FLIGHT SAFETY FOUNDATION
Airport Operations
Vol. 31 No. 3 *For Everyone Concerned With the Safety of Flight* May–June 2005

Noise-abatement Procedures Require Periodic Risk Assessment

European authorities typically require airport managers, air traffic controllers and aircraft operators to reduce aircraft noise through operating procedures and other methods. Demonstration flights and flight-data monitoring could help determine if noise-related operating constraints conflict with safety objectives, said the U.K. Civil Aviation Authority.

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FSF Editorial Staff

European airports, air traffic control (ATC) organizations and aircraft operators work under "considerable pressure" from governments to conduct flight operations within noise-related environmental restrictions, said a 2004 report by the U.K. Civil Aviation Authority (CAA). If these operational constraints were implemented many years ago, current methods of operational risk assessment and risk mitigation may not have been applied.

"The common feature [of noise management] is that the aircraft's operation has to be significantly different from what it would have been in the absence of the environmental constraints," the report said.

The underlying study compared current factors that affect operational decisions by pilots and air traffic controllers with factors that were relevant 40 years ago. The early determinants of aircraft flight paths were aerodynamics, pilot workload and ATC separation rather than effects of noise to people on the ground, the report said.

More recently, the greatest reductions of aircraft noise levels have occurred through design of quieter engines on new aircraft. Airports and ATC also began implementing the following methods: relocating aircraft ground tracks, using each ground track less frequently, increasing the altitude of aircraft, reducing aircraft power settings and/or changing aircraft aerodynamic configurations.

The study combined analysis of international specialists' opinions[1] with a review of aviation safety literature and data[2] about the following constraints: ATC assignment of runways providing only nonprecision approaches; noise-preferential routing; continuous-descent approaches; noise-abatement takeoff procedures; low-power low-drag approaches; assignment of runways with a crosswind component; and assignment of runways with a tailwind component.

The operational constraints targeted for study have functioned as follows, the report said:

- "Continuous-descent approach [might require] an aircraft [crew] to descend from 6,000 feet altitude to intercept the instrument landing system (ILS) glide slope without using level flight. … The [noise-reduction] benefit, from 6,000 feet to ILS intercept, arises from reduced thrust and higher altitude of the aircraft and is substantial — typically five [decibels sound-exposure level (dB), which compares with a maximum 55 dB sound-exposure level under guidelines of the International Civil Aviation Organization (ICAO)];

- "In low-power low-drag [approaches], the aircraft is flown at the highest safe [airspeed] with aircraft configuration as 'clean' as possible [i.e., with landing gear retracted and flaps retracted]. … The pilot delays the extension of wing flaps and undercarriage until the final stage of the approach. [The noise-reduction benefit] typically is one dB;

- "[When ATC assigns nonprecision approaches] for certain time periods and conditions — e.g., at night — aircraft [crews] might not be permitted to use the usual ILS-equipped runways, but rather [are instructed to conduct] a 'nonprecision' approach — e.g., using very high frequency omnidirectional range (VOR)/distance-measuring equipment (DME) on a different runway. This removes noise from populated communities at sensitive times;

- "As aircraft design[s] and flight-control systems have developed, aircraft … [for example, may] operate on runways with crosswinds of … 25 knots. This may be environmentally beneficial [i.e., runways with crosswinds may be assigned by ATC to reduce flights over noise-sensitive communities];

- "Governments may decide to change the operating rules ('preferences') so that in some periods, operations can take place in tailwinds of up to … five knots. … [Otherwise, only conducting takeoffs and landings] into the wind … can result in aircraft flying over [the same] communities for a high proportion of the time;

- "Several types of noise-abatement takeoff procedures have been adopted to reduce the [noise effect] on sensitive areas near the airport runway. They generally involve a thrust reduction after a first [climb/acceleration] segment at takeoff power/thrust. The simplest procedure involves a cutback to climb setting power/thrust at 1,500 feet above the [airport] surface level;[3] and,

- "Noise-preferential routes are specific ground tracks [that] map onto the standard instrument departure (SID) structure; the noise-preferential route is essentially the first part of the SID. By careful choice of noise-preferential route/SID, aircraft tracks can be moved several miles away from a sensitive community, producing very large reductions in noise."

