

**Agenda Item 2: Implementation of performance-based navigation (PBN) in the SAM Region**

2.1 During the SAM/IG/1 meeting, note was taken that PBN implementation would require the preparation of detailed guidance material for the States and International Organizations with regard mainly to three aspects:

- a) Analysis of the experiences of other regions;
- b) Data collection air traffic movement analysis in order to identify the main flows;
- c) Data collection and air navigation infrastructure analysis (communications, navigation, surveillance, meteorology, AIS).

2.2 These tasks could be carried out, as agreed at the First Meeting of the Coordination Committee of Project RLA/06/901 (Lima Peru, 5 December 2007), by hiring experts on the subject. In this connection, during the SAM/IG/1 meeting, the work programme was drawn up in order that a consultant could fulfil the initial tasks.

2.3 On the basis of the indicated work programme, the consultant studied and processed the aforementioned information and prepared a document clearly describing the current situation in SAM States. The work programme used for the tasks developed by the consultant appear in **Appendix A** to this part of the Report and is in line with tasks 1.1 of Project RLA/06/901.

**En-route PBN - RNAV-5 Implementation Programme**

2.4 The Meeting recognized that PBN implementation for en-route operations will require extensive participation by SAM States and will depend upon the completion of specific tasks, many of which will be in charge of Regional Project RLA/06/901. In light of the need for the harmonization and correct interpretation of each of the tasks connected with PBN implementation, an explanation text of en-route PBN Implementation was developed to permit a better understanding of the activities and the expected results. Its objective was to clearly define the deliverables in order to break down the large volume of work into specific activities. These activities will be used as a basis for possible adjustments in project timetables.

2.5 Note was taken that the PBN Implementation Programme established a new Action Plan that was amended to bring it into line with the results of the PBN Seminar (Lima, 17-20 June 2008) and the PBN Manual (Doc. 9613). The changes made in the Action Plan did not modify its essence and it proved possible to maintain the task dates set at the SAM/IG/1 Meeting. The proposed new action plan is set out in **Appendix B, Attachment 1** to this part of the Report.

2.6 In view of the above, the Meeting formulated the following conclusion:

**Conclusion SAM/IG/2-1 PBN implementation Programme for en-route operations**

That the ICAO SAM States take appropriate actions to follow the guidelines and comply with the targets established in the PBN implementation for en-route operations, which is shown in Appendix B to this part of the Report.

**Development Status of the Tasks of the En-Route PBN – RNAV 5 Action Plan that should be completed at the SAM/IG/2 Meeting**

2.7 **Establish and prioritize strategic objectives (safety, capacity, the environment, etc.)**

2.7.1 The Meeting observed that the Airspace Concept provides the basis for operations within an airspace and is developed to meet strategic objectives like improving safety, adjusting the services provided to air traffic growth, mitigating environmental impact, etc. The airspace concept must include details about the practical organization of the airspace, based on user characteristics and the CNS/ATM infrastructure that is available or to be implemented. Further details about the Airspace Concept can be found in the PBN Manual, Volume I, Chapter 2.

2.7.2 Two strategies can be considered for developing the Airspace Concept in the case of the En-Route PBN Implementation Programme:

- a) *Gradual implementation of new routes and realignment and elimination of existing ones* – This implementation strategy would lead to the development of several “small” airspace concepts, one for each route to be implemented, realigned or eliminated, or a coherent route implementation/realignment/elimination “package.”
- b) *Complete restructuring of the route network in a given airspace volume like, for instance, between FL 290 and FL 410* – This strategy would require the development of a complete airspace concept, including the entry and exit points of the main SAM TMAs.

2.7.3 The strategic objectives that must be met through PBN implementation for en-route operations are included in paragraph 1.1 of **Appendix B** to this part of the Report. The Meeting made the necessary changes, approved the strategic objectives to be considered in PBN implementation for en-route operations, and considered the task as finalized.

## 2.8 **Collection of traffic data in order to understand traffic flows in a given airspace**

2.8.1 The Meeting was of the opinion that traffic data are essential for developing a consistent Airspace Concept. Accordingly, Project RLA/06/901 used CARSAMMA data collected over the period 13 to 28 January 2008. This traffic sample is limited to RVSM flight levels (FL 290 to FL 410) since it was established to assess RVSM safety. This limitation has caused some problems for the analysis of, for example, en-route flights in the Sao Paulo TMA, which contains one of the most important flows in Latin America, that between Rio de Janeiro and Sao Paulo. In this case, most flights are conducted on FL 280 and, because of that, were not computed in the sample analyzed. Another problem occurred in the Ezeiza FIR, with flights to/from Brazil--particularly Sao Paulo and Rio de Janeiro--that were not included in the sample, probably because flights cross the boundaries of the Ezeiza FIR before reaching FL 290.

2.8.2 **Appendix B, Attachment 2** to this part of the Report contains graphs representing air traffic movement on the main ATS routes, by FIR. **Appendix B, Attachment 3** to this part of the Report reveals the volume of traffic between the principal city pairs in the FIRs of the SAM Region. The complete analysis of ATS routes and city pairs can be found at the SAM Office website. The Excel spreadsheets used can be employed to deepen the analysis of air traffic movement on ATS routes, in order to identify routes that need to be realigned or eliminated. These spreadsheets can also be used to identify regional flows and for the identification by the States of the flow at the main TMAs, always bearing in mind that the sample is limited to the airspace volume between FL 290 and FL 410.

2.8.3 Limitations posed by the samples considered in the analysis of air traffic flows made a full assessment impossible, considering that segmentation by FIRs is not appropriate for obtaining an overview of the SAM Region. Furthermore, consideration of only the flows between FL 290 and FL 410 means that a significant portion of air traffic is not assessed and hampers the analysis of TMAs in particular. The Meeting should therefore study the need for a new data collection effort and the systematic development of an air traffic movement database.

## 2.9 **Post PBN documentation at ICAO SAM Office website**

2.9.1 The Meeting took note that the website is an important mechanism for disseminating PBN documentation. The ICAO SAM Regional Office established the SAM PBN website format, which can be used by accessing the following address: [www.lima.icao.int](http://www.lima.icao.int), e-document, ATM, PBN. In this manner, the Meeting considered this task as finalized.

## 2.10 **Assess PBN implementation in automated ATC systems in light of amendment 1 to the PANS/ATM (FPLSG)**

2.10.1 The Meeting took note that the changes in automated ATC systems for PBN application must be based on amendment 1 to the PANS/ATM, resulting from the work of the ICAO Air Navigation Commission Flight Plan Study Group and which was approved by that Commission at its 177<sup>th</sup> session and will enter into effect on 15 November 2012. Letter to the States AN 13/2.1-08/50 of 25 June 2008 informed them about the approval of amendment 1 to the PANS/ATM. The amendment can be found at the SAM Office website.

2.10.2 It was also observed that the amendment in question is complex and involves other aspects, in addition to PBN. In this connection, it will be necessary to decide upon a strategy for modifying ATC Automated Systems and whether the modification will be comprehensive, including all aspects of the amendment, or partial, only to meet PBN requirements. The GREPECAS ATM/CNS Subgroup will create a specific task force to deal with this matter.

2.10.3 The requirements for changes in ATC automated systems will depend upon the complexity of the airspace being considered and can involve from the simple insertion of a specific code in the controller flight progress strip to a more complete change that includes the use of specific symbols or colours in ATS surveillance targets, as well as a system for assigning aircraft the procedures (route, SID, STAR, approach) that correspond to the fleet navigation capacity. Paragraph 5.1 of **Appendix B** to this part of the Report contains further considerations about the subject.

2.10.4 Taking into account the complexity of this task and the need for a further analysis, the Meeting was of the opinion that the target date for its finalization should be postponed until SAM/IG/3 meeting.

2.11 **Analyze aircraft and operator (pilots, dispatchers and maintenance personnel) approval requirements as established in the PBN Manual and prepare the necessary documentation**

2.11.1 Project RLA/99/901 (Regional Safety Oversight Cooperation System) was responsible for this task, which is considered under Agenda Item 3 - *Standards and procedures for performance-based navigation operations approval*.

2.12 **Assess the regulations for GNSS use and, if appropriate, proceed to their publication**

2.12.1 The Meeting noted that the use of GNSS is of key importance for all PBN navigation specifications, considering that some aircraft possess only this equipment to meet the established performance requirement and that there are some specifications that only GNSS can meet.

2.12.2 The key issue is the State policy with regard to the application of GNSS as a means of navigation. In order for the system to be used to its fullest, States must regulate its application as a primary means of navigation, even if this should require imposing some operational restrictions, such as, for example, requiring the alternate aerodrome to provide for “conventional” (VOR, NDB, ILS) approaches. Another aspect that must be considered is the need to establish a navigation reversal mode in case the GNSS signal is lost, requiring aircraft to be equipped with “conventional” air navigation systems.

2.12.3 Note was also taken that some States in the Region have already published their regulations for GNSS use and these could be taken as an example by other States to prepare their own regulations. Model documents are available at the SAM Office website. The status of regulations on the use of GNSS is shown in **Appendix B, Attachment 4** to this part of the Report.

### 2.13 **AIC model to report PBN implementation plans**

2.13.1 The Meeting was of the opinion that it was essential to report RNAV-5 implementation for en-route operations, in order that users can start with the aircraft and operator approval process.

2.13.2 Upon reviewing some paragraphs of the AIC, one State expressed its concern over the possibility that some operators that had some RNAV capability might not meet the conditions to obtain RNAV-5 approval. In this regard, the State indicated that it will seek an alternate solution to this problem.

2.13.3 States agreed to publish their initial AIC before **9 April 2009**. In this regard, the Meeting agreed to formulate the following conclusion:

#### **Conclusion SAM/IG/2-2 Initial AIC**

That States of ICAO SAM Region using as model the AIC presented in Appendix C to this part of the Report:

- a) publish in the AIRAC date of 9 April 2009 an Aeronautical Information Circular (AIC) informing the aeronautical community on their intention to implement RNAV 5 on **18 November 2010**;
- b) reflect in this AIC the specific situations within the airspace under their jurisdiction.

#### **Status of compliance of the main tasks started at the SAM/IG/1 Meeting.**

### 2.14 **Analyze aircraft fleet navigation capacity**

2.14.1 The Meeting took note that the Safety Oversight Cooperation System (RLA/99/901) is supporting the operational approval required for the PBN implementation. The operational approval process includes the evaluation of the aircraft and airline capacities for especial operations approval, such as RNAV 1, RPN 10 AR APCH, etc.

2.14.2 When analyzing the impact of the PBN implementation in the Regions and how to support it, a doubt arose on the PBN capacity of the total fleet of the Region, revealing a lack of data and also pointing the necessity to organize a data base for understand the status of all aircraft that operate in the Region, and with that, to joint in an assertive way, the PBN implementation.

2.14.3 In this regard, the Meeting approved the proposal to carry out a survey in all States of the SAM Regional, for identify each aircraft by its Registry versus its PBN capacity. Likewise, taking into consideration that this survey is addressed to all aircraft registered in each State, it is recommended to perform the survey considering phases for collecting the information.

2.14.4 Taking into account the foregoing, the Meeting formulated the following conclusion:

**Conclusion SAM/IG/2-3 Survey on the Fleet Navigation Capacity**

That States conduct a survey on the fleet navigation capacity, using, to that end, the form contained in **Appendix D** to this part of the Report, and send the information collected to the ICAO South American Regional Office, on the following dates:

- a) Aircraft operating commercial flights, which have more than 5 700 kg. of MTOW – 15 February 2009;
- b) Aircraft operating commercial flights, which have less than 5 700 kg. of MTOW – 15 May 2009;
- c) Other aircraft registered in the Region – 15 August 2009.

2.14.5 The Meeting recognized that it is essential to know not only the fleet navigation capacity, but also the number/percentage of operations approved for the navigation application to be implemented. In order to make this analysis, it will be necessary to collect information about the operators and types of aircraft operating in the SAM Region. Project RLA/06/901 used the CARSAMMA traffic sample collected over the period of 13 to 28 January 2008, to prepare the graphs of air traffic movement by type/operator in each FIR of the SAM Region, as shown in **Appendix B, Attachment 5** to this part of the Report. The analysis was limited to flights made at RVSM flight levels (FL 290 to FL 410), because the sample was established to assess RVSM safety. The complete analysis of operators/aircraft types can be found at the SAM Office website.

2.15 **Analyze the ground-based means of communication, navigation (VOR, DME) and surveillance available for complying with the navigation specifications and the navigation reversal mode**

2.15.1 The Meeting took note that Appendix B to this part of the Report, paragraph 1.4, contains details about CNS requirements for RNAV-5 implementation. The assessment of VOR and DME coverage in the SAM Region is a matter of key importance for the implementation, in order to identify if the infrastructure is appropriate for supporting RNAV-5 operations. If coverage is not appropriate in a given airspace, RNAV-5 implementation could be based only on GNSS and INS. The Meeting should discuss a strategy for assessing VOR and DME coverage to support the RNAV-5 navigation application.

2.15.2 A summary on the status of compliance of the tasks for PBN Action Plan for En route Operations is shown in Appendix B, Attachment 1, to this part of the Report.

2.16 **Tasks to be developed by Project RLA/06/901**

2.16.1 Project RLA/06/901 should perform the following tasks of the Action Plan, with their respective numbers, which were initiated at the SAM/IG/1 and SAM/IG/2 meetings but could not be completed. According to the en-route PBN action plan, the results shall be submitted at the SAM/IG/3 and/or SAM/IG/4 meeting:

<b>TASK NUMBER</b>	<b>TASK</b>	<b>Completion Date</b>
1.2	Collect traffic data in order to understand the traffic flows in a given airspace.	SAM/IG/4
1.3	Analyze the aircraft fleet navigation capacity.	SAM/IG/3
1.4	Analyze the communications, navigation (VOR, DME) and ground surveillance means to meet navigation specifications and navigation reversal mode.	SAM/IG/4
1.5	Optimize the airspace structure, by reorganizing the network or implementing new routes based on the strategic objectives of the airspace concept, taking into account airspace modeling, ATC simulations (fast time and/or real time), live tests, etc.	SAM/IG/4
2.1	Prepare a performance measurement plan, including gas emissions, safety, efficiency, etc.	SAM/IG/4
3.1	Determine the methodology to be used to evaluate airspace safety and route spacing, depending on navigation specifications, taking into consideration airspace modeling, ATC simulations (accelerated and/or real time), live trials, etc.	SAM/IG/4
3.2	Prepare a data collection program for airspace safety assessment.	SAM/IG/4
3.3	Prepare a preliminary airspace safety assessment.	SAM/IG/4
5.1	Evaluate PBN implementation in ATC automated systems, taking into account Amendment 1 to PANS/ATM (FPLSG).	SAM/IG/4

2.16.2 Regarding tasks 3.1, 3.2 and 3.3, Project RLA/06/901 shall develop detailed guidance material in order to enable CARSAMMA to carry out these tasks.

#### 2.17 **PBN implementation model for TMA and approach operations**

2.17.1 The Meeting took note that Regional Project RLA/06/901 developed a PBN Implementation model for TMA and Approach operations to gain a better understanding of the activities involved and the expected results. The objective was to clearly define the deliverables, in order to be able to break down the large volume of work into specific activities. These activities will serve as a basis for the preparation of programme timetables.

2.17.2 It was also noted that the PBN Implementation model for TMA and Approach Operations establishes new Model Action Plans for TMA and Approach Operations, which are shown as **Attachments 1 and 2 to Appendix E** of this part of the Report, respectively. These plans were modified to conform to the results of the PBN Seminar (Lima, 17-20 June 2008) and the PBN Manual (Doc 9613). The changes made in the model Action Plans did not modified the essence of the previous action plan. In this sense, the Meeting formulated the following conclusion:

**Conclusion SAM/IG/2-4****PBN Implementation Model for TMA and Approach**

That States/Territories and International Organizations use the PBN Implementation Model for TMA and Approach in the preparation of their PBN implementation programmes for TMA and Approach, shown in **Appendix E** to this part of the Report.

**2.18 Flexibility with Special Use Airspace**

2.18.1 The Meeting took note that Special Use Airspace was designed to enable “special” operations while minimizing impact to ordinary operations. With traditional route structures, this methodology worked well allowing SUA to be designated as active either H24 or for extended periods. They also allow a significant range of altitudes, often encompassing all suitable cruising levels.

2.18.2 However, optimized paths from PBN implementation, such as UPRs, can be severely limited by SUA. While the necessity of SUA is recognized, it is necessary to set up procedures to ensure airspace use flexibility.

2.18.3 In this regard, the Meeting was of the opinion that Air Navigation Service Providers (ANSP) must establish a coordination mechanism with their States’s military authorities in order to discuss issues such as location, altitudes and validity periods of specific SUA, thus, reaching the efficient use of airspace for all users.

**2.19 Managing the Environmental Issues of Air Transportation**

2.19.1 The Meeting took note that the ICAO 36<sup>th</sup> General Assembly requested the Council to encourage Contracting States to improve air traffic efficiency, reporting the progress in this area, and requested them to accelerate the development and implementation of fuel efficient procedures to reduce emissions produced by aviation.

2.19.2 The Meeting was of the opinion that it is important that States and Air Navigation Service Providers (ANSP) take on a proactive role on implementation programmes that are “pro-environment”. The ICAO airspace planning forums need to aggressively promote awareness of environment issues, pursue environmental saving initiatives, document environment benefits, promote environmental saving programmes and implement measures to reduce emissions.

2.19.3 In this regard, the Meeting considered that the specific task to measure the performance, included in PBN Implementation Project, will start the process to obtain objective data on the benefits to be reached in terms of reduction of gas emissions hazardous to the atmosphere.

**2.20 Procedure Design Training for RNP Approach with Authorization Required (AR)**

2.20.1 The Meeting observed the results of the Prototype RNP AR Course given in August 2008 at the FAA’s Mike Monroney Aeronautical Center in Oklahoma City. Course participants were from Australia, Brazil, Chile, Mexico and EUROCONTROL.

2.20.2 The course is designed for trained, experienced PANS OPS procedure designers. Course duration is 13 class days. The language of instruction is English. TSI will levy tuition charges; in addition, participants will need to fund their travel and lodging expenses.

2.20.3 TSI has established the following list of course dates at Oklahoma City. A minimum enrollment of six students is necessary to confirm a scheduled class.

- 3 Nov - 20 Nov 2008
- 5 May - 21 May 2009
- 9 Sept - 25 Sept 2009

2.20.4 TSI is also able to present the course at locations outside the U.S by specific arrangement with requesting agencies.

2.20.5 To request a position in a scheduled class, or to arrange presentation of the course at a location outside the U.S., the point of contact is the TSI Course Manager, Mr. Joseph Florio. Contact information:

Email: Joe.Florio@tsi.jcabi.gov  
Telephone: 1 405 954 8533  
Fax: 1 405 954 2649

## **2.21 Input from the ICAO PBN Programme**

2.21.1 During the PBN WG meeting, the ICAO PBN Implementation and Resource Development Coordinator, updated the meeting on some of the initiatives ongoing with the ICAO headquarters PBN programme.

2.21.2 ICAO, in cooperation with the French DGAC and ENAC are planning a series of PBN Procedure Design Courses for experienced procedure designers in the region. Two of these courses have already been conducted in Asia. There are plans to conduct at least two courses in Spanish in the CAR/SAM region over the next one to two years in cooperation with either the French or Spanish governments, depending on availability of funds.

2.21.3 The meeting noted the ICAO Secretariat presentation on the regional Flight Procedure Programme (FPP) concept. Under this concept, a Flight Procedure Programme office would be established in a region to address shortcomings in procedure design capability in the States, including:

- a) Lack of procedure design training: initial, OJT, and/or recurrent;
- b) High turnover among procedure designers;
- c) Insufficient procedure design work in some States to attain or maintain proficiency;
- d) Lack of depth in procedure design organization to perform quality assurance (QA);
- e) Insufficient expertise in procedure design organization to provide adequate QA of procedures;
- f) Lack of procedure design and obstacle data storage automation in the States; and

- g) Insufficient regulatory expertise to oversee the procedure design service provider.

2.21.4 The FPP office is envisioned by ICAO to be a not-for-profit center of excellence in the field of flight procedure design. The FPP would employ best practices in training, automation and quality assurance with experts in the field to address the procedure design needs of the States. It would be organized as a Technical Cooperation Bureau project and managed by a full-time ICAO employee whose position would be funded from the FPO funding sources, in order to assure the States that the credibility of ICAO stands behind the project. Location, size and initial operational capability date of a regional FPP would however be based on demand for the services and the level of financial support extended by the States and international organizations for start-up and initial operating costs. It is anticipated that success of the concept will require that there be at least one donor State or organization that provides the start-up capital and operating costs for the first 2-3 years, and infrastructure support after that time. Under this concept, user fees would be introduced at the level necessary to cover the cost of the services not covered by donors.

2.21.5 The primary goal of the FPP would be to develop and enhance the States' capabilities in procedure design and quality assurance, so that they can achieve the PBN implementation goals of Assembly resolution A36-23.

2.21.6 As a follow up from a joint agreement at the 18<sup>th</sup> IATA Operations Committee meeting, the International Civil Aviation Organization (ICAO) and International Air Transport Association (IATA) have decided to form a Global Performance Based Navigation (PBN) Implementation Group. The purpose of this group is to identify and develop a systematic approach to assist in a complete and accelerated implementation of PBN worldwide. This group will have its first meeting in December 2008. The ICAO Secretariat asked the group to provide feedback on what they see as the biggest obstacles in their States, to PBN implementation. The following issues were brought out by the group:

- a) training for regulators, AIS, pilots, ATC, procedure designers
- b) training in airspace planning
- c) training in conducting safety assessments, focusing on the safety assessments required for implementing airspace changes
- d) harmonized methodology for safety assessments
- e) access to software for evaluating DME support of DME/DME flight procedures

2.21.7 This feedback will be used by the global PBN implementation group to help set priorities for action.

## **2.22 Special Implementation Project (SIP)**

2.22.1 ICAO informed to the Meeting that in view of FAA proposal to develop a Procedure Design Training for RNP Approach with authorization required (see paragraph 2.20), a SIP will be proposed to be considered by ICAO Council, which will permit the SAM Region to carry out said course in Regional Office premises. SAM States will be informed if approval is obtained.

## APPENDIX A

### SHORT TERM ACTIVITIES OF THE RLA/06/901 PBN EXPERT WITH REGARD TO PBN

Results	Activities	Party responsible for each activity
1.1 Implementation of performance-based navigation (PBN) – (GPIs 5, 7, 10, 11, 12, and 21).	<p>1.1.1. Process and analyse the information, learning about the current status in the participating States and organisations in the following priority order: RNAV-5, RNAV-1 and RNP APCH, with respect to:</p> <ul style="list-style-type: none"> <li>a) Available CNS infrastructure, with the corresponding coverage and plans for future facilities;</li> <li>b) Characteristics of available ATM automated systems and future automation plans;</li> <li>c) Aircraft fleet operating in the CAR/SAM ATS route network and its RNAV and RNP capabilities, including capacity for arrival procedures based on the flight management system (FMS) and future plans of the users;</li> <li>d) Airworthiness and operational approval capabilities;</li> <li>e) Airports that might derive operational benefits from the use of RNAV and/or RNP;</li> <li>f) Status of implementation of WGS 84;</li> <li>g) Existing SIDs and STARs connecting international airports to ATS routes;</li> <li>h) Real-time and accelerated simulation of operations;</li> <li>i) Cost-benefit analysis of facilities;</li> <li>j) Safety assessment models;</li> <li>k) Regulation of GNSS use (secondary, primary means)</li> </ul>	ATM Expert, RO

<b>Results</b>	<b>Activities</b>	<b>Party responsible for each activity</b>
	<p>l) Documentation concerning the training of air traffic controllers;</p> <p>m) Evaluate the impact of PBN implementation in ATC automated systems.</p> <p>n) Analyse existing data on air traffic movement, with a view to:</p> <ul style="list-style-type: none"> <li>i. cost-benefit analysis</li> <li>ii. fleet capacity assessment</li> <li>iii. identification of main traffic flows</li> <li>iv. safety assessment</li> </ul> <p>o) Identify the need for collection and additional data analysis.</p> <p>Start up date: week 1 Estimated duration: 2 weeks</p>	

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**APPENDIX B**

**PBN IMPLEMENTATION PROJECT**

**EN-ROUTE OPERATIONS**

**SHORT TERM**

**SAM REGION**

### Introduction

The purpose of this document is to detail the activities of the Short-term Performance-Based Navigation Implementation Project for En-Route Operations in the South American Region in relation to RNAV-5 implementation. It also specifies the results that should be obtained from each of the activities of the action plan.

Project RLA 06/901 will carry out the activities of the PBN Project for En-Route Operations in the SAM Region, with the support of States and International Organizations. Project 99/901 will provide support in the areas concerning fleet navigation capacity and aircraft and operator approval documentation.

The Short Term Action Plan for En-Route Operations is shown in **Attachment 1**.

## **PBN Implementation – En-Route Operations - Short Term**

### **1.           Airspace Concept**

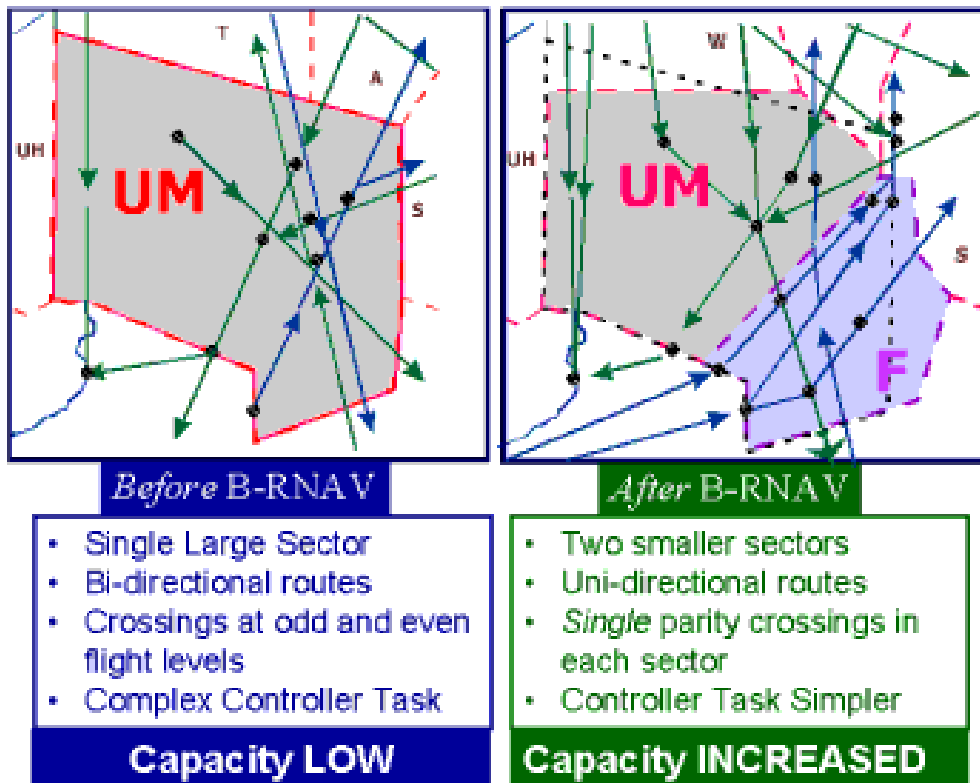
The Airspace Concept provides the scheme of operations within an airspace and is developed to meet explicit strategic objectives, such as safety enhancement, adjustment of service provision to air traffic growth, environmental impact mitigation capacity, etc. The Airspace Concept must include details about the practical organization of the airspace, based on user characteristics and on the CNS/ATM infrastructure in place or to be implemented. Further details about the Airspace concept can be found in the PBN Manual, Volume I, Chapter 2.

1.1.           Establish and prioritize strategic objectives (safety, efficiency, the environment, etc.).

RNAV-5 implementation in the SAM Region will address mainly the following Strategic Objectives:

- a)           Safety – At present, there is no formal airworthiness certification and operational approval process for flights in RNAV routes in the SAM Region. Implementation of RNAV-5, which is the least demanding navigation specification in terms of airborne equipment, will make it possible to formalize and harmonize the use of RNAV in new and existing RNAV routes, and will provide the necessary conditions for a complete restructuring of the route network. This will permit the development of an optimized route network, thus reducing conflict points and, as a result, increasing safety.
- b)           Capacity – The reduction in airspace complexity and the resulting decrease in controller workload will enhance sector ATC capacity, thus permitting a larger number of flights.
- c)           Cost-effectiveness –PBN implementation will enable a larger number of aircraft to fly their optimum flight profiles, offering users a better cost-effectiveness ratio.
- d)           Efficiency - RNAV-5 application will improve operational efficiency through:
  - ✓           Improvements in airspace management via the repositioning of intersections
  - ✓           Better use of available airspace by means of a route structure that will allow for the establishment of:
    - More direct routes (double and parallel, if necessary) to accommodate a larger air traffic flow
    - A “bypass” route for aircraft overflying TMAs with high air traffic density
    - Alternate or contingency routes
    - Optimum in-flight holding positions
    - Optimized feeder routes

- ✓ Reduction of distances flown, resulting in a fuel saving
  - ✓ Reduction in the number of radio navigation aids
- e) Environmental Protection – Increased efficiency and fuel savings will reduce noxious gas emissions into the atmosphere. Furthermore, the application of specific procedures may help reduce aircraft noise (*e.g.*, continuous descent approach – CDA).
- f) Access and Equity – PBN implementation shall not prevent the flight of unapproved aircraft in a given airspace unless absolutely necessary due to air traffic density. Access and equity are expected to be addressed in this way.
- g) Global Interoperability – RNAV application, as provided for in the PBN Manual, will guarantee global interoperability through the application of standard navigation specifications, thereby avoiding the need to obtain various aircraft and operator approvals in order to fly in airspaces that use the same navigation application.
- h) ATM Community Participation– The success of PBN implementation will depend upon the effective participation of the ATM community, with a view towards guaranteeing that the operational requirements of both the different airspace users and the service providers are met.



1.2. Collect air traffic data in order to understand air traffic flows within a particular airspace.

Domestic and international RNAV routes already handle the main traffic flows. Even so, aircraft operators continue to request new RNAV routes, which must be assessed from the viewpoint of their application, in order to be able to favour the main air traffic flows. It is important to note that the composition and mix of RNAV and non-RNAV routes add complexity to the airspace and prevent a better air traffic management in the SAM Region. The elimination of unused and “conventional” routes should be the first step toward optimizing the route network, depending upon the analysis of the fleet navigation capacity, which will be considered in paragraph 1.3 below. Furthermore, the complete restructuring of the route network in the SAM Region should be undertaken simultaneously with the route implementation, elimination and realignment strategy. This activity will require the creation of an aircraft movement database, in order to precisely identify air traffic flows in the region.

**Attachment 2** contains graphic information about the use of the main ATS routes in the Region, by FIR. **Attachment 3** presents graphs showing the city pairs with the largest number of flights, by FIR. The same air traffic sample for which CARSAMMA data were collected over the period of 13 to 28 January 2008 for the RVSM safety assessment was used to prepare the graphs. As a result, only flights between FL 290 and FL 410 were considered. Full information may be obtained at the SAM Office website.

1.3. Analyze fleet navigation capacity

ICAO is developing a global system to register operator certificates and the corresponding operating specifications. This registry will offer access to information about the authorized operating specifications of any commercial aircraft and is expected to be ready within 5 years.

Given the specific requirements of the SAM Region, it will be necessary to create a PBR regional database before the deadline set by ICAO, in order to make it possible to verify aircraft PBN capacity from the registration data for each aircraft operating in the region.

A survey must first be conducted, so that Civil Aviation Authorities (CAA) can collect the necessary information for the creation of that database.

CAAs shall complete the survey by phases given the complexity of obtaining PBN information for all aircraft operating in the SAM Region. This survey shall include a specific table for each Navigation Specification, making easy and direct consultation by aircraft operators possible, in order to determine whether a specific aircraft is eligible for a given Navigation Specification based only on the list of its installed avionics. An example of the list used by the FAA, which is applicable to RNAV-1 and RNAV-2 navigation specifications, can be found at [http://www.faa.gov/about/office\\_org/headquarters\\_offices/avs/offices/afs/afs400/afs470/media/AC90-100compliance.xls](http://www.faa.gov/about/office_org/headquarters_offices/avs/offices/afs/afs400/afs470/media/AC90-100compliance.xls).

Once the database of PBN-Approved Aircraft and Operators has been created, it will be necessary to compare it with the air traffic movement in the Region, in order to determine the number/percentage of operations that would be carried out by the aircraft approved for each of the

navigation specifications that are expected to be applied in the short term (RNAV-5, RNAV-1, RNP-APCH). In this way, the feasibility of implementation can be determined. The graphs showing the distribution of air traffic movement, of the main operators and types of aircraft, by FIR, are included in **Attachment 5**. In this case, CARSAMMA data for the period 13 - 28 January 2008 was also considered. Complete information can be found at the SAM Office website.

1.4. Analyze the ground communication, navigation (VOR, DME) and surveillance infrastructure for navigation specifications, in order to comply with the Navigation Specification and the navigation reversal mode.

The ground communication, navigation (VOR, DME) and surveillance infrastructure is of fundamental importance for RNAV-5, both to permit the application of that navigation specification and to guarantee the navigation reversal mode in case of loss of the GNSS signal, considering that:

- a) The application of a single RNAV system consisting of one or more sensors, an RNAV computer, a control display unit and a navigation display (HSI, CDI, etc.) can assure the required minimum level of availability and integrity. This is acceptable if the system is monitored by the crew and if the aircraft is capable of navigating using a ground-based navigation system (VOR, DME) in case of a system failure. Therefore, aircraft must fly within the service area of one of the ground-based navigation systems, in order to permit a navigation reversal to a “conventional” system, if needed for safety purposes.
- b) Inasmuch as this is an RNAV specification that does not require on board performance monitoring and alerting systems, ATS surveillance can mitigate the requirement for greater route spacing in order to remedy possible navigation systems failures undetected by the flight crew.
- c) Another basic requirement for RNAV-5 implementation is direct controller-pilot communication, considering that, for the reasons explained in “a” and “b” above, reversion to another navigation system and/or the observation by the controller of the aircraft possible “exit” from its planned flight path, will make an immediate controller-pilot contact necessary.

A full evaluation of the VOR/DME and DME/DME infrastructure will be necessary in order to verify the possibility of implementing the RNAV-5 navigation specification with the use of VOR/DME and/or DME/DME. The information available at this time does not permit this analysis. It is important to stress that in airspaces where this coverage is not available, RNAV-5 can be applied with the use of GNSS and of INS, the latter being limited to 2 hours of flight without a system update.

1.5. Optimize airspace structure by reorganizing the route network or implementing new routes based on the strategic objectives of the Airspace Concept, considering Airspace Modelling, ATC Simulations (in fast time and/or real time), and live trials, etc.

The optimization of airspace structure through a complete reorganization of the route network is the strategy that will guarantee the efficiency of en-route operations in the SAM Region. Because of the complexity and extension of the route network, however, this strategy cannot be carried out in the short term. A short-term strategy should be to optimize the existing network by implementing new routes and, particularly, eliminating unused RNAV or “conventional” routes. The SAM/IG could, after assessing the aircraft fleet navigation capacity and CNS infrastructure, recommend the exclusionary implementation of RNAV-5 within a given airspace volume, between FL 290 and FL 410, for example. If that application is possible, it will, consequently, also be possible to eliminate existing “conventional” routes and to implement a larger number of new RNAV routes to replace routes that have been eliminated, as well as to completely review all existing RNAV routes. In order to be successful with this new route structure, it will be necessary to establish well-defined departure and arrival points in the main TMAs of the Region, in order to favour the main traffic flows.

In the case of a complete restructuring of the route network, Project RLA 06/901 shall consider using the following tools:

- a) airspace modelling;
- b) Fast Time Simulation (FTS);
- c) Real Time Simulation (RTS);
- d) live ATC trials

Use of these tools is not necessary for simple airspace modifications like the implementation of a new RNAV route. But for more complex airspace changes, these tools can provide essential information for guaranteeing efficiency and safety. More information about these tools can be found in the PBN Manual, Volume I, part B, item 4.3.2.

Use of a specific methodology established in the Guide for the Implementation of RNAV Routes in the CAR/SAM Regions, approved in Conclusion 12/7 of GREPECAS/12, should be considered for reorganizing the route structure and/or RNAV route implementation, realignment or elimination.

Route implementation requires the establishment of route spacing and aircraft separation. To accomplish this, it will be necessary to hire experts to make the necessary assessment or to perform a comparative analysis, with other airspaces, for example. The studies made in Europe led to the following route spacing values:

- a) Without additional workload for the air traffic controller:
  - ✓ 18 NM for bi-directional routes;
  - ✓ 16.5 NM for one-way routes; and
  - ✓ 15 NM if aircraft in adjacent routes (opposite directions) do not use the same cruising levels and the percentage of climbs and descents is 40% or less.

- b) When monitoring through ATS surveillance is feasible and ATC intervention capacity is available, a reduction in route spacing to 10-15 NM is possible.
- c) In cases where the application of reduced spacing had been considered, data had to be obtained in order to establish RNAV performance on RNAV-5 routes in Europe.

RNAV-5 approval requirements will enable most aircraft equipped with RNAV systems to meet such requirements. RNAV-5 use does not require a navigation database and does not specify the fulfilment of ARINC 424 leg types. The RNAV-5 Navigation Specification does not meet the requirements for RNAV operations in complex TMAs. RNAV-5 may be used above the MSA, depending on path spacing requirements in the TMAs involved. The purpose of RNAV-5 requirements is to establish RNAV capacity as soon as possible, without any need for significant changes in the airborne equipment of most aircraft.

**2. Develop a performance measurement plan, including gas emissions, safety, efficiency, etc.**

Performance-Based Air Traffic Management is organized based on the principle that ATM community expectations can best be met by quantifying those needs. Therefore, a series of performance objectives, goals and indicators should be established that would make it possible to objectively justify projects that seek to implement performance improvements in the air traffic management system.

The estimated future performance of the ATM system will be of fundamental importance in guiding the planning of the improvements to be implemented. Research and development initiatives should be organized to foster risk analysis in the following situations:

- a) the consequences of keeping the current ATM system status unchanged. In this case, the ATM system would be subject to changes outside the scope of operation of the service provider, such as: air traffic growth, changes in the fleet mix, etc.; and
- b) the consequences of making changes that do not generate the expected improvement in system performance, therefore ceasing to meet established performance goals.

In the case of simple implementations, such as an RNAV route the Key Performance Areas (KPA) involved are safety, efficiency and environmental protection. Safety can be measured qualitatively through a safety case. This possibility will be better described in the specific point on Safety Assessment. Efficiency and environmental protection are intrinsically related, inasmuch as an increase in efficiency normally results in a reduction in fuel consumption, thereby decreasing the amount of gas emissions released into the atmosphere. RNAV route implementation must at least measure the expected savings in flying time and fuel. It is important to stress that the implementation of an RNAV route will not always result in a reduction in flying time, inasmuch as the purpose for its implementation could be, for example, to simplify TMA entry and exit flows, thus reducing the workload of air traffic controllers and, consequently, increasing ATC capacity. In this case, a longer route could possibly create the necessary conditions for the use of continuous descent approach (CDA) procedures.

In more complex implementations, such as a complete restructuring of the route network, the performance assessment will normally depend upon the use of specific tools like Fast Time Simulation, because a full and integrated assessment of the system will be needed that would be difficult to perform manually. Therefore, if the SAM/IG decides on the complete restructuring of the route network, it will be necessary to study alternatives for using the necessary assessment tools.

PBN implementation should consider at least the savings in flying time and fuel consumption, as well as the reduction of noxious gas emissions into the atmosphere. IATA has developed a fuel saving calculation template that can be used to measure system performance. This template can be obtained at the SAM Office website.

### **3. Safety Assessment**

3.1. Determine the methodology to be used for assessing airspace safety and route spacing, depending upon the navigation specification, considering the airspace model, ATC (fast time and/or real time) simulations, and live ATC trials, etc.

Airspace safety assessment methodology may be either quantitative or qualitative. An example of a quantitative method is the safety assessment applied to RSVM implementation and post-implementation. These quantitative methods are based on the Collision Risk Model (CRM) and require the use of experts in specific areas, such as Statistics and Mathematics. CARSAMMA will be responsible for the safety assessment for en-route PBN application. However, this safety assessment would be justified only in the case of major airspace changes such as the complete restructuring of the route network in a significant volume of airspace. Examples of Collision Risk Models used in safety assessments can be found in DOC 9689 – Manual on the Airspace Planning Methodology for Determining Separation Minima.

A qualitative assessment based on the operational judgment would be more advisable in the case of lone route implementation. This type of assessment should be documented through an SMS methodology-based safety case. Doc. 9859, the ICAO Safety Management Manual, and United Kingdom Doc. CAP 760 (Guidance on the Conduct of Hazard Identification, Risk Assessment and the Production of Safety Cases) offer examples of systematic use of this methodology. The latter document can be found at the following website: <http://www.caa.co.uk/docs/33/CAP760.PDF>

Another matter to be considered is the need to calculate route spacing on the basis of the specific characteristics of a given airspace, such as passing frequency, air traffic volume, lateral deviations, etc. This method is based on quantitative methods using CRM.

- 3.2. Prepare a data collection programme for the airspace safety assessment.

In order to prepare the data collection programme, the SAM/IG shall decide upon the safety assessment strategy, considering whether the assessment should be quantitative or qualitative. In the case of complete route network restructuring, CARSAMMA should indicate which data are needed for the safety assessment and/or determining the route spacing to be applied in the SAM Region.

- 3.3. Prepare the preliminary airspace safety assessment.

The preliminary airspace safety assessment should be completed before the implementation date, in order to guarantee the necessary conditions for the start of the pre-operational phase, which normally takes one year.

- 3.4. Prepare the final airspace safety assessment.

The final airspace safety assessment is usually performed one year after the implementation date, which will guarantee the start of the operational phase of a route or of a route network.

#### **4. Establish a collaborative decision-making process (CDM)**

The objective of the collaborative decision-making process is to guarantee that all actors involved in the implementation participate in the different phases of the project, thereby guaranteeing its transparency and adjustment to the interests of all users and service providers.

- 4.1. Coordinate planning and implementation needs with air navigation service providers, airports, regulators, users, aircraft operators and military authorities.

The SAM/IG meetings coordinate most of the planning and implementation needs, bearing in mind the involvement of most of the actors that should participate in the process. Nonetheless, the participating States should ensure that the interests of actors not represented at SAM/IG meetings are also taken into account in the planning and implementation, such being, for example, general aviation, military flights, air navigation service providers (when the representatives in the SAM/IG involve only regulators), etc.

- 4.2. Establish the implementation date.

The implementation date is one of the main project aspects to be taken into account, bearing in mind that it may possibly be adjusted to the interests of the various actors involved.

- 4.3. Establish the documentation format at the CAR/SAM RNAV/RNP website.

The Internet is an important mechanism for disseminating PBN documentation to all actors involved in its implementation. The SAM/IG Meeting should decide the form to be given to the website, so that PBN supporting documents can be posted there. The South American Regional Office already has a website for the PBN: <http://www.lima.icao.int/submenu1.asp?Url=/ICAOSAMNET/AirNav-eDocumentsMenu.asp>. This website appears to be “hidden,” however, and does not facilitate access by those involved in PBN implementation in the Region.

4.4. Report advances in planning and implementation to the relevant Regional office.

Planning and implementation advances will be made known to the South American Regional Office through the reports of SAM/IG meetings. It will also be necessary to set up a mechanism to ensure the harmonization of CAR and SAM implementation. Several members from the CAR Region expressed their interest, at the Sixth Meeting of the GREPECAS ATM Committee, in participating in SAM/IG meetings with a view towards achieving joint CAR/SAM implementation by following the same RVSM implementation model. In this connection, the SAM/IG/2 Meeting should study the advisability of adopting a mechanism similar to that used for RVSM implementation for PBN en-route implementation.

