



FLIGHT SAFETY FOUNDATION

Airport Operations

Vol. 24 No. 3-4

For Everyone Concerned with the Safety of Flight

May-August 1998

SPECIAL DOUBLE ISSUE

Europe's Air Traffic Strategy Offers Safety Insights Beyond the Region

In Europe, the safety of air traffic management requires changes in procedural standardization, system integration and international cooperation that might show the way to a finely tuned global transportation system of the future. Technology will increase capacity incrementally from now until 2015, but rapid improvements in air traffic safety will be necessary.

FSF Editorial Staff

While the nations of Europe unite in many ways, the region's air traffic controllers manage some of the world's most complex airspace, a microcosm of air traffic issues and emerging solutions. Since the early 1990s, the airline business in Europe has rebounded from an economic crisis. But the resulting air traffic increases could push air traffic management (ATM) to the limits of safe operation, said analysts at two recent European conferences.

European nations have pursued common interests through the 15-member European Union (EU).¹ EU nations have supported a single market in air transport and one air space for Europe, for example. EU processes provide a model for study by aviation authorities considering treaties and aviation-safety cooperation in other regions. Competing interest groups must harmonize various methods for the safe expansion of European air traffic capacity. An abbreviated list of interest groups would include airlines, organized labor, airport monopolies, governments and private investors.

The airline-accident rate in Europe has compared favorably with that of other regions. Aviation-safety authorities have



recognized, however, that significant reductions in the European accident rate will be necessary to prevent more frequent airline accidents in the future. Forecasts based on current accident rates, and expected increases in air traffic, project that one major accident will occur every three days near 2005, said Jean-Luc Garnier of the European Organisation for the Safety of Air Navigation (Eurocontrol).² Such forecasts have prompted the International Civil Aviation Organization (ICAO) and the European Civil Aviation Conference (ECAC)³ to urge rapid safety improvements.

Garnier said that a 1995 Eurocontrol survey of European-aviation interest groups found, however, that just 21 percent of respondents ranked safety first among priorities. Safety ranked below reduced delays, lower costs, increased capacity, a gate-to-gate solution and routing flexibility. Several European-conference speakers said that this low ranking of safety may reflect an assumption that European aviation safety is excellent and can be taken for granted.

Eurocontrol drafts ATM Strategy for 2000+. ECAC transport ministers approved a broad plan — the Institutional

Strategy for Air Traffic Management in Europe — in February 1997. The ministers then asked Eurocontrol, which celebrated its 35th anniversary in March 1998, to propose a comprehensive, uniform, gate-to-gate strategy describing how the ATM system in Europe should develop in the early years of the 21st century. Eurocontrol responded by creating the ATM Strategy for 2000+ Board in December 1997 and publicly releasing a proposed edition of this strategy in May 1998. Work on the strategy will continue until October 1998, when a final strategy will be developed for presentation to ECAC transport ministers in spring 1999.⁴

The ATM Strategy for 2000+ will carry forward Eurocontrol's European Air Traffic Control Harmonisation and Integration Programme (EATCHIP), which has been working since 1990 to harmonize the region's ATM by 1998 and to integrate ATM systems by the early 21st century.

European air carriers handle approximately one-fourth of the more than 1.25 billion passengers per year aboard the world's airlines, according to the ATM Strategy for 2000+, which will succeed the ECAC's "En-Route and Airport Strategies for the 1990s." (Europe is defined in the new strategy as the area covered by 36 ECAC member nations and 27 Eurocontrol member nations, excluding Iceland and oceanic airspace. The strategy contains provisions for the interface between European airspace and the airspace of contiguous non-European nations.)

The ATM Strategy for 2000+ comprises a series of objectives in 2005, 2010 and 2015. It seeks to integrate world-class technologies into common systems adopted by national air traffic service (ATS) providers. ATS providers, in turn, will work with Eurocontrol to implement standards, procedures, technology and training. Conference presenters said that the ECAC transport ministers and industry leaders need to develop a deep understanding of technological, cultural and organizational issues to safely meet the growing need for airspace capacity.

In developing its strategy, Eurocontrol tapped the expertise of the European Commission (EC), the EU's executive branch; the ECAC, including the Joint Aviation Authorities (JAA) Board; ICAO; the U.S. Federal Aviation Administration (FAA); and other organizations. The EC has proposed that the EU become a member of Eurocontrol, and that Eurocontrol should have expanded authority to enforce ATM performance and safety standards.

Eurocontrol's ATM Strategy for 2000+ addresses four primary processes: "airspace organization and management (the structure, division and categorization of airspace, and applicable rules); flow and capacity management (the approximate balance between capacity and demand, and avoidance of system overflow); en route and terminal air traffic control (the separation of aircraft, traffic sequencing and metering, and trading between capacity and flexibility for en

route and terminal airspace); and airport air traffic control (air-side traffic management, separation and sequencing of traffic on the airport, and other airport issues)."

The ATM Strategy for 2000+ said: "All flights [in Europe] use ATS to a greater or lesser degree. Civil commercial-passenger flights are the majority users of ATS, and fly in 'controlled' airspace where [ATS provides] extensive services. A significant number of business aircraft and some military flights also fly in this type of airspace, but are minority users. Some business, many recreational and most military aircraft fly in 'uncontrolled' airspace, where the range of services provided is much less extensive. ... Military flights often operate under the control of their own military air traffic units. Any change to this overall balance of use is likely to be marginal."

Eurocontrol oversees most ATM activity. Eurocontrol presently has charge of air traffic management in the upper airspace of Belgium, Luxembourg, Netherlands and part of Germany — providing services through a multinational team of air traffic controllers who work at the Upper Area Control Centre at Maastricht, Netherlands. The division between upper airspace and lower airspace in Europe, in general, is at 24,500 feet, but in some areas the division is at 19,500 feet. This basic division provides a practical method of managing controller workload by applying operating conditions to air traffic, such as prohibition of visual-flight-rules operations or the use of area-type control versus airway-type control. The agency also oversees the ATS providers responsible for the lower airspace of these nations.

Eurocontrol representatives said that, ideally, all ECAC nations should have a common approach to aviation-safety regulation and common procedures to share best practices in safety regulation and management. Eurocontrol's Garnier said that all of Europe needs a central authority to set minimum safety standards; certify individuals, organizations and ATM systems; and oversee safety competence and performance.

