The Boeing 777 is a wide-body airliner developed and manufactured by Boeing Commercial Airplanes, commonly referred to as the *Triple Seven*. The 777 was designed to bridge the gap between Boeing's 767 and 747, and to replace older DC-10s or L-1011s. Developed in consultation with eight major airlines, with a first meeting in January 1990, the program was launched on October 14, 1990 with a first order from United Airlines. The prototype was rolled out on April 9, 1994, and first flew on June 12, 1994. The 777 first entered commercial service with United Airlines on June 7, 1995. Longer range variants were launched on February 29, 2000 and were first delivered on April 29, 2004.

It is the largest twinjet and has a typical 3-class capacity of 301 to 368 passengers, with a range of 5,240 to 8,555 nautical miles (9,704 to 15,844 km). It is recognizable for its large-diameter turbofan engines, six wheels on each main landing gear, fully circular fuselage cross-section, and a blade-shaped tail cone. It has fly-by-wire controls, a first for Boeing. It competed initially with the out-of-production Airbus A340 and McDonnell Douglas MD-11, with the Airbus A330-300 and newer Airbus A350 XWB. The original 777 with a maximum takeoff weight (MTOW) of 545,000–660,000 lb (247–299 t) was produced in two fuselage lengths: the initial -200 was followed by the extended-range 777-200ER in 1997; and the 33.25 ft (10.13 m) longer 777-300 in 1998. Those 777 Classics were powered with 77,200–98,000 lbf (343–436 kN) General Electric GE90, Pratt & Whitney PW4000, or Rolls-Royce Trent 800 engines. The longer range 777-300ER and a MTOW of 766,000–775,000 lb (347–352 t) entered service in 2004, the ultra long-range 777-300LR in 2006, and the 777F freighter in 2009. These long haul variants feature 110,000–115,300 lbf (489–513 kN) GE90 engines and extended raked wingtips. In November 2013, Boeing announced the 777X development with the -8 and -9 variants, scheduled to enter service by 2020. The 777X features composite wings with folding wingtips and General Electric GE9X engines.

The 777 has received more orders than any other wide-body airliner; as of August 2019, more than 60 customers had placed orders for 2,049 aircraft of all variants, with 1,609 delivered. The most common and successful variant is the 777-300ER with 810 delivered and 844 orders. As of July 2018, Emirates was the largest operator with 163 aircraft. By March 2018, the 777 had become the most-produced Boeing wide-body jet, surpassing the Boeing 747.

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Development

Background

In the early 1970s, the Boeing 747, McDonnell Douglas DC-10, and the Lockheed L-1011 TriStar became the first generation of wide-body passenger airliners to enter service.[35] In 1978, Boeing unveiled three new models: the twin-engine Boeing 757 to replace its 727, the twin-engine 767 to challenge the Airbus A300, and a trijet 777 concept to compete with the DC-10 and L-1011.[16][17][18] The mid-size 757 and 767 launched to market success, due in part to 1980s’ extended-range twin-engine operational performance standards (ETOPS) regulations governing transoceanic twinjet operations.[19] These regulations allowed twin-engine airliners to make ocean crossings at up to three hours’ distance from emergency diversionary airports.[20] Under ETOPS rules, airlines began operating the 767 on long-distance overseas routes that did not require the capacity of larger airliners.[19] The trijet 777 was later dropped, following marketing studies that favored the 757 and 767 variants.[21]

Boeing was left with a size and range gap in its product line between the 767-300ER and the 747-400.[22] By the late 1980s, DC-10 and L-1011 models were approaching retirement age, prompting manufacturers to develop replacement designs.[23] McDonnell Douglas was working on the MD-11, a stretched and upgraded successor of the DC-10,[23] while Airbus was developing its A330 and A340 series.[24] In 1986, Boeing unveiled proposals for an enlarged 767, tentatively named 767-X,[24] to target the replacement market for first-generation wide-bodies such as the DC-10,[20] and to complement existing 767 and 747 models in the company lineup.[25] The initial proposal featured a longer fuselage and larger wings than the existing 767.[24]along with winglets.[26] Later plans expanded the fuselage cross-section but retained the existing 767 flight deck, nose, and other elements.[24]

Airline customers were uninterested in the 767-X proposals, and instead wanted an even wider fuselage cross-section, fully flexible interior configurations, short-to intercontinental-range capability, and an operating cost lower than that of any 767 stretch.[20] Airline planners’ requirements for larger aircraft had become increasingly specific, adding to the heightened competition among aircraft manufacturers.[23] By 1988, Boeing realized that the only answer was a new clean-sheet design, which became the 777 twin-jet.[27] The company opted for the twin-engine configuration given past design successes, projected engine developments, and reduced-cost benefits.[28] On December 8, 1989, Boeing began issuing offers to airlines for the 777.[24]

Design effort

Alan Mulally served as the Boeing 777 program’s director of engineering, and then was promoted in September 1992 to lead it as vice-president and general manager.[29][30] The design phase for the new twinjet was different from Boeing’s previous commercial jetliners. For the first time, eight major airlines – All Nippon Airways, American Airlines, British Airways, Cathay Pacific, Delta Air Lines, Japan Airlines, Qantas, and United Airlines – had a role in the development.[31] This was a departure from industry practice, where manufacturers typically designed aircraft with minimal customer input.[32] The eight airlines that contributed to the design process became known within Boeing as the “Working Together” group.[31] At the first group meeting in January 1990, a 23-page questionnaire was distributed to the airlines, asking what each wanted in the design.[20] By March 1990, Boeing and the airlines had decided upon a basic design configuration: a cabin cross-section close to the 747’s, capacity up to 325 passengers, flexible interiors, a glass cockpit, fly-by-wire controls, and 10 percent better seat-mile costs than the A330 and MD-11.[20] Boeing selected its Everett factory in Washington, home of 747 production, as the 777’s final assembly site.[33]

On October 14, 1990, United Airlines became the 777’s launch customer when it placed an order for 34 Pratt & Whitney-powered aircraft valued at US$11 billion with options on an additional 34.[34][35] The development phase coincided with United’s replacement program for its aging DC-10s.[36] United required that the new aircraft be capable of flying three different routes: Chicago to Hawaii, Chicago to Europe, and non-stop from Denver, a hot and high airport, to Hawaii.[36] ETOPS certification was also a priority for United.[37] given the overwater portion of United’s Hawaii routes.[34] In January 1993, a team of United developers joined other airline teams and Boeing designers at the Everett factory.[38] The 240 design teams, with up to 40 members each, addressed almost 1,500 design issues with individual aircraft components.[39] The fuselage diameter was increased to suit Cathay Pacific, the baseline model grew longer for All Nippon Airways, and British Airways’ input led to added built-in testing and interior flexibility,[20] along with higher operating weight options.[40]

