INTERNATIONAL CIVIL AVIATION ORGANIZATION SAM/IG/10-WP/05
South American Regional Office - Regional Project RLA/06/901 09/04/12
Assistance for the Implementation of a Regional ATM System, taking into account the ATM operational concept and the corresponding CNS technological support
Tenth Workshop/Meeting of the SAM Implementation Group (SAM/IG/10)
(Lima, Peru, 1-5 October 2012)

Agenda Item 2: ATS route structure optimisation - Phase 3 Version 2

SAFETY PLAN FOR THE OPTIMISATION OF THE ATS ROUTE NETWORK (ATSRO) IN THE SAM REGION PHASE 3 VERSION 2

(Presented by the Secretariat)

Summary

This working paper presents the safety plan that precedes the implementation of Phase 3 Version 2 of the SAM ATS route network optimisation (ATSRO) programme. The safety assessment has been conducted applying a qualitative methodology through the SMS, as established in the action plan of the ATS route network optimisation. The aforementioned safety plan is submitted to the consideration of the Meeting for its analysis and approval.

References:
- Annex 11 to the ICAO Convention
- ICAO SMM (Doc 9859)
- SAMIG meeting reports
- SAM ATS route network optimisation programme
- Meeting/workshop SAM/RA/3

ICAO strategic objectives:	*A – Safety* *C – Environmental protection*

1 Background

1.1 SAMIG meetings have reviewed the safety assessment issue on several occasions, not only for the purpose of optimising the airspace structure and implementing Version 1 of the ATS route network, but also within the scope of RNAV 5 implementation.

1.2 Likewise, with the support of Project RLA/06/901, and pursuant to the action plan of the airspace structure optimisation programme, task 3.2.9 - *Conduct the required safety assessment applying the qualitative methodology using the SMS*, was implemented prior to the implementation of Phase 3 Version 2 of the SAM ATS route network. In this regard, the Implementation Group determined that the qualitative methodology shown in ICAO Doc 9859, *Safety Management Manual (SMM)* would be used through a "safety case".

2 Discussion

2.1 In accordance with the aforementioned planning, the ICAO South American (SAM) Regional Office, with the support of Regional Project RLA/06/901, scheduled the meeting/workshop SAM/RA/3 to assess the risks of the system prior to the implementation of Phase 3 Version 2 of the SAM ATS Route Network Optimisation (ATSRO) Programme, in order to comply with the safety provisions of Annex 11 before introducing important changes in the aeronautical system structure. Also, it contemplated the participation of an expert for a period of three weeks to assist the Secretariat at the meeting/workshop SAM/RA/3 and in the drafting of the safety case. Such responsibility was assigned to ATM/SAR consultant, Mr. Jorge Fernández Demarco.

2.2 This meeting/workshop permitted the participation of experts in the various fields of knowledge, as well as civil aviation authorities and air traffic service providers. The creation of this group of experts enabled the identification of hazards that might affect or prevent optimisation, the assessment of consequences in terms of probability and severity, the tolerability of operational risks, and the mitigation measures required to increase the resulting safety.

2.3 This multidisciplinary team applied the aforementioned risk management methodology contained in the Safety Management Manual (Doc 9859) through the application of safety systems (SMS). To this end, operational risks were identified and the different stages of the operational risk management process were applied to measure safety levels.

2.4 The ATSRO safety study shown in **Appendix A** to this working paper starts with a brief description of the system, based on the planning defined for the SAM Region and the ATS route network optimisation programme. The objective of this study is to determine the feasibility of the aforementioned optimisation, based on a risk assessment, in order to ensure the safety of operations in the SAM Region within this new scope of application.

2.5 This study showed that the level of risk related to the optimisation of the ATS route network was acceptable, and permitted the use of the existing network and the introduction of modifications without affecting its normal operation, thus achieving an orderly transition. Finally, it provides recommendations for its implementation by the various participating organisations of the Region in order to enhance safety in the airspace analysed. In summary, the implementation of Phase 3 Version 2 of the ATSRO Programme in the SAM Region is feasible, as shown by this study.

3. Suggested action

3.1 The Meeting is invited to take note of the information presented in this paper, review the safety plan for Phase 3 Version 2 of the SAM ATS Route Network Optimisation (ATSRO) Programme and, if applicable, make comments and propose actions in relation to the cited document.

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INTERNATIONAL CIVIL AVIATION ORGANIZATION (ICAO)

SOUTH AMERICAN REGIONAL OFFICE

PRELIMINARY SAFETY PLAN FOR THE IMPLEMENTATION OF THE ATS ROUTE NETWORK OF THE SOUTH AMERICAN REGION, PHASE 3, VERSION 02 (ATSRO PROGRAM, PHASE 3)

Version 1.0	
Date	**September 2012**

FOREWORD

The *Safety Plan for the Implementation of the ATS Route Network of the SAM Region, Phase 3, Version 02* is published by the SAM Implementation Group (SAMIG). This paper describes the risk analysis conducted before the implementation.

SAMIG will publish revised editions of this Document, as needed, to reflect the activities already completed and that could impact this document. Copies of this *SP* may be requested to:

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This edition (Version 1.0) includes all revisions and changes made until September 2012. Subsequent changes and corrections will be reflected in the Amendments and Corrections Record, in accordance with the procedure set out on page 2.

Publication of amendments and corrections shall be announced regularly through correspondence with the States and International Organisations, and on the web page of the ICAO South American Regional Office; users of this publication should check those sources. Blank slots allow for easier annotation.

RECORD OF AMENDMENTS AND CORRIGENDA

AMENDMENTS			
No.	Effective date:	Date recorded:	Recorded by:

CORRIGENDA			
No.	Effective date:	Date recorded:	Recorded by:

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Executive Summary

1. This safety plan aims to conduct a risk analysis using the qualitative methodology to assess the impact that the implementation of the SAM ATS route network Phase 3, Version 02 might have on safety, and to demonstrate that implementation will be acceptably safe.

2. The criterion used to define that implementation will be acceptably safe in this context is established by comparison, which requires that the risk of an accident / incident in the proposed route system does not exceed the implemented reference system, the reference system being the ATS route network before the implementation of Phase 3, Version 02.

3. The implementation of airspace improvements contributes directly to the achievement of ICAO Strategic Objectives related to safety and environmental protection.

4. A regional assessment does not always contain the information necessary to meet specific local requirements. It should be noted then that this safety assessment does not replace the responsibility of States for conducting their own safety assessment following the implementation of the routes included in Phase 3, Version 02 of the SAM ATS Route Network in their respective FIRs, as established in ICAO SARPs.

5. The area covered by the safety assessment includes the airspace under the responsibility of the SAM States that have agreed to implement Phase 3 Version 02 of the ATS Route Network, encompassing air operations under normal conditions within the boundaries of the following flight information regions (FIRs): Antofagasta, Amazónica, Asunción, Barranquilla, Brasilia, Bogotá, Comodoro Rivadavia, Córdoba, Curitiba, Ezeiza, Georgetown, Guayaquil, La Paz, Lima, Maiquetía, Mendoza, Montevideo, Panama, Paramaribo, Puerto Montt, Punta Arenas, Recife, Resistencia, Rochambeau, and Santiago.

6. Chapter 1 of the document analyzes the background related to the optimization of the ATS route network carried out since 2001 and explains in summary how SAM States, together with airspace users, have resolutely and constantly been working to make improvements to the structure of the airspace under their jurisdiction.

7. Chapter 2 analyzes the current situation of the SAM ATS route system, briefly describes its design, identifies a set of general and planning principles that were considered during the analysis of Phase 3 Version 02 of the ATS route network that should also be taken into account by the airspace planners of the States.

8. It also summarizes the planning principles and challenges planners face in designing airspace besides the expected growth in air traffic, such as meeting, among other things, ATS demand to ensure that sector capacity is at least maintained at current levels and that delays due to restrictions in terminal airspace are minimized; safety requirements; requirements to ensure environmental protection and the different demands and requirements of airspace users taking into account new and diverse user development plans.

9. This Chapter also assesses the situation of the ATS route network optimization after implementing Phase 3, Version 02 of the ATS route network, highlighting the operational benefits to be derived from the implementation.

10. Chapter 3 analyzes the general aspects of safety management considering that, according to the universally accepted definition of the International Civil Aviation Organization (ICAO), safety in civil aviation is the condition whereby risk of personal injury or property damage is reduced and maintained at or below an acceptable level through a continuous process of hazard identification and risk assessment.

11. The chapter then explains the methodology used and the hazard identification processes, which are defined as a potential situation that could affect the acceptable level of safety. Then, the document reviews the hazard identification methodology based on the one described in the ICAO SMM (Doc 9859), which identifies potential hazards in a logical and sequential manner, based on which it is possible to determine the feasibility of the implementation of ATSRO Phase 3 Version 02 of the ATS route network.

12. The document states that hazards and their consequences were identified and recorded by a team of experts that conducted the risk analysis during the Meeting / Workshop SAMRA/03 (September 2012), evaluating in each case the probability of occurrence and severity of an event, considering a predictable worst case scenario, based on a qualitative analysis, and finally, applying the operational risk matrix and determining what further actions could be applicable to minimize or contain efficiently the operational risks that could result from the implementation of Phase 3, Version 02 of the ATS Route Network.

13. That meeting / workshop approved the use of different matrices to determine the probability, severity, risk classification and criteria for mitigating operational risks, taking into account the experience of States at regional and global level.

14. Chapter 4 explains the work done by the multidisciplinary team that participated in the SAMRA/3 meeting/workshop, identifying first the generic hazard and then striving to identify specific components of the hazard that could affect air navigation in the ATS Route Network in its Phase 3, Version 02.

15. Chapter 5 analyzed and compared the information available and that defined by the experts participating in the SAMRA/03 meeting/workshop and once this information was validated, the methodology was applied to determine the level of operational risk for each hazard identified by the panel. This Chapter shows the main causes leading to the identified hazard, the current barriers to hazard control, and the risk assessment with the existing barriers, and then, proposes a number of mitigation measures that would permit the implementation of Phase 3, Version 02 of the ATS route network with acceptable levels of safety for the Region.

16. Chapter 6 summarizes the conclusions and recommendations of the risk analysis, taking into account that the current SAM ATS route network, with currently available air traffic services, communication, navigation, and surveillance systems, aeronautical and meteorological information, and all the support systems available for ATM are sufficient for conducting safe and efficient air operations in the Region.

17. However, with the implementation of a new route network version with a structure that is different from the existing one, opportunities for improvement were identified in order to enhance and maintain safety standards through the implementation of the measures proposed by this document as described in detail in Chapter 5, which will permit the optimization of safety in the new operational environment, thus contributing to the achievement of the strategic objectives of the regional performance-based air navigation implementation plan.

18. Finally, the document provides a series of conclusions and recommendations for civil aviation authorities, aircraft operators, air navigation service providers, the South American Implementation Group, and ICAO, which, if applied efficiently, will permit a safe and orderly implementation of Phase 3, Version 02 of the ATS route network.

Definitions and acronyms

For the purposes hereof, the following definitions and acronyms shall apply with the following meaning:

Definitions

Accident: An occurrence associated with the operation of an aircraft that takes place between the moment any person boards the aircraft with the intention of flight until such time as all persons have disembarked, in which:

a) Any person is fatally or seriously injured as a result of:
- being in the aircraft; or
- direct contact with any part of the aircraft, including parts which have become detached from the aircraft; or
- direct exposure to jet blast;
- except when the injuries are from natural causes, self-inflicted or inflicted by other persons, or when the injuries are to stowaways hiding outside the areas normally available to passengers and crew; or

b) the aircraft sustains damage or structural breakage that:
- adversely affects its structural strength, performance or flight characteristics; and
- would normally require major repair or replacement of the affected component, except for engine failure or damage, when the damage is limited to the engine, its cowlings or accessories; or for damage limited to propellers, wing tips, antennas, tyres, brakes, fairings, small dents or puncture holes in the aircraft skin; or

c) the aircraft is missing or is completely inaccessible.

AIRPROX. Code word used in an air traffic incident report to designate aircraft proximity.

Safety Barriers: Term used to indicate systems, sub-systems or methods used to reduce the probability of a hazard escalating into an incident or accident, and/or reduce their severity.

Air Traffic Control: A service provided for the purpose of preventing collisions between aircraft or between aircraft and obstructions (in the manoeuvring area) and for the purpose of expediting and maintaining an orderly flow of air traffic.

Hazard Consequence: Probable outcome of a hazard.

Safety Assessment Criteria: The set of quantitative or qualitative criteria to be used in a safety assessment to determine the acceptability of the assessed level of safety.

