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INTERNATIONAL CIVIL AVIATION ORGANIZATION

Runway Safety

Previewing ICAO's 2011 Global Runway Safety Symposium and Highlighting the Wide Range of State and Industry Initiatives Now Addressing Runway Safety Outcomes

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Vol. 66, No. 2

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THE ICAO JOURNAL
VOLUME 66, NUMBER 2, 2011

Editorial
ICAO Communications Office
Tel: +01 (514) 954-8220
Web site: www.icao.int

Anthony Philbin Communications
Senior Editor: Anthony Philbin
Tel: +01 (514) 886-7746
E-mail: info@philbin.ca
Web site: www.philbin.ca

Production and Design
Bang Marketing
Stéphanie Kennan
Tel: +01 (514) 849-2264
E-mail: info@bang-marketing.com
Web site: www.bang-marketing.com

ICAO Photographs: Gerry Ercolani

Advertising
FCM Communications Inc.
Yves Allard
Tel: +01 (450) 677-3535
Fax: +01 (450) 677-4445
E-mail: fcmcommunications@videotron.ca

Submissions
The *Journal* encourages submissions from interested individuals, organizations and States wishing to share updates, perspectives or analysis related to global civil aviation. For further information on submission deadlines and planned issue topics for future editions of the *ICAO Journal*, please forward your request to info@philbin.ca.

Subscriptions and single copies
Yearly subscription (Six Issues per year) US $40. Single copies available for US $10. For subscription and sales information please contact the ICAO Document Sales Unit,
Tel: +01 (514) 954-8022
E-mail: sales@icao.int

Published in Montreal, Canada. ISSN 0018 8778.

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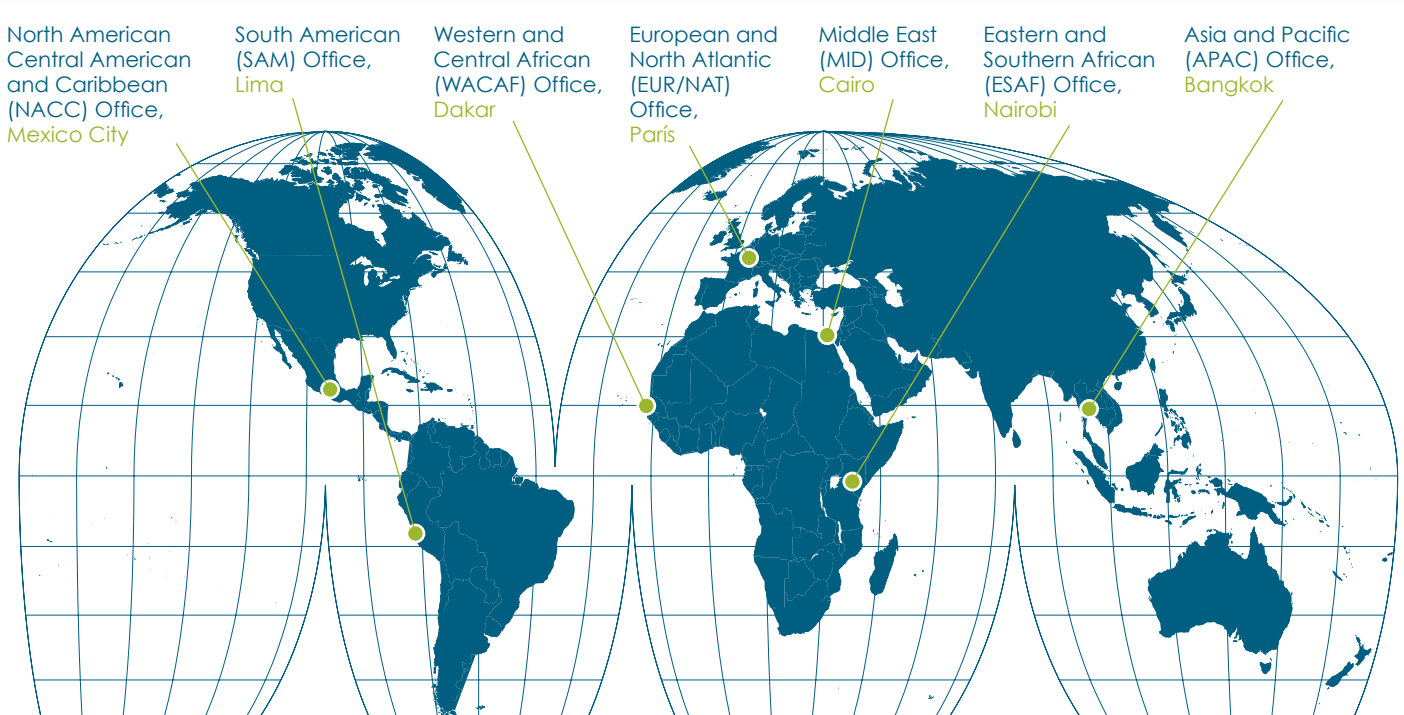
ICAO's Global Presence



NANCY GRAHAM, DIRECTOR, AIR NAVIGATION BUREAU

Focusing on Risk

A Global Approach to Runway Safety

Safety is ICAO's top priority. Every year, millions of passengers are transported safely through scheduled air operations.

Despite the economic downturn, demand for international air transport continues to grow. World traffic is expected to rise by 4.7 percent in 2011 and 4.9 percent in 2012, with similar growth rates for the rest of the decade and beyond. Despite this growth, aviation remains our safest form of transportation—with a remarkably low global accident rate of roughly 4.1 accidents per million departures. But, as we all know, this record differs significantly from region to region.

In the last few years, ICAO has taken a more action-oriented approach to promoting the safe development of international civil aviation. The Organization has been advancing safety management practices through the introduction of Safety Management Systems (SMS) for service providers and the State Safety Programme for regulators (SSP).

Last year, during the High-level Safety Conference, I outlined ICAO's own plan for performing safety management. From our standpoint, it's all about focusing resources more effectively to reduce risk, and runway safety is currently our highest risk area.

In Europe and North America, stakeholders have been working on the runway safety issue for some time now with significant success. Over a decade ago, studies had begun to point to the correlations between traffic growth and runway incursion increases, with one study in particular demonstrating that a traffic increase of 20 percent could result in as much as a 140 percent jump in the risk of a runway incursion. This was obviously an unacceptable outcome.

Accordingly, States and industry responded on a number of fronts over the past decade to address the causes of runway incursions. In 2005, ICAO completed some of the initial work in this area and provided Member States with a Runway Safety Toolkit through the ICAO Flight Safety Information Exchange (FSIX).

As work in this area proceeded over the next few years, ICAO's contributions included establishment of a global agreement on a new definition for runway incursions. Though seemingly a minor step, this in fact paved the way for safety data in this area to be analyzed and shared by relevant global safety stakeholders in a much more meaningfully way than had previously been the case. By 2007, the Organization's ongoing reviews and analyses led to a series of international seminars and to the publication of Doc 9870, the *Manual on the Prevention of Runway Incursions.*

All of these efforts by ICAO and other organizations have helped to improve runway safety significantly. Thanks to improved outreach and coordination locally and globally, these successes are ongoing as new technologies and procedures come online. Implementation of Airport Surface Detection Equipment, Model X (ASDE-X) and similar systems will continue to provide the more immediate and accurate situational awareness that pilots and controllers require to reduce the risk of incidents and accidents resulting from runway incursions.

Staying Focused on Risk: Runway Excursions

Despite these successes on the runway incursion front, runway excursions have remained a prominent area of risk and concern. The Flight Safety Foundation's 2009 *Global Plan for the Prevention and Mitigation of Runway Excursions* documents that excursions are absolutely 'public enemy number one' when it comes to runway safety. Currently, excursions are roughly 30 times more likely to occur than incursions—again, this is an unacceptable situation.

I need to reinforce here that runway safety, with respect to incursions and excursions as well as an additional risk category, runway confusion, are by their nature multidisciplinary issues requiring high levels of coordination and cooperation between all stakeholders in the air transport community. Airport and aircraft operators, associations representing pilots and air traffic controllers, aircraft and avionics manufacturers, air navigation service providers and regulators all have important contributions to make and parts to play in the development of any effective runway safety solution.

For its part, ICAO has continued to review and amend its requirements and guidance material to better reflect new information and best practices that are being implemented by all safety stakeholders globally. I would draw your attention to the sidebar in our main Runway Safety feature story in this issue (page 10), which provides a more detailed account of the ongoing improvements being made to Annexes 6, 11 and 14, as well as new provisions and amendments to our Standards and Recommended Practices (SARPs) which can contribute to reducing runway excursions.

At the global level, IATA, ACI, CANSO and many other stakeholders should also be commended for their proactive approaches to tackling the issue of runway excursions. ICAO has contributed important data and expertise to several tools and programmes that are presently being put in place.

Moving forward, as more State- and facility-specific programmes are additionally implemented, one of ICAO's main challenges is to establish higher levels of coordination so that the sharing of information and best practices related to runway excursions can benefit aviation stakeholders more quickly and on a globally-harmonized basis. It's for this and other reasons that ICAO has organized its Global Runway Safety Symposium (GRSS 2011) which will be held in Montreal this May.

The 2011 ICAO Global Runway Safety Symposium

Beyond clearly identifying the common elements in the runway safety framework, GRSS 2011 will benefit Industry and States as ICAO fine tunes more locally-focused tools and solutions through delivery of a series of special regional runway safety workshops during the next three years.

By better defining specific safety objectives related to runway safety, ICAO will help to support States in their efforts to define and implement more effective runway safety legal frameworks. In conjunction with industry initiatives and the increased outreach and awareness that are now apparent among all pertinent stakeholders, air transport can be confident that reductions in the rate of runway excursions will soon compare to those that have been achieved for runway incursions.

All of these runway safety efforts will undoubtedly benefit from the high-level strategic programmes and agreements on safety that ICAO has been working hard to achieve. During last year's Assembly we signed one such agreement with the European Commission, the U.S. Department of Transportation and IATA, to share safety information through ICAO's new Global Safety Information Exchange system.

A concrete example of ICAO's improved safety analysis capabilities is the Organization's Integrated Safety Trend Analysis and Reporting System, also known as iSTARS. This system provides crucial information to guide policy decisions and to prioritize the use of limited safety resources. ICAO is also continuously partnering with other organizations to increase the distribution of safety information, one great example being our partnership with Skybrary, the excellent EUROCONTROL initiative.

All of the above, and how it fits together to continue to improve aviation safety worldwide, will be outlined in a revision to ICAO's Global Aviation Safety Plan, due out at the end of this year and accompanied by ICAO's first annual Aviation Safety Report.

In short, this is a new ICAO and we are working hard to be more strategic, efficient and effective in order to best support your global needs toward a continuously improving aviation system. A system that is more safe, secure and environmentally friendly each and every day. ■

Nancy Graham
Director, ICAO Air Navigation Bureau

Leadership and Vision in Global Civil Aviation

GRSS 2011:
Ensuring a Globally Harmonized Approach to the Mitigation of Runway Safety Risks

ICAO will be hosting a high-level and multidisciplinary Global Runway Safety Symposium (GRSS 2011) from 24–26 May in Montreal. The priorities of this event will be to highlight the evolution towards a more integrated safety management approach in ICAO's runway safety programme, to better coordinate global efforts to improve runway safety by specifying State-controllable safety outcomes, and to identify a more common framework for the enhancement of runway safety.

To support improved capacity-building in this area, significant emphasis at the event will also be placed on determining the structure and delivery of near-term regional runway safety workshops, featuring the commitment and participation of all key industry and regulatory partners.

As reflected by the input from the many high-level stakeholders and organizations that contributed to this special symposium preview, this safety category remains a point of high concern for the global aviation community and ICAO's coming GRSS 2011 event is expected to generate a strong, comprehensive and multidisciplinary response leading to measurable improvements for all runway safety outcomes.

Airport runways, simply put, are where virtually every airplane flight—from the largest commercial jet to the smallest private aircraft—begin and end. As new data has revealed over the past few years, they are also one of aviation's most risk-intensive areas of concern.

Runway accidents fall into three main categories: incursions, excursions and confusion. Runway incursions are characterized by any incorrect presence of an aircraft, vehicle, or person on the runway and associated protected area, regardless of whether or not that presence presents a potential conflict. Runway excursions refer to any event where an aircraft veers off the side of, or overruns, its designated runway during take-off or landing. Runway confusion is considered to have occurred whenever an aircraft has made an unintentional use of the wrong runway or taxiway.

Multiple factors enter into all runway accidents, including airport design and construction, Air Traffic Control (ATC), Air Traffic Management (ATM) systems and processes, airline operations, flight crew awareness and communications, etc. It is because of this complex series of interrelated potential causes that any effective runway safety programme or provision must be characterized by highly consultative and multidisciplinary research and solutions.

At the international level, ICAO Annex 14, Volume I—*Aerodrome Design and Operations,* in addition to Annex 11—*Air Traffic Services,* currently provide ICAO Standards and Recommended Practices (SARPs) that address occurrences related to runway safety from aerodrome design and operational perspectives. In recent years, ICAO has also developed and updated additional SARPs pertaining to runways, work which is still ongoing, to further enhance safety in this area on a global basis *(see sidebar on page 10).*

Despite the presence of this guidance and the continuing efforts of ICAO and the industry, data compiled and published over the past few years by the Flight Safety Foundation (FSF, see sidebar, right) reveals that runways are still characterized by ongoing and, in some cases, significant levels of risk to the safety of aircraft, flight crews, ground crew and passengers.