The 777 was the first commercial aircraft designed entirely by computer.[20][34][41] Each design drawing was created on a three-dimensional CAD software system known as CATIA, sourced from Dassault Systemes and IBM.[42] This lets engineers assemble a virtual aircraft, in simulation, to check for interference and verify that the thousands of parts fit properly—thus reducing costly rework.[43] Boeing developed its high-performance visualization system, FlyThru, later called IVT (Integrated Visualization Tool) to support large-scale collaborative engineering design reviews, production illustrations, and other uses of the CAD data outside of...
engineering.\[44\] Boeing was initially not convinced of CATIA's abilities and built a physical mock-up of the nose section to verify its results. The test was so successful that additional mock-ups were canceled.\[45\] The 777 “was completed with such precision that it was the first Boeing jet that didn’t need its kinks worked out on an expensive physical mock-up plane”, which contrasted sharply with the development of Boeing’s next new airliner, the 787.\[46\]

### Into production and testing

The production process included substantial international content, an unprecedented level of global subcontracting for a Boeing jetliner.\[47\] later exceeded by the 787.\[48\] International contributors included Mitsubishi Heavy Industries and Kawasaki Heavy Industries (fuselage panels),\[49\] Fuji Heavy Industries, Ltd. (center wing section),\[49\] Hawker de Havilland (elevators), and Aerospace Technologies of Australia (rudder).\[50\] An agreement between Boeing and the Japan Aircraft Development Corporation, representing Japanese aerospace contractors, made the latter risk-sharing partners for 20 percent of the entire development program.\[47\] The initial 777-200 model was launched with propulsion options from three manufacturers, General Electric, Pratt & Whitney, and Rolls-Royce,\[51\] giving the airlines their choice of engines from competing firms.\[52\] Each manufacturer agreed to develop an engine in the 77,000 lb (340 kN) and higher thrust class (a measure of jet engine output) for the world’s largest twinjet.\[51\]

To accommodate production of its new airliner, Boeing doubled the size of the Everett factory at the cost of nearly US$1.5 billion\[34\] to provide space for two new assembly lines.\[56\] New production methodologies were developed, including a turn machine that could rotate fuselage subassemblies 180 degrees, giving workers access to upper body sections.\[42\] Major assembly of the first aircraft began on January 4, 1993.\[53\] By the start of production, the program had amassed 118 firm orders, with options for 95 more from 10 airlines.\[54\] Total investment in the program was estimated at over US$4 billion from Boeing, with an additional US$2 billion from suppliers.\[55\]

On April 9, 1994, the first 777, line number WA001, was rolled out in a series of 15 ceremonies held during the day to accommodate 100,000 invited guests.\[56\] The first flight took place on June 12, 1994,\[57\] under the command of chief test pilot John E. Cashman.\[58\] This marked the start of an 11-month flight test program that was more extensive than testing for any previous Boeing model.\[59\] Nine aircraft fitted with General Electric, Pratt & Whitney, and Rolls-Royce engines\[57\] were flight tested at locations ranging from the desert airfield at Edwards Air Force Base in California to frigid conditions in Alaska, mainly Fairbanks International Airport.\[61\] To satisfy ETOPS requirements, eight 180-minute single-engine test flights were performed.\[62\] The first aircraft built was used by Boeing’s nondestructive testing campaign from 1994 to 1996, and provided data for the -200ER and -300 programs.\[63\] At the successful conclusion of flight testing, the 777 was awarded simultaneous airworthiness certification by the U.S. Federal Aviation Administration (FAA) and European Joint Aviation Authorities (JAA) on April 19, 1995.\[57\]

### Entry into service

Boeing delivered the first 777 to United Airlines on May 15, 1995.\[64\][65\] The FAA awarded 180-minute ETOPS clearance (“ETOPS-180”) for the Pratt & Whitney PW4084-engined aircraft on May 30, 1995, making it the first airliner to carry an ETOPS-180 rating at its entry into service.\[66\] The first commercial flight took place on June 7, 1995, from London Heathrow Airport to Dulles International Airport near Washington, D.C.\[67\] Longer ETOPS clearance of 207 minutes was approved in October 1996.\[68\]

On November 12, 1995, Boeing delivered the first model with General Electric GE90-77B engines to British Airways,\[69\] which entered service five days later.\[70\] Initial service was affected by gearbox bearing wear issues, which caused British Airways to temporarily withdraw its 777 fleet from transatlantic service in 1997,\[70\] returning to full service later that year.\[69\] General Electric subsequently announced engine upgrades.\[86\]

The first Rolls-Royce Trent 877-powered aircraft was delivered to Thai Airways International on March 31, 1996,\[69\] completing the introduction of the three powerplants initially developed for the airliner.\[71\] Each engine-aircraft combination had secured ETOPS-180 certification from the point of entry into service.\[72\] By June 1997, orders for the 777 numbered 323 from 25 airlines, including satisfied launch customers that had ordered additional aircraft.\[77\] Operations performance data established the consistent capabilities of the twinjet over long-haul transoceanic routes, leading to additional sales.\[73\] By 1998, the 777 fleet had approached 900,000 flight hours.\[74\] Boeing states that the 777 fleet has a dispatch reliability (rate of departure from the gate with no more than 15 minutes delay due to technical issues) above 99 percent.\[75\][76][77][78]

### Initial derivatives

After the original model, Boeing developed an increased gross weight variant of the 777-200 with greater range and payload capability.\[79\] Initially named 777-200IGW,\[80\] the 777-200ER first flew on October 7, 1996.\[81\] received FAA and JAA certification on January 17, 1997,\[82\] and entered service with British Airways on February 9, 1997.\[82\] Offering greater long-haul performance, the variant became the most widely ordered version of the aircraft through the early 2000s.\[79\]
On April 2, 1997, a Malaysia Airlines 777-200ER named “Super Ranger” broke the great circle "distance without landing" record for an airliner by flying eastward from Boeing Field, Seattle to Kuala Lumpur, a distance of 10,823 nautical miles (20,044 km; 12,455 mi), in 21 hours and 23 minutes.\[74\]

Following the introduction of the -200ER, Boeing turned its attention to a stretched version of the airliner. On October 16, 1997, the 777-300 made its first flight.\[81\] At 242.4 ft (73.9 m) in length, the -300 became the longest airliner yet produced (until the A340-600), and had a 20 percent greater overall capacity than the standard length model.\[81\] The -300 was awarded type certification simultaneously from the FAA and JAA on May 4, 1998,\[84\] and entered service with launch customer Cathay Pacific on May 27, 1998.\[81\][85]

The first generation of Boeing 777 models, the -200, -200ER, and -300 have since been known collectively as Boeing 777 Classics.\[9\]

### Second generation models

From the program's start, Boeing had considered building ultra-long-range variants\[86\] Early plans centered on a 777-100X proposal,\[87\] a shortened variant of the -200 with reduced weight and increased range,\[87\] similar to the 747SP.\[88\] However, the -100X would have carried fewer passengers than the -200 while having similar operating costs, leading to a higher cost per seat.\[87\][88] By the late 1990s, design plans shifted to longer-range versions of existing models.\[87\]