Integrated Aeronautical Information Package: A package which consists of the following elements;

- aeronautical information publications (AIP), including amendments;
- AIP supplements;
- the NOTAM and pre-flight information bulletins (PIB);
- aeronautical information circulars (AIC); and
- checklists and lists of valid NOTAMs.

Risk Assessment: A process that for identified hazards, evaluates their risk in terms of probability and severity of consequences.

Safety Assessment: Assessment consisting of a structured hazard identification process and a systematically coherent operational risk assessment.

Risk Management: Identification, analysis and elimination (or mitigation down to an acceptable or tolerable level) of the hazards and subsequent risk threatening the feasibility of an organization.

Incident: An occurrence, other than an accident, associated with the operation of an aircraft which affects, or would affect, the safety of operation.

Serious incident: An incident involving circumstances indicating that there was a high probability of an accident and associated with the operation of an aircraft which, in the case of a manned aircraft, takes place between the time any person boards the aircraft with the intention of flight until such time as all such persons have disembarked, or in the case of an unmanned aircraft, takes place between the time the aircraft is ready to move with the purpose of flight until such time as it comes to rest at the end of the flight and the primary propulsion system is shut down. Typical examples include:

a) A near collision requiring an avoidance manoeuvre, or when an avoiding manoeuvre would have been appropriate to avoid a collision or an unsafe situation.

b) Controlled flight into terrain (CFIT) only marginally avoided.
c) An aborted take-off on a closed or engaged runway or a take-off from such runway with marginal separation from obstacle.
d) A landing or attempted landing on a closed or engaged runway.
e) Gross failure to achieve predicted performance during take-off or initial climb.
f) All fires and smoke in the passenger compartment or in cargo compartments, or engine fires, even though such fires are extinguished with extinguishing agents.
g) Any events that required the emergency use of oxygen by the flight crew.
h) Aircraft structural failure or engine disintegration that is not classified as an accident.
i) Multiple malfunctions of one or more aircraft systems that seriously affect the operation of the aircraft.
j) Any case of flight crew incapacitation in flight.
k) Any fuel state that would require the declaration of an emergency by the pilot.
l) Take-off or landing incidents, such as undershooting, overrunning or running off the side of runways.
m) System failures, weather phenomena, operation outside the approved flight envelope or other occurrences that could have caused difficulties controlling the aircraft.
n) Failure of more than one system in a redundancy system that is mandatory for flight guidance and navigation.

Mitigation: Measures to address the potential hazard or to reduce the risk probability or severity.

Acceptable Level of Safety (ALoS): expresses the established safety goals. It constitutes a reference against which safety performance can be measured. This level is expressed by safety indicators and safety goals.

Safety Objective: The definition of a hazard together with its target maximum rate of occurrence. A goal or target that, where achieved, demonstrates that a tolerable level of safety is being, or will be achieved for the hazard concerned.

Hazard: A condition or an object with the potential of causing injuries to personnel, damage to equipment or structures, loss of material, or reduction of ability to perform a prescribed function.

Risk Probability: probability that an unsafe event or condition might occur.

Acceptable region: The risk is acceptable under the existing circumstances.

Emergency Response: Description of the steps to follow in case of an emergency in which the responsibilities in the execution of the procedure and duties to be performed are defined.

Intolerable Region: Risk that is unacceptable at any level.

Tolerable Region: Risk that is acceptable based on risk mitigation. It might require a cost/benefit analysis.

Safety Risk: The assessment, expressed in terms of predicted probability and severity, of the consequence of a hazard, taking as a reference the worst foreseeable situation.

Safety Requirements: Specified system criteria that are required in order to reduce the risk of an accident or incident to an acceptable level. Also, it is defined as the requirement to help achieve a safety goal.

Applicable Safety Regulatory Requirements: The requirements for the provision of air traffic services or for the operation of an aerodrome in respect of facilities applicable to a specific situation under review in relation to, among others:

a) The technical and operational competence and suitability to provide the service or facility;
b) Systems and processes for security management, and
c) Technical systems, their constituents and associated procedures.

Safety: Condition in which the risk of personal injury or property damage is reduced and maintained at an acceptable level, or below it, through a continuing process of hazard identification and risk management.

Severity: The possible consequences of an unsafe event or condition, taking as reference the worst foreseeable situation

System: A term used to describe the collection of equipment, procedures and / or personnel to perform a function.

As Low As Reasonably Practical: A risk is low enough so as not to try to lower it further, or the cost of the evaluation of the improvement in an attempt to reduce risk, it would actually be more expensive than any costs likely to come from one's own risk.

Risk Tolerability: This criterion relates to the probability and severity of risk.

Acronyms

AIC	Aeronautical information circular
ALARP	As low as reasonably practicable
ALoS	Acceptance level of safety
AIP	Aeronautical information publication
AIRAC	Aeronautical information regulation and control
AIREP	Air-report
AIS	Aeronautical information service(s)
AMS	Aeronautical mobile service
APP	Approach control office or approach control service
ASHTAM	NOTAM on volcanic ash
ASM	Airspace management
ATC	Air traffic control (in general)
ATCO	Air traffic controller
ATFM	Air traffic flow management
ATM	Air traffic management
ATS	Air traffic service
ATSRO	ATS Route Network Optimization Program
AC	Advisory circular
CB	Cumulus nimbus clouds
CDO	Continuous descent operations
CDM	Collaborative decision-making
CEO	Executive director
CFIT	Controlled flight into terrain
CATC	Civil aviation training centre
CU	Cumulus clouds
DME	Distance measuring equipment
CO2	Carbon dioxide
FTS	Fast-time simulation
FDE	Failure detection and exclusion
FIR	Flight information region
FPL	Filed flight plan
GANP	Global air navigation plan
GNSS	Global navigation satellite system
GREPECAS	Caribbean/South American Regional Planning and Implementation Group
HIRA	Hazard identification and risk assessment
LOA	Letter of operational agreement
MET	Meteorological or meteorology
NOTAM	Notice to airmen
NAV	Navigation
NAVAID	Navigation aids
ICAO	International Civil Aviation Organization
OPS	Operations
PANS	Procedures for air navigation services

PBN	Performance-based navigation
PIREP	Pilot report
SP	Safety plan
QMS	Quality management system
RAIM	Receiver autonomous integrity monitoring
RNAV	Area navigation
SAM	South America
SAMIG	South American Implementation Group
SARPS	Standards and recommended practices (ICAO)
SLA	Service level agreement
SMS	Safety management system
SMM	Safety Management Manual (Doc 9859)
SUA	Special use airspace
TMA	Terminal control area
TCU	Towering cumulus
UAS	Unmanned aircraft system
WPT	Waypoint
WGS 84	World geodetic system 1984

Chapter 1 Preface

Purpose of the Safety Assessment

1.1 In order to comply with ICAO standards and recommended practices and to meet the aspirations of the ATM community, a safety assessment needs to be conducted before implementing Phase 3 Version 02 of the SAM ATS route network.

1.2 The purpose of this safety plan is to conduct a risk analysis using the qualitative methodology, assess the impact that the implementation of Phase 3, Version 02 of the SAM ATS route network could have on safety, and demonstrate that the implementation will be acceptably safe.

1.3 *What does acceptably safe implementation mean in this context?* The criterion used to determine that the implementation will be acceptably safe is established by a comparison that requires that the risk of an accident/incident in the proposed route system shall not exceed the reference system in place, the reference system being the ATS route network before the implementation of Phase 3, Version 02.

1.4 In principle, it is recognized that absolute safety is unachievable and that the arguments used herein are intended to evaluate and determine whether the analyzed system is acceptably safe to operate in its current context.

1.5 This safety plan by itself does not improve safety and will only do so if there is a commitment by stakeholders to develop and implement it.

1.6 The introduction of airspace improvements contributes directly to the achievement of the following ICAO Strategic Objectives:

- Safety — *To improve the safety of civil aviation worldwide*
- Environmental protection — *To minimize the adverse effect of global civil aviation on the environment*

1.7 The safety plan discusses the hazards identified at the third workshop/meeting for risk assessment prior to the implementation of Phase 3 - Version 02 of the SAM ATS route network – Regional Project RLA/06/901 (SAM/RA/3 Lima, Peru, 3-7 September 2012).

1.8 The safety assessment on the implementation of Phase 3, Version 2 of the ATS Route Network seeks to establish the safety levels before this implementation, taking into account existing barriers, and, if appropriate, to propose mitigation measures for these risk levels to remain within acceptance margins and serve as reference material for States that so require as a sort of "benchmarking".

1.9 States should consider that a regional assessment does not always contain the information necessary to meet specific local requirements. Then it should be noted that this safety assessment does not replace the responsibility of the States or the air navigation services provider,as applicable, to carry out their safety assessment following the implementation of the routes included in Phase 3, Version 2 of the SAM ATS route network in their respective FIRs, as established in ICAO SARPs.

1.10 The safety assessment process seeks to answer questions like:

a) What could be wrong with the evaluated system that could affect safety during the implementation and post-implementation of Phase 3, Version 02 of the SAM ATS route network?

b) What could be the consequences for air traffic if the findings and decisions made during the planning and implementation of the action plan for the implementation of Phase 3, Version 02 of the optimization program are not met?

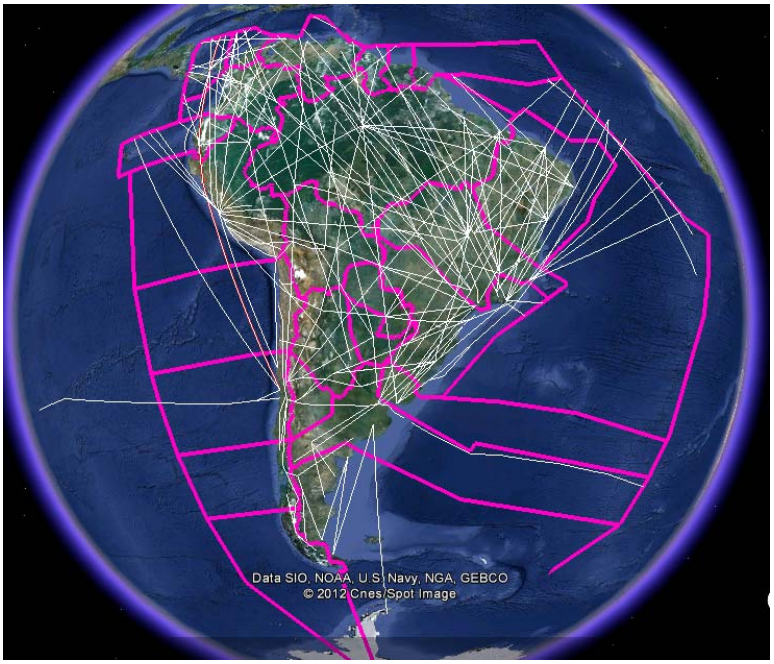
c) What would be the consequences if mitigation measures identified during the analysis to reduce risk were not applied?

1.11 The implementation of Phase 3, Version 02 of the SAM ATS route network requires applying a standard methodology to identify hazards, analyze their consequences and thereby allow managing operational risks during the optimization of the route network. Consequently, the Safety Management manual (Doc 9859) has been applied to this assessment, that is, a structured process of hazard identification and a systematic and consistent assessment of operational risk. Likewise, the experience of the Region and of individual States in the application of risk analysis has been taken into account.

1.12 Taking into account the diversity of scenarios in the Region and the agreements reached at different workshops by the SAM Implementation Group (SAMIG), it was considered that this type of safety studies would be a complex task that should be supported by the Regional Project RLA/06/901. In this regard, the aforementioned regional project assisted the Region in the preparation and conduction of the SAM/RA/3 meeting/workshop and in the development of this safety plan.

Scope

1.13 The area covered by the safety assessment includes the airspace under the responsibility of SAM States that have agreed to implement Phase 3 Version 02 of the ATS Route Network and covers air operations under normal conditions within the boundaries of the following flight information regions (FIR): Antofagasta, Amazónica, Asunción, Barranquilla, Brasilia, Bogotá, Comodoro Rivadavia, Córdoba, Curitiba, Ezeiza, Georgetown, Guayaquil, La Paz, Lima, Maiquetía, Mendoza, Montevideo, Panama, Paramaribo, Puerto Montt, Punta Arenas, Recife, Resistencia, Rochambeau, and Santiago. By way of reference, a chart with SAM FIRs and the ATS route network in the upper airspace is shown below.



Work Program

1.14 In order to implement the work program, Project RLA 06/901 hired a specialist to assist the Regional Office in the safety assessment process. Initially, work was done for a period of two weeks involving the preparation of the third meeting/workshop for the risk assessment prior to the implementation of Phase 3 - Version 02 of the SAM ATS route network, and the drafting of the various working papers and the corresponding presentations. Then, during a second period of three weeks, support was given to the ATM officers of the SAM Regional Office for the conduction of the meeting/workshop and the development of the safety plan.

