FLIGHT SAFETY FOUNDATION

ALAR

APPROACH-AND-LANDING ACCIDENT REDUCTION

TOOL KIT

FSF ALAR BRIEFING NOTE 8.6

Wind Information

Wind information is available to the flight crew from two primary sources:

- Air traffic control (ATC); and,
- Aircraft systems.

Statistical Data

The Flight Safety Foundation (FSF) Approach-and-landing Accident Reduction (ALAR) Task Force found that adverse wind conditions (i.e., strong crosswinds, tail winds or wind shear) were involved in about 33 percent of 76 approach-and-landing accidents and serious incidents worldwide in 1984 through 1997.[1]

The FSF Runway Safety Initiative (RSI) team found that wind factors (i.e., crosswinds, gusts, tail winds, wind shear and turbulence) were involved in 36 percent of the 435 runway-excursion landing accidents worldwide in 1995 through March 2008.[2]

Reporting Standards

Recommendations for measuring and reporting wind information have been developed by the International Civil Aviation Organization (ICAO).

They have been implemented by ICAO member states' national weather services (NWSs) and local airport weather services (AWSs).

Average Wind and Gust

Wind direction and wind velocity are sampled every second by wind sensors that may be distant from the runway touchdown zone.

Data averaged over the past two-minute period provide the automatic terminal information service (ATIS) or tower-reported "average wind."

The average wind is available to the controller on a display terminal. (Some control towers, however, have instantaneous indications of wind direction and wind velocity.)

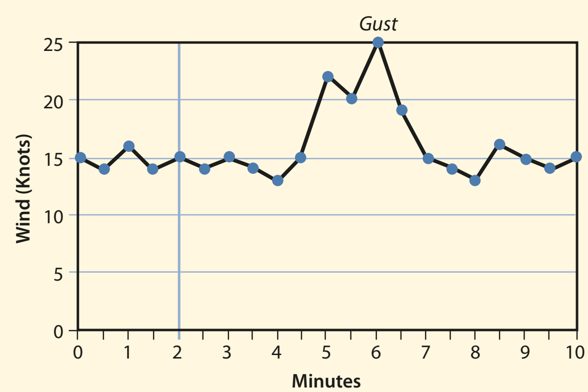
A wind profile of data collected over the past 10-minute period shows the maximum (peak) wind value recorded during this period; this value is reported as the gust.

ICAO recommends that gusts be reported if the 10-minute peak value exceeds the two-minute average wind by 10 knots or more.[3] Nevertheless, gust values lower than 10 knots often are provided by AWSs.

Figure 1 shows a 10-minute wind profile with:

- A two-minute average wind of 15 knots; and,
- A gust of 10 knots (i.e., a 25-knot peak wind velocity) during the 10-minute period.

Wind Profile Resulting in ATC/ATIS Report of 15-Knot Wind Velocity and Gusts to 25 Knots



ATC = air traffic control; ATIS = automatic terminal information service

Source: FSF ALAR Task Force

Figure 1

This wind condition would be shown in an aviation routine weather report (METAR) as "XXX15G25KT," where XXX is the wind direction, referenced to true north. ATIS and tower-reported winds are referenced to magnetic north.

If the peak wind value is observed during the past two-minute period, the gust becomes part of the average wind (Figure 2).

Such a wind condition would be shown as:

- "XXX20G25KT"; or,
- "XXX20KT" (if the five-knot gust is not included).

Average-wind values and gust values displayed to a controller are updated every minute.

The two-minute average wind and the 10-minute peak gust are used by ATC for:

- ATIS broadcasts; and,
- Wind information on ground, tower, approach and information frequencies.

METARs include a 10-minute average-wind velocity and the 10-minute peak gust (Figure 3).

Maximum Demonstrated Crosswind

The *maximum demonstrated crosswind* published in the approved airplane flight manual (AFM), aircraft operating manual (AOM) and/or quick reference handbook (QRH) is the maximum crosswind component that was encountered and documented during certification flight tests or subsequent tests by the manufacturer.

The wind value is recorded during a time period bracketing the touchdown (typically from 100 feet above airport elevation to when the airplane reaches taxi speed).

For some aircraft models, if a significant gust is recorded during this period, a demonstrated gust value may also be published.

The maximum demonstrated crosswind;

- Is not an operating limitation (unless otherwise stated);
- Is not necessarily the maximum aircraft crosswind capability; and,
- Generally applies to a steady wind.