To respond to these continuing concerns and provide a recognized global forum to define and better coordinate the required solutions at the international level, ICAO has organized a special high-level Global Runway Safety Symposium (GRSS 2011), to be held this 24–26 May at ICAO Headquarters in Montreal.

"The overall objective of GRSS 2011 is to better identify the common elements in the runway safety framework," commented Captain John Illson of ICAO's Integrated Safety Management Section. "These affect multiple operational domains as well as regulatory authorities. Our goal is to come to an understanding with the various stakeholders involved in this issue and also to set the stage for a series of regional runway safety workshops that ICAO will be holding during the next three years."

Illson also stressed that there is a regional component to the runway safety issue, primarily related to the varying geographical, regulatory and especially infrastructure aspects that can have an effect on related safety metrics. Much of ICAO's focus will be on assessing runway safety factors on virtually a State-by-State basis in order to provide tailored, meaningful workshops and proposals for States to eventually act on.

Other aviation community stakeholders have also taken notice of the FSF findings over the past few years and have similarly put in place programmes and tools to help the sector improve its safety performance in this area. Much of the excellent and ongoing work in this regard is outlined in the paragraphs that follow. One ambition of GRSS 2011 will be to provide a forum to these organizations so that they can share experiences and best practices to

KEY CONTRIBUTOR: THE FLIGHT SAFETY FOUNDATION RUNWAY SAFETY INITIATIVE AND *GLOBAL PLAN*

The issue of runway safety became increasingly highlighted in recent years due to the concerted and multidisciplinary research and efforts of the FSF and its 2006 Runway Safety Initiative (RSI). This work was achieved on an international basis in conjunction with approximately 20 organizations, which together formed the RSI Group. Members included aircraft and airport operators, manufacturers, air navigation service providers, pilot groups and other industry associations.

The RSI Group initially reviewed the three known areas of runway safety risk: runway incursions; runway confusion; and runway excursions. The runway excursion category quickly revealed itself to be the area requiring the most urgent research and attention. Whereas 431 turbojet and turboprop accidents of the total 1,429 that occurred between 1995 and 2008 were runway related (30 percent), 417 of these were caused by runway excursions (97 percent of the runway accident total).

The RSI was completed in 2009 with the publishing by the FSF of its *Global Plan for the Prevention and Mitigation of Runway Excursions*. This document significantly intensified the aviation community's attention to the broader subset of runway safety issues and was one of the catalysts for GRSS 2011.

further improve aviation's overall coordination and response to the issue of runway safety.

IATA Runway Excursion Risk Reduction Tool Kit - Second Edition

ICAO, IFALPA, IFATCA and other industry safety organizations have been providing important input in recent months to IATA towards the Second Edition of the airline association's Runway Excursion Risk Reduction Tool Kit (RERR Tool Kit). The RERR Tool Kit was developed on a first stage basis by IATA and the FSF using the data and conclusions established by the FSF's 2006–2009 Runway Safety Initiative (RSI).

"The preliminary version of the IATA RERR Tool Kit, prepared with support from the FSF, was an important starting point in the evolution of this important new tool," remarked Günther Matschnigg, IATA's Director of Safety, Operations and Infrastructure. "Once it was prepared, IATA then distributed over 8,000 copies worldwide and hosted more than 18 runway safety workshops and presentations. Input from hundreds of participants was collated over the past two years and incorporated into the Second Edition of the Tool Kit. We have recently noted a 40 percent annual reduction in runway excursions accidents since 2008 so these efforts are beginning to make a difference."

While these first steps were ongoing, IATA had already begun consulting with ICAO's Air Navigation Bureau and other industry organizations, including CANSO, ACI, IFALPA, the FSF and EUROCONTROL, for further input toward the RERR Tool Kit's Second Edition. This new version will include animations of near runway excursions and greatly expanded guidance for airports and Air Navigation Service Providers (ANSPs). It also includes new case studies of all recent runway excursion accidents, an updated accident analysis report, industry best practices survey results, and an all new Runway Excursion Risk Management Process module.

The Second Edition RERR Tool Kit will be released in May 2011 at the ICAO Global Runway Safety Symposium—where IATA will also be an event sponsor.

"IATA and the airlines alone cannot solve a multidisciplinary safety issue of this nature, that much is very clear," stressed Matschnigg. "Involving regulatory, operator, ATM and all other affected stakeholders is the only path towards a comprehensive and effective solution and this is the path that we have been following."

"As we look ahead," he concluded, "especially to the role that newer Performance-based Navigation (PBN) technologies can play in improving safety results across the board in this area, IATA and ICAO will need to work even more closely together because the major stumbling block in that regard continues to be State approvals. We know how to fly it, we know how to design it, but it seems that many local regulators don't know how to certify it. A new communications, awareness and education programme for State regulators, in close cooperation with ICAO, is IATA's next big priority on this front."

Günther Matschnigg

Airport-led Programmes and the ACI APEX Initiative

At the ACI World Annual General Assembly in Bermuda in November 2010, airport representatives voted unanimously to launch a new safety advancement initiative that will ensure that airports contribute proactively to the demands of a safe and secure air transport system. This multi-pronged programme is designed to unite all regions in a proactive global safety improvement initiative, which will focus on a management systems approach and, initially, on runway safety improvements, in particular.

"Our industry has undergone a great deal of change since ACI was founded 20 years ago and the need for our strong airport voice has grown," declared ACI Director General Angela Gittens. "We've witnessed a progressive evolution in airport management that has tipped the scales from the public utility model that characterized us in the past to an entrepreneurial business model that prizes management efficiency, financial vitality, and customer service excellence. This retains the traditional values of safety, security and environmental responsibility."

Angela Gittens

"That model requires that we chart our own course," Gittens continued, "initiating action and taking a leadership role, rather than merely drifting through the channel designed for us by others. In pursuit of these objectives, a new safety initiative has been developed with the seal of approval of the ACI World Governing Board, called APEX in Safety, which stands for Airport Excellence in Safety."

The ACI APEX initiative has been formulated based on extensive consultation with a variety of stakeholders, including an initial survey of ACI members, ACI World Safety and Technical Committee, ACI Regional offices and their regional safety committees, and finally with ICAO.

Of the APEX strategy's four primary objectives, minimizing runway excursions will form an important component. Recognizing that it is a complex issue and one that does not fall solely under the responsibility of the airport operator, ACI will suggest its members focus on the important coordination role that they will need to play together with other stakeholders, especially pilots, airlines and air traffic control services.

Global Runway Safety Symposium

24–26 May 2011
ICAO Headquarters, Montréal, Canada

Runway Safety Programme Partners:

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- Air navigation service providers
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Ms. Ivana Modoryova
Telephone: +1 514 954-8219, ext. 8097
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New Developments in ICAO Provisions for Runways

States and industry have responded on a number of fronts over the past decade to address the causes of runway incursions. In 2005, ICAO completed some first work in this area and provided Member States with a Runway Safety Toolkit through the ICAO Flight Safety Information Exchange (FSIX).

As work in this area proceeded over the next few years, ICAO's contributions included establishing global agreement on a new definition for runway incursions. This paved the way for runway safety data to be much more effectively analyzed and shared between all stakeholders. By 2007, the Organization's ongoing reviews and analyses had led to a series of international seminars and to the publication of Doc 9870, the *Manual on the Prevention of Runway Incursions.*

The following are some of the more recent developments which ICAO has adopted and is continuing to undertake to improve runway safety outcomes:

Annex 14

Runway Incursions

Annex 14, Volume I, contains provisions on visual aids for navigation, surface movement guidance and control systems (SMGCS), aerodrome vehicle operations, etc., to help prevent runway incursions. With respect to visual aids, ICAO encourages the use of stop bars (even in good visibility conditions), runway guard lights and various additional lighting systems, signs and markings.

Recently, ICAO has introduced new provisions for enhanced taxiway centre line markings and has strengthened the use of mandatory instruction markings as part of its increased runway incursion prevention measures (see example, below).

An example of the enhanced runway centre line markings now being stipulated under new Annex 14 provisions.

New runway-related provisions were also proposed at the autumn 2010 second meeting of the Aerodromes Panel (AP/2), including new technologies in visual aids for navigation. These are undergoing review and consultation and are envisaged to be applicable in 2012.

In addition to these developments, guidance material on aerodrome design to help prevent runway incursions is now being finalized for inclusion in the Aerodrome Design Manual. Other new tasks, including the standardization of taxiway naming conventions to help prevent runway incursions, are included in the future work programme.

Runway Excursions

Proper implementation of ICAO SARPs during the design, operation and maintenance of an aerodrome is a very important measure in helping to avoid or minimize runway excursions.

Proper design of the runway and associated facilities, according to the physical characteristics as specified in Annex 14, Volume I, provides a solid foundation for preventing and mitigating the consequences of runway excursions. Runway surface conditions, including runway surface friction characteristics, are similarly vital to runway excursion prevention.

New and amended provisions concerning runway friction measurement and surface condition assessment and reporting were also proposed at AP/2. An ICAO circular containing the latest information on the subject is now being finalized and should be posted on the ICAONet within 2011. The future work in this area includes developing provisions for a global reporting format, including common taxonomy for runway surface conditions and their correlation to aircraft braking performance, in order to help prevent excursions.

Runway-associated facilities, including runway strips and Runway End Safety Areas (RESAs) are extremely important in mitigating the consequences of a runway excursion. New provisions on RESAs and associated mitigating measures have been proposed by AP/2 and the prevention of runway excursions is also being enhanced by provisions for standardized visual aids that provide consistent situational awareness to flight crews, including visual aids designed to guide aircraft to the correct landing point.

The Second Edition of IATA's Runway Excursion Risk Reduction Toolkit, featuring considerable input from ICAO's Air Navigation Bureau, is now being finalized to address runway excursions in the fields of aerodrome design and operations, air traffic management and flight operations *(see page 8).*

Foreign Object Damage (FOD)

ICAO has also strengthened provisions concerning the inspection, monitoring and maintenance of movement areas, including runways, through Amendment 10-A to Annex 14, Volume I.

The amendment upgraded to a Standard the existing provisions requiring regular inspection of the movement area. The inspection and regular monitoring of the movement area shall constitute part of an aerodrome's preventive and corrective maintenance programme so that runway pavements are kept clear of Foreign Object Damage (FOD).

Future work in this area includes the development of guidance on the use of automated FOD detection systems.

Annex 11

The SARPs of Annex 11 (Air Traffic Services) elaborate explicit requirements associated with State implementations of ATS safety management systems and the establishment of national, acceptable levels of safety, including consideration for the aerodrome environment.

At the operational level, the ICAO PANS-ATM provides the global framework for harmonized aerodrome-related procedures, applicable to both ATC and flight crews. The PANS-ATM is under a continuous process of review, ensuring it remains effective in contributing to a safe and orderly aerodrome operating environment.

Annex 6

ICAO Annex 6—*Operation of Aircraft,* Part I, *International Commercial Air Transport—Aeroplanes,* requires that States approve an operations manual. Appendix 2 to Annex 6 provides guidance material for the organization and content of a State manual, which should address procedures that contribute of to runway safety, such as:

- Standard Operating Procedures (SOPs) for each phase of flight.
- Instructions on the maintenance of altitude awareness and the use of automated or flight crew altitude call-outs.
- Instructions on the clarification and acceptance of ATC clearances, particularly where terrain clearance is involved.
- Departure and approach briefings.
- Procedures for familiarization with areas, routes and aerodromes.
- Stabilized approach procedures.

Promoting pilot adherence to SOPs, which would include stabilized approach criteria and go/no-go take-off decision making procedures, is key to preventing and reducing the risk of runway excursions.

"ACI was a key contributor to the FSF 2009 report and has helped develop the guidance material issued at the conclusion of that effort," noted Gittens. "We'll be focusing on runway excursions as a specific project, identifying key performance indicators that should decrease the number of incidents and accidents."

ACI has provided a substantial annex, based on relevant material from its *Airside Safety Handbook,* for the next edition of the RERR Toolkit. Moreover, part of the Toolkit is based on the work that ACI and Flight Safety Foundation initiated, as well as the FSF *Report*. On Runway incursions, ACI has been very involved in ICAO and industry efforts aimed at related prevention.

The council actively encourages the establishment of local Runway Safety Teams to deal with the prevention and mitigation of all types of runway hazards, bearing in mind local circumstances. These teams can help to ensure that runways are constructed and maintained to maximize effective friction and drainage, that runways are closed when conditions dictate, that airports provide timely and accurate runway condition reports, and that they put in place effective snow and ice control plans.

Additionally the teams help airports establish clearly visible runway markings, the presence of adequate runway end safety areas (RESAs) or equivalent systems, and appropriate obstacle assessments.

"ACI is officially designating 2011, our 20th anniversary, as 'The Year of Safety—Safer Still'," Gittens noted. "We'll support two regional safety events during 2011, in Africa and Latin America and the Caribbean, and runway excursion-related topics will be high on both agendas. ACI and its members are very much looking forward to playing a significant role in addressing this cross-industry concern."

European Perspective

Ensuring the safety of runway operations continues to be a difficult and complex issue. A successful Europe-wide initiative over recent years, promoting the concept of an open and blame-free reporting culture, has resulted in a significant increase in all types of ATM occurrences.

For 2010, over 1300 reports involving runway incursions have been received, which averages out at an unacceptably high

figure of more than three per day in the European region. Since the runway accident at Milan Linate Airport 10 years ago, there have been two other instances of aircraft hitting obstructions on a runway, fortunately without loss of life.