In March 1997, the Boeing board approved the 777-200X/300X specifications: 298 passengers in three classes over 8,600 nmi (15,900 km) for the 200X and 6,600 nmi (12,200 km) with 355 passengers in a tri-class layout for the 300X, with design freeze planned in May 1998, 200X certification in August 2000, and introduction in September and in January 2001 for the 300X. The 1.37 m (4 ft 6 in) wider wings was to be strengthened and the fuel capacity enlarged, and it was to be powered by simple derivatives with similar fans. GE was proposing a 454 kN (102,000 lbf) GE90-102B, while P&W offered its 436 kN (98,000 lbf) PW4098 and R-R was proposing a 437 kN (98,000 lbf) Trent 8100.\[89\] Rolls-Royce was also studying a Trent 8102 over 445 kN (100,000 lbf).\[90\] Boeing was studying a semi-levered, articulated main gear to help the take-off rotation of the proposed -300X, with its higher 324,600 kg (715,600 lb) MTOW\[91\] by January 1999, its MTOW grew to 340,500 kg (750,000 lb), and thrust requirements increased to 110,000–114,000 lbf (490–510 kN).\[92\]

A more powerful engine in the thrust class of 100,000 lbf (440 kN) was required, leading to talks between Boeing and engine manufacturers. General Electric offered to develop the GE90-115B engine,\[52\] while Rolls-Royce proposed developing the Trent 8104 engine.\[93\] In 1999, Boeing announced an agreement with General Electric, beating out rival proposals.\[52\] Under the deal with General Electric, Boeing agreed to only offer GE90 engines on new 777 versions.\[52\]

On February 29, 2000, Boeing launched its next-generation twinjet program,\[94\] initially called 777-X,\[86\] and began issuing offers to airlines.\[79\] Development was slowed by an industry downturn during the early 2000s.\[86\] The first model to emerge from the program, the 777-300ER, was launched with an order for ten aircraft from Air France,\[95\] along with additional commitments.\[79\] On February 24, 2003, the -300ER made its first flight, and the FAA and EASA (European Aviation Safety Agency, successor to the JAA) certified the model on March 16, 2004.\[96\] The first delivery to Air France took place on April 29, 2004.\[83\] The -300ER, which combined the -300’s added capacity with the -200ER’s range, became the top-selling 777 variant in the late 2000s,\[97\] benefitting as airlines replaced comparable four-engine models with twinjets for their lower operating costs.\[98\]

The second long-range model, the 777-200LR, rolled out on February 15, 2005, and completed its first flight on March 8, 2005.\[81\] The -200LR was certified by both the FAA and EASA on February 2, 2006,\[99\] and the first delivery to Pakistan International Airlines occurred on February 26, 2006.\[100\] On November 10, 2005, the first -200LR set a record for the longest non-stop flight of a passenger airliner by flying 11,664 nautical miles (21,602 km) eastward from Hong Kong to London.\[101\] Lasting 22 hours and 42 minutes, the flight surpassed the -200LR’s standard design range and was logged in the Guinness World Records.\[102\]

The production freighter model, the 777F, rolled out on May 23, 2008.\[103\] The maiden flight of the 777F, which used the structural design and engine specifications of the -200LR\[104\] along with fuel tanks derived from the -300ER, occurred on July 14, 2008.\[105\] FAA and EASA type certification for the freighter was received on February 6, 2009,\[106\] and the first delivery to launch customer Air France took place on February 19, 2009.\[107\][108]

### Production developments and 777X

Initially second to the 747 as Boeing's most profitable jetliner,\[109\] the 777 became the company's most lucrative model in the 2000s.\[109\] Program sales accounted for an estimated US$400 million of Boeing's pretax earnings in 2000, US$50 million more than the 747.\[109\] By 2004, the airliner accounted for the bulk of wide-body revenues for the Boeing Commercial Airplanes division.\[111\] In 2007, orders for second-generation 777 models approached 350 aircraft,\[112\] and in November of that year, Boeing announced that all production slots were sold out to 2012.\[98\] The program backlog of 356 orders was valued at US$95 billion at list prices in 2008.\[113\]

In 2010, Boeing announced plans to increase production from 5 aircraft per month to 7 aircraft per month by mid-2011, and 8.3 per month by early 2013.\[114\] Complete assembly of each 777-300ER requires 49 days.\[115\] The smaller Boeing 787 Dreamliner, the first stage of a replacement aircraft initiative called the Boeing Yellowstone Project,\[116\] entered service in 2011. Reportedly, the 777 could eventually be replaced by a new aircraft family, Yellowstone 3, which would draw upon technologies from the 787.\[112\] In November 2011, assembly began on the 1,000th 777, a -300ER model for Emirates,\[115\] which was rolled out in March 2012.\[117\]
By the late 2000s, the 777 was facing increased potential competition from Airbus’ planned A350 XWB and internally from proposed 787 variants[112] that offered fuel efficiency improvements. As a consequence, the 777-300ER received an engine and aerodynamics improvement package for reduced drag and weight.[118] In 2010, the variant further received a 5,000 lb (2,300 kg) maximum zero-fuel weight increase, equivalent to a higher payload of 20–25 passengers; its GE90-115B1 engines received a 1–2.5 percent thrust enhancement for increased takeoff weights at higher-altitude airports.[118] More changes were targeted for late 2012, including possible extension of the wingspan,[118] along with other major changes, including a composite wing, new powerplant, and different fuselage lengths.[118][119][120] Emirates was reportedly working closely with Boeing on the project, in conjunction with being a potential launch customer for new 777 versions.[121] Among customers for the aircraft during this period, China Airlines ordered ten 777-300ER aircraft to replace 747-400s on long-haul transpacific routes (with the first of those aircraft entering service in 2015), noting that the 777-300ER’s per seat cost is about 20% lower than the 747’s costs (varying due to fuel prices).[122]

In November 2013, with orders and commitments totaling 259 aircraft from Lufthansa, Emirates, Qatar Airways, and Etihad Airways, Boeing formally launched the 777X program, the third generation of the 777 (not to be confused with the 777-X variants, which were the second generation of the aircraft), with two models: the 777-8 and 777-9.[123] The 777-9 was to be a further stretched variant with a capacity of over 400 passengers and a range of over 15,200 km (8,200 nmi), whereas the 777-8 was slated to seat approximately 350 passengers and have a range of over 17,200 km (9,300 nmi).[123] Both models were to be equipped with new generation GE9X engines and feature new composite wings with folding wingtips. The first member of the 777X family, the 777-9, was set to enter service by 2020. By the mid-2010s, the 777 had become prevalent on the longest flights internationally and had become the most widely used airliner for transpacific routes, with variants of the type operating half of all scheduled flights and with the majority of transpacific carriers.[124][125]

By April 2014, with cumulative sales surpassing those of the 747, the 777 became the best-selling wide-body airliner; at existing production rates, the aircraft was on track to become the most-delivered wide-body airliner by mid-2015.[126] As of February 2015, the backlog of undelivered 777s totaled 278 aircraft, representing just under three years of current production at 8.3 aircraft per month,[127] causing Boeing to ponder the 2018–2020 time frame. In January 2016, Boeing confirmed plans to reduce the production rate of the 777 family from 8.3 per month to 7 per month in 2017 to help close the production gap between the 777 and 777X created by a lack of new orders.[128] In 2018, assembling test 777-9 aircraft was expected to lower output to an effective rate of 5.5 per month.[129] Boeing was expected to drop 777 production to five per month in August 2017.[130]

