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Sampling the Aggregate

BY MARK LACAGNINA

First annual C-FOQA report provides benchmarks for corporate aircraft operators.

Aviation departments participating in the Flight Safety Foundation corporate flight operational quality assurance (C-FOQA) program have received their first annual report, which is based on aggregate data and focuses on five key areas: unstable approaches, exceedance of aircraft limitations, maintenance events, flight operations events and landing performance.[1] The report provides a fleetwide yardstick that individual operators can use to measure their own results, as presented in separate reports tailored to each participant.

The annual report is based on analyses of aggregate data gathered during the 6,614 flights and 13,814 flight hours logged by the participants from 2006 through 2008 (Figure 1). "Not much compared with the longstanding airline FOQA experience, but enough to begin seeing some patterns," said William R. Voss, FSF president and CEO.[2] "Like most changes in aviation, it takes time, but we are starting to build and aggregate data in the business aviation industry."

The Foundation's Corporate Aviation Committee and the National Business Aviation Association's Safety Committee pioneered C-FOQA in 2004. The goal is to provide corporate aircraft operators the safety measurement tools that the airlines have been using for many years. About 100 airlines worldwide currently have flight data monitoring programs designed to collect and analyze recorded flight data to detect unsafe procedures or events early enough to allow timely intervention to avoid accidents and incidents.

Two corporate aircraft operators were enrolled when the C-FOQA program was launched in 2006 following a successful demonstration project. As of the end of 2008, nine corporate aircraft operators were participating. The C-FOQA fleet currently comprises 24 aircraft, some of the same model, including the Bombardier Challenger and Global Express, Dassault Falcon 900 and 7X, Embraer 135, and Gulfstream IV, V, 450 and 550.

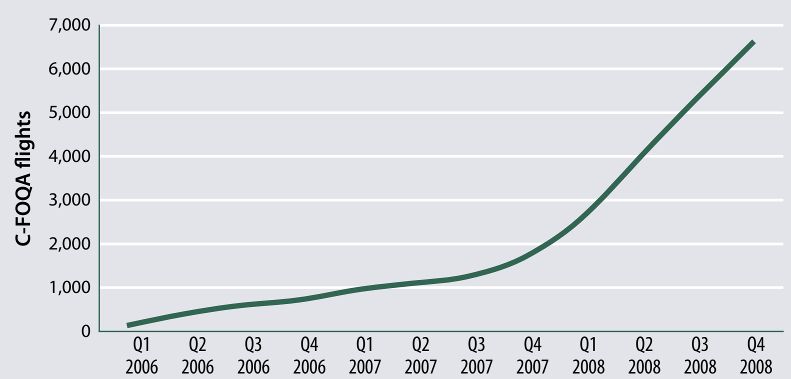
As a natural follow-up to the Foundation's work in approach and landing accident reduction, the primary focus of C-FOQA data analysis is identifying unstable approaches and their causes. The report shows that about 8 percent of the 6,614 flights in 2006–2008 involved unstable approaches (Figure 2).

The report includes the rates of unstable approaches that occurred seasonally, quarterly and yearly during the period. The highest rates of unstable approaches occurred in the second and third quarters of each year — April through September — with 10.0 percent and 9.4 percent, respectively. The unstable approach rates for the first and fourth quarters were 6.0 percent and 6.4 percent, respectively.

A breakdown of the C-FOQA data indicates that the leading cause of unstable approaches in 2008 was a high rate of descent on final approach. High descent rates were identified in 66 of the unstable approaches (Figure 3, p. 20). Fifty of the approaches were designated as *caution events* and 16 as *warning events*. These designations stem from the Foundation's development of *standard event limits* to guide the data processing and analysis conducted chiefly by Austin Digital, which provides similar highly automated services for numerous airlines with flight data monitoring programs.

The report provides information about the standard event limit parameters that were established for unstable approaches. For example, for the analysis of recorded descent rate on final approach, the Foundation established maximum descent rates — or limits — for altitudes below 500 ft HAT (height above touchdown) — that is, 500 ft above the runway touchdown zone elevation. The limits range from 1,800 fpm at 500 ft HAT to 1,200 fpm near touchdown.

C-FOQA Flights by Quarter, 2006–2008

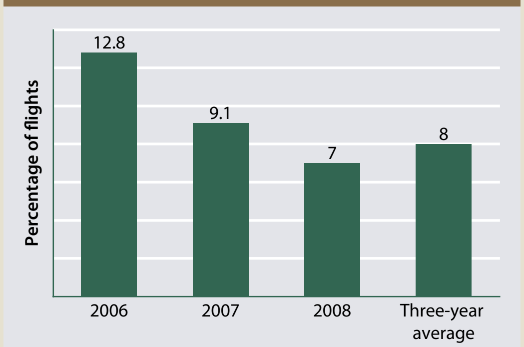


Q = quarter

Source: Flight Safety Foundation

Figure 1

Unstable Approach Event Rates



Source: Flight Safety Foundation

Figure 2

During data analysis, descent rates that exceed the limits are flagged. The standard event limits in this case define the severity of an event based on the percentage by which the descent rate exceeds a limit. Exceedances up to 10 percent beyond the limits are identified as caution events, and those greater than 10 percent are identified as warning events.