"The first edition of the European Action Plan for the Prevention of Runway Incursions was published in 2004," remarked Yvonne Page, Runway Safety Manager at EUROCONTROL. "The document was produced by representatives of all organizations involved in airport maneuvering area operations and the recommendations contained in the Action Plan have been widely implemented across the European region. Many local runway safety teams are now in place."

Yvonne Page

37th ASSEMBLY RESOLUTION ON RUNWAY SAFETY

A37-6: Runway Safety

Whereas runway accidents constitute a large portion of all accidents and have resulted in a great number of fatalities;

Whereas runway excursions are the highest single occurrence category of all accidents over the last ten years for all commercial and general aviation operations of fixed-wing aircraft above 5,700kg certified maximum take-off mass;

Whereas there are several areas of technological development underway in the aviation industry that show great promise in the prevention and mitigation of runway accidents and serious incidents:

The Assembly:

1. *Urges* States to take measures to enhance runway safety, including the establishment of runway safety programmes using a multidisciplinary approach, that include at least regulators, aircraft operators, air navigation services providers, aerodrome operators and aircraft manufacturers, to prevent and mitigate the effects of runway excursions, runway incursions and other occurrences related to runway safety;
2. *Resolves* that ICAO shall actively pursue runway safety using a multidisciplinary approach; and
3. *Invites* States to monitor runway safety events and related precursors as part of the safety data collection and processing system established under their State Safety Programmes.

Associated Practices

1. Runway safety programmes should be based on inter-organizational safety management including the creation of local runway safety teams that address prevention and mitigation of runway excursions, runway incursions and other occurrences related to runway safety.
2. The Council should further develop provisions to assist States in establishing runway safety programmes.
3. States should be encouraged to participate in global and regional seminars and workshops to exchange safety information and best practices on runway safety.

The feedback from pilots operating in Europe has thus far been positive, as they report a greater level of consistency and application of the ICAO procedures and standards across Europe, which was one of the prime objectives of the first Action Plan.

"Since 2004, many lessons have been learned and new data received which has led to a number of new recommendations being developed," continued Page. "Accordingly, an updated second edition of the European Action Plan for the Prevention of Runway Incursions has now been produced. Enhancing the safety of runway operations remains very high on the European agenda."

Comprehensive U.S. Responses

Whereas the European region faces a more complex path to its runway safety solution, given the number of States, regulators and approaches to aviation safety that must be managed there, in the United States the Federal Aviation Administration (FAA), working closely with the National Transportation Safety Board (NTSB) and other U.S. aviation safety stakeholders, has been proactively coordinating national and local runway safety events, training, solutions and tools for several years now.

"ICAO's involvement in getting these straightforward best practices out to a broader international audience will make flying safer—not only for U.S. passengers travelling abroad but for all passengers everywhere."

Wes Timmons, FAA

"The FAA has placed a very high degree of priority on runway safety," began the Administration's Director of Runway Safety, Wes Timmons. "We currently have a dedicated programme office for runway safety and specific resources out in the field working every day with our sector partners to improve related safety results."

As far back as August of 2007, the FAA had issued a 'call to action' for runway safety. It brought in participants from industry, labour, the NTSB and other organizations and has pursued in the years since a focused agenda which thus far has generated a tremendous level of partnership across the U.S. air transport community as well as internationally.

"Pilots made more than 50 million takeoffs and landings in fiscal year 2009 at U.S. airports with air traffic control towers," commented Timmons. "The sheer number of flights, people, and vehicles moving across airport runways and taxiways means there is no single way to reduce runway incursions."

Runway safety solutions and initiatives already put in place by the U.S. regulator are too numerous to list here, but even a brief visit to the organization's dedicated runway safety web site reveals an impressive and list of outreach, awareness, improved infrastructure and technological measures that help to round out its Runway Safety Management Strategy. These include, in part: the establishment of a specific Runway Safety Council with industry; the hiring of new regional FAA runway safety management personnel; outreach and training in con-junction with the Aircraft Owners and Pilots Association (AOPA); airport—specific Action Teams to improve surface safety and situational awareness; and a wide range of technological measures that leverage the latest in NextGen capabilities—including ADS-B, AMASS and ASDE-X solutions.

Wes Timmons

The NTSB similarly had included runway safety on its 2009 'Most Wanted List' of transportation safety priorities. Though the NTSB is often thought of as a responsive accident investigation stakeholder only, part of its mandate does require it to use the data it collects and form proactive recommendations to U.S. transpor-tation stakeholders across the board.

"In the last 20 years, we've made numerous recommendations to improve runway safety, one of the most important of which was the provision of more immediate, realtime warnings of probable collisions/incursions directly to cockpit flight crews," commented NTSB Vice-Chairman Christopher Hart. "Additional recommendations at that time also included requiring specific air traffic control clearance for each and every runway crossing, as well as the installation of cockpit moving map displays or other automatic systems

to alert pilots of attempted take-offs from taxi-ways or wrong runways."

Hart stressed that, based on his organization's accident data, pilots are best suited to recognizing and responding to potentially dangerous runway situations. The NTSB's priority therefore is to promote the imple-mentation of NextGen and related technologies as quickly as possible so as to give pilots the realtime and more comprehensive situational awareness they require on runways and taxiways in order to avoid close calls before they happen.

"Everyone associated with aviation realizes that, in both the short and the long term, we're going to see an increase in the number of aircraft using basically the same number of runways," Hart noted. "As the risks in this area increase in relation to the amount of conges-tion, we think it's important that pilots should be given the tools to recognize and respond to potential danger without the need for a controller to have to tell them first that a collision is imminent."

Both the NTSB and the FAA had been focusing almost exclusively on runway incursion—related incidents and accidents over the past decade. The amount of serious runway incursions—classified as Categories A and B—dropped by more than 63 percent from fiscal year 2000 through fiscal year 2008 largely due to these efforts according to FAA tracking data. In fiscal year 2009, there were twelve serious runway incursions, 50 percent fewer than the previous fiscal year, and all categories of runway incursions were down by six percent in fiscal year 2009 versus fiscal year 2008 (951 in 2009 compared to 1009 in 2008). In fiscal year 2010, there were six serious runway incursions, another 50 percent improvement over the previous fiscal year despite being based on more than 50 million take-offs and landings.

"We'd focused a lot of our attention on incursions since 2000 and have seen some excellent safety results from these collaborative efforts," remarked Timmons. "The recent work by the FSF and the U.S. Commercial Aviation Safety Team (CAST) has now helped to identify the importance of excursion-related risks as well, and so the FAA's attention is moving to that area accordingly. We've already begun collating the data to inform the programmes that will deal with the excursion problem and have held some important events recently to get the quality collaborative input required to ensure that the solutions we put in place address every aspect of the problem."

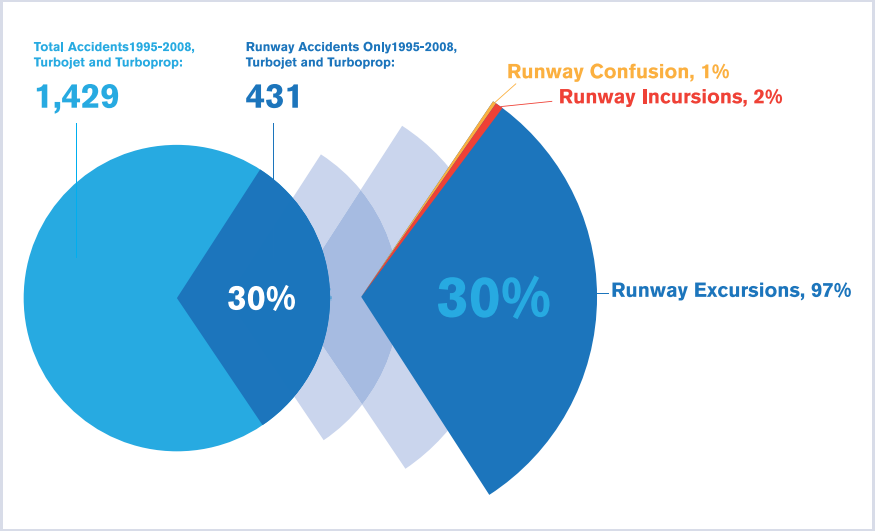
Christopher Hart

One such event was the International Runway Safety Summit that drew 500 participants from 20 countries when the FAA hosted it in December 2009. The Summit consisted of discussions, analyses and reviews of critical runway safety issues such as human factors, airport geo-metry, technologies of today and tomorrow, the cockpit, ATC procedures, and related Safety Management Systems (SMS).

"The summit helped to further focus industry and indeed the aviation community globally to this issue," summarized Timmons. "It began a process that, in part, led to runway safety being put on the agenda at ICAO's 2009 High-Level Aviation Safety Conference and to the establishment of the GRSS 2011 event in the coming months. I'm very pleased with where the overall programme has come in the last couple of years and I'm especially pleased that ICAO is now making it such a priority worldwide. A lot of what the FAA has achieved has been based on procedural rather than strictly technological solutions and ICAO's involvement in getting these straight-forward best practices out to a broader international audience will make flying

RUNWAY-RELATED ACCIDENTS FOR COMMERCIAL (TURBOJET AND TURBOPROP) AIRCRAFT: 1995-2008

Between 1995 and 2008 there have been an average of 30 runway excursion accidents per year for turbojet and turboprop aircraft, while runway incursion and confusion accidents have together combined for an average of only one accident per year.



Data courtesy of the Flight Safety Foundation and the World Aircraft Accident Summary.

safer—not only for U.S. passengers travelling abroad but for all passengers everywhere."

ANSP Responses: CANSO's View

CANSO has thus far stressed that, while improving runway safety is achievable, it also requires significant change to arguably the most complex area of aviation operations.

"Runways are where everyone and everything, airport operators and ground personnel, pilots, controllers, regulations, aircraft and ATC equipment must simultaneously work seamlessly," commented Mark DeNicuolo, CANSO Safety Programme Manager. "Given the many different personnel and organizations responsible for runway safety, improvement can be successfully attained only if aviation partners focus on the overall effect that any change will have on a given operation."

Part of CANSO's runway safety focus has been on the 'three Cs': collaboration, communication and commitment. A change to taxi routes or preferential departure runways, for instance, can improve the ability for controllers to effectively sequence departures and potentially reduce the likelihood of runway incursions. More effective collaboration, meanwhile, will help to reduce confusion and the chance of decreased situational awareness, especially amongst pilots and ground personnel who routinely operate in the airport environment and who are used to older procedures. This is just one example of how the provision of air navigation services is a key component to runway safety improvement initiatives.

"CANSO plays a vital role in supporting the 'three Cs' by bringing the global perspective on air navigation service provision to the discussion and supporting a holistic approach to reducing runway safety risk," highlighted DeNicuolo. "As a first step, the CANSO Safety Committee is working with its members and industry partners to develop and document a runway safety risk model. This will identify key threats, causal factors, potential controls and mitigations and priorities for action. This is not to say that runway safety risk models haven't been done in the past, however the CANSO version will have the three C's as its foundation, ensuring identified priorities consider a wide range of perspectives and are not redundant to other initiatives already underway. Identified risk priorities will then be addressed by the CANSO Operations committee, again in collaboration with industry partners, to develop appropriate solutions to those risks."

By collaborating with airline and pilot communities, ANSPs can ensure that ATC contributing factors to runway safety are well understood by pilots and controllers alike and therefore appropriately mitigated. CANSO is currently addressing this area by developing awareness and educational material to help bring greater visibility to ATC considerations in regard to runway safety and to improve understanding of phase of flight workloads for both ATCs and pilots. CANSO stresses their commitment to continue to work with their partners to make the best use of industry data to improve risk identification and develop the most appropriate mitigation methods.

Mark DeNicuolo

"ANSPs are at the forefront of implementing many new technologies, such as Runway Status Lights (RSLs) and Low Cost Ground Surveillance Systems (LCGSSs)," commented DeNicuolo, "solutions targeted at improving runway safety situational awareness for air traffic controllers and pilots. Again, the 'three Cs' are paramount as collaboration with aviation partners is essential to the success of these initiatives."

DeNicuolo noted that the implementation of runway status lights and the development of technology that alerts the cockpit of an occupied runway will be most effective, safe, as well as fiscally sound, only through strong collaboration amongst stakeholders. Since ANSPs are often in the lead role of ensuring that new technologies are implemented safely and effectively they often take the role of leading industry collaboration, especially during the implementation phase of acquisition.

"CANSO plays the vital role of providing guidance and best practices to its members," he concluded, "to not only validate the operational effectiveness of these new programmes, but more importantly to ensure no unacceptable risk is introduced."

A Role for Manufacturers

To better understand the role and responsibility of aircraft manufacturers in helping to limit the risk, frequency and severity of runway accidents, the *Journal* spoke to Brian Nield, Chief Engineer, Aviation System Safety, at Boeing Commercial Airplanes.

"The airplane manufacturer has a key role in addressing runway safety," Nield began. "Its primary responsibility is in designing and producing an airplane that has good flight characteristics and predictable responses that facilitate safe takeoffs and landings through operational capabilities and information and awareness tools that are useful to crews. The manufacturer also should offer robust, effective training for safe maintenance and operation of the airplane."

Nield noted that manufacturers also have a responsibility to engage in global industry initiatives that identify safety concerns, establish root causes, develop effective interventions and encourage newer, safer technology and

process implementations. He acknowledged that runway safety is a system wide challenge that requires system wide solutions and that, by using data to drive collaborative decisions, industry could successfully develop and implement the most effective and efficient solutions to safety issues, including runway-related risks.