### Updates and improvements

In tandem with the development of the third generation Boeing 777X, Boeing worked with General Electric to offer a 2% improvement in fuel efficiency to in-production 777-300ER aircraft. General Electric improved the fan module and the high-pressure compressor stage-1 blisk in the GE-90-115B1, as well as reduced clearances between the tips of the turbine blades and the shroud during cruise. These improvements, of which the latter is the most important and was derived from work to develop the 787, were stated by GE to lower fuel burn by 0.5%. Boeing’s wing modifications were intended to deliver the remainder. Boeing stated that every 1% improvement in the 777-300ER’s fuel burn translates into being able to fly the airplane another 75 nmi (139 km; 86 mi) on the same load of fuel, or add ten passengers or 2,400 lb (1,100 kg) of cargo to a “load limited” flight.[131]

In March 2015, additional details of the improvement package were unveiled. The 777-300ER was to shed 1,800 lb (820 kg) by replacing the fuselage crown with new carbon-fiber structures, new winglets, extended slats, and new powerplants. In addition, Boeing announced that new flight control software was to eliminate the need for the tail skid by keeping the tail off the runway surface regardless of the extent to which pilots command the elevators. Boeing was also redesigning the inboard flap fairings to reduce drag by reducing pressure on the underside of the wing. The outboard raked wingtip was to have a divergent trailing edge, described as a “poor man’s airfoil” by Boeing; this was originally developed for the McDonnell Douglas MD-12 project. Another change involved elevator trim bias. These changes were to increase fuel efficiency and allow airlines to add 14 additional seats to the airplane, increasing per seat fuel efficiency by 5%.[132]

Mindful of the long time required to bring the 777X to the market, Boeing continued to develop improvement packages which improve fuel efficiency, as well as lower prices for the existing product. In January 2015, United Airlines ordered ten 777-300ERs, normally costing around US$150 million each but paid around US$130 million, a discount to bridge the production gap to the 777X. As of December 2015, the backlog of undelivered 777s totaled 278 aircraft, representing just under three years of current production at 8.3 aircraft per month, causing Boeing to ponder the 2018–2020 time frame. In January 2016, Boeing confirmed plans to reduce the production rate of the 777 family from 8.3 per month to 7 per month in 2017 to help close the production gap between the 777 and 777X created by a lack of new orders.[128] In 2018, assembling test 777-9 aircraft was expected to lower output to an effective rate of 5.5 per month.[129] Boeing was expected to drop 777 production to five per month in August 2017.[130]

As of 2019, Boeing lists prices for the 777-200ER, -200LR, 777F, -300ER, 777-8, and 777-9 variants. The -200ER is the only Classic variant remaining available.[4]

### Design

Boeing introduced a number of advanced technologies with the 777 design, including fully digital fly-by-wire controls,[133] fully software-configurable avionics, Honeywell LCD glass cockpit flight displays,[136] and the first use of a fiber optic avionics network on a commercial airliner.[137] Boeing made use of work done on the cancelled Boeing 7J7 regional jet,[138] which utilized similar versions of the chosen technologies.[138] In 2003, Boeing began offering the option of cockpit electronic flight bag computer displays.[139] In 2013, Boeing announced that the upgraded 777X models would incorporate airframe, systems, and interior technologies from the 787.[140]

#### Fly-by-wire

In designing the 777 as its first fly-by-wire commercial aircraft, Boeing decided to retain conventional control yokes rather than change to sidestick controllers as used in many fly-by-wire fighter aircraft and in many Airbus airliners.[133] Along with traditional yoke and rudder controls, the cockpit features a simplified layout that retains similarities to previous Boeing models.[141] The fly-by-wire system also incorporates flight envelope protection, a system that guides pilot inputs within a computer-calculated framework of operating parameters, acting to prevent stalls, overspeeds, and excessively stressful maneuvers.[131] This system can be overridden by the pilot if deemed necessary.[131] The fly-by-wire system is supplemented by mechanical backup.[142]
Airframe and systems

The wings on the 777 feature a supercritical airfoil design that is swept back at 31.6 degrees and optimized for cruising at Mach 0.83 (revised after flight tests up to Mach 0.84).[143] The wings are designed with increased thickness and a longer span than previous airliners, resulting in greater payload and range, improved takeoff performance, and a higher cruising altitude.[144] The wings also serve as fuel storage, with longer-range models able to carry up to 47,890 US gallons (181,300 L) of fuel.[144] This capacity allows the 777-200LR to operate ultra-long-distance, trans-polar routes such as Toronto to Hong Kong.[145] In 2013, a new wing made of composite materials was introduced for the upgraded 777X, with a wider span and design features based on the 787’s wings.[140]

Unlike smaller airliners like the Boeing 737, no current 777 wings have winglets; instead, the exceptionally long raked wings of the 777 serve the same drag-reducing function. Large folding wingtips, 21 feet (6.40 m) long, were offered when the 777 was first launched, to appeal to airlines who might use gates made to accommodate smaller aircraft, but no airline purchased this option.[140] Folding wingtips reemerged as a design feature at the announcement of the upgraded 777X in 2013. Smaller folding wingtips of 11 feet (3.35 m) in length will allow 777X models to use the same airport gates and taxiways as earlier 777s.[140] These smaller folding wingtips are less complex than those proposed for earlier 777s, and internally only affect the wiring needed for wingtip lights.[140]

The airframe incorporates the use of composite materials, which comprise nine percent of its original structural weight (all models outside the 777-8 and 777-9).[147] Elements made from composite material include the cabin floor and rudder. The main fuselage cross-section is circular[148] and tapers rearward into a blade-shaped tail cone with a port-facing auxiliary power unit.[8] The aircraft also features the largest landing gear and the biggest tires ever used in a commercial jetliner.[149] The six-wheel bogies are designed to spread the load of the aircraft over a wide area without requiring an additional centerline gear. This helps reduce weight and simplifies the aircraft’s braking and hydraulic systems. Each tire of a 777-300ER six-wheel main landing gear can carry a load of 59,490 lb (26,680 kg), which is heavier than other wide-bodies such as the 747-400.[150] The aircraft has triple redundant hydraulic systems with only one system required for landing.[151] A ram air turbine—a small retractable device which can provide emergency power—is also fitted in the wing root fairing.[152]

Interior

The original 777 interior, also known as the Boeing Signature Interior, features curved panels, larger overhead bins, and indirect lighting.[70] Seating options range from four[153] to six abreast in first class up to ten abreast in economy.[154] The 777’s windows were the largest of any current commercial airliner until the 787, and measure 15-inch (380 mm) by 10-inch (250 mm) in size (all models outside the 777-8 and -9).[155] The cabin also features “Flexibility Zones”, which entails deliberate placement of water, electrical, pneumatic, and other connection points throughout the interior space, allowing airlines to move seats, galleys, and lavatories quickly and more easily when adjusting cabin arrangements.[154] Several aircraft have also been fitted with VIP interiors for non-airline use.[156] Boeing designed a hydraulically damped toilet seat cover hinge that closes slowly.[157]

In 2003, Boeing introduced overhead crew rests as an option on the 777.[158] Located above the main cabin and connected via staircases, the forward flight crew rest contains two seats and two bunks, while the aft cabin crew rest features multiple bunks.[158] The Signature Interior has since been adapted for other Boeing wide-body and narrow-body aircraft, including 737NG, 747-400, 767-300, and newer 767 models, including all 767-400ER models.[159] The 747-8 and 767-400ER have also adopted the larger, more rounded windows of the original 777.