## 5. Automated ATC Systems

5.1. Assess PBN implementation in automated ATC systems, considering amendment 1 to the PANS/ATM (FPLSG).

Making changes in the automated ATC system as a result of PBN implementation is closely related to the need of the air traffic controller to differentiate between aircraft that are equipped for operations based on RNAV and RNP navigation specifications, and those that are not. That differentiation is particularly important in operating environments where aircraft separation depends upon aircraft PBN approval. Changes in automated systems may vary in complexity, from the insertion of letters or codes in the flight progress cards and/or in the radar screen targets, to a complete change involving differentiated colours or a prior analysis before a flight plan is entered into the flight plan processing system, in order to guarantee that only approved aircraft may fly an RNAV route or perform an RNP procedure at the FPL.

Changes in automated ATC systems must consider amendment 1 to the PANS/ATM. This amendment, resulting from the work of the ICAO Air Navigation Commission Study Group on Flight Plans, was approved at the 177th Session of that Commission and will enter into effect on 15 November 2012. States were informed of the approval of amendment 1 to the PANS/ATM through ICAO State Letter AN 13/2.1-08/50, of 25 June 2008.

The amendment involves making significant changes in the insertion of alphanumeric codes relating to RNAV and RNP approval that are of key importance for PBN implementation. Considering the present flight plan limitations, most of these codes will be inserted in field 18. To sum up, the changes concerning PBN are as follows:

- a) The name of FPL field 10 is changed to "Equipment and Capabilities";
- b) The letter "R" in field 10 is changed to mean "PBN Approval". Navigation specifications for which the aircraft and operator are approved should be inserted in FPL field 18, using the following codes:

**- RNAV SPECIFICATIONS**

- ✓ A1 - RNAV 10 (RNP 10)
- ✓ B1 - RNAV 5 all permitted sensors

- ✓
- ✓ B2 - RNAV 5 GNSS
- ✓ B3 - RNAV 5 DME/DME
- ✓ B4 - RNAV 5 VOR/DME
- ✓ B5 - RNAV 5 INS or IRS
- ✓ B6 - RNAV 5 LORANC
- ✓ C1 - RNAV 2 all permitted sensors
- ✓ C2 - RNAV 2 GNSS
- ✓ C3 - RNAV 2 DME/DME
- ✓ C4 - RNAV 2 DME/DME/IRU
- ✓ D1 - RNAV 1 all permitted sensors
- ✓ D2 - RNAV 1 GNSS
- ✓ D3 - RNAV 1 DME/DME
- ✓ D4 - RNAV 1 DME/DME/IRU
- RNP SPECIFICATIONS**
- ✓ L1 - RNP 4
- ✓ O1 - Basic RNP 1 all permitted sensors
- ✓ O2 - Basic RNP 1 GNSS
- ✓ O3 - Basic RNP 1 DME/DME
- ✓ O4 - Basic RNP 1 DME/DME/IRU
- ✓ S1 - RNP APCH
- ✓ S2 - RNP APCH with BARO-VNAV
- ✓ T1 - RNP AR APCH with RF (special authorization required)
- ✓ T2 - RNP AR APCH without RF (special authorization required)

- c) The letter “G” continues to be used in field 10 to mean “Equipped with GNSS.” The corresponding augmentations should be entered in field 18, using the NAV code.

5.2. Make the necessary changes in the automated ATC systems.

Making changes in automated ATC systems is usually a complicated, expensive and slow process for most States. As a result, only changes that are deemed essential for safety and efficiency purposes shall be made. Two main scenarios are possible in the case of PBN en-route implementation:

- a) RNAV and non-RNAV routes combined – in this scenario, use of the automated ATC system would be limited to “investigating” whether the aircraft is effectively approved for flight on the RNAV route. This investigation could be made offline, through the comparison of air traffic samples with a database of approved aircraft, in the same way that CARSAMMA and the States do in the case of RVSM operations. In this scenario, aircraft separation is not considered to be dependent upon RNAV approval. In the case of RNAV routes in which the separation depends upon RNAV approval, a greater degree of ATC automation will be needed to indicate to the air traffic controller which aircraft have RNAV approval and which do not.
- b) The existence in this scenario of exclusionary RNAV airspaces (with or without special exceptions--State aircraft, humanitarian flights, first delivery, etc.) means that route spacing will depend upon aircraft RNAV approval and ATC automation will be essential to indicate the approval status of aircraft to the air traffic controller.

## **6. Aircraft and operator approval**

6.1. Analyze the requirements for aircraft and operator approval (pilots, dispatchers and maintenance personnel), as established in the PBN Manual, and prepare the necessary documentation.

The PBN Manual, Volume II, Part B, Chapter 2 stipulates the general requirements for aircraft and operator approval for RNAV-5. EUROCONTROL and the FAA have the following documents:

- a) EUROCONTROL - AMC 20-4 - Airworthiness Approval and Operational Criteria for the Use of Navigation Systems in European Airspace Designated for Basic RNAV Operations.
- b) FAA – AC 90-96A - Approval of U.S. Operators and Aircraft to Operate under Instrument Flight Rules (IFR) in European Airspace Designated for Basic Area Navigation (B-RNAV) and Precision Area Navigation (P-RNAV).

6.2. Publish national regulations for implementing the RNAV-5 navigation specification.

The navigation specifications in the PBN Manual identify the operational and airworthiness approval requirements for the use of RNAV or RNP applications. Provision must be made in national operational regulations for checking compliance with these requirements, which may require specific operational approval.

The RLA/99/901 Project is preparing the Latin American (LAR) Regulations, whose purpose is to harmonize the operational and airworthiness approval process in Latin America. Regional documentation provided through the LARs is expected to be available shortly. Coordination between this project and Project RLA 06/901 is fundamental for avoiding a duplication of efforts and facilitating the work of the States involved. Project RLA 99/901 could at least offer guidance material for adoption and publication by the States.

One option already in use by CAR/SAM States has been to adopt documents of other States and International Organizations, as in the case of Interim Guidance 91 (RVSM) and Order 8400-12 (RNP-10).

6.3. Start the aircraft and operator approval process.

In order to meet the established implementation deadline, States should start the aircraft and operator approval process and Project RLA 06/901 should check to see whether all States effectively initiate that process, in order to harmonize the activities of the States involved.

6.4. Establish a database of approved aircraft and operators and keep it up-to-date.

The SAM/IG shall establish a strategy for creating a database of aircraft and operators approved for RNAV-5 operations, as it did in the case of RVSM implementation, bearing in mind the following objectives:

- a) When the route network is to be completely restructured, and mainly in the case of an exclusive airspace, the process will rely on a minimum percentage of approved RNAV-5 operations. In this connection, the creation of the database will be essential for analyzing the minimum percentage.
- b) Verify whether the aircraft flying RNAV routes are effectively approved for RNAV-5 operations.

6.5. Check operations through the use of a continuous monitoring programme (aircraft and procedures).

6.6. Safety must be ensured by a continuous operational verification programme regulated by the States.

## 7. Standards and Procedures

7.1. Assess the regulations for GNSS use and, where appropriate, proceed to their publication.

GNSS application is of key importance for all PBN navigation specifications, considering that some aircraft possess only this equipment to meet the established performance requirements and that there are some specifications that only GNSS can satisfy.

The key issue is the State policy with regard to GNSS application as a means of navigation. In order for the system to be used fully, States must regulate its use as a primary means of navigation, even if this should require imposing some operational restrictions, such as, for example, requiring alternative aerodromes to provide for conventional approaches (VOR, NDB, ILS). Another aspect that should be considered is the need to establish a reversion to navigation mode if the GNSS signal is lost, requiring aircraft to be equipped with conventional air navigation systems.

States in the Region have already published some regulations for GNSS use. **Attachment 4** shows the current status of these regulations in the SAM Region. Regulation of GNSS use is essential for all navigation applications.

GNSS use as a means of navigation is of key importance for fulfilling RNAV-5 requirements, considering that some aircraft only have this type of RNAV equipment. As a result, SAM States should consider regulating GNSS use and make any changes they deem necessary.

7.2. Finalize WGS-84 implementation.

7.3. Prepare a model AIC to report PBN implementation plans.

The AIC reporting that PBN implementation will be effected within almost 2 years will give aircraft operators sufficient time to obtain RNAV-5 approval before that date.

7.4. Publish the AIC reporting the planning of PBN implementation.

States must publish the AIC reporting PBN implementation plans, based on the model prepared by Project RLA 06/901. These AICs must be published on the same date, to be determined by States at the SAM/IG meetings.

7.5. Prepare an AIP Supplement model containing applicable standards and procedures, including the corresponding in-flight contingencies.

The AIP Supplement will contain specific operational standards and procedures for RNAV-5 implementation. Project RLA 06/901 will prepare a model similar to that developed for RVSM implementation, whose use will be considered by States based on discussions at the SAM/IG meetings.

7.6. Publish an AIP Supplement containing applicable standards and procedures, including the corresponding flight contingencies.

7.7. States should publish the AIP Supplement, based on the model prepared by Project RLA/06/901, on a common date to be determined at the SAM/IG meetings.

7.8. Review the Procedural Handbook of ATS units involved.

The Procedural Handbook of ATS units gives a detailed account of their mode of operation, in an effort to harmonize the operational procedures applied by air traffic controllers. RNAV-5 implementation will require the review of these procedures, considering in particular:

- a) Aircraft separation;
- b) Contingency procedures;
- c) New route network or networks implemented, eliminated and/or realigned;
- d) Essential radio aids for the use of a given navigation specification;
- e) New air traffic routing models (new area circulation), including uni-directional and bi-directional routes and TMA feeding.

7.9. Update letters of agreement between ATS units

Letters of agreement between ATS units should be updated (between ACCs or between an ACC and an APP), in order to reflect the new airspace structure implemented and the procedures mentioned in the previous paragraph.

7.10. Prepare an amendment to regional documentation, if necessary.

SAM/IG meetings shall assess whether amendments to regional documentation will be necessary in the light of PBN implementation for en-route operations. RNAV route implementation, elimination and realignment will undoubtedly require the amendment of the Regional Air Navigation Plan – Volume I – Basic (Doc. 8733). Nonetheless, consideration should be given to inserting a specific chapter for RNAV-5 application to en-route operations in the Regional Supplementary Procedures (Doc. 7030 – SUPPS), if a complete reformulation of the route network is decided upon as a result of RNAV-5 implementation. Chapter 17 of the European part of Doc. 7030 – SUPPS, which establishes all applicable procedures for using BRNAV (RNAV-5) is an example of this documentation.

7.11. Channel the proposed amendment to Doc. 7030 in the right direction, if necessary.

The ICAO South American Regional Office will, if necessary, channel proposed amendments to Doc 7030 in the right direction in time to reach the implementation deadline.

7.12. Revise practices and procedures for improving fuel consumption management and environmental care

This should be an objective to be sought at all SAM/IG meetings, in accordance with the environmental policy of ICAO and of the SAM States.

## **8. Training**

8.1. Prepare a training and documentation programme for operators (pilots, dispatchers and maintenance personnel).

The documentation and training leading to the operational approval of aircraft operators is normally part of the operational certification process guaranteeing the use of an air navigation application. Each aircraft operator must prepare a training programme for approval by the Civil Aviation Authority, in order to obtain approval for the use of an air navigation application. The PBN Manual, Volume II, Part B contains some general training guidelines designed for Aircraft Operators that cover each Navigation Specification.

Project 99/901 will develop a training document model for operators.

8.2. Prepare a training and documentation programme for air traffic controllers and AIS operators.

The PBN Manual, Volume II, Part B contains some general training guidelines designed for air traffic controllers that cover each Navigation Specification.

Project RLA/06/901 will prepare a training document model for air traffic controllers and AIS operators.

8.3. Prepare a training programme for regulators (aviation safety inspectors).

States should offer aviation safety inspectors the necessary training to equip them to check compliance with PBN specification norms.

8.4. Conduct training programmes

States, service providers and aircraft operators must conduct the necessary training programmes within the stipulated period in order to guarantee implementation by the established deadline.

**ATTACHMENT 1 TO APPENDIX B**

**SHORT-TERM EN-ROUTE PBN ACTION PLAN (RNAV-5)  
(GPIs 1, 4, 5, 7, 8, 10, 11, 12, 16, 21, 23)**

<b>1. Airspace concept</b>	<b>Start</b>	<b>End</b>	<b>Responsible party</b>	<b>Remarks</b>
1.1 Establish and prioritize strategic objectives (safety, capacity, environment, etc.)	June/2008	SAM/IG/2	SAM/PBN/IG (Project RLA/06/901)	Completed
1.2 Collect traffic data in order to understand traffic flows in a given airspace	June/2008	SAM/IG/2	SAM/PBN/IG (Project RLA/06/901)	In process
1.3 Analyze the navigation capacity of the aircraft fleet	June/2008	SAM/IG/4	SAM/PBN/IG (Projects RLA/06/901 and RLA/99/901) States IATA	
1.4 Analyze ground-based means of communication, navigation (VOR, DME) and surveillance to meet navigation specifications and the navigation reversal mode	June/2008	SAM/IG/3	SAM/PBN/IG (Projects RLA/06/901 and RLA/99/901) States	
1.5 Optimize airspace structure, reorganizing the network or implementing new routes based on the strategic objectives of the airspace concept, taking into account airspace modelling, ATC simulations (fast time and/or real time), live tests, etc.	SAM/IG/2	SAM/IG/4	SAM/PBN/IG (Project RLA/06/901) States IATA	
<b>2. Develop a performance measurement plan</b>	<b>Start</b>	<b>End</b>	<b>Responsible party</b>	<b>Remarks</b>
2.1 Draft a plan to measure performance, including gas emissions, safety, efficiency, etc.	SAM/IG/2	SAM/IG/4	SAM/PBN/IG (Project RLA/06/901)	

<b>2. Develop a performance measurement plan</b>	<b>Start</b>	<b>End</b>	<b>Responsible party</b>	<b>Remarks</b>
2.2 Implement the performance measurement plan	Nov/2010	Permanent	SAM/PBN/IG (Project RLA/06/901) States IATA	

<b>3 Safety assessment</b>	<b>Start</b>	<b>End</b>	<b>Responsible party</b>	<b>Remarks</b>
3.1 Determine the methodology to be used to assess airspace safety and route spacing, based on the navigation specification, taking into account airspace modelling, ATC simulations (fast time and/or real time), live tests, etc.	SAM/IG/2	SAM/IG/4	CARSAMMA Project RLA/06/901	RLA/06/901 in order to provide guidance material to CARSAMMA
3.2 Develop a data collection programme to assess airspace safety	SAM/IG/2	SAM/IG/4	CARSAMMA Project RLA/06/901	RLA/06/901 in order to provide guidance material to CARSAMMA
3.3 Prepare the preliminary airspace safety assessment	SAM/IG/2	SAM/IG/4	CARSAMMA Project RLA/06/901	RLA/06/901 in order to provide guidance material to CARSAMMA
3.4 Prepare the final airspace safety assessment	SAM/IG/4	Nov/2010	CARSAMMA	

<b>4 Establish a collaborative decision-making process (CDM)</b>	<b>Start</b>	<b>End</b>	<b>Responsible party</b>	<b>Remarks</b>
4.1 Coordinate planning and implementation requirements with air navigation service providers, regulators, users, aircraft operators and military authorities	SAM/IG/2	SAM/IG/4	SAM/PBN/IG States	

<b>4</b>	<b>Establish a collaborative decision-making process (CDM)</b>	<b>Start</b>	<b>End</b>	<b>Responsible party</b>	<b>Remarks</b>
4.2	Establish the implementation date	SAM/IG/1	SAM/IG/4	SAM/PBN/IG States	States must analyze the feasibility of the tentative date in coordination with domestic operators and military authorities
4.3	Establish the documentation format in the SAM PBN website	SAM/IG/1	SAM/IG/2	SAM Regional Office	Completed
4.4	Report planning and implementation progress to the corresponding Regional Office	SAM/IG/2	SAM/IG/4	SAM/PBN/IG States	

<b>5</b>	<b>ATC automated systems</b>	<b>Start</b>	<b>End</b>	<b>Responsible party</b>	<b>Remarks</b>
5.1	Assess PBN implementation in ATC automated systems, taking into account amendment 1 to the PANS/ATM (FPLSG).	June/2008	SAM/IG/4	SAM/PBN/IG (Project RLA/06/901)	Assign task to the Project
5.2	Implement the necessary changes in ATC automated systems	SAM/IG/2	TBD	States	

<b>6</b>	<b>Aircraft and operator approval</b>	<b>Start</b>	<b>End</b>	<b>Responsible party</b>	<b>Remarks</b>
6.1	Analyze aircraft and operator approval requirements (pilots, dispatchers and maintenance personnel) in keeping with the PBN manual, and develop the necessary documentation.	June/2008	SAM/IG/2	Regional Project RLA/99/901-Regional Safety Oversight Cooperation System	Completed
6.2	Publish national regulations for the implementation of the RNAV-5 navigation specification	SAM/IG/2	SAM/IG/3	States	

<b>6</b>	<b>Aircraft and operator approval</b>	<b>Start</b>	<b>End</b>	<b>Responsible party</b>	<b>Remarks</b>
6.3	Begin the approval of aircraft and operators	SAM/IG/3	SAM/IG/5	States	
6.4	Establish and keep up to date a registry of approved aircraft and operators	SAM/IG/3	Permanent	CARSAMMA States	
6.5	Verify the operation of the continuous monitoring programme (aircraft and procedures)	Nov/2010	Permanent	States	

<b>7</b>	<b>Standards and procedures</b>	<b>Start</b>	<b>End</b>	<b>Responsible party</b>	<b>Remarks</b>
7.1	Assess and, if applicable, publish the regulations on the use of GNSS.	June/2008	SAM/IG/2	SAM/PBN/IG (Project RLA/06/901) States	Completed
7.2	Finalize WGS-84 implementation	TBD	TBD		AIS provide information
7.3	Develop an AIC model to report PBN implementation plans	June/2008	SAM/IG/2	SAM/PBN/IG (Project RLA/06/901)	Completed
7.4	Publish the AIC reporting PBN implementation plans	SAM/IG/2	SAM/IG/3	States	
7.5	Develop an AIP Supplement model containing applicable standards and procedures, including the corresponding in-flight contingencies	SAM/IG/4	SAM/IG/5	SAM/PBN/IG (Project RLA/06/901)	
7.6	Publish the AIP Supplement containing applicable standards and procedures, including the corresponding in-flight contingencies	SAM/IG/5	SAM/IG/6	States	
7.7	Review the Procedural Handbook of the ATS units involved	SAM/IG/5	SAM/IG/6	States	
7.8	Update the letters of agreement between ATS units	SAM/IG/5	SAM/IG/6	States	
7.9	Develop an amendment to regional documentation, if necessary	SAM/IG/3	SAM/IG/4	SAM/PBN/IG (Project RLA/06/901)	

<b>7 Standards and procedures</b>	<b>Start</b>	<b>End</b>	<b>Responsible party</b>	<b>Remarks</b>
7.10 Submit a proposal of amendment to Doc. 7030, if necessary	SAM/IG/5	SAM/IG/6	SAM Regional Office	
7.11 Review practices and procedures to improve fuel consumption management and environmental protection	SAM/IG/1	Permanent	SAM/PBN/IG (Project RLA/06/901)	

<b>8. Training</b>	<b>Start</b>	<b>End</b>	<b>Responsible party</b>	<b>Remarks</b>
8.1 Develop a training and documentation programme for operators (pilots, dispatchers and maintenance personnel)	SAM/IG/4	SAM/IG/5	Regional Project RLA/99/901	
8.2 Develop a training and documentation programme for air traffic controllers and AIS operators	SAM/IG/4	SAM/IG/5	SAM/PBN/IG (Project RLA/06/901)	
8.3 Develop a training programme for regulators (aviation safety inspectors)	SAM/IG/4	SAM/IG/5	States	
8.4 Conduct training programmes	SAM/IG/5	SAM/IG/6	States	
8.5 Conduct seminars for operators, explaining plans and expected operational and economic benefits	SAM/IG/1	SAM/IG/3	States	

<b>9. Implementation decision</b>	<b>Start</b>	<b>End</b>	<b>Responsible party</b>	<b>Remarks</b>
9.1 Assess the available operational documentation (ATS, OPS/AIR)	July/2010	N/A	States	
9.2 Assess the percentage of aircraft and operators (non-exclusionary airspace)	July/2010	N/A	States	

<b>9. Implementation decision</b>	<b>Start</b>	<b>End</b>	<b>Responsible party</b>	<b>Remarks</b>
9.3 Analyze the results of the safety assessment	July/2010	N/A	States	
9.4 Publish trigger NOTAM	Nov/2010	N/A	States	

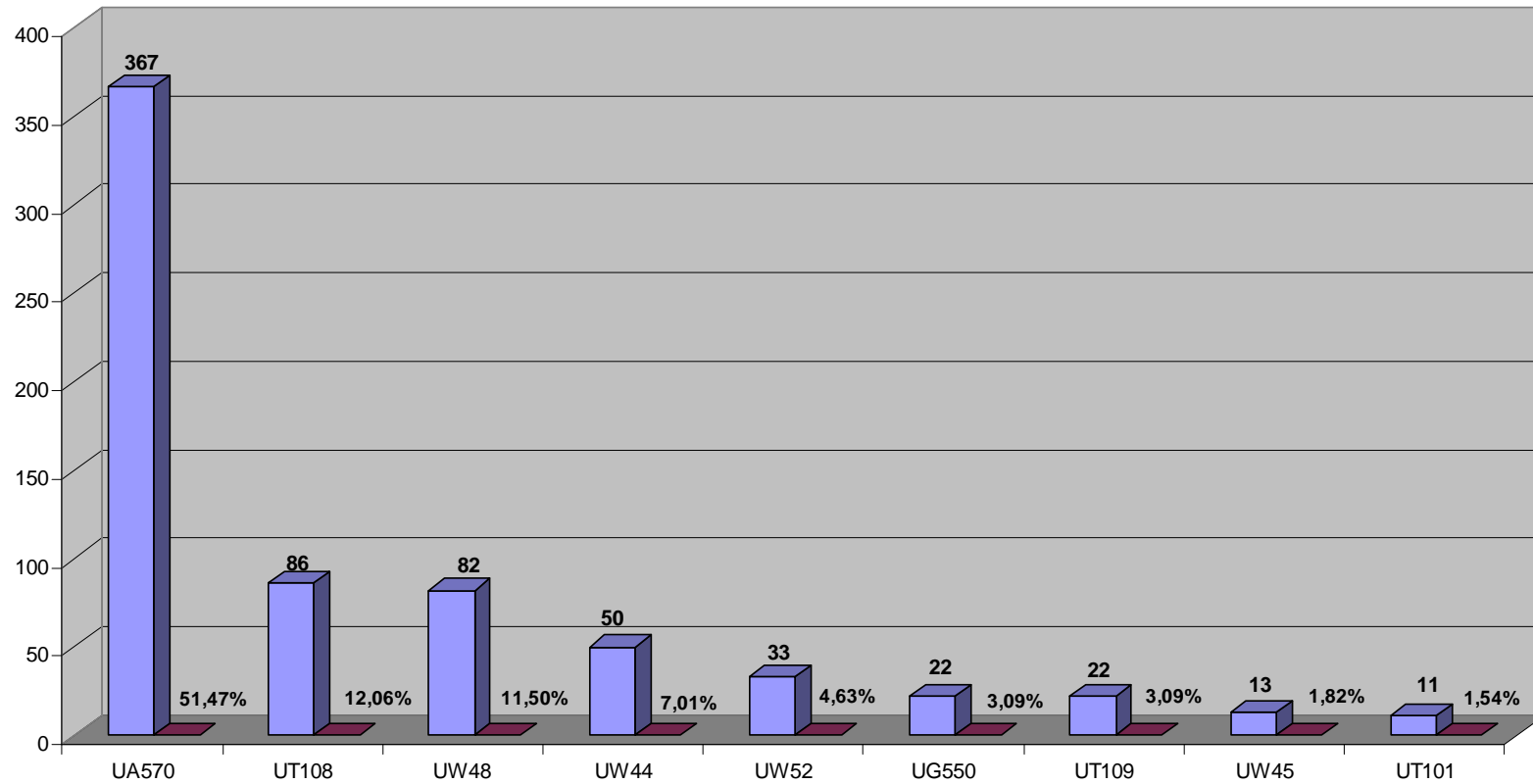
<b>10. Performance monitoring system</b>	<b>Start</b>	<b>End</b>	<b>Responsible party</b>	<b>Remarks</b>
10.1 Develop a post-implementation en-route operations monitoring programme	SAM/IG/4	SAM/IG/5	SAM/PBN/IG (Project RLA/06/901)	
10.2 Implement a post-implementation en-route operations monitoring programme	Nov/2010	Nov/2011	States	
<b>Pre-operational implementation date</b>	Nov/2010	N/A		
<b>Definitive implementation date</b>	Nov/2011	N/A		

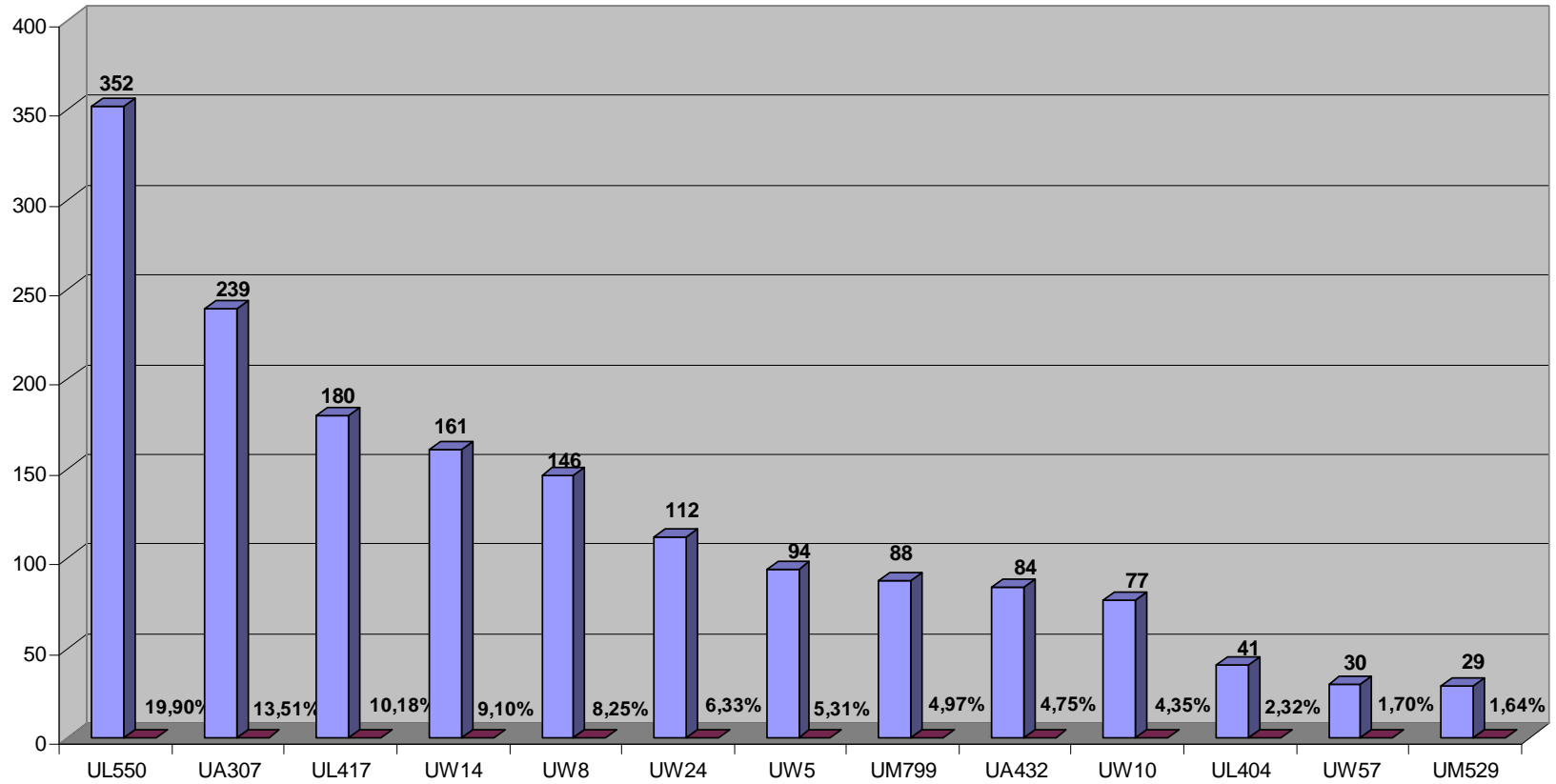
**ADJUNTO 2 AL APÉNDICE B / ATTACHMENT 2 TO APPENDIX B**

**ATS ROUTES – SAM REGION / RUTAS ATS - REGIÓN SAM**

**ARGENTINA**

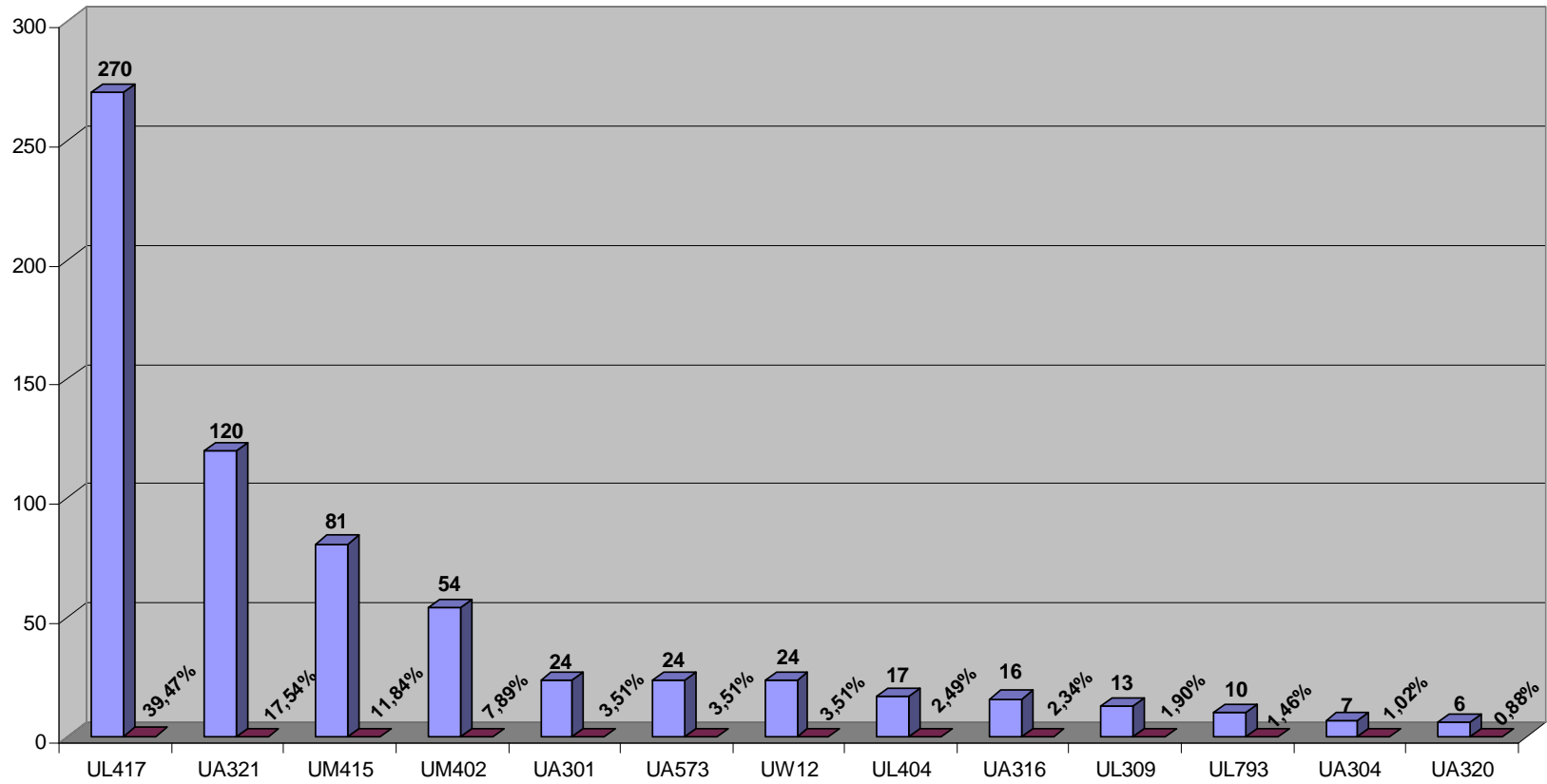
**FIR COMODORO RIVADAVIA - RUTAS ATS**  
96% del tránsito de la muestra

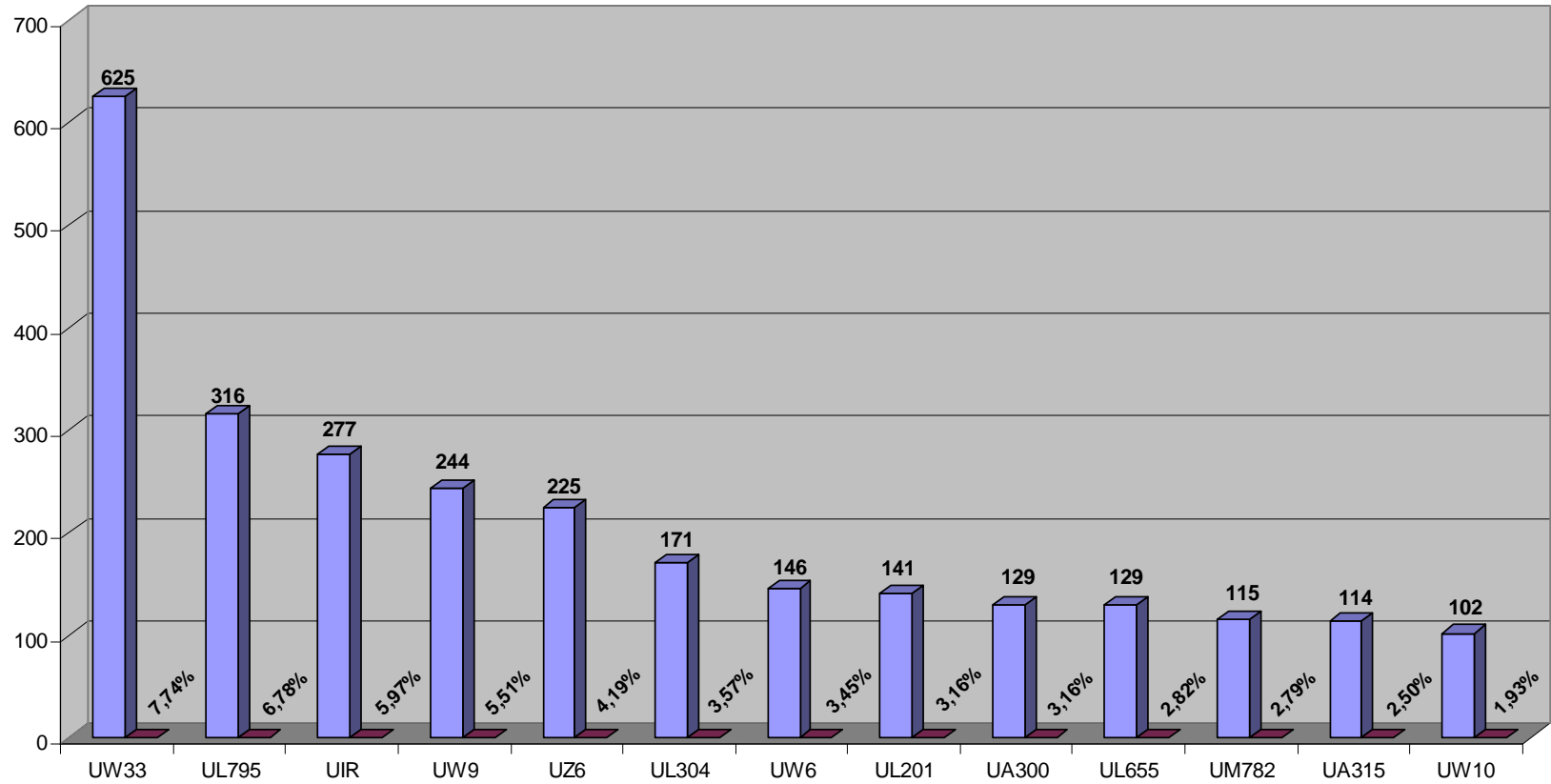


**FIR CORDOBA - RUTAS ATS**  
**92% del tránsito de la muestra**

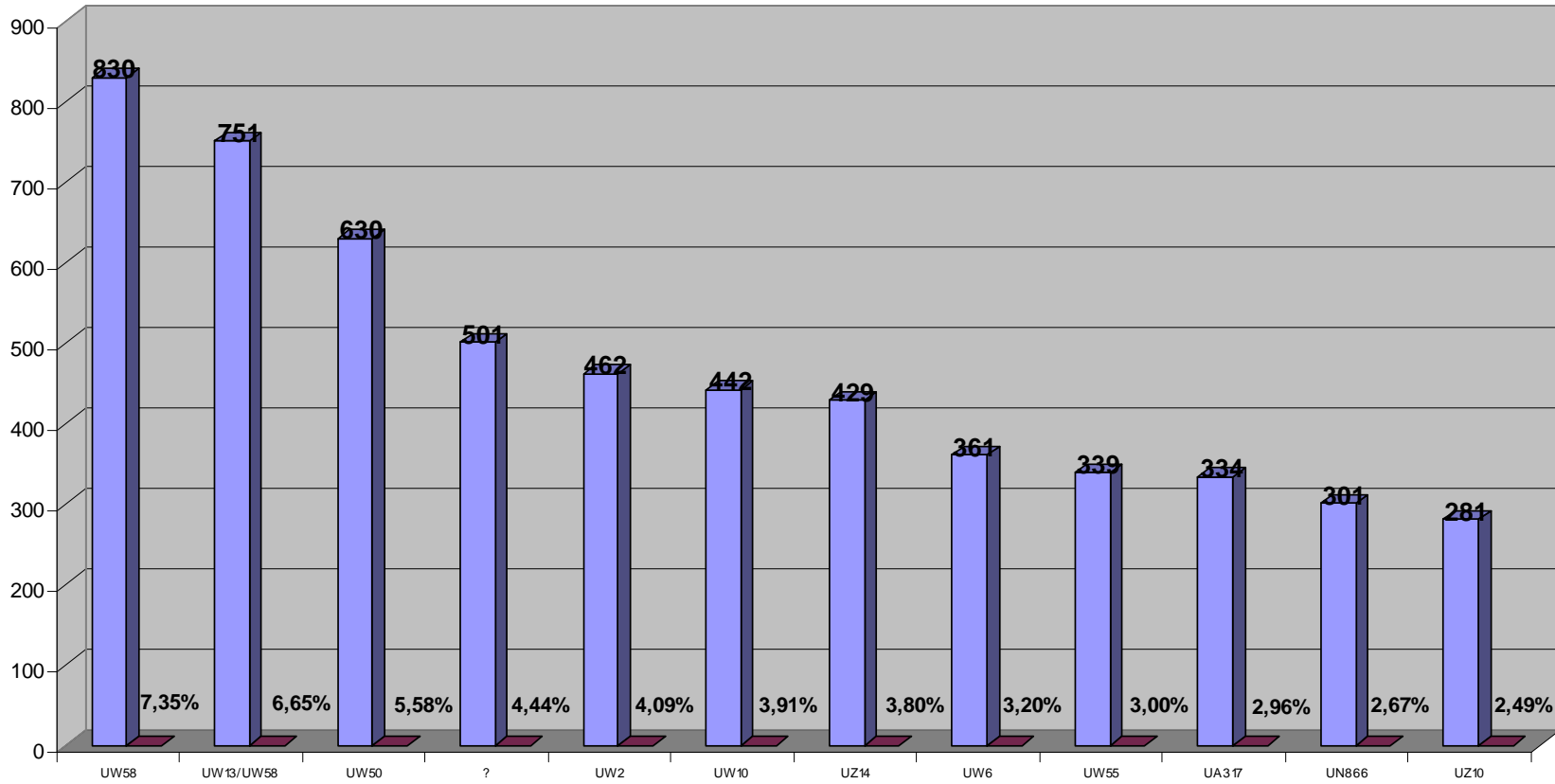
**BOLIVIA**

**FIR LA PAZ - RUTAS ATS**  
97% del tránsito de la muestra

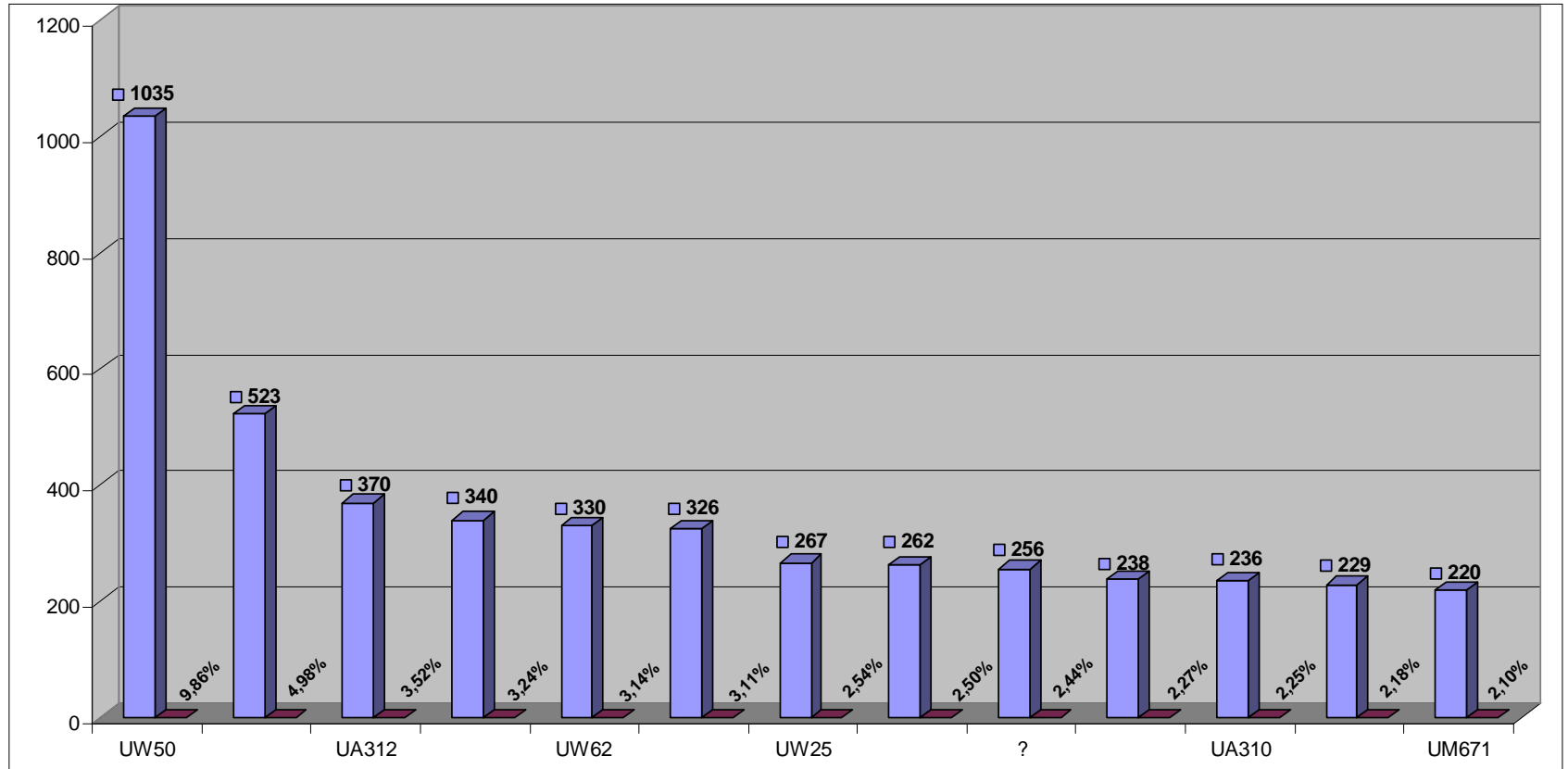


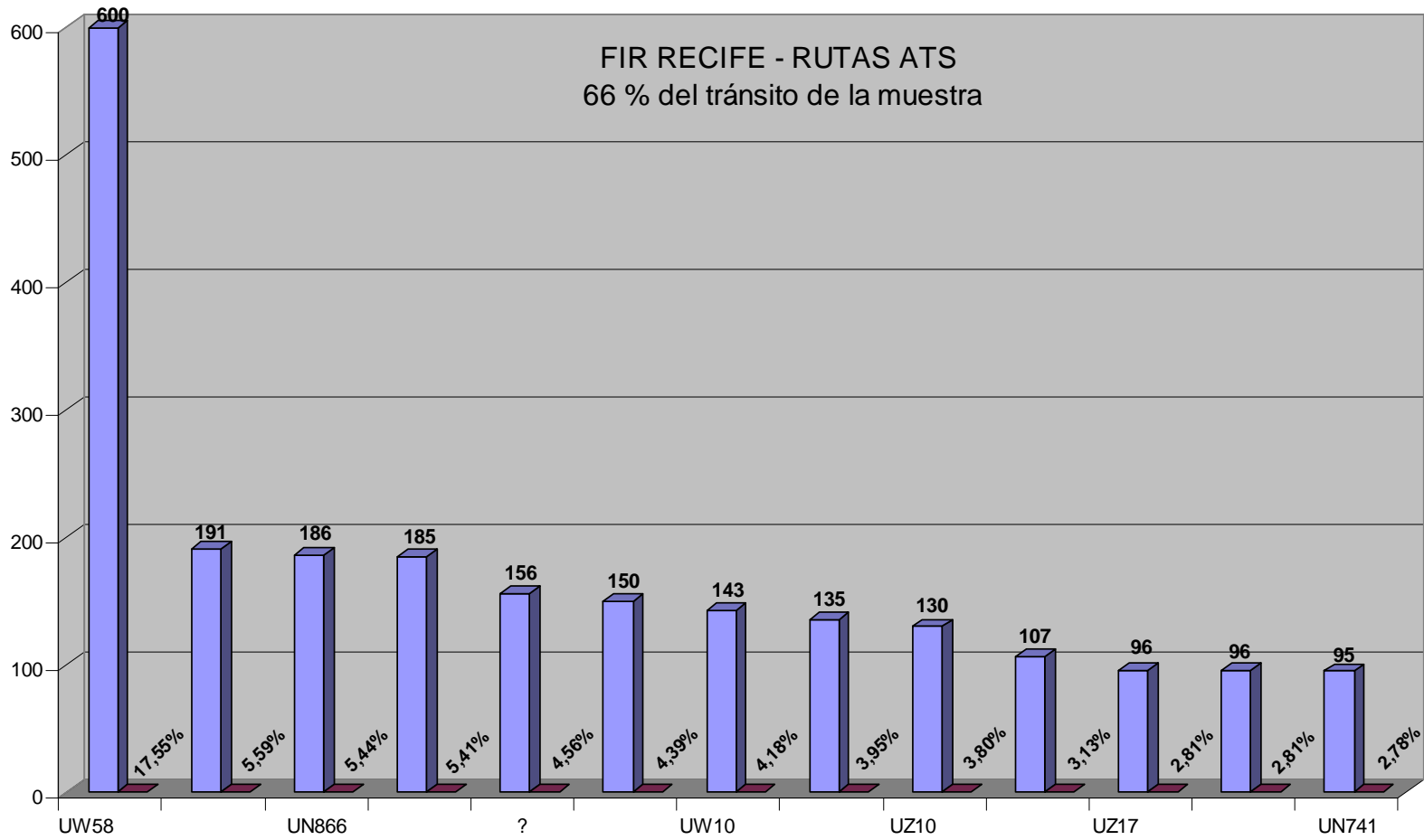
**BRAZIL / BRASIL****FIR Amazónica - RUTAS ATS  
67 % del tránsito de la muestra**

