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ICAO PBN Programme status • IATA's PBN priority: Operational approvals
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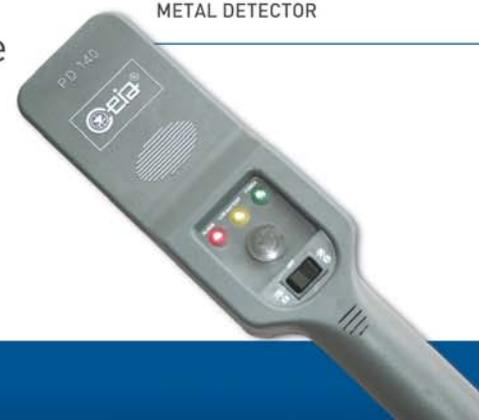
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Contents

COVER STORY

The promise of PBN: ICAO and stakeholder perspectives on the status and challenges as air navigation evolves into the next stage of air navigation efficiency.

ICAO's PBN accomplishments

Erwin Lassoij, ICAO PBN Programme Manager, reports on the ongoing priorities for ICAO and the industry and the win-win aspects of this important component of ICAO's Communications Navigation and Surveillance/Air Traffic Management (CNS/ATM) strategy. 4

Carrier focus: Operational approvals

Dave Behrens, IATA Director, Infrastructure Strategy, describes how operational approvals remain a key stumbling block for aircraft operators as they seek to more immediately leverage the bottom-line benefits of PBN. 9

PBN enablers

CANSO's Members remain at the forefront of PBN development. The organization reports on current status and on how its stakeholders are already seeing the benefits of this exciting technological enabler 13

AVIATION AND THE ALTERNATIVE FUELS (AF) OPTION

In the lead-up to our special review of aviation environmental concerns in Issue 5, the Journal reviews ICAO and key stakeholder perspectives on where the industry and technology now stands on AF adoption and implementation:

- **ICAO ENV Section Chief: Jane Hupe** 16
- **Shell Aviation** 20
- **International Coalition for Sustainable Aviation** 23
- **Commercial Aviation Alternative Fuels Initiative** 25
- **International Coordinating Council of Aerospace Industries Associations** 27

The EC and ICAO: Celebrating accomplishments

Timothy Fenoulhet, EC Representative at ICAO, reports on the progress that has been made in building closer cooperation between the two organizations through a relationship that is of major importance to international civil aviation. 29

State Profile: Egypt

Egypt continues to advance aviation priorities to the benefit of its people and its Region, managing the largest North African aviation market. A special State Profile for the *ICAO Journal* 32

ICAO Calendar of Events 36



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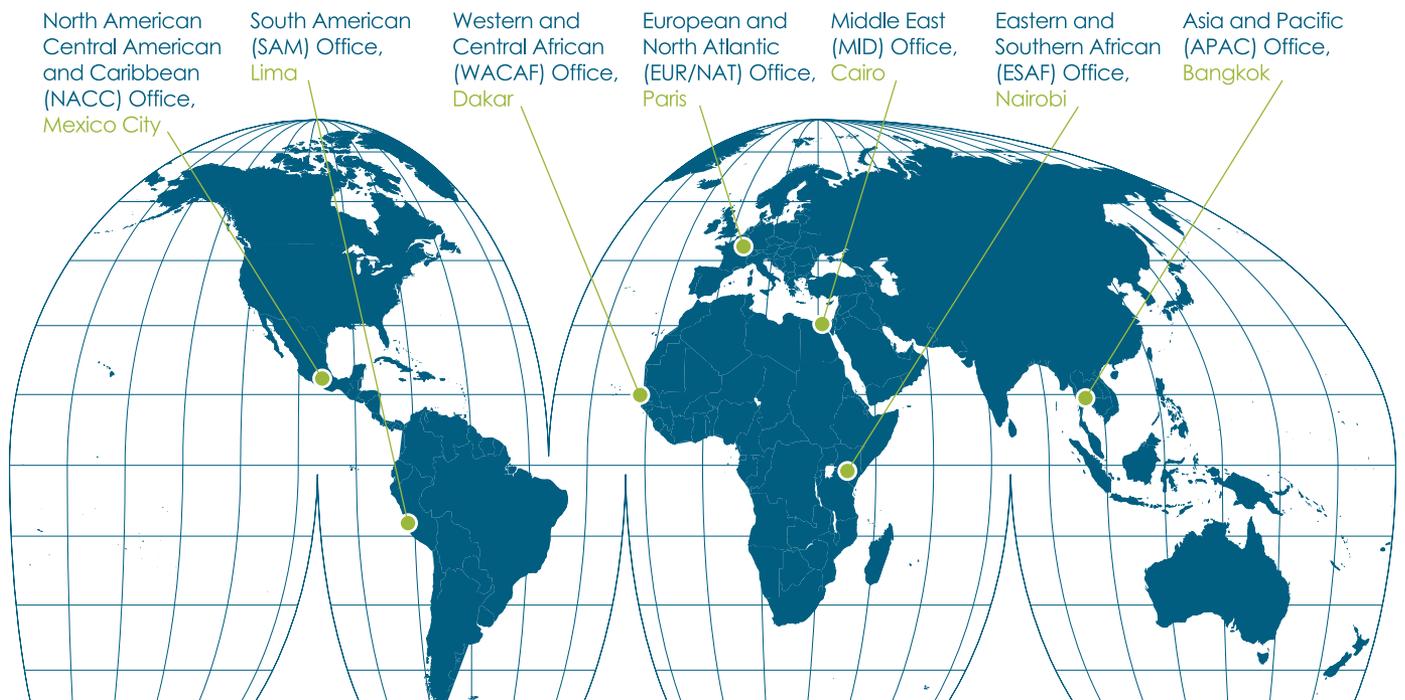
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ICAO's Global Presence



Leadership and Vision in Global Civil Aviation





A landmark year for PBN

2009 is poised to stand out as an important year for ICAO, States and the respective industry stakeholders now working to evolve global air navigation procedures and technologies toward the safer, greener, more efficient and more sustainable alternative promised by Performance-based Navigation (PBN).

The *Journal* spoke recently with Erwin Lassoij, ICAO's PBN Programme Manager, about the ongoing PBN priorities for ICAO and the industry as the truly win-win benefits of this crucial component of the broader ICAO Communications Navigation and Surveillance/Air Traffic Management (CNS/ATM) strategy begin to be realized.

On April 1, 2009, ICAO and its State and industry partners in the Global PBN Task Force signed a special new declaration calling for the rapid implementation of Performance-based Navigation (PBN). Speaking on behalf of the group the President of the Council of ICAO, Mr. Roberto Kobeh González, emphasized that PBN "...will help reduce airport and airspace congestion, conserve fuel and protect the environment, reduce the impact of aircraft noise near airports, and ensure reliable, all-weather operations. It will also provide operators with greater flexibility, while increasing safety and efficiency."

"Our collective mission has always been to provide the citizens of the world with the safest and most efficient air transport system possible," Kobeh stressed. "Performance-based Navigation is vital to helping us fulfill our mission today and in the future."

The special PBN declaration was developed and signed in Geneva at the Aviation Environmental Summit by 10 organizations representing global aviation's primary stakeholders. The Environment Summit setting was significant in the sense that, once significantly implemented, PBN promises to bring about a minimum two percent savings to the total operational efficiency of the air traffic system, which equates to approximately four million tonnes of fuel savings and 13 million tonnes of CO₂ reductions per year.

As well as the signing of this special declaration, a move intended to help draw attention to and enhance the significant momentum already being generated around the PBN programme and objectives, 2009 also marks the deadline for finalized PBN implementation plans which ICAO set out for its Member States at the 36th ICAO General Assembly in 2007.

PERFORMANCE-BASED NAVIGATION: RESOLUTION 36-23 AS AGREED AT THE ICAO 36TH ASSEMBLY (2007)

The Assembly:

1. *Urges* all States to implement RNAV and RNP air traffic services (ATS) routes and approach procedures in accordance with the ICAO PBN concept laid down in the *Performance-based Navigation Manual* (Doc 9613);
2. *Resolves* that:
 - a) States and planning and implementation regional groups (PIRGs) complete a PBN implementation plan by 2009 to achieve:
 - 1) Implementation of RNAV and RNP operations (where required) for en route and terminal areas according to established timelines and intermediate milestones; and
 - 2) Implementation of approach procedures with vertical guidance (APV) (Baro-VNAV and/or augmented GNSS) for all instrument runway ends, either as the primary approach or as a back-up for precision approaches by 2016 with intermediate milestones as follows: 30 percent by 2010, 70 percent by 2014; and
 - b) ICAO develop a coordinated action plan to assist States in the implementation of PBN and to ensure development and/or maintenance of globally harmonized SARPs, Procedures for Air Navigation Services (PANS) and guidance material including a global harmonized safety assessment methodology to keep pace with operational demands; *II-34 Assembly Resolutions in Force*.
 - 3) *Urges* that States include in their PBN implementation plan provisions for implementation of approach procedures with vertical guidance (APV) to all runway ends serving aircraft with a maximum certificated take-off mass of 5,700 kg or more, according to established timelines and intermediate milestones.
 - 4) *Instructs* the Council to provide a progress report on PBN implementation to the next ordinary session of the Assembly; and
 - 5) *Requests* the Planning and Implementation Regional Groups (PIRGs) to include in their work programme the review of status of implementation of PBN by States according to the defined implementation plans and report to ICAO any deficiencies that may occur.



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Regional PBN plans are now already in place and have been developed by ICAO's Regional office teams in cooperation with local stakeholders, and State plans are currently on track for their 2009 submission deadlines.

Erwin Lassoij, Secretary of the PBN Study Group and ICAO PBN Programme Manager, spoke recently with the *Journal* regarding ICAO's current priorities in this promising new area. With the global PBN strategic planning processes now in place, and with Regions and States refining local implementation planning accordingly, the Organization's main focus has now turned to ongoing training and implementation activities and enhancements to existing criteria and guidance material that will facilitate PBN implementations globally.

"In the area of guidance material, at present our focus is centred on refinements to allow for increased use of the aircraft's capabilities, particularly those relating to Radius-to-Fix legs (RF legs)," began Lassoij. "We are also developing a new, advanced RNP navigation specification for high density airspaces that will feature the new RF legs while also factoring in additional PBN elements,

such as Required Time of Arrival (RTA). The timeline we're working under should see the next step in these guidance refinements completed by 2010."

PBN background

At ICAO's 36th Assembly, State representatives enthusiastically agreed Resolution 36-23, which urged all ICAO Members to implement Area Navigation (RNAV) and Required Navigation Performance (RNP) routes and approach procedures in accordance with the guidance and specifications reflected in ICAO's *Performance-based Navigation Manual* (Doc 9613—for more details on Assembly Resolution 36-23 please see the sidebar on page 4).

PBN represents a framework for defining a navigation performance specification along a route, during a procedure, or in an airspace within which an aircraft must comply with specified operational performance requirements (see diagrams on page 7). It provides a basis for the development of automated flight paths, as well as for more efficient airspace design, aircraft separation and obstacle avoidance. PBN also facilitates the communication of the performance and operational capabilities

ICAO'S GLOBAL PBN BODIES

In addition to the PBN Task Forces that have been established at all of ICAO's Regional Offices, the following is a list of the main ICAO groups and bodies now overseeing PBN-related activities:

Global PBN Task Force

Made up of ICAO, IATA, international organizations and States, along with key industry players. The Task Force is working to implement PBN quickly and safely throughout the world. (includes promotion, development of guidance and education, implementation management).

PBN Study Group

Development and maintenance of PBN concept and its navigation specifications.

Instrument Flight Procedures Panel (IFPP)

Development of flight procedure design and charting requirements.

Separation and Airspace Safety Panel (SASP)

Development of separation requirements.

necessary for the utilization of such paths and airspace.

