SAFETY BULLETIN

April 2021

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contact@airflex-ingenierie.fr

Notre Safety Bulletin n'est pas une institution pour les professionnels de l'aéronautique, ni une analyse de chacun des règlements. Il n'a pour vocation que d'informer les utilisateurs de moyens aériens sur les diverses activités de l'aéronautique.

Il appartient à chacun d'utiliser ces informations dans le cadre de ses activités.

Soyez professionnel, préparez vos voyages par une petite analyse des conséquences d'un déplacement.

Our Safety Bulletin is not an institution for aviation professionals, nor is it an analysis of each of the regulations. Its purpose is only to inform users of air assets about the various activities of aeronautics.

Cabinet d'Expertise en Aéronautique - Inscrit près la cour d'appel d'Amiens – Indépendant de l'EASA

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It is up to everyone to use this information in the course of their activities.

Be professional, prepare your travels with a little analysis of the consequences of a trip.

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Subject of the Month:

EASA approves the first Virtual Reality (VR) based Flight Simulation Training Device

COLOGNE, April 26, 2021 - The European Union Aviation Safety Agency (EASA) has granted the first certificate for a Virtual Reality (VR) based Flight Simulation Training Device (FSTD).

The device, for rotorcraft pilots, enhances safety by opening up the possibility of practising risky manoeuvres in a virtual environment. This addresses a key risk area in rotorcraft operations, where statistics show that around 20% of accidents occur during training flights. The device was developed and built by VRM Switzerland (VRMotion Ltd.)

“This is a significant milestone in the evolution of Flight Simulation Training Devices,” said Jesper Rasmussen, EASA Flight Standards Director. “The Agency is pursuing the modernisation of its regulation for training devices to reflect their actual capability and technology advancement. This evolution will make a wider range of cost-effective training devices available to complement Full Flight Simulators and is being driven in part by training needs for new Vertical Take Off & Landing (VTOL) aircraft.

“This also aligns with the Safety Objectives of the EASA Rotorcraft Safety Roadmap to review the most critical training scenarios and promote the use of simulators for high-risk training operations.”

The suitability of the VR concept was verified through a training evaluation program involving pilots from industry and aviation authorities, including helicopter flight instructors and test pilots. This evaluation confirmed the suitability of the VR concept for training purposes, particularly for cases such as autorotation, hovering and slope landing where exact height perception and wide field of view are required.

“Developing a new technology that revolutionises aviation training was a challenging and ambitious project,” said Fabi Riesen, CEO VRM Switzerland. “We were delighted to work with pilots of many different nationalities on the evaluation. Our VR concept sets a benchmark which meets the high requirements in the aviation industry. This journey was highly motivating and super interesting for all of us!”

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As this is the first VR based FSTD qualification, the process applied by EASA had to be adapted to ensure an equivalent safety level compliant with the FSTD certification specifications. EASA applied Special Conditions from the existing regulations that take account of the specificities of the new technology adapted to cockpit, display and motion systems.

The FSTD is qualified as Flight and Navigation Procedures Trainer (FNPT) level II for a Robinson R22 Beta II helicopter, the most used helicopter worldwide for the initial training of helicopter pilots.

EASA completes regulatory updates on Global Reporting Format for runway conditions

With the publication of EASA's Agency Decision ED Decision 2021/005/R, the Agency completes its work on the implementation of the Global Reporting Format for runway conditions in Europe, by adding or amending the related means of compliance (AMC) and guidance material (GM) of the Air Operations Regulation.

The same Agency Decision also covers means of compliance and guidance necessary for the implementation of additional topics such as in-flight recording for light aircraft, allowing recording of flight data at an affordable cost for light aeroplanes, performance-based communication and surveillance (PBCS) enabling a more efficient use of airspace.

The implementation of this Agency Decision will enhance safety in European skies.

EUROCONTROL Think Paper #10: Flying the 'perfect green flight' – How can we make every journey as environmentally friendly as possible?

We would like to share with you our latest EUROCONTROL Think Paper, which looks at what all aviation actors can do now and in the medium term to improve aviation sustainability and make every air journey as close to a 'perfect green flight' as possible.

Using exclusive EUROCONTROL aviation data and analysis, our tenth in a series of thought-provoking Think Papers explains why is it not always possible to fly a 'perfect green flight' today, shows which measures have the greatest potential to improve the sustainability of aviation now and in the future, and sets out what needs to be done to make every single flight greener, by taking a close look at every aspect of a flight – before, during and immediately after.

We find that purely using existing technology, every flight operating in Europe could become on average over 25% greener by 2030, with CO2 emissions reduced by up to 25.8% through a combination of measures including increased use of Sustainable Aviation Fuel, better use of fuel-efficient airspace and technological solutions by all European ATM network stakeholders, and fleet modernisation by airlines.

This is strong progress towards Net Zero by 2050. We predict that emerging aircraft technologies in the form of hybrid, electric and hydrogen airplanes will transform aviation over the period 2030-2050, enabling

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aviation to meet its climate-neutrality goal by 2050. By 2050, these new airplanes will be increasingly prevalent on short to medium haul sectors. In parallel, 83% of fuel used by 2050 will be SAF, with SAF

1st Webinar on Fatigue Risk Management in Cargo and On-Demand Operations

EASA is organising a Webinar on fatigue risk management (FRM) in cargo and on-demand operations. The event is primarily intended for representatives from national aviation authorities, the European aviation industry and crew organisations and will take place on March 15, 2021 from 13:00 to 16:00.

This interactive online workshop will include practical examples of implementations of FRM in cargo / on-demand operations and a presentation of state-of-the-art technology to support FRM.

With the kind support of Cargolux, the European Cockpit Association and Thales.

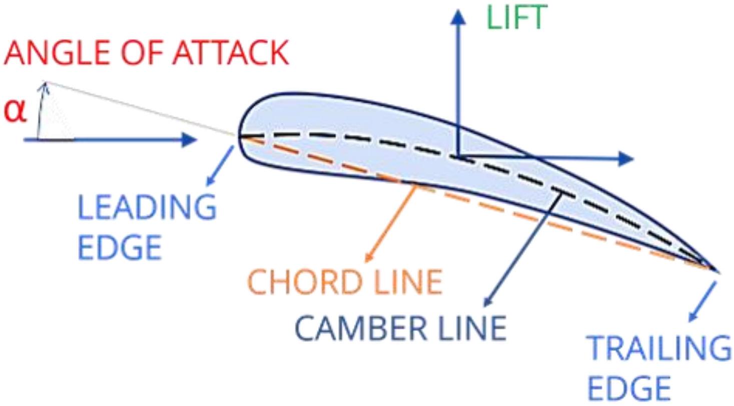
see attached

Angle of Attack Awareness

The General Aviation Joint Steering Committee's (GAJSC) loss of control workgroup believes that a lack of awareness, with respect to angle of attack (AOA), has resulted in the loss of aircraft control and contributed to fatal GA accidents. The GAJSC also maintains that increasing a pilot's awareness of the aerodynamic effects of AOA and available technology will help reduce the likelihood of inadvertent loss of control.

What is Angle of Attack?

The angle of attack is the angle at which the chord of an aircraft's wing meets the relative wind. The chord is a straight line from the leading edge to the trailing edge.



What's So Critical About AOA?

At low angles of attack, the airflow over the top of the wing flows smoothly and produces lift with a relatively small amount of drag. As the AOA increases, both lift and drag increase; however, above a wing's critical AOA, the flow of air separates from the upper surface and backfills, burbles, and eddies, which reduces lift and increases drag. This condition is a stall, which can lead to loss of control and an abrupt loss of altitude if the AOA is not reduced.

It is important for the pilot to understand that a stall is the result of exceeding the critical AOA, not of insufficient airspeed. The critical AOA is an aerodynamic constant for a given airfoil in a given configuration. The velocity of the relative wind does not matter; the airfoil will ALWAYS stall when the critical AOA is reached.

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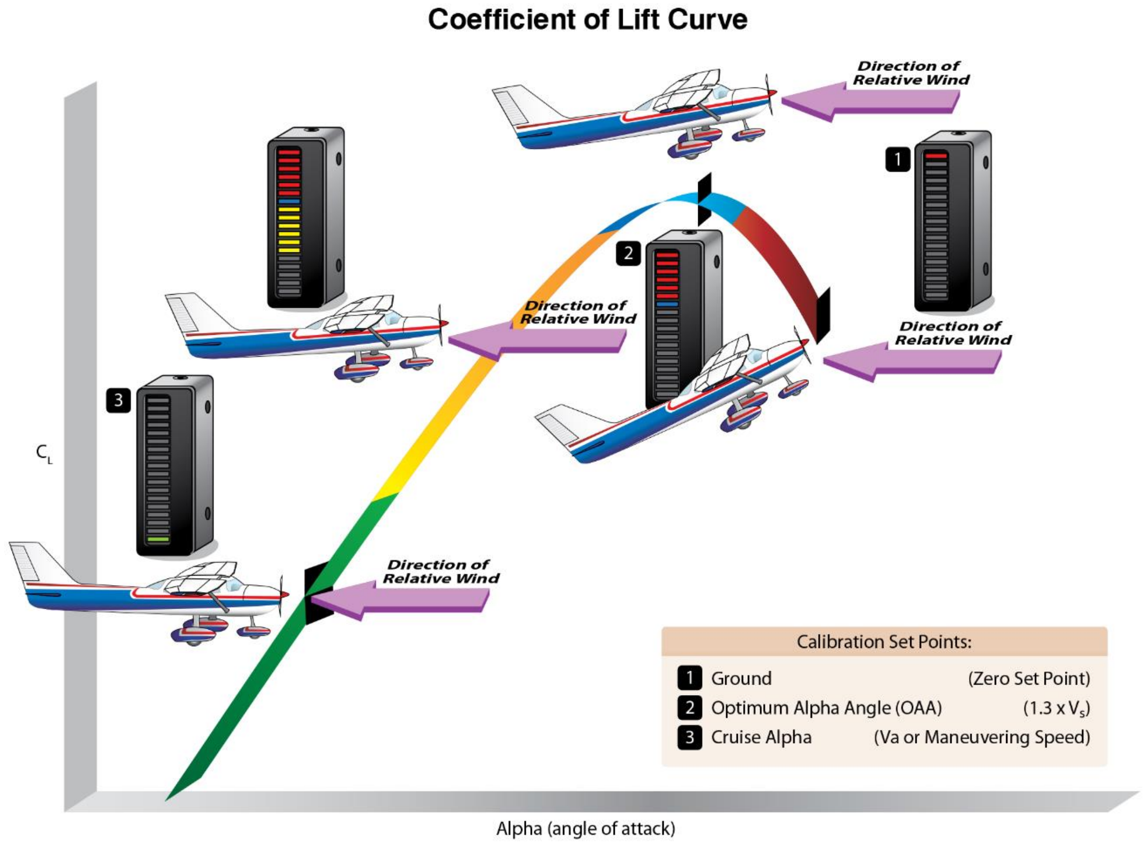

An AOA indicator can have several benefits when installed in general aviation aircraft, not the least of which is increased situational awareness. These devices measure several parameters simultaneously and provide a visual image to the pilot of the current AOA. They also tell the pilot how close he or she is getting to the critical AOA. Increase the AOA or increase pitch to a yellow indication and lift will go up. Decrease pitch to a green indication translates to less lift being made. This is why airplanes cruise at a low AOA. However, upon slowing down, increase the AOA to compensate for the decrease in lift formed by the airflow speed. Also, every AOA equates to a specific airspeed once the plane is allowed to settle down. For each individual airspeed, a specific AOA is required to support flight.

Please also note that the term "stalling speed" can be misleading, as this speed is often discussed when assuming 1G flight at a particular weight and configuration. Increased load factor directly affects stall speed (as do other factors such as gross weight, center of gravity, and flap setting). Therefore, it is possible to stall the wing at any airspeed, at any flight attitude, and at any power setting.

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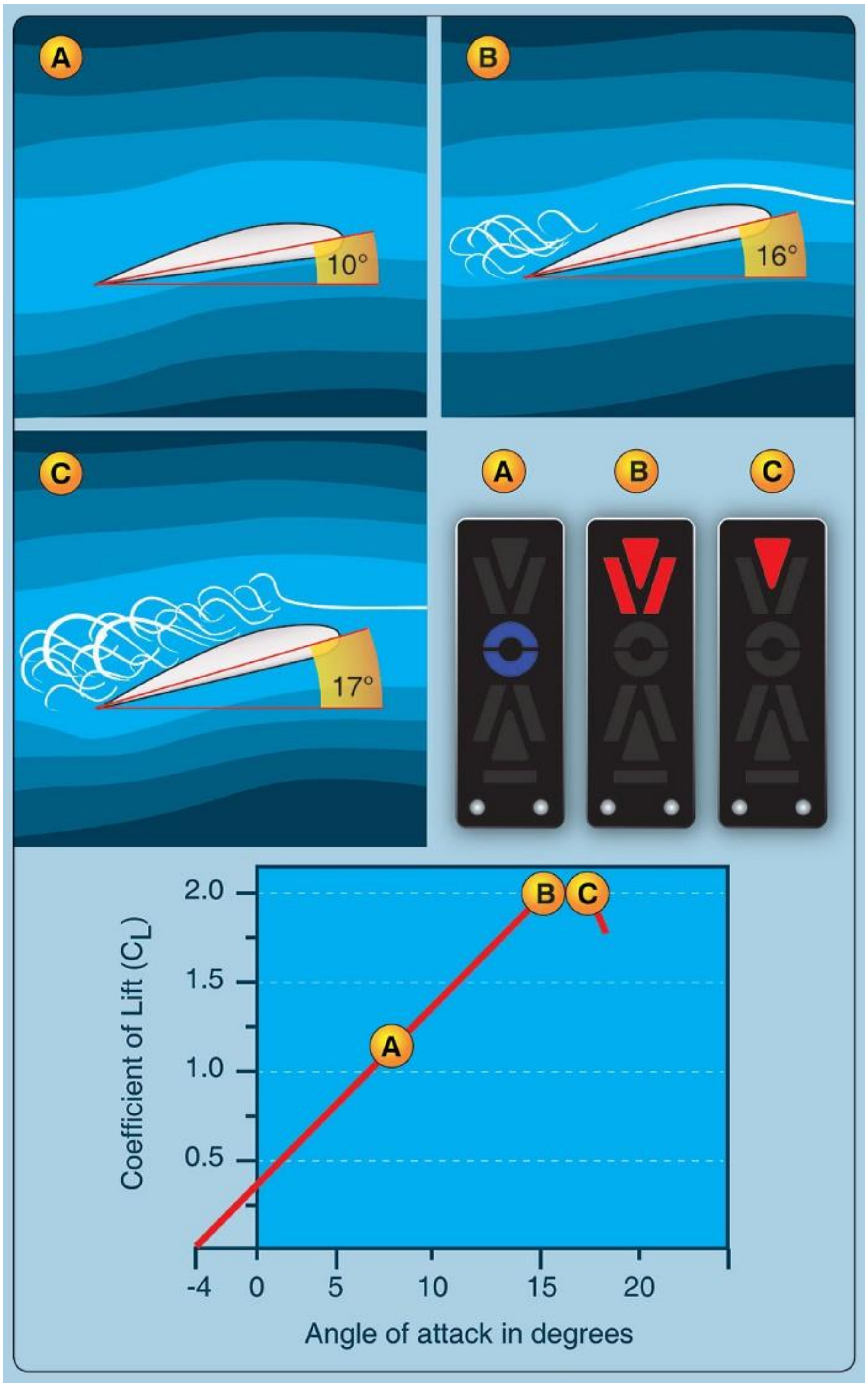

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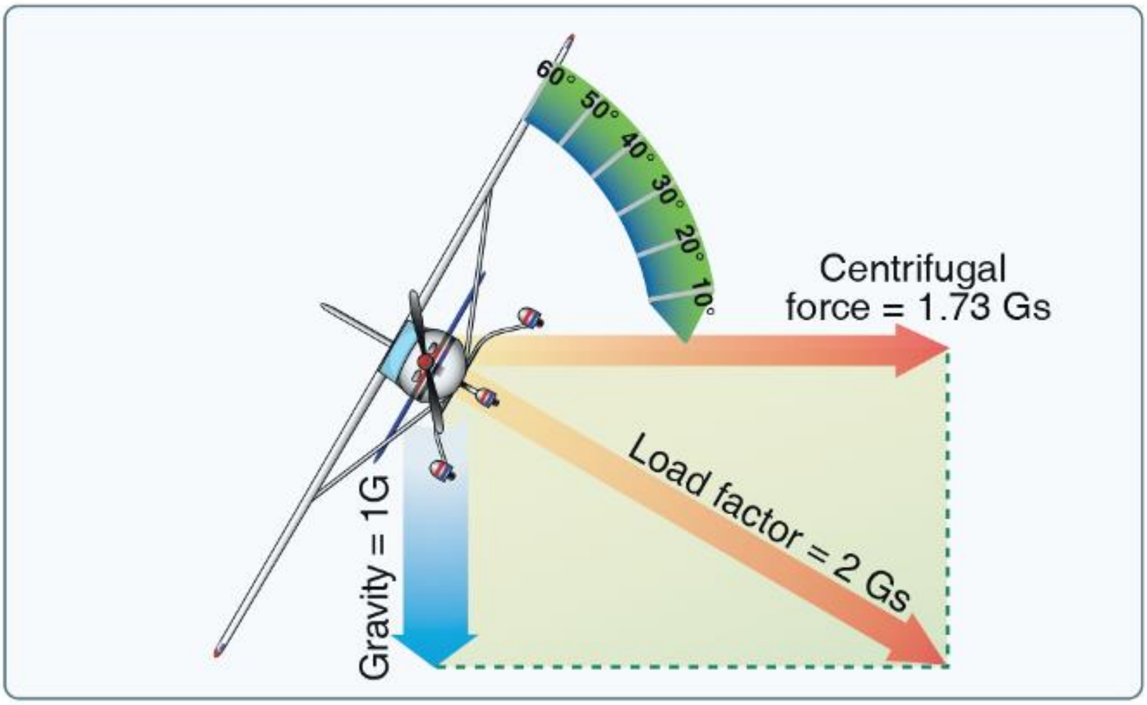
AOA in Steep Turns



Increased load factor can directly affect stall speed. For example, if a pilot maintains airspeed and rolls into a coordinated, level 60° banked turn, the load factor is 2Gs, and the airplane will stall at a speed that is 40% higher than the straight-and-level stall speed.

Due to the increased aerodynamic loading of the aircraft in a steep turn, the wing is much closer to the critical AOA. Here are a few things you'll want to remain aware of during a steep turn:

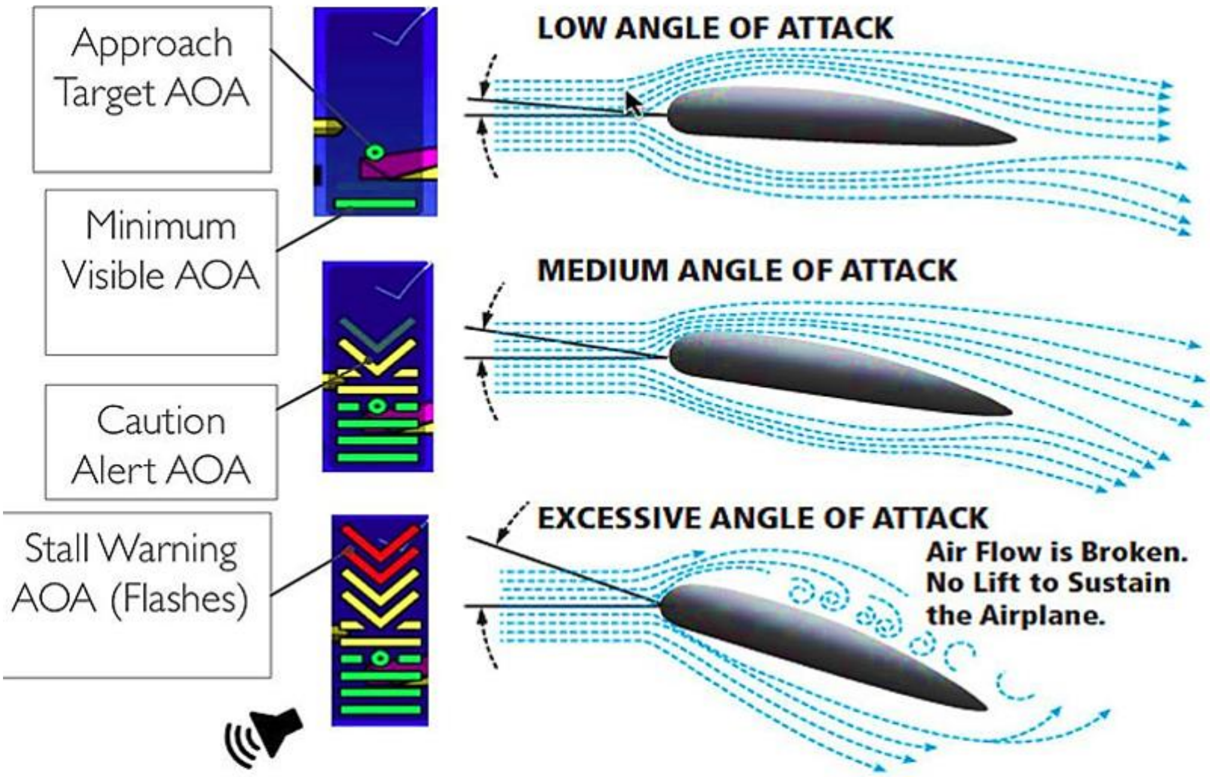
- The increase in pitch angle may be much smaller than expected to stall the wing.
- The indicated airspeed at the critical AOA is significantly higher than in normal flight.
- The increased load (i.e., aerodynamic loading) of the airplane requires greater lift which can be created by increasing airspeed or increasing the AOA.
- Due to the increased aerodynamic loading, the stall sequence is condensed. The progression from indication, to buffeting, to fully stalled can be very rapid.

Make it a point to practice stalls and steep turns at different configurations during your next flight training opportunity.

AOA Indicators

Since we know that stall speed changes with the aircraft's configuration (e.g., cruise, landing, etc.) and aerodynamic loads, the use of an AOA indicator can help provide a more reliable indication of airflow over the wing, regardless of its configuration. Without it, AOA is essentially "invisible" to pilots.

An AOA indicator can be used to get the pilot's attention (via audio and/or low-cost stick shakers) even if the pilot is not looking at it. This focuses the pilot's attention on where it needs to be to avoid the stall. It can also help when used in conjunction with airspeed and existing stall warning systems, when available.



The AOA indicator delivers critical information visually or through an aural tone to indicate the actual safety margin above an aerodynamic stall. The more efficiently the airfoil operates; the larger stall margin that is present. Remember Green — nice and clean; Yellow — extreme caution to the fellow; and Red — your gonna bump your head.

A New Angle on Safety

AOA systems offer many benefits to safe flying so consider looking into one for the aircraft you own or fly. And if you do install one, make sure you're familiar with its operation and limitations. Check out this video produced by the FAA's Center of Excellence to Enhance General Aviation Safety, Accessibility, and Sustainability (PEGASAS) that explains the concept of AOA and demonstrates how certain AOA indicators work in flight.

https://www.youtube.com/watch?v=8JcjWnAJGKQ&list=PL5vHkqHi51DT2Y54kjRtmjJ3Dgaj_Sv7V&index=66

It's also a good idea to keep your skills sharp through practice of stalls and slow flight as well as pattern and instrument work with a flight instructor. Be sure to document your achievement in the WINGS Pilot Proficiency Program too. It's a great way to stay on top of your game. Go to FAASafety.gov for more.

Resources

- FAA news release on streamlining the AOA installation process for small aircraft.
- FAA Airplane Flying Handbook, Chapter 4, Maintaining Aircraft Control (PDF download)
- "Pushing the Envelope: A Plan of Attack for Loss of Control," FAA Safety Briefing, May/June 2018
- "A Long Term Plan of 'Attack'", FAA Safety Briefing, May/June 2016 p. 33 (PDF download)
- "The Alpha (and Omega): How a Small Angle Can Make a Huger Difference," FAA Safety Briefing May/June 2014 p. 28 (PDF download)
- "AOA: More than Just a Display: Real World Uses for Angle of Attack," FAA Safety Briefing, May/June 2014 p. 25 (PDF download)

see attached

Upcoming WINGS-credit Webinars

→ Monday, April 19, 2021, at 7:00 PM Eastern: Enhance Stall Awareness with Angle of Attack (AOA) Systems

→ Sunday, April 25, 2021, at 3:00 PM Eastern: Angle of Attack Indicators: What You Didn't Know

→ Monday, April 26, 2021, at 7:00 PM Eastern: Double Header — Angle of Attack and IMC Club Scenario

What are the accident investigation provisions in Annex 13 of the Chicago Convention?

To help the public and media better understand the scope and substance of ICAO's involvement in international aircraft accident investigations, we are providing answers to some frequently asked questions below. ICAO does not normally participate in aircraft accident investigations, except when the State or States with due authority under Annex 13— Aircraft Accident and Incident Investigation request our assistance directly. In those exceptional circumstances, assistance normally involves ICAO acting as an official observer and/or clarifying various Annex 13 requirements when requested.

Annex 13 outlines how accident investigation participating States are determined, as well as the process leading to the issuance of an accident investigation Preliminary Report (within 30 days of the event) and Final Report (asap or within 12 months of the event) following completion of the investigation. Final Reports ultimately provide as much official information as possible on an accident investigation's findings, causes and/or contributing factors, as well as any safety recommendations on how applicable aviation safety frameworks should be amended in the future.

We are sharing Annex 13 in its entirety below. Links to view the publication in ICAO's six official languages are also provided.

What is the international definition of an aircraft accident?

Annex 13 to the Convention on International Civil Aviation, which reflects the Standards and Recommended Practices covering Aircraft Accident and Incident Investigation, defines an accident as an occurrence associated with the operation of an aircraft: – in which a person is fatally or seriously injured; – in which an aircraft sustains damage or structural failure requiring repair; – after which the aircraft in question is classified as being missing.

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Which State or States are responsible for conducting an accident investigation, and what other States may participate?

Annex 13 stipulates that the State of Occurrence shall institute an investigation into the circumstances of the accident and be responsible for the conduct of the investigation. The State of Occurrence may also delegate all or part of the investigation's responsibilities to another State, or to a regional accident and incident investigation organization. Besides the State of Occurrence, Annex 13 also identifies the additional States which are entitled to appoint an accredited representative (with or without associated advisers) to take part in an investigation. These include:

- The State of Registry: the State on whose register the aircraft is entered.
- The State of the Operator: the State in which the operator's principal place of business is located or, if there is no such place of business, the operator's permanent residence.
- The State of Design: The State having jurisdiction over the company responsible for the aircraft type design.
- The State of Manufacture: The State having jurisdiction over the company responsible for the final assembly of the aircraft.

Additionally, a State which has a special interest in an accident, for example by virtue of the number of its citizens involved in or impacted by it, is also entitled to appoint an expert to the accident investigation. These special interest State experts are entitled to:

- visit the scene of the accident;
- have access to the factual information released by the State in charge;
- receive a copy of the accident investigation Final Report.

What is the primary objective of an Annex 13 investigation?

The sole objective of an Annex 13 investigation is to generate safety data and information to aid with the prevention of future and similar accidents or incidents. Annex 13 investigations do not concern themselves in any way with the apportioning of blame or liability.

How are Annex 13 accident investigations reported?

According to Annex 13, which is shared in full below, the State conducting the investigation of an accident or incident is expected to produce a Preliminary Report within 30 days of the accident. This Preliminary Report may be public or confidential at the discretion of the State in charge. A publicly available Final Report is encouraged to be produced by the State in charge of the investigation within 12 months of the accident.

Annex 13 is also available in the following languages:

- Arabic

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- Chinese
- English
- French
- Russian
- Spanish

Travel care for travelers and crewmembers

French Advice (in French)

RAA Spécial N°971-2021-090 publié le 16 avril 2021 - RECUEIL DES ACTES ADMINISTRATIFS SPÉCIAL N°971-2021-090

What about this month:

Final PT6A-41 production - Get one of the last 11 new engines to be manufactured

While quantities last, exchange your used PT6A-41 engine for a factory-new engine for as little as $395,000 USD and refresh your King Air 200 aircraft. With only 11 remaining engines in final production, this offer is available on a first-come first-served basis.

Benefits:

- Secure one of only 11 remaining factory-new latest-configuration PT6A-41 engines with a new engine warranty.
- Get a fixed price of as little as $395,000 USD with no over-and-above charges.
- Can help lower your maintenance and HSI expenses.

Engines will be shipped between 60 and 90 days following the order date and upon the receipt of deposit.

Eligibility:

- Offer is available to owner/operators and FBOs of PT6A-41 engines.
- Engine must have been operated according to its type certificate, on a civil registered aircraft, and maintained by a civilly registered entity, otherwise a military premium will apply.

Shipping:

All shipping costs, taxes, duties, tariffs and insurance are to be covered by the customer.

This is limited-time offer and P&WC reserves the right to modify or terminate this program at any time. Limited quantity of PT6A-41 factory-new engines available. This offer is only available through P&WC.

The story :

Le PT6A- 41 est la version moyenne du moteur à turbine libre fiable Pratt et Whitney Canada. Avec la construction de la facilité d'écoulement d'entrée inverse de réparation et de la section chaude reconstructions sont essentiels pour le modèle de succès PT6. Le - 41 utilise la nouvelle technologie avec une turbine de puissance à deux étages et nouveau compresseur augmenté de débit massique. Ce moteur turbopropulseur est fortement plat classé offre 903 ESHP et 850 shp pour le décollage.

Le - 41 est utilisé dans Beechcraft King Air 200 / B200 et le Piper Cheyenne III / III Aircraft.

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FAA regulations

- UAS Testing Changes Information document
- Remote Pilot – Small Unmanned Aircraft Systems Airman Certification Standards (FAA-S-ACS-10B)
- Knowledge Testing Authorization Requirements Matrix
- What's New and Upcoming in Airman Testing
- Unmanned Aircraft General — Small — UAG sample questions

Draft ACs

Advisory Circular

Forms - Orders & Notices

JO 3120.153 - OS/STMC Instructional Program Guide

JO 7340.632 - CALL SIGN AND 3LD CHANGE FOR COMPANY "THRO AVIATION, INC."

EASA regulations

Approval Data Library | EASA (europa.eu)

Rules

Regulations | EASA (europa.eu)

COMMISSION IMPLEMENTING REGULATION (EU) 2021/665 - Commission Implementing Regulation (EU) 2021/665 of 22 April 2021 amending Implementing Regulation (EU) 2017/373 as regards requirements for providers of air traffic management/air navigation services and other air traffic management network functions in the U-space airspace designated in controlled airspace.

COMMISSION IMPLEMENTING REGULATION (EU) 2021/666 - Commission Implementing Regulation (EU) 2021/666 of 22 April 2021 amending Regulation (EU) No 923/2012 as regards requirements for manned aviation operating in U-space airspace, has been published in EUR-Lex.

COMMISSION IMPLEMENTING REGULATION (EU) 2021/664 - COMMISSION IMPLEMENTING REGULATION (EU) 2021/664 of 22 April 2021 on a regulatory framework for the U-space.

COMMISSION IMPLEMENTING REGULATION (EU) 2021/700 - Commission Implementing Regulation (EU) 2021/700 of 26 March 2021 amending and correcting Regulation (EU) No 1321/2014 as regards the maintenance data and the installation of certain aircraft components during maintenance

COMMISSION DELEGATED REGULATION (EU) 2021/699 - COMMISSION DELEGATED REGULATION (EU) 2021/699 of 21 December 2020 amending and correcting Regulation (EU) No 748/2012 as regards the instructions for continued airworthiness, the production of parts to be used during maintenance and the consideration of ageing aircraft aspects during certification

Easy access Rules

Agency Decisions

Overview | EASA (europa.eu)

ED Decision 2021/006/R - AMC-20 Amendment 21 - Extended range operation with two-engine aeroplanes ETOPS certification and operation

Notices of Proposed Amendment

Notices of Proposed Amendment (NPAs) | EASA (europa.eu)

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NPA 2021-06 - Regular update of the Certification Specifications for Standard Changes and Standard Repairs — CS-STAN Issue 4 :

The objective of this Notice of Proposed Amendment (NPA) is to support general aviation (GA) in Europe by reducing the administrative burden for the embodiment of simple changes and simple repairs in certain aircraft when applying the acceptable methods, techniques, and practices defined in CS-STAN, and thus to promote safety.

Taking into account the principles of efficiency and proportionality, this NPA proposes to amend CS-STAN in order to:

- update and complement the contents of Subpart A (General);
- introduce some new Standard Changes (SCs) and update some existing ones; and
- update some existing Standard Repairs (SRs).

The amendments introduced by this NPA are based on lessons learned and proposals submitted by affected stakeholders, as well as technological innovations from the industry, which can bring safety benefits in a cost-effective manner. Overall, this is expected to bring a moderate safety benefit, to have no social or environmental impacts, and it may provide major economic benefits by reducing the administrative burden for the embodiment of simple changes and simple repairs in certain aircraft.

