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FOR THE SAFETY OF AIR NAVIGATION



EUROCONTROL EXPERIMENTAL CENTRE

**EQUIVALENCES REPORT FOR
THE BASE OF AIRCRAFT DATA (BADA)
REVISION 2.5**

EEC Note No. 30/96

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Originator: EEC - APO (Aircraft Performance and Operations)		Originator (Corporate Author) Name/Location: EUROCONTROL Experimental Centre B.P.15 F - 91222 Brétigny-sur-Orge CEDEX FRANCE Telephone : +33 1 69 88 75 00				
Sponsor: EEC		Sponsor (Contract Authority) Name/Location: EUROCONTROL Agency Rue de la Fusée, 96 B -1130 BRUXELLES Telephone : +32 2 729 9011				
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Abstract: The Base of Aircraft Data (BADA) provides a set of ASCII files containing performance and operating procedure coefficients for 69 different aircraft types. These are the so-called directly supported models. Besides these 69 aircraft models there are an additional 96 models that are considered to be equivalent to one of these directly supported models. This report gives an overview of the equivalences added to BADA since the release of the previous version of BADA (2.4).						

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EUROCONTROL Experimental Centre
Publications Office
B.P. 15
91222 - BRETIGNY-SUR-ORGE CEDEX
France

**Equivalences Report
for the
Base of Aircraft Data (BADA)
Revision 2.5**

EUROCONTROL Experimental Centre

Summary

The Base of Aircraft Data (BADA) provides a set of ASCII files containing performance and operating procedure coefficients for 69 different aircraft types. These are the so-called directly supported models. Besides these 69 aircraft models there are an additional 96 models that are considered to be equivalent to one of these directly supported models. This report gives an overview of the equivalences added to BADA since the release of the previous version of BADA (2.4).

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1. INTRODUCTION

1.1 Identification and Scope

This document presents an evaluation of new and modified aircraft equivalences for the Base of Aircraft Data (BADA) [RD1]. The aircraft equivalences covered in this document are for inclusion in BADA Revision 2.5. An overview of all existing equivalences can be found in the SYNONYM.LST/NEW files.

1.2 Organisation

This document is presented in three sections including Section 1, the Introduction. This first section includes a list of referenced documents and a glossary of acronyms.

The results of the equivalence analysis is summarised in Section 2 with the conclusions stated in Section 3.

Appendix A contains an aircraft equivalence report for each of the aircraft under consideration.

1.3 Referenced Documents

RD1 User Manual for the Base of Aircraft Data (BADA) Revision 2.4; EEC Note 5/96; February 1996.

RD2 Aircraft Type Designators 24th Edition, ICAO Doc 8643/24, January 1994

1.4 Acronyms

APO Centre for Aircraft Performance and Operations

BADA Base of Aircraft Data

EEC Eurocontrol Experimental Centre

ICAO International Civil Aviation Organisation

PTF Performance Table File

RD Referenced Document

2. AIRCRAFT EQUIVALENCES

2.1 New Equivalences

A total of 38 new equivalenced aircraft are proposed for BADA Revision 2.5. A summary list of these aircraft with their associated reference aircraft is given in Table 2-1 below.

Table 2-1: New Equivalence Aircraft for BADA 2.5

Equivalenced Aircraft	Referenced Aircraft (Directly Supported)
Learjet 31	Learjet 35
LET 410	Dornier D-228
Convair 580	ATR-72
Lockheed C-141 Starlifter	McDonnell Douglas DC-8S
Lockheed C-140 Jetstar	Canadair CL-600 Challenger
IAI 1124 Westwind	BAe 125
Rockwell Sabreliner 265	Dassault DA-20 Falcon
Mooney Mark 20	Aerospatiale TB-20 Trinidad
Mitsubishi MU-300	Cessna Citation II
Embrear E-110 Bandeirante	Dornier D-228
Cessna 425 Corsair/Conquest	Piper PA-31T Cheyenne II
Cessna Citationjet 525	Cessna Citation II
Cessna 310	Piper PA-31 Navajo
Beech 58 Baron	Piper PA-23 Aztec
Beech 36 Bonanza	Piper PA-34 Seneca
Boeing 720 B	Boeing 707 (1)
Fairchild Metro II/A	Fairchild Merlin IVC

