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Airbus ACJ TwoTwenty – *In a Class of Its Own*

BY **FRED GEORGE**

Airbus ACJ TwoTwenty is an iconoclast among large cabin business aircraft. Airbus says it's one of the few air transport aircraft that was purposely developed from the outset also for use as a business jet, even though it shares its airframe, systems and engines with the A220-100 commercial jetliner. While it has the same 5,120 cubic foot cabin, ACJ Two Twenty offers more than 5,650 nm of range, and more than 12 hours of endurance. This enables it to fly between east and west continents, not just east and west continental coasts.

This aircraft leaps forward into the 21st century, an era in which business aircraft operators are seeking considerably more cabin comfort and greater fuel efficiency without sacrificing range or runway performance. ACJ TwoTwenty has nearly twice the cabin volume and more than twice the floor area of the largest purpose-built business jets coming from Toronto or Savannah. Airbus Corporate Jets [ACJ] is positioning it as an "Xtra Large Cabin value proposition," pricing it head-to-head against top-end offerings from Bombardier, Dassault and Gulfstream.

Sylvain Mariat, ACJ's head of creative design, leads the ACJ TwoTwenty interiors team to craft innovative, functional and durable interiors. ACJ has tapped Comlux Indianapolis to be the exclusive outfitter for the first 15 ACJ TwoTwenties, leveraging Comlux's considerable expertise in VVIP completions.

Mariat has taken a modular approach to floor plans to speed completions and reduce costs for customers. Comlux began cabin engineering work using Mariat's computer design files months before the first ACJ TwoTwenty arrived in Indianapolis. The first completion is slated to take 12 months. Subsequent completions should take eight months or less.

Step inside and ACJ TwoTwenty's size advantage is immediately apparent. The interior is nearly one-third wider and seven inches taller than the roomiest purpose-built business jet. It's 78 feet long from the flight deck door to the aft bulkhead of the rear lavatory, providing room for six separate cabin zones.

The left forward entry door sill is about 10 ft above the ground, so ACJ will equip the aircraft with a left forward internal airstair with handrails and step lights to facilitate autonomous operations.

When passengers enter the front of the aircraft, they are welcomed into the first and largest cabin zone: a 210 sq ft foyer with a three-star chef's galley; a prep kitchen including a copious pantry; and a 73 cubic foot, two-level carry-on luggage closet. There are separate crew and VIP lavatories up front. There is an additional 364 cu ft external baggage compartment in the belly cargo compartment ahead of the wing.

This is an aircraft designed for both crew and passenger comfort on long-range missions. In contrast to smaller business aircraft, there are two fold-down crew seats up front, providing rest spots with ample legroom for both cabin crew and relief pilots outside of the flight deck's usual jump seat. An available optional crew rest compartment can be installed in place of the forward luggage compartment, an option that should prove especially popular with air charter operators.

The aft sixth cabin zone is a full-width, en suite bathroom with two wardrobe compartments, wash basin and storage closets. An optional fully stand-up "rain shower" is available as a replacement for one of the wardrobe closets.

Between the forward foyer and aft en suite bathroom, there are four separate 130 sq ft main living areas, including a forward lounge, dedicated conference and dining lounge, aft lounge and private master suite. The cabin windows measure 11- by 16-inches, assuring plenty of ambient light can flood the cabin. Daylight too bright? Electrochromic shades provide infinitely variable dimming.

The front two seating areas are ideal for business day activities, including inflight meetings and video conferences taking full advantage of high-speed Ku band SATCOM, WiFi and 55-inch, 4K-resolution monitors.

The aft two compartments provide a private refuge for diversion and rest. All seats have USB charging outlets for mobile phones and tablet computers. There are inductive chargers in credenzas and cabinets to charge smart phones and wristwatches. WiFi calling assures each person on board can stay connected by mobile phone to friends and family on the ground.

The third cabin section is a six-seat dining and conference lounge that has a standardized configuration to provide free access to the Type III over-wing emergency exits. The other five zones are available with a wide choice of floor plans, providing more than 100 different cabin configurations. The forward lounge, for example, can be configured as an executive suite, a conference room, a six-seat club compartment or five-seat business office. The aft lounge can be configured for families, as a guest bedroom, an AV entertainment room, or a private lounge that complements the aft stateroom. The aft master suite is available with a full-time king-size bed or a sofa sleeper. Typical layouts accommodate up to 18 passengers.

The cabin may be further customized by choosing one of four interior décor ambiences – Timeless, Avant-Garde,

ACJ TwoTwenty Business Lounge

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Quintessence or the intriguingly outré Cyril Kongo Special Edition. Customers are free to mix and match or choose other interior décor designs, plus they can choose cabinet finishes, upholstery fabrics, carpets and accents to personalize their aircraft.

Such VIP interiors add heft to aircraft empty weight. Fueling up all five auxiliary center tanks, fitted to the aft belly cargo compartment, also adds 12,000 lb to BOW. However, ACJ TwoTwenty still can carry 13 passengers with full fuel. Each additional passenger costs only about 25 nm of range performance. Fill the seats and you can fly London to Los Angeles, New York to Tel Aviv or Shanghai to San Diego.

Older generation jetliner derivatives offered roomy cabins, but they were not quiet by business aircraft standards nor were they as comfortably pressurized. ACJ TwoTwenty aims to shatter those shortcomings by slashing interior sound levels and lowering cabin altitudes. Estimated noise levels will be in the mid- to high-forty dBA range, on par with the quietest large cabin business aircraft. The 9.3 psi △ pressurization system provides a 5,85o ft cabin altitude. A cabin humidifier will be an option.

ACJ TwoTwenty is especially kind to airport neighbors. When connected to ground AC power and a high-pressure ground air source, all cabin systems are available and both air-conditioning packs can be operated to warm or cool the interior prior to the arrival of passengers, avoiding unnecessary use of the APU. The aircraft also may be connected to low-pressure ground air for heating and cooling. On takeoff and landing, it beats ICAO Annex 6 limits by 18 dB, making it one of the quietest extra-large cabin business jets.

Quite clearly, ACJ TwoTwenty is a marked departure from the previous generation of regional or trunk jetliner derivatives, because of its range, cabin size and impressively low operating cost.

Pilots are going to love this aircraft, based upon our flying impressions of its first cousin, an A220-300 [née CS 300] jetliner, six years ago. The windshields and side windows are large, providing exceptionally large vertical and lateral fields of view. Less is more. The flight deck is paradigm of pilot-friendly design, one of the best Collins Pro Line Fusion-based platforms we've flown. The five displays are impressively uncluttered. There are outboard docking stations for tablet computers. Single or dual head-up displays are options. EVS and CVS upgrades will be developed, if market demand is sufficient.