Working Arrangement – China

WA between EASA and CAAC On the Airbus A319 and A320 Aircraft Final Assembly Line and Delivery Centre, A330 and A350Aircraft

WA between EASA and CAAC on the Airbus Helicopters Final Assembly Line and Delivery Centre in China

WA between EASA and CAAC on the production in China of “Austro Engine” engines

WA between EASA and CAAC on validation by CAAC of certificates issued by EASA on "Austro Engine" engines

WA between EASA and CAAC on validation by CAAC of certificates issued by EASA on Turbomeca engines

WA between EASA and CAAC on ETSO and CTSO articles

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WA between CAAC and EASA on Eurocopter rotorcraft certification

WA between CAAC and EASA on the validation by CAAC of a STC approved by EASA on the Airbus A300

WA between CAAC and EASA on validation by CAAC of certificates issued by EASA on PZL-Swidnik rotorcraft

WA between CAAC and EASA on validation by CAAC of certificates issued by EASA on POLSKIE ZAKLADY LOTNICZE Sp.zo.o aircraft

WA between CAAC and EASA on validation by CAAC of certificates issued by EASA on Pilatus Aircraft Ltd. arircraft

WA between CAAC and EASA on validation by CAAC of certificates issued by EASA on EVEKTOR-AEROTECHNIK a.s. aircraft

WA between CAAC and EASA on validation by CAAC of certificates issued by EASA on Hoffmann GmbH & Co. KG propellers

WA between CAAC and EASA on validation by CAAC of certificates issued by EASA on MT-Propeller Entwicklung GmbH proellers

WA between CAAC and EASA on validation by CAAC of certificates issued by EASA on EADS SOCATA aircraft

WA between CAAC and EASA on validation by CAAC of certificates issued by EASA on VULCANAIR S.p.A. aircraft

WA between CAAC and EASA on validation by CAAC of certificates issued by EASA on Piaggio Aero Industries S.p.A aircraft

WA between CAAC and EASA on validation by CAAC of certificates issued by EASA on Dowty Propellers

WA between CAAC and EASA on validation by CAAC of certificates issued by EASA on Limbach Flugmotoren GmbH & Co. KG engines

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WA between EASA and CAAC on Costruzioni Aeronautiche TECNAM S.r.l. aircraft

WA between CAAC and EASA on validation by CAAC of certificates issued by EASA on Lindstrand Technologies Ltd ballons

WA between EASA and CAAC on validation by CAAC of the Supplemental Type Certificate CAA.21NE2.00023

WA between EASA and CAAC on the validation by CAAC of the STC LBA No TA0274

WA between EASA and CAAC on the validation by CAAC of the STC No. EASA.A.S.01333.R.1

WA between EASA and CAAC on EC175/Z15 program certification

WA between EASA and CAAC on the validation by CAAC of the STC CAA.21NE2.00100

WA between CAAC and EASA on validation by CAAC of the EASA Supplemental Type Certificate 10027884

WA between EASA and CAAC on validation by CAAC of an EASA Supplemental Type Certificate Project No. 0010007574-001

WA between EASA and CAAC on validation by CAAC of an EASA Supplemental Type Certificate No. 10035677

WA between EASA and CAAC on validation by CAAC of an EASA Supplemental Type Certificate No. A.S.03127

WA between EASA and CAAC on validation by CAAC of an EASA Supplemental Type Certificate LBA No. 21E2.TA0311

WA between EASA and CAAC on validation by CAAC of an EASA Supplemental Type Certificate 10029547

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WA between EASA and CAAC on validation by CAAC of an EASA STC Project No.10011424 (STC holders Lufthansa Technik AG)

WA between EASA and CAAC on validation by CAAC of an EASA STC Project No.10011829 (GCT Design Organisation GmbH)

WA between EASA and CAAC on validation by CAAC of an EASA Supplemental Type Certificate EASA STC No. TA0304

WA between EASA and CAAC on validation by CAAC of the Supplemental Type Certificate No. 10038094

Working Arrangement between EASA and CAAC on the validation by CAAC of an EASA Supplemental Type Certificate (Project No. 0010016005-001 - STC holder, Lufthansa Technik AG

WA between EASA and CAAC the validation by CAAC of certificates issued by EASA on GE Aviation Czech s.r.o. engines

WA between EASA and CAAC on the validation by CAAC of the EASA STC No. A.S.02556 (STC holder, Lufthansa Technik AG - VIP completion Bombardier) 10038094

WA between EASA and CAAC on the validation by CAAC of an EASA STC (Project Number 0010018243-STC holder Aerotec A330 Wi-Fi installation)

WA between EASA and CAAC on validation by CAAC of certificates issued by EASA on GE Aviation Czech s.r.o. engines

WA between EASA and CAAC on validation by CAAC of certificates issued by EASA on Helicopters Guimbal S.A. rotorcraft models

WA between EASA and CAAC on validation by CAAC of an EASA STC (Project Number 0010019162)

WA between EASA and CAAC on validation by CAAC of the EASA STC N. 10031757

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WA between CAAC and EASA on validation by CAAC of certificates issued by EASA on Magnaghi Aeronautica S.P.A. aircraft models

WA between CAAC and EASA on validation by CAAC of certificates issued by EASA on XtremeAir aircraft models

WA between CAAC and EASA on validation by CAAC of certificates issued by EASA on EAD Aerospace STC EASA.A.S00234

WA between CAAC and EASA on validation by CAAC of certificates issued by EASA on AERO AT Sp. z.o.o aircraft models

WA between CAAC and EASA on validation by CAAC of the EASA Supplemental Type Certificates No. 10017259 and No 10017156 and subsequent revisions.pdf

WA between CAAC and EASA on validation by CAAC of the EASA STC No. 10029211, Rev.6 and subsequent revisions, STC holder, Bucher Leichtbau AG.pdf

WA between CAAC and EASA on validation by CAAC of the EASA STC No. 180-SF-0213 and subsequent revisions, STC holder EAD Aerospace.pdf

WA between CAAC and EASA on validation by CAAC of an EASA STC 10029629 (STC holder SA Beringer)

WA between CAAC and EASA on validation by CAAC of an EASA STC 10014281 (STC holder Lufthansa Technik AG)

WA between CAAC and EASA on Diamond Aircraft Industries

WA between CAAC and EASA on validation by CAAC of the EASA Supplemental Type Certificate STC 10014059 Rev. 2 and subsequent

WA between CAAC and EASA on validation by CAAC of the EASA Supplemental Type Certificate STC 10014287, Rev. 8 and subsequent

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WA between CAAC and EASA on validation by CAAC of the EASA Supplemental Type Certificate STC 10014364, Rev. 12 subsequent

WA between CAAC and EASA on validation by CAAC of the EASA Supplemental Type Certificate STC 10017241 Rev.3 and subsequent

WA between CAAC and EASA on validation by CAAC of the EASA Supplemental Type Certificate STC 10036328, Rev. 1 and subsequent

WA between CAAC and EASA on validation by CAAC of the EASA Supplemental Type Certificate STC 10052366, Rev. 1 and subsequent

WA between CAAC and EASA on validation by CAAC of the EASA Supplemental Type Certificate STC EASA.R.S.01331 (10017194)

WA between CAAC and EASA on validation by CAAC of the EASA Supplemental Type Certificate STC 10056336 and subsequent revisions

WA between CAAC and EASA on validation by CAAC of the EASA Supplemental Type Certificate STC 10034706 Rev. 1 and subsequent rev.

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ASECNA

AIP ASECNA

Regulations

Notam

Consultation NOTAM (asecna.aero)

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French regulations

JORF

joe_20210429_0101_0032 - Arrêté du 27 avril 2021 portant création d'une zone interdite temporaire dans la région de Saint-Léger-en-Yvelines (Yvelines), identifiée Saint-Léger-en-Yvelines, dans la région d'information de vol de Paris - Active le jeudi 29 avril 2021, de 11 heures à 16 heures.

joe_20210427_0099_0011 - Arrêté du 23 avril 2021 portant création d'une zone interdite temporaire dans la région de Melun (Seine-et-Marne), identifiée Melun, dans la région d'information de vol de Paris - Active le lundi 26 avril 2021 de 5 h 30 à 12 heures.

joe_20210422_0095_0015 - Arrêté du 20 avril 2021 portant création d'une zone interdite temporaire à Luxeuil (Haute-Saône) identifiée ZIT Luxeuil, dans la région d'information de vol de Reims - Active H 24 du 22 avril 2021 au 20 avril 2022.

joe_20210420_0093_0085 - Arrêté du 19 avril 2021 fixant la liste des parcelles cadastrales mentionnées à l'article 1er du décret n° 2021-470 du 19 avril 2021 pris pour l'application à l'aérodrome de Nantes-Atlantique des dispositions de l'article L. 6353-3 du code des transports

joe_20210420_0093_0084 - Arrêté du 31 mars 2021 portant pérennisation d'une expérimentation du service technique du centre en route de la navigation aérienne Ouest

joe_20210420_0093_0082 - Décret n° 2021-470 du 19 avril 2021 pris pour l'application à l'aérodrome de Nantes-Atlantique des dispositions de l'article L. 6353-3 du code des transports

joe_20210420_0093_0047 - Arrêté du 16 avril 2021 portant création d'une zone interdite temporaire dans la région de Nans-les-Pins (Var) identifiée ZIT Sainte-Baume, dans la région d'information de vol de Marseille - Active H 24 du 22 avril 2021 au 20 avril 2022.

joe_20210420_0093_0046 - Arrêté du 16 avril 2021 portant création d'une zone interdite temporaire à Solenzara (Corse-du-Sud) identifiée ZIT Solenzara, dans la région d'information de vol de Marseille - Active H 24 du 22 avril 2021 au 20 avril 2022.

joe_20210420_0093_0045 - Arrêté du 16 avril 2021 portant création d'une zone interdite temporaire dans la région d'Orange (Vaucluse) identifiée ZIT Orange-Caritat, dans la région d'information de vol de Marseille - Active H 24 du 22 avril 2021 au 20 avril 2022.

joe_20210420_0093_0044 - Arrêté du 16 avril 2021 portant création d'une zone interdite temporaire dans la région de Nice (Alpes-Maritimes) identifiée ZIT Mont Agel, dans la région d'information de vol de Marseille - Active H 24 du 22 avril 2021 au 20 avril 2022.

joe_20210420_0093_0043 - Arrêté du 16 avril 2021 portant création d'une zone interdite temporaire dans la région de Lyon (Rhône) identifiée ZIT Lyon, dans la région d'information de vol de Marseille - Active H 24 du 22 avril 2021 au 20 avril 2022.

joe_20210420_0093_0042 - Arrêté du 16 avril 2021 portant création d'une zone interdite temporaire dans la région de Le Luc (Var) identifiée ZIT Le Luc, dans la région d'information de vol de Marseille - Active H 24 du 22 avril 2021 au 20 avril 2022.

joe_20210420_0093_0041 - Arrêté du 16 avril 2021 portant création d'une zone interdite temporaire dans la région de Hyères (Var) identifiée ZIT Pradère, dans la région d'information de vol de Marseille - Active H 24 du 22 avril 2021 au 20 avril 2022.

joe_20210420_0093_0040 - Arrêté du 16 avril 2021 portant création d'une zone interdite temporaire dans la région de Martigues (Bouches-du-Rhône) identifiée ZIT La Couronne, dans la région d'information de vol de Marseille - Active H 24 du 22 avril 2021 au 20 avril 2022.

joe_20210420_0093_0039 - Arrêté du 16 avril 2021 portant création d'une zone interdite temporaire dans la région de La Ciotat (Bouches-du-Rhône) identifiée ZIT Bec de l'Aigle, dans la région d'information de vol de Marseille - Active H 24 du 22 avril 2021 au 20 avril 2022.

joe_20210420_0093_0038 - Arrêté du 16 avril 2021 portant création d'une zone interdite temporaire dans la région de Hyères (Var) identifiée ZIT AD Hyères le Palyvestre, dans la région d'information de vol de Marseille - Active H 24 du 22 avril 2021 au 20 avril 2022.

joe_20210420_0093_0037 - Arrêté du 16 avril 2021 portant création d'une zone interdite temporaire dans la région de Bastia (Haute-Corse) identifiée ZIT Serra di Pigno, dans la région d'information de vol de Marseille - Active H 24 du 22 avril 2021 au 20 avril 2022.

joe_20210420_0093_0036 - Arrêté du 16 avril 2021 portant création d'une zone interdite temporaire dans la région de Neubourg (Bas-Rhin) identifiée ZIT Neubourg, dans la région d'information de vol de Reims - Active H 24 du 22 avril 2021 au 20 avril 2022.

joe_20210420_0093_0035 - Arrêté du 16 avril 2021 portant création d'une zone interdite temporaire dans la région de Chaumont (Haute-Marne) identifiée ZIT d'Aboville, dans la région d'information de vol de Paris - Active H 24 du 22 avril 2021 au 20 avril 2022.

joe_20210420_0093_0034 - Arrêté du 16 avril 2021 portant création d'une zone interdite temporaire dans la région de Strasbourg (Bas-Rhin) identifiée ZIT Moussy, dans la région d'information de vol de Reims - Active H 24 du 22 avril 2021 au 20 avril 2022.

joe_20210420_0093_0033 - Arrêté du 16 avril 2021 portant création d'une zone interdite temporaire à Servance (Haute-Saône) identifiée ZIT Servance, dans la région d'information de vol de Reims - Active H 24 du 22 avril 2021 au 20 avril 2022.

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joe_20210420_0093_0032 - Arrêté du 16 avril 2021 portant création d'une zone interdite temporaire dans la région de Phalsbourg (Moselle) identifiée ZIT La Horie, dans la région d'information de vol de Reims - Active H 24 du 22 avril 2021 au 20 avril 2022.

joe_20210420_0093_0031 - Arrêté du 16 avril 2021 portant création d'une zone interdite temporaire à Nancy Ochey (Meurthe-et-Moselle) identifiée ZIT Ochey, dans la région d'information de vol de Reims - Active H 24 du 22 avril 2021 au 20 avril 2022.

joe_20210420_0093_0030 - Arrêté du 16 avril 2021 portant création d'une zone interdite temporaire à Luxeuil (Haute-Saône) identifiée ZIT Luxeuil, dans la région d'information de vol de Reims - Active H 24 du 22 avril 2021 au 20 avril 2022.

joe_20210420_0093_0029 - Arrêté du 16 avril 2021 portant création d'une zone interdite temporaire dans la région de Haguenau (Bas-Rhin) identifiée ZIT Estienne, dans la région d'information de vol de Reims - Active H 24 du 22 avril 2021 au 20 avril 2022.

joe_20210420_0093_0028 - Arrêté du 16 avril 2021 portant création d'une zone interdite temporaire dans la région d'Etain (Meuse) identifiée ZIT Mantoux, dans la région d'information de vol de Reims - Active H 24 du 22 avril 2021 au 20 avril 2022.

joe_20210420_0093_0027 - Arrêté du 16 avril 2021 portant création d'une zone interdite temporaire dans la région de Montauban (Tarn-et-Garonne) identifiée ZIT Vergnes, dans la région d'information de vol de Bordeaux - Active H 24 du 22 avril 2021 au 20 avril 2022.

joe_20210420_0093_0026 - Arrêté du 16 avril 2021 portant création d'une zone interdite temporaire dans la région de Bordeaux (Gironde) identifiée ZIT Sauvagnac, dans la région d'information de vol de Bordeaux - Active H 24 du 22 avril 2021 au 20 avril 2022.

joe_20210420_0093_0025 - Arrêté du 16 avril 2021 portant création d'une zone interdite temporaire dans la région de Pau (Pyrénées-Atlantiques) identifiée ZIT Pau, dans la région d'information de vol de Bordeaux - Active H 24 du 22 avril 2021 au 20 avril 2022.

joe_20210420_0093_0024 - Arrêté du 16 avril 2021 portant création d'une zone interdite temporaire dans la région de Cognac (Charente) identifiée ZIT Cognac, dans la région d'information de vol de Bordeaux - Active H 24 du 22 avril 2021 au 20 avril 2022.

joe_20210420_0093_0023 - Arrêté du 16 avril 2021 portant création d'une zone interdite temporaire à Cazaux (Gironde) identifiée ZIT Cazaux, dans la région d'information de vol de Bordeaux - Active H 24 du 22 avril 2021 au 20 avril 2022.

joe_20210420_0093_0022 - Arrêté du 16 avril 2021 portant création d'une zone interdite temporaire dans la région de Bayonne (Pyrénées-Atlantiques) identifiée ZIT Bergé, dans la région d'information de vol de Bordeaux - Active H 24 du 22 avril 2021 au 20 avril 2022.

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joe_20210420_0093_0021 - Arrêté du 16 avril 2021 portant création d'une zone interdite temporaire dans la région de Domme (Dordogne) identifiée ZIT Domme, dans la région d'information de vol de Bordeaux - Active H 24 du 22 avril 2021 au 20 avril 2022.

joe_20210420_0093_0020 - Arrêté du 16 avril 2021 portant création d'une zone interdite temporaire dans la région de Beignon (Morbihan) identifiée ZIT Montervilly, dans la région d'information de vol de Brest - Active H 24 du 22 avril 2021 au 20 avril 2022.

joe_20210420_0093_0019 - Arrêté du 16 avril 2021 portant création d'une zone interdite temporaire à Vélizy-Villacoublay (Yvelines) identifiée ZIT Villacoublay, dans la région d'information de vol de Paris - Active H 24 du 22 avril 2021 au 20 avril 2022.

joe_20210420_0093_0018 - Arrêté du 16 avril 2021 portant création d'une zone interdite temporaire à Taverny (Val-d'Oise) identifiée ZIT Taverny, dans la région d'information de vol de Paris - Active H 24 du 22 avril 2021 au 20 avril 2022.

joe_20210420_0093_0017 - Arrêté du 16 avril 2021 portant création d'une zone interdite temporaire sur l'aérodrome d'Orléans-Bricy (Loiret) identifiée ZIT Orléans, dans la région d'information de vol de Paris - Active H 24 du 22 avril 2021 au 20 avril 2022.

joe_20210420_0093_0016 - Arrêté du 16 avril 2021 portant création d'une zone interdite temporaire dans la région de Langeais (Indre-et-Loire) identifiée ZIT La Bécellière, dans la région d'information de vol de Paris - Active H 24 du 22 avril 2021 au 20 avril 2022.

joe_20210420_0093_0015 - Arrêté du 16 avril 2021 portant création d'une zone interdite temporaire sur l'aérodrome d'Evreux-Fauville (Eure) identifiée ZIT Evreux, dans la région d'information de vol de Paris - Active H 24 du 22 avril 2021 au 20 avril 2022.

joe_20210420_0093_0014 - Arrêté du 16 avril 2021 portant création d'une zone interdite temporaire à Creil (Oise) identifiée ZIT Creil, dans la région d'information de vol de Paris - Active H 24 du 22 avril 2021 au 20 avril 2022.

joe_20210420_0093_0013 - Arrêté du 16 avril 2021 portant création d'une zone interdite temporaire dans la région de Tours (Indre-et-Loire) identifiée ZIT Tours, dans la région d'information de vol de Paris - Active H 24 du 22 avril 2021 au 20 avril 2022.

joe_20210420_0093_0012 - Arrêté du 16 avril 2021 portant création d'une zone interdite temporaire dans la région de Les Alluets-le-Roi (Yvelines) identifiée ZIT Les Alluets, dans la région d'information de vol de Paris - Active H 24 du 22 avril 2021 au 20 avril 2022.

joe_20210420_0093_0011 - Arrêté du 16 avril 2021 portant création d'une zone interdite temporaire dans la région de Lorient (Morbihan) identifiée ZIT Lorient, dans la région d'information de vol de Brest - Active H 24 du 22 avril 2021 au 20 avril 2022.

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joe_20210420_0093_0010 - Arrêté du 16 avril 2021 portant création d'une zone interdite temporaire dans la région de Brest (Finistère) identifiée ZIT Landivisiau, dans la région d'information de vol de Brest - Active H 24 du 22 avril 2021 au 20 avril 2022.

joe_20210420_0093_0009 - Arrêté du 16 avril 2021 portant création d'une zone interdite temporaire à Loperhet (Finistère) identifiée ZIT Brest Loperhet, dans la région d'information de vol de Brest - Active H 24 du 22 avril 2021 au 20 avril 2022.

joe_20210418_0092_0043 - Arrêté du 12 avril 2021 modifiant l'arrêté du 9 juillet 2007 relatif à l'exploitation de services de transport aérien par la société Transavia France

joe_20210418_0092_0008 - Arrêté du 13 avril 2021 établissant des conditions de suspension temporaire des conditions de maintien de la validité des agréments pour l'exercice des fonctions de pompier d'aérodrome et de chef de manœuvre sur les aérodromes en période d'état d'urgence sanitaire pour faire face à l'épidémie de covid-19

RAA Spécial N°971-2021-090 publié le 16 avril 2021 - RECUEIL DES ACTES ADMINISTRATIFS SPÉCIAL N°971-2021-090

joe_20210417_0091_0039 - Arrêté du 12 avril 2021 fixant la répartition du produit de la majoration de la taxe d'aéroport

joe_20210415_0089_0036 - Ordonnance n° 2021-443 du 14 avril 2021 relative au régime de responsabilité pénale applicable en cas de circulation d'un véhicule à délégation de conduite et à ses conditions d'utilisation

joe_20210415_0089_0035 - Rapport au Président de la République relatif à l'ordonnance n° 2021-443 du 14 avril 2021 relative au régime de responsabilité pénale applicable en cas de circulation d'un véhicule à délégation de conduite et à ses conditions d'utilisation

joe_20210415_0089_0034 - Ordonnance n° 2021-442 du 14 avril 2021 relative à l'accès aux données des véhicules

joe_20210415_0089_0033 - Rapport au Président de la République relatif à l'ordonnance n° 2021-442 du 14 avril 2021 relative à l'accès aux données des véhicules

joe_20210414_0088_0012 - Arrêté du 9 avril 2021 portant création d'une zone interdite temporaire dans la région de Biscarosse (Landes) identifiée ZIT Eulalie, dans la région d'information de vol de Bordeaux - Activation par NOTAM avec préavis de 48 heures, le 16 avril 2021 de 5 heures à 10 heures.

joe_20210414_0088_0011 - Arrêté du 9 avril 2021 portant création d'une zone interdite temporaire dans la région de Carcans (Gironde) identifiée ZIT Hourtin, dans la région d'information de vol de Bordeaux - Activation par NOTAM avec un préavis de 48 heures, le 16 avril 2021 de 5 heures à 10 heures.

joe_20210414_0088_0010 - Arrêté du 9 avril 2021 portant création d'une zone interdite temporaire dans la région de Quimper (Finistère) identifiée ZIT Pluguffan, dans la région d'information de vol de Brest - Activation par NOTAM avec un préavis de 48 heures, le 16 avril 2021 de 5 heures à 10 heures.

joe_20210408_0083_0048 - Arrêté du 19 mars 2021 désignant une opération de restructuration au sein de la direction générale de l'aviation civile ouvrant droit à la prime de restructuration de service et à l'allocation d'aide à la mobilité du conjoint ainsi qu'à l'indemnité de départ volontaire

joe_20210408_0083_0047 - Arrêté du 15 mars 2021 modifiant l'arrêté du 26 décembre 2016 fixant la liste des sites ou services de la direction générale de l'aviation civile en application de l'arrêté du 26 décembre 2016

joe_20210407_0082_0001 - Arrêté du 29 mars 2021 modifiant l'arrêté du 14 décembre 2017 relatif aux conditions de conversion des qualifications voltige, remorquage, montagne et autorisation de site des personnels navigants professionnels et non professionnels de l'aéronautique civile en qualifications additionnelles conformes au règlement (UE) n° 1178/2011 de la Commission du 3 novembre 2011

joe_20210404_0081_0034 - Arrêté du 28 mars 2021 relatif aux redevances pour services rendus sur l'aérodrome de Bâle-Mulhouse

joe_20210404_0081_0031 - Arrêté du 18 mars 2021 désignant une opération de restructuration au sein de la direction générale de l'aviation civile ouvrant droit à la prime de restructuration de service et à l'allocation d'aide à la mobilité du conjoint ainsi qu'à l'indemnité de départ volontaire

joe_20210404_0081_0006 - Arrêté du 1er avril 2021 modifiant l'arrêté du 8 janvier 2018 relatif au survol du territoire français par des aéronefs étrangers de construction amateur et l'arrêté du 8 janvier 2018 relatif au survol du territoire français par certains aéronefs anciens étrangers

OSAC-DSAC

L0100Ed3v0 - Répertoire des documents

P2401Ed0v0 - Contrôle de l'activité des personnels de certification au titre des M.A.801(b)(1) / ML.A.801(b)(2)

G4504Ed0v0 - Guide des Facteurs Humains dans le cadre du maintien de la navigabilité

Bulletin officiel de la DGAC

[Bulletin Officiel des Ministères de la Transition écologique et solidaire et de la Cohésion des territoires et des Relations avec les collectivités territoriales (developpement-durable.gouv.fr)]

TRAA2112516S_extrait - Décision du 15 avril 2021 relative à l'intérim des fonctions de sous-directeur des affaires juridiques du secrétariat général de la direction générale de l'aviation civile.

TREA2110469S - Décision du 2 avril 2021 portant organisation de la délégation de mayotte au sein de la direction de la sécurité de l'aviation civile océan indien.

TREA2112330S - Décision du 16 avril 2021 relative aux consignes particulières de circulation aérienne de l'aérodrome de la rochelleîle-de-ré.

TREA2110507S - décision du 5 avril 2021 portant organisation de la direction de la sécurité de l'aviation civile nord.

TRAA2108601S - décision du 30 mars 2021 établissant, en application de l'article 14.1 du règlement (CEE) N°95/93 modifié, une procédure de suspension manuelle des plans de vol sans créneaux horaires sur l'aéroport de Cannes-Mandelieu, pour les périodes de coordination de l'été 2021.

TREA2113412S - Décision du 28 avril 2021 portant organisation de la direction de la sécurité de l'aviation civile sud-ouest.

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European Centre for Cybersecurity in Aviation (ECCSA)

See : https://www.easa.europa.eu/eccsa

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U.A.S. – Drones

joe_20210415_0089_0036 - Ordonnance n° 2021-443 du 14 avril 2021 relative au régime de responsabilité pénale applicable en cas de circulation d'un véhicule à délégation de conduite et à ses conditions d'utilisation

joe_20210415_0089_0035 - Rapport au Président de la République relatif à l'ordonnance n° 2021-443 du 14 avril 2021 relative au régime de responsabilité pénale applicable en cas de circulation d'un véhicule à délégation de conduite et à ses conditions d'utilisation

joe_20210415_0089_0034 - Ordonnance n° 2021-442 du 14 avril 2021 relative à l'accès aux données des véhicules

joe_20210415_0089_0033 - Rapport au Président de la République relatif à l'ordonnance n° 2021-442 du 14 avril 2021 relative à l'accès aux données des véhicules

See : https://www.easa.europa.eu/eccsa

- UAS Testing Changes Information document
- Remote Pilot – Small Unmanned Aircraft Systems Airman Certification Standards (FAA-S-ACS-10B)
- Knowledge Testing Authorization Requirements Matrix
- What's New and Upcoming in Airman Testing
- Unmanned Aircraft General — Small — UAG sample questions

ICAO - Exploring the latest developments with unmanned and remotely piloted aircraft systems

When she opened the fourth consecutive edition of ICAO's 'Drone Enable' Symposium this week, ICAO Secretary General Dr. Fang Liu acknowledged that traditional aviation continues to undergo a fundamental evolution in light of the increasingly widespread use of unmanned aircraft systems (UAS), as well as related modernization trends associated with digital communications and the emergence of advanced air mobility operators and other new entrants.

"We are now routinely seeing new types of aircraft, new use-cases, and new types of operations sharing airspace with traditional aviation," Dr. Liu emphasized, "and this includes new businesses and humanitarian operations leveraging unmanned aviation technologies to better peoples' lives, as exemplified by the transport of UN COVAX vaccine shipments from ports to hard-to-reach inland communities."

As standards setters, our efforts in supporting this dynamic growth are being guided by the priority to ensure the safety, security, efficiency and sustainability of the aircraft and operations now being innovated. National regulators are on the front lines of this challenge, and many States and organizations are already contributing to the development of regulatory and certification frameworks.

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ICAO is leading the global effort to assess and harmonize these approaches through events such as its Drone Enable symposia, and through the hard work undertaken by relevant government and industry experts in the related panels and working groups we have established, such as the Unmanned Aircraft Systems Advisory Group (UAS-AG), and the Remotely Piloted Aircraft Systems (RPAS) Panel.

"Subsequent to State requests, ICAO has reached out directly to innovators to help understand their expectations and needs," Dr. Liu noted, "with initial efforts focused on the integration and authorization processes for UAS now resulting in new guidance material for the development and deployment of UAS traffic management (UTM) systems."

In addition to ongoing UAS work, ICAO is also continuing to evolve the remotely piloted aircraft system (RPAS) regulatory framework for international operations. When complete, this will provide the basis for certificated remotely piloted aircraft (RPA) to operate alongside traditional aircraft, employing similar procedures and separation standards.

"SARPs addressing RPAS operations, air traffic management, and detect and avoid will follow over the next few years, most with a common applicability date in November 2026," Dr. Liu commented.

To support States in addressing their immediate need to regulate domestic operations, ICAO publishes free model UAS regulations which can be tailored to fit the needs of individual States. Persisting challenges in this area refer mostly to the continuous resource shortages faced by national regulators as they try to keep pace with the latest RPAS advances.

Dr. Liu concluded her remarks by stressing that COVID-19 has been an accelerator for many UAS and UTM innovations, and that "a domain as dynamic and innovative as UAS places a clear onus on the industry and regulatory communities to work better together to achieve effective results."

EASA issues guidelines for the design verification of drones operated in the 'specific' category

COLOGNE, April 8, 2021 - The European Union Aviation Safety Agency (EASA) published guidance for drone operators, manufacturers and national authorities explaining the process for the design verification of drones, an important element in ensuring safe drone operations in the 'specific' category.

Since the new EU drone regulation became applicable on December 31, 2020, the volume of drone operations taking place across Europe has been stepped up. Operators are also gradually increasing the scope of their operations and the design verification of the drone by EASA is an important element to ensure safety, in particular when operations are conducted in populated areas.

The process applied for the design verification will depend on the level of risk of the operation. When the drone is used in operations classified as high risk (i.e. SAIL V and VI according to SORA), EASA will issue a type certificate according to Part 21 (Regulation (EU) 748/2012). When the drone is used in operations classified in the medium risk (i.e. SAIL III and IV according to SORA), a more proportionate approach will be applied, leading to a 'design verification report'. The procedure to apply to EASA for the issuance of the 'design verification report' are described in the Guidelines.

"EASA continues its efforts to ensure safe, secure and sustainable operations of drones," EASA Executive Director Patrick Ky said. "This new design verification process was developed to support all stakeholders, applying a proportionate approach which will foster innovation and growth in this promising sector".

The design verification process is immediately applicable and national aviation authorities are encouraged to require all UAS operators who are conducting operations in the 'specific' category, with medium risk, to operate drones for which EASA has issued a 'design verification report'.

NAT OPS Bulletin

[NAT OPS Bulletins - All Documents (icao.int)]

NO publication for this month

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IOSA

IATA - IOSA

ISM Edition 13 and 14 - Temporary Revision 2021-2

IATA Reference Manual for Audit Programs (IRM) Ed 11

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Safety Alerts

esf-b25.143-01_issue-01_-_for_consultation - Proposed Equivalent Safety Finding ref. ESF-B25.143-01 on "Electronic Flight Control Systems – Normal Load Factor Limiting System" - Issue 01

Affected Product(s)	Effective Date	Subject and Additional Information
56-Day NASR Subscriber File, AWY.txt File	April 22, 2021	Error discovered in Airway V8 of AWY.txt file. See the 21-03 NASR Safety Alert (PDF) for complete information.
US Gulf Coast VFR Aeronautical Chart	April 22, 2021	Oil Drilling Platform Depiction. See the 21-02 VIS Charting Notice (PDF) for complete information.
Chart Supplement Publications	April 22, 2021	Associated Data in Chart Supplement - Q-Routes. See the 20-19 CS Charting Notice (PDF) for complete information.
Users of Temporary Flight Restrictions (TFR)	April 5, 2021	Temporary Flight Restrictions will be formatted in accordance with FAAO 7930.2. See the 21-01 USNOF Safety Alert (PDF) for complete information.

Press Release – FAA Clears Path for Installation of Angle of Attack Indicators in Small Aircraft

February 5, 2014

Measure Could Improve Safety in Thousands of Aircraft

WASHINGTON – The Federal Aviation Administration (FAA) today took an important step to help improve safety in small aircraft by simplifying design approval requirements for a cockpit instrument called an angle of attack (AOA) indicator. AOA devices, common on military and large civil aircraft, can be added to small planes to supplement airspeed indicators and stall warning systems, alerting pilots of a low airspeed condition before a dangerous aerodynamic stall occurs, especially during takeoff and landing.

"Safety is our top priority, and with today's announcement we are improving safety by streamlining regulations and cutting red tape – a win-win situation," said U.S. Department of Transportation Secretary Anthony Foxx.

An "angle of attack" is the angle between a plane's wing and the oncoming air. If the angle of attack becomes too great, the wing can stall and lose lift. If a pilot fails to recognize and correct the situation, a stall could lead to loss of control of the aircraft and an abrupt loss of altitude. Stalls can happen during any phase of flight, but they are critical when planes are near the ground and have less room to recover, such as during landing and takeoff.

AOA indicators may help prevent loss of control in small aircraft because they provide a more reliable indication of airflow over the wing. Although they have been available for some time, the effort and cost associated with gaining installation approval has limited their use in general aviation. The streamlined requirements are expected to lead to greater use of the devices and increased safety in general aviation.

"We have eliminated major barriers so pilots can add another valuable cockpit aid for safety," said FAA Administrator Michael Huerta. "These indicators provide precise information to the pilot, and could help many avoid needless accidents."

Under the new policy, manufacturers must build the AOA indicator system according to standards from the American Society for Testing and Materials (ATSM) and apply for FAA approval for the design via a letter certifying that the equipment meets ATSM standards and was produced under required quality systems. The FAA's Chicago Aircraft Certification Office will process all applications to ensure consistent interpretation of the policy.

The FAA believes this streamlined policy may serve as a prototype for production approval and installation of other add-on aircraft systems in the future

see attached

AIR100-14-110-PM01

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Safety information bulletin

FAA

All Information for Operators (InFOs) (faa.gov)

All Safety Alerts for Operators (SAFOs) (faa.gov)

https://rgl.faa.gov/Regulatory_and_Guidance_Library/rgSAIB.nsf/MainFrame?OpenFrameSet

01/04/2021	InFO21003	Issues Related to the Use of Light Emitting Diode (LED) Landing Lights in an Icing Environment
08/04/2021	AIR-21-05R1	Cirrus SR22 Aeroplanes - Tornado Alley Turbo, Inc. (STC-installed) Turbocharger Inlet Check Valves
16/04/2021	CASA-2021-06	Havilland Aircraft of Canada DHC-8-401 and DHC-8-402 Aeroplanes - Electrical Connector Corrosion

EASA

EASA Safety Publications Tool (europa.eu)

08/04/2021	AIR-21-05R1	Cirrus SR22 Aeroplanes - Tornado Alley Turbo, Inc. (STC-installed) Turbocharger Inlet Check Valves
12/04/2021	SD 2021-01 R1	Boeing 737-8 and 737-9 (MAX) Aeroplanes – Return to Service
16/04/2021	CASA-2021-06	Havilland Aircraft of Canada DHC-8-401 and DHC-8-402 Aeroplanes - Electrical Connector Corrosion
19/04/2021	2021-07	Bird Strike Risk Mitigation in Rotorcraft Operations
28/04/2021	2012-10R1	Single Event Effects on Aircraft Systems caused by Atmospheric Radiation
28/04/2021	2012-09R1	Effects of Space Weather on Aviation

Suspected Unapproved Parts Details

Part name

AFDX-2120 Remote Network

Part Number

182597-002

Serial Number

45C3M0

EASA has become aware that an AFDX-2120 Remote Network with P/N 182597-002 and S/N 45C3M0, that had been placed in a Fly Away kit on an Boeing 789 aircraft, has been lost or stolen. The operator estimates that the part had gone missing during the flights from Casablanca, Morocco to Beyrut, Lebanon on 06 – 08 June 2020. The part is considered not-airworthy and not eligible for installation on an aircraft.

Recommendation: If this part is found in stock or installed on an aircraft, it should be quarantined until a determination can be made regarding its eligibility for installation.

Suspected Unapproved Parts Details

Part name

Flight Control Module

Part Number

4091610-902

Serial Number

35567011

EASA has become aware that a Flight Control Module with P/N 4091610-902 and S/N 35567011, that had been placed in a Fly Away kit on an Boeing 789 aircraft, has been lost or stolen. The operator estimates that the part had gone missing during the flights from Casablanca, Morocco to Beyrut, Lebanon on 06 – 08 June 2020. The part is considered not-airworthy and not eligible for installation on an aircraft.

Recommendation: If this part is found in stock or installed on an aircraft, it should be quarantined until a determination can be made regarding its eligibility for installation.

Part name

General Processor Module (GPM)

Part Number

182513-001

Serial Number

160306382

EASA has become aware that a General Processor Module (GPM) with P/N 182513-001 and S/N 160306382, that had been placed in a Fly Away kit on an Boeing 789 aircraft, has been lost or stolen. The operator estimates that the part had gone missing during the flights from Casablanca, Morocco to Beyrut, Lebanon on 06 – 08 June 2020. The part is considered not-airworthy and not eligible for installation on an aircraft.

Recommendation: If this part is found in stock or installed on an aircraft, it should be quarantined until a determination can be made regarding its eligibility for installation.