Table 2-1: New Equivalence Aircraft for BADA 2.5 (continued)

Equivalenced Aircraft	Referenced Aircraft (Directly Supported)
Beech 1900	BAe 31 Jetstream
Shorts 330	Shorts 360
Gulfstream Jetprop Commander	Piper PA-42 Cheyenne III/IV
Cessna 414 Chancellor	Cessna 421 Golden Eagle
Beech 60 Duke	Cessna 421 Golden Eagle
Beech Bonanza 33	Piper PA-34 Seneca
Aerospatiale SN 601 Corvette	Cessna Citation II
Lockheed C-5 Galaxy	Boeing 747 (2)
Boeing KC-135R Stratotanker	Boeing 707 (3)
Cessna 303 Crusader	Piper PA-31 Navajo
Cessna Citation II/SP	Cessna Citation II (4)
A-10 Thunderbolt II, A-4 Skyhawk, A-6 Intuder, T-45 Goshawk, F-14 Tomcat, SAAB 105, SAAB 32 Lansen, SAAB 35 Draken, SAAB 37 Viggen, SAAB 39 Gripen	FGTR (5)

Note 1: No equivalence report was made for this aircraft. The match is based on an almost identical airframe/engine combination

Note 2: The C-5 is equivalenced with the B-747 since it is the heaviest model that is available. No equivalence report was made for this aircraft.

Note 3: An insufficient amount of information was available to establish an equivalence report this aircraft. The equivalence is based on the identical airframe

Note 4: The C551 is a special version of the C550. These two types are therefore equivalenced. No equivalence report was made for this aircraft.

Note 5: All military jet fighters are equivalenced with the generic fighter model (FGTR). Equivalence reports are not produced for these aircraft.

2.2 Modified Equivalences

One modified equivalence is proposed for BADA 2.5. This equivalent was modified from B747 to B74F in order to offer a higher maximum altitude to the B74S.

Table 2-2: Modified Equivalence Aircraft for BADA 2.5

Equivalenced Aircraft	Referenced Aircraft (Directly Supported)
B74S	B74F

2.3 Equivalence Data

In all, a total of 39 aircraft equivalences are evaluated with the results given in Appendix A. These summary reports compare the attributes of the equivalence and reference aircraft, that is:

- maximum take-off weight (MTOW);
- number and type of engines;
- service ceiling;
- maximum operating speed;
- maximum range;
- year of introduction (FAA certification or first flight); and,
- maximum rate of climb at sea level.

An equivalence is accepted when the average error between the equivalence and the reference aircraft for MTOW, ceiling, rate of climb at sea level, range and speed does not exceed 20 %. The speed can be given in Mach number or knots depending on the data that was available.

The sources for this information are Jane's All the World's Aircraft. In the source field only the volume of referenced Jane's is mentioned. For all data it is assumed that Source (1) is used unless indicated otherwise in the Aircraft Equivalence Reports in Appendix A. In those cases where a PTF file is mentioned as a reference source, it always concerns the 2.4 version of the file.

Table 2-3 and 2-4 summarise the difference in the attributes. Note that the percentage difference is calculated as the difference in values divided by the value of the reference aircraft. The aircraft models are identified through the use of their ICAO designators as found in RD2. The average percentage difference is the average for the MTOW, ceiling, maximum speed, maximum range and climb rate at sea level (if available).

Table 2-3: Percentage Differences for New Equivalences

Equiv. A/C	Ref. A/C	Weight	Ceiling	Speed	Range	Climb	avg.	max.
LR31	LR35	16	13	1	31	7	14	31
O410	D228	2	33	15	-	26	19	33
CV58	AT72	15	-	10	20	21	17	21
C141	DC8S	4	-	6	37	11	15	37
C140	CL60	1	7	1	20	9	7	20
WW24	HS25	5	10	1	45	17	16	45
N265	DA20	9	7	6	24	13	12	24
MO20	TB20	17	14	7	1	21	12	21
MU30	C550	10	5	4	4	8	6	10
E110	D228	4	24	1	2	13	9	24
C425	PAYE	9	10	4	3	25	10	25
C525	C550	25	5	1	10	-	10	25
C310	PA31	15	18	2	30	15	16	30
BE58	PAZT	4	6	12	20	21	13	21
BE36	PA34	21	7	9	12	24	15	24
SW4	SW3	0	14	17	14	13	12	17
BE02	BA31	8	0	2	6	12	6	12
SH33	SH36	17	-	12	18	22	17	22
GA84	PA42	0	9	13	7	25	11	25
C414	C421	9	2	9	11	22	11	22
BE60	C421	9	1	5	21	18	11	21
C303	PA31	21	4	5	2	21	10	21
BE33	PA34	28	20	7	8	17	16	28
S601	C550	9	5	4	18	20	11	20

