CF6-80C2 fuel burn performance

The CF6-80C2 powers a large number of widebody aircraft types and variants. The fuel burn performance of the most popular types is examined.

The CF6-80C2 has several applications, which include the A300-600, A310, 767 family, 747-400 and MD-11 *(see CF6-80C2 series specifications, page 10)*. While there are up to 13 different variants of the -80C2, there are a few that dominate the fleet. Moreover, the fleet is dominated by several airframe-engine variant combinations: the A300-600 with -80C2A5, the A310 with the -80C2A2; the 767-200ER with the -80C2B6F; the 767-300ER with the -80C2B6F and -B7F; the 747-400 with the -80C2B1F; and the MD-11 with the -80C2D1F. The fuel burn performance of these airframe-engine combinations has been analysed on sample routes.

Aircraft analysed

There are several weight and fuel capacity specifications of each aircraft type with different variants of the CF6-80C2, but the weight and fuel capacity specifications of the aircraft analysed are summarised *(see table, page 17)*.

The A300-600 with the -A5 engine has been analysed with a maximum take-off weight (MTOW) of 375,900lbs and a fuel capacity of 16,124 USG. It has been analysed with a 260-seat configuration.

The A310-300 model analysed has an MTOW of 361,600lbs, a fuel capacity of 18,030USG and -80C2A2 engines *(see table, page 17)*. This is the highest gross weight and fuel capacity version of the A310-300. The aircraft has been analysed with 230 seats, which is typical of a European-style, two-class configuration.

The 767-200 and -300 models analysed are aircraft with MTOWs of 351,000lbs and 350,000lbs. Both have fuel capacities of 16,700USG, and are powered by the -B2F engine. The -200 has been analysed with 230 seats, and the -300 with 260 seats. This is typical for a two-class configuration.

The 767-200ER has an MTOW of 351,000lbs, a fuel capacity of 21,140USG and -80C2B6F engines. The aircraft has been analysed with 180 seats, typical of a tri-class configuration.

The 767-300ER has an MTOW of 412,000lbs, the highest gross weight version of the -300ER, and a fuel capacity of 21,140USG, and is equipped with -80C2B6F engines. It has been analysed with 215 and 260 seats, typical of tri- and two-class configurations.

The CF6-80C2B4, -B6, -B7 and -B8 variants power more than 400 767 family aircraft. The majority of these are the 767-300ER with B6, B6F and B7F engines.

The 747-400 has the highest MTOW available of 870,000lbs, a fuel capacity of 57,065USG, and is equipped with -B1F engines *(see table, page 17)*. It has been examined with a 390-seat configuration.

The passenger variant of the MD-11 has an MTOW of 630,500lbs, the highest available for the aircraft, a fuel capacity of 38,615USG, standard -D1F engines, and an interior layout of 298 seats.

Routes analysed

All airframe-engine combinations have been analysed on routes with lengths typical for their gross weight and range capability. The performance of each aircraft has been examined with a payload of a full complement of passengers. All routes used do not limit the aircraft's payload-carrying performance below its maximum capacity. Its performance has been examined in both directions on a route, to reveal the effect of head- and tailwinds, and its impact on fuel burn performance.

The low-weight and short-range aircraft, the A300-600R, 767-200 and 767-300, have been analysed on the intra-European route of Rome-Athens, which has a tracked distance of 600nm and a flight time of 90 minutes for most types. This route length is similar to many US and Japanese domestic city-pairs where many of these aircraft operate.

The A310-300 and 767-300ER with 260 seats have been analysed on Larnaca-Paris. This is typical of a medium-haul route, with a tracked distance of 1,650nm and flight time of close to four hours.

The 767-300ER and MD-11 with 215 seats have been examined on Copenhagen-Tokyo Narita, a typical long-haul route of about 5,000nm, with a flight time of nearly 11 hours.

The 747-400's performance has been examined on Auckland-Los Angeles, which has a tracked distance of about 5,700nm and flight time of 12-13 hours.

The performance of all aircraft has been examined using 85% annual winds for the month of June, a 20-minute taxi time for each leg and the long-range cruise speed for each aircraft type.

The standard weight for each passenger has been taken as 220lbs.

