INTERNATIONAL CIVIL AVIATION ORGANIZATION

SIXTEENTH MEETING OF THE SAT (SAT 16)
(Recife, Brazil, 02 to 06 May 2010).

Agenda Item 3: The INSPIRE Partnership

(Presented by South Africa)

SUMMARY

Since February 18, 2008, a multi-lateral partnership known as the Asia and South Pacific Initiative to Reduce Emissions (ASPIRE) has been successfully promoting industry initiatives that positively affect the environment. Focuses on the region of South Pacific, North Pacific and SE ASIA. With such positive results and success with the ASPIRE model it was envisaged that the model would be expanded to other regions. To complement this work, the Indian Ocean Strategic Partnership to Reduce Emissions (INSPIRE) was formed in 2010.

This paper provides information regarding series of recommended procedures, practices and services that have been demonstrated or have shown the potential to provide efficiencies in fuel and emissions reduction management. They encompass all phases of flight from *gate-to-gate,* and are designed to reflect the requirements, in particular but not limited to, long haul flights that typically exceed 8 hours in duration.

1. INTRODUCTION

The air transportation industry is essential for future economic growth and development, trade and commerce, cultural exchange and understanding among peoples and nations. Today it provides approximately 32 million direct and indirect jobs worldwide. Aircraft carry approximately 40% of the value of all world trade. In 2007 more travellers than ever before flew on the world's scheduled air carriers, nearly 2.2 billion people, with predictions of 9 billion passengers by 2025. In the Arabian Sea and Indian Ocean region, the rapid movement of people and materials provided by aviation will be crucial to continued economic growth and development over the next few decades.

The aviation sector has a long and distinguished record of environmental achievement. Relative to other industries that emit global green house gases (GHG), aviation's contribution represents only 3% of global greenhouse gas emissions. Technological advancement has significantly reduced aircraft fuel consumption and emissions on a per passenger basis over the last 30 years, and the industry is committed to improving on this record. But we face a real challenge in the Arabian Sea and Indian Ocean region as air transport activity is expected to continue to grow steadily throughout the region.

In order to meet the growing regional demand for air transportation, while maintaining the industry's leadership position, it is essential for aviation partners to collaborate on environmental stewardship.

2. DISCUSSION

The INSPIRE Partnership

History

On February 18, 2008, a multi-lateral partnership known as the Asia and South Pacific Initiative to Reduce Emissions (ASPIRE) was created in Singapore. The first air navigation service providers (ANSPs) to sign the ASPIRE joint statement were Airservices Australia, Airways New Zealand, and the Federal Aviation Administration. Since then ASPIRE has expanded to include the Japan Civil Aviation Authority (JCAB) and the Civil Aviation Authority of Singapore (CAAS) as a major partners. Aeronautical Radio of Thailand (AeroThai) is expected to join the partnership in June 2011.

To complement this work, the **In**dian Ocean **S**trategic **P**artnership to **R**educe **E**missions (INSPIRE) was formed. The INSPIRE partnership is intended to be collaborative network of partners across the Arabian Sea and Indian Ocean region dedicated to improving the efficiency and sustainability of aviation.

The INSPIRE Commitment

The INSPIRE partners are committed to work closely with airlines and other stakeholders in the region in order to:

- accelerate the development and implementation of operational procedures to reduce the environmental footprint for all phases of flight on an operation by operation basis, from gate to gate;
- facilitate world-wide interoperability of environmentally friendly procedures and standards;
- capitalise on existing technology and best practices;
- develop shared performance metrics to measure improvements in the environmental performance of the air transport system;
- provide a systematic approach to ensure appropriate mitigation actions with short, medium and long-term results; and
- communicate and publicise INSPIRE environmental initiatives, goals, progress and performance to the global aviation community, the press and the general public.