"The remaining functions, involving implementation and enforcement, would continue, of necessity, to be regulated by individual states, since under international agreements, safety regulation of civil aviation, including ATM, is a national responsibility discharged under national legal instruments," Garnier said.

EC's Claude Probst said that in March 1996 his organization proposed that all European nations empower Eurocontrol as their common safety regulator. But the Revised Eurocontrol Convention, signed in June 1997, fell short of that objective, he said. The EC also proposed a centralized European Aviation Safety Authority responsible for aviation safety throughout Europe, not just for nations using Eurocontrol.

The basic objectives of Eurocontrol, based in Brussels, Belgium, are:

Principles Guide Europe's ATM Strategy for 2000+

One airspace: The airspace of the [European Civil Aviation Conference] states shall, for [air traffic management] purposes, be considered a continuum and not constrained by national boundaries.

Safety: Uniform safety standards and risk-management practices shall be applied systematically to the European [air traffic management] system. Within the total aviation-safety system approach, an air traffic management safety-regulatory regime shall be established and, in principle, shall be separated from service provision both at European and national level. [Air traffic management] safety objectives shall be established, and safety performance shall be monitored.

Freedom of movement and service quality: All airspace users shall be allowed maximum freedom of movement subject to the need to meet the other principles, and shall receive services of a nature and quality to satisfy their requirements. Performance targets shall be defined and monitored.

Sovereignty: The [air traffic management] system shall respect that every state has complete and exclusive sovereignty over the airspace above its territory.

National security and defense requirements: The [air traffic management] system shall satisfy national-security and national- and international-defense requirements.

Environment: The environmental impact of noise and gaseous emissions caused by aviation shall be considered in the definition and application of [air traffic management] improvements and in deciding associated CNS/ATM implementation dates with a view to accelerating those measures which are beneficial to the environment.♦

Source: Eurocontrol

- “Ensuring that air traffic management operations are compliant with ICAO’s Communication Navigation Surveillance/Air Traffic Management (CNS/ATM) plans, providing a consistent service to the user at all times, and operating on the basis of uniformity throughout the ECAC area;
- Providing timely standards and procedures for CNS/ATM and associated avionics requirements; and,
- Enabling interoperability between the different elements (aircraft, airport and ATM systems) together with their consistent integration, development and upgrading with new technology.”

New Safety Regulation Commission develops standards.

Jacques Beaufays of Eurocontrol said that a new safety-regulation structure for European ATM has been created by the ECAC Institutional Strategy for Air Traffic Management in Europe and the Revised Eurocontrol Convention. ECAC nations had adopted the EATCHIP Safety Policy in 1995. The EATCHIP Safety Group, representing the ECAC nations and Eurocontrol, has been defining safety-management elements to encourage common ways to monitor and improve safety.

The safety group also has been developing a safety-assessment methodology for air-navigation systems, Garnier said. A safety-improvement subgroup, added in spring 1997, provides a forum to share experiences, communicate lessons learned from accident and incident investigations, and make recommendations for safety improvements.

The Revised Eurocontrol Convention authorized a new Eurocontrol Safety Regulation Commission (SRC) supported by a staff that maintains contact with all segments of the industry regarding minimum safety standards; approves personnel, organizations and systems; and monitors safety competence and performance. Such structures help address the need for a clear chain of responsibility in case of accidents, and enable ATS providers to cooperate and compete with a common understanding of safety issues.

“ATM safety regulation must be addressed from a total-aviation-system perspective,” Garnier said. “This is particularly important because ... ATM should not look only at its contribution to incidents/accidents, but also at the way it could indirectly help improve overall aviation safety. [The FSF-led international task force to prevent] controlled flight into terrain [CFIT] might be a very good example.”

In 1997, Eurocontrol also created the Agency Safety Regulation Bureau. The bureau audits Eurocontrol’s internal safety-rule compliance and safety-management-system plans, and regulates Eurocontrol’s operational units, such as the Upper Area Control Centre at Maastricht and the Central Flow Management Unit (CFMU) at Haren in Brussels, Belgium. The CFMU, which replaced five regional flow-management units in 1996, provides air traffic flow management service throughout the ECAC airspace. Eurocontrol has cited the CFMU as Europe’s prime example of successfully resolving institutional, financial, political and social issues to integrate airspace management.

ATM safety authority traditionally has been divided.

Although international efforts continue to centralize and clarify responsibility for aviation safety, authority remains divided among several entities. The most basic building block remains national governments, which exercise authority for the safety regulation of civil aviation, including ATM. ICAO generally develops minimum safety standards and provides arbitration. Political and legislative authority at the regional level, such as the proposed European Air Safety Authority, has its basis in

ATM Strategy for 2000+ Provides Safety Framework

- The airspace of the ECAC states will be considered as a continuum for ATM purposes and not constrained by national boundaries.
- Collaborative decision making involving all partners at both strategic and operational levels based on improved information management and data communications.
- Concurrent enhancement of airspace and airport capacity.
- Cost-effective ATM services tailored to users' business requirements and allied to monitored performance targets.
- An effective management structure which can be adapted to meet both pan-European and local implementation needs.
- A regulatory framework to provide effective and timely common rules governing ATM service application and provision by all states.
- Improved and uniform safety standards and risk-management procedures compatible with ICAO global objectives.
- Safety regulation separated from service-provision responsibilities at both European and national levels.
- Prioritized gate-to-gate-oriented research and development tasking, and concept and strategy validation aimed at delivering early benefits to the airspace users, together with improved research and development coordination and management;
- Consideration of the relevant environmental aspects concerning aviation emissions.♦

Source: Eurocontrol

the EU. For regional implementation of policies, the ECAC carries out specific safety actions at this level, such as the European Safety Action Programme and Safety Assessment of Foreign Aircraft.

At the level of air-transport operations, both the JAA and Eurocontrol's SRC focus on harmonized regulation of safety requirements (areas such as aircraft design and manufacture, aircraft operations and maintenance, and licensing of aviation professionals) and procedures for uniform implementation of the requirements.

"The need for establishing relationships between the JAA and SRC has been identified, but these relationships have not yet

been formally established," Eurocontrol said. Several new systems, such as the airborne-collision-avoidance system (ACAS II), already have involved coordinated work by Eurocontrol and the JAA.