The original flight deck design team, test pilots and Collins avionics engineers not only embraced the well-proven, quiet-dark design philosophy, designers opted for simple, consistent color conventions. Cyan indicates a pilot target, magenta shows computer-generated targets, green is active and white is standby. We never wondered "What's it doing now?" even though it was the first time we had flown it.

The flightdeck layout sets high standards for ease of use, situational awareness and low workload. The tactile feel and positions of knobs and most switches, particularly those on the overhead panel, would seemingly talk to your fingertips during a blindfold flight-deck check. We especially appreciate the left and right control tuning panels in the glareshield, providing immediate access to comm / nav / surveillance radio control and display functions, plus altimeter baro set, and one-touch access to FMS, MAP, data, checklist and radio functions on the inboard MFDs. Everything is designed to promote heads-up scan patterns and prevent head-down fixation.

Electronic checklists prevent pilots from skipping over or forgetting to return to deferred items. The electronic checklist interacts with many aircraft systems, so it automatically completes the associated checklist items if switches, knobs and buttons are in their correct positions.

Checklists are comparatively short. After setting the parking brake, switching batteries to auto and pulling up the electronic checklist on the pilot's inboard display, we only had to check hydraulic panel knob positions, verify the engine run switches were off, look at a few other items, and we were ready to start the APU.

Once running, the APU automatically powers all AC busses and furnishes bleed air for the packs. Everything comes to life in the cockpit. Running the pre-start electronic checklist is quick and easy. The FMS is programmed by phase of flight or function, selected by clicking on tabs in the flight management window of the inboard or lower displays. An alphanumeric keypad on the cursor control panel provides data entry.

Starting the engines simply requires turning on the engine run switches one at a time. The aircraft automatically reconfigures bleed air, air-conditioning, electrical and fuel systems for the start and then again when the engines start is complete. After both engines were running, we checked knobs in the 12 o'clock position, verified annunciator switch lights were dark and eyed the EICAS for alerts and warnings. We checked flight control movement and set auto brakes to rejected takeoff in case of an abort.

The aircraft has left and right sidesticks used for fly-by-wire control inputs. The auto-throttles are back-driven so they move with thrust changes, keeping pilots in the loop. The fly-by-wire system uses speed stable pitch control law, similar to Bombardier or Gulfstream business jets with digital flight controls. This means pilots must use pitch trim in response to speed changes, another feature that promotes situational awareness. It's easy to keep the aircraft in trim as the need for pitch trim changes moderately and predictably with airspeed changes. It automatically compensates for high-lift, airbrake and landing gear configuration changes.

ACJ TwoTwenty's fly-by-wire system has unsurpassed redundancy, being equipped with three dual-channel primary flight control computers. The PFCCs provide full flight envelope protections that keep the aircraft within safe speed, attitude, angle of attack and load limits. Additional protections include tail strike prevention, yaw damping and partial thrust asymmetry compensation during one-engine-inoperative operations. If a proverbial black swan event were to disable all three PFCCs, there is an alternate flight control unit that provides three-axis direct control of the primary flight control surfaces and horizontal stabilizer.

Pushing up the power levers to 60 percent engaged the auto-throttles. At full takeoff thrust, the aircraft impressed us with its low sound levels. The aircraft we flew in 2016 was fitted with lower thrust PW1521 engines. ACJ TwoTwenty will be equipped with 24,400 lbf [uninstalled] PW1524G powerplants that have 73-inch fans that turn less than 3,500 rpm at takeoff. All PW1500-series engines have 12:1 bypass ratios, assuring low FAR Part 36 / ICAO Annex 6 noise levels and class-leading fuel efficiency.

On rotation, we found sidestick control forces to be lighter in feel compared to some larger fly-by-wire aircraft we've flown. It's essential to keep this in mind to avoid sharp inputs that might alarm passengers.

Clear of Class D airspace, we settled into a 250 KIAS climb to 10,000 ft, transitioning to a 280 KIAS / 0.76M climb to altitude. Plan on burning 4,500 lb for the first hour and then settling into a 0.78M cruise speed while consuming 3,500 to 3,800 pph during cruise. We estimate the last hour of typical missions will require less than 2,000 lb of fuel.

The aircraft has three-position slats, five position flaps and ailerons that droop 5° to 10° with trailing flap extension to increase lift and reduce approach speeds. At light weights with NBAA IFR reserves and at Flaps 5 [Slats 27° / flaps 37°], VREF can be as low as 110 to 115 KIAS. Notably, the aircraft has a 32-knot demonstrated crosswind factor, adding to its operational flexibility.

ACJ TwoTwenty's flight deck provides flight crews with all the essentials, but not all the embellishments of top end business jets from Bombardier, Dassault and Gulfstream. It dispenses with synthetic vision PFDs and 3D taxi diagrams, but it does have an available 2D airport moving map with taxiway, runway and ramp markers.

It's also a low maintenance workhorse. A low utilization program pegs basic scheduled inspections at 72 months, sufficient for up to 1,500 hours annual utilization – far more than most corporate operators are likely to fly each year. ACJ intends for this aircraft to have a much lower maintenance cost per hour than purpose-built business jets.

The PW1500-series engines also are airline tough. More than 200 A220 jetliners that are PW1500 powered are in service and they've logged more than a million flight hours in the past six years. The airlines are the fleet leaders, flying up to 3,000 to 3,500 hours per year. So, airline operators are likely to experience snags long before ACJ TwoTwenty business aircraft operators. This assures that remedies will be developed by Airbus and Pratt & Whitney well before ACJ TwoTwenty operators are likely to need them.

Given enough runway, among other factors, pilots can opt for both derate and flex takeoff thrust ratings, further reducing engine wear and extending the time between shop visits. Reduced thrust takeoffs make a quiet aircraft even quieter for airport neighbors.

Rock-bottom FAR Part 142 pilot recurrent training costs are another strong suit of the aircraft. Taking advantage of Airbus' footprint and the number of A220 operators around the world, ACJ's goal is to provide considerably more cost-effective training than its purpose-built business jet competitors. ACJ TwoTwenty pilots should be able to complete recurrent sim training in a single day, in parallel with most commercial airlines' training syllabi.

ACJ asserts that ACJ TwoTwenty's hourly operating costs will be 22% lower than conventional large cabin business jets, mainly because of lower pilot training and maintenance costs. This assumes 500 hours annual utilization.