Aircraft fuel burns

As described, the aircraft have been analysed in groups, with two or three

FUEL BURN PERFORMANCE OF CF6-80C2 SERIES

City-pair variant	Aircraft	Engine model	MTOW lbs	Fuel capacity USG	Fuel burn USG	Flight time mins	Passenger payload	ESAD nm	Fuel per seat	Wind speed
Rome-Athens	A300-600R	CF6-80C2A5	375,900	16,124	2,400	87	260	601	9.23	+15
Rome-Athens	767-200	CF6-80C2B2F	351,000	16,700	2,012	92	230	601	8.75	+15
Rome-Athens	767-300	CF6-802C2B2F	350,000	16,700	2,197	91	260	601	8.45	+15
Athens-Rome	A300-600R	CF6-80C2A5	375,900	16,124	2,746	100	260	713	10.56	-57
Athens-Rome	767-200	CF6-80C2B2F	351,000	16,700	2,295	106	230	713	9.98	-57
Athens-Rome	767-300	CF6-80C2B2F	350,000	16,700	2,489	105	260	714	9.57	-57
Paris-Larnaca	A310-300	CF6-80C2A2	361,600	18,030	5,000	218	230	1,613	21.74	+9
Paris-Larnaca	767-300ER	CF6-80C2B6F	412,000	21,140	5,401	224	260	1,612	20.77	+9
Larnaca-Paris	A310-300	CF6-80C2A2	361,600	18,030	5,794	251	230	1,860	25.19	-56
Larnaca-Paris	767-300ER	CF6-80C2B6F	412,000	24,140	6,212	255	260	1,862	23.89	-56
Copenhagen-Tokyo	767-200ER	CF6-80C2B6F	351,500	20,400	14,950	675	180	5,101	83.06	-6
Copenhagen-Tokyo	767-300ER	CF6-80C2B6F	412,000	24,140	17,551	675	215	5,101	81.63	-6
Copenhagen-Tokyo	MD-11	CF6-80C2D1F	630,500	38,615	26,974	646	298	5,098	90.52	-6
Tokyo-Copenhagen	767-200ER	CF6-80C2B6F	351,500	20,400	15,598	688	180	5,214	86.66	-31
Tokyo-Copenhagen	767-300ER	CF6-80C2B6F	412,000	24,140	17,983	688	215	5,214	83.64	-31
Tokyo-Copenhagen	MD-11	CF6-80C2D1F	630,500	38,615	27,480	657	298	5,197	92.22	-31
Auckland-Los Angeles	747-400	CF6-80C2B1F	870,000	57,065	37,648	695	390	5,606	96.53	10
Los Angeles-Auckland	747-400	CF6-80C2B1F	870,000	57,065	43,612	764	390	6,189	111.83	-36

Source: Navtech

airframe-engine combinations being analysed on a specific city-pair that would be typical of airline deployment.

The A300-600R, 767-200 and 767-300 have been examined on Rome Fiumicino-Athens. Travelling eastwards to Athens, aircraft experience a 15-knot tailwind. The tracked distance is 623nm, and the tailwind reduces this to an equivalent still air distance (ESAD) of 601nm *(see table, this page)*. The 767-200/-300 have a flight time of 92 minutes, while the A300-600R is a little faster at 87 minutes. On this sector both 767 models burn similar amounts of fuel per passenger, with the -200 using just 0.30USG more. The A300-600R's fuel burn is 9.23USG per passenger.

In the westerly direction to Rome, a headwind of 57 knots increases the tracked distance by about 100nm to 713nm *(see table, this page)*, which increases the fuel required. The fuel burned per passenger is again similar for both 767 models: about 10USG in both cases. The A300-600R, by comparison, burns 10.56USG per passenger.

The A310-300 and 767-300ER are examined on Larnaca-Paris CDG, which is a medium-haul route of similar length to that on which many aircraft in this category are operated. In the easterly direction to Larnaca, the aircraft benefit from a small tailwind of nine knots *(see table, this page)*. This reduces the tracked distance of 1,645nm to an ESAD of 1,612nm. The A310-300's flight time is 218 minutes, while the 767-300ER is a little slower with 224 minutes. The 767-300ER is the larger of the two aircraft and so gains from this scale effect with a slight fuel burn advantage per passenger of about 1USG.

In the westerly direction the aircraft face a headwind of 46 knots, which increases the tracked distance by about 200nm to 1,860nm *(see table, this page)*. There is a small difference in flight times between the two, with the 767-300ER completing the flight in about four and a quarter hours. Again, the 767-300ER has the lower fuel burn per seat, being about 1.3USG less than the A310-300.

The 767-200ER, 767-300ER and MD-11 are examined on Copenhagen Kastrup-Tokyo Narita, a long-haul route within their full payload-range capability that allows all three to comfortably carry a full passenger load. This is a trans-Siberian routing, so the aircraft face a headwind when operating in both directions. However, this is small at just six knots when travelling east to Tokyo, increasing the tracked distance of 5,034nm to about 5,100nm. On this long sector the 767's relatively low cruise speed gives it a 30-minute longer flight time than the MD-11.

Despite having 83 more seats than the 767-300ER, the MD-11 has a poorer fuel burn performance per passenger because of the inefficiency of its three-engined design. The MD-11 has a fuel burn rate per seat of about nine USG more than the 767-300ER, equal to a higher cost of about $20 at current fuel prices.

In the westerly direction, the tailwind rises to 31 knots, increasing the tracked distance by about 350nm to 5,200nm. The MD-11 has a flight time of 11 hours, while that of the slower 767-300ER is 31 minutes longer at 11 hours and 28 minutes *(see table, this page)*.

Again, the MD-11 has a higher fuel burn per passenger of about nine USG over the route than the 767-300ER.

The 747-400 is examined on an ultra-long-haul route: Auckland-Los Angeles International. Flying to Los Angeles the aircraft has a small tailwind that reduces the ESAD to 100nm less than the tracked distance of 5,722nm. The headwind in the opposite direction increases the tracked distance by 460nm to an ESAD of 6,189nm, about 1,000nm longer than the ESAD of the Tokyo-Copenhagen route. Although the 747-400 is able to carry a full passenger load on Auckland-Los Angeles, its fuel burn performance is worse than the 767-300ER in terms of per available seat-mile, and is similar to the MD-11. This is due to the 747's four-engined design, which is heavier per seat than the twin-engined aircraft. AC