**FIR BRASÍLIA - RUTAS ATS**  
**50% del tránsito de la muestra**

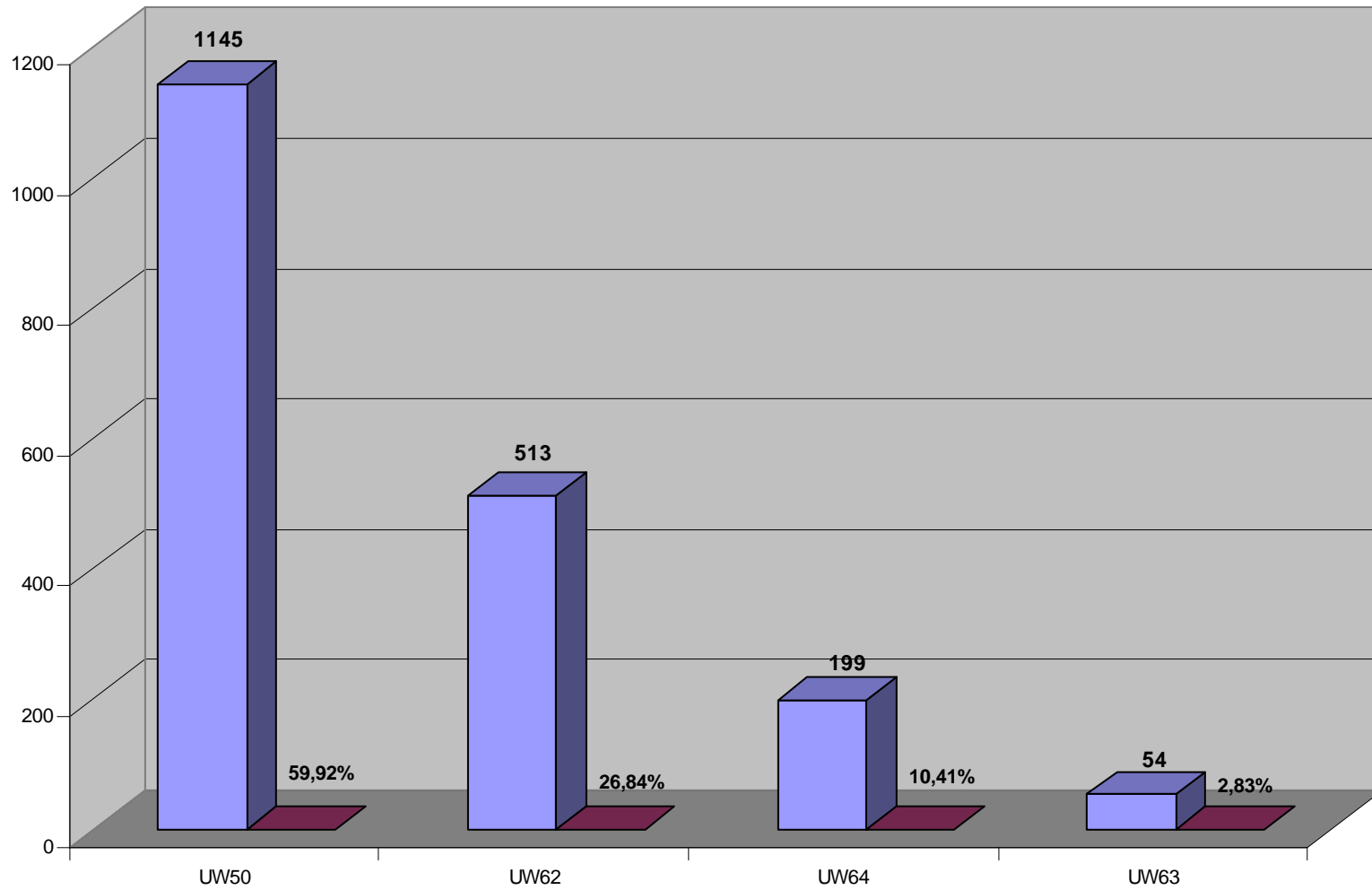


**FIR CURITIBA - RUTA ATS**  
**44% del tránsito de la muestra**



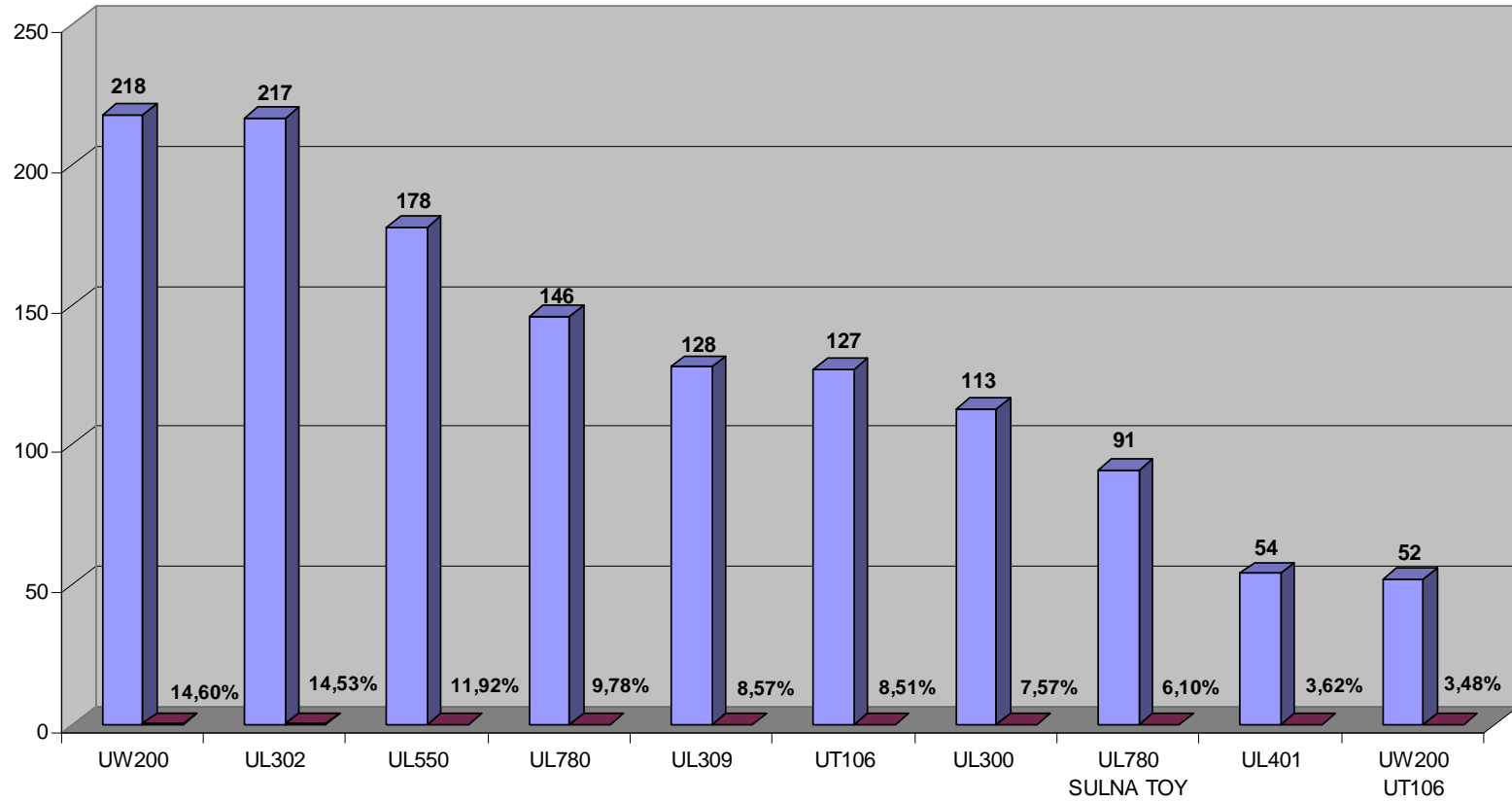


**TMA SÃO PAULO - RUTAS ATS**  
**100% del tránsito de la muestra**

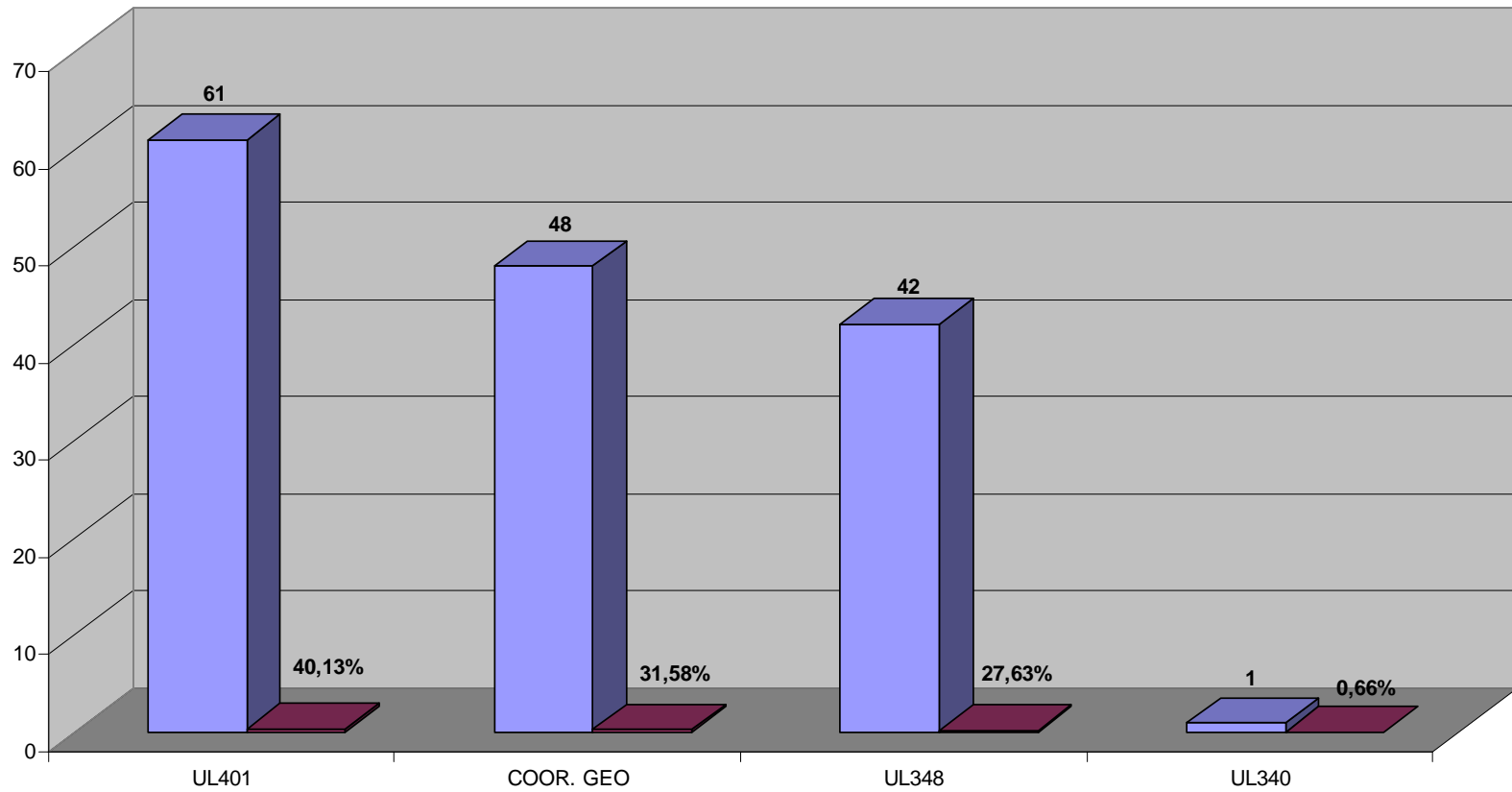


**CHILE**

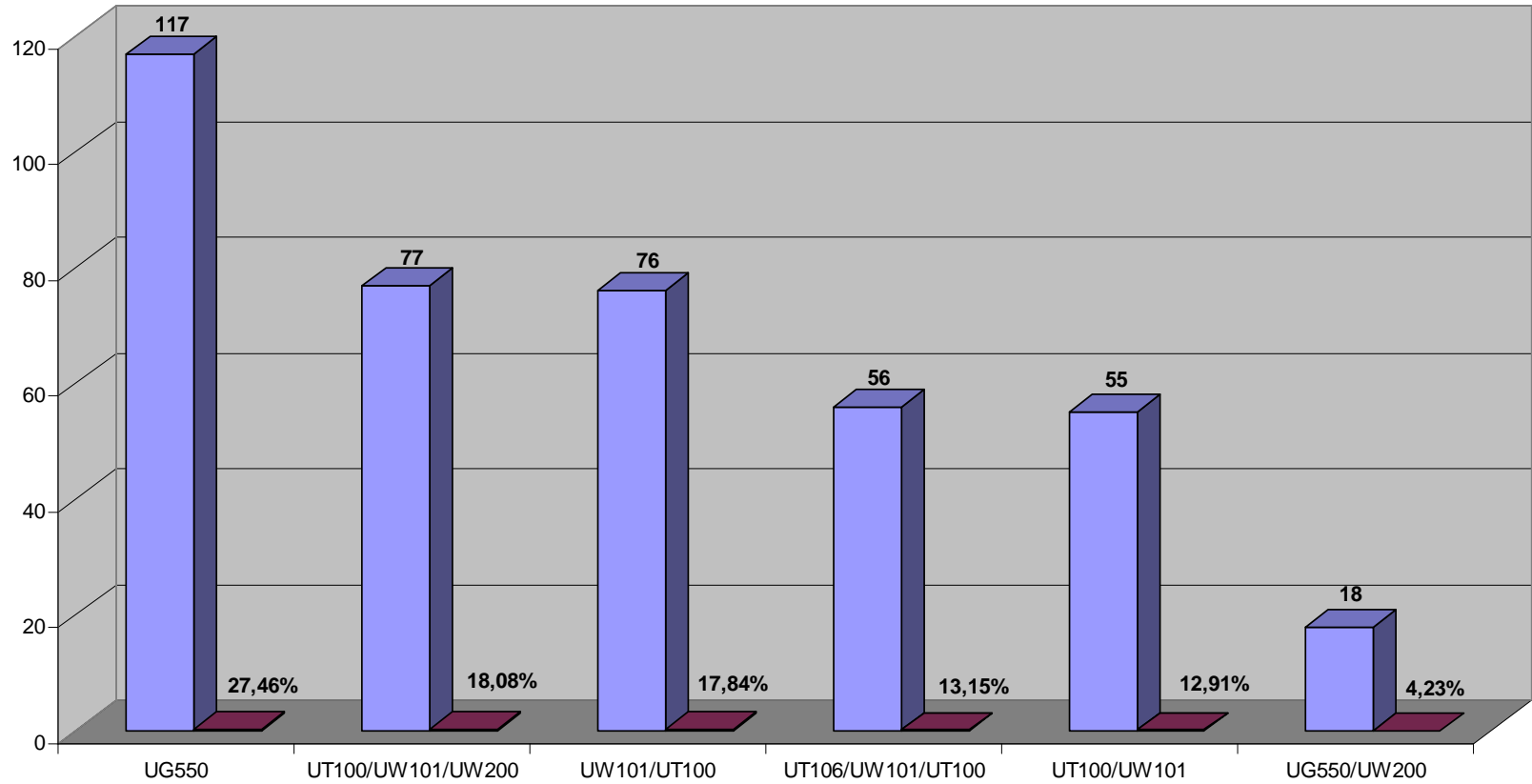
**FIR ANTOFOGASTA - RUTAS ATS**  
**89% del tránsito de la muestra**



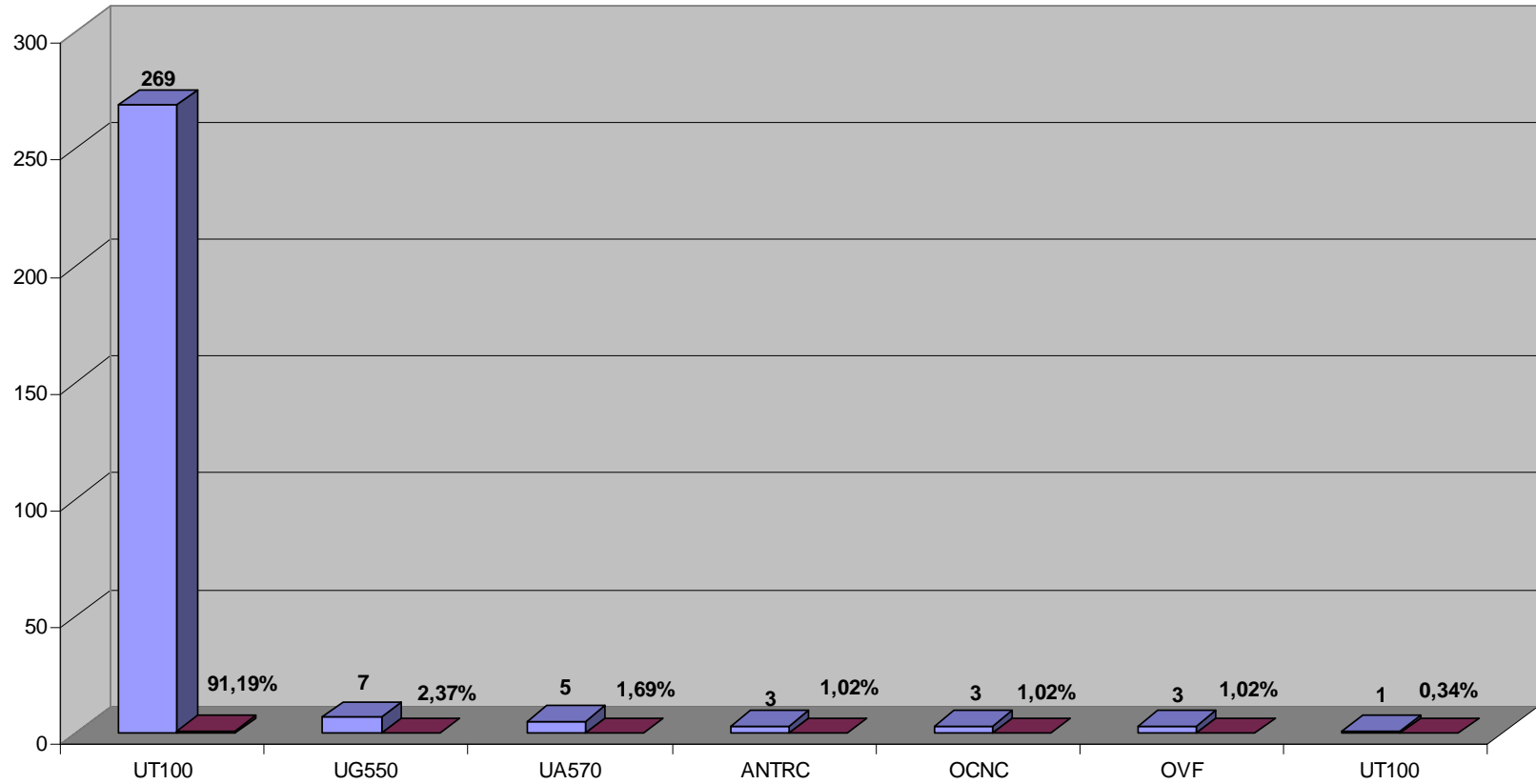
**FIR PASCUA - RUTAS ATS**  
**100% del tránsito de la muestra**



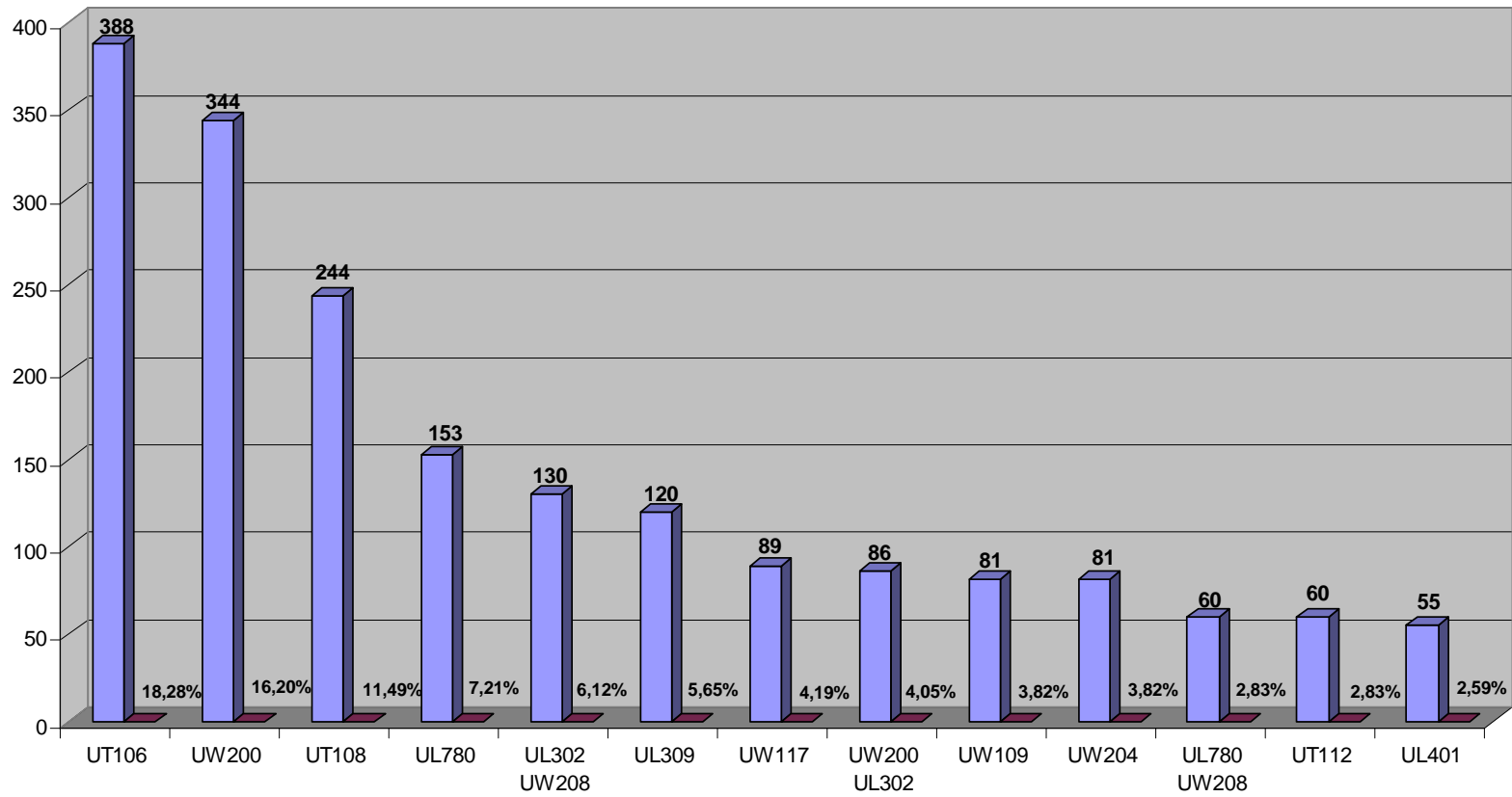
**FIR PUERTO MONTT - RUTAS ATS**  
**94% del tránsito de la muestra**



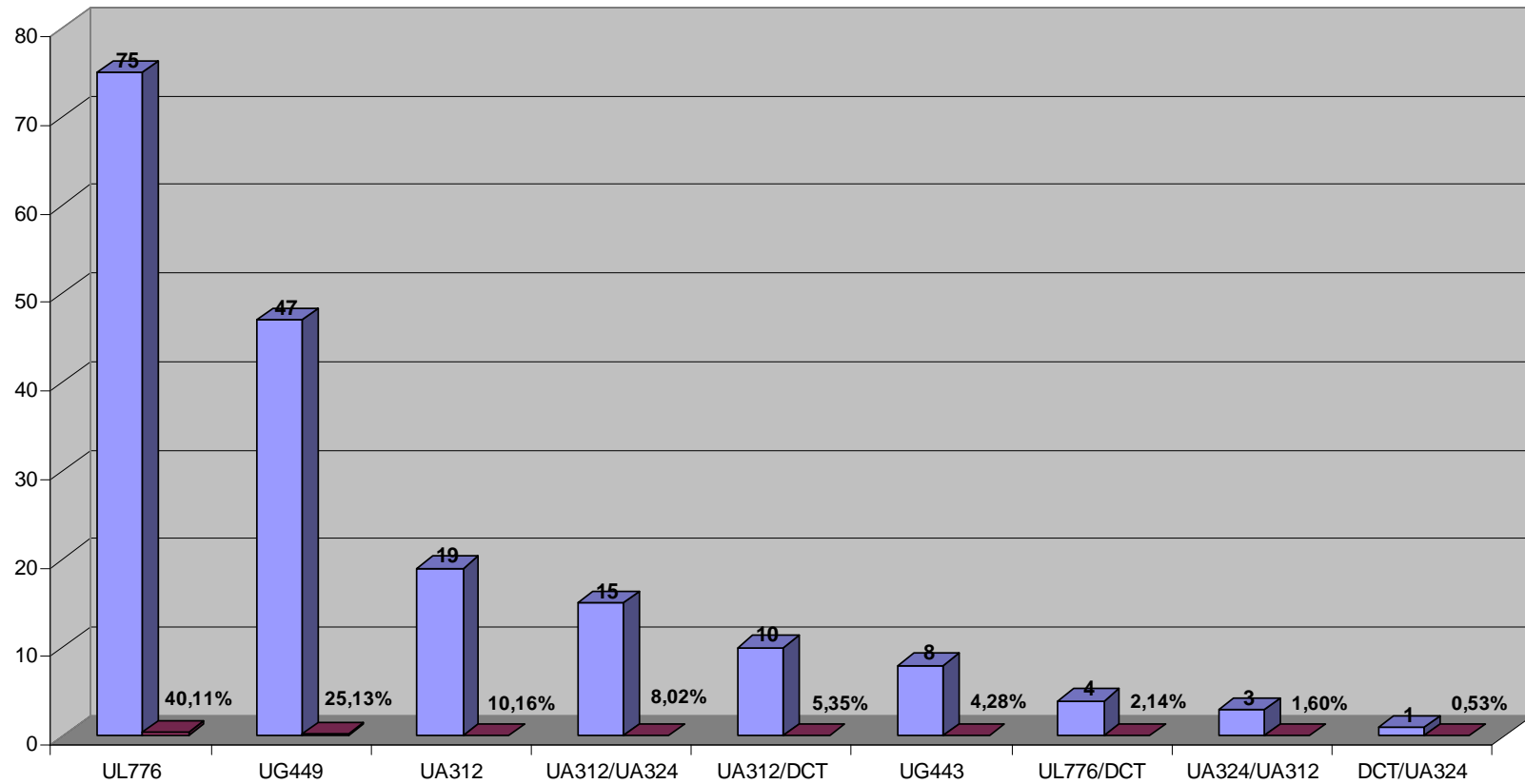
**FIR PUNTA ARENAS - RUTAS ATS**  
**98% del tránsito de la muestra**