However, ACJ TwoTwenty cruises at 0.78 Mach, while its main competitors cruise at 0.85 Mach. This narrows its cost per mile advantage on longer trips. Notably, the speed difference only adds about 15 – 20 minutes to trans-continental US missions.

ACJ TwoTwenty has the potential to be the most successful jetliner derivative developed for use as a business aircraft in the last two decades. It has an unparalleled blend of range, cabin comfort, and SATCOM connectivity, plus operating efficiency, low maintenance costs, and flight deck ergonomics. This is an airplane with strong appeal as a practical alternative to a smaller, purpose-built business jet. If you turn right as a passenger, you'll settle into one of the quietest and most comfortable cabins in the sky. If you left as a pilot, you'll seat yourself in one of the most welcoming flight decks in any aircraft we've yet flown. **BCA**


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ACJ TwoTwenty Cockpit

How to Use the Airplane Charts*

For an aircraft to be listed in the Purchase Planning Handbook, a production-conforming article must have flown by June 1 of this year. The dimensions, weights and performance characteristics of each model listed are representative of the current production aircraft being built or for which a type certificate application has been filed. The basic operating weights are representative of actual production turboprop and turbofan aircraft because we've insisted upon manufacturers supplying us with the actual weights of delivered aircraft to commercial customers. The takeoff field length distances are based on maximum takeoff weight unless otherwise indicated in the tables.

Manufacturer, Model and Type Designation

There are three rows at the top of each column for a specific aircraft: The airplane manufacturer's name, abbreviated in some cases; the commercial model name; and the type certificate data sheet model designation.

BCA Equipped Price

► Price *estimates* are first quarter, current year dollars for the next available delivery. Some aircraft have long lead times; thus, the actual price will be higher than our published price. Note well, manufacturers may adjust prices without notification.

► **Piston-powered airplanes** — Computed retail price with at least the level of equipment specified in the "*BCA* Required Equipment List."

► **Turbine-powered airplanes** — Average price of 10 of the last 12 commercial deliveries, if available. The aircraft serial numbers aren't necessarily consecutive because of variations in completion time and because some aircraft may be configured for non-commercial, special missions.

Characteristics

► **Seating Capacity:** Crew + typical executive seating/maximum seating by certification. — For example, 2+8/19 indicates that the aircraft requires two pilots, there are eight seats in the typical executive configuration and the aircraft is certified for up 19 passenger seats. A four-place single-engine aircraft is shown as 1+3/3, indicating that one pilot is required and there are three other seats available for passengers. We require two pilots for all FAR Part 25 transport-category certified turbofan airplanes. A single pilot is required for all Part 23 normal category airplanes, including turbine airplanes up to 19 occupants/19,000-lb. certified maximum takeoff weight, except where otherwise noted. Four crewmembers are specified for ultra-long-range aircraft—three pilots and one flight attendant.

Each occupant of a turbine-powered airplane is assumed to weigh 200 lb., thus allowing for stowed luggage and carry-on items. In the case of piston-engine airplanes, we assume each occupant weighs 170 lb. There is no luggage allowance for piston-engine airplanes.

► **Wing Loading** — MTOW divided by total wing area.

► **Power Loading** — MTOW divided by total rated horsepower or total rated thrust.

► **FAR Part 36 Certified Noise Levels** — Flyover noise in A-weighted decibels (dBA) for small and turboprop aircraft. For turbofan-powered aircraft, we provide EPNdB (effective perceived noise levels) for Lateral, Flyover and Approach.

Dimensions

► **External Length, Height and Span** dimensions are provided for use in determining hangar and/or tiedown space requirements.

Internal Length, Height and Width are based on a completed interior, including insulation, upholstery, carpet, carpet padding and fixtures. Note well: These dimensions are not based upon metal-to-metal or composite airframe gross interior measurements. They must reflect the actual net dimensions with all soft goods installed.

For small airplanes other than "cabin-class" models, the length is measured from the forward bulkhead ahead of the rudder pedals to the back of the rearmost passenger seat in its normal, upright position.

For so-called cabin-class and larger aircraft, we provide the net length of the cabin that may be occupied by passengers. It's measured from the aft side of the forward cabin divider to an aft point defined by the rear of the cabin floor capable of supporting passenger seats, the rear wall of an aft galley or lavatory, an auxiliary pressure bulkhead or the front wall of the pressurized baggage compartment. Some aircraft have the same net and overall interior length because the manufacturer offers at least one interior configuration with the aft-most passenger seat located next to the front wall of the aft luggage compartment.

For large aircraft, we also show the main seating area length, the prime section of the cabin occupied by passengers not including the galley, full-width lavatory(ies) or internal, inflight accessible baggage compartment.

The overall length of the passenger cabin is measured from the aft side of the forward cabin divider to the aft-most bulkhead of the cabin pressure vessel. The aft-most point is defined by the rear side of a baggage compartment that is accessible to passengers in flight or the aft pressure bulkhead. The overall length is reduced by the length of any permanent mounted system or structure that is installed in the fuselage ahead of the aft bulkhead. For example, some aircraft have full-fuselage cross-section fuel tanks mounted ahead of the aft pressure bulkhead.

Interior height is measured at the center of the cross section. It may be based on an aisle that is dropped several inches below the main cabin floor that supports the passenger seats. Some aircraft have dropped aisles of varying depths, resulting in less available interior height in certain sections of the cabin, such as the floor sections below the passenger seats.

Two width dimensions are shown for multiengine turbine airplanes--one at the widest part of the cabin and the other at floor level. The dimensions, however, are not completely indicative of the usable space in a specific aircraft because of individual variances in interior furnishings.

Power

Number of engines, if greater than one, and the abbreviated name of the manufacturer: CFE—ASE/GE joint venture; CFMI—CFM International; Cont—Teledyne Continental; GE; GE Honda; Hon—Honeywell Aerospace; IAE—International Aero Engines; Lyc—Textron Lycoming; PW—Pratt & Whitney; P&WC—Pratt & Whitney Canada; RR—Rolls-Royce; Wms Intl—Williams International.

► **Output** — Takeoff rated horsepower for propeller-driven aircraft or pounds thrust for turbofan aircraft. If an engine is flat rated, enabling it to produce takeoff rated output at a higher than ISA

**page 6-10 were reproduced from BCA*

(standard day) ambient temperature, the flat rating limit is shown as ISA+XXC. Highly flat-rated engines, i.e., engines that can produce takeoff rated thrust at a much-higher-than-standard ambient temperature, typically provide substantially improved high-density-altitude takeoff and climb, and high-altitude cruise performance.

► **Inspection Interval** is the longest, scheduled hourly major maintenance interval for the engine, either "t" for TBO or "c" for compressor zone inspection. OC is shown only for engines that have "on condition" repair or replace parts maintenance.