Since its inception in early 1998, Eurocontrol's SRC has been identifying key risk areas where ATM could contribute to overall aviation-safety improvement. Eurocontrol said that from a safety-regulation perspective, the SRC expects the following ATM initiatives to have the greatest influence on air safety: reduced vertical separation minima (RVSM), global navigation satellite systems (GNSS) and data link. Cultural issues also come into play, regional analysts said.

"One element is the cultural change, to move from the strictly hierarchical, legal and possibly punitive environment into a truly preventive environment," said Yves Lambert of Eurocontrol. "One issue at stake is the reporting scheme. We have to think in terms of establishing a voluntary European reporting scheme. It exists outside Europe, and it exists in some places within Europe."

In France, the Direction Générale de L'Aviation Civile (civil aviation administration), for example, no longer treats annual statistics on near mid-air collisions (NMACs) confidentially, Lambert said. The Eurocontrol Experimental Centre, the agency's research and development division, could become a data-collection point for voluntary incident reporting and classifying causal factors, he said.

Europe's ATM safety record remains stable. Eurocontrol said that harmonizing European standards and ATM services has contributed to aviation safety in several ways. Examples include ATM "safety nets" such as short-term conflict alerts, minimum-safe-altitude warnings and area-proximity warnings, and new safety-management programs in ATM.

The average annual *rate* of airline accidents per departure in Europe has remained constant for 20 years. *Numbers* of accidents involving ATM have remained relatively low and stable. European air traffic increased six percent in 1997, however, and analysts have said that it will double by 2015.

Philip Marien of the Eurocontrol Guild of Air Traffic Services (EGATS) said, "Proof of the fact that pressure has increased proportionally on everyone is that accident causes haven't shifted over the past 10 years, despite the dramatic traffic increase. ... If the pressures on [ATM] had increased more rapidly than in other areas, [ATM] would have been responsible for more accidents.

"Technological advances have enabled a more efficient, and at the same time safe, application of existing separation standards. But it seems that, at least with the current minima for separation, the physical limit of how many aircraft fit in one sector is about to be reached. Measures such as reducing

the vertical separation minimum above 29,000 feet might increase capacity, but it is unlikely that it will be able to satisfy the demand for a very long time.”

A recent analysis in the United Kingdom showed that six percent of European airline accidents were related to ATM and airports, said Eurocontrol’s Lambert. Lambert said that 1996 data from Boeing Commercial Airplane Group showed that ATM and airports were the primary-cause factors in 3.4 percent of accidents in the worldwide commercial jet fleet from 1987 to 1996. Garnier of Eurocontrol said that the air traffic agency’s data showed that ATM and airports counted for less than five percent of the primary-cause factors in European air-carrier accidents.

“I would suggest that we take a much wider view of ATM’s linkage to safety,” Lambert said. “When we start talking about safety, many items of aviation borders are of very little significance.” Regardless of the statistics, he said, the typical accident in ATM is a midair collision. This has far-reaching consequences for “the political and psychological environment,” he said.

Despite Europe’s “extremely low” number of accidents relative to the volume of traffic, human error figures in 95 percent of air-proximity [NMAC] accidents where air traffic management is the cause, said Ian Hall of National Air Traffic Services (NATS) of the United Kingdom.

The international measure for ATM safety is the collision risk, defined by ICAO as the number of accidents per flight hour, said Job Brüggén of the Netherlands’ National Aerospace Laboratory (NLR). “The expression is not easily quantifiable, and it takes serious efforts to estimate the collision risk for new conceptual situations,” Brüggén said.

Germany, for example, reported 15 NMACs in 1997 compared to 36 investigated in 1993, but only one was caused by air-navigation services [ATM], said Dieter Kaden of DFS Deutsche Flugsicherung of Germany. DFS is the state-owned company that provides air-navigation services.

“Within the next few years, reduced vertical separation minima will be extended from the North Atlantic into Europe’s airspace, with the objective of achieving en route lateral radar separation standards of five nautical miles (9.3 kilometers) throughout the ECAC area,” said Hall of the U.K. NATS. “But [airborne collision avoidance systems (ACAS II)] are not scheduled to be mandatory in European airspace for another two years, and short-term conflict alert is still only available in the more advanced [ATM] centers. These ‘safety nets’ must not be considered the last resort of the [ATM] system ... they are ‘layers of defense’ to reduce collision risk should minimum standards of separation be breached.”

Eurocontrol said that formal safety-management programs are fairly new for European leaders and ATS managers. The

agency’s own safety-management initiatives began three years ago, for example, and include agreements to provide common safety-assessment methods for new systems used in ATS. Eurocontrol also wants to establish reliable safety-monitoring tools based on surveillance data for an objective perspective of trends and actual collision risks in specific areas, Lambert said.

CNS/ATM and Free Route chart future direction. The ICAO Future Air Navigation System (FANS) CNS/ATM plan is the internationally endorsed systems concept, dependent mainly on satellites. The CNS/ATM plan for the ICAO EUR Region provides the foundation for future ATM. This region is part of a global structure of ATM areas and major international traffic flows. Some European industry analysts have concerns about implementing CNS/ATM, however.

“Especially in Europe, it seems as if the promises of CNS/ATM will just about keep up with capacity demand, and that assumes that you can deliver these developments, and in the required time frame,” said Tony Kelly of the International Air Transport Association (IATA). “However, the idea that controllers in one country could provide a service across the border in another country is still anathema in most European countries. So every state has to provide a full site of equipment and services within [its] own borders. ... We do have to have flexibility of air-transport operations, irrespective of borders. ... Cross-border management, if not ownership, breaks down the borders, and allows the customers to get a cheaper product.”

Eurocontrol has integrated safety management into the region’s plans for the transition to CNS/ATM.

Certain concepts in CNS/ATM, such as “free flight” planned for the United States, may not be appropriate in Europe. Free flight is unlikely to have significant benefit in the most congested parts of Europe’s airspace, said Hall of the U.K. NATS. For Europe’s typical short-haul commuter routes, free flight will not sustain very low separation minima or multi-aircraft sequencing, Hall said.

“We envisage some increase in direct routings, and situations where the pilot — in agreed circumstances — can be responsible for maintaining separation already established by [ATM],” said Hall. Free-route airspace seems more feasible, Hall said. Eurocontrol defines “free flight” as the capability for aircraft to fly user-preferred trajectories, in which the flight crew in each aircraft takes responsibility for separation from other aircraft. Eurocontrol defines “free route” as the capability for aircraft to fly user-preferred trajectories, in which ATM takes responsibility for separation.

