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USER MANUAL FOR THE BASE OF AIRCRAFT DATA (BADA) REVISION 2.4

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Abstract:

The Base of Aircraft Data (BADA) provides a set of ASCII files containing performance and operating procedure coefficients for 125 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 2.4 of BADA provides definitions of each of the coeffcients and then explains the file formats. Instructions for remotely accessing the files via Internet are also given.

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User Manual for the Base of Aircraft Data (BADA) Revision 2.4

EUROCONTROL Experimental Centre

Summary

The Base of Aircraft Data (BADA) provides a set of ASCII files containing performance and operating procedure coefficients for 125 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 2.4 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.

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)

User Manual Modification History (cont'd)

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

Table of Contents

1. INTRODUCTION

1.1 Identification

This document is the User Manual for the Base of Aircraft Data (BADA) Revision 2.4. This manual replaces the previous User Manual for BADA Revision 2.3 [RD1].

1.2 Purpose

BADA is a collection of ASCII files which specifies operation performance parameters, airline procedure parameters and performance summary tables for 125 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 Experimental Centre (EEC) at Brétigny-sur-Orge, France.

This document describes the mathematical models on which the data is based and specifies the format of the files which contain the data. In addition, this document describes how the files can be remotely accessed from the EEC.

1.3 Document Organisation

This document consists of seven 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, provides a list of the aircraft types supported by BADA 2.4 and summarises the differences between BADA 2.4 and the previous revision BADA 2.3

Section 3, Operation Performance Models, defines the set of equations which are used to parameterise aircraft performance. This includes models of aerodynamic drag, engine thrust, and fuel consumption.

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

Section 5, File Structure, describes the files in which the BADA aircraft parameters are maintained. Four types of files are identified:

- Synonym Files 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; and,
- Performance Table Files (PTF) containing summary performance tables of true air speed. climb/descent rates and fuel consumption at various flight levels for a specific aircraft type.

Section 6, Remote Access to BADA, provides instructions on how to remotely access BADA files from the EEC computing facilities over the Internet.

Section 7, Comments on Data, presents some comments concerning the data contained in Revision 2.4 and identifies possible upgrades for further revisions.

Two appendices are also provided with this document. Appendix A presents a summary list of all files contained in BADA Revision 2.3. A listing of the tar file contents available for remote data access is given in Appendix B.

1.4 Referenced Documents

RD1 User Manual for the Base of Aircraft Data (BADA) Revision 2.3; EEC Note No. 23/95; October 1995.

RD2 Aircraft Type Designators, ICAO Document 8643; November 1993.

RD3 Coverage of 1994 European Air Traffic by the Base of Aircraft Data 2.2; EEC Note 07/95; May 1995.

RD4 Revision Summary Document for BADA 2.4; EEC Note No. 6/96; February 1996.

RD5 Aircraft Modelling Standards for Future ATC Systems; Eurocontrol Division E1 Document No. 872003, July 1987

RD6 Manual of the ICAO Standard Atmosphere; ICAO Document No. 7488, 2nd Edition, 1964.

RD7 BADA Configuration Management Manual; Internal EEC Note 4/B2.3/1995; Oct 1995.

RD8 Design and User Manual for BADA Excel Spreadsheets; EEC Note 6/95; 12 May 1995.

RD9 Technical Note on Maximum Altitude for BADA Revision 2.4; TN/9505; 20 December 1995

1.5 Glossary of Acronyms

APF	Airlines Procedures File
ASCII	American Standard Code for the Interchange of Information
ATM	Air Traffic Management
BADA	Base of Aircraft Data
CAPO	Centre for Aircraft Performance and Operations
CAS	Calibrated Airspeed
CRCO	Central Route Charges Office
EEC	Eurocontrol Experimental Centre
ESF	Energy Share Factor
IAS	Indicated Airspeed
ICAO	International Civil Aviation Organisation
ISA	ICAO Standard Atmosphere
MASS	Multi-Aircraft Simplified Simulator
MTOW	Maximum Take-off Weight
OPF	Operations Performance File
PARZOC	Parabolic Approximation Coefficients for use in a Zone of Convergence
PTF	Performance Table File
RCS	Revision Control System
ROCD	Rate of Climb or Descent
SIM	Simplified Aircraft Model
TAS	True Airspeed
TEM	Total-Energy Model

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 is also given.

a	speed of sound	[m/s]
d	distance	[nautical miles]
f	fuel flow	[kg/min]
g	gravitational acceleration	[m/s^2]
$\frac{dh}{dt}$	rate of climb or descent	[m/s] or [ft/min]
h	altitude above sea level	[metres] or [ft]
C	general coefficient	
D	drag force	[Newtons]
m	aircraft mass	[tonnes] or [kg]
M	Mach number	
R	real gas constant for air	[m^2/Ks^2]
S	reference wing surface area	[m^2]
T	thrust temperature	[N] [Kelvin]
V	speed	[m/s] or [knots]
ΔT	temperature difference	[Kelvin]
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 2.4 along with the updates that have been made from the previous release, BADA Revision 2.3.

2.1 Supported Aircraft

BADA 2.4 provides operations and procedures data for a total of 125 aircraft types. For 67 of these aircraft types, data is provided directly in files. These aircraft types are referred to as being directly supported. For the other 58 aircraft types, the data is specified to be the same as one of the directly supported 67 aircraft types. This second set of aircraft types are referred to as being supported through equivalence.

With two exceptions, each supported aircraft type is identified by a 4-character designation code assigned by the International Civil Aviation Organisation (ICAO) [RD2]. The two exceptions are the model representing a generic military fighter which uses the designator: FGTR and the model MIG which represents the Mig fighter family and is equivalenced by the FGTR model.

The list of aircraft types supported by BADA 2.4 is given below in Table 2.1-1. In this table the supported aircraft types are listed alphabetically by their designation code. For each aircraft type the aircraft name and type of BADA support (either direct or equivalence) is specified. Also, for each aircraft which is supported through equivalence, the corresponding equivalent aircraft type is specified.

Table 2.1-1: List of Aircraft Types Supported by BADA 2.4

Aircraft Code	BADA Support	Aircraft Name	Equivalent Type
AC6T	equivalence	Rockwell Turbo Commander 690C	BE20
AN12	equivalence	Antonov AN-12	C130
AN24	equivalence	Antonov AN-24	FK27
AN26	equivalence	Antonov AN-26	FK27
AT42	direct	ATR 42	
AT72	direct	ATR 72	
B707	direct	Boeing 707, all series	
B727	direct	Boeing 727, all series	
B737	direct	Boeing 737-100/200 series	
B73F	direct	Boeing 737-400	
B73S	direct	Boeing 737-300 series	
B73V	direct	Boeing 737-500 series	
B747	direct	Boeing 747-100/200/300 series	
B74F	direct	Boeing 747-400	
B74S	equivalence	Boeing 747 SP	B747
B757	direct	Boeing 757 all series	
B767	direct	Boeing 767 all series	
BA11	direct	BAe 111, all series	
BA31	direct	BAe Jetstream 31	
BA41	direct	BAe Jetstream 41	
BA46	direct	BAe 146-100/200/300, RJ Series	
BATP	direct	BAe Advanced Turboprop	
BE20	direct	Beech Super King Air 200 / Huron	
BE30	equivalence	Beech Super King Air 300	BE20
BE90	direct	Beech King Air 90	

Table 2.1-1: List of Aircraft Types Supported by BADA 2.4 (continued)

Aircraft Code	BADA Support	Aircraft Name	Equivalent Type
BE95	equivalence	Beech Travelair 95	PA31
BE99	direct	Beech Airliner C99	
BN2	equivalence	Pilatus Islander BN2-A/B	PA31
C9	equivalence	McDonnell-Douglas DC-9	DC9
C12	equivalence	Beech Super King Air 200 / Huron	BE20
C20A	equivalence	Gulfstream III	CL60
C130	direct	Lockheed Hercules	
C135	equivalence	Boeing Stratolifter 717	B707
C172	equivalence	Cessna Skyhawk 172	PA28
C177	equivalence	Cessna Cardinal 177	PA28
C182	equivalence	Cessna Skylane 182	PA28
C340	equivalence	Cessna 340/340A	PA31
C402	equivalence	Cessna 402	PA31
C421	direct	Cessna Golden Eagle 421	
C500	equivalence	Cessna Citation	C550
C550	direct	Cessna Citation II-S2	
C560	direct	Cessna Citation V	
C650	equivalence	Cessna Citation III	LR35
CL60	direct	Canadair Challenger 600/601	
CL65	equivalence	Canadair Regional Jet	CL60
CN35	equivalence	Airtech CN-235	AT42
CONC	equivalence	BAe-Aerospatiale Concorde	FGTR
D228	direct	Dornier 228-100/200	
D328	direct	Dornier 328	

Table 2.1-1: List of Aircraft Types Supported by BADA 2.4 (continued)

Aircraft Code	BADA Support	Aircraft Name	Equivalent Type
DA01	direct	Dassault Mercure 100	
DA10	direct	Dassault Falcon 10	
DA20	direct	Dassault Falcon 20 /FJF/C/D/E/F	
DA50	direct	Dassault Falcon 50	
DA90	direct	Dassault Falcon 900	
DC8	equivalence	McDonnell-Douglas DC-8, all series	DC8S
DC8S	direct	McDonnell-Douglas Super DC-8, all series	
DC9	direct	McDonnell-Douglas DC-9	
DC10	direct	McDonnell-Douglas DC-10	
DH8	direct	De Havilland Dash 8 DHC-8	
DO28	equivalence	Dornier DO 28	PA31
E120	direct	Embraer Brasilia EMB-120/HH/RT	
E3A	equivalence	Boeing E-3A Sentry	B707
EA30	direct	Airbus A300	
EA31	direct	Airbus A310	
EA32	direct	Airbus A320	
EA33	direct	Airbus A330	
EA34	direct	Airbus A340	
F1	equivalence	Dassault Mirage F1	FGTR
F4	equivalence	McDonnell-Douglas F4 Phantom	FGTR
F15	equivalence	McDonnell-Douglas F15 Eagle	FGTR
F16	equivalence	General Dynamics F16 Fighting Falcon	FGTR
F18	equivalence	McDonnell-Douglas F18 Hornet	FGTR
FA22	equivalence	Fairchild Model F227	FK27

Table 2.1-1: List of Aircraft Types Supported by BADA 2.4 (continued)

