E+00 /
```

The first data line specifies the following BADA parameters used to calculate the maximum climb thrust, that is:

$C_{Tc,1}$ $C_{Tc,2}$ $C_{Tc,3}$ $C_{Tc,4}$ $C_{Tc,5}$

These parameters are specified in the following fixed format (Fortran notation):

'CD', 2X, 5 (3X, E10.5)

The second data line specifies the following BADA parameters used to calculate cruise and descent thrust, that is:

$C_{Tdes,low}$ $C_{Tdes,high}$ $H_{p,des}$ $C_{Tdes,app}$ $C_{Tdes,ld}$

These parameters are specified in the following fixed format (Fortran notation):

'CD', 2X, 5 (3X, E10.5)

Note that the $C_{Tdes,app}$ and $C_{Tdes,ld}$ coefficients are determined in order to obtain a 3° descent gradient during approach and landing.

The third data line specifies the reference speeds during descent, that is:

$V_{des,ref}$ $M_{des,ref}$

These parameters are specified in the following fixed format (Fortran notation):

'CD', 2X, 2 (3X, E10.5)

Note that these two parameters are no longer used in BADA model implementation, but are left in place only to provide information on one of the reference speeds during descent used during the model identification.

The zero values at the end of this data line are not used but are included in the file due to compatibility requirements with previous versions.

6.4.7. Fuel Consumption Block

The OPF fuel consumption block consists of 3 data lines with 4 comment lines for a total of 7 lines. An example of a fuel consumption block is shown below.

```
        CC====== Fuel Consumption ============================================/
        CC   Thrust Specific Fuel Consumption Coefficients                     /
1 ->    CD     .63936E+00   .10047E+04                                         /
        CC   Descent Fuel Flow Coefficients                                    /
2 ->    CD     .21196E+02   .67071E+05                                         /
        CC   Cruise Corr.    unused       unused       unused       unused    /
3 ->    CD     .98852E+00   .00000E+00   .00000E+00   .00000E+00   .00000E+00 /
```

The first data line specifies the following BADA parameters for thrust specific fuel consumption.

C_{f1} C_{f2}

These parameters are specified in the following fixed format (Fortran notation):

'CD', 2X, 2 (3X, E10.5)

The second data line specifies the following BADA parameters for descent fuel flow.

C_{f3} C_{f4}

These parameters are specified in the following fixed format (Fortran notation):

'CD', 2X, 2 (3X, E10.5)

The third data line specifies the cruise fuel flow correction factor.

C_{fcr}

The parameter is specified in the following fixed format (Fortran notation):

'CD', 5X, E10.5

6.4.8. Ground Movement Block

The OPF ground movement block consists of 1 data line with 3 comment lines for a total of 4 lines. An example of a ground movement block is shown below. The ground movement block is the last block in the OPF file and is thus followed by the end-of-file line as shown below.

```
        CC====== Ground =======================================================/
        CC        TOL          LDL          span          length        unused    /
1 ->    CD      .23620E+04   .15550E+04   .44840E+02   .54080E+02   .00000E+00 /
        CC=====================================================================/
        FI                                                                      /
```

The data line specifies the following BADA parameters for ground movements:

TOL LDL span length

These parameters are specified in the following fixed format (Fortran notation):

'CD', 2X, 4 (3X, E10.5)

6.5. APF FILE FORMAT

The Airlines Procedures File (APF) is an ASCII file which, for a particular aircraft type, specifies recommended speed procedures for climb, cruise, and descent conditions. An example of an APF file for the Airbus A306 aircraft is shown below.

```
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC A306__.APF CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC/
CC                                                                                                  /
CC                  AIRLINES PROCEDURES FILE                                                        /
CC                                                                                                  /
CC       File_name: A306__.APF                                                                      /
CC                                                                                                  /
CC       Creation_date: Apr 30 2002                                                                 /
CC                                                                                                  /
CC       Modification_date: Mar 05 2009                                                             /
CC                                                                                                  /
CC                                                                                                  /
CC                                                                                                  /
CC    LO= 087.00 to ---.--   /  AV= ---.-- to ---.--   /  HI= ---.-- to 171.70                      /
CC                                                                                                  /
CC==================================================================================================/
CC  COM CO     Company name ------climb-------  --cruise--  -----descent------  --approach-  model- /
CC                     mass  lo  hi               lo  hi          hi  lo           (unused)         /
CC    version engines  ma  cas cas mc xxxx xx  cas cas mc  mc cas cas xxxx xx  xxx xxx xxx  opf___ /
CC===:=======:=======::==::===:===:==:====:==::===:===:==::==:===:===:====:==::===:===:===::======:/
CD  *** **     Default Company                                                                      /
CD    B4_622           LO  310 310 79          250 310 79  79 290 290              0   0   0  A306__ /
CD    B4_622           AV  310 310 79          250 310 79  79 290 290              0   0   0  A306__ /
CD    B4_622           HI  310 310 79          250 310 79  79 290 290              0   0   0  A306__ /
CC===:=======:=======::==::===:===:==:====:==::===:===:==::==:===:===:====:==::===:===:===::======:/
CC////////////////////////////////////////////THE END////////////////////////////////////////////
```

There are two types of lines in the APF file with the line type identified by the first two characters in the line. These line types with their associated two leading characters are listed below.

CC - comment line
CD - data line

The last line in the file, as shown above, is also a comment line.

The comment lines are provided solely for the purpose of improving the readability of the file. All coefficients are contained within the CD lines in a fixed format.

The data is organised into 2 blocks separated by a comment line containing a string of equal signs, "=":

- file identification block
- speed procedures block

Each of the two blocks is described further in the subsections below.

6.5.1. File Identification Block

The file identification block provides information on the file name, creation date and modification date. The block consists of 14 comment lines. An example of a file identification block is shown below.

```
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC A306__.APF CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC/
CC                                                                                                 /
CC                 AIRLINES PROCEDURES FILE                                                        /
CC                                                                                                 /
CC      File_name: A306__.APF                                                                      /
CC                                                                                                 /
CC      Creation_date: Apr 30 2002                                                                 /
CC                                                                                                 /
CC      Modification_date: Mar 05 2009                                                            /
CC                                                                                                 /
CC                                                                                                 /
CC                                                                                                 /
CC   LO= 087.00 to ---.--  /  AV= ---.-- to ---.--  /  HI= ---.-- to 171.70                        /
CC                                                                                                 /
```

The comment lines provide background information on the file contents. In addition, the comment lines specify the file name along with the creation and last modification date. The creation date indicates the date when the file was created for the first time. The modification date indicates when the contents of the file were last modified.

The second last comment line in the identification block specifies three mass ranges for the aircraft in tonnes. That is, a low range (LO), average range (AV) and high range (HI). The definition of these ranges is used for interpreting the information presented below in the procedures specification block. In the example given above, all three ranges are assumed equivalent.

6.5.2. Procedures Specification Block

The APF procedures specification block consists of 4 data lines with 7 comment lines for a total of 11 lines. An example of a procedures specification block is shown below.

```
        CC=================================================================================================/
        CC  COM CO    Company name ------climb-------  --cruise--  -----descent------  --approach-  model- /
        CC                    mass  lo  hi              lo  hi         hi  lo            (unused)          /
        CC    version engines  ma  cas cas mc xxxx xx  cas cas mc  mc cas cas xxxx xx  xxx xxx xxx  opf___ /
        CC===:=======:=======::==::===:===:==:====:==::===:===:==::==:===:===:====:==::===:===:===::======:/
1 ->    CD  *** **    Default Company                                                                      /
2 ->    CD    B4_622           LO  310 310 79          250 310 79  79 290 290            0   0   0  A306__ /
3 ->    CD    B4_622           AV  310 310 79          250 310 79  79 290 290            0   0   0  A306__ /
4 ->    CD    B4_622           HI  310 310 79          250 310 79  79 290 290            0   0   0  A306__ /
        CC===:=======:=======::==::===:===:==:====:==::===:===:==::==:===:===:====:==::===:===:===::======:/
        CC/////////////////////////////////////////////THE END/////////////////////////////////////////////
```

The first data line specifies the company name for which the next three datalines are valid. The company can be identified by its 3 and 2 letter code plus the company name. The dataline fomat is:

'CD', 2X, A3, 1X, A2, 4X, A15

As it is, within BADA all APF files specify procedures for only one "default" company.

The next three data lines specify the following parameters corresponding to climb, cruise and descent:

$V_{cl,1}$ $V_{cl,2}$ M_{cl} $V_{cr,1}$ $V_{cr,2}$ M_{cr} M_{des} $V_{des,2}$ $V_{des,1}$

Note that all Mach number values are also multiplied by a value of 100. For example, the 78 indicated for M_{cl} above corresponds to a Mach number of 0.78.

The three lines specify parameters for mass ranges of Low (LO), Average (AV) and High (HI) respectively. These parameters are specified in the following fixed format (Fortran notation):

'CD', 25X, 2(I3, 1X), I2, 10X, 2(I3, 1X), I2, 2X, I2, 2(1X, I3)

Note that approach values are set to zero. These values are not used but are included in the file due to compatibility requirements with previous versions.

Also, each line specifies an aircraft version number, engine, and operational model. The operational model is always the same as the file name. The version number may provide some additional information on the aircraft version covered by the file while the engine states which engine is used by the aircraft.

The file format is designed such that the four data lines can be repeated for the different companies which operate the aircraft and which may have different standard procedures. If data were to be provided for more than one company then the version, engine and operational model fields may be useful since different companies could operate different versions of the aircraft with different engines and thus different associated operational models.

6.6. PTF FILE FORMAT

The Performance Table File (PTF) is an ASCII file, which for a particular aircraft type specifies cruise, climb and descent performance at different flight levels. An example of a PTF file for the Airbus A306 aircraft is shown below.

```
BADA PERFORMANCE FILE                                         Apr 01 2010

AC/Type: A306__
                              Source OPF File:                Sep 05 2008
                              Source APF file:                Mar 05 2009

 Speeds:   CAS(LO/HI)  Mach   Mass Levels [kg]         Temperature:  ISA
 climb   - 250/310     0.79   low     -  104400
 cruise  - 250/310     0.79   nominal -  140000        Max Alt. [ft]:  41000
 descent - 250/290     0.79   high    -  171700
==========================================================================================
 FL |          CRUISE           |                 CLIMB                  |      DESCENT
    |  TAS          fuel        |  TAS           ROCD          fuel      |  TAS  ROCD    fuel
    | [kts]       [kg/min]      | [kts]          [fpm]       [kg/min]    | [kts] [fpm] [kg/min]
    |          lo    nom    hi  |          lo    nom    hi     nom       |        nom     nom
==========================================================================================
  0 |                           |  157   2454  1925  1556   219.7    |  131    698    84.1
    |                           |                                    |
  5 |                           |  158   2437  1907  1536   217.8    |  132    714    83.3
    |                           |                                    |
 10 |                           |  159   2420  1889  1517   215.9    |  138    730    82.9
    |                           |                                    |
 15 |                           |  166   2530  1974  1588   214.9    |  149    774    82.9
    |                           |                                    |
 20 |                           |  167   2512  1955  1568   213.0    |  181    988    28.3
    |                           |                                    |
 30 |  230     53.3  69.9  88.8 |  190   2940  2289  1852   212.9    |  230   1287    20.2
    |                           |                                    |
 40 |  233     53.4  70.1  89.0 |  225   3474  2695  2191   214.6    |  233   1306    19.9
    |                           |                                    |
 60 |  272     60.0  73.3  88.5 |  272   4081  2973  2285   213.7    |  272   1520    19.3
    |                           |                                    |
 80 |  280     60.3  73.8  89.1 |  280   3932  2846  2168   206.0    |  280   1561    18.7
    |                           |                                    |
100 |  289     60.5  74.2  89.7 |  357   3897  2879  2256   208.7    |  334   1984    18.0
    |                           |                                    |
120 |  297     60.9  74.6  90.3 |  367   3687  2706  2101   200.8    |  344   2027    17.4
    |                           |                                    |
140 |  378     82.2  91.8 102.8 |  378   3472  2527  1941   193.0    |  354   2071    16.8
    |                           |                                    |
160 |  389     82.4  92.3 103.4 |  389   3250  2344  1776   185.2    |  365   2075    16.1
    |                           |                                    |
180 |  401     82.7  92.7 104.0 |  401   3023  2156  1607   177.4    |  376   2119    15.5
    |                           |                                    |
200 |  413     82.9  93.1 104.6 |  413   2790  1962  1434   169.6    |  387   2163    14.9
    |                           |                                    |
220 |  425     83.2  93.5 105.2 |  425   2551  1765  1256   161.8    |  399   2206    14.2
    |                           |                                    |
240 |  438     83.4  93.9 105.8 |  438   2308  1563  1074   154.1    |  412   2248    13.6
    |                           |                                    |
260 |  452     83.6  94.3 106.5 |  452   2059  1357   889   146.3    |  425   2289    13.0
    |                           |                                    |
280 |  466     83.8  94.7 107.1 |  466   1807  1147   700   138.6    |  438   2330    12.3
    |                           |                                    |
290 |  468     82.3  93.6 106.4 |  468   2417  1499   872   134.2    |  445   2349    12.0
    |                           |                                    |
310 |  464     77.5  89.8 103.8 |  464   2192  1359   648   124.9    |  459   2388    11.4
    |                           |                                    |
330 |  459     73.3  86.8 102.1 |  459   2214  1111   405   115.8    |  459   3297    10.8
    |                           |                                    |
350 |  455     69.7  84.4 101.2 |  455   1919   842   142   106.8    |  455   3198    10.1
    |                           |                                    |
370 |  453     66.8  83.0 101.4 |  453   1477   511     0    98.1    |  453   2882     9.5
    |                           |                                    |
390 |  453     64.6  82.4 102.7 |  453   1180   229     0    89.7    |  453   2873     8.9
    |                           |                                    |
410 |  453     62.9  82.6 104.9 |  453    859     0     0    81.5    |  453   2892     8.2
    |                           |                                    |
==========================================================================================
```

The OPF and APF files are generated as a result of a modelling process using MatLab [RD6]. Once these two files are generated, the PTF can be automatically generated. A brief summary of the format of these files is given below.

The header of each PTF file contains information as described below.

file creation date:	This is in the first line, at the top-right corner
aircraft type:	This is in the third line.
source file dates:	The last modification dates of the OPF and APF files which were used to create the PTF file are given in the 4th and 5th lines respectively.
Speeds:	The speed laws for climb, cruise and descent are specified in lines 8, 9 and 10, that is:

climb	min($V_{cl,1}$, 250kt) / $V_{cl,2}$	M_{cl}
cruise	min($V_{cr,1}$, 250kt) / $V_{cr,2}$	M_{cr}
descent	min($V_{des,1}$, 250kt) / $V_{des,2}$	M_{des}

Mass levels: The performance tables provide data for three different mass levels in lines 8, 9 and 10, that is:

low	1.2 $m_{min.}$
nominal	m_{ref}
high	m_{max}

Note that the low mass is not the minimum mass but 1.2 times the minimum mass.

Temperature: The temperature is mentioned in line 7. All PTF files currently provide data for ISA conditions only.

Maximum altitude: The maximum altitude as specified in the OPF file, h_{MO}, is given in line 9.

The table of performance data within the file consists of 13 columns. Each of these columns is described below:

Column 1	FL
Column 2	cruise TAS (nominal mass) [knots]
Column 3	cruise fuel consumption (low mass) [kg/min]
Column 4	cruise fuel consumption (nominal mass) [kg/min]
Column 5	cruise fuel consumption (high mass) [kg/min]
Column 6	climb TAS (nominal mass) [knots]
Column 7	rate of climb with reduced power (low mass) [ft/min]
Column 8	rate of climb with reduced power (nominal mass) [ft/min]
Column 9	rate of climb with reduced power (high mass) [ft/min]
Column 10	climb fuel consumption (nominal mass) [kg/min]
Column 11	descent TAS (nominal mass) [knots]
Column 12	rate of descent (nominal mass) [ft/min]
Column 13	descent fuel consumption (nominal mass) [kg/min]

The format for data presented in each line of the table is as follows (Fortran notation):

I3, 4X, I3, 2X, 3(1X, F5.1), 5X, I3, 2X, 3(1X, I5), 3X, F5.1, 5X, I3, 2X, I5, 2X, F5.1

Further explanatory notes on the data presented in the performance tables are given below:

(a) Cruise data are only specified for flight levels greater than or equal to 30.

(b) Performance data are specified up to the aircraft maximum altitude.

(c) True airspeed for climb, cruise and descent is determined based on the speed schedules specified in Sections 4.1, 4.2 and 4.3 respectively.

(d) Rates of climb are calculated at each flight level assuming the energy share factors associated with constant CAS or constant Mach speed laws and using the reduced power correction as given in Section 3.8.

(e) The fuel consumption in climb is independent of the aircraft mass and thus only one value is given. There are three different climb rates however corresponding to low, nominal and high mass conditions.

(f) The rate of descent and fuel consumption in descent is calculated assuming the nominal mass. Values for other mass conditions are not provided.

(g) Discontinuities in climb rate can occur for the following reasons:
- change in speed between flight levels (e.g. removal of 250 kt restriction above FL100),
- transition from constant CAS to constant Mach (typically around FL300),
- transition through the tropopause (FL360),
- end of the application scope for reduced climb power (at 80% of h_{max}).

(h) Discontinuities in descent rate can occur for the following reasons:
- transition through the tropopause (FL360),
- transition from constant Mach to constant CAS,
- change in assumed descent thrust (specified by the BADA h_{des} parameter),
- change to approach or landing aerodynamic configuration,
- change in speed between flight levels (e.g. application of 250 kt limit below FL100).

(i) The PTF files are generated using "non-clean" configuration data for approach and landing when such data are available (see Section 3.6.1).

(j) The performance data presented in the table are computed by using ‘point type’ calculation, that is without performing integration over time: aircraft weight is constant and does not account for consumed fuel, and speed changes take place immediately.

(k) The flight envelope limitations are not taken into account for calculation of performance parameters[8].

Note that all PTF files are available in document form in [RD9].

[8] Example: cruise fuel flow is calculated without checking, for given aircraft weight, speed and FL, that aircraft drag is lower than maximum available cruise thrust.

6.7. PTD FILE FORMAT

In addition to the data provided in the PTF file, more detailed climb and descent performance data are presented in the PTD file. An example of a PTD file for the Airbus A306 aircraft is shown below (partial listing):