Area of Operations

INSPIRE is aimed at supporting operations in three distinct regions:

- Arabian Gulf – Australia
- Southern Africa – Australia / South East Asia
- South-West Indian Ocean – Arabian Gulf

Support of ICAO Objectives

The INSPIRE partners will ensure that INSPIRE is in support of the ICAO Strategic Objectives for 2005-2010:[1]

[1] Strategic Objectives of ICAO: Consolidated Mission and Vision Statement, 17 December, 2004

- Strategic Objective C: Environmental Protection — Minimise the adverse effect of global civil aviation on the environment
- Strategic Objective D: Efficiency — Enhance the efficiency of aviation operations

Support of the CANSO Work Program

The INSPIRE partners will work to ensure that INSPIRE is consistent with environmental planning under Civil Air Navigation Services Organisation (CANSO) Environmental Work Group which is committed to the following goals for improving aviation sustainability:

1. To develop metrics and targets for the reduction of environmental impact.
2. To define and advance best practice in environmental management for ANSPs and to promote implementation as widely as possible.
3. To influence environmental policy, regulations and legislation to balance capacity, efficiency and the environment, without compromising safety.
4. To enhance understanding of ATM's environmental impact and mitigation measures.

INSPIRE and the Future Air Transportation System

INSPIRE directly supports the implementation of air traffic management (ATM) modernisation programs on State, regional and global levels to support future projected air traffic levels. INSPIRE is a forward-looking collaborative effort to accelerate the transition from today's operating norms to more advanced, efficient and environmentally friendly concepts.
Examples of such concepts are outlined in the Next Generation Air Transportation System (NextGen) in the United States and the Australian ATM Strategic Plan.

The INSPIRE Strategic Plan

The INSPIRE Strategic Plan outlines recommended procedures, applications and technologies that support the stated goals of the INSPIRE partnership. This document will be updated regularly by the INSPIRE partners to reflect the most current considerations regarding regional emissions reductions and efficiencies.
The INSPIRE strategic plan activities will aim to reduce fuel burn and greenhouse gas emissions, thus reducing aviation's impact on the environment.

Recommended ANSP Best Practices in the Indian Ocean Region

In consultation with stakeholders, the initial INSPIRE partners have compiled a series of recommended procedures, practices and services that have been demonstrated or have shown the potential to provide efficiencies in fuel and emissions reduction management. They encompass all phases of flight from *gate-to-gate,* and are designed to reflect the requirements, in particular but not limited to, long haul flights that typically exceed 8 hours in duration.

The recommendations contained below are for procedures, practices and services that are fully developed or that have reached a state of demonstrable maturity. New and conceptual applications will be added as they reach a proven state of readiness.

Surface Movement Optimisation

Surface Movement Optimisation procedures and surface and runway movement monitoring technologies have the potential to substantially improve the fuel and emissions efficiency of aircraft by reducing taxi times through improved planning of surface movements.

Surface movement optimisation procedures will be aimed at minimising the delay from start request to approval, and the time/fuel burn from start approval to take off. The INSPIRE partners recognise the potential benefit of surface and runway movement monitoring capabilities at congested airports using surveillance via radar and/or automatic dependent surveillance – broadcast (ADS-B), often enhanced by multilateration. While these surface movement systems are principally designed to enhance safety and reduce the potential for runway incursion, they also serve as the foundation for future systems that will optimise surface and runway movement.

Departure Optimisation

Optimisation for departure profiles is a developing ANS enhancement. Procedures for the fuel and emissions optimisation of departures have yet to be defined within INSPIRE. Procedures are expected to include optimise departure to facilitate unconstrained climb to cruise level and track to route start point, and manipulate taxi and departure time to optimise oceanic entry altitude and position in the enroute sequence.
Departure optimisation procedures are expected to substantially improve the fuel and emissions efficiency of aircraft during the climb-to-cruise portion of flight by minimising low altitude vectoring and the need to level-off at interim altitudes.

Oceanic Flight

User Preferred Routes

A User Preferred Route (UPR) during the oceanic phase of flight is defined as a lateral profile developed for each individual flight by the flight operator. These lateral profiles are customised in order to meet the specific needs of the aircraft operator for that flight, such as fuel optimisation, cost-index performance, or specific mission requirements.

Figure 1 - User Preferred Route Example

Typically a UPR will be calculated by an aircraft operator’s flight dispatch based on factors such as forecasted winds, aircraft type and performance, convective weather and scheduling requirements. UPRs are a favoured enhancement to oceanic operations where air traffic control (ATC) limitations previously required that aircraft fly on fixed air traffic services (ATS) routes, or published flexible track systems. This enhancement is directly attributable to the implementation of ground and airborne improvements such as automated conflict prediction, conformance monitoring and automatic dependent surveillance (ADS).

When UPRs are created based on fuel optimisation considerations, the corresponding savings in greenhouse gas emissions can be substantial.