Aircraft Code	BADA Support	Aircraft Name	Equivalent Type
FGTR	direct	Generic Military Fighter	
FK10	direct	Fokker 100	
FK27	direct	Fokker Friendship F27	
FK28	direct	Fokker Fellowship F28	
FK50	direct	Fokker 50	
FK70	direct	Fokker 70	
G2	equivalence	Gulfstream II	CL60
G3	equivalence	Gulfstream III	CL60
G4	equivalence	Gulfstream IV	CL60
HAR	equivalence	BAe Harrier	FGTR
HS25	direct	BAe 125 Series 400/600/700/800	
IL18	equivalence	Ilyushin IL-18	C130
IL62	equivalence	Ilyushin IL-62	B707
IL76	equivalence	Ilyushin IL-76	EA30
IL86	equivalence	Ilyushin IL-86	DC8S
JAG1	equivalence	Dassault-Breguet Jaguar	FGTR
JAGR	equivalence	BAe Jaguar	FGTR
KC10	equivalence	McDonnell-Douglas DC-10 Tanker	DC10
L101	direct	Lockheed L-1011 Tristar	
L188	equivalence	Lockheed Electra/Orion	C130
LR35	direct	Bombardier Learjet 35	
LR36	equivalence	Bombardier Learjet 36	LR35
LR55	equivalence	Bombardier Learjet 55	LR35
MD11	direct	McDonnell-Douglas MD-11	
MD80	direct	McDonnell-Douglas MD-80/81/82/83/87/88	

Table 2.1-1: List of Aircraft Types Supported by BADA 2.4 (continued)

Aircraft Code	BADA Support	Aircraft Name	Equivalent Type
MIG	equivalence	Mikoyan MiG, all types	FGTR
MIR2	equivalence	Dassault-Breguet Mirage 2000	FGTR
MIR4	equivalence	Dassault-Breguet Mirage IV	FGTR
MRC	equivalence	Panavia Tornado	FGTR
MU2	direct	Mitsubishi Marquise/Solitaire	
ND16	direct	Aerospatiale Transall C160	
P3	equivalence	Lockheed Orion	C130
PA23	equivalence	Piper Apache	PAZT
PA28	direct	Piper Cherokee Archer/Dakota/Warrior	
PA31	direct	Piper Chieftain/Mojave/Navaho	
PA34	direct	PA34-200T Seneca-III	
PA42	direct	Piper Cheyenne III/IV, 400SL	
PARO	equivalence	Piper Cherokee Arrow IV	TB20
PAYE	direct	Piper Cheyenne II	
PAZT	direct	Piper Aztec	
SF34	direct	Saab Fairchild 340	
SH36	direct	Shorts 360	
SW2	equivalence	Fairchild Merlin IIA/B, IIIB/C, IVA	SW3
SW3	direct	Fairchild Merlin IVC / Metro III	
TB10	equivalence	Aerospatiale Tobago TB-10	PA28
TB20	direct	Aerospatiale Trinidad TB-20	
TU34	direct	Tupolev TU-134/A/B	
TU54	direct	Tupolev TU-154/A/B/B2/C/M	
U11	equivalence	Piper Aztec	PAZT
VC10	equivalence	BAe VC10-1100	B707

Table 2.1-1: List of Aircraft Types Supported by BADA 2.4 (continued)

YK40	equivalence	Yakolev Yak-40	DH8
YK42	equivalence	Yakolev Yak-42	BA46

2.2 Updates for BADA Revision 2.4

All updates made to BADA Revision 2.4 from the previous revision 2.3 are noted in the BADA 2.4 Revision Summary Document [RD4]. A brief listing is given below.

(a) There is 1 new aircraft model:

FK70	- Fokker 70

(d) There are 3 re-developed aircraft models:

FK50	- This aircraft was re-modellised as part of a re-modellisation proces that will be done for the most important aircraft in BADA.
TU34	- The former TU34 model was based on Jane's data combined with extrapolated DC9 data. This aircraft was re-modelised using new reference information that had become available.
TU54	- The former TU54 model was based on Jane's data combined with extrapolated B727 data. This aircraft was re-modelised using new reference information that had become available.

(c) There are 10 new equivalences

AN12	- Antonov 12
AN24	- Antonov 24
AN26	- Antonov 26
CL65	- Canadair Regional Jet
CN35	- Airtech CN-235
CONC	- BAe-Aerospatiale Concorde
E3A	- Boeing E-3A Sentry
MIG	- Mikoyan MiG fighters (family)
YK40	- Yakolev Yak-40
YK42	- Yakolev Yak-42

(d) One model was changed from equivalence to directly supported:

C421	- Cessna 421 Golden Eagle

(e) There is one modified equivalence:

IL76	- Ilyushin IL-76 (from DC8S to EA30)

(f) Addition of three new parameters in the OPF files for determining the infuence of weight and temperature on maximum altitude.

(g) A new algorithm for the influence of temperature on thrust was introduced. For this purpose all the Ctc4 values of -50 were set to zero.This was done for the following models:

AT42	- ATR-42
AT72	- ATR-72
BE20	- Beech 200
BE99	- Beech 99
DA50	- Dassault Falcon 50
DA90	- Dassault Falcon 900
DH8	- De Havilland Dash 8
FK27	- Fokker F-27
ND16	- C-160 Transall
SF34	- Saab 340

At the same time the negative values for Ctc5 were set to zero as well. This was done for the following models:

DA10	- Dassault Falcon 10
DA20	- Dassault Falcon 20

(h) Cruise Mach numbers were changed for the following models:

B707	- Boeing 707
B767	- Boeing 767
FK28	- Fokker F-28
LR35	- Learjet 35

(i) Maxumum altitudes were changed for three models:

BA46	- BAe 146
C130	- Lockheed C-130
EA30	- Airbus A300

(j) Minimum weights were changed for two models:

B73F	- Boeing 737-400
B73S	- Boeing 737-300

(k) Two changes to the OPF file format were made:

- The section heading "Speed enveloppe" was changed to the more general "Flight envelope".
- The unit of Vmo was corrected from KIAS to KCAS.

3. OPERATIONS PERFORMANCE MODEL

This section defines the various equations and coefficients used by the BADA operations performance model. This model is sometimes referred to as the Simplified Aircraft Model or SIM model.

The first two subsections describe the Total-Energy Model (TEM) equations and standard atmosphere equations respectively.

The remaining six subsections define the aircraft model in terms of the six categories listed below.

- aircraft type,
- mass,
- flight envelope,
- aerodynamics,
- engine thrust, and,
- fuel consumption.

3.1 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:

$$(T - D)V_{TAS} = mg\frac{dh}{dt} + mV_{TAS}\frac{dV_{TAS}}{dt} \qquad (3.1\text{-}1)$$

The symbols are defined below with metric units specified:

T	-	thrust acting parallel to the aircraft velocity vector	[Newtons]
D	-	aerodynamic drag	[Newtons]
m	-	aircraft mass	[kilograms]
h	-	altitude	[m]
g	-	gravitational acceleration	[9.81 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 ROCD to be controlled. The other variable is then determined by equation 3.1-1. 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 3.1-1 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 3.1-1 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 3.1-1 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 3.1-1 is most often used to calculate the rate of climb or descent. To facilitate this calculation, equation 3.1-1 can be rearranged as follows:

$$(T - D)\,V_{TAS} = mg\frac{dh}{dt} + mV_{TAS}\left(\frac{dV_{TAS}}{dh}\right)\left(\frac{dh}{dt}\right) \qquad (3.1\text{-}2)$$

Isolating the rate of climb or descent on the left hand side gives:

$$\frac{dh}{dt} = \frac{(T - D)V_{TAS}}{mg}\left[1 + \left(\frac{V_{TAS}}{g}\right)\left(\frac{dV_{TAS}}{dh}\right)\right]^{-1} \qquad (3.1\text{-}3)$$

It has been shown by Renteux [RD5] that the last term can be replaced by an energy share factor as a function of Mach number, f{M}, as follows:

$$\frac{dh}{dt} = \left[\frac{(T - D)V_{TAS}}{mg}\right] f\{M\} \qquad (3.1\text{-}4)$$

This Energy Share Factor (ESF) specifies how much of the available power is allocated to climb as opposed to acceleration.

For several common flight conditions equation 3.1-4 can be rewritten as is done below. A more comprehensive description of this process can be found in RD**l:

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

$$f\{M\} = 1.0 \qquad (3.1\text{-}5)$$

Note that above the tropopause (approximately 11000 metres under ISA conditions) the air temperature and the speed of sound is constant. Maintaining 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

$$f\{M\} = \{1\text{-}0.133M^2\}^{-1} \qquad (3.1\text{-}6)$$

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 air speed decreases with altitude. Thus, 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

$$f\{M\} = \{1\text{-}0.133M^2 + (1+0.2M^2)^{-2.5}[(1+0.2M^2)^{3.5} - 1]\}^{-1} \qquad (3.1\text{-}7)$$

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 air speed. Thus, some of the available power needs to be allocated to acceleration leaving the remainder for climb.

(d) Constant Calibrated Airspeed (CAS) above tropopause

$$f\{M\} = \{1+ (1+0.2M^2)^{-2.5}[(1+0.2M^2)^{3.5} - 1]\}^{-1} \qquad (3.1\text{-}8)$$

This is a very uncommon situation that would only occure at very low temperatures (ISA -20 or below) and it is therefore not incorporated in BADA, but merely mentioned for the sake of completeness.

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 a constant Mach number or constant CAS is not maintained, the following energy share factors are specified by the BADA model.

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 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 one since the change of altitude benefits from a transfer of kinetic energy.

3.2 Standard Atmosphere

Calculations for lift, drag, and conversions from CAS to TAS and Mach number require the determination of several atmospheric properties as a function of altitude.

The equations used by BADA for the standard atmosphere and CAS/TAS conversion are summarised below. These equations are based on the ICAO Standard Atmosphere (ISA) [RD6].

(a) Determination of the Tropopause

$$h_{trop} = 11000 + 1000 \; \Delta T_{ISA} / 6.5 \qquad (3.2\text{-}1)$$

Here the tropopause altitude, h_{trop} , is specified in metres.

ΔT_{ISA} is the temperature difference from the ICAO Standard Atmosphere (ISA). That is, the temperature at sea level, T_0 , would be:

$$T_0 = (T_0)_{ISA} + \Delta T_{ISA} \qquad (3.2\text{-}2)$$

$$(T_0)_{ISA} = 288.15 \text{ K} \qquad (3.2\text{-}3)$$

For standard atmosphere conditions, ($\Delta T_{ISA} = 0$) the tropopause is at 11000 metres altitude.

(b) Determination of Temperature

Above the tropopause, the temperature is a constant, that is,

$$T_{trop} = 216.65 \text{ K} \qquad (3.2\text{-}4)$$

Below the tropopause, the temperature is calculated as a function of altitude as follows:

$$T = T_0 - 6.5h/1000 \qquad (3.2\text{-}5)$$

Here the altitude, h, is specified in metres.