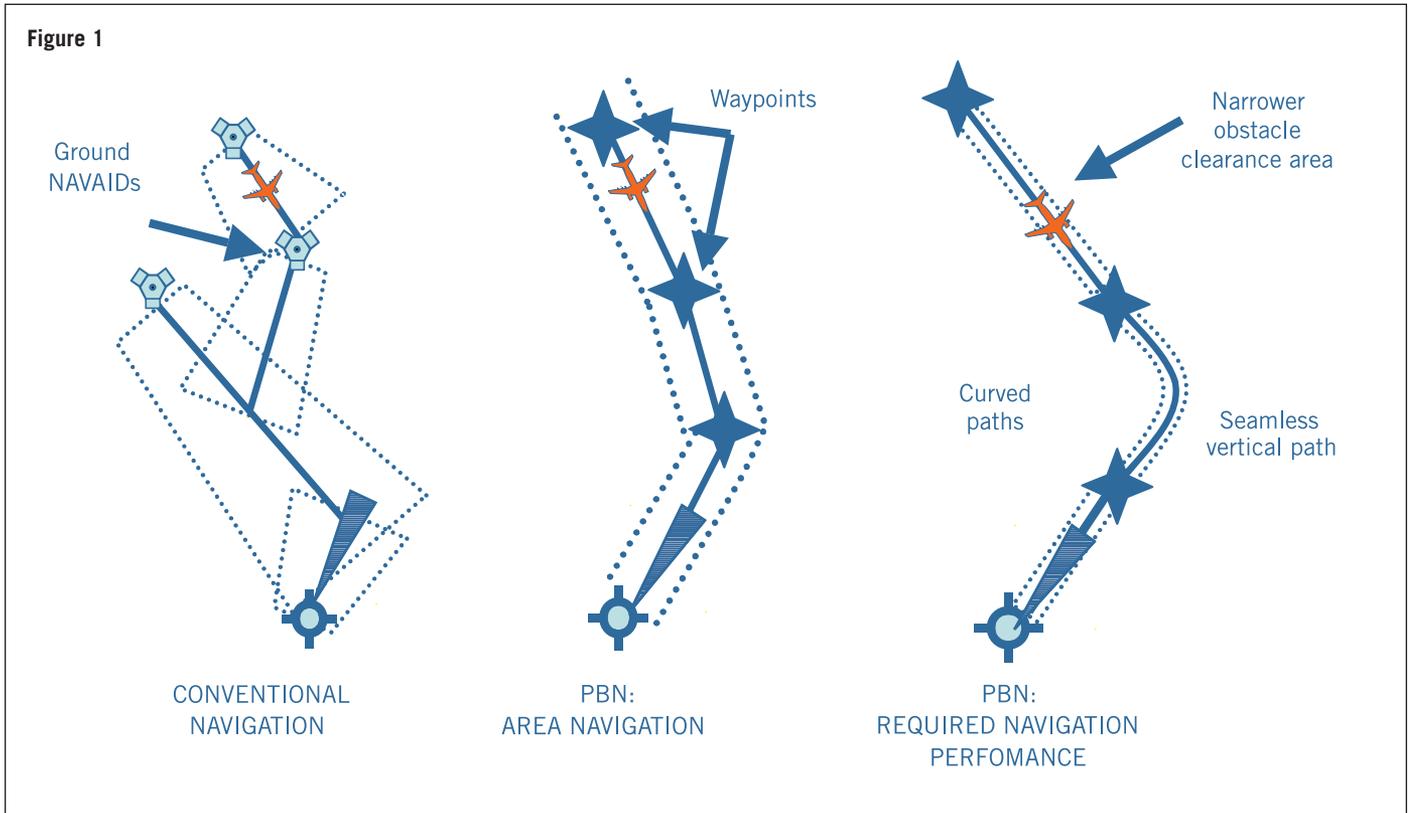
Once the performance level is established on the basis of operational needs, the aircraft's avionics capability determines whether it can safely achieve the specified performance and qualify for the operation. It should be noted that many of the navigational advancements enabled by PBN are compatible with the avionics technology currently installed in most of the world's major commercial fleets—meaning minimal or no retrofit and equipment outlay requirements for major aircraft operators or Air Navigation Service Providers (ANSPs). Regulators and industry have agreed from the outset that the PBN system would have to be guided by precisely this type of pragmatic evolutionary, rather than revolutionary approach.

"PBN is a cornerstone enabler of the planned FAA NextGen and European SESAR initiatives, which represent the best-known Regional implementation examples of the future ICAO Global ATM Concept," clarified Lassoij.

PBN'S PRIMARY BENEFITS:

1. Increased airspace safety through the implementation of continuous and stabilized descent procedures using vertical guidance.
2. Reduced aircraft flight times due to the implementation of optimal flight paths, with the resulting reductions in fuel use, noise and environmental harm.
3. Use of existing aircraft RNAV and/or RNP capabilities.
4. Improved airport and airspace arrival paths in all weather conditions, and the possibility of meeting critical obstacle clearance and environmental requirements through the application of optimized RNAV or RNP paths.
5. Implementation of more precise approach, departure and arrival paths to reduce dispersion and foster smoother traffic flows.
6. Reduced delays in high-density airspaces and airports through the implementation of additional parallel routes and additional arrival and departure points in terminal areas.
7. Reduction of lateral and longitudinal separation between aircraft to accommodate more traffic.
8. Decreased Air Traffic Controller (ATC) and pilot workloads through the use of RNAV/RNP procedures and airborne capabilities.
9. Reduced need for ATC-Pilot communications and radar vectoring.
10. Increased predictability of flight paths.

Figure 1



Current challenges and highlights

Though PBN technology is in place and the will to implement its specifications regionally has now been established and formalized, one of the main challenges that remains is to drive more rapid and comprehensive implementation at the national level. This will involve delivering the guidance, training and assistance that's required in order for States to bring their PBN capabilities online.

One of the key issues for States is the requirement to have qualified personnel available who can operationally approve airlines for PBN routes and approaches (see related topic in *IATA PBN interview on page 9*). This and other challenges still remain to be overcome in order to achieve the more universal level of implementation of PBN that current technologies already allow for, along with the broader enabling of the efficiency gains that carriers want to start seeing in their bottom lines as soon as possible.

On the training front, ICAO, in cooperation with the French DGAC and ENAC (the French Civil Aviation University), has developed and is now finalizing delivery of PBN Procedure Design Courses in every ICAO Region. ICAO is presently developing a new course for State regulators on operational approval, which is to be delivered through its proven network of Cooperative Development of Operational Safety and Continuing Airworthiness Projects (COSCAPs). Other organizations, such

as EUROCONTROL and the FAA, are also aggressively pursuing international PBN training objectives, for instance in the area of airspace planning, and are coordinating their activities with those of ICAO. These joint efforts highlight how quickly regulators and agencies are now moving the PBN programme forward.

One of the bright lights on PBN's near horizon in the APAC Region is the planned October opening of a new Beijing Flight Procedure Programme (FPP) office in China (*editor's note: for more on what all of ICAO's Regional Offices have planned as part of their 2009–2010 PBN activities, please see the table on page 8*). On March 26, 2009, ICAO and China signed a letter of intent to establish the new facility.

"The APAC Region was chosen for the first Flight Procedure Programme (FPP) because of the tremendous growth in traffic there," commented David Van Ness, Implementation & Resource Development Coordinator for the ICAO PBN programme. "One of the features of the APAC FPP is that it will help in the implementation of PBN by providing assistance to States in the area of instrument flight procedures."

The formal signing for the new Beijing facility will likely take place at the upcoming Asia-Pacific DGCA Conference to be held in October. All States in the Region are being encouraged to join the programme. ■

ICAO'S REGIONAL PBN OBJECTIVES AND ACCOMPLISHMENTS, 2009–2010

Bangkok: Asia and Pacific (APAC) Office

- PBN Seminar, Japan (March 2009).
- Fifth APAC Performance-based Navigation Task Force Meeting, Thailand (July 2009).
- Asia Pacific Flight Procedure Programme Office established, China (October 2009).
- PBN Seminar, CAD Hong Kong (February 2010).
- Model Operational and Airworthiness Approval Documentation provided to States.
- APAC Regional PBN Implementation Plan Interim Edition (V 0.2) developed.
- RNP APCH (with Baro-VNAV) in 30 percent of instrument runways by 2010.
- RNAV 1 SID/STAR for 50 percent of international airports by 2010.

Cairo: Middle East (MID) Office

- PBN points of contact developed and State letter sent.
- Completed PBN MID Regional Implementation Strategy and plan (MIDANPIRG/11 conc. 11/73).
- States urged to complete PBN State Plan by September 30, 2009 (MIDANPIRG/11 conc. 11/74).
- State PBN plan template developed to assist States in developing their national plans
- Implemented RNAV 5 in MID according to Strategy approved in conclusion MIDANPIRG/11 conc. 11/73.
- PBN Procedures Design Course conducted for MID Region, Abu-Dhabi, UAE, March 2009.
- First RNAV 1 route implemented in December 2008 in UAE, inter alia to facilitate ATS route through Mil airspace, with significant fuel savings.
- RNAV approach procedures published in 14 MID airports.

Lima: South American (SAM) Office

- Regional PBN Implementation Plan adopted and available to all SAM States.
- National PBN Plan Guidance adopted and available to all SAM States.
- PBN points of contact developed.
- Collect traffic data in order to understand traffic flows in a given airspace in process (October 2009).
- Survey to analyze the navigation capacity of the aircraft fleet in process (October 2009).
- Optimize airspace structure, reorganizing the network or implementing new routes based on the strategic objectives of the airspace concept, taking into account airspace modelling, ATC simulations (fast time and/or real time), live tests, etc., in process (October 2009).
- States must analyze the feasibility of the tentative date in coordination with domestic operators and military authorities to establish the PBN regional implementation date (October 2009).
- Advisory Circulars developed and available to all SAM States:
 - CA 91-008 – Aircraft and operators approval for RNP APCH operations.
 - CA 91-009 – Aircraft and operators approval for RNP AR APCH operations.
 - CA 91-010 – Aircraft and operators approval for APV/baro-VNAV operations.
- Advisory Circulars in process (October 2009):
 - CA 91-001 – Aircraft and operators approval for RNAV 10.
 - CA 91-004 – Aircraft and operators approval for RNAV 1.
 - CA 91-007 – Aircraft and operators approval for RNP 1.
- Course on Airport Capacity Estimate and ATC sectors, Río de Janeiro, Brazil, March 2009.
- Third Meeting/Workshop of the SAM Implementation Group, Lima, Perú, April 2009.
- Course for RNAV/RNP instrument procedures design, Lima, Perú, Sept. 2009.
- Course for RNP AR APCH instrument procedures design, Lima, Perú, Sept. 2009.
- Fourth Meeting/Workshop of the SAM Implementation Group, Lima, Perú, October 2009.
- Course for APV Baro VNAV instrument procedures design (First half 2010).
- Fifth Meeting/Workshop of the SAM Implementation Group (First half 2010).
- SAM Workshop on routes network and safety assessment required (Second half 2010).
- Sixth Meeting/Workshop of the SAM Implementation Group (Second half 2010).

Mexico: North American, Central American and Caribbean (NACC) Office

- Performance-based Framework Implementation Workshop (Mexico City, July 2009).
- Seventh Central Caribbean Working Group Meeting (Mexico City, July 2009).
- Fifth Central American Working Group Meeting (Tegucigalpa, Honduras, September 2009).
- Thirty-first Eastern Caribbean Working Group Meeting (Antigua and Barbuda, 2009).
- First CNS/ATM Subgroup Meeting (GREPECAS) (Santiago, Chile, October 2009).
- Airspace and ATS route Network Capacity Workshop (First half 2010).
- Eighth Central Caribbean Working Group Meeting (First half 2010).
- Thirty-second Eastern Caribbean Working Group Meeting (First half 2010).
- Sixth Central American Working Group Meeting (Second half 2010).
- Second CNS/ATM Subgroup Meeting (GREPECAS) (Second half 2010).
- PBN points of contact developed following GREPECAS Conclusions 14/51, 15/1 and 15/38 addressing PBN Regional strategies and a model for national action plans.
- Complete all PBN national action plans by end December 2009. Mexican, Canadian and U.S. plans already completed.
- RNP 4 implemented in Alaskan oceanic airspace.
- RNP 10 implemented in WATRS airspace (amendment to Doc 7030, approved in 2008).
- Coordination for RNP implementation in the Gulf of Mexico. RNP 4 is the most appropriate specification for this oceanic area.
- CAR States implementing RNAV procedures in international airports.
- PBN Procedures Design Course, Havana, Cuba, June 2009.
- Draft of PBN Circular developed by CAR States to address:
 - Aircraft and operators approval for RNAV-5 operations.
 - Aircraft and operators approval for RNP APCH operations.
 - Aircraft and operators approval for RNP AR APCH operations.
 - Aircraft and operators approval for RNP Baro-VNAV operations.

Nairobi: Eastern and Southern African (ESAF) Office

- Adopted Regional PBN Implementation Plan and made it available to all AFI States.
- Adopted National PBN Plan Template and made it available to all AFI States.
- APIRG PBN Task Force third meeting (third quarter of 2009).
- Urged States to develop their National PBN Plan, no later than December 31, 2009.

Paris: European and North Atlantic (EUR/NAT) Office

- PBN compliant applications have been implemented in majority of the EUR airspace. Some pre-PBN implementations do exist but conversion programmes are being launched to progress toward PBN.
- PBN Implementation and Harmonisation Strategy agreed at the EANPG in December 2009.
- PBN Implementation Roadmap as part of the Regional Navigation Systems Evolution Strategy is being developed.
- Amendment to the Regional SUPPs Doc 7030 to reflect mandatory carriage requirements is being drafted.
- Monitoring mechanism for tracking the PBN implementation progress is established.
 - EASA is progressing in development of associated certification material.
 - A workshop on APV held June 2009 in Paris.
 - A PBN workshop to be held in St. Petersburg, October 2009.

Seeking approval



Although many aircraft and infrastructures in some Regions and States may already possess the technological enablers required for Performance-based Navigation (PBN)

procedures, local operational approvals remain a key stumbling block for aircraft operators as they seek to leverage the bottom-line benefits promised by PBN as quickly as possible.