Conflict zone information bulletin

[Conflict Zone Information Bulletin (CZIB's) | EASA (europa.eu)]

Publication date	Valid until	Subject/CZIB number
30/04/2021	30/10/2021	**Airspace of Afghanistan** *CZIB-2017-08R7* ACTIVE
30/04/2021	30/10/2021	**Airspace of South Sudan** *CZIB-2018-03R6* ACTIVE
30/04/2021	30/10/2021	**Airspace of Mali within Niamey Flight Information Region** *CZIB-2017-01R9* ACTIVE
30/04/2021	30/10/2021	**Airspace of Saudi Arabia – Jeddah Flight Information Region** *CZIB-2018-01R7* ACTIVE
30/04/2021	30/10/2021	**Airspace of Libya** *CZIB-2017-02R8* ACTIVE
30/04/2021	30/10/2021	**Airspace of Iraq** *CZIB-2017-04R8* ACTIVE
30/04/2021	30/10/2021	**Airspace of Syria** *CZIB-2017-03R8* ACTIVE
30/04/2021	30/10/2021	**Airspace of Somalia** *CZIB-2017-05R8* ACTIVE
30/04/2021	30/10/2021	**Airspace of Yemen – Sana'a Flight Information Region** *CZIB-2017-07R8* ACTIVE
30/04/2021	30/10/2021	**Airspace of Pakistan – Karachi and Lahore Flight Information Regions** *CZIB-2018-02R8* ACTIVE
30/04/2021	30/10/2021	**Airspace of Egypt Sinai Peninsula** *CZIB-2017-09R7* ACTIVE

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23/04/2021	**16/07/2021**	**Airspace of Iran** *CZIB-2020-01R1* ACTIVE
19/02/2016		**Airspace of Eastern Ukraine** *SIB 2014-21R1* ACTIVE

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Certification Up date

FAA do not need to be followed in this part? due to ECFR – See part Regulation or safety Bulletins for completion.

- 2021-19: Transfer of 26 STCs from SR Technics Switzerland to GroWING Engineering Partners GmbH
- 2021-18: Request from GE Aviation Czech s.r.o. for partial surrender of the EASA Type Certificate No. EASA.E.070 affecting the M601F-11, M601F-22, M601F-32 and M601T engine models
- EASA Certification Information 2021-17: Decision to accept EMTEQ Europe GmbH request to surrender various ETSO Authorisations

EASA

Final Special Condition **SC E-19 - Electric** / Hybrid Propulsion System - Issue 01

Proposed Special Condition SC-E21 - Propeller control system components as part of engine type design - Issue 01

Proposed Certification Memorandum CM-S-011 - Compliance with CS 27/29.952 (a)(4) for Helicopter external installations - Issue 02

Proposed Special Condition **SC-B22.151-01** - sustainer supported aerotow issue 01

NPA 2021-06 - Regular update of the Certification Specifications for Standard Changes and Standard Repairs — CS-STAN Issue 4

sc-f25.1353-01_issue-01_-_update - Final Special Condition ref. SC-F25.1553-01 on Non-rechargeable Lithium Battery Installations

Proposed Equivalent Safety Finding ESF-D29.783-01 on Passenger doors locking visual inspection by fibre-optic light - Issue 01

EASA Certification Information 2021-17: Decision to accept EMTEQ Europe GmbH request to surrender various ETSO Authorisations

EASA certification noise levels

The EASA certification noise levels are approved by EASA as part of the aircraft certification process. These noise levels are established in compliance with the applicable noise standards as defined in ICAO Annex 16, Volume I. They are the basis against which the National Aviation Authorities of EASA Member States issue individual noise certificates to aircraft on their registers using the EASA Form 45.

EASA publishes a database of certification noise levels containing all approved aircraft configurations (see Downloads section below). The database covers: aircraft for which EASA has issued a type certificate data sheet for noise (TCDSN) accessible from the TCDS page; aircraft modifications resulting from acoustically significant supplemental type certificates (STCs); aircraft and aircraft modifications certified by Member States prior to EASA becoming responsible, the so-called “transferred products”. It comprises four distinct files, one for each of the following aircraft categories: jet aeroplanes, heavy propeller-driven aeroplanes, light propeller-driven aeroplanes and rotorcraft.

Questions concerning the content of either the TCDSN or the database of EASA certification noise levels, as well as the notification of any possible errors and omissions, should be sent to noise@easa.europa.eu. To facilitate communication concerning errors and omissions please use the following forms:

EASA Form 47 - Notification of possible amendment of entry in TCDSN database

EASA Form 46 - Notification of possible omission in TCDSN database

Heavy propeller driven aeroplanes noise database - Issue 34 of 25 March 2021

Jet aeroplanes noise database - Issue 36 of 08 April 2021

Light propeller driven aeroplanes noise database - Issue 36 of 31 March 2021

Rotorcraft noise database - Issue 35 of 25 March 2021

Final Equivalent Safety Finding ESF-D29.783-01 on Passenger doors locking visual inspection by fibre-optic light - Issue 01

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Master MEL-OSD

MMEL

ocument Title:	MMEL AS-365 Rev 5, Airbus Helicopters, SA-365C, SA-365C1, SA-365C2, SA-365N, AS-365N2, SA-365N1, SA 366G1, AS 365 N3 (TCDS H10EU)
Summary:	Outlines the Master Minimum Equipment requirements and procedures for Airbus helicopter models SA 365C, SA 365C1, SA 365C2, SA 365N, AS 365N2, SA 365N1, SA 366G1, and AS 365 N3. Provides lists/tables and resources for use by inspectors, pilots, technicians, and others in the field and public sector.
Documents for Download:	Draft Document (PDF) Draft Document Comment Grid (MS Word)
Reference:	**Title 14 of the Code of Federal Regulations (14 CFR)** • Part 91, General Operating and Flight Rules • Part 121, Operating Requirements: Domestic, Flag, and Supplemental Operations • Part 125, Certification and Operations: Airplanes Having A Seating Capacity of 20 or More Passengers or A Maximum Payload Capacity of 6,000 Pounds or More; and Rules Governing Persons On Board Such Aircraft • Part 129, Operations: Foreign Air Carriers and Foreign Operators of U.S.-Registered Aircraft Engaged In Common Carriage • Part 135, Operating Requirements: Commuter and On Demand Operations and Rules Governing Persons On Board Such Aircraft. MMEL Policy Letter PL-25, MMEL and MEL Definitions MMEL Policy Letter PL-34, MMEL and MEL Preamble MMEL Policy Letter PL-36, FAR Part 91 MEL Approval & Preamble.
Comments Due:	May 3, 2021
How to Comment:	**Deliver comments by mail or hand to:** Colin A. Cook 600 Maryland Ave SW Suite 610E Washington, DC 20024

ocument Title:	MMEL AS-365 Rev 5, Airbus Helicopters, SA-365C, SA-365C1, SA-365C2, SA-365N, AS-365N2, SA-365N1, SA 366G1, AS 365 N3 (TCDS H10EU)
	Email comments to: Email Comments
Document Title:	**MMEL B767 Rev 40, Boeing 767**
Summary:	Outlines the Master Minimum Equipment requirements and procedures for the [example: ATR-GIE aircraft ATR-42]. Provides lists/tables and resources for use by inspectors, pilots, technicians, and others in the field and public sector.
Documents for Download:	Draft Document (PDF) Draft Document Comment Grid (MS Word)
Reference:	**Title 14 of the Code of Federal Regulations (14 CFR)** • Part 25, Airworthiness Standards: Transport Category Airplanes • Part 117, Flight and Duty Limitations and Rest Requirements: Flightcrew Members • Part 121, Operating Requirements: Domestic, Flag, and Supplemental Operations • Part 125, Certification and Operations: Airplanes Having A Seating Capacity of 20 or More Passengers or A Maximum Payload Capacity of 6,000 Pounds or More; and Rules Governing Persons On Board Such Aircraft • Part 129, Operations: Foreign Air Carriers and Foreign Operators of U.S.-Registered Aircraft Engaged In Common Carriage • Part 135, Operating Requirements: Commuter and On Demand Operations and Rules Governing Persons On Board Such Aircraft. MMEL Policy Letter PL-25, MMEL and MEL Definitions MMEL Policy Letter PL-34, MMEL and MEL Preamble.
Comments Due:	May 12, 2021
How to Comment:	**Deliver comments by mail or hand to:** Colin A. Cook 600 Maryland Ave SW

ocument Title:	MMEL AS-365 Rev 5, Airbus Helicopters, SA-365C, SA-365C1, SA-365C2, SA-365N, AS-365N2, SA-365N1, SA 366G1, AS 365 N3 (TCDS H10EU)
	Suite 610E Washington, DC 20024 **Email comments to:** Email Comments

Document Title:	MMEL DA-7X/8X Rev 13, Dassault Aviation, Falcon 7X/8X
Summary:	Outlines the Master Minimum Equipment requirements and procedures for Dassault Aviation Falcon aircraft, models DA-7X and DA-8X. Provides lists/tables and resources for use by inspectors, pilots, technicians, and others in the field and public sector.
Documents for Download:	Draft Document (PDF) Draft Document Comment Grid (MS Word)
Reference:	**Title 14 of the Code of Federal Regulations (14 CFR)** • Part 91, General Operating and Flight Rules • Part 121, Operating Requirements: Domestic, Flag, and Supplemental Operations • Part 125, Certification and Operations: Airplanes Having A Seating Capacity of 20 or More Passengers or A Maximum Payload Capacity of 6,000 Pounds or More; and Rules Governing Persons On Board Such Aircraft • Part 129, Operations: Foreign Air Carriers and Foreign Operators of U.S.-Registered Aircraft Engaged In Common Carriage • Part 135, Operating Requirements: Commuter and On Demand Operations and Rules Governing Persons On Board Such Aircraft. MMEL Policy Letter PL-25, MMEL and MEL Definitions MMEL Policy Letter PL-34, MMEL and MEL Preamble MMEL Policy Letter PL-36, FAR Part 91 MEL Approval & Preamble.
Comments Due:	May 28, 2021
How to Comment:	**Deliver comments by mail or hand to:** Colin A. Cook

Document Title:	MMEL DA-7X/8X Rev 13, Dassault Aviation, Falcon 7X/8X
	600 Maryland Ave SW Suite 610E Washington, DC 20024 **Email comments to:** Email Comments

OSD – FSBR

Operational Evaluation Guidance Material (OE GM) / Operational Evaluation Reports (OEB) / Operational Suitability Data (OSD) | EASA (europa.eu)

FAA Safety Briefing

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Publications

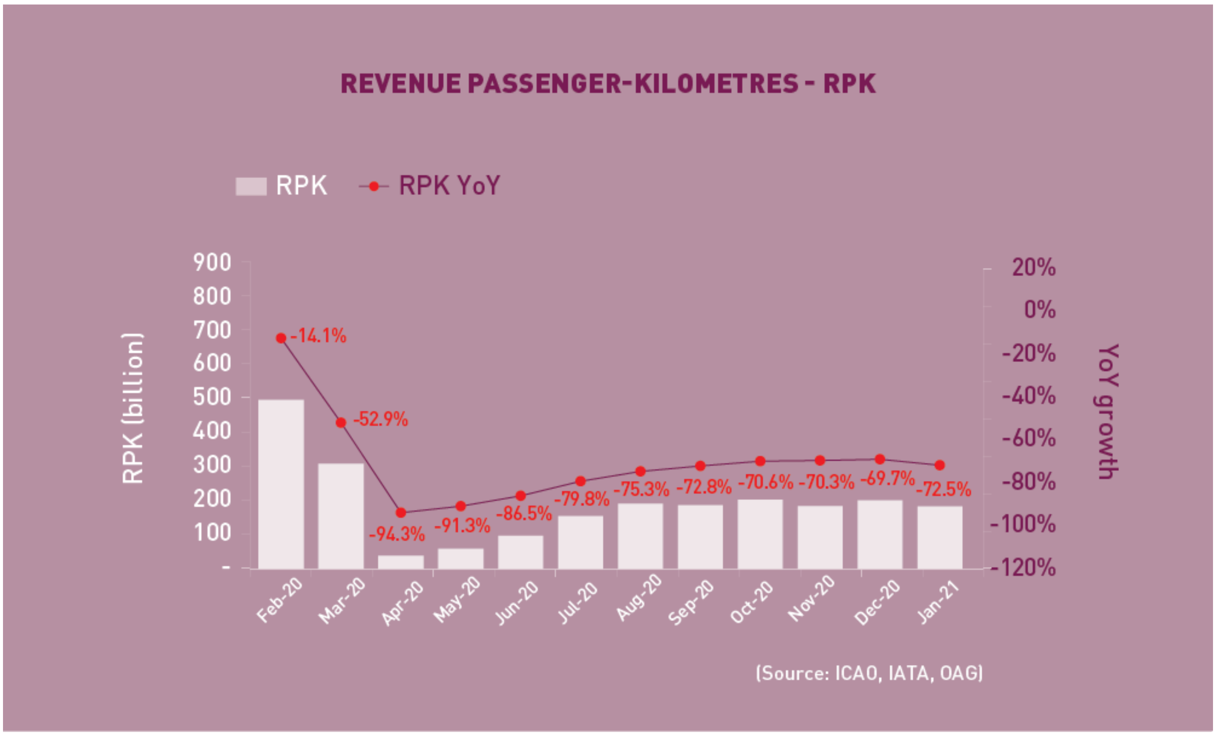
The Air Transport Monthly Monitor for March 2021

The air transport industry is not only a vital engine of global socio-economic growth, but it is also of vital importance as a catalyst for economic development. Not only does the industry create direct and indirect employment and support tourism and local businesses, but it also stimulates foreign investment and international trade.

Informed decision-making is the foundation upon which successful businesses are built. In a fast-growing industry like aviation, planners and investors require the most comprehensive, up-to-date, and reliable data. ICAO's aviation data/statistics programme provides accurate, reliable and consistent aviation data so that States, international organizations, aviation industry, tourism and other stakeholders can:

- make better projections;
- control costs and risks;
- improve business valuations; and
- benchmark performance.

The UN recognized ICAO as the central agency responsible for the collection, analysis, publication, standardization, improvement and dissemination of statistics pertaining to civil aviation. Because of its status as a UN specialized agency, ICAO remains independent from outside influences and is committed to consistently offering comprehensive and objective data. Every month ICAO produces this Air Transport Monitor, a monthly snapshot and analysis of the economic and aviation indicators.



Revenue Passenger-Kilometres – RPK

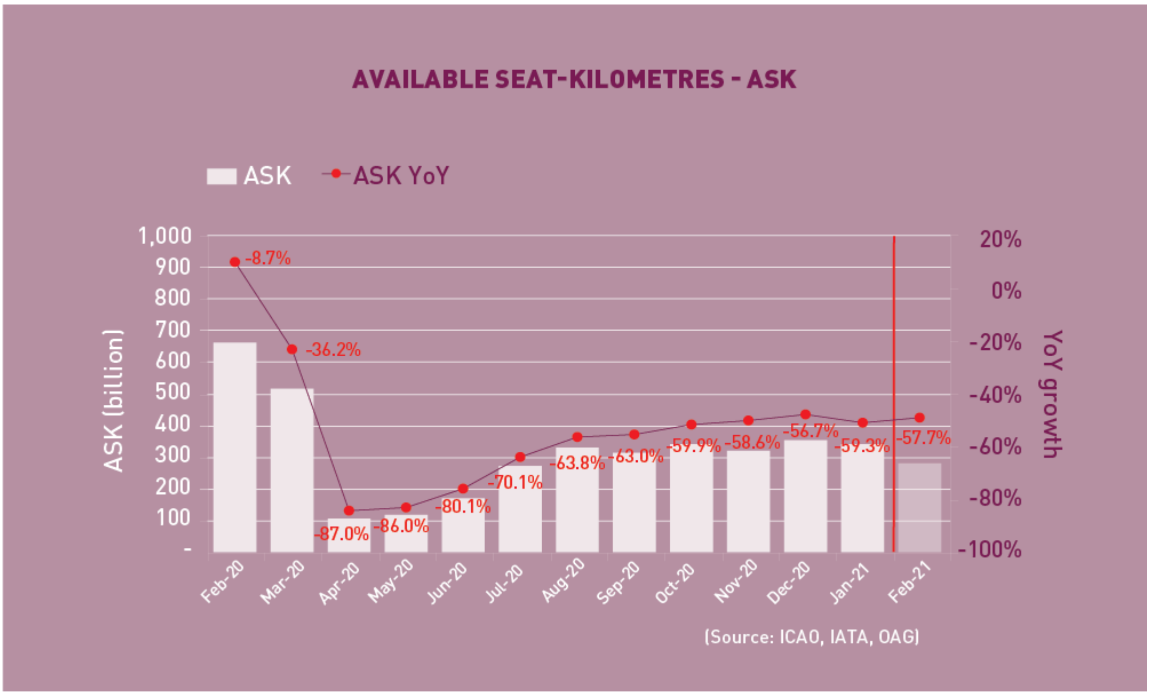
World passenger traffic fell by -72.5% YoY in January 2021, -2.8 percentage points lower than the decline in the previous month. Entering into the new year, the pandemic intensified across the globe, with the emergence of more contagious virus variants and the imposition of stricter control measures. Consequently, 2021 started with a worsening decline in passenger traffic, the first deterioration since bottoming out from the lowest point of the crisis in April. Domestic traffic was mostly impacted, particularly in China where traffic plunged due to the tightened travel restrictions.

International Traffic vs. Tourist Arrivals

International passenger numbers fell by -85.9% YoY in January 2021, -1.2 percentage points down from the decline in the previous month. International traffic remained muted across all regions and further weakened, affected by the pandemic acceleration and new lockdowns.

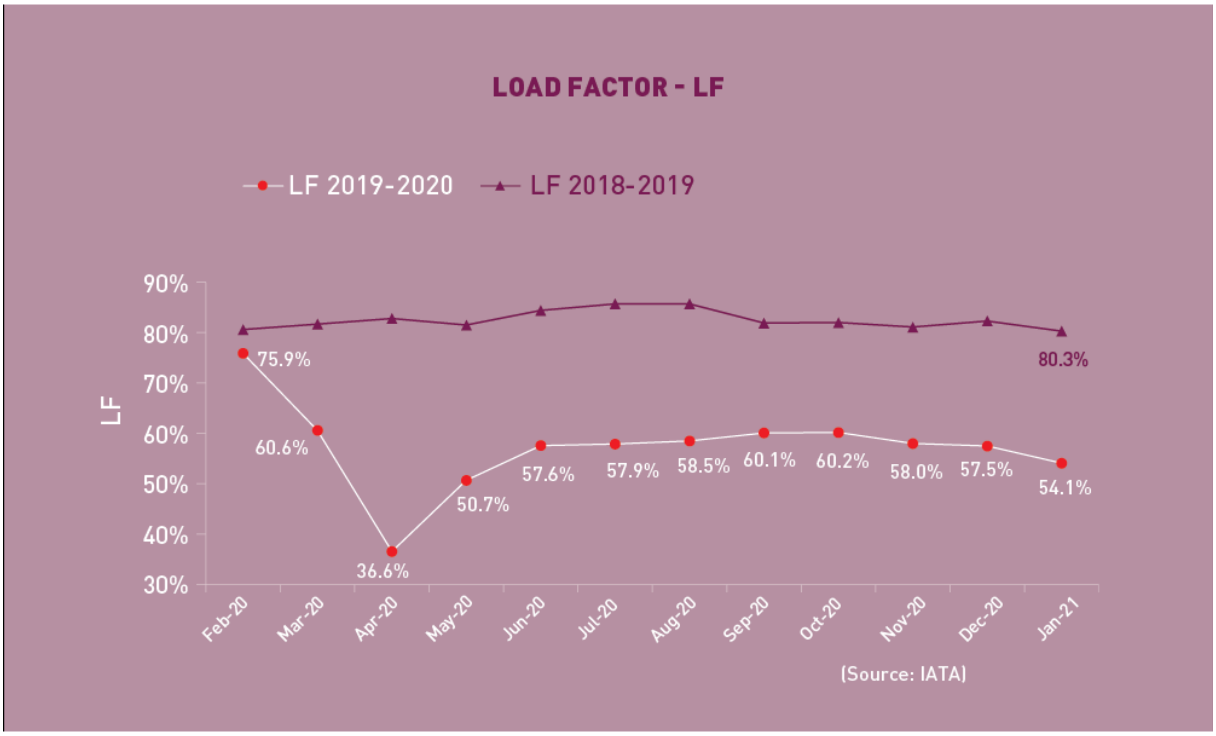
The international tourist arrivals also remained stagnant and followed a similar trend as international passenger traffic.

Capacity



Available Seat-Kilometres – ASK

Capacity worldwide fell by -59.3% YoY in January 2021, -2.6 percentage points down from the decline in the previous month (-56.7%). Amid the surge of new COVID-19 cases and increasing travel restrictions, capacity is likely to stay at a similar level as in February 2021 with a decline of -57.7% YoY.



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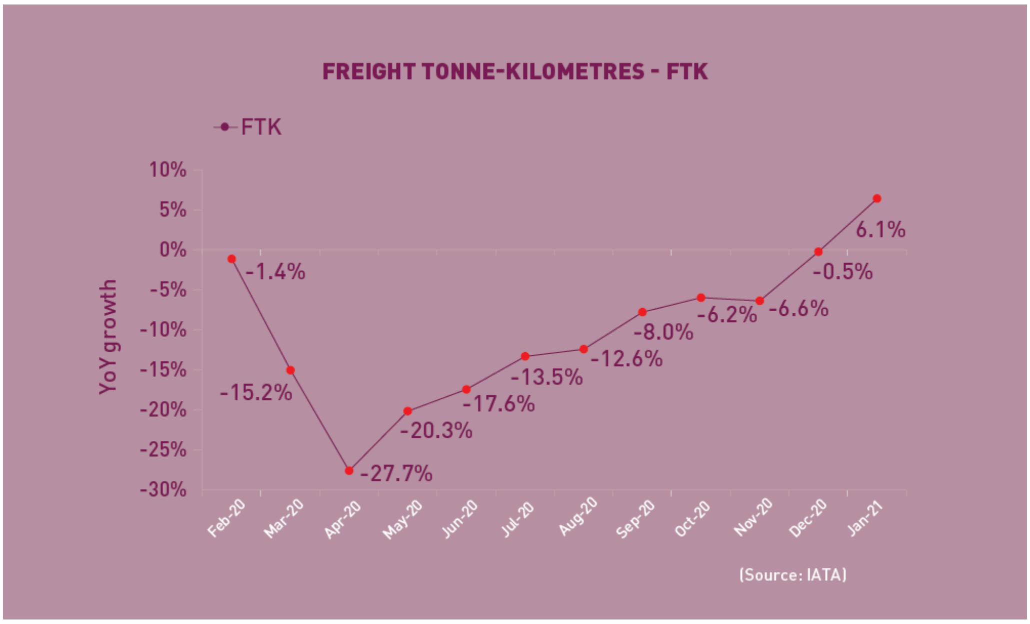
Freight Traffic



Freight Tonne-Kilometres – FTK

World freight traffic reported a growth of +6.1% YoY in January 2021, +6.6 percentage points up from the fall in the previous month. After experiencing 21-month of continuous YoY decline since April 2019, freight traffic finally saw positive growth and exceeded the 2019 levels. Despite the renewed outbreaks, air cargo demand remained robust supported by the recovery in economic activities, and strengthening in manufacturing and goods trade. Air cargo demand improved in all regions, particularly in Africa and North America where traffic has expanded double-digitally. The Middle East also grew solidly, while Latin America/Caribbean posted the weakest performance and was the only region recording negative growth.

TOP 15 AIRLINE GROUPS (RANKED BY RPK)

	RPK (billion)	YoY	% Share of World Total	Cumulative % Share
American	10.3	↓ -64.7%	5.6%	5.6%
Delta	9.7	↓ -65.8%	5.3%	10.8%
United	9.4	↓ -66.7%	5.1%	16.0%
China Southern	9.3	↓ -59.1%	5.0%	21.0%
China Eastern	7.1	↓ -60.6%	3.9%	24.9%
Air China	7.1	↓ -62.5%	3.8%	28.7%
AF-KLM	7.0	↓ -69.1%	3.8%	32.6%
Southwest	6.1	↓ -61.0%	3.3%	35.9%
Hainan Airlines	5.1	↓ -42.0%	2.8%	38.6%
Aeroflot	4.9	↓ -56.0%	2.7%	41.3%
Emirates	4.3	↓ -84.0%	2.3%	43.6%
IAG	4.2	↓ -80.2%	2.3%	45.9%
Turkish Airlines	4.1	↓ -67.5%	2.2%	48.1%
LATAM Airlines Group	3.8	↓ -67.2%	2.1%	50.2%
Lufthansa Group	3.8	↓ -82.5%	2.1%	52.3%
Top 15 Total RPKs	**96 billion**	**↓ -67.7%**	**52.3%**	
World Total RPKs	**184 billion**	**↓ -72.5%**	**100%**	

(Source: ICAO, airline's webistes)

Note: Total scheduled and non-scheduled services

January 2021: –67.7% YoY in terms of RPK for the Top 15

In terms of RPK, the Top 15 airline groups accounted for 52.3% of the world's total RPK in January 2021 and declined by –67.7% YoY. This decline was 4.8 percentage points smaller than the fall in the world's average RPK, with all airlines in the Top 15 posting contractions.

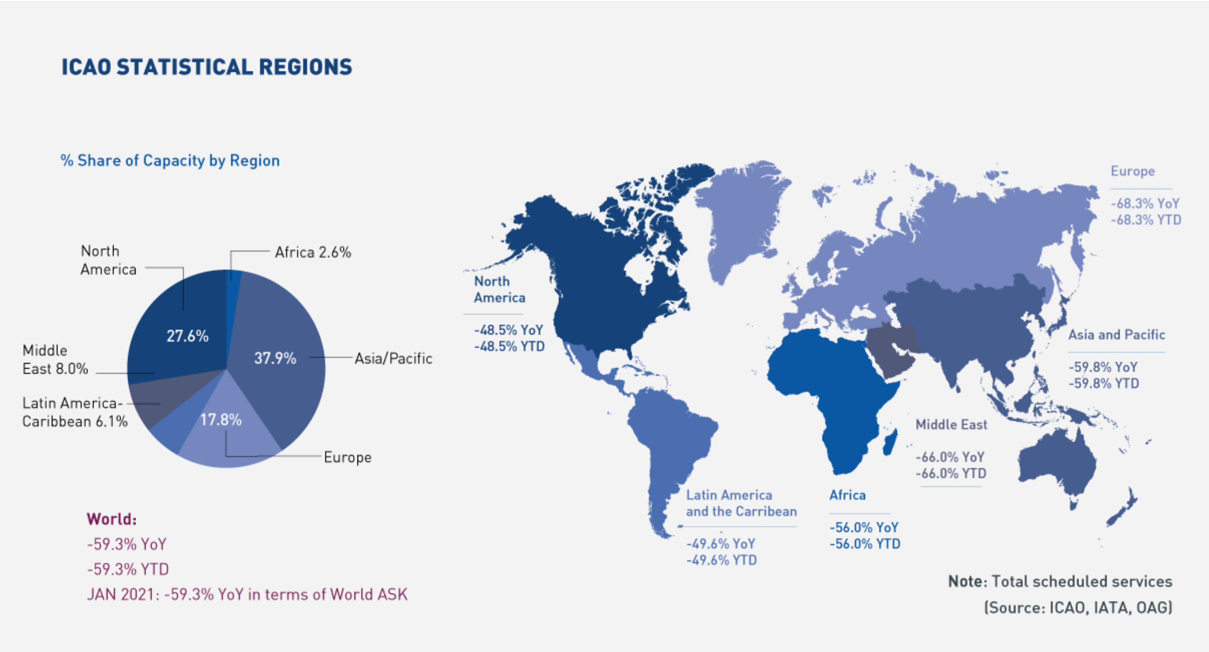
Airlines in the two largest domestic markets, US and China, continued to lead the recovery chart. However, their rankings changed significantly being hampered by virus resurgence at varying degrees.

For the first time since April 2020, the three major US airlines overtook Chinese airlines and became Top 3. This was mainly due to the sudden traffic fall in China. American ranked 1st with a similar decline as in December, followed by Delta and United. Southwest dropped one position to 8th.

All the three major Chinese airlines, China Southern, China Eastern, and Air China, posted noticeable deterioration in traffic as domestic travel was strictly controlled in response to the new outbreaks. Compared to December, the traffic of China Southern was down 40% from 15.6 billion to 9.3 billion RPKs, and the latter two showed approximately 30% less traffic.

Airlines in Europe maintained a similar decline as in the previous month. While AF-KLM climbed up one position to 7th, the recovery of Lufthansa and IAG slowed down and recorded the second and third largest YoY decline among the Top 15.

The traffic of both Emirates and LATAM trended sideways slightly, and ranked 11th and 14th, respectively.



Worldwide capacity contracted by -59.3% YoY in January 2021. All regions registered smaller capacity than in December, except for marginal increases in the Middle East and Latin America/Caribbean. The most noticeable decrease was seen in Asia/Pacific, affected by the new outbreaks.

Capacity in North America recovered the fastest, whereas Europe posted the largest capacity decline among all regions.

Click here to download the Monthly Monitor March PDF version.

For any queries for further information, please contact the ICAO Economic Development (ECD), Air Transport Bureau ecd@icao.int

DUBAI AIRSHOW 2021 BROCHURE

The Dubai Airshow, now in it's 17th edition, has become the most important point of convergence for aerospace professionals to witness the most innovative products and solutions alongside a host of exciting features and thought-leadership conferences.

By participating in the Dubai Airshow, you're joining a global community of trailblazers, market disruptors and industry experts pushing the boundaries of aviation. Download our brochure to know what is new for the Dubai Airshow 2021 and how it will elevate your business and the aerospace industry.

A range of new features for Dubai Airshow 2021 have been introduced, which include a strong focus on cutting edge technologies used in the aviation industry.

EASA General Aviation Season Opener 2021

In normal circumstances, in April we would be welcoming people to our stand at AERO in Friedrichshafen to answer questions from the GA Community and share all sorts of useful information. Sadly, COVID means that AERO is delayed until July this year and with so many pilots not having had the chance to fly in the past few months, we thought it would be useful to host a virtual season opener to help us all prepare for the summer ahead.

If you register you will be able to join these 3 interesting sessions:

Restarting Safely: All the latest news from EASA and the GA Roadmap, lots of great tips on preparing yourselves and your aircraft for the season ahead with support from our roving news reporters across Europe.

Coping with Weather: Although summer is just around the corner, the weather in Europe will be as unpredictable as always. This session will highlight the role of instrument flying with all the latest about the Basic Instrument Rating, landing at non-instrument runways and lots more.

Airworthiness and Maintenance: Maintenance of GA aircraft is a key part of enjoying flying safely - equipment needs to be operating in the best condition if we are going to reduce accidents and save lives. You will learn more about Part M Light, technician licencing, Part 21 Light and CS-STAN.

Register now and join the discussion in the EASA's General Aviation Community and also in the General Aviation Facebook Group.

We have opened SLIDO for questions before the event – please ask your question

The EASA GA Season Opener will be held on April 28-29, 2021 and registration is free

Cabinet d'Expertise en Aéronautique - Inscrit près la cour d'appel d'Amiens – Indépendant de l'EASA
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Sites de surveillance

https://flightsafety.org/toolkits-resources/

https://aviation-safety.net

http://www.skybrary.aero

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Bulletin Officiel des Ministères de la Transition écologique et solidaire et de la Cohésion des territoires et des Relations avec les collectivités territoriales (developpement-durable.gouv.fr)

SIA - La référence en information aéronautique - Page d'accueil (aviation-civile.gouv.fr)

Info sécurité DGAC | Ministère de la Transition écologique (ecologie.gouv.fr)

http://www.developpement-durable.gouv.fr/Objectif-Securite-lebulletin.html

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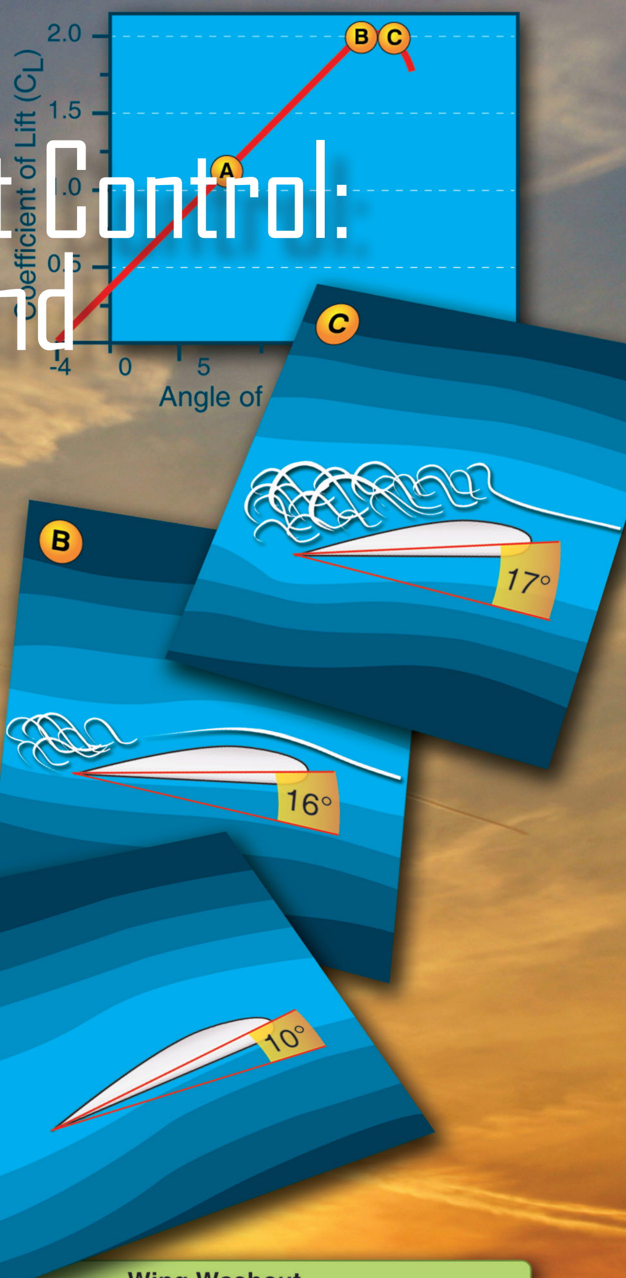
Chapter 4

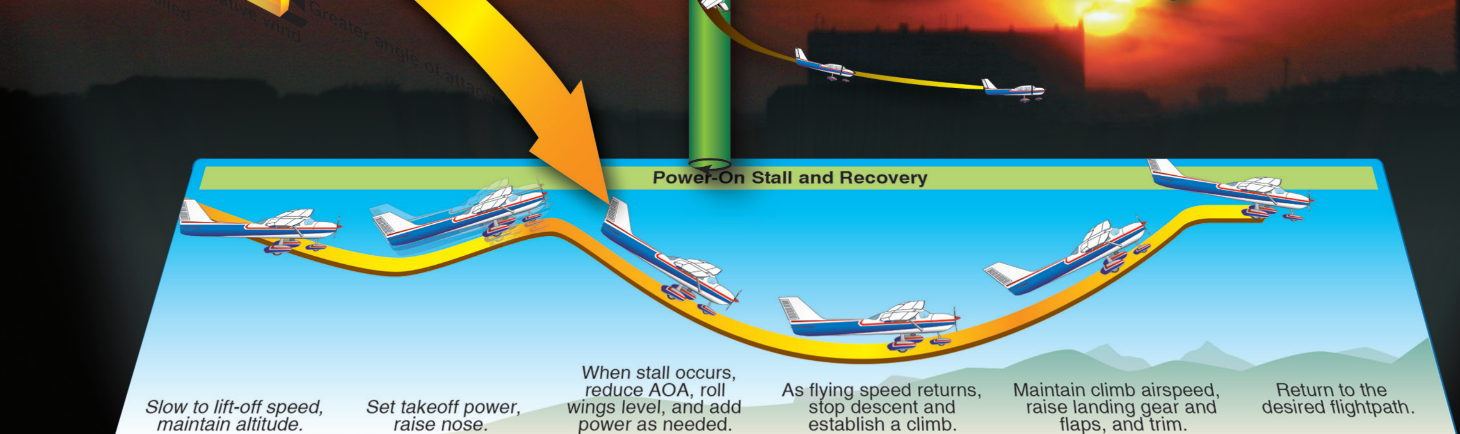
Maintaining Aircraft Control: Upset Prevention and Recovery Training



Introduction

A pilot's fundamental responsibility is to prevent a loss of control (LOC). Loss of control in-flight (LOC-I) is the leading cause of fatal general aviation accidents in the U.S. and commercial aviation worldwide. LOC-I is defined as a significant deviation of an aircraft from the intended flightpath and it often results from an airplane upset. Maneuvering is the most common phase of flight for general aviation LOC-I accidents to occur; however, LOC-I accidents occur in all phases of flight.