(c) Determination of Air Density

Below the tropopause, the air density, ρ , in kg/m^3 is calculated as function of temperature as follows:

$$\rho = \rho_0 \, [\, T/T_0 \,]^{4.255876} \qquad (3.2\text{-}6)$$

Here ρ_0 is the air density at sea level:

$$\rho_0 = (\rho_0)_{ISA} \, (T_0)_{ISA} \, / \, T_0 \qquad (3.2\text{-}7)$$

and $(\rho_0)_{ISA}$ is the standard atmosphere air density at sea level:

$$(\rho_0)_{ISA} = 1.225 \ \text{kg/m}^3 \qquad (3.2\text{-}8)$$

Above the tropopause, the air density, ρ , in kg/m^3 is calculated by an approximation to ISA [RD5] as follows:

$$\rho = 0.36392 \left[\frac{37000 - h}{15000 + h} \right]^2 \qquad (3.3\text{-}9)$$

Here h represents the altitude in feet.

(d) Determination of Sound Speed

Above the tropopause the speed of sound, a , is a constant:

$$a_{trop} = 295.07 \ \text{m/s} \qquad (3.2\text{-}10)$$

Below the tropopause, the speed of sound is calculated as a function of temperature:

$$a = 340.29 \sqrt{\frac{T}{(T_0)_{ISA}}} \qquad (3.2\text{-}11)$$

(e) CAS/TAS Conversion

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

$$V_{TAS} = \left[\frac{2}{\mu} \frac{P}{\rho} \left\{ \left(1 + \frac{(P_0)_{ISA}}{P} \left[\left(1 + \frac{\mu}{2} \frac{(\rho_0)_{ISA}}{(P_0)_{ISA}} V_{CAS}^{\ 2} \right)^{1/\mu} - 1 \right] \right)^{\mu} - 1 \right\} \right]^{1/2} \qquad (3.2\text{-}12)$$

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

$$V_{CAS} = \left[\frac{2}{\mu} \frac{(P_0)_{ISA}}{(\rho_0)_{ISA}} \left\{ \left(1 + \frac{P}{(P_0)_{ISA}} \left[\left(1 + \frac{\mu}{2} \frac{\rho}{P} V_{TAS}^{\ 2} \right)^{1/\mu} - 1 \right] \right)^{\mu} - 1 \right\} \right]^{1/2} \qquad (3.2\text{-}13)$$

where symbols not previously defined are explained below:

μ = $(\gamma - 1) / \gamma$ (3.2-14)

γ is the isentropic expansion coefficient for air = 1.4

P is the pressure at altitude [Pa]

$(P_0)_{ISA}$ is the ISA pressure at sea level = 101325 Pa

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

The pressure at altitude, P, can be determined from the temperature at altitude, T, by the following formula which is valid for altitudes below the tropopause:

$$P = (P_0)_{ISA} \left(\frac{T}{T_0} \right)^{5.255876} \qquad (3.2\text{-}15)$$

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, or,
- Piston.

The wake category can also be one of three values:

H - heavy
M - medium
L - light

Note that the 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_{ref}	- reference mass	
m_{min}	- minimum mass	(operational weight empty)
m_{max}	- maximum mass	(maximum take-off)
m_{pyld}	- maximum payload mass	

The reference mass is the mass for which other BADA performance coefficients are calculated.

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

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

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

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

V_{MO} - maximum speed (CAS), in knots;

M_{MO} - maximum operational Mach number;

h_{MO} - maximum operational height, in feet above sea level;

h_{max} - maximum altitude (300 fpm) at MTOW under ISA conditions;

G_w - weight gradient on maximum altitude;

G_t - temperature gradient on maximum altitude;

where the maximum altitude for any given weight is:

$$H_{max/act} = MIN(h_{MO}, h_{max} + G_t * (X - C_{tc4}) + G_w * (MTOW - M_{act})) \quad (3.5\text{-}1)$$

with: $G_w >= 0$;
$G_t <= 0$;
and: $(X - C_{tc4}) >= 0$;

with X being the temperature deviation from ISA and M_{act} being the actual aircraft weight.

A more complete description of this algorithm can be found in RD 9.

The minimum speed for the aircraft is specified as follows:

$$V_{min} = 1.3\ V_{stall} \quad \text{if in cruise} \quad (3.5\text{-}2)$$

$$V_{min} = 1.1\ V_{stall} \quad \text{otherwise} \quad (3.5\text{-}3)$$

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 given for each:

TO - take-off configuration (up to 400 ft altitude) $(V_{stall})_{TO}$

IC - initial climb configuration (between 400 and 3000 ft) $(V_{stall})_{IC}$

CR	- cruise (clean) configuration (above 3000 ft in climb, above 6000 ft in descent)	$(V_{stall})_{CR}$
AP	- approach configuration (between 400 and 6000 ft)	$(V_{stall})_{AP}$
LD	- landing configuration (below 400 ft)	$(V_{stall})_{LD}$

Note that these 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:

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

3.6 Aerodynamic Drag

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

$$C_D = (C_{D0} + C_{D2} C_L^2) (1 + C_{M16} M^{16}) \quad (3.6\text{-}1)$$

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

$$D = C_D \rho V_{TAS}^2 S / 2 \quad (3.6\text{-}2)$$

where ρ is the air density (kg/m^3), S is the wing reference area (m^2), and V_{TAS} is the true airspeed (m/s). Note that the air density is a function of altitude as described in subsection 3.2.

The lift coefficient, C_L, is determined assuming that the lift is equal to the weight, that is:

$$C_L = 2mg / \rho V_{TAS}^2 S \quad (3.6\text{-}3)$$

The above equations thus result in four coefficients for the specification of drag: S, C_{D0}, C_{D2}, and C_{M16}.

Additional drag for various other configurations (e.g. flap/slat settings, spoilers extended, landing gear down and brakes on) are not currently specified by BADA.

3.7 Engine Thrust

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

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

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

3.7.1 Maximum Climb Thrust

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

- engine type: either Jet, Turboprop or Piston;
- altitude above sea level, h, in feet;
- true air speed, V_{TAS}, in knots; and,
- temperature deviation from standard atmosphere, ΔT_{ISA}, in degrees Celsius.

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

Jet: $$(T_{max\ climb})_{ISA} = C_{Tc,1}\,(1 - h/C_{Tc,2} + C_{Tc,3}\,h^2) \quad (3.7\text{-}1)$$

Turboprop: $$(T_{max\ climb})_{ISA} = C_{Tc,1}\,(1 - h/C_{Tc,2})/V_{TAS} + C_{Tc,3} \quad (3.7\text{-}2)$$

Piston: $$(T_{max\ climb})_{ISA} = C_{Tc,1}\,(1 - h/C_{Tc,2}) + C_{Tc,3}/V_{TAS} \quad (3.7\text{-}3)$$

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

$$T_{max\ climb} = (T_{max\ climb})_{ISA}\,[1 - C_{Tc,5}(\Delta T_{ISA})_{eff}] \quad (3.7\text{-}4)$$

where $$(\Delta T_{ISA})_{eff} = \Delta T_{ISA} - C_{Tc,4} \quad (3.7\text{-}5)$$

with the limit: $$0.0 <= (\Delta T_{ISA})_{eff} * C_{Tc,5} <= 0.3 \quad (3.7\text{-}6)$$

and: $$C_{Tc,5} >= 0.0 \quad (3.7\text{-}7)$$

3.7.2 Maximum Take-Off Thrust

The maximum take-off thrust is specified to be 1.2 times the maximum climb thrust, that is:

$$(T_{take\text{-}off})_{max} = 1.2\,T_{max\ climb} \quad (3.7\text{-}8)$$

This factor of 1.2 is applied at flight levels below 400 ft and is the same for all aircraft and all aircraft types (jet, turboprop or piston).

3.7.3 Maximum Cruise Thrust

Cruise thrust is by definition set equal to drag. The maximum cruise thrust is calculated as a ratio of the maximum climb thrust given in section 3.7.1, that is:

$$(T_{cruise})_{max} = C_{Tcr} \; T_{max\,climb} \qquad (3.7\text{-}9)$$

The coefficient C_{Tcr} can vary with each aircraft type but is currently uniformly set to 0.95 for all aircraft.

3.7.4 Descent Thrust

Descent thrust is calculated similarly to cruise thrust with difference correction factors used for high and low altitude, that is:

for $h < h_{des}$

$$(T_{des,low})_{nom} = C_{Tdes,low} \, (m/m_{ref})^{0.5} \, (T_{max\,climb})_{nom} \qquad (3.7\text{-}10)$$

and for $h > h_{des}$

$$(T_{des,\,high})_{nom} = C_{Tdes,high} \, (m/m_{ref})^{0.5} \, (T_{max\,climb})_{nom} \qquad (3.7\text{-}11)$$

Note that the correction factors take into account the ratio of the aircraft mass to the reference mass.

Both low and high altitude descent thrusts are also corrected by a speed ratio as shown below:

$$T_{des} = (T_{des})_{nom} \, (V_{CAS} / V_{des,ref})^2 \qquad (3.7\text{-}12)$$

or,

$$T_{des} = (T_{des})_{nom} \, (M/M_{des,ref})^2 \qquad (3.7\text{-}13)$$

Here V_{CAS} is the actual CAS in descent while $V_{des,ref}$ and $M_{des,ref}$ are the reference descent CAS and Mach number for which the coefficients ($C_{Tc,1}$, $C_{Tc,2}$, etc.) are calculated.

3.8 Fuel Consumption

The thrust specific fuel consumption, η , in kg/minute/kN is specified as a function of true airspeed, V_{TAS} (knots) for the jet and turboprop engines:

jet: $\eta = C_{f1} \, (1 + V_{TAS} / C_{f2})$ (3.8-1)

turboprop: $\eta = C_{f1} \, (1 - V_{TAS} / C_{f2})(V_{TAS} /1000)$ (3.8-2)

Minimum fuel flow, f, corresponding to idle thrust or descent conditions for both jets and turboprop engines is specified in kg/minute as a function of altitude above sea level, h (ft), that is:

jet/turboprop: $f = C_{f3} \, (1 - h / C_{f4})$ (3.8-3)

For piston engines the fuel flow, f , in kg/minutes is specified to be a constant, that is,

piston: $f = C_{f1}$ (cruise/climb) (3.8-4)

$f = C_{f3}$ (idle/descent) (3.8-5)

3.9 Summary of Operations Performance Parameters

A summary of the parameters specified by the BADA operations performance model is supplied in Table 3.9-1 below. This table excludes those parameters whose values are not verified and thus have been set to zero.

