CRUCIAL MEASURES FOR REDUCING THE CFIT RISK

# ICAO JOURNAL

VOLUME 62 NUMBER 2, 2007

## CHINA'S GROWTH STRATEGY

### SAFETY IMPROVEMENTS PLAY A VITAL ROLE

# ICAO Journal

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## FEATURES



## UPDATE



**COVER** *(Photo courtesy of the CAAC)*
China has been refashioning its approach to safety to ensure a continuation of the downward trend in the aircraft accident rate (page 7). Among changes shaping Chinese civil aviation today are the fostering of a safety culture based on accountability, a shift to proactive safety management, an effort to ensure compliance with international standards, and strengthened oversight.

## Promoting the Development of International Civil Aviation

The International Civil Aviation Organization, created in 1944 to promote the safe and orderly development of civil aviation worldwide, is a specialized agency of the United Nations. Headquartered in Montreal, ICAO develops international air transport standards and regulations and serves as the medium for cooperation in all fields of civil aviation among its 190 Contracting States.

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# PERFORMANCE INDICATORS

THE LATEST long-term forecast released by ICAO in April estimates that passenger traffic on scheduled airline services, measured in terms of passenger-kilometres performed, will grow at the average annual rate of 4.6 percent over a 20-year period ending in 2025. International traffic is expected to increase at 5.3 percent per annum, outpacing domestic traffic growth of 3.4 percent annually.

From a regional perspective, the airlines of the Middle East and the Asia/Pacific regions are expected to experience the highest growth in passenger traffic, at 5.8 percent per annum through to 2025, followed by the airlines of the African and the Latin American/Caribbean regions, predicted to grow at 5.1 and 4.8 percent per year, respectively.

Passenger traffic growth on the major international route groups, with the exception of the intra-North America route group, is expected to range from 4.5 to 6 percent per annum through to 2025.

World scheduled freight traffic measured in terms of tonne-kilometres performed is forecast to increase at a "most likely" average annual rate of 6.6 percent during the 2005–25 period. International freight traffic is predicted to increase at an average annual growth rate of 6.9 percent, compared with a domestic freight traffic growth of 4.5 percent annually.

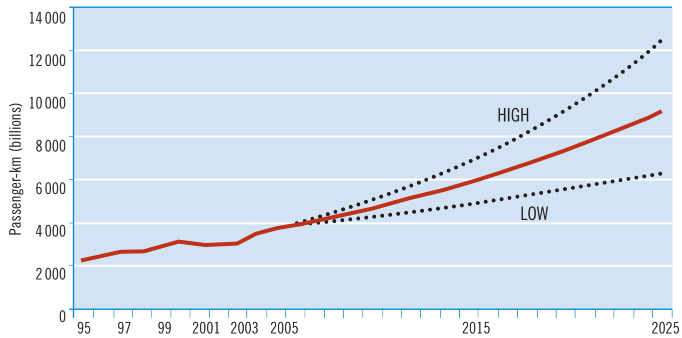
World scheduled aircraft movements, in terms of aircraft departures and aircraft kilometres flown, will double (or grow even more) over the 2005–25 period, and are expected to increase at average annual rates of 3.6 and 4.1 percent, respectively. In 2005, there were over 24.9 million aircraft departures and 30.8 billion aircraft-kilometres flown.

Future growth of air transport will continue to depend primarily on world economic and trade growth and airline cost developments, which are in turn heavily dependent on fuel prices. This growth will also be influenced, however, by the extent to which the industry faces up to major challenges such as airport and airspace congestion, environmental protection and increasing capital investment needs. The shape and size of the air transport system will also be affected by government decisions, notably those determining the type and extent of economic regulation of airlines.

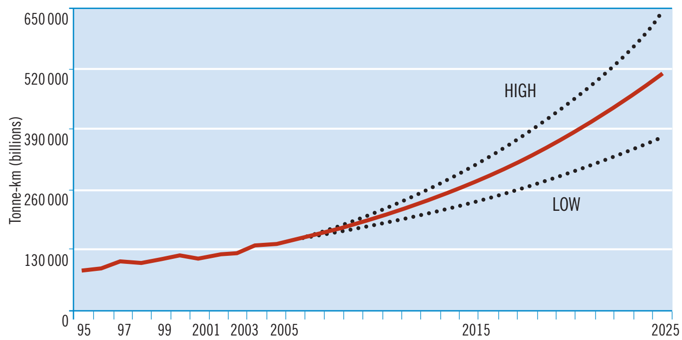
| Scheduled services | Actual 1985 | Actual 2005 | Forecast 2025 | Average annual growth rate (%) 1985-2005 | 2005-2025 |
|---|---|---|---|---|---|
| **TOTAL** | | | | | |
| Passenger-kilometres (billions) | 1 366 | 3 720 | 9 180 | 5.1 | 4.6 |
| Freight tonne-kilometres (millions) | 39 813 | 142 579 | 510 000 | 6.6 | 6.6 |
| Passengers carried (millions) | 896 | 2 022 | 4 500 | 4.2 | 4.1 |
| Freight tonnes carried (thousands) | 13 742 | 37 660 | 145 000 | 5.2 | 5.5 |
| Aircraft-kilometres (millions)* | n.a. | 30 845 | 69 040 | n.a. | 4.1 |
| Aircraft departures (thousands)* | n.a. | 24 904 | 50 450 | n.a. | 3.6 |
| **INTERNATIONAL** | | | | | |
| Passenger-kilometres (billions) | 589 | 2 197 | 6 225 | 6.8 | 5.3 |
| Freight tonne-kilometres (millions) | 29 384 | 118 482 | 452 120 | 7.2 | 6.9 |
| Passengers carried (millions) | 194 | 704 | 1 950 | 6.7 | 5.2 |
| Freight tonnes carried (thousands) | 5 884 | 22 630 | 110 000 | 7.0 | 6.5 |

**Worldwide air traffic forecasts to 2025**

** Data on operations of airlines based in the Commonwealth of Independent States not available for 1985*




**Trends in worldwide scheduled passenger traffic, 1995-2025**

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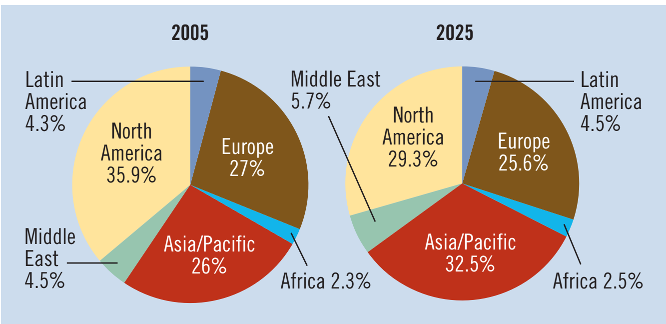
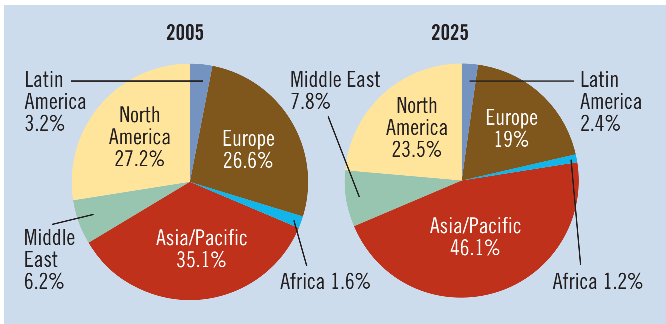



**Share of scheduled passenger traffic by region, 2005 vs 2025 (passenger-kilometres performed)**




**Share of scheduled freight traffic by region, 2005 vs 2025 (tonne-kilometres performed)**

# China focused on safety improvements in spite of rapid industry growth

*Faced with explosive growth in traffic volume and lagging infrastructure, China is embracing management principles that will help ensure it can meet ambitious safety targets by 2010*

WANG CHANGSHUN
GENERAL ADMINISTRATION OF
CIVIL AVIATION OF CHINA

DESPITE the rapid expansion of China's aviation sector in recent years, long-term safety data show a general improvement in the level of safety. While this is encouraging, China's yearly traffic growth is projected in double-digit percentages, and the challenge now is to implement measures that will yield still lower accident rates. This is essential in order to maintain public confidence in the air transport system, and ensure that industry growth can be sustained over the long term.

During the decade that ended in 2005, China experienced 32 fatal aircraft accidents, of which nine involved aircraft engaged in commercial services. In all, there were 482 fatalities over the 10-year period, with general aviation (GA) accounting for 23 accidents and 41 fatalities. Flight crew performance was cited as a significant factor in well over half of the fatal accidents, while mechanical causes were found to be significant in 25 percent of the investigations.

Encouragingly, the number of accidents experienced in the last half of the 1996-2005 decade was 47.6 percent fewer than in the preceding five-year period. The accident rate in China averaged 0.649 hull losses per million flight hours over the entire 10-year period, which compares favourably with an average worldwide rate of 0.999 hull losses per million flight hours during the same time span. The Chinese rate, however, remains considerably higher than the corresponding ratio in the United States, which is home to the largest aviation industry in the world. This is significant, considering that China's air transport industry is now ranked second in the world, with 25.8 billion tonne-kilometres performed in 2005, not including the Hong Kong and Macao Special Administrative Regions (SARs).

In terms of incidents, during the 1996-2005 period a total of 1,147 were reported throughout China, with the vast majority of these incidents (1,040) related to commercial air transport operations. In terms of the rate of incidents per 10,000 flight hours and per million departures, encouragingly, this trend, too, has been downward.

Of the air transport incidents reported during the 10-year period, 307 (29.5 percent) involved mechanical problems; 296 (28.5 percent) were related to weather; and in 267 cases (25.7 percent), flight crew performance played a significant role.

China has been refashioning its approach to safety to ensure the trend in the aircraft accident rate continues downward. For one, it has adopted safety management system (SMS) principles (e.g. air carriers are being required to implement SMS, which is considered the most effective way of responding to the need for results-based supervision with a minimum number of safety inspectors).

**Aircraft at busy Shanghai Pudong Airport, and passengers awaiting their flights (top). The number of air passengers in China is expected to reach 270 million in 2010**

Among the changes shaping Chinese civil aviation today are:

- the fostering of a safety culture whereby organizations and companies accept responsibility for ensuring safety;
- a shift to proactive safety management instead of reliance entirely on post-accident action;
- efforts to ensure compliance with international safety standards;

- a new emphasis on training programmes;
- the greater utilization of technological solutions; and
- strengthened oversight.

The emphasis on the role of corporations and organizations in upholding safety has helped bolster everyone's awareness of their place in conducting safe operations. But while individual front-line personnel and top-level decision makers must be concerned with safety, overseeing bodies such as the General Administration of Civil Aviation of China (CAAC) and regional administrations that perform oversight are also held accountable for safety performance.

Equally important has been a shift to emphasis on proactive management, with the focus today on lessons learned from incidents and the analysis of normal operations that can help build an effective safety management strategy.

In an international context, the changes taking place in China today are multifaceted. The first requirement is to gradually promote and adopt international standards, and ensure qualified personnel and transport aircraft operators are certified in accordance with international expectations. Other international obligations apply with respect to safety evaluations and audits conducted in China.

The importance of adequate training for all professionals is fully recognized, and in particular, the fundamental role played by specialized institutions such as civil aviation colleges and universities in properly preparing personnel for a safe and productive career in aviation. Training programmes for various aviation professions have been established, and existing programmes upgraded. Relevant laws and regulations now incorporate additional and more rigorous training requirements. Importantly, the evaluation of the specific skills required for performing highly specialized work has been carried out, and an employment qualification system has now been set up. Lastly, a safety team, comprised mainly of operations supervisors and inspectors, has been set up.

On the technological side, installation of the airborne collision avoidance system (ACAS II) and the enhanced ground proximity warning system (EGPWS) on all transport aircraft has been mandated, while on the ground, functions such as


short-term conflict alert (STCA) and minimum safe altitude warning (MSAW) have been added to air traffic control (ATC) radar to reduce the risk of mid-air collisions or controlled flight into terrain (CFIT). Radar coverage has been expanded by installing more radar systems. Procedures related to the transition altitude and to establishing altimeter settings at civil aviation airports have also been updated.

Another innovation welcomed in China is performance-based navigation (PBN), a concept that encompasses both area navigation (RNAV) and required navigation performance (RNP). An overall plan to apply PBN is under development, but RNAV is available in some busy terminal areas and on remote and oceanic routes, and RNP procedures are now in use for some airports in mountainous Tibet. In addition to providing important capacity and operational improvements, the more precise flight paths associated with RNP procedures contribute to safe operations, especially at airports surrounded by high terrain.

The monitoring of flight operations through the collection of safety-related operating data is well established in China. At present, more than 90 percent of the country's airline fleet is equipped with some system of data collection, and 85 percent of its airline flights are now monitored.

With the reform of the safety system in China, the CAAC is taking steps to meet all of its obligations with respect to managing safety both at home and abroad, while also granting authority for the provision of air carrier services and air traffic services (ATS). Its primary function, along with regional administrations and supervision offices, is to oversee operations from a broad safety perspective.


**Airside view of Beijing's busy airport. Anticipating a double-digit growth rate every year for the foreseeable future, the CAAC is intent on reducing the aircraft accident rate to less than 0.30 hull losses per million hours by 2010**

**Challenges remain**

Although China is taking steps to heighten safety, a number of problems remain to be solved. Among these are:

- the shortage of qualified operating personnel;
- lack of infrastructure;
- scarcity of airspace;
- legal and regulatory shortcomings; and
- the need for enhanced safety management.

While China's air transport system must expand rapidly to meet the growing demand for air services, there remains a serious shortage of pilots, mechanics, air traffic controllers and flight dispatchers. This shortfall of qualified personnel makes it more difficult to ensure safety, and moreso when there is so much pressure to expand services. Rapid growth, when combined with the deficit of qualified personnel, can increase the risk to flight safety.

Considering the growth of China's air carrier fleet, civil aviation infrastructure is not keeping pace. The absence of adequate facilities at some airports can have a bearing on safety. There is simply not enough ATC automation, and the lack of information integration and data sharing can adversely impact safety and air traffic management (ATM) efficiency.

The amount of usable airspace also poses a problem. Although China is a large country, the amount of airspace that can be utilized by the ATS administration accounts for just 20 percent of the total airspace. This curbs flexibility, and thus limits economical operation. In addition to fixed arrival and departure routings, radar control functions are also restricted. With the pressure to increase traffic because of the growing demand for air services, airspace congestion can only worsen unless the airspace can be better utilized.

Importantly, certain legal and regulatory requirements need to be updated so that they reflect reforms made in the civil aviation sector, in part because regulations based on old technology are a hindrance to further infrastructure development. Consistent enforcement in the field is also wanted: regional administrative and supervisory offices, while responsible for safety oversight, do not enforce the regulatory requirements in a uniform manner.

Despite China's recent focus on safety management, there is still a difference in how safety is managed in China and how it is managed in countries having highly developed aviation sectors. In countries with mature air transport industries, safety management is supported by relatively generous resources, both in terms of technology and funding. By contrast, China manages safety chiefly by issuing administrative orders.