Kaden of Germany’s DFS said, “Independent of the reorganization of airspace below 30,000 feet, the implementation of a free-route airspace within the ECAC area will lead to annual savings for the airlines in the amount of 250 million to 570 million European Currency Units [US\$273

million to \$621 million⁵], according to recent [estimates], while at the same time safety will be increased and conflict areas, especially in the German airspace, [will be] reduced.” DFS plans to reorganize its airspace by integrating six German control centers into three centers, and 12 approach-control units for German airports into the three centers, said Kaden.

Corporatized ATS grows in the region. Historically, Europe’s air traffic services were planned and operated by national governments with varying degrees of coordination by international organizations. In 1998, many ATS providers — while still decentralized — have been involved directly in regional planning, harmonization and integration efforts. In increasing numbers, they also agree to abide by safety and technical standards of the regional organizations that perform regulatory functions and supervise their performance.

Eurocontrol said that a current initiative in regional ATM, for example, is the Central European Air Traffic Services (CEATS), based on an agreement signed by Austria, Croatia, Czech Republic, Hungary, Italy, Slovak Republic and Slovenia. Eurocontrol said that Bosnia-Herzegovina will sign the agreement in the future. CEATS will provide a new upper-area control center, to be built and operated by Eurocontrol when the center’s location is determined. The center will provide ATM services in the upper airspace of these nations (with limited coverage of Italy).

Corporatized ATS has emerged as an industry in Europe, adding nontraditional financial considerations to the safety equation. The term refers to ATS providers that are private-sector companies created by governments, or contractors of governments. This type of ATS is considered part of Europe’s trend of liberalizing trade and privatizing hierarchical government services. The intent has been to provide responsive, efficient services at lower cost. Eurocontrol’s Garnier said that the agency’s safety agenda takes into account the liability concerns of the 12 corporatized European ATS providers.⁶ Belgium and Latvia also are developing corporatized ATS providers, said Fabio Gamba, office manager of the Civil Air Navigation Services Organisation (CANSO) in Geneva, Switzerland.

Different approaches have been taken by national governments to define the responsibilities of ATS providers and aviation authorities. CANSO focuses on ATS safety and measurement of performance. CANSO has grown to 17 members, including non-European providers from Australia, Canada, New Zealand, South Africa and Thailand, Gamba said. Even where they have exclusive contracts to serve entire nations, corporatized ATS providers operate in a competitive environment. But Eurocontrol said that it is too early to identify or characterize major differences between corporatized and government ATS providers, or how they approach ATM safety issues.

Cultures and professions seek common understandings. Changes in ATM technology alone require unprecedented

levels of cooperation among European governments, airlines, suppliers, ATS providers and safety authorities. The ECAC and Eurocontrol help to bridge different languages and cultures to develop solutions that would be difficult for individual nations. An agreement between Czech and German air-navigation services, for example, allowed shorter routings between Munich and Berlin by using Czech airspace, Germany’s DFS said.

Marien of EGATS said that the multicultural human factors also add to the complexity, however. These factors include whether controllers are accustomed to working with one another; language differences; different training standards; and controller motivation, work environment and cultural habits, he said.

Nearly all professions in the European air-transport system — from pilots and controllers to airline leaders and airport managers — face major changes at least through 2015. Table 1 shows the expected changes anticipated by the ECAC’s ATM Strategy for 2000+. Hall of the U.K. NATS said that the changes for European air traffic controllers would happen in several phases. First, better computer assistance and automation will reduce the work load for today’s “tactical” radar controllers. Adding separate, suitably equipped “planning” controllers where appropriate will make it possible to focus on predictive conflict detection and resolution. The planning controllers’ tools would leave a minimum number of conflicts for the tactical controllers to resolve in real time, he said.

“This will enable clearances across several sectors with controllers using the system rather than totally holding the mental picture,” said Hall. In the longer term, automatic conflict-resolution systems will be introduced, he said.

B-RNAV and ACAS II require new onboard equipment. Eurocontrol said that basic area navigation (B-RNAV) equipment aboard aircraft — with track-keeping accuracy of plus or minus five nautical miles for 95 percent of flight time — has been required since April 23, 1998 (with a final compliance deadline of Oct. 1, 1998) as the primary means of navigation for all ECAC en route operations under instrument flight rules. Eurocontrol and the JAA have set standards that can be met by appropriately certified global-positioning-system (GPS) equipment and systems using ground-based navigation technologies aboard aircraft. The accuracy standard for precision area navigation (P-RNAV) after 2002 will be one nautical mile (1.9 kilometers) in selected areas of ECAC airspace.

Development of European GNSS advanced in June 1998 when the European Space Agency (ESA), the EC and Eurocontrol agreed to establish a regional satellite navigation and positioning service as part of the worldwide effort. Eurocontrol said that the first-generation GNSS will use the present U.S. GPS and Russian global orbiting navigation satellite system (GLONASS) constellations, augmented by space-based,

