767 family fuel burn performance

The fuel burn performance of the most prominent 767 family members are analysed.

The 767 family comprises five main types: the 767-200, 767-200ER, 767-300, 767-300ER and 767-400ER. These types are also broadly split between those powered by General Electric (GE) engines and those powered by Pratt & Whitney (PW) engines. There are also several maximum take-off weight (MTOW) variants of each airframe-engine combination. When basic variant, engine type and weight specifications are taken into consideration, there are more than 20 different variants of the 767.

The 767-200ER and 767-300ER account for the majority of 767s in the fleet *(see 767 family fleet analysis, page 15)*, although the 767-200 and 767-400ER play significant roles. The fuel burn performance of the 767-200, -200ER, -300ER, -400ER, -200F and -300ERF is analysed.

767 variants

The 767-200 fleet comprises aircraft with MTOWs of 300,000lbs, 310,000lbs, 320,000lbs and 335,000lbs, as well as aircraft equipped with JT9D-7R4D and CF6-80A engines.

The 767-200ER proved popular with many airlines around the world for long-haul operations. Operators in Africa, Latin America, North America, the Asia Pacific and Europe regularly used the 767-200ER for routes of 4,500nm or more.

The 767-200ER fleet includes aircraft with MTOWs of 313,000lbs, 335,000lbs, 345,000lbs, 351,000lbs, 387,000lbs and 395,000lbs. Most of these aircraft have a fuel capacity of 24,140 US Gallons (USG) and many also have extended-range twin-engine operations (Etops) capability. The most popular engine types are the JT9D-7R4D/E, PW4056, CF6-80A2 and CF6-80C2B2/4.

The 767-300ER is mainly utilised on routes of 3,000-5,000nm. There are more than 500 active 767-300ERs in operation, and most aircraft in the fleet have MTOWs of 360,000lbs, 407,000lbs and 412,000lbs. The majority of aircraft are powered by PW4060 and CF6-80C2B2/4/6/7 engines.

The 767-400ER was introduced as a natural follow-on to the -300ER, with Boeing intending the aircraft to offer airlines similar range capability with extra seating capacity. However, the 767-400ER has had limited success, and Delta and Continental are its only operators. All aircraft have an MTOW of 450,000lbs and a fuel capacity of 24,140 USG, and are powered by CF6-80C2B7/8 engines.

A few 767-200s have been converted to freighter, and although the -200ER has additional fuel capacity this only gives the aircraft added range when payload is less than maximum *(see 767 modification & upgrade programmes, page 17)*. This means that the additional range of the -200ER is unlikely to be of use to most freight operators. The 767-300ERF will have an attractive payload-range performance and a large number of these are expected to be converted to freighters over the coming years.

Fuel burn performance

A Jeppesen flight planning system has been used to analyse the fuel burn performance of the 767-200, 767-200ER, 767-300ER and 767-400ER on routes that are representative of the type of operations on which these aircraft are utilised.

The fuel burn performance of the 767-200F and 767-300ERF has also been analysed on a medium- and long-haul route.

The 767-200 has been examined in a tri-class configuration of 176 seats on a route between Los Angeles International (LAX) and La Guardia, New York (LGA). This route has a tracked distance of 2,188nm. When flown in an easterly direction to LGA, the aircraft experiences a tailwind of 20 knots. This reduces the tracked distance from 2,188nm to an equivalent still air distance (ESAD) of 2,101nm *(see table, page 22)*. The aircraft faces a headwind of 50 knots when flying the other direction to LAX, and increases the distance to an ESAD of 2,424nm.

An average weight of 220lbs per passenger has been assumed, giving the aircraft a payload of 38,720lbs. The specification weights of the aircraft used are shown, and two variants with JT9D-7R4D and CF6-80A engines have been analysed. Both aircraft have an MTOW of 320,000lbs, an operating empty weight (OEW) of 181,000lbs, and a fuel capacity of 16,866 USG *(see table, this page)*.