In 2011, Flight International reported that Boeing is considering replacing the Signature Interior on the 777 with a new interior similar to that on the 787, as part of a move towards a “common cabin experience” across all Boeing platforms.[161] With the launch of the 777X in 2013, Boeing confirmed that the aircraft would be receiving a new interior featuring 787 cabin elements and larger windows.[140] Further details released in 2014 included re-sculpted cabin sidewalls for greater interior room, noise-dampening technology, and higher cabin humidity.[162]

Air France has a 777-300ER sub-fleet with 472 seats each, more than any other international 777, to achieve a cost per available seat kilometer (CASK) around €0.05, similar to Level’s 344-seat Airbus A340-200, its benchmark for low-cost, long-haul. Competing on similar French overseas departments destinations, Air Cariibes has 389 seats on the A350-900 and 429 on the -1000. French Bee’s is even more dense with its 411 seats A350-900, due to 10-abreast economy seating, reaching a €0.04 CASK according to Air France, and lower again with its 480 seats to-1000.[163]

Variants

Boeing uses two characteristics – fuselage length and range – to define its 777 models.[22][164] Passengers and cargo capacity varies by fuselage length: the 777-300 has a stretched fuselage compared to the base 777-200. Three range categories were defined: the A-market would cover domestic and regional operations, the B-market would cover routes from Europe to the US West coast and the C-market the longest transpacific routes.[165] The A-market would be covered by a 4,200 nmi (7,800 km) range, 234 t (516,000 lb) MTOW aircraft for 353 to 374 passengers powered by 316 kN (71,000 lbf) engines, followed by a 6,600 nmi (12,200 km) B-market range for 286 passengers in three-class, with 365 kN (82,000 lbf) unit thrust and 263 t (580,000 lb) of MTOW, an A340 competitor, basis of an A-market 409 to 434 passengers stretch, and eventually a 7,600 nmi (14,000 km) C-market with 400 kN (90,000 lbf) engines.[166]
When referring to different variants, the International Air Transport Association (IATA) code collapses the 777 model designator and the -200 or -300 variant designator to “772” or “773”. The International Civil Aviation Organization (ICAO) aircraft type designator system adds a preceding manufacturer letter for “B772” or “B773”Designations may append a range identifier like "B77W" for the 777-300ER by the ICAO, "777" for the IATA, though the -200ER is a company marketing designation and not certificated as such. Other notations include “773ER” and “773B” for the -300ER.

777-200

The initial 777-200 made its maiden flight on June 12, 1994 and was first delivered to United Airlines on May 15, 1995. With a 545,000 lb (247 t) MTOW and 77,000 lbf (340 kN) engines, it has a range of 5,240 nautical miles (9,700 km) with 355 passengers in a three-class configuration. The -200 was primarily aimed at U.S. domestic airlines although several Asian carriers and British Airways have also operated the type. Nine different -200 customers have taken delivery of 88 aircraft, with 55 in airline service as of July 2018. The competing Airbus aircraft was the A330-300.

In 2016, United Airlines shifted operations with all 19 of its -200s to exclusively domestic U.S. routes, including flights to and from Hawaii, and added more economy class seats by shifting to a ten-abreast configuration (a pattern that matched American Airlines' reconfiguration of the type). As of 2019, Boeing no longer markets the -200, as indicated by its removal from the manufacturer's price listings for 777 variants.

777-200ER

The B-market 777-200ER ("ER" for Extended Range), originally known as the 777-200IGW (increased gross weight), has additional fuel capacity and an increased MTOW for transatlantic routes. With a 658,000 lb (298 t) MTOW and 93,700 lbf (417 kN) engines, it has a 7,065 nmi (13,084 km) range. It was delivered first to British Airways on February 6, 1997. Thirty-three customers received 422 deliveries, with no unfilled orders as of April 2019.

As of July 2018, 338 examples of the -200ER are in airline service. It competed with the A340-300. Boeing proposes the 787-10 to replace it. The value of a new -200ER rose from US$110 million at service entry to US$130 million in 2007; a 2007 model 777 was selling for US$30 million ten years later, while the oldest ones had a value around US$5–6 million, depending on the remaining engine time.

It could be delivered de-rated with reduced engine thrust for shorter routes to lower the MTOW, reduce purchase price and landing fees (as 777-200 specifications) but can be re-rated to full standard. Singapore Airlines ordered over half of its -200ERs de-rated.

777-200LR

The 777-200LR ("LR" for Longer Range), the C-market model, entered service in 2006 as one of the longest-range commercial airliners. Boeing nicknamed it Worldliner as it can connect almost any two airports in the world although it is subject to ETOPS restrictions. It holds the world record for the longest nonstop flight by a commercial airliner. It has a maximum design range of 8,555 nautical miles (15,844 km) as of 2017. The -200LR was intended for ultra-long haul routes such as Los Angeles to Singapore.

Developed alongside the -300ER, the -200LR features an increased MTOW and three optional auxiliary fuel tanks in the rear cargo hold. Other new features include extended raked wingtips, redesigned main landing gear, and additional structural strengthening. As with the -300ER and 777F, the -200LR is equipped with wingtip extensions of 12.8 ft (3.90 m). The -200LR is powered by GE90-110B1 or GE90-115B turbfans. The first -200LR was delivered to Pakistan International Airlines on February 26, 2006. Eleven different -200LR customers took delivery of 59 aircraft, with two unfilled orders. Airlines operated 50 of the -200LR variant as of July 2018. Delta Air Lines and Emirates are the largest operators of the LR variant with each operating 10 aircraft. The closest competing aircraft from Airbus are the discontinued A340-500HGW and the current A350-900ULR.

777-300

Launched at the Paris Air Show on June 26, 1995, its major assembly started in March 1997 and its body was joined on July 21, 1997. Boeing proposed the 777-300 as an extension of the -200's 6.3 to 11.4 mm (0.25 to 0.45 in), and received a new evacuation door pair. Its overwing fuselage section 44 was strengthened, with its skin thickness going to 0.060 in (1.5 mm). It has ground maneuvering cameras for taxiing and a tailskid to rotate, while the proposed 716,000 lb (324.6 t) MTOW -300X would have needed a semi-levied main gear. Its overwing fuselage section 44 was strengthened, with its skin thickness going from the -200’s 6.3 to 11.4 mm (0.25 to 0.45 in), and received a new evacuation door pair. Its operating empty weight with Rolls-Royce engines in typical tri-class layout is 343,300 lb (155.72 t) compared to 307,300 lb (139.38 t) for a similarly configured -200. Boeing wanted to deliver 170 -300s by 2006 and to produce 28 per year by 2002, to replace Boeing 747 Classics, burning one-third less fuel with 40% lower maintenance costs.