Weights (lb.)

Weight categories are listed as appropriate to each class of aircraft.

► **Max Ramp** — Maximum ramp weight for taxi.

► **Max Takeoff** — Maximum takeoff weight as determined by structural limits.

► **Max Landing** — Maximum landing weight as determined by structural limits.

► **Zero Fuel** — Maximum zero fuel weight, shown by "c," indicating the certified MZFW, or "b," a *BCA*-computed weight based on MTOW minus the weight of fuel required to fly 1.5 hr. at high-speed cruise.

► **Max ramp, max takeoff and max landing** weights may be the same for light aircraft that may only have a certified max takeoff weight.

► **EOW/BOW** — Empty operating weight is shown for piston-powered airplanes. Basic operating weight, which essentially is EOW plus required flight crew, is shown for turbine-powered airplanes. EOW is based on the factory standard weight, plus items specified in the "*BCA* Required Equipment List," less fuel and oil. BOW, in contrast, is based on the average EOW weight of the last 10 commercial deliveries, plus 200 lb. for each required crewmember. We require four 200-lb. crewmembers, three flight crew and one cabin attendant for ultra-long-range aircraft.

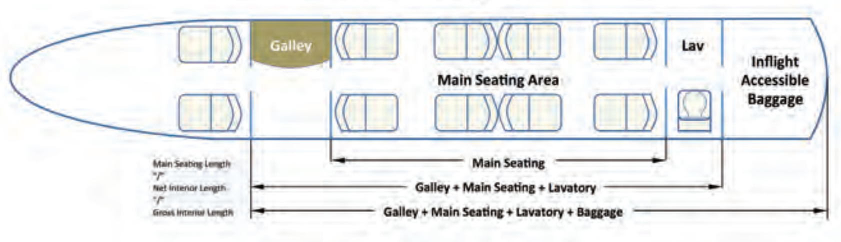
► **Max Payload** — ZZero fuel weight minus EOW or BOW, as appropriate. For piston-engine airplanes, max payload frequently is a computed value because it is based on the *BCA* ("b") computed maximum ZFW.

► **Max Fuel** — Usable fuel weight based on 6.0 lb. per U.S. gallon for avgas or 6.7 lb. per U.S. gallon for jet fuel. Fuel capacity includes optional, auxiliary and long-range tanks, unless otherwise noted.

► **Available Payload With Max Fuel** — Max ramp weight minus the tanks-full weight, not to exceed zero fuel weight minus EOW or BOW.

► **Available Fuel With Max Payload** — Max ramp weight minus zero fuel weight, not to exceed maximum fuel capacity.

Cabin Length



Limits

BCA lists V speeds and other limits as appropriate to the class of airplane. These are the abbreviations used on the charts:

► **VNE** — Never exceed speed (redline for piston-engine airplanes).

► **VNO** — Normal operating speed (top of the green arc for piston-engine airplanes).

► **VMO** — Maximum operating speed (redline for turbine-powered airplanes).

► **MMO** — Maximum operating Mach number (redline for turbofan-powered airplanes and a few turboprop airplanes).

► **FL/VMO** — Transition altitude at which Vmo equals Mmo (large turboprop and turbofan aircraft).

► **VA** — Maneuvering speed (except for certain large turboprop and all turbofan aircraft).

► **Vdec** — Accelerate/stop decision speed (multiengine piston and light multiengine turboprop airplanes).

► **Vmca** — Minimum control airspeed--airborne (multiengine piston and light multiengine turboprop airplanes).

► **Vso** — Maximum stalling speed, landing configuration (single-engine airplanes).

► **Vx** — Best angle-of-climb speed (single-engine airplanes).

► **Vxse** — Best angle-of-climb speed, one-engine inoperative (multiengine piston and multiengine turboprop airplanes under 12,500 lb.).

► **VY** — Best rate-of-climb speed (single-engine airplanes).

► **VYSE** — Best rate-of-climb speed, one-engine inoperative (multiengine piston and multiengine turboprop airplanes under 12,500 lb.).

► **V2** — Takeoff safety speed (large turboprops and turbofan airplanes).

► **VREF** — Reference landing approach speed (large turboprops and turbofan airplanes, four passengers, NBAA IFR reserves; eight passengers for ultra-long-range aircraft).

► **PSI** — Cabin pressure differential (all pressurized airplanes).

Airport Performance

Airplane Flight Manual takeoff runway performance is shown for sea-level, standard-day and 5,000ft, elevation/25C day, density altitude. All-engine takeoff distance (TO) is shown for single-engine and multiengine piston, and turboprop airplanes with an MTOW of less than 12,500 lb. Takeoff distances and speeds assume MTOW, unless otherwise noted, such as when takeoff weight is limited because of density altitude.

► **Accelerate/Stop (A/S)** distance is shown for small multiengine piston and small turboprop airplanes.

► **Takeoff Field Length (TOFL),** the greater of the one-engine inoperative (OEI) takeoff distance or the accelerate/stop distance, is shown for FAR Part 23 Commuter category and Part 25 airplanes. If the distances are equal, the TOFL is the balanced field length.

► **Landing Distance** is shown for Part 23 Commuter category and Part 25 Transport category airplanes. The landing weight is EOW plus three passengers or BOW plus four passengers as applicable. Fuel reserves on landing are based on 100-nm NBAA IFR reserves for Part 23 aircraft and 200-nm NBAA IFR reserves for Part 25 aircraft. We assume that 80,000+ lb. ultra-long-range aircraft will have eight passengers on board.

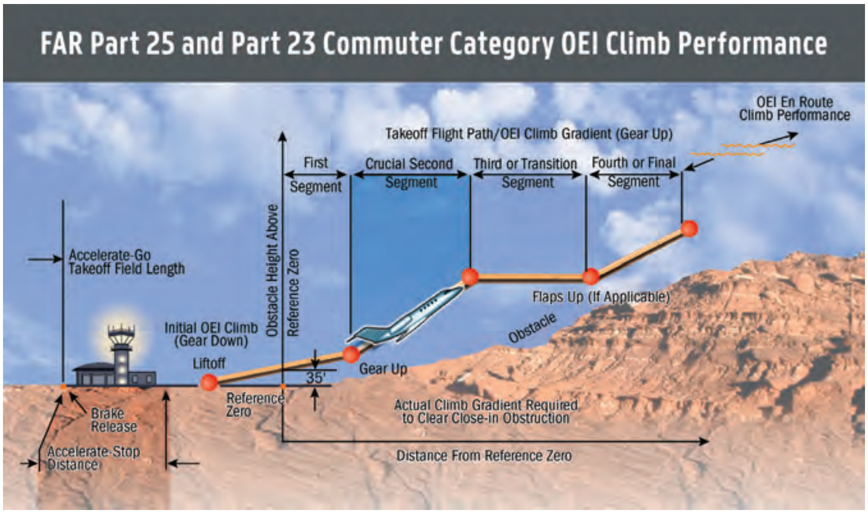
► **V2 and VREF** speeds are useful for reference when comparing the TOFL and landing distance numbers because they provide an indication of potential minimum-length runway performance when low RCR or runway gradient is a factor.