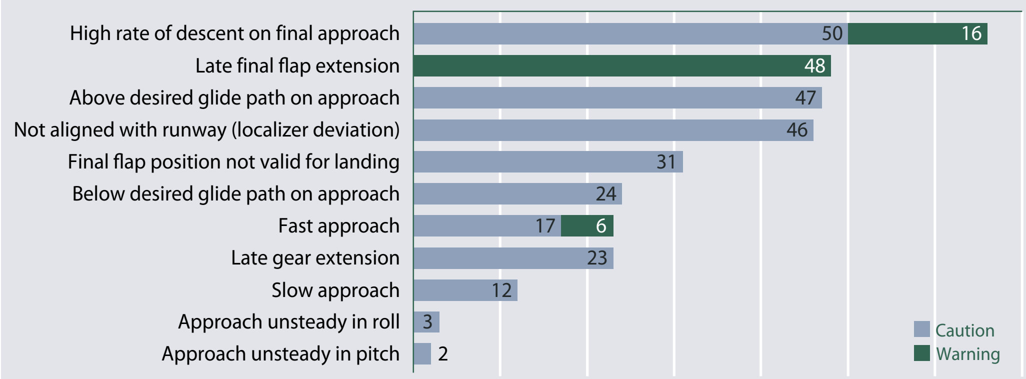
The report shows that the second most prominent cause of unstable approaches in 2008 was late extension of flaps to the landing configuration, which occurred during 48 approaches. The Foundation established only a warning limit for this critical procedure: If the recorded data show that the final flap selection was made below 500 ft HAT, the approach is flagged as a warning event.

Deviations from the glideslope and localizer during instrument landing system approaches also were found to be significant causes of unstable approaches. The caution limits are a deviation of two "dots" above the glideslope, as indicated by the horizontal situation indicator, a deviation of one dot from the localizer and any deviation below the glideslope between 500 ft HAT and 200 ft HAT. Among the unstable approaches involving these deviations were 47 that strayed above the glideslope limit, 46 that exceeded the localizer limit and 24 that went below the glideslope limit.

Selection of a final flap setting that was not appropriate for landing was the cause of 31 unstable approaches. Excessive airspeed was the destabilizing factor in 23 approaches, including 17 caution events, in which airspeed exceeded VAPP, the target approach speed, by more than 20 kt, and six warning events, in which airspeed exceeded VAPP by more than 25 kt.

Late extension of the landing gear was the cause of 23 additional unstable

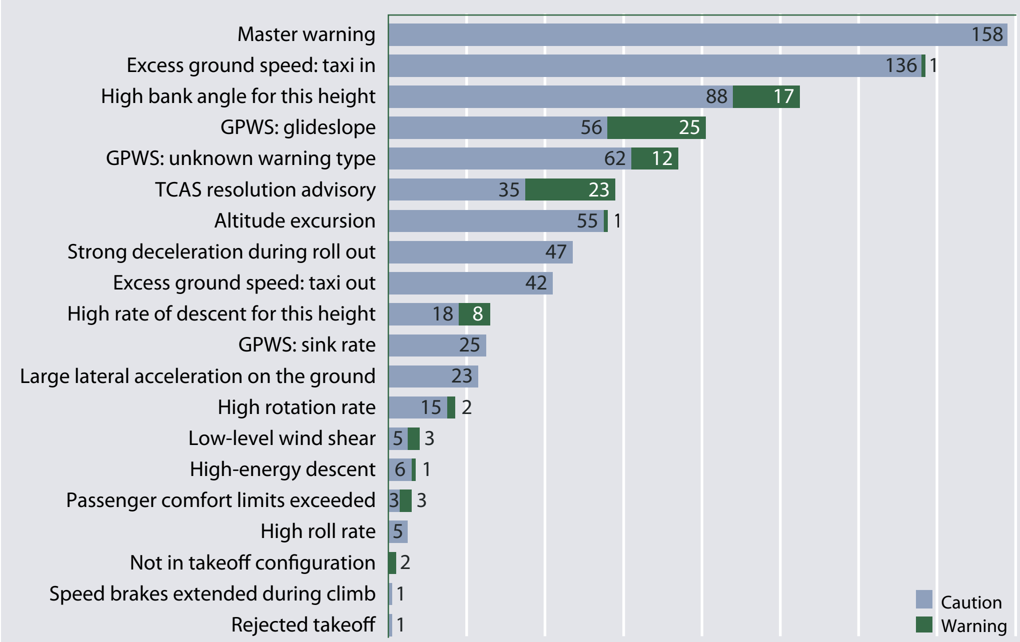
Breakdown of Unstable Approach Events by Cause (2008)