Table 3.9-1: BADA Operations Performance Parameter Summary

Model Category	Symbols	Units	Description
aircraft type (3 values)	n_{eng} engine type wake category	dimensionless string string	number of engines either Jet, Turboprop or Piston either H (heavy), M (medium) or L (light)
mass (4 values)	m_{ref} m_{min} m_{max} m_{pyld}	tonnes tonnes tonnes tonnes	reference mass minimum mass maximum mass maximum payload mass
flight envelope (6 values)	V_{MO} M_{MO} h_{MO} h_{max} G_w G_t	knots (CAS) dimensionless feet feet feet/kg feet/C	maximum operating speed maximum operating Mach number maximum operating altitude maximum altitude at MTOW and ISA weight gradient on maximum altitude temperature gradient on maximum altitude
drag (9 values)	S C_{D0} C_{D2} C_{M16} $(V_{stall})_i$	m^2 dimensionless dimensionless dimensionless knots (CAS)	reference wing surface area parasitic drag coefficient induced drag coefficient Mach drag coefficient stall speed for various configurations $i \in$ [TO, IC, CR, AP, LD]

Table 3.9-1: BADA Operations Performance Parameter Summary (continued)

Model Category	Symbols	Units	Description
engine thrust (11 values)	$C_{Tc,1}$	Newton (jet/piston) knot-Newton (turboprop)	1st max. climb thrust coefficient
	$C_{Tc,2}$	feet	2nd max climb thrust coefficient
	$C_{Tc3,}$	$1/feet^2$ (jet) Newton (turboprop) knot-Newton (piston)	3rd max. climb thrust coefficient
	$C_{Tc,4}$	deg. C	1st thrust temperature coefficient
	$C_{Tc,5}$	dimensionless	2nd thrust temperature coefficient
	C_{Tcr}	dimensionless	cruise thrust coefficient
	$C_{Tdes,low}$	dimensionless	low altitude descent thrust coefficient
	$C_{Tdes,high}$	dimensionless	high altitude descent thrust coefficient
	h_{des}	feet	transition altitude for calculation of descent thrust
	$V_{des,ref}$	knots	reference descent speed (CAS)
	$M_{des,ref}$	dimensionless	reference descent Mach number
fuel flow (4 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

The total number of BADA performance coefficients summarised in the above table is 34.

4. AIRLINE PROCEDURE MODELS

This section defines the standard airline procedures which are parameterised by the BADA procedures model. Three separate flight phases are considered:

- climb,
- cruise, and,
- descent.

Each of theses phases are described in the subsections below.

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 3,000 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 transition altitude

Note that the Mach transition altitude is defined to be the altitude where a CAS value corresponding to $V_{cl,2}$ results in a Mach number of M_{cl}. That is, M_{cl} imposes an upper limit on the Mach number during climb.

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

below 3000 ft	$1.3\,(V_{stall})_{TO} + 10$
from 3000 to 10000 ft	$V_{cl,1}$ (or 250 knots which ever is lower)
from 10000 ft to transition	$V_{cl,2}$
above transition	M_{cl}

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

below 2000 ft	$1.3\,(V_{stall})_{TO} + 10$
from 2000 ft to transition	$V_{cl,2}$ (or 250 knots which ever is lower)
above transition	M_{cl}

Note that the take-off stall speed, $(V_{stall})_{TO}$, must be corrected for the difference in aircraft mass from the reference mass using the formula as described in section 3.4.

Also, the transition altitude, h_{trans}, in feet for a given V_{CAS} (in m/s), and Mach number, M, can be calculated as follows:

$$h_{trans} = \left(\frac{1000}{(.3048)(6.5)}\right)\left[T_0\left(1-\theta_{trans}\right)\right] \qquad (4.1\text{-}1)$$

where,

T_0 is the temperature at sea level in Kelvin,

$(T_0)_{ISA}$ is the ISA temperature at sea level = 288.15 K,

θ_{trans} is the temperature ratio at the transition altitude,

$$\theta_{trans} = (\delta_{trans})^{0.1903} \qquad (4.1\text{-}2)$$

δ_{trans} is the pressure ratio at the transition altitude,

$$\delta_{trans} = \frac{\left[1+\left(\frac{\gamma-1}{2}\right)\left(\frac{V_{CAS}}{(a_0)_{ISA}}\right)^2\right]^{\frac{\gamma}{\gamma-1}}-1}{\left[1+\frac{\gamma-1}{2}M^2\right]^{\frac{\gamma}{\gamma-1}}-1} \qquad (4.1\text{-}3)$$

$(a_0)_{ISA}$ is the ISA speed of sound at sea level = 340.29 m/s

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 feet

$V_{cr,2}$ - standard cruise CAS (knots) above 10,000 ft until Mach transition altitude

M_{cr} - standard cruise Mach number above transition altitude

From 3000 ft to 10000 ft, any aircraft is assumed to cruise with a constant CAS equal to $V_{cr,1}$ or 250 knots whichever is lower.

Above 10000 ft, the cruise speed is assumed to be a constant CAS equal to $V_{cl,2}$ until the transition altitude is reached. Above the transition altitude the aircraft is assumed to climb with a constant Mach number equal to M_{cl} .

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 6,000 and 11,000 ft

$V_{des,2}$ - standard descent CAS (knots) above 11000 ft until Mach transition

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

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

below 1500 ft	$1.3\ (V_{stall})_{LD} + 5$
from 1500 to 1999 ft	$1.3\ (V_{stall})_{LD} + 20$
from 2000 to 2999 ft	$1.3\ (V_{stall})_{LD} + 60$
from 3000 to 3999 ft	$1.3\ (V_{stall})_{LD} + 80$
from 4000 to 5999 ft	$1.3\ (V_{stall})_{LD} + 100$
from 6000 to 10999 ft	$V_{des,1}$ (or 250 knots which ever is lower)
above 11000 ft to transition	$V_{des,2}$
above transition	M_{des}

For piston aircraft the following CAS schedule is assumed:

below 400 ft	$1.3\ (V_{stall})_{LD} + 5$
from 400 to 3999 ft	$1.3\ (V_{stall})_{LD} + 20$
above 4000 ft to transition	$V_{des,2}$
above transition	M_{des}

Note that 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.

5. FILE STRUCTURE

5.1 File Types

All data provided by BADA Revision 2.3 is organised into three types of files:

- two Synonym Files;
- a set of Operations Performance Files, and
- a set of Airline Procedure Files, and,
- a set of Performance Table Files.

The two Synonym Files which have the names:

SYNONYM.LST
SYNONYM.NEW

Both files provide a list of all the aircraft types which are supported by BADA and indicate 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). The only difference between these two files is their formats which are described in Section 5.3.

There is one Operations Performance File (OPF) provided for each aircraft type which is directly supported. This file specifies parameter values for the mass, speed envelope, drag, engine thrust, fuel consumption, and take-off models that are described in Section 3. Details on the format of the OPF file are given in Section 5.4.

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 5.5.

There is also 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.

The name of both OPF, APF and PTF files on the designation code for the aircraft type. With the one exception of the generic military fighter aircraft type (FGTR), 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

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 as shorter (e.g. DC9) and thus require more underscore characters. For example, an Airbus 310 which has the ICAO code of EA31 is represented in BADA 2.4 by the following files:

Operations Performance File:	EA31__.OPF
Airline Procedures File:	EA31__.APF
Performance Table File:	EA31__.PTF

The De-Havilland Dash-8 which has the ICAO code of DH8 is represented in BADA 2.4 by the following files:

Operations Performance File:	DH8___.OPF
Airline Procedures File:	DH8___.APF
Performance Table File:	DH8___.PTF

All files belonging to BADA Revision 2.3, that is the Synonym Files and all APF and OPF files are controlled within a configuration management system. This system is described in Section 5.2

5.2 File Configuration Management

The BADA Synonym File and all APF and OPF files are placed under configuration management at the EEC using the UNIX-based Revision Control System (RCS). The specific procedures used for configuration management are specified in the BADA Configuration Management Manual [RD7].

The PTF files are not placed under the Revision Control System since these files are generated automatically from the OPF and APF files. Integrity of the PTF files is however traced through the recording of checksums.

Under the BADA configuration management system, users have access to the following files:

- a Revision Summary File listing all APF, OPF and PTF files contained in the revision;
- the two Synonym Files;
- all APF, OPF and PTF files; and,
- all RCS files corresponding to the APF and OPF files.

Detailed instructions for remote access of the files is given in Section 6.

5.2.1 Revision Summary File

The Revision Summary File provides a list of all files provided as part of the BADA Revision. The name of the Revision Summary File is simply:

revisionSummary

A copy of the Revision Summary file for BADA Revision 2.4 is included in this document as Appendix A.

The Revision Summary File lists for each file the last modification date, size in bytes and checksum.

The checksum provides a useful means to ensure that a file has not been inadvertently modified. To verify a checksum, the UNIX command **cksum** is used on the file. The first number returned is the checksum and should match the value specified in the Revision Summary File.

5.2.2 Revision Numbers

All BADA Revisions are identified by a two digit number, e.g. 2.0 or 2.1. All files belonging to the BADA Revision have a file revision number which is the same as the BADA revision number.

Between releases of successive BADA Revisions, the contents of various files may be updated due to correction of coefficients, removal of excess information or addition of new information. In this case the modified file revision number is updated to a four digital number, for example:

2.1.1.3

The first two digits of the modified file revision number are the same as the last BADA Revision number in which the file was released. The third digit is always 1. The fourth digit is incremented by 1 for each successive modification of a file. It is recognised that the third digit is not necessary. This digit, however, is included for consistency with RCS numbering conventions.

Thus, if a file is modified twice between revision 2.1 and 2.2, the file revision number will undergo the following evolution:

2.1	- initial file revision in BADA Revision 2.1
2.1.1.1	- first modification
2.1.1.2	- second modification
2.2	- file released in BADA Revision 2.2, identical to 2.1.1.2.

In the Revision Summary File, the last modification date will then reflect the date on which revision 2.1.1.2 was made.

5.2.3 RCS Files

RCS files are files organised in a format internal to RCS which allows for the tracking of all modifications to a file.

The RCS files corresponding to the Synonym Files or each APF or OPF file are named with an ",v" extension. For example the RCS files corresponding to B747__.OPF is:

B747__.OPF,v

These files are provided to BADA users for information purposes. The use of standard UNIX/RCS utilities such as **rlog** and **co** on these files allows for information on the file modifications to be recovered along with previous file revisions. Instructions on the use of rlog and co can be obtained from the UNIX man pages.

5.3 Synonym File Format

5.3.1 SYNONYM.LST File

The SYNONYM.LST file is an ASCII file which lists all aircraft types which are supported by the BADA revision. An example of the SYNONYM.LST file is given below (partial listing).

```
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC SYNONYM.LST CCCCCCCCCCCC/
CC                                                                  /
CC                BADA SYNONYM FILE                                 /
CC                                                                  /
CC     BADA RCS File Id                                             /
CC    File Name        Current Revision      Last Modification      /
CC                     revision    date      revision     date      /
CC    SYNONYM.LST      2.3.1.7   95/12/08    2.3.1.7   95/12/08     /
CC                                                                  /
CC   BADA Revision:                                                 /
CC                                                                  /
CD   Rev  2.3                                                       /
CC====== Aircraft List =============================================/
CC                                                                  /
CC   A/C   NAME OR MODEL        FILE                 SYNONYMS       /
CC   CODE                                                           /
CC                                                                  /
 - AT42__  ATR 42               AT42__               AT42  CN35
 - AT72__  ATR 72               AT72__               AT72
 - B707__  BOEING 707-300/400   B707__               B707  C135  E3A
          SERIES                                    IL62   VC10
 - B727__  BOEING 727, ALL SE-  B727__               B727
           RIES
 - B737__  BOEING 737-100/200   B737__               B737
           SERIES
 - B73F__  BOEING 737-400       B73F__               B73F
 - B73S__  BOEING 737-300/500   B73S__               B73S
 - B747__  BOEING 747-100/200/  B747__               B747  B74S
           300 SERIES
 - B74F__  BOEING 747-400       B74F__               B74F
 - B757__  BOEING 757, ALL      B757__               B757
           SERIES
 - B767    BOEING 767, ALL      B767                 B767
          SERIES
```

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

CC comment line
CD data line
\- synonym line

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

- file identification block; and,
- aircraft list block.