BCA lists two additional numbers for large turboprop- and turbofan-powered airplanes. First, we publish the Mission Weight, which is the lower of: (1) the actual takeoff weight with four passengers (eight passengers for ultra-long-range aircraft) and full fuel when departing from a 5,000-ft./25C airport, or (2) the maximum allowable takeoff weight when departing with the same passenger load and at the same density altitude.

For two-engine aircraft, the mission weight, when departing from a 5,000-ft., ISA+20C airport, may be less than the MTOW because of Part 25 second-segment, one-engine-inoperative, climb performance requirements. Aircraft with highly flat-rated engines are less likely to have a mission weight that is performance limited when departing from hot-and-high airports.

For three-engine aircraft, the mission weight usually is based on full tanks and the actual number of passengers, rather than being performance limited.

Second, we publish the NBAA IFR Range for the 5,000-ft. elevation, ISA+20C departure, assuming a transition into standard day, ISA flight conditions after takeoff. For purposes of computing NBAA IFR range, the aircraft is flown at the long-range cruise speed shown in the “Cruise” block or at the same speed as shown in the “Range” block. Missions assume four passengers and full tanks, unless otherwise noted. Thus, some aircraft, not weight limited when departing such hot-and-high airports, have longer ranges than when departing sea-level facilities because they start their climbs 5,000 ft. higher on their way up to initial cruise altitude.



FAR Part 25 and Part 23 Commuter Category OEI Climb Performance

Climb

The all-engine time-to-climb provides an indication of overall climb performance, especially if the aircraft has an all-engine service ceiling well above our sample top-of-climb altitudes. We provide the all-engine time to climb to one of three specific altitudes, based on type of aircraft departing at MTOW from a sea-level, standard-day airport: (1) FL 100 (10,000 ft.) for normally aspirated, single-engine and multiengine piston aircraft, plus pressurized single-engine piston aircraft and unpressurized turboprop aircraft; (2) FL 250 for pressurized single-engine and multiengine turboprop aircraft; or (3) FL 370 for turbofan-powered aircraft. The data is published as time-to-climb in minutes/climb altitude. For example, if a non-pressurized twin-engine piston aircraft can depart from a sea-level airport at MTOW and climb to 10,000 ft. in 8 min., the time to climb is expressed as 8/FL 100.

We also publish the initial all-engine climb feet-per-nautical-mile gradient, plus initial engine-out climb rate and gradient, for single-engine and multiengine pistons and turboprops with MTOWs of 12,500 lb. or less.

The one-engine-inoperative (OEI) climb rate for multiengine aircraft at MTOW is derived from the Airplane Flight Manual. OEI climb rate and gradient is based on landing gear retracted and wing flaps in the takeoff configuration used to compute the published takeoff distance. The climb gradient for such airplanes is obtained by dividing the product of the climb rate (fpm) in the AFM times 60 by the Vy or Vyse climb speed, as appropriate.

The OEI climb gradients we show for FAR Part 23 Category C and Part 25 Transport category aircraft are the second-segment net climb performance numbers published in the AFMs. Please note: The AFM net second-segment climb performance numbers are adjusted downward by 0.8% to compensate for variations in pilot technique and ambient conditions.

The OEI climb gradient is computed at the same flap configuration used to calculate the takeoff field length.

Ceilings (ft.)

► **Maximum Certificated Altitude —** Maximum allowable operating altitude determined by airworthiness authorities.

► **All-Engine Service Ceiling —** Maximum altitude at which at least a 100-fpm rate of climb can be attained, assuming the aircraft departed a sea-level, standard-day airport at MTOW and climbed directly to altitude.

► **OEI (Engine-Out) Service Ceiling —** Maximum altitude at which a 50-fpm rate of climb can be attained, assuming the aircraft departed a sea-level, standard-day airport at MTOW and climbed directly to altitude.

► **Sea-Level Cabin (SLC) Altitude —** Maximum cruise altitude at which a 14.7-psia, sea-level cabin altitude can be maintained in a pressurized airplane. Note: Some aircraft equipped with digital pressurization systems have altitude-proportionate cabin pressurization scheduling that limits sea-level cabin altitude to relatively low cruise altitudes.

Cruise

Cruise performance is computed using EOW with four occupants or BOW with four passengers and one-half fuel load. Ultra-long-range aircraft carry eight passengers for purposes of computing cruise performance. Assume 170 lb. for each occupant of a piston-engine airplane and 200 lb. for each occupant of a turbine-powered aircraft.

► **Long Range —** True airspeed (TAS), fuel flow in pounds/hour, flight level (FL) cruise altitude and specific range for long-range cruise by the manufacturer.

► **Recommended (Piston-Engine Airplanes) —** TAS, fuel flow in pounds/hour, FL cruise altitude and specific range for normal cruise performance specified by the manufacturer.

► **High Speed —** TAS, fuel flow in pounds/hour, FL cruise altitude and specific range for short-range, high-speed performance specified by the manufacturer.

Speed, fuel flow, specific range and altitude in each category are based on one mid-weight cruise point, and these data reflect standard-day conditions. They are not an average for the overall mission, and they are not representative of the above standard-day temperatures at cruise altitudes commonly encountered in everyday operations.