**FIR SANTIAGO - RUTAS ATS**  
**89% del tránsito de la muestra**

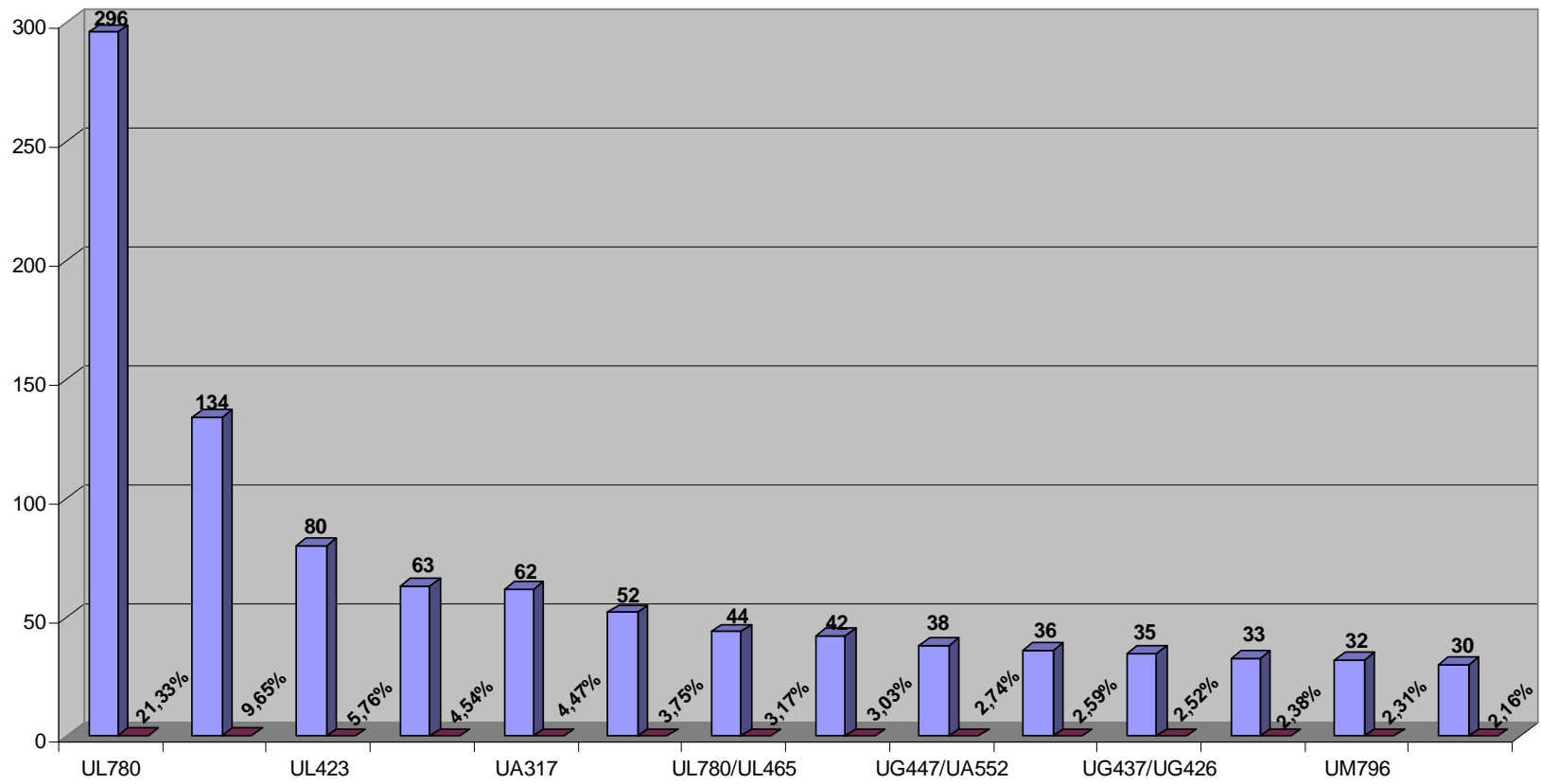


## GUYANA

FIR GEORGETOWN - RUTAS ATS  
97% del tránsito de la muestra

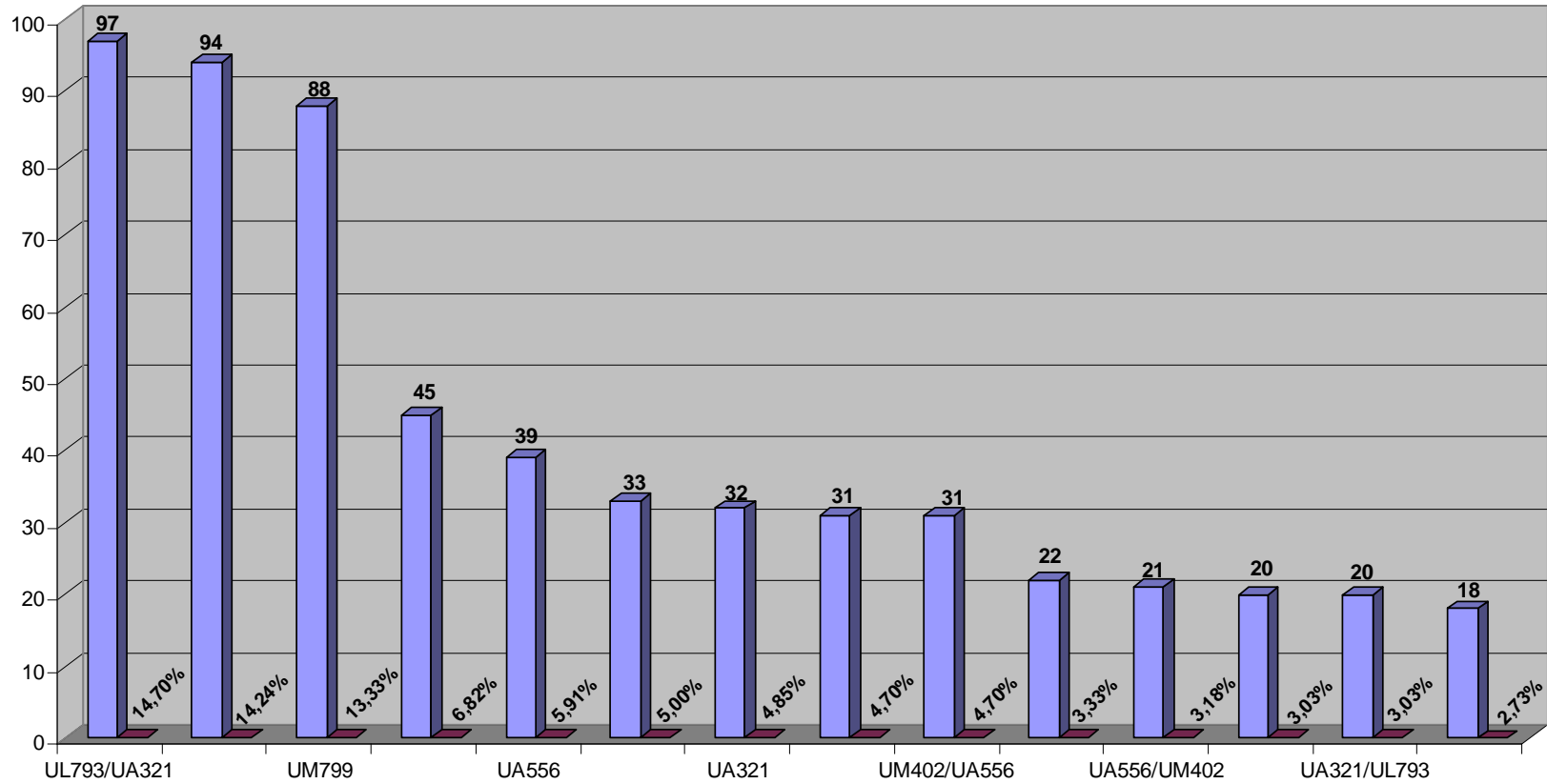
PANAMA

**FIR PANAMA - RUTAS ATS**  
**70% del tránsito de la muestra**



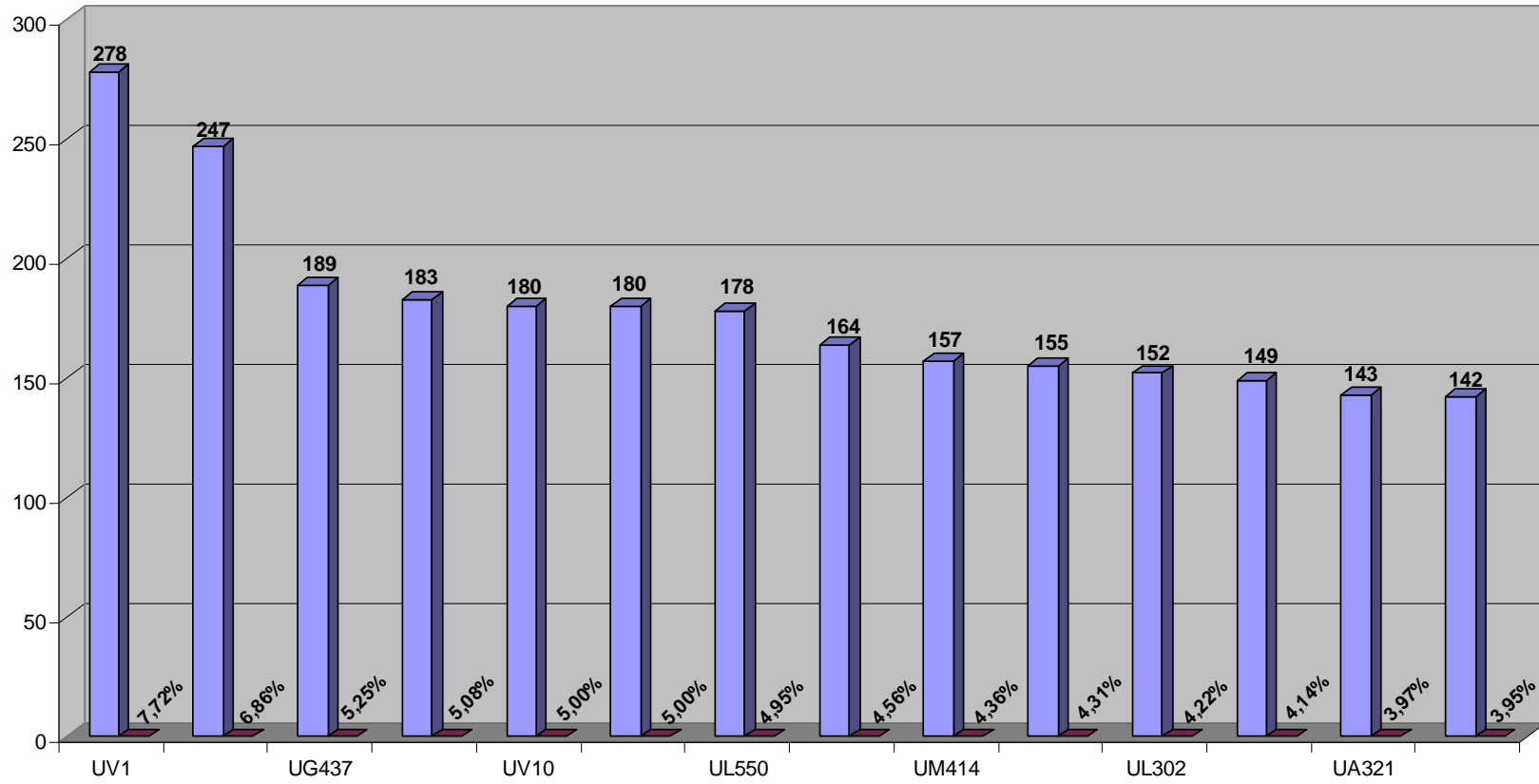
**PARAGUAY**

**FIR ASUNCIÓN - RUTAS ATS**  
**90% del tránsito de la muestra**



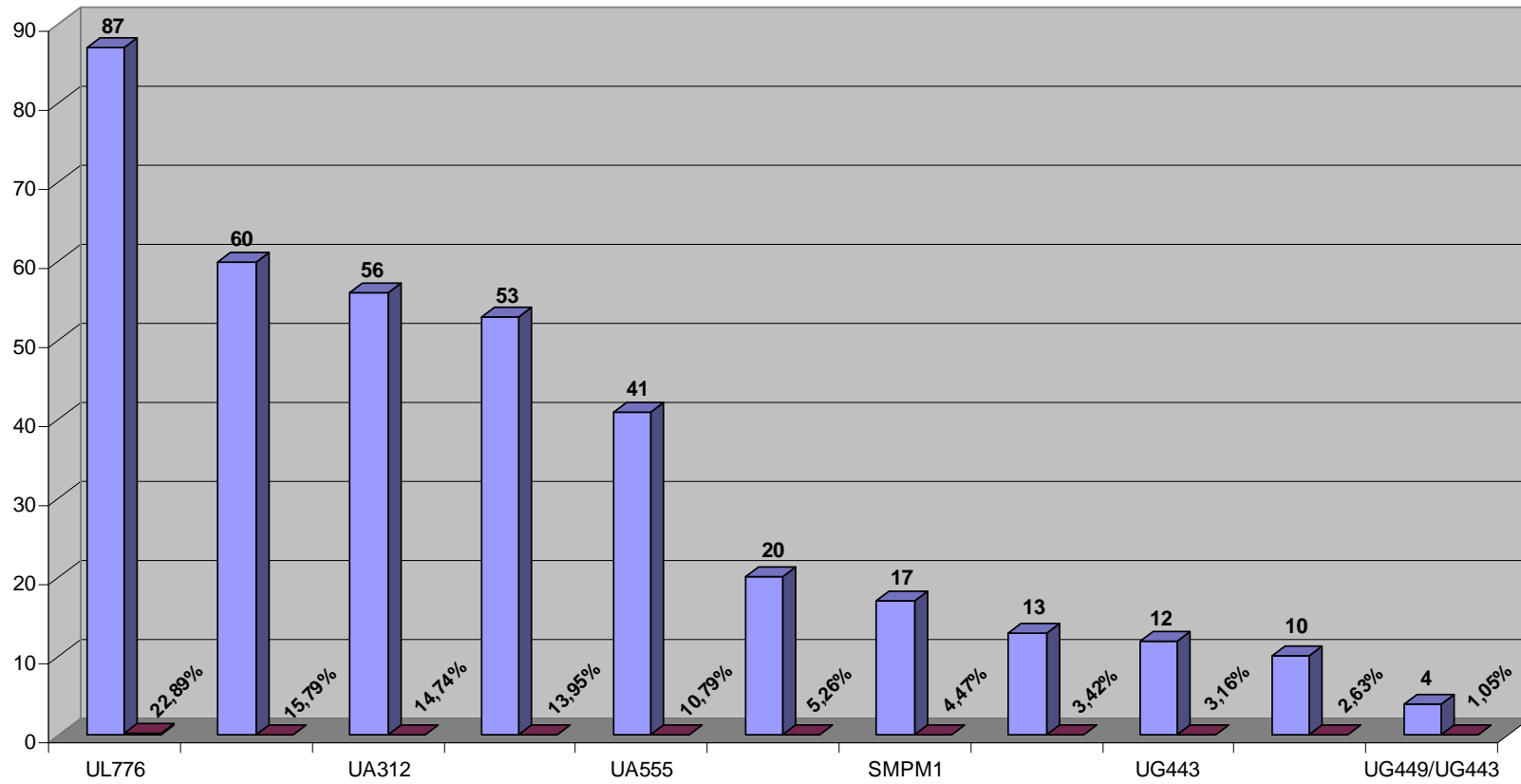
**PERU**

**FIR LIMA - RUTAS ATS**  
**69% del tránsito de la muestra**



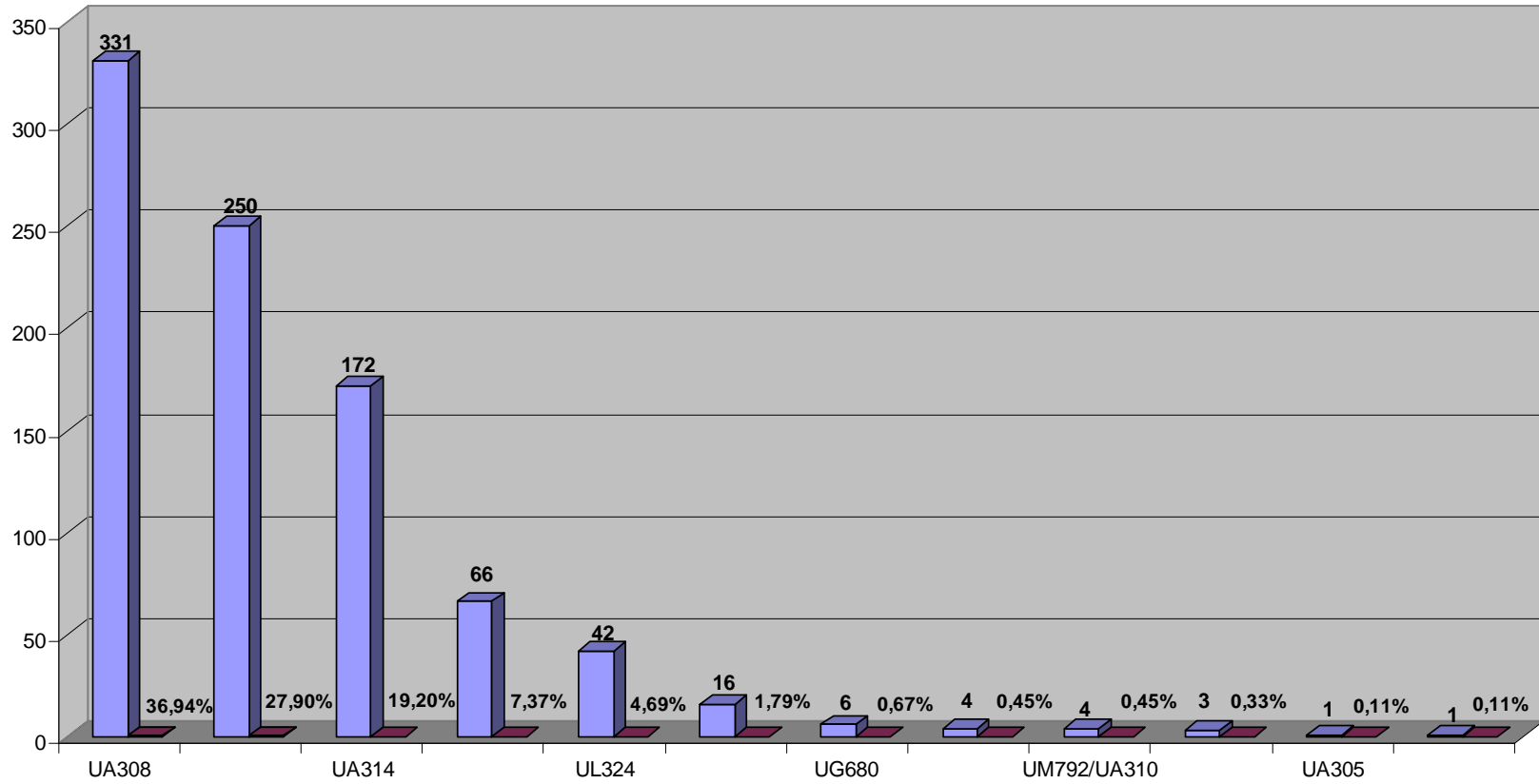
**SURINAME**

**FIR PARAMARIBO - ROTAS ATS**  
**98% del tránsito de la muestra**



**URUGUAY**

**FIR MONTEVIDEO - RUTAS ATS  
100% del tránsito de la muestra**



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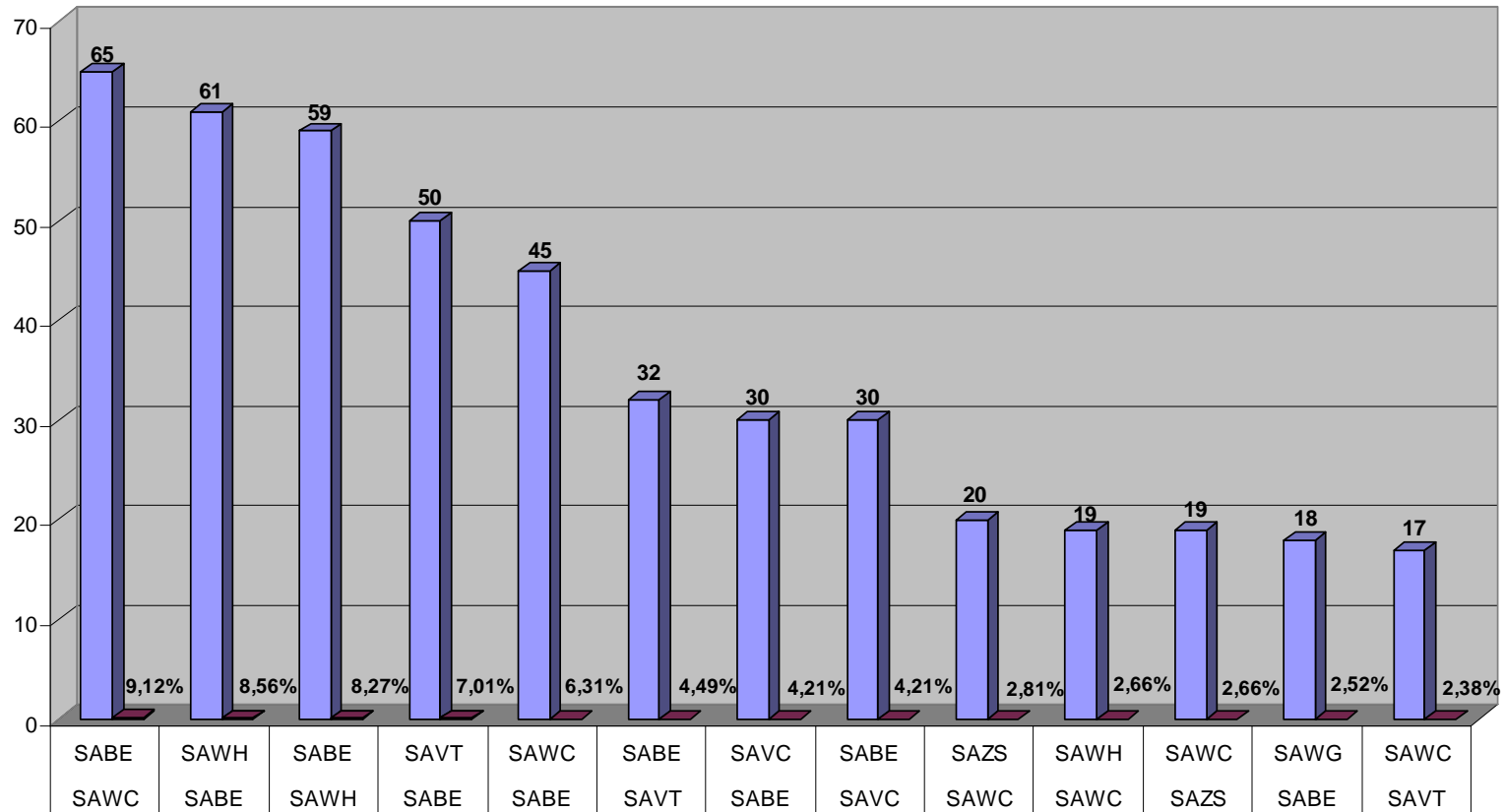
**ADJUNTO 3 AL APENDICE B / ATTACHMENT 3 TO APPENDIX B**

**Región SAM  
Pares de Ciudades**

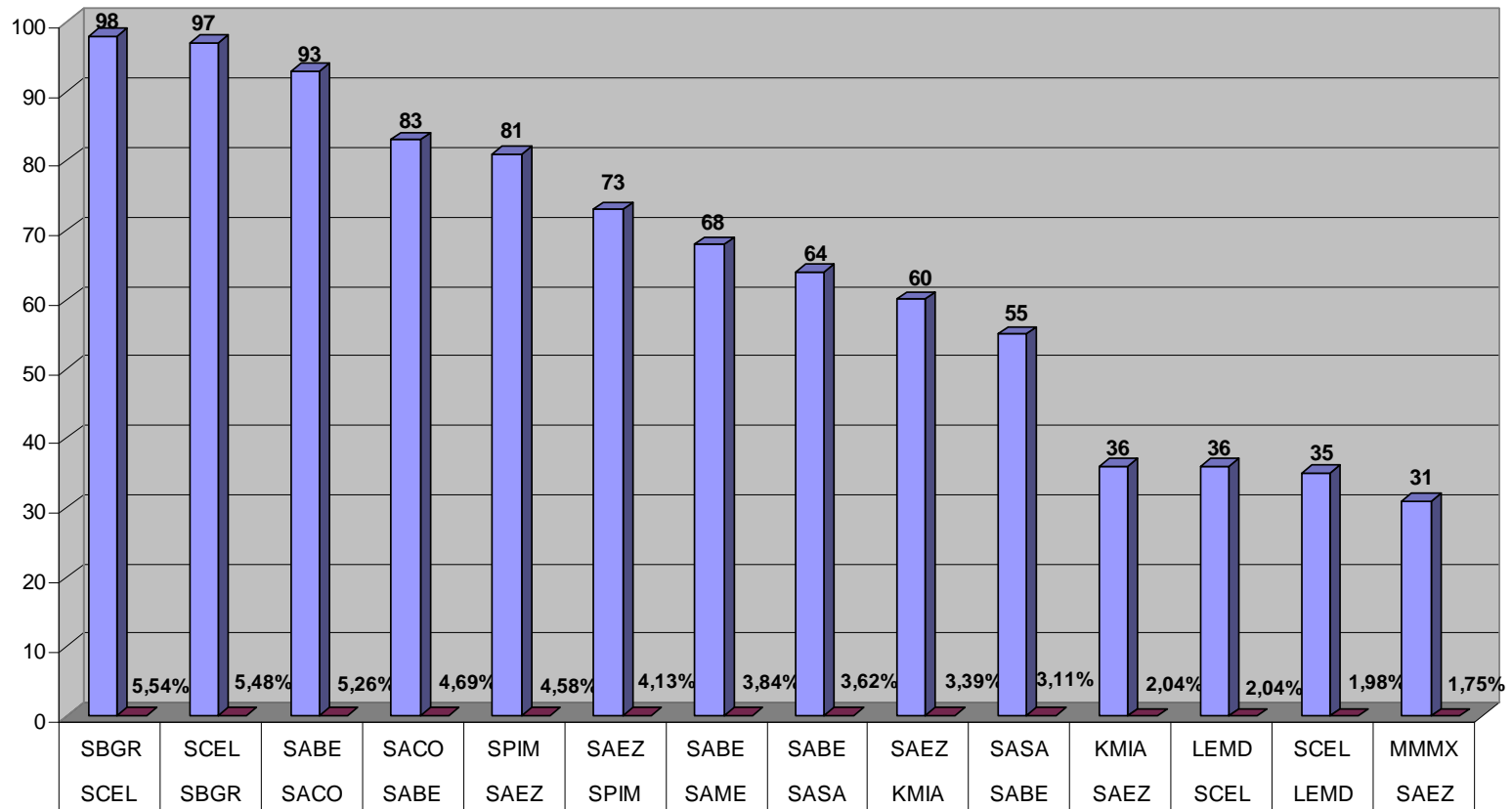
**SAM Region  
Pairs of Cities**

# ARGENTINA

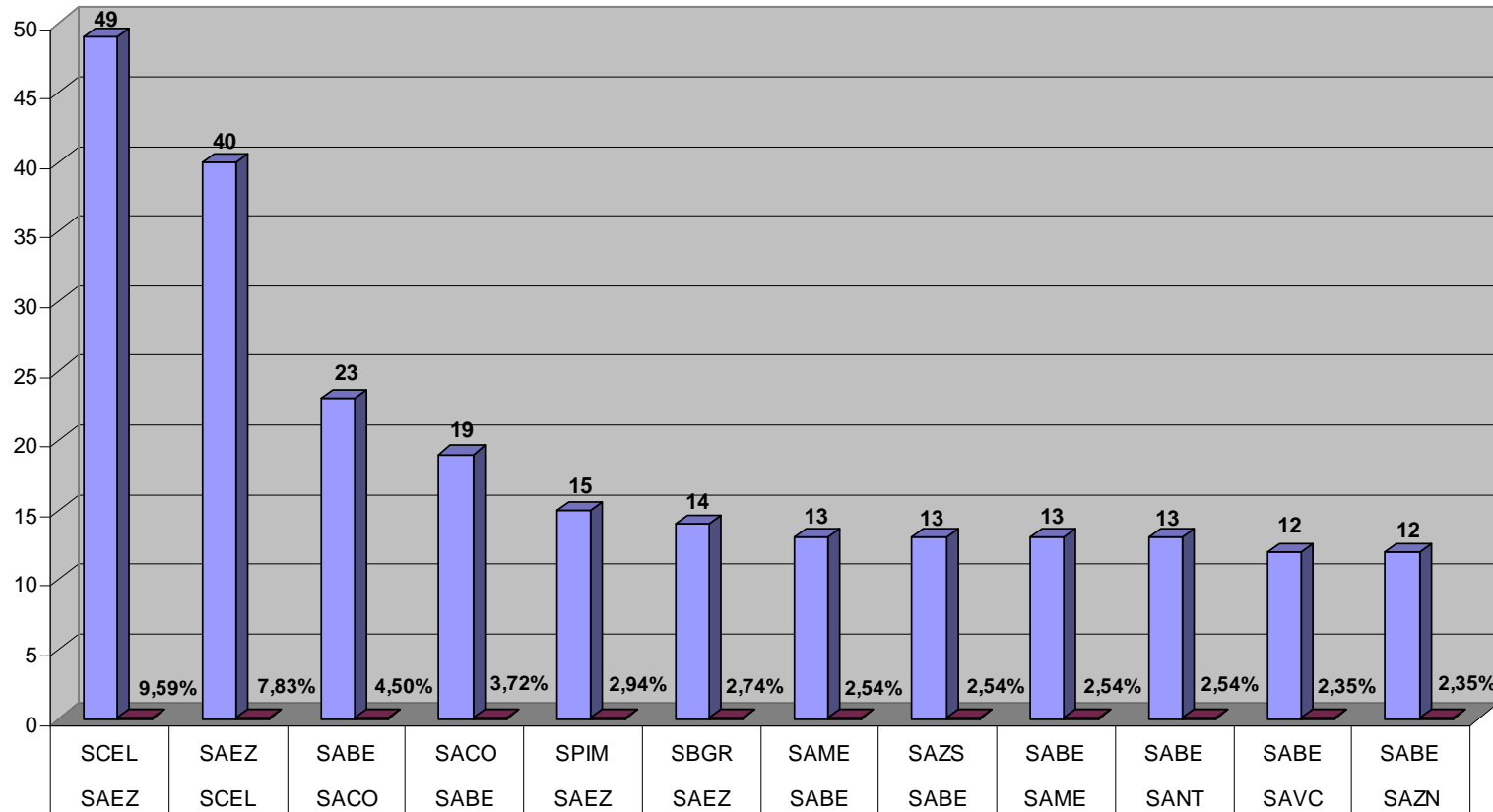
**FIR COMODORO RIVADAVIA - Pares de Ciudades**  
**65% del tránsito de la muestra**



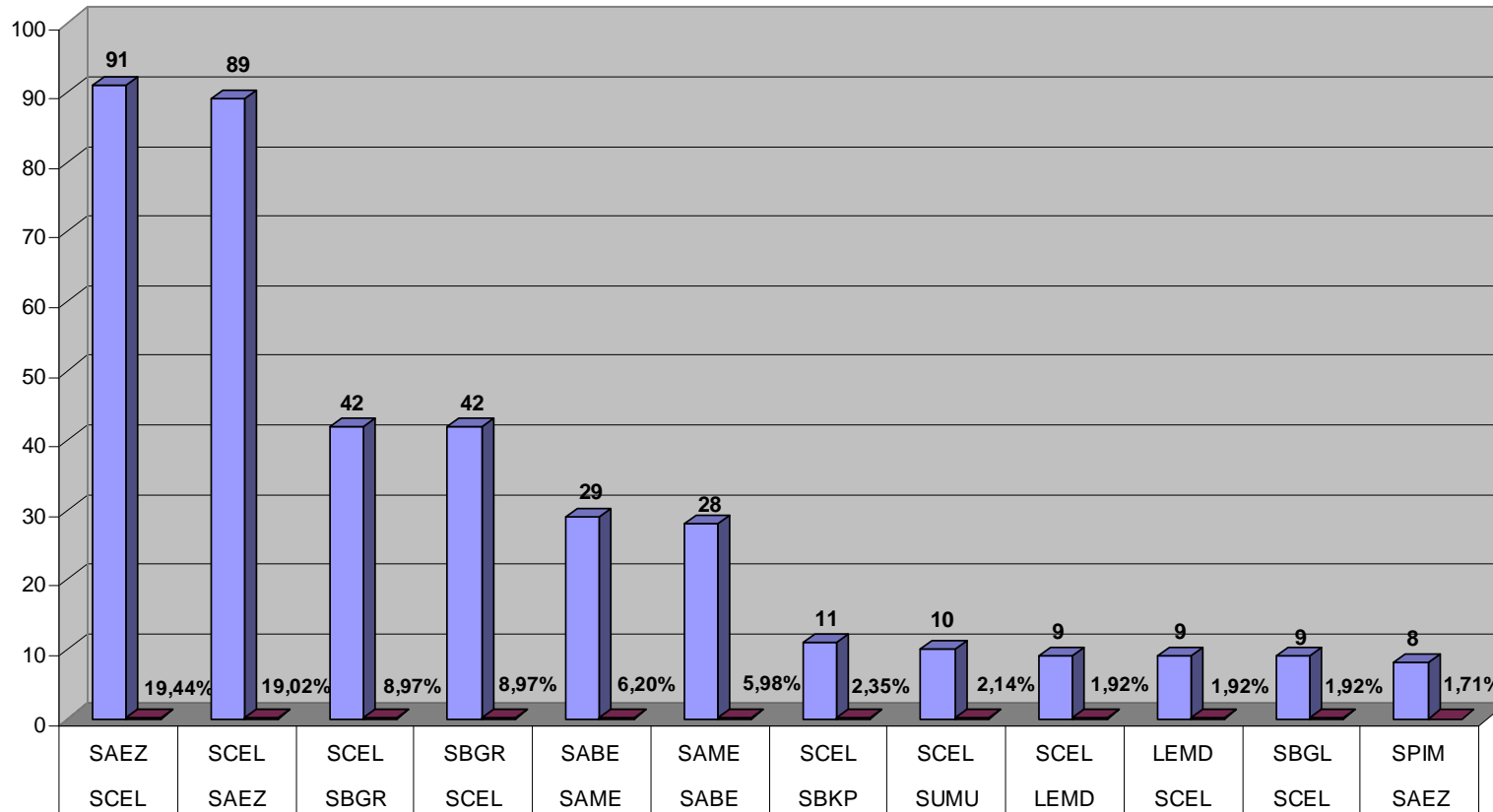
**FIR CORDOBA - Pares de Ciudades**  
**51% del tránsito de la muestra**



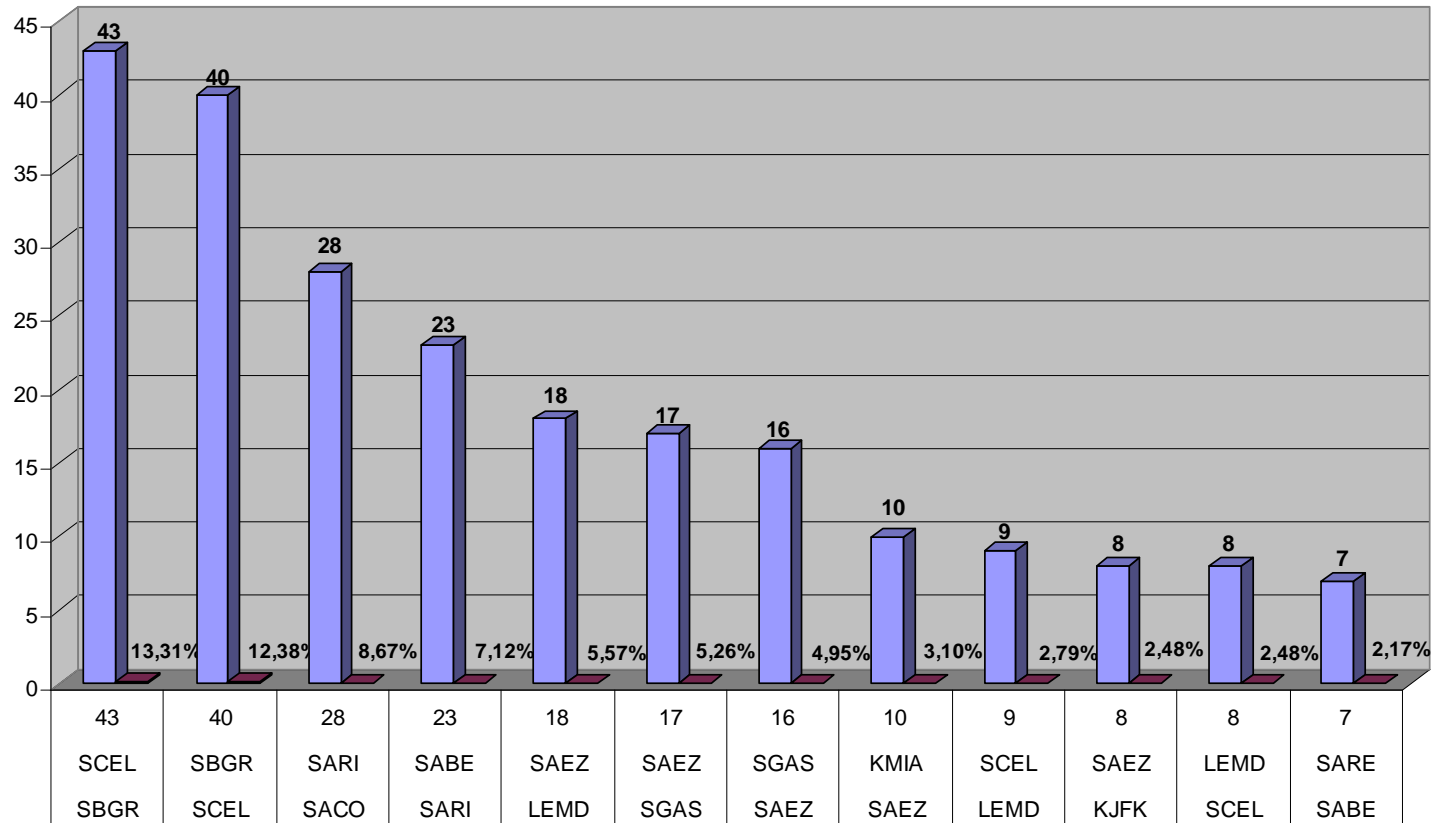
**FIR EZEIZA - Pares de Ciudades**  
**46% del tránsito de la muestra**



**FIR MENDOZA - Pares de Ciudades**  
**80% del tránsito de la muestra**

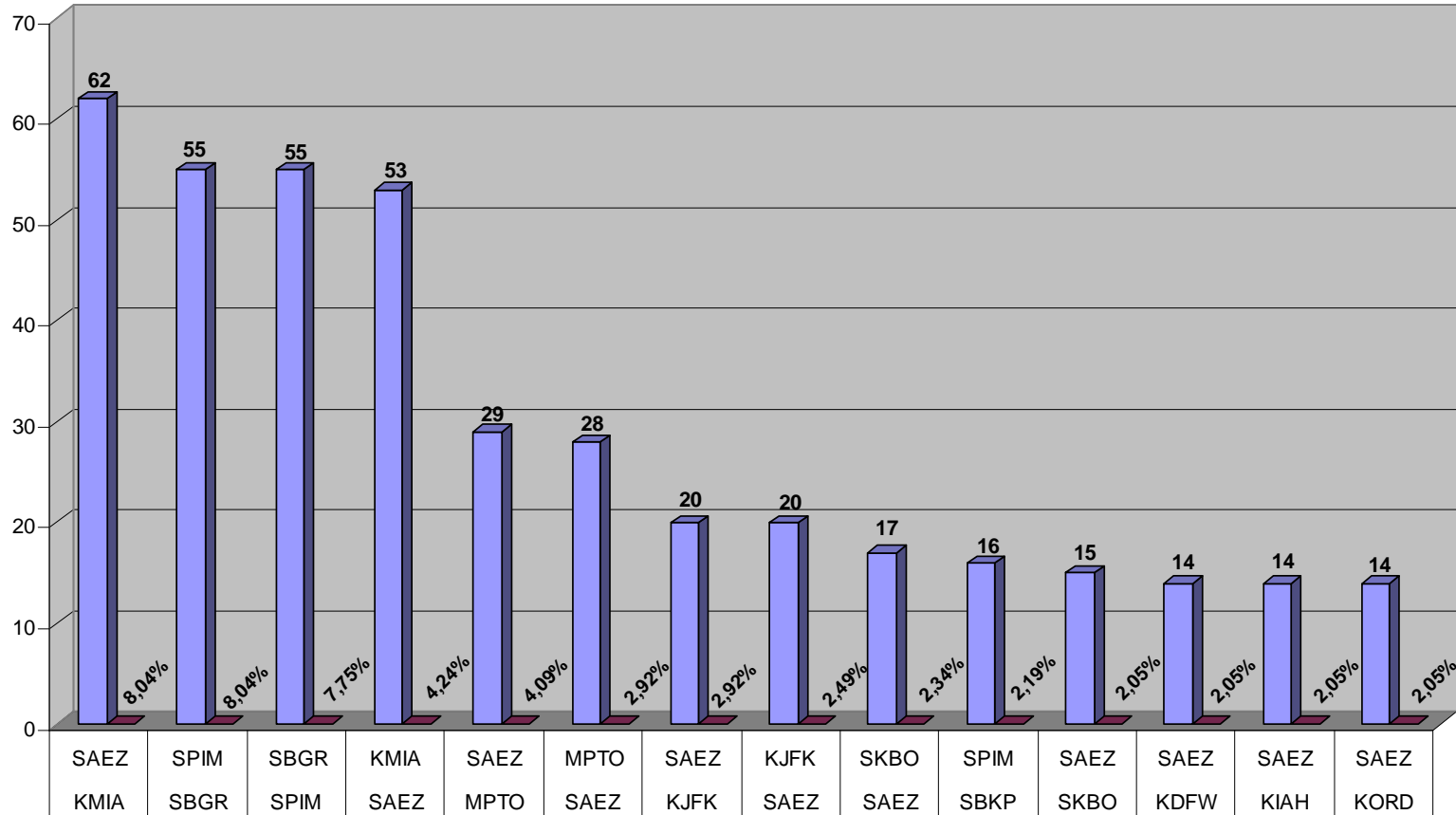


**FIR RESISTENCIA - Pares de Ciudades**  
**70% del tránsito de la muestra**



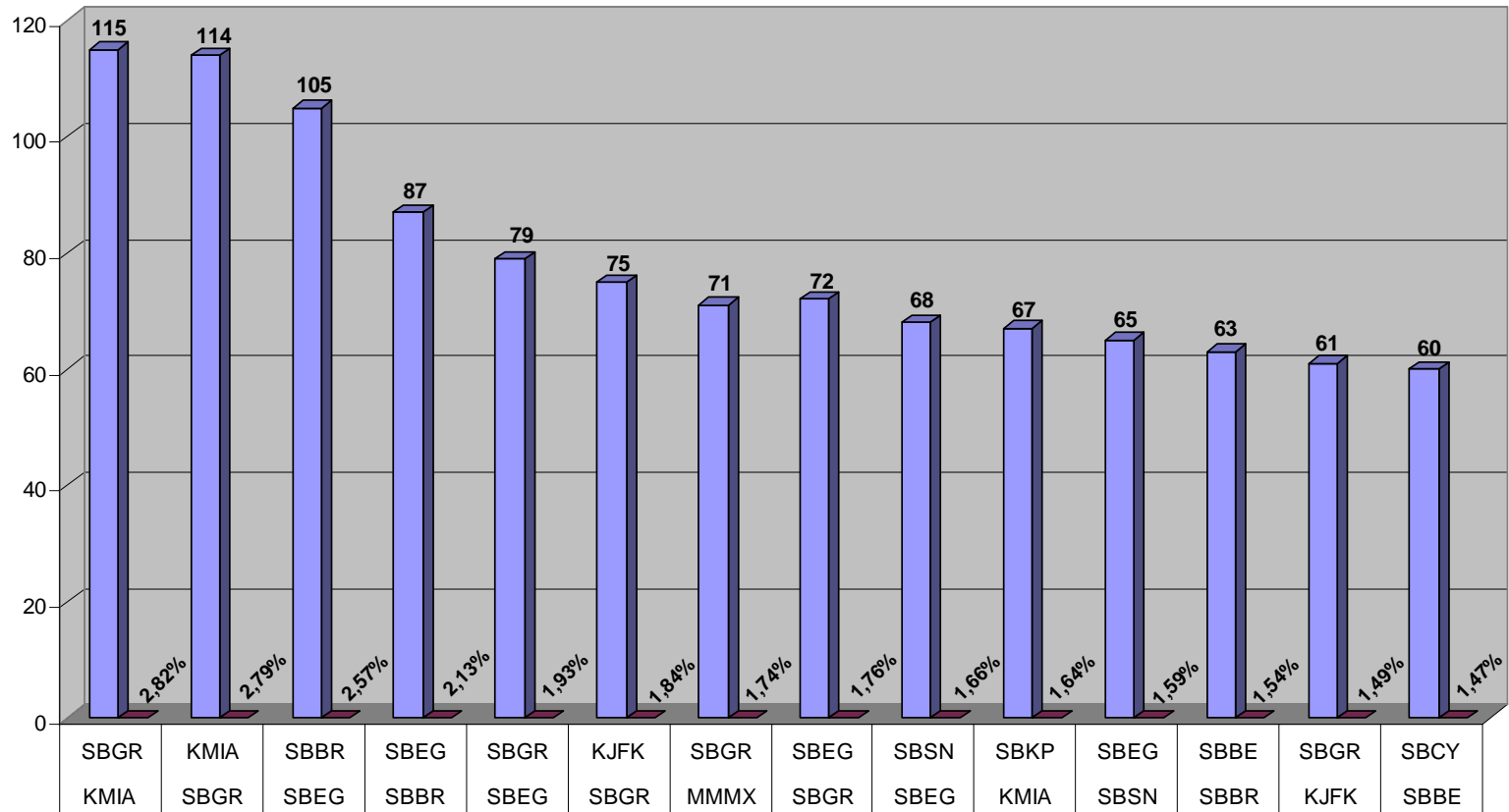
# BOLIVIA

**FIR LA PAZ - Pares de Ciudades**  
**60% del tránsito de la muestra**

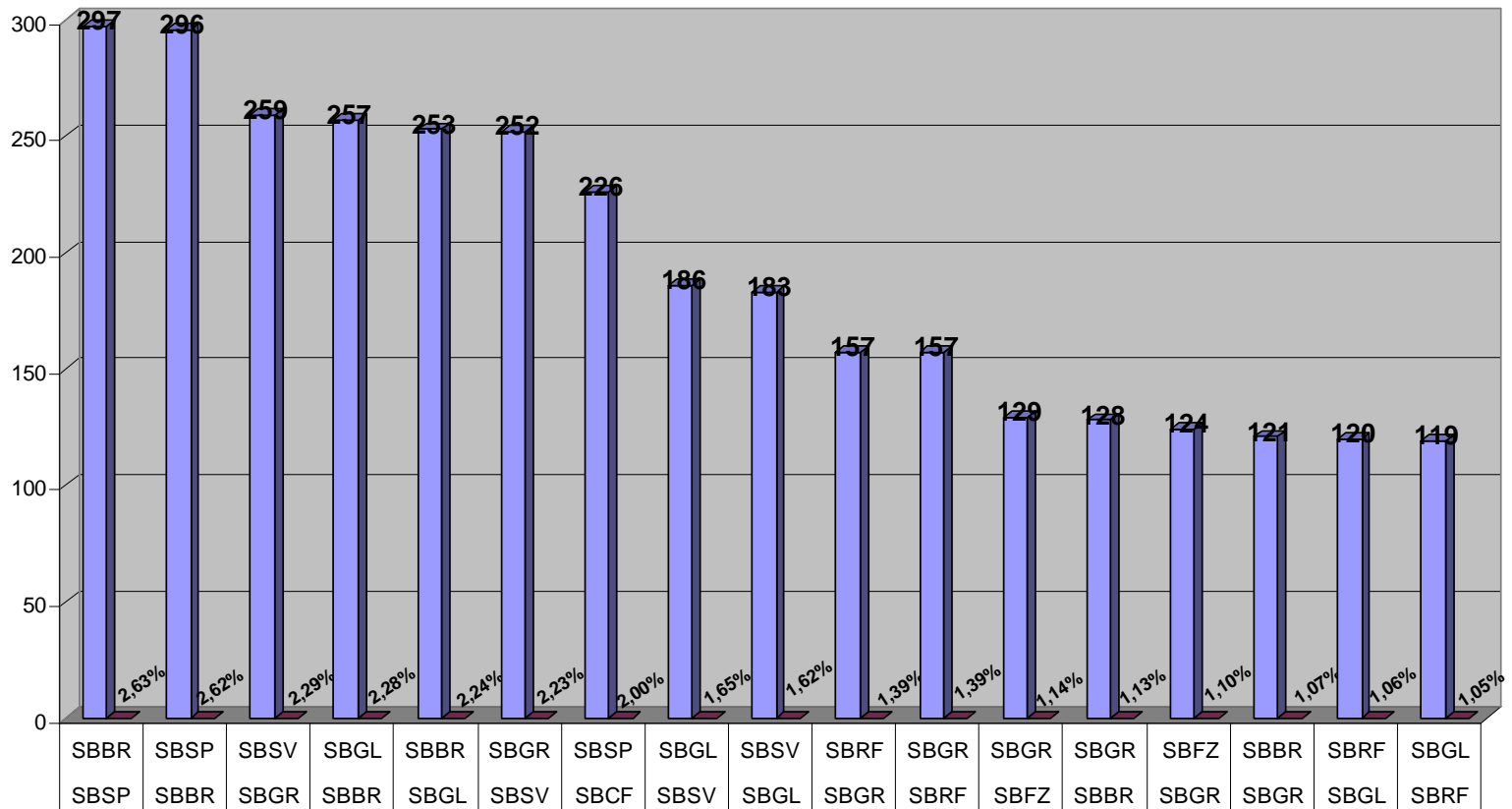


# BRAZIL

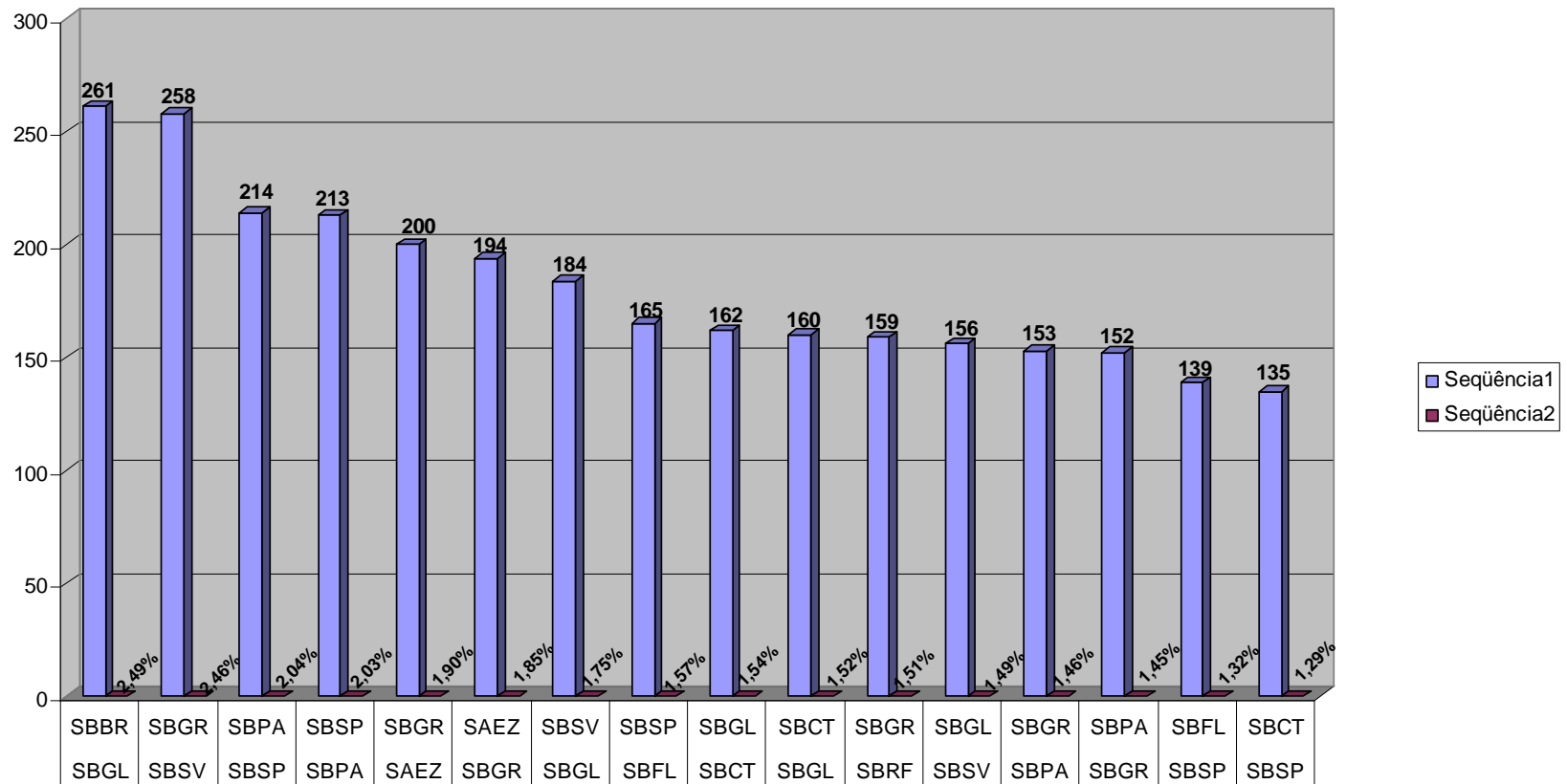
**FIR AMAZONICA - Pares de Ciudades**  
**27% del tránsito de la muestra**



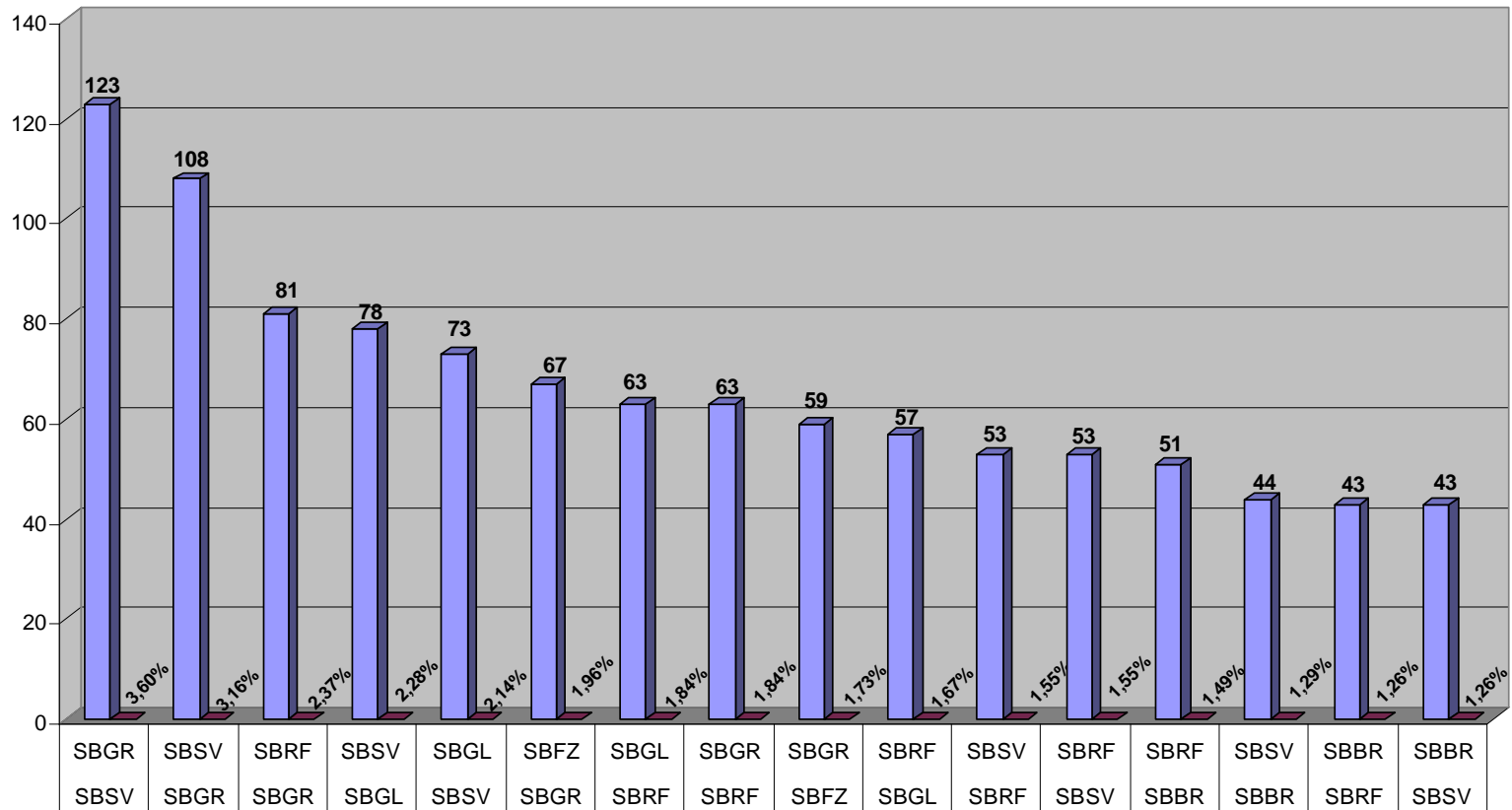
**FIR BRASÍLIA - Pares de Ciudades**  
**28% del tránsito de la muestra**