To prevent LOC-I accidents, it is important for pilots to recognize and maintain a heightened awareness of situations that increase the risk of loss of control. Those situations include: uncoordinated flight, equipment malfunctions, pilot complacency, distraction, turbulence, and poor risk management – like attempting to fly in instrument meteorological conditions (IMC) when the pilot is not qualified or proficient. Sadly, there are also LOC-I accidents resulting from intentional disregard or recklessness.



To maintain aircraft control when faced with these or other contributing factors, the pilot must be aware of situations where LOC-I can occur, recognize when an airplane is approaching a stall, has stalled, or is in an upset condition, and understand and execute the correct procedures to recover the aircraft.

Defining an Airplane Upset

The term "upset" was formally introduced by an industry work group in 2004 in the "Pilot Guide to Airplane Upset Recovery," which is one part of the "Airplane Upset Recovery Training Aid." The working group was primarily focused on large transport airplanes and sought to come up with one term to describe an "unusual attitude" or "loss of control," for example, and to generally describe specific parameters as part of its definition. Consistent with the Guide, the FAA has defined an upset as an event that unintentionally exceeds the parameters normally experienced in flight or training. These parameters are:

- Pitch attitude greater than 25°, nose up
- Pitch attitude greater than 10°, nose down
- Bank angle greater than 45°
- Within the above parameters, but flying at airspeeds inappropriate for the conditions.

The reference to inappropriate airspeeds describes a number of undesired aircraft states, including stalls. However, stalls are directly related to angle of attack (AOA), not airspeed.

To develop the crucial skills to prevent LOC-I, a pilot must receive upset prevention and recovery training (UPRT), which should include: slow flight, stalls, spins, and unusual attitudes.

Upset training has placed more focus on prevention—understanding what can lead to an upset so a pilot does not find himself or herself in such a situation. If an upset does occur, however, upset training also reinforces proper recovery techniques. A more detailed discussion of UPRT to include its core concepts, what the training should include, and what airplanes or kinds of simulation can be used for the training can be found later in this chapter.

Coordinated Flight

Coordinated flight occurs whenever the pilot is proactively correcting for yaw effects associated with power (engine/propeller effects), aileron inputs, how an airplane reacts when turning, and airplane rigging. The airplane is in coordinated flight when the airplane's nose is yawed directly into the relative wind and the ball is centered in the slip/skid indicator. *[Figure 4-1]*

A pilot should develop a sensitivity to side loads that indicate the nose is not yawed into the relative wind, and the airplane is not slipping or skidding. A correction should be made by applying rudder pressure on the side toward which one feels a leaning sensation. This will be the same side to which the ball in the slip/skid indicator has slewed (i.e., the old saying "step on the ball").

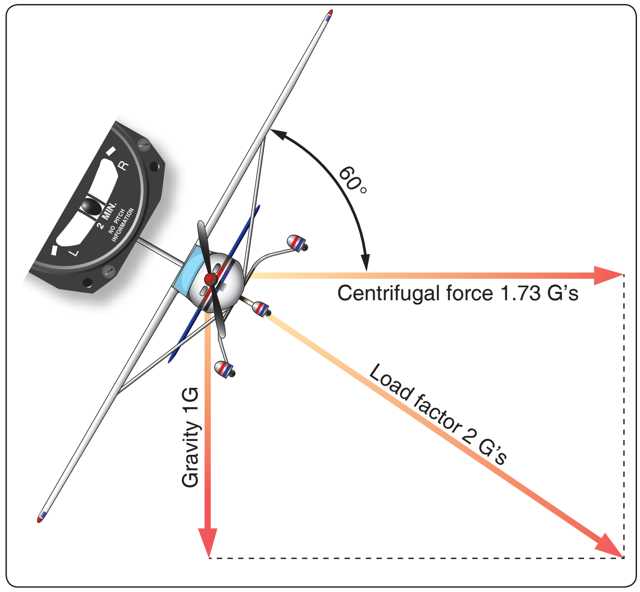


Figure 4-1. *Coordinated flight in a turn.*

Angle of Attack

The angle of attack (AOA) is the angle at which the chord of the wing meets the relative wind. The chord is a straight line from the leading edge to the trailing edge. At low angles of attack, the airflow over the top of the wing flows smoothly and produces lift with a relatively small amount of drag. As the AOA increases, lift as well as drag increases; however, above a wing's critical AOA, the flow of air separates from the upper surface and backfills, burbles and eddies, which reduces lift and increases drag. This condition is a stall, which can lead to loss of control if the AOA is not reduced.

It is important for the pilot to understand that a stall is the result of exceeding the critical AOA, not of insufficient airspeed. The term "stalling speed" can be misleading, as this speed is often discussed when assuming 1G flight at a particular weight and configuration. Increased load factor directly affects stall speed (as well as do other factors such as gross weight, center of gravity, and flap setting). Therefore, it is possible to stall the wing at any airspeed, at any flight attitude, and at any power setting. For example, if a pilot maintains airspeed and rolls into a coordinated, level 60° banked turn, the load factor is 2Gs, and the airplane will stall at a speed that is 40 percent higher than the straight-and-level stall speed. In that 2G level turn, the pilot has to increase AOA to increase the lift required to maintain altitude. At this condition, the pilot is closer to the critical AOA than during level flight and therefore closer to the higher speed that the airplane will stall at. Because "stalling speed" is not a constant number, pilots must understand the underlying factors that affect it in order to maintain aircraft control in all circumstances.

Slow Flight

Slow flight is when the airplane AOA is just under the AOA which will cause an aerodynamic buffet or a warning from a stall warning device if equipped with one. A small increase in AOA may result in an impending stall, which increases the risk of an actual stall. In most normal flight operations the airplane would not be flown close to the stall-warning AOA or critical AOA, but because the airplane is flown at higher AOAs, and thus reduced speeds in the takeoff/departure and approach/landing phases of flight, learning to fly at reduced airspeeds is essential. In these phases of flight, the airplane's close proximity to the ground would make loss of control catastrophic; therefore, the pilot must be proficient in slow flight.

The objective of maneuvering in slow flight is to understand the flight characteristics and how the airplane's flight controls feel near its aerodynamic buffet or stall-warning. It also helps to develop the pilot's recognition of how the airplane feels, sounds, and looks when a stall is impending. These characteristics include, degraded response to control inputs and difficulty maintaining altitude. Practicing slow flight will help pilots recognize an imminent stall not only from the feel of the controls, but also from visual cues, aural indications, and instrument indications.

For pilot training and testing purposes, slow flight includes two main elements:

1. Slowing to, maneuvering at, and recovering from an airspeed at which the airplane is still capable of maintaining controlled flight without activating the stall warning—5 to 10 knots above the 1G stall speed is a good target; and
2. Performing slow flight in configurations appropriate to takeoffs, climbs, descents, approaches to landing, and go-arounds.

Slow flight should be introduced with the airspeed sufficiently above the stall to permit safe maneuvering, but close enough to the stall warning for the pilot to experience the characteristics of flight at a very low airspeed. One way to determine the target airspeed is to slow the airplane to the stall warning when in the desired slow flight configuration, pitch the nose down slightly to eliminate the stall warning, add power to maintain altitude and note the airspeed.

When practicing slow flight, a pilot learns to divide attention between aircraft control and other demands. How the airplane feels at the slower airspeeds aids the pilot in learning that as airspeed decreases, control effectiveness decreases. For instance, reducing airspeed from 30 knots to 20 knots above the stalling speed will result in a certain loss of effectiveness of flight control inputs because of less airflow over the control surfaces. As airspeed is further reduced, the control effectiveness is further reduced and the reduced airflow over the control surfaces results in larger control movements being required to create the same response. Pilots sometimes refer to the feel of this reduced effectiveness as "sloppy" or "mushy" controls.

When flying above minimum drag speed (L/D_{MAX}), even a small increase in power will increase the speed of the airplane. When flying at speeds below L/D_{MAX}, also referred to as flying on the back side of the power curve, larger inputs in power or reducing the AOA will be required for the airplane to be able to accelerate. Since slow flight will be performed well below L/D_{MAX}, the pilot must be aware that large power inputs or a reduction in AOA will be required to prevent the aircraft from decelerating. It is important to note that when flying on the backside of the power curve, as the AOA increases toward the critical AOA and the airplane's speed continues to decrease, small changes in the pitch control result in disproportionally large changes in induced drag and therefore changes in airspeed. As a result, pitch becomes a more effective control of airspeed when flying below L/D_{MAX} and power is an effective control of the altitude profile (i.e., climbs, descents, or level flight)

It is also important to note that an airplane flying below L/D_{MAX}, exhibits a characteristic known as "speed instability" and the airspeed will continue to decay without appropriate pilot action. For example, if the airplane is disturbed by turbulence and the airspeed decreases, the airspeed may continue to decrease without the appropriate pilot action of reducing the AOA or adding power. *[Figure 4-2]*

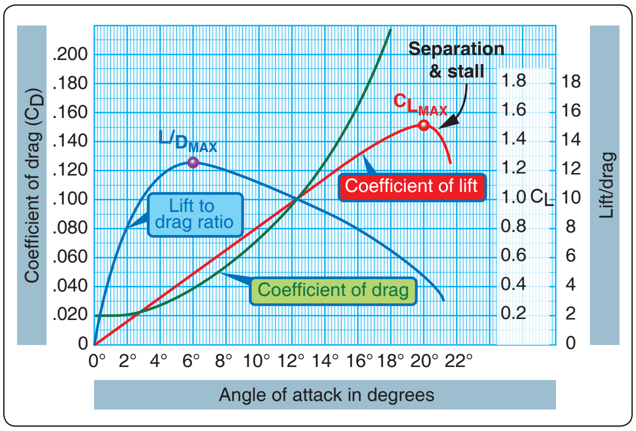


Figure 4-2. *Angle-of-attack in degrees.*

Performing the Slow Flight Maneuver

Slow flight should be practiced in straight-and-level flight, straight-ahead climbs and climbing medium-banked (approximately 20 degrees) turns, and straight-ahead power-off gliding descents and descending turns to represent the takeoff and landing phases of flight. Slow flight training should include slowing the airplane smoothly and promptly from cruising to approach speeds without changes in altitude or heading, and understanding the required power and trim settings to maintain slow flight. It should also include configuration changes, such as extending the landing gear and adding flaps, while maintaining heading and altitude. Slow flight in a single-engine airplane should be conducted so the maneuver can be completed no lower than 1,500 feet AGL, or higher, if recommended by the manufacturer. In all cases, practicing slow flight should be conducted at an adequate height above the ground for recovery should the airplane inadvertently stall.

To begin the slow flight maneuver, clear the area and gradually reduce thrust from cruise power and adjust the pitch to allow the airspeed to decrease while maintaining altitude. As the speed of the airplane decreases, note a change in the sound of the airflow around the airplane. As the speed approaches the target slow flight speed, which is an airspeed just above the stall warning in the desired configuration (i.e., approximately 5–10 knots above the stall speed for that flight condition), additional power will be required to maintain altitude. During these changing flight conditions, it is important to trim the airplane to compensate for changes in control pressures. If the airplane remains trimmed for cruising speed (a lower AOA), strong aft (back) control pressure is needed on the elevator, which makes precise control difficult unless the airplane is retrimmed.

Slow flight is typically performed and evaluated in the landing configuration. Therefore, both the landing gear and the flaps should be extended to the landing position. It is recommended the prescribed before-landing checks be completed to configure the airplane. The extension of gear and flaps typically occurs once cruise power has been reduced and at appropriate airspeeds to ensure limitations for extending those devices are not exceeded. Practicing this maneuver in other configurations, such as a clean or takeoff configuration, is also good training and may be evaluated on the practical test.

With an AOA just under the AOA which may cause an aerodynamic buffet or stall warning, the flight controls are less effective. *[Figure 4-3]* The elevator control is less responsive and larger control movements are necessary to retain control of the airplane. In propeller-driven airplanes, torque, slipstream effect, and P-factor may produce a strong

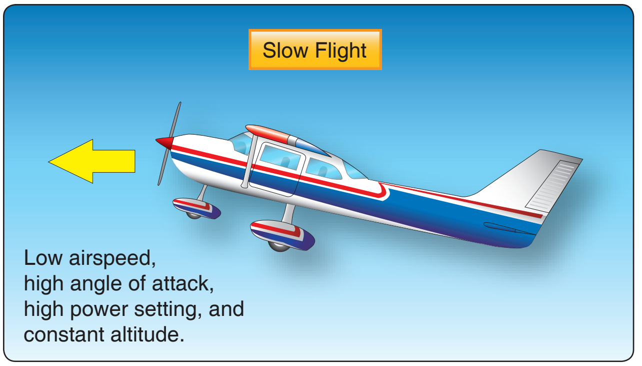


Figure 4-3. *Slow flight—low airspeed, high angle of attack, high power, and constant altitude.*

left yaw, which requires right rudder input to maintain coordinated flight. The closer the airplane is to the 1G stall, the greater the amount of right rudder pressure required.

Maneuvering in Slow Flight

When the desired pitch attitude and airspeed have been established in straight-and-level slow flight, the pilot must maintain awareness of outside references and continually cross-check the airplane's instruments to maintain control. The pilot should note the feel of the flight controls, especially the airspeed changes caused by small pitch adjustments, and the altitude changes caused by power changes. The pilot should practice turns to determine the airplane's controllability characteristics at this low speed. During the turns, it will be necessary to increase power to maintain altitude. Abrupt or rough control movements during slow flight may result in a stall. For instance, abruptly raising the flaps while in slow flight can cause the plane to stall.

The pilot should also practice climbs and descents by adjusting the power when stabilized in straight-and-level slow flight. The pilot should note the increased yawing tendency at high power settings and counter it with rudder input as needed.

To exit the slow flight maneuver, follow the same procedure as for recovery from a stall: apply forward control pressure to reduce the AOA, maintain coordinated flight and level the wings, and apply power as necessary to return to the desired flightpath. As airspeed increases, clean up the airplane by retracting flaps and landing gear if they were extended. A pilot should anticipate the changes to the AOA as the landing gear and flaps are retracted to avoid a stall.

Common errors in the performance of slow flight are:

- Failure to adequately clear the area
- Inadequate back-elevator pressure as power is reduced, resulting in altitude loss

- Excessive back-elevator pressure as power is reduced, resulting in a climb followed by a rapid reduction in airspeed
- Insufficient right rudder to compensate for left yaw
- Fixation on the flight instruments
- Failure to anticipate changes in AOA as flaps are extended or retracted
- Inadequate power management
- Inability to adequately divide attention between airplane control and orientation
- Failure to properly trim the airplane
- Failure to respond to a stall warning

Stalls

A stall is an aerodynamic condition which occurs when smooth airflow over the airplane's wings is disrupted, resulting in loss of lift. Specifically, a stall occurs when the AOA—the angle between the chord line of the wing and the relative wind—exceeds the wing's critical AOA. It is possible to exceed the critical AOA at any airspeed, at any attitude, and at any power setting. *[Figure 4-4]*

For these reasons, it is important to understand factors and situations that can lead to a stall, and develop proficiency in stall recognition and recovery. Performing intentional stalls will familiarize the pilot with the conditions that result in a stall, assist in recognition of an impending stall, and develop the proper corrective response if a stall occurs. Stalls are practiced to two different levels:

- Impending Stall—an impending stall occurs when the AOA causes a stall warning, but has not yet reached the critical AOA. Indications of an impending stall can include buffeting, stick shaker, or aural warning.
- Full Stall—a full stall occurs when the critical AOA is exceeded. Indications of a full stall are typically that an uncommanded nose-down pitch cannot be readily arrested, and this may be accompanied by an uncommanded rolling motion. For airplanes equipped with stick pushers, its activation is also a full stall indication.

Although it depends on the degree to which a stall has progressed, some loss of altitude is expected during recovery. The longer it takes for the pilot to recognize an impending stall, the more likely it is that a full stall will result. Intentional stalls should therefore be performed at an altitude that provides adequate height above the ground for recovery and return to normal level flight.

Stall Recognition

A pilot must recognize the flight conditions that are conducive to stalls and know how to apply the necessary corrective action. This level of proficiency requires learning to recognize an impending stall by sight, sound, and feel.

Stalls are usually accompanied by a continuous stall warning for airplanes equipped with stall warning devices. These devices may include an aural alert, lights, or a stick shaker all which alert the pilot when approaching the critical AOA. Certification standards permit manufacturers to provide the required stall warning either through the inherent aerodynamic qualities of the airplane or through a stall warning device that gives a clear indication of the impending stall. However, most vintage airplanes, and many types of light sport and experimental airplanes, do not have stall warning devices installed.

Other sensory cues for the pilot include:

- Feel—the pilot will feel control pressures change as speed is reduced. With progressively less resistance on the control surfaces, the pilot must use larger control movements to get the desired airplane response. The pilot will notice the airplane's reaction time to control movement increases. Just before the stall occurs, buffeting, uncommanded rolling, or vibrations may begin to occur.

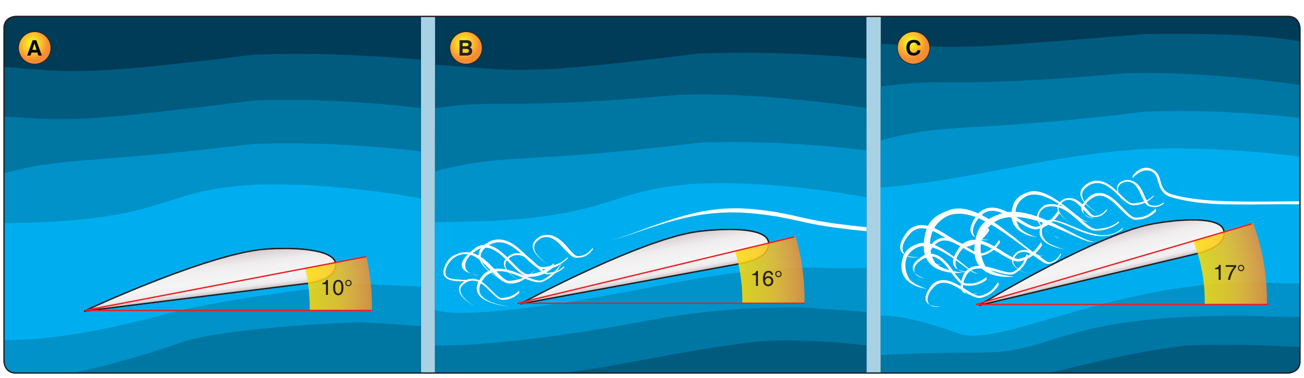


Figure 4-4. *Critical angle of attack and stall.*

- Vision—since the airplane can be stalled in any attitude, vision is not a foolproof indicator of an impending stall. However, maintaining pitch awareness is important.
- Hearing—as speed decreases, the pilot should notice a change in sound made by the air flowing along the airplane structure.
- Kinesthesia—the physical sensation (sometimes referred to as "seat of the pants" sensations) of changes in direction or speed is an important indicator to the trained and experienced pilot in visual flight. If this sensitivity is properly developed, it can warn the pilot of an impending stall.

Pilots in training must remember that a level-flight 1G stalling speed is valid only:

- In unaccelerated 1G flight
- In coordinated flight (slip-skid indicator centered)
- At one weight (typically maximum gross weight)
- At a particular center of gravity (CG) (typically maximum forward CG)

Angle of Attack Indicators

Learning to recognize stalls without relying on stall warning devices is important. However, airplanes can be equipped with AOA indicators that can provide a visual indication of the airplane's proximity to the critical AOA. There are several different kinds of AOA indicators with varying methods for calculating AOA, therefore proper installation and training on the use of these devices is important. AOA indicators measure several parameters simultaneously, determine the current AOA, and provide a visual image of the proximity to the critical AOA. *[Figure 4-5]* Some AOA indicators also provide aural indications, which can provide awareness to a change in AOA that is trending towards the critical AOA prior to installed stall warning systems. It's important to note that some indicators take flap position into consideration, but not all do.

Understanding what type of AOA indicator is installed on an airplane, how the particular device determines AOA, what the display is indicating and when the critical AOA is reached, and what the appropriate response is to those indications are all important components to AOA indicator training. It is also encouraged to conduct in-flight training to see the indications throughout various maneuvers, like slow flight, stalls, takeoffs, and landings, and to practice the appropriate responses to those indications. It is also important to note that some items may limit the effectiveness of an AOA indicator (e.g., calibration techniques, wing contamination, unheated probes/vanes). Pilots flying an airplane equipped with an AOA indicator should refer to the pilot handbook information or contact the manufacturer for specific limitations applicable to that indicator type.

Stall Characteristics

Different airplane designs can result in different stall characteristics. The pilot should know the stall characteristics of the airplane being flown and the manufacturer's recommended recovery procedures. Factors that can affect the stall characteristics of an airplane include its geometry, CG, wing design, and high-lift devices. Engineering design variations make it impossible to specifically describe the stall characteristics for all airplanes; however, there are enough similarities in small general aviation training-type airplanes to offer broad guidelines.

Most training airplanes are designed so that the wings stall progressively outward from the wing roots (where the wing attaches to the fuselage) to the wingtips. Some wings are

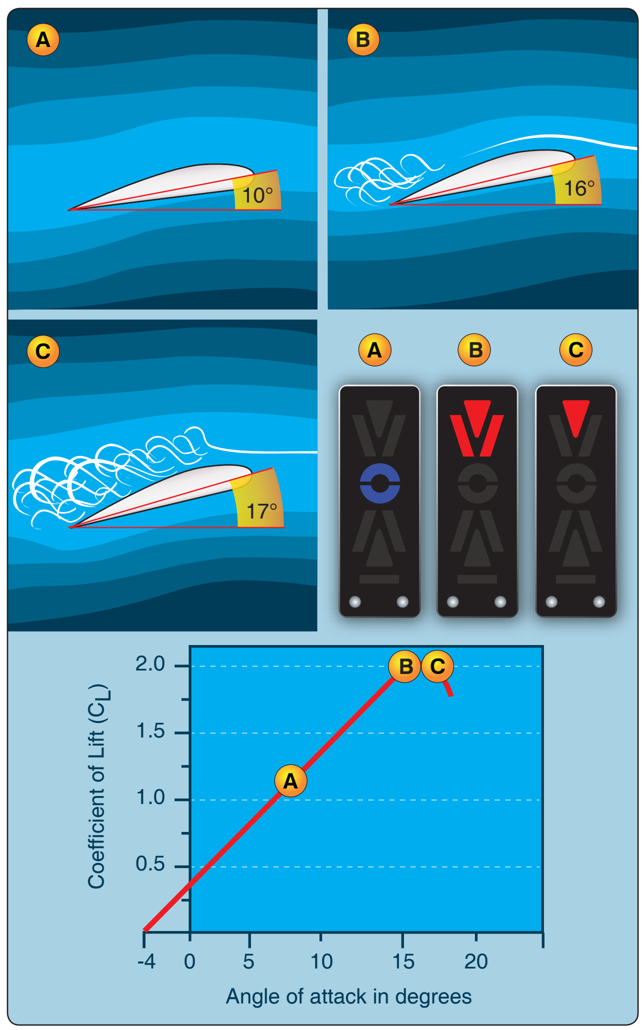


Figure 4-5. *A conceptual representation of an AOA indicator. It is important to become familiar with the equipment installed in a specific airplane.*

manufactured with a certain amount of twist, known as washout, resulting in the outboard portion of the wings having a slightly lower AOA than the wing roots. This design feature causes the wingtips to have a smaller AOA during flight than the wing roots. Thus, the wing roots of an airplane exceed the critical AOA before the wingtips, meaning the wing roots stall first. Therefore, when the airplane is in a stalled condition, the ailerons should still have a degree of control effectiveness until/unless stalled airflow migrates outward along the wings. Although airflow may still be attached at the wingtips, a pilot should exercise caution using the ailerons prior to the reduction of the AOA because it can exacerbate the stalled condition. For example, if the airplane rolls left at the stall ("rolls-off"), and the pilot applies right aileron to try to level the wing, the downward-deflected aileron on the left wing produces a greater AOA (and more induced drag), and a more complete stall at the tip as the critical AOA is exceeded. This can cause the wing to roll even more to the left, which is why it is important to first reduce the AOA before attempting to roll the airplane.

The pilot must also understand how the factors that affect stalls are interrelated. In a power-off stall, for instance, the cues (buffeting, shaking) are less noticeable than in the power-on stall. In the power-off, 1G stall, the predominant cue may be the elevator control position (full up elevator against the stops) and a high descent rate.

Fundamentals of Stall Recovery

Depending on the complexity of the airplane, stall recovery could consist of as many as six steps. Even so, the pilot should remember the most important action to an impending stall or a full stall is to reduce the AOA. There have been numerous situations where pilots did not first reduce AOA, and instead prioritized power and maintaining altitude, which resulted in a loss of control. This section provides a generic stall recovery procedure for light general aviation aircraft adapted from a template developed by major airplane manufacturers and can be adjusted appropriately for the aircraft used. *[Figure 4-6]* However, a pilot should always follow the aircraft-specific manufacturer's recommended procedures if published and current.

The recovery actions should be made in a procedural manner; they can be summarized in *Figure 4-6*. The following discussion explains each of the six steps:

1. Disconnect the wing leveler or autopilot (if equipped). Manual control is essential to recovery in all situations. Disconnecting this equipment should be done immediately and allow the pilot to move to the next crucial step quickly. Leaving the wing leveler or autopilot connected may result in inadvertent changes or adjustments to the flight controls or trim that may not be easily recognized or appropriate, especially during high workload situations.
2. a) Pitch nose-down control. Reducing the AOA is crucial for all stall recoveries. Push forward on the flight controls to reduce the AOA below the critical AOA until the impending stall indications are eliminated before proceeding to the next step.

   b) Trim nose-down pitch. If the elevator does not provide the needed response, pitch trim may be necessary. However, excessive use of pitch trim may aggravate the condition, or may result in loss of control or high structural loads.
3. Roll wings level. This orients the lift vector properly for an effective recovery. It is important not to be tempted to control the bank angle prior to reducing AOA. Both roll stability and roll control will improve considerably after getting the wings flying again. It is also imperative for the pilot to proactively cancel yaw with proper use of the rudder to prevent a stall from progressing into a spin.
4. Add thrust/power. Power should be added as needed, as stalls can occur at high power or low power settings, or at high airspeeds or low airspeeds. Advance the

Stall Recovery Template	
1. Wing leveler or autopilot	1. Disconnect
2. a) Pitch nose-down b) Trim nose-down pitch	2. a) Apply until impending stall indications are eliminated b) As needed
3. Bank	3. Wings Level
4. Thrust/Power	4. As needed
5. Speed brakes/spoilers	5. Retract
6. Return to the desired flight path	

Figure 4-6. *Stall recovery template.*

throttle promptly, but smoothly, as needed while using rudder and elevator controls to stop any yawing motion and prevent any undesirable pitching motion. Adding power typically reduces the loss of altitude during a stall recovery, but it does not eliminate a stall. The reduction in AOA is imperative. For propeller-driven airplanes, power application increases the airflow around the wing, assisting in stall recovery.

5. Retract speedbrakes/spoilers (if equipped). This will improve lift and the stall margin.
6. Return to the desired flightpath. Apply smooth and coordinated flight control movements to return the airplane to the desired flightpath being careful to avoid a secondary stall. The pilot should, however, be situationally aware of the proximity to terrain during the recovery and take the necessary flight control action to avoid contact with it.

The above procedure can be adapted for the type of aircraft flown. For example, a single-engine training airplane without an autopilot would likely only use four of the six steps. The first step is not needed therefore reduction of the AOA until the stall warning is eliminated is first. Use of pitch trim is less of a concern because most pilots can overpower the trim in these airplanes and any mistrim can be corrected when returning to the desired flightpath. The next step is rolling the wings level followed by the addition of power as needed all while maintaining coordinated flight. The airplane is not equipped with speedbrakes or spoilers therefore this step can be skipped and the recovery will conclude with returning to the desired flightpath.

Similarly, a glider pilot does not have an autopilot therefore the first step is the reduction of AOA until the stall warning is eliminated. The pilot would then roll wings level while maintaining coordinated flight. There is no power to add therefore this step would not apply. Retracting speedbrakes or spoilers would be the next step for a glider pilot followed by returning to the desired flightpath.

Stall Training

Practice in both power-on and power-off stalls is important because it simulates stall conditions that could occur during normal flight maneuvers. It is important for pilots to understand the possible flight scenarios in which a stall could occur. Stall accidents usually result from an inadvertent stall at a low altitude, with the recovery not completed prior to ground contact. For example, power-on stalls are practiced to develop the pilot's awareness of what could happen if the airplane is pitched to an excessively nose-high attitude immediately after takeoff, during a climbing turn, or when trying to clear an obstacle. Power-off turning stalls develop the pilot's awareness of what could happen if the controls are improperly used during a turn from the base leg to the final approach. The power-off straight-ahead stall simulates the stall that could occur when trying to stretch a glide after the engine has failed, or if low on the approach to landing.

As in all maneuvers that involve significant changes in altitude or direction, the pilot must ensure that the area is clear of other air traffic at and below their altitude and that sufficient altitude is available for a recovery before executing the maneuver. It is recommended that stalls be practiced at an altitude that allows recovery no lower than 1,500 feet AGL for single-engine airplanes, or higher if recommended by the AFM/POH. Losing altitude during recovery from a stall is to be expected.

Approaches to Stalls (Impending Stalls), Power-On or Power-Off

An impending stall occurs when the airplane is approaching, but does not exceed the critical AOA. The purpose of practicing impending stalls is to learn to retain or regain full control of the airplane immediately upon recognizing that it is nearing a stall, or that a stall is likely to occur if the pilot does not take appropriate action. Pilot training should emphasize teaching the same recovery technique for impending stalls and full stalls.

The practice of impending stalls is of particular value in developing the pilot's sense of feel for executing maneuvers in which maximum airplane performance is required. These maneuvers require flight in which the airplane approaches a stall, but the pilot initiates recovery at the first indication, such as by a stall warning device activation.

Impending stalls may be entered and performed in the same attitudes and configurations as the full stalls or other maneuvers described in this chapter. However, instead of allowing the airplane to reach the critical AOA, the pilot must immediately reduce AOA once the stall warning device goes off, if installed, or recognizes other cues such as buffeting. Hold the nose down control input as required to eliminate the stall warning. Then level the wings maintain coordinated flight, and then apply whatever additional power is necessary to return to the desired flightpath. The pilot will have recovered once the airplane has returned to the desired flightpath with sufficient airspeed and adequate flight control effectiveness and no stall warning. Performance of the impending stall maneuver is unsatisfactory if a full stall occurs, if an excessively low pitch attitude is attained, or if the pilot fails to take timely action to avoid excessive airspeed, excessive loss of altitude, or a spin.

Full Stalls, Power-Off

The practice of power-off stalls is usually performed with normal landing approach conditions to simulate an accidental stall occurring during approach to landing. However, power-off stalls should be practiced at all flap settings to ensure familiarity with handling arising from mechanical failures, icing, or other abnormal situations. Airspeed in excess of the normal approach speed should not be carried into a stall entry since it could result in an abnormally nose-high attitude.

To set up the entry for a straight-ahead power-off stall, airplanes equipped with flaps or retractable landing gear should be in the landing configuration. After extending the landing gear, applying carburetor heat (if applicable), and retarding the throttle to idle (or normal approach power), hold the airplane at a constant altitude in level flight until the airspeed decelerates to normal approach speed. The airplane should then be smoothly pitched down to a normal approach attitude to maintain that airspeed. Wing flaps should be extended and pitch attitude adjusted to maintain the airspeed.

When the approach attitude and airspeed have stabilized, the pilot should smoothly raise the airplane's nose to an attitude that induces a stall. Directional control should be maintained and wings held level by coordinated use of the ailerons and rudder. Once the airplane reaches an attitude that will lead to a stall, the pitch attitude is maintained with the elevator until the stall occurs. The stall is recognized by the full-stall cues previously described.

Recovery from the stall is accomplished by reducing the AOA, applying as much nose-down control input as required to eliminate the stall warning, leveling the wings, maintaining coordinated flight, and then applying power as needed. Right rudder pressure may be necessary to overcome the engine torque effects as power is advanced and the nose is being lowered. *[Figure 4-7]* If simulating an inadvertent stall on approach to landing, the pilot should initiate a go-around by establishing a positive rate of climb. Once in a climb, the flaps and landing gear should be retracted as necessary.

Recovery from power-off stalls should also be practiced from shallow banked turns to simulate an inadvertent stall during a turn from base leg to final approach. During the practice of these stalls, take care to ensure that the airplane remains coordinated and the turn continues at a constant bank angle until the full stall occurs. If the airplane is allowed to develop a slip, the outer wing may stall first and move downward abruptly. The recovery procedure is the same, regardless of whether one wing rolls off first. The pilot must apply as much nose down control input as necessary to eliminate the stall warning, level the wings with ailerons, coordinate with rudder, and add power as needed. In the practice of turning stalls, no attempt should be made to stall or recover the airplane on a predetermined heading. However, to simulate a turn from base to final approach, the stall normally should be made to occur within a heading change of approximately 90°.

Full Stalls, Power-On

Power-on stall recoveries are practiced from straight climbs and climbing turns (15° to 20° bank) to help the pilot recognize the potential for an accidental stall during takeoff, go around, climb, or when trying to clear an obstacle. Airplanes equipped with flaps or retractable landing gear should normally be in the takeoff configuration; however, power-on stalls should also be practiced with the airplane in a clean configuration (flaps and gear retracted) to ensure practice with all possible takeoff and climb configurations. Power for practicing the takeoff stall recovery should be maximum power, although for some airplanes it may be reduced to a setting that will prevent an excessively high pitch attitude.

To set up the entry for power-on stalls, establish the airplane in the takeoff or climb configuration. Slow the airplane to normal lift-off speed while continuing to clear the area of other traffic. Upon reaching the desired speed, set takeoff power or the recommended climb power for the power-on stall (often referred to as a departure stall) while establishing a climb attitude. The purpose of reducing the airspeed to lift-off airspeed before the throttle is advanced to the recommended setting is to avoid an excessively steep nose-up attitude for a long period before the airplane stalls.