With a 660,000 lb (299 t) MTOW and 90,000 lbf (400 kN) engines, it has a range of 6,005 nautical miles (11,121 km) with 368 passengers in three-class. Eight different customers have taken delivery of 60 aircraft of the variant, of which 18 were powered by the PW4000 and 42 by the RR Trent (none were ordered with the GE90, which was never certificated on this variant), with 48 in airline service as of July 2018. The last -300 was delivered in 2006 while the longer-range...
-300ER started deliveries in 2004.[1]

### 777-300ER

The 777-300ER ("ER" for Extended Range) is the B-market version of the -300. Its higher MTOW and increased fuel capacity permits a maximum range of 7,370 nautical miles (13,650 km) with 396 passengers in a two-class seating arrangement.[175] The 777-300ER features raked and extended wingtips, a strengthened fuselage and wings and a modified main landing gear.[190] Its wings have an aspect ratio of 9.0.[191] It is powered by the GE90-115B turbofan, the world’s most powerful jet engine with a maximum thrust of 115,300 lbf (513 kN).[192]

Following flight testing, aerodynamic refinements have reduced fuel burn by an additional 1.4%.[97][103] At Mach 0.839 (495 kn; 916 km/h), FL300, -59 °C and at a 513,400 lb (232.9 t) weight, it burns 17,300 lb (7.8 t) of fuel per hour. Its operating empty weight is 371,600 lb (168.6 t).[104] The projected operational empty weight is 168,560 kg (371,610 lb) in airline configuration, at a weight of 216,370 kg (477,010 lb) and FL350, total fuel flow is 6,790 kg/h (14,960 lb/h) at M0.84/472 kn (874 km/h), rising to 8,890 kg (19,600 lb)/h at M0.87/506 kn (937 km/h).[193]

Since its launch, the -300ER has been a primary driver of the twinjet’s sales past the rival A330/340 series.[196] Its direct competitors have included the Airbus A340-600 and the A350-1000.[112] Using two engines produces a typical operating cost advantage of around 8–9% for the -300ER over the A340-600.[107] Several airlines have acquired the -300ER as a 747-400 replacement amid rising fuel prices given its 20% fuel burn advantage.[98] The -300ER has an operating cost of US$44 per seat hour, compared to an Airbus A380’s roughly US$50 per seat hour (hourly cost is about US$26,000), and US$90 per seat hour for a Boeing 747-400 as of November 2015.[198]

The first -300ER was delivered to Air France on April 29, 2004.[199] The -300ER is the best-selling 777 variant, having surpassed the -200ER in orders in 2010 and deliveries in 2013.[11] As of July 2018, 784 -300ER aircraft were in service.[100] As of August 2019, -300ER deliveries to 45 different customers totalled 810, with 34 unfilled orders.[11] At its peak, a new 777-300ER was valued US$170 million, falling to US$150 million in 2019.[200]

### 777 Freighter

The 777 Freighter (777F) is an all-cargo version of the twinjet, and shares features with the -200LR; these include its airframe, engines,[201] and fuel capacity.[144] With a maximum payload of 224,900 lb (102,000 kg) (similar to the 243,000 lb (110,000 kg) of the Boeing 747-200F), it has a range of 4,970 nmi (9,200 km).[175] Greater range is possible if less cargo weight is carried.[202]

As the aircraft promises improved operating economics compared to older freighters,[98] airlines have viewed the 777F as a replacement for freighters such as the Boeing 747-200F, McDonnell Douglas MD-11F and McDonnell Douglas MD-10F.[104][105] The first 777F was delivered to Air France on February 19, 2009.[107] As of August 2019, 170 freighters had been delivered to 23 different customers, with 60 unfilled orders.[11] Operators had 140 of the 777F in service as of July 2018.[10]

In the 2000s, Boeing began studying the conversion of 777-200ER and -200 passenger airliners into freighters, under the name 777 BCF (Boeing Converted Freighter).[204] The company has been in discussion with several airline customers, including FedEx Express, UPS Airlines, and GE Capital Aviation Services, to provide launch orders for a 777 BCF program.[205]

### 777-300ER Special Freighter (SF)

In July 2018, Boeing was studying a 777-300ER freighter conversion, targeted for the volumetric market instead of the density market served by the 777F. After having considered a -200ER P2F program, Boeing hopes to conclude its study by the Fall as the 777X replacing aging -300ERs from 2020 will generate feedstock.[206] New-build 777-300ER freighters may maintain the delivery rate at five per month, to bridge the production gap until the 777X is delivered.[207]

In October 2019, Boeing and IAI launched the 777-300ERSF passenger to freighter conversion program with GECAS ordering 15 aircraft and 15 options, the first aftermarket 777 freighter conversion program. The converted aircraft has a maximum payload of 224,000 lb (101,000 kg) and 4,500 nmi (8,300 km) and shares the door aperture and aft position of the 777F. It has a cargo volume capacity of 28,900 cu ft (819 m³), 5,800 cb ft (164 cb m) greater than the 777F and can hold 47 standard 96 x 125 in pallet (P6F) positions, 10 more positions than a 777-200LRF or eight more than a 747-400F. Within the 811 777-300ERS delivered and 33 to be delivered, GECAS anticipates up to 150-175 orders through 2030, the four to five months conversion costs around $35m. IAI will receive the first aircraft in December 2020 while certification and service entry is scheduled for late 2022.[208]

### 777X

The 777X is to feature new GE9X engines and new composite wings with folding wingtips. It was launched in November 2013 with two variants: the 777-8 and the 777-9.[123] The 777-8 provides seating for 384 passengers and has a range of 8,730 nmi (16,170 km) while the 777-9 has seating for 426 passengers and a range of over 7,285 nmi (13,500 km). The 777-9 first flew on January 25, 2020, with deliveries expected to commence in 2021.[209]

### Government and corporate

Versions of the 777 have been acquired by government and private customers. The main purpose has been for VIP transport, including as an air transport for heads of state, although the aircraft has also been proposed for other military applications.

https://en.wikipedia.org/wiki/Boeing_777
- **777 Business Jet (777 VIP)** – the Boeing Business Jet version of the 777 that is sold to corporate customers. Boeing has received orders for 777 VIP aircraft based on the 777-200LR and 777-300ER passenger models. The aircraft are fitted with private jet cabins by third party contractors and completion may take 3 years.

- **777 Tanker (KC-777)** – the KC-777 is a proposed tanker version of the 777. In September 2006, Boeing announced that it would produce the KC-777 if the United States Air Force (USAF) required a larger tanker than the KC-767, able to transport more cargo or personnel. In April 2007, Boeing offered its 767-based KC-767 Advanced Tanker instead of the KC-777 to replace the smaller Boeing KC-135 Stratotanker under the USAF's KC-X program. Boeing officials have described the KC-777 as suitable for the related KC-Z program to replace the wide-body McDonnell Douglas KC-10 Extender.

- In 2014, the Japanese government chose to procure two 777-300ERs to serve as the official air transport for the Emperor of Japan and Prime Minister of Japan. The aircraft, to be operated by the Japan Air Self-Defense Force under the call sign Japanese Air Force One, entered service in 2019 and replaced two 747-400s. The 777-300ER was specifically selected by the Ministry of Defense owing to its similar capabilities to the preceding 747 pair. Besides VIP transport, the 777s are also intended for use in emergency relief missions.

- The 777s are serving or have served as official government transports for nations including Gabon (VIP-configured 777-200ER), Turkmenistan (VIP-configured 777-200LR), and the United Arab Emirates (VIP-configured 777-200ER and 777-300ER operated by Abu Dhabi Amiri Flight). Prior to returning to power as Prime Minister of Lebanon, Rafic Hariri acquired a 777-200ER as an official transport. India's government is to use two Air India 777-300ERs for VIP transport.