Dynamic Airborne Reroute Procedures

Dynamic Airborne Reroute Procedures (DARP) refers to an oceanic in-flight procedure whereby the lateral profile of a flight can be modified periodically in order to take advantage atmospheric conditions of updated and updated forecasts. Typically, flight operators file flight plans some hours prior to a flight estimate time of departure. Often, revised upper wind forecasts are available after the flight plan is filed or the aircraft departs.

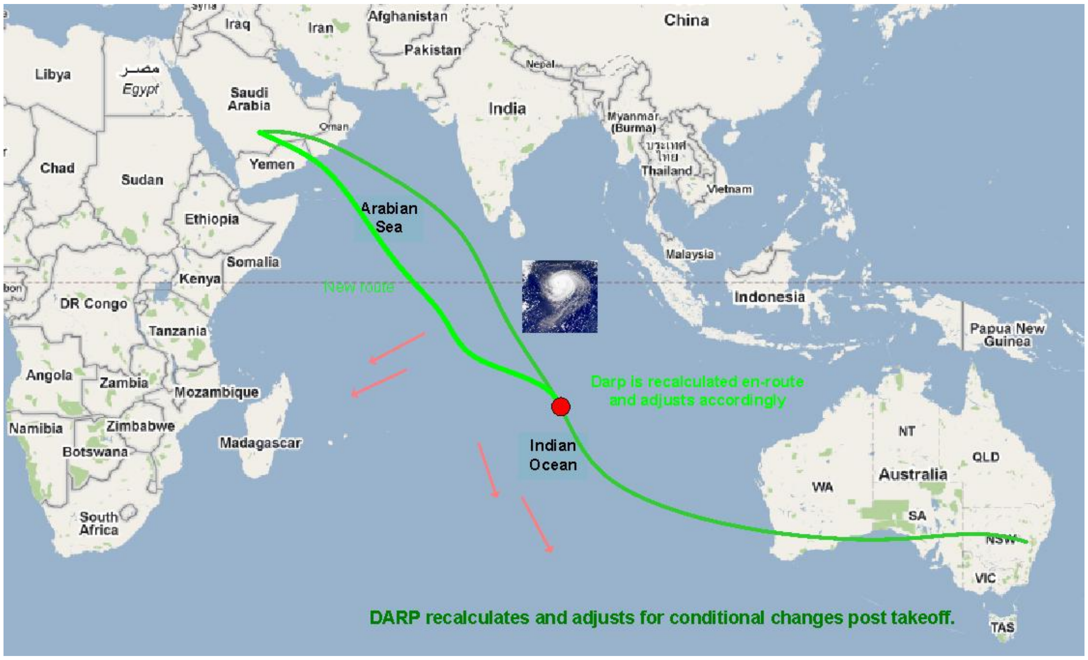

Figure 2 - Dynamic Airborne Reroute Procedure Example

DARP allows aircraft operators to calculate revised profiles from the aircraft's present position to any subsequent point in the cleared route of flight in order to realise savings in fuel or time. This update profile is coordinated by the Airline Operations Center (AOC) with the flight crew, and sent to ATC as a reroute request from the aircraft.

Initially demonstrated in the South Pacific in 1999, recent enhancements to conflict prediction, conformance monitoring and inter-facility coordination in Air Traffic Management automation systems have enabled the wider implementation of the DARP. Participating ANSPs can accommodate multiple in-flight reroute requests across airspace boundaries.

The DARP can provide significant savings in fuel and emissions. A recent Air New Zealand analysis concluded that 58% of all flights from Auckland to North America assessed during the analysis sample would achieve fuel savings from the DARP procedure, resulting in an average fuel burn reduction of 453kg per flight, or roughly 1431kg of CO_2 emissions.[2]

Flexible Track Systems

In an oceanic environment where the use of UPRs is not feasible, flexible track systems can provide an alternative vastly more efficient than fixed ATS routes. A flexible track is typically calculated so that all flights flying a specific city-pair route will utilise a single lateral profile or track. This track is calculated based on forecasted meteorological data and a representative aircraft performance model and published via NOTAM. A flexible track system is a series of flexible tracks designed to provide a generic optimised route between nominated city pairs.

Flexible tracks provide greater efficiencies than fixed ATS routes, because they are optimised to take advantage of favourable winds. Flexible tracks do not provide the same level of efficiencies to individual aircraft that can be achieved in a UPR system. However in circumstances where implementation of UPRs

[2] ISPACG/22 IP-16

is not yet feasible a flexible track system provides a notable improvement in efficiency and reduction in emissions.