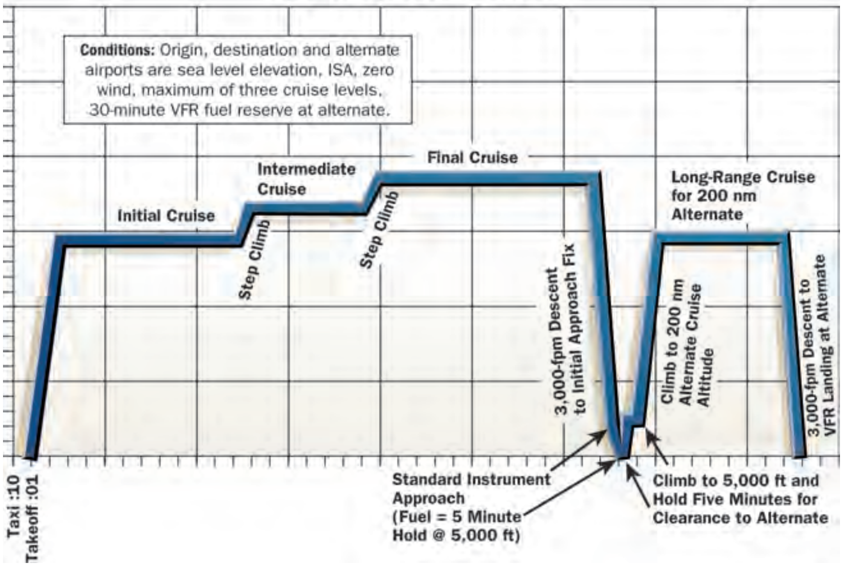
BCA imposes a 12,000-ft. maximum cabin altitude requirement on CAR3/FAR Part 23 normally aspirated aircraft. Non-pressurized, turbine-powered or turbocharged airplanes are limited to FL 250, providing they are fitted with supplemental oxygen systems having sufficient capacity for all occupants for the duration of the mission. Pressurized CAR 3/FAR Part 23 aircraft are limited to a maximum cruise altitude at which cabin altitude can be maintained at 10,000 ft. or below. For FAR Part 23 Category C and Part 25 aircraft, the maximum cabin altitude for computing cruise performance is 8,000 ft.

To conserve space, we use flight levels (FL) for all cruise altitudes, which is appropriate considering that we assume standard-day ambient temperature and pressure conditions. Cruise performance is subject to *BCA*’s verification.

Range

BCA shows various paper missions for each aircraft that illustrate range versus payload tradeoffs, runway and cruise performance, plus fuel efficiency. Similar to the cruise profile calculations, *BCA* limits the maximum altitude to 12,000 ft. for normally aspirated, non-pressurized CAR3/FAR Part 23 aircraft, 25,000 ft. for non-pressurized

NBAA IFR RANGE PROFILE



turbocharged or turbine airplanes with supplemental oxygen, 10,000-ft. cabin altitude for pressurized CAR 3/FAR Part 23 airplanes and 8,000-ft. cabin altitude for FAR Part 23 Category C or FAR Part 25 aircraft.

► **Seats-Full Range (Single-Engine Piston Airplanes) —** Based on typical executive configuration with all seats filled with 170-lb. occupants, with maximum available fuel less 45-min. IFR fuel reserves. We use the lower of seats full or maximum payload.

► **Tanks-Full Range (Single-Engine Piston Airplanes) —** Based on one 170-lb. pilot, with full fuel less 45-min. IFR fuel reserves.

► **Maximum Fuel With Available Payload (Single-Engine Turboprops) —** Based on BOW, plus full fuel and the maximum available payload up to maximum ramp weight. Range is based on arriving at destination with NBAA IFR fuel reserves, but only a 100-mi. alternate is required.

► **Ferry (CAR 3/FAR Part 23 Category A and B) —** BBased on one 170-lb. pilot, with maximum fuel less 45-min. IFR fuel reserves.

► **Please note:** None of the missions for piston-engine aircraft include fuel for diverting to an alternate. However, single-engine turboprops are required to have NBAA IFR fuel reserves, but only a 100-mi. alternate is required.

NBAA IFR range format cruise profiles, having a 200-mi. alternate, are used for FAR Part 25 Transport category turbine-powered aircraft. In the case of Part 23 turboprops, including those certified in Category B and C, and Part 23 turbofan aircraft, only a 100-mi. alternate is needed. The difference in alternate requirements should be kept in mind when comparing range performance of various classes of aircraft.

► **Available Fuel With Max Payload (Multiengine Turbine Airplanes) —** Based on aircraft loaded to maximum ZFW, with maximum available fuel up to maximum ramp weight, less NBAA IFR fuel reserves at destination.

► **Available Payload With Max Fuel (Multiengine Turbine Airplanes) —** Based on BOW plus full fuel and maximum available payload up to maximum ramp weight. Range based on NBAA IFR reserves at destination.

► **Full/Max Fuel With Four Passengers (Multiengine Turbine Airplanes) —** Based on BOW plus four 200-lb. passengers and the lesser of full fuel or maximum available fuel up to maximum ramp weight. Ultra-long-range aircraft must have eight passengers on board.

► **Ferry (Multiengine Turbine Airplanes) —** Based on BOW, required crew and full fuel, arriving at destination with NBAA IFR fuel reserves.

We allow 2,000-ft.-increment step climbs above the initial cruise altitude to improve specific range performance. The altitude shown in the range section is the highest cruise altitude for the trip – not the initial cruise or mid-mission altitude.

The range profiles are in nautical miles, and the average speed is computed by dividing that distance by the total flight time or weight-off-wheels time en route. The Fuel Used or Trip Fuel includes the fuel consumed for start, taxi, takeoff, cruise, descent and landing approach, but not after-landing taxi or reserves.

The Specific Range is obtained by dividing the distance flown by the total fuel burn. The Altitude is the highest cruise altitude achieved on the specific mission profile shown.

Missions

Various paper missions are computed to illustrate the runway requirements, speeds, fuel burns and specific range, plus cruise altitudes. The mission ranges are chosen to be representative for the airplane category. All fixed-distance missions are flown with four passengers on board, except for ultra-long-range airplanes, which have eight passengers on board. The pilot is counted as a passenger on board piston-engine airplanes. If an airplane cannot complete a specific fixed-distance mission with the appropriate payload, *BCA* shows a reduction of payload in the Remarks section or marks the fields NP (not possible) at our option.

Runway performance is obtained from the Airplane Flight Manual. Takeoff distance is listed for single-engine airplanes; accelerate/stop distance is listed for piston-twins and light turboprops; and takeoff field length, which often corresponds to balanced field length, is used for FAR Part 23 Category C and Part 25 large Transport category airplanes.

Flight Time (takeoff to touchdown, or weight-off-wheels, time) is shown for turbine airplanes. Some piston-engine manufacturers also include taxi time, resulting in a chock-to-chock, Block Time measurement. Fuel Used, though, is the actual block fuel burn for each type of aircraft, but it does not include fuel reserves. The cruise altitude shown is that which is specified by the manufacturer for fixed-distance missions.

► **200 nm —** (Piston-engine airplanes).

► **500 nm —** (Piston-engine airplanes).

► **300 nm —** (Turbine-engine airplanes, except ultra-long-range).

► **600 nm —** (Turbine-engine airplanes, except ultra-long-range).