```
Low mass CLIMBS
===============

 FL[-] T[K] p[Pa] rho[kg/m3] a[m/s] TAS[kt] CAS[kt]  M[-] mass[kg] Thrust[N] Drag[N] Fuel[kgm] ESF[-] ROC[fpm] TDC[N]  PWC[-]
     0 288 101325   1.225     340   136.35   136.35  0.21 104400    297160     85670   215.8     0.98    2452   186284   0.88
     5 287  99508   1.207     340   137.34   136.35  0.21 104400    294268     85680   213.9     0.98    2435   183727   0.88
    10 286  97717   1.190     339   138.34   136.35  0.21 104400    291385     85691   212.0     0.98    2417   181179   0.88
    15 285  95952   1.172     339   144.45   141.35  0.22 104400    288510     82072   211.0     0.97    2527   181833   0.88
    20 284  94213   1.155     338   145.51   141.35  0.22 104400    285643     82082   209.1     0.97    2509   179299   0.88
    30 282  90812   1.121     337   168.52   161.35  0.26 104400    279935     72295   209.0     0.96    2937   182892   0.88
    40 280  87511   1.088     336   202.72   191.35  0.31 104400    274260     67093   210.7     0.95    3470   182476   0.88
    60 276  81200   1.024     333   272.30   250.00  0.42 104400    263011     74643   213.7     0.91    4075   165917   0.88
    80 272  75262   0.963     331   280.34   250.00  0.44 104400    251895     74535   206.0     0.91    3925   156222   0.88
   100 268  69682   0.905     328   345.37   300.00  0.54 104400    240914     91120   207.0     0.87    3905   131941   0.88
   120 264  64441   0.849     326   355.51   300.00  0.56 104400    230066     90785   199.1     0.86    3703   122681   0.88
   140 260  59524   0.796     324   366.04   300.00  0.58 104400    219352     90425   191.3     0.85    3495   113561   0.88
   160 256  54915   0.746     321   376.97   300.00  0.60 104400    208772     90038   183.6     0.84    3281   104583   0.88
   180 252  50600   0.698     319   388.32   300.00  0.63 104400    198326     89622   175.8     0.83    3060    95748   0.88
   200 249  46563   0.653     316   400.10   300.00  0.65 104400    188013     89175   168.1     0.82    2834    87059   0.88
   220 245  42791   0.610     314   412.32   300.00  0.68 104400    177835     88694   160.4     0.81    2601    78516   0.88
   240 241  39271   0.569     311   425.00   300.00  0.70 104400    167790     88179   152.7     0.80    2364    70123   0.88
   260 237  35989   0.530     308   438.16   300.00  0.73 104400    157879     87627   145.0     0.79    2122    61879   0.88
   280 233  32932   0.493     306   451.80   300.00  0.76 104400    148102     87036   137.3     0.78    1875    53788   0.88
   290 231  31485   0.475     304   458.81   300.00  0.78 104400    143263     86725   133.4     0.78    1749    49800   0.88
   310 227  28745   0.442     302   463.54   293.28  0.79 104400    133687     83916   124.9     1.09    2184    43839   0.88
   330 223  26201   0.410     299   459.48   280.58  0.79 104400    124245     79587   115.8     1.09    2205    44658   1.00
   350 219  23842   0.380     297   455.37   268.17  0.79 104400    114936     75881   106.8     1.09    1911    39055   1.00
   370 217  21663   0.348     295   453.12   256.08  0.79 104400    105761     72808    98.1     1.00    1470    32953   1.00
   390 217  19677   0.316     295   453.12   244.46  0.79 104400     96720     70398    89.7     1.00    1174    26322   1.00
   410 217  17874   0.287     295   453.12   233.34  0.79 104400     87813     68640    81.5     1.00     855    19173   1.00
```

The performance values presented in the PTD file are a superset of the climb and descent performance values presented in the PTF file. They are generated in the same conditions as the corresponding PTF file: same aircraft, same source OPF and APF files, same speed laws, same mass levels, same temperature and same flight levels. The purpose of this file is mainly to provide the user with a greater number of computed parameters, especially intermediate parameters used to compute the final TAS and ROCD, which may be useful to validate an implementation of the BADA model.

The files contain performance data consisting of 4 sections:

- low mass climb performance
- nominal mass climb performance
- high mass climb performance
- nominal mass descent performance

Each section contains a table that presents, for several flight levels, a set of performance parameters spread across 16 columns. Each of these columns is described below:

Column 1	Flight level [FL]
Column 2	Temperature [K]
Column 3	Pressure [Pa]
Column 4	Air density [kg/m^3]
Column 5	Speed of sound [m/s]
Column 6	TAS [kt]
Column 7	CAS [kt]
Column 8	Mach [dimensionless]
Column 9	Mass [kg]
Column 10	Thrust [N]
Column 11	Drag [N]
Column 12	Fuel flow [kg/min]
Column 13	Energy share factor [dimensionless]
Column 14	Rate of climb/descent [ft/min]
Column 15	(Thr – D) · $C_{pow,red}$ [kg/min] (see section 3.8)
Column 16	- climb tables: Power reduction coefficient $C_{pow,red}$ [dimensionless] - descent table: Descent gradient [degree]

The format for data presented in each line of the table is as follows (Fortran notation):

Climb tables:

I6, 1X, I3, 1X, I6, 1X, F7.3, 1X, I7, 2(1X, F8.2), 1X, F7.2, 1X, I6, 2(1X, I9), 1X, F7.1, 1X, F7.2, 1X, I7, 1X, I8, 1X, F7.2

Descent tables:

I6, 1X, I3, 1X, I6, 1X, F7.3, 1X, I7, 2(1X, F8.2), 1X, F7.2, 1X, I6, 2(1X, I9), 1X, F7.1, 1X, F7.2, 1X, I7, 1X, I8, 1X, F8.2

6.8. BADA.GPF FILE FORMAT

The BADA.GPF file is an ASCII file which specifies the values of the global aircraft parameters (see Section 5). The complete BADA.GPF file is shown below:

```
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC BADA.GPF CCCCCCCCCCCCCCCCCCCCCCCCCCCCCC/
CC                                                                                   /
CC                              GLOBAL PARAMETERS FILE                               /
CC                                                                                   /
CC                                                                                   /
CC      File_name: BADA.GPF                                                          /
CC                                                                                   /
CC      Creation_date: Apr 30 2002                                                   /
CC                                                                                   /
CC      Modification_date: Mar 30 2015                                               /
CC                                                                                   /
CC                                                                                   /
CC======== Class ===================================================================/
CC                                                                                   /
CC Flight = civ,mil                                                                  /
CC Engine = jet,turbo,piston                                                         /
CC Phase  = to,ic,cl,cr,des,hold,app,lnd,gnd                                         /
CC                                                                                   /
CC======== Parameters List =========================================================/
CC                                                                                   /
CC Name              Unit                                                            /
CC Parameter        Flight  Engine           Phase                        Value      /
CC                                                                                   /
CC max. long. acc.   [fps2]                                                          /
CD acc_long_max     civ     jet,turbo,piston to,ic,cl,cr,des,hold,app,lnd  .20000E+01 /
CC max. norm. acc.   [fps2]                                                          /
CD acc_norm_max     civ     jet,turbo,piston to,ic,cl,cr,des,hold,app,lnd  .50000E+01 /
CC nom. bank angle   [deg]                                                           /
CD ang_bank_nom     civ     jet,turbo,piston to,lnd                        .15000E+02 /
CC nom. bank angle   [deg]                                                           /
CD ang_bank_nom     civ     jet,turbo,piston ic,cl,cr,des,hold,app         .30000E+02 /
CC nom. bank angle   [deg]                                                           /
CD ang_bank_nom     mil     jet,turbo,piston to,ic,cl,cr,des,hold,app,lnd  .50000E+02 /
CC max. bank angle   [deg]                                                           /
CD ang_bank_max     civ     jet,turbo,piston to,lnd                        .25000E+02 /
CC max. bank angle   [deg]                                                           /
CD ang_bank_max     civ     jet,turbo,piston hold                          .35000E+02 /
CC max. bank angle   [deg]                                                           /
CD ang_bank_max     civ     jet,turbo,piston ic,cl,cr,des,app              .45000E+02 /
CC max. bank angle   [deg]                                                           /
CD ang_bank_max     mil     jet,turbo,piston to,ic,cl,cr,des,hold,app,lnd  .70000E+02 /
CC exp. desc. fact. [-]                                                              /
CD C_des_exp        civ,mil jet,turbo,piston des                           .16000E+01 /
CC to thrust factor [-]                                                              /
CD C_th_to          mil,civ jet,turbo,piston to                            .12000E+01 /
CC cr thrust factor [-]                                                              /
CD C_th_cr          mil,civ jet,turbo,piston cr                            .95000E+00 /
CC max alt for to   [ft]                                                             /
CD H_max_to         mil,civ jet,turbo,piston to                            .40000E+03 /
CC max alt for ic   [ft]                                                             /
CD H_max_ic         mil,civ jet,turbo,piston ic                            .20000E+04 /
CC max alt for app   [ft]                                                            /
CD H_max_app        mil,civ jet,turbo,piston app                           .80000E+04 /
CC max alt for ld   [ft]                                                             /
CD H_max_ld         mil,civ jet,turbo,piston lnd                           .30000E+04 /
CC min speed coef.  [-]                                                              /
CD C_v_min          mil,civ jet,turbo,piston cr,ic,cl,des,hold,app,lnd     .13000E+01 /
CC min speed coef.  [-]                                                              /
CD C_v_min_to       mil,civ jet,turbo,piston to                            .12000E+01 /
CC spd incr FL < 15 [KCAS]                                                           /
CD V_cl_1           mil,civ jet              cl                            .50000E+01 /
CC spd incr FL < 30 [KCAS]                                                           /
CD V_cl_2           mil,civ jet              cl                            .10000E+02 /
CC spd incr FL < 40 [KCAS]                                                           /
CD V_cl_3           mil,civ jet              cl                            .30000E+02 /
CC spd incr FL < 50 [KCAS]                                                           /
CD V_cl_4           mil,civ jet              cl                            .60000E+02 /
CC spd incr FL < 60 [KCAS]                                                           /
```

```
CD V_cl_5          mil,civ jet               cl                            .80000E+02 /
CC spd incr FL < 5  [KCAS]                                                            /
CD V_cl_6          mil,civ turbo,piston      cl                            .20000E+02 /
CC spd incr FL < 10 [KCAS]                                                            /
CD V_cl_7          mil,civ turbo,piston      cl                            .30000E+02 /
CC spd incr FL < 15 [KCAS]                                                            /
CD V_cl_8          mil,civ turbo,piston      cl                            .35000E+02 /
CC spd incr FL < 10 [KCAS]                                                            /
CD V_des_1         mil,civ jet,turbo         des                           .50000E+01 /
CC spd incr FL < 15 [KCAS]                                                            /
CD V_des_2         mil,civ jet,turbo         des                           .10000E+02 /
CC spd incr FL < 20 [KCAS]                                                            /
CD V_des_3         mil,civ jet,turbo         des                           .20000E+02 /
CC spd incr FL < 30 [KCAS]                                                            /
CD V_des_4         mil,civ jet,turbo         des                           .50000E+02 /
CC spd incr FL < 5  [KCAS]                                                            /
CD V_des_5         mil,civ piston            des                           .50000E+01 /
CC spd incr FL < 10 [KCAS]                                                            /
CD V_des_6         mil,civ piston            des                           .10000E+02 /
CC spd incr FL < 15 [KCAS]                                                            /
CD V_des_7         mil,civ piston            des                           .20000E+02 /
CC hold. spd FL < 140 [KCAS]                                                          /
CD V_hold_1        mil,civ jet,turbo,piston hold                           .23000E+03 /
CC hold. spd FL < 200 [KCAS]                                                          /
CD V_hold_2        mil,civ jet,turbo,piston hold                           .24000E+03 /
CC hold. spd FL < 340 [KCAS]                                                          /
CD V_hold_3        mil,civ jet,turbo,piston hold                           .26500E+03 /
CC hold. spd FL > 340 [M]                                                             /
CD V_hold_4        mil,civ jet,turbo,piston hold                           .83000E+00 /
CC backtrack spd    [KCAS]                                                            /
CD V_backtrack     mil,civ jet,turbo,piston gnd                            .35000E+02 /
CC taxi spd         [KCAS]                                                            /
CD V_taxi          mil,civ jet,turbo,piston gnd                            .15000E+02 /
CC apron spd        [KCAS]                                                            /
CD V_apron         mil,civ jet,turbo,piston gnd                            .10000E+02 /
CC gate spd         [KCAS]                                                            /
CD V_gate          mil,civ jet,turbo,piston gnd                            .50000E+01 /
CC Piston pow. red. [-]                                                               /
CD C_red_piston    mil,civ piston            ic,cl                         .00000E+00 /
CC Turbo pow. red.  [-]                                                               /
CD C_red_turbo     mil,civ turbo             ic,cl                         .25000E+00 /
CC Jet power red.   [-]                                                               /
CD C_red_jet       mil,civ jet               ic,cl                         .15000E+00 /
FI=====================================================================================/
CC//////////////////////////////  THE END  ///////////////////////////////////////////
```

There are three types of lines in the BADA.GPF file with the line type identified by the first two characters in the line. These line types with their associated two leading characters are listed below.

CC comment line
CD data line
FI end-of-file line

The data is organised into three blocks separated by a comment line consisting of the block name and equal signs "=":

- file identification block
- class block
- parameter block

Each of these blocks is described in the subsections below.

6.8.1. File Identification Block

The file identification block provides information on the file name, creation and modification date. The block consists of 12 comment lines.

```
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC BADA.GPF CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC/
CC                                                                                    /
CC                 GLOBAL PARAMETERS FILE                                             /
CC                                                                                    /
CC      File_name: BADA.GPF                                                           /
CC                                                                                    /
CC      Creation_date: Mar 26 2002                                                    /
CC                                                                                    /
CC      Modification_date: Mar 26 2002                                               /
```

The comment lines specify the file name along with the creation date and last modification date. The creation date indicates the date when the file was created for the first time. The modification date indicates when the contents of the file were last modified.

6.8.2. Class Block

The class block consists of 6 comment lines and defines the three classes (Flight, Engine and Phase) and their instances that are used in the BADA.GPF file.

```
CC======== Class ===================================================================/
CC                                                                                  /
CC Flight = civ,mil                                                                 /
CC Engine = jet,turbo,piston                                                        /
CC Phase  = to,ic,cl,cr,des,hold,app,lnd,gnd                                        /
CC                                                                                  /
```

With:

civ	=	civil flight
mil	=	military flight
jet	=	jet engine
turbo	=	turboprop engine
piston	=	piston engine
to	=	take-off
ic	=	initial climb
cl	=	climb
cr	=	cruise
des	=	descent
hold	=	holding
app	=	approach
lnd	=	landing
gnd	=	ground

6.8.3. Parameter Block

The parameter block contains the values of the global aircraft parameters. This block has 5 comment lines plus a comment line and a dataline for each parameter.