Maximum Computed Crosswind

The *maximum computed crosswind* reflects the design capability of the aircraft in terms of:

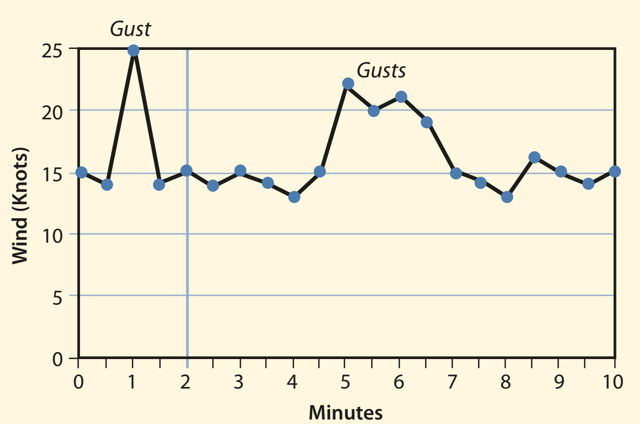
- Rudder authority;
- Roll-control authority; and,
- Wheel-cornering capability.

Crosswind Capability

Crosswind capability is affected adversely by the following factors:

- Runway condition (e.g., contaminated by standing water, snow, slush or ice);
- Systems malfunctions (e.g., rudder jam); or,
- Minimum equipment list (MEL)/dispatch deviation guide (DDG) conditions (e.g., inoperative nosewheel steering).

Wind Profile Resulting in ATC/ATIS Report of 20-Knot Wind Velocity With Gusts to 25 Knots

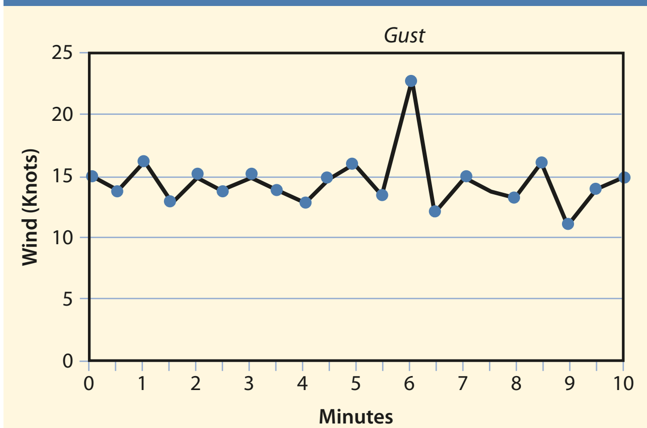


ATC = air traffic control; ATIS = automatic terminal information service

Source: FSF ALAR Task Force

Figure 2

Wind Profile Resulting in METAR Report of 15-Knot Wind Velocity and Gusts to 23 Knots



METAR = aviation routine weather report

Source: FSF ALAR Task Force

Figure 3

Wind Information on Navigation Display

The wind information on the navigation display (ND) consists of two elements (Figure 4):

- A wind arrow:
  - The direction of the wind arrow is referenced to magnetic north and indicates the wind direction;
  - The length of the wind arrow may be fixed (velocity information is displayed separately), or the length of the wind arrow may be varied to indicate the wind velocity (depending on aircraft models and standards); and,
  - The wind arrow is the primary visual wind reference during the final approach (together with the groundspeed display); and,
- Digital wind information showing wind direction (typically referenced to true north) and wind velocity:
  - Digital wind information is used primarily to compare the current wind to the predicted wind, as provided on the computerized flight plan.

Lower-Left Corner of Navigation Display Shows Winds From 212 Degrees at 20 Knots

Source: FSF ALAR Task Force

Figure 4

Depending on aircraft models and standards, the wind information may be computed either by the inertial reference system (IRS) or by the flight management system (FMS).

Depending on the equipment, different time delays for "smoothing" (i.e., averaging) the wind value are applied, as discussed below.

The wind information on the ND typically is updated 10 times per second.

IRS Wind

IRS wind is assessed geometrically using the triangle of true airspeed (TAS), groundspeed and wind vectors.

The TAS vector and groundspeed vector are defined, in terms of velocity and direction, as follows:

- TAS vector:
  - Velocity: TAS from the air data computer (ADC); and,
  - Direction: magnetic heading from the IRS; and,
- Groundspeed vector:
  - Velocity: groundspeed from the IRS; and,
  - Direction: magnetic track from the IRS.

The IRS wind is computed and is transmitted typically 10 times per second to the electronic flight instrument system (EFIS) for display on the ND.

The IRS wind display provides, for practical purposes, *near-real-time* wind information.

FMS Wind

FMS wind is computed similarly to IRS wind, but FMS wind is averaged over a 30-second period.

FMS wind is more accurate than IRS wind because distance-measuring equipment (DME) position or global positioning system (GPS) position, when available, are included in the computation.

FMS wind is less accurate (i.e., delayed) under the following conditions:

- Shifting wind;
- Sideslip; or,
- Climbing or descending turn.

FMS wind cannot be considered instantaneous wind, but the FMS wind shows:

- More current wind information than the ATIS or tower average wind; and,
- The wind conditions prevailing on the aircraft flight path (aft of the aircraft).

Summary

METAR wind is a 10-minute average wind.

ATIS wind or tower average wind is a two-minute average wind.

ATIS gust or tower gust is the wind peak value during the past 10-minute period.