Based on the study's information sources, three problem areas were identified; for the other operational constraints, the accident risks were deemed less significant. The report said that the conclusions about problem areas were:

- Use of nonprecision approaches solely for environmental reasons (i.e., noise abatement) is unwise if precision approaches could be used;

- Airports/ATC authorities periodically should demonstrate that their noise-preferential routing meets safety criteria under current operational conditions (i.e., confirm that regardless of the aircraft type, these routes can be flown under the pilot's full control in normal flight conditions); and,

- ATC/airport operators periodically should demonstrate that the pilot/crew workload is acceptable during continuous-descent approaches.

"The missing ingredient [in] existing policies and regulations appears to be the system safety case,"[4] the report said. "Environmental changes tend to have been introduced decades ago, before the safety-case philosophy was developed, so there is a need for the [airports, ATC and aircraft operators] to meet the [current] safety-case requirements."

The report said that there should be no trade-offs between safety and other considerations.

"Where the aircraft-noise impact on people can safely be reduced, then this should be done," said the report. "But nobody would want to discover that an accident had happened as even a partial consequence of environmental constraints."

Criteria should be developed to enable civil aviation authorities and other European regulators to determine that noise-preferential routing meets safety standards and to determine that safety defenses of continuous-descent approaches have not been weakened in comparison with current guidelines, the report said.

Several problems with noise-related operating constraints were identified during the study.

Regarding ATC assignment of runways equipped only for nonprecision approaches, the study cited findings and recommendations by the Flight Safety Foundation (FSF) Approach-and-landing Accident Reduction (ALAR) Task Force, which found that nonprecision approaches involve significantly greater risk than precision approaches. Moreover, one specialist in the U.K. CAA study said that nonprecision approaches currently involve an even greater risk than the risk identified by the FSF task force.

"The message from studies of accidents is clear: It is difficult to see how the use of nonprecision approaches — when precision approaches are available — can be justified purely for environmental reasons," the report said.

An aircraft noise-abatement agreement between Germany and Switzerland was considered during the investigation of a 2001 accident in Zürich, Switzerland, the report said.[5]

Regarding noise-preferential routes, some specialists in the study said that various safety problems have occurred. The main problems are absence of design criteria for noise-preferential routes; absence of methods for validating the flyability of noise-preferential routes (beyond checking ICAO obstacle-clearance standards) for aircraft with wide differences in performance; awkward design of standard instrument departures and standard instrument arrivals to accommodate operating constraints; uncertainty among air traffic controllers about when to deviate from operating constraints when required for safety of flight; possibly unsafe influence on the individual controller's decisions by the public's noise complaints; and inadequate design of some older standard instrument departures for the automatic flight systems of current large transport jets.

One specialist said during the study, "It is the opinion of many international pilots that many noise SIDs cannot be successfully flown either automatically or manually."

Regarding continuous-descent approaches, research found that crew errors and other factors can cause an overshoot of the glide slope and generate a high workload for crews and air traffic controllers during the approach (i.e., airspeed changes and aircraft-configuration changes). Overemphasis on the continuous-descent approach "may lead to an increase in rushed or unstable approaches by pilots and errors by ATC," the report said. Moreover, one concern for crews confronting high workload during a critical phase of flight is the "erosion of spare capacity" to respond to an unusual situation such as an engine failure.

Regarding requirements/expectations for noise-abatement takeoff procedures — which have been conducted for more than 25 years — the report said that inadequate information was available on which to base safety concerns or recommendations.

Regarding low-power low-drag approaches, the study found no information that indicated a safety problem with this method of airport noise reduction.

Regarding ATC assignment of runways with a significant crosswind component for noise-abatement reasons, the report cited the ICAO *Procedures for Air Navigation Services–Aircraft Operations (PANS–OPS)* Volume 1, Part 5, Chapter 2, paragraph 2.1.3, which says: "Noise abatement should not be the determining factor in runway nomination … if the runway is not clear and dry … when the crosswind component including gusts exceeds 28 kilometers per hour (15 knots)."

During the study, specialists said that their main concern was that although aircraft have maximum demonstrated crosswind values, strong crosswinds produce difficult control conditions that require crews to apply "drift" [crabbing] techniques or "wing-down" techniques.