Table 1
Changing Roles and Responsibilities in European Airspace, 1998–2015

Period	Pilots	Controllers	Airport Operators
1998 to 2005	<p>Responsible for:</p> <ul style="list-style-type: none"> conduct of flight and <i>instigating changes to plan</i>; <p>In an environment with:</p> <ul style="list-style-type: none"> navigation-based RNAV systems; greater choice of flight trajectory available on free routes in upper airspace for suitably equipped aircraft; RT used as main communications with controller and initial/air ground data-link applications; improved cockpit HMI with some automated inputs into FMS. 	<p>Responsible for:</p> <ul style="list-style-type: none"> separating aircraft; a defined fixed airspace sector; <p>In an environment with:</p> <ul style="list-style-type: none"> a largely unchanged control team; some tasks (coordination and transfer, etc.) automated; RT used as main communications but initial air-ground data-link applications; electronic flight strips in many units; increasing reliance on computer tools for monitoring and alerting; growing emphasis on deconfliction planning; arrivals manager for sequencing aircraft at major airports. 	<p>Responsible for:</p> <ul style="list-style-type: none"> pre-planning of flights <p>In an environment with:</p> <ul style="list-style-type: none"> some automated links with CFMU, Met. and AIS; more choice on re-routings.
2005 to 2010	<p>Responsible for:</p> <ul style="list-style-type: none"> conduct of flight and negotiating <i>changes to trajectory with the ground controller</i>, in some instances in conjunction with AOC; <i>separation in some defined circumstances</i> (climb, same-way routes) in suitably equipped aircraft; <p>In an environment with:</p> <ul style="list-style-type: none"> less reliance on RT and many routine messages exchanged via data link; greater reliance on 4-D flight trajectories and navigation techniques using satellite systems; integrated FMS with route-change inputs automated on many aircraft; early introduction of ASAS capabilities with improved situational awareness displays on some aircraft; greater reliance on cockpit systems for airport-surface movement. 	<p>Responsible for:</p> <ul style="list-style-type: none"> separating aircraft <i>except in limited and defined circumstances</i>; defined airspace sector but boundaries are <i>subject to change to reflect traffic patterns</i>; <p>In an environment with:</p> <ul style="list-style-type: none"> progressive emphasis on planning rather than tactical intervention; less reliance on RT and many routine messages exchanged via data link; most inter-unit data exchange automated, and electronic flight strips at most ATC units; growing reliance on planning tools and computer-generated resolution advice; controller relying on automated slot sequencing for arrivals and departures at most major airports. 	<p>Responsible for:</p> <ul style="list-style-type: none"> preplanning of flights <i>and diversions</i>; <p>Involved in:</p> <ul style="list-style-type: none"> <i>route choices and in-flight trajectory changes</i>; some operators: <i>direct negotiation with ATC and aircraft on dynamic route and timings changes</i>. <p>In an environment with:</p> <ul style="list-style-type: none"> automated links with CFMU, AIS, Met., ATC and airports.
2010 to 2015	<p>Responsible for:</p> <ul style="list-style-type: none"> <i>conduct of flight and negotiating changes to trajectory in conjunction with AOC</i>; <i>maintaining own separation in designated free-route airspace</i> using ASAS; <p>In an environment with:</p> <ul style="list-style-type: none"> routine messages passed by data link with much-reduced use of RT; most trajectory monitoring and change automated within FMS; automated systems used for airport-surface movement. 	<p>Responsible for:</p> <ul style="list-style-type: none"> separating aircraft in <i>managed airspace</i>; managing the organization of traffic to ensure a smooth flow, <i>particularly in border areas between free and managed airspace</i>; <p>In an environment with:</p> <ul style="list-style-type: none"> emphasis on automated medium-term planning over a number of sectors and monitoring of deconflicted trajectories; routine messages passed by data link with much-reduced use of RT; controller relying on automated slot sequencing for arrivals and departures at major airports. 	<p>Responsible for:</p> <ul style="list-style-type: none"> preplanning of flights and diversions; <p>Involved in:</p> <ul style="list-style-type: none"> direct negotiation with ATC and aircraft on dynamic route and timings changes; changes to aircraft <i>landing and takeoff times negotiated directly with ATC, CFMU and airports</i>; <p>In an environment with:</p> <ul style="list-style-type: none"> automated down-linking of flight parameters from aircraft in flight and dynamic optimization of trajectories passed directly to aircraft.

Note: Roles and responsibilities are more complex than indicated. This chart highlights the evolution of roles for people responsible for flight and ATM operations. The main changes appear in italics.

RNAV = area navigation RT = radiotelephony HMI = human-machine interface FMS = flight management system
 CFMU = Eurocontrol Central Flow Management Unit Met. = meteorological services AIS = aeronautical information services
 AOC = aircraft operations center ATC = air traffic control
 ASAS = airborne separation assurance systems 4-D = four dimensional (latitude, longitude, altitude, time)

Source: ATM Strategy for 2000+, Proposed Edition 2.0 (May 1998), Eurocontrol

ground-based and mobile-autonomous-based techniques. The European space-based augmentation system — called the European Geostationary Navigation Overlay Service (EGNOS) — will be developed by ESA for completion in 2002 using navigation equipment on geostationary satellites, continuously monitored by ground stations inside and outside Europe, Eurocontrol said. Decisions on how to proceed with a second phase of the European GNSS program will be made during 1999, the agency said.

Eurocontrol said that beginning Jan. 1, 2000, all civil fixed-wing turbine-engine aircraft having a maximum takeoff weight exceeding 15,000 kilograms (33,000 pounds), or maximum approved passenger seating configuration of more than 30, will be required to carry and operate ACAS II. Beginning Jan. 1, 2005, all civil fixed-wing turbine-engine aircraft having a maximum takeoff weight exceeding 5,700 kilograms (12,500 pounds), or maximum approved passenger-seating configuration of more than 19, also will be required to carry and operate ACAS II.

Plans call for RVSM in 2001. Eurocontrol, ICAO, JAA, participating nations and user organizations have entered the second of four phases on the path to implementing reduced vertical separation minima — a vertical separation of 1,000 feet (305 meters) between aircraft in designated European RVSM Airspace to replace the 2,000-foot (610-meter) vertical-separation minimum now applied above 29,000 feet — as of November 2001. RVSM requires additional equipment, but Marien of EGATS said that there is concern that some operators will try to use the system without the required equipment.

“This is already happening on a fairly large scale for [area navigation (RNAV)] routes, which are only available for suitably equipped aircraft,” Marien said.

ATM radio communications will require new channel spacing. Eurocontrol said that safety-enhancement and capacity-enhancement plans also are proceeding to optimize the use of the very high frequency (VHF) radio spectrum. This initiative will reduce channel spacing from 25 kilohertz (kHz) to 8.33 kHz on January 1, 1999, for all ICAO EUR Region air traffic control sectors above 24,500 feet — and above 19,500 feet over France. Aircraft in this region must carry appropriate equipment unless granted an exemption by an individual nation for its area of ATM responsibility. The initial nations to implement this radio-frequency spacing will be Austria, Belgium, France, Germany, Luxembourg, Netherlands, Switzerland and United Kingdom.

ATM prototypes demonstrate networks and data link. Research, development and prototype testing involve many European nations planning for the next generation of ATM, including radar systems, computer networks, digital data-link technologies and the aeronautical telecommunications network (ATN). For example, Eurocontrol said that during May and June 1998 its Experimental Centre demonstrated advanced 4-D

trajectory negotiations in an integrated air/ground ATM system through the European Programme for Harmonised Air Traffic Management Research in Eurocontrol (PHARE). Test aircraft transmitted the 4-D trajectories to an ATM-system flight database on the ground for computers to use in aircraft sequencing and separation management, reducing the work load of air traffic controllers.