After establishing the climb attitude, smoothly raise the nose to increase the AOA, and hold that attitude until the full stall

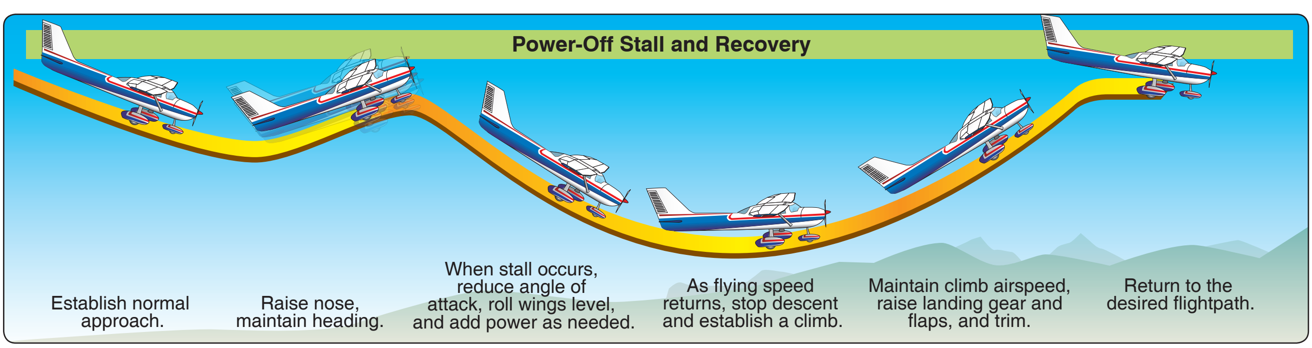


Figure 4-7. *Power-off stall and recovery.*

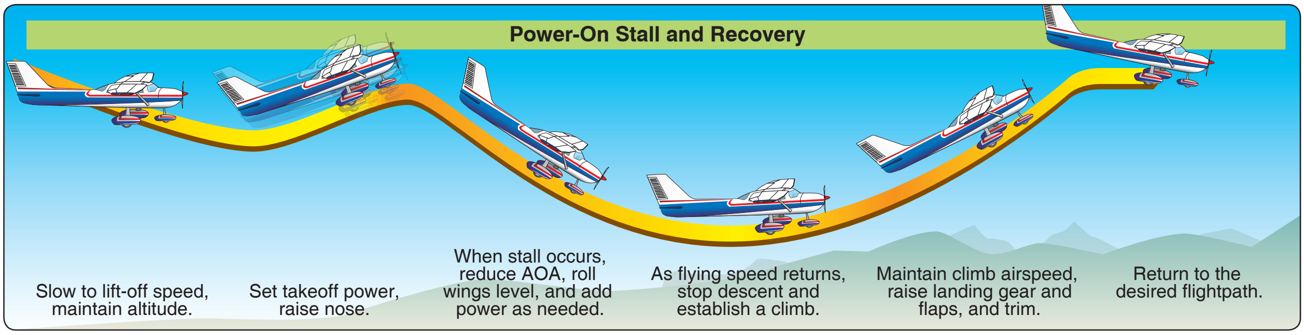


Figure 4-8. *Power-on stall.*

occurs. As described in connection with the stall characteristics discussion, continual adjustments must be made to aileron pressure, elevator pressure, and rudder pressure to maintain coordinated flight while holding the attitude until the full stall occurs. In most airplanes, as the airspeed decreases the pilot must move the elevator control progressively further back while simultaneously adding right rudder and maintaining the climb attitude until reaching the full stall.

The pilot must promptly recognize when the stall has occurred and take action to prevent a prolonged stalled condition. The pilot should recover from the stall by immediately reducing the AOA and applying as much nose-down control input as required to eliminate the stall warning, level the wings with ailerons, coordinate with rudder, and smoothly advance the power as needed. Since the throttle is already at the climb power setting, this step may simply mean confirming the proper power setting. *[Figure 4-8]*

The final step is to return the airplane to the desired flightpath (e.g., straight and level or departure/climb attitude). With sufficient airspeed and control effectiveness, return the throttle to the appropriate power setting.

Secondary Stall

A secondary stall is so named because it occurs after recovery from a preceding stall. It is typically caused by abrupt control inputs or attempting to return to the desired flightpath too quickly and the critical AOA is exceeded a second time. It can also occur when the pilot does not sufficiently reduce the AOA by lowering the pitch attitude or attempts to break the stall by using power only. *[Figure 4-9]*

When a secondary stall occurs, the pilot should again perform the stall recovery procedures by applying nose-down elevator pressure as required to eliminate the stall warning, level the wings with ailerons, coordinate with rudder, and adjust power as needed. When the airplane is no longer in a stalled condition the pilot can return the airplane to the desired flightpath. For pilot certification, this is a demonstration-only maneuver; only flight instructor applicants may be required to perform it on a practical test.

Accelerated Stalls

The objectives of demonstrating an accelerated stall are to determine the stall characteristics of the airplane, experience stalls at speeds greater than the +1G stall speed, and develop the ability to instinctively recover at the onset of such stalls. This is a maneuver only commercial pilot and flight instructor applicants may be required to perform or demonstrate on a practical test. However, all pilots should be familiar with the situations that can cause an accelerated stall, how to recognize it, and the appropriate recovery action should one occur.

At the same gross weight, airplane configuration, CG location, power setting, and environmental conditions,

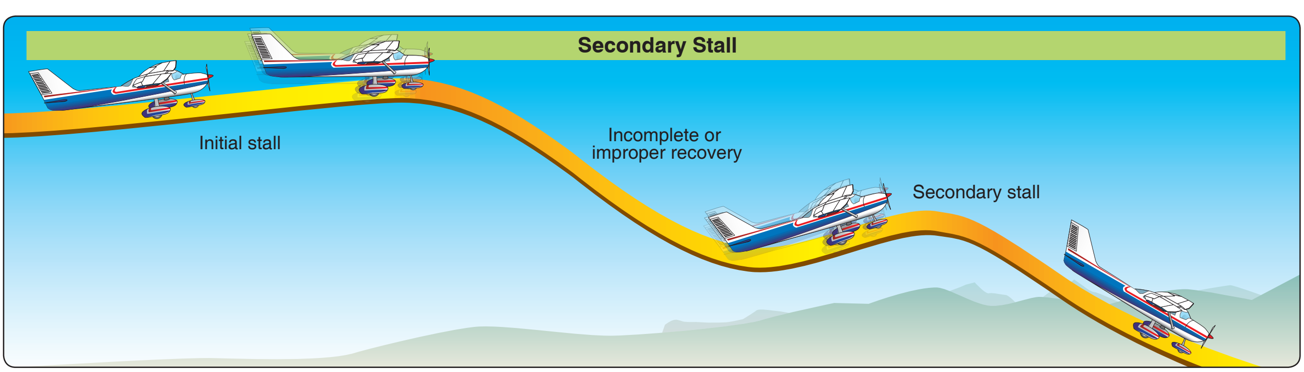


Figure 4-9. *Secondary stall.*

a given airplane consistently stalls at the same indicated airspeed provided the airplane is at +1G (i.e., steady-state unaccelerated flight). However, the airplane can also stall at a higher indicated airspeed when the airplane is subject to an acceleration greater than +1G, such as when turning, pulling up, or other abrupt changes in flightpath. Stalls encountered any time the G-load exceeds +1G are called "accelerated maneuver stalls". The accelerated stall would most frequently occur inadvertently during improperly executed turns, stall and spin recoveries, pullouts from steep dives, or when overshooting a base to final turn. An accelerated stall is typically demonstrated during steep turns.

A pilot should never practice accelerated stalls with wing flaps in the extended position due to the lower design G-load limitations in that configuration. Accelerated stalls should be performed with a bank of approximately 45°, and in no case at a speed greater than the airplane manufacturer's recommended airspeed or the specified design maneuvering speed (V_A).

It is important to be familiar with V_A, how it relates to accelerated stalls, and how it changes depending on the airplane's weight. V_A is the maximum speed at which the maximum positive design load limit can be imposed either by gusts or full one-sided deflection with one control surface without causing structural damage. Performing accelerated stalls at or below V_A allows the airplane to reach the critical AOA, which unloads the wing before it reaches the load limit. At speeds above V_A, the wing can reach the design load limit at an AOA less than the critical AOA. This means it is possible to damage the airplane before reaching the critical AOA and an accelerated stall. Knowing what V_A is for the weight of the airplane being flown is critical to prevent exceeding the load limit of the airplane during the maneuver.

There are two methods for performing an accelerated stall. The most common accelerated stall procedure starts from straight-and-level flight at an airspeed at or below V_A. Roll the airplane into a coordinated, level-flight 45° turn and then smoothly, firmly, and progressively increase the AOA through back elevator pressure until a stall occurs. Alternatively, roll the airplane into a coordinated, level-flight 45° turn at an airspeed above V_A. After the airspeed reaches V_A, or at an airspeed 5 to 10 percent faster than the unaccelerated stall speed, progressively increase the AOA through back elevator pressure until a stall occurs. The increased back elevator pressure increases the AOA, which increases the lift and thus the G load. The G load pushes the pilot's body down in the seat. The increased lift also increases drag, which may cause the airspeed to decrease. It is recommended that you know the published stall speed for 45° of bank, flaps up, before performing the maneuver. This speed is typically published in the AFM.

An airplane typically stalls during a level, coordinated turn similar to the way it does in wings level flight, except that the stall buffet can be sharper. If the turn is coordinated at the time of the stall, the airplane's nose pitches away from the pilot just as it does in a wings level stall since both wings will tend to stall nearly simultaneously. If the airplane is not properly coordinated at the time of stall, the stall behavior may include a change in bank angle until the AOA has been reduced. It is important to take recovery action at the first indication of a stall (if impending stall training/checking) or immediately after the stall has fully developed (if full stall training/checking) by applying forward elevator pressure as required to reduce the AOA and to eliminate the stall warning, level the wings using ailerons, coordinate with rudder, and adjust power as necessary. Stalls that result from abrupt maneuvers tend to be more aggressive than unaccelerated, +1G stalls. Because they occur at higher-than-normal airspeeds or may occur at lower-than-anticipated pitch attitudes, they can surprise an inexperienced pilot. A prolonged accelerated stall should never be allowed. Failure to take immediate steps toward recovery may result in a spin or other departure from controlled flight.

Cross-Control Stall

The objective of the cross-control stall demonstration is to show the effects of uncoordinated flight on stall behavior and to emphasize the importance of maintaining coordinated flight while making turns. This is a demonstration-only maneuver; only flight instructor applicants may be required to perform it on a practical test. However, all pilots should be familiar with the situations that can lead to a cross-control stall, how to recognize it, and the appropriate recovery action should one occur.

The aerodynamic effects of the uncoordinated, cross-control stall can surprise the unwary pilot because it can occur with very little warning and can be deadly if it occurs close to the ground. The nose may pitch down, the bank angle may suddenly change, and the airplane may continue to roll to an inverted position, which is usually the beginning of a spin. It is therefore essential for the pilot to follow the stall recovery procedure by reducing the AOA until the stall warning has been eliminated, then roll wings level using ailerons, and coordinate with rudder inputs before the airplane enters a spiral or spin.

A cross-control stall occurs when the critical AOA is exceeded with aileron pressure applied in one direction and rudder pressure in the opposite direction, causing uncoordinated flight. A skidding cross-control stall is most likely to occur in the traffic pattern during a poorly planned and executed base-to-final approach turn in which the airplane overshoots the runway centerline and the pilot attempts to correct back to centerline by increasing the bank angle, increasing back elevator pressure, and applying rudder in the direction of the turn (i.e., inside or bottom rudder pressure) to bring the nose around further to align it with the runway. The difference in lift between the inside and outside wing will increase, resulting in an unwanted increase in bank angle. At the same time, the nose of the airplane slices downward through the horizon. The natural reaction to this may be for the pilot to pull back on the elevator control, increasing the AOA toward critical. Should a stall be encountered with these inputs, the airplane may rapidly enter a spin. The safest action for an "overshoot" is to perform a go-around. At the relatively low altitude of a base-to-final approach turn, a pilot should be reluctant to use angles of bank beyond 30 degrees to correct back to runway centerline.

Before performing this stall, establish a safe altitude for entry and recovery in the event of a spin, and clear the area of other traffic while slowly retarding the throttle. The next step is to lower the landing gear (if equipped with retractable gear), close the throttle, and maintain altitude until the airspeed approaches the normal glide speed. To avoid the possibility of exceeding the airplane's limitations, do not extend the flaps. While the gliding attitude and airspeed are being established, the airplane should be retrimmed. Once the glide is stabilized, the airplane should be rolled into a medium-banked turn to simulate a final approach turn that overshoots the centerline of the runway.

During the turn, smoothly apply excessive rudder pressure in the direction of the turn but hold the bank constant by applying opposite aileron pressure. At the same time, increase back elevator pressure to keep the nose from lowering. All of these control pressures should be increased until the airplane stalls. When the stall occurs, recover by applying nose-down elevator pressure to reduce the AOA until the stall warning has been eliminated, remove the excessive rudder input and level the wings, and apply power as needed to return to the desired flightpath.

Elevator Trim Stall

The elevator trim stall demonstration shows what can happen when the pilot applies full power for a go-around without maintaining positive control of the airplane. *[Figure 4-10]* This is a demonstration-only maneuver; only flight instructor applicants may be required to perform it on a practical test. However, all pilots should be familiar with the situations that can cause an elevator trim stall, how to recognize it, and the appropriate recovery action should one occur.

This situation may occur during a go-around procedure from a normal landing approach or a simulated, forced-landing approach, or immediately after a takeoff, with the trim set for a normal landing approach glide at idle power. The objective of the demonstration is to show the importance of making smooth power applications, overcoming strong trim forces, maintaining positive control of the airplane to hold safe flight attitudes, and using proper and timely trim techniques. It also develops the pilot's ability to avoid actions that could result in this stall, to recognize when an elevator trim stall is approaching, and to take prompt and correct action to prevent a full stall condition. It is imperative to avoid the occurrence of an elevator trim stall during an actual go-around from an approach to landing.

At a safe altitude and after ensuring that the area is clear of other air traffic, the pilot should slowly retard the throttle and extend the landing gear (if the airplane is equipped with retractable gear). The next step is to extend the flaps to the one-half or full position, close the throttle, and maintain altitude until the airspeed approaches the normal glide speed.

When the normal glide is established, the pilot should trim the airplane nose-up for the normal landing approach glide. During this simulated final approach glide, the throttle is then advanced smoothly to maximum allowable power, just as it would be adjusted to perform a go-around.

The combined effects of increased propwash over the tail and elevator trim tend to make the nose rise sharply and turn to the

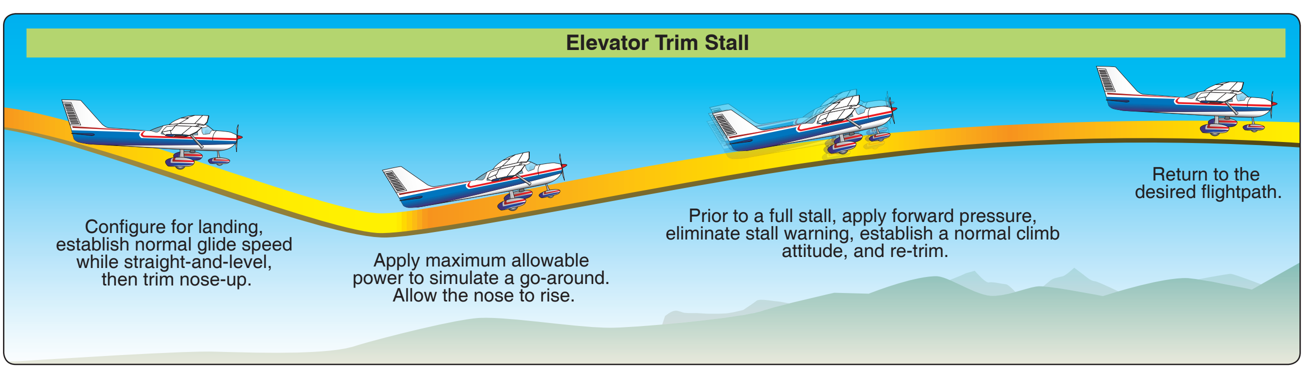


Figure 4-10. *Elevator trim stall.*

left. With the throttle fully advanced, the pitch attitude increases above the normal climbing attitude. When it is apparent the airplane is approaching a stall, the pilot must apply sufficient forward elevator pressure to reduce the AOA and eliminate the stall warning before returning the airplane to the normal climbing attitude. The pilot will need to adjust trim to relieve the heavy control pressures and then complete the normal go-around procedures and return to the desired flightpath. If taken to the full stall, recovery will require a significant nose-down attitude to reduce the AOA below its critical AOA, along with a corresponding significant loss of altitude.

Common Errors

Common errors in the performance of intentional stalls are:

- Failure to adequately clear the area
- Over-reliance on the airspeed indicator and slip-skid indicator while excluding other cues
- Inadvertent accelerated stall by pulling too fast on the controls during a power-off or power on stall entry
- Inability to recognize an impending stall condition
- Failure to take timely action to prevent a full stall during the conduct of impending stalls
- Failure to maintain a constant bank angle during turning stalls
- Failure to maintain proper coordination with the rudder throughout the stall and recovery
- Recovering before reaching the critical AOA when practicing the full stall maneuver
- Not disconnecting the wing leveler or autopilot, if equipped, prior to reducing AOA
- Recovery is attempted without recognizing the importance of pitch control and AOA
- Not maintaining a nose down control input until the stall warning is eliminated
- Pilot attempts to level the wings before reducing AOA
- Pilot attempts to recover with power before reducing AOA
- Failure to roll wings level after AOA reduction and stall warning is eliminated
- Inadvertent secondary stall during recovery
- Excessive forward-elevator pressure during recovery resulting in low or negative G load
- Excessive airspeed buildup during recovery
- Losing situational awareness and failing to return to desired flightpath or follow ATC instructions after recovery.

Spin Awareness

A spin is an aggravated stall that typically occurs from a full stall occurring with the airplane in a yawed state and results in the airplane following a downward corkscrew path. As the airplane rotates around a vertical axis, the outboard wing is less stalled than the inboard wing, which creates a rolling, yawing, and pitching motion. The airplane is basically descending due to gravity, rolling, yawing, and pitching in a spiral path. *[Figure 4-11]* The rotation results from an unequal AOA on the airplane's wings. The less-stalled rising wing has a decreasing AOA, where the relative lift increases and the drag decreases. Meanwhile, the descending wing has an increasing AOA, which results in decreasing relative lift and increasing drag.

A spin occurs when the airplane's wings exceed their critical AOA (stall) with a sideslip or yaw acting on the airplane at, or beyond, the actual stall. An airplane will yaw not only because of incorrect rudder application but because of adverse yaw created by aileron deflection; engine/prop effects, including p-factor, torque, spiraling slipstream, and gyroscopic precession; and wind shear, including wake turbulence. If the yaw had been created by the pilot because of incorrect

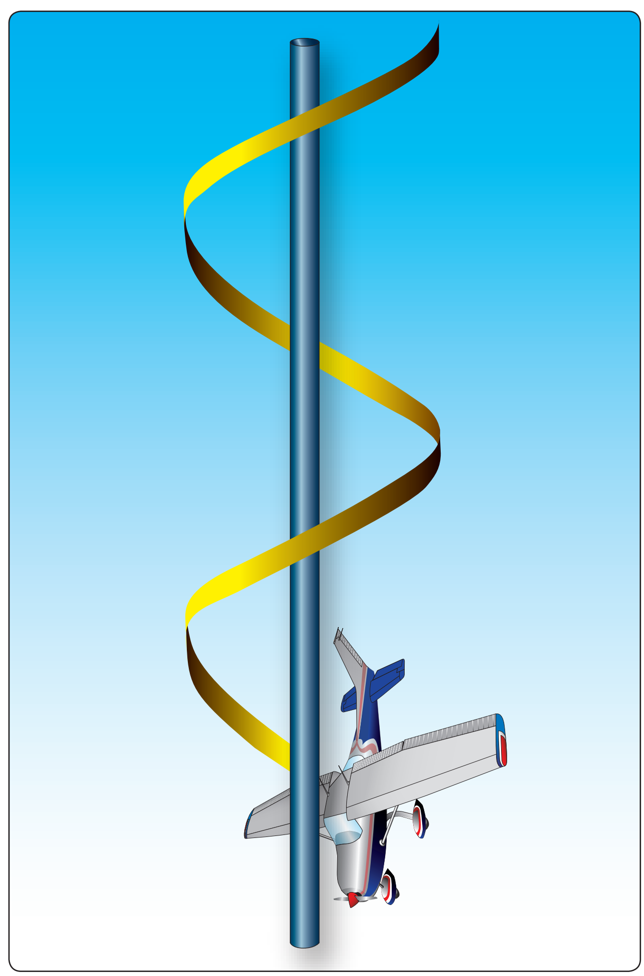


Figure 4-11. *Spin—an aggravated stall and autorotation.*

rudder use, the pilot may not be aware that a critical AOA has been exceeded until the airplane yaws out of control toward the lowering wing. A stall that occurs while the airplane is in a slipping or skidding turn can result in a spin entry and rotation in the direction of rudder application, regardless of which wingtip is raised. If the pilot does not immediately initiate stall recovery, the airplane may enter a spin.

Maintaining directional control and not allowing the nose to yaw before stall recovery is initiated is key to averting a spin. The pilot must apply the correct amount of rudder to keep the nose from yawing and the wings from banking.

Modern airplanes tend to be more reluctant to spin compared to older designs, however it is not impossible for them to spin. Mishandling the controls in turns, stalls, and flight at minimum controllable airspeeds can put even the most reluctant airplanes into an accidental spin. Proficiency in avoiding conditions that could lead to an accidental stall/spin situation, and in promptly taking the correct actions to recover to normal flight, is essential. An airplane must be stalled and yawed in order to enter a spin; therefore, continued practice in stall recognition and recovery helps the pilot develop a more instinctive and prompt reaction in recognizing an approaching spin. Upon recognition of a spin or approaching spin, the pilot should immediately execute spin recovery procedures.

Spin Procedures

The first rule for spin demonstration is to ensure that the airplane is approved for spins. Please note that this discussion addresses generic spin procedures; it does not cover special spin procedures or techniques required for a particular airplane. Safety dictates careful review of the AFM/POH and regulations before attempting spins in any airplane. The review should include the following items:

- The airplane's AFM/POH limitations section, placards, or type certification data to determine if the airplane is approved for spins
- Weight and balance limitations
- Recommended entry and recovery procedures
- The current 14 CFR Part 91 parachute requirements

Also essential is a thorough airplane preflight inspection, with special emphasis on excess or loose items that may affect the weight, center of gravity, and controllability of the airplane. It is also important to ensure that the airplane is within any CG limitations as determined by the manufacturer. Slack or loose control cables (particularly rudder and elevator) could prevent full anti-spin control deflections and delay or preclude recovery in some airplanes.

Prior to beginning spin training, clear the flight area above and below the airplane for other traffic. This task may be accomplished while slowing the airplane for the spin entry. In addition, all spin training should be initiated at an altitude high enough to complete recovery at or above 1,500 feet AGL.

It may be appropriate to introduce spin training by first practicing both power-on and power-off stalls in a clean configuration. This practice helps familiarize the pilot with the airplane's specific stall and recovery characteristics. In all phases of training, the pilot should take care with handling of the power (throttle), and apply carburetor heat, if equipped, according to the manufacturer's recommendations.

There are four phases of a spin: entry, incipient, developed, and recovery. *[Figure 4-12]*

Entry Phase

In the entry phase, the pilot intentionally or accidentally provides the necessary elements for the spin. The entry procedure for demonstrating a spin is similar to a power-off stall. During the entry, the pilot should slowly reduce power to idle, while simultaneously raising the nose to a pitch attitude that ensures a stall. As the airplane approaches a stall, smoothly apply full rudder in the direction of the desired spin rotation while applying full back (up) elevator to the limit of travel. Always maintain the ailerons in the neutral position during the spin procedure unless AFM/POH specifies otherwise.

Incipient Phase

The incipient phase occurs from the time the airplane stalls and starts rotating until the spin has fully developed. This phase may take two to four turns for most airplanes. In this phase, the aerodynamic and inertial forces have not achieved a balance. As the incipient phase develops, the indicated airspeed will generally stabilize at a low and constant airspeed and the symbolic airplane of the turn indicator should indicate the direction of the spin. The slip/skid ball is unreliable when spinning.

The pilot should initiate incipient spin recovery procedures prior to completing 360° of rotation. The pilot should apply full rudder opposite the direction of rotation. The turn indicator shows a deflection in the direction of rotation if disoriented.

Incipient spins that are not allowed to develop into a steady-state spin are the most commonly used maneuver in initial spin training and recovery techniques.

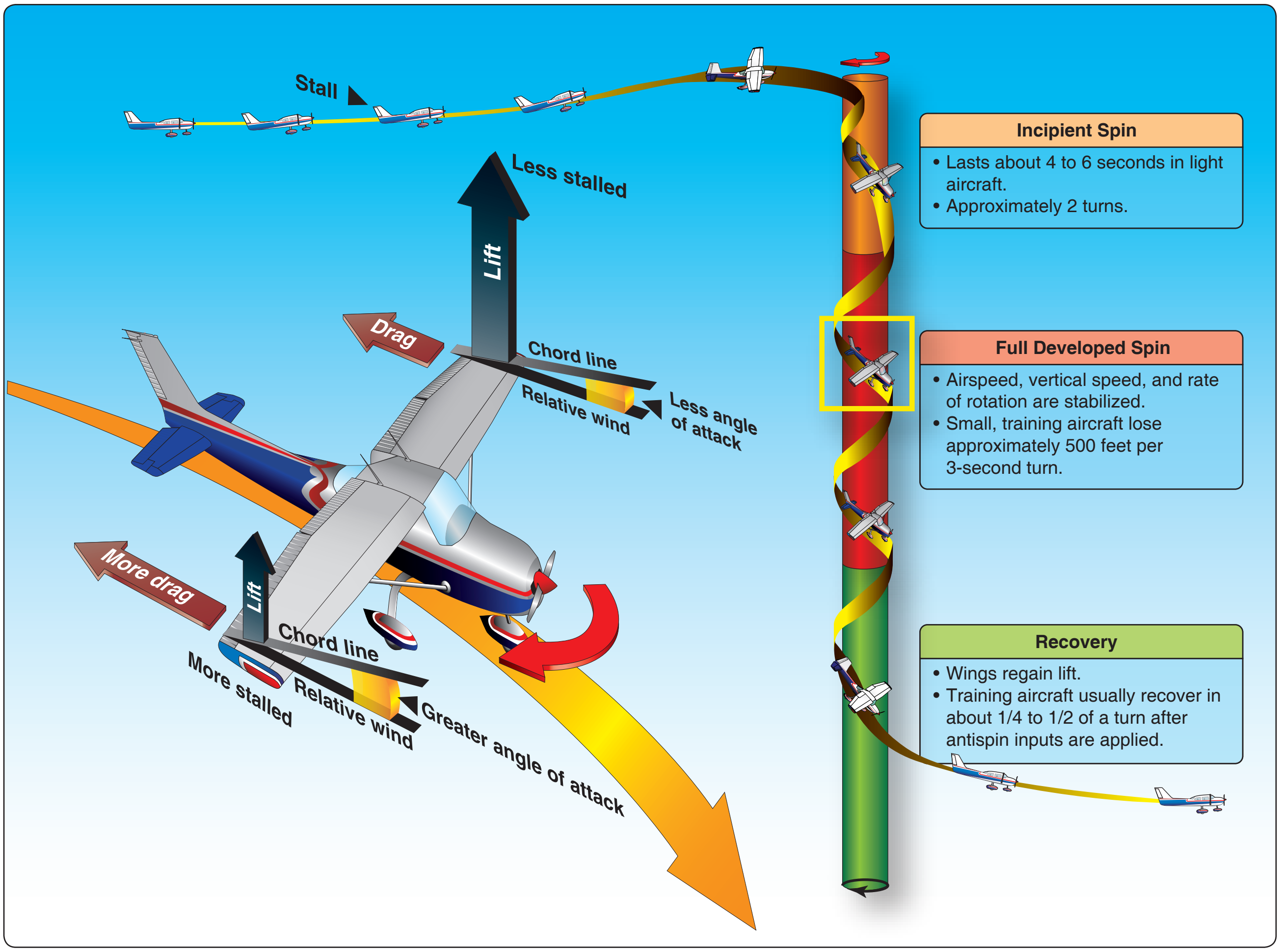


Figure 4-12. *Spin entry and recovery.*

Developed Phase

The developed phase occurs when the airplane's angular rotation rate, airspeed, and vertical speed are stabilized in a flightpath that is nearly vertical. In the developed phase, aerodynamic forces and inertial forces are in balance, and the airplane's attitude, angles, and self-sustaining motions about the vertical axis are constant or repetitive, or nearly so. The spin is in equilibrium. It is important to note that some training airplanes will not enter into the developed phase but could transition unexpectedly from the incipient phase into a spiral dive. In a spiral dive the airplane will not be in equilibrium but instead will be accelerating and G load can rapidly increase as a result.

Recovery Phase

The recovery phase occurs when rotation ceases and the AOA of the wings is decreased below the critical AOA. This phase may last for as little as a quarter turn or up to several turns depending upon the airplane and the type of spin.

To recover, the pilot applies control inputs to disrupt the spin equilibrium by stopping the rotation and unstalling the wing. To accomplish spin recovery, always follow the manufacturer's recommended procedures. In the absence of the manufacturer's recommended spin recovery procedures and techniques, use the spin recovery procedures in *Figure 4-13.* If the flaps and/or retractable landing gear are extended prior to the spin, they should be retracted as soon as practicable after spin entry.

1. Reduce the Power (Throttle) to Idle
2. Position the Ailerons to Neutral
3. Apply Full Opposite Rudder against the Rotation
4. Apply Positive, Brisk, and Straight Forward Elevator (Forward of Neutral)
5. Neutralize the Rudder After Spin Rotation Stops
6. Apply Back Elevator Pressure to Return to Level Flight

Spin Recovery Template
1. Reduce the power (throttle) to idle
2. Position the ailerons to neutral
3. Apply full opposite rudder against the rotation
4. Apply positive, brisk, and straight forward elevator (forward of neutral)
5. Neutralize the rudder after spin rotation stops
6. Apply back elevator pressure to return to level flight

Figure 4-13. *Spin recovery template.*

The following discussion explains each of the six steps:

1. Reduce the Power (Throttle) to Idle. Power aggravates spin characteristics. It can result in a flatter spin attitude and usually increases the rate of rotation.
2. Position the Ailerons to Neutral. Ailerons may have an adverse effect on spin recovery. Aileron control in the direction of the spin may accelerate the rate of rotation, steepen the spin attitude and delay the recovery. Aileron control opposite the direction of the spin may cause flattening of the spin attitude and delayed recovery; or may even be responsible for causing an unrecoverable spin. The best procedure is to ensure that the ailerons are neutral.
3. Apply Full Opposite Rudder against the Rotation. Apply and hold full opposite rudder until rotation stops. Rudder tends to be the most important control for recovery in typical, single-engine airplanes, and its application should be brisk and full opposite to the direction of rotation. Avoid slow and overly cautious opposite rudder movement during spin recovery, which can allow the airplane to spin indefinitely, even with anti-spin inputs. A brisk and positive technique results in a more positive spin recovery.
4. Apply Positive, Brisk, and Straight Forward Elevator (Forward of Neutral). This step should be taken immediately after full rudder application. Do not wait for the rotation to stop before performing this step. The forceful movement of the elevator decreases the AOA and drives the airplane toward unstalled flight. In some cases, full forward elevator may be required for recovery. Hold the controls firmly in these positions until the spinning stops. (Note: If the airspeed is increasing, the airplane is no longer in a spin. In a spin, the airplane is stalled, and the indicated airspeed should therefore be relatively low and constant and not be accelerating.)
5. Neutralize the Rudder After Spin Rotation Stops. Failure to neutralize the rudder at this time, when airspeed is increasing, causes a yawing or sideslipping effect.
6. Apply Back Elevator Pressure to Return to Level Flight. Be careful not to apply excessive back elevator pressure after the rotation stops and the rudder has been neutralized. Excessive back elevator pressure can cause a secondary stall and may result in another spin. The pilot must also avoid exceeding the G-load limits and airspeed limitations during the pull out.

Again, it is important to remember that the spin recovery procedures and techniques described above are recommended for use only in the absence of the manufacturer's procedures. The pilot must always be familiar with the manufacturer's procedures for spin recovery.

Intentional Spins

If the manufacturer does not specifically approve an airplane for spins, intentional spins are not authorized by the CFRs or by this handbook. The official sources for determining whether the spin maneuver is approved are:

- Type Certificate Data Sheets or the Aircraft Specifications
- The limitation section of the FAA-approved AFM/POH. The limitation section may provide additional specific requirements for spin authorization, such as limiting gross weight, CG range, and amount of fuel.
- On a placard located in clear view of the pilot in the airplane (e.g., "NO ACROBATIC MANEUVERS INCLUDING SPINS APPROVED"). In airplanes placarded against spins, there is no assurance that recovery from a fully developed spin is possible.

Unfortunately, accident records show occurrences in which pilots intentionally ignored spin restrictions. Despite the installation of placards prohibiting intentional spins in these airplanes, some pilots and even some flight instructors attempt to justify the maneuver, rationalizing that the spin restriction results from a "technicality" in the airworthiness standards. They believe that if the airplane was spin tested during its certification process, no problem should result from demonstrating or practicing spins.

Such pilots overlook the fact that certification of a normal category airplane only requires the airplane to recover from a one-turn spin in not more than one additional turn or three seconds, whichever takes longer. In other words, the airplane may never be in a fully developed spin. Therefore, in airplanes placarded against spins, there is absolutely no assurance that recovery from a fully developed spin is possible under any circumstances. The pilot of an airplane placarded against intentional spins should assume that the airplane could become uncontrollable in a spin.

Weight and Balance Requirements Related to Spins

In airplanes that are approved for spins, compliance with weight and balance requirements is important for safe performance and recovery from the spin maneuver. Pilots must be aware that even minor weight or balance changes can affect the airplane's spin recovery characteristics. Such changes can either degrade or enhance the spin maneuver and/or recovery characteristics. For example, the addition of weight in the aft baggage compartment, or additional fuel, may still permit the airplane to be operated within CG, but could seriously affect the spin and recovery characteristics. An airplane that may be difficult to spin intentionally in the utility category (restricted aft CG and reduced weight) could have less resistance to spin entry in the normal category (less restricted aft CG and increased weight). This situation arises from the airplane's ability to generate a higher AOA. An airplane that is approved for spins in the utility category but loaded in accordance with the normal category may not recover from a spin that is allowed to progress beyond one turn.

Common Errors

Common errors in the performance of intentional spins are:

- Failure to apply full rudder pressure (to the stops) in the desired spin direction during spin entry
- Failure to apply and maintain full up-elevator pressure during spin entry, resulting in a spiral
- Failure to achieve a fully-stalled condition prior to spin entry
- Failure to apply full rudder (to the stops) briskly against the spin during recovery
- Failure to apply sufficient forward-elevator during recovery
- Waiting for rotation to stop before applying forward elevator
- Failure to neutralize the rudder after rotation stops, possibly resulting in a secondary spin
- Slow and overly cautious control movements during recovery
- Excessive back elevator pressure after rotation stops, possibly resulting in secondary stall
- Insufficient back elevator pressure during recovery resulting in excessive airspeed

Upset Prevention and Recovery

Unusual Attitudes Versus Upsets

An unusual attitude is commonly referenced as an unintended or unexpected attitude in instrument flight. These unusual attitudes are introduced to a pilot during student pilot training as part of basic attitude instrument flying and continue to be trained and tested as part of certification for an instrument rating, aircraft type rating, and an airline transport pilot certificate. A pilot is taught the conditions or situations that could cause an unusual attitude, with focus on how to recognize one, and how to recover from one.