"The aircraft [in a strong crosswind] is subject to yawing and rolling moments, and can suffer stability problems," the report said. "The [accident risk may be greatest] just after touchdown [when] gusts may require pilots to input large, rapid and positive steering inputs with the rudder pedals. Several [participating specialists] mentioned that the '[noise-]preferential runway is not always the preferred option for the pilots [because of] crosswind and turbulence.'"

Investigation of a 1999 runway-excursion incident at Amsterdam Airport Schiphol found that the ATC runway-allocation system "resulted in strong crosswind conditions for the landing runway in use." The final report said, "There is a reasonable probability that an actually encountered wind during landing deviates from the reported wind. This uncertainty warrants substantial margins to theoretical wind limitations when operating in crosswind. The accident risk increases exponentially when operating in crosswind conditions exceeding 20 knots, including gusts. The crosswind criteria of 25 knots and the freedom to exceed this value, as laid down in the [noise-]preferential-runway allocation system … [potentially is] an invitation to unsafe operations."[6]

The U.K. CAA report also cited U.K. Air Accidents Investigation Branch recommendations in 2002 after a runway-excursion incident during landing on London (England) Heathrow Airport Runway 27R. "A recommendation to make changes in [ATC] nomination of runways so as to minimize the use of Runway 27R during periods of strong southwesterly winds was accepted by Heathrow ATC and the airport company … This kind of recommendation has been put in place at many other airports," the report said.

Regarding ATC assignment of runways with a tailwind component, the report cited ICAO *PANS-OPS* Volume 1, Part 5, Chapter 2, paragraph 2.1.3, which says: "Noise abatement should not be the determining factor in runway nomination … if the runway is not clear and dry … when the tailwind component including gusts exceeds nine kilometers per hour (five knots)."

Air traffic controllers must consider the effects of tailwind on landing distance and the relationship of tailwind to the following: aircraft approach speed; runway braking action;

tailwind effectively requiring a relatively high rate of descent at low altitude; tailwind possibly causing pilots to use flight-idle thrust to compensate for its effect; tailwind reducing total time available for the aircraft crew to conduct a stabilized approach and landing; and increased likelihood of a go-around prompted by an unstabilized approach.

The specialists said that airports, ATC and aircraft operators should consider revising their safety cases whenever an aircraft type begins operating from a runway, and airport procedures that include a permissible tailwind component should be checked against the operating limitations of that aircraft type, which may not be designed to tolerate the tailwind permitted by existing procedures.

Overall, ATC assignment of runways with a tailwind generates concerns if the runway is contaminated but generates much less concern if the runway is dry, the report said.

U.K. CAA's policy on noise-related operating constraints includes a basic principle: "Safety could not be downgraded because of environmental concerns, no matter how significant."[7]

Moreover, the report said that guidance to U.K. CAA from the U.K. Department for Transport includes the following relevant principles:

- "[One of four elements][8] is to apply (and to encourage and assist airports and operators of aircraft to apply) noise-abatement operational procedures to the extent possible without affecting safety, in order to control operational noise and to mitigate its worst effects;
- "The balance of social and environmental advantage lies in concentrating aircraft taking off from airports along the least possible number of specified routes, consistent with airspace-management considerations and the overriding need for safety;
- "Changes to airspace arrangements (which include procedures for the use of controlled airspace in addition to its design) should be made after consultation, only where it is clear that an overall environmental benefit will accrue or where airspace-management considerations and the overriding need for safety allow for no practical alternative;
- "Departure procedures should be designed to enable aircraft to climb quickly and not be inhibited from climbing by conflicts with other traffic, including [those in] holding positions, taking into account the overriding need for safety; [and,]
- "If safety factors preclude consideration of an option that would have a significantly better environmental impact, those factors should be explained."