```
       CC======== Parameters List ==========================================================/
       CC                                                                                    /
       CC Name              Unit                                                             /
       CC Parameter        Flight  Engine           Phase                             Value      /
       CC                                                                                    /
       CC max. long. acc.   [fps2]                                                           /
1 ->   CD acc_long_max     civ     jet,turbo,piston to,ic,cl,cr,des,hold,app,lnd  .20000E+01 /
       CC max. norm. acc.   [fps2]                                                           /
2 ->   CD acc_norm_max     civ     jet,turbo,piston to,ic,cl,cr,des,hold,app,lnd  .50000E+01 /
       CC nom. bank angle   [deg]                                                            /
3 ->   CD ang_bank_nom     civ     jet,turbo,piston to,lnd                         .15000E+02 /
```

The parameter comment line contains the parameter name and its unit.

The parameter data line contains five fields:

(a) Parameter Field: This field identifies the parameter.

(b) Flight Field: This field identifies whether the parameter is valid for a civil flight, a military flight or both.

(c) Engine Field: This field identifies the engine type (jet, turboprop or piston) for which the parameter is valid.

(d) Phase Field: This field identifies for which flight phase the parameter is valid. 8 different flight phases are currently defined

(e) Value Field: The value field gives the value of the parameter.

The fields above are specified in the following fixed format (Fortran notation):

'CD', 1X, A15, 1X, A7, 1X, A16, 1X, A29, 1X, E10.5

The parameter list continues until 'FI' (end of file) is reached.

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APPENDIX A

BADA REVISION 3.15 – LIST OF AVAILABLE AIRCRAFT MODELS

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Table 6-1: List of Aircraft Types Supported by BADA Revision 3.15

A/C Code	Model Type	Aircraft manufacturer	Aircraft model	Synonym aircraft	h_{MO} [ft]	h_{max} [ft]	WTC
A1	equiv.	DOUGLAS	A-1 Skyraider	SW4	31000	23968	M
A10	direct	FAIRCHILD	A-10A	A10	45000	22124	M
A124	direct	ANTONOV	An-124-100	A124	39370	30583	H
A140	direct	ANTONOV	An-140	A140	24934	20296	M
A148	direct	ANTONOV	An-148-100B	A148	40020	38217	M
A158	direct	ANTONOV	An-158	A158	38060	35946	M
A178	equiv.	ANTONOV	An-178	E190	41000	36652	M
A19	equiv.	AEROPRACT	A-19	SVNH	14000		L
A19N	equiv.	AIRBUS	A319neo	A20N	41100	36410	M
A20J	equiv.	SCHLEICHER	ASW-20CL-J	DIMO	16400		L
A20N	direct	AIRBUS	A320-271N	A20N	41100	36410	M
A210	equiv.	AQUILA	A-210/211	C162	14625	12791	L
A211	equiv.	ALFA-M	A-211	SVNH	14000		L
A21N	direct	AIRBUS	A321-251N	A21N	39800	33918	M
A22	equiv.	SADLER	A-22 Piranha	P28R	18400	13994	L
A225	equiv.	ANTONOV	An-225 Mriya	A124	39370	30583	H
A23	equiv.	AEROPRACT	A-23 Dragon	SVNH	14000		L
A270	equiv.	IBIS	Ae-270 Spirit	F406	30000	28292	L
A3	equiv.	DOUGLAS	A-3 Skywarrior	A10	45000	22124	M
A306	direct	AIRBUS	A300B4-622	A306	41000	32378	H
A30B	direct	AIRBUS	A300B4-203	A30B	39000	31966	H
A310	direct	AIRBUS	A310-204	A310	41000	35718	H
A318	direct	AIRBUS	A318-112	A318	41000	37606	M
A319	direct	AIRBUS	A319-131	A319	41000	37575	M
A320	direct	AIRBUS	A320-231	A320	41000	33295	M
A321	direct	AIRBUS	A321-111	A321	39100	35396	M
A33	equiv.	AEROPRACT	A-33	MAGC	12000	12312	L
A332	direct	AIRBUS	A330-243	A332	41450	36210	H
A333	direct	AIRBUS	A330-301	A333	41450	36392	H
A337	equiv.	AIRBUS	A330-700 Beluga XL	A3ST	35000		H
A338	equiv.	AIRBUS	A330-800	A339	41450	35930	H
A339	direct	AIRBUS	A330-941	A339	41450	35930	H
A342	direct	AIRBUS	A340-213	A342	41450	31369	H
A343	direct	AIRBUS	A340-313	A343	41450	31059	H
A345	direct	AIRBUS	A340-541	A345	41450	32862	H
A346	direct	AIRBUS	A340-642	A346	41450	33613	H
A358	equiv.	AIRBUS	A350-800 XWB	A359	43100	35108	H
A359	direct	AIRBUS	A350-941	A359	43100	35108	H
A35K	direct	AIRBUS	A350-1041	A35K	41450	34133	H
A37	equiv.	CESSNA	A-37 Dragonfly	L39	39370	29225	L
A388	direct	AIRBUS	A380-841	A388	43100	34330	J
A3ST	direct	AIRBUS	A300B4-608ST	A3ST	35000		H
A4	equiv.	DOUGLAS	A-4 Skyhawk	HAWK	40000	40555	M
A400	equiv.	AIRBUS	A-400M	IL76	39700	28685	H
A5	equiv.	ICON	A-5	MAGC	12000	12312	L

A/C Code	Model Type	Aircraft manufacturer	Aircraft model	Synonym aircraft	h_{MO} [ft]	h_{max} [ft]	WTC
A50	equiv.	BERIEV	A-50	IL76	39700	28685	H
A500	equiv.	ADAM	A-500	B58T	25000		L
A6	equiv.	GRUMMAN	A-6E Intruder	A10	45000	22124	M
A660	equiv.	THRUSH	660 Turbo Thrush	AN28	13780		L
A7	equiv.	LTV	A-7 Corsair 2	F16	60000		M
A743	equiv.	ANTONOV	An-74-300	A158	38060	35946	M
A748	equiv.	AVRO	748	F27	25000	22777	M
A900	equiv.	AVIATIKA	MAI-900 Acrobat	MAGC	12000	12312	L
AA1	equiv.	GRUMMAN AMERICAN	AA-1 Yankee	C162	14625	12791	L
AA5	equiv.	GRUMMAN AMERICAN	AA-5 Cheetah	P28A	12000		L
AAT3	equiv.	AERO	AT-3	C162	14625	12791	L
AAT4	equiv.	AERO	AT-4	C162	14625	12791	L
AC11	equiv.	ROCKWELL	Commander 115	M20T	25000		L
AC4	equiv.	LIGHT WING	AC-4	MAGC	12000	12312	L
AC50	equiv.	AERO	Commander 500	DA62	20000		L
AC52	equiv.	AERO	Commander 520	DA62	20000		L
AC56	equiv.	AERO	Commander 560	C414	30000	28339	L
AC5A	equiv.	NANJING	AC-500 Aircar	C182	18100	15991	L
AC68	equiv.	AERO	Commander 680 Super	C421	30000	28328	L
AC6L	equiv.	ROCKWELL	Commander 685	C414	30000	28339	L
AC72	equiv.	AERO	Commander 720 Alti Cruis	C421	30000	28328	L
AC80	equiv.	ROCKWELL	Turbo Commander 680	BE99	25000	19485	L
AC90	equiv.	ROCKWELL	Turbo Commander 690	PAY3	35000		L
AC95	equiv.	ROCKWELL	Jetprop Commander 980	PAY3	35000		L
ACAM	equiv.	LOCKWOOD	Air Cam	C182	18100	15991	L
ACAR	equiv.	AUSTER	J-5B Autocar	MAGC	12000	12312	L
ADVE	equiv.	AUSTER	J-5 Adventurer	MAGC	12000	12312	L
AE45	equiv.	LET	Aero 45	C82S	20000		L
AERK	equiv.	AERONCA	K Scout	SVNH	14000		L
AEST	equiv.	PIPER	Aerostar	B58T	25000		L
AFOX	equiv.	HALLEY	Apollo Fox	SVNH	14000		L
AIGT	equiv.	AUSTER	J-5F Aiglet Trainer	MAGC	12000	12312	L
AJ27	equiv.	COMAC	ARJ21-700 Xiangfeng	A148	40020	38217	M
AJET	direct	DASSAULT-DORNIER	Alpha Jet	AJET	50000	33703	M
AKRO	equiv.	STEPHENS	Akro	TB21	25000		L
ALC1	equiv.	ALTAIR COELHO	AC-11	SVNH	14000		L
ALGR	equiv.	FANTASY AIR	Allegro	EV97	16500		L
ALIG	equiv.	ARION	LS-1 Lightning	E300	16000	14908	L
ALPI	equiv.	AUSTER	J-5R Alpine	T206	27000	25654	L
ALSL	equiv.	AIRLONY	Skylane	EV97	16500		L
AMX	equiv.	AMX	A-1	AJET	50000	33703	M
AN12	direct	ANTONOV	An-12	AN12	33465	27396	M
AN2	equiv.	ANTONOV	An-2	C188	15700	8744	L
AN22	equiv.	ANTONOV	An-22 Antheus	A339	41450	35930	H
AN24	direct	ANTONOV	An-24	AN24	27560	24490	M

A/C Code	Model Type	Aircraft manufacturer	Aircraft model	Synonym aircraft	h_{MO} [ft]	h_{max} [ft]	WTC
AN26	equiv.	ANTONOV	An-26	AN30	29528	21982	M
AN28	direct	ANTONOV	An-28	AN28	13780		L
AN30	direct	ANTONOV	An-30	AN30	29528	21982	M
AN32	direct	ANTONOV	An-32B	AN32	30840	29601	M
AN38	direct	ANTONOV	An-38-100	AN38	13780		M
AN70	equiv.	ANTONOV	An-70	C30J	45000	25885	M
AN72	equiv.	ANTONOV	An-72	F100	35000	35000	M
ANGL	equiv.	ANGEL	44 Angel	P28T	18400	14000	L
ANKA	equiv.	TAI	Anka	C402	30000	24204	L
AP20	equiv.	AEROPRAKT	A-20	SVNH	14000		L
AP22	equiv.	AEROPRAKT	A-22	EV97	16500		L
AP24	equiv.	AEROPRAKT	A-24	SVNH	14000		L
AP26	equiv.	AEROPRAKT	A-26	MAGC	12000	12312	L
AP28	equiv.	AEROPRAKT	A-28	SVNH	14000		L
AP32	equiv.	AEROPRAKT	A-32 Vixxen	C162	14625	12791	L
AP36	equiv.	AEROPRAKT	A-36	T210	28500	26833	L
APM2	equiv.	ISSOIRE	APM-20 Lionceau	MAGC	12000	12312	L
APM3	equiv.	ISSOIRE	APM-30 Lion	C162	14625	12791	L
APM4	equiv.	ISSOIRE	APM-40 Simba	P28A	12000		L
APUP	equiv.	AEROPUP	Aeropup	MAGC	12000	12312	L
AR11	equiv.	AERONCA	11 Chief	MAGC	12000	12312	L
AR15	equiv.	AERONCA	15 Sedan	MAGC	12000	12312	L
AR50	equiv.	AERONCA	50 Chief	SVNH	14000		L
AR5T	equiv.	AERONCA	50 Tandem	SVNH	14000		L
AR65	equiv.	AERONCA	65 Super Chief	SVNH	14000		L
AR6T	equiv.	AERONCA	65 Tandem	SVNH	14000		L
ARCE	equiv.	SCHEMPP-HIRTH	Arcus E	DIMO	16400		L
ARCP	equiv.	SCHEMPP-HIRTH	Arcus M	DIMO	16400		L
ARV1	equiv.	ARV	ARV-1 Super 2	SVNH	14000		L
ARVA	equiv.	IAI	Arava	C208	25000	21484	L
AS02	equiv.	FFA	AS-202-15/18/26 Bravo	C182	18100	15991	L
AS14	equiv.	SCHLEICHER	ASK-14	SF25	14800		L
AS16	equiv.	SCHLEICHER	ASK-16	DIMO	16400		L
AS20	equiv.	SCHLEICHER	ASW-20TOP	DIMO	16400		L
AS21	equiv.	SCHLEICHER	ASK-21Mi	DIMO	16400		L
AS22	equiv.	SCHLEICHER	ASW-22BE	SF25	14800		L
AS25	equiv.	SCHLEICHER	ASH-25E/M/Mi/SL	DIMO	16400		L
AS26	equiv.	SCHLEICHER	ASH-26E	DIMO	16400		L
AS30	equiv.	SCHLEICHER	ASH-30Mi	DIMO	16400		L
AS31	equiv.	SCHLEICHER	ASH-31Mi	DIMO	16400		L
ASTO	equiv.	TECNAM	Astore	C162	14625	12791	L
ASTR	equiv.	IAI	1125 Astra	G150	45000	40535	M
AT2P	equiv.	AIR TRACTOR	AT-250	C188	15700	8744	L
AT3	equiv.	AIDC	AT-3 Tzu-Chung	AJET	50000	33703	M
AT3P	equiv.	AIR TRACTOR	AT-300/301/401	C188	15700	8744	L
AT3T	equiv.	AIR TRACTOR	AT-302/400/402	P750	20000		L
AT43	direct	ATR	42-300	AT43	25000	22699	M

A/C Code	Model Type	Aircraft manufacturer	Aircraft model	Synonym aircraft	h_{MO} [ft]	h_{max} [ft]	WTC
AT44	equiv.	ATR	42-400	AT45	25000	23591	M
AT45	direct	ATR	42-500	AT45	25000	23591	M
AT46	equiv.	ATR	42-600	AT45	25000	23591	M
AT5T	equiv.	AIR TRACTOR	AT-502/503/504	P750	20000		L
AT6T	equiv.	AIR TRACTOR	AT-602	C208	25000	21484	L
AT72	direct	ATR	72-200	AT72	25000	20317	M
AT73	direct	ATR	72-210	AT73	25000	20943	M
AT75	direct	ATR	72-210A	AT75	25000	20779	M
AT76	direct	ATR	72-212A 600	AT76	25000	20347	M
AT8T	equiv.	AIR TRACTOR	AT-802	AN38	13780		M
ATL	equiv.	ROBIN	ATL	SVNH	14000		L
ATLA	equiv.	DASSAULT	Atlantique 2	C160	30000	25500	M
ATP	direct	BRITISH AEROSPACE	ATP	ATP	25000	21628	M
AUJ2	equiv.	AUSTER	J-2 Arrow	SVNH	14000		L
AUS3	equiv.	TAYLORCRAFT	Auster 3	MAGC	12000	12312	L
AUS4	equiv.	TAYLORCRAFT	Auster 4	MAGC	12000	12312	L
AUS5	equiv.	TAYLORCRAFT	Auster 5	MAGC	12000	12312	L
AUS6	equiv.	AUSTER	Auster AOP6	SVNH	14000		L
AUS7	equiv.	AUSTER	Auster T7	SVNH	14000		L
AUS9	equiv.	AUSTER	Auster AOP9	C182	18100	15991	L
AV68	equiv.	M&D FLUGZEUGBAU	AVO-68 Samburo	DIMO	16400		L
AVID	equiv.	AVID	Avid Flyer	EV97	16500		L
B1	equiv.	ROCKWELL	B-1 Lancer	FGTL	41000		H
B103	equiv.	BERIEV	Be-103 Bekas	C188	15700	8744	L
B13	equiv.	AKAFLIEG BERLIN	B-13	DIMO	16400		L
B14A	equiv.	BELLANCA	14 Cruisair Senior	DA40	16400		L
B17	equiv.	BOEING	B-17 Flying Fortress	C30J	45000	25885	M
B18T	equiv.	VOLPAR	Turbo 18	BE9L	31000		L
B190	direct	BEECH	1900D	B190	25000		M
B2	equiv.	NORTHROP	B-2 Spirit	FGTL	41000		H
B209	equiv.	BOLKOW	BO-209 Monsun	C182	18100	15991	L
B23	equiv.	DOUGLAS	B-23 Dragon	E120	32000	31215	M
B24	equiv.	CONSOLIDATED	B-24 Liberator	C160	30000	25500	M
B25	equiv.	NORTH AMERICAN	B-25 Mitchell	AT43	25000	22699	M
B26	equiv.	DOUGLAS	A-26/B-26 Invader	SF34	25000	25000	M
B350	direct	BEECHCRAFT	Super King Air 350	B350	35000	35004	L
B36T	equiv.	BEECH	Bonanza 36 Turbine	E500	25000	23610	L
B37M	equiv.	BOEING	737 MAX 7	B38M	41000	36344	M
B38M	direct	BOEING	B737-8 MAX	B38M	41000	36344	M
B39M	direct	BOEING	B737-9 MAX	B39M	41000	35741	M
B461	equiv.	BRITISH AEROSPACE	BAe 146-100 Statesman	B462	31000	32716	M
B462	direct	BRITISH AEROSPACE	BAe 146-200	B462	31000	32716	M
B463	direct	BRITISH AEROSPACE	BAe 146-300	B463	31000	29305	M
B52	equiv.	BOEING	B-52 Stratofortress	FGTL	41000		H

A/C Code	Model Type	Aircraft manufacturer	Aircraft model	Synonym aircraft	h_{MO} [ft]	h_{max} [ft]	WTC
B58T	direct	BEECH	Baron 58P	B58T	25000		L
B60	equiv.	BOISAVIA	B-60 Mercurey	C182	18100	15991	L
B701	equiv.	BOEING	707-100	B752	42000	35478	M
B703	direct	BOEING	B707-300	B703	42000	35000	H
B712	direct	BOEING	B717-200	B712	37000	35187	M
B720	equiv.	BOEING	720	B752	42000	35478	M
B721	equiv.	BOEING	727-100	B752	42000	35478	M
B722	direct	BOEING	B727-228 Adv	B722	42000	33672	M
B731	equiv.	BOEING	737-100	T134	39000	34764	M
B732	direct	BOEING	B737-200	B732	37000	34508	M
B733	direct	BOEING	B737-300	B733	39000	33636	M
B734	direct	BOEING	B737-400e	B734	37000	33448	M
B735	direct	BOEING	B737-500	B735	37000	34768	M
B736	direct	BOEING	B737-600	B736	41000	39276	M
B737	direct	BOEING	B737-700	B737	41000	37332	M
B738	direct	BOEING	B737-800	B738	41000	34982	M
B739	direct	BOEING	B737-900ER	B739	41000	34683	M
B741	equiv.	BOEING	747-100	B743	45000	30943	H
B742	direct	BOEING	B747-200	B742	45000	33180	H
B743	direct	BOEING	B747-300	B743	45000	30943	H
B744	direct	BOEING	B747-400	B744	45000	32726	H
B748	direct	BOEING	B747-8F	B748	43100	32973	H
B74D	equiv.	BOEING	747-400 (domestic)	B743	45000	30943	H
B74R	equiv.	BOEING	747SR	B743	45000	30943	H
B74S	equiv.	BOEING	747SP	B742	45000	33180	H