Each of these blocks is described in the subsections below.

5.3.1.1 File Identification Block

The file identification block provides information on the file name, revision number and modification date. The block consists of 11 comment lines and one data line.

```
       CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC SYNONYM.LST CCCCCCCCCCCC/
       CC                                                                   /
       CC               BADA SYNONYM FILE                                   /
       CC                                                                   /
       CC     BADA RCS File Id                                              /
       CC    File Name        Current Revision      Last Modification       /
       CC                     revision    date      revision     date       /
       CC    SYNONYM.LST      2.3.1.7   95/12/08    2.3.1.7   95/12/08      /
       CC                                                                   /
       CC   BADA Revision:                                                  /
       CC                                                                   /
1 ->   CD   Rev  2.3                                                        /
```

The comment lines specify the file name along with the RCS current revision and last modification revision. For all released files, the current revision number and date will be the same as the number and date of the BADA Revision. The last modification revision number and date indicate when the contents of the file were last modified.

The data line gives the BADA Revision Id to which the file belongs. This value is specified in the following fixed format (Fortran notation):

‘CD’, 8X, F3.1

5.3.1.2 Aircraft Listing Block

The aircraft listing block consists of 5 comment lines with additional synonym lines for each aircraft supported by the BADA Revision.   A partial listing of this block is shown below.

```
        CC====== Aircraft List =============================================/
        CC                                                                  /
        CC   A/C   NAME OR MODEL       FILE                 SYNONYMS        /
        CC   CODE                                                           /
        CC                                                                  /
1 ->     - AT42__  ATR 42               AT42__               AT42  CN35
2 ->     - AT72__  ATR 72               AT72__               AT72
3 ->     - B707__  BOEING 707-300/400   B707__               B707  C135  E3A
                   SERIES                                    IL62  VC10
4 ->     - B727__  BOEING 727, ALL SE-  B727__               B727
                   RIES
5 ->     - B737__  BOEING 737-100/200   B737__               B737
```

There is one synonym line for each of the directly supported aircraft within the BADA release. Each such line consists of 4 fields as described below:

(a) Aircraft Code Field

This field identifies the aircraft type. It consists of a four-character ICAO code followed by two or more underscore characters.

(b) Name or Model Field

This field identifies the manufacturer and model of the aircraft.

(c) File Name Field

This field identifies the file name for the APF, OPF or PTF files associated with the aircraft (minus the file extension). For each aircraft this is the same as the A/C code.

(d) Equivalence Field

This field lists any equivalences associated with the aircraft. By default, each aircraft has at least one equivalence to itself.

Note that in some cases the name or model or equivalence fields may be continued onto the next line. This is the case in the example above for the Boeing 707.

5.3.2 SYNONYM.NEW File

The SYNONYM.NEW file is an ASCII file which lists all aircraft types which are supported by the BADA revision. Its format differs from the SYNONYM.LST file in that 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).

```
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC SYNONYM.NEW CCCCCCCCCCCC/
CC                                                                    /
CC                BADA SYNONYM FILE                                   /
CC                                                                    /
CC     BADA RCS File Id                                               /
CC    File Name        Current Revision      Last Modification        /
CC                     revision    date      revision     date        /
CC    SYNONYM.NEW      2.3.1.7   95/12/08    2.3.1.7   95/12/08       /
CC                                                                    /
CC   BADA Revision:                                                   /
CC                                                                    /
CD   Rev  2.3                                                         /
CC====== Aircraft List ==============================================/
CC                                                                    /
CC   A/C    MANUFACTURER        NAME OR MODEL             FILE        /
CC   CODE                                                             /
CC                                                                    /
CD * AC6T   ROCKWELL            TURBOCOMMANDER           BE20__       /
CD * AN12   ANTONOV             AN-12                    C130__       /
CD * AN24   ANTONOV             AN-24                    FK27__       /
CD * AN26   ANTONOV             AN-26                    FK27__       /
CD - AT42   ATR                 ATR 42                   AT42__       /
CD - AT72   ATR                 ATR 72                   AT72__       /
CD - B707   BOEING              707-100/200              B707__       /
CD - B727   BOEING              737-100/200              B737__       /
CD - B737   BOEING              737-100/200              B737__       /
CD - B73F   BOEING              737-400                  B73F__       /
CD - B73S   BOEING              737-300/500              B73S__       /
CD - B747   BOEING              747-100/200/300          B747__       /
CD - B74F   BOEING              747-400                  B74F__       /
CD * B74S   BOEING              747 SP                   B747__       /
CD - B757   BOEING              757, ALL SERIES          B757__       /
CD - B767   BOEING              767, ALL SERIES          B767__       /
CC ==================================================================/
FI                                                                    /
```

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 a two blocks separated by a comment line consisting of equal signs "=":

- file identification block; and,
- aircraft list block.

Each of these blocks is described in the subsections below.

5.3.1.1 File Identification Block

The file identification block provides information on the file name, revision number and modification date. The block consists of 1 data line with 11 comment lines for a total of 12 lines as shown below.

```
       CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC SYNONYM.NEW CCCCCCCCCCCCC/
       CC                                                                     /
       CC                  BADA SYNONYM FILE                                  /
       CC                                                                     /
       CC      BADA RCS File Id                                               /
       CC     File Name        Current Revision      Last Modification        /
       CC                      revision    date      revision     date        /
       CC     SYNONYM.NEW      2.3.1.7   95/12/08    2.3.1.7   95/12/08       /
       CC                                                                     /
       CC    BADA Revision:                                                   /
       CC                                                                     /
1 ->   CD    Rev  2.3                                                         /
```

The only data line gives the BADA Revision Id to which the file belongs. This value is specified in the following fixed format (Fortran notation):

'CD', 8X, F3.1

The comment lines specify the file name along with the RCS current revision and last modification revision. For all released files, the current revision number and date will be the same as the number and date of the BADA Revision. The last modification revision number and date indicate when the contents of the file were last modified.

5.3.2.2 Aircraft Listing Block

The aircraft listing block consists of 4 comment lines with one data line for each aircraft supported by the BADA Revision. A partial listing of this block is shown below.

```
CD * AN24   ANTONOV             AN-24                     FK27__       /
CD * AN26   ANTONOV             AN-26                     FK27__       /
CD - AT42   ATR                 ATR 42                    AT42__       /
CD - AT72   ATR                 ATR 72                    AT72__       /
```

Each data line consists of 5 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 four-character ICAO code.

(c) Manufacturer Field

This field identifies the manufacturer of the aircraft. Examples are Boeing, Airbus or Dassault-Breguet.

(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 or PTF 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 the B707 will be B707__. This indicates an OPF file B707__.OPF, an APF file B707__.APF and a PTF file B707__.PTF. For the DeHavilland Dash 8 with an ICAO code of DH8, the file names include three underscore characters, that is, DH8____.OPF, DH8___.APF, and DH8___.PTF.

For an aircraft type which is supported through an equivalence, the file name will indicate the file for the equivalent aircraft type which should be used. As an example, the Breguet Atlantic (ATLA) is equivalenced to the Aerospatiale Transall (ND16). Thus the files ND16__.OPF, ND16__.APF and ND16__.PTF should be used.

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

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

5.4 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 2. An example of an OPF file for the MD80 aircraft is shown below.

```
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC MD80__.OPF CCCCCCCCCCCCCC/
CC                                                                    /
CC                AIRCRAFT PERFORMANCE                                /
CC                operational    files                                /
CC                                                                    /
CC     BADA RCS File Id                                               /
CC    File Name        Current Revision      Last Modification        /
CC                     revision    date      revision     date        /
CC    MD80__.OPF       2.3.1.1   95/12/14    2.3.1.1    95/12/14      /
CC                                                                    /
CC   BADA Revision:                                                   /
CD   Rev  2.3                                                         /
CC======Actype =======================================================/
CD   MD80__         2 engines    Jet                       H          /
CC  Douglas MD83        with JT8-219 engines              wake        /
CC           Source: (Douglas OPS Manual)                             /
CC====== Mass (t) ====================================================/
CC    reference      minimum      maximum     max payload mass grad   /
CD     .54430E+02   .36400E+02   .72480E+02   .19193E+00  .32000E+00  /
CC====== Flight envelope =============================================/
CD     VMO (KCAS)     MMO         Max.Alt      Hmax       temp grad   /
CD     .34000E+03   .84000E+00   .37000E+05  .31450E+05  -.24000E+03  /
CC====== Aerodynamics ================================================/
CC Basic Drag Polar coefficients (SIM)                                /
CCndrst Surf(m2)       CD0          CD2           CM16                /
CD 5   .11800E 03   .20600E-01   .35170E-01     .00000E+00            /
CC   Configuration characteristics                                    /
CC n Phase  Name    Vstall(IAS)   unused       unused       unused    /
CD 1 CR   Clean     .15300E+03   .00000E+00   .00000E+00   .00000E+00 /
CD 2 IC   Flap15    .13800E+03   .00000E+00   .00000E+00   .00000E+00 /
CD 3 TO   Flap15    .13800E+03   .00000E+00   .00000E+00   .00000E+00 /
CD 4 AP   Flap28    .13000E+03   .00000E+00   .00000E+00   .00000E+00 /
CD 5 LD   Flap40    .12300E+03   .00000E+00   .00000E+00   .00000E+00 /
CC   Spoiler                                                          /
CD 1      RET                                                         /
CD 2      EXT                                 .00000E+00   .00000E+00 /
CC   Gear                                                             /
CD 1      UP                                                          /
CD 2      DOWN                   .00000E+00   .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     .12685E+06    .48500E+05  .66000E-10   .00000E+00   .73600E-02 /
CC      Cruise       Desc(low)   Desc(high)   Desc level    unused    /
CD     .95000E+00    .10000E-02  .20000E+00   .38800E+05   .00000E+00 /
CC      Desc CAS     Desc Mach    unused       unused       unused    /
CD     .29000E+03    .76000E+00  .00000E+00   .00000E+00   .00000E+00 /
CC====== Fuel Consumption ============================================/
CC   Thrust Specific Fuel Consumption Coefficients                    /
CD     .16500E+00   .57350E+02                                        /
CC   Descent Fuel Flow Coefficients                                   /
CD     .17300E+02   .50000E+05                                        /
CC      unused       unused        unused      unused       unused    /
CD     .00000E+00   .00000E+00    .00000E+00  .00000E+00   .00000E+00 /
CC======= Take-Off ===================================================/
CC      unused       unused        unused      unused       unused    /
CD     .00000E+00   .00000E+00    .00000E+00  .00000E+00   .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 nine 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,
- speed envelope block,
- aerodynamics block,
- engine thrust block,
- fuel consumption block, and,
- take-off performance block.

5.4.1 File Identification Block

The file identification block provides information on the file name, revision number and modification date. The block consists of 1 data line with 11 comment lines for a total of 12 lines. An example of the file identification block for the MD80__.OPF file is shown below.