In summary, the report said that analysis of data from flight data monitoring programs would be an appropriate method to begin re-evaluating the designs of current noise-preferential routes. This analysis would enable, for example, identification of situations in which aircraft exceeded a 30-degree angle of bank to comply with such routing, and would enable civil aviation authorities to specify "flyability" criteria. For continuous-descent approaches, researchers should compare prevailing safety defenses with current European guidelines and should study aircraft-control issues and pilot-workload issues. The results could be used to develop and update safety cases for these methods of environmental noise-related operating constraints. [A major, multi-year European research project is underway to address such issues, including the identification of conflicts between environmental goals and safety goals in airport approach/departure procedures.][9]♦

[This article, except where specifically noted, has been adapted from U.K. Civil Aviation Authority (CAA) *Delivering Safety in the Context of Environmental Restrictions: Aviation Expert and Research Review,* U.K. CAA Paper 2004/08, July 2004. The report was written by Peter Brooker of Cranfield University, Cranfield, Bedfordshire, U.K.]

Notes

1. Participating specialists were U.K. Civil Aviation Authority (CAA) staff, individuals selected for their aviation safety expertise by U.K. CAA staff and individuals selected for their expertise by National Aerospace Laboratory (NLR)–Netherlands.

2. The literature review and accident/incident data searches took information from the U.K. Mandatory Occurrence Reporting Scheme; U.K. Confidential Human Factors Incident Reporting Program (CHIRP); Eurocontrol Safety Regulation Commission Doc 2 (2002), *Aircraft Accidents/Incidents and ATM [Air Traffic Management] Contribution: Review and Analysis of Historical Data*; publications of Flight Safety Foundation; and deidentified information from flight data monitoring programs.

3. International Civil Aviation Organization (ICAO) Volume 1, *Flight Procedures,* Part V, "Noise Abatement Procedures," Chapter 3 paragraph 3.2.3 (a) says, "Noise-abatement procedures [for departure climb] shall not be executed below a height of 240 meters (800 feet) above [airport] elevation." Brooks, Jim. "New Noise Abatement Departure Procedures Published in ICAO PANS–OPS." *ICAO Journal.* October 2002. Brooks represented the ICAO Committee on Aviation Environmental Protection working group on noise-abatement operational procedures. Effective Nov. 1, 2001, revisions to the safety criteria in PANS–OPS for noise-abatement departure procedures also included requirements that "the thrust setting after the cutback [during departure climb] must be no less than that required to maintain the one-engine-inoperative minimum-climb gradient required by airworthiness regulations [and] each airline is expected to comply with only one noise-abatement procedure." The safety criteria help ensure that the specified climb gradient will be flown after one engine failure without requiring thrust lever/throttle input by the flight crew, Brooks said.

4. Profit, R. *The Safety Case: A Means of Managing Change Safely.* Presentation to IBC Aviation Safety Management Conference, May 14–15, 1998. U.K. CAA, London, England. The U.K. CAA report used Profit's definition of system safety case: "A formal document that provides the evidence, arguments and assumptions to support the claim that the system is safe enough for operational use. This should describe the 'system' and its functions, identify the hazards, assess the risks, identify the measures in place to control the risks, and define the safety-management arrangements for the operational system. This provides an assurance that any risks introduced by the change have been minimized as far as is reasonably practicable."

5. Swiss Aircraft Accident Investigation Bureau (AAIB; Büro für Flugunfalluntersuchungen). *Investigation Report of the Aircraft Accident Investigations Bureau on the Accident to Aircraft AVRO 146-RJ100, HB-IXM, Operated by Crossair Under Flight Number CRX 3597, on 24 November 2001 near Bassersdorf/ZH* (English translation). At 2206 local time, the flight crew was conducting the very-high-frequency omnidirectional radio/distance-measuring equipment (VOR/DME) approach to Runway 28 at Zürich (Switzerland) Airport in nighttime instrument meteorological conditions when the airplane struck terrain. The two pilots, one cabin crewmember and 21 passengers were killed; one cabin crewmember and four passengers received serious injuries; and one cabin crewmember and three passengers received minor injuries or no injuries. In its final report, AAIB said that the following were causal factors: "The commander deliberately descended below the minimum descent altitude (MDA) of the standard VOR/DME [Runway 28] approach without having the required visual contact [with] the approach lights or the runway; [and,] the copilot made no attempt to prevent the continuation of the flight below the [MDA]." ATC assignment of the nonprecision approach procedure was not among issues that AAIB listed as contributing factors to the accident. Nevertheless, the U.K. CAA report said that this investigation included review of a noise-abatement agreement between Germany and Switzerland. The AAIB report said, "These transitional agreements [involving Runway 28] made it impossible to grant clearance to aircraft over German territory for flight levels [FL] below FL 100 between 2100 and 0500 UTC, regardless of whether these aircraft were flying under their own navigation or were controlled by radar. Thus, between the above-mentioned times, on the basis of the prevailing weather and the published minimums for Runway 28, it was not permitted to make [instrument landing system (ILS)] approaches on Runways 14 or 16. Accordingly, Zürich approaches had to be conducted on standard VOR/DME [Runway 28 approach]. Until the [agreements were effective] 19 October 2001, the standard VOR/DME [Runway 28 approach] was used by air traffic control only sporadically, where there was a pronounced westerly wind. Except for precipitation, typical westerly [wind] situations are generally characterized by good visibility and a relatively high cloud base."