B752	direct	BOEING	B757-200	B752	42000	35478	M
B753	direct	BOEING	B757-300	B753	43000	33339	M
B762	direct	BOEING	B767-200	B762	43000	35861	H
B763	direct	BOEING	B767-300ER	B763	43100	36502	H
B764	direct	BOEING	B767-400	B764	45000	33210	H
B772	direct	BOEING	B777-200ER	B772	43100	34643	H
B773	direct	BOEING	B777-300	B773	43100	31857	H
B778	equiv.	BOEING	777-8	B77W	43100	34314	H
B779	equiv.	BOEING	777-9	B77W	43100	34314	H
B77L	direct	BOEING	B777-200LR	B77L	43100	35104	H
B77W	direct	BOEING	B777-300ER	B77W	43100	34314	H
B788	direct	BOEING	B787-8	B788	43100	37131	H
B789	direct	BOEING	B787-9	B789	43100	36568	H
B78X	direct	BOEING	B787-10	B78X	41100	37816	H
BA11	direct	BAC	1.11/400	BA11	35000	29750	M
BCS1	equiv.	BOMBARDIER	CS100	B736	41000	39276	M
BCS3	equiv.	BOMBARDIER	CS300	B737	41000	37332	M
BD17	equiv.	BEDE	BD-17 Nuggett	EV97	16500		L
BD4	equiv.	BEDE	BD-4	E300	16000	14908	L
BDOG	equiv.	SCOTTISH AVIATION	SA-3 Bulldog	C82S	20000		L
BE10	equiv.	BEECH	100 King Air	F406	30000	28292	L
BE12	equiv.	BERIEV	Be-12 Tchaika	C27J	30000	25721	M

A/C Code	Model Type	Aircraft manufacturer	Aircraft model	Synonym aircraft	h_{MO} [ft]	h_{max} [ft]	WTC
BE17	equiv.	BEECH	17 Staggerwing	TB21	25000		L
BE18	equiv.	BEECH	18 Twin Beech	PA46	25000		L
BE19	equiv.	BEECH	19 Sport	P28A	12000		L
BE20	direct	BEECHCRAFT	Super King Air B200	BE20	35000		L
BE23	equiv.	BEECH	23 Musketeer	C172	14000		L
BE24	equiv.	BEECH	24 Sierra	P06T	14000		L
BE30	direct	BEECH	Super King Air 300	BE30	35000		L
BE32	equiv.	BERIEV	Be-30/32	AN38	13780		M
BE33	equiv.	BEECH	33 Bonanza	P28T	18400	14000	L
BE35	equiv.	BEECH	35 Bonanza	BE36	18500	16757	L
BE36	direct	BEECHCRAFT	Bonanza G36	BE36	18500	16757	L
BE40	direct	HAWKER	400XP	BE40	45000	41042	M
BE4W	equiv.	NEXTANT	400XPi	BE40	45000	41042	M
BE50	equiv.	BEECH	50 Twin Bonanza	C402	30000	24204	L
BE55	equiv.	BEECH	55 Baron	PA27	20000		L
BE56	equiv.	BEECH	56 Turbo Baron	PAY3	35000		L
BE58	direct	BEECHCRAFT	Baron 58	BE58	20688		L
BE60	equiv.	BEECH	60 Duke	C414	30000	28339	L
BE65	equiv.	BEECH	65 Queen Air	C414	30000	28339	L
BE70	equiv.	BEECH	70 Queen Air	C414	30000	28339	L
BE76	direct	BEECH	Duchess 76	BE76	20000	17924	L
BE77	equiv.	BEECH	77 Skipper	C162	14625	12791	L
BE80	equiv.	BEECH	80 Queen Air	C414	30000	28339	L
BE88	equiv.	BEECH	88 Queen Air	C414	30000	28339	L
BE95	equiv.	BEECH	95 Travel Air	C210	18000	13360	L
BE99	direct	BEECH	99A Airliner	BE99	25000	19485	L
BE9L	direct	BEECHCRAFT	King Air E90	BE9L	31000		L
BE9T	equiv.	BEECH	90 (F90) King Air	F406	30000	28292	L
BEAR	equiv.	R&B	RB-4 Bearhawk	DA40	16400		L
BELF	equiv.	SHORT	SC-5 Belfast	C130	33000	21891	M
BER2	direct	BERIEV	Be-200ES	BER2	26575	32367	M
BIRD	equiv.	TAYLOR	TA-2/3 Bird	SVNH	14000		L
BL17	equiv.	BELLANCA	17 Viking	TB21	25000		L
BL19	equiv.	BELLANCA	19 Skyrocket	C340	30000	28221	L
BL8	equiv.	BELLANCA	8 Scout	C182	18100	15991	L
BLCF	equiv.	BOEING	747-400LCF Dreamlifter	B77W	43100	34314	H
BMAN	equiv.	AAK	Bushman	MAGC	12000	12312	L
BN2P	equiv.	BRITTEN-NORMAN	BN-2 Islander	DA42	18000		L
BN2T	equiv.	BRITTEN-NORMAN	BN-2T Turbine Islander	KODI	25000	18797	L
BOLT	equiv.	STEEN	Skybolt	P28R	18400	13994	L
BR60	equiv.	BRUMBY	600	C162	14625	12791	L
BR61	equiv.	BRUMBY	610 Evolution	C162	14625	12791	L
BRAV	equiv.	TECNAM	P-2004 Bravo	C162	14625	12791	L
BREZ	equiv.	AEROSTYLE	Breezer	MAGC	12000	12312	L
BROU	equiv.	MAX HOLSTE	MH-1521 Broussard	C182	18100	15991	L
BT36	equiv.	BEECH	Bonanza B36TC	S22T	25000		L
BTX1	equiv.	BOEING	BTX-1	L39	39370	29225	L

A/C Code	Model Type	Aircraft manufacturer	Aircraft model	Synonym aircraft	h_{MO} [ft]	h_{max} [ft]	WTC
BU31	equiv.	BUCKER	Bü-131 Jungmann	EV97	16500		L
BU33	equiv.	BUCKER	Bü-133 Jungmeister	C162	14625	12791	L
BUCA	equiv.	ADVANCED AVIATION	Buccaneer	SVNH	14000		L
BUSH	equiv.	RAINBOW SKYREACH	BushCat	SVNH	14000		L
BX2	equiv.	BRANDLI	BX-2 Cherry	C162	14625	12791	L
C02T	equiv.	CESSNA	402 (turbine)	E500	25000	23610	L
C04T	equiv.	CESSNA	404 (turbine)	PAY1	29000		L
C06T	equiv.	CESSNA	206 (turbine)	P750	20000		L
C07T	equiv.	CESSNA	207 (turbine)	E500	25000	23610	L
C1	equiv.	KAWASAKI	C-1	A10	45000	22124	M
C101	equiv.	CASA	Aviojet	L39	39370	29225	L
C10T	equiv.	CESSNA	P210 Turbine	E500	25000	23610	L
C119	equiv.	FAIRCHILD	C-119 Flying Boxcar	F27	25000	22777	M
C120	equiv.	CESSNA	120	EV97	16500		L
C123	equiv.	FAIRCHILD	C-123 Provider	C160	30000	25500	M
C125	equiv.	NORTHROP	C-125 Raider	S2P	21000		M
C130	direct	LOCKHEED	L-100-30 Hercules	C130	33000	21891	M
C133	equiv.	DOUGLAS	C-133 Cargomaster	C130	33000	21891	M
C135	equiv.	BOEING	C-135 Stratolifter	B703	42000	35000	H
C140	equiv.	CESSNA	140	EV97	16500		L
C141	equiv.	LOCKHEED	C-141 Starlifter	A310	41000	35718	H
C14T	equiv.	CESSNA	414 (turbine)	E500	25000	23610	L
C15	equiv.	MCDONNELL DOUGLAS	YC-15	T154	41000	37285	M
C150	equiv.	CESSNA	150	MAGC	12000	12312	L
C152	equiv.	CESSNA	152	C162	14625	12791	L
C160	direct	TRANSALL	C-160P	C160	30000	25500	M
C162	direct	CESSNA	162	C162	14625	12791	L
C17	equiv.	BOEING	C-17 Globemaster 3	B764	45000	33210	H
C170	equiv.	CESSNA	170	C162	14625	12791	L
C172	direct	CESSNA	172S Skyhawk SP	C172	14000		L
C175	equiv.	CESSNA	175 Skylark	EV97	16500		L
C177	equiv.	CESSNA	177 Cardinal	C172	14000		L
C180	equiv.	CESSNA	180	C182	18100	15991	L
C182	direct	CESSNA	182T Skylane	C182	18100	15991	L
C185	equiv.	CESSNA	185 Skywagon	C182	18100	15991	L
C188	direct	CESSNA	A188B	C188	15700	8744	L
C190	equiv.	CESSNA	190	M20P	20000	18649	L
C195	equiv.	CESSNA	195	C182	18100	15991	L
C2	equiv.	GRUMMAN	C-2 Greyhound	C160	30000	25500	M
C205	equiv.	CESSNA	205	C206	15700	13917	L
C206	direct	CESSNA	206H	C206	15700	13917	L
C207	equiv.	CESSNA	207 Stationair 7	C206	15700	13917	L
C208	direct	CESSNA	208B	C208	25000	21484	L
C210	direct	CESSNA	210M	C210	18000	13360	L
C212	equiv.	CASA	C-212 Aviocar	JS32	25000		M

A/C Code	Model Type	Aircraft manufacturer	Aircraft model	Synonym aircraft	h_{MO} [ft]	h_{max} [ft]	WTC
C21T	equiv.	CESSNA	421 (turbine)	TBM7	31000		L
C22J	equiv.	CAPRONI VIZZOLA	C-22J Ventura	EA50	41000		L
C240	equiv.	CESSNA	T240 Corvalis TTx	S22T	25000		L
C25A	direct	CESSNA	Citation CJ2+	C25A	45000		L
C25B	direct	CESSNA	Citation CJ3	C25B	45000		L
C25C	direct	CESSNA	Citation CJ4	C25C	45000		M
C25M	equiv.	CESSNA	525 Citation M2	C525	41000		L
C270	equiv.	CAUDRON	C-275 Luciole	SVNH	14000		L
C27J	direct	ALENIA AERMACCHI	C-27J	C27J	30000	25721	M
C295	equiv.	CASA	C-295	F27	25000	22777	M
C303	equiv.	CESSNA	Crusader	PA31	26300		L
C309	equiv.	CEA	CEA-309 Mehari	E300	16000	14908	L
C30J	direct	LOCKHEED MARTIN	C-130J	C30J	45000	25885	M
C310	direct	CESSNA	310R	C310	20000	16998	L
C311	equiv.	CEA	CEA-311 Anequim	E300	16000	14908	L
C320	equiv.	CESSNA	320 Skyknight	T210	28500	26833	L
C335	equiv.	CESSNA	335	C402	30000	24204	L
C336	equiv.	CESSNA	336 Skymaster	BE76	20000	17924	L
C337	equiv.	CESSNA	337 Super Skymaster	C82S	20000		L
C340	direct	CESSNA	340A	C340	30000	28221	L
C365	equiv.	EKW	C-3605	TEX2	31000		L
C402	direct	CESSNA	402B	C402	30000	24204	L
C404	equiv.	CESSNA	404 Titan	PA31	26300		L
C408	equiv.	CESSNA	408 SkyCourier	C208	25000	21484	L
C411	equiv.	CESSNA	411	PA31	26300		L
C414	direct	CESSNA	414A	C414	30000	28339	L
C42	equiv.	IKARUS	C-42	C162	14625	12791	L
C421	direct	CESSNA	421C	C421	30000	28328	L
C425	equiv.	CESSNA	425 Corsair	PAY3	35000		L
C441	equiv.	CESSNA	441 Conquest	PAY3	35000		L
C46	equiv.	CURTISS	C-46 Commando	F27	25000	22777	M
C5	equiv.	LOCKHEED	C-5 Galaxy	A345	41450	32862	H
C500	equiv.	CESSNA	500 Citation 1	C551	43000		L
C501	equiv.	CESSNA	501 Citation 1SP	C551	43000		L
C510	direct	CESSNA	Citation Mustang	C510	41000		L
C525	direct	CESSNA	Citation CJ1+	C525	41000		L
C526	equiv.	CESSNA	526 CitationJet	E50P	41000	40400	L
C550	direct	CESSNA	Citation II	C550	43000		L
C551	direct	CESSNA	Citation II/SP	C551	43000		L
C55B	direct	CESSNA	Citation Bravo	C55B	45000	42466	L
C560	direct	CESSNA	Citation V	C560	45000	41516	M
C56X	direct	CESSNA	Citation XLS+	C56X	45000	44474	M
C5M	equiv.	LOCKHEED	C-5M Super Galaxy	A345	41450	32862	H
C650	direct	CESSNA	Citation VII	C650	51000	42447	M
C680	direct	CESSNA	Citation Sovereign	C680	47000		M
C68A	equiv.	CESSNA	680A Citation Latitude	C680	47000		M
C700	equiv.	CESSNA	Citation Longitude	CL30	45000	44827	M

A/C Code	Model Type	Aircraft manufacturer	Aircraft model	Synonym aircraft	h_{MO} [ft]	h_{max} [ft]	WTC
C72R	equiv.	CESSNA	172RG Cutlass RG	DA40	16400		L
C750	direct	CESSNA	Citation X	C750	51000	43086	M
C77R	equiv.	CESSNA	177RG Cardinal RG	P28A	12000		L
C82	equiv.	FAIRCHILD	C-82 Packet	S2P	21000		M
C82R	equiv.	CESSNA	R182 Skylane RG	TB20	20000		L
C82S	direct	CESSNA	T182T Skylane TC	C82S	20000		L
C82T	equiv.	CESSNA	TR182 Turbo Skylane RG	C82S	20000		L
C919	equiv.	COMAC	C-919	A20N	41100	36410	M
C97	equiv.	BOEING	C-97 Stratofreighter	C30J	45000	25885	M
CA12	equiv.	COMP AIR	CA-12 Comp Air 12	BE9L	31000		L
CA19	equiv.	COMMONWEALTH	CA-13/19 Boomerang	C402	30000	24204	L
CA25	equiv.	COMMONWEALTH	CA-25 Winjeel	C182	18100	15991	L
CA41	equiv.	CORVUS	CA-41 Racer	E300	16000	14908	L
CA9	equiv.	COMP AIR	CA-9 Comp Air 9	TBM7	31000		L
CAT	equiv.	CONSOLIDATED	PBY Catalina	S2P	21000		M
CC19	equiv.	CUB CRAFTERS	CC-19 XCub	C172	14000		L
CD2	equiv.	DORNIER	CD-2 Seastar	L410	20000	17610	L
CE22	equiv.	CHERNOV	Che-22 Corvette	SVNH	14000		L
CE25	equiv.	CHERNOV	Che-25	MAGC	12000	12312	L
CE43	equiv.	CERVA	CE-43 Guepard	SR22	17500		L
CH10	equiv.	ZENAIR	CH-100 Mono-Zénith	MAGC	12000	12312	L
CH20	equiv.	ZENAIR	CH-200 Zénith	C162	14625	12791	L
CH25	equiv.	ZENAIR	CH-250 Zénith	C162	14625	12791	L
CH2T	equiv.	ZENAIR	CH-2000 Zénith	MAGC	12000	12312	L
CH30	equiv.	ZENAIR	CH-300 Tri-Zénith	MAGC	12000	12312	L
CH40	equiv.	CHAMPION	402 Lancer	C172	14000		L
CH50	equiv.	ZENAIR	CH-50 Mini Zénith	SVNH	14000		L
CH60	equiv.	ZENAIR	CH-601 Zodiac	EV97	16500		L
CH70	equiv.	ZENITH	CH-701 Stol	SVNH	14000		L
CH7A	equiv.	BELLANCA	Citabria Aurora 7ECA	MAGC	12000	12312	L
CH7B	equiv.	BELLANCA	Citabria Adventure 7GCAA	EV97	16500		L
CHIN	equiv.	ASAP	Chinook	EV97	16500		L
CHIP	equiv.	LEGER	Super-Chipmunk	DA40	16400		L
CJ6	equiv.	NANCHANG	CJ-6	TB20	20000		L
CL2P	equiv.	CANADAIR	CL-215	S2P	21000		M
CL2T	equiv.	CANADAIR	CL-415	SH36	20000		M
CL30	direct	BOMBARDIER	Challenger 300	CL30	45000	44827	M
CL35	equiv.	BOMBARDIER	Challenger 350	G280	45000	43631	M
CL41	equiv.	CANADAIR	CL-41 Tutor	L39	39370	29225	L
CL44	equiv.	CANADAIR	CL-44 Forty Four	C130	33000	21891	M
CL60	direct	CANADAIR	Challenger 604	CL60	41000	39223	M
CN12	equiv.	CIRCA	Nieuport 12-7/8	SVNH	14000		L
CN35	equiv.	CASA	CN-235	AT43	25000	22699	M
CNBR	equiv.	SHORT	Canberra	F900	51000	38187	M
CO50	equiv.	COBALT	Co-50 Valkyrie	M20T	25000		L
COAR	equiv.	COBRA	Arrow	C162	14625	12791	L
COL3	equiv.	CESSNA	350 Corvalis	SR22	17500		L

A/C Code	Model Type	Aircraft manufacturer	Aircraft model	Synonym aircraft	h_{MO} [ft]	h_{max} [ft]	WTC
COL4	equiv.	CESSNA	400 Corvalis TT	S22T	25000		L
CONI	equiv.	LOCKHEED	(Super) Constellation	C160	30000	25500	M
CORV	equiv.	WOLFSBERG	Corvus	DA42	18000		L
COUG	equiv.	NESMITH	Cougar	C162	14625	12791	L
COUR	equiv.	HELIO	H-295 Super Courier	C82S	20000		L
COY2	equiv.	RANS	S-6 Coyote 2	EV97	16500		L
COZJ	equiv.	CO-Z	CozyJet	SF50	31000		L
COZY	equiv.	CO-Z	Cozy	TB20	20000		L
CP10	equiv.	CAP AVIATION	CAP-10	P28R	18400	13994	L
CP13	equiv.	SCINTEX	CP-1310 Super Emeraude	C162	14625	12791	L
CP20	equiv.	MUDRY	CAP-20	E300	16000	14908	L
CP21	equiv.	MUDRY	CAP-21	C162	14625	12791	L
CP22	equiv.	CAP AVIATION	CAP-222	E300	16000	14908	L
CP23	equiv.	CAP AVIATION	CAP-232	E300	16000	14908	L
CP30	equiv.	PIEL	CP-30/301/311 Emeraude	C162	14625	12791	L
CP32	equiv.	PIEL	CP-320/325/328 Super Eme	C162	14625	12791	L
CR10	equiv.	DYN'AERO	CR-100/110/120	P28U	20000	19000	L
CRER	equiv.	RANS	S-7 Courier	EV97	16500		L
CRES	equiv.	PACIFIC AEROSPACE	Cresco	P750	20000		L
CRJ1	direct	CANADAIR	CRJ-100	CRJ1	41000	34333	M
CRJ2	direct	CANADAIR	CRJ-200	CRJ2	41000	36855	M
CRJ7	equiv.	BOMBARDIER	CRJ-700	CRJ9	41000	36457	M
CRJ9	direct	CANADAIR	CRJ-900	CRJ9	41000	36457	M
CRJX	direct	BOMBARDIER	CRJ-1000	CRJX	41000	35031	M
CRUZ	equiv.	CZAW	SportCruiser	EV97	16500		L
CT4	equiv.	PACIFIC AEROSPACE	CT-4 Airtrainer	P28R	18400	13994	L
CUCA	equiv.	CULVER	Cadet	EV97	16500		L
CVLP	equiv.	CONVAIR	CV-240 Convairliner	S2P	21000		M
CVLT	equiv.	CANADAIR	CL-66	ATP	25000	21628	M
CX5	equiv.	THATCHER	CX-5	MAGC	12000	12312	L
D1	equiv.	WING	D-1 Derringer	M20P	20000	18649	L
D11	equiv.	JODEL	D-11	MAGC	12000	12312	L
D139	equiv.	DORNA	D-139 Blue Bird	C162	14625	12791	L
D140	equiv.	JODEL	D-140 Mousquetaire	DA40	16400		L
D150	equiv.	JODEL	D-150 Mascaret	EV97	16500		L
D18	equiv.	JODEL	D-18/19/20	EV97	16500		L
D228	direct	DORNIER	228-212	D228	28000		L
D250	equiv.	CENTRE EST	DR-200/250	C162	14625	12791	L