Table 2-4: Percentage Differences for Modified Equivalences

Equiv. A/C	Ref. A/C	Weight	Ceiling	Speed	Range	Climb	avg.	max.
B74S	B74F	20	0.2	0.4	19	-	10	20

3. CONCLUSIONS

All of the 39 aircraft shown in Table 2.3 and Table 2.4 meet the acceptance criteria of 20 % for the average deviation in performance figures.

Thus, all 39 equivalences are suitable for insertion into BADA.

APPENDIX A

BADA 2.5

Aircraft Equivalence Reports

Aircraft Equivalence Report

Equivalence Aircraft: **LR31**

Reference Aircraft: **LR35**

Property	Equivalence Aircraft	Reference Aircraft	Difference (%)
Aircraft Name	Learjet 31	Learjet 35	
MTOW (kg)	7,000	8,300	16
Engines	2 jet	2 jet	
Ceiling (ft)	51,000	45,000	13
V _{MO} (kts)	463	460	1
Max Range (nm)	1660	2410	31
Year of Introduction	-	-	
max rate of climb at sea level (ft/min)	5480	5100	7
Source (1)	76/77	76/77	
Source (2)			

Aircraft Equivalence Report

Equivalence Aircraft: O410

Reference Aircraft: D228

Property	Equivalence Aircraft	Reference Aircraft	Difference (%)
Aircraft Name	LET 410	D228	
MTOW (kg)	5,800	5,700	2
Engines	2 turbo	2 turbo	
Ceiling (ft)	19,700	29,600	33
V _{MO} (kts)	197	233	15
Max Range (nm)	-	-	-
Year of Introduction	1969	-	
max rate of climb at sea level (ft/min)	1500	2050	26
Source (1)	82/83	82/83	
Source (2)			

Aircraft Equivalence Report

Equivalence Aircraft: **CV58**

Reference Aircraft: **AT72**

Property	Equivalence Aircraft	Reference Aircraft	Difference (%)
Aircraft Name	Convair 580	ATR-72	
MTOW (kg)	24,670	21500	15
Engines	2 turbo	2 turbo	
Ceiling (ft)	-	25,000	
V _{MO} (kts)	294	268	19
Max Range (nm)	2866	2370	21
Year of Introduction	1960	1988	
max rate of climb at sea level (ft/min)	2050 @ 5000ft	2600 @ 5000 ft (2)	21
Source (1)	68/69	91/92	
Source (2)		AT72__.PTF	

Aircraft Equivalence Report

Equivalence Aircraft: **C141**

Reference Aircraft: **DC8S**

Property	Equivalence Aircraft	Reference Aircraft	Difference (%)
Aircraft Name	C-141 Starlifter	DC-8-63/73CF	
MTOW (kg)	146,500	152,000	4
Engines	4 jet	4 jet	
Ceiling (ft)	-	42,500	
V _{MO} (kts)	492	521	6
Max Range (nm)	2550	4040	37
Year of Introduction	1979	1981	
max rate of climb at sea level (ft/min)	2920	3270 (2)	11
Source (1)	82/83	82/83	
Source (2)		DC8S__.PTF	

Aircraft Equivalence Report

Equivalence Aircraft: **C140**

Reference Aircraft: **CL60**

Property	Equivalence Aircraft	Reference Aircraft	Difference (%)
Aircraft Name	C-140 Jetstar	CL-600 Challenger	
MTOW (kg)	19,800	19,550	1
Engines	4 jet	2 jet	
Ceiling (ft)	38,000	41,000	7
V _{MO} (kts)	475	476	1
Max Range (nm)	2700	3400	20
Year of Introduction	1976	1991	
max rate of climb at sea level (ft/min)	4200	4600 (2)	9
Source (1)	76/77	91/92	
Source (2)		CL60__.PTF	