Background

1.15 Since 2001, SAM States, together with airspace users, have been working constantly to make improvements in the structure of the airspace under their jurisdiction.

1.16 Since 2008 and with the support of the Regional Project RLA/06/901, the SAM Region developed an airspace optimization program to maximize the efficient use of airspace while maintaining the required levels of safety.

1.17 The ATSRO Program seeks to achieve significant improvements in airspace organization and management and it was agreed that it should be executed in phases in order to achieve operational benefits as early as possible and to get the necessary experience in each of these phases to facilitate program implementation.

1.18 Phase 1 corresponded to the implementation of RNAV-5, taking into account that the implementation of this navigation specification would facilitate the optimization of the ATS route network. This phase of the program was implemented in October 2011. The RNAV-5 was implemented in all RNAV routes of the SAM Region, except in oceanic airspace where RNAV / RNP 10 had already been implemented.

1.19 It was agreed that, starting in Phase 2 of the program, the concept of route network versions would be incorporated, since airspace structure changes due to air traffic growth, the shifting of air traffic demand from one region or airport to another region or airport, available technology, among others. The use of versions of the route network reflects the need for a periodic review in an integrated manner to always ensure the best possible airspace structure. The implementation of Version 01 of the ATS route network was successfully completed in March 2011.

1.20 The SAM Implementation Group at its eighth meeting (SAMIG/8), held in Lima in November 2011, reviewed the results of the analysis conducted by the third meeting of the ATS Route Network Optimization Group (ATSRO/3, Lima, July 2011) in relation to Phases 1 and 2 of the program and particularly the lessons learned during the implementation of Phase 2 in order to incorporate that experience in Phase 3 of the program.

1.21 Phase 3 of the program aims at the implementation of Version 2 of the ATS Route Network and has taken into account the difficulties encountered during the previous implementation processes.

1.22 This implementation program was initially analyzed at the SAMIG/9 meeting and subsequently at the ATSRO/4 meeting, which introduced a number of modifications to meet the requirements of States and airspace users.

1.23 The ATS route network optimization program contains the lessons learned during the implementation of Phases 1 and 2 of the ATSRO Program, the general planning principles on which the program is based, and the guidelines for the implementation of the concept of flexible use airspace. It also specifies the tools and equipment used during the analysis of the SAM ATS route network, analyzes the available statistical data on air traffic movement and fleet capacity, makes a diagnosis of the SAM ATS Route Network, provides a consistent set of proposals to improve the structure of the regional route network, proposes guidelines for the application of techniques for continuous descent operations (CDO), and finally proposes interface guidance between the SAM route network and the route network of adjacent Regions.

1.24 At the time of preparing this safety plan, the program continued to be coordinated by the ICAO Regional Office and analyzed by States and airspace users. While progress has been satisfactory, it still needs to define some of the routes that will be implemented, especially in certain parts of the airspace. Nevertheless, progress has been significant and the safety analysis was performed without any problem.

1.25 Therefore, this SP should be considered a living document that will incorporate, and will be enhanced as necessary with, additional information that will come from SAMIG meetings and particularly the results of the fast-time simulation (FTS) to be conducted in 2013. This simulation can provide additional arguments and evidence to the SP and will be key to demonstrate the acceptably safe performance of the route system in the pre-operational phase.

Chapter 2 Description of the Air Traffic System in the SAM Region

General Situation of the ATS Route System in the SAM region

2.1 The ATS route network is part of the structure and organization of airspace where the recommended facilities, services and air navigation procedures are provided in order to achieve a safe, orderly and efficient flow of air operations. SAM airspace is divided into upper and lower airspace, the limit being set at FL 250. This study applies to the ATS route network in the upper airspace.

2.2 In general, the development of the SAM route network was always based on the specific requirements of isolated routes, without a comprehensive analysis that took into account broader operational requirements and sought a functional relationship between the various elements of the airspace structure, such as ATS routes, control sectors, control areas, TMAs, and others.

2.3 Based on the work done by States and the SAM Implementation Group (SAMIG), with the support of Regional Project RLA/06/901, improvements were introduced to the ATS route network in phases and in route network versions. Phase 2 involved the introduction of Version 01 in March 2011.

2.4 During the implementation of Version 01, the SAMIG identified some difficulties that were taken into account when analyzing Version 02 of the ATS route network and resulted in a series of improvements to Phase 3, Version 02 of the ATSRO program action plan.

2.5 The SAMIG also developed a set of general and planning principles as described below, which were considered for the analysis of Phase 3 Version 02 of the ATS route network. These principles should also be taken into account by airspace planners of the States:

a) request States to participate actively in the international working groups established to plan or review the regional route network in order to develop a harmonized and consistent route network,

b) identify the main regional air traffic flows as well as those that extend beyond the Region and have a direct impact on the regional route network, in order to find gaps in the route network and in the organization of ATC sectors,

c) establish and review the ATS route network and the supporting sectorization to accommodate the main air traffic flows, reducing the complexity of the airspace structure and balancing ATC workload,

d) integrate the required routes to provide access to the regional routes network to/from airports not served by it. It is also necessary to integrate the non-permanent routes required to ease air traffic load on the main ATS routes and to ensure optimum flight profiles,

e) ensure connectivity between the ATS route network to/from TMA airspace,

f) establish a phased implementation to ensure consistency with the implementation by States,

2.6 The SAMIG/8 meeting established planning principles and identified the challenges planners face when designing airspace. Among these challenges, in addition to the expected growth in air traffic, the highlights were:

a) how to meet ATS demands to ensure that sector capacity is maintained at current levels and that delays due to restrictions in terminal airspace are minimized;
b) safety requirements;
c) environmental protection requirements; and
d) the various demands and requirements of airspace users, taking into account the new and diverse user development plans.

2.7 All these guidelines are intended to avoid the tendency to create terminal areas (TMA) independent of the route network. That is to say, planners should consider, together with PANS/OPS procedure designers, the ATC operational requirements, taking into account environmental protection and the associated costs and benefits.

2.8 The systematic application of flexible use of airspace (FUA), the collaborative decision making (CDM) concept and, insofar as possible, the use of techniques for continuous descent operations (CDO) have also been identified as essential in the optimization program.

2.9 Unidirectional routes have been partially used in the Region, since they were considered to be a limiting factor and, except for exceptional cases, there are no parallel route structures with sufficient spacing between route centre lines to facilitate traffic management and consequently, increase airspace capacity.

2.10 Regarding longitudinal separation, the Region applies 10 minutes between aircraft flying at the same cruising level in FIR boundaries, while for vertical separation RVSM is used between flight levels 290 and 410, inclusive.

2.11 Within the airspace under study, air traffic services are provided that include en-route air traffic control services, flight information services, and alert services. In the upper airspace, ground-air communications are available in all the airspace through the use of VHF, and in recent years the availability of surveillance systems has increased significantly in the SAM Region.

2.12 Curently, the route network is based on the application of RNAV 5 routes, but conventional routes are still maintained in order to allow aircraft operations that cannot yet meet this navigation specification. A high percentage of the fleet has autonomous navigation systems available to fly on any desired flight path within the coverage of station referenced navigation aids, or within the limits of autonomous aids, or a combination of both, and a large percentage of the fleet has been approved for RNAV 5. In order to comply with the RNAV 5 specification, the navigation structure maintains fixed radio aids (VOR, VOR/DME).

2.13 Regarding the aeronautical fixed service communications, the Region has a strong AMHS system support and ATS speech circuits through the REDDIG, which ensures communications between ATC units responsible for air traffic services.

2.14 An aeronautical meteorological and aeronautical information service that meets the standards set out in the relevant ICAO Annexes is also available. All the States of the region provide search and rescue services.

2.15 In case of ATS system failure, there are contingency plans that have been duly agreed and harmonized among all the States in the region. In the event of a partial or total interruption of ATS and/or related support services, these contingency plans ensure the continuation of air operations and that major international air routes remain open, contemplating the agreed safety levels.

2.16 In summary, the States in the Region have taken steps to facilitate, establish, and provide traffic services in the airspace under study, in accordance with the provisions of ICAO Annex 11.

Situation after the implemention of Phase 3, Version 02 of the ATS route network

2.17 As noted earlier, the optimization of the SAM route network is being carried out in phases in order to achieve the corresponding operational benefits as early as possible.

2.18 It is expected that the implementation of Phase 3, Version 02 of the ATS route network will favour the necessary conditions for the introduction of substantial improvements for establishing the proper spacing among routes and a significant reduction of CO2 emissions into the atmosphere by reducing the distances flown by aircraft.

2.19 The application of unidirectional routes will be an advantage for enhancing the airspace structure, leading to an increase in ATC capacity of ATC sectors. The vast majority of ATS routes will be established on a permanent basis. However, there are cases where the application of non-permanent routes, depending on the existence of temporary special use airspace (SUA) may allow the optimization of the airspace structure, either to reduce the the traffic load in the main routes or to allow optimum flight profiles.

2.20 The implementation of Phase 3, Version 02 of the ATS route network is expected to provide, *inter alia,* the following benefits:

- Maintain and / or improve safety levels
- Reduce CO2 emissions to the atmosphere
- Meet the needs of users (civil, military, general aviation, UAS, etc.)
- Operate in direct routes, or as close as possible, between the point of origin/destination of flights
- Reduce the complexity of the airspace structure
- Improve airspace sectorization
- Reduce controller workload
- Improve deficiencies in civil/military cooperation and coordination
- Allow the use of the flexible use of airspace (FUA) concept
- Allow the integration of the regional network with State domestic routes
- Eliminate or reduce bottlenecks where possible
- Avoid ATS redundant routes
- Apply CDM
- Apply CDO wherever possible

2.21 Once Phase 3 Version 02 of the ATS Route Network is implemented, and pursuant to the Performance-based Air Navigation Implementation Regional Plan for SAM (SAM ANIP PB), the Region will be ready to continue with plans to optimize the airspace in the short and medium term.

Chapter 3. General Aspects of Safety Management

3.1 According to the universally accepted definition of the International Civil Aviation Organization (ICAO), safety in civil aviation is the state in which the risk of personal injury or property damage is reduced and maintained at or below an acceptable level, by means of a continuous process of hazard identification and risk management.

3.2 Safety has always been a matter to be considered in all aviation activities. This activity should, at least:

a) Identify safety hazards;

b) Ensure the implementation of the corrective measures necessary to maintain an acceptable level of safety;

c) Provide permanent oversight and regular assessment of safety level achieved; and

d) Continuously improve overall performance of the safety management system.

Risk analysis methodology

3.3 The safety assessment process was carried out in orderly stages or steps as detailed below, following the provisions contained in Doc 9859 SMM:

a) Full description of the system being assessed and of the environment in which the system must operate;
b) Identification of hazards and consequences;
c) Risk assessment, expressed in terms of probability;
d) Risk assessment, expressed in terms of severity;
e) Tolerability index/risk;
f) Risk mitigation; and
g) Prepare safety plan.

Analysis of the hazard identification process

3.4 In the aeronautical activity, hazards are defined as a potential situation that may affect the acceptable level of safety. Materialization of a hazard produces consequences that affect all operational areas, such as: technical aspects, loss of separation between aircraft, flight into terrain and loss of separation between aircraft and obstacles, increased workload in the services, and others. Once the relationship between hazards and their consequences is clearly understood, the next stage can be executed, which involves operational risk management.

3.5 For purposes of safety management, the consequences of hazards are described in operational terms. Many hazards have the potential to produce the final and ultimate consequence (loss of human lives). However, describing the consequences of hazards in extreme terms makes it difficult to design mitigation strategies, except for the cancellation of the operation. In order to design mitigation strategies that address the safety issues underlying low-level and not-extreme operational consequences of the hazard, such consequences are described in operational terms, not in extreme terms (loss of life).

3.6 The hazard identification process identified only the hazards within the scope of the described system that were related to, or were a consequence of, the implementation of Phase 3, Version 02 of the ATS route network. Therefore, system boundaries are defined broad enough to cover all possible repercussions of the system, but always within the setting described above.

3.7 The safety impact of a possible loss or degradation of the analyzed system is determined by the characteristics of the operational environment in which the new scenario or system will be integrated. Therefore, the description of such environment included all factors that could have a significant effect on the safety of the SAM ATS route network.

Hazard Identification Methodology

3.8 As noted above, the methodology used was that described in the ICAO SMM (Doc 9859), which allows for the identification in a logical and sequential way of all possible hazardous situations, making it possible to determine the technical feasibility of the implementation of the ATSRO Program Phase 3 Version 02 of the ATS route network.

3.9 To document this process, a hazard identification and risk assessment (HIRA) form was used, that meets regional needs and was approved by the SAMRA/03 meeting. (See **Appendix A** to this part of the SP).