"Boeing is a key partner in global safety initiatives where industry and government work together to collect and analyze safety data," Nield commented. "That data then can be turned into knowledge to develop and implement prioritized action plans to enhance safety. For example, in collaboration with the FAA and other governmental agencies, airlines, Airbus and other manufacturers, unions and the FSF, Boeing developed runway safety training aids for flight crews as well as aids for upset recovery and wind shear encounters. Boeing flight technical and safety pilots also attend worldwide safety seminars, provide outreach to operators and conduct audits under our Flight Operations Support Programs. In addition, our Airport Technology Group works directly with airports worldwide to assist in setting design standards."

Manufacturers can also help address runway safety concerns through the development of airplane flight deck enhancements to their products to improve pilot situational awareness during taxi, take-off, approach and landing. These enhancements can reduce the risk of runway incursion, confusion or excursion while minimizing risks from destabilized approaches.

Brian Nield

Like other suppliers, Boeing also offers and supports safety and efficiency enhancements such as its Electronic Flight Bag (EFB) and Airport Moving Map (AMM). These integrated information management systems provide performance and navigation data to the flight crew (in the case of the EFB) and realtime aircraft position data on the apron, thereby lessening taxi and runway confusion, reducing runway incursions and minimizing wrong-runway errors (AMM).

Many newer aircraft today also support Required Navigational Performance (RNP) operations, which enhance safety by standardizing approach procedures (including visual), providing lateral and vertical guidance to help in flying stabilized approaches, and in avoiding obstacles down to lower altitudes above the runway threshold, leading the airplane to an on-speed landing in the touchdown zone. The Honeywell Runway Awareness and Advisory System also provides runway and runway-remaining information, as well as head-up displays which present essential information as an overlay to the view out of the cockpit window, where traffic and the runway environs can be seen.

Further enhancements now in development at Boeing include improved traffic displays (both airborne and on the ground), monitoring and alerting for unstable approach and long landing, optimized runway exiting, taxi guidance, and improved crew awareness of take-off and landing performance—particularly for short, wet or contaminated runways.

"Boeing continues to work on improving all aspects of commercial aviation safety," Nield stressed, "including airplane design, training, navigation and control and operational procedures."

With regard to runway safety collaborative efforts specifically, Boeing actively supports government and industry initiatives, working with the FAA, the Radio Technical Commission for Aeronautics (RTCA), ICAO, CAST, and the FSF, among others, to develop industry guidelines, standards and solutions.

RUNWAY NUMBERING AND THE EARTH'S MAGNETIC FIELD

The Earth's magnetic field is constantly wavering and has finally shifted so far toward Russia that the magnetic alignment of airport runways in Florida, U.S.A., recently had to be re-numbered. The Tampa runways were closed early in 2011 for this purpose and to update taxiway signs.

"The Earth's poles are changing constantly, and when they change more than three degrees, that can affect runway numbering," commented Kathleen Bergen, a spokeswoman for the FAA.

All runways are numbered according to the compass direction they point to. The numbers are rounded-off so that a runway bearing 270 degrees due west would have the number '27' painted on it.

The magnetic pole generally slowly shifts back and forth, so no regular adjustments to the runways are needed until the error builds up. Since the earth's magnetic field isn't constant from place to place, there wasn't a need to re-number all the airports across the United States.

Source: Aquapour.com

Boeing is furthermore a key partner in CAST, serves as a member of the Aviation Safety Information Analysis and Sharing (ASIAS) programme, and is a founding member of the Industry Safety Strategy Group (ISSG), which was formed to develop and implement a global aviation safety roadmap to assist ICAO in promoting aviation safety worldwide. The ISSG works together with CAST in a coordinated effort to improve safety around the globe and has contributed to many ICAO Working Groups as well.

"These national, regional and international efforts that Boeing and other major manufacturers participate in share a common foundation—they are jointly led by industry and government and participation is both voluntary and non-punitive. This ensures that all sides can be heard and the best solutions can be found," Nield concluded. "These efforts also are data-driven and risk-based, which provides for appropriate prioritization so that resources can be used to greatest effect, while continuous monitoring practices ensure that progress on safety continues to be made."

Challenges for General Aviation

It is one thing to be piloting a 747 on a landing approach, 40 feet above a well-marked and well-lit runway, and quite another to be seated low in the cockpit of a much smaller aircraft, over a diminutive airfield where the runways and taxiways can almost be indistinguishable from one another at times depending on the terrain and angle of approach. This is why runway safety for General Aviation (GA) pilots encompasses a different set of risk factors and solutions than what is more commonly discussed for commercial aviation operations.

Frank Hofmann

"Many of the runway and taxi-way accident risks for GA pilots and aircraft have more to do with the inability to orient yourself on the apron due to poor or no signage being present, as well as the inexperience of some GA pilots with busier airports," commented Frank Hofmann of the International Council of Aircraft Owners and Pilots Associations (IAOPA). "Runway-specific factors are not generally a significant contributor to aggregate GA accident results."

According to the 2010 Nall Report (the *Joseph T. Nall Report of Accident Trends and Factors*), published by the Aircraft Owner and Pilots Association (AOPA) Air Safety Institute, runway conditions accounted for 11.8 percent of GA take-off- and climb-related accidents and 7.2 percent of landing-related accidents. More pilot-specific landing accident results, such as short landings, long landings and hard landings, accounted for an additional 13.6 percent of the total landing accident factors.

"Another factor for GA pilots is that they normally work off narrower runways," continued Hofmann. "In these instances cross winds and other conditions can lead to runway excursions far more easily than if you're on a 200 foot wide runway somewhere. Then you get the complimentary danger associated with somebody who is used to flying off a narrow strip and then finds themselves approaching that much wider runway. The pilot's perception about how high above the ground they are becomes skewed and they end up having an accident when their airplane either drops out of the sky or drives into the concrete. The same can be true at night because the wider placement of the runway lights creates the impression that you're much closer to the ground than you actually are."

With GA and the full range of other perspectives on the runway safety issue now set to be presented and considered at ICAO's GRSS 2011, considerable results should be expected towards the development of much more comprehensive and globally-achievable runway safety results in every area.

"ICAO is fortunate that a great deal of research and effort at the national and regional level has already been accomplished on the runway safety issue," suggested ICAO Runway Safety Programme Coordinator, Michelle Millar. "GRSS 2011 will benefit from the data and best practices that all of our partners and stakeholders on this issue will be bringing to the table. It will undoubtedly help the Organization in its efforts to bring very effective regional workshops to our Member States over the near-term and to determine those State-controllable safety outcomes in this area that will eventually support a much safer runway environment on a truly global basis." ■

A More Fluid Approach

In the early years of manned flight, aviation pioneers from Alexander Graham Bell to Louis Blériot learned to respect the dangers of taking to the air in hazardous weather conditions. As the field of aviation evolved, engineers and aviators made continuous improvements to aircraft designs, permitting safe operation in most meteorological conditions. Some hazards, however, such as in-flight icing, have eluded aviation experts and still represent a recurring safety risk area to the flying community.

As Danial Zeppetelli and Wagdi Habashi of the Computational Fluid Dynamics Laboratory at McGill University's Department of Mechanical Engineering report, the continuing recurrence of these types of accidents has lent renewed impetus to the development of advanced analytical predictive tools to study both the accretion of ice on aircraft components in flight, as well as the aerodynamic consequences of such ice accumulations.

Danial Zeppetelli is a graduate student in the Computational Fluid Dynamics Laboratory at McGill University's Department of Mechanical Engineering. In the summer of 2010, Zeppetelli worked in the ICAO Integrated Safety Management Section as part of the Organization's ongoing internship programme. In addition to providing him with a unique opportunity to complement his academic research on the hazard of in-flight icing, this internship was a chance to learn firsthand about how aviation safety is managed.

Professor Wagdi Habashi holds the NSERC-J. Armand Bombardier-Bell Helicopter-CAE Industrial Research Chair of Multidisciplinary CFD in the Mechanical Engineering Department of McGill University and directs its Computational Fluid Dynamics Laboratory. He also serves as President of Newmerical Technologies International. Habashi is the author of 320 scientific papers and is Editor-in-Chief of the International Journal of Computational Fluid Dynamics. He is a Fellow of the Academy of Science of the Royal Society of Canada, of the Canadian Academy of Engineering, of the American Institute of Aeronautics & Astronautics and of the American Society of Mechanical Engineers. In 2009-2010 Habashi was the recipient of the Killam Prize for Engineering from the Canada Council for the Arts, of the inaugural James C. Floyd Award from the Aerospace Industries Association of Canada and of an Honorary Pioneer Award from Pratt & Whitney Canada, of which he is a Research Fellow.

It is not for lack of will or effort that in-flight icing problems continue to persist in the realms of commercial and general aviation. Many hours have been devoted to dry air and wet air tunnel testing, as well as flight tests, to demonstrate that an aircraft is safe and can be certified for flight into known icing conditions.

An aircraft operating in overcast or precipitation conditions and below freezing temperatures risks encountering super-cooled liquid water droplets during takeoff, landing, or holding. These droplets, still in the liquid phase despite their temperature being below freezing, hit the aircraft, and their heat of fusion is released causing them to freeze on impact or to run down as water and freeze further after the point of impact.

This process represents the starting point for ice accumulation on exposed aircraft surfaces, immediately introducing roughness and gradually changing its aerodynamic profile. The smooth flow of air over the wings is disrupted and the aircraft's stability and control are adversely impacted.

The presence of roughness on a wing causes its airflow to turn turbulent sooner (more energy loss for the air), resulting in more drag and less lift. The degraded performance increases the aircraft's stall speed and decreases its angle of stall, making flying particularly dangerous during low speed maneuvers such as take-off, landing and holding.

In situations where the aircraft's performance is degraded, some of the current stall protection systems are not able to alert the pilot that the stall margin has been significantly reduced. The consequences of underestimating or ignoring the effects of ice on the surfaces are substantial and can in-fact prevent proper stall recovery when ice contamination is present.

ICAO's Role in In-Flight Icing Data Analysis

In order to gain a better understanding of the in-flight icing problem, an analysis of the accidents and incidents that have occurred in icing conditions must be considered. These analyses are performed at ICAO's Integrated Safety Management Section (ISM), where a team led by Captain John Illson is dedicated to providing essential safety information and recommendations to better guide new aviation safety strategies and measures.

The ISM's activities and mandate have led to the development in recent years of a dedicated Integrated Safety Trend Analysis and Reporting System (iSTARS). The study described in this article has made use of these tools to analyze the global occurrences of in-flight icing under the guidance of Marco Merens, ISM's Technical Officer responsible for the development and evolution of iSTARS and related analytic methodologies.

The ICAO Accident and Incident Data-reporting Database (ADREP), available through iSTARS, contains an archive of events officially reported to ICAO as per Annex 13. ADREP characterizes events according to several fields, including: Occurrence Category; Occurrence Class; Operation Type; Injury Level; Damage to Aircraft; Date; and State of Occurrence.

The icing incident database used for this study was created by querying the European Coordination Centre for Aviation Incident Reporting Systems (ECCAIRS), a software tool used to manage all reported events having occurred since 1970, with the following parameters:

Occurrence Category = Ice / Icing
Icing Intensity = Light / Moderate / Severe

This ECCAIRS query resulted in a list of over 350 events involving icing from every corner of the globe. The data was adjusted manually to filter out incidents caused primarily by ground icing, which were not considered in this study. The final list includes 323 events that are described by the geographic location of the occurrence as well as meteorological conditions and flight parameters at the time of the occurrence.

A preliminary study of the causal relationships between occurrence categories has revealed a strong correlation between icing, loss of in-flight control and abnormal runway contacts. Further studies of the causal relationships between occurrence categories can be found on the iSTARS website, along with a wealth of other safety related information.

This data was then analyzed to identify which aircraft types, flight phases and meteorological conditions combine simultaneously in a large percentage of occurrences. These combinations are determined to represent hazardous icing scenarios that require a more in-depth study of the aerodynamic consequences.

Data Visualization through ArcGIS

The ICAO visual safety management tool, ArcGIS, developed by Aeronautical GIS Officer Gilbert Lasnier, is one of the many tools used by ISM to analyze the vast amounts of aviation data available to it. In this study, ArcGIS is used to geographically position the accident using the latitude and longitude data provided in the accident report. ArcGIS also contains other relevant information, such as global average temperature and precipitation distribution, global air traffic densities, air traffic routes and economic information. The information can then be displayed in layers on a map *(see Fig. 2 below),* allowing for the simultaneous visualization of independent data sets.

Figure 1: In-flight Icing Along Wing Span

With this tool it is possible to quickly visualize where the accidents are concentrated and correlate this to the temperature and precipitation levels, as well as traffic concentrations in these regions. Figures 3, 4 and 5 on page 20 highlight in red those regions characterized by high traffic and a large proportion of in-flight icing accidents.

Regions highlighted in yellow, meanwhile, have similar meteorological conditions to the red regions and are predicted to experience an increase in air traffic

Figure 2: ICAO ArcGIS Accident Report

volumes—making them vulnerable to increased risk of future in-flight icing incidents.

The accidents in these reports are also analyzed based on the flight phase at the time of the icing encounter, to determine when the aircraft is most vulnerable to the aerodynamic penalties accruing from ice buildup. The most common flight phase for icing incidents is found to be during approach, these occurrences are highlighted in Figure 6, bottom right.

As noted earlier, ice accumulation on the aircraft and, in particular, wing surface ice contamination, decreases an aircraft's stall margin by increasing the speed at which it will begin to stall. The reduction in speed that occurs during approach can lead to unexpected behaviors as the aircraft operates on the edge of the reduced stall margin.