Aircraft Equivalence Report

Equivalence Aircraft: **WW24**

Reference Aircraft: **HS25**

Property	Equivalence Aircraft	Reference Aircraft	Difference (%)
Aircraft Name	IAI 1124	BAe 125	
MTOW (kg)	10,360	9,848	5
Engines	2 jet	2 jet	
Ceiling (ft)	45,000	41,000	10
M_{MO} (-)	0.765	0.755	1
Max Range (nm)	2400	1650	45
Year of Introduction	1976	64	
max rate of climb at sea level (ft/min)	4040	4900	17
Source (1)	76/77	76/77	
Source (2)			

Aircraft Equivalence Report

Equivalence Aircraft: **N265**

Reference Aircraft: **DA20**

Property	Equivalence Aircraft	Reference Aircraft	Difference (%)
Aircraft Name	Sabreliner 65	Falcon 20	
MTOW (kg)	10,886	12,000	9
Engines	2 jet	2 jet	
Ceiling (ft)	45,000	42,000	7
M_{MO} (-)	0.83	0.78	6
Max Range (nm)	2800	2250	24
Year of Introduction	1977	-	
max rate of climb at sea level (ft/min)	3450	4000 (2)	13
Source (1)	82/83	82/83	
Source (2)		INSTILUX Aircraft Performance Training Note 1982	

Aircraft Equivalence Report

Equivalence Aircraft: **MO20**

Reference Aircraft: **TB20**

Property	Equivalence Aircraft	Reference Aircraft	Difference (%)
Aircraft Name	Mooney Mk 20	TB-20 Trinidad	
MTOW (kg)	1160	1400	17
Engines	1 piston	1 piston	
Ceiling (ft)	17,200	20,000	14
V _{MO} (kts)	179	167	7
Max Range (nm)	1040	1030	1
Year of Introduction	1961	1981	
max rate of climb at sea level (ft/min)	1000	1260	21
Source (1)	68/69	91/92	
Source (2)			

Aircraft Equivalence Report

Equivalence Aircraft: **MU30**

Reference Aircraft: **C550**

Property	Equivalence Aircraft	Reference Aircraft	Difference (%)
Aircraft Name	MU-300 Diamond	Cessna Citation II	
MTOW (kg)	6,620	6,025	10
Engines	2 jet	2 jet	
Ceiling (ft)	41,000	43,000	5
M_{MO} (-)	0.73	0.70	4
Max Range (nm)	1520	1460	4
Year of Introduction	1979	1977	
max rate of climb at sea level (ft/min)	3100	3370	8
Source (1)	82/83	82/83	
Source (2)			

Aircraft Equivalence Report

Equivalence Aircraft: **E110**

Reference Aircraft: **D228**

Property	Equivalence Aircraft	Reference Aircraft	Difference (%)
Aircraft Name	Embrear 110 Bandeirante	Dornier 228	
MTOW (kg)	5,670	5,700	4
Engines	2 turbo	2 turbo	
Ceiling (ft)	22,500	29,600	24
V _{MO} (kts)	230	233	1
Max Range (nm)	1080	1063	2
Year of Introduction	1970	1982	
max rate of climb at sea level (ft/min)	1788	2050	13
Source (1)	82/83	82/83	
Source (2)			

Aircraft Equivalence Report

Equivalence Aircraft: **C425**

Reference Aircraft: **PAYE**

Property	Equivalence Aircraft	Reference Aircraft	Difference (%)
Aircraft Name	Cessna Corsair	Piper Cheyenne	
MTOW (kg)	3,720	4,082	9
Engines	2 turbo	2 turbo	
Ceiling (ft)	34,700	31,600	10
V _{MO} (kts)	264	275	4
Max Range (nm)	1370	1330	3
Year of Introduction	80	72	
max rate of climb at sea level (ft/min)	2027	2710	25
Source (1)	82/83	82/83	
Source (2)			