3.10 It is important to note that the process used for the identification of hazards and specific hazard components has permitted the analysis of all possible alternatives that could have an impact on the implementation of Phase 3, Version 02, going from low incidence up to the most likely scenario, foreseeing the “worst” possible conditions or contexts.

3.11 It is also important to note that the team of experts that carried out the risk analysis recorded hazards making sure they were based on credible or plausible data, according to the context and operational experience of all participants. The list of participants of the SAMRA/03 neeting/workshop appears in **Appendix B** of this part of the SP.

3.12 With the techniques applied in this workshop, it was possible to achieve a structured, multidisciplinary approach, which included the following aspects:

a) The lessons learned in previous implementation processes were taken into account, as well as the planning criteria of the ATSRO program.

b) Plenary sessions have permitted a free and extensive generation of ideas on hazards, as well as a detailed analysis of possible scenarios. This type of sessions could be carried out because there were participants with different operational and technical experience, and the work was done through guided discussions. In the SAM/RA/03 meeting/workshop, a facilitator was appointed who was familiar with teamwork techniques.

c) The experts were representatives validated by each participating State of the Region, with knowledge of the relevant areas of the ATSRO program. The range of knowledge was wide enough to ensure that all aspects of the ATSRO route system were addressed; however, it is also important to note that the group has contributed its operational experience, which facilitated the qualitative analysis.

d) Through the participation of all workshop attendees in the plenary sessions, it was possible to reach a consensus and validate each hazard and its relationship with the consequences, which was documented for the “safety library” of the Region.

Operational risk management process

3.13 At this stage of the process, the background information described in the preceding paragraphs was analyzed and compared, and using this information, the methodology was applied to determine the associated risk level. The analysis was based on two defined variables, namely probability of the occurrence of an event and severity of an event considering the worst foreseeable scenario, based on a qualitative analysis, to finally apply the operational risk matrix and determine what further action could be applied to minimize or efficiently contain operational risks that could result from the implementation of Phase 3, Version 02 of the ATS route network.

Aspects considered to determine risk probability

3.14 For this stage of the study, the matrix proposed in the last version of the SMM was applied, with some amendments resulting from the experience in previous analysis processes and that of the States at regional and global level. The matrix that was reviewed and approved by the SAM/RA/3 meeting/workshop and then used in the safety evaluation is shown below:

Matrix for determining the probability of an event

PROBABILITY MATRIX			
Probability of the event	**Qualitative definition**	**Quantitative definition**	**Equivalent annual/daily quantitative (approx..)**
1. Extremely unlikely	Almost inconceivable that the event will occur	Less than 10^{-9} per hour	One event in more than 100,000 years. Never.
2. Unlikely	Not known to have occurred. Event may be possible.	$10^{-7} – 10^{-9}$ per hour	From once every 1,000 years up to once every 100,000 years
3. Remote	Unlikely to occur during the total operational life of the system	$10^{-5} – 10^{-7}$ per hour	From once every 10 years up to once every 1,000 years
4. Occasional	It has occurred infrequently. (It occurs less than once per interval of exposure and is likely to occur again within that interval)	$10^{-3} – 10^{-5}$ per hour	From once every 40 days up to once every 10 years
5. Frequent	It has occurred frequently. (It occurs once per interval of exposure and is very likely that it will occur again within this interval)	$1 – 10^{-3}$ per hour	From once per hour up to once every 40 days

Aspects considered to determine severity

3.15 At this stage of the process, all hazards and consequences identified are analyzed in order to determine the worst plausible scenario and, based on this point of reference, identify defences to promote a scenario that is more solid and tolerant to operational errors.

3.16 In order to determine this important risk management function, use was also made of the matrix suggested in the SMM as amended based on the experience of the States at regional and global level regarding the meaning of the different severity elements of the event. The matrix used in the severity assessment is shown below:

Severity matrix for safety risks

SEVERITY MATRIX		
SEVERITY	**MEANING**	**VALUE**
Catastrophic	• Accident • Destruction of equipment • Deaths	A
Major	• Severe incident • Major damage to equipment • For the aerodrome, an event that could have caused an accident • There are no safety barriers left. • The results are uncontrolled and may lead to an accident. • Damage to the main facilities of the aerodrome. • Severe injury to the staff and/or the public. • Total loss of ATC capacity (zero ATC)	B
Moderate	• Incident • An incident related to the operation of an aircraft in which the safety of aircraft has been jeopardized, which could have led to an airprox or CFIT • Significant reduction of safety margins • Significant reduction of airspace and/or ATC capacity • Significant reduction of aircraft navigation capacity • The result can be controlled using emergency o non-standard procedures and/or emergency equipment. • Very few safety barriers. • Mild injury to staff and/or public.	C
Minor	• Significant incident indicating that an accident may have occurred if the risk had not been managed within the safety margins. • Significant reduction of safety margins, but several safety barriers remain for the prevention of accidents. • Slight reduction of airspace and/or ATC capacity • Slight reduction of aircraft navigation capacity • Inconveniences to passengers on board the aircraft, the staff or the public. • Significant increase in the workload of ATCO and/or the crew	D
Insignificant	• Slight increase in the workload of ATCO and/or the crew • Safety barriers come into play to prevent the event from becoming an incident or an important accident.	E

Note: The States, when performing the risk analysis, may extend the matrix according to their needs.

Classification of safety risk

3.17 According to the risk assessment process, once the severity assessment of all consequences of the identified hazards has been completed, along with classification of results, they were recorded in the HIRA Form.

3.18 In the fifth stage of the process and after the risk assessment in terms of probability and severity, the safety risk classification matrix shown below was used. This matrix gives more flexibility to the analysis for establishing the risk index or tolerability. Also, as in the previous matrices, this matrix was assessed and approved for use by the SAM/RA/03 meeting/workshop.

Matrix for safety risk classification

TOLERABILITY ASSESSMENT MATRIX					
RISK CLASSIFICATION					
PROBABILITY	SEVERITY				
	Catastrophic A	Major B	Moderate C	Minor D	Insignificant E
Frequent (5)	5A	5B	5C	5D	5E
Occasional (4)	4A	4B	4C	4D	4E
Remote (3)	3A	3B	3C	3D	3E
Unlikely (2)	2A	2B	2C	2D	2E
Extremely Unlikely (1)	1A	1B	1C	1D	1E

Criteria for operational risk mitigation

3.19 Concerning the concept of tolerable risk, it was acknowledged that there is an area between acceptable and unacceptable risk in which the decision regarding acceptability is not clear and decisive. These last risks are part of a category in which risk may be tolerable if reduced to a level as low as reasonably practicable (ALARP).

3.20 In the case of risks classified in the intermediate area (low, medium, high risk) for operational risk mitigation (as shown in the picture below), they are marked as acceptable based on risk mitigation. Risks included in this category were not thoughtlessly classified as tolerable. Each case has been individually examined as stated in the preceding paragraphs, taking into account the costs and benefits to be derived from the implementation of the proposed changes.

Table of criteria for operational risk mitigation

Risk index	Tolerability	Suggested criteria
5A 5B 4A	**EXTREME RISK**	Immediately stop operations or process. Unacceptable under the current circumstances. No operation is allowed until enough measures are implemented to reduce risk to an acceptable level. It requires CEO approval
5C 4B 3A	**HIGH RISK**	Attention. Ensure that the risk analysis has been successfully completed and that preventive controls have been implemented. It requires managerial approval before starting the operation or continuing the process
1A 2A 2B 3B 3C 4C 4D 5D 5E	**MEDIUM RISK**	It is necessary to implement mitigating measures or review the risk. It requires approval at the SMS unit level
1B 1C 2C 2D 3D 3E 4E	**LOW RISK**	Risk mitigation or review is optional

1D 1E 2E	**ACCEPTABLE RISK**	It is acceptable the way it is. It does not require mitigating actions

APPENDIX A

<table>
<tr><th colspan="3">HAZARD IDENTIFICATION AND RISK ASSESSMENT FORM (HIRA)</th></tr>
<tr><td colspan="2">1. Hazard record ID:</td><td>2. Identification date:</td></tr>
<tr><td colspan="3">3. Hazard description:</td></tr>
<tr><td colspan="3">4. Causes of hazard:</td></tr>
<tr><td colspan="3">5. Consequence of hazard:</td></tr>
<tr><td colspan="3">6. Existing barriers:</td></tr>
<tr><td>7. Probability:</td><td>8. Severity:</td><td>9. Risk Index:</td></tr>
<tr><td colspan="3">10. Mitigation/action proposed:</td></tr>
<tr><td>11. Resulting probability after mitigation:</td><td>12. Resulting severity after mitigation:</td><td>13. Resulting risk Index:</td></tr>
<tr><td colspan="2">14. Entity responsible for applying the proposed mitigation/action:</td><td>15. Date of implementation of the proposed mitigation/ action:</td></tr>
</table>

Explanation of HIRA Form

1. Hazard record ID: Unique code identifying the hazard identified.
2. Date of identification: It indicates the date in which the identified hazard or the occurrence of the event is reported, as applicable.
3. Hazard description: Describe briefly and clearly the identified hazard.
4. Causes: Describe briefly and clearly the causes of hazard.
5. Consequence of hazard: Describe briefly and clearly the possible consequences of the hazard.
   NOTE: a single hazard may generate more than one consequence. Several forms should be used whenever other significant consequences are required to be recorded.
6. Existing barriers: Mitigation currently implemented (if any). If known, it should include the defence(s) currently implemented.
7. Hazard probability: Enter, in coded format and in clear text, the probability index that would be achieved with the existent barriers.
8. Severity: Enter, in coded format and in clear text, the severity index that would be achieved with the existent barriers.
9. Risk level: Enter the risk level estimated with the existent barriers.
10. Proposed mitigation/action: Enter the action(s) or mitigation identified to control this hazard.
11. Resulting hazard probability after mitigation: Enter the resulting probability after the implementation of the actions suggested.
12. Resulting severity after mitigation: Enter resulting severity after the implementation of the proposed action.
13. Resulting risk Index: Enter resulting index after the implementation of the proposed action.

14. Identify the entity or unit responsible for implementing the proposed mitigation or action.
15. Date of implementation of the proposed mitigation or action(s).

APPENDIX B

LIST OF EXPERTS PARTICIPATING AT THE SAMRA/03 MEETING/WORKSHOP

BOLIVIA

Miguel Ángel Castillo Ochoa

BRAZIL

Enidio Arestides dos Santos

PANAMA

Ricardo Deville

PERU

Fredy Núñez Munárriz
José Víctor Mondragón Hernández
Walter Warthon Ortiz
Renzo Gallegos Begazo
Manuel Fernando Cabredo Castro

URUGUAY

Alberto Raúl Fernández Moyano

VENEZUELA

Carlos Alberto Castañeda Parra

ICAO / ICAO

Celso Figueiredo
Roberto Arca Jaurena
Jorge Fernández Demarco

Chapter 4. Hazard Identification

Generic Hazard Identification

4.1 The work of the multidisciplinary team that attended the SAMRA/3 meeting/workshop served to identify hazards and link them to their consequences, to eventually determine their level of operational risk in order to validate the implementation.

4.2 Taking into consideration the foregoing, experts, in the first place, identified as a generic hazard the implementation of ATS route network Phase 3, Version 2.

Identification of Specific Hazard Components

4.2.1 After establishing the generic hazard, the specific components of hazard that may affect the operation in the new ATS route network were identified.

4.3 In the phase of identification of the hazard components, all possible sources of system failure were studied including air traffic services, aeronautical information, communications, navigation and oversight, aeronautical meteorology and aircraft operators and their navigation and communication systems. Among these sources, the following were considered:

a) equipment (design, logical and physical support);
b) operational environment;
c) regulatory factors, including their application, equipment certification, oversight, etc.;
d) human operators;
e) person-machine interphase;
f) operational practices and procedures;
g) barriers, including factors such as supply of adequate detection and warning systems, error tolerance of the equipment, and capacity of equipment to recover following errors and failures; and
h) organizational factors, such as resource allocation, operational pressures , etc.

4.4 It should be noted that, in this process, hazards within the scope of the system described were identified. Therefore, system limitations comprised all possible repercussions.

4.5 The materialization of a hazard has consequences that affect the operational environment, such as technical aspects, loss of separation, increased workload in services and others. For natural hazards defined as severe turbulence or volcanic ash, the consequences of damage to aircraft components will be immediate. Another aspect to be considered is the degradation of communication systems, thus affecting the integrity of the ATM system.