In this exclusive interview with the ICAO Journal, Dave Behrens, IATA Director, Infrastructure Strategy, describes the background leading up to the Geneva PBN Declaration signed earlier this year and details how aviation's key stakeholders hope to more effectively address current shortcomings.

When did ICAO and IATA begin to discuss the idea of a Joint PBN Task Force?

In October of 2008, IATA was hosting an Operations Committee (OPC) meeting with high-level Flight Ops representatives from airlines all over the world. Our Senior Vice President, Guenther Matschnigg, invited Nancy Graham, ICAO Air Navigation Bureau (ANB) Director, and her staff over and began some very engaging dialogue on what the main PBN issues were and how we could move these forward effectively. We realized that a lot was underway already, such as the Regions putting together their own Task Forces, the first edition of the PBN Manual being released, etc., but first and foremost the airlines were very concerned about the topic of streamlining operational approvals.



Could you elaborate on this last point for our readers?

Many times, the operational approval is the last required step to successful implementation, but if the airline's regulator isn't familiar with the navigation specification then everything stops. This has been a traditional challenge when you step back and look at it from the international airline perspective and so IATA wanted to highlight the need for education and training of regulators early in the planning process.

As it stands now, a given country may develop and publish, by way of one example, suitable Required Navigation Performance (RNP) procedures and approaches for a particular airport. After they publish these, however, suitably-equipped airlines from other States can't fly these procedures until they receive the operational approval back home from their own State regulator. This approval

certifies that the carrier's equipment, personnel and operating procedures are qualified for the specified PBN operations.

The problem that arises is that many States, because they do not yet have a PBN programme in their own country, lack the human resources, knowledge and skill base to effectively regulate the PBN operations of their airlines in another State's airspace, and this in turn restricts them from implementing PBN in their own airspace. It's a vicious "no win" circle.

Where does ICAO's assistance become useful for IATA and its Members with respect to streamlining these operational approvals?

IATA and its Members are in full support of what the ICAO General Assembly put forward in 2007 as a set of PBN objectives (*editor's note: see related sidebar on page 4*), and we were eager to

get moving quickly with PBN. However in terms of the whole departure-to-arrival scenario these operational approvals remain a major stumbling block.

In the OPC meeting with Nancy Graham and her staff, it was discussed how we might jointly table these issues on a global basis to develop a clearer idea of what was missing and what would be needed in terms of enabling tools that could make State implementation and approval procedures more efficient. There was a lot of discussion at this stage on the need to assemble implementation teams with the proper subject matter experts that could go out and work with any needful States on a country-by-country basis.

How did this progress once these issues were agreed at the OPC meeting?

It was really amazing how quickly everything began to move from that point. These decisions were taken in



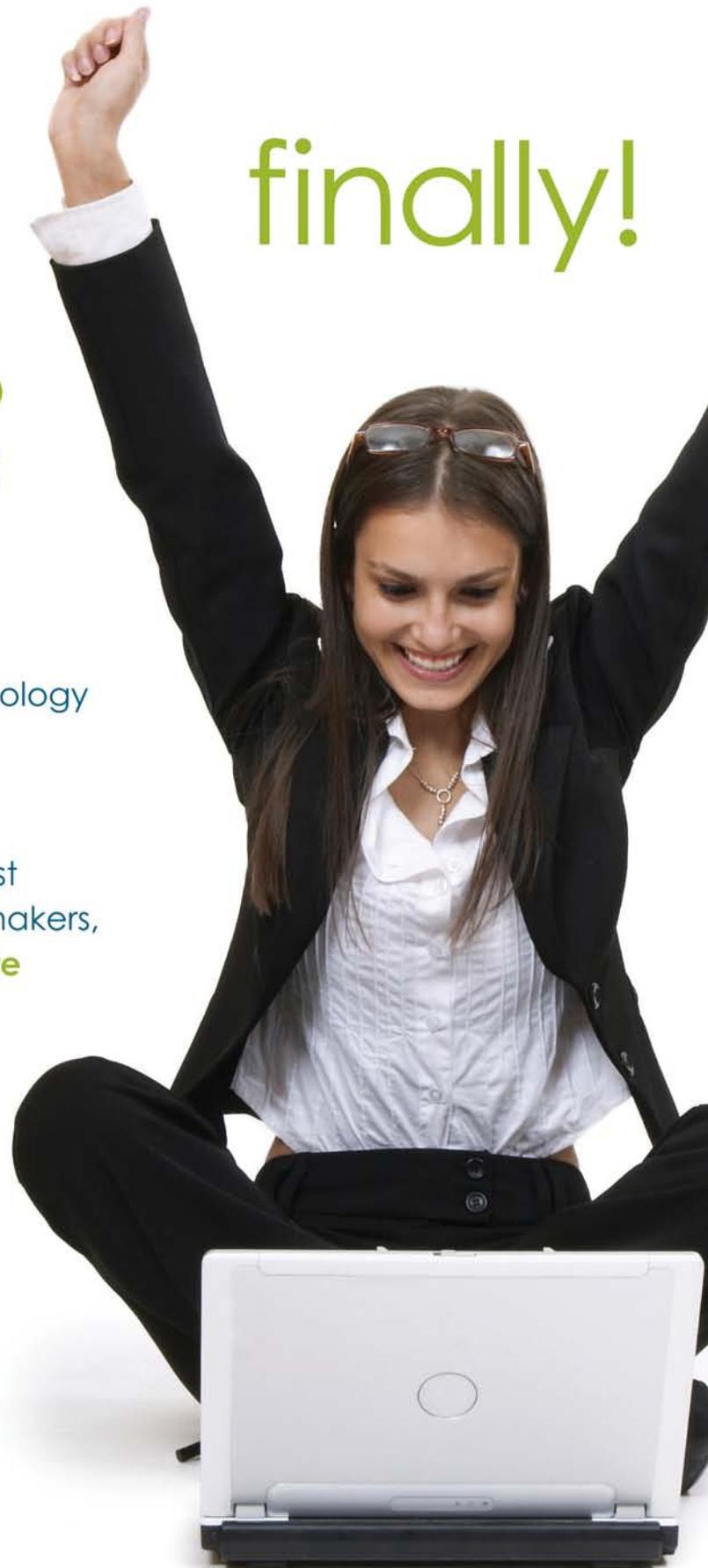
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“The problem that arises is that many States, because they do not yet have a PBN programme in their own country, lack the human resources, knowledge and skill base to effectively regulate the PBN operations of their airlines in another State’s airspace, and this in turn restricts them from implementing PBN in their own airspace. It’s a vicious ‘no-win’ circle.”

October and before the December holidays plans had already been set into motion. Task Force members analyzed all the issues before us and identified some huge gaps in terms of knowledge and understanding. From there, business cases and a variety of promotional, educational and training tools were identified for development, owing to the fact that we needed to get key messages out to a wide variety of high-level, mid-level and also operational stakeholders. In many ways this was one of the first big efforts on behalf of the Global PBN Task Force.

In what other ways was ICAO instrumental to the Task Force efforts?

One of the next issues that quite naturally arose was: “What’s lacking in terms of ICAO documentation?” ICAO created the PBN Study Group to look into the answers to this question and those activities are now moving ahead well. Additionally, ICAO just completed a successful round-the-world tour that, at the Regional level, introduced local stakeholders to the *PBN Manual* and worked them through PBN criteria and airspace planning concepts.

These outreach efforts are essential to the process, but the problem is that there’s a huge difference between establishing the basic concepts and points of reference and actually rolling up the sleeves and moving ahead with detailed implementation and granting the effective approvals. This is where the Regional implementation teams

become so important, but as yet this is not moving as fast as it might because all the pieces really need to be in place before States will even be capable of identifying where and when they may need a team to come in and assist them.

Is IATA also addressing this issue with its own programmes?

Definitely. We have a number of training courses that now address PBN-related issues and activities. We’ve put together operational approval guidelines on things that have to be addressed, recommended resource material, best practices, etc. There are also courses now being put together to assist airlines and their regulators through the operational approval process.

Do you think the R36-23 timeline that’s been put in place, namely 30 percent implementation by 2010, is doable based on the challenges that remain?

I do. One of the things we identified early in the Task Force process was that we had to build on the Assembly Resolution and the State/CAA buy-in and roll that momentum out to bring in the Air Navigation Service Providers (ANSPs), the individual airlines, the pilots, the controllers, etc.

Was that need to maintain and even augment the Task Force’s momentum one of the reasons behind the recent Geneva Declaration?

Exactly. We identified the organizations that we needed, everyone from airports to flight safety specialists to controllers, business aviation, helicopters, etc., as well as, of course, ICAO, IATA and CANSO. Between the ICAO Assembly Resolution and this new Declaration, the PBN push has now assembled the breadth of aviation’s key stakeholders behind the concept and the timetable that ICAO established.

What does the near-term hold for the PBN roll-out as the Task Force leverages what it’s achieved in Geneva?

We’re beginning now to more specifically identify the stakeholders and resources and volunteers involved. We’re putting together databases on who in the airline will be the point of contact for PBN or who in your air navigation services organization will be the point of contact or who in your CAA or who in your industry. By establishing and making it easy to find the relevant nodes within this new Global PBN network it’s hoped that all stakeholders are going to begin seeing the collective benefits of these developments much more quickly than might have been the case without these collaborative efforts.

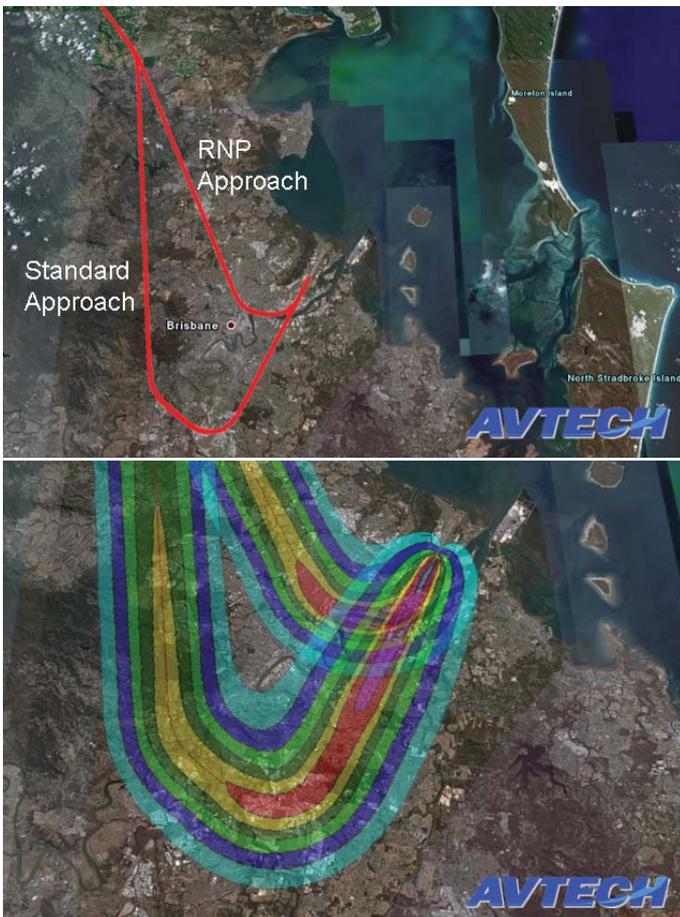
It will be a challenge for aviation—no one is kidding themselves in this respect—and with respect to IATA we’re trying as much as possible to ensure that this evolution is constantly informed by sound business cases across the board: for operators, facilities and suppliers across the PBN chain. ■

PBN results today

Members of the Civil Aviation Services Organization (CANSO) remain at the forefront of PBN development. The organization reports on current status and on how its stakeholders are already seeing the benefits of this exciting technological enabler.

The long-term aim of ongoing Performance-based Navigation (PBN) activities is to create global harmonization of navigation specifications so that operators can take advantage of modern avionics to improve both flight efficiency and environmental performance. The introduction of common navigation standards underpins modernization programmes like SESAR and NextGen, which use precise aircraft navigation concepts to improve airspace safety and capacity.

PBN relies on area navigation systems that employ satellite signals with advanced cockpit technology that allow an aircraft to be flown without depending on navigation to/from conventional ground-based navigational aids. It requires a shift from ground-based navaids that emit signals to aircraft receivers to advanced in-aircraft systems that compute the aircraft's global position. The result is a more direct flight path that no longer needs to zig-zag between beacons on the ground. Many such navigation systems are already implemented and in daily use, but their ad-hoc development and lack of regulatory requirements has led to prescriptive applications, Regional variations, and unnecessary costs.



RNP procedures introduced at Brisbane Airport reduced the facility's 70 dB and 75 dB footprints, and allowed the procedure to be placed over non-residential areas such as the Brisbane River (details courtesy of AVTECH).