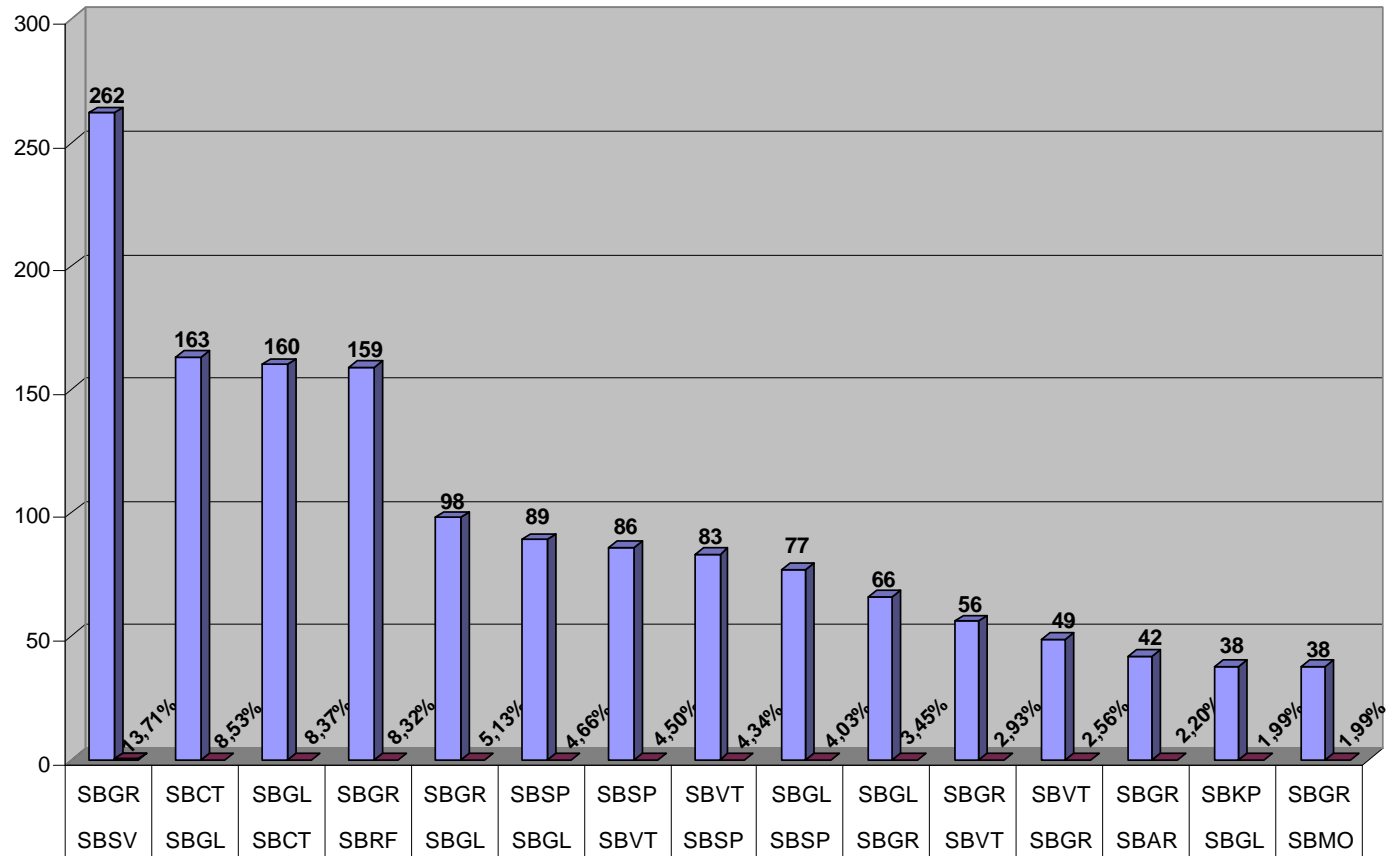
**FIR CURITIBA - PARES DE CIUDADES**  
**28% del tránsito de la muestra**



**FIR RECIFE - Pares de Ciudades**  
**31% del tránsito de la muestra**

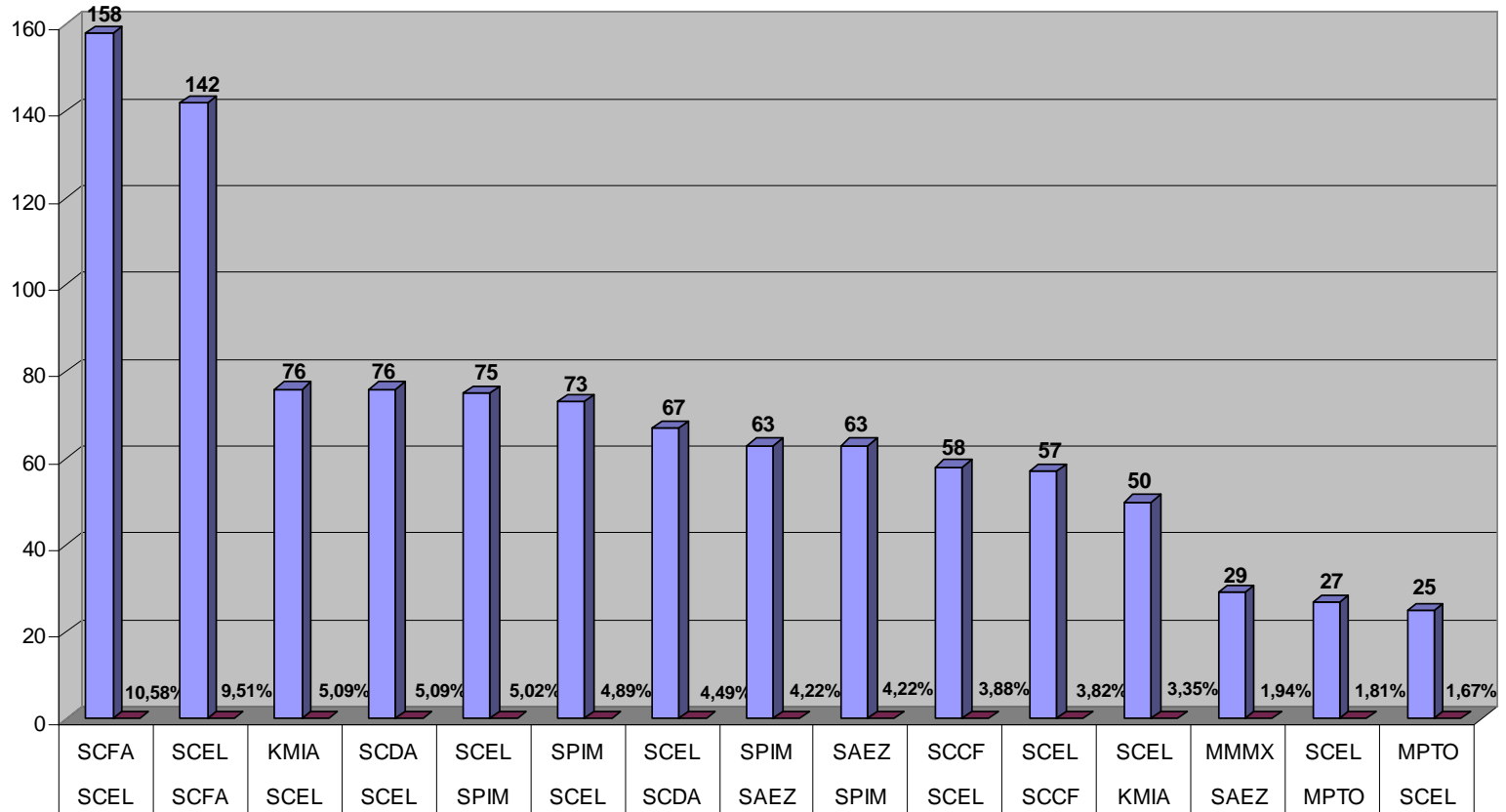


**TMA SÃO PAULO - Pares de Ciudades**  
**76% del tránsito de la muestra**

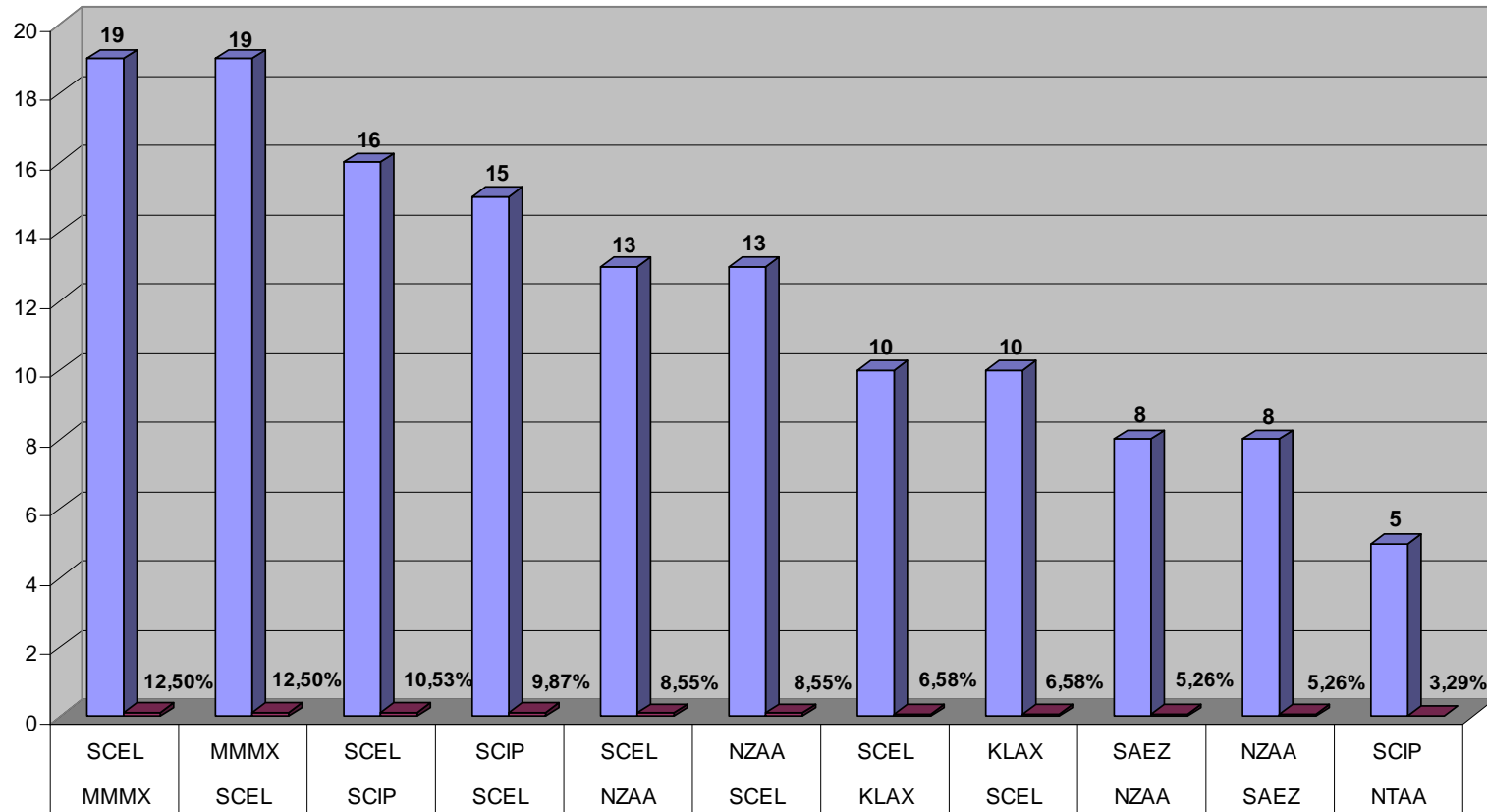


# CHILE

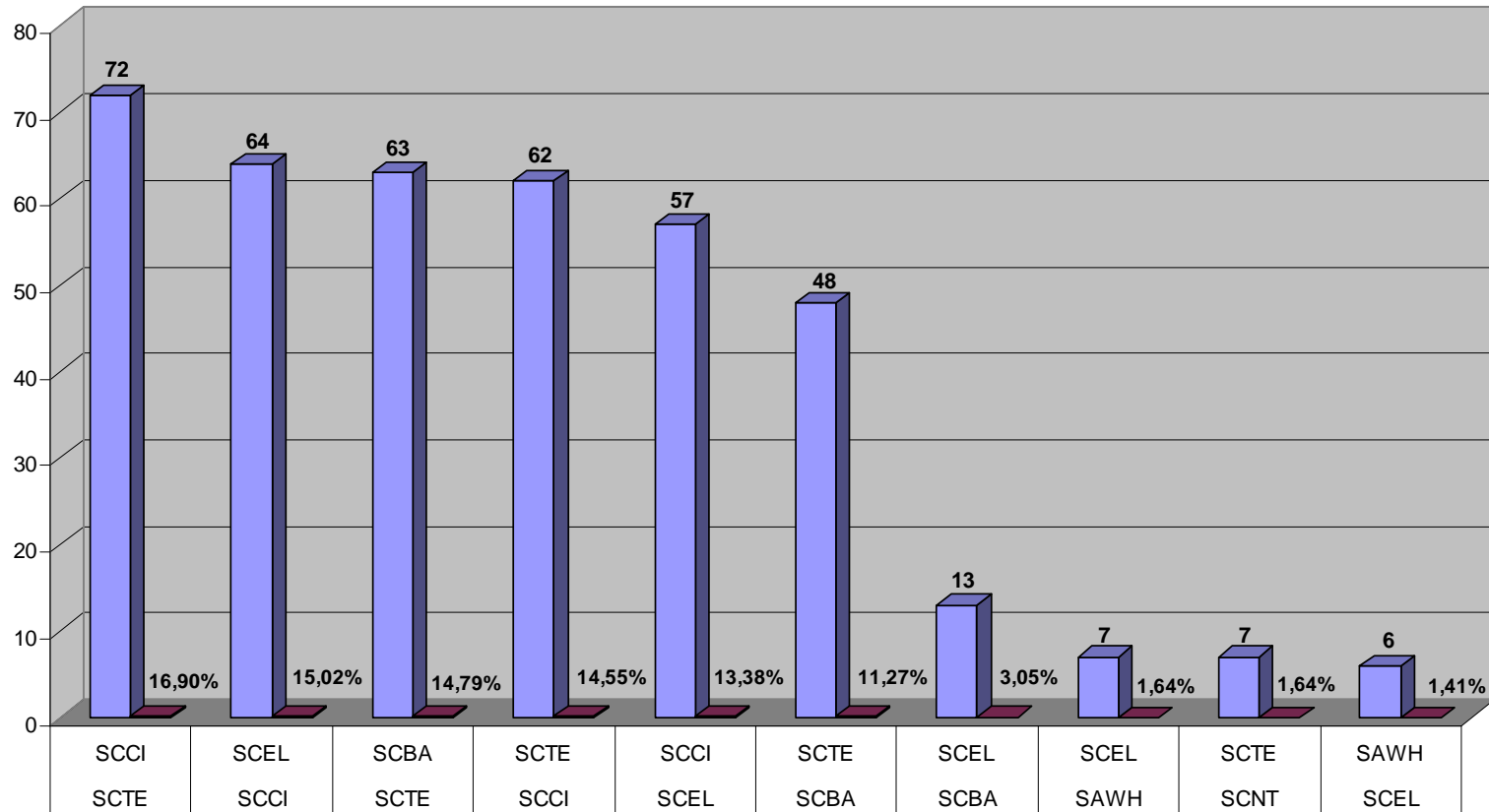
**FIR ANTOFOGASTA - Pares de Ciudades**  
**70% del tránsito de la muestra**



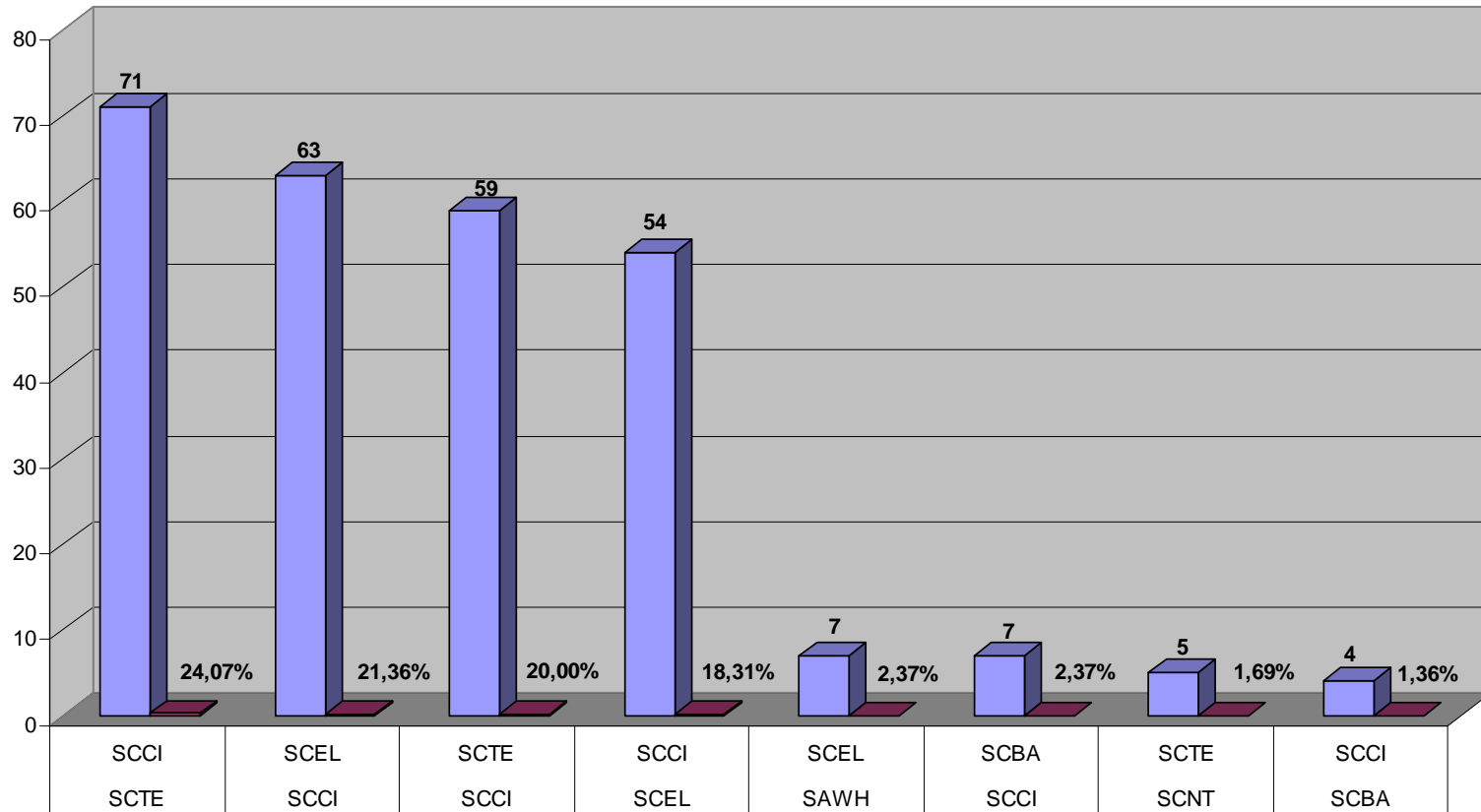
**FIR PASCUA - PARES DE CIUDADES**  
**89% del tránsito de la muestra**



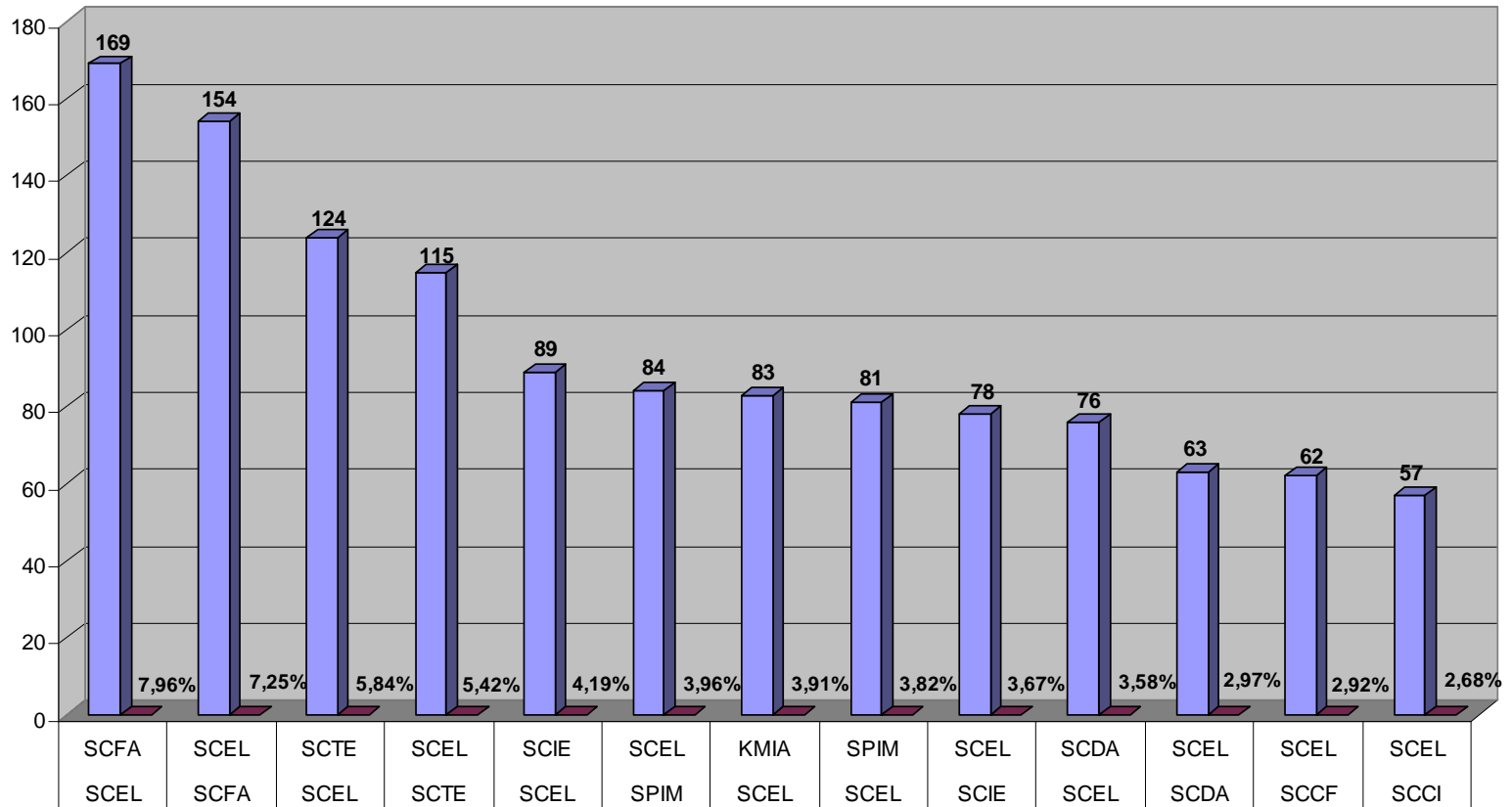
**FIR PUERTO MONTT - PARES DE CIUDADES**  
**94% del tránsito de la muestra**



**FIR PUNTA ARENAS - PARES DE CIUDADES**  
**92% del tránsito de la muestra**

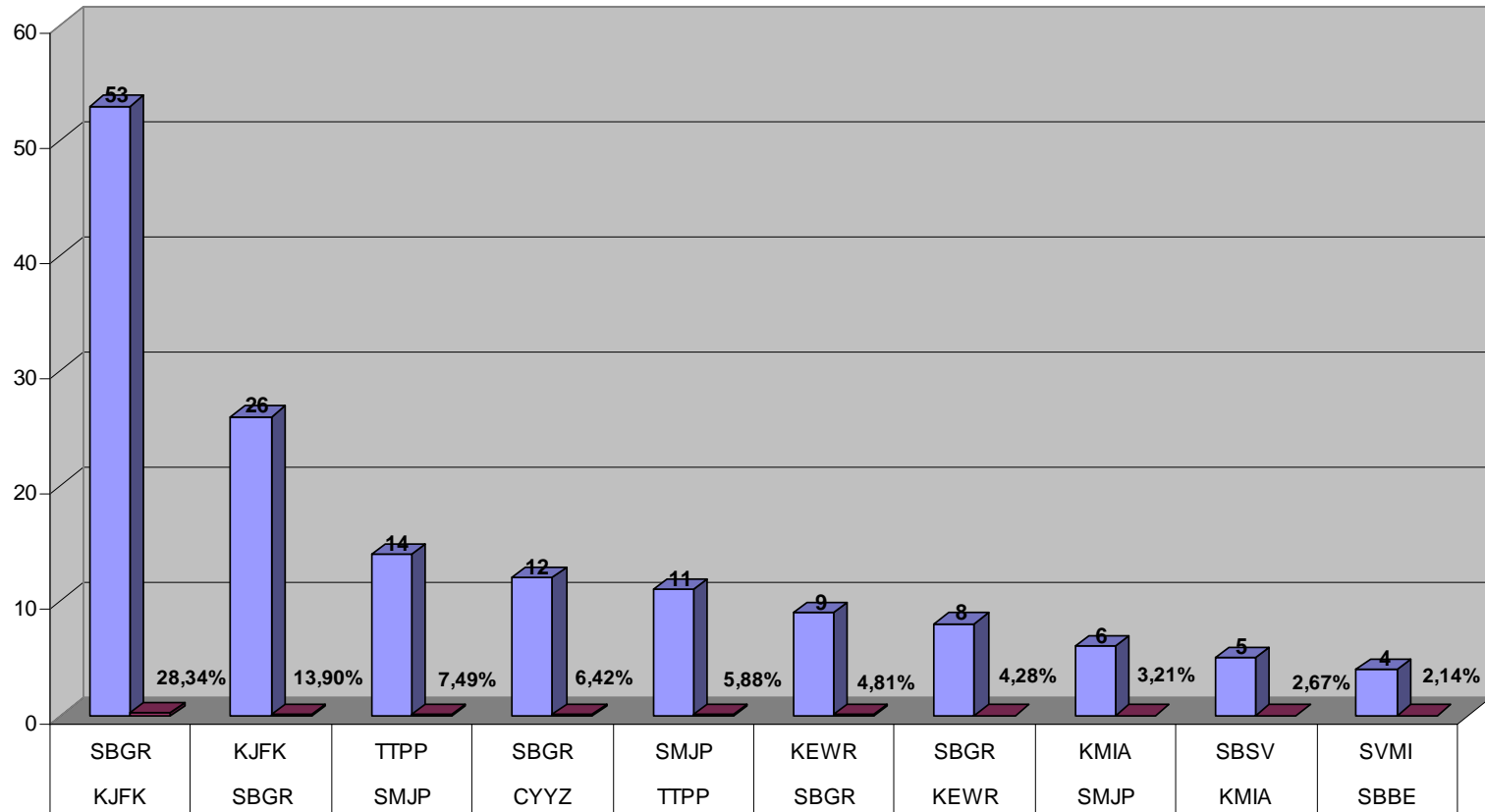


**FIR SANTIAGO - PARES DE CIUDADES**  
**58% del tránsito de la muestra**



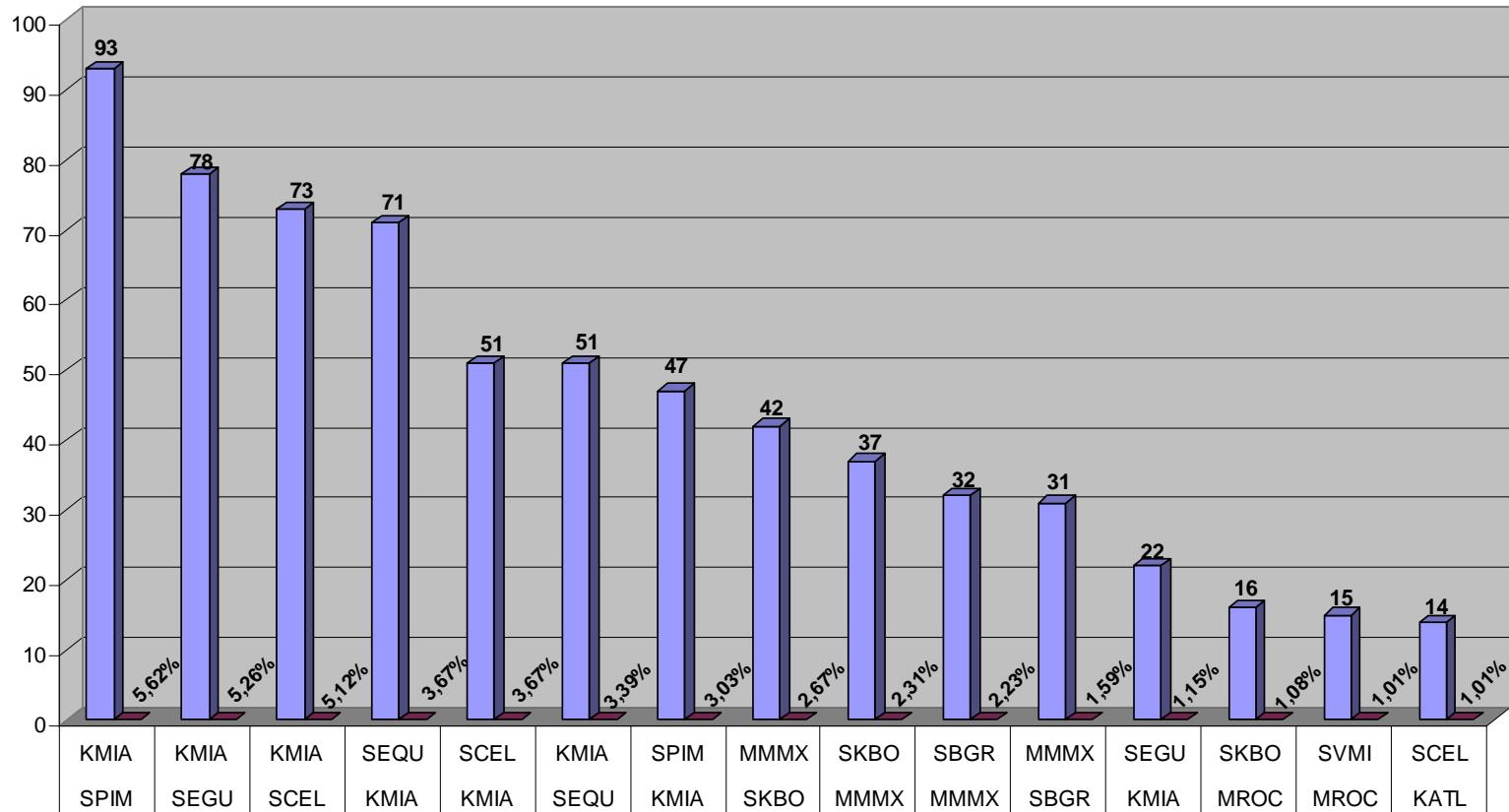
# GUYANA

**FIR GEORGETOWN - PARES DE CIUDADES**  
**79% del tránsito de la muestra**



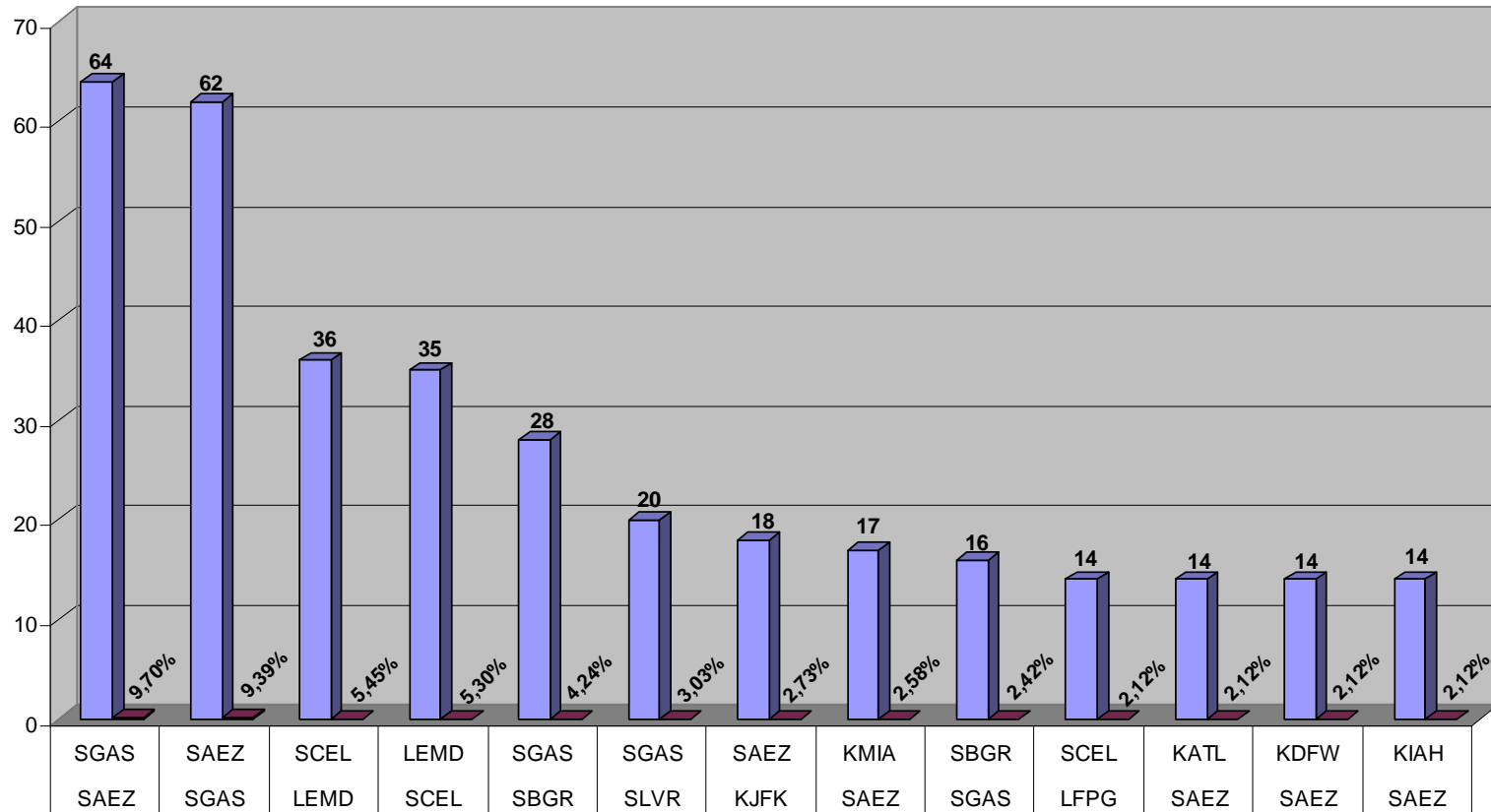
# PANAMA

**FIR PANAMA - PARES DE CIUDADES**  
**48% del tránsito de la muestra**



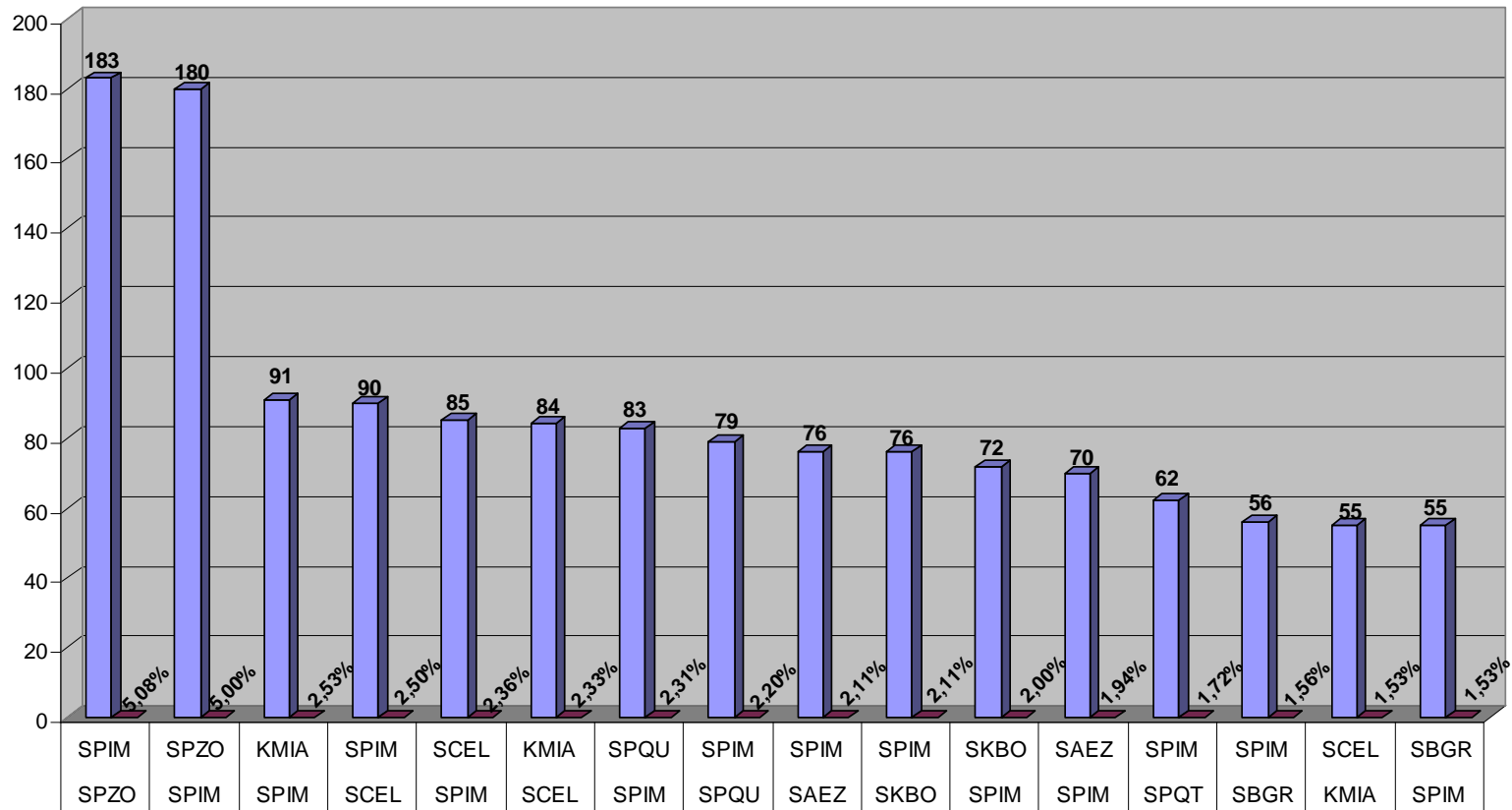
# PARAGUAY

**FIR ASUNCIÓN - PARES DE CIUDADES**  
**53% del tránsito de la muestra**



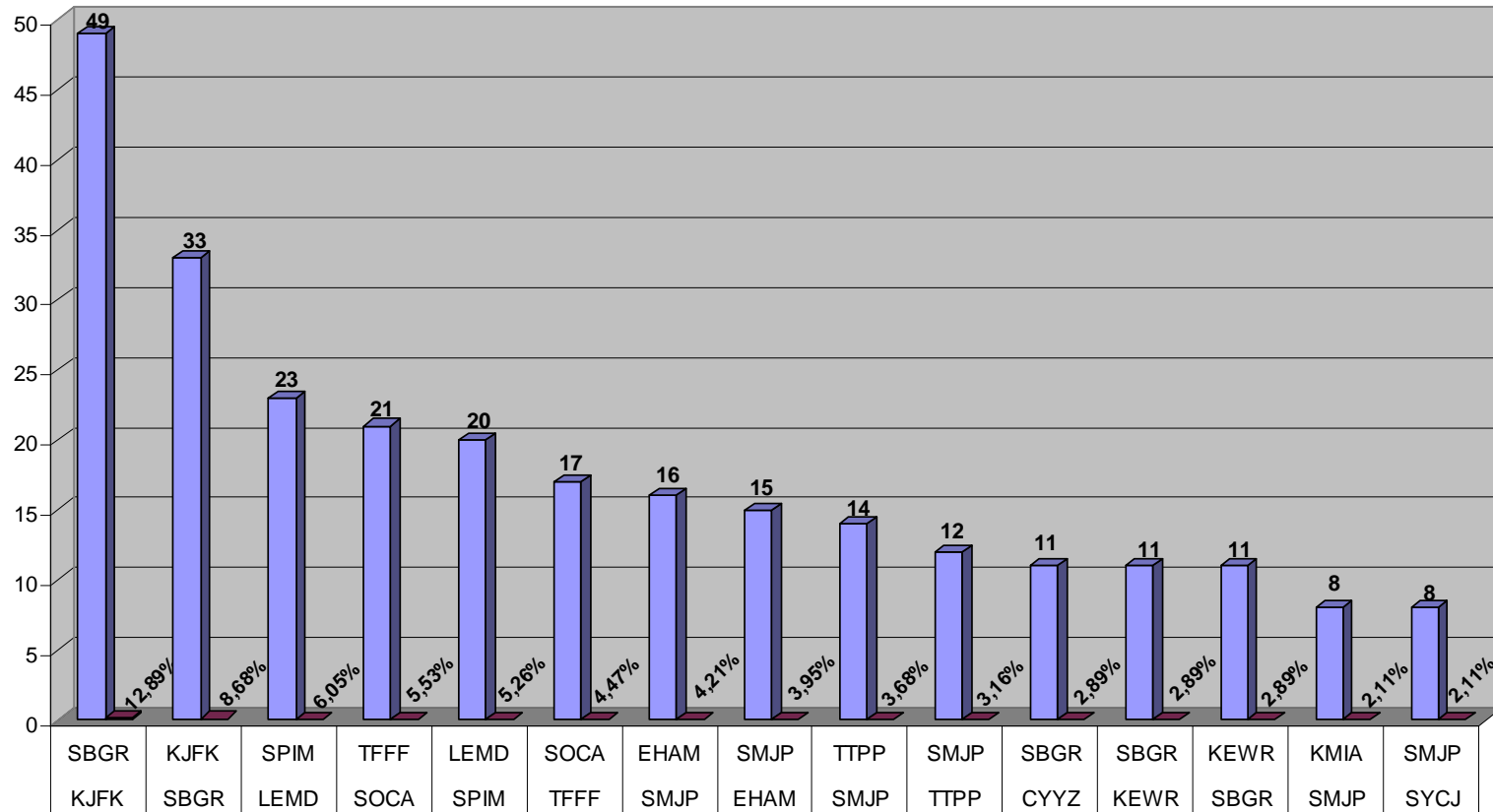
PERU

**FIR LIMA - PARES DE CIUDADES**  
**39% del tránsito de la muestra**



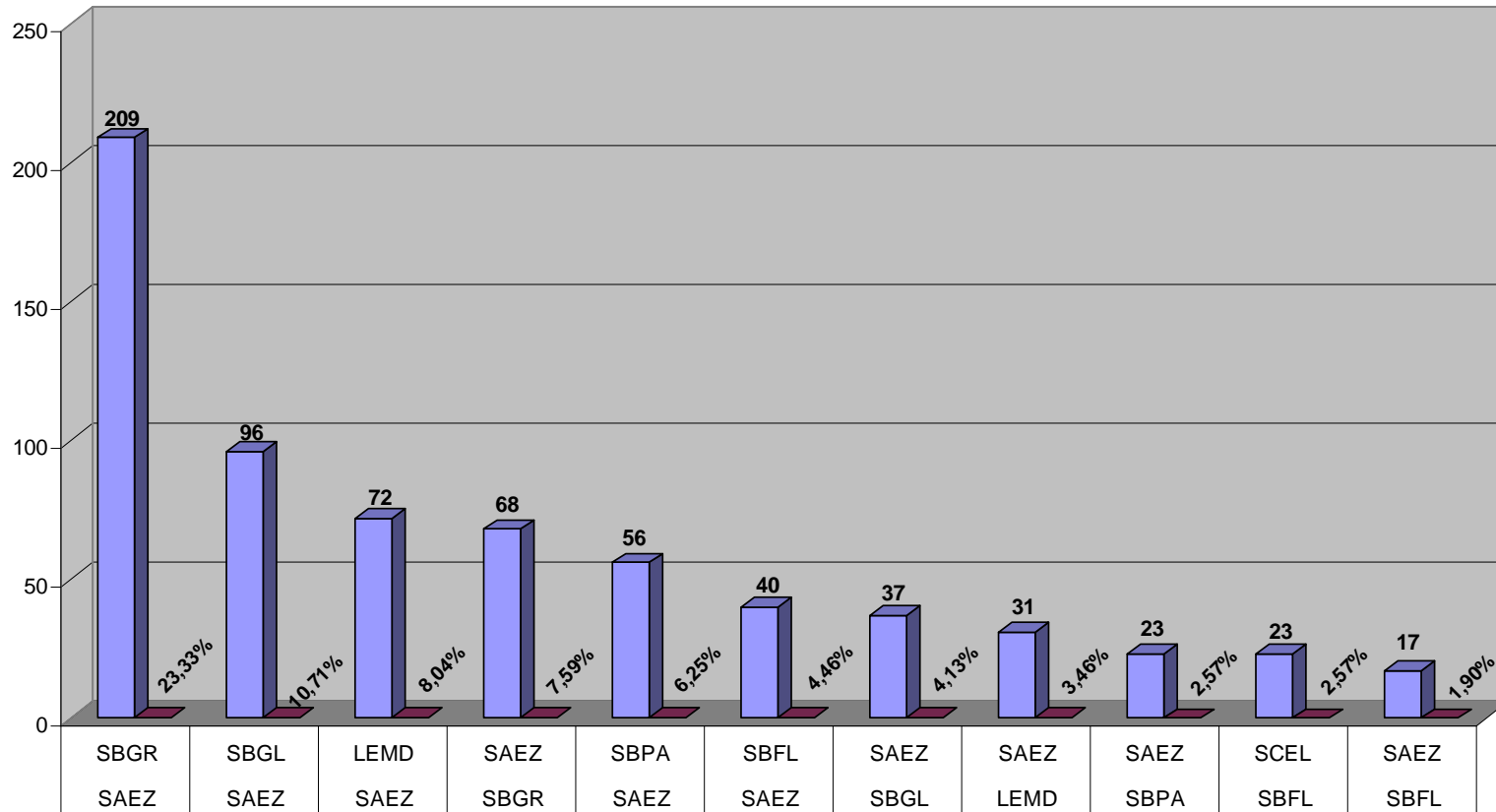
# SURINAME

**FIR PARAMARIBO - PARES DE CIUDADES**  
**71% del tránsito de la muestra**



# URUGUAY

**FIR MONTEVIDEO - PARES DE CIUDADES**  
**75% del tránsito de la muestra**



**ATTACHMENT 4 TO APPENDIX B****STATUS OF GNSS REGULATIONS IN SAM STATES****ARGENTINA**

The use of GNSS was approved as a primary means of navigation in VFR and IFR flights in oceanic routes, ATS routes, TMA and non-precision approach procedures (NPA) through provision CRA N 55/07. The resolution is published in section ENR 4-2 of the AIP.