4.6 From the analysis conducted at the SAMRA/3 meeting/workshop, the following hazards and their respective consequences were identified:

Hazard Description	Consequences
1. Outdated ATS route database not update	Increased flight crew or air traffic control workload
2. Adverse weather conditions	Significant reduction of airspace and/or ATC capacity
3. Special use airspace	Serious incident
4. Failure to apply SAM ATS route network planning criteria	A significant reduction of safety margins
5. Lack of training of ATCOs/pilots in the use of ATS route network	A significant reduction of safety margins
6. Aircraft not capable of maintaining RNAV5 route	A significant reduction of safety margins

Once hazards have been identified, risks are assessed and mitigated as shown in the next Chapter.

Chapter 5 Operational Risk Management Process for the Implementation of the ATS (ATSRO) route network, Phase 3, Version 2

5.1 In this phase of the process, available background information and that defined by experts attending the SAMRA/03 meeting/workshop was analyzed and compared, and based on this validated information, the methodology to determine the level of operational risk for each hazard identified by the group of experts was applied.

5.2 This analysis phase was executed based on two variables: the probability of occurrence of an event and the worst foreseeable scenario defined as the severity of an event, based on a qualitative analysis, to finally apply the operational risk matrices and determine subsequent actions that could be applied and agreed by the panel of experts to efficiently minimize or restrain operational risks in the optimization of the ATS route network.

5.3 Each of the identified hazards is herein explained and **Appendix A** to this part of the Safety Plan includes the HIRA form related to the 6 hazards.

HAZARD 1. OUTDATED ATS ROUTE DATABASE

Note: See Appendix A, FORM HID01

Hazard Description

At present, databases are essential for aircraft navigation in a performance-based navigation (PBN) environment.

But, although a navigation database is not part of the functions required for RNAV 5, the lack of such database requires manual entry of WPTs, which significantly increases the possibility of WPT errors. Route charts should support the verification of serious errors by the flight crew, publishing information on the fixes for the WPTs selected on RNAV 5 routes.

Notwithstanding the above, most of the fleet that operates in the Region has an on-board navigation database. Therefore, these databases must be current and suited for the region where the foreseen operations will be conducted and must include navigation aids, waypoints, and the relevant coded ATS routes for departures, arrivals, and alternate aerodromes.

Navigation databases must be current throughout the flight. If the AIRAC cycle must change during the flight, operators and pilots should establish procedures to ensure the accuracy of navigation data and make sure that navigation facilities used are capable of defining the routes and procedures for the flight.

The navigation database must be obtained from a provider that meets the requirements set forth in Document DO 200 A from RTCA/ED 76 of EUROCAE and should be compatible with the function of the equipment foreseen in Annex 6. The provider of the navigation database must be advised of discrepancies invalidating a route, and the affected routes must be prohibited through a notice from the operator to its flight crew.

Outdated databases can have immediate consequences and affect the air navigation system.

Causes of the Hazard

When assessing the possible or potential causes of the hazard, the following were identified:

1. Failure to publish the AIRAC dates agreed for the implementation of Phase 3, Version 02.
2. Lack of harmonization of geographical coordinates of the points of transfer between adjacent FIRs.
3. Provision to the AIS of information and data lacking the integrity or accuracy required, beyond the publishing deadlines.
4. Failure to meet coordination agreements or processes between States and database providers.
5. Failure to meet coordination agreements or processes between database providers and aircraft operators.
6. Lack of specific regulations for handling navigation databases.

Consequences of the Hazard

The immediate consequence of this hazard would be an increased workload for flight crews or air traffic control.

Existing Barriers

Existing barriers for mitigating the probability and/or severity of the consequences of hazard are listed below, assuming these have been already implemented by all the administrations and organizations involved:

- Annex 4 or the corresponding national regulations
- Annex 15 or the corresponding national regulations
- Oversight system available practically throughout the entire analyzed Region
- Contingency operational procedures
- ATS messaging system
- AIRAC system for AIS publication
- SLAs (service level agreements–State/internal or external navigation database provider)
- Letters of operational agreement (LOAs) between ATC units
- WGS 84 implemented

Estimation of Probability

With the existing barriers, the probability of an event of this nature occurring if all aircraft flying over the airspace in question do not have updated databases would be one for every

exposure interval and would quite probably occur again within this interval, being qualified as: **FREQUENT 5.**

Estimation of Severity

A significant increase of ATCO and/or crew workload is qualified as **MINOR D** severity.

Risk Index

Applying the Risk Tolerability Matrix used in this study, a risk index is obtained: **MEDIUM RISK 5D**.

Therefore, it is necessary to implement mitigating measures and to review the risk to reduce its impact.

Mitigation Proposed to Reduce the Risk Index

In order to control and mitigate the safety risks identified, several mitigations aimed at reinforcing defences and reducing safety risks at a level "as low as reasonably practicable" (ALARP) are proposed. Further measures related to the aforementioned causes of the hazard, include:

(**Cause 1**)

- Ensure compliance with AIRAC cycles.

(**Cause 2**)

- Apply the WGS84.
- Ensure coordination between mapping units of adjacent States.

(**Cause 3**)

- Establish and meet the schedule for delivering information and data to the AIS with the integrity and accuracy required for the publication of ATS route network Phase 3, Version 2.
- Apply a Quality Management System (QMS) pursuant to Annex 15.

(**Cause 4**) (**Cause 5**)

- Improve and ensure the establishment of agreements and processes with database providers.

(Cause 6)

- Publish and comply with regulations established by the State related to navigation database handling.

Resulting Probability after Applying Mitigating Measures

After implementing further measures, the probability index is: **4 OCCASIONAL.**

Resulting Severity after Applying Mitigating Measures

The resulting severity is: **INSIGNIFICANT E.**

Resulting Risk Index:

The resulting index after applying mitigating measures is: **LOW RISK 4E**, risk mitigation is acceptable and its revision is optional.

Entity or entities responsible for implementing further measures:

- SAM States.
- ANS providers (ATS/AIS/MET).

HAZARD 2. ADVERSE WEATHER CONDITIONS

Note: See Appendix A, FORM HID02

Hazard Description

The effects related to adverse weather conditions are frequent and affect air navigation worldwide. In adverse weather conditions, such as hurricanes, storms, (CB/TCU), volcanic eruptions, severe turbulence, etc., aircraft, in coordination with air traffic services, seek to avoid those airspaces in order to preserve aircraft safety. Therefore, the ATS route network could be significantly affected; however, it is recognized that adverse weather conditions are independent from the implementation of the ATS route network Phase 3, Version 02.

Although aircraft carry equipment that help minimize weather effects, such as weather radars, deicing equipment, and others, the need to reach and operate in airspaces not affected by adverse weather conditions increases the workload of pilots and controllers and therefore, significantly reduces airspace and ATC capacity. Sometimes, it could also mean the reduction in aircraft navigation capacity depending on the circumstances in which the event occurs.

Causes of the Hazard

The causes identified by the Working Group are referred to:

1. Hurricanes
2. Volcanic eruptions
3. Storms (CB/TCU)
4. Severe Turbulence

Consequences of the Hazard

The immediate consequence of this hazard would be a significant reduction in airspace and/or ATC capacity.

Existing Barriers

Existing barriers to mitigate the probability and/or the severity of the consequences of hazard are listed below, assuming these have already been implemented by all administrations and organizations concerned:

- Annex 3 or the corresponding national regulations
- Weather radars

- On-board equipment to mitigate adverse weather conditions
- MET reports
- MET forecasts
- PIREP
- NOTAMs/ASHTAMs
- Contingency plans
- ATS/MET letters of agreement
- ATC letters of operational agreement
- ATC Procedural Handbook and Operators' Operating Manuals
- Doc 4444 Chapter 15
- Guidance on volcanic ash contingencies
- Guidance on the implementation of ATFM and the CDM concept of the SAM Region

Estimation of Probability

With the existing barriers, the probability of a significant reduction in airspace and/or ATC capacity is occasional and could occur frequently but less than one per interval of exposure to weather conditions and it is quite likely to occur again within that interval, its classification being: **OCCASIONAL 4.**

Estimation of Severity

The significant reduction in airspace and/or ATC capacity is considered to be high-risk severity, as is qualified as **MAJOR B.**

Risk Index

Applying the Risk Tolerability Matrix used in this study, the resulting risk index is: **HIGH RISK 4B.**

Therefore, the hazard must be immediately addressed, making sure preventive controls are implemented or the risk checked in order to reduce its impact.

Proposed Mitigation Measures to Reduce the Risk Index

In order to control and mitigate the identified safety risks, several mitigation measures aimed at reinforcing defences and reducing safety risks to a level "as low as reasonably practicable" (ALARP) are proposed. Further measures related to the aforementioned causes of the hazard include:

(Causes 1, 2, 3 and 4)

- Establish a MET QMS system in accordance with Annex 3.
- Apply ATFM and CDM procedures.

(Causes 1, 2 and 3)

- Improve training in MET aspects for flight crews, ATCOs, operational personnel, and flight dispatchers.
- Apply ATFM measures and the CDM concept.

(Causes 1 and 2)

- Apply contingency plans.

(Causes 1, 2 and 3)

- Apply ATC letters of operational agreement.

(Cause 2)

- Effective exchange of ASHTAM information.
  Incorporate volcanic ash management procedures in ATC letters of operational agreement.
- Incorporate volcanic ash procedures in the operators' operating manuals.

(Cause 4)

- Apply procedures in case of severe turbulence.
- Improve training in MET aspects for flight crews, ATCOs, operational personnel, and flight dispatchers.

Resulting Probability after Applying Mitigating Measures

Considering the new defences introduced, flight safety risks in adverse weather conditions continue to be classified as: **OCCASIONAL 4**.

Resulting Severity after Applying Mitigating Measures

The resulting severity is: **MINOR D.**

Resulting Risk Index:

The resulting index after applying mitigating measures is: **MEDIUM RISK 4D**, which would require approval by the organization's SMS unit.

Entity or entities responsible for implementing further measures:

- SAM States

- ANS (ATS/ MET) providers
- Aircraft operators

HAZARD 3. SPECIAL USE AIRSPACE

Note: See Appendix A, FORM HID03

Hazard Description

The demand for air transportation has multiplied in recent years; therefore, airspace and airport capacity must increase to address this demand.

Within the ATM operational concept, airspace management (ASM) is the process whereby airspace utilization options are selected and applied to meet user needs.

In the South American Region, there are different and sometimes conflicting interests concerning the use of airspace, reason why ASM is such a complex exercise. Moreover, there are activities, whether military or civil, for which a certain volume of airspace needs to be reserved for their exclusive or special use during certain periods of time, due to their flight profile characteristics, the importance of their operations, risks related to operations to be conducted in such airspace, and the need to have an effective and safe separation between them and other types of air activities.

Airspace management must be based on certain principles and strategies, such as application of dynamic flight paths. When conditions require segregation based on different types of operations and/or aircraft, the extent, shape and time schedules of this airspace must be identified in order to minimize the impact on operations, etc.

Therefore, the lack or incorrect definition of special use airspaces and the lack of adequate regulations may lead to a potential risk for air operations.

Causes of the Hazard

The identified causes of the hazard are referred to:

1. Lack of an ATC/civil/military coordination committee or an appropriate organic unit for coordination purposes.
2. Lack of boundaries or errors in the designation of special use areas.
3. Inadequate coordination for airspace restructuring.
4. Complexity of the airspace structure (congestion and number of routes).
5. Lack of operational agreements for the use of procedures in certain airspaces
6. Failure to publish special use areas.

7. Lack of ATC/civil/military coordination for the use of special use airspaces.
8. Failure to meet operational agreements.
9. Failure of communications between the units involved.
10. Inadequate video charts.

Consequences of the Hazard

The potential immediate consequence of this hazard would be a severe incident.

Existing Barriers

The barriers that exist to mitigate the probability and/or the severity of the consequences of the hazard are listed below, assuming these have already been implemented by all the administrations and organizations concerned:

- Annex 11 or the corresponding national regulations.
- Circular 330 AN189 on civil/military cooperation for air traffic management.
- Regional guidelines on the application of the flexible use of airspace (FUA) concept.
- Doc 4444 (PANS/ATM).
- CARSAM/3 recommendations (1999).
- GREPECAS recommendations
- ATSRO program.
- Letters of operational agreement.
- Integrated aeronautical information documentation
- ATC procedural handbooks.
- International agreements.
- Communication systems.
- Surveillance systems.

Estimation of the Probability

With the existing barriers, events affecting civil aviation or civil aircraft that have entered into special use airspaces have occurred infrequently, less than one per exposure interval, and are likely to occur again within this interval. The probability of occurrence of a serious event is **OCCASIONAL 4.**

Estimation of the Severity

A serious incident is classified with a severity: **MAJOR B.**

Risk Index

Applying the Risk Tolerability Matrix used in this safety plan, the resulting risk index is: **HIGH RISK 4B.**

Therefore, it is necessary to make sure that the risk analysis has been satisfactorily completed and additional preventive controls have been implemented.