Alain Bourrez of Airsys ATM said that Eurocontrol recently has launched its ATM Surveillance Tracker and Server (ARTAS) program. This distributed network comprises identical cooperating ATM surveillance units (ASUs). Bourrez said that regional wide-area networks (WANs) can be connected to other regional WANs, allowing each ATS provider to define its area of interest, including different domains of operation of several adjacent ASUs. Netherlands, France, Italy, Portugal and Eurocontrol’s Upper Area Control Centre at Maastricht expect to adopt ARTAS, Eurocontrol said.

“Today ARTAS is using data from current conventional primary and secondary radars, but future versions of the system will be able to work with both conventional and mode-S radars as well as with other aircraft-derived surveillance data which will become available as Automatic Dependent Surveillance (ADS), ADS Broadcast and probably some others. This makes a big difference [compared to] the previous situation prevailing in Europe, where 30 different types of radar-data-processing systems were implemented within the 50 main [ATM] centers, and obviously with different levels of performance,” said Bourrez.

“The first full [ARTAS] production system will be operational in the Netherlands during 1998, but some preproduction systems are already in extensive testing and evaluation in different parts of Europe,” said Bourrez. Prototypes of the ATN will be available by 1998–1999 in Europe and in other parts of the world, and ATN applications will be assessed in the same time frame, said Bourrez. A project called ProATN has been the primary effort, and seven ground validation sites are under development in Europe, he said.

The European Pre-operational Data-link Application (EOLIA), a prototype data-link service, is being tested by a consortium led by Aerospatiale with the U.K. NATS, the French Direction Générale de L’Aviation Civile (Sofreavia), NLR, Thomson-CSF Airsys and Airbus Industrie as partners. Services being tested include air traffic control clearances, air traffic control communication management, flight-plan consistency and dynamic route availability.

DADI (data linking of aircraft-derived information) is being tested to link aircraft and ground computers. A consortium funded by the EU and consortium members includes NLR, Sofreavia, British Airways, Air France, DERA, Kongsberg Defense & Aerospace AS and Airsys ATM. Tests involve aircraft and helicopters operating in the North Sea, all equipped with live data links. The ground evaluation includes ATM sites in France, Norway and Netherlands. Bourrez said that the

technologies to be tested by DADI include mode-S data link (secondary-surveillance radar selective-interrogation mode) using aircraft transponders with unique identification codes for information exchange and ATM surveillance in the high-density traffic of the ECAC core area. DADI tests also will include ATN, ATS data-link simulators and dynamic safety-assessment tools.

As of 1998, increasing numbers of aircraft are equipped with flight-management-system (FMS) technology (Lufthansa German Airlines has equipped 96 percent of its fleet) that can “provide nearly any kind of data via data link to improve performance of ground systems,” said Burkard Wigger of the German airline. “[Data link] has become a backbone of Lufthansa operations,” he said. The technology reduces costs, expedites information for crews and passengers, and improves maintenance.

Proposed long-term data-link applications have potentially significant safety implications. Wigger said that these include:

- “traffic information for enhanced situation awareness and conflict resolution; improved separation standards, especially under bad weather conditions in dense traffic areas;
- “addressed air-ground or air-air data link for conflict resolution by negotiation;
- “surface-movement guidance-control systems, including ground vehicles;
- “[GNSS] augmentation, especially wide-area augmentation data; and,
- “4-D trajectory negotiation [enabling controllers to continuously project latitude, longitude, altitude and time for waypoints to provide tactical conflict detection and resolution].

The increased use of data-link technology will underscore the need for regional cooperation in European ATM, said an analyst from the United Kingdom.

“Data links will provide real-time access to achieve a totally integrated air-ground system in which each party contributes to, and enhances, the safety and efficiency of each other’s operations. In [ATM] terms, for example, this might mean U.K. controllers taking action to reduce predicted conflicts in Dutch, French or German airspace, and vice versa,” said Hall of U.K. NATS.

As European ATM professionals manage this microcosm of air traffic issues and emerging solutions, the growing volume of flights — and potential gains from integrated common information such as data link — reinforce the need for one sky over Europe in which everything comes together to meet safety objectives. ♦

Growth of Air Traffic Challenges European ATM Providers to Reduce Delays

The European Organisation for the Safety of Air Navigation (Eurocontrol) must meet airlines’ increasing demand for system capacity, passengers’ demand for on-schedule service and universal demands for an affordable cost structure and maximum safety. Air traffic management (ATM) professionals in Europe, however, said that highly integrated airspace and airport improvements would be needed to handle the anticipated growth in air traffic. Measurement of delays and accurate diagnosis of reasons for delays within the 36 nations of the European Civil Aviation Conference (ECAC) have been difficult and complex, Eurocontrol said.

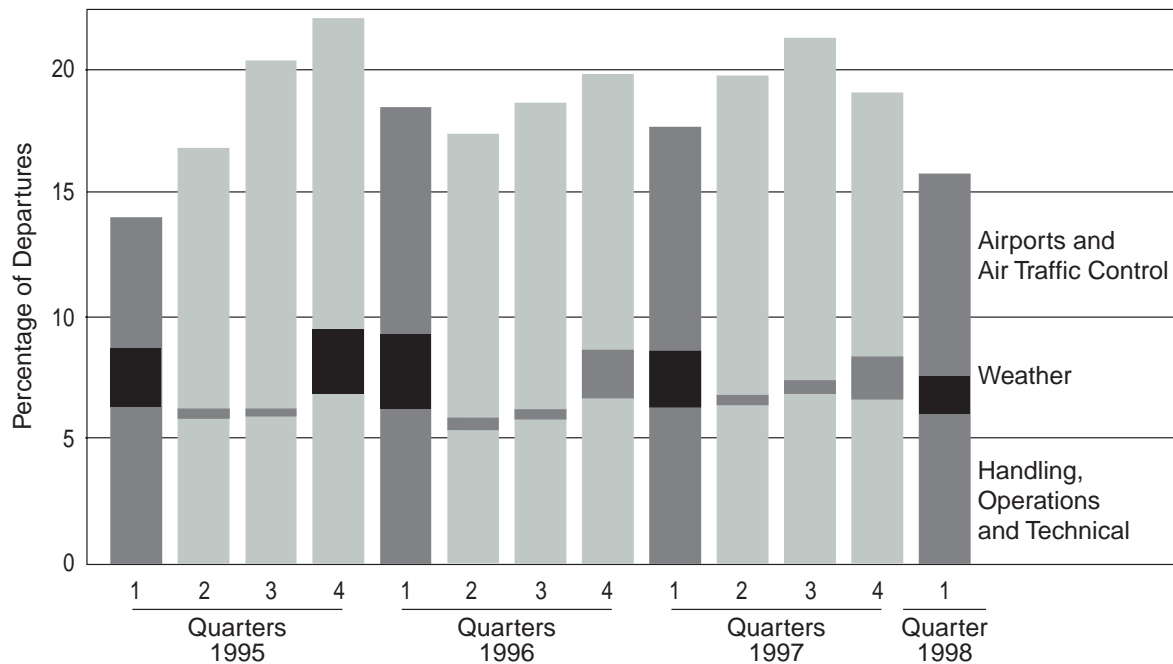
“Commercial aviation in Europe enjoys a worldwide reputation for high standards of safety and efficiency,” said Ian Hall of National Air Traffic Services (NATS) of the United Kingdom. “Over the past 20 years to 30 years, technical developments, fail-safe systems and automation have steadily reduced the number of air-safety incidents ... flying has become much safer than it was 30 years ago, expressed in terms of accidents per million hours flown.