```
        CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC MD80__.OPF CCCCCCCCCCCCCC/
        CC                                                                    /
        CC                AIRCRAFT PERFORMANCE                                /
        CC                operational    files                                /
        CC                                                                    /
        CC      BADA RCS File Id                                              /
        CC     File Name        Current Revision      Last Modification       /
        CC                      revision    date      revision     date       /
        CC     MD80__.OPF       2.3.1.1   95/12/14    2.3.1.1    95/12/14     /
        CC                                                                    /
        CC    BADA Revision:                                                  /
1 ->    CD    Rev  2.3                                                        /
```

The only data line gives the BADA Revision Id to which the file belongs. This value is specified in the following fixed format (Fortran notation):

'CD', 8X, F3.1

The comment lines specify the file name along with the RCS current revision and last modification revision. For all released files, the current revision number and date will be the same as the number and date of the BADA Revision. The last modification revision number and date indicate when the contents of the file were last modified.

5.4.2 Aircraft Type Block

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

```
      CC======Actype ========================================================/
1 ->  CD   MD80__        2 engines    Jet                       H          /
      CC  Douglas MD83        with JT8-219 engines             wake        /
      CC           Source: (Douglas OPS Manual)                            /
```

The data line specifies the following aircraft type parameters:

- ICAO aircraft code
  (following by 2 or more underscore characters as required to form a six character string),
- number of engines, n_{eng} ,
- engine type, and,
- 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 three values H (heavy), M (medium) or L (light).

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

'CD', 2X, A6, 10X, I1, 12X, A9, 17X , A1

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

5.4.3 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     .54430E+02   .36400E+02   .72480E+02   .19193E+00  .32000E+00  /
```

The data line specifies the following BADA mass model parameters (in tonnes):

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)

5.4.4 Flight Envelope Block

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

```
        CC====== Flight envelope =============================================/
        CD     VMO (KCAS)     MMO         Max.Alt      Hmax       temp grad   /
1 ->    CD     .34000E+03   .84000E+00   .37000E+05  .31450E+05  -.24000E+03  /
```

The date line specifies the following BADA speed envelope parameters:

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

Note that all speeds are CAS with the velocities in knots and the height in feet above sea level.

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

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

5.4.5 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 Basic Drag Polar coefficients (SIM)                                 /
         CCndrst Surf(m2)       CD0          CD2           CM16                 /
1 ->     CD 5   .11800E+03   .20600E-01   .35170E-01    .00000E+00              /
         CC   Configuration characteristics                                     /
         CC n Phase  Name    Vstall(IAS)   unused       unused       unused    /
2 ->     CD 1 CR   Clean     .15300E+03   .00000E+00   .00000E+00   .00000E+00 /
3 ->     CD 2 IC   Flap15    .13800E+03   .00000E+00   .00000E+00   .00000E+00 /
4 ->     CD 3 TO   Flap15    .13800E+03   .00000E+00   .00000E+00   .00000E+00 /
5 ->     CD 4 AP   Flap28    .13000E+03   .00000E+00   .00000E+00   .00000E+00 /
6 ->     CD 5 LD   Flap40    .12300E+03   .00000E+00   .00000E+00   .00000E+00 /
         CC   Spoiler                                                           /
7 ->     CD 1                                                                   /
8 ->     CD 2                                           .00000E+00   .00000E+00 /
         CC   Gear                                                              /
9 ->     CD 1                                                                   /
10 ->    CD 2                             .00000E+00   .00000E+00   .00000E+00 /
         CC   Brakes                                                            /
11 ->    CD 1                                                                   /
12 ->    CD 2                                           .00000E+00   .00000E+00 /
```

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

S C_{D0} C_{D2} C_{M16}

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

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

The next five data lines correspond to the various configurations and specify the stall speed for each configuration. The configurations are specified in the following order, corresponding to a semi-monotonically decreasing stall speed:

CR cruise
IC initial climb
TO take-off
AP approach
LD landing

The stall speed, $(V_{stall})_i$, is specified for each configuration in the following fixed format (Fortran notation):

'CD', 18X, E10.5

The other zero values for each configuration are not used but are included in the file due to compatibility requirements with previous versions.

The data lines 7 through 12 are also not used are included for the same reason of compatibility with previous versions.

5.4.6 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     .12685E+06    .48500E+05  .66000E-10   .00000E+00   .73500E-02 /
       CC       Cruise        Desc(low)  Desc(high)   Desc level   unused    /
2 ->   CD     .95000E+00    .10000E-02  .20000E+00   .30800E+05   .00000E+00 /
       CC      Desc CAS      Desc Mach   unused       unused       unused    /
3 ->   CD     .29000E+03    .76000E+00  .00000E+00   .00000E+00   .00000E+00 /
```

The first data line specifies the following BADA parameters used to calculated 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, 4 (3X, E10.5)

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

C_{Tcr} $C_{Tdes,low}$ $C_{Tdes,high}$ h_{des}

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

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

The third data line specifies the reference speed used to calculate the coefficients 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)

The zero values in the data lines are not used but are included in the file due to compatibility requirements with previous versions.

5.4.7 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     .16500E+00   .57350E+02                                      /
        CC   Descent Fuel Flow Coefficients                                 /
2 ->    CD     .17300E+02   .50000E+05                                      /
        CC      unused       unused       unused       unused       unused  /
3 ->    CD     .00000E+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 is not used but is included in the file due to compatibility requirements with previous versions.

5.4.8 Take-off Block

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

```
        CC====== Take-off ==================================================/
        CC      unused       unused       unused       unused       unused  /
1 ->    CD     .00000E+00   .00000E+00   .00000E+00   .00000E+00   .00000E+00 /
        CC==================================================================/
        FI                                                                  /
```

The data in this block is not used but is included in the file due to compatibility requirements with previous versions.

5.5 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 Boeing 767 aircraft is shown below.

```
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC B767__.APF CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC/
CC                                                                                                /
CC                 AIRLINES PROCEDURES FILE                                                       /
CC                                                                                                /
CC   File Name          Current Revision           Last Modification                              /
CC                      revision    date           revision     date                              /
CC   B767__.APF         2.3.1.1   95/08/29         2.3.1.1    95/08/29                            /
CC                                                                                                /
CC   BADA Revision:                                                                               /
CD   Rev 2.3                                                                                      /
CC                                                                                                /
CC   LO= 110.00 to ---.--- /  AV= ---/-- to ---/--    Hi= ---.-- to 143.00                        /
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===:=======:=======::==::===:===:==:====:==::===:===:==::==:===:===:====:==::===:===:===::=====:/
CC  *** **    Default Company                                                                     /
CD    200R    PW4060   LO  290 290 78          310 310 80  78 290 290           0   0   0  B767__/
CD    200R    PW4060   AV  290 290 78          310 310 80  78 290 290           0   0   0  B767__/
CD    200R    PW4060   HI  290 290 78          310 310 80  78 290 290           0   0   0  B767__/
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, and,
- speed procedures block.

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

5.5.1 File Identification Block

The file identification block provides information on the file name, revision number and modification date. The block consists of 1 data line with 12 comment lines for a total of 13 lines.
An example of a file identification block is shown below.

```
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC B767__.APF CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC/
CC                                                                                                 /
CC                 AIRLINES PROCEDURES FILE                                                        /
CC                                                                                                 /
CC   File Name          Current Revision            Last Modification                              /
CC                      revision    date            revision     date                              /
CC   B767__.APF         2.3.1.1   95/08/29          2.3.1.1    95/08/29                            /
CC                                                                                                 /
CC   BADA Revision:                                                                                /
CD   Rev 2.3                                                                                       /
CC                                                                                                 /
CC   LO= 110.00 to ---.--- /  AV= ---/-- to ---/--    Hi= ---.-- to 143.00                         /
CC                                                                                                 /
```

The only data line gives the BADA Revision Id to which the file belongs. This value is specified in the following fixed format.

'CD', 8X, F3.1

The comment lines provide background information on the file contents. In addition, the comment lines specify the file name along with the RCS current revision and last modification. For all released files, the current revision number and date are the same as the number and date of the BADA revision. The last modification revision number and date indicate 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.

5.5.2 Procedures Specification Block

The APF procedures specification block consists of 3 data lines with 8 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===:=======:=======::==::===:===:==:====:==::===:===:==::==:===:===:====:==::===:===:===::=====:/
     CC  *** **    Default Company                                                                     /
1 -> CD    200R    PW4060   LO  290 290 78          310 310 80  78 290 290            0   0   0  B767__/
2 -> CD    200R    PW4060   AV  290 290 78          310 310 80  78 290 290            0   0   0  B767__/
3 -> CD    200R    PW4060   HI  290 290 78          310 310 80  78 290 290            0   0   0  B767__/
     CC===:=======:=======::==::===:===:==:====:==::===:===:==::==:===:===:====:==::===:===:===::=====:/
     CC//////////////////////////////////  THE END   ///////////////////////////////////////////////////
```

The 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} $V_{des,1}$ $V_{des,2}$

Note that all Mach numbers 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 three 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. As it is, within BADA 2.3, all APF files specified procedures for only one "default" company.