The influence of culture should not be overlooked when attempting to manage safety. Most of the world's civil aircraft are designed and built from a Western perspective, and it is only natural that their operation and management are established in this cultural context. But while it may be convenient for a country to simply adopt the international technology that goes hand-in-hand with effective safety management, it is also important when developing a safety culture to respect the differences that characterize people around the world.

**Safety goals**

In the coming years, China's air transport industry will expand in a dramatic fashion. The volume of tonne-kilometres performed is expected to continue rising by an average of 14 percent annually, to reach 50 billion tonne-kilometres by 2010. At the same time, the number of passengers is forecast to grow to 270 million from 138 million in 2005. Meanwhile, the air transport fleet is expected to swell to over 1,500 aircraft by 2010, with some 190 civil airports in operation.

The main goal of China's training system in the near term is to address the current shortage of aviation professionals, including air traffic controllers, but also to establish an approach to recruitment that prevents serious personnel shortages from arising in the future

With this anticipated growth in mind, China has set specific safety targets. The accident rate needs to decline during the 2006-10 period to less than 0.300 hull losses for every million hours of flight time. In particular, China intends to reduce the number of accidents in GA operations, as well as the number of accidents on the ground, and it is determined to prevent any accidents arising from security violations. The objective is to establish a safety level comparable to that of countries having highly developed aviation industries, and not worse than the average level achieved by these countries. Put in another way, China's goal is to ensure that its accident rate is better than the world average.

To help achieve such goals, China is embracing the concept of organizational accountability, a key principle of SMS. While holding organizations accountable for safe operations, it will vigorously promote safety audits as a means of monitoring progress and will invest in improved training efforts. It will make greater use of safety-related technology and will establish a new mechanism for funding safety initiatives. More emphasis will be placed on international cooperation. Finally, China plans to evolve a safety culture that reflects its national goals and values.

Every individual who can have an influence on safety will be held accountable for the industry's performance in this respect, in particular executives whose leadership style and safety-related decisions filter down to front-line personnel. This goes hand-in-hand with improved monitoring and analysis of safety data, as well as with enactment of legislation that serves to promote safety.

Safety audits, an important means of enhancing safety, are to be carried out in China at three levels. At the international level, Universal Safety Oversight Audit Programme (USOAP) audits performed by ICAO highlight the government's capacity to oversee safety, primarily through its compliance with international standards. The next USOAP audit — the first under the new comprehensive approach that covers all safety-related provisions in the Chicago Convention — is expected to take place in early 2007. Audits to be conducted by China itself will examine the potential safety hazards faced by the country's aviation industry, and will pressure those audited to address shortcomings, thereby improving the level of safety across the entire industry. The third type of audit will occur at the organizational level, and takes the form of a systematic self-evaluation of the organization's compliance with government regulations and its shouldering of safety responsibilities by using SMS — the most effective means of managing risk. In assuming these responsibilities, decision makers must adequately address all safety-related deficiencies that come to their attention.

More than ever, training will play a critical role in the development of China's air transport system. No less than 11,000 additional pilots will be required during the 2006-10 period, and another 18,000 pilots are to be recruited in the following five-year period. The main goal of the training system in the near term is to address the current shortage of aviation professionals such as pilots, but also to establish an approach to recruitment that prevents serious shortages from arising in the future.

A number of programmes will be undertaken to further develop human resources. One project is concerned with establishing training regulations and standards that comply with international provisions. Yet another training initiative will build teams of aviation professionals,

*continued on page 33*

Mr. Wang is the Vice-Minister of the General Administration of Civil Aviation of China (CAAC).

## PRESSURE ON TO REDUCE GLOBAL ACCIDENT RATE

THE GLOBAL SAFETY picture has certain parallels to the aviation safety situation in China. As in China, worldwide safety has improved steadily over the past 10 years, with a general downward trend in the fatal accident rate. However, with strong traffic growth anticipated — ICAO foresees an average annual growth of 4.4 percent in passenger-kilometres during the 2007-15 period, and as many as 2.8 billion passengers per year by 2015, compared to 2.1 billion in 2006 — public confidence in the world's air transport system can only be maintained by continuing to reduce the accident rate as the number of departures multiply.

In the past 10 years, certain trends in global

*continued on page 33*

# While CFIT record has improved markedly, certain issues have also come to light

*Several low-cost but crucial measures can be taken by stakeholders to reduce the likelihood of false EGPWS warnings or, more seriously still, the system's failure to provide a valid warning*

RICHARD T. SLATTER
*ICAO SECRETARIAT*

A controlled flight into terrain (CFIT) accident occurs when an airworthy aircraft under the control of the flight crew is flown unintentionally into terrain, obstacles or water, usually with no awareness of the impending collision on the part of the crew. ICAO has been involved for many years in a worldwide effort to prevent this type of accident, which usually involves heavy loss of life.

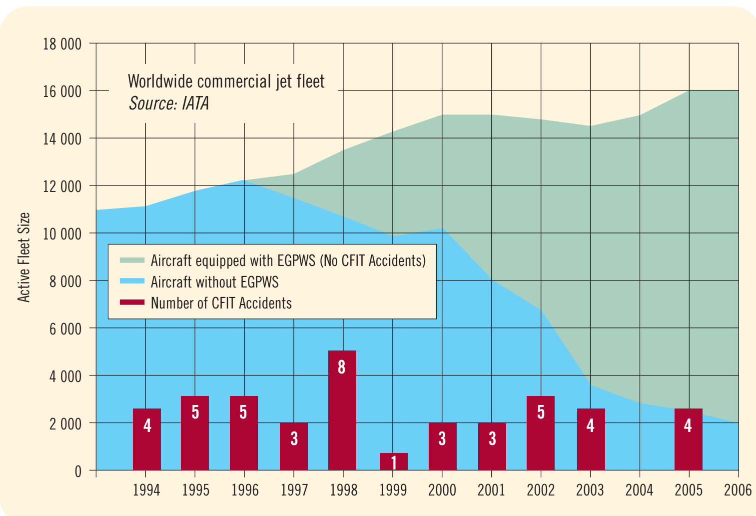
ICAO's first action in this regard can be traced to 1978, when requirements for equipping commercial air transport aircraft with the ground proximity warning system (GPWS) were introduced in Part I of Annex 6 to the Chicago Convention. This led to a significant decrease in the number of CFIT occurrences, but not to their complete elimination. A further step was taken with the development of GPWS with a forward-looking function, generally referred to as the enhanced ground proximity warning system (EGPWS), and known in the United States as the terrain awareness and warning system (TAWS). With the advent of EGPWS/TAWS in 1996, there have been no CFIT accidents involving aircraft equipped with this technology (see adjacent figure).*

While the aviation community can be justifiably proud of its achievement in reducing CFIT accidents, there is no place for complacency. Operational experience has identified concerns about the use of EGPWS that must be addressed to ensure that the timely warning that has proven so valuable to accident avoidance is available all of the time.

The EGPWS safety issues that have been identified concern the upkeep of software on which EGPWS/TAWS depends, as well as the obstacle, runway and terrain database, the provision of global navigation satellite system (GNSS) positioning, the operation of the system's "peaks and obstacles" function, and the geometric altitude function of the equipment.

Perhaps the most easily rectified shortcoming involves the software utilized by EGPWS/TAWS. Software updates are issued regularly, yet industry sources reveal these are not being implemented by all operators, or are not installed in a timely manner. Aside from the fact updates are often available free of charge from equipment manufacturers, there is ample reason to perform this task since the use of current information is clearly critical to safety.

Application of software updates improves the characteristics of the equipment. Such improvements are possible on the basis of operational experience, and enable warnings in situations effectively closer to the runway threshold where previously it was not possible to provide such warnings.




**Mandated operation of EGPWS/TAWS has brought impressive results: to date, no aircraft equipped with this technology has suffered a CFIT accident**

Without information provided by the latest version of software, operation of EGPWS/TAWS may be compromised in specific situations. The flight crew, who has no convenient means of knowing the software status of the equipment on which they ultimately rely, may have a false sense of confidence in its capability.

An example of the effect of outdated EGPWS software arose recently at Zacatecas, Mexico, where a CFIT accident was narrowly averted, not by a timely EGPWS warning but by the aircraft striking power lines on its final approach, prompting the crew to initiate a go-around in time. The Airbus A319 was on a very high frequency omnidirectional radio range/distance measuring equipment (VOR/DME) approach using a stabilized, continuous descent technique in conditions where fog was reported. The descent commenced some 2.5 kilometres early and continued below the minimum descent height (MDH 459 ft) until about 100 feet below threshold level, at which point the aircraft hit the power lines some 2,200 metres (7,220 ft) short of the threshold.

Although the A319 was equipped with EGPWS/TAWS, no warning was provided in this instance. It was reported that, apart from operational deficiencies, the aircraft's EGPWS software was out of date. A software update that would have provided 30 seconds' warning in the circumstances of the incident had been issued by the equipment manufacturer four years earlier, and by the airframe manufacturer one year prior to the incident, but it appears this had not been applied.

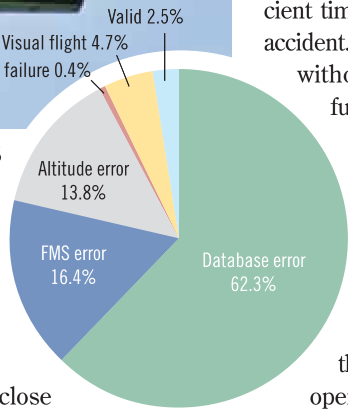
Similarly, it is crucial to regularly update the obstacle, runway and terrain database provided by manufacturers for use with their equipment, since the proper functioning of the EGPWS/TAWS may otherwise be jeopardized. Again, updates are issued for these databases on a regular basis, free of charge by equipment manufacturers. EGPWS/TAWS operation can also be undermined by the lack of suitable navigational input. The equipment was designed to function with a position update system, but not all installations are linked to GNSS receivers. While the required position data can be acquired by using an effective ground-based navaid network, the most reliable of which is provided by DME/DME, such support for area navigation systems is not available everywhere. Use of GNSS, accessible worldwide, eliminates the possibility of position shift, which is another source of false warnings (or worse, the failure to provide a genuine warning).

There is also concern that the potential advantage of the obstacle and terrain database information may be reduced or even negated by the failure of the operator to enable the peaks and altitude function provided with some EGPWS/TAWS equipment.

Operation of EGPWS/TAWS is subject to altimetry-based errors. This problem can be avoided when the equipment, originally designed to work with the QNH altimeter setting, is operated together with GNSS-provided geometric altitude. Additionally, use of the geometric altitude function prevents errors that arise from the use of the QFE altimeter setting for approach and landing.

The limited coverage of obstacle data for the database has also raised concerns. While this information is needed for operations worldwide, in practice data for obstacles higher than 30 metres (98 ft) are available only in certain regions and countries, specifically Australia, the Caribbean, Central America, New Zealand, North America and Western Europe. Wherever data for obstacles are not available, or whenever the peaks and obstacles function of the EGPWS/TAWS is not enabled, the equipment's basic GPWS function cannot alert the crew to the presence of obstacles close to the flight path.

Jim Jorgenson




**The problem of false EGPWS/TAWS warnings can be curtailed by adopting certain practices such as updating software and databases to the latest available standard. Most false warnings are related to database errors, as reflected in the pie chart supplied by Honeywell.**

In some instances, lack of timely information on runway thresholds prior to the commissioning of a new runway has been cited as a problem. Such information, moreover, is not always to the required accuracy, or is not always provided as World Geodetic System – 1984 (WGS-84) coordinates, although WGS-84 is the common horizontal reference system.

Data for new runways must be distributed well in advance of the service entry date if this information is to be incorporated in the applicable databases and subsequently implemented by operators prior to commencement of the runway's operation. Aside from timeliness, it is imperative that such data meet ICAO's quality requirements, as specified in ICAO Annex 14, Volume I, Appendix 5.

In some cases, it has been found that terrain data meeting the WGS-84 standard is not available, or that conversions of data to the WGS-84 standard are not correct.

The type of deficiencies cited above can only heighten the probability of false warnings or, more seriously, the risk that a genuine warning will not be forthcoming. The problem with false warnings is their potential negative conditioning: if they occur too often, a flight crew may not react promptly and aggressively when there is a valid alert. The frequent occurrence of false warnings is also known to encourage crews to operate with the EGPWS/TAWS function selected off. In this case the basic GPWS will still provide a warning, but as shown in the past, the basic GPWS may not provide a warning in sufficient time for the avoidance of an accident. In any event, operating without the EGPWS/TAWS function engaged simply defeats the purpose behind installing the forward-looking element.

Collectively, these various shortcomings in the software, databases and procedures that support EGPWS/TAWS operation can degrade the value of the warning system, and clearly call for attention by national regulatory authorities, aircraft operators and airframe manufacturers. To reduce the risk of CFIT as much as possible, countries around the world need to ensure that timely information of required quality on runway thresholds, as well as terrain and obstacle data, are provided for databases in accordance with the common reference systems (ICAO Annex 15, Chapter 3). ICAO requirements for runway, terrain and obstacle data are established in relevant annexes to the Chicago Convention, specifically Annex 11, *Air Traffic Services*; Annex 14, *Aerodromes*, Volume I — *Aerodrome Design and Operations*, and Volume II — *Heliports*; and Annex 15, *Aeronautical Information Services*.

States are required to ensure that electronic terrain and obstacle data related to their entire territory are made available for international civil aviation in the manner specified in ICAO Annex 15 (paragraphs 10.2, 10.3 and 10.4). Notably, current requirements for the provision of such data are addressed by a recommended practice contained in Annex 15 (10.6.1.3), which applies to specifications for terrain and obstacle data for defined areas (i.e. the territory of the State, terminal control areas, and so forth).

Annex 15 also requires that States — as of November 2008 — ensure electronic terrain data and obstacle data are made available in accordance with the specifications for Area 1 (i.e. the entire territory of the State, including aerodromes and heliports), as well as terrain data in accordance with Area 4 specifications (Area 4 pertains to runways where precision approach Category II or III operations have been established). As of November 2010, States are also required to make sure that electronic terrain and obstacle data are made available in accordance with the Annex 15 specifications for Areas 2 and 3. (Area 2 refers to the terminal control area as published in a State's aeronautical information publication, or a 45-kilometre radius from the aerodrome or heliport reference point, whichever area is the smaller; at IFR aerodromes and heliports where a terminal control area has not been established, it covers the zone within a 45-kilometre radius of the aerodrome or heliport reference point. Area 3 pertains only to IFR aerodromes/heliports, and concerns a defined space extending from the edge of the runway and the aerodrome/heliport movement area.)

ICAO has developed guidance material in the form of Document 9881, *Guidelines for Electronic Terrain, Obstacle and Aerodrome Mapping Information*, to assist States in the provision of terrain and obstacle data.

Aircraft operators can obtain the greatest benefit from EGPWS/TAWS by following certain practices. They should:

- update software to the latest available standard;
- update databases to the latest available standard;
- ensure that the GNSS position is provided to EGPWS/TAWS;
- enable the EGPWS/TAWS geometric altitude function (if available);
- enable the EGPWS/TAWS peaks and obstacles function (if available); and
- implement any applicable service bulletins offered by airframe manufacturers.