In a recent trial, 592 Emirates Airlines flights from Dubai to Melbourne and Sydney were selected to examine the benefits of the flexible track system. For eastbound flights alone Emirates Airlines saved 628 tonnes of fuel and 57 hours in trip time[3]. Analysing one recent flight from Dubai to Sydney, using this optimal air traffic management, Emirates Airlines saved 8040kg of fuel and 43 minutes of flight time. This equates to more than 6,800 kilograms of C02 saved. The average saving per flight was six minutes of flight time and one ton of fuel.

Oceanic Separation Minima (50/50 & 30/30)

The capacity of oceanic airspace is severely constrained when legacy oceanic separation standards are in use.
Improvements in navigation capabilities have enabled reduction in the Oceanic separation minima to 50NM longitudinally and 50NM laterally. When coupled with direct controller pilot communications via data-link and automatic dependent surveillance, aircraft meeting certain navigation performance requirements can be safely separated at as little as 30NM longitudinally and 30NM laterally.
The reduced separation minima for use in the oceanic environment are published in the ICAO Procedures for Air Navigation Services – Air Traffic Management (Doc 4444) and the ICAO Annex 11 - Air Traffic Services.

RNP10 Aircraft	50nm longitudinal, 50nm lateral
RNP4 Aircraft	30nm longitudinal, 30nm lateral

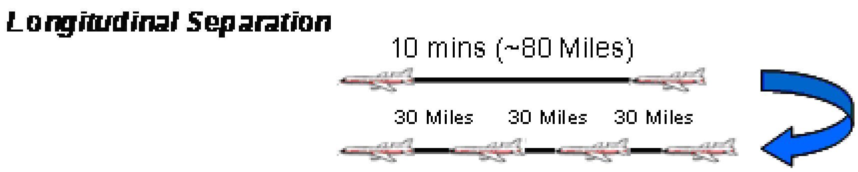

Figure 3 - Reduced Oceanic Separation Minima

Qualified aircraft navigating in airspace where these reduced separation minima have been implemented achieve significantly greater efficiencies than aircraft that cannot meet these standards. This is due to the vastly increased access to optimum flight profiles associated with the tighter spacing of the aircraft. This enhanced efficiency is reflected in lower fuel burn and reduced emissions as more aircraft can fly closer to optimal tracks and altitudes.

Reduced Vertical Separation Minima (RVSM)

Improvements in vertical height keeping and altimetry in the modern fleet of aircraft, coupled with new procedures and monitoring requirements has allowed a reduction of vertical separation between aircraft operating above FL290. This standard, known as Reduced Vertical Separation Minimum (RVSM), allows the vertical spacing of qualified aircraft to be reduced from 2000ft to 1000ft in airspace where the standard has been implemented.
Oceanic RVSM increases airspace capacity and allows aircraft to fly closer to fuel efficient altitudes.

[3] Each minute of flying-time saved reduces fuel consumption by an average of 62 litres and reduces C02 emissions by 160 kilograms.

Cruise Climb (Block levels)

A cruise climb allows pilots to execute a gradual climb from one cruise altitude to another, which when properly configured enables the optimum altitude to be sustained for reduce fuel burn and emissions. In circumstances where cruise climb is not permitted, block levels provide an efficient alternative. In a block level clearance a pilot is cleared to operate between two altitudes. As with the cruise climb the pilot is able to configure the aircraft for the optimum altitude to reduce fuel burn and emissions.

Time Based Arrivals Management

To reduce the environmental impact of delays caused by congestion at airports ANSP's have introduced traffic flow management procedures and automated decision support automation to reduce the need for fuel techniques such as low altitude vectoring and aircraft holding, and improve fuel and emissions efficiency by shifting delays to the enroute phase of flight.

Arrivals Optimisation

Overview

Arrivals Optimisation includes any one of several procedures available to aircraft operators and air navigation service providers to improve the fuel efficiency for aircraft during final descent phase of a flight. Qualifying arrivals optimisation procedures include, continuous descent arrivals, continuous descent approaches, optimised profile descents, tailored arrivals, and are generally referred to by ICAO as Continuous Descent Operations.