- In 2014, the USAF examined the possibility of adopting modified 777-300ERs or 777-9Xs to replace the Boeing 747-200 when it was just beginning to prove itself with ETOPS; decades later, the 777 and other twin jets established a comparable level of performance as quad-jet aircraft).

### Operators

Boeing customers that have received the most 777s are Emirates, Singapore Airlines, United Airlines, ILFC, and American Airlines. Emirates is the largest airline operator as of July 2018 and is the only customer to have operated all 777 variants produced, including the -200, -200ER, -200LR, -300, -300ER, and 777F. The 1,000th 777 off the production line, a -300ER set to be Emirates' 102nd 777, was unveiled at a factory ceremony in March 2012.

A total of 1,416 aircraft (all variants) were in airline service as of July 2018, with Emirates (163), United Airlines (91), Air France (70), Cathay Pacific (69), American Airlines (67), Qatar Airways (67), British Airways (58), Korean Air (53), All Nippon Airways (50), Singapore Airlines (46), and other operators with fewer aircraft of the type.

In 2017, 777 Classics are reaching the end of their mainline service: with a -200 age ranging from three to 22 years, 43 Classic 777s or 7.5% of the fleet have been retired. Values of 777-200ERs have declined by 45% since January 2014, faster than Airbus A330s and Boeing 767s with 30%, due to the lack of a major secondary market but only a few budget, air charters and ACMI operators. In 2015, Richard H. Anderson, then Delta Air Lines' chairman and chief executive, said he had been offered 777-200s for less than US$10 million. To keep them cost efficient, operators densify their 777s for about US$10 million each, like Scoot with 402 seats in its dual-class -200s, or Cathay Pacific which switched the 3–3–3 economy layout of 777-300s to 3–4–3 to seat 396 on regional services.

### Orders and deliveries

The 777 surpassed 2,000 orders by the end of 2018.

<table>
<thead>
<tr>
<th>Total orders</th>
<th>Total deliveries</th>
<th>Unfilled</th>
</tr>
</thead>
<tbody>
<tr>
<td>777-200</td>
<td>88</td>
<td>–</td>
</tr>
<tr>
<td>777-200ER</td>
<td>422</td>
<td>–</td>
</tr>
<tr>
<td>777-200LR</td>
<td>61</td>
<td>1</td>
</tr>
<tr>
<td>777-300</td>
<td>60</td>
<td>–</td>
</tr>
<tr>
<td>777-300ER</td>
<td>838</td>
<td>19</td>
</tr>
<tr>
<td>777F</td>
<td>231</td>
<td>50</td>
</tr>
<tr>
<td>777X</td>
<td>309</td>
<td>309</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2,009</strong></td>
<td><strong>1,630</strong></td>
</tr>
</tbody>
</table>

Orders and deliveries through February 2020

[1] [Boeing 777 orders and deliveries by type](https://en.wikipedia.org/wiki/Boeing_777)
Aircraft on display

- The first prototype Boeing 777-200, B-HNL[229] (ex. N7771), was retired in mid-2018 amid press reports that it was to be displayed at the Museum of Flight in Seattle, although these reports were subsequently denied by the museum.[230] On September 18, 2018, Cathay Pacific and Boeing announced that B-HNL would be donated to the Pima Air & Space Museum near Tucson, Arizona, where it would be placed on permanent display.[231] This aircraft, which had previously been in regular use by Cathay Pacific between 2000 and 2018, was manufactured in 1994 and was delivered to the airline after spending six years with Boeing.[232][233]

Accidents and incidents

As of February 2019, the 777 has been involved in 28 aviation accidents and incidents,[12] including a total of seven hull-losses (five in-flight and two in ground incidents) resulting in 541 fatalities along with three hijackings.[13][14] The first fatality involving the twinjet occurred in a fire while an aircraft was being refueled at Denver International Airport in the United States on September 5, 2001, during which a ground worker sustained fatal burns.[233] The aircraft, operated by British Airways, suffered fire damage to the lower wing panels and engine housing; it was later repaired and returned to service.[233][234]

The type’s first hull-loss occurred on January 17, 2008, when a 777-200ER with Rolls-Royce Trent 895 engines, flying from Beijing to London as British Airways Flight 38, crash-landed approximately 1,000 feet (300 m) short of Heathrow Airport's runway 27L and slid onto the runway’s threshold. There were 47 injuries and no fatalities. The impact severely damaged the landing gear, wing roots and engines.[237][238] The accident was attributed to ice crystals suspended in the aircraft’s fuel clogging the fuel-oil heat exchanger (FOHE).[234][239] Two other minor momentary losses of thrust with Trent 895 engines occurred later in 2008.[240][241] Investigators found these were also caused by ice in the fuel clogging the FOHE. As a result, the heat exchanger was redesigned.[234][242]

The type’s second hull-loss occurred on July 29, 2011 when a 777-200ER scheduled to operate as EgyptAir Flight 667 suffered a cockpit fire while parked at the gate at Cairo International Airport before its departure.[243] The aircraft was evacuated with no injuries.[243] and airport fire teams extinguished the fire.[244] The aircraft sustained structural-, heat- and smoke damage, and
was written off.[243][244] Investigators focused on a possible short circuit between an electrical cable and a supply hose in the cockpit crew oxygen system.[243]

The type's third hull-loss occurred on July 6, 2013 when a 777-200ER, operating as Asiana Airlines Flight 214, crashed while landing at San Francisco International Airport after touching down short of the runway. The 307 surviving passengers and crew on board evacuated before fire destroyed the aircraft. Two passengers, who had not been wearing their seatbelts, were ejected from the aircraft during the crash and were killed.[245] A third passenger died six days later as a result of injuries sustained during the crash.[246] These were the first fatalities in a crash involving a 777 since its entry into service in 1995.[247][248][249] The official accident investigation concluded in June 2014 that the pilots committed 20 to 30 minor to significant errors in their final approach, and that complexities of the automated controls contributed to the accident.[249][250]

The type's apparent fourth hull-loss occurred on March 8, 2014 when a 777-200ER carrying 227 passengers and 12 crew, en route from Kuala Lumpur to Beijing as Malaysia Airlines Flight 370, was reported missing. Air Traffic Control's last reported coordinates for the aircraft were over the South China Sea at 6°55′15″N 103°34′43″E.[251][252] After the search for the aircraft began, Malaysia's prime minister announced on March 24, 2014 that after analysis of new satellite data it was now to be assumed "beyond reasonable doubt" that the aircraft had crashed in the Indian Ocean and there were no survivors.[253][254] The cause remains unknown, but the Malaysian Government declared it was an accident in January 2015.[255][256] On July 29, 2015, an item later identified as a flaperon strongly suspected to be from the missing aircraft was found on the island of Réunion in the western Indian Ocean.[257]

The type's fifth hull-loss occurred on July 17, 2014, when a 777-200ER, bound for Kuala Lumpur from Amsterdam as Malaysia Airlines Flight 17 (MH17), broke up in mid-air and crashed[258] in the Donetsk province in eastern Ukraine, after being hit by an anti-aircraft missile.[259] All 298 people (283 passengers and 15 crew) on board were killed, making this the deadliest crash involving the Boeing 777. The incident was linked to the ongoing Donbass insurgency in the region.[260][261] The official accident report, released in October 2015, states that airliner was brought down by a Buk missile launched from territory held by pro-Russian separatists.[262]