Jim Jorgenson

**Information on the location of runway thresholds is needed for database entry well in advance of the commissioning date of a new runway**

Irrespective of these recommended practices, it is essential that other necessary efforts aimed at CFIT prevention, such as crew training, use of standard operating procedures and implementation of a safety management system by the operator, are also undertaken.

Aircraft manufacturers also have a role to play in efforts to reduce the risk of CFIT. Aside from offering EGPWS/TAWS in new aircraft and supporting retrofit of older aircraft through issuance of appropriate service bulletins, they could facilitate utilization of GNSS positioning by accommodating the preference of many operators for less costly receivers. At present, only multi-mode receivers are recognized by airframe manufacturers as a GNSS source, but these units typically cost in excess of U.S. $40,000 each. Other types of receivers now available can provide EGPWS/TAWS with GNSS position at an installation cost of less than $10,000.

With respect to false warnings, industry sources indicate that over 62 percent of unjustified warnings arise from database errors, while more than 16 percent arise from flight management system (FMS) errors and over 13 percent stem from altitude errors (see pie chart, page 14). The practices and actions suggested above are important because they have the potential to significantly reduce the 92.5 percent of false warnings resulting from database, FMS and altitude errors.

In summary, while without doubt the reduction of CFIT accidents is a major achievement, the risk of a CFIT accident remains higher than it should be. The shortcomings or deficiencies in equipment and procedures necessary for the prevention

*continued on page 38*

* Recent presentations and articles have highlighted the importance of EGPWS/TAWS in avoiding accidents. These include presentations on TAWS by Capt. Dan Gurney at the Flight Safety Foundation (FSF) European Aviation Safety Seminar in Athens in March 2006, the FSF Corporate Aviation Safety Seminar in Phoenix in May 2006, and the FSF International Air Safety Seminar in Paris in October 2006 ("Celebrating TAWS Saves, But Lessons Still to be Learned"). Capt. Gurney also recently wrote on this subject in the FSF magazine, AeroSafety World ("Last Line of Defence: Learning from Experience," January 2007).

Richard T. Slatter, an aircraft operations consultant employed by ICAO, has been involved in the ICAO programmes for the prevention of CFIT and reduction in approach and landing accidents since 1990.

# Ground-based wind shear detection systems have become vital to safe operations

*Various warning systems deployed at the most vulnerable locations across the United States provide varying levels of protection against wind shear, with collocation of certain systems offering the most effective safety solution*

CHRISTOPHER KEOHAN
FEDERAL AVIATION ADMINISTRATION
(UNITED STATES)

WIND SHEAR-related accidents have caused more than 1,400 fatalities worldwide since 1943, including over 400 deaths in the United States alone during the 1973-85 period. This loss of life has prompted the development and deployment of wind shear detection systems.

Four types of systems have so far entered operation across the United States, where sites are chosen on the basis of traffic volume and thunderstorm frequency. Those commissioned to date — the terminal Doppler weather radar (TDWR), the low level wind shear alert system (LLWAS), the weather systems processor (WSP) and the integrated terminal weather system (ITWS) — collectively serve 121 U.S. aerodromes. Other non-commissioned turbulence and wind shear systems, such as the light detecting and ranging (LIDAR) Doppler and the Juneau airport wind system (JAWS), have recently been evaluated.

The wind shear systems currently in operation detect a change in the wind speed and/or direction and issue an automated alert to an air traffic controller, who then relays this alert to pilots. In general, automated ground-based systems detect wind shear that involves an airspeed change of 15 knots or greater over a distance of one to four kilometres. For alerting purposes, wind shear is classified as a microburst when it involves a speed loss of 30 knots or greater. The alert provides the wind shear type (i.e. wind shear or microburst), the strength, and the location of the first encounter on the approach or departure corridor, as the case may be. Coverage varies with each system, but is focused on the runway and up to three nautical miles (NM) from the end of the runway.

A brief description of the capability of each wind shear detection system, including recent improvements made, is presented below. Weather products that improve air traffic management (ATM) efficiency are also highlighted.

**TDWR (left) experienced early problems with outages that have now been resolved. The ASR-9 system, right, has been upgraded with implementation of WSP. Less costly than TDWR, WSP allows for wind shear prediction at medium-capacity airports; however, it does not perform effectively in a dry environment**

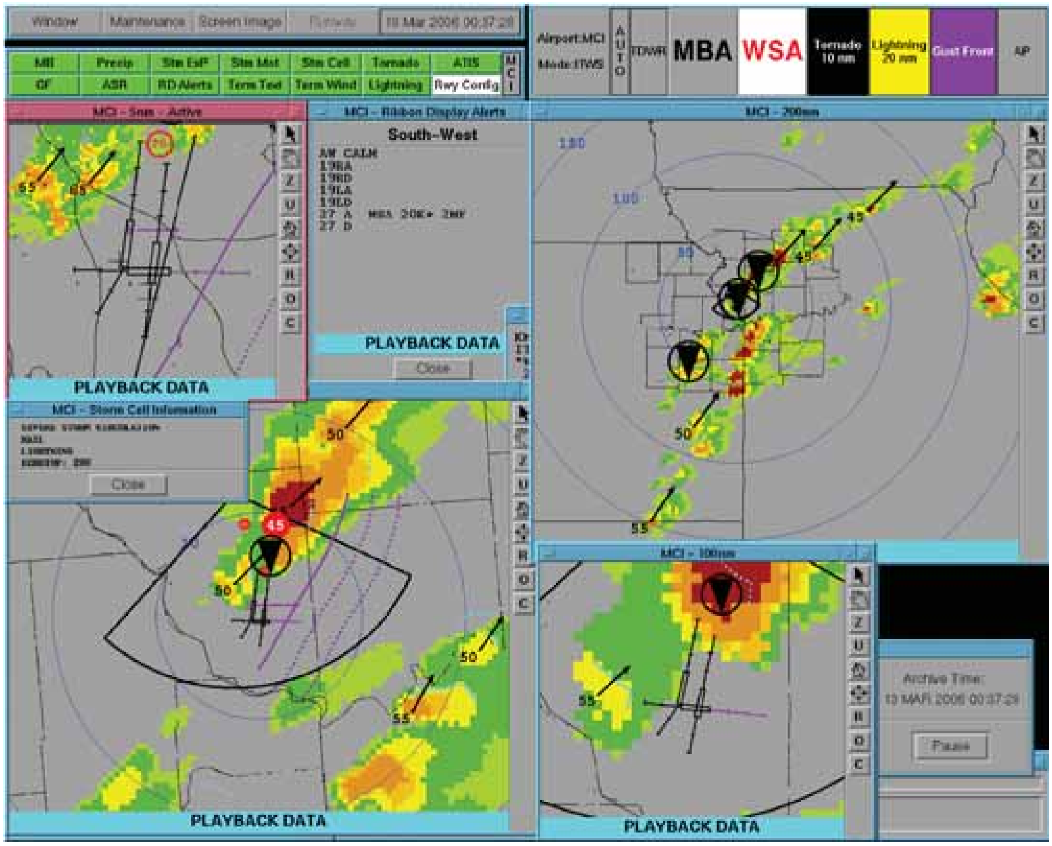
*Terminal Doppler weather radar.* There are currently 45 TDWRs commissioned in the United States. This five-centimetre radar system, designed to specifically detect wind shear at an aerodrome, achieves better than 90 percent probability of detection (POD) of wind shear loss while maintaining less than 10 percent probability of false alarm (PFA) — values that are nominal east of the Rocky Mountains but not attained in the inter-mountain west. The gust front, or wind shear gain in airspeed, is generally above 70 percent probability of detection east of the Rockies, but less than 50 percent among the western mountains.

The problem of TDWR outages — related to issues such as unreliable power, poor communications with Air Traffic Services (ATS), computer limitations and antenna wear — have been overcome during the past decade. To remedy the problem of antenna wear, the aerodrome pie sector scan strategy has been upgraded to a 360-degree scan; this has increased the scan strategy volume time and gust front update time from five to six minutes, while maintaining the wind shear loss surface scan update time of one minute.

An improvement in TDWR reliability was essential for winning the confidence of ATS. TDWR information is also relayed to many U.S. National Weather Service (NWS) offices, which issue weather warnings and forecasts to aerodromes and the public.

As implied by the POD values above, one concern is the less than desirable wind shear performance in the western United States. TDWR detects wind shear well when the shear is accompanied by rain, but does not perform so effectively when there is little or no rain. Although the scan strategy and clutter maps have been optimized, the performance has remained outside of specifications (POD ≥ 90% and PFA ≤ 10%). In an effort to address this shortcoming, the Massachusetts Institute of Technology Lincoln Laboratory (MIT/LL) and the U.S. Federal Aviation Administration (FAA) have begun developing new TDWR radar data acquisition (RDA) techniques that are expected to improve data quality. Testing of these new techniques is expected in 2007.

*LIDAR Doppler.* In addition to TDWR improvements, an evaluation of an alternative dry wind shear detection system was performed at Las Vegas in the summer of 2005. The LIDAR Doppler system was provided by Lockheed Martin Coherent Technologies and tested by FAA. Results showed the LIDAR Doppler was effective at detecting dry wind shear, while TDWR performed well at identifying wet wind shear in this high clutter environment.




**Example of ITWS display of severe weather containing microbursts, a gust front and tornados (Kansas City, 13 March 2006). ITWS features a prediction product that forewarns of a microburst**

An integration of TDWR and LIDAR Doppler systems can achieve the desired wind shear detection rate of better than 90 percent POD, while also limiting false alarms to under 10 percent, provided the integrated systems incorporate the TDWR RDA upgrade and some modifications to the LIDAR Doppler wind shear detection algorithms.

The ability of LIDAR Doppler in detecting dry wind shear has been proven in Hong Kong, where the system can discern terrain-induced wind shear. Other sensors installed at Hong Kong include the TDWR, anemometers, weather buoys and wind profilers. The information from each of these systems is used in the wind shear and turbulence warning system (WTWS), making the source of the alert transparent to ATS personnel.

According to the Hong Kong Observatory, the use of these various systems results in an integrated wind shear POD rate of greater than 90 percent. The LIDAR Doppler contributes to the detection of nearly 70 percent of these wind shears. This success has led to the acquisition of a second LIDAR system for improved coverage and redundancy. (A recent description of the Hong Kong WTWS is available on the web at http://www.science.gov.hk/paper/HKO_PWLi.pdf.) Also worth noting is that obstacle wind shear and turbulence caused by large hangars is being detected by a LIDAR system at Tokyo Haneda.

Another use of LIDAR is to track the movement of wake vortices in order to increase aerodrome capacity. With the goal of safely reducing aircraft spacing in certain wind conditions, research continues with operations on closely spaced parallel runways at airports in St. Louis, San Francisco, Houston, Frankfurt and Paris. When wind conditions are favourable, capacity gains can be achieved by increasing the number of departures. The wind must be above a specific crosswind threshold for aircraft on the upwind runway to depart without imposing wake-induced aircraft spacing on the parallel runway (i.e. the wind must be strong enough to disperse wake vortices before they can reach the downwind runway).

In addition, LIDAR will be used to determine headwind criteria for reducing aircraft spacing at London Heathrow. With this information, it may be possible to introduce spacing based on a time interval instead of distance. A combination of all LIDAR wake vortex research could result in a new aircraft type matrix which is not based only on aeroplane weight, but aircraft attributes such as wingspan.

*Juneau airport wind system.* Terrain-induced turbulence and wind shear is a serious hazard in Juneau, Alaska, which is why the U.S. National Center of Atmospheric Research (NCAR) and FAA have developed JAWS. The system, which includes wind profilers and wind sensors at various locations around the city, generates moderate and severe turbulence warnings for B737-size aircraft on the control tower display. These warnings are based on regressions derived from aircraft measurements of turbulence in relation to wind profiler and sensor information.

In addition to turbulence warnings, the JAWS prototype display provides air traffic controllers with runway headwind and crosswinds, profiler-based winds every 500 feet above ground to an altitude of 6,000 feet, and sensor wind speed and direction that include the recent peak wind. Though the turbulence alerts produced by JAWS provide useful information for pilots, future funding for this project remains uncertain. Other sites whose topography is complex could benefit from the JAWS research already performed, but tailored regressions would be required.

*Low level wind shear alert system.* The network expansion of the LLWAS (LLWAS-NE), also referred to as LLWAS-NE++ since being rehosted, is located at nine U.S. aerodromes collocated with TDWR. In addition, a stand-alone system is located in Juneau, Alaska. The LLWAS Relocation and Sustainment (LLWAS-RS) project involves 40 U.S. aerodromes not equipped with TDWR. Both systems provide detailed wind shear alerts to ATS. Unlike the original LLWAS system, which issues sector wind shear alerts, the LLWAS-NE and LLWAS-RS provide detailed wind shear alerts to air traffic controllers. Information contained in the alert includes wind shear type, strength, and the location of the first encounter on the approach or departure corridor, whichever is appropriate.

The probability of detection and false alarms of all LLWAS types historically is greater than 95 percent and less than 5 percent respectively. The strengths of these systems are their ability to detect both wet and dry wind shear, as well as an alert update rate of 10 seconds. Unlike the radar-based gust front alerts, the LLWAS-based alerts are oriented to the runway and are more accurate.

The reliability of both LLWAS systems has been improved by replacing vane anemometer sensors with sonic sensors. Hardware and software upgrades provide a warning to local technicians if a sensor is not functioning properly. Even with this in place, a false wind shear alert of only several minutes' duration can negatively impact capacity at a busy aerodrome. Wind shear coverage is more limited than radar, and the cost of deployment is expensive if the airport is located near prime real estate.

| Product Type | Product | Update (minutes) | TDWR | LLWAS-NE & RS | WSP | ITWS |
|---|---|---|---|---|---|---|
| Wind Shear | Microburst | 1, 1/6, 1/2, 1 | ✔ | ✔ | ✔ | ✔ |
| | MB Prediction | 3 | | | | ✔ |
| | Gust Front | 6, 1/6, 2, 6 | ✔ | ✔ | ✔ | ✔ |
| | GF Prediction 10-, 20-minute | 6, -, 2, 6 | ✔ | | ✔ | ✔ |
| | Wind Shift | 6, -, 2, 6 | ✔ | | ✔ | ✔ |
| Precipitation | Aerodrome – high resolution | 1 | ✔ | | | ✔ |
| | Terminal Area | 6, -, 1/2, 1/2 | ✔ | | ✔ | ✔ |
| | Long Range | 2 1/2 | | | | ✔ |
| | Storm Motion | 6, -, 1, 1 Aero/ Term 2 1/2 Long | ✔ | | ✔ | ✔ |
| | Storm Extrapolated Position | 1 Aero/Term 2 1/2 Long | | | ✔ | ✔ |
| | Terminal Convective Weather Forecast | 5 | | | | ✔ |
| | Anomalous Propagation Edit | 1/2 | | | | ✔ |
| Storm Cell Information | Hail, Lightning, Echo Tops, Severe Storm Circulation | 1 Aero 1/2 Term 2 1/2 Long | | | | ✔ |
| Tornado | Tornado | 6 | | | | ✔ |
| Term Winds | Terminal Winds | 5 | | | | ✔ |
| Pilot Info | Terminal Weather Information for Pilots | 1 | ✔ | | | ✔ |

**Wind shear and weather products available from systems commissioned in United States**

As mentioned above, the LLWAS-NE is collocated with TDWR, and serves as a backup when the TDWR is out of service. When both systems are operating, wind shear alerts are integrated and the source of the alert is not apparent to the air traffic controller. The integration of the two systems provides a lower false alarm rate at high capacity aerodromes. Gust front wind shear alerts are improved as well, because the logic takes advantage of the higher gust front detection provided by the LLWAS-NE. The ITWS is also integrated with LLWAS-NE at aerodromes where the two systems are collocated.