“Forecasts of extraordinary growth in Europe’s air traffic are commonplace ... a projected doubling of traffic by 2015 is widely accepted. Safely handling those numbers in Europe’s already congested airspace is not feasible with the existing operations infrastructure [based on a 1950s design philosophy], and ultimately air traffic growth would be limited before safety would be compromised. ... For example, there are already situations in Europe where sector-transit times are down to four minutes ... this is not much time to deal with anything but routine [ATM] problems. In the busiest parts of Europe’s airspace ... traditional methods of increasing capacity will not take us far beyond 2005.”

Eurocontrol said that the busiest ATM sectors occupy a core area comprising the southern United Kingdom, France, Belgium, Netherlands, Luxembourg and northern Germany. Peripheral areas (outside the core) have lower volumes of air traffic.

In early 1998, the Association of European Airlines (AEA) said that Eurocontrol’s air traffic management in 1997 did not keep pace with the capacity needs. AEA said that 19.5 percent of intra-European flights in 1997 were delayed by more than 15 minutes, a one-percent increase compared to 1996. Figure 1 (page 10) shows the departure delays reported by the Association of European Airlines since 1995. In March, Eurocontrol said that the AEA’s statistics did not accurately reflect air-transport delays or the percentage attributable to air traffic control and airports.

International Short-haul and Medium-haul Flights, Total AEA Departure Delays Over 15 Minutes



Source: Association of European Airlines (AEA)

Figure 1

Eurocontrol said that total traffic within Europe grew seven percent from 7 million flights in 1996 to 7.5 million flights in 1997. The agency said that total delays caused by the gap between airline demand and ATM capacity remained at the same level. Eurocontrol said that capacity in the ECAC airspace has grown by an estimated six percent since 1997. The agency said that it hoped this figure would reach seven percent during the summer of 1998.

“The integration of [ATM] in Europe is, owing to its extreme complexity, a long-term target. Nevertheless, [the European Air Traffic Control Harmonisation and Integration Programme] EATCHIP has already managed to achieve considerable progress in European ATM,” Eurocontrol said in a March 1998 news release. “Furthermore, the ATM Strategy for 2000+ and the individual projects supporting it,¹ such as RVSM [reduced vertical separation minima], FUA [flexible use of airspace], B-RNAV [basic area navigation], etc., will do much to relieve the acute congestion in European airspace, despite the relentless growth of air traffic.”

Eurocontrol said that RVSM — providing six more flight levels for use in the region’s highly congested airspace between 29,000 feet and 41,000 feet, inclusive — will be the most cost-effective solution to traffic growth while reducing aircraft fuel requirements and the work load of air

traffic controllers. Aircraft operated by national governments, and not compliant with RVSM standards, probably will reduce the potential capacity gains, the agency said.

Eurocontrol said that the percentage of departure delays attributable to ATM is lower than shown in AEA’s statistics (Figure 1).

“None of the parties involved is complacent vis-à-vis the delays reported by airlines in Europe, which are still at an unacceptable level and are of great concern to us,” Eurocontrol said. “However, it is worth noting that only approximately 20 percent of the total delays reported by airlines are [ATM]-related. The remainder result from other factors, such as airports, weather, ground handling, airlines themselves, etc.”

The average delay per flight — reduced 50 percent since 1989 — also decreased from 1996 to 1997, Eurocontrol said. The agency said that additional capacity was provided in 1997 primarily through EATCHIP and its Central Flow Management Unit (CFMU). Both were designed to prevent flight delays of the extent experienced from 1988 to 1990, when AEA said that as many as 30.8 percent (June 1989) of AEA international short-haul and medium-haul flights were delayed more than 15 minutes.

The annual average percentages of flights delayed were 19 percent in 1988, 23.8 percent in 1989 and 20 percent in 1990, said AEA.

EATCHIP was the product of ECAC transport ministers' "ECAC Strategy for the 1990s" (later known as the "ECAC En Route Strategy"). A representative of the Eurocontrol Guild of Air Traffic Services (EGATS) said that these measures have been effective in preventing the most serious sector overloads, but can be improved.

Philip Marien of EGATS said, "Since it seems that [CFMU capacity] solutions are in no way able to keep up with demand, flow-control restrictions will probably remain an absolute necessity. ... The flexible-use-of-airspace project ... has had only a very limited effect in making more airspace available where and when it is needed."

Eurocontrol's main objective today is developing a coherent, coordinated ATM system.

"The CFMU has made a crucial contribution to the more efficient use of available [ATM] capacity and delay reduction," Eurocontrol said. "The fact that nowadays the overwhelming majority of flights are not subject to ATM-imposed delay or flow restrictions is a good measure of the CFMU's success. [It] is also of political significance in that European states realized that [this] national operational activity ... could best be organized at a European level." The agency said that real-time, on-line collaboration by some airlines in flow-management problems gives all parties a better understanding of delays.

Eurocontrol said that causes of the congestion and delays in the late 1980s included inadequate ATM communication, significant differences in ATM equipment among nations, and insufficient financial resources to make improvements. Traffic grew steadily after an economic recession in 1993, and by 1995 the European Commission (EC) said that the flight delays again were intolerable (18 percent delayed more than 15 minutes). At the same time, intra-European charges for air-traffic services were increasing, the EC said.