Proposed Mitigation Measures to Reduce the Risk Index

In order to control and mitigate the identified safety risks, several mitigation measures aimed at reinforcing defences and reducing safety risks at a level “as low as reasonably practicable” (ALARP) are proposed. Further measures related to the aforementioned causes of the hazard, include:

(Cause 1, Cause 7 and Cause 8)

- Effectively implement an ATC/civil/military coordination committee and/or body

(Cause 2, Cause 6)

- Define and publish special use airspaces in the AIP.

(Cause 3, Cause 4)

- Consider airspace complexity in ATC/civil/military coordination.

(Cause 5)

- Prepare and apply complete and structured ATC/civil/military letters of operational agreement.

(Cause 9)

- Establish redundant communication systems where applicable.
- Establish contingency measures in the event of communication failure between the units involved, where applicable.

(Cause 10)

- Update video charts of the surveillance system where applicable.

Resulting Probability after Applying Mitigating Measures

After implementing further measures, the probability index is: **REMOTE 3.**

Severity Resulting after Applying Mitigating Measures

The resulting severity is: **MINOR D.**

Resulting Risk Index:

The resulting index after applying mitigation measures is: **LOW RISK 3D**, risk mitigation is acceptable and its revision is optional.

Entity or entities responsible for implementing further measures:

- SAM States.
- ANS [(ATS/AIS/MET)] providers.

- Military authorities.
- Aircraft operators.

HAZARD 4. FAILURE TO APPLY THE SAM ATS ROUTE NETWORK PLANNING CRITERIA

Note: See Appendix A, FORM HID04

Hazard Description

The SAM airspace optimization program comprises two essential elements, the optimization of the SAM ATS route network and the implementation of performance-based navigation (PBN) according to GREPECAS directions contained in the PBN Roadmap. To facilitate project management, both objectives were included in the SAM ATS Route Network Optimization Program (SAM ATSRO Program).

The ATSRO Program aims at achieving significant improvements in airspace organization and management, using as a reference the Global Air Navigation Plan (GANP) and airspace management (AOM), which offer the necessary guidelines to plan and implement an optimal airspace infrastructure.

It was agreed that the ATSRO Program would be conducted in phases, in order to reach operational benefits as soon as possible and to obtain the necessary experience in each of these phases to facilitate program execution.

In order to execute the program, the SAM Region has identified a set of planning criteria for the ATS route network and has requested the States to follow these planning criteria for a safe and efficient implementation of the ATS route network Phase 3, Version 02.

Failure to apply regional criteria, for example, not ensuring the connectivity of the route network with the TMAs, or failure to apply the established requirements and/or criteria, or failure to analyze sectorization at national level, *inter alia*, may reduce or jeopardize airspace safety.

Causes of the Hazard

The identified causes of the hazard are referred to:

1. Failure to ensure connectivity between the route network and the TMAs.
2. Failure to apply the requirements and/or criteria established in Doc 8168 concerning the establishment of RNAV-5 routes, arrival, approach, and take-off procedures.
3. Lack of a detailed analysis of airspace sectorization.
4. Lack of the proper integration between the domestic route network and the regional network.

5. Failure to review the ATS route network structure with the affected TMAs.
6. Lack of participation and/or continuity of States and organizations in regional implementation groups.
7. Lack of statistics on the aircraft and fleet movements, thus preventing good planning.
8. Insufficient number of ATCOs available.

Consequences of the Hazard

The immediate consequence of this hazard would be a significant reduction in safety margins.

Existing Barriers

The barriers that exist to mitigate the probability and/or the severity of the consequences of the hazard are listed below, assuming these have already been implemented by all the administrations and organizations concerned:

- ATSRO Program (planning criteria developed by the SAMIG).
- Doc 8168 PANS OPS.
- Annex 11 or the corresponding national regulations.
- Doc 9426, ATS Planning Manual.
- Invitations to participate in Project RLA/06/901 and in implementation activities of the regular program and of the project.
- Conclusions and decisions of SAMIG/ATSRO meetings.

Estimation of the Probability

With the existing barriers, the probability of a significant reduction in safety margins due to failure of SAM States to apply the planning criteria of the ATS route network implementation program, Phase 3, Version 02 would be less than one event per exposure interval, and quite likely to occur again within this interval, its classification being: **OCCASIONAL 4.**

Estimation of the Severity

A significant reduction in safety margins is qualified with a severity index: **MODERATE C.**

Risk Index

Applying the Risk Tolerability Matrix used in this study, the resulting risk index is **MEDIUM RISK 4C.**

Therefore, it is necessary to implement additional mitigating measure or review the risk in order to reduce its impact.

Proposed Mitigation Measures to Reduce the Risk Index

In order to control and mitigate the identified safety risks, several mitigation measures aimed at reinforcing defences and reducing safety risks to a level "as low as reasonably practicable" (ALARP) are proposed. Further measures related to the abovementioned causes of the hazard include:

(Cause 1)

- Ensure connectivity between the route network and TMAs through an optimum planning of airspace structure.

(Cause 2)

- Meet the requirements and/or criteria established in Doc 8168 for en-route, TMA, approach and take-off operations.

(Cause 3- Cause 4 -Cause 5 and Cause 6)

- Analyze the airspace sectorization when planning the implementation of Phase 3, Version 02 and verify post-implementation performance.
- Analyze and plan the integration of the domestic route network with the regional network.
- Review the ATS route network structure with the incorporation of the main TMAs of the State.
- Encourage the on-going participation of States and organizations in regional implementation groups.

(Cause 7)

- Develop statistics on aircraft and fleet movement and send that data to the Regional Office in accordance with SAMIG conclusions and decisions.
- Apply and execute the ATSRO action plan.
- Incorporate into the ATSRO program the need for medium-term aircraft movement forecasts for planning purposes.

(Cause 8)

- Have a sufficient number of ATCOs.

Resulting Probability after Applying Mitigating Measures

After implanting further measures, the probability index is: **REMOTE 3.**

Resulting Severity after Applying Mitigating Measures

The resulting severity is: **INSIGNIFICANT E.**

Resulting Risk Index:

The resulting index after applying mitigating measures is: **LOW RISK 3E**, risk mitigation is acceptable and its revision is optional.

Entity or entities responsible for implementing further measures:

- SAM States.
- ANS (ATS) providers.
- SAMIG.

HAZARD 5. LACK OF TRAINING OF ATCOs/PILOTS AND FLIGHT DISPATCHERS IN THE USE OF THE ATS ROUTE NETWORK

Note: see Appendix A, FORM HID05

Description of the Hazard

The participation of safety experts, air traffic controllers, as well as of the pilots and flight dispatchers involved in the ATSRO program since the beginning will permit a better planning of training, with the introduction of two different phases: validation of simulation scenarios and training of controllers and pilots based on validated procedures.

Training provided in advance of the effective date of the new route network and its associated procedures will reduce the impact on air traffic due to the introduction of Phase 3, Version 02 of the ATS route network, especially in those areas where new routes, parallel routes based on RNAV 5, and possibly changes in coordination procedures between adjacent ATC units will be applied. Although the proposed changes may not be significant, it is absolutely necessary to train the personnel on the proposed new routes and procedures and to make them deeply aware of what the implementation entails.

Failure to meet the publication dates, as well as the lack of resources and prioritization of training for ATCOs, pilots, and flight dispatchers prior to implementation could result in a significant impact and a reduction of safety margins.

Also, upon analyzing the ATSRO program, it was noted that its action plan did not define a task on personnel training prior to the effective implementation of Phase 3, Version 02. Therefore, it would be necessary to include that task in the action plan, and also in the national action plans of the States.

Causes of the Hazard

The identified causes of the hazard are referred to:

1. Failure to meet the publication dates.
2. Lack of a plan and failure to provide training.
3. Lack of resources (financial, personnel, material, technological, etc.) and their allocation for training as a matter of priority.

Consequences of the Hazard

The immediate consequence of this hazard could be a significant reduction of safety margins.

Existing Barriers

The barriers that exist to mitigate the probability and/or severity of the consequences of the hazard are listed below, assuming that they have already been implemented by all administrations and organizations concerned:

- Annex 1 or the corresponding national regulations.
- Integrated aeronautical information documentation.
- Training programs.
- Resources and their allocation for training as a matter of priority (financial, personnel, material, technological, etc.).
- Surveillance and communications system.
- ATSRO program.
- Regional guidelines on training.
- Meetings of the directors of civil aviation training centres (CATCs) to address training issues.

Estimation of the Probability

With the existing barriers, the probability that the lack of training of ATCOs/pilots and aircraft dispatchers in the use of the ATS route network will result in a significant reduction in safety margins is less than one per exposure interval and quite likely to occur again within that interval, its classification being: **OCCASIONAL 4.**

Estimation of the Severity

The lack of training of ATCOs/pilots and aircraft dispatchers in the use of the ATS route network is classified with a severity: **MODERATE C.**

Risk Index

Applying the Risk Tolerability Matrix used in this study, the resulting risk index is: **MEDIUM RISK 4C.**

Therefore, it is necessary to implement additional mitigating measures or review the risk in order to reduce its impact.

Proposed Mitigation to Reduce the Risk Index

In order to control and mitigate the identified safety risks, several mitigation measures aimed at reinforcing defences and reducing safety risks to a level "as low as reasonably practicable" (ALARP) are proposed. Further measures related to the aforementioned causes of the hazard include:

(Cause 1)

- Meet the publication dates in accordance with the ATSRO action plan.

(Cause 2)

- Incorporate the training activity in the national action plans and in the regional action plan for the implementation of Phase 3, Version 02.
- Develop and implement a theoretical and practical (simulation) training program (simulación) on a date suitable for the implementation of Phase 3, Version 02.
- Analyse regional implementation programs at CATC meetings and plan training based on those programs.

(Cause 3)

- Have available the necessary resources (personnel, financial, material, technological, etc.) for timely implementation of the training plan, and assign priority to training according to operational requirements.

Resulting Probability After Applying Mitigating Measures

After implementing further measures, the probability index is: **REMOTE 3.**

Resulting Severity After Applying Mitigating Measures

The resulting severity is: **INSIGNIFICANT E.**

Resulting Risk Index:

The resulting index after applying mitigating measures is: **LOW RISK 3E**, risk mitigation is acceptable and its revision is optional.

Entity or entities responsible for implementing further measures:

- SAM States.
- ANS providers (ATS/AIS).
- SAMIG.
- CATCs.
- Aircraft operators.

•

HAZARD 6. INABILITY OF THE AIRCRAFT TO MAINTAIN THE RNAV 5 ROUTE

Note: see Appendix A, FORM HID06

Description of the Hazard

The inability of the aircraft to maintain the approved RNAV 5 route may be due to different causes, for example, aircraft without RNAV approval, in-flight loss of on-board RNAV capacity, lack of ground-based navaid or GNSS coverage, including events caused by weather conditions, etc.

Also, as noted when analysing Hazard 1, outdated on-board databases could also have serious consequences on navigation.

Any of these alternatives could cause the aircraft to be unable to maintain the RNAV route approved by the ATC, which could result in a reduction of the safety margins.

Causes of the Hazard

1. Failure of the GNSS.
2. Loss of RNAV 5 capacity of the aircraft due to failure of on-board navigation systems d.
3. Loss of RNAV 5 capacity of the aircraft due to failure of ground navigation systems.
4. Weather contingencies.
5. Outdated on-board database.
6. Aircraft without RNAV 5 approval.
7. Solar storms.

Consequences of the Hazard

The immediate consequence of this hazard would be a significant reduction of safety margins.

Existing Barriers

The barriers that exist to mitigate the probability and/or severity of the consequences of the hazard are listed below, assuming that they have already been implemented by all administrations and organizations concerned:

- Regional RNAV 5 implementation program.
- Advisory circular RNAV 5 (CA: 91-002).
- RNAV 5 approval process for aircraft and operators.
- RAIM.
- GNSS.
- ATS surveillance system.
- Ground-based navigation aids.
- MET reporting systems.
- Volcanic ash reporting systems.
- Safety oversight program for aircraft operators.
- DME/DME coverage study.
- RAIM and FDE availability prediction.
- New FPL format.
- Procedures to revert to conventional systems in the event of a navigation failure.
- Operators' operating manuals and ATC procedural handbooks.

Estimation of Probability

With the existing barriers, the probability that an aircraft unable to maintain the RNAV 5 route approved by the ATC could generate a significant reduction in safety margins would be less than one per exposure interval and quite likely to occur again within this interval, its classification being: **OCCASIONAL 4.**

Estimation of the Severity

A significant reduction in safety margins is classified with a severity: **MODERATE C.**

Risk Index

Applying the Risk Tolerability Matri used in this study, the resulting risk index is: **MEDIUM RISK 4C.**

Therefore, it is necessary to implement additional mitigating measures or review the risk in order to reduce its impact.