D253	equiv.	CENTRE EST	DR-253 Regent	DA40	16400		L
D28D	equiv.	DORNIER	Do-28D-2 Skyservant	PA46	25000		L
D28T	equiv.	DORNIER	128-6 Turbo Skyservant	P46T	30000	30945	L
D31	equiv.	DRUINE	D-31 Turbulent	EV97	16500		L
D328	direct	DORNIER	328	D328	32800	29051	M
D6	equiv.	AUSTER	D-6	P28A	12000		L
D8	equiv.	FOKKER	D-8 Replica	P28U	20000	19000	L

A/C Code	Model Type	Aircraft manufacturer	Aircraft model	Synonym aircraft	h_{MO} [ft]	h_{max} [ft]	WTC
DA2	equiv.	DAVIS	DA-2	MAGC	12000	12312	L
DA36	equiv.	DIAMOND	DA-36 E-Star	DIMO	16400		L
DA40	direct	DIAMOND	DA40 NG	DA40	16400		L
DA42	direct	DIAMOND	DA42 Twin Star	DA42	18000		L
DA5	equiv.	DAVIS	DA-5	EV97	16500		L
DA50	equiv.	DIAMOND	DA-50 Magnum	C182	18100	15991	L
DA62	direct	DIAMOND	DA62	DA62	20000		L
DAL4	equiv.	DALLACH	D-4 Fascination	C162	14625	12791	L
DC10	direct	MCDONNELL DOUGLAS	DC10-30	DC10	42000	32000	H
DC3	equiv.	DOUGLAS	DC-3	F27	25000	22777	M
DC3S	equiv.	DOUGLAS	R4D-8	F27	25000	22777	M
DC3T	equiv.	BASLER	Turbo 67	F27	25000	22777	M
DC4	equiv.	DOUGLAS	DC-4	F27	25000	22777	M
DC6	equiv.	DOUGLAS	DC-6	C27J	30000	25721	M
DC7	equiv.	DOUGLAS	DC-7 Seven Seas	C130	33000	21891	M
DC85	equiv.	DOUGLAS	DC-8-50	DC87	42000	34000	H
DC86	equiv.	DOUGLAS	DC-8-60	DC87	42000	34000	H
DC87	direct	DOUGLAS	DC8-72CF	DC87	42000	34000	H
DC91	equiv.	DOUGLAS	DC-9-10	B712	37000	35187	M
DC92	equiv.	DOUGLAS	DC-9-20	DC94	35000	33500	M
DC93	direct	DOUGLAS	C9-B	DC93	37000	33500	M
DC94	direct	DOUGLAS	DC9-40	DC94	35000	33500	M
DC95	equiv.	DOUGLAS	DC-9-50	DC94	35000	33500	M
DEFI	equiv.	RUTAN	40 Defiant	BE36	18500	16757	L
DFLY	equiv.	VIKING	Dragonfly	C162	14625	12791	L
DG1T	equiv.	DG FLUGZEUGBAU	DG-1000T	DIMO	16400		L
DG40	equiv.	GLASER-DIRKS	DG-400	SF25	14800		L
DG50	equiv.	GLASER-DIRKS	DG-500M	DIMO	16400		L
DG60	equiv.	GLASER-DIRKS	DG-600M	DIMO	16400		L
DG80	equiv.	GLASER-DIRKS	DG-800	DIMO	16400		L
DH2T	equiv.	DEHAVILLAND CANADA	DHC-2 Mk3 Turbo Beaver	KODI	25000	18797	L
DH60	equiv.	DE HAVILLAND	DH-60 Moth	SVNH	14000		L
DH80	equiv.	DE HAVILLAND	DH-80 Puss Moth	C182	18100	15991	L
DH82	equiv.	DE HAVILLAND	DH-82 Tiger Moth	SVNH	14000		L
DH83	equiv.	DE HAVILLAND	DH-83 Fox Moth	SVNH	14000		L
DH85	equiv.	DE HAVILLAND	DH-85 Leopard Moth	T206	27000	25654	L
DH87	equiv.	DE HAVILLAND	DH-87 Hornet Moth	SVNH	14000		L
DH88	equiv.	DE HAVILLAND	DH-88 Comet Replica	BE58	20688		L
DH89	equiv.	DE HAVILLAND	DH-89 Dragon Rapide	DA40	16400		L
DH8A	direct	DEHAVILLAND CANADA	DHC-8 100	DH8A	25000	25000	M
DH8B	equiv.	DEHAVILLAND CANADA	DHC-8 200	DH8C	25000	24804	M
DH8C	direct	DEHAVILLAND CANADA	DHC-8 300	DH8C	25000	24804	M
DH8D	direct	DEHAVILLAND CANADA	Dash-8 Q400	DH8D	27000		M

A/C Code	Model Type	Aircraft manufacturer	Aircraft model	Synonym aircraft	h_{MO} [ft]	h_{max} [ft]	WTC
DHA3	equiv.	DEHAVILLAND AUSTRAL	DHA-3 Drover	C188	15700	8744	L
DHC1	equiv.	DEHAVILLAND CANADA	DHC-1 Chipmunk	EV97	16500		L
DHC2	equiv.	DEHAVILLAND CANADA	DHC-2 Beaver	C182	18100	15991	L
DHC3	equiv.	DEHAVILLAND CANADA	DHC-3 Otter	C182	18100	15991	L
DHC4	equiv.	DEHAVILLAND CANADA	DHC-4 Caribou	F27	25000	22777	M
DHC5	equiv.	DEHAVILLAND CANADA	DHC-5 Buffalo	SW4	31000	23968	M
DHC6	equiv.	DEHAVILLAND CANADA	DHC-6 Twin Otter	C208	25000	21484	L
DHC7	equiv.	DEHAVILLAND CANADA	DHC-7 Dash 7	AN30	29528	21982	M
DIMO	direct	DIAMOND	HK36 TC 100	DIMO	16400		L
DINO	equiv.	GANZAVIA	GAK-22 Dinó	MAGC	12000	12312	L
DISC	equiv.	SCHEMPP-HIRTH	Discus bT	SF25	14800		L
DO27	equiv.	DORNIER	Do-27	T206	27000	25654	L
DO28	equiv.	DORNIER	Do-28A/B	DA62	20000		L
DOVE	equiv.	DE HAVILLAND	DH-104 Dove	PA31	26300		L
DR10	equiv.	CENTRE EST	DR-1050 Sicile	MAGC	12000	12312	L
DR22	equiv.	CENTRE EST	DR-221 Dauphin	P28A	12000		L
DR30	equiv.	ROBIN	DR-315 Petit Prince	C162	14625	12791	L
DR40	equiv.	ROBIN	DR-400	DA40	16400		L
DT45	equiv.	DIAMOND	Dart-450	E500	25000	23610	L
DTA1	equiv.	VERHEES	D-1 Delta	EV97	16500		L
DTA2	equiv.	VERHEES	D-2 Delta	C162	14625	12791	L
DUB2	equiv.	DUBNA	2 Osa	SVNH	14000		L
DUOD	equiv.	SCHEMPP-HIRTH	Duo Discus XLT	DIMO	16400		L
DV1	equiv.	DOVA	DV-1 Skylark	C162	14625	12791	L
DV2	equiv.	DOVA	DV-2 Infinity	C162	14625	12791	L
DV20	equiv.	DIAMOND	DV-20 Katana	C172	14000		L
E110	equiv.	EMBRAER	EMB-110 Bandeirante	D228	28000		L
E120	direct	EMBRAER	EMB-120	E120	32000	31215	M
E121	equiv.	EMBRAER	EMB-121 Xingu	MU2	31000	26111	L
E135	direct	EMBRAER	EMB-135LR	E135	37000		M
E145	direct	EMBRAER	EMB-145LR	E145	37000		M
E170	direct	EMBRAER	ERJ 170-100 IGW	E170	41000	35758	M
E190	direct	EMBRAER	ERJ 190-100 IGW	E190	41000	36652	M
E195	direct	EMBRAER	ERJ 190-200 IGW	E195	41000	35815	M
E2	equiv.	GRUMMAN	E-2 Hawkeye	C27J	30000	25721	M
E200	equiv.	EXTRA	EA-200	E300	16000	14908	L
E230	equiv.	EXTRA	EA-230	E300	16000	14908	L
E275	equiv.	EMBRAER	ERJ-190-500 (E175-E2)	E75L	41000	34725	M
E290	direct	EMBRAER	ERJ 190-300	E290	41000	37767	M
E295	equiv.	EMBRAER	ERJ-190-400 (E195-E2)	B736	41000	39276	M
E29E	equiv.	BINDER	EB-29DE	DIMO	16400		L
E300	direct	EXTRA	EA 300/L	E300	16000	14908	L

A/C Code	Model Type	Aircraft manufacturer	Aircraft model	Synonym aircraft	h_{MO} [ft]	h_{max} [ft]	WTC
E314	equiv.	EMBRAER	EMB-312H/314	TEX2	31000		L
E350	equiv.	CESSNA	E350	TBM9	31000		L
E35L	direct	EMBRAER	EMB-135BJ Legacy 600	E35L	41000	38617	M
E3CF	equiv.	BOEING	E-3A (CFM56) Sentry	B762	43000	35861	H
E3TF	equiv.	BOEING	E-3A (TF33) Sentry	B762	43000	35861	H
E400	equiv.	EXTRA	EA-400	PA34	25000	22500	L
E45X	direct	EMBRAER	EMB-145XR	E45X	37000	36780	M
E500	direct	EXTRA	EA 400-500	E500	25000	23610	L
E50P	direct	EMBRAER	EMB-500 Phenom 100	E50P	41000	40400	L
E530	equiv.	CESSNA	E530 Scorpion	AJET	50000	33703	M
E545	direct	EMBRAER	EMB-545 Legacy 450	E545	45000	43540	M
E550	direct	EMBRAER	EMB-550 Legacy 500	E550	45000	43476	M
E55P	direct	EMBRAER	EMB-505 Phenom 300	E55P	45000	44923	M
E6	equiv.	BOEING	E-6 Mercury	DC87	42000	34000	H
E737	equiv.	BOEING	737-700 Wedgetail	B738	41000	34982	M
E75L	direct	EMBRAER	ERJ 170-200 IGW EWT	E75L	41000	34725	M
E75S	direct	EMBRAER	ERJ 170-200 IGW	E75S	41000	34725	M
E767	equiv.	BOEING	E-767	B763	43100	36502	H
EA40	equiv.	ECLIPSE	Eclipse 400	EA50	41000		L
EA50	direct	ECLIPSE	EA500	EA50	41000		L
EAGX	equiv.	EAGLE AIRCRAFT	Eagle 150	C162	14625	12791	L
EB29	equiv.	BINDER	EB-29	DIMO	16400		L
EBOY	equiv.	FMA	20 El Boyero	SVNH	14000		L
ECHO	equiv.	TECNAM	P-92 Echo	C162	14625	12791	L
EDGE	equiv.	ZIVKO	Edge 540	E300	16000	14908	L
EFAN	equiv.	AIRBUS	E-Fan	SVNH	14000		L
EFOX	equiv.	AEROPRO	Eurofox	C162	14625	12791	L
EFUS	equiv.	MAGNUS	MG-11 eFusion	C162	14625	12791	L
EGRT	equiv.	GROB	G-520 Strato 1	LJ25	51000	43367	L
ELIT	equiv.	EPIC AIRCRAFT	Epic Elite	C551	43000		L
ELPS	equiv.	EXPLORER	Ellipse	C162	14625	12791	L
ELSP	equiv.	A2 CZ	Ellipse Spirit	C162	14625	12791	L
ELST	equiv.	PUTZER	Elster	SF25	14800		L
EM10	equiv.	MARGANSKI	EM-10 Bielik	L39	39370	29225	L
EPIC	equiv.	EPIC AIRCRAFT	Epic E-1000	PAY3	35000		L
EPX1	equiv.	EPERVIER	X-1	EV97	16500		L
ERAC	equiv.	DICKEY	E-Racer	TB21	25000		L
ERCO	equiv.	ERCO	Ercoupe 415-C	C162	14625	12791	L
ESCA	equiv.	EPIC AIRCRAFT	Epic Escape	TBM7	31000		L
ETA	equiv.	ETA AIRCRAFT	Eta	DIMO	16400		L
ETAR	equiv.	DASSAULT	Super Etendard	HAWK	40000	40555	M
EUFI	equiv.	EUROFIGHTER	Typhoon	F16	60000		M
EUPA	equiv.	EUROPA	Europa	C162	14625	12791	L
EV97	direct	EVEKTOR	EV-97 EuroStar	EV97	16500		L
EVIC	equiv.	EPIC AIRCRAFT	Epic Victory	SF50	31000		L
EVOP	equiv.	LANCAIR	Evolution Piston	C340	30000	28221	L
EVOT	equiv.	LANCAIR	Evolution Turbine	TBM7	31000		L

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EVSS	equiv.	EVEKTOR	SportStar	SVNH	14000		L
EXPR	equiv.	WHEELER	Express	TB20	20000		L
EZFL	equiv.	BLUE YONDER	E-Z Flyer	SVNH	14000		L
EZFT	equiv.	BLUE YONDER	E-Z Twin E-Z Flyer	EV97	16500		L
EZHV	equiv.	BLUE YONDER	E-Z Harvard	SVNH	14000		L
EZKC	equiv.	BLUE YONDER	E-Z King Cobra	SVNH	14000		L
F1	equiv.	MITSUBISHI	F-1	HAWK	40000	40555	M
F100	direct	FOKKER	100	F100	35000	35000	M
F104	equiv.	LOCKHEED	F-104 Starfighter	F16	60000		M
F106	equiv.	CONVAIR	F-106 Delta Dart	F16	60000		M
F111	equiv.	GENERAL DYNAMICS	F-111 Aardvark	F15	65000	35759	M
F117	equiv.	LOCKHEED	F-117 Nighthawk	A10	45000	22124	M
F14	equiv.	GRUMMAN	F-14 Tomcat	F15	65000	35759	M
F15	direct	MCDONNELL DOUGLAS	F-15E	F15	65000	35759	M
F16	direct	GENERAL DYNAMICS	F-16C	F16	60000		M
F16X	equiv.	GENERAL DYNAMICS	F-16XL Fighting Falcon	F16	60000		M
F18H	equiv.	BOEING	F/A-18C/D Hornet	F16	60000		M
F18S	equiv.	BOEING	F/A-18E/F Super Hornet	F16	60000		M
F1FV	equiv.	AVION	F-1 Favorit	E300	16000	14908	L
F2	equiv.	MITSUBISHI	F-2	F16	60000		M
F22	equiv.	LOCKHEED MARTIN	F-22 Raptor	F15	65000	35759	M
F260	equiv.	SIAI-MARCHETTI	SF-260	M20P	20000	18649	L
F26T	equiv.	AERMACCHI	SF-260TP	E500	25000	23610	L
F27	direct	FOKKER	F27-500 Friendship	F27	25000	22777	M
F28	direct	FOKKER	F28-4000 Fellowship	F28	35000	31000	M
F2TH	direct	DASSAULT	Falcon 2000EX	F2TH	47000	41486	M
F30	equiv.	GOLDEN CAR	F-30 Brio	C182	18100	15991	L
F35	equiv.	LOCKHEED MARTIN	F-35A Lightning II	F16	60000		M
F4	equiv.	MCDONNELL	F-4 Phantom 2	F16	60000		M
F406	direct	CESSNA	406	F406	30000	28292	L
F5	equiv.	NORTHROP	F-5	AJET	50000	33703	M
F50	direct	FOKKER	50	F50	25000	22108	M
F5SA	equiv.	IRIAF	Saeghe	AJET	50000	33703	M
F60	equiv.	FOKKER	60	F50	25000	22108	M
F600	equiv.	SIAI-MARCHETTI	SF-600 Canguro	KODI	25000	18797	L
F70	direct	FOKKER	70	F70	37000	36565	M
F8	equiv.	LTV	F-8 Crusader	F16	60000		M
F86	equiv.	NORTH AMERICAN	F-86 Sabre	AJET	50000	33703	M
F8L	equiv.	SEQUOIA	F-8L Falco	P28T	18400	14000	L
F900	direct	DASSAULT	Falcon 900EX	F900	51000	38187	M
FA01	equiv.	FLAMING AIR	FA-01 Smaragd	C162	14625	12791	L
FA02	equiv.	FLAMING AIR	FA-02 Smaragd VLA	C162	14625	12791	L
FA03	equiv.	FLAMING AIR	FA-03 Smaragd TMG	DIMO	16400		L
FA04	equiv.	FLAMING AIR	FA-04 Peregrine	MAGC	12000	12312	L

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FA10	direct	DASSAULT	Falcon 10	FA10	45000	38400	M
FA11	equiv.	FAIRCHILD	F-11 Husky	C188	15700	8744	L
FA20	direct	DASSAULT	Falcon 20	FA20	42000	38000	M
FA24	equiv.	FAIRCHILD	F-24 Argus	MAGC	12000	12312	L
FA50	direct	DASSAULT	Falcon 50EX	FA50	49000	41177	M
FA5X	equiv.	DASSAULT	Falcon 5X	FA7X	51000	39848	M
FA62	equiv.	FAIRCHILD	M-62 Cornell	C162	14625	12791	L
FA7X	direct	DASSAULT	Falcon 7X	FA7X	51000	39848	M
FA8X	equiv.	DASSAULT	Falcon 8X	FA7X	51000	39848	M
FAET	equiv.	ATEC	321 Faeta	C162	14625	12791	L
FALM	equiv.	MILES	M-3 Falcon Major	C162	14625	12791	L
FBA2	equiv.	FOUND	FBA-2 Bush Hawk	C210	18000	13360	L
FDCT	equiv.	FLIGHT DESIGN	CT	C162	14625	12791	L
FDMC	equiv.	FLIGHT DESIGN	MC	C162	14625	12791	L
FFLY	equiv.	FAIREY	Firefly	C421	30000	28328	L
FGTH	direct	GENERIC	military fighter (manoeu	FGTH	50000		M
FGTL	direct	GENERIC	military bomber (long ra	FGTL	41000		H
FK12	equiv.	B&F TECHNIK	FK-12 Comet	EV97	16500		L
FK14	equiv.	B&F TECHNIK	FK-14 Polaris	C162	14625	12791	L
FK9	equiv.	B&F TECHNIK	FK-9	EV97	16500		L
FLCO	direct	LEONARDO	Falco	FLCO	16400		L
FLSS	equiv.	FLYER	Flyer SS	MAGC	12000	12312	L
FM25	equiv.	FLYING MACHINES	FM-250 Vampire	EV97	16500		L
FOUG	equiv.	FOUGA	CM-170R Magister	L39	39370	29225	L
FOX	equiv.	DENNEY	Kitfox	MAGC	12000	12312	L
FU24	equiv.	FLETCHER	FU-24	EV97	16500		L
FURY	equiv.	HAWKER	Fury	C402	30000	24204	L
FUSI	equiv.	MAGNUS	MG-11 Fusion	C162	14625	12791	L
FW02	equiv.	FLYWHALE	FW-02 Flywhale	C162	14625	12791	L
FW44	equiv.	FOCKE-WULF	Fw-44 Stieglitz	MAGC	12000	12312	L
FX1	equiv.	INNOVAVIATION	FX-1	EV97	16500		L
G103	equiv.	GROB	G-103C Twin 3SL	DIMO	16400		L
G109	equiv.	GROB	G-109	DIMO	16400		L
G115	equiv.	GROB	G-115	P28U	20000	19000	L
G120	equiv.	GROB	G-120A	BE36	18500	16757	L
G12T	equiv.	GROB	G-120TP	E500	25000	23610	L
G140	equiv.	GROB	G-140TP	E500	25000	23610	L
G150	direct	GULFSTREAM	G150	G150	45000	40535	M
G159	equiv.	GRUMMAN	G-159 Gulfstream	D328	32800	29051	M
G160	equiv.	GROB	G-160 Ranger	KODI	25000	18797	L
G164	equiv.	GRUMMAN	G-164 (Super) Ag-Cat	C188	15700	8744	L
G180	equiv.	GENERAL AIRCRAFT	G1-80 Skyfarer	MAGC	12000	12312	L
G200	equiv.	GILES	G-200	E300	16000	14908	L
G202	equiv.	GILES	G-202	E300	16000	14908	L
G21	equiv.	GRUMMAN	G-21A Goose	BE58	20688		L
G21M	equiv.	MCKINNON	G-21C/D Goose	C414	30000	28339	L
G21T	equiv.	MCKINNON	G-21E/G Turbo Goose	BE20	35000		L

A/C Code	Model Type	Aircraft manufacturer	Aircraft model	Synonym aircraft	h_{MO} [ft]	h_{max} [ft]	WTC
G222	equiv.	ALENIA	G.222	F27	25000	22777	M
G250	equiv.	GULFSTREAM	G250	G280	45000	43631	M
G280	direct	GULFSTREAM	G280	G280	45000	43631	M
G2GL	equiv.	SOKO	G-2 Galeb	L39	39370	29225	L
G2T1	equiv.	WACO	Great Lakes 2T-1A	EV97	16500		L
G3	equiv.	REMOS	G-3 Mirage	MAGC	12000	12312	L
G44	equiv.	GRUMMAN	G-44 Widgeon	C188	15700	8744	L
G4SG	equiv.	SOKO	G-4 Super Galeb	L39	39370	29225	L
G70	equiv.	GROPPO	G-70	EV97	16500		L