Furthermore, the approach phase represents a period of high workload within the cockpit, with pilots focused on communicating with air traffic controllers and preparing for landing. Although pilots are continuously monitoring meteorological conditions throughout the approach phase, the additional workload and the complexity of the aerodynamic changes caused by the ice make anticipating the performance degradation of the iced aircraft difficult for even the most experienced pilots.

Icing accident investigations can take months, even when conducted by specialists who have designed or certified that particular aircraft. It is highly unrealistic to expect pilots to second guess, in a matter of minutes or sometimes merely seconds, the ice protection system design of an aircraft.

This data analysis shows that propeller driven aircraft on approach phase, operating in temperatures between -5°C and freezing, with a dew point to temperature spread of less than 2°C, are most vulnerable to experiencing in-flight icing problems. This conclusion is consistent with other studies in the field, yet it still does not offer a precise characterization of aircraft performance when encountering specific icing conditions.

Moving Forward

The analysis of accident data is critical to gaining a better understanding of aircraft vulnerabilities and is an important step in preventing future accidents. Unfortunately, the current accepted analysis methods can only help prevent similar accidents but do not offer predictive information to avoid accidents in situations that have little or no precedence.

As a result, the industry's icing certification regimen remains in a reactive state, making adjustments primarily in response to accidents and incidents. Some of these responses, such as the FAA's new *Appendices D* and *O* (still at the NPRM stage), if adopted, will affect the design of future aircraft that will enter into service a full 20 years after the identification of the cause of the original accident.

Figure 3: Global Traffic Distribution Combined with In-Flight Icing Accidents.

Figure 4: Global Average Temperature Distribution Combined with In-Flight Icing Accidents.

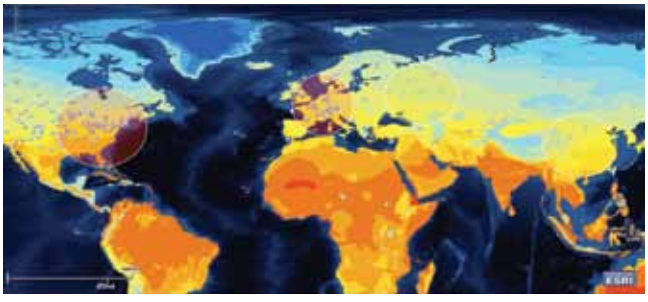
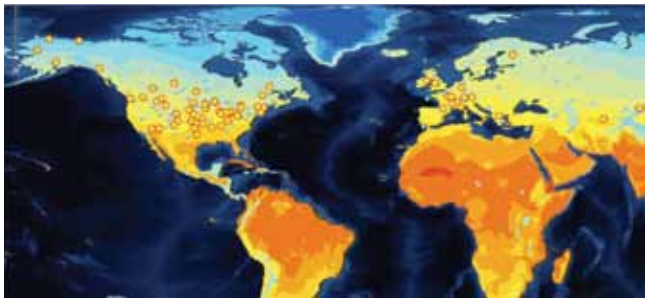


Figure 5: Global Average Precipitation Distribution Combined with In-Flight Icing Accidents.

Figure 6: Distribution of In-flight Icing Occurrences During Approach Phase.



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Accidents seldom occur due to a single cause, but that is unfortunately how most aircraft are certified: item by item. It is not unusual for an ice protection system, certified for flight into icing conditions, to fail to ensure safe operation under the combination of exceptional atmospheric or aerodynamic circumstances, pilot workloads during landing and the lack of reliable advance warning mechanisms.

Aviation can better consider the icing impact of varying meteorological conditions and the position of different aircraft components during the certification process. The following sections propose a method by which computer-generated scenarios simulate icing conditions in the regions vulnerable to in-flight icing. The degradation of the aircraft's aerodynamic properties in these conditions can then be analyzed with Computational Fluid Dynamics (CFD) to generate predictive information on potential future accidents, thereby helping to characterize the consequences of specific icing conditions on specific aircraft.

FENSAP-ICE Simulations

At the McGill Computational Fluid Dynamics Laboratory (CFDLab), we are developing FENSAP-ICE, a numerical icing simulation and aid-to-certification tool that can accurately predict ice accretion on an entire aircraft in all atmospheric conditions.

Interestingly, FENSAP-ICE was originally proposed in an *ICAO Journal* submission. Based on new three-dimensional governing partial differential equations, FENSAP-ICE realistically predicts water impingement rates, the limits of water impingement, the resulting ice shapes, the melted ice runback, as well as the iced aircraft's degraded performance characteristics.

This modern, modular approach divides the prediction of icing into four interactive modules. The first module in icing simulation consists of the solution of the compressible Navier-Stokes equations using the Finite Element Navier-Stokes Analysis Package (FENSAP). This provides detailed information regarding the flow characteristics around the aircraft, meaning one no longer needs to analyze the wing, fuselage, engine, etc., in isolation, but rather the entire aircraft as an integrated system. The calculated flow is then passed on to a second module known as DROP3D, which computes the collection efficiency distribution (water concentration) on the entire aircraft's surface.

Employing local water concentrations computed by DROP3D, as well as the surface heat fluxes and shear stresses computed by the FENSAP module, the ICE3D module predicts the ice shape accreted on the entire aircraft's surface. Rather than assume empirical data for surface roughness, a new model analytically predicts the evolving surface roughness in space and time depending on whether it is metal and whether it is covered by a bead, a rivulet or a water film.

The prediction of the heat loads by a conjugate heat transfer (multi surfaces of adjacent metal and air, such as external flow + aircraft skin + internal flow in the wing) approach is performed in the CHT3D module.

This type of platform is capable of simulating the entire aircraft, including the engines and propellers, enabling it to consider the important interactions between the various components as well as the impact of these interactions on droplet trajectories. This could enable engineers to consider the consequences of icing early on the design of the aircraft, rather than as an afterthought with all aerodynamic parameters already defined.

Practical Applications

The current in-flight icing certification process involves testing the aircraft operation within a defined atmospheric icing envelope. In the United States, the icing certification envelope is defined in *14 CFR, Part 25, Appendix C,* and is expanded in the recently proposed *Appendix D* and *Appendix O* to include supercooled large droplets (SLDs) of greater than 50 microns in size.

The full combination of the conditions within these envelopes, however, cannot feasibly be tested in the icing tunnel or through tanker flight tests, nor can they readily be encountered in natural icing flight tests. As a result, conditions within the certified envelopes may prove to be hazardous for certain aircraft flying in a particular configuration. Only through analytical methods such as CFD can we expect to explore all possible conditions present in the icing certification envelope.

Figure 7: Simulated Impingement Limits with DROP3D.

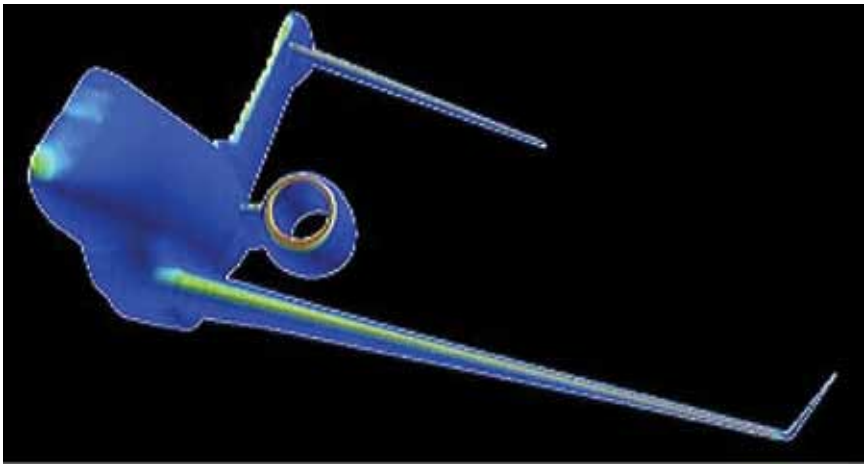
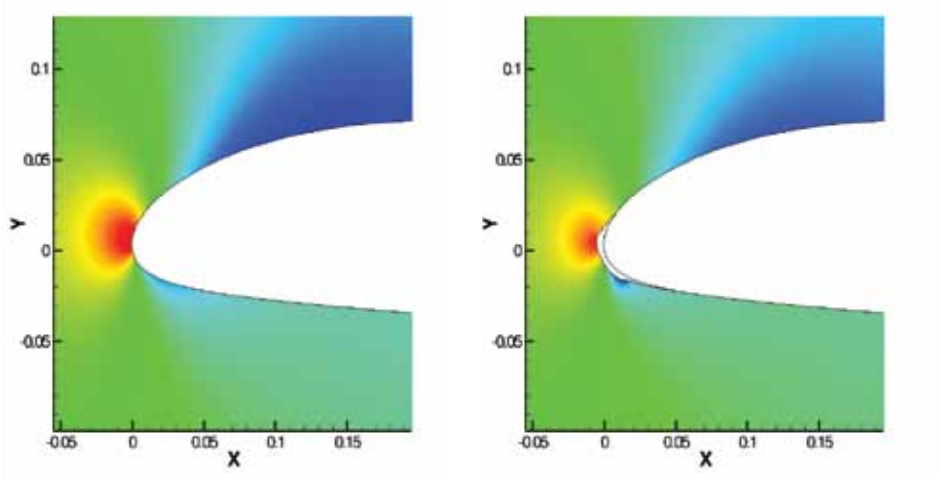


Figure 8: Pressure Distribution over Clean and Contaminated Airfoils.



The numerical simulations can provide a variety of pertinent data, which can then be classified in the matrix shown in Figure 9, below—taken from the ICAO *Safety Management Manual.* Conditions shown in the red and yellow thirds of the matrix are most problematic and thus require more detailed characterizations to enable pilots to better identify the situation and be aware of the magnitude of performance degradation that they are likely to experience.

The CFD codes have been shown to accurately predict the ice accretion on the wing cross-section and entire aircraft, as well as the aerodynamic degradation caused by the ice accumulation. The flow visualization reveals important information on the effect of the shape as well as the position of the ice on the wing. This provides aircraft designers and regulators with the shape, size and location of the most critical ice, thereby affording them the opportunity to adjust their hazard mitigation strategies accordingly.

Hazard Analysis and Safety Management

By simulating an aircraft response in different regions of the certification envelope, one can ascertain, even if only qualitatively, the magnitude of the aerodynamic consequences of specific icing conditions on specific aircraft. This information, coupled with the likelihood of encountering such conditions, forms the basis of ICAO's related risk assessment matrix.

As an example, this simulation tool could be implemented to measure the change in stall characteristics for different atmospheric conditions and flight configurations. The results would then be categorized in terms of severity and probability of occurrence. In this case, a catastrophic event would constitute conditions that degrade the performance to such an extent that the aircraft stalls rapidly and without warning, despite the ice protection system.

A hazardous encounter would involve significant performance degradation such that the pilot is no longer able to maintain altitude. An encounter that has major consequences could be defined by conditions that would cause the aircraft to buffet or where the response to controls is degraded due to change in flow over the control surfaces. This information could be supplemented with measures of lift reduction as a percent of uncontaminated performance or other performance based metrics.

While the existing simulation tools are time consuming and require significant computing power, the CFD Lab is currently implementing reduced-order modelling techniques to significantly reduce both computational time and costs, making it feasible to rapidly explore the extents of the icing envelope and making it possible to integrate a more realistic in-flight icing hazard into aircraft training simulators.

Figure 9: Distribution of In-flight Icing Occurrences During Approach Phase.

	Catastrophic	Hazardous	Major	Minor	Negligible
Frequent	5A	5B	5C	5D	5E
Occasional	4A	4B	4C	4D	4E
Remote	3A	3B	3C	3D	3E
Improbable	2A	2B	2C	2D	2E
Extremely Improbable	1A	1B	1C	1D	1E

By simulating and understanding the aircraft's performance degradation due to icing on the ground, we can help improve pilot awareness and reactions in the air.

The McGill CFD Lab is currently teaming up with the McGill Institute of Air and Space Law to investigate possible improvements to the certification process and requirements for in-flight icing in terms of flight operations and airworthiness. This recently-formed partnership is one that we hope will continue to grow over the years, encompassing activities like those described above in addition to other aviation concerns, such as carbon emissions and noise regulations, in both the legal and technical contexts. ■

Vertical Progress

Profiling the ICAO Heliport Design Working Group

The ICAO Heliport Design Working Group (HDWG) evolved from the Heliport Design Study Group (HDSG) in November 2004, during the creation of the Organization's Aerodromes Panel (AP).

Concurrent with this elevation of the heliport group of experts to the status of a full working group came acceptance of the fact that the then current edition of Annex 14, Volume II, *Heliports,* needed more than the limited scope of 'stick and rudder' maintenance that had previously sufficed.

As David Evans de Maria, ICAO Technical Officer, reports, many of the then current provisions had been drafted by applying fixed-wing assumptions to rotorcraft operations—an approach which has been greatly improved upon by the more specific work of the HDWG in recent years.

David Evans de Maria has been with ICAO since 2008, when he was brought in to fill the role of Secretary for the Visual Aids Working Group (VAWG) and the Heliport Design Working Group (HDWG), and now also serves as the Secretary of the Aerodromes Panel (AP). He joined ICAO from the FAA Airports Division, after serving in various capacities within the FAA for nearly 20 years. Evans de Maria is also a registered professional engineer holding a commercial pilot's license with an instrument rating.

Prior to the creation of the ICAO Heliport Design Working Group (HDWG) in 2004, the Panel work of the Aerodromes Section (AGA) of the Air Navigation Bureau (ANB) was performed with the Visual Aids Panel (VAP). Other areas of work were performed by four Study Groups; for example heliport design work was accomplished in the now pre-empted Heliport Design Study Group (HDSG).