6. Dutch Transport Safety Board (Raad voor de Transport Veiligheid). *Final Report 97-75/A-26, PH-TKC, Boeing 757, 24 December 1997, Amsterdam Airport Schiphol.* At about 2247 UTC on Dec. 24, 1997, the Transavia Boeing 757 experienced a runway excursion during landing after the crew conducted an autopilot-coupled ILS approach for Runway 19R at Amsterdam Airport Schiphol in strong, gusty wind conditions. The crew had disconnected the autopilot at approximately 100 feet to conduct a manual landing. "The aircraft then touched down hard with its right main landing gear first," the report said. "When the nose gear touched down hard with the aircraft in a crab angle, the nose gear doghouse broke out of the nose section and rotated backwards. The collapse of the doghouse resulted in serious damage to the electric/electronic systems and several flight[-control cables] and engine-control cables. The aircraft slid down the runway for approximately 3.0 kilometers [1.6 nautical miles], veered to the right and came to rest in the grass." The two pilots, six cabin crewmembers and 205 passengers evacuated without serious injuries. The following causal factors were identified: "The runway-allocation system at Schiphol Airport resulted in strong crosswind conditions for the landing runway in use; by the omission to state clear and definite crosswind limitations in the Transavia operations manual, a defense barrier against unsafe operations was lost; noncalculation and/or discussion of crosswind component resulted in continuing the approach in adverse weather conditions; disconnect of the autopilot in the align mode under the existing wind conditions resulted in an out-of-trim condition of the aircraft; the low altitude of the autopilot disconnect in relation to the existing wind conditions allowed the pilot insufficient time to gain complete control of the aircraft, which resulted in a hard traversing landing; and, the hard nose-wheel touchdown exceeding the certified design limits resulted in a failure of the nose-gear construction."

7. U.K. CAA. *Sustainable Development and Environmental Policy.* Doc. 2000/53. 2000.

8. U.K. Department for Transport. Other elements are aircraft/engine technology, land-use planning and management policies, and legal framework for "operating restrictions on the numbers and types of aircraft that may operate at particular airports or at particular times." ICAO. Assembly Resolution A33–7: *Consolidated Statement of Continuing ICAO Policies and Practices Related to Environmental Protection;* Appendix C, "Policies and Programs Based on a Balanced Approach to Aircraft Noise Management." October 2001. ICAO said, "The balanced approach to noise management … consists of identifying the noise problem at an airport and then analyzing the various measures available to reduce noise through the exploration of four principal elements, namely reduction at source; land-use planning and management; noise-abatement operational procedures [to the extent possible without affecting safety] and operating restrictions, with the goal of addressing the noise problem in the most cost-effective manner."

9. The European Commission–funded project is called Study of Optimization Procedures for Decreasing the Impact of Noise II (SOURDINE II). This research, technology development and demonstration project seeks solutions to "airport approach and departure procedures that are aimed at reducing the environmental [noise/emissions effect] around airports." The project also works to standardize and harmonize European and international procedures; to migrate from "the current situation to advanced, environmentally friendly approach and departure procedures"; to produce tools for air traffic controllers and pilots that help ensure the safety of new procedures; and to produce tools for policy makers "to provide insight into the relation between safety, the environment, efficiency and financial aspects." <www.sourdine.org>

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