*Weather systems processor.* The WSP is a hardware and software modification to the existing airport surveillance radar-9 (ASR-9) system that provides wind shear and weather information to controllers at 34 U.S. aerodromes. The WSP is less costly than TDWR, allowing for wind shear protection at medium-capacity aerodromes and busy aerodromes with less convective activity.

The primary function of the ASR-9 is to detect aircraft in the terminal area, and consequently, it has a large beam width. In fact, the ASR-9 azimuth and elevation beam widths are 2.5 and nine times larger than the TDWR beam width, resulting in a coarser resolution. Combined with a faster antenna speed and robust ground clutter removal technique, this results in a wind shear detection rate that is lower than that available from TDWR. The WSP wind shear detection specifications include a probability of detection of 70 percent for wind shears involving at least 20 knots loss, while maintaining a probability of false alarm under 20 percent.

Many false alarms generated by WSP have been triggered by bird activity and different winds aloft captured by the wide beam. The wind shear specifications are graduated with wind shear strength and increase to 90 percent for intensities exceeding a speed loss of 40 knots or more. Update rates are 30 seconds for wind shear loss and two minutes for gust front products; these are faster than the TDWR wind shear product update rates of one minute and six minutes respectively.

In the dry environment, the WSP performs even less effectively than the TDWR because of the surveillance radar properties. Therefore, a complementary dry wind shear detection system is desired at WSP locations in the intermountain west.

*Integrated terminal weather system.* Located at 13 U.S. approach control units and serving 23 aerodromes, ITWS melds numerous weather systems in the terminal area to provide one display with various weather products associated with safety and efficiency. One of these inputs is the TDWR, which is used mainly to detect wind shear. Relative to TDWR, ITWS wind shear detection algorithms are more accurate in depicting the strongest shear zone, an attribute that reduces the frequency of false wind shear alarms. The introduction of a more robust wind shear storm validation also decreases the false alarm rate. A threshold on the water content of the storm above the wind shear is applied to verify a wind shear source. These improvements translate to a probability of detection of at least 95 percent for microburst loss alerts, while decreasing the false alarm rate to less than 5 percent. As with TDWR and WSP, ITWS wind shear detection may be less reliable in the dry environment.

One positive feature of ITWS is the microburst prediction product, which foretells whether a weak wind shear (i.e. 15-25 knots loss) will strengthen to a microburst. This advance warning of up to two minutes is critical for air traffic management, because for some airlines the term "microburst alert" brings into effect a no-fly situation. The extra warning time is important, since many microbursts reach their maximum strength five to 10 minutes after first contacting the ground.

In addition to safety, ITWS dispenses weather products that are used by ATS to increase aerodrome capacity (all of the radar systems cited above are also used to increase ATM efficiency). A list of weather products associated with various wind shear systems is given in the accompanying table. As shown, ITWS features the greatest quantity of weather products that take advantage of the various input sensors including TDWR, next generation radar (NEXRAD), ASR, LLWAS, automated surface observing system (ASOS), automated weather observation system (AWOS), national lightning detection network (NLDN), meteorological data collection and reporting system (MDCRS) and rapid update cycle (RUC).

Ten and 20-minute gust front predictions are given on the TDWR, WSP and ITWS displays at the air traffic supervisory positions in the tower and approach control unit. In the case of ITWS, the ATS centre also has a display. Anticipating a wind shift allows ATS to find a potential gap in downstream traffic where the change in runway can be implemented with relative smoothness. In addition, aircraft can be instructed to taxi to the anticipated runway prior to the change in the active, saving both time and fuel. A mosaic of gust fronts is provided at ITWS locations with more than one TDWR, thus reducing the number of radar blind spots and improving the reliability of the gust-front product.

Predicting the location of moderate and heavy precipitation is important for changing the departure and arrival corridors and determining aerodrome capacity and proper holding locations (higher altitudes are preferred because of the fuel savings compared with holding patterns at lower altitudes). The storm-extrapolated position product predicts the location of the leading edge of moderate to heavy precipitation in 10 and 20 minutes, while other aviation hazards such as hail, lightning, echo tops and severe storm circulation are included in the ITWS storm cell information product.

A storm containing hail can be avoided through traffic coordination. The lightning product is used to suspend ground operations, such as baggage handling, when cloud-to-ground lightning occurs within 20 NM of the aerodrome. Lastly, the centre supervisor uses echo top information to determine if long-range routes are impacted by convective weather that requires rerouting.

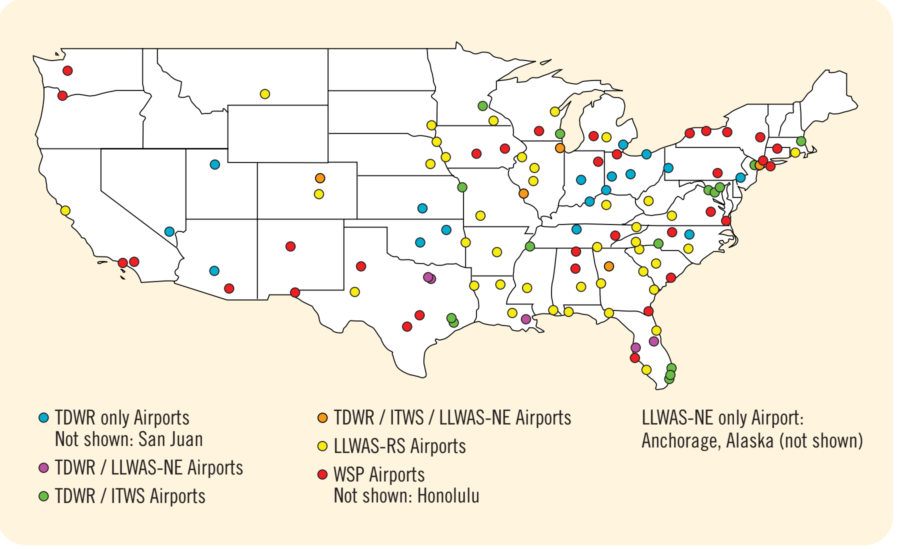
ATM planning may continue to improve with the deployment of the ITWS terminal convective weather forecast (TCWF) product. This depicts the probable location of significant precipitation out to 60 minutes (in increments of 10 minutes). The TCWF scores its own predictions and gives real-time forecast accuracy. The flow of traffic from centre to centre, from centre to approach and from approach to tower can benefit from the TCWF product by anticipating routes with convective activity.

The ITWS terminal winds product provides winds at various altitudes at desired locations in the terminal area. Anticipating adjustments to aircraft spacing in the terminal area can increase aerodrome capacity by several departures or arrivals per hour. A cost-benefit study performed by MIT/LL in 1997 showed that an increase in capacity for long durations over the course of a year saves tens of millions of dollars in delays at some congested aerodromes.

Planning is available to flight crews through the terminal weather information for pilots (TWIP) product, which is available with TDWR and ITWS. The TWIP presents wind shear and precipitation information via text or text graphics. Traffic entering the terminal airspace can utilize the aircraft communications addressing and reporting system (ACARS) to obtain information on convective-type weather at the aerodrome. Common awareness of both pilots and controllers serves to promote more efficient communications.

At least one carrier, Northwest Airlines, automatically sends the TWIP product to

*continued on page 33*




**Location of FAA terminal wind shear and weather systems. In addition to sites shown, four LLWAS-NE systems are collocated with TDWR, and five LLWAS-NE systems are collocated with TDWR and ITWS. As of 2 February 2007, 13 ITWSs serve 23 aerodromes equipped with TDWRs**

Christopher Keohan is a senior meteorologist on wind shear systems at the FAA Mike Monroney Aeronautical Center in Oklahoma City, Okla. Mr. Keohan contributed to an update of the ICAO *Manual on Low-level Wind Shear and Turbulence* (Document 9817) in 2005 and has developed a wind shear course for the FAA's Airports and International Training Division.

# ATNS knows Africa


## Whichever way you look at it

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# Safety data integration can lead to better understanding of risk

*By integrating safety data from different sources and applying a risk model, it should be possible to build a more complete safety picture that highlights those improvements that can deliver the greatest benefit*

Bob Dodd
*Qantas Airways (Australia))*

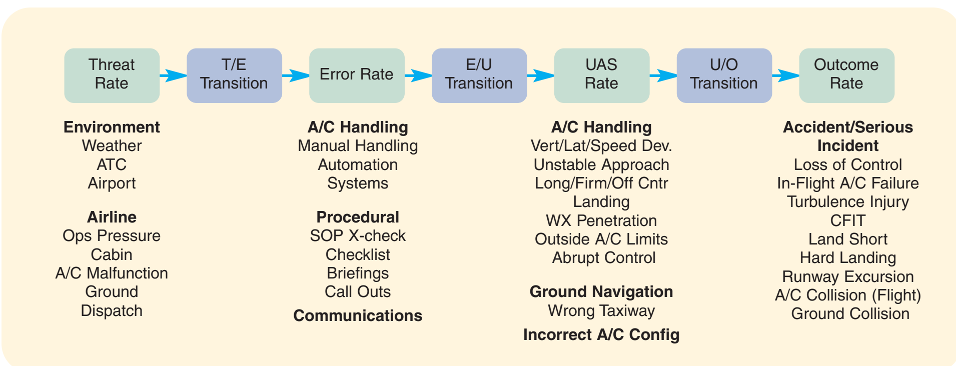
THE history of advances in aviation safety is marked by a series of insights. Often these insights have been linked to the development of new data-gathering methods. The recognition of the role of human factors in aviation accidents led to a plethora of human factors coding schemes for accident and incident reports. Professor James Reason's work on organizational accidents led to a number of both reactive (i.e. after the incident or accident) and proactive organizational safety measures. The development of the threat and error management (TEM) framework was inextricably linked to the Line Operations Safety Audit (LOSA) data collection method.

These and many more initiatives have been incorporated into the arsenal of aviation safety practitioners. Airlines, manufacturers, industry groups and State and international bodies have all implemented these and many other concepts into their safety processes. In general, however, the different data types are brought together in an informal, ad hoc way. The question that naturally arises is how well these data can be integrated to provide a more complete understanding of safety risks.

Safety data integration, as described below, can be achieved through the use of a risk model based on the framework of threat and error management. This approach builds on the work initiated by ICAO and the International Air Transport Association (IATA) to develop an integrated threat analysis (ITA) that combines TEM concepts with existing accident and incident databases. The approach proposed in this article expands on the ITA concept, and provides a means of bringing together quite disparate information to build a more complete picture of the flight safety risk. For example, the insightful human factors-based analysis of the crew's management of threats and errors drawn from LOSA can be combined with the detailed profile of flight performance provided by an analysis of recorded flight data; the result of this combination is an improvement in the utility of both data sources.

Before describing the details of the proposed model, it is worthwhile considering the nature of safety data generally available. Typical elements in the safety information programme of an airline can include mandatory safety reports, voluntary reports of safety occurrences and hazards, confidential reports of hazards and safety issues, flight data monitoring programmes, investigations and line observations. A brief comment on each of these elements follows.

- *Mandatory safety reports.* Reports of safety occurrences required by local civil aviation authority or international regulations commonly include pilot reports of operational incidents and engineering reports relating to technical defects and maintenance difficulties.
- *Voluntary reports of safety occurrences and hazards.* Airlines commonly extend the reporting requirement to include a variety of occurrences and situations which may indicate a potential safety hazard.
- *Confidential reports of hazards and safety issues.* Airlines can offer confidentiality to employees to encourage reporting of situations or practices that represent a potential hazard but where the employee may be reluctant to disclose information using existing reporting mechanisms.
- *Flight data monitoring programmes.* This type of programme, often referred to as FOQA (Flight Operations Quality Assurance), collects data from flight recorders and analyses them to identify significant deviations from ideal flight performance, or examines the distribution of one or more parameters for all or a sampling of flights.
- *Investigations.* Information derived from in-house investigations of reported occurrences, hazards or situations, is generally focused on the factors that have contributed to the event. Factors may be structured under a number of classification schemes, many of which draw on Professor Reason's work.
- *Line observations.* Traditionally, flight operations standards groups have operated programmes of line surveillance over and above regulatory line or route checks. With the development of LOSA, these programmes have in some cases been supple-




**As illustrated by this flow chart, the TEM framework can be used to significantly improve our understanding of risks for specific accident categories**

mented or replaced by human factors observation programmes based on TEM concepts. Initially focused on the flight deck, some airlines have extended this concept to cabin, ramp and maintenance operations.

Over and above airline safety data collection, government organizations, industry bodies, aircraft manufacturers, international organizations such as ICAO and other independent groups have implemented a range of safety information programmes. Among the most comprehensive of these are the ICAO Accident/Incident Data Reporting (ADREP) system and Bird Strike Information System (IBIS), the IATA Safety Trend Evaluation, Analysis and Data Exchange System (STEADES), and the archive of the LOSA Collaborative (ARCHIE), which contains data collected from numerous airlines worldwide that have implemented a LOSA programme. These sources provide information covering broad sections of worldwide aviation activity.

All of these sources of data are designed to address different aspects of flight safety, and each has various strengths and weaknesses. While the process of safety assessment and analysis will lead to some combining of these data, it generally concerns an individual event or possibly a specific issue, and usually takes place on an informal or qualitative basis.

The TEM framework can be used to significantly improve our understanding of risks for specific accident categories. The first step is to look at the rate at which crews are exposed to threats and errors and the rate at which these evolve into undesired aircraft states. This information is then combined with global data on the rate at which undesired aircraft states of various severity result in accidents or serious incidents. In this way, it is possible to develop a quantitative model of risk.

| Data sources | Threats | Errors | Undesired A/C state | T/E transition | E/U transition | U/O transition | Outcomes |
|---|---|---|---|---|---|---|---|
| ARCHIE | ✔ | ✔✔ | ✔✔ | ✔✔ | ✔✔ | | |
| Airline Line Obs | ✔ | ✔ | ✔ | ✔ | ✔ | | |
| FOQA | | | ✔✔ | | | | |
| Safety Reports | ✔✔ | ✔ | ✔ | | | | ✔ |
| ADREP | | | | | | ✔ | ✔✔ |
| STEADES | ✔ | ✔ | ✔ | | | | ✔ |

**Relative utility of various international and internal airline data sources in terms of estimating rates for use in a risk model (checkmarks signify level of quality)**

This concept is illustrated in the accompanying figure (page 21). The process begins with an assessment of the rate at which flights are exposed to threats of various sorts — weather, air traffic control (ATC), aircraft malfunction, and so on. The next step is to transition from threats to errors (this includes the rate at which errors occur without a previous threat, and also the rate at which crews successfully manage the threat, resulting in no errors). This process leads to a profile of error rates.