Under ICAO's PBN initiative, navigation is defined based on operational requirements. The concept offers a number of advantages, not least of which being how it allows technology to evolve over time without requiring a specific and costly certification process for each new operation. Operators have a limited set of navigation specifications that apply on a global basis and which have been designed to support fuel-efficient route profiles, respond to noise abatement programmes, accommodate terrain issues, and in the long-term reduce costs associated with conventional ground-based infrastructure.

Air traffic management relies on Communications, Navigation, and Surveillance (CNS) to safely operate an airspace. While PBN refers to the navigation element of CNS, it additionally has to operate effectively with the communications and surveillance infrastructure. To encourage states to adopt advanced navigation concepts, ICAO has published an implementation guide, called the *PBN Manual* (ICAO Document 9613), which details performance requirements for aircraft operators and navigation service providers.

Area navigation (RNAV) is a cornerstone of the PBN approach, enabling aircraft to fly independently of ground-based navaids within conventional flight segment airspace design. Navigation specifications define the Required Navigation Performance (RNP) of the RNAV system, together with any aircraft and crew requirements. A defining characteristic of more precise RNP operations is the ability of the aircraft navigation system to monitor the navigation performance it achieves by means of onboard checks and alerting systems.

Under PBN, therefore, each navigation specification has a designator: for example RNAV 5, Basic RNP 1, RNP APCH, RNP AR APRCH. The number in the designator represents the minimum lateral navigation accuracy in nautical miles (nm) that must be maintained for at least 95 percent of the respective operation. The detailed airworthiness requirements for RNAV and RNP were developed by the United States along with Europe's Radio Technical Commission for Aeronautics (RTCA) and UROCAE. These standards specify system accuracy, integrity, continuity and availability requirements for aircraft navigation and flight management systems.

PBN, and in particular the RNP navigation specifications, allow the introduction of precise, curved paths on an aircraft's trajectory. It also offers advantages during approach phases of flight, where it can support routes that avoid densely populated areas or difficult terrain.

At the most extreme end of the scale, RNP AR (Authorization Required) criteria are specially customized and require advanced aircraft equipage and training, but yield more in terms of benefits for the operator. For example, RNP AR paths can typically reduce straight-in segments by 7–10 nm from the start



of an Instrument Landing System ILS), bringing them down to four nm or less.

RNAV 5 and B-RNAV routes are already used in en route and continental airspace. The introduction of B-RNAV in Europe contributed to over 20 percent increase in en route capacity in the late 1990s. In addition to the numerous RNAV 2 routes in the en route environment, the United States has introduced hundreds of RNAV 1 routes in terminal airspace that provide alternatives to crowded conventional routes for suitably-equipped aircraft.

At present, PBN performance requirements support the safety case for implementation, and a number of projects worldwide already demonstrate reduced fuel use, greener operations and capacity gain.

CANSO members remain at the forefront of PBN development. NAV CANADA has been working with the U.S. FAA and Mexico's SENEAM to develop a North American strategy for implementing PBN. It has redesigned Vancouver terminal airspace to reduce costs and delays, which resulted in one customer saving \$18.5 million in fuel costs in just one year.

Among other successful projects, Airservices Australia introduced RNP approach procedures at Brisbane

International Airport in 2007. During the first year of operation, Qantas carried out over 15,500 procedures including more than 8,000 approaches. The airline achieved a reduction in track miles of 10.7 nm (an average of two minutes and 40 seconds) for each arrival, saving 650,000 kg of CO₂ and 200,000 kg of fuel over the year. Airservices worked closely with Naverus Inc, Qantas Airways, Avtech of Sweden and Australia's safety authority CASA to implement six RNP approach procedures and 12 RNP departures based on proprietary criteria.

Brisbane reported additional benefits. In addition to a reduction in aircraft noise impact, non-RNP aircraft experienced reduced delays resulting from shorter arrivals for RNP aircraft. Australia has introduced RNP procedures at close to 15 airports. Naverus Chief Technical Officer Steve Fulton stated: "In Australia, the results clearly have shown that RNP is not so much a Next-Generation solution as it is a solution available today."

This focus on delivering the advantages of PBN today—as opposed to waiting for new and expensive technology to be adopted—is also being explored in Europe. The SESAR Joint Undertaking has launched a co-funded project to demonstrate the environmental benefits that can be derived from using current

aircraft capabilities. The Minimum CO₂ in the Terminal Manoeuvring Area (TMA with current capabilities (MINT) programme is a consortium of Avtech, LFV, Novair, Airbus and Egis Avia. Avtech Programme Manager Christer Forberg commented that:

"Many commercial aircraft can already support RNP and time-based operation. If RNP is used not only for terrain purposes but also for efficiency in the TMA then a lot of fuel could be saved. This could start already during low density periods. Of course peak periods will be more challenging and arrival management needs to set the sequence earlier than today. In peak periods, ATC would issue RTAs to spread out arrival traffic over time, and thereby sequence arrivals in a smooth way instead of arrival peaks. The future support system will be a form of arrival manager, sequencer and/or conformance monitoring tool."

The experience gained from operations at Brisbane in Australia, Innsbruck in Austria, and several U.S. airports shows clearly that RNP operations result in benefits in terms of route efficiency and environmental impact. While the requirements for RNP AR are rigorous, many operators are beginning to discover the benefits can outweigh the costs in instances where terrain and noise issues are at stake. ■



Alternative fuels and aviation: Toward more sustainable air travel

Previous *ICAO Journal* articles have showcased the importance of Alternative Fuels (AFs) as a key component of any future action on addressing aviation emissions and the achievement of sustainable aviation operations. These submissions have been part of ongoing efforts to respond to a request agreed at the last ICAO Assembly, whereby the Council was mandated to promote an improved understanding of the potential uses and related emissions impacts of AFs.

In this *Journal* issue, Jane Hupe, Chief of ICAO's Environment Section, outlines further progress in global aviation's understanding of the potential of these developments and provides an overview of main AF events being organized by ICAO to help facilitate ongoing AF research and deployment. This includes ICAO's upcoming *Conference on Alternative Fuels for Aviation*, which will be held in Rio de Janeiro, Brazil, this November.

The objective of the ICAO Workshop on Aviation and Aviation Fuels, held in Montreal from February 10–12, 2009, was to examine the options and challenges related to the development and deployment of AFs and to consider initiatives to help promote more effective international cooperation in this area. The workshop was designed as a preparatory event to a major ICAO conference currently planned for later this year. During the workshop, attendees learned about a number of recent and successful in-flight tests of a range of AFs, and of the newer AF types that will be made available in due course.

When employing appropriate technologies and feedstocks, AFs offer the ability to significantly reduce lifecycle CO₂ emissions when compared with conventional, petroleum-derived Jet A (i.e. the CO₂ required to produce the fuel as well as the CO₂ generated from burning it). Consensus



Presenters to the special Alternative Fuels (AF) side event at the United Nations Framework Convention on Climate Change (UNFCCC) Climate Talks, Bonn, Germany, June 2009. *Front row, from right to left:* Jane Hupe, ICAO; Lourdes Maurice, FAA-CAAFI; Doris Schroeker, EC; *Second row, from right to left:* Bill Hemmings, ICASA; Thomas Roetger, IATA; Philippe Fonta, ICCAIA; Mike Farmery, Shell Aviation.

emerged at the ICAO event indicating that global harmonization is needed in the vision and goals being developed by aviation stakeholders while recognizing that there remains multiple and acceptable analysis approaches.

A number of AFs are already in the process of being certified for use, meaning these AFs now under consideration for certification would be “drop-in” options, meaning that they would be capable of being transported through existing pipeline infrastructures and used in modern aircraft *without modification*.

Over the past two years, a number of successful in-flight tests using various blends of AFs have been conducted. A great deal of progress has been achieved so far in this regard, and expectations are high that aviation will witness a greater use of environmentally friendly drop-in bio-fuels in the short- to medium-term. Given sufficient demand or incentive, significant supplies of biofuels offering approximately 50 percent or more reduction in life-cycle CO₂ emissions could be available within 15 years.

To fully assess the environmental impact of AFs there is a strong need now to agree on methodologies for the quantification of life-cycle carbon footprints of all fuels. While focusing on climate change and related issues, it should be noted that synthetic jet fuels now under consideration offer more than just a reduced carbon footprint. They also offer local air quality benefits in the form of reduced sulphur content and particulate matter emissions. AFs could therefore form part of a comprehensive aviation energy strategy that includes new technologies, operational measures, and market-based measures.

Following its Aviation and Alternative Fuels Workshop, work was initiated with a view to preparing for the ICAO Alternative Fuels Conference currently planned for November 2009. An Alternative Fuels Conference Organizing Committee, composed

of core experts representing the various areas of direct involvement in the development and deployment of AFs, was established and has since progressed in the development of the agenda and possible recommendations, including a global roadmap that will ultimately facilitate the use of alternative fuels in aviation.

In line with its leadership mandate leading up to the Conference, ICAO is engaged in promoting and informing stakeholders as much as possible on the status of activities in the alternative fuels area. As part of these responsibilities, ICAO recently organized a side event on aviation and alternative fuels to the United Nations Framework Convention on Climate Change (UNFCCC) Climate Talks, in advance of COP/15, which took place in Bonn in June 2009.

This side event, entitled “Aviation Alternative Fuels—Toward Sustainable Air Travel” took place on June 3rd and was attended by approximately 60 participants, including NGO and academic specialists, climate negotiators and environmental experts from all Regions of the world. It provided an update of ICAO’s work in this area and of the possible outcomes that the planned High Level Conference in November could deliver.

UNFCCC presentations review

At the opening of the side-event presentations, ICAO provided background information on its activities relating to AFs, covering the main findings from the February Workshop and highlighting the importance of AFs to fuel security and reducing the effects of aircraft operations on climate change and local air quality. The main reasons why international aviation should be the first global sector to move forward on AFs also formed part of the points made the Environment Unit on behalf of the Organization.

Mike Farmery of Shell Aviation, represented the views of fuel producers. He provided an overview of the process involved in producing synthetic fuels and stressed that any aviation AF must be a “drop-in” solution that can be mixed with currently-used jet fuels in any proportion, while additionally making use of the existing fuelling infrastructure. His views are defined in more detail in the Shell submission to this issue on page 20.

Thomas Roetger, of the International Air Transport Association (IATA), presented the airlines' ongoing activities on alternative fuels. He emphasised that AFs must offer net emission reductions over their entire life cycle and not generate adverse impacts on, for example, freshwater needs, land use or food security. He provided a summary of the main flight tests undertaken by major airlines and highlighted the potential of new-generation biofuels in this regard, and also presented the “Beginner’s Guide to Aviation Biofuels”, which has been prepared by ATAG (www.atag.org).

“ In line with its leadership mandate leading up to the Conference, ICAO is engaged in promoting and informing stakeholders as much as possible on the status of activities in the alternative fuels area. As part of these responsibilities, ICAO recently organized a side event on aviation and alternative fuels to the United Nations Framework Convention on Climate Change (UNFCCC) Climate Talks, in advance of COP/15, which took place in Bonn in June 2009.”



Philippe Fonta, of the International Coordinating Council of Aerospace Industries Association (ICCAIA), represented the views of manufacturers by noting that the industry is committed to action on climate change and embracing the use of AFs despite all the associated challenges. He presented the different types of AFs and reinforced the notion that valuable lessons can be learned from testing fuels synthesized using other sources—such as gas. He concluded that further biofuels development would require effective and ongoing partnerships between relevant stakeholders and that aviation is uniquely structured to maximize benefits of sustainable biofuels.

Lourdes Maurice, on behalf of the Commercial Aviation Alternative Fuels Initiative (CAAFI), presented some of the U.S. initiatives including their work on life cycle assessment. She highlighted that aviation is dependent on hydrocarbon-based liquid fuels and because of the concentrated airport distribution a rapid deployment (80 percent of fuel in 35 locations in United States would be feasible). She stressed the importance of a timely Fuel Certification crucial for market and stabilizing the right life cycle assessment for allowing policy decisions and investment. She noted the importance of CAAFI helping to bring these pieces together and the key role of ICAO to achieve global harmonization (see additional CAAFI submission to this issue on page 25).

Doris Schroeker, of the European Commission, brought the views of the policy-makers and highlighted a two-year study, entitled: *Sustainable Way for Alternative Fuel and Energy in Aviation*. She emphasized that alternative and biofuels alone will not be sufficient to reach environmental objectives but are expected to contribute to environmental reductions within a package of measures, noting that aviation will be included in the European Emissions Trading Scheme as of 2012. She also reaffirmed the need for the global

connections that are necessary, through an adequate ICAO framework.

Bill Hemmings, of the International Coalition for Sustainable Aviation (ICSA), represented the environmental NGO community and stressed that sustainability is the key issue and although biofuels demonstrate significant potential for environmental benefits, it will take time to develop them for use as alternative aviation fuels and that other short-term solutions are therefore required. He cautioned that the indirect land-use impact of biofuels remains uncertain, and stressed that emissions from the aviation sector must be brought “into the box” of broader emission regulations, including within the UNFCCC framework showing some disappointment that a global solution hasn’t yet been set up in place in ICAO. (see in-depth ICSA text on page 23).