Optimum Profile Descents

An Optimum Profile Descent (OPD) is a cockpit-based flight technique where the vertical profile of an arrival is optimised to minimise undesired level flight segments so that the aircraft can be flown with engines at idle thrust from a high altitude, potentially from cruise, until touch down on the runway. Aircraft executing an OPD realise a far more efficient fuel burn profile and reduced emissions during the descent and arrival phases of flight, as compared to a traditional arrival path. A variety of Optimum Profile Descent applications have been analysed and developed for fuel and emission efficiency improvements.

Optimum Profile Descents via RNAV and RNP-AR Approaches

Where conditions will allow, arrival, departure and en route traffic flows will allow, descent profiles and airspace restrictions on published Area Navigation (RNAV) and Required Navigation Performance – Authorisation Required (RNP-AR) approaches are modified to provide more optimum arrival profiles. This optimisation reduces fuel burn and carbon emissions by taking advantage of the sophisticated navigational capability of modern aircraft that can fly closer to optimal tracks and altitudes.

For example, RNP-AR approaches are conducted using idle power, continuous descent from an optimally chosen top of descent point. In Australian RNP-AR implementations, this has typically saved around 200Kg of fuel per approach. This results in a reduction of 620Kg of $CO2$ emission per approach. During the first 18 months of implementing RNP-AR OPD, Airservices Australia estimates that 33 B737-800 aircraft have conducted more than 10,000 RNP-AR approaches. The estimated cumulative savings in jet fuel is 345,240 kg with estimated carbon dioxide emissions reductions of 1,151,280 kg.

Optimum Profile Descent via Tailored Arrivals

Another application of Optimum Profile Descent procedures, known as a Tailored Arrival (TA), is a procedure where trajectories are dynamically optimised for each aircraft to permit a fuel-efficient, lownoise descent profile that has imbedded compliance with arrival sequencing requirements and other airspace constraints.

Operational trials in Australia, New Zealand, and the United States have demonstrated that both types of Optimum Profile Descent described above provide significant fuel and emissions savings. Although the successful execution of an uninterrupted Optimum Profile Descent is greater during periods of light traffic, the INSPIRE partners are pursuing the use of Optimum Profile Descent during congested traffic periods under the INSPIRE Work Program.

Estimated Actual Fuel & CO2 Savings from SFO Tailored Arrivals*

Airline	Airplane	Potential Fuel & CO_2 Savings**	Actual Fuel & CO_2 Savings	% Realized Potential
Air New Zealand	**777-200ER**	Fuel: 215,140 lbs CO_2: 669,090 lbs	Fuel: 73,530 lbs CO_2: 228,690 lbs	34%
United Airlines	**777-200ER**	Fuel: 736,610 lbs CO_2: 2,290,870 lbs	Fuel: 76,200 lbs CO_2: 237,000 lbs	10%
United Airlines	**747-400**	Fuel: 1,556,790 lbs CO_2: 4,841,620 lbs	Fuel: 112,800 lbs CO_2: 350,810 lbs	7%
Japan Airlines	**747-400**	Fuel: 64,400 lbs CO_2: 200,280 lbs	Fuel: 7240 lbs CO_2: 22,510 lbs	11%

* From December 4, 2007 to May 27, 2008
** Potential Fuel Savings based on Total number of flights recorded by ANOMS8 per Airline

PBN is a framework for defining navigation performance requirements that can be applied to an air traffic route, instrument procedure, or defined airspace. PBN includes both Area Navigation (RNAV) and Required Navigation Performance (RNP) specifications. PBN provides a basis for the numerous Air Traffic Services enhancements such as oceanic RNP separation reductions, Optimum Profile Descents, and the development of aircraft and the development of future concepts for trajectory based operations. These PBN enabled enhancements are a cornerstone of ANSP efforts to improve fuel and emission efficiencies
ANSP guidance for the implementation of PBN and associated ATS applications will be contained in the ICAO Performance Based Navigation Manual, Doc 9613.

Performance Measurement

Individual ANSPs, airlines and industry partners track efficiency and environmental performance to varying degrees in the course of everyday business activities. However, few arrangements are in place to accurately track the end-to-end performance and efficiency of flights within the region. Comprehensive and comparable measurement of emissions performance is a key to assessing the progress of environmental initiatives and to identifying areas in need of improvement.