In a similar fashion, an assessment is made of the transition from errors to undesired aircraft states. Finally, we look at the transition to accidents or serious incidents as an overall indication of the adverse safety outcome.

The proposed approach is to use a variety of data sources to provide quantitative estimates of the rates of threats, errors, undesired aircraft states and outcomes, and the transition rates between them. Such an approach can be applied to both worldwide aviation and individual airlines.

By taking this approach, an airline is able to estimate the overall risk level for specific categories of accidents, such as controlled flight into terrain (CFIT) and runway excursion. It would also make possible an assessment of the intensity of the relationship between "upstream" safety elements (e.g. ATC threat rates or procedural error rates) and the risk of an accident "downstream." This information, in turn, would help direct safety efforts to where they deliver the greatest benefit. In addition, it would provide guidance on the level of risk associated with rates of undesired aircraft states. At any airline today, if a flight operations manager were to question whether, for example, a particular rate of long landings is something to be concerned about, no one would be able to provide a really useful answer. While the proposed model cannot be perfect, it would nonetheless give a general sense of when particular rates of undesired aircraft states are a concern.

Using the approach described here, an airline could also benchmark overall safety performance against other worldwide rates.

Existing safety data sources can be used to estimate the rates to be used in the model. The accompanying table illustrates the relative utility of various international and internal airline data sources in this respect.

In general, more than one data source is available to estimate rates. For example, an airline may have completed a LOSA session or run an internal observation process using the TEM framework, and by using the results, will be able to compute rates directly. However, these calculations will generally be based on fairly small samples. Other available data sources, such as the ARCHIE data, are based on larger samples but may not reflect as well the specific operation of the airline concerned. A good method of combining multiple estimates is the technique of Bayesian estimation which provides, in essence, a probabilistic-based weighting.

While the specific approach to estimating the components of the model will vary from organization to organization, depending on the data available, some general comments are appropriate.

With respect to threat rates, the initial estimate can be based on airline (or group of airlines) LOSA data or internal line observations combined with the LOSA archived data. Safety reports from pilots are a generally good indicator of threats (though people are generally better reporters of safety problems created by others than of the errors committed by themselves!). Because such data in principle come from all flights, they should provide a more comprehensive coverage of threats than the first source. By combining these two sources, an airline can come closer to a good estimate of the rate at which flights are subject to threats, along with the ability to reduce

*continued on page 36*

Bob Dodd is the Manager of Data Systems and Analysis in the Group Safety Office of Qantas Airways.

# Air cargo security regime strengthened by changes to known-consignor system

*The independent validation scheme for accrediting known consignors has worked well since it was established by the United Kingdom in 2003, and further changes introduced last year will help minimize the vulnerability of cargo*

JOHN WRIGHT
*DEPARTMENT FOR TRANSPORT (UNITED KINGDOM)*

THE United Kingdom has had a comprehensive air cargo security regime in place since August 1994 (see "New security regime requires that cargo agents demonstrate compliance with security regulations," *ICAO Journal* December 1997, pp 14-15).

Over the course of time, however, the U.K. Department for Transport (DfT) became aware that the "known customer" programme — an important component of its security regime — needed to be overhauled to better meet security requirements while still facilitating the movement of air shipments.

Consultation with stakeholders led to a proposal that the Department for Transport should appoint independent "validators" to carry out the assessments of potential known customers and establish whether they could meet the security requirements, rather than have this function carried out by regulated agents and airlines. The new arrangements came into effect in August 2003, and since that time all acceptance of known customers has been carried out by the DfT-appointed validators.

To become a validator, an applicant must demonstrate a good knowledge of the U.K. air cargo regime. Once accredited, the government-appointed validator is able to carry out inspections for a three-year period. Employees of airlines and regulated air cargo agents are no longer permitted to perform this function because of the potential for conflict of interest.

A validator may charge a consignor a set fee of £400 (U.S. $780), plus travelling expenses. In the event it is necessary to make a return visit to a potential known consignor, the validator is allowed to charge an additional £200 fee. Details of the scheme, and how companies can become known consignors, are posted on a DfT website. (In order to come into line with European Union terminology, known customers have been redesignated as "known consignors.")

The United Kingdom has introduced changes to its security regime designed to minimize the vulnerability of air cargo

There is no requirement to become a known consignor in order to move freight by air: it remains possible for any freight forwarder to submit cargo as "unknown." Such cargo is then screened by accepted methods, by either an airline or a regulated air cargo agent, for a fee.

An air freight originator that opts to become a known consignor simply contacts the dedicated DfT website to request a validation visit. The DfT validator assesses the suitability of the customer to become a known consignor using a checklist devised by the Department for Transport, an approach that ensures thoroughness and uniformity. If the validator is satisfied with the security arrangements, the customer is assigned a unique reference number (URN) and is awarded the security status of known consignor. The freight forwarder is then entered on the list of known consignors, whose details are held on a protected computerized database available only to airlines and regulated air cargo agents.

Known consignors need an annual validation in order to retain their status. They are required to include their URN on consignment security certificates accompanying the cargo, and regulated air cargo agents and airlines are in turn required to check the validity of the URN by reference to the website.

Ministerial acceptance in 2003 of the independent validation system included a requirement that its operation be reviewed after three years. This review was undertaken in the first half of 2006. As part of the process, each consignor was asked for views on the performance of the validation scheme.

The overwhelming response to this survey was positive. Many consignors said they had benefited from the help and advice provided by the validators, and that they now felt more involved in the fight against terrorism, rather than feeling as

*continued on page 35*

John Wright is a Senior Aviation Security Policy Adviser in the Transport Security and Contingencies Directorate of the U.K. Department for Transport.

# Runway incursions pose a risk at every airport, but accidents are not inevitable

*Aware that effective safety programmes represent the difference between disaster and just another day of routine operations, ICAO has assembled practical tools and educational material that can assist with establishing runway safety initiatives*

ICAO SECRETARIAT

VALUABLE information on the prevention of runway incursions can be found at the ICAO Flight Safety Information Exchange (FSIX) website, where it has been posted as part of an ongoing awareness and education campaign initiated in 2001.

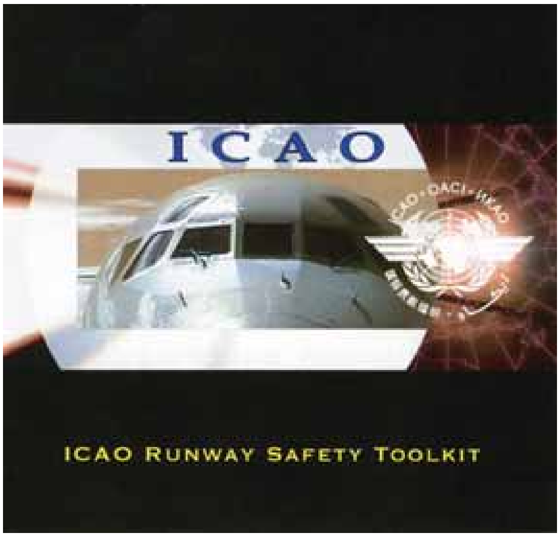
Included at the website (www.icao.int/fsix/res_ans.cfm) is the ICAO *Manual on the Prevention of Runway Incursions* (Document 9870), which offers best practices to assist States in implementing runway safety programmes. Completed in mid-2006, the manual was produced with substantial support from the U.S. Federal Aviation Administration (FAA), Eurocontrol and Airservices Australia.

Also accessible at the FSIX website is the ICAO version of the runway incursion severity classification (RISC) calculator. This interactive tool encourages users to categorize aviation incidents according to international criteria, providing the uniformity needed to facilitate analysis and information sharing around the world.

The website also features an interactive educational tool that is available for downloading. Developed by ICAO with the support of Embry-Riddle Aeronautical University, the Runway Safety Toolkit is a compilation of the contributing factors in runway incursions, illustrative examples and constructive solutions, and is intended to support any initiative focused on preventing runway incursions. The toolkit was designed to accomplish three main objectives:

• raise awareness of all those involved in aerodrome movements regarding the dangers that accompany runway incursion;
• identify the most common hazards, and describe why they occur; and
• provide practical solutions and best operating practices that will improve runway safety.

The toolkit incorporates modules on key elements of runway safety, namely air traffic control (ATC), flight operations, and aerodrome and management responsibilities. The interactive component is composed of quizzes to test the user's knowledge of the material, and supplementary material includes a glossary, an appendix containing ICAO provisions on runway safety, and references and web links. Also featured are educational posters suitable for display, information videos created by various countries, and a compendium of selected seminar presentations. In addition to English, the entire narrative for the toolkit is available in Arabic, Chinese, French, Russian and Spanish.




**The Runway Safety Toolkit is a free, interactive educational tool available for downloading at ICAO's website**

As noted in ICAO's educational material, runway incursions are one of the leading categories of incidents on and in the vicinity of airports. Specifically, the areas of greatest concern are radiotelephony phraseology; aviation language proficiency; ATC procedures; standards and performance requirements for equipment, aerodrome visual aids and charts; and flight operational and situational awareness. Efforts are under way to further enhance ICAO provisions and guidance to the aviation community in these areas, as well as to create an awareness of the important role played by human factors in the improvement of aviation safety.

Below follows an extract from the Runway Safety Toolkit's narrative dealing specifically with flight operations, and highlighting some of the measures that pilots can take to reduce the risk of incursions. Aside from pilots, the narrative available at the website features modules intended primarily for air traffic controllers, ground vehicle operators, and decision makers who are removed from day-to-day operations.

### Clear communications

Runway incursions are an all-too-common occurrence at airports around the world.

ICAO defines a runway incursion as, "Any occurrence at an aerodrome involving the incorrect presence of an aircraft, vehicle, or person on the protected area of a surface designated for the landing and take-off of aircraft." The protected area also includes those portions of the taxiway located between the applicable runway-holding positions and the actual runway.

Movements around the aerodrome can be confusing, even for the most experienced of pilots. Knowing which way to turn, and when, can be even more intimidating when coupled with low visibility or night operations. Confusion can quickly compromise the safety of operations on the manoeuvring area.

Many errors, especially those that result in runway incursions, are caused by a failure to gain or maintain good situational awareness. Research has shown that the following factors often result in diminished situational awareness: incomplete or misunderstood communications; lack of planning; workload peaks; distractions; and loss of visual cues. By far, the most important cause of mistakes arising from poor situational awareness is communication problems. Communication difficulties most often result from the use of non-standard phraseology and/or a lack of language proficiency.

These communication shortcomings cause a discrepancy between what ATC intends and what pilots understand, and vice versa. Clear, accurate and timely communications are essential in establishing and updating the "shared mental picture" necessary for good situational awareness. There are a number of ways flight crews can ensure that transmissions are fully understood. In brief, pilots should always:

• use standard phraseology, both in requests and acknowledgements;

• during readback of taxi instructions, include runway in use, any runways to be entered, landed on, taken off from, held short of, crossed, back-tracked upon, and all holding instructions;

• use full call signs;

• clear up uncertainties as they occur, before proceeding, either by use of in-cockpit resources or by contacting ATC;

• when different primary languages are used by ATC and pilots, speak as slowly and clearly as needed to ensure comprehension of the common language;

• always monitor and announce intentions on the common frequency at uncontrolled aerodromes;

• write down unfamiliar taxi instructions, and have the aerodrome ground movement chart in hand during taxi;

• be aware of differences in standard phraseologies in use in different States (e.g. the ICAO standard phraseology to line-up an aircraft on a runway is "line up" or "line up and wait," but in some States other phrases are prescribed, such as "position and hold" or "taxi to position and wait");

• be alert for similar call signs that could lead to confusion;

• avoid what is termed "expectation bias," which simply means that we often hear — or at least we think we do — what we expect to hear;

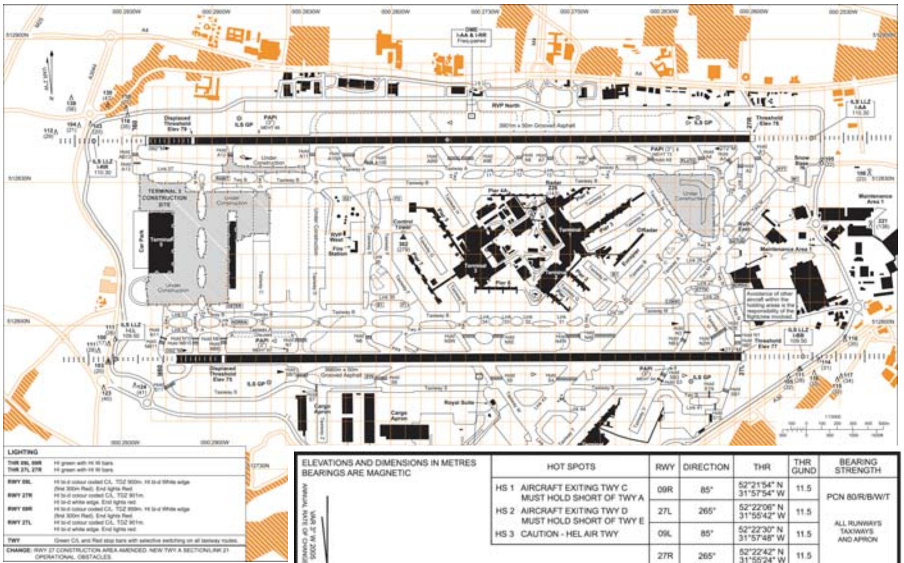
• obey stop bars if illuminated, even if clearance across the runway has been previously received (ATC may have had a radio failure, or the aircraft's receiver may not be functioning); and

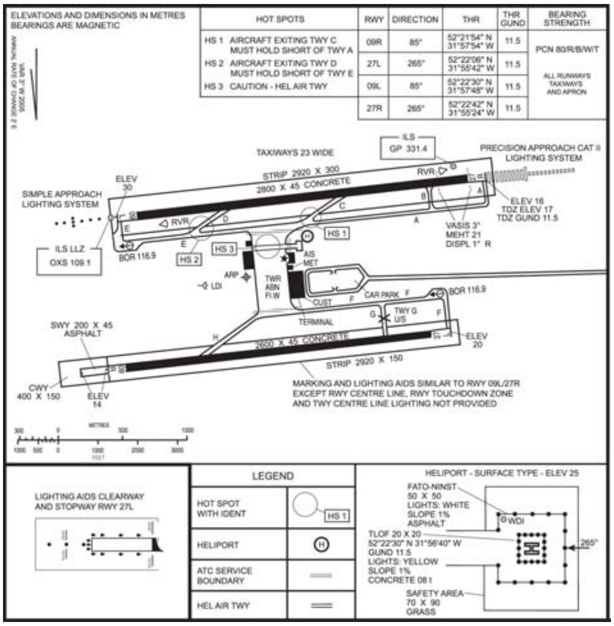
• monitor ATC transmissions to other aircraft, and visualize their positions and movements.

On an operational note, pilots should bear in mind that a departing aircraft's take-off clearance is never issued until the en-route clearance has been transmitted and acknowledged by the crews concerned.