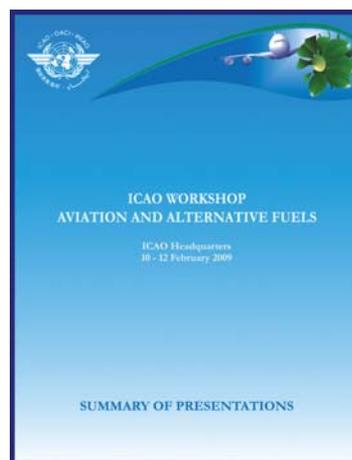
In wrapping-up the main ideas brought forward by the various presenters, Ms. Hupe summarized as follows:

- In addition to technical, operational and market-based measures, AFs provide a key approach for addressing aviation emissions.
- “Drop-in” fuel solutions are needed for short/medium term.
- Aviation is a highly technical industry committed to achieving rapid progress in the development and deployment of biofuels.
- Concrete solutions exist with some alternatives now test-proven, and still more to come.
- Challenges:
 - Define “sustainable biofuels”.
 - Public acceptance of biofuels.
 - Cultivate the quantities of feedstock required.
 - Develop the facilities to process and refine.
 - Economic viability.
- Incentives/investment are paramount for development/deployment.
- Aviation alternative fuels can offer a globally-flexible solution with environmental benefits while providing economic opportunities to local communities.

A Conference, to be hosted by Brazil in Rio de Janeiro, is now planned for November 2009. Its aim is to develop a globally-harmonized roadmap involving all stakeholders. ICAO will endeavour to gather the best available expertise in order to support data-based decision making for global aviation. All members of the aviation community involved in energy and environmental policy, including energy producers, airlines, airports and equipment manufacturers, as well as policy-makers at Regional, national and local levels, will be invited. Topics to be addressed include:

- Certification of new AFs.
- Standard methodologies for life-cycle analysis.
- Globally harmonized assessment of technology readiness levels.
- Standardized vocabulary.
- Guidance to facilitate cost/benefit analyses.
- Alignment of research roadmaps and programmes.
- Overcoming barriers with incentives for investments.

Results of this Conference will provide critical input to ICAO and will allow consideration of sound policy options surrounding aviation AFs that can be brought to the attention of COP/15. ■



Documents and a brochure (inset) reflecting the main outcomes of the Workshop are available on the ICAO Web site at www.icao.int.

The role of alternative fuels in commercial aviation

Though some may claim that the rapid development of commercial aviation has been fuelled by the imagination and ingenuity of engineers, coupled with the romance and excitement of aviators determined to defy gravity, at a more mundane level air transport is fuelled by kerosene, which sits between gasoline and diesel fuel in the distillation of crude oil.

Dr. Mike Farmery of Shell Aviation describes for the *Journal* the unique characteristics of kerosene and the reasons why any replacement or alternative is still likely decades away from a practical and comprehensive roll-out.



After eight years in various research roles, Mike Farmery joined Shell in 1981. He worked initially in fuels research, followed by technical roles in commercial fuels and distribution. Since 1992, Farmery has been Global Fuel Technical Manager in Shell Aviation, responsible for quality, specifications, fuel development and environmental

issues. He is an active participant in many industry bodies and steering groups and chairs the JIG Product Quality Committee. Farmery recently received an IATA award for Outstanding Contribution to the Aviation Industry.



Although yields vary widely, on average kerosene represents about 10 percent of a barrel of crude oil. Adding in all other sources of carbon-based fossil fuels, such as coal and natural gas, CO₂ emissions from aviation kerosene account for approximately two percent of total anthropogenic CO₂ emissions.

Despite starting from this relatively small base, the challenge is growth which currently stands near five percent pa and is widely predicted to double in 20 years. Recognizing this, the airline industry body IATA has a vision for carbon neutral growth in the short to medium term.

Carbon neutral growth cannot be achieved by incremental improvements in fuel efficiency: we need to do something radical with the fuel. This is exciting for fuel producers because jet fuel has not really changed for the past 40 years, but it is not going to be easy. Kerosene is a great aviation fuel and has

Effective Global Leadership Through Balanced Priorities

many properties that make it ideal for this purpose. Also, because the aviation industry is focused on safety, changes don't happen quickly.

For jet fuel, the options for alternative fuels are rather restricted compared to automotive fuels. The consensus is that

even if they are not renewable. An example is gas-to-liquid synthetic fuel created from synthesizing methane via the Fischer-Tropsch process. Although this fuel has a similar carbon life cycle as traditional fossil fuels, recent research has indicated that there are potential benefits in using these types

others are being developed. The biomass-to-liquids process takes any biomass (e.g. bio waste such as waste wood or straw), gasifies it, and then synthesizes a hydrocarbon (via the Fischer-Tropsch process). The result is a great jet fuel but it is a costly process that is still in demonstration mode.

“Carbon neutral growth cannot be achieved by incremental improvements in fuel efficiency: we need to do something radical with the fuel.”

kerosene will remain the principal aviation fuel for the foreseeable future (20–30 years). The main reasons for this view are that it works well, there is a large legacy fleet of aircraft, and lastly that aviation needs a single, globally available fuel.

In addition to the drive to reduce CO₂ emissions, the other driver for developing alternative fuels for aviation is diversifying supply. The days of easy oil are over and there is now strong competition with diesel for the middle distillate fraction. New sources of kerosene molecules will be welcome

of synthetic fuels for reducing other emissions relevant to local air quality.

Easy biofuels, such as vegetable oil esters in biodiesel and ethanol in gasoline, are not suitable for aviation. They carry a weight penalty (linked to their oxygen content) that, together with performance and handling problems, makes them unattractive for aviation.

Producing kerosene-like molecules from bio sources is challenging. Effectively, you need to remove the oxygen to leave a pure hydrocarbon. At the moment, there are two potential processes but

The other promising route, hydrogenating vegetable oils, is less energy intensive but the vegetable oil feedstock is expensive and can be controversial. Competition with food and land use is currently a critical issue linked to vegetable oils and a global agreement is required to define what can or cannot qualify as a sustainable vegetable oil.

The idea of producing the vegetable oil from algae has been presented as a particularly attractive solution. Many see it as a route to sequester CO₂ and produce hydrocarbons at the same time. Yields per hectare are estimated as high as 200 times conventional crops, and farms can be on arid land and use saline water—a renewable fuel Nirvana! Unfortunately, it is early days for this solution and there are many technical problems to overcome. Think in terms of 10–20 years for a significant contribution from algae or comparable sources.

In summary, we know that using new fuels to reduce environmental impact is more complicated for aviation than for ground transportation because of the extra focus on safety and the more demanding performance requirements. Fortunately, the industry has a great track record of technological innovation and there are many good ideas and exciting projects in play. However, it is hard to see how significant volumes of renewable jet fuel are going to be produced quickly. In the short term it looks like we will have to continue to rely on the incremental improvements that continue to be delivered by improved aerodynamics, increased use of lightweight composites, improved air traffic management and more fuel-efficient engines. ■



A critical year

While sustainably-produced alternative fuels (AFs) may play a role in a comprehensive, long-term strategy to control GHG emissions from aviation, there is little reason to believe that the use of those fuels will significantly reduce emissions within the next 15 years.

In this year of action, the International Coalition for Sustainable Aviation (ICSA) describes why it is incumbent upon ICAO to work closely with its Member States to develop a comprehensive AF strategy for the aviation sector.

2009 is a critical year for aviation and the environment. ICAO's Group on International Aviation and Climate Change (GIACC), faced with projections that global carbon dioxide (CO₂) emissions from aviation are likely to increase fourfold from 2006 to 2050 if left uncontrolled, is rushing to recommend a climate action plan for the Copenhagen COP-15 meeting.

There has been a burst of related enthusiasm for alternative fuels within the aviation community, with some seeing biofuels in particular as a way to stave off more difficult measures to reduce emissions. Without downplaying the significant technical, economic, and operational barriers facing the use of alternative fuels in aviation—topics we expect our industry colleagues to cover in some depth—ICSA here focuses on the possible climate benefits associated with their use.

It is impossible to predict with any confidence how much alternative fuels (here defined as biofuels, as well as synthetic and cryogenic fuels) will contribute to controlling the climate footprint of aviation. A brief survey of first principles is sobering, however. The rush to develop “drop-in” fuels suitable for use in today's fleet, while perhaps understandable on economic and operational grounds, means that on a life-cycle basis many alternative fuels are likely to have *higher* greenhouse gas (GHG) intensities than petroleum-based jet fuel.

These higher intensities are associated primarily with direct and indirect land-use change, the use of carbon-intensive feedstocks, or the consumption of large quantities of energy for processing. Furthermore, feedstocks that might otherwise be used to support a step function improvement in transport efficiencies—biomass used to drive the electrification of passenger vehicles, or natural gas for fuel cell buses—would instead be used to support an efficiency status quo if diverted toward aviation.

Biofuels in particular deserve special comment. The aviation industry's commitment to developing alternative fuel feedstocks and production pathways that do not compete with food production, therefore avoiding significant emissions through direct and indirect land-use change, is laudable. That being said, experts increasingly argue that biofuels that *can*

be produced on marginal land are in fact likely to be produced on arable land with irrigation and fertilizers given the high willingness of wealthy consumers to pay for mobility.

Particularly instructive is a major fuel producer's recent admission that jatropha produced under marginal conditions is in fact likely to produce marginal yields. As food and fuel come into competition, vulnerable consumers and the environment predictably suffer, as evidenced by last year's dramatic run-up in global food prices blamed in part on policies promoting first generation biofuels. The question therefore becomes: how will the commitments to sustainable production of biofuels, that might justify their use in commercial aviation, be verified and monitored worldwide on an ongoing basis?

One way to consider the question of alternative fuels is through the use of scenarios, or the modelling of possible future states of the world. During this past February's Workshop on Aviation Alternative Fuels (WAAF), ICSA presented one simple, very optimistic scenario for the possible environmental benefits of alternative fuels in aviation. We assumed that production volumes of an alternative fuel with half the life-cycle CO₂ emissions of conventional jet fuel could be doubled annually from today to 2025—in relative terms five times faster than the introduction of ethanol into U.S. gasoline in recent years—bringing overall use to approximately 10 percent of worldwide consumption in 2025.

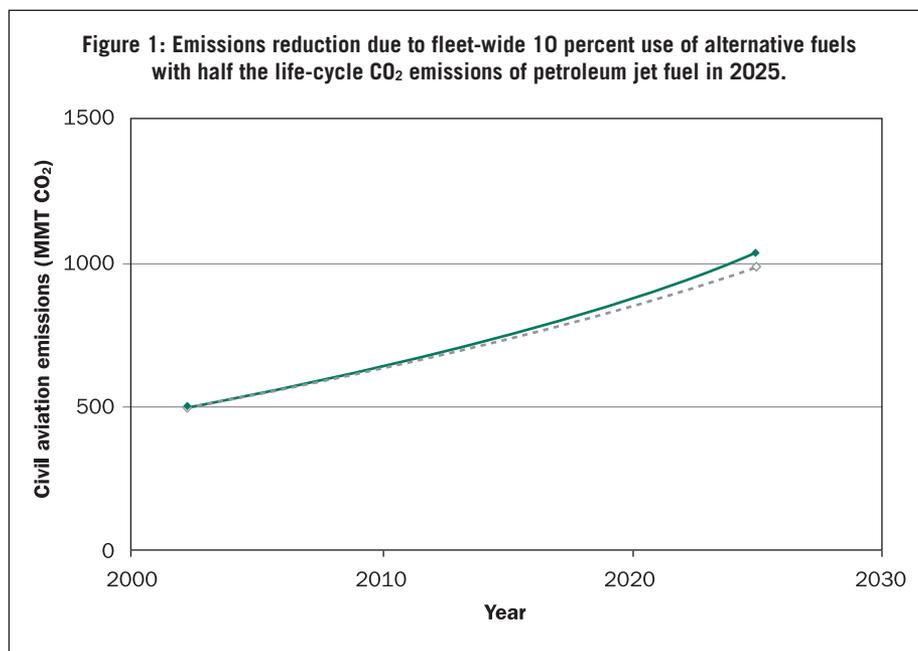
The resulting emissions reduction, of approximately 50 million metric tons of CO₂ from one baseline projection, is shown in Figure 1 (*page 24*). Compare this to the 60–80 percent reductions in GHG emissions believed to be required from developed countries by mid-century in order to avoid dangerous anthropogenic influence on the global climate.

While sustainably produced alternative fuels may play a role in a comprehensive, long-term strategy to control GHG emissions from aviation, there is little reason to believe that the use of those fuels will significantly reduce emissions within the next 15 years. In this year of action, it is incumbent that ICAO work

with its Member States to develop a comprehensive strategy for the aviation sector, including:

- Absolute medium- and long-range emission reduction targets.
- CO₂ standards for new aircraft that leverage the full range of technology and design parameters affecting engine-out emissions.
- Market-based measures to cap emissions and put a price on aviation carbon.
- Flanking instruments to address the non-CO₂ climate impacts of aircraft.