The fuel burn performances of the 767-200ER, -300ER and -400ER have been analysed on a route between LAX and Stockholm Arlanda airport (ARN).

This route has a tracked distance of 4,899nm. Aircraft operating in a easterly direction from LAX to ARN have a small tailwind averaging 4 knots, which takes the ESAD down to 4,856nm *(see table, page 22)*. Operations in the other direction face a headwind of 14 knots, increasing the ESAD to 5,007nm.

The 767-200ER has been analysed with JT9D-7R4E and CF6-80A engines, MTOWs of 345,000lbs and 360,000lbs, an OEW of 181,000lbs, and a fuel capacity of 20,446 USG *(see table, this page)*. The aircraft has also been analysed with a full payload of 176 passengers.

The 767-300ER has been analysed with an MTOW of 409,000lbs and a fuel capacity of 24,140 USG. The two engine types considered are the PW4060 and

WEIGHT SPECIFICATIONS OF ANALYSED 767 VARIANTS

Aircraft type	MTOW lbs	MZFW lbs	OEW lbs	Payload lbs	Seats	Fuel USG	Engine model
767-200	320,000	248,000	181,000	67,000	176	16,866	JT9D-7R4D
767-200	320,000	250,000	181,000	69,000	176	16,866	CF6-80A
767-200ER	345,000	253,000	181,000	72,000	176	20,448	JT9D-7R4E
767-200ER	345,000	253,000	181,000	72,000	176	20,179	CF6-80C2B4
767-300ER	409,000	288,000	199,000	89,000	215	24,149	PW4060
767-300ER	409,000	287,450	202,400	85,050	215	24,149	CF6-80C2B6
767-400ER	450,000	330,000	226,500	103,500	243	25,192	CF6-80C2B8
767-200F	351,000	258,000	164,600	93,400	N/A	16,866	JT9D-7R4D
767-300ERF	407,000	295,000	183,000	112,000	N/A	24,149	PW4060

FUEL BURN PERFORMANCE OF 767-200, -300, -200ER, -300ER & -400ER

City-pair	Aircraft variant	MTOW lbs	Engine model	Fuel USG	Flight time	Passenger payload	Fuel USG per passenger	ESAD nm	Wind speed factor
LAX-LGA	767-200	320,000	JT9D-7R4D	6,282	4:47	176	35.6	2,101	+20
LAX-LGA	767-200	320,000	CF6-80A	6,343	4:48	176	36.0	2,101	+20
LGA-LAX	767-200	320,000	JT9D-7R4D	7,294	5:29	176	41.4	2,424	-50
LGA-LAX	767-200	320,000	CF6-80A	7,375	5:31	176	41.9	2,424	-50
LAX-ARN	767-200ER	345,000	JT9D-7R4E	15,713	10:36	176	89.3	4,855	+4
LAX-ARN	767-200ER	360,000	CF6-80C2	15,486	10:36	176	88.0	4,855	+4
LAX-ARN	767-300ER	409,000	PW4060	16,894	10:35	215	78.6	4,855	+4
LAX-ARN	767-300ER	409,000	CF6-80C2B6	16,633	10:34	215	77.4	4,855	+4
LAX-ARN	767-400ER	450,000	CF6-80C2B8	17,858	10:36	243	73.5	4,855	+4
ARN-LAX	767-200ER	345,000	JT9D-7R4E	16,993	11:17	176	96.6	5,157	-14
ARN-LAX	767-200ER	360,000	CF6-80C2	16,124	11:17	176	91.6	5,157	-14
ARN-LAX	767-300ER	409,000	PW4060	18,054	11:18	215	84.0	5,157	-14
ARN-LAX	767-300ER	409,000	CF6-80C2B6	17,803	11:19	215	82.8	5,157	-14
ARN-LAX	767-400ER	450,000	CF6-80C2B8	18,784	11:18	243	77.3	5,157	-14