## Planning measures

Aerodromes have grown and increased in complexity, and taxi routes have become more complex as well. Consider, for example, the complexity of the taxiways at London Heathrow (see adjacent chart). Obviously, prior preparation and planning is in order at Heathrow and other busy aerodromes, but the same applies to less busy aerodromes as well. The first and most basic step is to have an aerodrome chart in hand during the taxi, both in and out.






**As illustrated by the chart for London Heathrow, pilots need to be well prepared for the taxi phase of flight, and it is essential to have an aerodrome chart in hand during the taxi in or out. Provisions for indicating "hotspots," as depicted in the detail from the ICAO sample aerodrome chart, will become applicable this November.**

Without this simple measure, situational awareness can rapidly degrade. At the gate, or prior to descent, pilots need to review and familiarize themselves with the airfield layout and probable taxi route options. NOTAMs and ATIS information must be included in this review, and all flight deck crew need to be briefed. In particular, the crew needs to know the runways along the taxi route. The crew should identify parallel runways and confirm use of left, right or centre runway. The crew should also brief "hotspots", which are locations on an aerodrome movement area having a history, or known to pose a risk, of collisions or runway incursions, and where heightened attention by pilots and vehicle operators is necessary. Hotspots are marked on some aerodrome charts (see ICAO sample chart, page 27), but their usage is not universal yet (associated provisions in ICAO Annex 4 and Document 4444, *Procedures for Air Navigation Services – Air Traffic Management*, will become applicable on 22 November 2007).

Properly employed, such planning measures will help reduce the next impediment to situational awareness: workload peaks. Every pilot knows that if workload becomes excessive, the ability to monitor the environment diminishes. Usually this is a circumstance that occurs in the air, for example, during instrument approaches when the work level is typically very high. However, the same situation can be found on the ground during taxi operations as well. Time constraints, company and ATC demands, etc., diminish the crew's knowledge of their precise location on the aerodrome, or what other aircraft are doing. Quite often the result is an inadvertent entry into or across a runway, and a procedural violation for the crew.

The solution, in addition to maximizing planning and preparation before taxi, is to resist demands that compromise safety. Every pilot wants to cooperate to maximize the efficiency of operations, but this should not be at the expense of safe operations. Flight instructors and check airmen also should employ good judgement so they won't boost the workload so high that a runway incursion becomes more than a remote possibility.

Distractions are inevitable. Usually they are manageable, but should they happen at the wrong time and be of sufficient magnitude, an accident may occur. At one time or another practically every pilot has climbed or descended through an assigned altitude because of something that happened on the flight deck that diverted attention. The same thing happens on the ground, but instead of flying through an altitude, the pilot taxies across a runway without clearance.

Distractions can be minimized by employing "sterile cockpit" procedures during taxiing — this is the elimination of all conversation and activities not directly related to the safe conduct of the flight. But some distractions cannot be controlled or predicted — ATC or company queries, caution or warning lights, or priority cabin crew requests, for example. In these cases, pilots need to minimize the impact of interruptions by dividing their duties so that the entire flight deck is not fixated on the distraction. Depending on the source of the interruption, the pilot should advise the person or agency to standby until the aircraft's position is certain. It should be noted that even essential information, such as a route clearance, can be a distraction from the primary task at hand, which is to taxi safely to the designated runway. In a multipilot aircraft, only one member should be "head down" at any time, while a lone pilot should stop the aircraft in order to copy anything but the simplest clearance.

While the great majority of runway incursions occur during good visibility, the worst accidents typically happen during periods when visual cues are lost or severely diminished by darkness, fog, dust, or rain, or even facing the sun when it is at a low angle.

Low visibility operations require special precautions, because almost without exception, situational awareness is reduced. First and foremost, pilots should stop and ask for help any time they are not certain of their position. ATC would much prefer to provide a detailed progressive taxi than to have an aircraft inadvertently end up on a runway. If necessary, a "follow-me" vehicle can be dispatched at many aerodromes.

Lights should be used as appropriate to make the aircraft more visible.

At unfamiliar airports, a crew member should be assigned to provide a running update of the aircraft's progress using an aerodrome ground movement chart.

Once on the runway, pilots should compare the directional indicator with the compass reading, and also confirm that the heading is that of the active runway. If the runway is equipped for an instrument landing system (ILS) or microwave landing system (MLS), the crew should also confirm the centreline guidance needle is where it should be. On both take-off and landing, collision avoidance systems can be used to increase situational awareness — this is especially important in low visibility.

There are other actions pilots can take to reduce the likelihood of runway incursions, but the measures highlighted above have proven to be highly effective in promoting runway safety. Pilots should review such measures on a regular basis to ensure they use them to the utmost. □

Rand K. Peck

**While the great majority of runway incursions occur during good visibility, the worst accidents typically happen during periods when visual cues are lost or severely diminished**

# State-of-the-art data collection system brings benefits to stakeholders

*Following successful implementation of a system for collecting and disseminating air transport data electronically, Canada is now ready to expand its programme beyond passenger data to air cargo activity, and perhaps also to GA operations*

MICHEL VILLENEUVE
*TRANSPORT CANADA*

AN electronic system for collecting and disseminating air transport statistics that has been implemented by Canada reflects the need for more complete and timely data on the airline industry, particularly the requirement for an expeditious assessment of the impact of events such as 9/11 and the outbreak of severe acute respiratory syndrome (SARS) in 2003.

From the outset, the Electronic Collection of Air Transportation Statistics (ECATS) Programme was set up in accordance with the Canadian government's "smart regulation" agenda, aimed at reducing the administrative burden associated with regulations, including data reporting. A successful pilot project in 2002 paved the way for the national roll-out of the programme in the following year (see "Pilot project illustrates feasibility of collecting air transport data electronically," *ICAO Journal* Issue 3/2003, pp 8-10).

Several objectives characterize this Canadian data initiative. Major goals have been to reduce the burden and cost of statistical reporting by electronically linking air carriers with Transport Canada, and working voluntarily in close collaboration with industry and other government partners on the handling of electronic information. A parallel objective has been to introduce procedures to widen the range of data collection and dissemination, while also improving on the timeliness of the validated data to near real-time. Another primary objective has been to maximize the use of state-of-the-art information technology (IT) in collecting and disseminating air transport statistics electronically. Yet another important goal has been to protect all data using standard Internet business processes established for the e-commerce marketplace by the banking industry.

There are a number of identifiable benefits for those participating in the programme. For airlines, the switch to electronic filing can reduce the reporting burden and associated costs of statutory reporting. Air carriers can access total passenger traffic at airports where they conduct operations, and compare this information with their own traffic numbers. Transport Canada can also dispense to airports — with a carrier's written permission — carrier-specific validated traffic data that yield a standard and timely set of figures that help prevent contention over various fee calculations.

Airports that participate in the programme stand to benefit by acquiring automated access to authorized data. Both aggregate and disaggregate data for each airport improves the ability of airport authorities to plan for the future and to have timely data for various other initiatives. (As alluded to above, disaggregate carrier-level data are only made available on a case-by-case basis, and only with the written permission of the carrier concerned.)

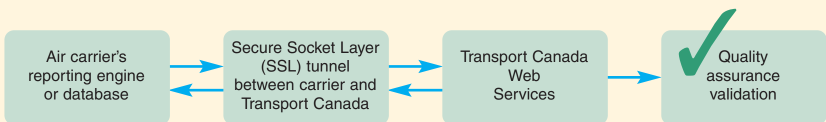
Participation in the programme is advantageous for other industry partners as well, because current and accurate air transport statistics impart a better understanding of industry trends and help ensure a more reliable analysis of air transport developments.

Bombardier Aerospace

**Under Phase II of Transport Canada's ECATS Programme, electronic data collection will be assessed with the aim of adapting existing tools and procedures to the realities of general aviation**

By the end of 2006 Transport Canada's ECATS Programme was collecting information from 173 air carriers that generate about 97 percent of Canada's domestic and international passenger traffic. Generally speaking, nearly all North American carriers serving Canada are submitting their data through the ECATS Programme, as well as most major international carriers with services to Canada.

A number of challenges had to be faced during implementation of the first phase of the ECATS project. In the first place, Transport Canada had to ensure that all aspects of Canada's privacy legislation were adhered to, which meant that no personal information related to any traveller could be captured by the ECATS system. Secondly, the differences in the IT capabilities of the various carriers operating in Canada had to be addressed. Some of these carriers manage very sophisticated IT systems for capturing and housing data, while other airlines, mostly those operating in the domestic realm, have very small operations and rely on basic IT capability. Still other carriers outsource all their data capturing and reporting functions, compelling Transport Canada to work with third parties in the data-gathering exercise. Moreover, there was a very broad range of software and hardware used by the carriers and third-party data handlers, making it necessary for the ECATS system to interact with the entire gamut of computer systems.




**Step 1.** At the closing of a flight (aircraft pushback) or at a scheduled time every day, flight data is prepared by the carrier and sent via the Internet using a standard Simple Object Access Protocol (SOAP) formatted call

**Step 2.** The inbound flight data arrives and is validated by the web services. Depending upon the quality of the data, it is stored in either a production, corrupted or superseded database. Stored data feeds into the quality assurance process at Transport Canada

**Step 3.** The web service aknowledges the transmission by issuing a unique receipt number

**Structure of an ECATS web service call: the bidirectional transmission is completed once the carrier receives a response, a process that requires about three seconds**

Importantly, the key objective of minimizing the effort and costs of statistical reporting by carriers was achieved by not requiring that airlines submit their data under a standard format. Consequently, the ECATS system was designed so that it can convert all raw data received from the carriers to a standard format in the database.

Under ECATS, data is collected in one of two ways. One approach involves a web-based service that provides for a completely hands-off submission of data to Transport Canada. Information is relayed each time an airliner closes its doors and pushes back from the terminal, or alternatively is forwarded each day from an internal database at a specific time. Another approach is via a secure Internet site that allows for a carrier to either upload a file or fill out a preformatted form that is then forwarded electronically to Transport Canada.

Whichever method is used, there is no cost to the carrier for transmitting data across the Internet. In either case, of course, the information is encrypted automatically at the source and transmitted over the Internet in a manner similar to the banking model. Transport Canada then edits and validates all data submitted, mainly through electronic processes. Section 51 of the Canada Transportation Act provides for the strict confidentiality of all information collected under the programme.

The fully automated web service model, illustrated in the accompanying figure, has been particularly successful. Since its launch in 2004, 1.9 million records have been received from 70 air carriers, and an additional 14 carriers are expected to begin using the automated web service in the near future.

During the 12 month-period ending on 31 January 2007, web services generated over half a million records. One of the major strengths of the web application is that it can operate without depending on a particular software platform, meaning it is able to connect with programmes in the Microsoft, UNIX, Linux and other environments. It is also independent of the application used to create the data to be transmitted. The structure of a web service call consists first of the assembly of the required data elements, followed by the opening of the communications channel by initiating a SOAP [simple object access protocol] session, and finally delivery of a return value. The bidirectional transmission is completed once the carrier receives a response, with the entire process occurring in about three seconds.

Building on the success of ECATS Phase I, Transport Canada is now moving ahead with Phase II. The second phase of the programme will address three main components: origin and destination modelling, air cargo and general aviation (GA).

The origin and destination (O/D) model will build on existing technology developed and implemented in Phase I, but with a different data layout. The collection of operational data in Phase I is based on a flight-centric model where all the information collected describes a specific flight event. The O/D model is passenger-centric, as the information obtained focuses on the passenger itinerary. Since major Canadian air carriers are currently obligated to report their origin and destination information, adding an O/D component to ECATS will allow them to meet this requirement in a more efficient and timely fashion. In addition, current origin and destination reporting is limited to an unbiased survey made up of 10 percent of tickets sold, whereas O/D collection through ECATS would amass data on all tickets, thus eliminating any margin of error in the O/D traffic statistics.

Under this next phase of ECATS, the range of data captured through the system will go beyond passenger statistics to include air cargo. ECATS web services can readily be adapted to collect air waybill data on each individual item shipped, or can be used to collect aggregated data related to each flight. ECATS can also be modified to provide either preflight or post-flight statistics.

Finally, the ECATS team is examining the possibility of collecting data for the general aviation segment of the industry, directly from the key players in the Canadian GA sector. GA figures are relevant to issues such as small airport viability and airport capacity, and allow for a better understanding of this segment of

*continued on page 34*

Michel Villeneuve is Chief of Aviation Statistics at Transport Canada, Ottawa. Any questions about the ECATS Programme, including those concerned with detailed technical aspects not addressed in this overview, can be directed to the author via e-mail (villenm@tc.gc.ca) or sent to the ECATS mailbox (ECATS@tc.gc.ca). Additional information on the programme is available from the website (www.tc.gc.ca/ecats).

# Experts propose guidance on how to include aviation in emissions trading schemes

*CAEP members are pictured at the committee's seventh meeting at ICAO headquarters from 5 to 16 February. CAEP produced various recommendations on environmental matters, including proposed guidance on how States can implement emissions trading schemes that include aviation.*

Emissions trading guidelines developed by the ICAO Committee on Aviation Environmental Protection (CAEP) at its seventh meeting held in February will be available to the organization's 190 member States in draft form until September, when the complex issue will then be taken up by the 36th Session of the ICAO Assembly, a triennial meeting of the organization's 190 Contracting States.

The draft guidance for States will be published with a foreword reflecting the views of the ICAO Council, the governing body of the organization. The foreword will note that a majority of the member States on Council have indicated that any approach to inclusion of aviation in emissions trading schemes must be on the basis of mutual agreement.

CAEP agreed by consensus on guidelines for incorporating international aviation emissions into national emissions trading schemes, consistent with the United Nations Framework Convention on Climate Change process, during its two-week meeting at ICAO headquarters in Montreal.

Some 250 participants from around the world took part in the committee's seventh meeting (CAEP/7), from 5 to 16 February, which dealt with various environmental matters, and produced a number of recommendations based on the work of leading experts. CAEP itself is composed of experts from 21 ICAO member States and major sectors of the aviation industry including airports, airlines and aircraft manufacturers, as well as environmental non-governmental organizations and United Nations bodies apart from ICAO.

Aside from dealing with the high profile emissions trading issue, the meeting also produced recommendations on aircraft engine emissions and aircraft noise, and the trade-offs between these measures. More information on ICAO and CAEP can be found at the ICAO website (www.icao.int).

The committee's proposed guidance on aviation emissions trading provides preferred options for the various elements of trading systems. In implementing any emissions trading scheme that includes aviation, CAEP/7 has recommended that:

- aircraft operators be deemed the accountable international aviation entity for purposes of emissions trading;
- obligations be based on the total aggregated emissions from all covered flights performed by each aircraft operator included in the scheme;
- States, in applying an inclusion threshold, consider aggregate air transport activity such as carbon dioxide ($CO_2$) emissions and/or aircraft weight as the basis for inclusion;
- States begin with an emissions trading scheme that includes $CO_2$ alone;
- States apply the latest Inter-governmental Panel on Climate Change definition of international and domestic emissions for the purpose of accounting for greenhouse gas emissions as applied to civil aviation;
- States put in place an accounting arrangement that ensures emissions from international aviation are counted separately and not against the specific reduction targets States may have established under the Kyoto Protocol; and
- States consider economic efficiency, environmental integrity, and equity and competitiveness when determining trading units.