The sixth hull-loss of the type occurred on August 3, 2016, when a 777-300 crashed while landing and caught fire at Dubai Airport at the end of its flight as Emirates Flight 521.[263] The preliminary investigation indicated that the aircraft was attempting a landing during active wind shear conditions. The pilots initiated a go-around procedure shortly after the main wheels touched-down onto the runway, however, the aircraft settled back onto the ground apparently due to late throttle application. As the undercarriage was in the process of being retracted, the aircraft landed on its rear underbody and engine nacelles, resulting in the separation of one engine, loss of control and subsequent crash.[264] There were no passenger casualties of the 300 people on board, however, one airport firefighter was killed fighting the fire. The aircraft's fuselage and right wing were irreparably damaged by the fire.[265][266]

The type's seventh hull-loss occurred on November 29, 2017, when a Singapore Airlines 777-200ER experienced a fire while being towed at Singapore Changi Airport. An aircraft technician was the only occupant on board and evacuated safely. The aircraft sustained heat damage and was written off.[266]

Other notable accidents and incidents include British Airways Flight 2276, a 777-200ER that aborted takeoff at Las Vegas McCarran International Airport on September 8, 2015 after a serious uncontained engine failure punctured ‘multiple’ holes in the engine case and caused severe fire damage to the outer skin of the forward fuselage, all crew and passengers evacuating with only minor injuries occurring.[267][268][269][270] Korean Air Flight 2708, a 777-300 that suffered a Number 1 Pratt & Whitney PW4000 engine fire prior to takeoff at Tokyo International Airport, with all aboard evacuating safely.[271][272][273] and Singapore Airlines Flight 368, a 777-300ER whose right engine and wing caught fire after an emergency landing at Singapore Changi Airport, due to an oil leak in the right engine, with no injuries.[274][275]

### Specifications

Boeing 777 specifications

<table>
<thead>
<tr>
<th>Variants</th>
<th>Initial[184]</th>
<th>Long-range[144]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>777-200/200ER</td>
<td>777-300ER</td>
</tr>
<tr>
<td>Crew</td>
<td>Two (cockpit)</td>
<td></td>
</tr>
<tr>
<td>3-class seats[171]</td>
<td>305 (24F/54J/227Y)</td>
<td>368 (30F/84J/254Y)</td>
</tr>
<tr>
<td>2-class seats[175]</td>
<td>313</td>
<td>396</td>
</tr>
<tr>
<td>Length</td>
<td>209 ft 1 in / 63.73 m</td>
<td>242 ft 4 in / 73.86 m</td>
</tr>
<tr>
<td>Wingspan</td>
<td>199 ft 11 in / 60.93 m, 31.6° Wing sweep[276]</td>
<td>212 ft 7 in / 64.80 m, 31.6° Wing sweep[276]</td>
</tr>
<tr>
<td>Wing area</td>
<td>4,605 sq ft (427.8 m²), 6.68 AR</td>
<td>4,702 sq ft (436.8 m²), 9.04 AR</td>
</tr>
<tr>
<td>Tail height[175]</td>
<td>60 ft 9 in / 18.5 m</td>
<td>60 ft 8 in / 18.5 m</td>
</tr>
<tr>
<td>Fuselage width</td>
<td>20 ft 4 in / 6.20 m</td>
<td></td>
</tr>
<tr>
<td>Cargo volume[175]</td>
<td>5,330 ft³ / 150.9 m³</td>
<td>7,120 ft³ / 201.6 m³</td>
</tr>
<tr>
<td>MTOW</td>
<td>545,000 lb / 247,200 kg</td>
<td>660,000 lb / 299,370 kg</td>
</tr>
<tr>
<td>OEW</td>
<td>299,550 lb / 135,850 kg</td>
<td>353,800 lb / 160,530 kg</td>
</tr>
<tr>
<td>Fuel capacity</td>
<td>31,000 US gal / 117,340 L / 207,700 lb / 94,240 kg</td>
<td>350,000 US gal / 137,460 kg</td>
</tr>
<tr>
<td>Ceiling[189]</td>
<td>43,100 ft (13,100 m)</td>
<td></td>
</tr>
<tr>
<td>Speed</td>
<td>Max. Mach 0.87–Mach 0.89 (499–951 kn; 924–1765 km/h); Cruise Mach 0.84 (482 kn; 892 km/h)</td>
<td></td>
</tr>
<tr>
<td>Range[175]</td>
<td>5,240 nmi / 9,700 km[9][171]</td>
<td>6,030 nmi / 11,165 km[8][171]</td>
</tr>
<tr>
<td>Takeoff[11]</td>
<td>8,000 ft (2,440 m)</td>
<td>10,600 ft (3,230 m)</td>
</tr>
<tr>
<td>Engine</td>
<td>2x PW4000 / Trent 800 / GE90</td>
<td>2x GEnx-115B[279]</td>
</tr>
<tr>
<td>Max thrust</td>
<td>2x 77,200 lbf (343 kN)</td>
<td>2x 98,000 lbf (440 kN)</td>
</tr>
<tr>
<td>ICAO designation[168]</td>
<td>B772</td>
<td>B773</td>
</tr>
</tbody>
</table>

See also

- [Competition between Airbus and Boeing](https://en.wikipedia.org/wiki/Competition_between_Airbus_and_Boeing)
- [Related development](https://en.wikipedia.org/wiki/Boeing_777)
- [Aircraft of comparable role, configuration and era](https://en.wikipedia.org/wiki/Boeing_777)

[Diagram of Boeing 777 variants with front, cross-section, side, and top views: 777-200ER on left, 777-300ER on right.]
Airbus A350 XWB – family of long-range, wide-body jet airliners
Boeing 787 Dreamliner – Wide-body twin-engine jet airliner, first airliner to be constructed primarily of composite materials
Ilyushin Il-96 – Four-engined long-haul wide-body airliner
McDonnell Douglas MD-11 – Wide body airliners developed from the DC-10

Related lists
- List of Boeing 777 operators
- List of Boeing 777 orders and deliveries
- List of Boeing customer codes
- List of jet airliners
- List of civil aircraft

References

Footnotes
a. 777F: 224,900 lb / 102,010 kg
b. 777F: 11
c. 777F: 23,051 ft³ / 652.7 m³
d. 305 passengers, Trents
e. 313 passengers
f. 368 passengers, GE90
g. 396 passengers
h. 317 passengers
i. 224,900 lb / 102,010 kg
j. MTOW, sea level, ISA

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7. Birtles 1998, pp. 52
8. Norris & Wagner 1996, p. 89
15. Wells & Rodrigues 2004, p. 146
17. Eden 2008, pp. 98, 102–103
20. Norris & Wagner 1999, p. 128
22. Eden 2008, p. 112

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Boeing 777 - Wikipedia


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on why the cockpit crew allowed speed to decay to such an extent ...


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https://en.wikipedia.org/wiki/Boeing_777

External links

- Boeing 777 Family page on Boeing.com (http://www.boeing.com/commercial/777family/)


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