**BOLIVIA**

Regulatory Bulletin N° DGAC/08/2002 (Operational Use of the Global Positioning System - GPS) establishes operational criteria for the use of GNSS in the Bolivian territory as a supplementary and primary means of air navigation.

**BRAZIL**

IAC 3512 91/121/135, which became effective 26 April 2001, and AIC 12/99 contain guidelines for the use of GPS equipment in en-route IFR operations, TMAs and non-precision approach procedures in the Brazilian airspace. The documentation is being updated in order to meet PBN requirements. The aforementioned documents can be found at the following websites:

[http://www.aisweb.aer.mil.br/aisweb\\_files/publicacoes/aic\\_a/aic\\_1999\\_a12.pdf](http://www.aisweb.aer.mil.br/aisweb_files/publicacoes/aic_a/aic_1999_a12.pdf)

<http://www.anac.gov.br/biblioteca/iac/IAC3512.pdf>

**CHILE**

The first amendment to the third edition of DAP 0613 (Operational Use of the GPS System) was published in Resolution DGAC n 2474 of 18 October 2006, setting the operational criteria for the use of the GPS system as a primary/supplementary means of air navigation in Chilean airspace, as appropriate.

Norm DAN 0805 (Resolution N° 0709 of 19 April 2004) regulates the installation of GPS systems on board aircraft with Chilean registry.

Norm DAN 06 21 (Exempt Resolution N° 1204 of 31 May 2007) establishes the technical and operational requirements for the approval of operators that wish to apply RNAV/GNSS procedures in TMA and non-precision approaches.

The aforementioned documents may be found at:

<http://www.dgac.cl/images/IMG/pdf/otros/dap/dap0613.pdf>

<http://www.dgac.cl/images/IMG/pdf/otros/dan/DAN%2008%2005.pdf>

<http://www.dgac.cl/images/IMG/pdf/otros/dan/dan0621.zip>

**COLOMBIA**

AICs C06 and A01, Global Positioning System, dated 10 September 1996, set forth the operational criteria for the use of GPS as a supplementary means of air navigation in Colombian airspace. The Aeronautical Regulations of Colombia, Part 6, Air Traffic Management, Section 6.10.3, establishes RNAV (GNSS) operations through standard arrival and departure (STAR/SID) procedures and non-precision instrument procedures at the following airports: SKAS, SKUI, SKUC SKYP.

**ECUADOR**

Aeronautical Information Circular of 14 May 2007, which supersedes AIC 07/96 of 3 December 1996, defines the regulations for applying the GNSS system. The circular establishes the use of GNSS in RNAV navigation for instrument arrival (STAR) and departure (SID) procedures and non-precision approaches.

**GUYANA**

Through AIC of 25 November 2004, the use of GPS in the Georgetown FIR airspace was approved. GPS may be used for departure, approach and en-route IFR navigation.

**FRENCH GUIANA**

The regulations enabling the use of GNSS RNAV equipment for non-precision approaches were published in Resolution N° F-2007-01, of 26 April 2007, which superseded Resolution N° F-2005-01.

**PANAMA**

AIC 04/07, Operational Criteria for the Use of GNSS in Panamanian Airspace, was published on 15 March 2007. The circular was aimed at establishing the criteria for the use of GPS as a primary means of navigation in the airspace over the national territory and its jurisdictional waters, particularly the implementation of STARs and SIDs developed for the international airports of Howard and Tocumen.

**PARAGUAY**

Resolution 169/2000, which authorizes the use of the global positioning system (GPS) in the Republic of Paraguay, was published on 12 May 2000.

**PERU**

The use of GPS as a supplementary means of navigation was authorized through AIC 02/96, GPS System, dated 17/05/96.

**SURINAME**

On 31 March 2008, AIP supplement 01/08 on the use of GPS as a primary means of IFR navigation in the Paramaribo FIR, was published.

**URUGUAY**

In the airspace under the jurisdiction of the Republic of Uruguay, GPS can be used as a supplementary means of navigation for en-route operations and as a primary means of navigation in oceanic airspace. There is a NOTAM, issued for a period of 60 days, enabling the use of GPS as a primary means of navigation in continental areas.

**VENEZUELA**

AIC A01/C01, dated 2 January 1997, defines the operational criteria for using the Global Positioning System (GPS) as a supplementary means of navigation in the upper airspace (Maiquetía FIR/UTA).

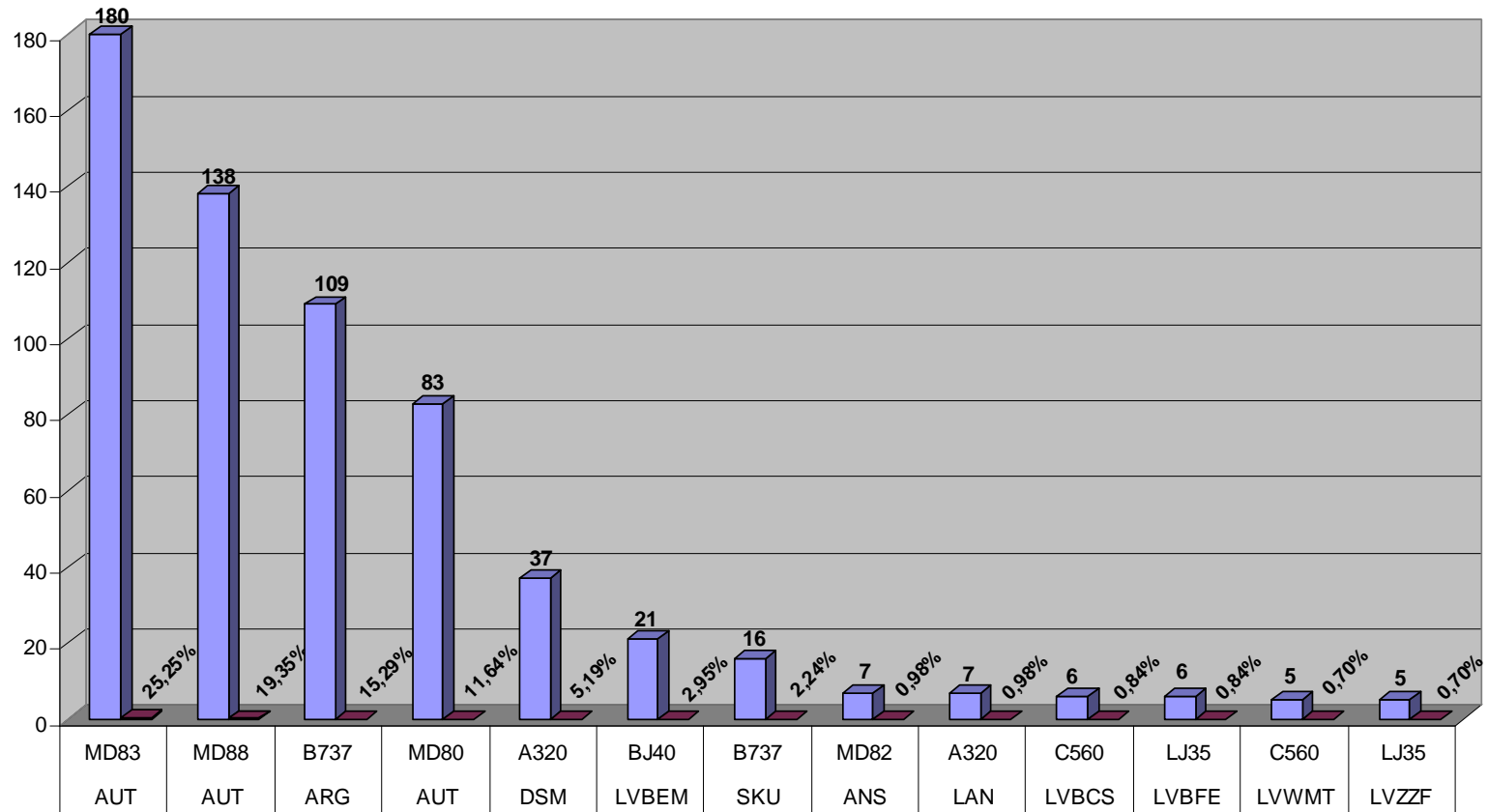
**ADJUNTO 5 AL APENDICE B / ATTACHMENT 5 TO APPENDIX B**

**Región SAM  
Aerolínea/Tipo/**

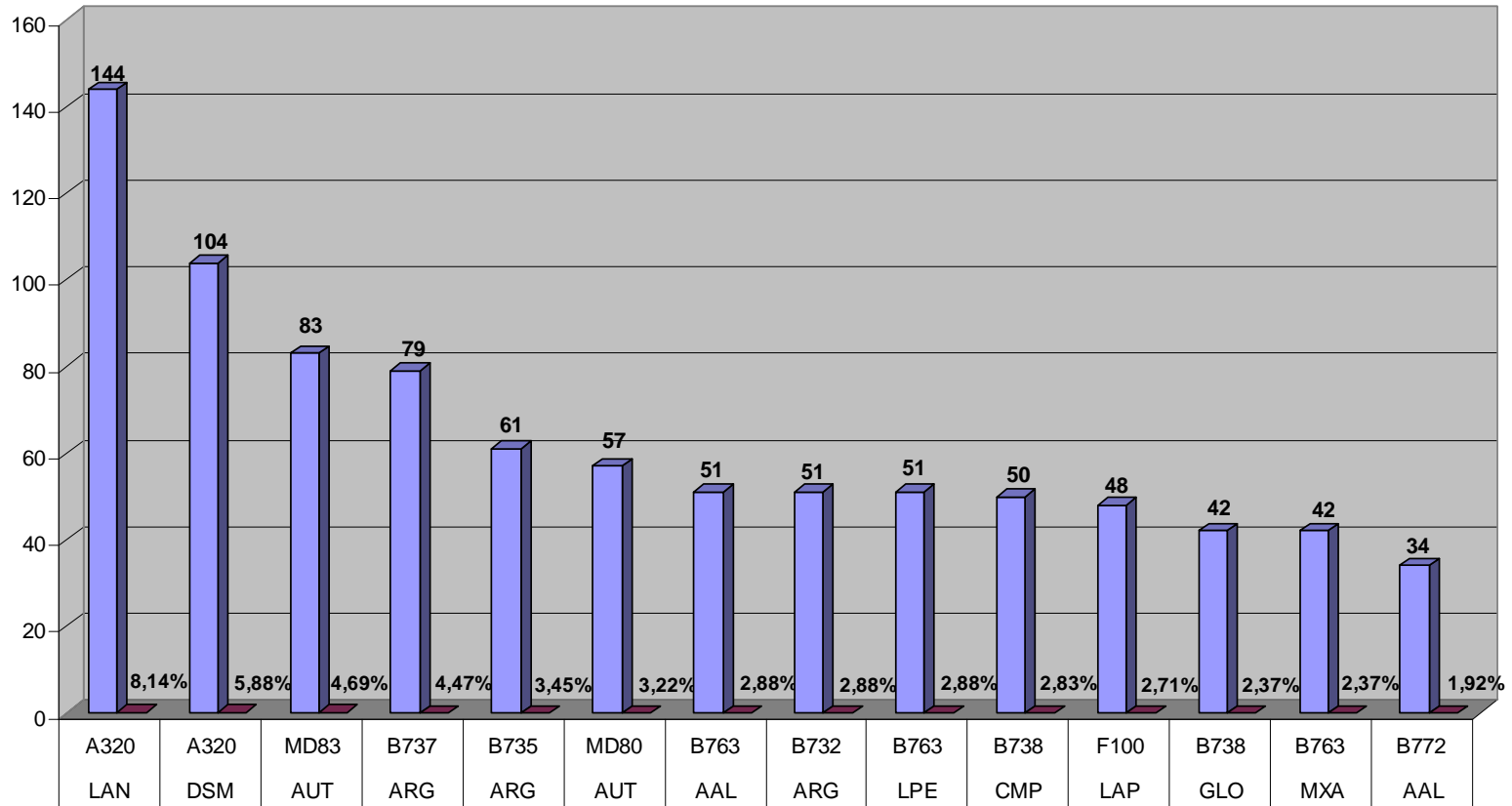
**SAM Region  
Airline/Type**

# ARGENTINA

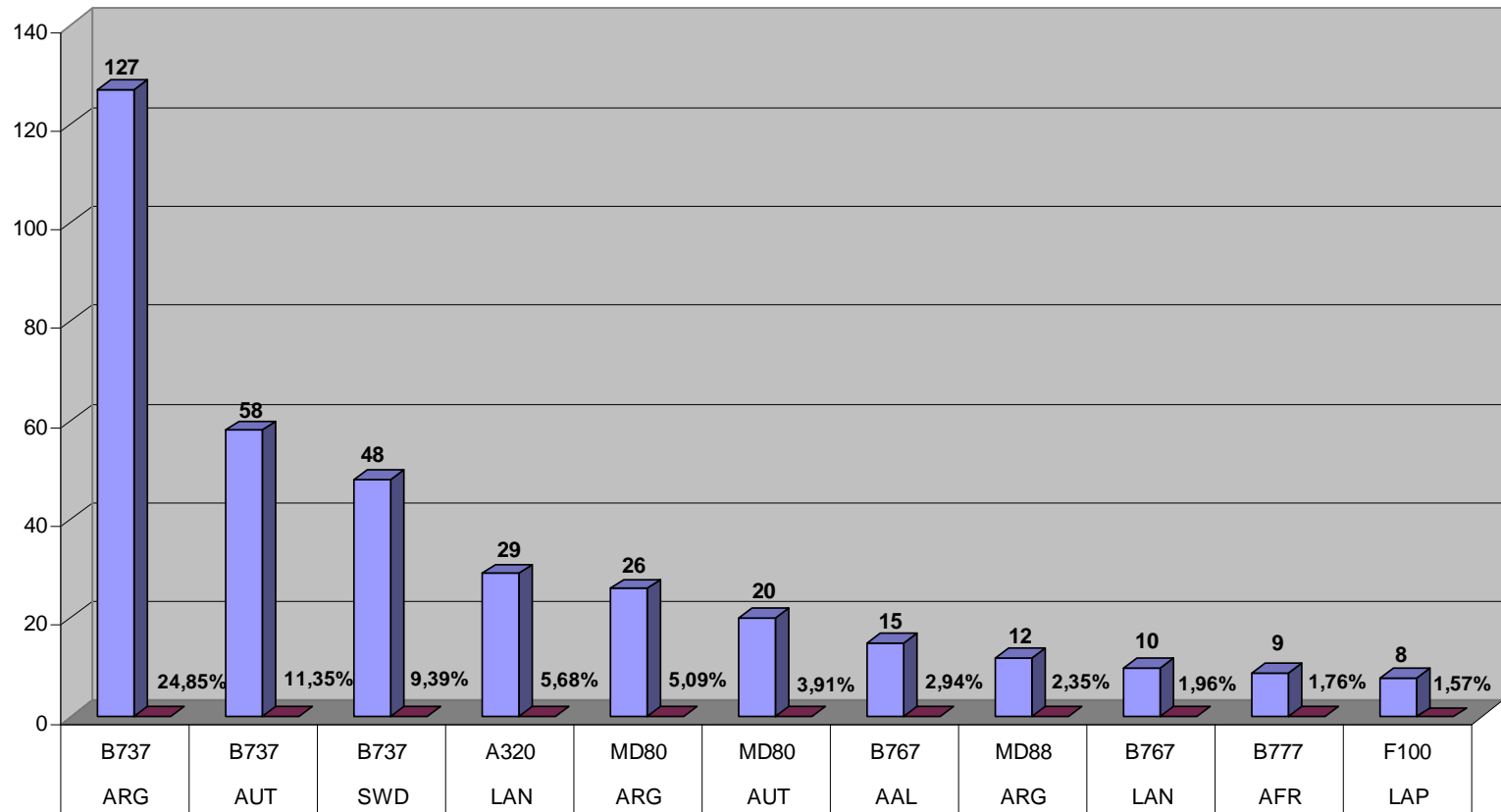
**FIR COMODORO RIVADAVIA - Aerolínea/Tipo**  
**87% del tránsito de la muestra**



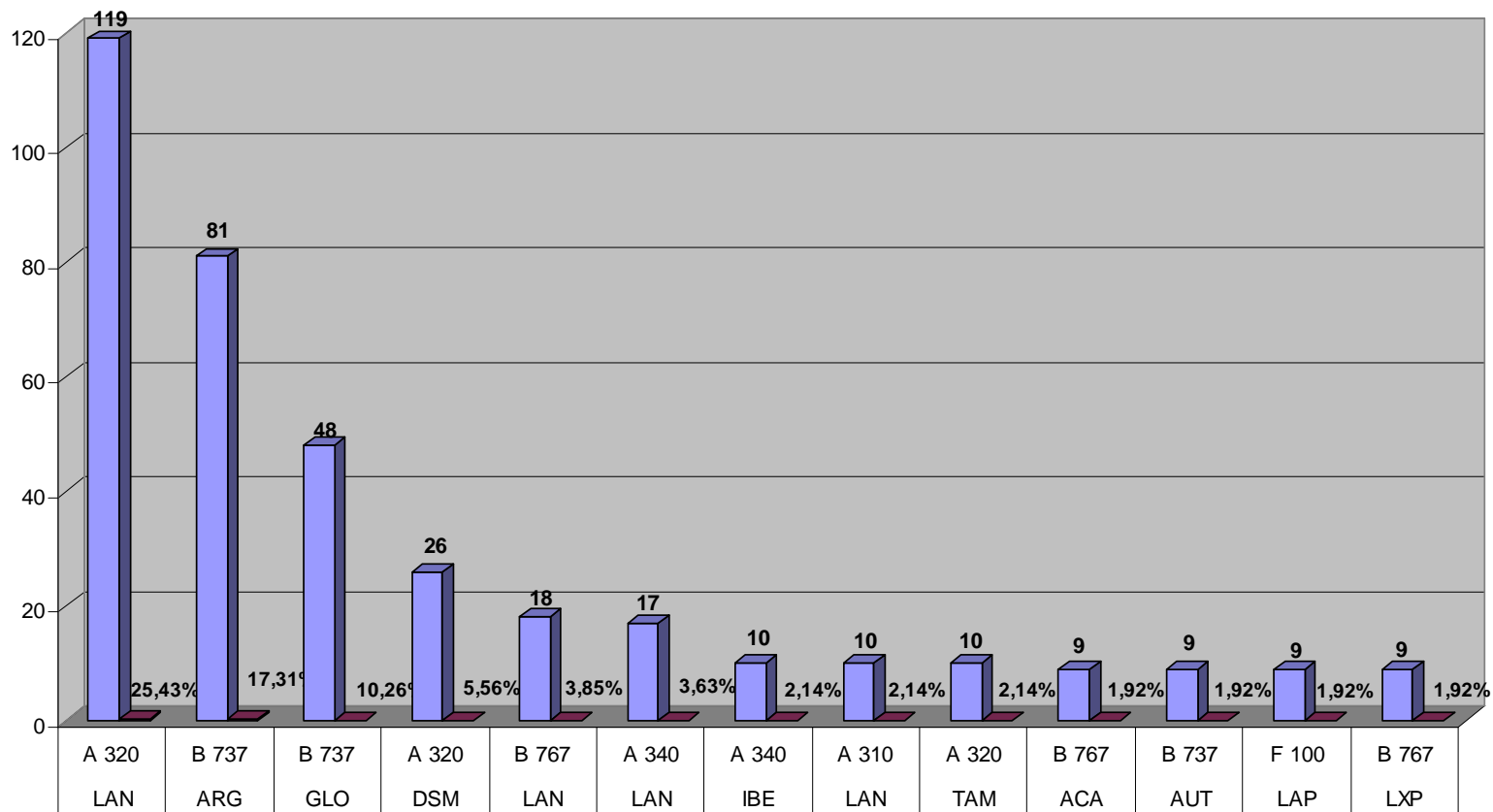
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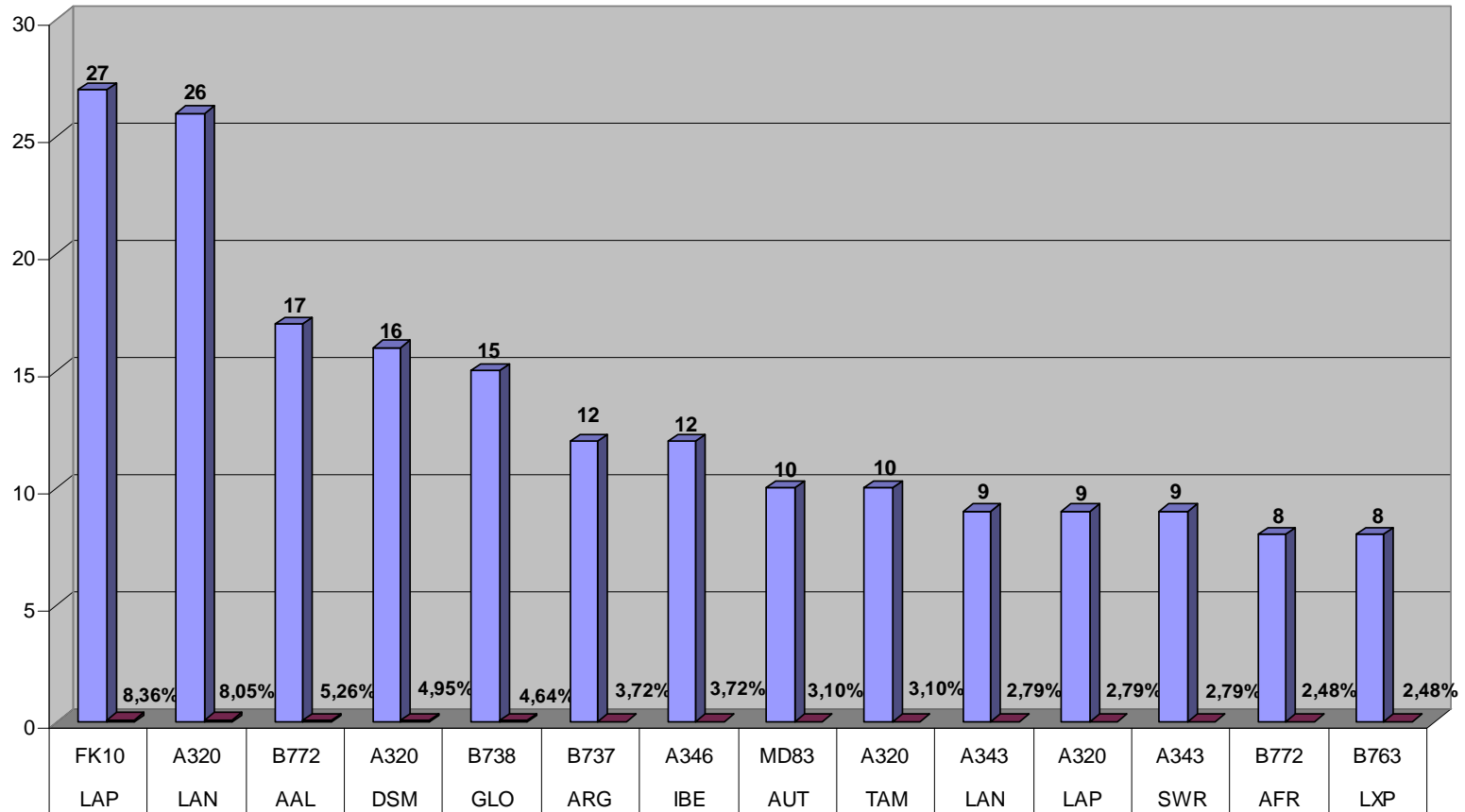
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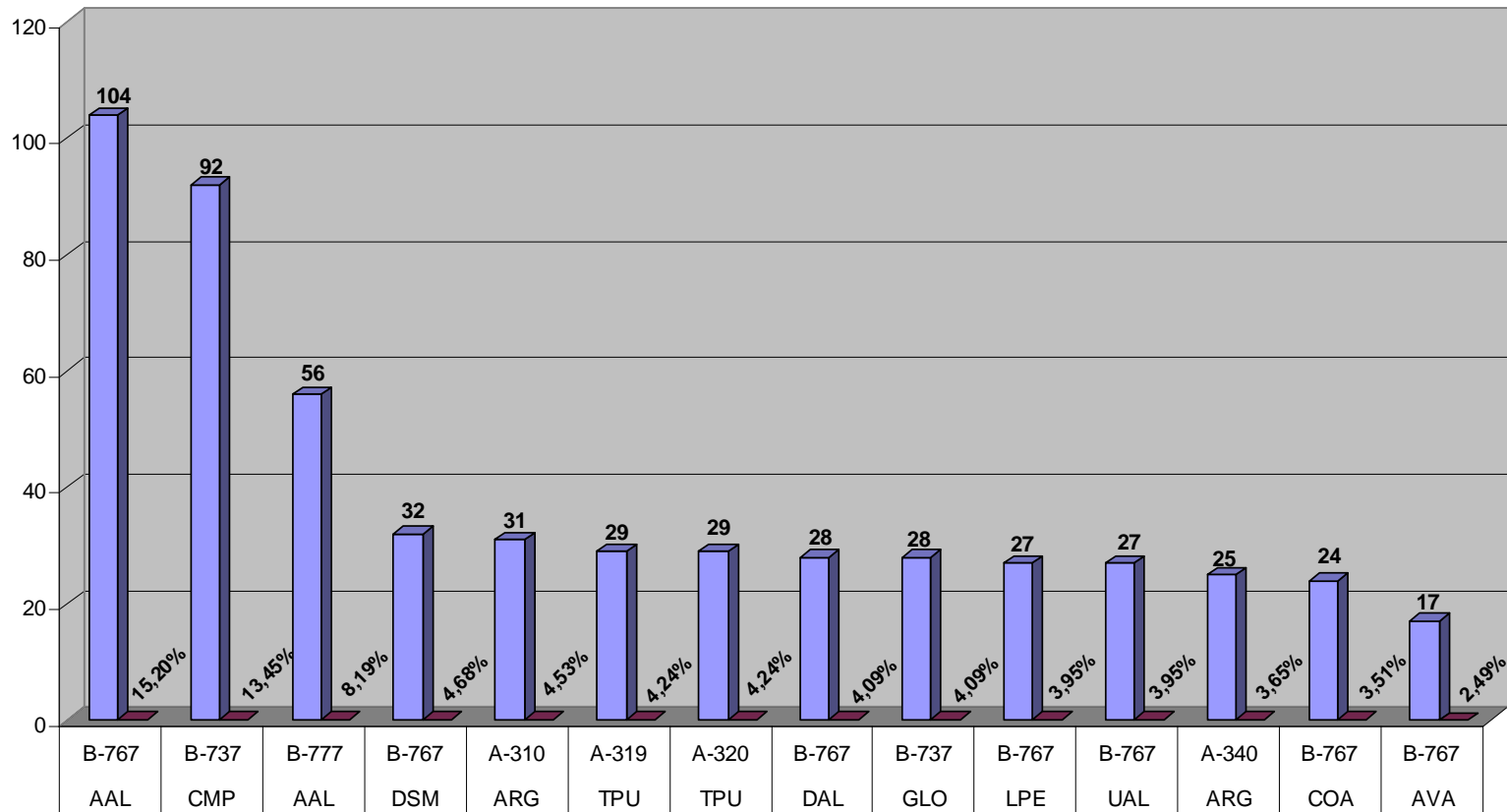


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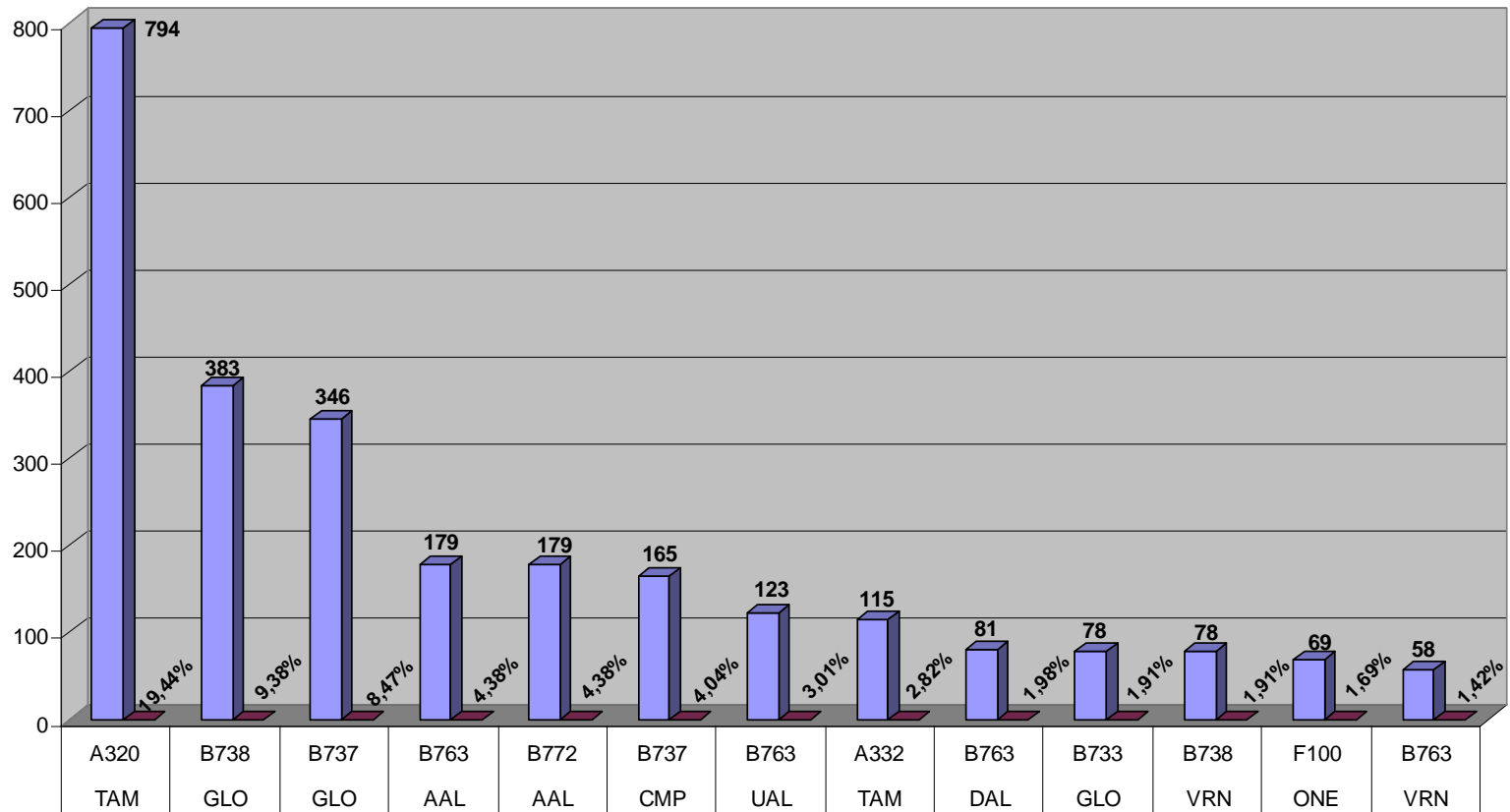
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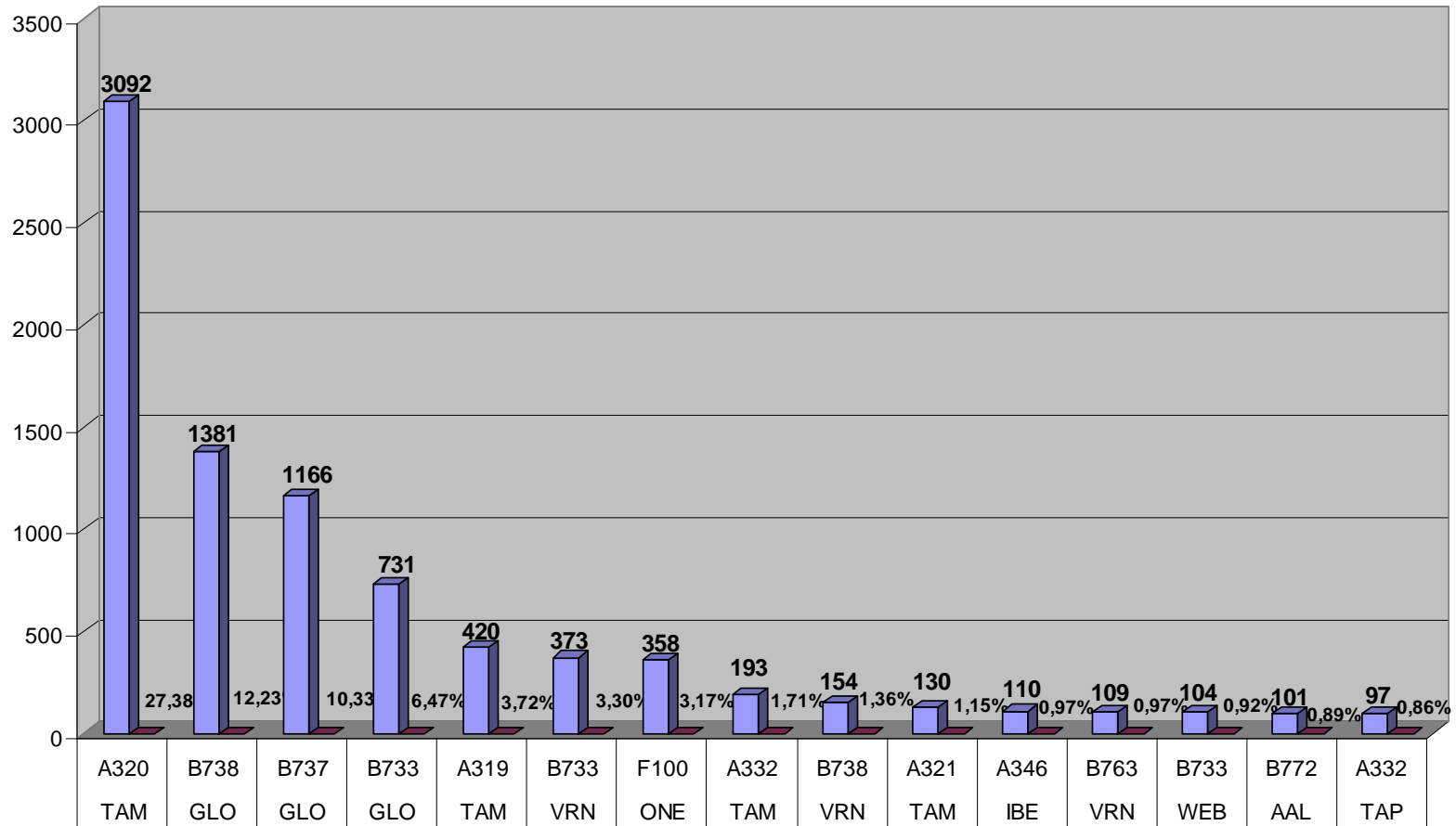


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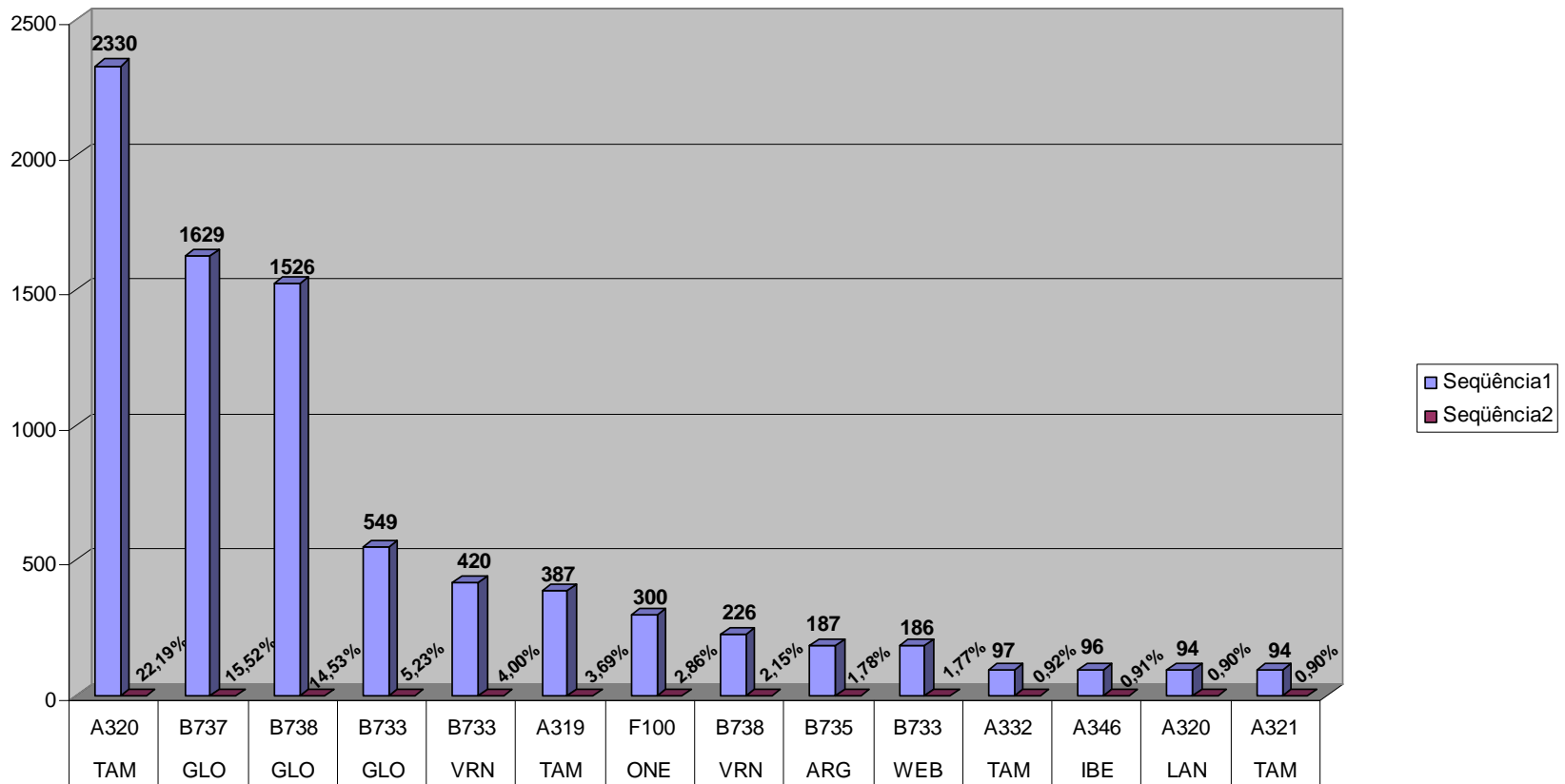
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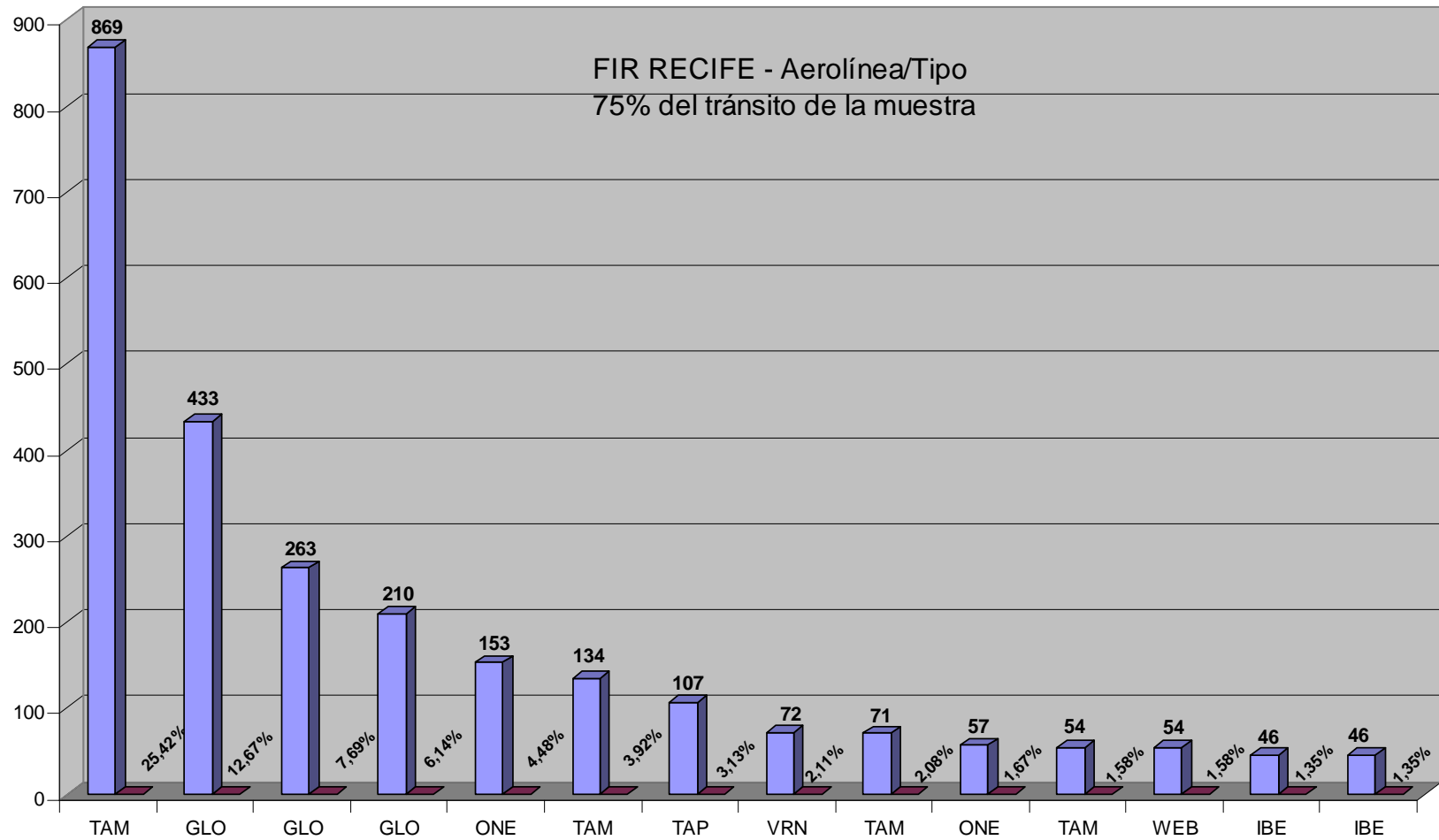