5.6 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 Fokker 50 aircraft (FK50) is shown below.

```
                         BADA PERFORMANCE FILE              95/06/08

AC/Type: FK50__               Last BADA Revision:  2.3
                              Source OPF File:     2.3        95/06/08
                              Source APF file:     2.3        95/06/08

 Speeds:   CAS   Mach         Mass Levels [kg]         Temperature:   ISA
 climb   - 150   0.47         low     -  15000
 cruise  - 190   0.47         nominal -  17000         Max Alt. [ft]:  25000
 descent - 220   0.47         high    -  20820
======================================================================================
 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     |
======================================================================================
  0 |                           |  118   2980 2500 1800     18.7   |   99   100      6.0
    |                           |                                  |
  5 |                           |  119   2940 2470 1770     18.5   |   99   110      6.1
    |                           |                                  |
 10 |                           |  120   2900 2430 1740     18.3   |  100   120      6.2
    |                           |                                  |
 15 |                           |  121   2870 2400 1710     18.2   |  116   120      6.3
    |                           |                                  |
 20 |                           |  154   2630 2220 1620     17.2   |  158   330      6.5
    |                           |                                  |
 30 |  198     7.1   7.5   8.4  |  157   2550 2150 1560     16.8   |  181   570      6.7
    |                           |                                  |
 40 |  201     7.2   7.6   8.5  |  159   2470 2080 1500     16.4   |  205   890      6.9
    |                           |                                  |
 60 |  207     7.4   7.7   8.6  |  164   2310 1930 1370     15.7   |  240  1480      7.4
    |                           |                                  |
 80 |  214     7.8   7.8   8.8  |  169   2150 1790 1250     15.0   |  247  1550      7.8
    |                           |                                  |
100 |  220     8.3   8.3   8.9  |  174   1990 1640 1120     14.3   |  254  1630      8.3
    |                           |                                  |
120 |  227     8.8   8.8   9.0  |  180   1830 1490 1000     13.6   |  262  1710      8.8
    |                           |                                  |
140 |  234     9.2   9.2   9.2  |  185   1670 1350  870     12.9   |  270  1780      9.2
    |                           |                                  |
160 |  241     9.7   9.7   9.7  |  191   1500 1200  740     12.3   |  279  1860      9.7
    |                           |                                  |
180 |  249    10.2  10.2  10.2  |  197   1340 1050  620     11.6   |  288  1940     10.2
    |                           |                                  |
200 |  257    10.6  10.6  10.6  |  204   1170  900  490     10.9   |  288  1570     10.6
    |                           |                                  |
220 |  266    11.1  11.1  11.1  |  211   1010  750  360     11.1   |  286  1470     11.1
    |                           |                                  |
240 |  275    11.5  11.5  11.5  |  218    840  600  230     11.5   |  284  1380     11.5
    |                           |                                  |
260 |  282    12.0  12.0  12.0  |  226    680  450   90     12.0   |  282  1310     12.0
    |                           |                                  |
280 |  279    12.5  12.5  12.5  |  233    510  300    0     12.5   |  279  1260     12.5
    |                           |                                  |
300 |  277    12.9  12.9  12.9  |  242    350  150    0     12.9   |  277  1220     12.9
    |                           |                                  |
320 |  274    13.4  13.4  13.4  |  250    180    0    0     13.4   |  274  1210     13.4
    |                           |                                  |
340 |  272    13.8  13.8  13.8  |  259     20    0    0     13.8   |  272  1210     13.8
    |                           |                                  |
360 |                           |                                  |
    |                           |                                  |
380 |                           |                                  |
    |                           |                                  |
400 |                           |                                  |
=====================================================================================
```

The OPF and APF files are generated as a result of a modelling processed using Excel spreadsheets [RD8]. Once these two files a generated, the PTF can be automatically generated as described in the Configuration Manual [RD7]. The PTF files are described more fully in a technical note which includes copies of all BADA 2.3 PTF files. 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.

last BADA revision: This is in the 3rd line and indicates the last BADA revision which has been released as of the file creation date.

source file revisions: The RCS revision numbers and 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 9, 10 and 11, that is:

climb	$V_{cl,1}$	M_{cl}
cruise	$V_{cr,2}$	M_{cr}
descent	$V_{des,2}$	M_{des}

mass Levels: The performance tables provide data for three different mass levels in lines 9, 10 and 11 that is:

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

temperature: All PTF files currently only provide data for ISA conditions.

maximum altitude: The maximum altitude as specified in the OPF file, h_{MO} , is given in line 10.

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 in knots
Column 3	cruise fuel consumption (low mass) in kg/min
Column 4	cruise fuel consumption (nominal mass) in kg/min
Column 5	cruise fuel consumption (high mass) in kg/min
Column 6	climb TAS in knots
Column 7	rate of climb (low mass) in fpm
Column 8	rate of climb (nominal mass) in fpm
Column 9	rate of climb (high mass) in fpm
Column 10	climb fuel consumption in kg/min
Column 11	descent TAS in knots
Column 12	rate of descent in fpm
Column 13	descent fuel consumption in fpm

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

I3, 4X, I3, 2X, 3(2X, F4.1), 5X, I3, 2X, 3(1X,I4), 4X, F4.1, 5X, I3, 2X, I4, 4X, F4.1

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

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

(b) Performance data is specified up to a maximum flight level of 400 or to highest level for which a positive rate of climb can be achieved at the low mass. This maximum level is not necessarily the same as the maximum level specified in the OPF file and given in the PTF header.

(c) True Air Speed 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.

(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 given.

(g) Discontinuities in climb rate can occur for the following reasons:

- change in speed between flight levels (e.g. removal of 250 knot restriction above FL100)
- transition from constant CAS to constant Mach (typically around FL300)
- transition through the tropopause (FL360 for ISA)

(h) Discontinuities in descent rate can occur for the following reasons:

- transition through tropopause (FL360 for ISA)
- transition from constant Mach to constant CAS
- change in assumed descent thrust (specified by the BADA h_{des} parameter)
- change in speed between flight levels (e.g. application of 250 knot limit below FL100)

6. REMOTE FILE ACCESS

All files associated with BADA Revision 2.4 are placed within a compressed tar file located on the EEC computing facilities.

This file can be access from a remote system using **ftp** over Internet in the following manner:

(a) Initiate a ftp session to the Internet address: **bada.eurocontrol.fr** via using the **anonymous** account. No password is needed for this account, however, to allow for tracing of access to the account it is requested that your E-mail address is used as the password, that is:

name@machine.domain.country

(b) Change the working directory to bada/2.4:

cd bada/2.4

(c) Copy the following file to your local system using the ftp **get** command:

get bada/2.4/badaRevision2.4.tar.Z

(d) Uncompress the file, that is,

uncompress badaRevision2.4.tar.Z

(e) Restore from the tar archive file, that is:

tar xf badaRevision2.4.tar bada2.4

This will restore the following files:

bada2.4/releaseSummary	
bada2.4/SYNONYM.LST	bada2.4/RCS/SYNONYM.LST,v
bada2.4/SYNONYM.NEW	bada2.4/RCS/SYNONYM.NEW,v
bada2.4/*.OPF	bada2.4/RCS/*.OPF,v
bada2.4/*.APF	bada2.4/RCS/*.APF,v
bada2.4/*.PTF	

Note that the *.OPF, *.APF, *.PTF, SYNONYM.* and revisionSummary files are also located on the directory and can also be copied individually. A summary list of the files to be restored as obtained using the tar -tvf command is provided as Appendix B.

Note that any enquiries can be addressed to the current BADA Configuration Manager at the EEC:

Email bada@eurocontrol.fr

APPENDIX A

BADA 2.4 - REVISION SUMMARY FILE

BADA Revision Summary File

Revision Id: 2.4
Release Date: 96/01/04
Number of Files: 203

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File Name	Revision	Last Modification (revision	date)	Size (bytes)	Checksum
SYNONYM.LST	2.4	2.3.1.7	95/12/08	8981	2523138945
SYNONYM.NEW	2.4	2.3.1.7	95/12/08	10443	3245449269
AT42__.APF	2.4	2.2.1.2	95/05/18	2424	4129374035
AT42__.OPF	2.4	2.3.1.2	95/12/13	4392	3529080171
AT42__.PTF	2.4			5376	2715442469
AT72__.APF	2.4	2.2.1.2	95/05/18	2424	833603854
AT72__.OPF	2.4	2.3.1.2	95/12/13	4392	41867126
AT72__.PTF	2.4			5356	1400059754
B707__.APF	2.4	2.3.1.1	95/08/29	2424	2615567612
B707__.OPF	2.4	2.3.1.1	95/12/13	4392	2647431411
B707__.PTF	2.4			5456	2306344356
B727__.APF	2.4	2.2.1.3	95/05/18	2424	609971738
B727__.OPF	2.4	2.3.1.1	95/12/13	4392	605042684
B727__.PTF	2.4			5456	628899423
B737__.APF	2.4	2.2.1.2	95/05/18	2424	619508167
B737__.OPF	2.4	2.3.1.1	95/12/13	4392	3167927336
B737__.PTF	2.4			5456	3614427476
B73F__.APF	2.4	2.2.1.2	95/05/18	2424	1101822935
B73F__.OPF	2.4	2.3.1.2	95/12/13	4392	3979397556
B73F__.PTF	2.4			5456	3517229188
B73S__.APF	2.4	2.2.1.2	95/05/18	2424	4071733794
B73S__.OPF	2.4	2.3.1.2	95/12/13	4392	2967856342
B73S__.PTF	2.4			5456	20749987
B73V__.APF	2.4	2.2.1.1	95/04/24	2424	438878897
B73V__.OPF	2.4	2.3.1.1	95/12/13	4392	913463735
B73V__.PTF	2.4			5456	2248995641
B747__.APF	2.4	2.2.1.2	95/05/18	2424	2300314197
B747__.OPF	2.4	2.3.1.1	95/12/13	4392	1750630184
B747__.PTF	2.4			5456	773458011
B74F__.APF	2.4	2.2.1.1	95/03/03	2424	2592242315
B74F__.OPF	2.4	2.3.1.1	95/12/13	4392	4204495524
B74F__.PTF	2.4			5456	598934754
B757__.APF	2.4	2.2.1.2	95/05/18	2424	1218306626
B757__.OPF	2.4	2.3.1.1	95/12/13	4392	613657130
B757__.PTF	2.4			5456	2379418796
B767__.APF	2.4	2.3.1.1	95/08/29	2424	3919836320
B767__.OPF	2.4	2.3.1.1	95/12/13	4392	826189095
B767__.PTF	2.4			5456	1773382912
BA11__.APF	2.4	2.2.1.2	95/05/18	2424	3492805552
BA11__.OPF	2.4	2.3.1.1	95/12/13	4392	3437920492