G73	equiv.	GRUMMAN	G-73 Mallard	C421	30000	28328	L
G73T	equiv.	GRUMMAN	G-73T Turbo Mallard	C208	25000	21484	L
GA10	equiv.	GIPPSAERO	GA-10	P750	20000		L
GA20	equiv.	GIPPSLAND	GA-200 Fatman	C188	15700	8744	L
GA5C	equiv.	GULFSTREAM	G500 (G-7)	FA7X	51000	39848	M
GA6C	equiv.	GULFSTREAM	G600 (G-7)	GL5T	51000	42639	M
GA7	equiv.	GRUMMAN AMERICAN	GA-7 Cougar	C210	18000	13360	L
GA8	equiv.	GIPPSAERO	GA-8 Airvan TC	P28U	20000	19000	L
GABR	equiv.	BLACKSHAPE	Bk-160 Gabriel	E300	16000	14908	L
GALX	equiv.	IAI	1126 Galaxy	G280	45000	43631	M
GC1	equiv.	GLOBE	GC-1 Swift	C182	18100	15991	L
GEMI	equiv.	MILES	M-65 Gemini	C172	14000		L
GENI	equiv.	IFB	E-Genius	DIMO	16400		L
GL5T	direct	BOMBARDIER	Global 5000	GL5T	51000	42639	M
GL7T	equiv.	BOMBARDIER	Global 7500	GLEX	51000	41287	M
GLAS	equiv.	GLASAIR	Glasair	M20P	20000	18649	L
GLEX	direct	BOMBARDIER	Global 6000	GLEX	51000	41287	M
GLF2	direct	GULFSTREAM	G-1159 Gulfstream II	GLF2	45000	40473	M
GLF3	equiv.	GULFSTREAM	III	GLF2	45000	40473	M
GLF4	equiv.	GULFSTREAM	IV	GLF2	45000	40473	M
GLF5	direct	GULFSTREAM	G550	GLF5	51000		M
GLF6	equiv.	GULFSTREAM	G650	GLEX	51000	41287	M
GLSP	equiv.	NEW GLASTAR	Sportsman 2+2	P28U	20000	19000	L
GLST	equiv.	GLASAIR	GlaStar	P28U	20000	19000	L
GM17	equiv.	INTRACOM	GM-17 Viper	KODI	25000	18797	L
GNAT	equiv.	FOLLAND	Fo-144 Gnat	L39	39370	29225	L
GOLF	equiv.	TECNAM	P-96 Golf	C162	14625	12791	L
GP1	equiv.	JIHLAVAN	Skyleader GP One	MAGC	12000	12312	L
GP4	equiv.	OSPREY	GP-4	TB20	20000		L
GRIZ	equiv.	AEROTEK	Turbo Grizzly	P750	20000		L
GSPN	equiv.	GROB	G-180 SPn Utility Jet	C550	43000		L
GX	equiv.	REMOS	GX	C162	14625	12791	L
GY20	equiv.	CAB	GY-20 Minicab	EV97	16500		L
GY80	equiv.	GARDAN	GY-80 Horizon	C162	14625	12791	L
H207	equiv.	HB-FLUGTECHNIK	HB-207 Alfa	C162	14625	12791	L
H25A	direct	HAWKER SIDDELEY	HS.125-3B	H25A	41000		M
H25B	direct	HAWKER	800XP	H25B	43000	38507	M
H25C	equiv.	HAWKER	1000	G150	45000	40535	M

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H40	equiv.	HOFFMANN	H-40	EV97	16500		L
HA4T	direct	HAWKER	4000	HA4T	45000	42979	M
HAR	equiv.	HAWKER SIDDELEY	Harrier	AJET	50000	33703	M
HAWK	direct	BRITISH AEROSPACE	T-45A Goshawk	HAWK	40000	40555	M
HB21	equiv.	BRDITSCHKA	HB-21 Hobbylifter	DIMO	16400		L
HB23	equiv.	BRDITSCHKA	HB-23 Hobbyliner	DIMO	16400		L
HB3	equiv.	BRDITSCHKA	HB-3	EV97	16500		L
HDJT	direct	HONDA	HA-420 HondaJet	HDJT	43000		L
HELI	equiv.	GENERIC	HELICOPTER	P28A	12000		L
HERN	equiv.	DE HAVILLAND	DH-114 Heron	DA42	18000		L
HF20	equiv.	MBB	HFB-320 Hansa	H25A	41000		M
HN70	equiv.	NICOLLIER	HN-700 Menestrel 2	EV97	16500		L
HR10	equiv.	ROBIN	HR-100 Tiara	M20P	20000	18649	L
HR20	equiv.	ROBIN	HR-200	MAGC	12000	12312	L
HRNT	equiv.	AAK	Hornet	MAGC	12000	12312	L
HU1	equiv.	SHENYANG SAILPLANE	HU-1 Seagull	DIMO	16400		L
HU2	equiv.	SHENYANG SAILPLANE	HU-2 Petrel	DIMO	16400		L
HUNT	equiv.	HAWKER	Hunter	AJET	50000	33703	M
HURI	equiv.	HAWKER	Hurricane	P180	41000	36226	L
HURK	equiv.	TAI	Hurkus	TEX2	31000		L
HUSK	equiv.	AVIAT	A-1 Husky	C82S	20000		L
HYPR	equiv.	P&M AVIATION	HypR	SVNH	14000		L
I3	equiv.	INTERAVIA	I-3	DA40	16400		L
IA63	equiv.	LMAASA	IA-63 Pampa	L39	39370	29225	L
IL18	equiv.	ILYUSHIN	Il-18	C130	33000	21891	M
IL38	equiv.	ILYUSHIN	Il-38	C30J	45000	25885	M
IL62	equiv.	ILYUSHIN	Il-62	A30B	39000	31966	H
IL76	direct	ILYUSHIN	Il-76TD	IL76	39700	28685	H
IL86	direct	ILYUSHIN	Il-86	IL86	37402	32337	H
IL96	direct	ILYUSHIN	Il-96-300	IL96	42979	31002	H
IMPU	equiv.	IMPULSE	Impulse	E300	16000	14908	L
IR23	equiv.	ICA	IAR-823	SR20	17500	12991	L
IR99	equiv.	AVIOANE	IAR-99 Soim	L39	39370	29225	L
IS28	equiv.	ICA	IS-28M2	DIMO	16400		L
J1	equiv.	AUSTER	J-1 Aiglet	C182	18100	15991	L
J10	equiv.	CHENGDU	J-10	F16	60000		M
J2	equiv.	PIPER	J-2 Cub	SVNH	14000		L
J20	equiv.	CHENGDU	J-20	F15	65000	35759	M
J3	equiv.	PIPER	J-3 Cub	SVNH	14000		L
J328	equiv.	DORNIER	328 Jet	E135	37000		M
J4	equiv.	PIPER	J-4 Cub Coupe	EV97	16500		L
JAB2	equiv.	JABIRU	Jabiru J160	MAGC	12000	12312	L
JAB4	equiv.	JABIRU	Jabiru J400	C162	14625	12791	L
JABI	equiv.	JABIRU	Jabiru ST	EV97	16500		L
JAGR	equiv.	SEPECAT	Jaguar	F16	60000		M

A/C Code	Model Type	Aircraft manufacturer	Aircraft model	Synonym aircraft	h_{MO} [ft]	h_{max} [ft]	WTC
JANU	equiv.	SCHEMPP-HIRTH	Janus CM	DIMO	16400		L
JB15	equiv.	OBERLERCHNER	JOB-15	C162	14625	12791	L
JCOM	equiv.	AERO COMMANDER	1121 Jet Commander	H25A	41000		M
JK05	equiv.	EKOLOT	JK-05 Junior	EV97	16500		L
JPRO	equiv.	BAC	145 Jet Provost	L39	39370	29225	L
JRC1	equiv.	CHALARD	JRC-01 Julcar	E300	16000	14908	L
JS1	equiv.	HANDLEY PAGE	Jetstream 1	D228	28000		L
JS20	equiv.	HANDLEY PAGE	Jetstream 200	D228	28000		L
JS3	equiv.	CENTURY	Jetstream 3	D228	28000		L
JS31	equiv.	BRITISH AEROSPACE	BAe-3100 Jetstream 31	JS32	25000		M
JS32	direct	BRITISH AEROSPACE	Jetstream 31	JS32	25000		M
JS41	direct	BRITISH AEROSPACE	Jetstream 41	JS41	26000	24685	M
JSX	equiv.	SONEX	JSX SubSonex	E300	16000	14908	L
JU52	equiv.	JUNKERS	Ju-52/3m	S2P	21000		M
JUNR	equiv.	MALMO	MFI-9 Junior	C162	14625	12791	L
K250	equiv.	KESTREL	K-250	C172	14000		L
K35A	equiv.	BOEING	KC-135A Stratotanker	B703	42000	35000	H
K35E	equiv.	BOEING	KC-135E Stratotanker	B703	42000	35000	H
K35R	equiv.	BOEING	KC-135R Stratotanker	B703	42000	35000	H
KAT3	equiv.	KHRUNICHEV	AT-3	KODI	25000	18797	L
KC2	equiv.	KAWASAKI	C-2	B703	42000	35000	H
KC39	equiv.	EMBRAER	KC-390	A321	39100	35396	M
KE3	equiv.	BOEING	KE-3	DC87	42000	34000	H
KEST	equiv.	FARNBOROUGH	Kestrel	TBM9	31000		L
KFAB	equiv.	KITPLANES FOR AFRIC	Bushbaby/Explorer	MAGC	12000	12312	L
KFAS	equiv.	KITPLANES FOR AFRIC	Safari	MAGC	12000	12312	L
KFIR	equiv.	IAI	Kfir	F16	60000		M
KIS2	equiv.	TRI-R	KIS TR-1	EV97	16500		L
KIS4	equiv.	TRI-R	KIS TR-4 Cruiser	DA40	16400		L
KL07	equiv.	BOLKOW	BO-207	C172	14000		L
KL10	equiv.	FLIGHT DESIGN-VESSE	KLA-100	C162	14625	12791	L
KL25	equiv.	KLEMM	L-25	SF25	14800		L
KL35	equiv.	KLEMM	Kl-35	C162	14625	12791	L
KODI	direct	QUEST	Kodiak 100	KODI	25000	18797	L
KP2	equiv.	JIHLAVAN	KP-2 Skyleader 200	C162	14625	12791	L
KP5	equiv.	JIHLAVAN	KP-5 Skyleader 500	C162	14625	12791	L
KR1	equiv.	RAND	KR-1	C340	30000	28221	L
KR2	equiv.	RAND	KR-2	T206	27000	25654	L
KR30	equiv.	EKOLOT	KR-030 Topaz	EV97	16500		L
KT1	equiv.	KOREA AEROSPACE	KT-1 Woong-Bee	TEX2	31000		L
KZ2	equiv.	SAI	KZ-2 Kupe	EV97	16500		L
KZ3	equiv.	SAI	KZ-3	SVNH	14000		L
KZ4	equiv.	SAI	KZ-4	C188	15700	8744	L

A/C Code	Model Type	Aircraft manufacturer	Aircraft model	Synonym aircraft	h_{MO} [ft]	h_{max} [ft]	WTC
KZ7	equiv.	SAI	KZ-7 Laerke	C162	14625	12791	L
KZ8	equiv.	SAI	KZ-8	C162	14625	12791	L
L101	direct	LOCKHEED	L-1011 TriStar	L101	42000	33000	H
L11E	equiv.	LUSCOMBE	11E	DA40	16400		L
L12	equiv.	LOCKHEED	L-12 Electra Junior	B58T	25000		L
L13S	equiv.	AEROTECHNIK	L-13S Vivat	DIMO	16400		L
L159	equiv.	AERO	L-159 Albatros 2	HAWK	40000	40555	M
L181	equiv.	ASSOCIATED AIR	Liberty 181	T206	27000	25654	L
L188	equiv.	LOCKHEED	L-188 Electra	C160	30000	25500	M
L200	equiv.	LET	L-200 Morava	BE76	20000	17924	L
L29	equiv.	AERO	L-29 Delfin	L39	39370	29225	L
L29A	equiv.	LOCKHEED	L-1329 Jetstar 6/8	CL60	41000	39223	M
L29B	equiv.	LOCKHEED	L-1329 Jetstar 2	CL60	41000	39223	M
L37	equiv.	LOCKHEED	L-137 Ventura	JS41	26000	24685	M
L39	direct	AERO	L-39C	L39	39370	29225	L
L4	equiv.	CHAIKA	L-4/42/44	C188	15700	8744	L
L40	equiv.	ORLICAN	L-40 Meta Sokol	EV97	16500		L
L410	direct	LET	L410 UVP-E20	L410	20000	17610	L
L5	equiv.	STINSON	L-5 Sentinel	EV97	16500		L
L59	equiv.	AERO	L-59	L39	39370	29225	L
L6	equiv.	AEROVOLGA	L-6	SVNH	14000		L
L60	equiv.	AERO	L-60 Brigadyr	C188	15700	8744	L
L70	equiv.	VALMET	L-70 Vinka	DA40	16400		L
L8	equiv.	LUSCOMBE	8 Silvaire	EV97	16500		L
L90	equiv.	VALMET	L-90TP Redigo	E500	25000	23610	L
LA25	equiv.	LAKE	LA-250/270	C172	14000		L
LA4	equiv.	LAKE	LA-4	C172	14000		L
LA8	equiv.	AEROVOLGA	LA-8 Flagman	DA40	16400		L
LAKR	equiv.	LASER	Akro Z	TB21	25000		L
LANC	equiv.	AVRO	683 Lancaster	F27	25000	22777	M
LCR	equiv.	LAIRD	LC-R Speedwing	MAGC	12000	12312	L
LEG2	equiv.	LANCAIR	Legacy	BE36	18500	16757	L
LESP	equiv.	LANCAIR	Lancair ES-P	M20T	25000		L
LGEZ	equiv.	RUTAN	Long-EZ	T206	27000	25654	L
LH10	equiv.	LH AVIATION	LH-10 Ellipse	C162	14625	12791	L
LJ23	equiv.	LEARJET	23	LJ25	51000	43367	L
LJ24	equiv.	LEARJET	24	LJ25	51000	43367	L
LJ25	direct	LEARJET	25D	LJ25	51000	43367	L
LJ28	equiv.	LEARJET	28/29	LJ25	51000	43367	L
LJ31	equiv.	LEARJET	31	LJ45	51000	44099	M
LJ35	direct	LEARJET	35	LJ35	45000	40287	M
LJ40	equiv.	LEARJET	40	LJ45	51000	44099	M
LJ45	direct	LEARJET	45	LJ45	51000	44099	M
LJ55	equiv.	LEARJET	55	LJ60	51000	42617	M
LJ60	direct	LEARJET	60XR	LJ60	51000	42617	M
LJ70	equiv.	LEARJET	70	C650	51000	42447	M
LJ75	equiv.	LEARJET	75	C650	51000	42447	M

A/C Code	Model Type	Aircraft manufacturer	Aircraft model	Synonym aircraft	h_{MO} [ft]	h_{max} [ft]	WTC
LJ85	equiv.	LEARJET	85	FA50	49000	41177	M
LN3	equiv.	FLYGFABRIKEN	LN-3 Seagull	C162	14625	12791	L
LNC2	equiv.	LANCAIR	Lancair 200/235	TB20	20000		L
LNC4	equiv.	LANCAIR	IV-P	TBM7	31000		L
LNCE	equiv.	LANCAIR	Lancair Super ES	SR22	17500		L
LNP4	equiv.	LANCAIR	IV PropJet	TBM7	31000		L
LS10	equiv.	DG FLUGZEUGBAU	LS-10ST	SF25	14800		L
LS8	equiv.	DG FLUGZEUGBAU	LS-8ST	SF25	14800		L
LW20	equiv.	HOWARD HUGHES	LightWing Speed SP-2000	MAGC	12000	12312	L
LW40	equiv.	HOWARD HUGHES	LightWing Speed SP-4000	P28A	12000		L
LWIN	equiv.	HOWARD HUGHES	LightWing Sport 2000	SVNH	14000		L
M10	equiv.	MOONEY	M-10 Cadet	MAGC	12000	12312	L
M101	equiv.	MYASISHCHEV	M-101T	KODI	25000	18797	L
M106	equiv.	LAMBERT	M-106 Mission	SVNH	14000		L
M108	equiv.	LAMBERT	M-108 Mission	MAGC	12000	12312	L
M10F	equiv.	MOONEY	M-10T	C172	14000		L
M10R	equiv.	MOONEY	M-10J	C82S	20000		L
M110	equiv.	AVIAT	110 Special	E300	16000	14908	L
M15	equiv.	PZL-MIELEC	M-15 Belphegor	C188	15700	8744	L
M17	equiv.	MYASISHCHEV	M-17 Stratosfera	U2	76000		M
M18	equiv.	PZL-MIELEC	M-18 Dromader	T206	27000	25654	L
M2	equiv.	KUBICEK	M-2 Scout	C162	14625	12791	L
M200	equiv.	MEYERS	200	BE36	18500	16757	L
M20P	direct	MOONEY	M20R Ovation 2 GX	M20P	20000	18649	L
M20T	direct	MOONEY	M20TN Acclaim Type S	M20T	25000		L
M21	equiv.	PZL-MIELEC	M-21 Dromader Mini	C188	15700	8744	L
M212	equiv.	LAMBERT	M-212 Mission	P28U	20000	19000	L
M22	equiv.	MOONEY	M-22 Mustang	PA34	25000	22500	L
M24	equiv.	PZL-MIELEC	M-24 Dromader Super	C172	14000		L
M26	equiv.	PZL-MIELEC	M-26 Air Wolf	TB20	20000		L
M28	equiv.	PZL-MIELEC	M-28	JS32	25000		M
M339	equiv.	AERMACCHI	MB-339	L39	39370	29225	L
M345	equiv.	LEONARDO	M-345	L39	39370	29225	L
M346	equiv.	AERMACCHI	M-346 Master	HAWK	40000	40555	M
M4	equiv.	MAULE	M-4	P28U	20000	19000	L
M5	equiv.	MAULE	M-5	TB21	25000		L
M55	equiv.	MYASISHCHEV	M-55 Geophysica	U2	76000		M
M6	equiv.	MAULE	M-6 Super Rocket	C82S	20000		L
M600	equiv.	PIPER	PA-46-600TP M600	TBM7	31000		L
M7	equiv.	MAULE	M-7-235/MT-7/M	TB20	20000		L
M7T	equiv.	MAULE	M-7-420 Star Craft	E500	25000	23610	L
M8	equiv.	MAULE	M-8	P28U	20000	19000	L
MA60	equiv.	XIAN	MA-60	F27	25000	22777	M
MA6H	equiv.	XIAN	MA-60H	F27	25000	22777	M
MAGC	direct	IBIS	Magic GS-700	MAGC	12000	12312	L
MAGN	equiv.	AVID	Magnum	C82S	20000		L
MAKO	equiv.	LANCAIR	Mako	M20T	25000		L

A/C Code	Model Type	Aircraft manufacturer	Aircraft model	Synonym aircraft	h_{MO} [ft]	h_{max} [ft]	WTC
MC23	equiv.	IRKUT	MC-21-300	A20N	41100	36410	M
MC90	equiv.	MONOCOUPE	90	EV97	16500		L
MCR1	equiv.	DYN'AERO	MCR-01 VLA	C162	14625	12791	L
MCR4	equiv.	DYN'AERO	MCR-4	C162	14625	12791	L
MD11	direct	MCDONNELL DOUGLAS	MD-11	MD11	43000	31837	H
MD3	equiv.	DATWYLER	MD-3 Swiss Trainer	C172	14000		L
MD81	equiv.	MCDONNELL DOUGLAS	MD-81	MD82	37000	34448	M
MD82	direct	MCDONNELL DOUGLAS	MD-82	MD82	37000	34448	M
MD83	direct	MCDONNELL DOUGLAS	MD-83	MD83	37000	33513	M
MD87	equiv.	MCDONNELL DOUGLAS	MD-87	MD82	37000	34448	M
MD88	equiv.	MCDONNELL DOUGLAS	MD-88	MD82	37000	34448	M
MD90	equiv.	MCDONNELL DOUGLAS	MD-90	MD83	37000	33513	M
ME08	equiv.	MESSERSCHMITT	Bf-108 Taifun	TB20	20000		L
ME09	equiv.	MESSERSCHMITT	Bf-109	P180	41000	36226	L
METR	equiv.	GLOSTER	Meteor	HAWK	40000	40555	M
MF17	equiv.	SAAB	MFI-17 Supporter	P06T	14000		L
MG15	equiv.	MIKOYAN	MiG 15	L39	39370	29225	L
MG21	equiv.	MIKOYAN	MiG 21	F16	60000		M
MG23	equiv.	MIKOYAN	MiG 23	F16	60000		M
MG25	equiv.	MIKOYAN	MiG 25	F15	65000	35759	M
MG29	equiv.	MIKOYAN	MiG 29	F16	60000		M
MG31	equiv.	MIKOYAN	MiG 31	F15	65000	35759	M
MICO	equiv.	MICROJET	Microjet 200B	SF50	31000		L
MIMU	equiv.	MUSTANG	MM-1 Midget Mustang	P28R	18400	13994	L
MIR2	equiv.	DASSAULT	Mirage 2000	F16	60000		M
MIR4	equiv.	DASSAULT	Mirage IV	F15	65000	35759	M
MIRA	equiv.	DASSAULT	Mirage 3	F16	60000		M
MJ10	equiv.	JURCA	MJ-10 Spit	C162	14625	12791	L
MJ5	equiv.	JURCA	MJ-5 Sirocco	EV97	16500		L
MOR2	equiv.	MORRISEY	2150	T206	27000	25654	L