In addressing the geographic scope of an emissions trading scheme, CAEP has advised States to weigh the different options, with their various advantages and disadvantages, and begin any integration of foreign aircraft operators in trading regimes on the basis of mutual agreement while also continuing to analyse further options.

The guidance on emissions trading is part of a package of recommendations from CAEP that address the issue of emissions directly attributable to aviation in relation to local air quality and global climate effects. CAEP's recommendations cover the reduction of emissions through technological, operational and market-based measures.

CAEP also established long-term technological goals for emissions of nitrogen oxides ($NO_x$), and proposed guidance on aircraft emissions charges related to local air quality. States are encouraged to evaluate the costs and benefits of the various measures available to them, with the goal of addressing emissions in the most cost-effective manner.

As in the past, CAEP underscored the importance of voluntary initiatives in addressing the problem of emissions, and recommended that information on voluntary emissions trading programmes and other voluntary measures covered at the meeting be posted at the ICAO public website.

ICAO will convene a colloquium on aviation emissions in May 2007. The colloquium, which will feature an exhibition, will provide a forum on aviation emissions, and in particular the outcome of the CAEP/7 meeting. Presentations will be given by renowned environmental experts and scientists. More information on the ICAO Colloquium on Aviation Emissions, to be held in Montreal from 14 to 16 May 2007, is available at the ICAO website (www.icao.int/envclq/clq07). □

## Amendments introduce usage of public Internet

Contracting States and international organizations have been asked to comment by 16 May 2007 on ICAO's plan to permit the operational use of the public Internet for disseminating and exchanging aeronautical messages that are not time critical. The proposed change would introduce provisions in ICAO Annex 3 and Annex 15, which address meteorological services and aeronautical information services (AIS) respectively, and would become applicable in November 2010.

Usage of the public Internet for disseminating operational meteorological information and AIS products would augment the aeronautical fixed service. Guidance material on non-time critical operational meteorological and aeronautical information and relevant aspects of the public Internet is provided in the *Guidelines on the Use of the Public Internet for Aeronautical Applications* (Document 9855). The document was prepared by an ICAO study group formed in 2003 for the purpose of establishing guidelines and criteria for the accreditation and qualification of providers of aeronautical information via the Internet. The guidance material it produced emphasizes the importance of approving Internet service providers through a process that entails a thorough review of safeguards against information security threats. □

## Member States visited

In recent months ICAO Council President Roberto Kobeh González and ICAO Secretary General Dr. Taïeb Chérif have made official visits to a number of Contracting States to meet with government officials and participate in various conferences.

The Council President visited Singapore in mid-December to give a keynote address at the World Civil Aviation Chief Executives Forum organized by the Singapore Aviation Academy (see "First priority must remain safety: Council President," *ICAO Journal* Issue 1/2007, pg 28). During his visit Mr. Kobeh González also met with government leaders to discuss safety and security-related topics.

The Council President also travelled to Thailand, where he toured the ICAO Asia and Pacific Office in Bangkok. He met with government leaders to discuss various aviation matters, in particular ICAO's policies and practices related to environmental protection, the ratification of air law instruments, air transport policy regulations, the ICAO safety and security audit programmes, and the establishment of an ICAO-Thailand training programme aimed at assisting developing States through fellowships for training at the Civil Aviation Training Centre in Bangkok.

The Council President was in Lima, Peru in mid-February to inaugurate the new premises of the ICAO South American Office. During his visit, he discussed ICAO's safety and security audit programmes, air transport policy regulations, and technical cooperation activities in the South American and Caribbean regions with high-level officials.

The Secretary General was in the United States in mid-December to meet with officials of the Federal Aviation Administration (FAA), the National Transportation Safety Board (NTSB), the Transportation Security Administration (TSA) and the State Department. The discussions in Washington, D.C. focused primarily on issues related to aviation safety, security, the environment, and ICAO's organizational reforms and budget for the 2008-10 triennium. The Secretary General also gave a keynote address at a reception hosted in his honour by the International Air Transport Association (IATA).

Dr. Chérif was in India in early February, where he met with government and industry officials to discuss various aviation issues including technical cooperation projects and activities, and progress made in India's rapidly growing aviation sector. He also delivered the keynote address at the Inaugural Session of the International Conference on Aviation, organized in conjunction with the 6th Biennial Aerospace Exposition "Aero India 2007," which was held in Bangalore from 7 to 11 February. □

## Fellowship training programme extended to 2009

The ICAO-Singapore Developing Country Training Programme, which has been awarding fellowship training at the Singapore Aviation Academy (SAA) since 2001, has been extended for another three years to 2009 because of an overwhelming and continued demand. The 2007 programme focuses on integrated safety management, safety oversight, civil aviation management, CNS/ATM developments, and aircraft accident investigation and management.

Various training sessions, ranging from five days to three weeks in duration, are available from mid-June to late January 2008. The fellowships are intended for participants nominated by their respective governments. For more details, consult the SAA website (www.saa.com.sg/fellowships).

Since its inception, the joint programme has provided 203 fellowships to participants from more than 70 ICAO member States. It is sponsored by the Singaporean Ministry of Foreign Affairs and is administered by ICAO's Technical Cooperation Bureau. □

## Technical cooperation

ICAO confirmed recently that it is implementing two new large-scale technical cooperation projects in Guatemala and Venezuela. In addition, ongoing large-scale projects in Argentina, Greece, Panama and Somalia, as well as the UN Mission in Kosovo, have been allocated additional funding. □

## Symposium heightens awareness of need for performance framework

A global symposium held at ICAO headquarters at the end of March brought regulators, air navigation service (ANS) providers, airport operators and airspace users together for a focused discussion on the performance of the world's air navigation system. Some 400 participants turned out for the event of 26-30 March, which was seen as a follow-up to the pivotal 11th Air Navigation Conference (AN-Conf/11) held in 2003. Although the Worldwide Symposium on Performance of the Air Navigation System (SPANS 2007) was not mandated to produce recommendations, it did articulate a way forward for both ICAO and symposium participants. Readers can access all of the documentation and presentations of the symposium on the web (www.icao.int/perf2007).

Today's emphasis on performance, explained ICAO Council President Roberto Kobeh González at the opening of the five-day event, had arisen from the move to corporatize air navigation services and its consequent pressure for greater accountability. The best way to respond to this need lies in a performance framework for an air navigation system based on the global ATM operational concept endorsed by the aviation community in 2003.

"For the first time, and under the auspices of ICAO," he said in recalling AN-Conf/11, "stakeholders of the world aviation community jointly developed a vision for an integrated and globally harmonized ATM system, with a planning horizon up to and beyond the year 2025. … In short, the operational concept outlines a total system performance framework to achieve defined requirements."

SPANS 2007 heard from numerous experts from civil aviation administrations, the industry and ICAO Secretariat during several panel discussions that touched on every aspect of performance. The key areas where performance needs to be measured are capacity, cost-effectiveness, efficiency, environmental impact, flexibility, global interoperability, access and equity, participation, predictability, safety and security.

Citing the need for meaningful action that transcends national boundaries, Eurocontrol Director General Victor Aguado highlighted an example of regional progress. Eurocontrol, he explained, established the fully independent Performance Review Commission in 1997 to advise on the setting of performance indicators, propose performance targets and produce guidelines on economic regulation. And while this body, which had proved effective in achieving harmonization, was designed to deal with Europe's own complex and varied set of circumstances, "some of its features may be of interest to other parts of the world," he suggested.

Europe was also interested in learning from others, Mr. Aguado emphasized. "By exchanging information on their prospective experiences, all regions will get an opportunity to raise their performance levels. … This regional approach can then feed into a global performance monitoring and management framework."

Global harmonization is critical if the aviation community is to establish a global performance-based ATM system, asserted Victoria Cox, Vice President of Operations Planning at the U.S. Federal Aviation Administration (FAA) Air Traffic Organization.

"Disparate systems won't benefit our users … not in the global economy," Ms. Cox continued. "We need a seamless system, and that means working together to standardize the definitions and requirements, and developing a consistent way to measure performance."

FAA is working very closely with the European Commission and Eurocontrol to ensure commonality and interoperability where possible between the future air navigation systems of the United States and Europe, she stated.

FAA and Eurocontrol are also working with ICAO to develop joint performance-based navigation (PBN) familiarization seminars, Ms. Cox added. A series of 10 seminars are to begin in June 2007, tentatively in New Delhi, India, and will be conducted in all regions of the world.

Among the benefits of PBN, which provides for more direct and precise flight paths, are increased safety, reduced fuel burn, more efficient traffic flows and reduced ATC communications (see "Implementation of performance-based navigation making notable progress," and "Performance-based navigation seen as key to global harmonization," *ICAO Journal* Issue 3/2006).

The symposium identified several objectives related to performance of the world's air navigation system. ICAO's role is to advance work in the operational, technical, safety and economic areas, and to secure global interoperability between major air navigation initiatives. The organization is also required to develop and promote minimum performance reporting requirements for ANS providers, develop a methodology for measuring performance expectations, and prepare guidance material on facilitating collaborative decision making. Another goal is to accelerate PBN implementation.

SPANS 2007 also defined a way forward for the symposium's participants. Aside from implementing area navigation

**WAI SCHOLARSHIP RECIPIENT**

Helen Emmanuel Umoh, of Nigeria, is congratulated by ICAO Secretary General Dr. Taïeb Chérif on becoming the first recipient of the ICAO Women in Aviation International (WAI) Scholarship. Ms. Umoh, an air traffic controller based in Lagos, recently completed a six-week sojourn in the Air Traffic Management Section at ICAO headquarters, Montreal, where she learned about ICAO and participated in the ATM Section's various activities. Pictured with the scholarship recipient and the Secretary General are Vince Galotti, Chief of the ATM Section (at left) and Diana Wall, ICAO's Focal Point for Women.

(RNAV) and required navigation performance (RNP) in accordance with the PBN concept, the participants are expected to use the ICAO *Global Air Navigation Plan* (Document 9750) in performance-based transition planning; collaborate on establishing performance indicators; employ ICAO-defined key performance areas for performance management; and use the *Global Aviation Safety Plan* (GASP) as a basis for meeting safety performance objectives. More specifically, ANS providers need to measure and report on performance, while States have to implement safety programmes and establish acceptable levels of safety. Service providers, aircraft operators, aerodromes and maintenance organizations were reminded of their requirement to implement safety management systems.

"Ultimately, the successful implementation of a global air navigation system depends on cooperation among all members of the civil aviation community and involves greater integration of ICAO regional offices and headquarters," stated Mr. Kobeh González.

"ICAO is committed to meeting expectations of all stakeholders," he stated. "Together we have a formidable task ahead of us: to ensure the viability of the air navigation system of the future and its continued contribution to global economic development in a safe, secure and efficient manner." □

## ICAO Council appointment

***T. Araki (Japan)***

Toshihiro Araki has been appointed as the Representative of Japan on the Council of ICAO. Mr. Araki's appointment took effect on 26 December 2006.

Mr. Araki is a graduate of Okayama University, where he obtained a degree in law in 1976. During 1977-78, he studied economics at Queen's University in Canada. Mr. Araki then joined the Foreign Ministry of Japan, where he has served in a number of progressively responsible posts both at home and abroad.

After serving in the Embassy of Japan in Vienna, Austria from 1981 to 1985, Mr. Araki returned to Japan to serve in different capacities, initially dealing with policies concerning science and technology and later information and communications. While in Tokyo he was assigned to the North American Bureau, and was involved in talks with the United States on both civil aviation and the fishery.

In 1991 Mr. Araki was assigned to the Embassy of Japan in Sofia, Bulgaria, as First Secretary, Economic Affairs, and was in charge of cooperation with Bulgaria in support of democratization. In 1993 he became the First Secretary of the Japanese Mission to the Organisation for Economic Co-operation and Development (OECD), in Paris, returning to Tokyo in 1996 as Chief, Deputy Foreign Minister's Office. He then went abroad as Deputy Head of Mission at the Embassy of Japan in Prague, Czech Republic (1998-2000) and subsequently as Chargé d'Affaires of the newly opened Embassy in the Slovak Republic (2001-02).

Mr. Araki returned to Tokyo in 2003 as Director for free trade agreement negotiations, and until 2006 represented Japan in talks with a number of countries concerning various trade matters. □

## New agreement formalizes cooperation with CBD Secretariat

ICAO and the Secretariat of the Convention on Biological Diversity (CBD), a part of the United Nations Environment Programme (UNEP), have signed a memorandum of understanding (MOU) covering a number of administrative services. The new agreement takes advantage of the proximity of the two UN bodies — both situated in Montreal, Canada — and formalizes cooperation in administrative areas.

In signing the agreement on 19 February 2007 (see photo), ICAO Secretary General Dr. Taïeb Chérif indicated ICAO's desire to also work more closely with the CBD Secretariat on technical issues of mutual interest, such as invasive alien species and the trans-boundary movement of genetically modified organisms. As highlighted in *ICAO Journal* Issue 1/2007 ("Air transport remains a major pathway for invasive alien species," pp. 22-23), the problem of invasive alien species is a serious issue for governments, and one that the CBD Secretariat and ICAO are working together to address.

The agreement between the organizations was signed at the opening of a major CBD meeting in Montreal that attracted delegates from 54 countries around the world. The arrangements for that meeting, which was held in ICAO's conference centre, typify the kind of collaboration provided for in the new MOU. The agreement reflects a wider effort to maximize the resources of UN bodies everywhere, thus ensuring more cost-effective and efficient service to the international community.

Dr. Ahmed Djoghlaf, the Executive Secretary of the CBD Secretariat, stated that the CBD looked forward to the enhanced collaboration on administrative arrangements, as well as on technical matters of major international importance.

Under the MOU, ICAO will make its meeting facilities available to the CBD Secretariat on a priority basis, and will provide support for setting up a computer network to service such meetings. ICAO will also facilitate recruitment of linguistic interpreters at CBD meetings in its building, and will provide printing and reproduction services. All of the services are to be provided to the CBD on a cost basis.

***ICAO Secretary General Dr. Taïeb Chérif (left) and Dr. Ahmed Djoghlaf, Executive Secretary of the Convention on Biological Diversity, sign an MOU at ICAO headquarters on 19 February 2007*** □

## China's safety improvements

*continued from page 10*

including safety specialists. It is estimated that China will require more than 10,000 new safety experts, including inspectors, managers and safety officers, in the years ahead.

China needs to focus more intently on the development of safety data reporting and analysis, as well as on more widespread utilization of safety technology. A special fund will be created for these purposes. As well as intensifying its investment in all matters related to safety, China will emphasize a closer cooperative relationship with international organizations such as ICAO, and with civil aviation administrations in other countries. All parties will benefit from this greater cooperation, which will facilitate information sharing and promote safety enhancement worldwide. □

## Global safety picture

*continued from page 10*

safety are notable. While the overall safety level has certainly improved, there remain significant differences in regional safety levels, as well as major differences in the level of safety in different types of operations. The final approach and landing phases — as well as take-off and initial climb — continue to account for the greatest number of accidents, while controlled flight into terrain (CFIT) accidents result in the greatest number of fatalities.