As discussed at the beginning of this chapter, the term "upset" is inclusive of unusual attitudes. An upset is defined as an event that unintentionally exceeds the parameters normally experienced in flight or training. These parameters are:

- Pitch attitude greater than 25°, nose up
- Pitch attitude greater than 10°, nose down
- Bank angle greater than 45°
- Within the above parameters, but flying at airspeeds inappropriate for the conditions.

(Note: The reference to inappropriate airspeeds describes a number of undesired aircraft states, including stalls. However, stalls are directly related to AOA, not airspeed.)

Given the upset definition, there are a few key distinctions between an unusual attitude and an upset. First, an upset includes stall events where unusual attitude training typically does not. Second, an upset can include overspeeds or other inappropriate speeds for a given flight condition, which is also not considered part of unusual attitude training. Finally, an upset has defined parameters; an unusual attitude does not. For example, for training purposes an instructor could place the airplane in a 30° bank with a nose up pitch attitude of 15° and ask the student to recover and that would be considered an unusual attitude, but would not meet the upset parameters. While the information that follows in this section could apply to unusual attitudes, the focus will be on UPRT.

The top four causal and contributing factors that have led to an upset and resulted in LOC-I accidents are:

1. Environmental factors
2. Mechanical factors
3. Human factors
4. Stall-related factors

With the exception of stall-related factors, which were covered in the previous section, the remaining causal and contributing factors to LOC-I accidents will be discussed further below.

Environmental Factors

Turbulence, or a large variation in wind velocity over a short distance, can cause upset and LOC-I. Maintain awareness of conditions that can lead to various types of turbulence, such as clear air turbulence, mountain waves, wind shear, and thunderstorms or microbursts. In addition to environmentally-induced turbulence, wake turbulence from other aircraft can lead to upset and LOC-I.

Icing can destroy the smooth flow of air over the airfoil and increase drag while decreasing the ability of the airfoil to create lift. Therefore, it can significantly degrade airplane performance, resulting in a stall if not handled correctly.

Mechanical Factors

Modern airplanes and equipment are very reliable, but anomalies do occur. Some of these mechanical failures can directly cause a departure from normal flight, such as asymmetrical flaps, malfunctioning or binding flight controls, and runaway trim.

Upsets can also occur if there is a malfunction or misuse of the autoflight system. Advanced automation may tend to mask the cause of the anomaly. Disengaging the autopilot and the autothrottles allows the pilot to directly control the airplane and possibly eliminate the cause of the problem. For these reasons the pilot must maintain proficiency to manually fly the airplane in all flight conditions without the use of the autopilot/autothrottles.

Although these and other inflight anomalies may not be preventable, knowledge of systems and AFM/POH recommended procedures helps the pilot minimize their impact and prevent an upset. In the case of instrument failures, avoiding an upset and subsequent LOC-I may depend on the pilot's proficiency in the use of secondary instrumentation and partial panel operations.

Human Factors

VMC to IMC

Unfortunately, accident reports indicate that continued VFR flight from visual meteorological conditions (VMC) into marginal VMC and IMC is a factor contributing to LOC I. A loss of the natural horizon substantially increases the chances of encountering vertigo or spatial disorientation, which can lead to upset.

IMC

When operating in IMC, maintain awareness of conditions and use the fundamental instrument skills—cross-check, interpretation, and control—to prevent an upset.

Diversion of Attention

In addition to its direct impact, an inflight anomaly or malfunction can also lead to an upset if it diverts the pilot's attention from basic airplane control responsibilities. Failing to monitor the automated systems, over-reliance on those systems, or incomplete knowledge and experience with those systems can lead to an upset. Diversion of attention can also occur simply from the pilot's efforts to set avionics or navigation equipment while flying the airplane.

Task Saturation

The margin of safety is the difference between task requirements and pilot capabilities. An upset and eventual LOC-I can occur whenever requirements exceed capabilities. For example, an airplane upset event that requires rolling an airplane from a near-inverted to an upright attitude may demand piloting skills beyond those learned during primary training. In another example, a fatigued pilot who inadvertently encounters IMC at night coupled with a vacuum pump failure, or a pilot fails to engage pitot heat while flying in IMC, could become disoriented and lose control of the airplane due to the demands of extended—and unpracticed—partial panel flight. Additionally, unnecessary low-altitude flying and impromptu demonstrations for friends or others on the ground often lead pilots to exceed their capabilities, with fatal results.

Sensory Overload/Deprivation

A pilot's ability to adequately correlate warnings, annunciations, instrument indications, and other cues from the airplane during an upset can be limited. Pilots faced with upset situations can be rapidly confronted with multiple or simultaneous visual, auditory, and tactile warnings. Conversely, sometimes expected warnings are not provided when they should be; this situation can distract a pilot as much as multiple warnings can.

The ability to separate time-critical information from distractions takes practice, experience and knowledge of the airplane and its systems. Cross-checks are necessary not only to corroborate other information that has been presented, but also to determine if information might be missing or invalid. For example, a stall warning system may fail and therefore not warn a pilot of close proximity to a stall, other cues must be used to avert a stall and possible LOC-I. These cues include aerodynamic buffet, loss of roll authority, or inability to arrest a descent.

Spatial Disorientation

Spatial disorientation has been a significant factor in many airplane upset accidents. Accident data from 2008 to 2013 shows nearly 200 accidents associated with spatial disorientation with more than 70% of those being fatal. All pilots are susceptible to false sensory illusions while flying at night or in certain weather conditions. These illusions can lead to a conflict between actual attitude indications and what the pilot senses is the correct attitude. Disoriented pilots may not always be aware of their orientation error. Many airplane upsets occur while the pilot is engaged in some task that takes attention away from the flight instruments or outside references. Others perceive a conflict between bodily senses and the flight instruments, and allow the airplane to divert from the desired flightpath because they cannot resolve the conflict.

A pilot may experience spatial disorientation or perceive the situation in one of three ways:

1. Recognized spatial disorientation: the pilot recognizes the developing upset or the upset condition and is able to safely correct the situation.
2. Unrecognized spatial disorientation: the pilot is unaware that an upset event is developing, or has occurred, and fails to make essential decisions or take any corrective action to prevent LOC-I.
3. Incapacitating spatial disorientation: the pilot is unable to affect a recovery due to some combination of: (a) not understanding the events as they are unfolding, (b) lacking the skills required to alleviate or correct the situation, or (c) exceeding psychological or physiological ability to cope with what is happening.

For detailed information regarding causal factors of spatial disorientation, refer to Aerospace Medicine Spatial Disorientation and Aerospace Medicine Reference Collection, which provides spatial disorientation videos. This collection can be found online at: www.faa.gov/about/office_org/ headquarters_offices/avs/offices/aam/cami/library/online_libraries/aerospace_medicine/sd/videos/.

Startle Response

Startle is an uncontrollable, automatic muscle reflex, raised heart rate, blood pressure, etc., elicited by exposure to a sudden, intense event that violates a pilot's expectations.

Surprise Response

Surprise is an unexpected event that violates a pilot's expectations and can affect the mental processes used to respond to the event.

This human response to unexpected events has traditionally been underestimated or even ignored during flight training. The reality is that untrained pilots often experience a state of surprise or a startle response to an airplane upset event. Startle may or may not lead to surprise. Pilots can protect themselves against a debilitating surprise reaction or startle response through scenario-based training, and in such training, instructors can incorporate realistic distractions to help provoke startle or surprise. To be effective the controlled training scenarios must have a perception of risk or threat of consequences sufficient to elevate the pilot's stress levels. Such scenarios can help prepare a pilot to mitigate psychological/physiological reactions to an actual upset.

Upset Prevention and Recovery Training (UPRT)

Upsets are not intentional flight maneuvers, except in maneuver-based training; therefore, they are often unexpected. The reaction of an inexperienced or inadequately trained pilot to an unexpected abnormal flight attitude is usually instinctive rather than intelligent and deliberate. Such a pilot often reacts with abrupt muscular effort, which is without purpose and even hazardous in turbulent conditions, at excessive speeds, or at low altitudes.

Without proper upset recovery training on interpretation and airplane control, the pilot can quickly aggravate an abnormal flight attitude into a potentially fatal LOC-I accident. Consequently, UPRT is intended to focus education and training on the prevention of upsets, and on recovering from these events if they occur. *[Figure 4-14]*

- Upset prevention refers to pilot actions to avoid a divergence from the desired airplane state. Awareness and prevention training serve to avoid incidents; early recognition of an upset scenario coupled with appropriate preventive action often can mitigate a situation that could otherwise escalate into a LOC-I accident.

Figure 4-14. *Maneuvers that better prepare a pilot for understanding unusual attitudes and situations are representative of upset training.*

- Recovery refers to pilot actions that return an airplane that is diverging in altitude, airspeed, or attitude to a desired state from a developing or fully developed upset. Learn to initiate recovery to a normal flight mode immediately upon recognition of the developing upset condition. Ensure that control inputs and power adjustments applied to counter an upset are in direct proportion to the amount and rates of change of roll, yaw, pitch, or airspeed so as to avoid overstressing the airplane unless ground contact is imminent. Recovery training serves to reduce accidents as a result of an unavoidable or inadvertently encountered upset event.

UPRT Core Concepts

Airplane upsets are by nature time-critical events; they can also place pilots in unusual and unfamiliar attitudes that sometimes require counterintuitive control movements. Upsets have the potential to put a pilot into a life-threatening situation compounded by panic, diminished mental capacity, and potentially incapacitating spatial disorientation. Because real-world upset situations often provide very little time to react, exposure to such events during training is essential for pilots to reduce surprise and it mitigates confusion during unexpected upsets. The goal is to equip the pilot to promptly recognize an escalating threat pattern or sensory overload and quickly identify and correct an impending upset.

UPRT stresses that the first step is recognizing any time the airplane begins to diverge from the intended flightpath or airspeed. Pilots must identify and determine what, if any, action must be taken. As a general rule, any time visual cues or instrument indications differ from basic flight maneuver expectations, the pilot should assume an upset and cross-check to confirm the attitude, instrument error or instrument malfunction.

To achieve maximum effect, it is crucial for UPRT concepts to be conveyed accurately and in a non-threatening manner. Reinforcing concepts through positive experiences significantly improves a pilot's depth of understanding, retention of skills, and desire for continued training. Also, training in a carefully structured environment allows for exposure to these events and can help the pilot react more quickly, decisively, and calmly when the unexpected occurs during flight. However, like many other skills, the skills needed for upset prevention and recovery are perishable and thus require continuous reinforcement through training.

UPRT in the airplane and flight simulation training device (FSTD) should be conducted in both visual and simulated instrument conditions to allow pilots to practice recognition and recovery under both situations. UPRT should allow them to experience and recognize some of the physiological factors related to each, such as the confusion and disorientation that can result from visual cues in an upset event. Training that includes recovery from bank angles exceeding 90 degrees could further add to a pilot's overall knowledge and skills for upset recognition and recovery. For such training, additional measures should be taken to ensure the suitability of the airplane or FSTD and that instructors are appropriately qualified.

Upset prevention and recovery training is different from aerobatic training. *[Figure 4-15]* In aerobatic training, the pilot knows and expects the maneuver, so effects of startle or surprise are missing. The main goal of aerobatic training is to teach pilots how to intentionally and precisely maneuver an aerobatic-capable airplane in three dimensions. The primary goal of UPRT is to help pilots overcome sudden onsets of stress to avoid, prevent, and recover from unplanned excursions that could lead to LOC-I.

Aerobatics vs. UPRT Flight Training Methods		
ASPECT OF TRAINING	**AEROBATICS**	**UPSET PREVENTION AND RECOVERY TRAINING**
Primary Objective	Precision maneuvering capability	Safe, effective recovery from aircraft upsets
Secondary Outcome	Improved manual aircraft handling skills	Improved manual aircraft handling skills
Aerobatic Maneuvering	Primary mode of training	Supporting mode of training
Academics	Supporting role	Fundamental component
Training Resources Utilized	Aircraft (few exceptions)	Aircraft or a full-flight simulator

Figure 4-15. *Some differences between aerobatic training and upset prevention and recovery training.*

Comprehensive UPRT builds on three mutually supportive components: academics, airplane-based training and, typically at the transport category type-rating training level, use of FSTDs. Each has unique benefits and limitations but, when implemented cohesively and comprehensively throughout a pilot's career, the components can offer maximum preparation for upset awareness, prevention, recognition, and recovery.

Academic Material (Knowledge and Risk Management)

Academics establish the foundation for development of situational awareness, insight, knowledge, and skills. As in practical skill development, academic preparation should move from the general to specific while emphasizing the significance of each basic concept. Although academic preparation is crucial and does offer a level of mitigation of the LOC-I threat, long-term retention of knowledge is best achieved when applied and correlated with practical hands-on experience.

The academic material needs to build awareness in the pilot by providing the concepts, principles, techniques, and procedures for understanding upset hazards and mitigating strategies. Awareness of the relationship between AOA, G-load, lift, energy management, and the consequences of their mismanagement, is essential for assessing hazards, mitigating the risks, and acquiring and employing prevention skills. Training maneuvers should be designed to provide awareness of situations that could lead to an upset or LOC. With regard to the top four causal and contributing factors to LOC-I accidents presented earlier in this chapter, training should include scenarios that place the airplane and pilot in a simulated situation/environment that can lead to an upset.

The academics portion of UPRT should also address the prevention concepts surrounding Aeronautical Decision Making (ADM) and risk management (RM), and proportional counter response.

Prevention Through ADM and Risk Management

This element of prevention routinely occurs in a time-scale of minutes or hours, revolving around the concept of effective ADM and risk management through analysis, awareness, resource management, and interrupting the error chain through basic airmanship skills and sound judgment. For instance, imagine a situation in which a pilot assesses conditions at an airport prior to descent and recognizes those conditions as being too severe to safely land the airplane. Using situational awareness to avert a potentially threatening flight condition is an example of prevention of a LOC-I situation through effective risk management. Pilots should evaluate the circumstances for each flight (including the equipment and environment), looking specifically for scenarios that may require a higher level of risk management. These include situations which could result in low-altitude maneuvering, steep turns in the pattern, uncoordinated flight, or increased load factors.

Another part of ADM is crew resource management (CRM) or Single Pilot Resource Management (SRM). Both are relevant to the UPRT environment. When available, a coordinated crew response to potential and developing upsets can provide added benefits such as increased situational awareness, mutual support, and an improved margin of safety. Since an untrained crewmember can be the most unpredictable element in an upset scenario, initial UPRT for crew operations should be mastered individually before being integrated into a multi-crew, CRM environment. A crew must be able to accomplish the following:

- Communicate and confirm the situation clearly and concisely;
- Transfer control to the most situationally aware crewmember;
- Using standardized interactions, work as a team to enhance awareness, manage stress, and mitigate fear.

Prevention through Proportional Counter-Response

In simple terms, proportional counter response is the timely manipulation of flight controls and thrust, either as the sole pilot or crew as the situation dictates, to manage an airplane flight attitude or flight envelope excursion that was unintended or not commanded by the pilot.

The time-scale of this element of prevention typically occurs on the order of seconds or fractions of seconds, with the goal being able to recognize a developing upset and take proportionally appropriate avoidance actions to preclude the airplane entering a fully developed upset. Due to the sudden, surprising nature of this level of developing upset, there exists a high risk for panic and overreaction to ensue and aggravate the situation.

Recovery

Last but not least, the academics portion lays the foundation for development of UPRT skills by instilling the knowledge, procedures, and techniques required to accomplish a safe recovery. The airplane and FSTD-based training elements presented below serve to translate the academic material into structured practice. This can start with classroom visualization of recovery procedures and continue with repetitive skill practiced in an airplane, and then potentially further developed in the simulated environment.

In the event looking outside does not provide enough situational awareness of the airplane attitude, a pilot can use the flight instruments to recognize and recover from an upset. To recover from nose-high and nose-low attitudes, the pilot should follow the procedures recommended in the AFM/POH. In general, upset recovery procedures are summarized in *Figure 4-16.*

Upset Recovery Template
1. Disconnect the wing leveler or autopilot
2. Apply forward column or stick pressure to unload the airplane
3. Aggressively roll the wings to the nearest horizon
4. Adjust power as necessary by monitoring airspeed
5. Return to level flight

Figure 4-16. *Upset recovery template.*

Common Errors

Common errors associated with upset recoveries include the following:

- Incorrect assessment of what kind of upset the airplane is in
- Failure to disconnect the wing leveler or autopilot
- Failure to unload the airplane, if necessary
- Failure to roll in the correct direction
- Inappropriate management of the airspeed during the recovery

Roles of FSTDs and Airplanes in UPRT

Training devices range from aviation training devices (e.g., basic and advanced) to FSTDs (e.g., flight training devices (FTD) and full flight simulators (FFS)) and have a broad range of capabilities. While all of these devices have limitations relative to actual flight, only the higher fidelity devices (i.e., Level C and D FFS) are a satisfactory substitution for developing UPRT skills in the actual aircraft. Except for these higher fidelity devices, initial skill development should be accomplished in a suitable airplane, and the accompanying training device should be used to build upon these skills. *[Figure 4-17]*

Airplane-Based UPRT

Ultimately, the more realistic the training scenario, the more indelible the learning experience. Although creating a visual scene of a 110° banked attitude with the nose 30° below the horizon may not be technically difficult in a modern simulator, the learning achieved while viewing that scene from the security of the simulator is not as complete as when viewing the same scene in an airplane. Maximum learning is achieved when the pilot is placed in the controlled, yet adrenaline-enhanced, environment of upsets experienced

Figure 4-17. *A Level D full-flight simulator could be used for UPRT.*

while in flight. For these reasons, airplane-based UPRT improves a pilot's ability to overcome fear in an airplane upset event.

However, airplane-based UPRT does have limitations. The level of upset training possible may be limited by the maneuvers approved for the particular airplane, as well as by the flight instructor's own UPRT capabilities. For instance, UPRT conducted in the normal category by a typical CFI will necessarily be different from UPRT conducted in the aerobatic category by a CFI with expertise in aerobatics.

When considering upset training conducted in an aerobatic-capable airplane in particular, the importance of employing instructors with specialized UPRT experience in those airplanes cannot be overemphasized. Just as instrument or tailwheel instruction requires specific skill sets for those operations, UPRT demands that instructors possess the competence to oversee trainee progress, and the ability to intervene as necessary with consistency and professionalism. As in any area of training, the improper delivery of stall, spin and upset recovery training often results in negative learning, which could have severe consequences not only during the training itself, but in the skills and mindset pilots take with them into the cockpits of airplanes where the lives of others may be at stake.

All-Attitude/All-Envelope Flight Training Methods

Sound UPRT encompasses operation in a wide range of possible flight attitudes and covers the airplane's limit flight envelope. This training is essential to prepare pilots for unexpected upsets. As stated at the outset, the primary focus of a comprehensive UPRT program is the avoidance of, and safe recovery from, upsets. Much like basic instrument skills, which can be applied to flying a vast array of airplanes, the majority of skills and techniques required for upset recovery are not airplane specific. Just as basic instrument skills learned in lighter and lower performing airplanes are applied to more advanced airplanes, basic upset recovery techniques provide lessons that remain with pilots throughout their flying careers.

FSTD–based UPRT

UPRT can be effective in high fidelity devices (i.e. Level C and D FFS), however instructors and pilots must be mindful of the technical and physiological boundaries when using a particular FSTD for upset training. The FSTD must be qualified by the FAA National Simulator Program for UPRT; and, if the training is required for pilots by regulation, the course must also be FAA approved.

Spiral Dive

A spiral dive, a nose low upset, is a descending turn during which airspeed and G-load can increase rapidly and often results from a botched turn. In a spiral dive, the airplane is flying very tight circles, in a nearly vertical attitude and will be accelerating because it is no longer stalled. Pilots typically get into a spiral dive during an inadvertent IMC encounter, most often when the pilot relies on kinesthetic sensations rather than on the flight instruments. A pilot distracted by other sensations can easily enter a slightly nose low, wing low, descending turn and, at least initially, fail to recognize this error. Especially in IMC, it may be only the sound of increasing speed that makes the pilot aware of the rapidly developing situation. Upon recognizing the steep nose down attitude and steep bank, the startled pilot may react by pulling back rapidly on the yoke while simultaneously rolling to wings level. This response can create aerodynamic loads capable of causing airframe structural damage and /or failure.

1. Reduce Power (Throttle) to Idle
2. Apply Some Forward Elevator
3. Roll Wings Level
4. Gently Raise the Nose to Level Flight
5. Increase Power to Climb Power

The following discussion explains each of the five steps:

1. Reduce Power (Throttle) to Idle. Immediately reduce power to idle to slow the rate of acceleration.
2. Apply Some Forward Elevator. Prior to rolling the wings level, it is important to unload the G-load on the airplane ("unload the wing"). This is accomplished by applying some forward elevator pressure to return to about +1G. Apply just enough forward elevator to ensure that you are not aggravating the spiral with aft elevator. While generally a small input, this push has several benefits prior to rolling the wings level in the next step – the push reduces the AOA, reduces the G-load, and slows the turn rate while increasing the turn radius, and prevents a rolling pullout. The design limit of the airplane is lower during a rolling pullout, so failure to reduce the G-load prior to rolling the wings level could result in structural damage or failure.
3. Roll Wings Level. Roll to wings level using coordinated aileron and rudder inputs. Even though the airplane is in a nose-low attitude, continue the roll until the wings are completely level again before performing step four.
4. Gently Raise the Nose to Level Flight. It is possible that the airplane in a spiral dive might be at or even beyond V_{NE} (never exceed speed) speed. Therefore, the pilot must make all control inputs slowly and gently at this point to prevent structural failure. Raise the nose to a climb attitude only after speed decreases to safe levels.

Spiral Dive Recovery Template
1. Reduce power (throttle) to idle
2. Apply some forward elevator
3. Roll wings level
4. Gently raise the nose to level flight
5. Increase power to climb power

Figure 4-18. *Spiral dive recovery template.*

5. Increase Power to Climb Power. Once the airspeed has stabilized to V_Y, apply climb power and climb back to a safe altitude.

In general, spiral dive recovery procedures are summarized in *Figure 4-18.*

Common errors in the recovery from spiral dives are:

- Failure to reduce power first
- Mistakenly adding power
- Attempting to pull out of dive without rolling wings level
- Simultaneously pulling out of dive while rolling wings level
- Not unloading the Gs prior to rolling level
- Not adding power once climb is established

UPRT Summary

A significant point to note is that UPRT skills are both complex and perishable. Repetition is needed to establish the correct mental models, and recurrent practice/training is necessary as well. The context in which UPRT procedures are introduced and implemented is also an important consideration. The pilot must clearly understand, for example, whether a particular procedure has broad applicability, or is type-specific. To attain the highest levels of learning possible, the best approach starts with the broadest form of a given procedure, then narrows it down to type-specific requirements.

Chapter Summary

A pilot's most fundamental and important responsibility is to maintain aircraft control. Initial flight training thus provides skills to operate an airplane in a safe manner, generally within normal "expected" environments, with the addition of some instruction in upset and stall situations.

This chapter discussed the elements of basic aircraft control, with emphasis on AOA. It offered a discussion of circumstances and scenarios that can lead to LOC-I, including stalls and airplane upsets. It discussed the importance of developing proficiency in slow flight, stalls, and stall recoveries, spin awareness and recovery, upset prevention and recovery, and spiral dive recovery.

Pilots need to understand that primary training cannot cover all possible contingencies that an airplane or pilot may encounter, and therefore they should seek recurrent/additional training for their normal areas of operation, as well as to seek appropriate training that develops the aeronautical skill set beyond the requirements for initial certification.

For additional considerations on performing some of these maneuvers in multiengine airplanes and jet powered airplanes, refer to Chapters 12 and 15, respectively.

Additional advisory circular (AC) guidance is available at www.faa.gov:

- AC 61-67 (as revised), Stall and Spin Awareness Training;
- AC 120-109 (as revised), Stall Prevention and Recovery Training; and
- AC 120-111 (as revised), Upset Prevention and Recovery Training.

Federal Aviation
Administration

Memorandum

Date: February 5, 2014

To: See Distribution List

From: David W. Hempe, Manager, Aircraft Engineering Division, AIR-100 D. Hempe
James D. Seipel, Manager, Production and Airworthiness Division, AIR-200

Subject: Approval of Non-Required Angle of Attack (AoA) Indicator Systems

Memo No.: AIR100-14-110-PM01

Regulatory Reference: Title 14 of the Code of Federal Regulations 21.8(d)

This memorandum establishes requirements and procedures for issuing a design and production approval to a United States (U.S.) manufacturer under Title 14 of the Code of Federal Regulations (14 CFR) 21.8(d) for a non-required/supplemental Angle of Attack (AoA) indicator system. This memo will expire in three years from the date of issuance, unless otherwise extended or incorporated into an order. Under this memo, all applications for AoA approval will be directed to the Chicago Aircraft Certification Office (ACO), Des Plaines, IL

Preventing loss of control in general aviation (GA) is a top focus area of the FAA and the GA community. Installation of an AoA system may aid in preventing loss of control accidents. Manufacturers have requested a streamlined method of design and production approval for non-required/supplemental systems. Since these systems provide only supplemental information to the pilot and are not required by regulation, the FAA has developed the following approval process under 14 CFR 21.8(d).

Applicability

This memo applies only to supplemental AoA system(s), not those required for type certification of the aircraft. Further, the word "system" refers to the AoA indicator and all of its associated parts and hardware allowing it to be installed and operated as an independent and stand-alone system. This memo applies only to systems installed in U.S.-registered aircraft, excluding commuter and transport category airplanes.

Procedure for Approving a Non-Required AoA Indicator System

1. Applicant Responsibilities.

a. An applicant (i.e., AoA manufacturer) submits a request for a letter of approval (LOA) to the Chicago ACO. The letter should contain:

(1) General information such as the applicant's address of the principle manufacturing facility that controls the design and quality of the article.

(2) A description of the article, including part number, and any other information that provides a general overview of the article (e.g., design, performance, operation, etc.).

(3) A statement of compliance certifying that the applicant's article meets the design requirements of ASTM F3011-13, and the applicant has met the requirements of this memo for the requested article. The statement of compliance will state: "I certify that we have complied with all applicable requirements, as identified in the memo no. AIR100-14-110-PM01, issued on 02/05/2014, and that the article is produced in accordance under the required quality system."

b. If the submitted documents are deficient, the applicant is required, when requested by the FAA, to provide information necessary to show compliance with this memo.

2. AoA Design Requirements.

a. A failure of the AoA system to perform its intended function or display erroneous indications must not adversely affect the safety of the aircraft, its occupants, or the proper functioning of equipment and systems that are required by the airworthiness standards or operating rules. At a minimum, a qualitative evaluation of the design is required to determine that neither its normal operation nor its failure will affect the safety of the aircraft or pilot workload. In most cases, a qualitative evaluation will be sufficient to satisfy the system safety assessment.

b. When isolation between the AoA and aircraft required systems is provided by complex means, more detailed evaluation methods, such as System Safety Analysis (SSA), Functional Hazard Analysis (FHA), or Failure Modes and Effects Analysis (FMEA) may be necessary.

c. The performance of the AoA system must meet ASTM F3011-13 and the following requirements:

(1) The AoA system operating instructions must clearly state the accuracy of the AoA instrument (ref: F3011-13, section 5.1.2).

(2) The AoA system calibration instructions must include a test that after calibration of the AoA system, the AoA does not provide information conflicting with the stall warning from a certified stall warning system, if the aircraft is so equipped.

(3) The AoA system must be a stand-alone unit and must not interface with a certificated system (e.g., pitot-static system, stall warning, etc.) with the exception of supplying electrical power to the AoA unit and mounting requirements for the sensor and the display unit.

(4) When properly installed and calibrated, the AoA system must not provide misleading information to the pilot (i.e., audible or visual cues that may conflict or interfere with the aircraft stall warning, if so equipped) (ref ASTM F3011-13, 5.2).

(5) Marking and placards for the AoA system display must state the following: "*Not for use as a primary instrument for flight.*"

(6) The AoA system installation instructions must require that the installation of the AoA display will not interfere with the pilot's view of the primary flight instruments.

(7) The following statement below must be included in the installation instructions:

> *"This AOA system has not been determined to be suitable for installation in any specific aircraft by ____________ (the AOA system manufacturer). It may be installed in a type-certificated aircraft, provided that it has been determined suitable for installation by an appropriately rated mechanic by means such as field approval or as a minor alteration*."

(8) A notice advising the installer that the AoA indicator cannot be placed in the cockpit in such a manner as to obstruct the pilot's view or cause distraction.

(9) A notice advising the installer that installation of the AoA system in a commuter or transport category airplane is prohibited.

(10) A notice advising that installation of the AoA system as a replacement for or modification to an existing approved stall warning system is prohibited.

3. Operating Limitations. The operating limitations (ref ASTM F3011-13, 4.3.3) must include the following:

a. An advisory that the AoA system is non-required and is to be used only as supplemental information to the pilot. The AoA system may not be used as a substitution for the certified aircraft stall warning system.

b. No operational credit may be taken for such items as reduced approach speed and shorter landing distances.

4. AoA Manufacturing Requirements. The applicant is required to control both the design and quality of the article. To control the quality means the AoA system manufacturer must build the article in accordance with its approved design. This also means that each design change to the article or any of its components, features or functions is controlled by the manufacturer to ensure that after a change or modification to the article it still meets the specified requirements in this memo and the associated documents are updated accordingly. Applicants who hold a production approval under 14 CFR part 21 may produce a supplemental AoA system under their existing quality system. Applicants who do not hold a part 21 production approval must have a quality system that contains the following elements:

Design data control	Document control
Supplier control	Manufacturing process control
Inspecting and testing	Inspection, measuring, and test equipment control
Inspection and test status	Nonconforming product and article control
Corrective and preventive actions	Handling and storage
Control of quality records	Internal audits
In-service feedback	Quality escapes

5. ACO Responsibilities. Applicants must state in the application letter that their AoA system meets the design and quality control requirements of this memo. The ACO may rely on the applicant's certifying statement and issue a production approval under § 21.8(d) and provide a copy of the approval to the geographical manufacturing inspection district office (MIDO). A MIDO audit is not required. A template for the approval is provided below.

Distribution List:

All Aircraft Certification Directorates
All Aircraft Certification Offices
All Manufacturing Inspection Offices
All Manufacturing Inspection District Offices/Satellite Offices
All Certificate Management Offices/Units
All Flight Standards Divisions
All Flight Standards Field Offices
All Flight Standards International Field Offices
All Flight Standards Regional Offices
Designee Standardization Branch, AFS-640

U.S. Department
of Transportation
**Federal Aviation
Administration**

Sample Letter of Approval

{ACO}
{ACO address}

{Date}

{Name of applicant point of contact (POC)}
{POC's title}
{Name of company}
{Street address}
{City and zip code}

Dear *{Mr. /Mrs. /Ms. Name of applicant POC}*:

Subject: Angle of Attack System Approval *{insert reference number}*

This is in reply to your letter of *{enter date of application}* requesting approval for the manufacture of your supplemental angle of attack system. We accept your statement certifying that your system meets the requirements of FAA memorandum number AIR-100-14-110xxxx.

All major components of the articles produced under this approval must be permanently and legibly marked with the authorization holder's name, or trademark, or symbol, part number and "21.8(d)."

You must allow the FAA to inspect your quality system, facilities, technical data, and any manufactured articles and witness any tests, including any inspections or tests at a supplier facility, necessary to determine compliance with this approval.

You must notify the FAA before making any changes to the location of any of your manufacturing facilities, company name or ownership.

This approval may not be transferred.

This approval, issued under 14 CFR 21.8(d), is effective until surrendered, withdrawn or otherwise terminated by the FAA.

Please note that technical data the FAA retains may be subject to Freedom of Information Act requests. This office will notify you of any requests pertaining to your data and give you the opportunity to protect the data from public disclosure. If you have any questions regarding this approval, contact *{enter FAA ACO contact and phone number.}*.

Sincerely,
{Name of ACO manager}
{Name of FAA ACO}
cc: AIR-112; *{insert routing symbol of responsible MIDO}*

EUROCONTROL

Flying the 'perfect green flight': How can we make every journey as environmentally friendly as possible?

European aviation has embarked on its most important trajectory for decades: the goal of achieving the ambitious target of carbon neutrality by 2050. The political will is there, with the European 'Green Deal' showing the way forward: the challenge is to make every journey as environmentally friendly as possible and aim to fly the 'perfect green flight'. This Think Paper takes the reader on a journey, looking at every aspect of a flight before, during and immediately after, to identify the main opportunities to improve aviation sustainability at each stage, the challenges that need to be tackled to get closer to that 'perfect green flight', and what we can do – now and in the medium term – to make that happen.

To identify where the greatest potential for improvement now and in the future lies, we ask:

- Why is it not always possible to fly a 'perfect green flight' today?
- Which measures have the greatest potential to improve the sustainability of aviation now, and in the future?
- What do we need to do to make every single flight greener?

The paper concludes that while various factors make flying 'perfect green flights' very complex, nevertheless a lot can be done now to make flights greener at every stage of a journey, and by every actor involved.

A perfect green flight in big numbers

- **25.8% less CO_2 emissions (4,286kg) per average wider-European area flight (16,632kg) by 2030 using current technology – a saving that will massively increase when emerging developments (electric, hydrogen or hybrid aeroplanes) enter into commercial service**
- **8%** of those reduced CO_2 emissions – **1,331 kg** – are based on **10%** Sustainable Aviation Fuel use – and more would yield even greater benefit
- **8.6-11.2%** of those reduced CO_2 emissions – up to **1,863 kg** – could be delivered by better use of fuel-efficient operational and technological solutions by all European ATM network stakeholders
- **7%** of those reduced CO_2 emissions – up to **1,164 kg** – can be provided by fleet modernisation now based on current types in service; this will increase as new, more fuel and emissions-efficient models are rolled out.

Main findings of this Think Paper

1. **A significant advance towards the "perfect green flight"** can be made by making better use of existing measures, and all actors working together: we estimate that per flight, **up to 4,286kg of CO_2 emissions (25.8%) could be eliminated by 2030 compared to 2019, out of an average 16,632kg of CO_2 for a total flight in the wider European area, and based on current technology.**
2. **Better use of fuel-efficient air traffic management improvements** could deliver 8.6%-11.2% (up to 1,863 kg) of those reduced CO_2 emissions per flight. To realise this benefits pool, accelerating the transition from SESAR R&D to deployment as well as improving the functioning and performance of the network to the greatest extent are crucial. This will require a network-centric cooperative decision-making (CDM) process with all network actors, as set out in the proposed recast Single European Sky (SES) package.
3. **Emerging aircraft technologies in the form of hybrid, fully-electric and hydrogen airplanes will transform aviation over the period 2030-2050, enabling aviation to meet its climate-neutrality goal by 2050. By 2050, these new airplanes will be increasingly prevalent on short to medium haul sectors**; while SAF use will predominate in the long-haul sector, with further upscaling of SAF production seeing 83% of fuel used being SAF, irrespective of any further technological developments.