Where alternative fuels further reduce emissions, they may be incorporated into that overall framework.



The International Coalition for Sustainable Aviation (ICSA) is the umbrella observer organization for environmental NGOs in ICAO. ICSA members share a common concern with the problems of air quality, climate change and noise in relation to aviation, and are committed to developing and providing technical expertise and common political strategies.

Conference on Aviation and Alternative Fuels

Rio de Janeiro, 16–18 November, 2009



Following on the momentum generated by ICAO's February 2009 Workshop on the topic, the Organization will be hosting a Conference on Aviation and Alternative Fuels in Rio de Janeiro this coming November.

ICAO's work in this area responds to Resolution A36-22, which recognizes the urgent need for more concerted and effective action to reduce the carbon footprint of international aviation and highlight the importance of accelerating research and development into fuel efficiency and fuel alternatives. The Rio Conference is expected to be a major event showcasing state of the art aviation alternative fuels and technologies, and participants will consider a new road map for the global implementation of aviation alternative fuels.

For more information please contact env@icao.int

Hosted by the Government of Brazil



CAAFI: Leading the way to alternative aviation fuels

Since 2006, the Commercial Aviation Alternative Fuels Initiative (CAAFI) has sought to enhance energy security and environmental sustainability for aviation by exploring the use of alternative jet fuels. CAAFI is a coalition of airlines, aircraft and engine manufacturers, energy producers, researchers, international participants and U.S. government agencies.

Together, these sponsors have been leading the development and deployment of alternative jet fuels for commercial aviation since the coalition's inception. CAAFI's goal is to promote the development of alternative jet fuel options that offer equivalent levels of safety and compare favourably on cost with petroleum-based jet fuel, while also offering environmental improvements and security of the energy supply for aviation.

The volatility in petroleum prices of the past few years has been a significant economic concern for airlines. Fuel became the single largest component of U.S. airline operating costs for the first time in history in 2006. And concern about the environmental impacts of aviation growth is also rising within the United States and internationally.

While U.S. commercial aviation consumes about three percent of that State's total energy use, it drives about six percent of the U.S. gross domestic product and just under nine percent of national employment. Secure and sustainable fuel sources are essential for this continued prosperity. Aviation is international in scope, highly integrated in its fuel supply chain and, because of a significant ability to align and coordinate within the industry, well positioned to pursue alternative fuels.

CAAFI is currently divided into four teams that are headed by representatives of sponsor organizations that have primary responsibility in each area. The team leaders organize and focus efforts in their discipline area with all other stakeholders. CAAFI's functional teams address critical needs essential to the development and deployment of alternative fuels in aviation using discipline specific roadmaps. The roadmaps act as a communication mechanism among team members and between the teams to provide status and essential needs in each area.

These roadmaps and supporting documentation are shared with funding sources and policy-makers to provide them with information to make informed decisions in their area of focus. CAAFI does not discriminate among feedstock types or fuel conversion processes and does not make policy decisions. Those decisions are left to individual sponsor and stakeholder organizations.

CAAFI Teams, Team Goals and Progress

The CAAFI team, team goals and team leader organizations are as follows:

1. Certification Qualification Team

Enables supply of alternative jet fuel by expediting new fuel certification.

Lead by Federal Aviation Administration Aircraft Certification Service

The CAAFI Certification Qualification team is concentrating on creating a new ASTM international specification (D-XXXX) for jet fuel made from alternative, or non-petroleum, feedstocks. Once completed, the specification will receive a new number and will complement the globally recognized Jet-A specification D-1655. D-XXXX is structured to accommodate new classes of alternative fuels as they complete the ASTM fuel evaluation process. The new fuels must pass critical properties testing, including both basic properties (e.g. freeze point, flash point, density), as well as expanded "fit-for-purpose" properties (e.g. lubricity, surface tension, electrical conductivity). In addition, the fuel may be tested on turbine aircraft engines or components of those engines, if necessary.

The initial fuel approval will be for synthetic paraffinic kerosene (SPK) made from natural gas, coal or biomass using the Fischer-Tropsch (FT) process. This approval for a 50 percent blend with petroleum jet is targeted for completion during 2009. Additional fuels, derived from plants bearing oil from seeds (e.g. jatropha, camelina, halophytes and algae) could receive approval by the end of 2010 once fit-for-purpose tests are complete. These fuel types fall under the category of Hydrotreated Renewable Jet (HRJ).

The Certification Qualification Team is also developing new FAA regulatory policy to accommodate future approvals of alternative fuels. These works, as well as the new specification, are being coordinated with international airworthiness authorities and specification-writing organizations.

2. Environment Team

Ensure environmental sustainability of alternative jet fuels via quantification of “well to wake” greenhouse gas (GHG) life-cycle impacts and air quality impacts.

Lead by Federal Aviation Administration Office of Environment and Energy

In October of 2008, the CAAFI environmental team held a workshop bringing together nine presenters on life-cycle analysis frameworks and the participation of FT and renewable biojet fuel processors. The group agreed to leverage individual strengths and create inclusive methods for measuring environmental impacts and thereby reduce environmental uncertainties for potential aviation fuels. Follow-up efforts now include:

- a) A U.S. Air Force/Department of Energy-led U.S. government Working Group to assess best practices for conducting jet fuel greenhouse gas life-cycle analyses. Conclusions may be used to assess specific alternative fuel production and distribution options for the “ground to wheels” portion of fuel production.
- b) Use of ICAO/FAA globally accepted aviation emissions forecasting tools for aircraft emissions output “wheels to wake”.
- c) Case studies of planned production and distribution of alternative fuel projects being considered by CAAFI energy company stakeholders using the tools from a) and b)

As of the writing of this article, the product of part a) is in peer review. Once accepted, these processes will provide guidance for U.S. government fuel

purchasers to prove compliance with U.S. Energy Act provisions that require any alternative fuel purchases to be better than that of fuels produced by oil refineries.

3. Business and Economics Team

Enable aviation as “first mover” user of alternative fuels among modes of transportation by supporting production and deployment of new fuels.

Lead by Air Transport Association of America (ATA)

On September 8–9, 2008, the U.S. Department of Commerce and CAAFI’s ATA and FAA sponsors hosted a business and economics team meeting in Washington, D.C. The session brought together representatives of 20 fuel buyers (including 15 individual airlines), 26 energy suppliers and 13 U.S. government agencies.

The workshop resulted in:

- a) Dramatic increase in the quality and quantity of dialogue between potential sellers and buyers of aviation fuels.
- b) Identification of eight specific areas for production technology enhancement for FT fuel blends (including use of biomass).
- c) Increased cooperation across CAAFI teams and with the USAF on advanced biofuels, ranging from HRJ fuels to fuels from other processes (e.g. fermentation) and feedstocks (e.g. algae).

During 2009, deployment opportunities have advanced with some 15 U.S. states and a myriad of federal and state programs identified for possible support of aviation alternative fuels production facilities. Fuel producer engagement increased represented, by the approximately 30 energy companies with links on CAAFI’s public Web site (www.caafi.org).

4. Research & Development (R&D) Team

Accelerate R&D efforts on advances

feedstocks and conversion processes to increase the range of fuel options, reduce cost and increase quality.

Lead by Aircraft Manufacturers

In January of 2009, the CAAFI R&D team joined with U.S. Air Force colleagues to develop joint roadmaps identifying priorities and aligning efforts for both alternative fuel R&D and renewable fuel energy crops (feedstocks). The jointly identified feedstocks ranged from those flown in Boeing flight tests in 2008 and 2009, such as jatropha, camelina and algae, to areas currently in early research.

In addition to research roadmaps, CAAFI and the U.S. Air Force agreed on a scale to track the technical and production readiness of alternative fuels, or Fuel Readiness Level (FRL). FRL can be used to easily communicate the status of fuels to stakeholders who are considering deployment of these fuels.

The R&D roadmaps and FRL scale are public documents and have been provided to a wide range of interests in the government and private sectors.

CAAFI’s Global Reach

As of mid-2009, CAAFI has grown to include contributing sponsors and stakeholders on all continents representing a global public/private coalition of approximately 300 experts. CAAFI’s collected data and analyses have been presented to aviation, environment, energy and financial organizations around the world. CAAFI leaders are engaged in programs both in the United States and as consultants to international groups.

CAAFI’s goal is to ensure that Aviation—with its unique characteristics of concentrated distribution, technical innovation, and global reach under a single regulatory authority—is the first and best market for the deployment of a new generation of sustainable and secure alternative fuels. ■



Sustainable fuels for aviation: The manufacturers' perspective

On top of the competitive, market-driven interest to continuously reduce the specific fuel consumption of aircraft, the aviation industry as a whole and the ICCAIA companies in particular recognize their environmental responsibility and have committed themselves to a pathway to carbon-neutral growth.

Alternative fuels research, in unison with ongoing technical achievements in other fields, will help aviation find success along this path as it ultimately aspires to a more sustainable and carbon-free future.

Airframe and engine manufacturers have managed to reduce fuel consumption/CO₂ emissions by 70 percent per passenger/km over the past 40 years. Improved designs and methodologies, along with the increasing use of composite and advanced materials and processes, have helped contribute to this remarkable record. These technologies, together with new concepts currently being developed within extensive research programmes, will keep delivering additional benefits into the future. To more effectively progress on our pathway to carbon neutral growth, however, investigation into low-carbon Alternative Fuels (AFs) remains essential and has thankfully accelerated significantly over the past two years.

Civil aviation aircraft currently use fuels derived almost exclusively from crude oil. These crude-based fuels provide



an excellent balance of properties that are required for aviation, including energy density, operational performance, cost and safety.

Though the specific compositions of current jet fuels vary within tight performance specification limits, as a blend of complex hydrocarbons it is inevitable that they will emit CO₂ when being burned, thus contributing to climate change.

Current AF research is focusing on synthetic paraffinic kerosenes. They can be derived from coal, natural gas or other hydrocarbon feedstocks, such as biomass and thus include bio-jet fuels. Aviation's immediate priority is focused on "drop-in" fuels, (i.e. direct-substitute fuels) which can be used without modification to the engine, aircraft or fuel-supply infrastructure. Other AFs, such as ethanol or bio-diesel derived from FAME (Fatty Acid Methyl Esters), are today anticipated to have limited application for aviation due to characteristics such as their slightly lower energy contents and higher freezing points. For specific applications, these options should not be completely rejected, however, and aircraft such as the Embraer IPANEMA are now being developed on the basis of employing ethanol as an AF source.

The environmental benefits of AFs have to be investigated along the entire life cycle of the fuel, from the feedstock itself (selection, seeding, growth, crop) to the resulting fuel (conversion, transportation, uplift onto aircraft and burn). This analysis also includes all intermediate phases and induced transportation needs. With current knowledge and in the absence of viable carbon sequestration and storage options, AFs developed out of coal (CTL) have a higher carbon footprint than conventional fuels. Fuels derived from gas (GTL) have a similar-to-slightly-higher carbon footprint, and those created from biomass (BTL) have a lower carbon footprint. They all have a better environmental performance with respect

to local air quality due to the fact that they emit far lower amounts of particulates and sulphur oxides.

There are no easy answers in the search for AFs. The unique requirements associated with the operation of conventional turbine engines in commercial service make a rigorous approval process absolutely necessary for any proposed AF. That being said, the experience gained by the manufacturing industry in the SASOL fully-synthetic jet fuel approval process can be leveraged when considering new AF proposals. This process includes engine performance and endurance tests, emissions measurements, low temperature atomization, cold ignition, as well as altitude re-light (only after successful laboratory testing).

In 2008 and early 2009, major milestones were passed in demonstrating the technical feasibility of flying commercial aircraft with AFs. Several flight tests were performed on both Airbus and Boeing aircraft that were equipped with different types of engines (from RR, GE, CFMI or P&W) employing various categories of AFs derived from gas or vegetable oils. Sources have included babassu, jatropha, camelina and even algae.

Developing AFs requires an industry-wide effort involving airlines, aerospace manufacturers, fuel standard bodies, regulators, airport operators and fuel suppliers all working together.

In the United States, an organization called the Commercial Aviation Alternative Fuel Initiative (CAAFI) has been formed to enable improved coordination (see CAAFI article, page 25). In Europe, several industry-wide initiatives funded by the EU are ongoing to identify, develop and evaluate AFs. These programmes are looking at short-, medium- and longer-term solutions. EU stakeholders are also developing tools to enhance coordination within and outside Europe, fine-tuning technical route maps and supporting EU policy

development. Two such programmes include the Sustainable Way for Alternative Fuel and Energy in Aviation (SWAFEA) and the ALFA-BIRD project.

From a commercial point of view, even if the overall market for AFs appears to be much wider in the land transportation sector than for aviation, the air transport sector still remains uniquely structured to maximize the benefits of sustainable AFs as an early adopter. Indeed, the comparatively limited numbers of fuelling stations (at airports) and vehicles (approximately 20,000 aircraft compared to hundreds of million cars, trucks and buses) makes aviation a more manageable market and infrastructure in which to implement and demonstrate the sustainability of AFs.