Source: Jeppesen

FUEL BURN PERFORMANCE OF 767-200F & -300ERF

City-pair	Aircraft variant	MTOW lbs	Engine model	Fuel USG	Flight time	Freight payload lbs	Fuel USG per ton-mile	ESAD nm	Wind speed factor
BOG-MIA	767-200F	351,000	JT9D-7R4D	5,033	3:12	93,400	0.09	1,406	-18
MIA-BOG	767-200F	351,000	JT9D-7R4D	4,969	3:07	93,400	0.09	1,361	-8
LHR-NBO	767-300ERF	407,000	PW4060	14,951	8:24	97,391	0.09	3,826	-4
NBO-LHR	767-300ERF	407,000	PW4060	15,864	8:46	100,989	0.09	4,013	-31

CF6-80C2B6. These aircraft have OEWs of 199,000lbs and 202,400lbs *(see table, this page)*. The aircraft has been analysed with 215 seats and a full payload.

The 767-400ER, equipped with CF6-80C2B8 engines, has an MTOW of 450,000lbs, an OEW of 226,500lbs and a fuel capacity of 25,192 USG *(see table, page 21)*. The aircraft has been analysed with 243 seats and a full payload.

The 767-200F has been analysed in both directions on Bogota-Miami as representative of a medium-haul route. The aircraft is powered by JT9D-7R4D engines, with an MTOW of 351,000lbs, an OEW of 164,600lbs, and a maximum zero fuel weight (MZFW) of 258,000lbs. It has a fuel capacity of 16,700 USG and a gross structural payload of 93,400lbs.

The 767-300ERF has been analysed on London-Nairobi, and has an MTOW of 407,000lbs, an OEW of 183,000lbs, an MZFW of 295,000lbs, and a fuel capacity of 24,140 USG. It is powered by PW4060 engines and has a gross structural payload of 112,000lbs.

The performance of all aircraft has been analysed with a long-range cruise speed of Mach 0.80, annual 85% winds and a taxi time of 20 minutes.

Fuel burn results

The two passenger variants of the 767-200 with JT9D-7R4D and CF6-80A engines have almost identical fuel burn, which implies that there is little economic difference between these two variants. This indicates that the 767-200 equipped with either engine type would make a suitable candidate for freighter conversion. The only probable difference between the two types would be engine-related maintenance costs.

The 767-200ER on the LAX-ARN route burns more fuel than the CF6-80C2-powered aircraft, which is more noticeable on the easterly routeing against a small headwind. The small fuel burn advantage of the CF6-80C2-powered aircraft is, however, unlikely to provide an advantage over aircraft equipped with JT9D-7R4 engines when conversion to freighter is taken into consideration.

There are small differences in the performance of the two 767-300ER variants. The difference in fuel burn per passenger is a maximum of 1 USG *(see table, this page)*, which indicates that both engine types will have almost identical fuel burns for the same operating conditions and payloads.

There is, however, a significant difference in fuel burn performance between the 767-300ER and smaller -200ER. The -200ER burns 10-11 USG more than its -300ER counterpart in both directions on the route analysed *(see table, this page)*. This is equal to an additional cost of $20 per seat at current fuel prices, which clearly illustrates the economic advantage of the -300ER. The -300ER is also likely to have similar, or possibly lower, maintenance costs compared to the -200ER. The -200ER is likely to have lower lease rentals than the -300ER, however.

The 767-400ER is marginally more fuel efficient than the -300ER, with the -400ER burning 4-5 USG less per passenger (equal to about 5%). This is equivalent to a cost saving of about $10 per seat on a one-way sector, which is a significant difference when passenger yields are considered. The small number of 767-400ERs in operation reduces the significance of its fuel burn advantage, however.

The 767-200F is able to carry a full payload in both directions on the Bogota-Miami route *(see table, this page)*. The northerly direction has an ESAD of 1,406nm. The 767-300ERF, however, has payload restrictions of about 3,500lbs on the southerly direction of London-Nairobi, and a payload restriction of about 11,000lbs operating in the other direction. In all cases, both the 767-200F and 767-300ERF have a fuel burn of 0.09 USG per available ton-mile *(see table, this page)*. AC