Aircraft Equivalence Report

Equivalence Aircraft: **C525**

Reference Aircraft: **C550**

Property	Equivalence Aircraft	Reference Aircraft	Difference (%)
Aircraft Name	Cessna Citationjet 525	Cessna Citation II	
MTOW (kg)	4,536	6,033	25
Engines	2 jet	2 jet	
Ceiling (ft)	41,000	43,000	5
M _{MO} (kts)	0.70	0.705	1
Max Range (nm)	1500	1662	10
Year of Introduction	1991	1977	
max rate of climb at sea level (ft/min)	-	3370	
Source (1)	91/92	91/92	
Source (2)			

Aircraft Equivalence Report

Equivalence Aircraft: **C310**

Reference Aircraft: **PA31**

Property	Equivalence Aircraft	Reference Aircraft	Difference (%)
Aircraft Name	Cessna 310	Piper Navajo	
MTOW (kg)	2,499	2,950	15
Engines	2 piston	2 piston	
Ceiling (ft)	19,750	24,000	18
V _{MO} (kts)	194	201	2
Max Range (nm)	1300	1011	30
Year of Introduction	1969	64	
max rate of climb at sea level (ft/min)	1662	1445	15
Source (1)	76/77	76/77	
Source (2)			

Aircraft Equivalence Report

Equivalence Aircraft: **BE58**

Reference Aircraft: **PAZT**

Property	Equivalence Aircraft	Reference Aircraft	Difference (%)
Aircraft Name	Beech Baron	Piper Aztec	
MTOW (kg)	2,449	2,360	4
Engines	2 piston	2 piston	
Ceiling (ft)	17,800	18,950	6
V _{MO} (kts)	210	187	12
Max Range (nm)	1050	1320	20
Year of Introduction	1969	1976	
max rate of climb at sea level (ft/min)	1694	1400	21
Source (1)	76/77	76/77	
Source (2)			

Aircraft Equivalence Report

Equivalence Aircraft: **BE36**

Reference Aircraft: **PA34**

Property	Equivalence Aircraft	Reference Aircraft	Difference (%)
Aircraft Name	Beech Bonanza	Piper Seneca	
MTOW (kg)	1633	2070	21
Engines	1 piston	2 piston	
Ceiling (ft)	16,000	15,000	7
V _{MO} (kts)	170	198	9
Max Range (nm)	770	877	12
Year of Introduction	1976	1971	
max rate of climb at sea level (ft/min)	1015	1340	24
Source (1)	76/77	76/77	
Source (2)			

Aircraft Equivalence Report

Equivalence Aircraft: **BE02**

Reference Aircraft: **BA31**

Property	Equivalence Aircraft	Reference Aircraft	Difference (%)
Aircraft Name	Beech 1900	BAe Jetstream	
MTOW (kg)	7,530	6,950	8
Engines	2 turbo	2 turbo	
Ceiling (ft)	25,000	25,000	0
V _{MO} (kts)	267	263	2
Max Range (nm)	1286	1209	6
Year of Introduction	1983	1984	
max rate of climb at sea level (ft/min)	2330	2080	12
Source (1)	88/89	88/89	
Source (2)			

Aircraft Equivalence Report

Equivalence Aircraft: **SH33**

Reference Aircraft: **SH36**

Property	Equivalence Aircraft	Reference Aircraft	Difference (%)
Aircraft Name	Shorts 330	Shorts 360	
MTOW (kg)	10,250	12,292	17
Engines	2 turbo	2 turbo	
Ceiling (ft)	-	-	-
V _{MO} (kts)	190	216	12
Max Range (nm)	750	636	18
Year of Introduction	1976	1982	
max rate of climb at sea level (ft/min)	1160	952	22
Source (1)	80/81	88/89	
Source (2)			

Aircraft Equivalence Report

Equivalence Aircraft: **GA84**

Reference Aircraft: **PA42**

Property	Equivalence Aircraft	Reference Aircraft	Difference (%)
Aircraft Name	Gulfstream Jetprop Commander	Piper Cheyenne III	
MTOW (kg)	5,080	5,080	0
Engines	2 turbo	2 turbo	
Ceiling (ft)	35,000	32,000	9
V _{MO} (kts)	252	290	13
Max Range (nm)	2080	2240	7
Year of Introduction	1981	1983	
max rate of climb at sea level (ft/min)	2802	2236	25
Source (1)	83/84	83/84	
Source (2)			