Source: Flight Safety Foundation

Figure 3

Breakdown of Flight Operations Events (2008)



GPWS = ground-proximity warning system; TCAS = traffic-alert and collision avoidance system

Source: Flight Safety Foundation

Figure 4

approaches. All were caution events, cases in which the gear was extended between 1,000 ft HAT and 500 ft HAT. (Gear extension below 500 ft HAT is a warning event.)

Twelve approaches were destabilized by airspeeds that deviated below VAPP. All were caution events, in which the recorded airspeeds were no more than 10 kt below the target.

Three of the unstable approaches were "unsteady in roll," with recorded roll rates exceeding 4 degrees per second; and two approaches were "unsteady in pitch," with pitch rates exceeding 1.5 degrees per second.

The report showed that few of the 28 tracked aircraft operating and performance limitations were exceeded in 2008. However, there was a surprisingly high number of events involving one limitation, the maximum flap-extension speed. The report showed that there were 59 exceedances, all of which were labeled as caution events.

The aggregate data also revealed three caution events in which airspeed exceeded the Mach limit, two caution events involving exceedance of the maximum landing gear extension speed and single caution events involving airspeed near stall speed and exceedance of the landing weight limit. There was one warning event that involved fuel temperature that apparently dropped far below the published limit, greatly increasing the risk of fuel icing.

The C-FOQA data for 2008 also were gleaned for 14 different events that could result in the need for nonroutine maintenance. The use of thrust reversers at slow speeds stood out with 104 caution events. The contribution of reverse thrust to stopping performance on a dry runway decreases substantially at airspeeds below about 80 kt and drops to zero at about 60 kt while increasing the risk of foreign object damage and compressor stalls, both of which are maintenance issues.[3]

Hard landings were involved in 33 maintenance events, one of which was designated as a warning event. Also among the warning events were two cockpit warnings of smoke, an engine fire, an engine compressor stall and one incident in which an aircraft was airborne with its thrust reversers not stowed. Low hydraulic pressure caused one caution maintenance event.

Master Warnings

Nearly 18 percent of the flights monitored by C-FOQA from 2006 through 2008 encountered flight operations events (Figure 4). The rate was fairly constant each year. Master warnings were the most frequent flight operations event recorded in 2008, with 158, followed by excessive groundspeed while taxiing in after landing, with 137, including one designated as a warning event. Excessive bank angles at low altitude were recorded during 105 flights, with 17 designated as warning events.

There were 81 ground-proximity warning system (GPWS) "glideslope" warnings, of which 25 were designated as warning events. Unknown types of GPWS warnings followed with 62 caution events and 12 warning events. Traffic alert and collision avoidance system (TCAS) resolution advisories were recorded during 58 flights, with 23 designated as warning events. There were 56 altitude excursions, including one warning event. Strong decelerations during rollout were recorded during 47 landings, and excessive groundspeeds while taxiing out for departure were flagged in 42 caution events. High descent rates at low altitude were tagged in 18 caution events and eight warning events.

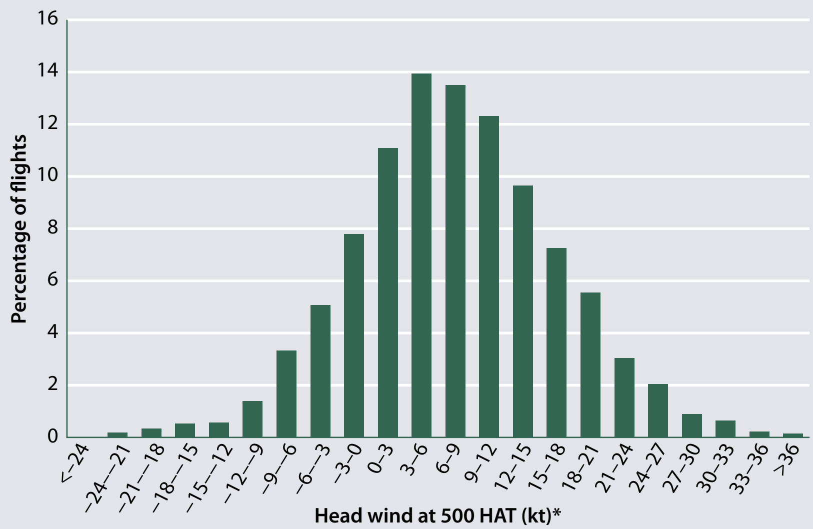
GPWS "sink rate" warnings were recorded during 25 flights, and large lateral accelerations on the ground were recorded during 23 flights. Other flight operations events included high rotation rates (17, with two warning events), low-level wind shear (eight, including three warning events), high-energy descents (seven, with one warning event), exceeding passenger-comfort limits (three caution events and three warning events), high roll rates (five), and improper takeoff configuration (two warning events). One caution event involved speed brakes that deployed during climb. Another involved a rejected takeoff.