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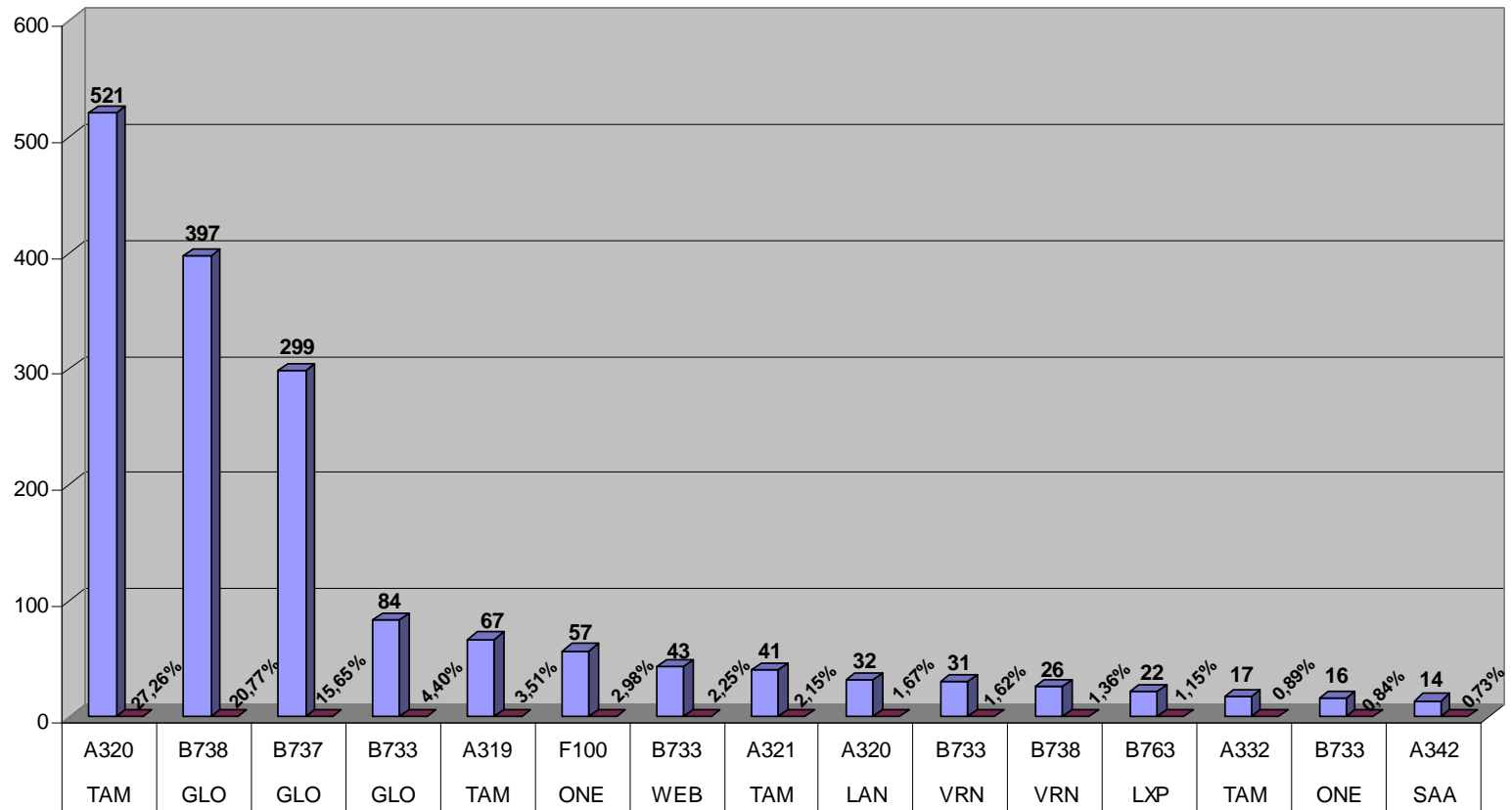


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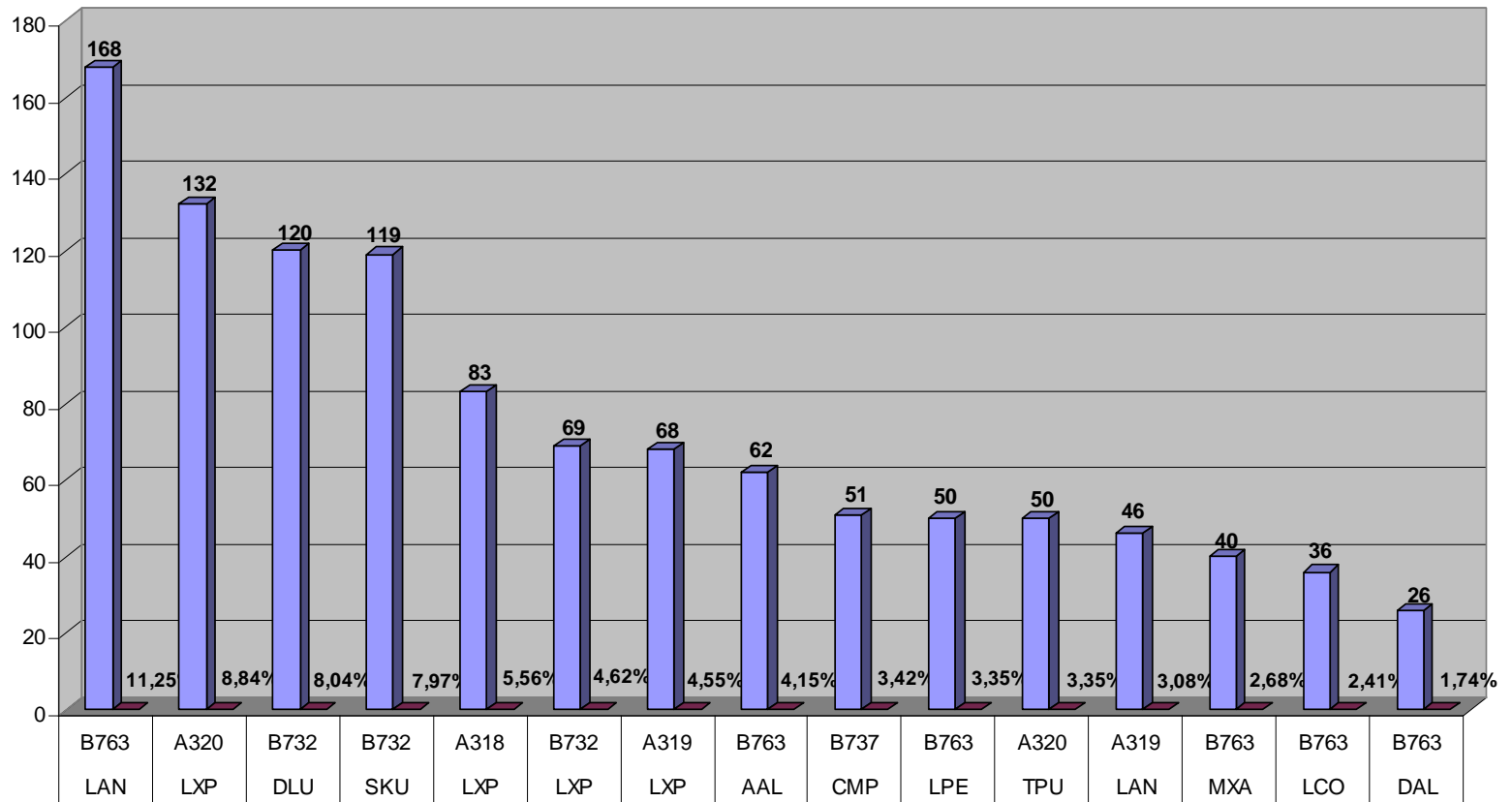


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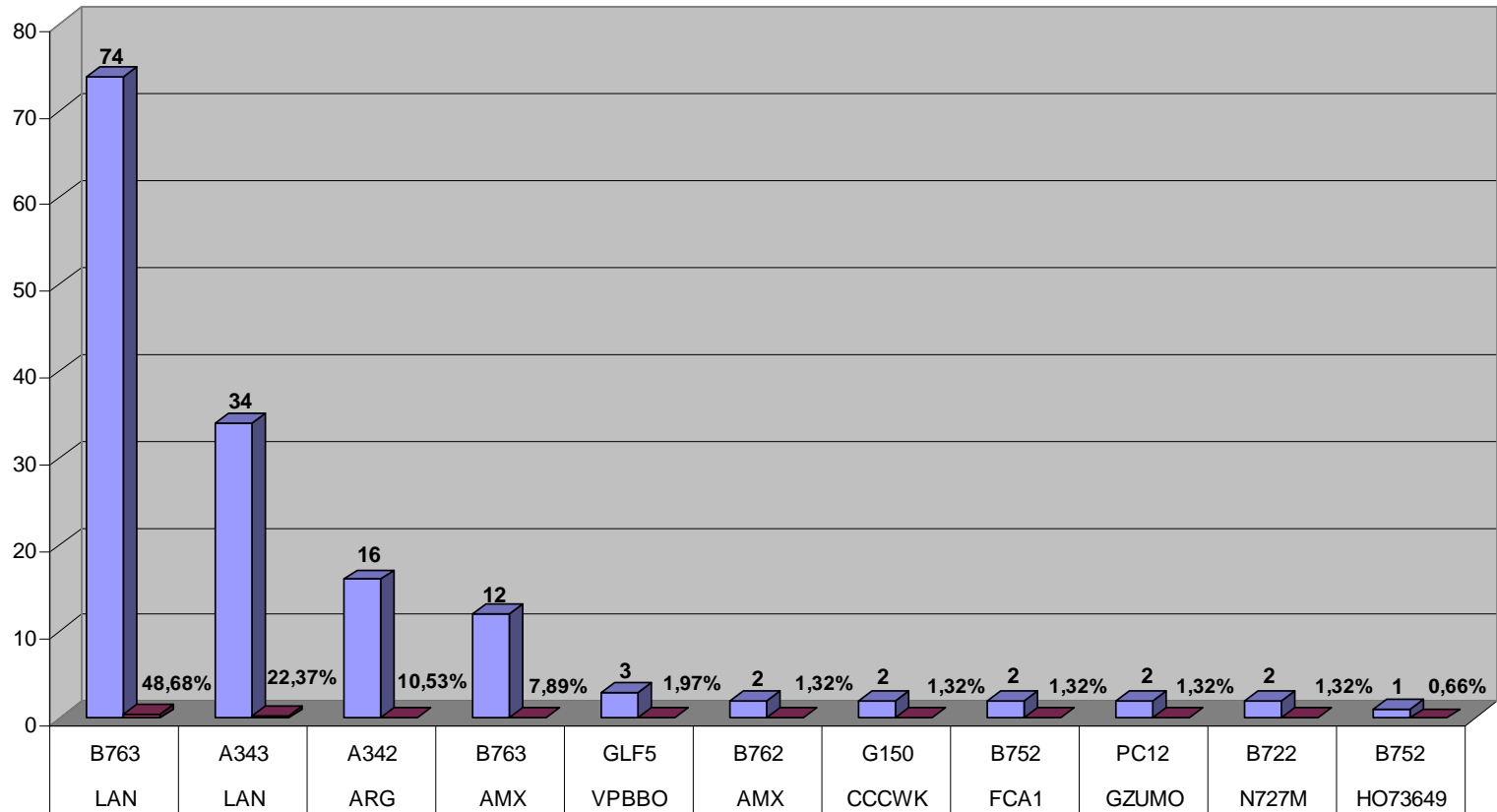


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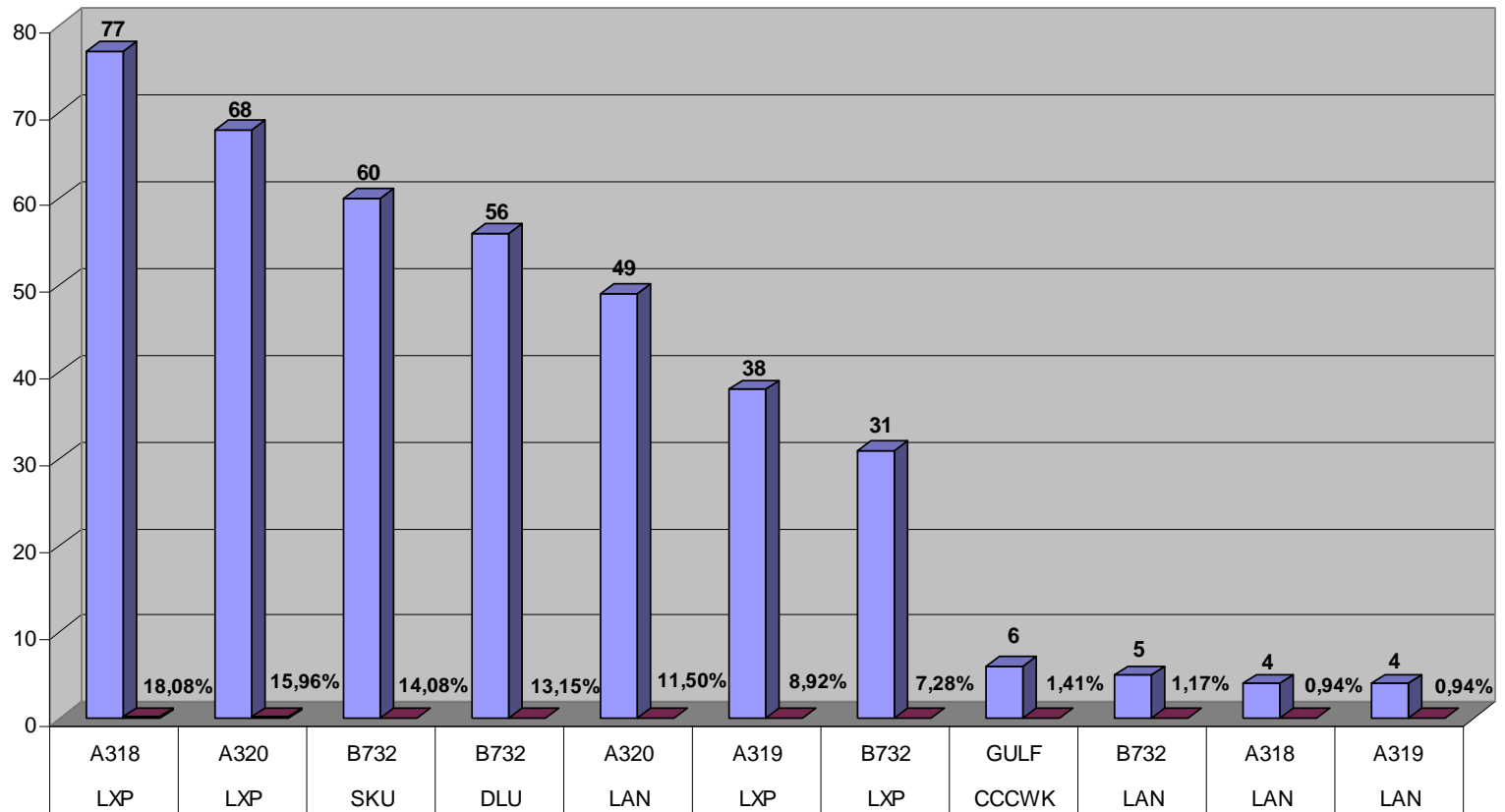
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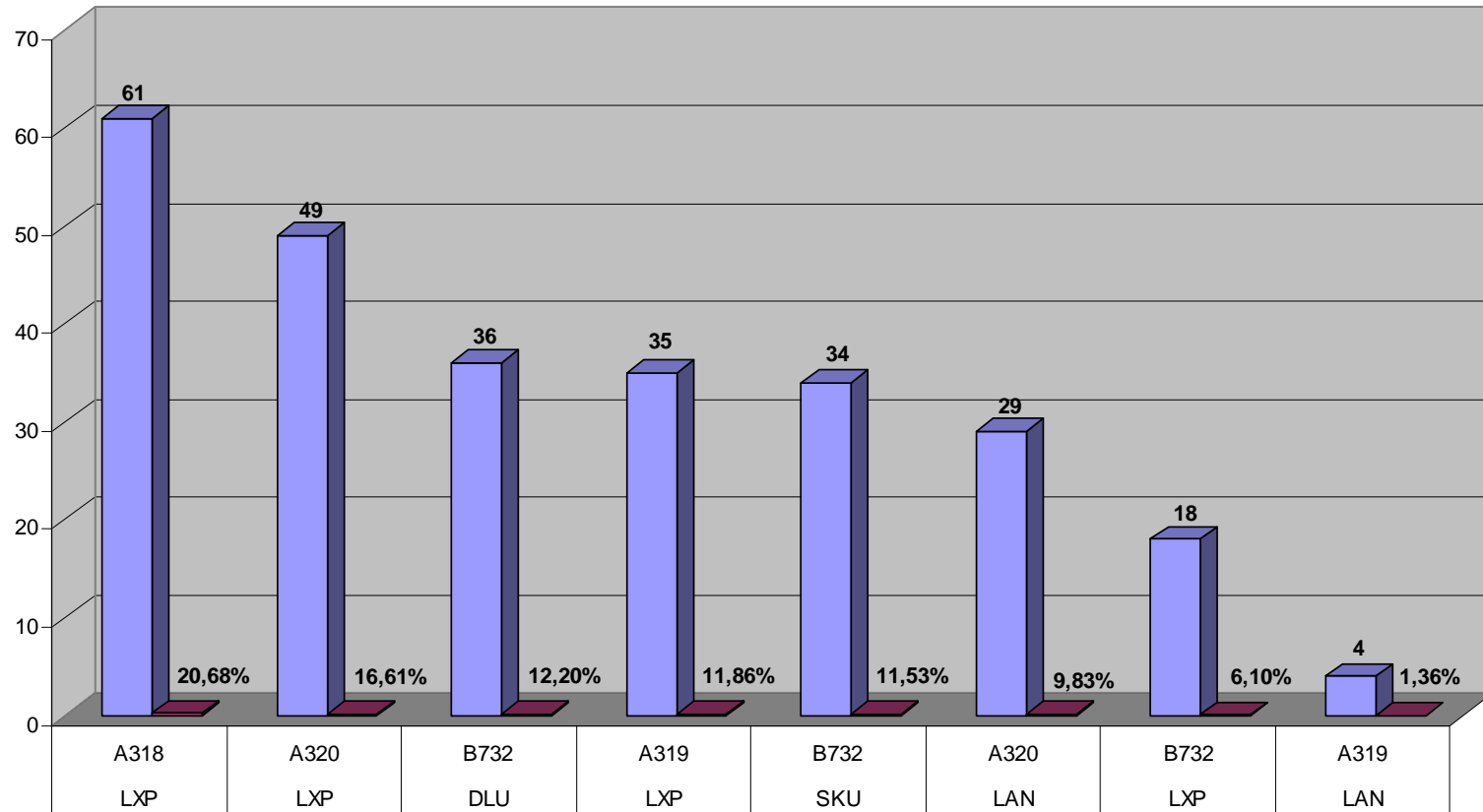
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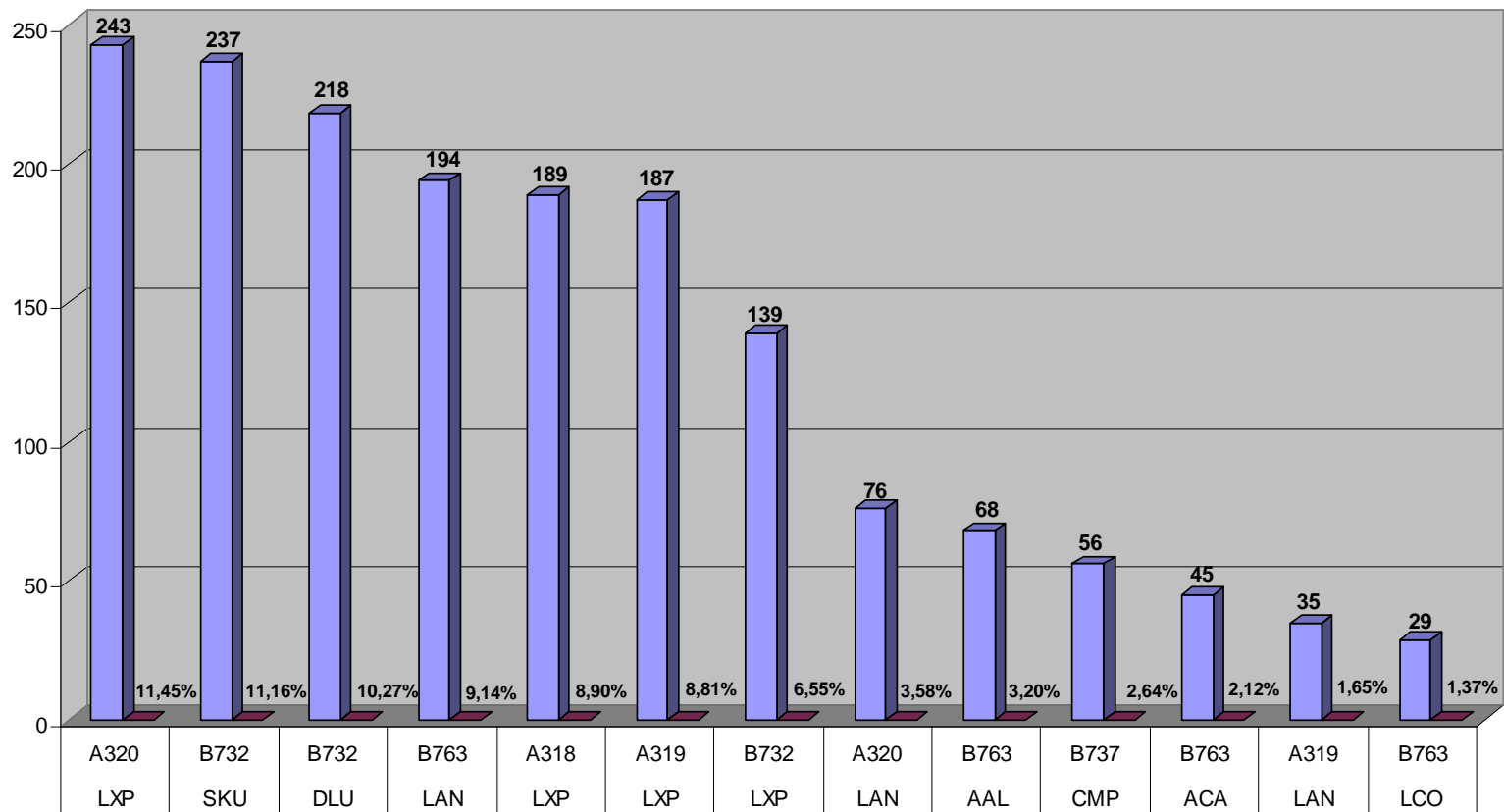
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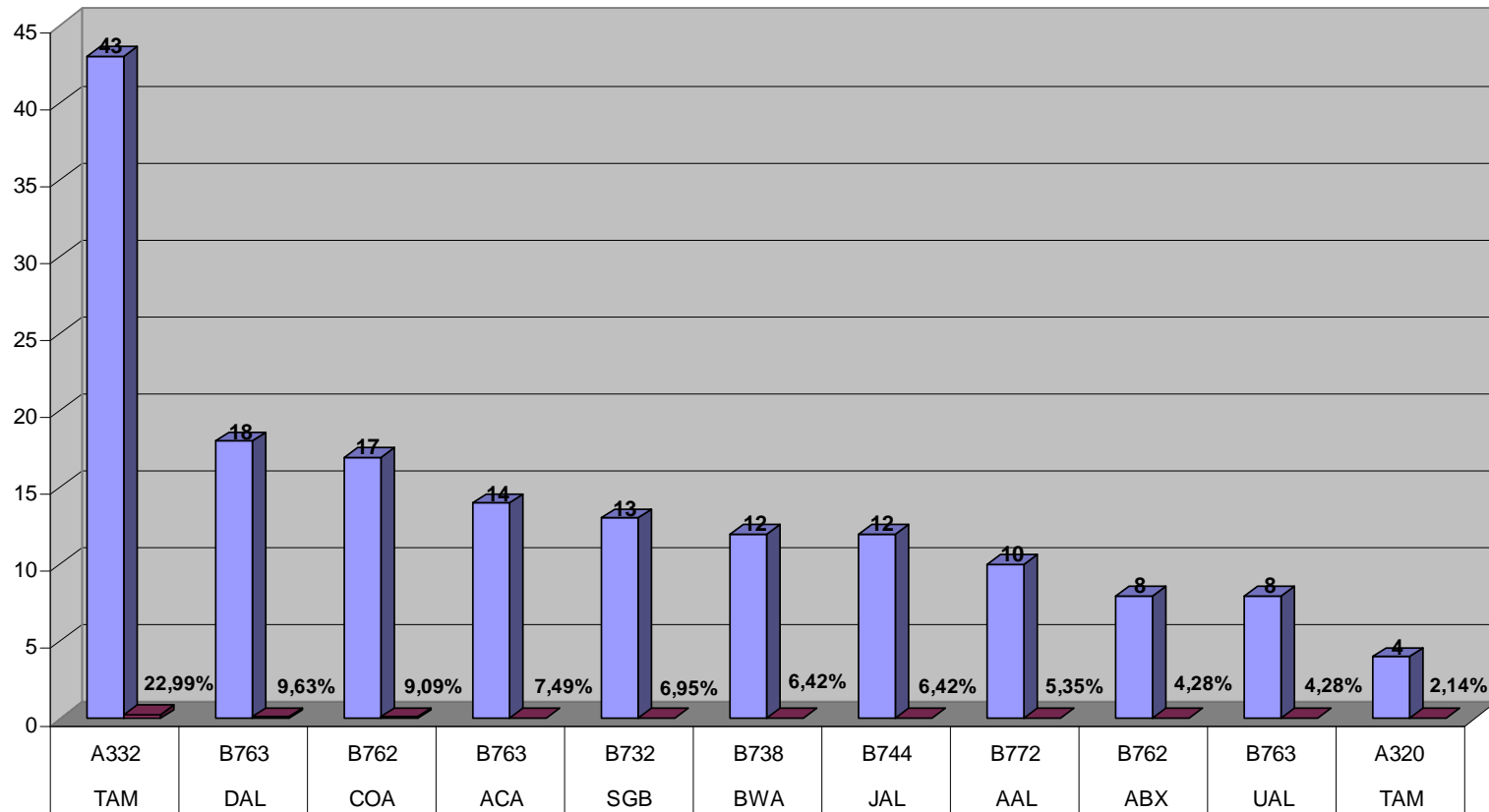


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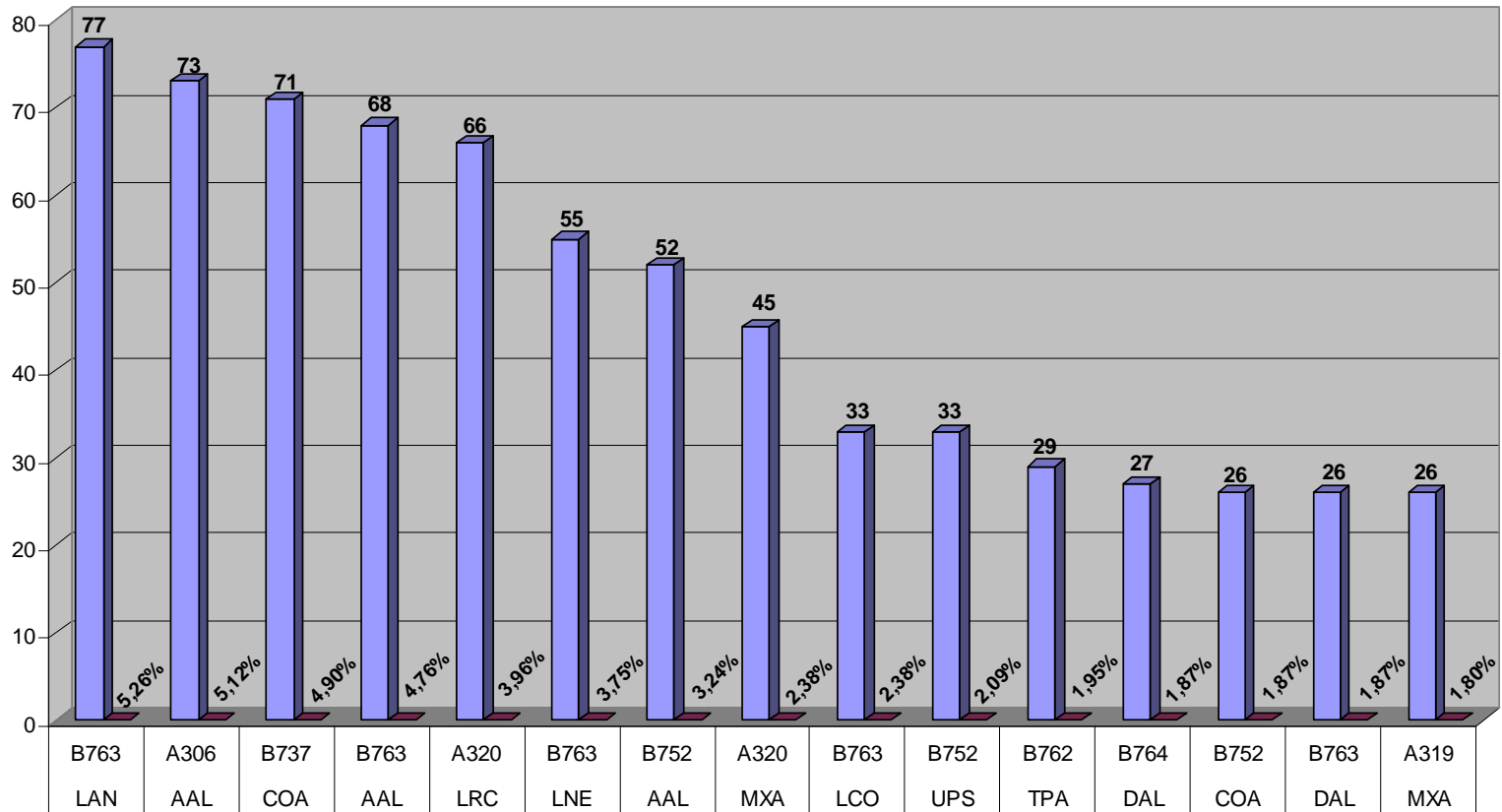
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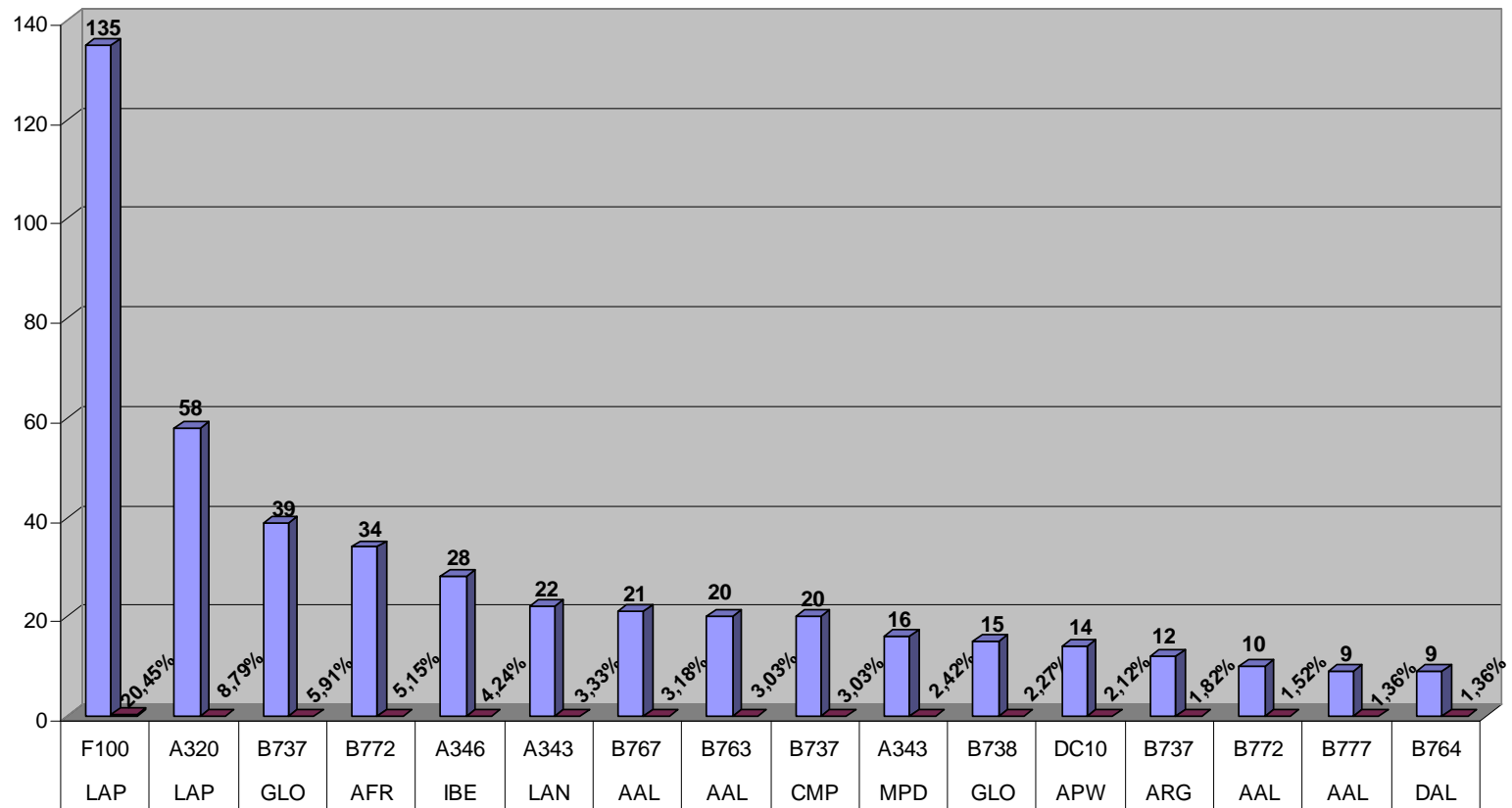
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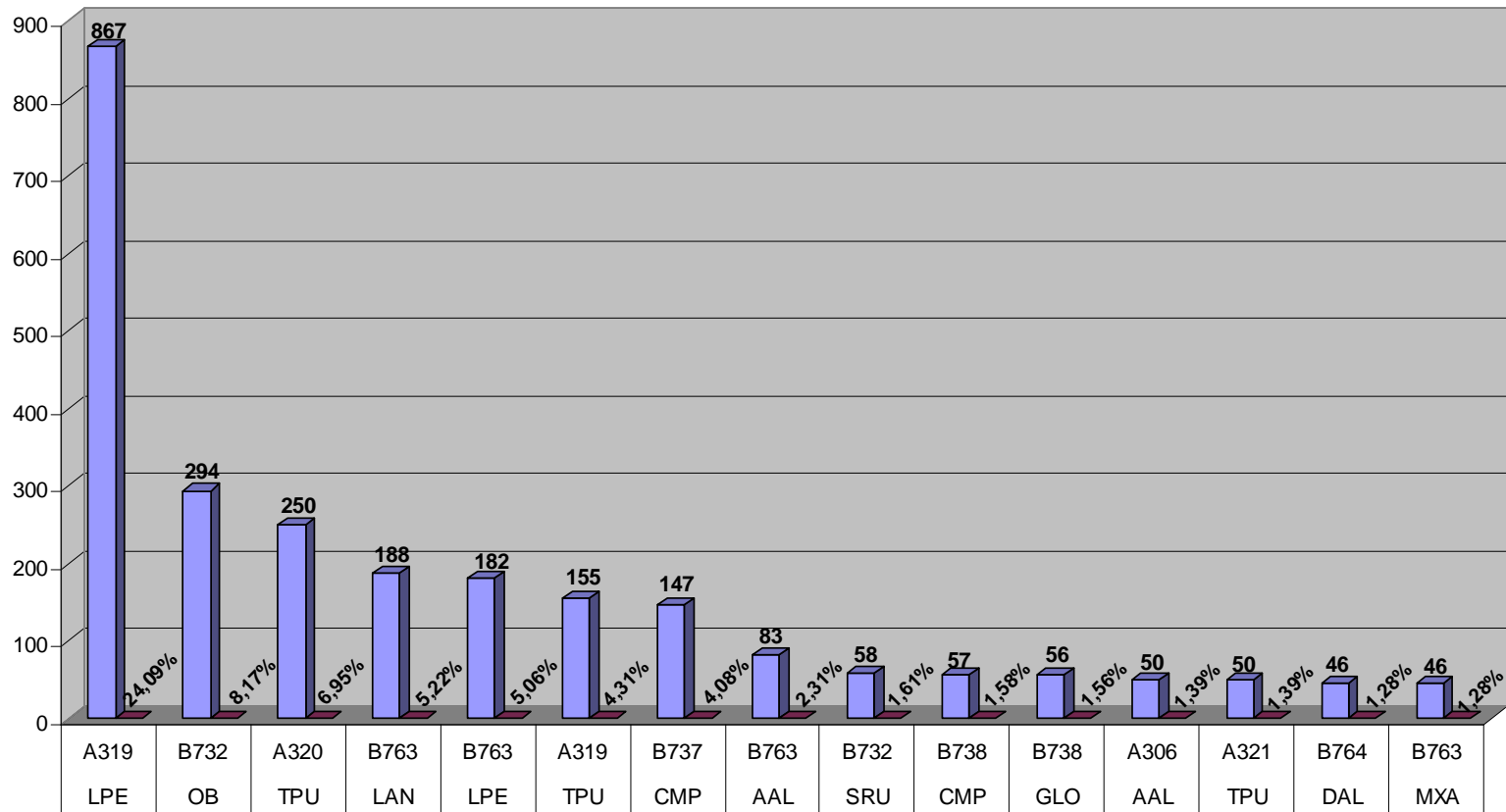
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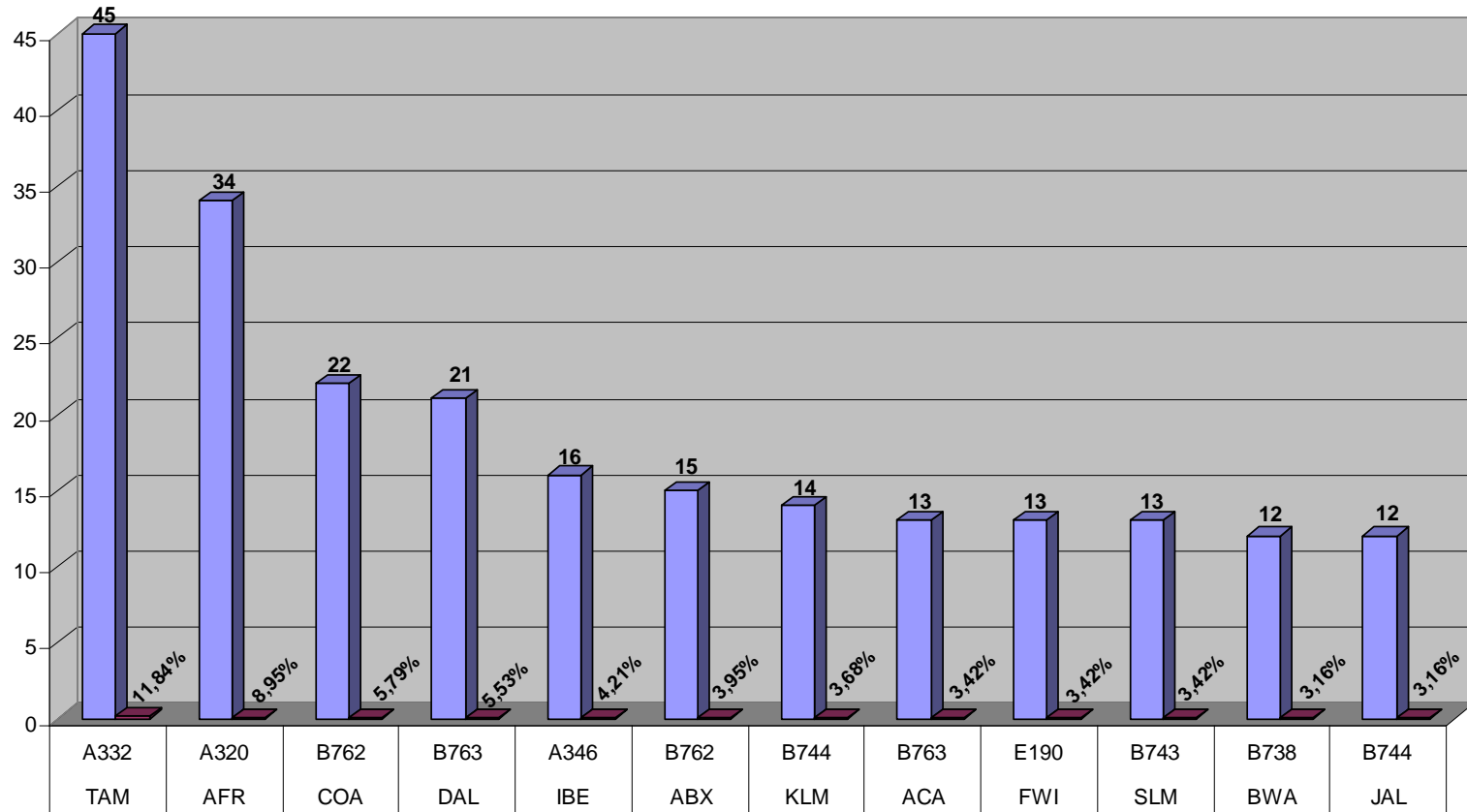
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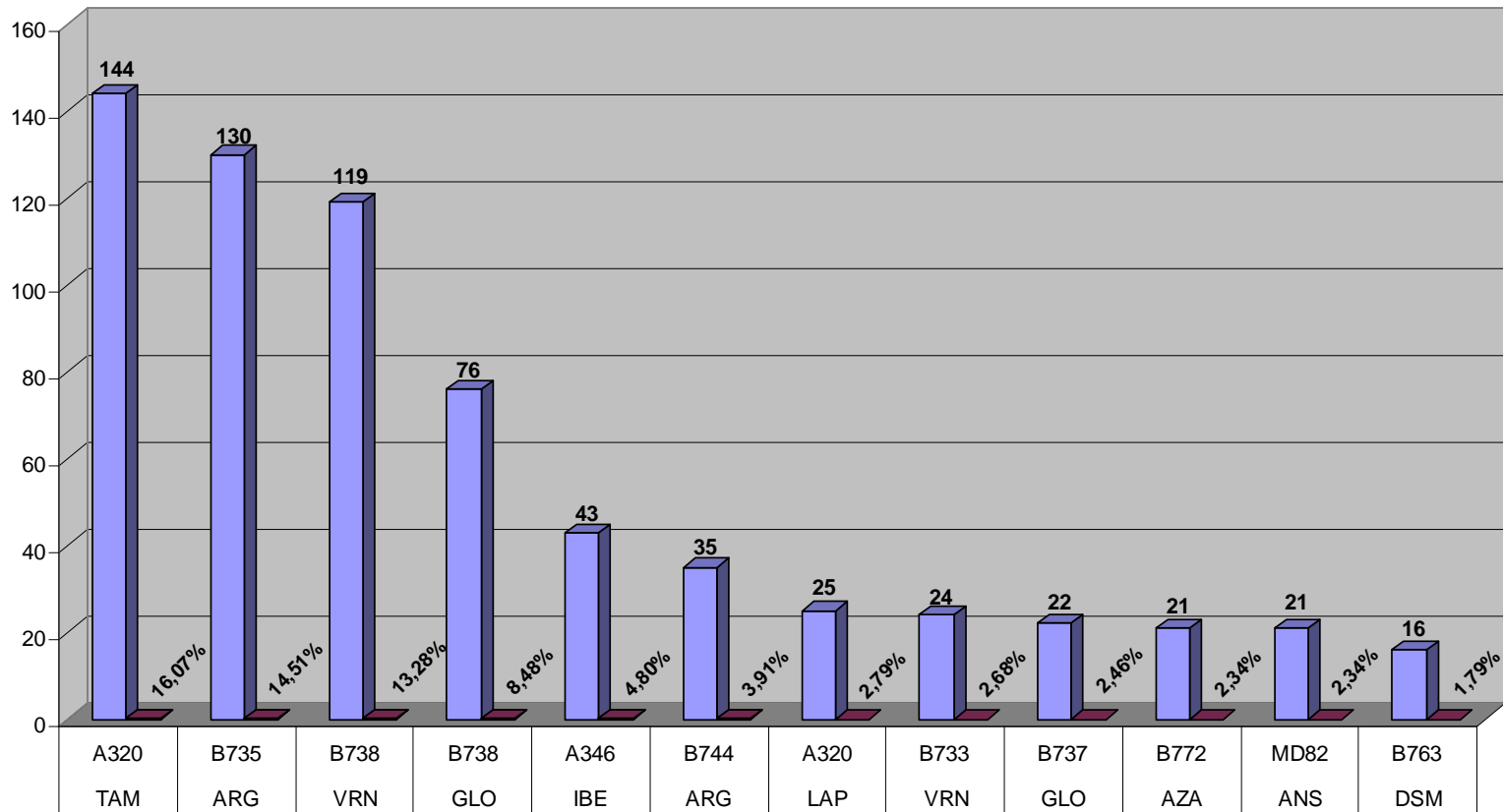
# SURINAME

**FIR PARAMARIBO - Aerolínea / Tipo**  
**61% del tránsito de la muestra**



# URUGUAY

**FIR MONTEVIDEO - Aerolínea / Tipo**  
**75% del tránsito de la muestra**



## APPENDIX C

### INITIAL AIC MODEL FOR RNAV-5 IMPLEMENTATION

<b>Telephone:</b> <b>Fax:</b> <b>E-mail:</b> <b>Sitatex:</b> <b>Telex:</b>	<b>STATE</b>  <b>AERONAUTICAL</b> <b>INFORMATION SERVICE</b>	<b>AIC N°</b>  <b>DATE</b>
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#### 1. Introduction

1.1. Continuous aviation growth makes it necessary to increase airspace capacity and points to the need for optimum use of available airspace. The improvement in operational efficiency deriving from the application of area navigation (RNAV) has resulted in the development of navigation applications in different regions and in all flight phases.