Proposed Mitigation to Reduce the Risk Index

In order to control and mitigate the identified safety risks, several mitigation measures aimed at reinforcing defences and reducing safety risks to a level "as low as reasonably practicable" (ALARP) are proposed. Further measures related to the aforementioned causes of the hazard include:

(Cause 1)

- Revert to another navigation system.

(Cause 2, Cause 3, Cause 4 and Cause 6)

- Establish and apply contingency procedures for operators and ATC.

(Cause 5)

- Ensure the updating of databases (see Hazard 1 on updated databases).

.

(Cause 7)

- Implement a regional RAIM and FDE availability prediction service.

Resulting Probability After Applying Migitating Measures

After implementing further measures, the probability index is: **OCCASIONAL 4.**

Resulting Severity After Applying Mitigating Measures:

The resulting severity is: **INSIGNIFICANT E.**

Resulting Risk Index:

The resulting index after applying the mitigating measures is: **LOW RISK 4E**, risk mitigation is acceptable and its revision is optional.

Entity or entities responsible for implementing further measures:

- SAM States.
- ANS providers (ATS/AIS/CNS/MET).
- Aircraft operators.

APPENDIX A

<table>
<tr><th colspan="3">HAZARD IDENTIFICATION AND RISK MANAGEMENT (HIRA) FORM</th></tr>
<tr><td colspan="2">1. Hazard record ID: HID01</td><td>2. Date of identification: 4/09/12</td></tr>
<tr><td colspan="3">3. Description of the hazard: Outdated ATS route database</td></tr>
<tr><td colspan="3">4. Causes of the hazard:
1) Failure to comply with the agreed AIRAC publication dates for the implementation of Phase 3, Version 02
2) Lack of harmonization of geographical coordinates of the points of transfer between adjacent FIRs
3) Provision to the AIS of information and data lacking the integrity and precision required and beyond the publication dates
4) Failure to comply with coordination agreements or processes between States and database providers
5) Failure to comply with coordination agreements or processes between database providers and aircraft operators
6) Lack of specific regulations for the management of navigation databases</td></tr>
<tr><td colspan="3">5. Consequence of the hazard:
Increased workload of the flight crew or air traffic control</td></tr>
<tr><td colspan="3">6. Existing barriers:
• Surveillance system
• Operational contingency procedures
• ATS messaging system
• AIRAC system for AIS publication
• SLAs (Service level agreements –State/internal or external navigation database providers)
• Letters of operational agreement (LOAs) between ATC units
• WGS 84
• Annex 4
• Annex 15</td></tr>
<tr><td>7. Probability:
FREQUENT 5</td><td>8. Severity:
MINOR D</td><td>9. Risk Index:
MEDIUM RISK 5D</td></tr>
<tr><td colspan="3">10. Proposed mitigation/action:
(Cause 1)
Enure compliane with AIRAC cycles
(Cause 2)
Apply WGS84
Ensure coordination between mapping units of adjacent States
(Cause 3)
Establish and meet the timetable for the delivery to the AIS of information and data with the integrity and precision required for publication of Phase 3, Version 2 of the</td></tr>
</table>

<table>
<tr><td colspan="3">ATS route network
Apply a quality management system (QMS) in accordance with Annex 15
(Cause 4) (Cause 5)
Improve and ensure the establishment of agreements and processes with database providers
(Cause 6)
Publish and comply with the regulatios established by the State concerning management of navigation databases</td></tr>
<tr><td>11. Resulting probability after mitigation:
OCCASIONAL 4</td><td>12. Resulting severity after mitigation:
INSIGNIFICANT E</td><td>13. Resulting risk index:

LOW RISK 4E</td></tr>
<tr><td colspan="2">14. Responsible entity:
• SAM States, ANS providers (ATS/AIS/MET)</td><td>15. Date of implementation of the proposed mitigation/action:
31/07/13</td></tr>
</table>

HAZARD IDENTIFICATION AND RISK MANAGEMENT (HIRA) FORM		
1. Hazard record ID: HID02		**2. Date of identification: 5-09-12**
3. Description of the hazard: Adverse weather conditions		
4. Causes of the hazard: 1) Hurricanes 2) Volcanic eruptions 3) Storms (CB/TCU) 4) Severe turbulence		
5. Consequence of the hazard: Significant reduction of airspace and/or ATC capacity		
6. Existing barriers: • Annex 3 or the corresponding national regulations • Weather radars • MET reports • MET forecasts • PIREPs • NOTAMs/ASHTAMs • Contingency plans • ATS/MET letters of agreement • ATC letters of operational agreement • ATC procedural handbook and operators' operating manuals • Doc 4444 Chapter 15 • Air Traffic Management (ATM) Volcanic Ash Contingency Plan template • Guidelines for the implementation of ATFM and the CDM concept in the SAM Region		
7. Probability: 4 Occasional	**8. Severity:** B Major	**9. Risk Index:** 4B High risk
10. Proposed mitigation/action: (Causes 1,2,3, and 4) Establish a MET QMS system in accordance with Annex 3. Application of ATFM procedures and the CDM concept (Causes 1,2, and 3) Improve MET training for flight crews, ATCOs, operational personnel, and flight dispatchers. Apply ATFM measures and the CDM concept (Causes 4) Apply procedures in the event of severe turbulence Improve traning in MET aspects for flight crews, ATCOs, operational personnel, and flight dispatchers. (Cause 2) Exchange ASHTAM information in an effective manner Incorporate volcanic ash management procedures into ATC letters of operational agreement Incorporate volcanic ash procedures into the operators' operating manuals (Causes 1 and 2) Apply contingency plans (Causes 1,2, and 3) Apply ATC letters of operational agreement		
11. Resulting probability after mitigation: Occasional 4	**12. Resulting severity after mitigation:** Minor D	**13. Reulting risk Index:** Medium risk 4D
14. Responsible entity: • SAM States • ANS providers (ATS//MET) • Aircraft operators		**15. Date of implementation of the proposed mitigation/action:** 31/07/13

HAZARD IDENTIFICATION AND RISK MANAGEMENT (HIRA) FORM	
1. Hazard record ID: HID03	**2. Date of identification: 05/09/12**

3. Description of the hazard: Special use airspaces

4. Causes of the hazard:

1) Lack of an ATC/civil/military coordination committee or organic unit charged with coordination.
2) Lack of definition in the designation of special use areas
3) Inadequate coordination for the restructuring of airspace
4) Complexity of airspace structure (congestion and number of routes)
5) Failure to develop operational agreements for applying procedures in given airspaces
6) Failure to publish special use areas
7) Lack of ATC/civil/militar coordination for the use of special use airspaces
8) Failure to comply with operational agreements
9) Lack of means of communication between the units involved
10) Inadequate video charts

5. Consequence of the hazard: Serious incident.

6. Existing barriers:

- Annex 11
- Circular 330 AN189 on civil/military cooperation for air traffic management.
- Regional guidelines for the application of the flexible use of airspace (FUA) concept
- Doc 4444 (PANS/ATM)
- CARSAM/3 recommendations (1999)
- GREPECAS recommendations
- ATSRO program
- Letters of operational agreement
- Integrated aeronautical information documentation
- ATC procedural handbooks
- International agreements
- Communication systems
- Surveillance systems

7. Probability:	**8. Severity:**	**9. Risk Index:**
Occasional 4	Major B	HIGH RISK 4B

10. Proposed mitigation/action:

(Cause 1, Cause 7, and Cause 8)
Effective implementation of an ATC/civil/military coordination committee and/or body
(Cause 2, Cause 6)
Define and publish in the AIP the special use airspaces
(Cause 3, Cause 4)
Consider airspace complexity in ATC/civil/military coordination
(Cause 5)
Develop and apply complete and structured ATC/civil/military letters of operational agreement
(Cause 9)
Establish redundant communication systems where applicable
Establish contingency measures in the event of communication failure between units concerned, where applicable
(Cause 10)
Update video charts of surveillance systems where applicable

11. Resulting probability after mitigation:	**12. Resulting severity after mitigation:**	**13. Resulting risk Index:**
3. Remote	D Minor	3D LOW RISK

14. Responsible entity: • SAM States • ANS providers (ATS/AIS/MET) • Military authorities • Aircraft operators	**15. Date of implementation of the proposed mitigation/action:** 31/07/13

HAZARD IDENTIFICATION AND RISK MANAGEMENT (HIRA) FORM

1. Hazard record ID: HID04	**2. Date of identication: 5/9/12**

3. Description of the hazard: **Failure to apply SAM ATS route network planning criteria**

4. Causes of the hazard:

1) The connectivity of the route network with TMAs is not guaranteed
2) Failure to apply the requirements and/or criteria established in Doc 8168 regarding the development of RNAV-5 routes, and arrival, approach, and take-off procedures.
3) Airspace sectorization is not analyzed in detail
4) The domestic route network and the regional route network are not properly integrated
5) Failure to review the structure of the ATS route network with the affected TMAs
6) Failure of States and organisations to participate in, and/or continue with, regional implementation groups
7) There are no statistics on aircraft and fleet movement, thus preventing good planning
8) Insufficient ATCOs available.

5. Consequences of the hazard: Significant reduction of safety margins

6. Existing barriers:

- ATSO Program (planning criteria developed by the SAMIG)
- Doc 8168 PANS OPS
- Annex 11
- Doc 9426
- Invitations to participate in Project RLA 06/901 and in activities related to the execution of the regular program and the project
- Conclusions and decisions of SAMIG/ATSRO meetings

7. Probability:	**8. Severity:**	**9. Risk Index:**
OCCASIONAL 4	Moderate C	MEDIUM RISK 4C

10. Proposed mitigation/action:

(Cause 1)

Ensure the connectivity of the route network with TMAs through optimum planning of the airspace structure

(Cause 2)

Meet the requirements and/or criteria established in Doc 8168 regarding en-route, TMA, approach, and take-off operations

(Cause 3- Cause 4 -Cause 5, and Cause 6**)**

Analyze airspace sectorization during the planning of Phase 3, Version 02, and verify post-implementation performance.

Study and plan the integration between the domestic routes and the regional network

Review the structure of the ATS route network with the incorporation of the main TMAs

Continuous participation by States and organisations in regional implementation groups

(Cause 7)

Prepare statistics on aircraft and fleet movements and send this information to the Regional Office, pursuant to the conclusions and decisions of the regional implementation groups

Apply the ATSRO action plan

Incorporate in the ATSRO program the need for medium-term aircraft movement forecasts for planning purposes

(Cause 8)

Have sufficient number of ATCOs

11. Resulting probability after mitigation:	**12. Resulting severity after mitigation:**	**13. Resulting risk index:**
Remote 3	Insignificant E	LOW RISK 3E

14. Responsible entity: • SAM States • ANS (ATS) providers • SAMIG	**15. Date of implementation of proposed mitigation/action: 31/07/13**

HAZARD IDENTIFICATION AND RISK MANAGEMENT (HIRA) FORM		
1. Hazard record ID: HID05		**2. Date of identification: 06/09/12**
3. Description of the hazard: **ATCOs/pilots lack training in the use of the ATS route network**		
4. Causes of the hazard: 1) Failure to meet publication dates 2) Lack of plan and training implementation 3) Lack of resources (financial, personnel, material, technological, etc.) and prioritization of training		
5. Consequences of the hazard: Significant reduction in safety margins		
6. Existing barriers: • Integrated aeronautical information system (IAIP) • Training programs • Lack of resources (financial, personnel, material, technological, etc.) and prioritization of training • Annex 1 or the corresponding national regulations • Surveillance and communication system • ATSRO program • Regional guidelines • CATC directors' meetings		
7. Probability: OCCASIONAL 4	**8. Severity:** Moderate C	**9. Risk Index:** MEDIUM RISK 4C
10. Proposed mitigation/action: (Cause 1) Comply with the publication dates, in accordance with the ATSRO action plan (Cause 2) Incorporate a training activity in the national action plans and in the regional plan for the implementation of Phase 3, Version 02 Develop and execute a theoretical and practical (simulation) training program on a date suitable for the implementation of Phase 3, Version 02 CATC meetings should analyze regional implementation programs and schedule training bsed on such programs (Cause 3) Have the resources necessary (financial, personnel, material, technological, etc.) for timely implementation of the training program and determine the priority to be assigned to training based on operational requirements		
11. Resulting probability after mitigation: Remote 3	**12. Resulting severity after mitigation:** Insignificant E	**13. Resulting risk index:** LOW RISK 3E
14. Responsible entity: • SAM States • ANS (ATS/AIS) providers • CATCs • Aircraft operators • SAMIG		**15. Date of implementation of proposed mitigation/action: 31/07/13**