► **1,000 nm —** (All turbine-engine airplanes).

► **3,000 nm —** (Ultra-long-range turbine-engine airplanes).

► **6,000 nm —** (Ultra-long-range turbine-engine airplanes).

Remarks

In this section, *BCA* generally includes the base price, if it is available or applicable; the certification basis and year; and any notes about estimations, limitations or qualifications regarding specifications, performance or price. All prices are in 2022 dollars, FOB at a U.S. delivery point, unless otherwise noted. The certification basis includes the regulation under which the airplane was originally type certified, the year in which it was originally certified and, if applicable, subsequent years during which the airplane was re-certified.

General

The following abbreviations are used throughout the tables: **"NA"** means not available; "—" indicates the information is not applicable; and **"NP"** signifies that specific performance is not possible. **BCA**

Manufacturer			Gulfstream Aerospace	Bombardier	Airbus	Gulfstream Aerospace
Model			**G800 GVIII-G800**	**Global 7500 BD-700-2A12**	**ACJTwoTwenty BD500-1A10***	**G700 GVIII-G700**
BCA **Equipped Price**			*$72,500,000*	$75,000,000	$78,000,000**	*$78,000,000*
Character-istics		Seating	*4+16/19/19*	4+17/19/19	5+8/19	*4+16/19/19*
		Wing Loading/Power Loading	*82.2/2.89*	91.6/3.04	116.2/2.88	*83.8/2.95*
		Noise (EPNdB): Lateral/Flyover/Approach	*NA/NA/NA*	91.6/80.3/88.8	87.9/79.6/91.3	*NA/NA/NA*
External Dimensions (ft.)		Length	*99.8*	111.0	114.8	*109.9*
		Height	*25.5*	27.0	38.7	*25.4*
		Span	*103.0*	104.0	115.1	*103.0*
Internal Dimensions (ft.)		**Length:** Main Seating/Net/Gross	*32.7/46.8/53.6*	36.0/54.4/60.6	51.6/78.1/78.1	*40.8/56.9/63.7*
		Height/Dropped Aisle Depth	*6.3/flat floor*	6.2/flat floor	6.9/flat floor	*6.3/flat floor*
		Width: Max/Floor	*8.2/6.7*	8.0/6.8	10.8/10.1	*8.2/6.7*
Baggage		**Internal:** Cu. ft./lb.	*195/2,500*	195/2,500	150***/NA	*195/2,500*
		External: Cu. ft./lb.	*—/—*	—/—	177/2,300	*—/—*
Power		Engines	*2 RR Pearl 700*	2 GE Passport 20-19BB1A	2 P&W PW1524G	*2 RR Pearl 700*
		Output (lb. each)/Flat Rating	*18,250/NA*	18,920/ISA+15C	24,400/ISA+15C	*18,250/NA*
		Inspection Interval/Manu. Service Plan Interval	*NA/—*	OC/—	OC/—	*NA/—*
Weights (lb.)		Max Ramp	*106,000*	115,100	141,000	*108,000*
		Max Takeoff	*105,600*	114,850	140,500	*107,600*
		Max Landing	*83,500*	87,600	112,500	*83,500*
		Zero Fuel	*60,500c*	67,500c	108,000c	*62,750c*
		BOW	*54,300*	61,700	87,675***	*56,365*
		Max Payload	*6,200*	5,800	20,325	*6,385*
		Useful Load	*51,700*	53,400	53,325	*51,635*
		Max Fuel	*49,400*	51,510	50,578	*49,400*
		Available Payload w/Max Fuel	*2,300*	1,890	2,747	*2,235*
		Available Fuel w/Max Payload	*45,500*	47,600	33,000	*45,250*
Limits		MMO	*0.925*	0.925	0.820	*0.925*
		Trans. Alt. FL/VMO	*FL 290/340*	FL 350/320	FL 275/330	*FL 290/340*
		PSI/Sea-Level Cabin	*10.7/31,900*	10.3/30,125	9.3/NA	*10.7/31,900*
Airport Perfor-mance		TOFL (SL elev./ISA temp.)	*6,000*	5,760	5,478	*6,250*
		TOFL (5,000-ft. elev.@25C)	*9,872*	8,679	8,706	*9,977*
		Mission Weight	*105,600*	114,850	140,500	*107,600*
		NBAA IFR Range	*8,025*	7,800	5,686	*7,510*
		V2	*NA*	137	NA	*NA*
		VREF	*115*	108	110	*1,178*
		Landing Distance	*2,500*	2,240	2,300	*2,570*
Climb		Time to Climb/Altitude	*17/FL 370*	20/FL 370	23/FL 370	*20/FL 370*
		FAR 25 Engine-Out Rate (fpm)	*NA*	NA	NA	*NA*
		FAR 25 Engine-Out Gradient (ft./nm)	*NA*	NA	NA	*NA*
Ceiling (ft.)		Certificated	*51,000*	51,000	41,000	*51,000*
		All-Engine Service	*NA*	43,000	41,000	*NA*
		Engine-Out Service	*NA*	26,600	24,000	*NA*
Cruise	**Long Range**	TAS	*488*	488	432	*488*
		Fuel Flow	*2,800*	2,983	3,507***	*2,992*
		Altitude	*FL 450*	FL 450	FL 410	*FL 450*
		Specific Range	*0.174*	0.164	0.123	*0.163*
	High Speed	TAS	*516*	516	465	*516*
		Fuel Flow	*3,438*	3,207	3,507***	*3,698*
		Altitude	*FL 430*	FL 450	FL 410	*FL 450*
		Specific Range	*0.150*	0.161	0.118	*0.140*
NBAA IFR Ranges (200-nm alternate)	**Max Payload** (w/available fuel)	Nautical Miles	*7,050*	6,930	3,105	*6,560*
		Average Speed	*482*	482	422	*482*
		Trip Fuel	*42,522*	44,501	28,150	*42,030*
		Specific Range/Altitude	*0.166/FL 490*	0.156/FL 510	0.110/FL 390	*0.156/FL 490*
	Max Fuel (w/available payload)	Nautical Miles	*7,952*	7,700	5,684	*7,450*
		Average Speed	*483*	482	427	*483*
		Trip Fuel	*46,526*	48,512	46,528***	*46,301*
		Specific Range/Altitude	*0.171/FL 510*	0.159/FL 510	0.122/FL 410	*0.161/FL 510*
	Eight Passengers (w/available fuel)	Nautical Miles	*8,025*	7,770	5,724	*7,510*
		Average Speed	*483*	483	427	*483*
		Trip Fuel	*46,544*	48,526	46,550	*46,319*
		Specific Range/Altitude	*0.172/FL 510*	0.160/FL 510	0.123/FL 410	*0.162/FL 510*
	Ferry	Nautical Miles	*8,190*	7,903	5,763	*7,660*
		Average Speed	*483*	483	427	*483*
		Trip Fuel	*46,587*	48,570	46,571	*46,364*
		Specific Range/Altitude	*0.176/FL 510*	0.163/FL 510	0.124/FL 410	*0.165/FL 510*
Missions (8 passengers)	**1,000 nm**	Runway	*3,500*	3,375	3,239	*3,100*
		Flight Time	*2+10*	2+11	2 + 34	*2+10*
		Fuel Used	*5,621*	6,191	8,004	*5,993*
		Specific Range/Altitude	*0.178/FL 510*	0.162/FL 510	0.125/FL 410	*0.167/FL 510*
	3,000 nm	Runway	*3,660*	3,510	3,654	*3,400*
		Flight Time	*6+17*	6+18	7 + 10	*6+17*
		Fuel Used	*15,396*	17,002	22,814	*16,564*
		Specific Range/Altitude	*0.195/FL 510*	0.176/FL 510	0.131/FL 410	*0.181/FL 510*
Remarks		Certification Basis	*FAR 25 pending; EASA CS 25 pending*	FAR 25, 2018; EASA CS 25, 2019	FAR 25, Q4 2023 NBAA IFR Ranges for FAR Part 25, 200-nm alternate *Also available with PW1521G engines rated at 21,000 lbf; includes five additional center tanks and VIP cabin. ***BCA* estimate. ***ACJ estimate.	*FAR 25 pending; EASA CS 25 pending*