MP20	equiv.	PLAN	MP-205 Busard	EV97	16500		L
MRF1	equiv.	DASSAULT	Mirage F1	F16	60000		M
MRJ7	equiv.	MITSUBISHI	MRJ-70	A148	40020	38217	M
MRJ9	equiv.	MITSUBISHI	MRJ-90	A148	40020	38217	M
MRMD	equiv.	CZAW	Mermaid	MAGC	12000	12312	L
MS18	equiv.	SOCATA	MS-200FG Morane	DA40	16400		L
MS25	equiv.	SOCATA	MS-200RG Morane	TB21	25000		L
MS30	equiv.	SOCATA	MS-300 Epsilon 2	TB20	20000		L
MS76	equiv.	MORANE-SAULNIER	MS-760 Paris	L39	39370	29225	L
MU2	direct	MITSUBISHI	MU-2B-60	MU2	31000	26111	L
MU23	equiv.	AKAFLIEG MUNCHEN	Mü-23 Saurier	DIMO	16400		L
MU30	equiv.	MITSUBISHI	MU-300 Diamond	BE40	45000	41042	M

A/C Code	Model Type	Aircraft manufacturer	Aircraft model	Synonym aircraft	h_{MO} [ft]	h_{max} [ft]	WTC
MUS2	equiv.	BUSHBY	Mustang 2	TB21	25000		L
MX10	equiv.	AEROTEC	MXP-100 Aventura	SVNH	14000		L
MX1T	equiv.	AEROANDINA	MXP-1000 Tayrona	MAGC	12000	12312	L
MX65	equiv.	AEROTEC	MXP-650 Amigo	C162	14625	12791	L
MX80	equiv.	AEROTEC	MXP-800 Fantasy	MAGC	12000	12312	L
N262	equiv.	AEROSPATIALE	N-262	JS41	26000	24685	M
N3	equiv.	NOSTALGAIR	N-3 Super Pup	SVNH	14000		L
NAVI	equiv.	RYAN	Navion	DA40	16400		L
NG4	equiv.	ROKO AERO	NG-4 Prodigy IV	C162	14625	12791	L
NG5	equiv.	BRM AERO	NG-5 Bristell	C162	14625	12791	L
NIM	equiv.	HAWKER SIDDELEY	Nimrod	B738	41000	34982	M
NIMB	equiv.	SCHEMPP-HIRTH	Nimbus 4DM	DIMO	16400		L
NM5	equiv.	NAL	NM-5	M20P	20000	18649	L
NNJA	equiv.	BEST OFF	Nynja	MAGC	12000	12312	L
NOMA	equiv.	GAF	Nomad	C208	25000	21484	L
NORS	equiv.	NOORDUYN	Norseman	DA40	16400		L
O1	equiv.	CESSNA	O-1 Bird Dog	C182	18100	15991	L
ONE	equiv.	C2P	ONE	C162	14625	12791	L
ONEX	equiv.	SONEX	Onex	EV97	16500		L
OSCR	equiv.	PARTENAVIA	Oscar	C182	18100	15991	L
P06T	direct	TECNAM	P2006T	P06T	14000		L
P1	equiv.	KAWASAKI	P-1	B38M	41000	36344	M
P100	equiv.	POTTIER	P-100	MAGC	12000	12312	L
P149	equiv.	PIAGGIO	P-149	C82S	20000		L
P180	direct	PIAGGIO	P.180 Avanti II	P180	41000	36226	L
P1HH	direct	PIAGGIO	P.1HH Hammerhead	P1HH	45000	34287	L
P2	equiv.	LOCKHEED	P-2 Neptune	F27	25000	22777	M
P208	equiv.	TECNAM	P-2008	C162	14625	12791	L
P210	equiv.	CESSNA	P210 Pressurized	PA46	25000		L
P212	equiv.	TECNAM	P-2012 Traveller	C421	30000	28328	L
P28A	direct	PIPER	PA-28-161	P28A	12000		L
P28B	equiv.	PIPER	PA-28-236 Dakota	C182	18100	15991	L
P28R	direct	PIPER	PA-28R-201	P28R	18400	13994	L
P28S	equiv.	PIPER	PA-28R-201T Turbo Arrow	P28U	20000	19000	L
P28T	direct	PIPER	PA-28RT-201	P28T	18400	14000	L
P28U	direct	PIPER	PA-28RT-201T	P28U	20000	19000	L
P3	equiv.	LOCKHEED	P-3 Orion	AN12	33465	27396	M
P32R	equiv.	PIPER	PA-32R-301T Turbo Sarato	TB20	20000		L
P32T	equiv.	PIPER	PA-32RT-300T Turbo Lance	TB20	20000		L
P337	equiv.	CESSNA	P337 Pressur. Skymaster	BE76	20000	17924	L
P38	equiv.	LOCKHEED	P-38 Lightning	SBR1	45000	38421	M
P39	equiv.	BELL	P-39 Airacobra	PAY3	35000		L
P40	equiv.	CURTISS	P-40 Warhawk	BE9L	31000		L
P46T	direct	PIPER	PA-46-500TP	P46T	30000	30945	L
P50	equiv.	POTTIER	P-50 Bouvreuil	EV97	16500		L
P51	equiv.	NORTH AMERICAN	P-51 Mustang	P180	41000	36226	L

A/C Code	Model Type	Aircraft manufacturer	Aircraft model	Synonym aircraft	h_{MO} [ft]	h_{max} [ft]	WTC
P60	equiv.	POTTIER	P-60 Minacro	MAGC	12000	12312	L
P61	equiv.	NORTHROP	P-61 Black Widow	D328	32800	29051	M
P63	equiv.	BELL	P-63 Kingcobra	HDJT	43000		L
P66P	equiv.	PIAGGIO	P-166B Portofino	C414	30000	28339	L
P66T	equiv.	PIAGGIO	P-166DL3	C208	25000	21484	L
P68	equiv.	PARTENAVIA	P-68 Observer	BE76	20000	17924	L
P68T	equiv.	PARTENAVIA	AP-68TP-300 Spartacus	E500	25000	23610	L
P70	equiv.	POTTIER	P-70	SVNH	14000		L
P750	direct	PAC	750XL	P750	20000		L
P8	equiv.	BOEING	P-8 Poseidon	B738	41000	34982	M
P80	equiv.	POTTIER	P-80	SVNH	14000		L
P82	equiv.	NORTH AMERICAN	F-82 Twin Mustang	A10	45000	22124	M
PA11	equiv.	PIPER	PA-11 Cub Special	EV97	16500		L
PA12	equiv.	PIPER	PA-12 Super Cruiser	P28A	12000		L
PA14	equiv.	PIPER	PA-14 Family Cruiser	MAGC	12000	12312	L
PA15	equiv.	PIPER	PA-15 Vagabond	SVNH	14000		L
PA16	equiv.	PIPER	PA-16 Clipper	MAGC	12000	12312	L
PA17	equiv.	PIPER	PA-17 Vagabond	SVNH	14000		L
PA18	equiv.	PIPER	PA-18 Super Cub	C182	18100	15991	L
PA20	equiv.	PIPER	PA-20 Pacer	EV97	16500		L
PA22	equiv.	PIPER	PA-22 Tri-Pacer	DA40	16400		L
PA23	equiv.	PIPER	PA-23-160 Apache	C182	18100	15991	L
PA24	equiv.	PIPER	PA-24 Comanche	M20T	25000		L
PA25	equiv.	PIPER	PA-25 Pawnee	SVNH	14000		L
PA27	direct	PIPER	PA-23-250 Aztec D	PA27	20000		L
PA30	equiv.	PIPER	PA-30 Turbo Twin Comanch	C402	30000	24204	L
PA31	direct	PIPER	PA-31 Navajo C	PA31	26300		L
PA32	equiv.	PIPER	PA-32-301T Turbo Saratog	P28U	20000	19000	L
PA34	direct	PIPER	PA-34-220T	PA34	25000	22500	L
PA36	equiv.	PIPER	PA-36 Pawnee Brave	P28A	12000		L
PA38	equiv.	PIPER	PA-38 Tomahawk	C162	14625	12791	L
PA44	direct	PIPER	PA-44-180 Seminole	PA44	15000	12527	L
PA46	direct	PIPER	PA-46-350P	PA46	25000		L
PA47	equiv.	PIPER	PA-47	C510	41000		L
PACE	equiv.	BELLANCA	CH-300/400 Pacemaker/Sky	C82S	20000		L
PAT4	equiv.	PIPER	PA-31T-3 T-1040	PAY1	29000		L
PAY1	direct	PIPER	PA-31T1 Cheyenne IA	PAY1	29000		L
PAY2	direct	PIPER	PA-31T2 Cheyenne 2XL	PAY2	31000		L
PAY3	direct	PIPER	PA-42 Cheyenne III	PAY3	35000		L
PAY4	equiv.	PIPER	PA-42-1000 Cheyenne 400	P180	41000	36226	L
PC12	direct	PILATUS	PC-12/45	PC12	30000	30143	L
PC21	equiv.	PILATUS	PC-21	TEX2	31000		L
PC24	equiv.	PILATUS	PC-24	C560	45000	41516	M
PC6P	equiv.	PILATUS	PC-6 Porter	DA42	18000		L

A/C Code	Model Type	Aircraft manufacturer	Aircraft model	Synonym aircraft	h_{MO} [ft]	h_{max} [ft]	WTC
PC6T	equiv.	PILATUS	PC-6C Turbo-Porter	KODI	25000	18797	L
PC7	equiv.	PILATUS	PC-7 Turbo Trainer	TEX2	31000		L
PC9	equiv.	PILATUS	PC-9	TEX2	31000		L
PELI	equiv.	ULTRAVIA	Pelican	EV97	16500		L
PETL	equiv.	AERO ITBA	Petrel	EV97	16500		L
PETR	equiv.	EDRA	Super Petrel	MAGC	12000	12312	L
PIAE	equiv.	PIPISTREL	Alpha Electro	EV97	16500		L
PIAT	equiv.	PIPISTREL	Alpha Trainer	C182	18100	15991	L
PICO	equiv.	PROCAER	F-15 Picchio	DA40	16400		L
PINO	equiv.	GENERAL AVIA	F.22 Pinguino	TB20	20000		L
PIPA	equiv.	PIPISTREL	Panthera	M20T	25000		L
PISI	equiv.	PIPISTREL	Sinus	DIMO	16400		L
PIT4	equiv.	PIPISTREL	Taurus Electro G4	P28A	12000		L
PITA	equiv.	PIPISTREL	Taurus 503	SF25	14800		L
PITE	equiv.	PIPISTREL	Taurus Electro	SF25	14800		L
PIVI	equiv.	PIPISTREL	Virus	EV97	16500		L
PL12	equiv.	TRANSAVIA	PL-12 Airtruk	T206	27000	25654	L
PL2	equiv.	PAZMANY	PL-2	MAGC	12000	12312	L
PL4	equiv.	PAZMANY	PL-4	EV97	16500		L
PNR2	equiv.	ALPI	Pioneer 200	EV97	16500		L
PNR3	equiv.	ALPI	Pioneer 300	P28U	20000	19000	L
PNR4	equiv.	ALPI	Pioneer 400	C82S	20000		L
PO2	equiv.	POLIKARPOV	Po-2	SVNH	14000		L
PO60	equiv.	POTEZ	60 Sauterelle	MAGC	12000	12312	L
PP3	equiv.	PILATUS	P-3	C182	18100	15991	L
PREN	equiv.	PERCIVAL	P-40 Prentice	C182	18100	15991	L
PRIM	equiv.	BLACKSHAPE	Bk-100 Prime	C162	14625	12791	L
PRM1	direct	HAWKER BEECHCRAFT	Premier IA	PRM1	41000	43453	L
PROC	equiv.	PERCIVAL	P-28/30/31/34/44 Proctor	C172	14000		L
PROT	equiv.	CZAW	Parrot	MAGC	12000	12312	L
PRXT	equiv.	PRIVATE EXPLORER	T-Explorer	KODI	25000	18797	L
PT22	equiv.	RYAN	PT-22 Recruit	EV97	16500		L
PT70	equiv.	POTTIER	P-170	SVNH	14000		L
PT80	equiv.	POTTIER	P-180	SVNH	14000		L
PTMS	equiv.	PITTS	S-12 Macho Stinker	E300	16000	14908	L
PTS1	equiv.	PITTS	S-1 Special	P28R	18400	13994	L
PTS2	equiv.	PITTS	S-2 Special	EV97	16500		L
PTSS	equiv.	PITTS	S-1-11 Super Stinker	E300	16000	14908	L
PULR	equiv.	P&M AVIATION	PulsR	SVNH	14000		L
PULS	equiv.	AERO DESIGNS	Pulsar	EV97	16500		L
PUP	equiv.	BEAGLE	B-121 Pup	C162	14625	12791	L
PZ01	equiv.	PZL-OKECIE	PZL-101 Gawron	SVNH	14000		L
PZ04	equiv.	PZL-OKECIE	PZL-104 Wilga 35/80	C172	14000		L
PZ06	equiv.	PZL-OKECIE	PZL-106BR Kruk	C188	15700	8744	L
PZ12	equiv.	PZL-OKECIE	PZL-112 Junior	C162	14625	12791	L
PZ3T	equiv.	PZL-OKECIE	PZL-130TC-1	PAY3	35000		L
PZ4M	equiv.	PZL-OKECIE	PZL-104M Wilga 2000	P28A	12000		L

A/C Code	Model Type	Aircraft manufacturer	Aircraft model	Synonym aircraft	h_{MO} [ft]	h_{max} [ft]	WTC
PZ6T	equiv.	PZL-OKECIE	PZL-106BT Turbo Kruk	C188	15700	8744	L
Q01	equiv.	REINER STEMME	Q-01	C402	30000	24204	L
Q1	equiv.	GENERAL ATOMICS	MQ-1 Predator	SF25	14800		L
Q2	direct	AAI	RQ-2A Pioneer	Q2	15000		L
Q4	direct	NORTHROP GRUMMAN	RQ-4A Global Hawk	Q4	65000		M
Q9	direct	GENERAL ATOMICS	MQ-9A Reaper	Q9	45000		L
R100	equiv.	ROBIN	R-1180T	DA40	16400		L
R109	equiv.	RIHN	DR-109 Rhino	E300	16000	14908	L
R11	equiv.	RUPERT	R-11	SVNH	14000		L
R135	equiv.	BOEING	RC-135	B703	42000	35000	H
R200	equiv.	ROBIN	R-2160 Alpha Sport	C162	14625	12791	L
R300	equiv.	ROBIN	R-300	C172	14000		L
R721	equiv.	BOEING	727-100	MD83	37000	33513	M
R722	equiv.	BOEING	727-200RE Super 27	B722	42000	33672	M
R90F	equiv.	RUSCHMEYER	R-90-230FG	DA40	16400		L
R90R	equiv.	RUSCHMEYER	R-90-230RG	DA40	16400		L
R90T	equiv.	RUSCHMEYER	R-90-420AT	E500	25000	23610	L
RALL	equiv.	MORANE-SAULNIER	Rallye Commodore	P28A	12000		L
RANG	equiv.	NAVION	Rangemaster	TB21	25000		L
RAV5	equiv.	RAVIN	Ravin 500	BE36	18500	16757	L
RBEL	equiv.	MURPHY	Rebel	MAGC	12000	12312	L
RC3	equiv.	REPUBLIC	RC-3 Seabee	MAGC	12000	12312	L
RC70	equiv.	ROCKWELL	Commander 700	PA31	26300		L
RD20	equiv.	DENIZE	RD-20 Raid Driver	E300	16000	14908	L
RENE	equiv.	MURPHY	Renegade	SVNH	14000		L
RF10	equiv.	FOURNIER	RF-10	DIMO	16400		L
RF3	equiv.	FOURNIER	RF-3	C182	18100	15991	L
RF4	equiv.	FOURNIER	RF-4	C182	18100	15991	L
RF5	equiv.	FOURNIER	RF-5	DIMO	16400		L
RF6	equiv.	FOURNIER	RF-6	C162	14625	12791	L
RFAL	equiv.	DASSAULT	Rafale	F16	60000		M
RJ1H	direct	AVRO	RJ100	RJ1H	35000	30949	M
RJ70	equiv.	AVRO	RJ70	RJ85	35000	32166	M
RJ85	direct	AVRO	RJ85	RJ85	35000	32166	M
RODS	equiv.	RIHN	DR-107 One Design	TB21	25000		L
RS18	equiv.	SPORTAVIA-PUTZER	RS-180 Sportsman	C182	18100	15991	L
RS20	equiv.	RANS	S-20 Raven	SVNH	14000		L
RV10	equiv.	VAN'S	RV-10	TB20	20000		L
RV12	equiv.	VAN'S	RV-12	C162	14625	12791	L
RV14	equiv.	VAN'S	RV-14	P28T	18400	14000	L
RV3	equiv.	VAN'S	RV-3	TB21	25000		L
RV4	equiv.	VAN'S	RV-4	P28T	18400	14000	L
RV6	equiv.	VAN'S	RV-6	E300	16000	14908	L
RV7	equiv.	VAN'S	RV-7	TB21	25000		L
RV8	equiv.	VAN'S	RV-8	TB21	25000		L
RV9	equiv.	VAN'S	RV-9	P28T	18400	14000	L
RYSA	equiv.	TECHNOAVIA	Rysachok	L410	20000	17610	L

A/C Code	Model Type	Aircraft manufacturer	Aircraft model	Synonym aircraft	h_{MO} [ft]	h_{max} [ft]	WTC
S05F	equiv.	SIAI-MARCHETTI	S-205-20F	DA40	16400		L
S05R	equiv.	SIAI-MARCHETTI	S-205-20R	C182	18100	15991	L
S1	equiv.	ARCTIC	S-1 Arctic Tern	C182	18100	15991	L
S10	equiv.	STINSON	105/10 Voyager	MAGC	12000	12312	L
S108	equiv.	STINSON	108 Voyager	EV97	16500		L
S10S	equiv.	STEMME	S-10 Chrysalis	DIMO	16400		L
S12	equiv.	SPENCER	S-12 Air Car	C172	14000		L
S122	equiv.	SKYLINE	SL-122 Pchelka	MAGC	12000	12312	L
S12S	equiv.	STEMME	S-12 Twin Voyager	DIMO	16400		L
S15S	equiv.	STEMME	S-15	DIMO	16400		L
S15U	equiv.	STEMME	S-15 Patroller	DIMO	16400		L
S200	equiv.	SIPA	S-200 Minijet	EA50	41000		L
S208	equiv.	SIAI-MARCHETTI	S-208	C182	18100	15991	L
S210	equiv.	SUD	SE-210 Caravelle	E290	41000	37767	M
S211	equiv.	SIAI-MARCHETTI	S-211	L39	39370	29225	L
S223	equiv.	SIAT	223 Flamingo	P28A	12000		L
S22T	direct	CIRRUS	SR22T	S22T	25000		L
S2P	direct	GRUMMAN	S-2D Tracker	S2P	21000		M
S2T	equiv.	GRUMMAN	S-2 Turbo Tracker	JS41	26000	24685	M
S3	equiv.	LOCKHEED	S-3 Viking	A10	45000	22124	M
S32E	equiv.	SCHLEICHER	ASG-32EL	DIMO	16400		L
S32M	equiv.	SCHLEICHER	ASG-32Mi	DIMO	16400		L
S38	equiv.	SIKORSKY	S-38 Replica	C188	15700	8744	L
S450	equiv.	AERO-EAST-EUROPE	SILA-450	EV97	16500		L
S6	equiv.	STEMME	S-6	DIMO	16400		L
S601	equiv.	AEROSPATIALE	SN-601 Corvette	C525	41000		L
SA02	equiv.	K&S	SA-102.5 Cavalier	C162	14625	12791	L
SA20	equiv.	BERIEV	SA-20	C188	15700	8744	L
SA30	equiv.	STOLP	SA-300 Starduster Too	TB21	25000		L
SA37	equiv.	SCHWEIZER	SA-2-37 Condor	DIMO	16400		L
SA50	equiv.	STOLP	SA-500 Starlet	EV97	16500		L
SAM	equiv.	SAM AIRCRAFT	Sam	C162	14625	12791	L
SASH	equiv.	SHARK AIRCRAFT	Shark	T206	27000	25654	L
SASP	equiv.	SUPERMARINE AIRCRAF	Spitfire Mk26	P28T	18400	14000	L
SATA	equiv.	HISPANO	HA-220 Super Saeta	L39	39370	29225	L
SAVA	equiv.	SADLER	Vampire	MAGC	12000	12312	L
SAVG	equiv.	ZLIN AVIATION	Savage	EV97	16500		L
SB05	equiv.	SAAB	105	L39	39370	29225	L
SB20	direct	SAAB	2000	SB20	31000		M
SB29	equiv.	SAAB	29	AJET	50000	33703	M
SB32	equiv.	SAAB	32 Lansen	AJET	50000	33703	M
SB35	equiv.	SAAB	35 Draken	F16	60000		M
SB37	equiv.	SAAB	37 Viggen	F16	60000		M
SB39	equiv.	SAAB	39 Gripen	F16	60000		M
SB7	equiv.	SEABIRD	SB-7 Seeker	C162	14625	12791	L
SB91	equiv.	SAAB	91 Safir	P28U	20000	19000	L

A/C Code	Model Type	Aircraft manufacturer	Aircraft model	Synonym aircraft	h_{MO} [ft]	h_{max} [ft]	WTC
SBR1	direct	ROCKWELL	CT-39G Sabreliner	SBR1	45000	38421	M
SBR2	equiv.	ROCKWELL	Sabre 75/80	SBR1	45000	38421	M
SC01	equiv.	GYROFLUG	SC-01 Speed Canard	P28R	18400	13994	L