FIGURE 1: AIRCRAFT TECHNOLOGIES & ENERGY TIMELINE 2021-2050

	Evolutionary tech phase	Breakthrough tech phase	Revolutionary tech phase
Conventional fleet	Growing use of SAF as a % of all fuel: 10% or more (assuming supply increases)	Upscaling of SAF as a % of all fuel to 50%	Further upscaling of SAF (bio and synthetic) as a % of all fuel to 83%
New aircraft technologies	New models with more efficient engines	Emergence of hybrid, fully electric & hydrogen aircraft	Increasing production of hybrid, fully electric & hydrogen aircraft

Think Paper scope (2021–2030)

2021 | 2030 | 2040 | 2050

Source: EUROCONTROL

4. **Sustainable aviation fuel (SAF) is the most promising measure towards aviation decarbonisation right now.** 10% use of SAF by 2030 would deliver 1,331 kg or 8% in CO_2 saving – but today, use stands at just 0.1%. To hit this target, investment in SAF must be ramped up now, and a firm policy support target set incentivising its use. This would accelerate SAF uptake, leading to higher demand and a faster decarbonisation of aviation – permitting **more ambitious target setting** in the future. 20% SAF use by 2030 would represent a colossal challenge to meet – but would potentially deliver up to 16% in CO_2 saving per flight.
5. **Airlines can play a significant role in reducing CO_2 emissions, but greater incentives may be needed to balance economic considerations:**
   - modernising their current fleets to remove less efficient aircraft older than 15 years – which would save 7% or 1,164 kg in emissions; here, the pandemic has prompted an acceleration in fleet renewal, with many older aircraft types unlikely to return;
   - reducing 'economic fuel tankering', whereby aircraft carry more fuel than they need to reduce or avoid refuelling at their destination airport; this could save a further 89 kg or 0.54% of emissions;
   - working with airports to use Ground Power Units rather than aircraft Auxiliary Power Units on the ground, saving 0.3% or 50 kg;
   - optimising the fuel efficiency of their existing fleets, building on a massive 25% improvement over the last 15 years that has seen aviation prove more fuel efficient than cars at 3 to 4 litres per passenger 100km.
6. **More attention needs to be paid to noise and non-CO2 impacts,** such as contrail avoidance.

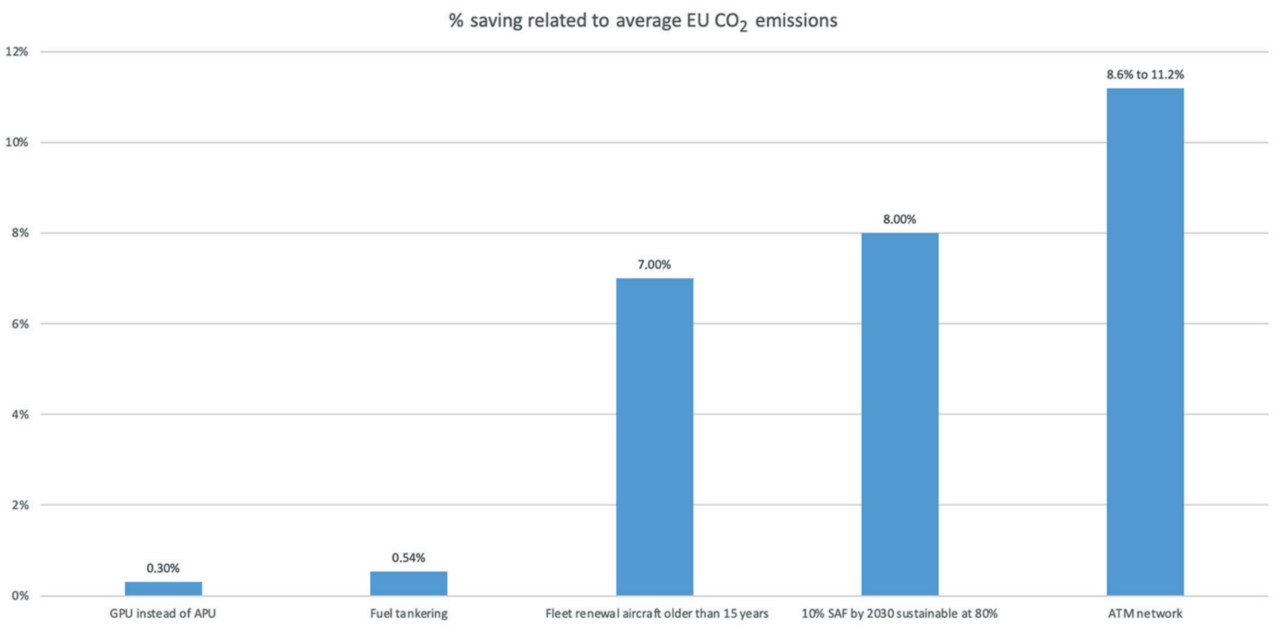
How much potential is there to 'green' every flight already?

Figure 2 summarises the potential savings in terms of CO_2 emissions that could be avoided on average per flight across the wider European (ECAC – European Civil Aviation Conference, 44 States including all 41 EUROCONTROL Member States) area by 2030. It shows that, by using a combination of existing measures more consistently, and without factoring in major technological leaps (e.g. hybrid/fully electric or hybrid/fully hydrogen-powered aircraft), a lot can already be done collectively to reduce CO_2 and non-CO_2 emissions from aviation using current technology.

We estimate that by 2030, up to 4,286kg of CO_2 emissions (25.8%) could be eliminated per flight compared to 2019 out of an average 16,632kg of CO_2 for a total flight in the ECAC area – a significant advance towards the "perfect green flight". And this potential saving is purely based on current aircraft technology: these reductions will massively increase when emerging developments (electric, hydrogen or hybrid aeroplanes) enter into commercial service.

The two most short-term promising fuel/CO_2 savings accelerators are air traffic management improvements including further use of the currently implemented continuous climb and descent operations (CCO/CDO), and Free Route Airspace (FRA), where air navigation service providers (ANSPs), airlines, airports, flight plan service providers and the EUROCONTROL Network Manager have a key role to play (from 8.6% up to 11.2%), and sustainable aviation

FIGURE 2: POTENTIAL CO_2 SAVINGS THAT COULD BE REALISED, KG/FLIGHT ACROSS THE WIDER EUROPEAN AREA



Source: EUROCONTROL

***Note:** Due to interdependencies, the sum of benefits does not always add up.*

fuel (SAF), which could deliver a 8% reduction in emissions based on just 10% use by 2030; this would however increase significantly if SAF were to become more widely used. The proposed recast SES package is central to the faster and wider adoption of these and other emerging solutions.

Next comes the renewal of the airline fleet, with the retirement of older, less fuel-efficient aircraft (over 15 years old) in favour of new, more fuel-efficient models, resulting in savings of **1,164 kg** of CO_2 emissions (7%).

Additional measures that also play their part in reducing CO_2 emissions are tackling the economic-environmental trade-off in "fuel tankering", whereby aircraft often carry more fuel than is needed on economic grounds generating on average 89kg of additional fuel burn (**0.54%** of CO_2 per flight); and the use of Ground Power Units rather than aircraft Auxiliary Power Units at airports (**0.3%** or **50 kg**).

The rest of this paper looks at each aspect of a flight to identify what measures are already partially or fully in place, and what their potential is to decrease emissions.

The initial findings of this paper will be tested, further harmonised and quantified by EUROCONTROL and partners in the ALBATROSS project,[1] which aims to quantify the benefits of "perfect green flights". A 2-year study launched by the SESAR Joint Undertaking under the EU's Horizon 2020 Research and Innovation programme, ALBATROSS will explore in real conditions the feasibility of implementing the most fuel/CO_2 efficient flights possible by conducting a series of live trials across Europe.

What additional decarbonisation potential will new aircraft technology bring?

The projected emissions savings outlined in this paper are based on existing technology, but we expect the picture to change significantly over the following 20 years up to 2050. New aircraft technologies are expected to accelerate progress and ensure that aviation meets the goal of climate-neutrality by 2050, as per the timeline (Figure 1) on the cover page. Nevertheless, the savings solutions proposed in this paper will still have a significant role to play in the near future in helping aviation decarbonise.

Between 2021 and 2030 only evolutionary technical developments are expected for commercial aviation, although the first hybrid-electric aircraft should be close to market introduction. Further efficiencies will be delivered by enhancements to existing aircraft models, but clearly increased SAF usage remains the most promising and realistic short-term solution for decarbonising aviation. Aircraft are already authorised to fly using 50% SAF, and certification to 100% SAF is expected in the coming years; however, the availability of SAF remains the main constraint in the short term, as this paper underlines with its assumption that SAF could account for 10% or more of all fuel used by 2030.

The picture is set to change significantly in the decade up to 2040, when we expect breakthrough developments via the progressive introduction of hybrid, fully-electric and hydrogen aircraft in the short to medium-haul segments. We expect SAF production to have ramped up, providing 50% of all fuel used by conventional airplanes, with particular relevance for the long-haul segment.

The phase 2041-2050 is what we term the "revolutionary tech phase", with hybrid, fully-electric and hydrogen aircraft predominating in the short to medium-haul segments. In the long-haul sector, further upscaling of SAF (bio and synthetic) production should reach up to 83% of fuel used, irrespective of any technological developments, as predicted in the Destination 2050 report.

Pre-flight: Airlines' business choices are crucial

Airlines need to embed environmental efficiency in their values and operating procedures. Fuel conservation and thus CO_2 reduction should be a priority objective. Every airline should have an ongoing fleet modernisation programme, replacing older models with newer, less fuel-consuming and quieter models, alongside a fuel conservation policy.

Aircraft performance degrades over the airframe lifecycle, requiring a strict fleet maintenance programme[2]. Airbus data indicate that as airframes and engines age, aerodynamic and performance deterioration tends to increase fuel burn and emissions, increasing the drag of an aircraft by up to 2% over 5 years[3]. Airlines should assign aircraft to city-pairs according to the most efficient fuel conservation and load factors.

By analysing the distance flown, fuel consumption, and ageing degradation of engines and airframe of a sample of more than 23,000 aircraft in service in 2019, we find that replacing them with more modern aircraft models would save about 7% of current CO_2 emissions based on replacing aircraft older than 15 years with new models; here, the pandemic has already triggered this. Furthermore, fleet renewal has an additional advantage of helping stabilise average noise levels at today's major airports by 2030. This 7% fleet renewal will provide an additional decarbonisation boost to aviation, complementing natural fleet renewal and fuel efficiency improvements. Here, it is essential to underline that this saving assumes fleet renewal based on current technology, whereas over the next years, ever more fuel and emissions-efficient types will enter into service such as electric, hydrogen and hybrid aircraft.

Airlines should also consider setting up robust flight emissions offsetting programmes, as some major European airlines are already starting to do.

Pre-flight: Passenger choices have an impact

Passengers have their own role to play in greening flights, from how they travel to the airport, to potentially which carrier they use, and in some cases which airport they decide to fly from. Having more accurate, up-to-date information on the environmental performance of aviation, and airlines in particular, would enable passengers to factor this into flight selection, encouraging airlines to develop stronger, more ambitious policies on these issues. The "Environmental Labelling Scheme" that EASA, the European Union Aviation Safety Agency, is committed to developing with Member States, industry and non-governmental organisations should certainly help in this respect.[4]

The passenger's environmental responsibility goes further. Among other things, s/he can select the greenest means of transport to and from airports, travel light, select the class of seat with the lowest environmental share (this however may depend on business choices made by airlines for that specific city-pair: an economy seat has half the environmental impact of a premium seat, 4 times less than a business seat, and 8 times less than a first class seat), or offset his/her own share of the flight climate impact, when the airline does not have a compensation system already in place.

Passengers may not always be able to choose their departure/arrival airports, but where they can, they **should be attentive to their environmental performance.** Significant advances have been made by many European airports: 52 already qualify as carbon-neutral as reported by ACI through its Airport Carbon Accreditation system, and many more are engaged in reducing their environmental footprint. The latest independently verified carbon reduction (2018-2019) achieved by European airports in the Airport Carbon Accreditation programme is 133,621 tonnes of CO_2 – a 7% decrease in emissions under their direct control.[5]

Pre-flight planning: Significant scope for reduced fuel and emissions

Considerable progress has been made by airport operators (AOs), ANSPs and the EUROCONTROL Network Manager (NM) to improve the safe flow of air traffic in all phases of flight, balancing demand and capacity, improving demand accuracy and predictability management, enhancing capacity or congestion management, increasing information exchange, all enabled by cooperative decision-making (CDM).

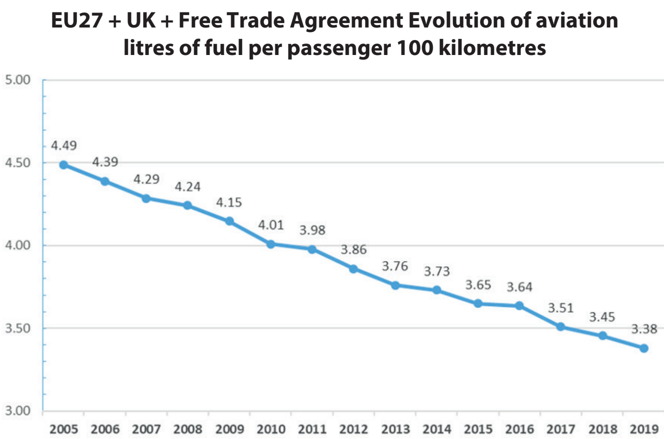
Some airlines already share data with ANSPs and the EUROCONTROL NM to help them optimise their operations. This improves traffic capacity management, increases fuel conservation and lowers the environmental impact in terms of noise and fuel/emissions reductions. This should increase to maximise the potential benefits to aviation.

In a recent fuel efficiency study[6] EUROCONTROL estimated the **fuel inefficiency of the ATM network in 2019 to be between 8.6% and 11.2% from take-off to landing** for flights within Europe.

Carrying unnecessary extra weight increases the quantity of fuel burned in flight, as an ICAO study[7] emphasises: *"The extra fuel burn attributable to additional weight carried on board an aircraft is typically of the order of 2.5 to 4.5 per cent of the additional weight, per hour of flight, depending on the characteristics of the aircraft. For example, 500 kg of extra weight for a ten-hour flight could result in the additional consumption of 125 to 225 kg of fuel and an increase in CO_2 emissions of 390 to 710 kg."* Therefore, it is of the utmost importance to minimise non-essential items on-board, such as paper, water, cups, waste, etc., and ensure necessary items are as light as possible.

Given the above efficiency gains, the payload of each flight (passengers plus cargo) should be maximised to optimise the **fuel-per-passenger ratio, which has steadily improved over the last 15 years** as per Figure 3. **Aviation is now more fuel efficient than cars at 3 to 4 litres per passenger 100km**, reflecting a massive

FIGURE 3: EVOLUTION OF AVIATION LITRES OF FUEL PER PASSENGER 100 KMs



Source: EUROCONTROL

FIGURE 4: NET SAVINGS DUE TO TANKERING VS. EXTRA CO_2 EMITTED

	Extra fuel burnt (tonnes/year)	Cost to transport extra fuel (M€/year)	Extra CO_2 emitted (tonnes/year)	Cost of purchasing CO_2 allowances (M€/year)	Net saving = Tankering saving - [Extra fuel + CO_2 cost] (M€/year)
Full tankering	160,000	88	504,000	10	217
Partial tankering	126,000	69	397,000	8	48
Total tankering	**286,000**	**157**	**901,000**	**18**	**265**

Source: EUROCONTROL Think Paper #1

25% improvement by airlines since 2005. This reflects steadily improving passenger load factors, which pre-pandemic stood at 82.5%[8],rising up to 97% for low-cost airlines.[9]

The fuel needed for a flight depends on the final payload; therefore, refuelling processes should end up close to final load-sheet delivery, in order to minimise any unnecessary additional fuel to be loaded and avoid CO_2 emissions.

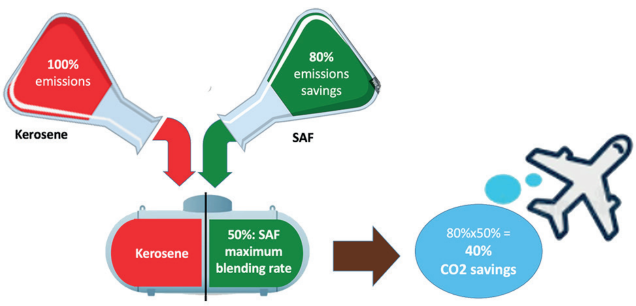
Incentives will need to be put in place to encourage airlines not to practise economic fuel tankering, whereby aircraft carry more fuel than they need for their flight in order to reduce or avoid refuelling at their destination airport, when the negotiated fuel price and the cost of fuel services at the departure airport are significantly lower than at the destination airport.

In 2018, as per Figure 4, we estimated that 21% of short and medium-haul flights in Europe were performing fuel tankering, representing a net saving of **265M€** per year to the airlines, but burning **286,000** tonnes of additional fuel burnt (equivalent to **0.54%** of the whole jet fuel used in Europe), or **901,000** tonnes of CO_2 per year (see EUROCONTROL Think Paper #1 for more details). [10]

The most important recent development on the aviation sustainability front is sustainable aviation fuel (SAF). Continuing to burn 100% fossil fuels on every flight should be avoided by replacing part of the standard fossil jet fuel used in aircraft by a sustainably-produced alternative fuel whose carbon impact is reduced by up to 80% over its lifecycle. [11, 12]

For now, SAFs are only certified to account for a maximum of 50% of an aircraft's fuel load[13], although trials are underway to demonstrate that it is already possible and safe to power cargo and commercial flights with 100% SAFs, in the hope of speeding up certification[14]. Therefore, based on a 50% blend, **SAF has the potential to reduce CO_2 emissions from aviation by up to 40%, as Figure 5 shows.**

FIGURE 5: SAF EMISSIONS SAVINGS



Recent "perfect green flight"[15] trials by Braathens,[16] DHL,[17] and KLM[18] show that collaboration between all parties is crucial to achieve maximum savings and substantially reduce CO_2 emissions, by around 46% for the regional flight trial in Sweden compared to standard regional jets. While difficult to draw conclusions in terms of maximum possible fuel savings, these trials clearly show that combining existing operational improvements with fuel-efficient aircraft can deliver real savings. However, they also show that the level of readiness for sustainable SAF is not yet satisfactory.

Using SAF as much as possible would be a considerable step forward towards aviation sustainability and is probably the technical solution that could be deployed most rapidly without modifications to existing systems and aircraft.

However, today SAF accounts for **less than 0.1%** of the roughly 300 million tonnes of EU aviation fuel consumption.[19] **It is vital to ramp up SAF production, and availability at major airport hubs, to reduce the cost of SAFs, currently 3 times higher than fossil jet-A1 fuel, and to incentivise their adoption.** The Destination 2050 report[20] estimates that, with proper incentives, 6% of fuel used could be SAFs by 2030; IEA's Sustainable Development Scenario[21] anticipates around 10% in 2030 and 19% in 2040; while some countries such as Norway and Finland are already targeting up to 30% of SAF by 2030.[22]

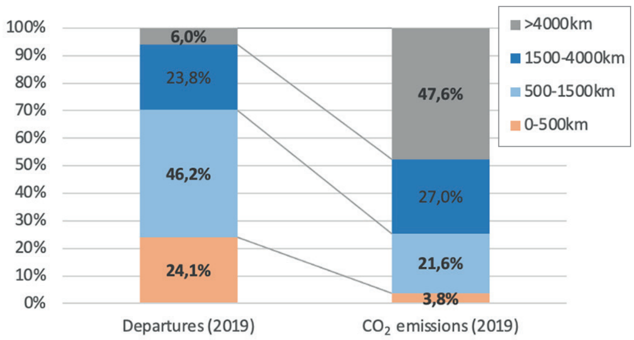
A firm policy support target of 10% SAF by 2030 could lead to higher demand than initially expected and a faster decarbonisation of aviation. This would accelerate SAF uptake, leading to higher demand and speeding up aviation decarbonisation – permitting **more ambitious target setting** in the future. 20% SAF use by 2030 would represent a colossal challenge to meet – but would potentially deliver **16%** in CO_2 saving per flight, leading, with the other measures proposed, to **34%** in CO_2 emissions savings per flight (**5,617kg** of CO_2).

SAFs can also improve aircraft fuel efficiency by 1-3% and can reduce SOx and particulate matter (PM) emissions by 100% and 90% respectively, according to SAF producer SKyNRG,[23] reducing the likelihood of contrail formation.

Rather than flying only the most economically beneficial route, AOs and ATM should also consider the most environmentally friendly route and cruising flight levels, taking into account weather conditions, air traffic constraints but also the possibilities offered by dynamic ATM (such as FUA, the Flexible Use of Airspace, which permits military airspace to be crossed by civil aircraft when not in use).[24] This means balancing delays, fuel burn and route charges.

SAF is also fundamental to reducing long-haul flight (>4,000km) emissions, which account for the bulk of flights in the wider European area, as Figure 6 shows.

FIGURE 6: % OF FLIGHT VERSUS CO_2 EMISSIONS IN 2019



Departures: Scope for improvement

From leaving the gate to taxiing onto the runway, there are a series of measures that could be optimised to make every flight greener.

The first is with passengers. Non-transit passengers arriving late to the gate cause small delays that may add complexity to managing departures. Airlines that opt to speed up en-route flight to compensate for delays and missed slots increase fuel burn and thus emissions.

The second is shared by airlines and airports. Moving an aircraft using its own auxiliary power unit (APU) burns more fuel in most cases than using a mobile GPU (ground power unit) for that purpose. This is non-negligible: according to United Continental,[25] APUs use **150 to 400+ kg** of fuel per hour, while GPUs provided by the airport use less than **20 kg** of fuel per hour. It is estimated that **0.3%** fuel savings could be realised (Destination 2050). APUs also generate more noise, more pollution, and increase aircraft maintenance costs.

The third lies with air traffic control (ATC). Each minute taxiing with engine on burns 3 to 10kg of fuel,[26] so ATC should prioritise minimising ground delays for aircraft with engines already running and facilitate engine-off taxi solutions. Some ATC and airport processes significantly influence the performance of the aircraft from the very beginning of the flight. From best practices for stand allocation, the use of Fixed Electrical Ground Power and Pre-Conditioned Air, to the flexible use of taxiways to minimise taxi time, the use of A-CDM[27] to avoid long queues at the holding points, to the optimisation of runway throughput to avoid delays. When A-CDM was implemented at 17 airports in Europe, over 102,700 tonnes of CO_2 per annum was saved, on top of over 2.2 million minutes of taxiing time and €26.7 million in fuel.[28]

The fourth is using at airports semi or fully electrical aircraft towing systems. These can be hooked or mounted onto the front wheel of the aircraft and used to tow the aircraft between the gate and the runway. This brings immediate environmental benefits: **delaying engine start-up can reduce fuel consumption during taxiing by 50-85%.**[29] Where this is not possible for logistical reasons, where airports have limited manoeuvring areas or budgets, and only when safety permits, "reduced engine taxi" is the best option for reducing fuel burn and noise.

Finally, ATC may be able to grant access to use a runway that minimises flight time, where local current conditions permit, as well as optimising the taxi route from stand to runway.

Take-off: Optimising Continuous Climb Operations can make a significant contribution to emissions

The take-off phase offers a number of potential improvements that can be followed by air traffic controllers (ATCOs) and airlines, of which CCO – Continuous Climb Operations – brings the most important environmental benefit.

ATCOs should, as far as possible, clear flights to climb, avoid unnecessary level-offs and permit CCOs which are more fuel-efficient. A 2018 EUROCONTROL study showed that optimising the climb and descent (CCO and CDO) phases could deliver fuel savings of up to **350,000 tonnes** per year for airlines. This corresponds to over **a million tonnes of CO_2** and **€150 million in fuel costs**. Another EUROCONTROL study carried out during COVID-19 has shown that the average time in level during descent has been reduced by 33%, suggesting that a 30% CDO target could be reasonable once traffic returns to normal.[30]

Fuel saving measures implemented during the departure, take-off, landing and arrival phases also minimise aviation's impact on local air pollution resulting from the emission of several non-CO_2 species.

Rolling take-offs save fuel, so ATCOs should try to seamlessly deliver take-off clearances to avoid aircraft stopping on the runway. Using the shortest departure route (SID) also minimises track miles flown.

In this flight phase, it is necessary to find the right trade-off between **noise impact** and fuel/emissions savings. As long as noise limits are not exceeded, the crew should be able to choose the best Noise Abatement Departure Procedure (NADP) to fly according to the aircraft, weight and weather conditions of the day. NADP 2 will save fuel while not significantly increasing noise in some sensitive areas. NADP 1 reduces noise for areas close to the departure end of the runway by delaying the acceleration climb speed until 3,000 feet is reached. For example, Boeing claims[31] that the fuel saved by flying a NADP2 procedure vs a NADP1 procedure is 67 kg , about 1%, on a Boeing 737-800 with winglets, and 197 kg on a Boeing 777-200ER, about 0.3%.

Ideally, flights should take off in optimum configuration using minimum flaps to save fuel, while following a balanced approach to avoid increasing the level of noise over the sensitive areas that may surround an airport. Reduced flap take-off improves fuel consumption by reducing drag, for example saving between 10kg (737-800wl) and 70kg (747-400) on take-off according to Boeing.[32]

En-route: the flight phase with the greatest impact on fuel consumption/CO_2

Cruising is typically the longest flight phase and has the greatest impact on fuel consumption/CO_2. Here, there are **a number of measures that can be taken to make flights greener.**

It is a common misconception that aircraft could always fly the most direct route between two airports, minimising fuel consumption by following an optimised flight profile, with unrestricted climb, fuel-efficient airspeeds, optimum cruise levels, uninterrupted descent profiles, and so on. In reality, other factors intrude, such as economic considerations, weather and safety considerations (aircraft have to take off and land with a headwind, as well as en-route weather considerations). There may be a lack of airport infrastructure or airspace capacity constraints (whether on holiday or on business trips, everyone wants to leave at the same time). Airspace fragmentation reduces efficiency; not all aircraft have equally modern equipment; air traffic in en-route areas and especially in the terminal manoeuvring areas (TMAs) close to airports may be complex, and military zones may need to be avoided, increasing flight time and fuel consumption.

There is also the natural complexity of a European network that, pre-COVID, saw on average 25-35,000 flights every day, with the all-time record of 37,228 flights set on 3 July 2019 – creating bottlenecks that often require re-routings to ease capacity constraints.

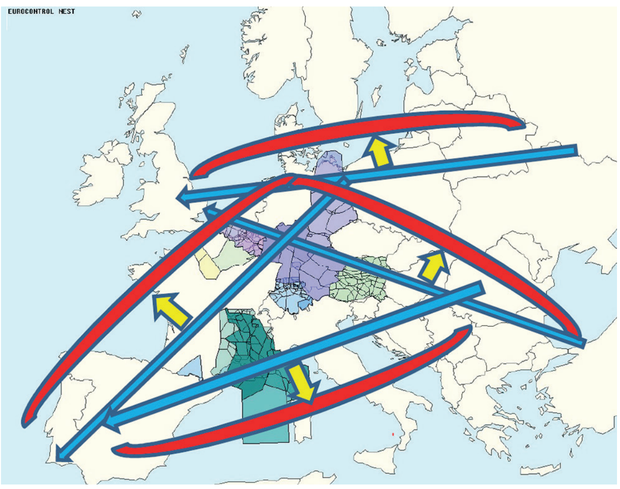
Nevertheless, there are a series of improvements that can be made. On-board systems like the Flight Management System (FMS) ensure that the crew can aim to **fly using the optimum values of speed and cruise level**. FMS's should be updated with the latest wind and atmospheric condition information, and the crew should fly at a speed corresponding to the best Specific Range (maximising the distance flown for a given amount of fuel), on minimal drag configuration whenever possible, and strive to maintain an optimum altitude.

In defining an optimal trajectory, ATC can help by offering a **better optimisation of the 4D trajectory** (horizontally and vertically) and **minimising the adoption of hard ATM constraints** such as permanent RAD restrictions[33] that affect the AOs. Where there is an unavoidable need to set such hard constraints, consideration should be taken to apply more flexible solutions such as dynamic RAD constraints that can be lifted depending on the traffic situation. Flying the 4D commercial trajectory selected also ensures optimal capacity management for the network as a whole. It is important to note that the greenest option is not always the most direct route: flights can be planned using wind-assisted routes, and a direct route would move the aircraft away from these benefits.

Key to efficient capacity management is **Free Route Airspace** (FRA), including cross-border FRA. Since its introduction in 2014, FRA is estimated to have saved airlines more than **2.6 million**

FIGURE 7: AO CONSIDERATIONS ON THE WARSAW (EPWA)-ROME (LIRF) ROUTE

FIGURE 8: eNM SHIFTING OF TRAFFIC FLOWS TO OFFLOAD CONGESTED ACCs



tonnes of CO_2, around 0.5% of total aviation emissions.[34] FRA projects are now in place across 3/4 of European airspace, bringing the region's flight efficiency targets within grasp. EUROCONTROL estimates that accelerating the use of FRA, particularly in the core area of Europe, could lead to huge emissions savings, cutting fuel burned by **3,000 tonnes of fuel/day**, and reducing CO_2 by **10,000 tonnes/day**, resulting in more efficient routings of up to **500,000 nautical miles** and **€3 million** less in fuel costs.[35] FRA helps overcome efficiency, capacity and environmental challenges by helping reduce fuel consumption and emissions, while improving flight efficiency. At the same time, it paves the way for further enhanced airspace design and ATM operational concepts.

In many cases, ATC could also facilitate a "more" optimum trajectory by **allowing the available capabilities of the aircraft to play a role.** For example, only the aircraft's FMS will be aware of the optimum 'top of descent' point, which can be downloaded to ATC by datalink. This will avoid the need for inefficient early descents, and is currently being researched by SESAR.

A new and promising area of research into making flying greener is **contrail avoidance**. Depending on ambient atmospheric conditions, in particular under low temperatures and when the air is moist enough, flight contrails can evolve into contrail-cirrus clouds. **Recent scientific publications attribute more than 50% of aviation's contribution to global climate change to non-CO_2 emissions, with the biggest factor being contrail and contrail-induced cirrus clouds.**[36] It is foreseen that ATCOs could implement avoidance measures especially when the additional fuel burn and the corresponding CO_2 emissions remain within acceptable limits. Live trials are underway at EUROCONTROL MUAC to assess the reliability of detecting these areas.

However, there are also a number of factors that make it more difficult for aircraft to fly as 'greenly' as possible. Financial considerations can lead airlines to deviate from the shortest constrained route (SCR), as Figure 7 shows, when a less direct route (in red) is cheaper to fly due to cheaper airspace route charges. In the example, the SCR route (in green) would have shaved off 15 nautical miles and 115kg less fuel (3.6%) compared to the less direct route flown – but the flight planned, which was actually flown, cost €109 less.

Capacity and scalability issues across the network also pose problems for delivering greener flights. Pre-pandemic, capacity had become an increasing issue, leading the EUROCONTROL NM to ramp up cooperation with all partners to find solutions. Summer 2019 saw the eNM/S19 initiative (Enhanced NM/ANSP Network Measures for summer 2019), which deployed a number of capacity-enhancing measures, shifting traffic flows to offload congested ACCs as per Figure 8[37]. Reroutings or level caps to alleviate constrained area control centres, or tactical measures, such as to reduce the impact of unexpected bad weather, all reduced en-route delay by around 12% between 2018 and October 2019 across the European network, increasing predictability and punctuality. Without the eNM measures, en-route delay per flight in summer 2019 could have reached twice the level of 2018 – but at the same time, saw an additional tonnes 16,000 of CO_2 emissions[38], with an impact on fuel burn on the city pairs affected by the RAD measures since the start of the summer.

Here, the recast SES package, which includes the idea of mechanisms to modulate route charges at Union-wide level as a means of improving environmental performance, will clearly support improvements in environmental performance and incentivise greener flights.

Another constraint to flying 'greener' is that airlines may also choose to burn fuel faster by speeding up to make up for accumulated delays before take-off, unless they have a clearly defined policy.

New ideas could also help make flights greener. In Oceanic airspace, having two aircraft flying in formation envisaged in Airbus' innovative **Fello'Fly project** is a promising concept from Airbus that **could save between 5 to 10% of fuel for the rear flight of each pair of flights.**[39]

Terminal Manoeuvre Area (TMA) – a potential source of significant environmental improvements

The **TMA**, which is at the convergence of arrival and departure flows, **may be a source of significant flight inefficiencies,** particularly in dense and complex TMAs serving one or more large airports, where traffic flows have to be strategically separated to ensure the highest possible level of safety. This may also be the case for TMAs subject to many airspace and environmental constraints, typically when located within the "core" European airspace. A 2015 NATS study[40] showed that **80% of remaining inefficiencies are within 40 nm of airports.** A current EUROCONTROL study indicates that in the TMAs of Europe's 27 major airports, excess flight time exceeds **33k hours** in 2019.

Another source of inefficiency arises from the need to optimise ground infrastructure, in particular runways. For airports with high traffic demand, runway capacity may constitute the main bottleneck, and in some cases, operations have been developed over years to ensure maximum pressure is guaranteed, and avoid losing any slots (e.g. arrival aircraft holding).

In the 1990s the introduction of performance-based navigation (PBN) enabled more efficient design of the route structure in the TMA, facilitating shorter routes, segregation of flows, and avoiding densely populated areas. Arrival managers (AMAN and recently extended AMAN) help ATC to meter arrival traffic by speed adjustments in upstream sectors prior to entering the TMA, which significantly reduces extra transit time and holding. ATC should facilitate CDO thanks to S-shape vectoring with distance-to-go or point merge, to optimise vertical profiles and avoid long level-offs at low altitudes. As with the cruise segment, the crew needs to have the information available to update FMS calculations to have a better chance to land on the shortest arrival procedure (STAR); implement a CDO, with a potential 10% fuel saving and 40% noise reduction; and land on the optimal runway with minimum flap configuration,[41] if landing distance permits. Reverse thrust should be limited to safety cases.

New initiatives continue to improve the situation. "Dynamic TMA" enables an agile adaptation to variation in traffic demand by activating the appropriate set of route structure designed for a given level of traffic. The systematic use of target time at metering points and on arrival also reduces extra time in the TMA, involving the flight crew more actively. Other possible trade-offs between maximising runway pressure and minimising flight inefficiency can also be explored.

Landing – room for more efficiency

More efficient taxi-in during ground operations means, as for departures, minimising the use of engine thrust and brakes, choosing the shortest route, using reduced engine taxi techniques such as using a single engine on arrival, delaying the start of the APU, and shutting it off as soon as possible. Stand allocation, Arrival Manager, A-CDM and green airport processes can also reduce emissions in this final flight phase.

Conclusion

Raising awareness on sustainability is essential at all levels and involves all actors combining forces. At EUROCONTROL, we actively promote sustainability solutions, helping actors reduce noise, CO_2 and non-CO_2 emissions, with particular focus on accelerating the implementation of innovative solutions through the SESAR programme, and supported by our operational services. Through our unique applications/models (IMPACT, Open-ALAQS, R-NEST), we assess the impact of aviation on the environment at all levels; we train aviation actors on environmental concerns, operations, and assessments; and we raise awareness via Think Papers and Aviation Sustainability Briefings.

In this Think Paper, we identify solutions that exist and can be optimised immediately to accelerate aviation's journey towards carbon neutrality at every stage of a journey. All can contribute, and all require continued cooperation between the various aviation actors – which include passengers and policy-makers as well as airports, airlines, aircraft, manufacturers and ANSPs. Every flight can aim to be as green as possible, and every flight can become greener by following the various measures detailed in this Paper.

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Main findings

1. Making better use of existing measures can take a significant advance towards the "perfect green flight", which could save up to 4,286kg of CO_2 emissions (25.8%) per flight out of an average 16,632kg of CO_2 for a total flight in the wider European area (ECAC). This is based on existing aircraft technology, and would significantly increase with the uptake of emerging technological solutions.