The ATIS broadcast is updated only if the wind direction changes by more than 30 degrees or if the wind velocity changes by more than five knots over a five-minute time period.

If an instantaneous wind reading is desired and is requested from ATC, the phraseology "instant wind" or "wind check" should be used in the request. (ATC may provide instant-wind information without request under shifting/gusting wind conditions.)

IRS wind is near-real-time wind.

FMS wind is a 30-second-average wind.

Maximum demonstrated crosswind generally applies to a steady wind and is not a limitation (unless otherwise stated).

The most appropriate source of wind information should be selected for the flight phase.

The following FSF ALAR Briefing Notes provide information to supplement this discussion:

- 8.5 — Wet or Contaminated Runways; and,
- 8.7 — Crosswind Landings.

Notes

1. Flight Safety Foundation. "Killers in Aviation: FSF Task Force Presents Facts About Approach-and-landing and Controlled-flight-into-terrain Accidents." *Flight Safety Digest* Volume 17 (November–December 1998) and Volume 18 (January–February 1999): 1–121. The facts presented by the FSF ALAR Task Force were based on analyses of 287 fatal approach-and-landing accidents (ALAs) that occurred in 1980 through 1996 involving turbine aircraft weighing more than 12,500 pounds/5,700 kilograms, detailed studies of 76 ALAs and serious incidents in 1984 through 1997 and audits of about 3,300 flights.
2. Flight Safety Foundation. "Reducing the Risk of Runway Excursions." Report of the FSF Runway Safety Initiative, May 2009.
3. International Civil Aviation Organization (ICAO). *International Standards and Recommended Practices, Annex 3 to the Convention of International Civil Aviation, Meteorological Service for International Air Navigation*. Chapter 4, "Meteorological Observations and Reports." Thirteenth edition – July 1998.

Related Reading From FSF Publications

Darby, Rick. "Keeping It on the Runway." *AeroSafety World* Volume 4 (August 2009).

Rosenkrans, Wayne. "Real-Time Defenses." *AeroSafety World* Volume 2 (May 2007).

Fahlgren, Gunnar. "Tail Wind Traps." *AeroSafety World* Volume 2 (March 2007).

Rosenkrans, Wayne. "Knowing the Distance." *AeroSafety World* Volume 2 (February 2007).

Berman, Benjamin A.; Dismukes, R. Key. "Pressing the Approach." *AviationSafety World* Volume 1 (December 2006).

Flight Safety Foundation (FSF) Editorial Staff. "Fast, Low Approach Leads to Long Landing and Overrun." *Accident Prevention* Volume 63 (January 2006).

FSF Editorial Staff. "DC-10 Overruns Runway in Tahiti While Being Landed in a Storm." *Accident Prevention* Volume 62 (August 2005).

FSF Editorial Staff. "Failure to Maintain Situational Awareness Cited in Learjet Approach Accident." *Accident Prevention* Volume 60 (June 2003).

FSF Editorial Staff. "Inadequate Weather Communication Cited in B-737 Microburst-downdraft Incident." *Airport Operations* Volume 29 (January–February 2003).

FSF Editorial Staff. "Crew Fails to Compute Crosswind Component, Boeing 757 Nosewheel Collapses on Landing." *Accident Prevention* Volume 57 (March 2000).

FSF Editorial Staff. "Unaware of Strong Crosswind, Fokker Crew Loses Control of Aircraft on Landing." *Accident Prevention* Volume 56 (November 1999).

FSF Editorial Staff. "MD-88 Strikes Approach Light Structure in Nonfatal Accident." *Accident Prevention* Volume 54 (December 1997).

FSF Editorial Staff. "Flight Crew of DC-10 Encounters Microburst During Unstabilized Approach, Ending in Runway Accident." *Accident Prevention* Volume 53 (August 1996).

Notice

The Flight Safety Foundation (FSF) Approach-and-Landing Accident Reduction (ALAR) Task Force produced this briefing note to help prevent approach-and-landing accidents, including those involving controlled flight into terrain. The briefing note is based on the task force's data-driven conclusions and recommendations, as well as data from the U.S. Commercial Aviation Safety Team's Joint Safety Analysis Team and the European Joint Aviation Authorities Safety Strategy Initiative.

This briefing note is one of 33 briefing notes that comprise a fundamental part of the FSF *ALAR Tool Kit,* which includes a variety of other safety products that also have been developed to help prevent approach-and-landing accidents.

The briefing notes have been prepared primarily for operators and pilots of turbine-powered airplanes with underwing-mounted engines, but they can be adapted for those who operate airplanes with fuselage-mounted turbine engines, turboprop power plants or piston engines. The briefing notes also address operations with the following: electronic flight instrument systems; integrated autopilots, flight directors and autothrottle systems; flight management systems; automatic ground spoilers; autobrakes; thrust reversers; manufacturers'/operators' standard operating procedures; and, two-person flight crews.

This information is not intended to supersede operators' or manufacturers' policies, practices or requirements, and is not intended to supersede government regulations.

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