Leading the Journey Towards Sustainable Aviation

Aviation has given us the possibility to explore all four corners of our planet. To connect with friends and to meet new ones—anywhere. To feel the thrill of seeing our world from 41,000 feet above.

Today, we know our love of air travel also comes at a cost: the aviation industry represents approximately 2.5% of global human-induced CO_2 emissions. But aviation is not the problem. Emissions are the problem.

At Airbus, we are convinced that carbon-neutral air travel is not only possible, but achievable in our lifetime. This is why we are taking a more robust approach to environmental protection and sustainability.

We are committed to leading the decarbonization of the aviation sector. This includes reducing the CO_2 emissions of our aircraft, as well as our industrial environmental footprint at sites worldwide and throughout our supply chain.

A Lifecycle Approach to Environmental Impact

We strongly believe that a successful business is a responsible business. Our approach to environmental responsibility starts at the design stage. We select the right materials and use them efficiently during production. After aircraft delivery, we continue to take the environment into account by optimizing aircraft operations and recycling end-of-life aircraft.

Design: We significantly invest in R&D to design fuel-efficient aircraft that achieve better environmental performance, including reduced NOx and CO_2 emissions.

Production and Manufacturing: We use the environmental management system ISO 14001 to manage the footprint of our industrial operations.

Sustainable Supply Chain: We work closely with our suppliers to select materials sourced ethically and responsibly with minimal environmental impact.

Operations: We develop sustainable fuels and air traffic management solutions to achieve optimal fuel savings throughout our aircraft's entire service lifespan.

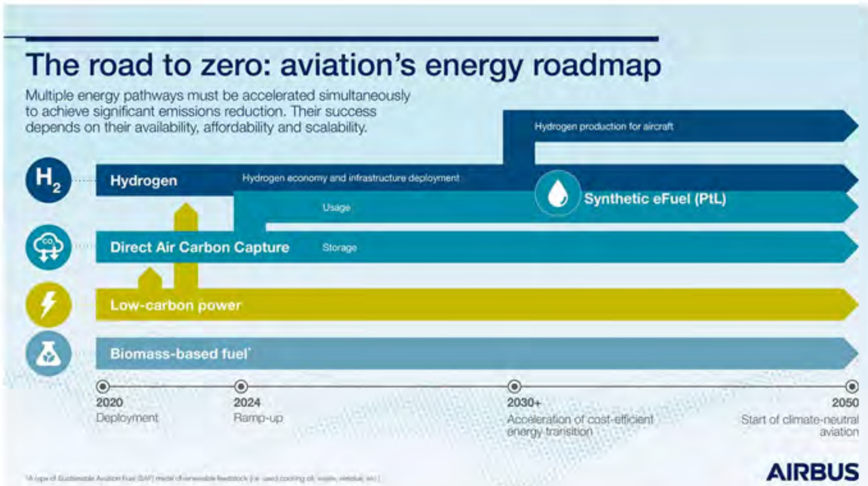
End-of-Life Recycling: We dismantle our aircraft in a manner that maximizes reuse and recycling, and focuses on the safe disposal of non-recyclable parts.

Transforming Aviation's Energy Mix

To achieve climate neutrality, the aviation industry must rapidly transform its energy mix. At Airbus, our climate strategy simultaneously accelerates several high-potential pathways while fostering the development of a new energy ecosystem.

Airbus is targeting disruptive CO_2 reductions over the medium to long term. Fostering new energy pathways is vital to making this a reality.

All Airbus commercial aircraft and helicopters are certified to fly with a 50% blend of SAF. Our goal is to achieve certification of 100% SAF by 2030.



Sustainable Aviation Fuel: These alternative fuels are designed for use as a "drop-in" replacement for traditional fossil-based fuels. Today, SAF are the only alternative fuels certified for use (up to 50% blend) in current aircraft.

Biomass-based fuel: This type of SAF is made of biomass – plant or animal material such as used cooking oil, waste, residue, etc. – used for energy production.

Power-to-Liquid (PtL) synthetic e-fuel: This type of SAF takes carbon dioxide from the atmosphere – for example, via Direct Air Carbon Capture – and synthesizes it with hydrogen extracted from water. This approach transforms greenhouse gas into a raw material from which a fossil-fuel substitute can be produced with the help of electricity from renewable sources.

Hydrogen: This energy carrier can store massive amounts of energy – up to three times more than traditional jet fuel. Hydrogen can be used either as "fuel" in modified gas-turbine engines or in fuel cells to generate electricity or power and heat.

A Company-Wide Approach to Sustainability

Sustainability at Airbus means uniting and safeguarding the world in a safe, ethical, and socially and environmentally responsible way. It is at the heart of our purpose to pioneer sustainable aviation for a safe and united world and is fully integrated into our corporate strategy.

We are working to deliver on our ambition to bring the world's first zero-emission commercial aircraft to market by 2035. Our approach is not only ambitious, but rather, a seismic shift for our industry.

AIRBUS