Today's safety issues are being addressed by employing technological solutions. Modern aircraft incorporate materials and systems that promote safety, and existing aircraft are being retrofitted with equipment such as the airborne collision avoidance system (ACAS), the enhanced ground proximity warning system (EGPWS), the aircraft communications addressing and reporting system (ACARS) and advanced communications, navigation and surveillance (CNS) systems that heighten situational awareness.

Equally important is the advent of safety management. While safety management focused initially on implementing technological improvements, human factors became increasingly important in the 1970s. In recent years, the focus has shifted to implementation of safety management systems, an approach to safety that holds organizations as well as individuals responsible for safety performance. ICAO has called for implementation of safety management systems around the world, a development that stresses enhancing safety through risk management and the employment of systematic and proactive management techniques. □

## Wind shear detection

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the pilot whenever wind shear is accompanied by storms. TWIP may also be available soon at Hong Kong. The Hong Kong Observatory and Northwest Airlines recently completed a six-month trial run of TWIP message alerts generated by the Hong Kong TDWR. According to the Hong Kong Observatory, if this trial is judged successful, future assessments may be conducted using wind shear, turbulence and storm information derived from the WTWS.

As indicated above, the ITWS — currently located at 13 approach control units — is a significant ATM planning tool. Nine more approach control units will receive an ITWS by the beginning of 2008, however, funding has not yet been secured for an additional 12 systems to be located mostly in the central United States, where the mean number of convection days ranges from 40 to 60.

With the goal of extending weather safety and planning coverage to medium-sized aerodromes, a test will be conducted at three such facilities where the available weather information will be generated by ITWS. If this proof-of-concept study proves successful and funding can be found, 42 additional aerodromes will receive convective weather hazard information (excluding low-level wind shear) and weather planning products such as terminal winds and TCWF.

In summary, ground-based wind shear detection systems can constitute a vital component in safe operations. This is especially true since the deployment of forward-looking wind shear systems on aircraft has been significantly less than expected for some airlines. The increase in regional jet service will also limit the potential number of aircraft with advanced warning of wind shear, because currently such aircraft cannot be equipped with forward-looking wind shear systems. Further system enhancements — the TDWR RDA upgrade, algorithm design changes, radar products generator capabilities and the use of terminal weather information among them — will allow for future weather product improvements. These will include detecting wind shear with less dependence on storm verification, decreasing the initial gust front detection time, processing frequent gust front detections, and issuing headwind gain alerts and crosswind alerts. As explained, the problem of dry wind shear detection in the western U.S. can be resolved; however, a national programme to address this issue has not yet been initiated.

Several weather efficiency products, as outlined above, can increase aerodrome capacity. The ITWS TCWF and terminal winds are examples of weather product efficiency tools. There has also been progress in predicting thunderstorms, although the capability to estimate convective weather one hour in advance remains under the two hours desired by ATS.

As air traffic continues to grow, the accuracy and timeliness of weather products derived from various systems will play a large role in capacity gains, provided these meteorological tools are integrated into automated air traffic management tools and wake vortex avoidance systems. □

**PUBLIC KEY DIRECTORY**

The ICAO Public Key Directory (PKD), an ICAO-coordinated service to facilitate authentication of electronic machine readable travel (MRTD) documents, entered operation recently after Australia became the fifth member State to submit its notice of participation to ICAO. Simon Clegg, Representative of Australia on the Council of ICAO (centre), is pictured on 6 March 2007 presenting Australia's notice of participation to Dr. Taïeb Chérif, the Secretary General. At left is ICAO Council President Roberto Kobeh González.

## Electronic data collection

*continued from page 28*

the industry. The focus at this stage is on establishing needs and determining which data elements can be collected. Once these have been defined, electronic data collection will be assessed with the aim of adapting existing ECATS tools and procedures to the realities of general aviation.

The advent of ECATS has permitted Transport Canada to become the heart of airline operational data collection for the Canadian government. But to proceed from being a simple collector of information to a data hub, it was necessary for ECATS to incorporate a secure dissemination application for use by stakeholders. The carefully crafted process means that once air carriers active in Canada have formally agreed to have their data communicated to the airports they serve, Transport Canada forwards this information via its secure channel. With this process in place, airlines need not make multiple filings of their operational statistics to multiple airport authorities. The obvious advantage is the savings of time, effort and cost.

A successful dissemination pilot project in which Transport Canada granted one operating authority access to data for six carriers serving its airport has already been carried out. The ECATS team is now working to increase the number of airline participants with the hope of meeting the growing interest from both air carriers and airport authorities in the efficient, reliable and secure reporting solution available from ECATS. First and foremost in this approach to data dissemination is Transport Canada's pledge to respect all legislative provisions regarding data confidentiality.

In addition to the air transport industry, Transport Canada foresees some important benefits in leveraging the ECATS approach to support data collection from other transportation sectors. Testing is now being undertaken with a trucking company and a courier operation to obtain data on both transported goods and chosen itinerary, using global positioning system (GPS) data. The GPS data which provides the complete itinerary of the transported goods can be collected directly through the web service approach.

While the layout of the data fields vary greatly from one mode to the next, the flexible structure of ECATS permits collection across different modes. From a conceptual viewpoint, all transportation statistics of interest pertain to either the vehicular mode or content, with both tied together by routing information. Therefore, by being independent of the carrier's mode and its computer-operating environment, ECATS offers the flexibility and capacity to become a secure data collection portal for all forms of transport.

The success of ECATS has not gone unnoticed. In 2005 the programme won a gold medal award at a Canadian government technology exhibition for its role in enhancing government operations. The ECATS model initially designed for the Canadian air transportation industry has also generated interest from other government bodies and from airport authorities outside Canada.

One of the main strengths of ECATS has been its ability to forge partnerships with stakeholders and across government departments. Airlines and airports realize the potential benefits of this programme and have often shown themselves to be its strongest proponents. In light of the highly competitive environment in which air carriers operate, these companies welcome measures that streamline their regulatory obligations. □

## Air cargo security

*continued from page 23*

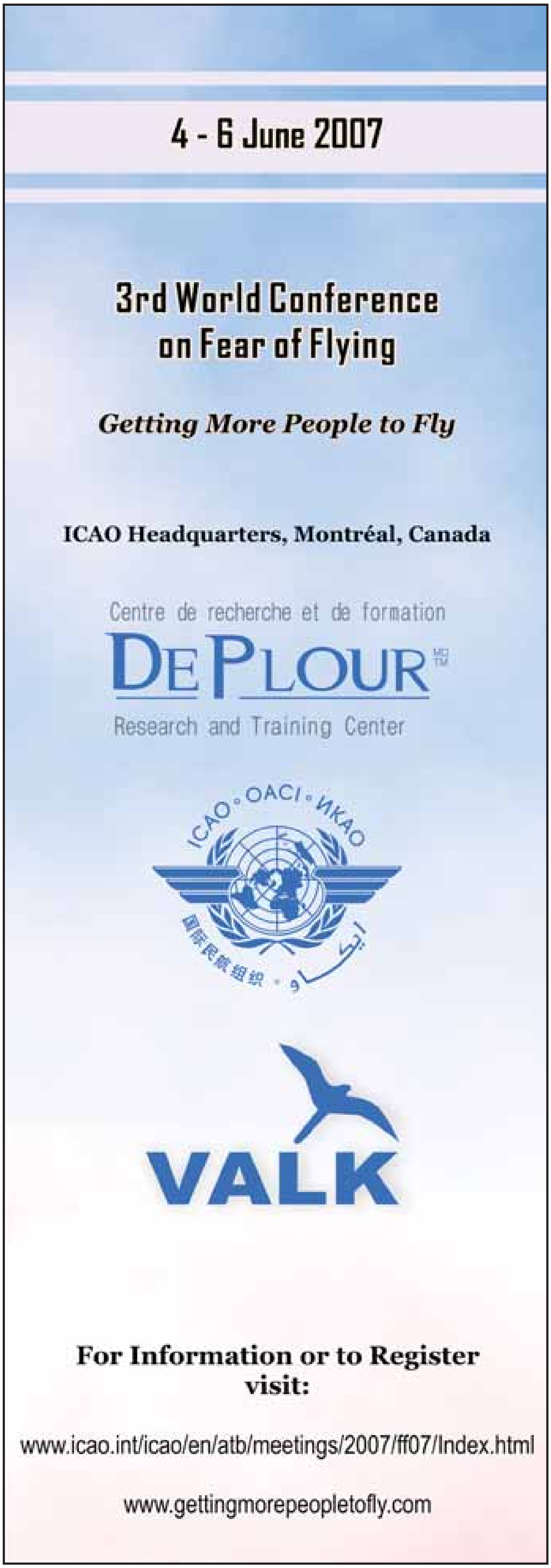
though they were a passive, potential victim of it. Many commented on the cost of validation, but only a minority considered that this was excessive, or felt the cost should be funded by taxation.

The review found that following the introduction of independent validation, the standards of security at known consignor premises had greatly improved. Staff originating known cargo are subjected to background checks and vetting, and are trained in aviation security. Known cargo, once identifiable as such, is secure while on the premises, and remains so during transit to the airline or regulated agent. Sites are subject to unannounced compliance inspections by DfT personnel, who can revoke the known consignor status should they discover that the standards have been allowed to slip. Where known consignor status is lost, the industry is informed of the fact, and any air cargo tendered from that consignor is then regarded as unknown and screened accordingly.

While the findings were generally positive, the security review also recommended a number of changes. One of these stemmed from the observation that there existed a disparity in the number of inspections completed by individual validators, with some undertaking more than 100 validations annually, while others performed only one or two per year. This raised concerns about the ability of the relatively inactive validators to render valid judgements, since they did not have a regular opportunity to exercise their skills. Consequently, the Department for Transport implemented a requirement that all validators undertake regular refresher training. It has also changed the allocation process: the Department for Transport now assigns validators to customers, whereas the original procedure allowed the customer to select a validator from the website list.

The review also found that there were too many accredited validators (97) given the number of known consignors (1,500). As the accreditation period for consignors coincided with the review, it was decided that each validator should undertake compulsory competency testing and a structured interview before he or she could be considered for reaccreditation. The result of this new procedure has been a decline in the number of validators being reaccredited for a further three-year period, to a total of 70.

In July 2006, the Department for Transport organized, on behalf of the European Commission, an international workshop on independent validation of known consignors. Over 20




European Union (EU) and European Free Trade Association (EFTA) States were represented, with four EU member States taking the opportunity to explain how they undertook the independent validation of known consignors.

The U.K. Department for Transport has found the independent validator scheme to be cost efficient and effective in raising the security standards at sites originating known cargo, and has concluded that it provides a pragmatic, practical and effective method for minimizing the vulnerability of air cargo. The European Commission is expected to propose shortly that independent validation of known consignors become a requirement across the European Communities. □

## Safety data integration

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the risk to a reasonable level by using the details inherent in the safety report data.

With respect to error rates, initial estimates of error rates would generally come from internal LOSA-type data, combined with data from ARCHIE. While safety reports of crew errors are available, these are unlikely to be consistently reported and therefore provide only limited value in a quantitative sense (they do, of course, provide substantial value in a qualitative sense). An additional estimate of error rates is provided by combining the estimated threat rates with the transition threat-to-error rates. Again, a Bayesian approach can be used to provide a best estimate that reconciles the three elements.

For the transition from errors to undesired aircraft states, again the estimate can be based on the internal LOSA data combined with ARCHIE data. Indications from analysis of ARCHIE data is that the pattern of the relationship between threats and errors is fairly stable between airlines. It is reasonable to suppose, therefore, that this estimate would be quite reliable.

With an initial approximation of the error rate in hand, data from FOQA could then be used to improve the estimate for most categories of undesired aircraft states. Finally, safety report data provide a reasonable estimate of this ratio, since it can be assumed that the most severe undesired aircraft states will be reported by crews.

With respect to outcome rates, these are based on ICAO ADREP and IATA safety report data, including information from STEADES. Outcome rates can potentially be updated to include the airline's actual record (using the Bayesian estimate again). This boils down to assessing statistically whether the actual airline record over a specified period of time is significantly different from the industry average.

Transition from undesired aircraft states to either an accident or serious incident would be based on analysis of undesired aircraft states reflected in ADREP and STEADES data, according to the current analytical method (i.e. integrated threat analysis). This would provide an estimate of which undesired aircraft states result in accidents or serious incidents, but would not highlight undesired states that do not result in an accident or serious incident. By comparing the rates of undesired aircraft states with the outcome rates and the information obtained from ADREP and STEADES analysis, we can find the missing elements.

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The overall model provides for linked estimates. Multiplying the threat rates by the transition-to-errors matrix provides an estimate of error rates and so on, through to undesired aircraft states. Extension to outcomes would not add value as users would be forced to compare undesired aircraft states and outcome rates to estimate the undesired states that do not result in accidents or serious incidents. As such, the calculation can be improved by iteratively applying this process until a consistent set of estimates is established.

The approach outlined above offers a structured method of combining all the safety data available to an airline or other organization with an interest in aviation safety. The risk model that results can be used to determine, for example, which types of adverse outcomes pose the greatest risk, and can indicate which improvements in upstream safety performance would materially reduce that risk. This approach can show, for instance, which undesired aircraft states contribute most significantly to risk. If these undesired aircraft states relate to specific FOQA parameters, clear improvement targets can then be set.

The model also provides a basis for incorporating lessons learned from investigations of adverse events. For example, if we are looking at the transition from unstable approach to outcomes in the categories of CFIT, landing short, hard landing and runway excursion, it would be useful to look at what could or did affect the outcome from the point that the crew decided to continue with the landing. Such a review could focus on flight crew training, technical and human factors, procedures, ground proximity warning system (GPWS) operation, airport and runway design (e.g. runway centreline lighting).

Finally, the model offers a breakthrough by promising to address the risk precursors to adverse outcomes in a quantitative fashion. This in turn offers the ability to better assess the benefits from safety improvement — the type of assessment that is increasingly relevant in today's economic conditions. While at this stage the promise should not be oversold, it is surely worth pursuing. □

## CFIT prevention

*continued from page 15*

of CFIT, as described above, call for action by States, operators and airframe manufacturers. States need to improve the provision of crucial terrain and aeronautical information, as required by ICAO standards; operators must update their systems, a task that can be achieved at very little cost; and airframe manufacturers should provide operators with the necessary service bulletins that affect EGPWS/TAWS operation.

The measures cited above would considerably reduce the risk of CFIT accidents by eliminating the possibility of there being no warning when a prompt warning should be forthcoming. Equally important, they would lower the risk of CFIT by reducing the possibility of navigation and position shift errors and the occurrence of false warnings.

It is also necessary, in the pursuit of safety, to make available to everyone the information and lessons learned from the investigation of incidents and accidents. To this end, it is essential that all near-CFIT incidents and CFIT accidents are reported and investigated. □

# CEIA EMDs

## STATE-OF-THE-ART ENHANCED METAL DETECTORS

CEIA S.p.A. An ISO 9001 Company CERTIFIED


CEIA EMD application

- Fully compliant with the New Security Standards for Conventional and non-Conventional Weapons
- Unsurpassed Passenger Throughput
- Exceptional Immunity to Environmental Interference

CSQ IQNet CERTIFIED MANAGEMENT SYSTEM

UNI EN ISO 9001 CERTIFIED

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