2. Better use of fuel-efficient air traffic management improvements through increased collaboration between all actors, and speedier implementation of SESAR solutions, could deliver 8.6%-11.2% (or 1,863 kg) of those reduced CO_2 emissions per flight. A more effectively functioning European network, as the recast SES legislation intends, should trigger airspace optimisation and boost the uptake of much required ATM solutions.

3. Emerging aircraft technologies in the form of hybrid, fully-electric and hydrogen airplanes will transform aviation over the period 2030-2050, enabling aviation to meet its climate-neutrality goal by 2050. By 2050, these new airplanes will be increasingly prevalent on short to medium haul sectors; while SAF use will predominate in the long-haul sector, with further upscaling of SAF production seeing 83% of fuel used being SAF, irrespective of any further technological developments.

4. Sustainable aviation fuel (SAF) is the most promising measure towards aviation decarbonisation right now. 10% use of SAF by 2030 would deliver 1,331 kg or 8% of that CO_2 saving. 20% SAF would deliver itself a huge 16% or 2,661kg – but major challenges need to be tackled to ramp up use from today's 0.1%.

5. Airlines can play a significant role in reducing CO_2 emissions by modernising their fleets, reducing 'economic fuel tankering', working with airports to use Ground Power Units rather than aircraft Auxiliary Power Units, and optimising the fuel efficiency of their existing fleets; here, greater incentives may be needed to balance economic considerations in some cases.

6. More attention needs to be paid to noise and non-CO_2 impacts, such as contrail avoidance..

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E-mail: ecd@icao.int

http://www.icao.int/sustainability/Pages/Air-Traffic-Monitor.aspx

GLOBAL KEY FIGURES

JAN 2021 *(versus JAN 2020)*

RPK ▼ -72.5% **ASK** ▼ -59.3% **FTK** ▼6.1% **LF**: 54.1% ▼ -3.4 pt

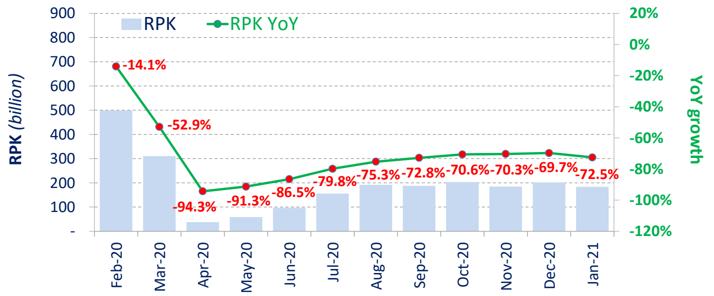
OUTLOOK* - FEB 2021 *(versus FEB 2020)*

ASK ▼ -57.7% * Source OAG

PASSENGER TRAFFIC

Revenue Passenger-Kilometres - RPK

World passenger traffic fell by -72.5% YoY in January 2021, -2.8 percentage points lower then the decline in the previous month. Entering into the new year, the pandemic intensified across the globe, with emergence of more contagious virus variants and imposition of stricter control measures. Consequently, 2021 started with a worsening decline in passenger traffic, the first deterioration since bottoming out from the lowest point of the crisis in April. Domestic traffic was mostly impacted, particularly in China where traffic plunged due to the tightened travel restrictions.

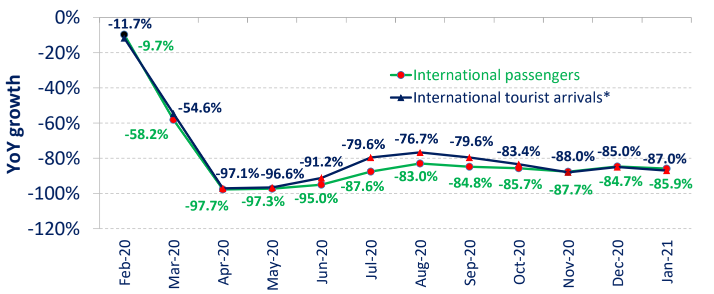


(Source: ICAO, IATA, OAG)

International Passengers vs. Tourist Arrivals

International passenger numbers fell by -85.9% YoY in January 2021, -1.2 percentage points down from the decline in the previous month. International traffic remained muted across all regions and further weakened, affected by the pandemic acceleration and new lockdowns.

The international tourist arrivals also remained stagnant and followed a similar trend as international passenger traffic.



*UNWTO Definition

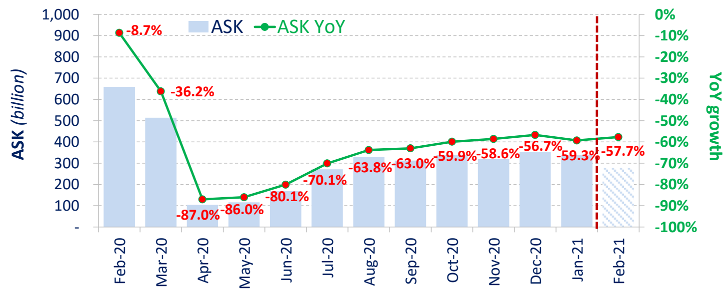
(Source: ICAO, UNWTO)

CAPACITY

Available Seat-Kilometres - ASK

Capacity worldwide fell by -59.3% YoY in January 2021, -2.6 percentage points down from the decline in the previous month (-56.7%).

Amid the surge of new COVID-19 cases and increasing travel restrictions, capacity is likely to stay at the similar level as in February 2021 with a decline of -57.7% YoY.

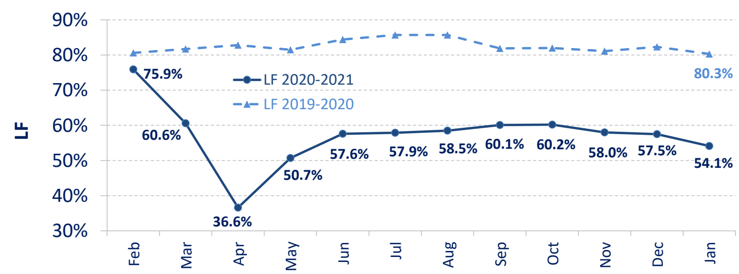


(Source: ICAO, IATA, OAG)

Load Factor - LF

The passenger Load Factor reached 54.1% in January 2021, -3.4 percentage points lower than the previous month.

As air travel demand fell faster than capacity, the January LF deteriorated to the lowest level since May 2020, and was -26.2 percentage points lower than the rate in the same period of 2020.

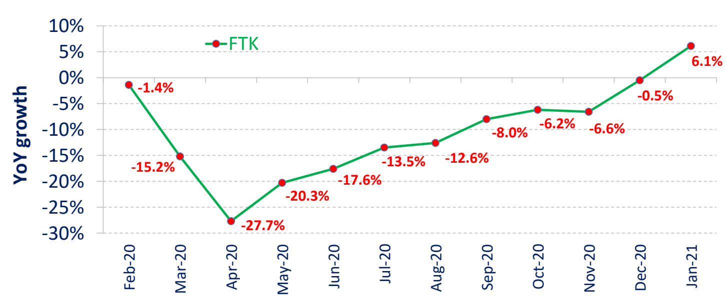


(Source: IATA)

FREIGHT TRAFFIC

Freight Tonne-Kilometres - FTK

World freight traffic reported a growth of +6.1% YoY in January 2021, +6.6 percentage points up from the fall in the previous month. After experiencing 21-month of continuous YoY decline since April 2019, freight traffic finally saw positive growth and exceeded the 2019 levels. Despite the renewed outbreaks, air cargo demand remained robust supported by the recovery in economic activities, and strengthening in manufacturing and goods trade. Air cargo demand improved in all regions, particularly in Africa and North America where traffic has expanded double-digitally. The Middle East also grew solidly, while Latin America/Caribbean posted the weakest performance and was the only region recording negative growth.



(Source: IATA)

ACRONYMS: **ACI**: Airports Council International; **ASK**: Available Seat-Kilometres; **IATA**: International Air Transport Association; **FTK**: Freight Tonne-Kilometres; **LF**: Passenger Load Factor; **OAG**: Official Airline Guide; **RPK**: Revenue Passenger-Kilometres; **UNWTO**: World Tourism Organization; **YoY**: Year-on-year; **YTD**: Year-to-date.

Air Transport Bureau
E-mail: ecd@icao.int

» Continued from page 1

TOP 15 AIRPORTS (Ranked by aircraft departures, passengers and volume of freight)

JAN 2021: -30.4%, -49.2%, and +21.0% YoY in terms of aircraft departures, passengers and freight for the Top 15

JAN 21

Airports (ranking by number of departures)	Departures	YoY
Atlanta GA, US (ATL)	25,391	-30.9%
Dallas/Fort Worth TX, US (DFW)	23,532	-18.5%
Chicago IL, US (ORD)	19,119	-46.5%
Denver CO, US (DEN)	19,048	-25.4%
Charlotte NC, US (CLT)	17,098	-31.2%
Guangzhou, CN (CAN)	16,075	-23.6%
Los Angeles CA, US (LAX)	15,729	-43.6%
Phoenix AZ, US (DVT)	14,355	-32.6%
New Delhi, IN (DEL)	14,044	-32.3%
Phoenix AZ, US (PHX)	13,884	-29.2%
Shenzhen, CN (SZX)	13,427	-15.6%
Shanghai, CN (PVG)	13,043	-39.1%
Salt Lake City UT, US (SLC)	12,937	-12.3%
Miami FL, US (MIA)	12,759	-33.1%
Chengdu, CN (CTU)	12,669	-19.4%

Airports (ranking by number of passengers)	Passengers*	YoY
Atlanta GA, US (ATL)	1,677,439	-59.6%
Guangzhou, CN (CAN)	1,623,486	-43.9%
Dallas/Fort Worth TX, US (DFW)	1,540,593	-46.7%
New Delhi, IN (DEL)	1,534,822	-49.7%
Chengdu, CN (CTU)	1,459,066	-35.5%
Denver CO, US (DEN)	1,414,643	-45.6%
Shenzhen, CN (SZX)	1,397,300	-33.7%
Kunming, CN (KMG)	1,306,502	-28.2%
Shanghai, CN (SHA)	1,154,099	-29.1%
São Paulo, BR (GRU)	1,143,387	-46.2%
Charlotte NC, US (CLT)	1,065,513	-49.1%
Mexico City, MX (MEX)	1,037,921	-50.7%
Dubai, AE (DXB)	1,023,001	-74.6%
Hangzhou, CN (HGH)	1,010,737	-29.4%
Chicago IL, US (ORD)	986,062	-66.5%

Airports (ranking by tonnes of freight)	Freight**	YoY
Hong Kong SAR, CN (HKG)	407,000	15.8%
Memphis TN, US (MEM)	393,332	15.3%
Shanghai, CN (PVG)	352,240	35.0%
Anchorage AK, US (ANC)	284,232	49.8%
Incheon, KR (ICN)	255,867	27.7%
Taipei, CN (TPE)	222,502	33.7%
Louisville KY, US (SDF)	212,893	0.0%
Doha, QA (DOH)	201,250	14.2%
Los Angeles CA, US (LAX)	193,063	32.6%
Tokyo, JP (NRT)	192,395	31.2%
Miami FL, US (MIA)	186,198	6.5%
Dubai, AE (DXB)	175,621	-7.5%
Frankfurt, DE (FRA)	169,067	21.2%
Guangzhou, CN (CAN)	163,123	19.5%
Chicago IL, US (ORD)	159,025	35.9%

__Note__: Total scheduled and non-scheduled services

(Source: ACI)

In terms of **aircraft departures**, the Top 15 airports reported a combined fall of **-30.4%** YoY. US airports continued to be at top of the chart followed by Chinese airports. **Atlanta** retained the **1st** position with **-30.9%** decline, followed by **Dallas/Fort Worth** (-18.5%). **Salt Lake City** reported the smallest fall at **-12.3%**, followed by **Shenzhen** (-15.6%).

In terms of **passengers**, the Top 15 airports posted a total fall of **-49.2%** YoY. While Chinese and US airports continued to dominant Top15, few airports from Latin America/Caribbean and the Middle East also appeared in the list. **Atlanta** overtook **Guangzhou** became **1st**, albeit with the third largest YoY decline. The smallest contraction was posted by **Kunming** (**-28.2%**) and **Shanghai** (**-29.1%**).

In terms of **freight**, the Top 15 airports reported a YoY increase of **+21.0%**. Unlike passenger traffic, air freight rose sharply with all Top 15 recording YoY growth, except for **Dubai** which posted a decline of **-7.5%**. **Hong Kong** retained the 1st position with a solid increase of **+15.8%**. The strongest growth was recorded by **Anchorage** at **+49.8%**.

TOP 15 AIRLINE GROUPS (Ranked by RPK)

JAN 2021: -67.7% YoY in terms of RPK for the Top 15

In terms of RPK, the Top 15 airline groups accounted for 52.3% of the world's total RPK in January 2021 and declined by -67.7% YoY. This decline was 4.8 percentage points smaller than the fall in world's average RPK, with all airlines in the Top 15 posting contractions.

Airlines in the two largest domestic markets, US and China, continued to lead the recovery chart. However, their rankings changed significantly being hampered by virus resurgence at varying degrees.

For the first time since April 2020, the three major US airlines overtook Chinese airlines and became Top 3. This was mainly due to the sudden traffic fall in China. **American** ranked **1st** with a similar decline as in December, followed by **Delta** and **United**. **Southwest** dropped one position to **8th**.

All the three major Chinese airlines, **China Southern**, **China Eastern**, and **Air China**, posted noticeable deteoriation in traffic as domestic travel was strictly controlled in response to the new outbreaks. Compared to December, traffic of China Southern was down 40% from 15.6 billion to 9.3 billion RPKs , and the latter two showed approximately 30% less traffic.

Airlines in Europe maintained the similar decline as in the previous month. While **AF-KLM** climbed up one position to **7th**, recovery of **Lufthansa** and **IAG** slowed down and recorded the second and third largest YoY decline among the Top 15.

Traffic of both **Emirates** and **LATAM** trended sideways slightly, and ranked **11th** and **14th**, respectively.

JAN 21

	RPK (billion)	YoY	% Share of World Total	Cumulative % Share
American[1]	10.3	-64.7%	5.6%	5.6%
Delta[1]	9.7	-65.8%	5.3%	10.8%
United[1]	9.4	-66.7%	5.1%	16.0%
China Southern	9.3	-59.1%	5.0%	21.0%
China Eastern	7.1	-60.6%	3.9%	24.9%
Air China	7.1	-62.5%	3.8%	28.7%
AF-KLM[1]	7.0	-69.1%	3.8%	32.6%
Southwest[1]	6.1	-61.0%	3.3%	35.9%
Hainan Airlines	5.1	-42.0%	2.8%	38.6%
Aeroflot	4.9	-56.0%	2.7%	41.3%
Emirates	4.3	-84.0%	2.3%	43.6%
IAG[1]	4.2	-80.2%	2.3%	45.9%
Turkish Airlines	4.1	-67.5%	2.2%	48.1%
LATAM Airlines Group	3.8	-67.2%	2.1%	50.2%
Lufthansa Group[1]	3.8	-82.5%	2.1%	52.3%
Top 15 Total RPKs	*96 billion*	*-67.7%*	***52.3%***	
World Total RPKs	*184 billion*	*-72.5%*	***100.0%***	

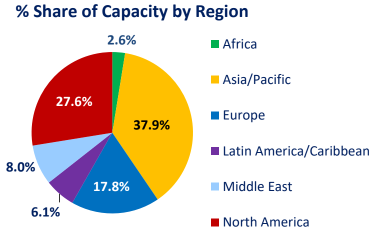
(Source: ICAO, airlines' websites)

__Note__: Total scheduled and non-scheduled services

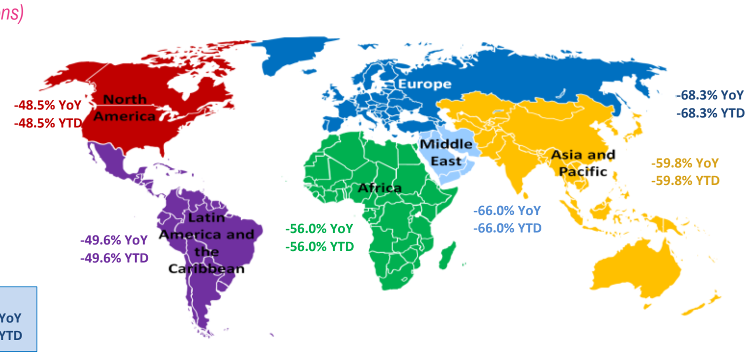
CAPACITY BY REGION *(ICAO Statistical Regions)*

JAN 2021: -59.3% YoY in terms of World ASK

% Share of Capacity by Region



(Source: ICAO, IATA, OAG)
__Note__: Total scheduled services



World:
-59.3% YoY
-59.3% YTD

Worldwide capacity contracted by -59.3% YoY in January 2021. All regions registered smaller capacity than in December, except for marginal increases in the Middle East and Latin America/Caribbean. The most noticeable decrease was seen in Asia/Pacific, affected by the new outbreaks.

Capacity in North America recovered the fastest, whereas Europe posted the largest capacity decline among all regions.

* Embarked Passengers ** Loaded and Unloaded Freight inTonnes 1. ICAO estimates

ACRONYMS: **ACI:** Airports Council International; **ASK:** Available Seat-Kilometres; **IATA:** International Air Transport Association; **FTK:** Freight Tonne-Kilometres; **LF:** Passenger Load Factor; **OAG:** Official Airline Guide; **RPK:** Revenue Passenger-Kilometres; **UNWTO:** World Tourism Organization; **YoY:** Year-on-year; **YTD:** Year-to-date.

THE FUTURE OF THE AEROSPACE INDUSTRY

DUBAI AIRSHOW 2021

14-18 NOVEMBER 2021

DWC, Dubai Airshow Site

www.dubaiairshow.aero

#dubaiairshow

in association with

UNITED ARAB EMIRATES
MINISTRY OF DEFENCE

مطارات دبي
DUBAIRPORTS

هيئة دبي للطيران المدني
Dubai Civil Aviation Authority

DAEP
DUBAI AVIATION ENGINEERING PROJECTS

DUBAI AIRSHOW

THE #1 MEETING PLACE FOR AEROSPACE

The Dubai Airshow, now in its 17th edition, has become the most important point of convergence for aerospace professionals to witness the most innovative products and solutions alongside a host of exciting features and thought-leadership conferences.

Based on a study conducted by an external research firm, **90%** of visitors strongly agreed that Dubai Airshow was the **most important show** for them amongst all other aerospace events.

By participating in the Dubai Airshow, you're joining a global community of trailblazers, market disruptors and industry experts pushing the boundaries of aviation.

The Dubai Airshow has been phenomenal, we've had great traffic and a lot of people have been very interested in our product. The event shows the best of all our different allies and friends coming together and working together to find solutions that promote commercial activity between countries.

MICHAEL DISHMAN, *Senior Regional Director, Middle East, Africa & South Asia OshKosh Defense*

DUBAI AIRSHOW IN NUMBERS

OVER
US$54.5B
ORDERS BOOKED

REPRESENTATIVES FROM
148
COUNTRIES

DECISION-MAKERS IN ATTENDANCE:
40%

CIVIL AND MILITARY DELEGATIONS:
314

1,200
EXHIBITORS

84,043
TRADE VISITORS

1,420
MEDIA ATTENDEES

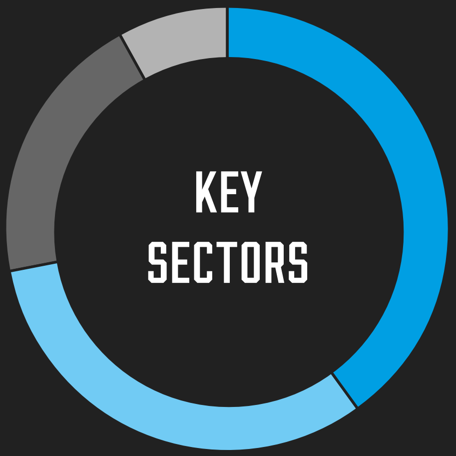
16
COUNTRY PAVILLIONS

161
AIRCRAFT ON DISPLAY

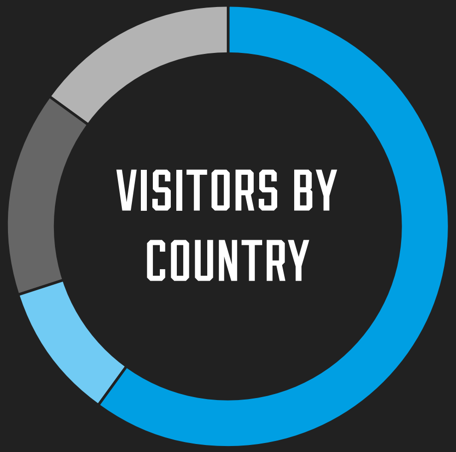
VISITORS AT A GLANCE

The amount of visitors has been fantastic! We've had so many meetings with new potential opportunities and have been able to reinforce some of the existing relationships that we have with customers in the area.

NEIL BOWLES, *Head of ATM, Searidge*



- Commercial Aviation 40%
- Business Aviation 30%
- Defence 20%
- Space 10%



- MENA 60%
- Americas 10%
- Europe 15%
- Rest of World 15%

Seniority of Delegations include:

+ Ministries of Defence
+ Deputy Ministers
+ Chiefs of Staff
+ Chiefs of Air Force

97% INTEND TO VISIT IN 2021

94% MET THEIR BUSINESS OBJECTIVES

89% RATE THE DUBAI AIRSHOW AS THE INDUSTRY BENCHMARK

WHO EXHIBITS

91%

OF EXHIBITORS RATE THE DUBAI AIRSHOW AS VERY IMPORTANT FOR THEIR BUSINESS

We have done more than we expected, we have met and had discussions with a lot of companies and we have seen a lot of customers and shown our aircraft to many people as well, so we are very happy with what has taken place. We are a new company, so relationships matter a lot. Communication matters as well, and Dubai Airshow is one of the best communicators.

YAHYA HOMOUD ALGHORAIBI, *CEO, The Helicopter Company, KSA*

- Commerical Aviation
- Business Aviation
- Defence & Military
- Aircraft Interiors
- Air Traffic Management
- Air Cargo
- MRO
- Space
- Emerging Technologies (New)

MEDIA REPRESENTATION

WHERE BUSINESS HAPPENS

Some of the deals at last edition include:

+ Emirates signed an order for 50 Airbus A350 XWB worth **$16B**
+ Air Arabia signed a deal for 120 aircraft worth **$14B**
+ Halcon, under the umbrella of EDGE, signed a deal worth **$980M** with UAE’s MOD
+ de Havilland signed a deal worth **$99M**
+ Boeing sold a pair of 787-9s worth **$585M**
+ Lockheed Martin received a UAE MOD contract for F-16 equipment worth **$20.6M**

OVER
US$54.5B
ORDERS BOOKED

OVER
US$4B
OF MILITARY CONTRACTS

AIRCRAFT DISPLAY

[View the list of aircrafts here]

Dubai Airshow’s famous static park and flying display is touted as the best in-class and the proximity to the exhibition hall and chalets makes it one of the most convenient and unique venues for both, exhibitors and visitors.

The 2019 edition displayed over 161 breath-taking aircraft which included the latest civil, business and military aircraft plus a selection of helicopters from industry leaders and new players.

HOSPITALITY CHALETS

The Hospitality Chalets at Dubai Airshow provide an exclusive opportunity to host your clients and conduct high-level meetings in a private environment.

The single or double-storey chalets, which are fully customisable, are positioned in proximity to the static display providing your guests with unrivaled and breath-taking views of the aircraft.

Exude a feeling of space and comfort while keeping a professional appeal along 89 chalets.

KEY NETWORKING OPPORTUNITIES

The Dubai Airshow is one of the best networking events in the world for aviation professionals. Moreover, the event is hosted in the most strategic location within the Middle East which serves as the perfect gateway to the rest of the World.

ADAM THOMAS, *Department for International Trade Defence and Security Organisation UK (DIT DSO)*

Delegation Program
The Dubai Airshow runs one of the most successful and far-reaching delegation programmes in the world - the 2019 edition welcomed **314** delegations from **148** countries which included military and civil.

Royal Pavilion
An important part of Dubai Airshow, the Royal Pavilion is an ultra-exclusive palatial space where the government leaders and official delegations converge. This also provides the perfect setting for the official opening ceremony during the first day of the show.*

*Access to the royal pavilion is by invite only and strictly controlled

Golf Tournament *16 - November 2021*
The Dubai Airshow Golf Tournament is held on the Emirates Golf Club, Faldo Course and is hosted by GT Exhibitions Limited and TWI Group, providing an unrivaled networking opportunity in a relaxed environment.

Exhibitor Party *12 - November 2021*
The Exhibitor Party is set in one of the most sought-after venues where exhibitors and sponsors have an opportunity to network with key industry influencers and establish business relationships in a fun atmosphere prior to the event opening.

GALA DINNER

16 - November 2021

Widely regarded as one of the most sought-after invitation of the year, the Dubai Airshow Gala Dinner is the social highlight of the Dubai Airshow week. An evening hosted by Dubai Airports attracts performances from a spectacular list of artists including Jennifer Lopez, Sir Tom Jones, Diana Ross, Stevie Wonder, Katy Perry, OneRepublic and many more.

Held at the Coca-Cola Arena at City Walk, the Dubai Airshow Gala Dinner is the aviation social event of the season.

CONTENT STREAMS

Dubai Airshow brings you a host of thought-leadership content based on current themes and future trends that are backed by leading experts and practitioners from the aerospace sector.

Our Main Stage will host **Global Air Traffic Management** and **Cargo Connect** - two integral conferences covering challenges and trends within the air traffic and cargo sectors.

Aerospace 2050 features a series of tracks dedicated to some of the key growth areas of the industry including future transport, sustainability, and space.

Tech Xplore will highlight how emerging technologies are helping reboot aviation and changing the entire flying experience using 5G, AI, Cyber Security and Automation.

	TECH XPLORE NEW	AEROSPACE 2050 FORUM	STARTUP STAGE NEW	MAIN STAGE
MONDAY 15 NOV 2021	Cyber Security	Aviation Sustainability - NEW	Startup Pitch & Mentorship	Global Air Traffic Management
TUESDAY 16 NOV 2021	AI	Advanced Aerial Mobility - NEW	Startup Pitch & Mentorship	Cargo Connect
WEDNESDAY 17 NOV 2021	Automation	Space	Mentorship & Investors Clinic	Cargo Connect
THURSDAY 18 NOV 2021	5G	Futures Day	Startup Competition	Aviation Event - NEW

NEW FOR

2021

SHOW FEATURES

Join us at Dubai Airshow 2021 where we will launch new features and activations across the show floor, making business networking and access to market intelligence more accessible than ever before.

The a team paints the sky with their national colors through an array of breathtaking aerial manoeuvres.

GUIDED TOURS

Enhancing visitor experience and offering exhibitors the opportunity to engage with the audience we will conduct hourly guided tours. We will conduct industry specific tours in multiple languages to showcase the latest technologies and event highlights. This additional networking opportunity will match visitors with exhibitors ensuring time is utilised and traffic is guided through the show floor.

SHOW FEATURES

FISH TANK TALKS

A rare opportunity to become a fly on the wall, this aquarium like live broadcast space creates an opportunity for engaging content to be delivered in a unique way. Important talks and discussions take place within a glass meeting room as visitors are able to listen in through headphones and capture the discussions as they unfold live.

MEETINGS IN THE SKY

Delegates and sponsors can book a meeting in the sky onboard an elevating boardroom within the exhibition hall. Offering a unique meeting experience this will be a meeting that your guests will not forget.

SHOW FEATURES

RUNWAY MEETINGS

Taking luxury networking to the next level with soundproofed and air-conditioned glass domes. Bookable throughout the event or can be taken exclusively this will give your private meetings the perfect location with prime views of flying displays.

FACILITATED NETWORKING

A brand new networking opportunity for all participants of Dubai Airshow whereby questions are asked and depending on the answers given you will be guided towards those with similar opinion. This is a unique opportunity to meet with likeminded people, discuss important topics and stimulate connections and introduction.

SHOW FEATURES

DIGITAL CAFÉ

The digital cafe will be a center piece on the exhibition floor, providing Realtime social media feeds and updates, news and opinion. It will provide an inviting and open atmosphere to allow visitors to congregate and witness the latest in robotics and automation serving fresh coffee to guests.

ARENA

Offering participants an enhanced program of demonstrations, performances and training. The arena will display the latest technology in robotics, drones and tech demos within aerospace during the day and will transform to double as an arena for music and entertainment throughout the show.

TECHNOLOGY SHOWCASE

The aviation sector is embracing cutting edge technologies to evolve and enhance its operations, boost efficiency, profitability and sustainability within the industry. Dubai Airshow 2021 is excited to provide a platform where the latest technologies in Aerospace will be showcased

The below sectors will be supported with

- + Enhanced conference programme
- + Crowdsourcing
- + Guided tours
- + Demonstrations
- + Debates
- + Activations
- + Trainings and Workshops
- + Pitch Competitions and challenges

Applied Intelligence - Not just AI

Cyber Security

Sustainability

Global Mobility

Biosecurity

5G Technology

Blockchain

BUSINESS CONNECT

B2B Matchmaking Programme

Provides you the ultimate networking opportunity to meet face-to-face and to do real business. Pre-registered visitors, delegates, speakers and exhibitors will be able to search, connect and book meetings with key contacts at the show.

Buyers Programme

Created specifically to facilitate business matchmaking at the show, our Buyers Programme will be an effective platform for top quality buyers from the procurement, purchasing and supply chain management divisions within the aviation sector.

Official Mobile App

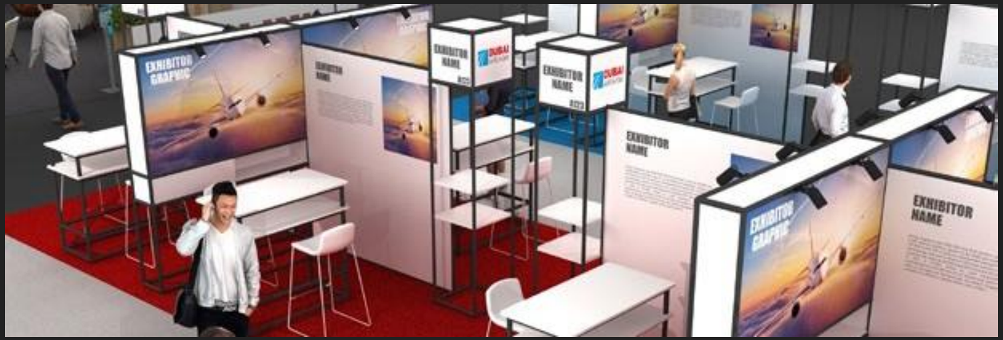
The official **'Dubai Airshow Mobile App'** will feature virtual floorplan, lead generation for sponsors and exhibitors, individual company profile, networking & matchmaking, live interactivity, session check-ins and much more.

VISTA

THE EAST WEST STARTUP HUB

Co-located with Dubai Airshow, Vista will give the stage startups access to programmes, mentorship and a chance to meet with key decision makers and globally ranked investors to launch, grow and scale their startups.

The global pandemic has encouraged a wave of new innovations required to support the various industries during this time and Dubai Airshow will be giving these technologies the platform they need to succeed by putting startups face to face with the right people in the right setting.



12 Inspirational Startup Sectors Redefining the Industry:

- Artificial Intelligence (AI)
- Future Mobility
- Software
- Cyber Security
- Defense
- Tourism
- Space
- Aerospace
- Material Science
- Robotics
- Drones
- Sustainability

WHAT YOU CAN SEE AT VISTA

Global & regional startups
An interactive map of startups from all over, come together to display and discuss the latest technologies and innovations.

Conferences/seminars
Dedicated startup stage for pitches, conferences and workshops bringing you the latest news and innovations from the entire aerospace ecosystem.

Mentorship clinic
Eager to be successful? Don't know where to start? Learn from the experience of startup success stories, entrepreneurs and investors

Meetings and investor programme
Guaranteed facetime with thousands of visitors and an opportunity to meet industry leaders, c levels, buyers, decision makers and globally ranked investors.

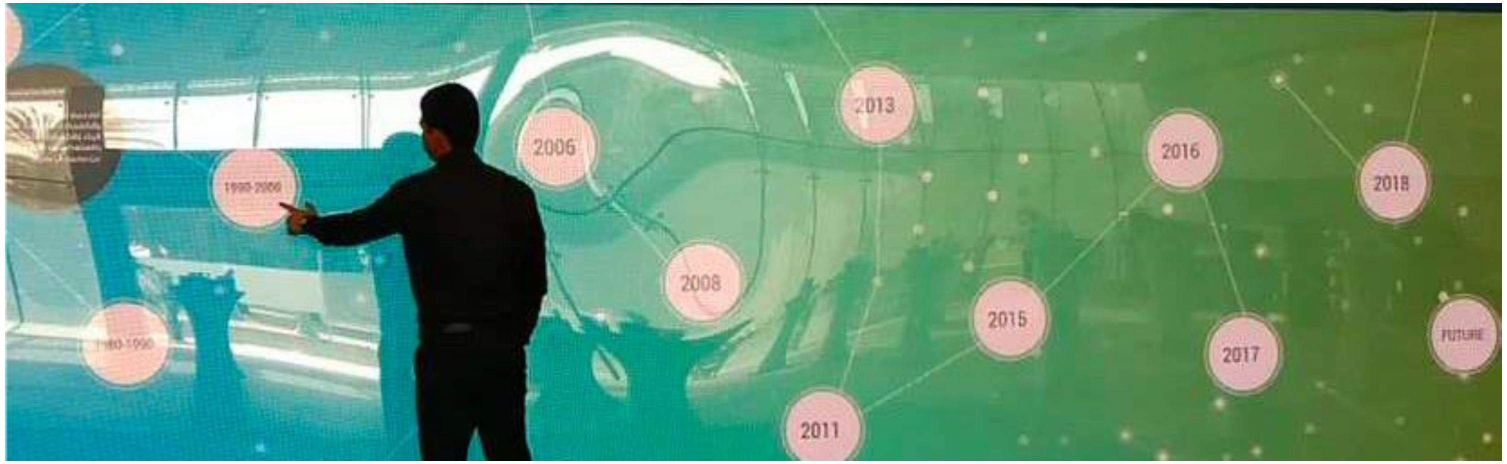
Networking lounge
Connect with a top class panel of investors, corporate and government buyers & international media for high level networking.

Challenges and pitch competitions
Startups get ready to pitch to the aerospace ecosystem, tech leaders and investors sponsored by corporate identities.

EXHIBITING OPPORTUNITIES

	STARTING FROM ($)	MINIMUM SPACE
Space only	710 per sqm	25sqm
Shell scheme	815 per sqm	12sqm
Chalet	Double Storey – 85,000 Single Storey – 44,000	
Outdoor space	470 per sqm	25sqm
Hospitality tables	4,500	
Aircraft display	2,200	
Startup Pods	1,950* Early Bird offer	

BRAND ENHANCEMENT



The Dubai Airshow offers an extensive range of advertising and sponsorship options to elevate your brand and boost your business opportunities before, during and after the event.

Based on your objectives, we can design tailored packages that incorporate a variety of mediums such as content, branding and digital to maximize your presence throughout the show lifecycle and across the industry.

Please contact our team to discuss further or view the full sponsorship opportunities brochure: sales@dubai.aero

DUBAI AIRSHOW

14-18 November 2021

Contact our team

info@dubaiairshow.aero | Tel: +971 (0)4 603 3300 | www.dubaiairshow.aero