[4] Rob Mead, Boeing, “Tailored Arrivals Activities Overview” 17 October, 2008

Baseline Performance Metrics

The INSPIRE partners have adopted the baseline performance metrics developed for the ASPIRE program. These baseline metrics are designed to:

- Calculate the benefits that recent efficiency enhancements (e.g. UPR, DARP, 30/30 separation minima) have contributed to fuel savings and emissions to date, and
- Provide the foundation for assessment of future emissions and efficiency initiatives developed within the INSPIRE partnership.

To successfully gauge environmental and operational efficiency benefits, it is necessary that INSPIRE Partners identify historical fuel use and weight records for aircraft operations in order to establish a performance baseline. Establishment of this baseline data is vital and valuable for comparison against the effects of ATS enhancements and the determination of benefits – fuels conserved, emissions reduced, and payload fuel efficiency.

To measure performance ANSPs and airline partners must collaborate to define and collect the data required to assess performance, and share data to ensure that there is consistency in the measurement, interpretation and reporting of performance.

Emissions Calculation

With the determination of the fuel difference, and by application of the 1st order approximation that assumes the complete fuel combustion assumption, Carbon Dioxide (CO_2), Water (H_2O) and Sulfur Oxides (SO_x) emission reductions can be estimated from the amount of unburned fuel saved by using the emission indices as follows:

- CO_2 (kg) = 3.155 x amount of fuel conserved (kg);
- H_2O (kg) = 1.237 x amount of fuel conserved (kg); and
- SO_x (kg) = 0.0008 x amount of fuel conserved (kg)

An online utility for the calculation of emissions is available at:
http://www2.icao.int/en/carbonoffset/Pages/default.aspx

http://www.epa.gov/cleanenergy/energy-resources/calculator.html

The “Ideal Flight” Benchmark

The development and computation of a flight benchmark that reflects the “Ideal Flight” will play an essential role in the INSPIRE program. This benchmark, calculated based on the most efficient and environmentally sound gate to gate flight profile possible, demonstrates the maximum potential gain in environmental performance that can be achieved under INSPIRE.

The calculation of this benchmark is a significant challenge due to the external influences impacting each flight. The INSPIRE partners will conduct a series of INSPIRE Green Flight demonstrations for a snapshot of benefits that can be achieved by removing all controllable constraints. However the development of a comprehensive benchmark will require a combination flight demonstration data, and aircraft performance modelling.

Table of Acronyms

AAI	Airports Authority India
ADS	automatic dependent surveillance
ADS-B	automatic dependent surveillance – broadcast
ADS-C	automatic dependent surveillance – contract
ANSP	air navigation service provider
ASIOACG	Arabian Sea/ Indian Ocean ATS Coordinating Group
ASPIRE	The Asia and South Pacific Initiative to Reduce Emissions
ATC	air traffic control
ATM	air traffic management
ATNS	Air Traffic and Navigation Services South Africa
ATS	air traffic services
CANSO	The Civil Air Navigation Services Organisation
CDA	continuous descent approach/arrival
CNS/ATM	communications, navigation, surveillance / air traffic management
CTMS	Central Traffic Management System
DANS	Dubai Air Navigation Services
DARP	dynamic airborne reroute procedures
GCAA	United Arab Emirates General Civil Aviation Authority
GHG	global greenhouse gas
IATA	The International Air Transport Association
ICAO	The International Civil Aviation Organisation
INSPIRE	Indian Ocean Strategic Partnership to Reduce Emissions
ISPACG	Informal South Pacific ATS Coordinating Group
MAESTRO	Means to Aid Expedition and Sequencing of Traffic with Research of Optimisation
NOTAM	Notice to Airmen
OPD	optimum profile descent
OTM-4D	Oceanic Trajectory Management – 4D
PBN	performance based navigation
RNAV	area navigation
RNP	required navigation performance
RNP-AR	required navigation performance – authorisation required
RVSM	reduced vertical separation minima
SOPAC	South Pacific
STAR	standard terminal arrival
TA	tailored arrival
TBD	to be determined
TMA	Traffic Management Advisor
TOD	top of descent
UPR	user preferred Routes

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) Note the benefits to airlines by implementing recommended best practices in areas, such as the Indian Ocean and in the South Atlantic,

b) Work toward the extension of INSPIRE in the South Atlantic, and

c) Support and encourage ongoing collaborative development of harmonized operational requirements and crew procedures with other Oceanic and Remote airspace around the world.