It remains the ICCAIA's position that policy-makers should thus develop and implement incentives which support this very proactive and cooperative approach to help address aviation's present and future economic and environmental challenges. ■

The International Coordinating Council of Aerospace Industries Associations (ICCAIA) was established in 1972 to provide the civil aircraft industry observer status as a means to be represented in the deliberations of the International Civil Aviation Organization (ICAO). ICCAIA members are the Aerospace Industries Association of America (AIA), the AeroSpace and Defence Industries Association of Europe (ASD), the Aerospace Industries Association of Canada (AIAC), the Society of Japanese Aerospace Companies (SJAC) and the Aerospace Industries Association of Brazil (AIAB).

A partnership in the making

In September 2005, the European Commission (EC) established a permanent presence in Montreal with the principal objective of strengthening relations between the European Community and ICAO.

Summarizing the current situation at the end of his four-year term, Timothy Fenoulhet, EC Representative at ICAO, reports on the progress that has been made in building closer cooperation between the two organizations through a relationship that is of major importance to international civil aviation.

In the past 15 years, a significant body of legislation, rules and regulations in all areas of aviation (including economic regulation, safety, security, the environment and Air Traffic Management (ATM)) has been adopted by the European Community.

This development is significant from ICAO's standpoint on several counts, most notably:

- The European Community has become a major player in the regulation of international civil aviation and is the prime legislator for Europe in this field.
- It signifies that the European Community is responsible for all these areas of fundamental importance to civil aviation.
- The European Community's air transport policy and regulatory activities cover virtually all the requirements of the 18 ICAO Annexes governing international civil aviation.

As a consequence of its broad civil aviation role and responsibilities, it was in the clear interests of the European Community and ICAO to strengthen their relations with a view to transforming them into a fruitful partnership.

Clearly, this relationship has to be developed within the framework of the Chicago Convention, signed 13 years before the creation of what is today the European Community. The Convention does not currently foresee a role for Regional Economic Integration Organizations (REIOs), such as the European Community. Nonetheless, both organizations have recognized the importance of working closely together on the basis of a pragmatic approach, acknowledging that ignoring the realities of, and need for their relationship would be against the interests of the wider international civil aviation community.

A first and significant step in this direction was the establishment of a permanent presence for the European Commission in Montreal—a move intended to help foster closer cooperation in the technical field and improved coordination on policy issues.



Attendees to the EC's ICAO Office inauguration, held on June 21, 2007. From left to right: Article contributor, Mr. Timothy Fenoulhet, Head of Office, Office of the European Commission; Mr. Roberto Kobeh González, President of the ICAO Council; and Mr. Jacques Barrot, Vice-President of the European Commission.

Technical cooperation

The establishment of a permanent office in Montreal has enabled the EC and the ICAO Secretariat to cooperate on technical matters on a daily basis. The EC now participates actively in all types of ICAO consultative activities, including Working Groups, Study Groups and Technical Briefings, and as a result provides direct contributions to the work of ICAO.

This closer degree of cooperation means that both organizations are kept far better informed about their respective activities and has led to the establishment of new formal working arrangements in a number of fields over the past four years.

In the field of safety, a Memorandum of Cooperation (MoC) was signed between ICAO and the European Aviation Safety Agency (EASA) in March 2006, which paved the way for EASA to be audited under the ICAO Universal Safety Oversight Audit Programme (USOAP). In addition, administrative arrangements have been put in place between the ICAO Secretariat and the EC/EASA to exchange important safety information and data in order to *inter alia* improve coordination of technical

assistance activities. The EC participated actively in the DGCA Conference on a Global Strategy for Aviation Safety in March 2006 at ICAO, strongly supporting policies promoted at that event to improve transparency in the sharing of safety information.

The European Commission also attaches great importance to assisting developing countries in the improvement of their safety oversight capabilities and raising their overall safety performance to meet the requirements of ICAO's SARPs. The EC has been a major contributor to ICAO's Cooperative Operational Safety and Continuing Airworthiness Programmes (COSCAPs) in Africa and in Asia in this respect and, more recently, has participated in the Comprehensive Regional Implementation Plan for Aviation Safety in Africa (ACIP). The EC and EASA have also made information available to ICAO concerning all ongoing EU safety projects. This information has been uploaded into the ICAO Database of Assistance Projects (IDAP).

Cooperation in the field of security has also been intensified as a result of an additional MoC signed in September 2008. This agreement strengthens mutual cooperation under the auspices of the ICAO Universal Security Audit Programme (USAP) such that it now carries out assessments of the EC's Civil Aviation Security Inspection System. This MoC recognizes that EC aviation security regulations currently cover most aspects of the ICAO Standards contained in Annex 17—*Security*, and eliminates the need for ICAO to systematically audit authorities in all 27 Member States of the EU who are already subjected to inspections by the EC. The agreement therefore avoids duplication, decreases the administrative burden on States

and reduces pressure on USAP's limited resources.

With respect to the environment, the EC is working closely with ICAO to seek agreement at the global level on how to mitigate the impact of aviation on climate change. It participates in ICAO's Committee on Aviation Environmental Protection (CAEP) and has also been closely associated with the activities of ICAO's Group on International Aviation and Climate Change (GIACC).

In the ATM sector, the EC collaborated with ICAO in organizing the important SESAR-NextGen Forum in September 2008. This event advanced the integration and interoperability of new generation ATM systems in line with ICAO's ATM Operational Concept and Global Air Navigation Plan.

Policy cooperation and a larger role for Regional bodies

Many EC/ICAO initiatives have been undertaken to ensure the best possible understanding by the two organizations of the importance of their respective roles and methods. Good examples include separate visits to EU Institutions in Brussels and EASA in Cologne by members of ICAO's Air Navigation Commission (ANC) and Representatives on the ICAO Council in 2008. Roberto Kobeh González, President of the ICAO Council, is scheduled to visit the EU in Brussels in July 2009.

For evident reasons, the EC has been a driving force at ICAO to promote the role of Regional civil aviation bodies. This form of cooperation is now being especially encouraged among developing countries with limited resources and low levels of aviation activity. The pooling of resources and

economies of scale that can be gained through Regional programmes can lead to effective solutions for developing and developed countries alike. Regional Safety Oversight Organizations (RSOOs) are now being actively promoted by ICAO, for example under the ACIP, but Regional civil aviation bodies can also carry out a wide range of other tasks such as: the monitoring and assessment of SARP implementation; training activities; administering technical assistance; common regulatory development; maintaining local pools of skilled personnel; accident investigation; and Regional ATM flow management functions.

In an effort to highlight the role of Regional bodies the EC and ICAO jointly hosted a successful Symposium on Regional Organizations in April 2008. The conclusions of the Symposium called for ICAO to establish working methods and arrangements with Regional civil aviation bodies to improve SARP implementation and to establish a regular formal dialogue with Regional organizations. The ICAO Council is following up on these conclusions via a dedicated Working Group, which is anticipated to propose a new ICAO policy governing its relations with Regional civil aviation bodies.

Possibilities for the future

The preceding paragraphs have illustrated the significant progress that has been made in strengthening EC/ICAO cooperation both in the policy and technical fields over the past few years. There is evidently still some way to go, but sound foundations have been laid. Looking ahead, as this relationship matures it would seem a logical step for it to be transformed into a fully-fledged partnership. ■

The views expressed in this article are those of the author and do not necessarily reflect the views of the European Commission.

Additional information on the EC at ICAO and broader EU air transport policy can be found at: http://ec.europa.eu/transport/air/index_en.htm

The European Commission is the executive body of the European Union. Its two main tasks are making policy and legislative proposals for adoption by the EU's two legislative bodies (the European Parliament and the Council of Ministers), as well as overseeing the implementation and enforcement of European Community legislation. In addition, the European Commission also adopts rules of a more technical nature which implement the EU legislation, in fields such as aviation safety or security.



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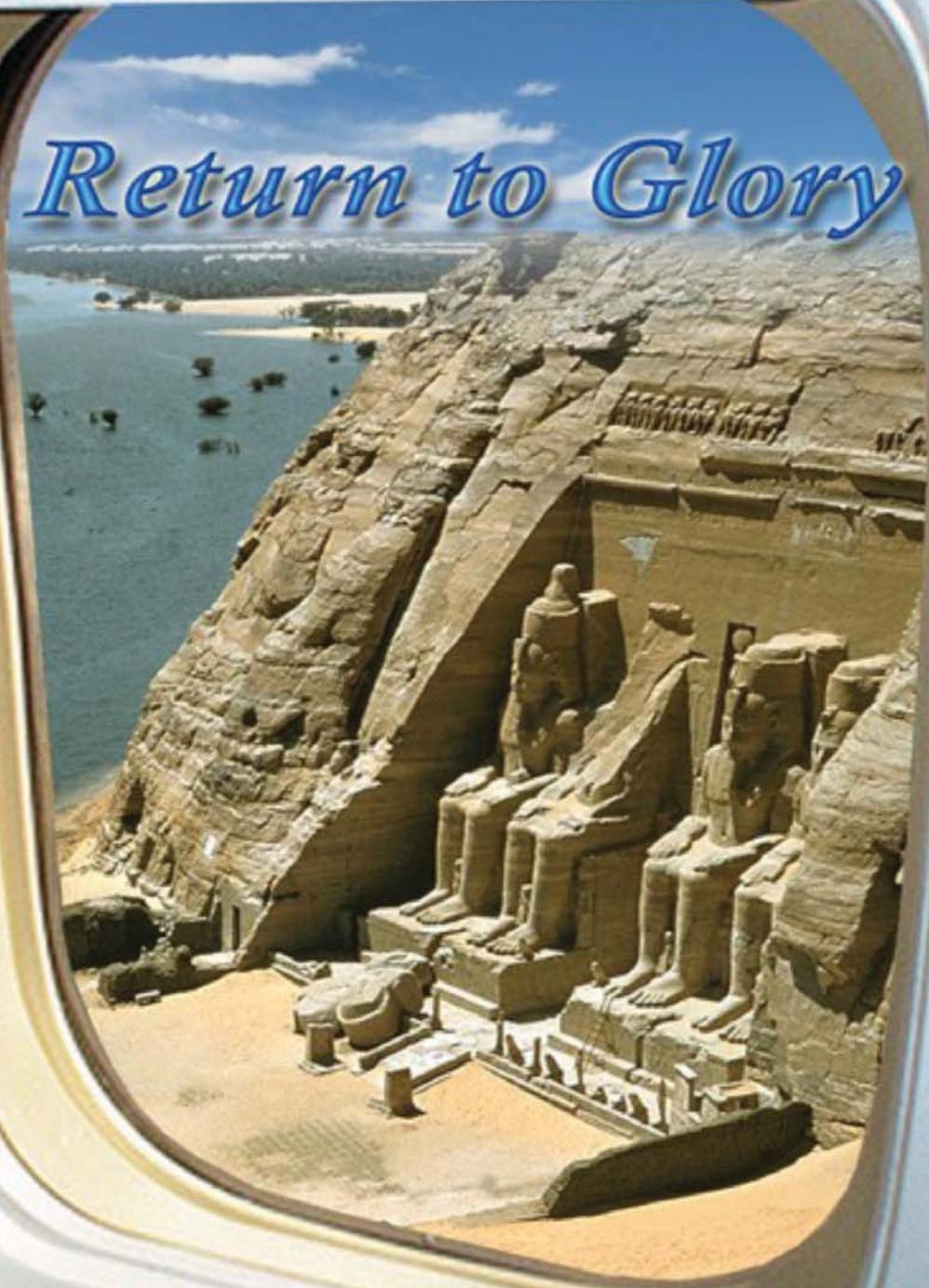
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Egypt: A dream of flying



The ancient Egyptians were the first true aviation pioneers, as evidenced by the discovery of a small, handmade wooden aircraft model in the shape of a bird that had been crafted by artisans in 200 B.C.

More than 2,000 years later, Egypt continues to advance aviation priorities to the benefit of its people and its Region, managing the largest North African aviation market as described in this special State Profile for the *ICAO Journal*.

In the first decades of twentieth century, Egypt had begun to exemplify its expertise in the sector of civil aviation, an effort clearly demonstrated by the development in 1932 of the first Egyptian aviation company (Egypt Air), realized through the issuance of a royal decree.



In the same year, another royal decree was issued to establish the first educational facility to teach aviation principles and practices in Egypt, and in a separate development the Egyptian government also established its own private airport facility.

To ensure aviation safety, accuracy and efficiency for its community, and in consideration of the remarkable increase in the number of passengers and flights that Egypt witnessed in its first years of aviation operations, a decree was issued in 1945 announcing the establishment of the Egyptian Civil Aviation Authority.

Egypt also became one of the founding States of ICAO during this period in its history, and is currently an active Member of Part 2 of the ICAO Council, which as per ICAO's stipulations includes States "which make the largest contribution to the provision of facilities for international civil aviation."