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File Name	Revision	Last Modification (revision	date)	Size (bytes)	Checksum
BA11__.PTF	2.4			5456	3068847236
BA31__.APF	2.4	2.2.1.2	95/05/18	2424	3116990731
BA31__.OPF	2.4	2.3.1.1	95/12/13	4392	2020058393
BA31__.PTF	2.4			5376	2247606561
BA41__.APF	2.4	2.2.1.2	95/05/18	2424	389789176
BA41__.OPF	2.4	2.3.1.1	95/12/13	4392	2196502647
BA41__.PTF	2.4			5376	2959423432
BA46__.APF	2.4	2.2.1.1	95/03/03	2424	4049368607
BA46__.OPF	2.4	2.3.1.2	95/12/13	4392	3955694144
BA46__.PTF	2.4			5456	273522764
BATP__.APF	2.4	2.2.1.3	95/05/18	2424	3386064691
BATP__.OPF	2.4	2.3.1.1	95/12/13	4392	4021371283
BATP__.PTF	2.4			5316	4186806093
BE20__.APF	2.4	2.2.1.1	95/03/03	2424	1003998807
BE20__.OPF	2.4	2.3.1.2	95/12/13	4392	2565649201
BE20__.PTF	2.4			5456	2224057591
BE90__.APF	2.4	2.3.1.1	95/12/04	2424	3247362897
BE90__.OPF	2.4	2.3.1.1	95/12/13	4392	3806694964
BE90__.PTF	2.4			5396	770220629
BE99__.APF	2.4	2.2.1.2	95/05/18	2424	2161339235
BE99__.OPF	2.4	2.3.1.2	95/12/13	4392	1611646767
BE99__.PTF	2.4			5456	1980323522
C130__.APF	2.4	2.2.1.1	95/03/03	2424	1047562286
C130__.OPF	2.4	2.3.1.1	95/12/13	4392	910995971
C130__.PTF	2.4			5456	4245683891
C421__.APF	2.4	2.3.1.1	95/12/08	2424	434048563
C421__.OPF	2.4	2.3.1.2	95/12/13	4392	1610985508
C421__.PTF	2.4			5416	2541299330
C550__.APF	2.4	2.2.1.1	95/03/03	2424	728175780
C550__.OPF	2.4	2.3.1.1	95/12/13	4392	1891792649
C550__.PTF	2.4			5456	3772714472
C560__.APF	2.4	2.2.1.1	95/03/03	2424	919057502
C560__.OPF	2.4	2.3.1.1	95/12/13	4392	3262162358
C560__.PTF	2.4			5456	1606468529
CL60__.APF	2.4	2.2.1.2	95/05/18	2424	4013204935
CL60__.OPF	2.4	2.3.1.1	95/12/13	4392	1896285997
CL60__.PTF	2.4			5456	2130327184
D228__.APF	2.4	2.2.1.2	95/03/03	2424	661310538
D228__.OPF	2.4	2.3.1.1	95/12/13	4392	1597257502
D228__.PTF	2.4			5456	3968300404

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File Name	Revision	Last Modification (revision	date)	Size (bytes)	Checksum
D328__.APF	2.4	2.2.1.2	95/05/18	2424	1569827360
D328__.OPF	2.4	2.3.1.1	95/12/13	4392	2379077438
D328__.PTF	2.4			5456	2960781694
DA01__.APF	2.4	2.2.1.2	95/05/18	2424	3328962461
DA01__.OPF	2.4	2.3.1.1	95/12/13	4392	2997114904
DA01__.PTF	2.4			5456	4196859984
DA10__.APF	2.4	2.2.1.2	95/05/18	2424	3754300257
DA10__.OPF	2.4	2.3.1.2	95/12/13	4392	3691516516
DA10__.PTF	2.4			5456	805888103
DA20__.APF	2.4	2.2.1.2	95/05/18	2424	1733729756
DA20__.OPF	2.4	2.3.1.2	95/12/13	4392	696726436
DA20__.PTF	2.4			5456	3285527825
DA50__.APF	2.4	2.2.1.2	95/05/18	2424	2898763800
DA50__.OPF	2.4	2.3.1.2	95/12/13	4392	460450473
DA50__.PTF	2.4			5456	814541089
DA90__.APF	2.4	2.2.1.2	95/05/18	2424	555707354
DA90__.OPF	2.4	2.3.1.2	95/12/13	4392	1162461483
DA90__.PTF	2.4			5456	3848694269
DC10__.APF	2.4	2.2.1.1	95/03/03	2424	3500769126
DC10__.OPF	2.4	2.3.1.1	95/12/13	4392	218603850
DC10__.PTF	2.4			5456	1325295628
DC8S__.APF	2.4	2.2.1.2	95/05/18	2424	2950057364
DC8S__.OPF	2.4	2.3.1.1	95/12/13	4392	753674757
DC8S__.PTF	2.4			5456	1364096626
DC9___.APF	2.4	2.2.1.1	95/03/03	2424	220973113
DC9___.OPF	2.4	2.3.1.1	95/12/13	4392	1935337812
DC9___.PTF	2.4			5456	3847965129
DH8___.APF	2.4	2.2.1.2	95/05/18	2424	480369563
DH8___.OPF	2.4	2.3.1.2	95/12/13	4392	463375713
DH8___.PTF	2.4			5376	182699117
E120__.APF	2.4	2.2.1.1	95/03/03	2424	3506851536
E120__.OPF	2.4	2.3.1.1	95/12/13	4392	1356086689
E120__.PTF	2.4			5416	244512474
EA30__.APF	2.4	2.2.1.1	95/03/03	2424	2463632725
EA30__.OPF	2.4	2.3.1.2	95/12/13	4392	1102586454
EA30__.PTF	2.4			5456	3305045975
EA31__.APF	2.4	2.2.1.2	95/05/18	2424	2759942771
EA31__.OPF	2.4	2.3.1.1	95/12/13	4392	4177495559
EA31__.PTF	2.4			5456	33758
EA32__.APF	2.4	2.2.1.1	95/03/03	2424	2341068593

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Release Date: 96/01/04
Number of Files: 203

File Name	Revision	Last Modification (revision)	Last Modification (date)	Size (bytes)	Checksum
EA32__.OPF	2.4	2.3.1.1	95/12/14	4392	1780333799
EA32__.PTF	2.4			5456	3702696042
EA33__.APF	2.4	2.2.1.2	95/05/18	2424	3167120099
EA33__.OPF	2.4	2.3.1.1	95/12/14	4392	2225296296
EA33__.PTF	2.4			5456	3472941936
EA34__.APF	2.4	2.2.1.1	95/03/03	2424	2242876341
EA34__.OPF	2.4	2.3.1.1	95/12/14	4392	2294714806
EA34__.PTF	2.4			5456	3511880709
FGTR__.APF	2.4	2.2.1.2	95/05/18	2424	981395725
FGTR__.OPF	2.4	2.3.1.1	95/12/14	4392	2258467108
FGTR__.PTF	2.4			5456	2465805146
FK10__.APF	2.4	2.2.1.1	95/03/03	2424	3556928232
FK10__.OPF	2.4	2.3.1.1	95/12/14	4392	1849106580
FK10__.PTF	2.4			5456	31757827
FK27__.APF	2.4	2.2.1.1	95/03/03	2424	1374780955
FK27__.OPF	2.4	2.3.1.2	95/12/14	4392	543551331
FK27__.PTF	2.4			5356	3983449696
FK28__.APF	2.4	2.3.1.1	95/08/29	2424	3807340606
FK28__.OPF	2.4	2.3.1.1	95/12/14	4392	1823304135
FK28__.PTF	2.4			5456	4059719588
FK50__.APF	2.4	2.3.1.2	95/07/13	2424	2823222007
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FK50__.PTF	2.4			5376	1591772080
FK70__.APF	2.4	2.3.1.1	95/12/04	2424	1769137857
FK70__.OPF	2.4	2.3.1.2	95/12/14	4392	2384589977
FK70__.PTF	2.4			5456	1576563107
HS25__.APF	2.4	2.2.1.2	95/05/18	2424	2518631659
HS25__.OPF	2.4	2.3.1.1	95/12/14	4392	3452785880
HS25__.PTF	2.4			5456	648767229
L101__.APF	2.4	2.2.1.1	95/03/03	2424	1095917081
L101__.OPF	2.4	2.3.1.1	95/12/14	4392	973429452
L101__.PTF	2.4			5456	2301178720
LR35__.APF	2.4	2.3.1.1	95/08/29	2424	2498197171
LR35__.OPF	2.4	2.3.1.1	95/12/14	4392	2145817284
LR35__.PTF	2.4			5456	3136610654
MD11__.APF	2.4	2.2.1.1	95/05/03	2424	3965471850
MD11__.OPF	2.4	2.3.1.1	95/12/14	4392	2628977386
MD11__.PTF	2.4			5456	3035863152
MD80__.APF	2.4	2.2.1.2	95/05/18	2424	1681342567
MD80__.OPF	2.4	2.3.1.1	95/12/14	4392	1233137407

BADA Revision Summary File

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File Name	Revision	Last Modification (revision	date)	Size (bytes)	Checksum
MD80__.PTF	2.4			5456	2028952987
MU2___.APF	2.4	2.2.1.1	95/03/03	2424	2208086585
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MU2___.PTF	2.4			5456	1784766282
ND16__.APF	2.4	2.2.1.1	95/03/03	2424	2090071924
ND16__.OPF	2.4	2.3.1.2	95/12/14	4392	1798204349
ND16__.PTF	2.4			5336	278973396
PA28__.APF	2.4	2.2.1.2	95/05/18	2424	2177836352
PA28__.OPF	2.4	2.3.1.1	95/12/14	4392	540914439
PA28__.PTF	2.4			5216	3621371612
PA31__.APF	2.4	2.2.1.1	95/03/03	2424	2201293131
PA31__.OPF	2.4	2.3.1.1	95/12/14	4392	18004561
PA31__.PTF	2.4			5356	1570458850
PA34__.APF	2.4	2.2.1.2	95/05/18	2424	2840664427
PA34__.OPF	2.4	2.3.1.1	95/12/14	4392	2035451499
PA34__.PTF	2.4			5236	995215998
PA42__.APF	2.4	2.2.1.1	95/03/03	2424	1067024817
PA42__.OPF	2.4	2.3.1.1	95/12/14	4392	1211094271
PA42__.PTF	2.4			5456	2692213027
PAYE__.APF	2.4	2.2.1.1	95/03/03	2424	1104323725
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PAZT__.OPF	2.4	2.3.1.1	95/12/14	4392	1923352446
PAZT__.PTF	2.4			5296	3132886115
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SF34__.OPF	2.4	2.3.1.2	95/12/14	4392	772116252
SF34__.PTF	2.4			5456	273007169
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SW3___.APF	2.4	2.2.1.1	95/03/03	2424	1487883665
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SW3___.PTF	2.4			5456	4022612319
TB20__.APF	2.4	2.2.1.2	95/05/18	2424	3434521749
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TB20__.PTF	2.4			5216	1305957397
TU34__.APF	2.4	2.3.1.1	95/11/09	2424	3930745030
TU34__.OPF	2.4	2.3.1.2	95/12/14	4392	2233947676
TU34__.PTF	2.4			5456	908017588

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File Name	Revision	Last Modification (revision	date)	Size (bytes)	Checksum
TU54__.APF	2.4	2.3.1.1	95/06/28	2424	3363806
TU54__.OPF	2.4	2.3.1.5	95/12/14	4392	3142116788
TU54__.PTF	2.4			5456	1560615875

APPENDIX B

BADA 2.4 - TAR FILE CONTENTS

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r--r--r-- 3095/3039   2424 Jan  4 13:16 1996 bada2.4/C560__.APF
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