An important point is that further analysis by the operator could shed a different light on the findings. For example, an event involving "improper takeoff configuration" might have resulted from the flight crew's proper selection of a nonstandard flap setting for departure from a high-density-altitude airport.

The report provides various analyses of landing performance data recorded during 2008. Presented as distributions from the mean, the analyses include factors such as wind components encountered at 500 ft HAT, airspeeds and the distances from runway approach thresholds and runway distances remaining on touchdown. Figure 5 (p. 22) is an example. A close look at the distribution of wind components shows that a fairly high number of approaches — nearly 20 percent — actually were conducted with tail winds. The tail wind component during nearly 3 percent — or 147 — of the 4,901 approaches conducted last year was 10 kt or more.

The annual C-FOQA report provides not only a glimpse of trends found in the aggregated data but also a benchmark that individual operators can use to compare their own results. Tailored quarterly and annual reports are generated for each operator enrolled in the program. Figure 6 (p. 22) is an example

Distribution of Head Wind on Approach (2008)



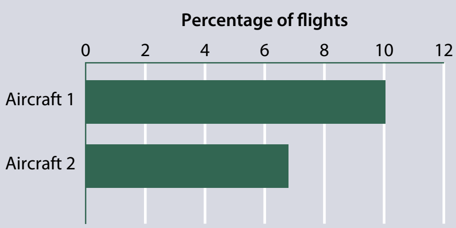
HAT = height above touchdown

* Negative values represent tail wind

Source: Flight Safety Foundation

Figure 5

Unstable Approach: Breakdown by Aircraft



	Number of Flights	Number of Unstable Approaches	Percent Totals
Aircraft 1	388	39	10.05%
Aircraft 2	338	23	6.80%
Total	726	62	8.54%

Source: Flight Safety Foundation

Figure 6

of what an operator might see in its own report. The breakdown shows that the rate of unstable approaches for one of the operator's airplanes was substantially higher than the other airplane and, compared with the information provided in the annual report, was higher than the 8 percent average rate for the C-FOQA fleet. Similar presentations in the individual operator's quarterly and annual reports would show the number and rate of unstable approaches that occurred at the specific airports used by the operator, facilitating its search for precursors and development of strategies to avoid them.

The first annual C-FOQA fleet report was well received. "From talking with the operators, I think they were pleased with the annual report and found it to be beneficial," said Edward D. "Ted" Mendenhall, coordinator of the C-FOQA program and a member of the Foundation's Corporate Advisory Committee. "Each one of them also received an annual report for their own operation and saw how they compared with all of the participants in the C-FOQA program."

A users' meeting was scheduled to be conducted near Teterboro, New Jersey, on June 23-24 to enable the participating operators to discuss the annual report with Foundation staff and to identify ways in which the data collection, analysis and presentation can be improved to meet their needs.

Confidentiality is a cornerstone of the program. "One of the things we have worked very hard to do is to protect the identity of the operators," Mendenhall said. "So, we have to be very careful about any changes we make and with the data we publish."

As participation in the C-FOQA program grows, more data will be gathered, and the new window to operational safety and efficiency will open further.[4] "The program really is in its infancy, and we have just begun to build a database that can be queried at any time to help analyze trends," Mendenhall said. "We are seeing increased interest from corporate aircraft operators"

Notes

1. Flight Safety Foundation. *2008 Annual C-FOQA Statistical Summary Report*. Prepared by Austin Digital Inc. January 2009.
2. Voss, William R. Welcoming address presented at the 54th annual Corporate Aviation Safety Seminar, Orlando, Florida, U.S., April 22, 2009.
3. Flight Safety Foundation. "Approach-and-landing Accident Reduction (ALAR) Briefing Notes." *Flight Safety Digest* Volume 19 (August–November 2000): 174–175.
4. More information about the C-FOQA program is available on the Foundation's Web site at <flightsafety.org/cfoqa.html>.

Further Reading

Lacagnina, Mark. "C-FOQA Takes Root." *AeroSafety World* Volume 2 (August 2007): 11–15.

Donoghue, J.A. "C-FOQA Advances." *AeroSafety World* Volume 1 (August 2006): 45–46.