Moving forward to 2002, Egypt's civil aviation sector was restructured with the establishment of its new Ministry of Civil Aviation, under the leadership of the Minister Ahmed Shafik. The Ministry's organizational scheme currently includes:

- Ministry of Civil Aviation general Divan.
- Economic Companies.
- Service Authorities.
- Private Airlines.

The Egyptian Ministry of Civil Aviation is responsible for:

- Developing the civil aviation sector in accordance with international best-practices.
- Ensuring air transport safety and security to serve local, Regional and international stakeholders and passengers.
- Maintaining training and educational facilities to keep Egypt's skilled aviation personnel up-to-date with the latest industry developments and technologies.
- Achieving the specific Egyptian environmental targets in accordance with internationally-agreed priorities and objectives.

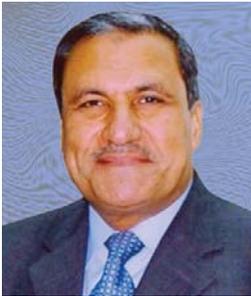




In March 2009, the Star Alliance (established in 1997 as the first truly global airline alliance) honoured His Excellency, Ahmed Shafik, Egyptian Minister of Civil Aviation, for his role in ensuring the success of civil aviation in Egypt, and for continuing its traditional role as both the largest aviation market on the African continent north of the equator,

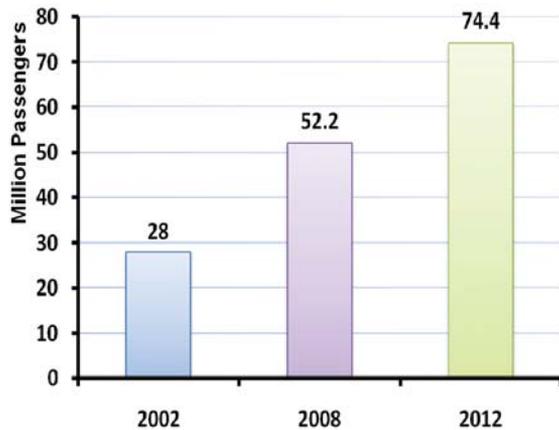
as well as a global leader in aviation with particular strengths in Africa and the Middle East.

Examples of recent Egyptian civil aviation accomplishments include EGYPTAIR's recent and exemplary transformation, culminating in its acceptance into the Star Alliance in 2008, and also the new Terminal 3 facility at Cairo Airport, which will further strengthen the Egyptian capital's position as the leading aviation hub in Northern Africa.



Providing unique facilities that assist the State in achieving the highest passenger safety, security and service levels, the Egyptian Holding Company for Airports and Air Navigation, under the leadership of Eng. Ibrahim Manaa, is continuing to boost capacity at airports across the country, with total capacity having been increased from 28 million passengers in 2002 to

52.2 million passengers in 2008. Egypt's current goal is to reach the 74.4 million passenger capacity mark by 2012.



Egypt today manages an aviation system comprised of no less than 22 airports, including seven international facilities, six international/domestic airports, seven domestic airports and two BOT (Build, Operate, Transfer) airports, with ongoing developments at these facilities and in additional operational capacities noted as follows:



Cairo International Airport remains a key focus in the State with the construction of its new Terminal 3 (TB3), which will establish Cairo as a truly Regional hub with capacity levels of 22 million passengers per year. CAI is looking forward to the completion of its new airport hotel, "Cargo City" and the implementation of a state-of-the-art automated people mover.

As a token of appreciation for these ongoing developments, the Egyptian Civil Aviation Minister was recently handed the registration certificate for his own star, "Ahmed Shafik", a stellar body located in the Cepheus Constellation as defined by the International Star Registry.

Sharm El-sheikh international airport is currently designated TB1 in order to increase its capacity to the 4,300 passengers per hour mark. Egypt is looking forward to raising the facility's capacity to 15 million passengers per year by 2012.



Hurghada International Airport has a new terminal with a capacity of 7.5 million passengers per year, as well as a new runway.



Luxor International Airport has a new terminal, which has been built to increase the airport capacity to 4,000 passengers per hour from its previous level of 800 passengers per hour.

Borg El-Arab International Airport has a total capacity 1.2 million passengers per year. It's currently undergoing the development of a new terminal, construction of a new control tower, and a dramatic increase in its cargo services through the establishment of a new cargo village with a capacity of 10,000 tonnes.

In the **Air Navigation sector**, several tremendous developments have been achieved in the last few years. Ongoing or recently-completed projects include the completion of State-wide radar coverage and a new network of satellite ground stations that have been established for air navigation services.

EGYPTAIR A Star Alliance member since July 2008, established May 7, 1932, and the seventh airline in the world to join IATA. In July, 2002, under the supervision of Egypt's Civil Aviation Ministry, Egyptair became a holding company and now has nine subsidiaries: Egyptair Airlines; Egyptair Express; Egyptair Cargo; Egyptair Maintenance & Engineering; Egyptair In-flight Services; Egyptair Ground Services; Egyptair Tourism & Duty Free Shop; Egyptair Supplementary Industries; and Egyptair Medical Services.

EGYPTAIR Airlines The first IOSA (IATA Operational Safety Audit) certified airline in the Middle East and Africa, and recipient of the TUV (Technischer Uberwachungs-Verein/Technical Inspection Association) certificate award, Egyptair Airlines successfully extended its network to reach more than 1,624 weekly departures to 69 cities in 44 countries, carrying more than 7.8 million passengers in 2007/2008. It possesses a modern fleet of 58 Airbus and Boeing aircraft.

EGYPTAIR Express Providing only economy and premium classes, Egyptair Express services domestic and Regional routes with convenient scheduling at affordable prices. It employs a network of medium-range routes in the Eastern Mediterranean area and a fleet of 76-seat Embraer-170 aircraft.

EGYPTAIR Cargo Employing two Airbus-380s with a capacity of 42 tonnes, and two Airbus 300/600 with a capacity of 45 tonnes, Egyptair Cargo maintains highest-standard cargo tracking systems and serves a network of more than 67 key international airports. It operates several major Cargo Hubs and stations in Europe, the Middle East and Africa.

EGYPTAIR Maintenance & Engineering Awarded with the EASA Part 145 certificate, Egyptair Maintenance & Engineering provides full technical support (Flight Hour Agreement), line maintenance and base maintenance technical support for more than 75 customers in Europe, Africa and the Middle East, specifically regarding the maintenance activities of most Boeing and Airbus aircraft (line maintenance, D-checks and component repair capabilities). The company has resident

certified engineers and technical staff at Cairo, Sharm El-sheikh, Hurghada, Luxor, Nozha, Borg el-Arab, and at outstations such as Riyadh, Dammam and Jeddah, in addition to another 15 outstations internationally (JFK, CDG, LHR, DXB, RUH, etc.).

EGYPTAIR Ground Services Company Recently awarded IATA's Safety Audit for Ground Operations (ISAGO) Certificate, the Egyptair Ground Services Company offers services to over 140 international carriers covering more than 71.5 percent of international flights to all major Egyptian airports. The company also provides ground transportation on airport premises and shuttle services for passengers, flight crews and Egyptair employees.

As the Star Alliance's 21st Member, Egyptair provides its passengers with a network of 975 airports in 162 countries, providing Star Alliance members with a strategic gateway into the Middle East and North Africa. ■

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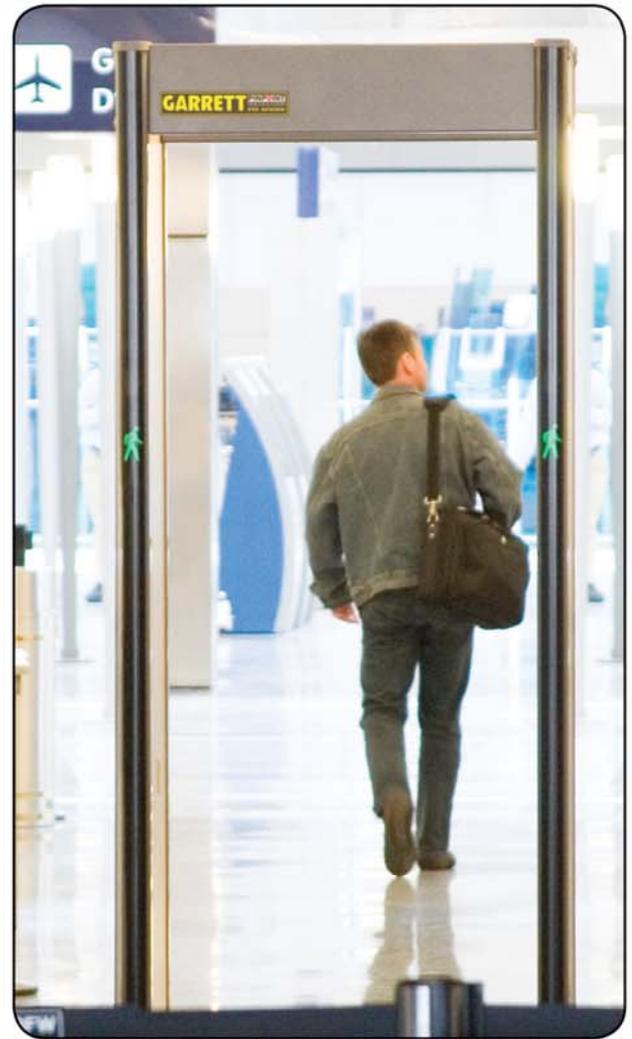
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2009–2010 ICAO CALENDAR OF EVENTS

Meeting	Site	Duration
Seventh MEVA II REDDIG Coordination Meeting (MR/7)	Mexico City, Mexico	10–11 June 2009
ICAO CAR/SAM Workshop on Data Collection, Forecasting and Analysis	Mexico City, Mexico	29 June–3 July 2009
ICAO/World Bank — Routes Development Forum Maximizing Civil Aviation's Contribution to Global Development Aviation Development: Focus on Asia/Pacific	Beijing, China	14–15 September 2009
Fifth Symposium on ICAO MRTDs, Biometrics and Security Standards	ICAO Headquarters, Montreal	21–23 September 2009
Global ATM (Air Traffic Management) Forum on Civil/Military Cooperation	ICAO Headquarters, Montreal	19–21 October 2009

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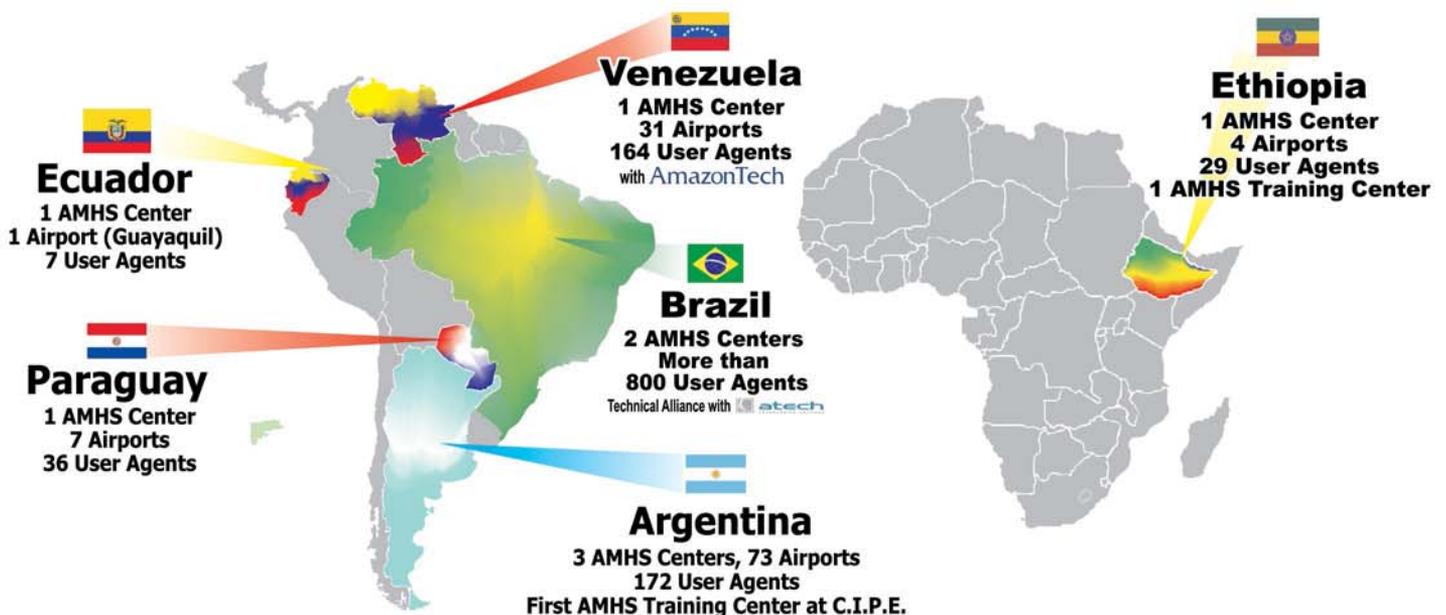
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