The urgent need for increased European airport capacity also should not be underestimated, European-conference speakers said. The ECAC region has more than 800 airports, but 15 percent of them handle 85 percent of all commercial traffic, said Eurocontrol's ATM Strategy for 2000+.

The strategy said, "While the [ATM] system is one source of the capacity problem, the increasing gap between traffic demand and the capacity provided by the physical infrastructure at many European airports is equally critical, and is seen as the ultimate limiting factor. ... Many of the major airports are already operating at their maximum throughput for longer and longer periods of the day, and some have already reached their limits as prescribed by political and environmental constraints." Airport representatives recently expressed the same concern about the need for airport improvements and expansion as part of a total solution.

Philippe Joppart of Airports Council International-Europe said, "A clear definition of operational responsibility between Eurocontrol and the airports is paramount. In our view, runway capacity and passenger-processing constraints must be harmonized with en route slot allocation for maximum use of scarce capacity." The organization represents 340 airports in 48 nations, and Eurocontrol shares the council's perspective of the airport-capacity issue.

Val K.H. Eggers of Eurocontrol's ATM Strategy for 2000+ Board said, "Airport and ATM capacities need to be developed in unison." Eggers also said that the participation of the U.S. Federal Aviation Administration (FAA) on this board has been "a unique opportunity to develop an instrument which may also lead to interfacing two major, continent-wide systems." A recent sign of this collaboration across the Atlantic Ocean was a January 1998 agreement between Eurocontrol and ATN Systems Inc. for cooperative development of the Common American European Reference Aeronautical Telecommunication Network Facility.♦

1. Eurocontrol, ATM Strategy for 2000+, Proposed Edition 2.0, May 1998. Work on this strategy is scheduled to continue until October 1998.

Notes

1. The 15 EU members are: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, and United Kingdom.
2. The following 27 nations are members of Eurocontrol: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, Malta, Monaco, Netherlands, Norway, Portugal, Romania, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.

3. The ECAC is an intergovernmental organization established in 1955 as an initiative of the Council of Europe, a predecessor of the EU. The ECAC promotes the safe and orderly development of civil aviation on routes to, from and within Europe. The ECAC has three associated bodies: the Joint Aviation Authorities Board, which oversees an arrangement among a number of ECAC nations for cooperation in developing and implementing common safety standards and procedures, including the Joint Aviation Requirements; the EATCHIP Project Board, which monitors and gives broad direction to an ATC harmonization and integration program using management by Eurocontrol for the ECAC; and the Airport/Air Traffic

Services Interface (APATSI) Project Board, which monitors and gives broad direction to a program for relieving air traffic congestion in and around airports. The 36 ECAC member nations are: Armenia, Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Monaco, Netherlands, Norway, Poland, Portugal, Republic of Moldova, Romania, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, former Yugoslav Republic of Macedonia, Turkey and United Kingdom. ECAC civil aviation authorities from the following 27 nations have adopted the JARs: Austria, Belgium, Cyprus, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Monaco, Netherlands, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.

4. ATM Strategy for 2000+, Proposed Edition 2.0, May 1998, published by Eurocontrol. Work on this strategy is scheduled to continue until October 1998.

5. The U.S. equivalent of one European Currency Unit (ECU), based on a market basket of European national currencies, was \$1.0898 as of July 1, 1998, the *Wall Street Journal* reported.

6. European members of the Civil Air Navigation Services Organisation (CANSO) include the following 12 air traffic services: AENA (Spain), ANA-EP (Portugal), ANS of the Czech Republic, ATC The Netherlands, Austro Control (Austria), DFS Deutsche Flugsicherung (Germany), the Irish Aviation Authority, Latvijas Gaisa Satikme (Latvia), National Air Traffic Services (NATS) United Kingdom, SERCO (United Kingdom), Swisscontrol (Switzerland) and UkSATSE (Ukraine).

Editorial note: This report was based on proceedings of the ATC '98 Maastricht Conference, Netherlands; recent documents of the European Organisation for the Safety of Air Navigation (Eurocontrol) and information provided by Eurocontrol for this article; and Eurocontrol's presentation to the 1998 FSF European Air Safety Seminar in Amsterdam, Netherlands.

Visit our World Wide Web site at <http://www.flightsafety.org>

AIRPORT OPERATIONS

Copyright © 1998 FLIGHT SAFETY FOUNDATION INC. ISSN 1057-5537

Suggestions and opinions expressed in FSF publications belong to the author(s) and are not necessarily endorsed by Flight Safety Foundation. Content is not intended to take the place of information in company policy handbooks and equipment manuals, or to supersede government regulations.

Staff: Roger Rozelle, director of publications; Rick Darby, senior editor; Mark Lacagnina, senior editor; Wayne Rosenkrans, senior editor; John D. Green, copyeditor; Karen K. Ehrlich, production coordinator; Ann L. Mullikin, assistant production coordinator; and David A. Grzelecki, librarian, Jerry Lederer Aviation Safety Library.

Subscriptions: US\$60 (U.S.-Canada-Mexico), US\$65 Air Mail (all other countries), six issues yearly. • Include old and new addresses when requesting address change. • Flight Safety Foundation, Suite 300, 601 Madison Street, Alexandria, VA 22314 U.S. • Telephone: (703) 739-6700 • Fax: (703) 739-6708

We Encourage Reprints

Articles in this publication may, in the interest of aviation safety, be reprinted in whole or in part, in all media, but may not be offered for sale or used commercially without the express written permission of Flight Safety Foundation's director of publications. All reprints must credit Flight Safety Foundation, *Airport Operations*, the specific article(s) and the author(s). Please send two copies of the reprinted material to the director of publications. These reprint restrictions also apply to all prior and current articles and information in all Flight Safety Foundation publications.

What's Your Input?

In keeping with FSF's independent and nonpartisan mission to disseminate objective safety information, Foundation publications solicit credible contributions that foster thought-provoking discussion of aviation safety issues. If you have an article proposal, a completed manuscript or a technical paper that may be appropriate for *Airport Operations*, please contact the director of publications. Reasonable care will be taken in handling a manuscript, but Flight Safety Foundation assumes no responsibility for submitted material. The publications staff reserves the right to edit all published submissions. The Foundation buys all rights to manuscripts and payment is made to authors upon publication. Contact the Publications Department for more information.