HAZARD IDENTIFICATION AND RISK MANAGEMENT (HIRA) FORM		
1. Hazard record ID: HID06		**2. Date of identification: 07/09/12**
3. Description of the hazard: Inability of aircraft to maintain RNAV5 route		
4. Causes of the hazard: 1) Failure of GNSS 2) Loss of RNAV 5 capacity of the aircraft due to failure of airborne navigation systems 3) Loss of RNAV 5 capacity of the aircraft due to failure of ground navigation systems 4) Weather contingencies 5) Outdated airborne database 6) Aircraft not approved for RNAV 5 7) Solar storms		
5. Consequences of the hazard: Significant reduction in safety margins		
6. Existing barriers: • Regional RNAV 5 implementation program • Advisory circular on RNAV 5 (CA 91-002) • RNAV 5 approval process for aircraft and operators • RAIM • GNSS • Surveillance system • Ground navigation aids • MET reporting systems • Volcanic ash reporting systems • Safety oversight program for aircraft operators • DME/DME coverage study • RAIM and FDE availability prediction • New FPL format		
7. Probability: OCCASIONAL 4	**8. Severity:** Moderate C	**9. Risk index:** MEDIUM RISK 4C
10. Proposed mitigation/action: (Cause 1) Revert to another navigation system (Cause 2, Cause 3, Cause 4, and Cause 6) Establish and apply contingency procedures for operators and ATC (Cause 5) Ensure the updating of the database (see Hazard 1) (Cause 7) Implement regional RAIM and FDE availability prediction service		
11. Resulting probability after mitigation: OCCASIONAL 4	**12. Resulting severity after mitigation:** Insignificant E	**13. Resulting risk index:** LOW RISK 4E
14. Responsible entity: • SAM States • ANS providers (ATS/AIS/CNS/MET) • Aircraft operators		**15. Date of implementation of poposed mitigation/action: 31/07/13**

Chapter 6 Conclusions and Recommendations

Conclusions

6.1 The existing SAM ATS route network, with the available air traffic services, communication, navigation, and surveillance systems, all the aeronautical and meteorological information, and all the ATM supporting systems are sufficient for the safe and efficient conduction of air operations in the route network of the Region.

6.2 Based on the risk analysis performed in this safety plan, it could be said that the hazards identified and the consequences associated to these hazards as the reason for the implementation of the ATS route network Phase 3, Version 02 are at a relatively acceptable level with the existing barriers, none of them is considered extremely risky, and two have a high level of risk, and have barriers to reduce their impact.

6.3 Within the implementation of Phase 3, Version 02, new concepts apply, such as the flexible use of airspace or the spacing of parallel routes under the RNAV 5 concept, or continuous descent operations, which could eventually increase risk regarding certain hazards if no additional measure is taken.

6.4 The identified hazards, along with the existing barriers and additional barriers proposed do not exceed the low risk index. Accordingly, they can be considered to be within acceptable levels, except for adverse weather conditions that have a medium risk level, recognizing however that weather conditions are independent from the implementation of the ATS route network Phase 3, Version 02.

6.5 In connection with the ATS route network Phase 3, Version 02, a table with a summary of the risk index calculated for each hazard is shown below as a reference, together with its consequences before mitigation, and the risk index calculated after mitigation or implementation of the proposed actions.

Summary Table with the Calculated Risk Index

Hazard identified if Phase 3, Version 02 is implemented	Risk index before mitigation	Risk index after mitigation
1. Outdated ATS route database	FREQUENT 5 MINOR D **MEDIUM RISK 5D**	OCCASIONAL 4 INSIGNIFICANT AND **LOW RISK 4E**
2. Adverse weather conditions	OCCASIONAL 4 MAJOR B **HIGH RISK 4B**	OCCASIONAL 4 MINOR D **MEDIUM RISK4D**
3. Special use airspaces	OCCASIONAL 4 MAJOR B **HIGH RISK 4B**	REMOTE 3 MINOR D **LOW RISK 3D**
4. Failure to apply ATS SAM route network planning criteria	OCCASIONAL 4 MODERATE C **MEDIUM RISK 4C**	REMOTE 3 INSIGNIFICANT AND **LOW RISK 3E**

Hazard identified if Phase 3, Version 02 is implemented	Risk index before mitigation	Risk index after mitigation
5. Lack of training of ATCOs/pilots in the use of the ATS route network	OCCASIONAL 4 MODERATE C **MEDIUM RISK4C**	REMOTE 3 INSIGNIFICANT AND **LOW RISK 3E**
6. Inability of the aircraft to maintain RNAV5 route	OCCASIONAL 4 MODERATE C **MEDIUM RISK4C**	OCCASIONAL 4 INSIGNIFICANT AND **LOW RISK 4E**

6.6 As a result of the analysis performed, it may be concluded that with the existing barriers, the implementation of the ATSRO route network, Phase 3, Version 02 does not entail any major inconveniences and will not generate any additional hazards to the existing airspace structure, and that the hazards and their consequences are duly controlled. Nevertheless, with the implementation of a new version of the route network with a structure that is different from the existing one, opportunities for improvement were identified to enhance and preserve safety standards through the implementation of the measures proposed in this document and detailed under Chapter 5. This will permit the optimization of safety in the new operational environment contributing to the attainment of the strategic objectives set out in the regional performance-based air navigation implementation plan.

Recommendations

6.7 The commitment of the States and organisations of the Region, whether civil aviation authorities (CAAs), air navigation service providers (ANSPs), operators, or airspace users, is necessary for the implementation of the ATS route network, Phase 3, Version 02 in the SAM Region. Consequently, all parties involved must be strongly committed with the execution of the action plan of the ATSRO program and particularly with the implementation of the national plans for the implementation of enhancements to the ATS route network, as approved by the Region.

6.8 **Civil aviation authorities** must ensure that the proposed actions are completed prior to the implementation of Phase 3, Version 02 in order to maintain the risk index at acceptable levels, and conduct a specific follow up and continuous monitoring of preparedness activities to be carried out by air navigation service providers, aircraft operators, and the various airspace users, coordinating and assisting as necessary all stakeholders in this process.

6.9 Likewise, they should commit to the development, approval, and publication, on the dates defined in the regional and national action plan, of rules, regulations, advisory circulars, and other documentation containing guidelines and procedures for the implementation of the ATS route network, Phase 3, Version 02, that will assist the ATM community to fulfill the regional agreements.

6.10 If applicable, they shall have an adequate number of duly trained human resources, as well as technological and financial resources for the implementation of the action plan. As an additional measure, the authorities, where applicable, must hold seminars, workshops, and courses, publish bulletins, and post on their websites sufficient information on the expected changes and the required documentation.

6.11 The mitigation measures proposed are mostly associated with regulatory aspects and the training of personnel involved. Although these measures have an associated cost, the figures do not prevent the efficient implementation of the ATSRO program.

6.12 CAAs must exchange safety data and relevant information at regional level, which, in the medium and long term, will result in better regional safety policies and will permit the definition and promotion of better performance indicators for the Region.

6.13 Furthermore, any aircraft navigation deviation shall be recorded and investigated, whether such deviations are technical and/or operational in nature. Regional experience concerning vertical navigation deviations and the number of such deviations shows that most are related to operational causes and coordination errors between adjacent ATCs. This leads to think that potentially, and for the same reasons, there could be lateral deviations that should be taken into account by civil aviation authorities.

6.14 In case this type of lateral navigation deviations is detected, the States should continue with the firm commitment to enact contingency measures to minimize such operational errors.

6.15 Likewise, and to the extent necessary, the States must establish training programs for operational personnel and conduct continuous safety oversight in ATC units.

6.16 **Aircraft operators.** Although this safety plan is not directly intended for aircraft operators, they, in turn, will have to perform a risk analysis of the operation of the new ATS route network. Aircraft operators shall promote and apply the exchange of safety data at the regional level in order to develop a database of performance indicators for the Region and to provide the necessary information to identify specific lateral deviations that could affect safety levels in the Region.

6.17 Regarding regulations, aircraft operators shall update their contingency plans and programs in order to operate in an optimized ATS route environment, as necessary.

6.18 Concerning training, they shall encourage recurrent training of pilots and aircraft dispatchers in operations in ATS routes, using navigation system failure simulation and exercises for timely identification if failures that affect or could affect aircraft capacity to maintain RNAV 5 routes, and in the efficient application of contingency procedures as applicable.

6.19 **Air navigation service providers (ANSPs)** must carefully apply mitigation measures and the proposed action to reduce risk indices. As may be noted in this safety plan, most of the measures proposed are related to the operation and are geared to the ANSPs.

6.20 In general, these measures seek to improve the provision of ATS, AIS, CNS, and MET services; optimize coordination between adjacent ATCs; encourage recurrent

training of staff; use simulations with standard scenarios and contingency program exercises, with a view to timely identifying failures affecting the capacity of the units.

6.21 As to regulations, update the CAA contingency plans and programs required to operate in an optimized ATS route environment. Promote oversight and eliminate operational errors between ATC units, one of the main causes that significantly increase risk to operations in the Region.

6.22 They shall also verify and implement the appropriate measures concerning communications, navigation, and surveillance, as well as in ARO/AIS units, particularly in connection with timing, accuracy, and reliability of data to be inserted in aeronautical information publications. The implementation of a quality system in aeronautical information services is a key element to ensure the quality and accuracy of data to be inserted in aircraft databases. In this same sense, and in order to have accurate and timely meteorological information, the States that have not yet done so should focus on implementing a quality management system in their MET units.

6.23 ANSPs are encouraged to exchange safety data to permit the definition and establishment of performance indicators in the Region, and to provide information on the identification and establishment of specific lateral deviations that affect operations in the Region.

6.24 The **South America Implementation Group (SAMIG)** shall do a follow up both before and after the implementation of the ATS route network, Phase 3, Version 02 in order to first verify that the mitigation measures and actions proposed in the safety plan have been adopted by the parties concerned, and subsequently, once Phase 3, Version 02 has been implemented, if the proposed mitigating measures have yielded the expected results and make sure no additional hazards have been introduced to the ATS route system.

6.25 As may be noted, work will not be finished, not even after the plan has been defined and delivered to the organizations and individuals responsible for leading the implementation. Implementation activities must be followed closely and continuously to make sure that measures are introduced, obstacles to implementation are eliminated, and attention continues focused on any new hazard that is identified.

6.26 Likewise, the SAMIG shall include an activity related to personnel training in the action plan for the implementation of Phase 3, Version 02. This training shall be provided before the entry into force of the new ATS route network.

6.27 The SAMIG shall make sure that the FTS foreseen in the action plan to be carried out in 2013 is conducted. This simulation shall provide valuable information on the performance of the new route system in the pre-operational phase.

6.28 In turn, the **ICAO South American Regional Office** will continue to offer its full support to the implementation of Phase 3, Version 02 of the ATS route network, by organizing regional events and facilitating the participation of States, ANSPs, aircraft operators, and users in general. Furthermore, the Regional Office, together with the States

that are having difficulties in implementing the ATSRO program, should review the assistance mechanisms, whether specific missions or personnel training.

6.29 It should be stressed that the purpose of this safety assessment is for use by States as reference material. It is worth noting that this safety assessment does not replace the responsibility of the States to conduct their own safety assessment following the implementation of the ATS route network, Phase 3, Version 02, as established in the action plans related to this topic.

6.30 The remarks, conclusions, and mitigation measures proposed in this safety plan must be kept as part of the safety library of the Region and will serve as a baseline to record the improvements to be suggested in the future concerning risk management and the safety level achieved by the SAM Region.

Bibliography

Annex 3, Meteorological Service for International Air Navigation
Annex 11, Air Traffic Services
Annex 10, Aeronautical Telecommunications
Annex 15, Aeronautical Information Services
CAR/SAM Air Navigation Plan
Performance-based Air Navigation Implementation Plan for the SAM Region
Doc 4444, Procedures for Air Navigation Services - Air Traffic Management
Doc 9613, Performance-Based Navigation (PBN) Manual
Doc 9750, Global Air Navigation Plan
Doc 9854 AN/458 Air Traffic Management Operational Concept
Doc 9859, Safety Management Manual
Doc 9331, Continuous Descent Operation (CDO)
Circular 330, Civil/Military Cooperation for air traffic management
GREPECAS meeting reports
SAMIG meeting reports
ATSRO Meeting Reports
ATS Route Network Optimisation Program
Regional Project RLA 06/901
CAP 760, Guidance on the Conduct of Hazard Identification, Risk Assessment and the Production of Safety Cases (UK)
SAM regional guidance for the application of the flexible use of airspace (FUA)
SAM regional guidance for the application of the collaborative decision-making concept (CDM)

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