In November 2004 the work programme of AGA was multiplied with the creation of a much larger umbrella panel of the Aerodromes Panel (AP) that not only encompassed the work of the previous VAP, but also elevated the other four Study Groups to the status of full Working Groups.

The work of each of these groups is now tracked and elevated through the protocols of a working group of a panel, and their proposed amendments are now subject to the protocols of a full panel meeting prior to presentation to the ANC and the State letter process.

Modernizing Heliport Approaches

There are many efficiencies relating to rotorcraft operations to be gained, as well as rotorcraft-specific safety measures to be enhanced, by modernizing the assumptions on which the previous standards had been based.

The ICAO AP agreed that Annex 14, Volume II, needed a comprehensive overhaul, with a subsequent revision of its supporting guidance material (Doc 9261—*Heliport Manual*). Thus, the HDWG was commissioned to provide an updated volume of SARPs that would give full consideration for the capabilities of modern helicopters.

The revision of Annex 14, Volume II, was readily recognized for the huge undertaking that it was, and it was agreed that the work would be broken down into two separate efforts. Termed Tranche 1 and Tranche 2, these were planned to be conducted over two sequential triennial work periods, with the Tranche 1 proposals having been presented to the first meeting of the Aerodromes Panel (AP/1) held in December 2006.

The inclusion of these provisions as *Amendment 4* formed the Third Edition of Annex 14, Volume II, which became applicable on 19 November 2009. The Tranche 2 proposals were presented to AP/2, held last October, and are expected to become applicable as of November 2012.

Subsequent to this effort, in addition to the need to address a few outstanding key issues for Annex 14, Volume II, the HDWG also plans to overhaul the supporting guidance material in Doc 9261 by 2013.

Of special interest, as in any story, are the people behind the work. The Director of the ICAO ANB, Nancy Graham, known for her strong support for the maintenance of the technical and professional currency of her ANB technical staff, agreed that a couple of well-focused field trips featuring effective resource use would result in increased value of ICAO assets toward the accomplishment of the ICAO mission.

Get your Dangerous Goods Information and Training Straight from the Source

ICAO Dangerous Goods Training Programme

ICAO has launched an exclusive new initial Dangerous Goods (DG) Training Programme based on the recently revised *Dangerous Goods Training Manual* (Doc 9375). The Programme consists of this new manual and several courses which will assist States in complying with the broad principles governing the international transport of dangerous goods by air as outlined in Annex 18—*The Safe Transport of Dangerous Goods by Air* and detailed in the *Technical Instructions for the Safe Transport of Dangerous Goods by Air* (Doc 9284).

Main benefits of the ICAO DG Training Programme include:

- **Courses and materials are delivered by ICAO directly—no third parties.**
- **Programme is developed specifically for State Inspectors, but will benefit all personnel dealing with DGs.**
- **Participants receive an official ICAO certificate upon successful completion of a test.**
- **Courses are based on the ICAO *Technical Instructions*—the only legal source of regulations for the safe transport of dangerous goods by air.**
- **Courses are delivered by senior level DG personnel with extensive experience.**
- **On-site training is offered to maximize availability and minimize costs.**

The first course—*Using the Technical Instructions*—is a prerequisite/refresher course that reviews the *Technical Instructions* section by section employing real-life examples and scenarios. Potential students should be well-versed in aviation terminology. Familiarization with the transportation of dangerous goods by air is useful, but not mandatory. Montréal course dates for Using the Technical Instructions are now established but spaces are limited.

Remaining 2011 course dates*:

7-11 May - Iran
16-20 May - Montréal
26-30 June - Qatar
25-29 July - Montréal
12-16 September - Montréal
24-28 October - Montréal
21-25 November - Montréal

** Course dates and availability are subject to change.*

Register today!

For more information contact:
Rick Lee
rlee@icao.int
+1-514-954-8219 ext. 7001

For additional details visit:
www.icao.int/anb/fls/dangerousgoods/training/

Enter here Kevin Payne, who came to ICAO after nearly 23 years in the UKCAA. He is currently serving as a Flight Standards Officer of the Flight Operations Inspectorate (Helicopters), located in the famous Aviation House centre of excellence at Gatwick Airport.

Payne served as the Rapporteur of the HDWG from January 2007 until AP/2 last year. During his tenure in this role he consistently presided with the judgement, balance and diplomacy necessary to successfully lead the massive mandate of this group of experts. True to the nature of his commitment to the cause, he quickly responded to the HDWG query in regard to relevant opportunities to experience details of rotorcraft operations and the rotorcraft operational environment that were distinct from the fixed-wing environment.

HDWG UK Tour Highlights

Payne arranged for HDWG attendance at a pre-planned inspection tour of a new FATO/TLOF lighting scheme for offshore helidecks currently under study by the UKCAA. This lighting scheme represents an acceptable alternative to TLOF floodlighting requirements in accordance with Annex 14, Volume II and is considered to be a significant safety enhancement over traditional floodlighting. In fact, the UKCAA intends to use every opportunity to actively encourage the industry it regulates to deploy the new lighting scheme in preference to floodlighting. Payne also made arrangements to site-visit four other heliports of as wide a variety as possible, including onshore surface-level heliports and elevated pads in diverse rural and urban settings.

The new FATO/TLOF lighting scheme under study had been installed on the CPC-1 helideck in the Irish Sea. The rig was accessed from CHC helicopter's Operations centre, located at the time at Blackpool Airport. In addition to HDWG representatives from ICAO, the inspection was attended by a number of other representatives from both CAAs

Figure 1: Aerial photograph of the AGI prototype lighting system on the CPC-1.

and industry. It was planned to take place during night conditions that would best simulate the operational scenario for which the lighting system was primarily designed. Unplanned however, but very appropriate, was a moderate rain with an approximately 1,100 to 1,200ft ceiling *(see Figure 1, above).*

An inspection under these conditions, including an approach and landing, perfectly accomplished the goal of giving the HDWG specific firsthand experience of the operational environment of the applicable lighting systems, whose international standards are developed in the HDWG.

The tour continued on to a site visit of the Coney Park Heliport (CPH): a surface-level licensed heliport hosting several helicopter training organizations and located just outside the perimeter of Leeds Bradford Airport. The very friendly reception and pride on behalf of the CPH staff in their local operation would prove to be typical of the entire itinerary.

The next stop was the onshore elevated heliport of the Leeds Royal Infirmary Hospital, where Rescue and Fire Fighting (RFF) staff briefed the visitors and provided a demonstration of their procedures during actual operations

Figure 2: The Yorkshire Air Ambulance which operates out of the Leeds Royal Infirmary Hospital.

of the Yorkshire Air Ambulance *(see Figure 2, bottom of page).* Of interest in this regard is the fact that these individuals, who are comprehensively trained for their RFF duties, also have other primary responsibilities in the hospital–from which they volunteer to be called away from when needed for air ambulance operations.

The final day of the UK tour began with a visit to the very unique situation of the London Heliport at Battersea.

Figure 3: The London Heliport at Battersea. The landing surface is located on a platform just off the banks of the Thames River and, depending on the tide, is classified as either a surface-level or elevated heliport. Making an approach even more challenging, the London Heliport is closely surrounded on the banks of the Thames by mid-rise buildings.

The landing surface of the London Heliport is located on a platform constructed directly above the River Thames. The heliport is licensed as a surface level heliport, but depending on the extreme tidal conditions the platform sometimes operates as an elevated landing area. Making approaches to it more challenging, the London Heliport is also closely surrounded on the banks of the Thames by mid-rise buildings *(see Figure 3, above),* making it necessary to publish approach and take-off climb surfaces offset by 15 degrees to align with the river.

The UK tour ended with a bang at London's Whitechapel Hospital. While the photo showing the proximity of a smokestack to the existing helideck provides a quintessential example of the kinds of obstacles that make operations in urban environments more challenging to manage safely *(see Figure 4, p.27),* the

new helideck under construction rises well above most of the nearby city skyline at 17 storeys above street level, providing a perfect perch to capture a beautiful evening view of London.

Canadian Maritime Outreach

Rounding out the HDWG's familiarization with the rotorcraft operational environment was a visit to the Canadian maritime. The then Chairman of the Oil and Gas Producers (OGP) Aviation Subcommittee representative of the HDWG, Robert Williams of ExxonMobil, introduced HDWG staff to J.J. Gerber, Director of Flight Operations for Cougar Helicopters—one of the OGP helicopter service providers for the Canadian maritime region.

Being familiar with the ICAO mission, and having participated in ICAO-related efforts in the past, Gerber welcomed the opportunity to increase the HDWG's familiarization with the operational environment of the rotorcraft community. He assigned the HDWG Secretary to Captain Adam Keats, pilot and Helideck Inspector for Cougar Helicopters (operating out of Cougar's Newfoundland base), who took the working group Secretary on a regularly scheduled operational run to the helideck on the Terra Nova FPSO (Floating Production, Storage and Offloading) facility.

Following a textbook approach, landing, and quick refuelling operation, a tour of the helideck operations centre was then

Figure 4: The Heliport at London's Whitechapel Hospital. While the photo showing the proximity of a smokestack to the existing helideck *(top)* provides a quintessential example of the kinds of obstacles that make operations in urban environments dangerous, the new helideck under construction *(lower image above)* rises well above most of the nearby city skyline at 17 storeys above street level, providing a perfect perch to capture a beautiful evening view of London.

Captain Adam Keats of Cougar Helicopters approaches the helideck on the Terra Nova FPSO.

provided. This tour included an introduction to the conduct of a helideck inspection, including checklists, record keeping and RFF preparedness. Throughout the entire visit, Keats provided useful details regarding rotorcraft operations and operational practices, including tours of the hangar and operational areas.

When advised about the UK development of the new FATO/TLOF lighting scheme to ultimately be proposed for inclusion in Annex 14, Volume II, Cougar representatives displayed keen interest and the HDWG has since put the Canadian maritime stakeholder in touch with the UKCAA so that the two can share information and best practices relating to these developments.

The following day revealed another reality about operations in the offshore environment when the flight entered a fog bank a few miles short of the Sea Rose FPSO. Following another textbook approach, the crew simply did not have the required visual contact at the approach point and a missed approach was declared—with the required procedures then being executed.

Based on pilot reports and other recent, nearly concurrent missed approaches at other rigs in the vicinity (specifically to the Henry Goodrich drill rig which was planned to be a second stop for the trip), the remaining itinerary was prudently cancelled and the flight returned home.

These experiences, taken together, provide exactly the kind of understanding of the specific operational environment that best fine tunes the knowledge and judgment of a professional serving as a Secretary to the relevant working group.

ANB's commitment to supporting the proficiency of its professionals in this manner when they identify an opportunity to improve, and most importantly, work together with Member States and industry, was key to the success of this mission. It is in part through these types of approaches and efforts that ICAO will continue to improve the quality of its standard making expertise to the benefit of the entire aviation community. ■

ICAO and WCO Develop New Cargo Security Cooperative Framework

ICAO and the World Customs Organization (WCO) have agreed to expand cooperation between their two agencies in tackling threats to global air cargo security. Closer collaboration between the WCO and ICAO is expected to significantly minimize the operational and financial impact of security measures by reducing or eliminating duplication in systems and processes, while enhancing synergies.

The end result will be a more effective and efficient response to current as well as new and emerging threats to the security of the global trade supply chain, a critical element of the world economy, the two heads stressed.

"The WCO has unique powers, a multi-faceted mandate, extensive information gathering capabilities, a physical presence at borders and interacts with industry on a day-to-day basis," commented WCO Secretary General Kunio Mikuriya. "These resources are essential in a global strategy to secure international air cargo."

In November 2010, the Council of ICAO approved new and strengthened standards which include a requirement for its 190 Member States to establish a supply chain security process on their territory. The new provisions become applicable in July 2011.

"Working closely with the WCO, we want to achieve the highest level of end-to-end cargo security, while preventing unnecessary delays in the movement of goods across international borders," ICAO Secretary General Raymond Benjamin emphasized.

The WCO, together with ICAO, will carry out a review of its existing procedures through a newly-constituted Technical Experts Group on Air Cargo Security. They will analyze such vital issues as electronic advance data, the sharing of information at various levels (government-to-government, Customs-to-Customs and Customs-to-Industry) and risk management. ■

ICAO Secretary General Raymond Benjamin, left, and WCO Secretary General Kunio Mikuriya. Closer collaboration between the WCO and ICAO is expected to significantly minimize the operational and financial impact of security measures by reducing or eliminating duplication in systems and processes.

Assad Kotaite Fund to Assist Prospective Aviation Personnel in Developing Nations

Established in March 2006, the objective of the Assad Kotaite Graduate and Postdoctoral Fellowship Fund (Assad Kotaite Fund) is to promote the safety and development of civil aviation by strengthening the capabilities of national civil aviation personnel in developing countries. This will be achieved through the provision of bursaries for students in high-level training programmes, as well as graduate and postdoctoral studies, conducted at internationally-recognized academic institutions, training centres and universities.

The main beneficiaries of the Assad Kotaite Fund shall be eligible candidates from developing countries that are most in need of assistance, especially in the area of aviation training. ICAO, through its Technical Co-operation Bureau administers the Assad Kotaite Fund.

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This year, the Assad Kotaite Fund will be awarding bursaries of US$10,500 to candidates who meet the required criteria. National civil aviation authorities are encouraged to promote the Assad Kotaite Fund to personnel willing to submit applications.