SC7	equiv.	SHORT	SC-7 Skyvan	D228	28000		L
SD4	equiv.	TOMARK	SD-4 Viper	EV97	16500		L
SEAW	equiv.	SEAWIND	Seawind	C182	18100	15991	L
SF2	equiv.	VIKING	SF-2 Cygnet	SVNH	14000		L
SF23	equiv.	SCHEIBE	SF-23 Sperling	EV97	16500		L
SF24	equiv.	SCHEIBE	SF-24 Motorspatz	SF25	14800		L
SF25	direct	SCHEIBE	SF-25B Falke	SF25	14800		L
SF27	equiv.	SCHEIBE	SF-27M	SF25	14800		L
SF28	equiv.	SCHEIBE	SF-28 Tandem Falke	DIMO	16400		L
SF31	equiv.	SPORTAVIA-PUTZER	SFS-31 Milan	DIMO	16400		L
SF34	direct	SAAB	SF 340B	SF34	25000	25000	M
SF36	equiv.	SCHEIBE	SF-36	DIMO	16400		L
SF50	direct	CIRRUS	SF50 Vision	SF50	31000		L
SG37	equiv.	SCHWEIZER	SGM-2-37	DIMO	16400		L
SG70	equiv.	GLASS	SG-70 STOLGlass	EV97	16500		L
SGRA	equiv.	SG AVIATION	Rally	MAGC	12000	12312	L
SGUP	equiv.	AERO SPACELINES	377SGT Super Guppy	C160	30000	25500	M
SH33	equiv.	SHORT	330	SH36	20000		M
SH36	direct	SHORT	SD3-60	SH36	20000		M
SHOP	equiv.	SALVAY-STARK	Skyhopper	EV97	16500		L
SHRK	equiv.	SHARK AERO	Shark	C162	14625	12791	L
SIRA	equiv.	TECNAM	P-2002 Sierra	C162	14625	12791	L
SJ30	equiv.	SINO SWEARINGEN	SJ-30	LJ25	51000	43367	L
SK70	equiv.	STARKRAFT	SK-700	C421	30000	28328	L
SKAR	equiv.	III	Sky Arrow	C162	14625	12791	L
SKRA	equiv.	BEST OFF	Sky Ranger	SVNH	14000		L
SKYR	equiv.	REARWIN	Skyranger	SVNH	14000		L
SLCH	equiv.	SCALED	351 Stratolaunch	A388	43100	34330	J
SLG2	equiv.	AIRPLANE FACTORY	Sling 2 Turbo	C162	14625	12791	L
SLG4	equiv.	AIRPLANE FACTORY	Sling 4	C162	14625	12791	L
SLK3	equiv.	SLICK	360	E300	16000	14908	L
SLK5	equiv.	SLICK	540	E300	16000	14908	L
SM19	equiv.	SIAI-MARCHETTI	SM-1019	E500	25000	23610	L
SM20	equiv.	TECHNOAVIA	SM-2000	E500	25000	23610	L
SM92	equiv.	TECHNOAVIA	SM-92 Finist	P28A	12000		L
SMAX	equiv.	AIRMAX	M-22 SeaMax	C162	14625	12791	L
SNAP	equiv.	DALLAIR	Snap	C162	14625	12791	L
SNTA	equiv.	AIRSPORT	Sonata	SF25	14800		L
SOL1	equiv.	SOLAR IMPULSE	1	EA50	41000		L
SOL2	equiv.	SOLAR IMPULSE	2	EA50	41000		L
SORA	equiv.	ACS	ACS-100 Sora	C162	14625	12791	L
SP7	equiv.	SPARTAN	7 Executive	PA34	25000	22500	L
SP95	equiv.	TECHNOAVIA	SP-95	DA40	16400		L
SPA2	equiv.	STARK-TREFETHEN	Sport-Aire 2	C162	14625	12791	L

A/C Code	Model Type	Aircraft manufacturer	Aircraft model	Synonym aircraft	h_{MO} [ft]	h_{max} [ft]	WTC
SPIT	equiv.	SUPERMARINE	Spitfire	P180	41000	36226	L
SPRT	equiv.	PRACTAVIA	Sprite	C162	14625	12791	L
SPUP	equiv.	SOPWITH	Pup	P28A	12000		L
SR01	equiv.	EURODISPLAY	SR-01 Magic	C162	14625	12791	L
SR20	direct	CIRRUS	SR20	SR20	17500	12991	L
SR22	direct	CIRRUS	SR22	SR22	17500		L
SR71	equiv.	LOCKHEED	SR-71 Blackbird	U2	76000		M
SREY	equiv.	PROGRESSIVE AERODYN	SeaRey	C182	18100	15991	L
SS2T	equiv.	THRUSH	S-2R-H80 Turbo Thrush	P750	20000		L
SSAB	equiv.	NORTH AMERICAN	F-100 Super Sabre	AJET	50000	33703	M
SSTM	equiv.	SG AVIATION	Sea Storm	C162	14625	12791	L
ST10	equiv.	SOCATA	ST-10 Diplomate	P28R	18400	13994	L
ST3	equiv.	STEARMAN	C-3	MAGC	12000	12312	L
ST4	equiv.	STEARMAN	4 Speedmail	C182	18100	15991	L
ST6	equiv.	STEARMAN	6 Cloudboy	EV97	16500		L
ST75	equiv.	STEARMAN	75 Kaydet	SVNH	14000		L
STAR	equiv.	BEECH	2000 Starship	P180	41000	36226	L
STCH	equiv.	FLY SYNTHESIS	Storch	EV97	16500		L
STRE	equiv.	TL ULTRALIGHT	Stream	C162	14625	12791	L
STRK	equiv.	BAC	167 Strikemaster	L39	39370	29225	L
STRM	equiv.	SG AVIATION	Storm	C162	14625	12791	L
SU17	equiv.	SUKHOI	Su-17/20/22	F16	60000		M
SU24	equiv.	SUKHOI	Su-24	F16	60000		M
SU25	equiv.	SUKHOI	Su-25 Scorpion	HAWK	40000	40555	M
SU26	equiv.	SUKHOI	Su-26	E300	16000	14908	L
SU27	equiv.	SUKHOI	Su-27	F15	65000	35759	M
SU7	equiv.	SUKHOI	Su-7	AJET	50000	33703	M
SU95	direct	SUKHOI	RRJ-95B SuperJet 100	SU95	40000	36297	M
SUBA	equiv.	FUJI	FA-200 Aero Subaru	C182	18100	15991	L
SV4	equiv.	STAMPE	SV-4	P28U	20000	19000	L
SVNH	direct	ICP	Savannah VG	SVNH	14000		L
SW18	equiv.	SKYWOOD	SW-18 Teddy	SVNH	14000		L
SW2	equiv.	SWEARINGEN	Merlin 2	BE9L	31000		L
SW3	equiv.	SWEARINGEN	Merlin 3	MU2	31000	26111	L
SW4	direct	SWEARINGEN	SA227-AC Metro III	SW4	31000	23968	M
SWIF	equiv.	SUPERMARINE	Swift	AJET	50000	33703	M
SX30	equiv.	SWEARINGEN	SX-300	E300	16000	14908	L
SYMP	equiv.	SYMPHONY	SA-160 Symphony	DA40	16400		L
T1	equiv.	FUJI	T-1	L39	39370	29225	L
T10	equiv.	TMM-AVIA	T-10 Avia-Tor	MAGC	12000	12312	L
T134	direct	TUPOLEV	Tu-134A-3	T134	39000	34764	M
T154	direct	TUPOLEV	Tu-154M	T154	41000	37285	M
T160	equiv.	TUPOLEV	Tu-160 Blackjack	FGTL	41000		H
T18	equiv.	THORP	T-18 Tiger	E300	16000	14908	L
T19	equiv.	THK	T-19 Speedfire	EV97	16500		L
T2	equiv.	ROCKWELL	T-2 Buckeye	L39	39370	29225	L
T204	direct	TUPOLEV	Tu-204-300	T204	39700	35429	M

A/C Code	Model Type	Aircraft manufacturer	Aircraft model	Synonym aircraft	h_{MO} [ft]	h_{max} [ft]	WTC
T206	direct	CESSNA	T206H	T206	27000	25654	L
T210	direct	CESSNA	T210M	T210	28500	26833	L
T211	equiv.	THORP	T-211	MAGC	12000	12312	L
T22M	equiv.	TUPOLEV	Tu-22M	FGTL	41000		H
T250	equiv.	BELLANCA	T-250 Aries	C182	18100	15991	L
T28	equiv.	NORTH AMERICAN	T-28 Trojan	P180	41000	36226	L
T30	equiv.	TERZI	T-30 Katana	E300	16000	14908	L
T33	equiv.	CANADAIR	CT-133 Silver Star	AJET	50000	33703	M
T34P	equiv.	BEECH	T-34B Mentor	TB20	20000		L
T34T	equiv.	BEECH	T-34C Turbo Mentor	E500	25000	23610	L
T35	equiv.	TEMCO	T-35 Buckaroo	EV97	16500		L
T37	equiv.	CESSNA	T-37-B	L39	39370	29225	L
T38	equiv.	NORTHROP	T-38 Talon	L39	39370	29225	L
T4	equiv.	KAWASAKI	T-4	AJET	50000	33703	M
T40	equiv.	TURNER	T-40	EV97	16500		L
T411	equiv.	KHRUNICHEV	T-411 Aist	C188	15700	8744	L
T50S	equiv.	SUKHOI	T-50	F15	65000	35759	M
T6	equiv.	NORTH AMERICAN	T-6 Texan	PA46	25000		L
TAIL	equiv.	WITTMAN	W-10 Tailwind	EV97	16500		L
TAMP	equiv.	SOCATA	TB-9 Tampico	P28A	12000		L
TARR	equiv.	PELEGRIN	Tarragon	C162	14625	12791	L
TAYD	equiv.	TAYLORCRAFT	L-2	SVNH	14000		L
TB05	equiv.	AMC	Texas Bullet 205	P28R	18400	13994	L
TB20	direct	SOCATA	TB 20 Trinidad	TB20	20000		L
TB21	direct	SOCATA	TB 21 Trinidad TC	TB21	25000		L
TB30	equiv.	SOCATA	TB-30 Epsilon	TB20	20000		L
TB31	equiv.	SOCATA	TB-31 Omega	P46T	30000	30945	L
TBEE	equiv.	UNITED CONSULTANT	Twin Bee	C182	18100	15991	L
TBM	equiv.	GENERAL MOTORS	TBM Avenger	JS32	25000		M
TBM7	direct	SOCATA	TBM-700	TBM7	31000		L
TBM8	direct	SOCATA	TBM-850	TBM8	31000		L
TBM9	direct	SOCATA	TBM-930	TBM9	31000		L
TEAL	equiv.	THURSTON	TSC-1 Teal	MAGC	12000	12312	L
TEX2	direct	RAYTHEON	T-6B	TEX2	31000		L
TFK2	equiv.	TECHNOFLUG	TFK-2 Carat	DIMO	16400		L
TFUN	equiv.	VALENTIN	Taifun	DIMO	16400		L
TJET	equiv.	MAVERICK	TJ-1500 TwinJet	SF50	31000		L
TL20	equiv.	TL ULTRALIGHT	TL-2000 Sting S3	C162	14625	12791	L
TL30	equiv.	TL ULTRALIGHT	TL-3000 Sirius	C162	14625	12791	L
TNAV	equiv.	CAMAIR	480 Twin Navion	PA34	25000	22500	L
TOBA	equiv.	SOCATA	TB-10 Tobago	C172	14000		L
TOR	equiv.	PANAVIA	Tornado	F16	60000		M
TOUR	equiv.	AESL	Airtourer	C162	14625	12791	L
TR20	equiv.	TECH'AERO	TR-200	P28R	18400	13994	L
TRAL	equiv.	GROPPO	Trail	EV97	16500		L
TRF1	equiv.	TEAM ROCKET	F-1	E300	16000	14908	L
TRIM	equiv.	FORD	Tri-Motor	DA42	18000		L

A/C Code	Model Type	Aircraft manufacturer	Aircraft model	Synonym aircraft	h_{MO} [ft]	h_{max} [ft]	WTC
TRIS	equiv.	BRITTEN-NORMAN	Trislander	DA42	18000		L
TS11	equiv.	PZL-MIELEC	TS-11 Iskra	L39	39370	29225	L
TU22	equiv.	TUPOLEV	Tu-22	FGTL	41000		H
TU95	equiv.	TUPOLEV	Tu-95	FGTL	41000		H
TUCA	equiv.	EMBRAER	EMB-312 Tucano	TBM7	31000		L
TUTR	equiv.	AVRO	621 Tutor	EV97	16500		L
TWEN	equiv.	TECNAM	P-2010 Twenty Ten	DA40	16400		L
TWIR	equiv.	DYN'AERO	Twin-R	P06T	14000		L
TWST	equiv.	SILENCE	Twister	EV97	16500		L
U15	equiv.	PHOENIX AIR	U-15 Phoenix	MAGC	12000	12312	L
U16	equiv.	GRUMMAN	HU-16 Albatross	S2P	21000		M
U2	direct	LOCKHEED	U-2	U2	76000		M
U21	equiv.	BEECH	U-21 Ute	F406	30000	28292	L
UF10	equiv.	URBAN	UFM-10 Samba	C162	14625	12791	L
UF13	equiv.	URBAN	UFM-13 Lambada	SF25	14800		L
UT75	equiv.	UTVA	75	SVNH	14000		L
V10	equiv.	NORTH AMERICAN	OV-10 Bronco	TEX2	31000		L
V22	equiv.	BELL-BOEING	V-22 Osprey	A140	24934	20296	M
V280	equiv.	BELL	V-280 Valor	AT76	25000	20347	M
VAMP	equiv.	DE HAVILLAND	DH-100 Vampire	L39	39370	29225	L
VC10	equiv.	VICKERS	VC-10	B703	42000	35000	H
VELO	equiv.	VELOCITY	Velocity TXL	M20T	25000		L
VELT	equiv.	VELOCITY	Velocity V-Twin	M20P	20000	18649	L
VENT	equiv.	SCHEMPP-HIRTH	Ventus cM	SF25	14800		L
VEZE	equiv.	RUTAN	33 VariEze	TB21	25000		L
VF14	equiv.	VFW	VFW-614	YK40	26575		M
VF35	equiv.	LOCKHEED MARTIN	F-35B Lightning II	F16	60000		M
VIX	equiv.	SKYSTAR	Kitfox Vixen	MAGC	12000	12312	L
VK3P	equiv.	CIRRUS	VK-30	S22T	25000		L
VL3	equiv.	VANESSA AIR	VL-3	C162	14625	12791	L
VM1	equiv.	VOL MEDITERRANI	VM-1 Esqual	C162	14625	12791	L
VNTR	equiv.	ICP	Ventura	C162	14625	12791	L
VO10	equiv.	VOLAIRCRAFT	Volaire 10/1035/1050	C172	14000		L
VP2	equiv.	EVANS	VP-2 Volksplane	SVNH	14000		L
VTOR	equiv.	PARTENAVIA	AP-68TP-600 Viator	E500	25000	23610	L
VTUR	equiv.	QUESTAIR	M-20 Venture	T210	28500	26833	L
WA40	equiv.	WASSMER	WA-40 Super 4	DA40	16400		L
WA41	equiv.	WASSMER	WA-41 Baladou	DA40	16400		L
WA42	equiv.	WASSMER	WA-421/235	P28T	18400	14000	L
WA50	equiv.	WASSMER	WA-54 Atlantic	P06T	14000		L
WACC	equiv.	WACO	C	C172	14000		L
WACF	equiv.	WACO	YMF	C172	14000		L
WACO	equiv.	WACO	10	SVNH	14000		L
WB57	equiv.	MARTIN	WB-57	A10	45000	22124	M
WBOO	equiv.	DEAN-WILSON	DW-200 Whitney Boomerang	C162	14625	12791	L
WHIL	equiv.	WHITE LIGHTNING	WLAC-1 White Lightning	M20P	20000	18649	L
WILT	equiv.	ULTRALEICHTBAU	WT-01/02 Wild Thing	MAGC	12000	12312	L

A/C Code	Model Type	Aircraft manufacturer	Aircraft model	Synonym aircraft	h_{MO} [ft]	h_{max} [ft]	WTC
WIRR	equiv.	COMMONWEALTH	Wirraway	T206	27000	25654	L
WSP	equiv.	AAK	Wasp	MAGC	12000	12312	L
WT9	equiv.	AEROSPOOL	WT-9 Dynamic	C162	14625	12791	L
WW23	equiv.	IAI	1123 Westwind	SBR1	45000	38421	M
WW24	equiv.	IAI	1124 Westwind	SBR1	45000	38421	M
X47B	equiv.	NORTHROP GRUMMAN	X-47B	F16	60000		M
XA41	equiv.	XTREMEAIR	XA-41	E300	16000	14908	L
XA42	equiv.	XTREMEAIR	XA-42	E300	16000	14908	L
XL2	equiv.	LIBERTY	XL-2	C162	14625	12791	L
Y112	equiv.	YAKOVLEV	Yak-112	C172	14000		L
Y12	equiv.	HARBIN	Y-12E Harbinger	C208	25000	21484	L
Y12F	equiv.	HARBIN	Y-12F Aircar	JS32	25000		M
Y130	equiv.	YAKOVLEV	Yak-130	AJET	50000	33703	M
Y18T	equiv.	YAKOVLEV	Yak-18T	C172	14000		L
YAK3	equiv.	YAKOVLEV	Yak-3	PAY3	35000		L
YAK9	equiv.	YAKOVLEV	Yak-9	PAY3	35000		L
YK11	equiv.	YAKOVLEV	Yak-11	B58T	25000		L
YK12	equiv.	YAKOVLEV	Yak-12	SVNH	14000		L
YK18	equiv.	YAKOVLEV	Yak-18	DA40	16400		L
YK28	equiv.	YAKOVLEV	Yak-28	F16	60000		M
YK40	direct	YAKOVLEV	Yak-40	YK40	26575		M
YK42	direct	YAKOVLEV	Yak-42	YK42	31496		M
YK50	equiv.	YAKOVLEV	Yak-50	P06T	14000		L
YK52	equiv.	YAKOVLEV	Yak-52	P28U	20000	19000	L
YK53	equiv.	YAKOVLEV	Yak-53	P28A	12000		L
YK54	equiv.	YAKOVLEV	Yak-54	C172	14000		L
YK55	equiv.	YAKOVLEV	Yak-55	DA40	16400		L
YK58	equiv.	YAKOVLEV	Yak-58	PA44	15000	12527	L
YL15	equiv.	BOEING	YL-15 Scout	EV97	16500		L
YS11	equiv.	MITSUBISHI	YS-11	ATP	25000	21628	M
YURO	equiv.	SOKO-CNIAR	J-22 Orao	AJET	50000	33703	M
Z26	equiv.	MORAVAN	Zlin Z-526 Trener Master	EV97	16500		L
Z42	equiv.	ZLIN	Z-42/142/242	C172	14000		L
Z43	equiv.	ZLIN	Z-43	C172	14000		L
ZEP2	equiv.	KEUTHAN	Zephyr 2	SVNH	14000		L
ZEPH	equiv.	ATEC	122 Zephyr	C162	14625	12791	L
ZERO	equiv.	MITSUBISHI	Zero	PAY3	35000		L
ZULU	equiv.	BUL	Zulu	SVNH	14000		L

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APPENDIX B

SOLUTIONS FOR BUFFETING LIMIT ALGORITHM

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A general solution for finding the roots of a cubic expression can be found in [RD13]. If we take expression 3.6-6, we can rewrite it to:

$$\mathrm{M}^3 - \frac{C_{Lbo(M=0)}}{k} \cdot \mathrm{M}^2 + \frac{\frac{W}{S}}{0.583 \cdot P \cdot k} = 0$$

Let:

$$a_1 = -\frac{C_{Lbo(M=0)}}{k}$$

$$a_2 = 0$$

$$a_3 = \frac{\frac{W}{S}}{0.583 \cdot P \cdot k}$$

Now let:

$$Q = \frac{\left(3 \cdot a_2 - a_1{}^2\right)}{9}$$

and:

$$R = \frac{\left(9 \cdot a_1 \cdot a_2 - 27 \cdot a_3 - 2 \cdot a_1{}^3\right)}{54}$$

The discriminant D is equal to: $Q^3 + R^2$. In our case D is usually strictly negative, which means that all roots are unequal and real. A simplified computation method with the help of trigonometry is given below:

$$\mathrm{X}_1 = 2 \cdot \sqrt{-Q} \cdot \cos\left(\frac{\theta}{3}\right) - \frac{a_1}{3}$$

$$\mathrm{X}_2 = 2 \cdot \sqrt{-Q} \cdot \cos\left(\frac{\theta}{3} + 120^0\right) - \frac{a_1}{3}$$

$$\mathrm{X}_3 = 2 \cdot \sqrt{-Q} \cdot \cos\left(\frac{\theta}{3} + 240^0\right) - \frac{a_1}{3}$$

With: $\cos\theta = \frac{R}{\sqrt{-Q^3}}$

The solutions X_1, X_2 and X_3 now give the possible values of M. One solution (in our case usually X_1) is always negative. The others are positive with the lower one (usually X_2) being the low speed buffeting limit we are looking for.