Aircraft Equivalence Report

Equivalence Aircraft: **C414**

Reference Aircraft: **C421**

Property	Equivalence Aircraft	Reference Aircraft	Difference (%)
Aircraft Name	Cessna Chancellor	Cessna Golden Eagle	
MTOW (kg)	3,062	3,379	9
Engines	2 piston	2 piston	
Ceiling (ft)	30,800	30,200	2
V _{MO} (kts)	235	258	9
Max Range (nm)	1327	1485	11
Year of Introduction	1978	1967	
max rate of climb at sea level (ft/min)	1520	1940	22
Source (1)	83/84	83/84	
Source (2)			

Aircraft Equivalence Report

Equivalence Aircraft: **BE60**

Reference Aircraft: **C421**

Property	Equivalence Aircraft	Reference Aircraft	Difference (%)
Aircraft Name	Beech 60 Duke	Cessna Golden Eagle	
MTOW (kg)	3,073	3,379	9
Engines	2 piston	2 piston	
Ceiling (ft)	30,000	30,200	1
V _{MO} (kts)	246	258	5
Max Range (nm)	1168	1485	21
Year of Introduction	1968	1967	
max rate of climb at sea level (ft/min)	1600	1940	18
Source (1)	83/84	83/84	
Source (2)			

Aircraft Equivalence Report

Equivalence Aircraft: **C303**

Reference Aircraft: **PA31**

Property	Equivalence Aircraft	Reference Aircraft	Difference (%)
Aircraft Name	Cessna Crusader	Piper Navajo	
MTOW (kg)	2,336	2,948	21
Engines	2 piston	2 piston	
Ceiling (ft)	25,000	24,000	4
V _{MO} (kts)	216	228	5
Max Range (nm)	1020	1040	2
Year of Introduction	1981	1964	
max rate of climb at sea level (ft/min)	1480	1220	21
Source (1)	83/84	83/84	
Source (2)			

Aircraft Equivalence Report

Equivalence Aircraft: **BE33**

Reference Aircraft: **PA34**

Property	Equivalence Aircraft	Reference Aircraft	Difference (%)
Aircraft Name	Beech Bonanza 33	Piper Seneca	
MTOW (kg)	1,542	2154	28
Engines	1 piston	2 piston	
Ceiling (ft)	18,000	15,000 (2)	20
V _{MO} (kts)	182	196	7
Max Range (nm)	824	900	8
Year of Introduction	1968	1971	
max rate of climb at sea level (ft/min)	1167	1400	17
Source (1)	80/81	83/84	
Source (2)		PA34__.PTF	

Aircraft Equivalence Report

Equivalence Aircraft: **S601**

Reference Aircraft: **C550**

Property	Equivalence Aircraft	Reference Aircraft	Difference (%)
Aircraft Name	SN 601 Corvette	Cessna Citation II	
MTOW (kg)	6,600	6,033	9
Engines	2 jet	2 jet	
Ceiling (ft)	41,000	43,000	5
V _{MO} (kts)	410	425	4
Max Range (nm)	1390	1700	18
Year of Introduction	1970	1976	
max rate of climb at sea level (ft/min)	2700	3370	20
Source (1)	77/78	83/84	
Source (2)			

Aircraft Equivalence Report

Equivalence Aircraft: **B74S**

Reference Aircraft: **B74F**

Property	Equivalence Aircraft	Reference Aircraft	Difference (%)
Aircraft Name	Boeing 747 SP	Boeing 747-400	
MTOW (kg)	315,700	394,625	20
Engines	4 jet	4 jet	
Ceiling (ft)	45,100	45,000 (2)	0.2
V _{MO} (kts)	529 @ FL300	527 @ FL300	0.4
Max Range (nm)	5850	7200	19
Year of Introduction	1976	1989	
max rate of climb at sea level (ft/min)	N/A	N/A	-
Source (1)	79/80	91/92	
Source (2)		Air France B747-400 Flight Manual	