For further information on how to apply for a bursary from the Assad Kotaite Fund, please consult the ICAO web site at **www.icao.int** and look for the Assad Kotaite Fund link, or else contact the ICAO Fellowships Unit directly via **fsu@icao.int.** ■

UPCOMING ICAO HQ EVENTS

Meeting	Site	Dates
Global Runway Safety Symposium (GRSS)	ICAO Headquarters, Montréal	24–26 May 2011
Fatigue Risk Management Systems Symposium and Forum (FRMS)	ICAO Headquarters, Montréal	30 August–2 September 2011
Symposium and Exhibition on MRTDs, Biometrics and Security Standards (MRTD Symposium)	ICAO Headquarters, Montréal	12–15 September 2011
Global Air Navigation Industry Symposium (GANIS)	ICAO Headquarters, Montréal	20–23 September 2011
ICAO Air Services Negotiation Conference (ICAN/2011)	Mumbai, India	17–22 October 2011
ICAO Workshop on Aviation and Sustainable Alternative Fuels (SUSTAF)	ICAO Headquarters, Montréal	18–20 October 2011

From Policy Setting to Implementation

National Action Plans Herald New Phase in Global Climate Efforts

A global agreement reached by the 37th Session of the ICAO Assembly in October 2010 established a new benchmark concerning ICAO's approach to environmental protection, especially climate change. This global agreement makes international aviation the first sector with a shared global commitment to its environmental goals of increasing fuel efficiency and stabilizing global CO_2 emissions in the medium term.

As Jane Hupe, Chief of the ICAO Environment Branch reports, States, together with industry, have agreed on an ambitious work programme to continue, during the next triennium and beyond, on the path towards sustainability. In particular, the agreement on voluntary submission of States' action plans to ICAO will now signal a shift from policy setting to implementation in ICAO's climate change activities.

Jane Hupe is Chief of the Environment Branch in ICAO's Air Transport Bureau. In addition to managing the Branch, she advises the Organization on aviation related environmental matters; cooperates with UN bodies and other International Organizations; and serves as the Secretary of the ICAO Council's Committee on Aviation Environmental Protection (CAEP). Prior to 1998, Hupe worked as a consultant to ICAO's Technical Co-operation Bureau and served as an advisor on environmental protection related subjects for the Civil Aviation Authority in Brazil for 15 years. Hupe was also lead author for the IPCC 2007 4th Assessment Report, for which she received a certificate acknowledging her contribution to the IPCC`s Nobel Prize.

The global agreement on environmental protection reached by the 37th Session of the ICAO Assembly in October 2010 invites States to voluntarily submit their action plans to ICAO. The plans will showcase the measures States intend to take in order to improve efficiency and reduce CO_2 emissions and thereby contribute to the global aspirational goals established by the Assembly.
In addition, the Resolution calls for ICAO to provide guidance and other technical assistance to States to facilitate the preparation of their action plans, to be submitted preferably by June 2012.

Through this transition, State action plans will now play a transformative role in ICAO's environmental programme and in the creation of a sustainable future for international civil aviation.

KEY ELEMENTS OF 37th ASSEMBLY CLIMATE CHANGE RESOLUTION

Building upon the series of ICAO achievements in the environmental area since the 36th Assembly Session in 2007, Resolution A37-19 incorporates some key elements, including:

- In addition to the 2 percent annual fuel efficiency improvement up to year 2050, a medium-term global aspirational goal from 2020 that would ensure that while the international aviation sector continues to grow, its global CO_2 emissions would be stabilized at 2020 levels.
- Further work to explore the feasibility of a long-term global aspirational goal for international aviation.
- Development of a framework for market-based measures, including further elaboration of the guiding principles adopted by the Assembly, and exploration of a global scheme for international aviation.
- *De minimis* provisions to ensure that States with small contributions to global air traffic totals are not burdened disproportionately.
- Voluntary submission of States' action plans, covering information on CO_2 emissions reduction activities and assistance needs.

The Value of State Action Plans

ICAO's transition to an implementation mode in its climate change initiatives creates a parallel with the Organization's activities in safety and security. Whereas the safety and security audit programmes of ICAO were binding, identifying areas for further improvement to comply with their findings, in the case of climate change it will be a voluntary initiative and entirely up to the States to identify the suitable basket of measures and assistance needs to reach their objectives. ICAO will assess progress resulting from all State initiatives towards the achievement of aspirational global goals.

37th ICAO ASSEMBLY DECISION ON VOLUNTARY ACTION PLANS

- States are encouraged to submit their action plans to ICAO outlining policies and actions, and annual reporting, on international aviation CO_2 emissions.
- Plans should indicate the basket of measures considered by States, reflecting their respective national capacities and circumstances.
- Plans should also include any specific assistance needs.
- ICAO should provide guidance and technical assistance for the preparation of the action plans.
- States that decide to submit plans should do so as early as possible, preferably by June 2012, so that ICAO can compile the information in relation to achieving the global aspirational goals.

Receiving action plans will also help ICAO to identify and respond to State needs for technical and financial assistance in a more effective way. Action plans will contribute to the transition to implementation as follows:

- Helping to clarify the extent to which States are able and will attempt to contribute to the achievement of the global aspirational goals.
- Helping States to identify gaps in their existing programmes and to fine-tune their strategies as they specify the particular basket of measures that they will employ to contribute to the achievement of the global aspirational goals.
- Ensuring that relevant stakeholders know about their States' planned actions, and are aware of the respective roles and expectations that apply to them.
- Enabling ICAO to determine the extent to which the planned actions of States are sufficient to meet the collective global aspirational goals established for the sector.
- Enabling ICAO to identify State needs for assistance with a view to responding appropriately through the development of a process and mechanism for the provision of assistance to States.

In this way, climate change action plans are expected to facilitate the achievement of the global aspirational goals related to improving fuel efficiency and stabilizing CO_2 emissions from the international aviation sector. Recognition of the importance of action plans is demonstrated by not only the relevant provisions of the Assembly Resolution, but furthermore by the responses from individual States. For example, some States had already initiated and some had concluded the preparation of their preliminary action plans, even before the 37th Assembly.

Preparing for an Effective Action Plan

The successful preparation of a State action plan would depend on the following prerequisites:

- Assessing the current situation, in particular by quantifying the emissions from international aviation, calculating fuel efficiency on the basis of volume of fuel used per Revenue Tonne-Kilometre (RTK) performed, identifying measures already undertaken, and reviewing relevant national and international obligations.
- Evaluating different emissions scenarios in light of national circumstances and with the aim of advancing the attainment of the global aspirational goals.
- Raising awareness and obtaining commitment at the appropriate levels among stakeholders, including the government, industry and the research community.
- Building multidisciplinary teams to bring together available technical and financial expertise and creating partnerships to obtain required advice.

Contents of an Action Plan

The heart of the action plan is the section outlining the proposed actions. This section will identify the measures the State will employ to limit or reduce emissions from international aviation. This basket of measures[1], may cover a broad range of initiatives, such as aircraft-related technology development, improved air-traffic management and infrastructure use, more efficient operations, economics/market-based measures, the use of sustainable alternative fuels, and regulatory measures. The process of deciding on the appropriate mix of measures may involve agreeing on the priority to be assigned to the aforementioned options. In this regard, ICAO is developing a guidance document to help States to identify the most suitable measures among those available.

An action plan should also recognize and provide for the role to be played by industry as well as other stakeholders, including the research/academic community. It should stipulate the resources that would be needed and are available to achieve the expected results and, where appropriate, indicate any assistance required.

Implementation and Review of the Action Plan

Depending on the basket of measures selected and the legal regime in place, immediate actions could involve the development of new rules and regulations to be adopted by the appropriate authorities. Other actions could include the planning or implementation of operational or technological measures to be taken by the industry, as well as organizational initiatives, such as recruitment or training.

Different States may design different arrangements to monitor implementation and to facilitate reporting to ICAO and to local constituencies. Also, an action plan, being a living document, is subject to ongoing updating and refinement.

ICAO's Next Steps

ICAO is taking immediate steps to help States prepare their action plans, by developing guidance material and a framework for collecting, analyzing and reporting aviation CO_2 emissions.

In addition, ICAO is planning regional hands-on training workshops from May to July 2011 in its Regional Offices (see table below). These workshops will allow States to obtain maximum benefit from the guidance material and provide opportunities for them to help refine their material.

The Organization is also preparing a web-interface that will serve as an electronic template for the submission of action plans. This web tool provides material to assist the preparation of action plans and disseminates information on the various measures being undertaken by States. The workshops will train participants on the use of the web interface.

Conclusion

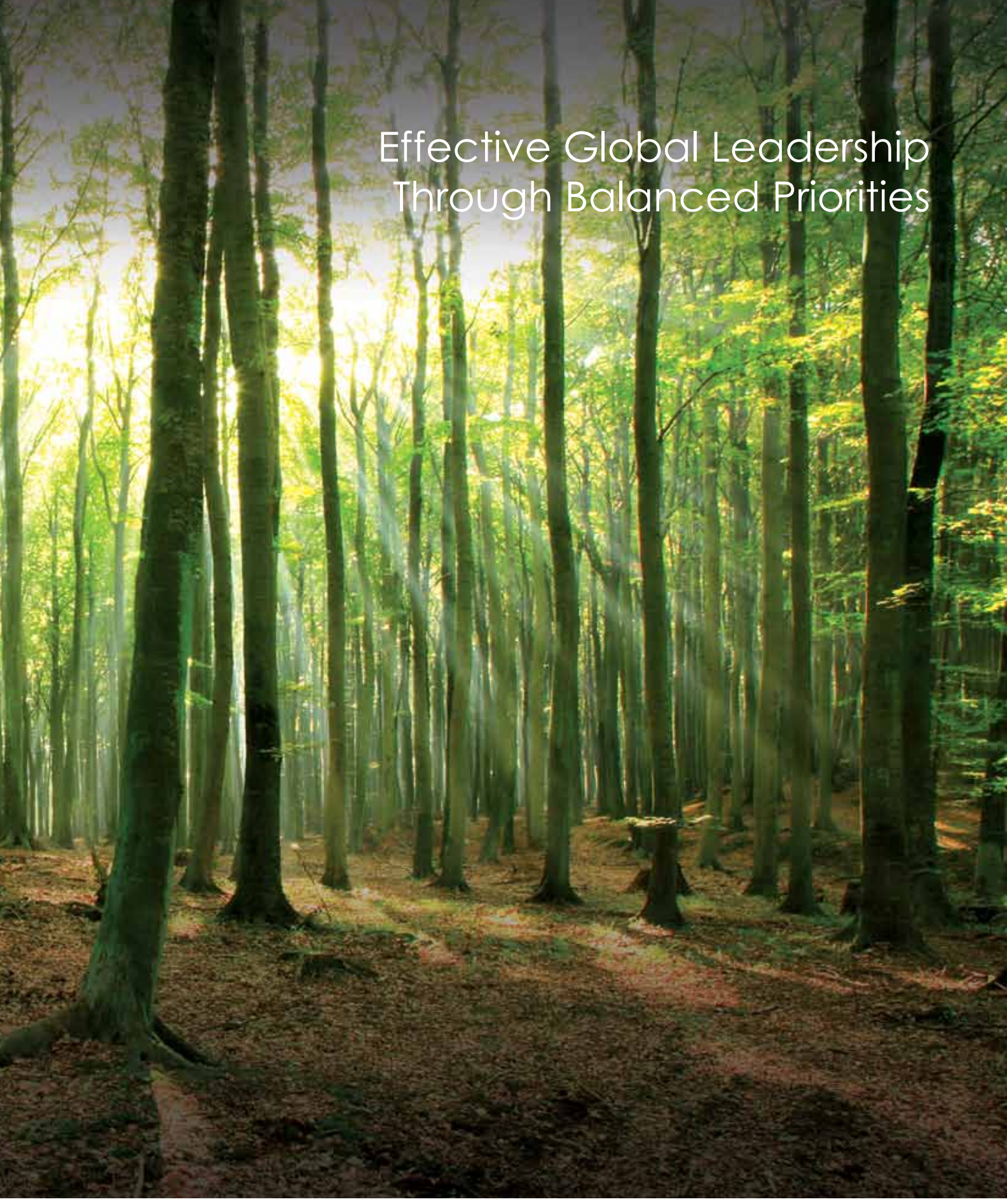
States' action plans are a critical element in the transition from policy setting to the implementation phase in ICAO's activities related to climate change. For the States themselves, action plans will be vital in identifying how, at the national level and from ICAO's basket of measures, they can contribute to the achievement of global aspirational goals.

ICAO is paving the way to support States in this new phase. As has been the case during the policy-setting stage, ICAO and its Member States, as well as industry, will work together to meet the shared commitment to address aviation's impact on the global climate and to help create aviation's green and sustainable future. ■

UPCOMING ICAO REGIONAL ACTION PLAN TRAINING WORKSHOPS:

- **SAM and NACC Regions:** 2 to 4 May 2011
- **APAC Region:** 25 to 27 May 2011
- **MID Region:** 14 to 16 June 2011
- **AFI Region:** 4 to 6 July 2011
- **EUR/NAT Region:** 11 to 13 July 2011

[1] http://www.icao.int/icao/en/atb/meetings/GIACC/Giacc_Root.html.


Effective Global Leadership
Through Balanced Priorities

Climate Change Impacts and Inter-agency Cooperation in Tourism and Travel

Chris Lyle's career spans British Airways, the United Nations Economic Commission for Africa, and ICAO, as well the World Tourism Organization (UNWTO) for which he is currently Representative to ICAO. He also heads up a Canadian-based consultancy, Air Transport Economics. Lyle's primary expertise is in regulatory policy, economic analysis and environmental protection. Over the past few years much of his focus has been on the climate change impacts of tourism and aviation. He is a graduate of Cambridge University with a postgraduate in operational research and a Fellow of the Royal Aeronautical Society.

Climate change is not some distant, future threat to tourism and travel. Its varied impacts are increasingly becoming evident in various destinations around the world and affecting the tourism and travel industry and the communities which depend upon it *(see Fig.1, p. 35).* The integrated effects of climate change are anticipated to have far reaching impacts on tourism and travel businesses and destinations.

Climate change is already altering the decisions of travelers in terms of the destinations they choose and the timing of their trips. There are four broad pathways by which climate change is now and will continue to affect tourism and travel[1]:

(i) *Direct climate impacts:* For example on winter sports holidays and sun-and-sea destinations, infrastructural damage, higher operating expenses.
(ii) *Indirect environmental change impacts:* For example changes in water availability, biodiversity loss, reduced landscape aesthetic, altered agricultural production, increased natural hazards, coastal erosion and inundation, damage to infrastructure and the increasing incidence of vector-borne diseases.
(iii) *Impacts of mitigation policies on tourism mobility:* National or international policies to reduce greenhouse gas (GHG) emissions causing an increase in transport costs and fostering environmental attitudes that lead tourists to change their travel patterns (for example shift transport mode or destination choices).
(iv) *Indirect societal change impacts:* Economic costs, constraints on economic growth and even effects on political stability.

Tourism Community Response

The *Davos Declaration,* adopted by the global Conference on Climate Change and Tourism in October 2007[2], specifies that:

> *"…the tourism sector must rapidly respond to climate change, within the evolving UN framework, and progressively reduce its GHG contribution if it is to grow in a sustainable manner; this will require action to:*
>
> - *Mitigate its GHG emissions, derived especially from transport and accommodation activities.*
> - *Adapt tourism businesses and destinations to changing climate conditions.*
> - *Apply existing and new technology to improve energy efficiency.*
> - *Secure financial resources to help poor regions and countries."*

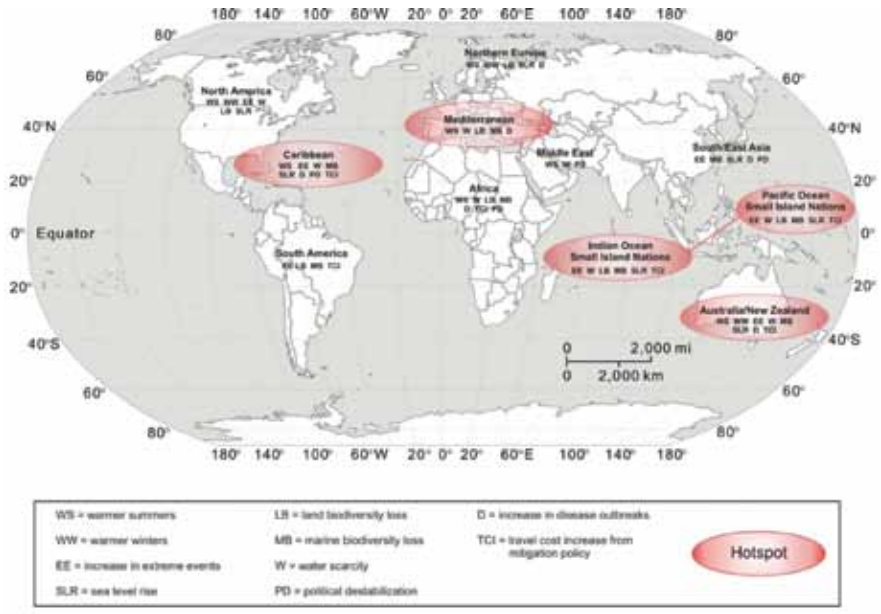
The Declaration calls for a range of actions, including for governments and international organizations to *"…collaborate in international strategies in the transport (in cooperation with the International Civil Aviation Organization and other aviation organizations), accommodation and related tourism activities."* These actions are being followed-up through the Davos Process in a manner consistent with the UNWTO's mandate to give special consideration to least-developed countries and small-island developing States.

Adaptation: Regardless of emissions reduction efforts, there is an inevitable need for societies around the world to adapt to unavoidable changes in climate. Irrespective of the nature and magnitude of climate change impacts, all tourism businesses and destinations will need to adapt. The capacity to adapt varies substantially between sub-sectors, destinations and individual businesses. UNWTO is fostering adaptation worldwide, propounding a diverse range of technological, managerial, educational, policy and behavioural actions to deal with climate variability.

Mitigation: Adaptation cannot be dissociated from mitigation. The increasing intensity in requirements for adaptation is correlated with increasing potential for climate destabilization and hence with the need for mitigation. The tourism community is thus focused both on adaptation and on

All footnotes collated at end of text on page 36.

Figure 1: Geographic distribution of major climate change impacts affecting tourism destinations.



mitigation from a sectoral as well as a global perspective. Major mitigation strategies include: reducing energy use; improving energy efficiency; increasing the use of renewable energy; sequestering carbon through sinks; applying tech nological improvements; environmental management; and economic and policy measures.

Domestic and international travel and tourism contribute about five percent of global anthropogenic carbon dioxide (CO_2) emissions, air transport being the primary contributor[3]. Air transport accounts for an estimated 40 percent of the travel and tourism contribution of CO_2 and an estimated 60 percent of the *international* travel and tourism contribution of CO_2. These factors are overwhelmingly dominant for medium- and long-haul trips.

A 'business as usual' forecast for travel and tourism for 2035 is for an increase over 2005 CO_2 levels 0f 160 percent, with the share of air transport emissions rising from 40 to just over 50 per cent. No global target for the reduction of CO_2 emissions has, as of yet, been established for travel and tourism. Both domestic and international destination tourism are encompassed in national inventories and associated with national targets where relevant under the UNFCCC framework.

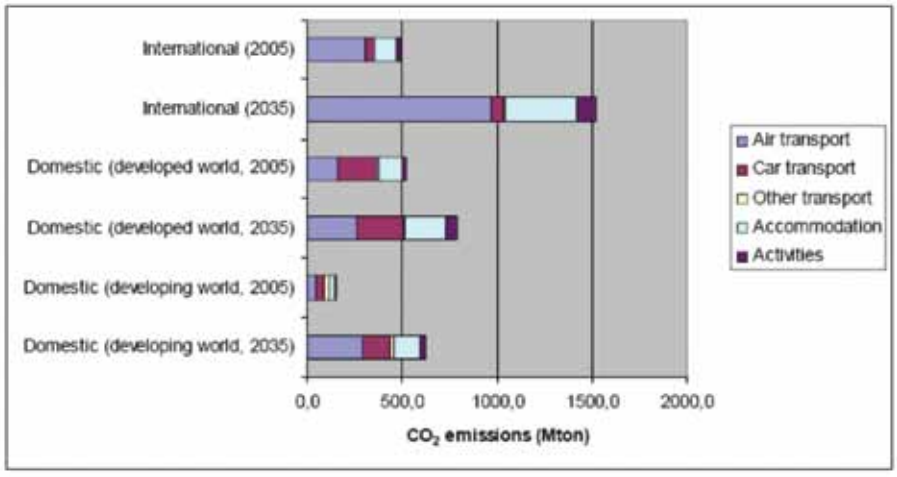
Resolution A37-19, adopted by the 37th Session of the ICAO Assembly, includes global aspirational goals for international aviation reflecting 2 percent annual fuel efficiency improvement and stabilizing CO_2 emissions at 2020 levels. The World Travel and Tourism Council (WTTC) has set out a vision for tackling emissions further, including a commitment, encompassing both domestic and international aviation and endorsed by more than 40 of the world's largest travel and tourism companies, to achieve a 50 percent reduction in 2005 carbon emission levels by 2035 ; there is also an interim target of achieving a 30 percent reduction by 2020 in the presence of an international agreement, or 25 percent reduction in the absence of such an agreement.

Implications for Air Transport

International air transport and international tourism are locked at the hip, a point which is reflected clearly by the correlations in passenger and tourism traffic and revenue levels. International air passengers are predominantly tourists (business and leisure travellers) and over half of the world's international tourist arrivals are by air (increasing yearly, with much higher proportions for long-haul destinations).

Adaptation: The primary need for air transport at present is to respond to changing patterns in tourism mobility. Tourists have great adaptive capacity (depending on three key resources: money, knowledge and time) with relative freedom to avoid destinations impacted by climate change or to shift the timing of their travel to avoid unfavourable climate conditions.

Figure 2: Projected CO^2 emissions from travel and tourism under a 'business as usual' scenario (excluding same-day visitors).



"Domestic and international travel and tourism contribute about five percent of global anthropogenic carbon dioxide (CO_2) emissions, air transport being the primary contributor. Air transport accounts for an estimated 40 percent of the travel and tourism contribution of CO_2 and an estimated 60 percent of the international travel and tourism contribution of CO_2. These factors are overwhelmingly dominant for medium and long-haul trips."

The aviation sector is starting to consider other adaptive requirements to respond to operational safety impacts (more frequent hostile weather, more intense weather systems, etc.) and infrastructural impacts (low-lying airports, etc.).

Mitigation: ICAO continues to play a key role leading the aviation sector to tighter standards on aircraft emissions and related operating procedures. A global CO_2 emission Standard for aircraft is now being developed, scheduled for 2013. Technological, operational and infrastructure enhancements, however, will fall well short on their own for the foreseeable future with respect to countering the anticipated growth of air traffic. Concrete economic instruments therefore, preferably globally-agreed, will also be necessary. Such instruments as emissions-related levies, emissions trading and carbon offset have scope implications well beyond air transport and well beyond individual countries or groups of countries; they thus require a cooperative inter-sectoral and inter-agency approach.

Tourism Perspective on Air Transport Activity

Because of the critical role of aviation in tourism, especially in developing countries, as well as the distinct treatment of air transport under the UNFCCC, in August 2010 the UNWTO issued a *Statement Regarding Mitigation of Green House Gas Emissions from Air Passenger Transport,* and this Statement was presented to the ICAO Assembly the following month.

In preparing this position, the UNWTO undertook specific analyses, with the United Nations Environment Programme (UNEP), the World Meteorological Organization, the World Economic Forum, in addition to work it carried out independently. The opening key elements are as follows:

1. Assessment of mitigation measures in the context of broad-spectrum tourism, including domestic, inbound and outbound flows, rather than for air transport in isolation, incorporating social and economic costs and benefits in cohesion with the climate change mitigation impact.
2. Application of the UNFCCC principle of Common but Differentiated Responsibilities (CBDR) amongst countries.
3. Classification of differentiation to alleviate negative impacts on tourism destination markets in developing and particularly least-developed and island-countries, through differentiated targets, financial transfer mechanisms, and/or reductions in emissions levies or requirements for emissions permits, preferably applied in a framework of traffic flow origin and destination rather than solely according to country.

Inter-agency Cooperation Going Forward

In January 2011, the UNEP and UNWTO announced the launch of the Global Partnership for Sustainable Tourism (GPST), presently made up of five UN organizations, governments, multilateral bodies, the private sector and non-governmental organizations.

The GPST aims to shift tourism onto a sustainable pathway worldwide, through the sharing of knowledge on successful sustainable tourism initiatives and replicating such initiatives to meet global needs. Two key thematic areas are policy frameworks and climate change. Given the major contribution of air transport to GHG emissions from travel and tourism, input from ICAO and the air transport industry will be essential.

The UNWTO also looks forward to working with ICAO closely in the development of a global framework for mitigation of aviation's contribution to climate change. This should occur in the context of travel and tourism as a whole and the 'delivering as one United Nations' initiative, notably as regards the elaboration of global aspirational goals and economic instruments. ■

Footnotes:

[1] Sources of much of the material in this article are: UNWTO-UNEP-WMO, Climate Change and Tourism: Responding to Global Challenges, June 2008; Discussion Paper on Tourism, Air Transport and Climate Change, September 2007; Discussion Paper on Climate Change Mitigation Measures for International Air Transport, August 2009. These and more general documents on climate change and tourism may be accessed under "Davos Declaration Support Materials" at http://www.unwto.org/climate/support/en/support.php.

[2] Convened by UNWTO jointly with the United Nations Environment Programme and the World Meteorological Organization, with the support of the World Economic Forum and the Swiss Government.

[3] Source: UNWTO-UNEP-WMO, Climate Change and Tourism: Responding to Global Challenges, June 2008. This figure has been reconciled with the Intergovernmental Panel on Climate Change (IPCC) Special Report on Aviation and the Global Atmosphere in 1999 and Fourth Assessment Report in 2007. The contributions to GHG emissions quoted are based on transport plus accommodation and activities at destination, whether for business or for leisure travel. Aviation's mitigation efforts at present relate to one primary GHG only, namely CO_2, while the UNFCCC encompasses several GHGs; current scientific evidence suggests that aviation's non-CO_2 impacts in relation to basic CO_2 effects are well above the average multiplier or ratio for all man-made emissions.

[4] WTTC (2009) Leading the challenge on climate change: http://www.wttc.org/eng/Tourism_Initiatives/Environment_Initiative/

[5] The full text may be found at http://www.unwto.org/climate/support/en/pdf/UNWTO_GHG_Aviation_Policy_2010.pdf.

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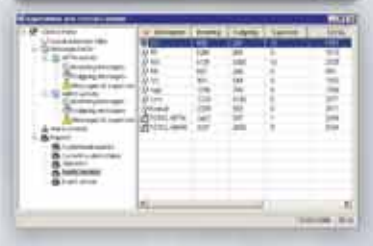

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