1.2. In planning navigation applications in specific routes or within a given airspace, it is necessary to define the requirements clearly and concisely. The reason for this is to ensure that the flight crew and the ATC are aware of the capacity and limitations of the navigation system (RNAV) and to guarantee that RNAV system performance is appropriate for airspace characteristics.

1.3. RNAV systems are used today in a way similar to ground-based conventional systems. An RNAV system is normally identified and its performance assessed through a combination of analyses and flight tests. The airspace concept is developed on the basis of information about RNAV equipment performance, being it necessary to determine whether different equipment models are appropriate for use in a given airspace.

1.4. In order to avoid this type of prescriptive RNAV specifications based on navigation equipment performance that result in delays in introducing new RNAV system capabilities and higher costs for appropriate maintenance and certification, ICAO developed the Performance-Based Navigation Concept (PBN).

1.5. This concept specifies the RNAV system performance requirements in terms of the accuracy, integrity, availability, continuity and functionality needed for the proposed operations in the context of the concept of a particular airspace. The PBN concept represents a shift away from systems-based navigation towards performance-based navigation. PBN application offers the following advantages:

- a) Reduces the need to maintain routes and procedures based on specific systems and, as a result, reduces the associated costs;
- b) Avoids the need to prepare operations based on specific systems for each new navigation system development, which would be prohibitively expensive;
- c) Allows for more efficient airspace use (fuel savings, noise reduction); and
- d) Facilitates operational approval of operators due to the application of a limited set of navigation specifications intended for global use.

1.6. The ICAO Manual on Performance-Based Navigation (Doc. 9613) establishes various different navigation specifications that can be applied globally. Given the air traffic characteristics for en-route operations in the South American Region, RNAV-5 is most appropriate for use there, inasmuch as the approval requirements will make it possible for most aircraft equipped with RNAV systems to meet those requirements. RNAV-5 use does not demand a navigation database, specify compliance with the ARINC 424 “leg types” nor require dual area navigation systems. RNAV-5 implementation aims to optimize the use of aircraft RNAV capacity as soon as possible, without requiring significant changes in airborne equipment for most aircraft.

2. **Purpose**

2.1. This AIC serves as a Note of Intent to implement RNAV-5 in the \_\_\_\_\_ FIR, on \_\_\_ November 2010.

3. **Area of application**

3.1. RNAV-5 will be implemented on all RNAV routes in the \_\_\_\_\_ FIR with the exception of routes \_\_\_\_\_ (applicable in routes which have other navigation specification – i.e.: UL780 and UL 302)

4. **RNAV-5 operations within the \_\_\_\_\_ FIR.**

4.1. Starting on November 18, 2010, only aircraft approved for RNAV-5 (airworthiness and operations approval) will be authorized to operate on RNAV routes in the \_\_\_\_\_ FIR.

4.2. RNAV-5 will be implemented in accordance with the Regional Air Navigation Agreements. Airworthiness and operations approval will be granted by state of operator or by state of registry, according to each case, under national regulations.

4.3. Updated documentation and information about RNAV-5 implementation may be found at the following website of the ICAO South American Office:

<http://www.lima.icao.int/submenu1.asp?Url=/ICAOSAMNET/AirNav-eDocumentsMenu.asp>.

4.4. Additional information, could be obtained through the following contacts:

- (States must add the RNAV-5 contacts for each ATS provider here)
- ICAO Lima

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**APPENDIX E**

**PBN IMPLEMENTATION PROJECT**

**TMA AND APPROACH OPERATIONS**

**SHORT TERM**

**SAM REGION**

### Introduction

The purpose of this document is to detail the activities of the Short-Term Performance-Based Navigation Implementation Project for TMA and Approach Operations in the South American Region, through the application of RNAV-1/RNP APCH/RNP AR. It also specifies the results that shall be obtained in each of the activities of the plan.

States shall develop their own PBN implementation projects for TMA and approach operations, based on the Model PBN Project for TMA and Approach Operations. Project RLA/06/901 will support SAM States through the development of guidance material and Project RLA/99/901 will provide support in the areas of fleet navigation capacity and aircraft and operator approval documentation.

The Short-Term Action Plan for TMA Operations is shown in **Attachment 1**, and **Attachment 2** presents the Short-Term Action Plan for Approaches.

## **PBN Implementation– TMA and Approach Operations - Short-Term**

### **1.           Airspace Concept**

The Airspace Concept provides the scheme of operations within an airspace and is developed to meet explicit strategic objectives, such as safety improvement, increase in air traffic, environmental impact mitigation capacity, etc. The airspace concept shall include details about the practical organization of the airspace, based on user characteristics and on the CNS/ATM infrastructure that is available or to be implemented. Further details about the Airspace Concept can be found in the PBN Manual, Volume I, Chapter 2.

In the case of TMA operations, the airspace concept shall cover the implementation of SIDs and STARs that avoid arrival and departure conflicts and favour aircraft flight at optimum profiles, with the application of continuous descent approaches – CDA.

STARs must, insofar as possible, be linked to IFR approach procedures based on RNP APCH w/Baro-VNAV or, if there are clearly established operational benefits to be obtained, be based on RNP AR.

1.1.           Establish and prioritize strategic objectives (safety, efficiency, the environment, etc.).

RNAV-1, RNP APCH and, in some cases, RNP AR, implementation in the SAM Region will address mainly the following Strategic Objectives:

- a)       Safety – RNAV-1 application in TMAs will allow for a separation between arrival and departure paths, thus avoiding conflicts among aircraft. The use of RNP APCH with APV/Baro-VNAV and/or RNP AR will reduce the risk of collision flight into terrain (CFIT).
- b)       Capacity – The use of RNAV-1 SIDs/STARs will make it possible to reduce the utilization of radar vectors and, as a result, will reduce airspace complexity and controller workload by improving the ATC capacity of the sectors and permitting a larger number of flight.
- c)       Cost-effectiveness – PBN implementation will enable a larger number of aircraft to fly their optimum flight profiles, primarily through CDA use, offering users a better cost-effectiveness ratio.
- d)       Efficiency – RNAV-1 application will improve operational efficiency, inasmuch as the establishment of well-defined arrival and departure points will make it possible to restructure the network of TMA incoming/outgoing routes, thereby reducing flying time. STAR–approach interaction will create the necessary conditions for establishing optimum arrival paths from the en-route to the final approach phase.

- e) Environmental Protection – Increased efficiency and fuel savings will reduce noxious gas emissions into the atmosphere. In addition, CDA application will help cut down on aircraft noise.
- f) Access and Equity – Implementation of the RNP APCH approach procedure and/or RNP AR will permit access to aerodromes under adverse weather conditions. PBN implementation shall not impede the flight of unapproved aircraft in a given airspace unless absolutely necessary because of air traffic density. It is expected that access and equity will be provided for in this way.
- g) Foreseeability – RNAV-1 navigation precision will make flight paths more foreseeable, facilitating aircraft separation and reducing the need for air traffic controller intervention in the case of possible aircraft diversions from the flight paths. STAR-approach integration will also enhance foreseeability.
- h) Global Interoperability – RNAV and RNP application, as provided for in the PBN Manual, will guarantee global interoperability through the application of standard navigation specifications, thereby avoiding the need to obtain various aircraft and operator approvals in order to fly in airspaces that use the same navigation application.
- i) ATM Community Participation – The success of PBN implementation will depend upon the effective participation of the ATM community, with a view towards guaranteeing that the operational requirements of both airspace users and service providers are met.

1.2. Collect air traffic data in order to understand air traffic flows.

Analysis of the main TMA arrival and departure flows is essential for prioritizing city pairs with a larger number of flights. The Excel spreadsheets used for the analysis of PBN en-route implementation can be obtained at the SAM Office website and used for analyzing the flows at the main TMAs in the SAM Region. It is important to note, however, that the air traffic sample used was the same as the one used for the CARSAMMA data collected between 13 and 28 January for RVSM safety assessment. This means that only flights between FL 290 and FL 410 were considered.

1.3. Analyze fleet navigation capacity.

The work to be carried out by ICAO and Project RLA/99/901, as mentioned in the PBN en-route Implementation Project, will cover PBN navigation specifications for the TMA.

There is a complete list of aircraft and avionics prepared by the FAA can be used to analyze fleet capacity for RNAV-1 and RNAV-2 specifications. This list can be found at: [http://www.faa.gov/about/office\\_org/headquarters\\_offices/avs/offices/afs/afs400/afs470/media/AC90-100compliance.xls](http://www.faa.gov/about/office_org/headquarters_offices/avs/offices/afs/afs400/afs470/media/AC90-100compliance.xls).

The appropriate GNSS-based navigation approach capacity shall be assessed for the RNP APCH specification.

For the RNP AR specification, the aircraft navigation capacity shall be assessed on the basis of clearly-established operational requirements, bearing in mind the flexibility of precision values in several approach segments that are normally between 0.3 and 0.1, as well as in accordance with the required functionalities for a specific airport, such as “radius to fix (RF) legs.”

The Excel templates used in the flow analyses for PBN en-route implementation may be obtained at the SAM Office website and used for analyzing the capacity of the fleet flying in the main SAM TMAs. Complete information is available at the SAM Office website.

1.4. Analyze the ground-based communication, navigation (VOR, DME) and surveillance infrastructure for navigation specifications, in order to comply with the Navigation Specification and the navigation reversal mode.

The ground-based communication, navigation (VOR, DME) and surveillance infrastructure is of fundamental importance for RNAV-1, both to permit the application of this navigation specification and to guarantee the navigation reversal mode in case of loss of the GPS signal. Inasmuch as this is an RNAV specification that does not require on board performance monitoring and alerting systems, ATS surveillance can mitigate the requirement for greater route spacing in order to overcome possible navigation system failures undetected by the flight crew.

The DME/DME navigation infrastructure will need to be assessed to verify whether the RNAV-1 navigation specification can be applied or whether it will be necessary to take one of the following measures:

- a) Use the inertial navigation system to cover possible gaps in DME coverage. In this case, it will be necessary to determine whether the aircraft fleet operating in the TMA is equipped with the inertial system.
- b) Assess the cost-benefit of implementing DME stations, in order to provide adequate coverage for DME/DME operations. This option will depend upon the percentage of aircraft that have DME/DME navigation alone and the State back-up policy in case of loss of the GNSS signal.
- c) Apply only GNSS to meet RNAV-1 requirements, considering the aspects cited in a) and b) above.

ATS surveillance is not required for RNP APCH approaches or RNP AR, but may be required if airspace complexity or the combined operation of approved and unapproved aircraft make it necessary.

1.5. Optimize airspace structure by implementing new SIDs and STARs and design instrument approach procedures (RNP APCH/APV Baro-VNAV or RNP AR) based on the strategic objectives of the airspace concept, considering airspace modelling, ATC simulations (in fast time and/or real time), live trials, etc.

Airspace structure will be optimized through the implementation of RNAV-1 SIDs and STARs that will provide well-defined TMA paths and arrival points, thereby avoiding air traffic conflicts and allowing users to fly their optimum flight profiles. For more complex airspaces, however, States should consider using the following tools:

- a) Airspace modelling;
- b) Fast-Time Simulation (FTS);
- c) Real-Time Simulation (RTS);
- d) live ATC trials

Use of these tools is not necessary for simple airspace changes like the implementation of a SID and/or a STAR. But for major changes in more complex airspaces, however, use of these tools can provide essential information for guaranteeing efficiency and safety. More information about these tools can be found in the PBN Manual, Volume I, part B, item 4.3.2.

The implementation of SIDs and STARs in an optimum configuration requires the spacing of TMA departure and/or arrival paths. In this respect, the State shall have trained personnel to make the necessary assessment or perform a comparative analysis, for example with other airspaces. Studies are being conducted by the Separation and Airspace Safety Panel (SASP) for the application of the aircraft separation protection areas for IFR procedures established in Doc. 8168. Approval of the proposal will facilitate appropriate TMA aircraft separation. It is important to highlight that some countries are already applying this aircraft separation methodology.

**2. Prepare a performance measurement plan, including gas emissions, safety, efficiency, etc.**

Performance-Based Air Traffic Management is organized based on the principle that ATM community expectations can best be met by quantifying such needs. Therefore, a series of performance objectives, goals and indicators shall be established that will make it possible to objectively justify projects for the improvement of air traffic management performance. **Attachment 6 to Appendix B** contains further details about Performance-Based ATM.

The estimated future performance of the ATM system will be of fundamental importance in guiding the planning of the improvements to be implemented. Research and development initiatives must be defined to foster the risk analysis of the following situations:

- a) the consequences of keeping the current ATM status unchanged. In this case, the ATM system would be subject to changes outside the sphere of operation of the service provider, such as: air traffic growth, changes in fleet composition, etc.; and
- b) the consequences of making changes that do not provide the expected improvement in system performance, therefore ceasing to meet the established performance goals.

The Key Performance Areas (KPA) involved in the case of simple implementations, like SIDs or STARs, are safety, efficiency and environmental protection. Safety can be measured qualitatively through a safety case. This possibility will be described more fully in the specific section on safety assessment. Efficiency and environmental protection are intrinsically related, inasmuch as an increase in efficiency normally results in a reduction in fuel consumption, thereby decreasing the amount of gas emissions released into the atmosphere. SID/STAR implementation must at least measure the expected saving in flying time and fuel consumption. It is important to stress that the implementation of a SID/STAR will not always result in a reduction in flying time, inasmuch as the purpose for its implementation could be, for example, to simplify TMA incoming and outgoing flows, thus reducing air traffic controllers and, consequently, increasing ATC capacity. In this case, a longer route could also create the necessary conditions for the use of continuous descent approach (CDA) procedures.

In more complex implementations, such as complete TMA restructuring, performance assessment will normally depend upon the use of specific tools like fast-time simulation (FTS), because a full and integrated assessment of the system will be needed that would be difficult to perform manually.

PBN implementation must consider at least the savings in flying time and fuel consumption, as well as the reduction of noxious gas emissions into the atmosphere. IATA has prepared a fuel saving calculation template that can be used to measure system performance. This template can be obtained at the SAM Office website.

### **3. Safety Assessment**

3.1. Determine the methodology to be used for assessing airspace safety and route spacing, depending upon the navigation specification, considering airspace modelling, ATC (fast and real time) simulations, live ATC trials, etc.

The methodology for assessing airspace safety may be either quantitative or qualitative. An RSVM implementation and post-implementation safety assessment offers an example of a quantitative method. These quantitative methods are based on the Collision Risk Model (CRM) and require the use of experts in specific areas, such as statistics and mathematics. However, this safety assessment would be justified only in the case of major airspace changes, such as the complete restructuring of the most complex TMAs. Examples of collision risk models used in safety assessments can be found in DOC 9689 – Manual on the Planning Methodology for Determining Separation Minima.

A qualitative assessment based on operational judgment could be applied in the case of a SID and/or STAR implementation or of PBN application in less complex TMAs. This type of assessment must be documented through an SMS methodology-based safety case. ICAO Doc. 9859, Safety Management Manual, and Doc. CAP 760 (Guidance on the Conduct of Hazard Identification, Risk Assessment and the Production of Safety Cases) of the United Kingdom offer an example of systematic use of this methodology. The latter document can be found at: <http://www.caa.co.uk/docs/33/CAP760.PDF>.

The qualitative analysis mentioned in the previous paragraph can be used to conduct the safety assessment for the application of RNP APCH and RNP AR procedures, considering that the implementation of new approach procedures does not normally involve significant airspace changes.

3.2. Develop a data collection programme for airspace safety assessment.

In order to develop the data collection programme, the State must decide upon the safety assessment strategy, considering whether the assessment will be quantitative or qualitative. In the case of the complete restructuring of complex TMAs, the State shall collect the necessary data for the safety assessment and/or determination of the route spacing to be applied in the SAM Region.

3.3. Conduct the preliminary airspace safety assessment.

The preliminary airspace safety assessment shall be completed before the implementation date, in order to guarantee the necessary conditions for the start of the pre-operational phase, normally for a one-year period.

3.4. Prepare the final airspace safety assessment.

The final airspace safety assessment is usually performed one year after the implementation date, which will guarantee the start of the operational phase.

#### **4. Establish a collaborative decision-making process (CDM)**

The purpose of the collaborative decision-making process is to guarantee that all actors involved in the implementation process participate in the different phases of the project, thereby ensuring transparency and compliance with the interests of all users and service providers.

4.1. Coordinate planning and implementation needs with air navigation service providers, airports, regulators, users, aircraft operators and military authorities. States should guarantee the participation of the main stakeholders in PBN planning and implementation in TMAs. Representatives of the airlines, general aviation, military aviation, air navigation service providers, regulators, etc. should participate from the very beginning of the planning process.

4.2. Establish the implementation date.

The implementation date is one of the main aspects to be considered in the project, bearing in mind that it will eventually need to be adjusted to the interests of the various stakeholders.

4.3. Establish the documentation format at the State PBN website.

The Internet is an important mechanism for disseminating PBN documentation to all implementation stakeholders. The States should create an appropriate website to facilitate the dissemination of PBN activities.

4.4. Report advances in planning and implementation to the corresponding Regional Office.

States must report planning and implementation developments to the South American Regional Office in order to guarantee the necessary harmonization among SAM States and to encourage the exchange of experiences and lessons learned.

## 5. Automated ATC Systems

5.1. Assess PBN implementation in automated ATC systems, taking into account amendment 1 to the PANS/ATM (FPLSG).

The introduction of changes to the automated ATC system based on PBN implementation is intrinsically related to the need for the air traffic controller to differentiate between aircraft that are equipped for operations based on RNAV and RNP navigation specifications, and those that are not. That differentiation is particularly important in non-exclusionary operating environments that permit flights of aircraft both approved and not approved for a given air navigation specification. Changes in automated systems may vary in complexity, from the insertion of letters or codes in the flight progress strips and/or in the radar screen targets, to a complete change involving differentiated colours or an analysis before a flight plan is entered into the flight plan processing system, in order to guarantee that only approved aircraft can fill in an RNAV route or RNP procedure in the FPL.

Modifications in automated ATC systems must take into account amendment 1 to the PANS/ATM. This amendment, resulting from the work of the ICAO Air Navigation Commission Study Group on Flight Plans, was approved at the 177th Session of said Commission and will enter into effect on 15 November 2012. States were informed of the approval of amendment 1 to the PANS/ATM through ICAO State Letter AN 13/2.1-08/50, of 25 June 2008. The amendment can be obtained at the SAM Office website.

This amendment involves significant changes in the insertion of alphanumeric codes relating to RNAV and RNP approval that are of key importance for PBN implementation. Considering current flight plan limitations, most of these codes will be inserted in field 18. In summary, the changes concerning PBN are as follows:

- a) The name of FPL field 10 is changed to “Equipment and Capabilities”;
- b) The letter “R” in field 10 will now mean “PBN Approval”. Navigation specifications for which the aircraft and operator are approved must be inserted in FPL field 18, using the following codes:

**- RNAV SPECIFICATIONS**

- ✓ A1 - RNAV 10 (RNP 10)
- ✓ B1 - RNAV 5 all permitted sensors
- ✓ B2 - RNAV 5 GNSS
- ✓ B3 - RNAV 5 DME/DME
- ✓ B4 - RNAV 5 VOR/DME
- ✓ B5 - RNAV 5 INS or IRS
- ✓ B6 - RNAV 5 LORANC
- ✓ C1 - RNAV 2 all permitted sensors
- ✓ C2 - RNAV 2 GNSS
- ✓ C3 - RNAV 2 DME/DME
- ✓ C4 - RNAV 2 DME/DME/IRU
- ✓ D1 - RNAV 1 all permitted sensors
- ✓ D2 - RNAV 1 GNSS
- ✓ D3 - RNAV 1 DME/DME
- ✓ D4 - RNAV 1 DME/DME/IRU

**- RNP SPECIFICATIONS**

- ✓ L1 - RNP 4
- ✓ O1 - Basic RNP 1 all permitted sensors
- ✓ O2 - Basic RNP 1 GNSS
- ✓ O3 - Basic RNP 1 DME/DME
- ✓ O4 - Basic RNP 1 DME/DME/IRU
- ✓ S1 - RNP APCH
- ✓ S2 - RNP APCH with BARO-VNAV
- ✓ T1 - RNP AR APCH with RF (special authorization required)
- ✓ T2 - RNP AR APCH without RF (special authorization required)

- c) The letter “G” continues to be used in field 10 to mean “Equipped with GNSS.” The corresponding augmentations must be entered in field 18, using the NAV/ code.

5.2. Make the necessary changes in the automated ATC systems.

The introduction of changes in automated ATC systems is usually a complicated, expensive and slow process for most States. Consequently, only changes that are deemed essential for safety and efficiency must be implemented. The following main scenarios would be possible in the case of PBN implementation in the TMA:

- a) Combination of conventional SIDs/STARs and RNAV-1 – In this scenario, use of the automated ATC system would enable the controller to assign the appropriate procedure, depending upon aircraft capacity, duly in advance. The system will also foster the necessary conditions for verifying whether the aircraft is effectively approved to fly RNAV-1 SIDs/STARs. This verification could be made by comparing air traffic samples with a database of approved aircraft. If aircraft separation depends upon RNAV approval, a greater degree of ATC automation would be needed to indicate to the air traffic controller which aircraft have RNAV approval and which do not.
- b) RNAV-1 SIDs and STARs and routing of unapproved aircraft using radar vectoring – Like in the previous scenario, the air traffic controller must know the aircraft RNAV approval status in advance in order to provide radar vectoring to unequipped aircraft.
- c) Exclusionary RNAV airspaces (with or without special exceptions –State aircraft, humanitarian flights, first delivery, etc.) – In this scenario, route spacing will depend upon aircraft RNAV approval, and ATC automation will be essential to indicate aircraft approval status to the air traffic controller.

## **6. Aircraft and Operator Approval**

6.1. Analyze aircraft and operator approval requirements (pilots, dispatchers and maintenance personnel) as established in the PBN Manual, and prepare the necessary documentation.

The PBN Manual, Volume II, Part B, Chapter 3 stipulates the general requirements for aircraft and operator approval for RNAV-1. EUROCONTROL and FAA documents on this topic are:

- a) EUROCONTROL – TGL-10 - Airworthiness and Operational Approval for Precision RNAV Operations in Designated European Airspace
- b) FAA – AC 90-100A – U.S. Terminal and En Route Area Navigation (RNAV) Operations.

The PBN Manual, Volume II, Part C, Chapter 5 contains the general requirements for aircraft and operator RNP APCH approval. EUROCONTROL and FAA documents on this topic are:

- a) EASA –AMC-20 Series – Airworthiness approval and operational criteria for RNP Approach (RNP APCH) operations (under development).
- b) FAA AC 20-138A - Airworthiness Approval of Navigation or Flight Management Systems Integrating Multiple Navigation Sensors.
- c) FAA AC 20-130A - Airworthiness Approval of Global Navigation Satellite System (GNSS) Equipment
- d) TSO C115b - Airborne Area Navigation Equipment Using Multi-Sensor Inputs

The PBN Manual, Volume II, Part C, Chapter 6 sets forth the general requirements for aircraft and operator RNP AR approval. The FAA document on this topic is:

- a) FAA AC 90-101 - Guidance for RNP Procedures with Special Aircraft and Aircrew Authorization Required

6.2. Publish national regulations for implementing RNP APCH and RNP AR for navigation specification RNAV-1.

Navigation specifications contained in the PBN Manual identify the requirements for operational and airworthiness approval for the use of RNAV or RNP applications. Provision must be made in national operational regulations for verifying compliance with these requirements, which may require specific operational approval.

Project RLA/99/901 is preparing the Latin American (LAR) Regulations, whose purpose is to harmonize the operational and airworthiness approval process in Latin America. Regional documentation provided through the LARs is expected to be available shortly. Coordination between this project and Project RLA 06/901 is fundamental for avoiding a duplication of efforts and facilitating the work of the States involved. Project RLA 99/901 could at least offer guidance material for adoption and publication by the States.

One option already in use by CAR/SAM States is to adopt documents of other States and International Organizations, as in the case of Interim Guidance 91 (RVSM) and Order 8400-12 (RNP-10).

6.3. Start the aircraft and operator approval process.

In order to meet the established implementation deadline, States must start the aircraft and operator approval process, and Project RLA 06/901 shall verify whether all States effectively initiate this process, in order to harmonize the activities of the States involved.

6.4. Establish a database of approved aircraft and operators and keep it up-to-date.

States shall establish a strategy for creating a database of aircraft and operators approved for RNP APCH and RNP AR RNAV-1 operations, similar to that created for RVSM implementation, taking into account the following objectives:

- a) When TMAs are to be completely restructured, and mainly in the case of an exclusionary airspace, it will be necessary to rely on a minimum percentage of operations approved for RNAV-1. In this connection, the creation of the database is essential for analyzing the minimum percentage.
- b) Verify whether the aircraft flying RNAV routes are effectively approved for RNAV-1, RNP APCH and RNP AR operations.

6.5. Verify operations using a continuous monitoring programme (aircraft and procedures).

Safety must be ensured through a continuous operational verification programme regulated by States.

## 7. Standards and Procedures

7.1. Assess the regulations for GNSS use and, where appropriate, proceed to their publication.

GNSS application is of key importance for all PBN navigation specifications, considering that some aircraft only have this equipment to meet the established performance requirements and that there are some specifications that only GNSS can meet.

The key issue is the State policy with regard to GNSS application as a means of navigation. In order for the system to be used fully, States must regulate its use as a primary means of navigation, even if this would require imposing some operational restrictions, such as, for example, requiring alternate aerodromes to provide for “conventional” approaches (VOR, NDB, ILS). Another aspect that should be considered is the need to establish a navigation reversal mode if the GNSS signal is lost, requiring the aircraft to be equipped with “conventional” air navigation systems.

States in the Region have already published some regulations for GNSS use. **Attachment 7 to Appendix B** shows the current status of these regulations in the SAM Region. Regulation of GNSS use is essential for all navigation applications.

The use of GNSS as a means of navigation is of key importance to meet RNAV-1 requirements, considering that some aircraft only have this type of RNAV equipment and that some TMAs may not have sufficient DME coverage to accommodate navigation based on this system. Consequently, SAM States should consider regulating the use of GNSS and make any changes they deem necessary.

For RNP APCH and RNP AR navigation specifications, GNSS is the only system that meets the requirements established in the PBN Manual.

7.2. Finalize WGS-84 implementation.

7.3. SID, STAR and Approach Ground Validation and Flight Inspection

A series of steps should be followed in preparing RNAV or RNP IFR procedures, starting with the generation of the data through their final publication and subsequent coding for use in the navigation database. The PBN Manual, Volume I, Part B, Appendix B contains information about the ground validation of IFR procedures. Quality control should be exercised in each design phase of the IFR procedures, in order to reach the necessary levels of precision and integrity. Doc. 8168 – PANS-OPS, Volume II, Part 1, Section 2, Chapter 4 (Quality Assurance) details the quality control procedures to be used.

Flight inspections must be made of the procedures and radio aids on which the procedures are based. Insofar as the procedure flyability is concerned, States must consider using flight simulators in order to verify whether the proposed procedures can properly serve the most critical aircraft in a given airspace/aerodrome.

7.4. Establish Navigation Database Validation Requirements and Procedures.

The integrity of navigation databases is a key safety element in a PBN environment, depending on the Navigation Specification requirements. Consequently, database integrity should meet the requirements set forth in documents DO 200A and/or EUROCAE ED 76 (Data Quality Assurance Process). The State must issue a Letter of Acceptance (LOA) documenting that the database provider meets the requirements of DO 200A and/or EUROCAE ED 76 or accept the LOAs issued by other States or International Organizations (FAA or EUROCONTROL).

7.5. Prepare the AIC model to report PBN implementation plans.

The AIC reporting PBN implementation, published approximately 2 years in advance, will give aircraft operators enough time to obtain approvals for RNP APCH and/or RNP AR RNAV-1 operations.

7.6. Publish the AIC reporting PBN implementation plans.

States must publish the AIC reporting PBN implementation plans.

7.7. Prepare an AIP Supplement model containing applicable standards and procedures, including the corresponding in-flight contingencies.

The AIP Supplement will contain specific operational standards and procedures for RNP APCH and/or RNP AR RNAV-1 implementation.

7.8. Publish an AIP Supplement containing applicable standards and procedures, including the corresponding in-flight contingencies.

7.9. Review the Procedural Handbook of the ATS units involved.

The Procedural Handbook of the ATS units gives a detailed account of their mode of operation, in an effort to harmonize the operational procedures applied by air traffic controllers. RNAV-1 implementation will require a review of these procedures, considering in particular:

- a) Aircraft separation;
- b) Contingency procedures;
- c) New SID/STAR/approach procedures;
- d) Radio aids that are essential for SID, STAR and approach procedures. For the approach, this is normally applied in cases when the missed approach is based on a ground-based radio aid.
- e) New air traffic routing models (new air flow), including the SID/STAR/approach procedures used, radar vectoring, if required, and the systematic “feeding” of TMAs.

- 7.10. Update letters of agreement between ATS units.

Letters of agreement between ATS units (between ACCs or between ACCs and APPs) shall be updated to reflect the new airspace structure implemented, if appropriate, and the procedures mentioned in the previous paragraph.

- 7.11. Review practices and procedures for improving fuel consumption management and environmental protection.

This must be an objective to be sought at all SAM/IG meetings, in accordance with the environmental policy of ICAO and of the SAM States.

## **8. Training**

- 8.1. Prepare a training and documentation programme for operators (pilots, dispatchers and maintenance personnel).

The documentation and training leading to the operational approval of an aircraft operator is normally part of the operational certification process that guarantees the use of an Air Navigation Application. Each aircraft operator must develop a training programme to be approved by the civil aviation authority, in order to obtain approval for the use of an Air Navigation Application. The PBN Manual, Volume II, Parts B and C, contains some general training guidelines for aircraft operators that cover each Navigation Specification.

- 8.2. Develop a training and documentation programme for air traffic controllers and AIS operators.

The PBN Manual, Volume II, Parts B and C, contains some general training guidelines for air traffic controllers that cover each Navigation Specification.

- 8.3. Develop a training programme for regulators (aviation safety inspectors).

Aviation safety inspectors must receive the necessary training so as to be able to verify compliance with PBN specification norms.

- 8.4. Conduct training programmes.

States, service providers and aircraft operators must conduct the necessary training programmes within the stipulated period in order to ensure implementation by the established deadline.

- 8.5. Hold seminars for operators, indicating the plans and expected operational and economic benefits.

The main purpose for holding seminars targeting operators is to urge them to equip their aircraft within an appropriate period of time, in keeping with the established navigation specifications, showing them the objectives and benefits to be attained through said implementation.

## **9. Decision to Implement**

At this point in the Action Plan, three basic questions must be answered:

- a) Is the aircraft operator ready for the implementation? (9.1 and 9.2)
- b) Is the air traffic service provider ready for the implementation? (9.1)
- c) Is the implementation safe? (9.3).

A specific meeting must be held to assess these three key points and reach a final implementation decision.

When a final decision has been reached, each State must publish the relevant ATS documentation, including the trigger NOTAM, seven days before the planned implementation date, in order to confirm it.

- 9.1. Assess the available operational documentation (ATS, OPS/AIR).
- 9.2. Assess the percentage of approved aircraft and operators (overall equipment involved).
- 9.3. Review the results of the safety assessment.
- 9.4. Publish the trigger NOTAM.

## **10. Performance Monitoring System**

Following the implementation of the navigation Application, the TMA will enter the pre-operational phase for a one-year period. At the end of this period, if the assessment is positive, it will be possible to move to the operational phase. During this period, a post-implementation operations monitoring programme must be established primarily to assess safety. A performance assessment system must also be implemented, as stipulated in item 2 of the Action Plan. Both the safety and the performance assessment, as a whole, must be carried out on an ongoing basis.

- 10.1. Develop a post-implementation monitoring programme for TMA and approach operations.
- 10.2. Implement a post-implementation monitoring programme for TMA and approach operations.

**ATTACHMENT 1 TO APPENDIX E**

**SHORT-TERM TMA PBN ACTION PLAN (RNAV-1)  
(GPIs 1, 4, 5, 7, 8, 10, 11, 12, 16, 21, 23)**

<b>1. Airspace concept</b>	<b>Start</b>	<b>End</b>	<b>Responsible party</b>	<b>Remarks</b>
1.1 Establish and prioritize strategic objectives (safety, capacity, environment, etc.)			States	
1.2 Collect traffic data in order to understand traffic flows in TMA airspace			States	
1.3 Analyze the navigation capacity of the aircraft fleet in the TMA			States	
1.4 Analyze ground-based means of communication, navigation (VOR, DME) and surveillance to meet navigation specifications and navigation reversal mode			States	
1.5 Optimize airspace structure, reorganizing the network or implementing new routes based on the strategic objectives of the airspace concept, taking into account airspace modelling, ATC simulations (fast time and/or real time), live tests, etc.			States	
<b>2. Develop a performance measurement plan</b>	<b>Start</b>	<b>End</b>	<b>Responsible party</b>	<b>Remarks</b>
2.1 Draft a plan to measure performance, including gas emissions, safety, efficiency, etc.			States	
2.2 Implement the performance measurement plan			States	
<b>3 Safety assessment</b>	<b>Start</b>	<b>End</b>	<b>Responsible party</b>	<b>Remarks</b>
3.1 Determine the methodology to be used to assess airspace safety and route spacing, based on the navigation specification, taking into account airspace modelling, ATC simulations (fast time and/or real time), live tests, etc.			States	
3.2 Develop a data collection programme to assess airspace safety			States	
3.3 Prepare the preliminary airspace safety assessment			States	

<b>3</b>	<b>Safety assessment</b>	<b>Start</b>	<b>End</b>	<b>Responsible party</b>	<b>Remarks</b>
3.4	Prepare the final airspace safety assessment			States	

<b>4</b>	<b>Establish a collaborative decision-making process (CDM)</b>	<b>Start</b>	<b>End</b>	<b>Responsible party</b>	<b>Remarks</b>
4.1	Coordinate planning and implementation requirements with air navigation service providers, regulators, users, aircraft operators and military authorities			States	
4.2	Establish the implementation date			States	
4.3	Establish the documentation format in the SAM PBN website			States	
4.4	Report planning and implementation developments to the corresponding Regional Office			States	

<b>5</b>	<b>ATC automated systems</b>	<b>Start</b>	<b>End</b>	<b>Responsible party</b>	<b>Remarks</b>
5.1	Assess PBN implementation in ATC automated systems, taking into account amendment 1 to the PANS/ATM (FPLSG).			States	
5.2	Implement the necessary changes in ATC automated systems			States	

<b>6. Aircraft and operator approval</b>	<b>Start</b>	<b>End</b>	<b>Responsible party</b>	<b>Remarks</b>
6.1 Analyze aircraft and operator approval requirements (pilots, dispatchers and maintenance personnel), in keeping with the PBN manual, and develop the necessary documentation.			States	
6.2 Publish national regulations for the implementation of the RNAV-1 navigation specification			States	
6.3 Begin the approval of aircraft and operators			States	
6.4 Establish and keep up to date a registry of approved aircraft and operators			States	
6.5 Verify the operation of the continuous monitoring programme (aircraft and procedures)			States	

<b>7. Standards and procedures</b>	<b>Start</b>	<b>End</b>	<b>Responsible party</b>	<b>Remarks</b>
7.1 Assess and, if applicable, publish the regulations on the use of GNSS.			States	
7.2 Finalize WGS-84 implementation			States	
7.3 Ground validation and in-flight inspection of SIDs and/or STARs			States	
7.4 Establishment of navigation database validation requirements and procedures			States	
7.5 Develop an AIC model to report PBN implementation plans			States	
7.6 Publish the AIC reporting PBN implementation plans			States	
7.7 Develop an AIP Supplement model containing applicable standards and procedures, including the corresponding in-flight contingencies			States	
7.8 Publish the AIP Supplement containing applicable standards and procedures, including the corresponding in-flight contingencies			States	
7.9 Review the Procedural Handbook of the ATS units involved			States	
7.10 Update the letters of agreement between ATS units			States	

<b>7. Standards and procedures</b>	<b>Start</b>	<b>End</b>	<b>Responsible party</b>	<b>Remarks</b>
7.11 Review practices and procedures to improve fuel consumption management and environmental protection			States	

<b>8. Training</b>	<b>Start</b>	<b>End</b>	<b>Responsible party</b>	<b>Remarks</b>
8.1 Develop a training and documentation programme for operators (pilots, dispatchers and maintenance personnel)			States	
8.2 Develop a training and documentation programme for air traffic controllers and AIS operators			States	
8.3 Develop a training programme for regulators (aviation safety inspectors)			States	
8.4 Conduct training programmes			States	
8.5 Conduct seminars for operators, explaining plans and expected operational and economic benefits			States	

<b>9. Implementation decision</b>	<b>Start</b>	<b>End</b>	<b>Responsible party</b>	<b>Remarks</b>
9.1 Assess the available operational documentation (ATS, OPS/AIR)			States	
9.2 Assess the percentage of approved aircraft and operators (non-exclusionary airspace)			States	
9.3 Analyze the results of the safety assessment			States	
9.4 Publish trigger NOTAM			States	

<b>10. Performance monitoring system</b>	<b>Start</b>	<b>End</b>	<b>Responsible party</b>	<b>Remarks</b>
10.1 Develop a post-implementation monitoring programme for TMA operations			States	
10.2 Implement a post-implementation monitoring programme for TMA operations			States	
<b>Pre-operational implementation date</b>			States	
<b>Definitive implementation date</b>			States	

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## ATTACHMENT 2 TO APPENDIX D

### APPROACH PBN ACTION PLAN GPIs 1, 12, 16, 21, 23

<b>1.     Airspace concept</b>	<b>Start</b>	<b>End</b>	<b>Notes</b>
1.1   Establish and prioritize strategic objectives (safety, capacity, environment, etc.)			
1.2   Analyze the navigation capacity of the aircraft fleet that operates at the airport			
1.3   Analyze ground-based means of communication, navigation (VOR, DME) and surveillance to meet the navigation specifications and the navigation reversal mode			
1.4   Design instrument approach procedures (APCH/APV Baro-VNAV RNP or RNP AR) based on the strategic objective of the airspace concept, taking into account airspace modeling, ATC simulations (fast time and/or real time), live tests, etc.			
<b>2.     Develop a performance measurement plan</b>	<b>Start</b>	<b>End</b>	<b>Notes</b>
2.1   Draft a plan to measure performance, including gas emissions, safety, efficiency, etc.			
2.2   Implement the performance measurement plan			
<b>3.     Safety assessment procedure</b>	<b>Start</b>	<b>End</b>	<b>Notes</b>
3.1   Determine the methodology to be used to assess airspace safety, based on the navigation specification, taking into account airspace modelling, ATC simulations (fast time and/or real time), live tests, etc.			
3.2   Develop a data collection programme to assess airspace safety			
3.3   Prepare a preliminary safety assessment for the application of the procedure(s)			
3.4   Prepare a final safety assessment for the application of the procedure(s)			
<b>4     Establish a collaborative decision-making process (CDM)</b>	<b>Start</b>	<b>End</b>	<b>Notes</b>
4.1   Coordinate planning and implementation requirements with air navigation service providers, regulators, users, aircraft operators and military authorities			

<b>4</b>	<b>Establish a collaborative decision-making process (CDM)</b>	<b>Start</b>	<b>End</b>	<b>Notes</b>
4.2	Establish the implementation date			
4.3	Establish the format and documentation of the SAM PBN website			
4.4	Report planning and implementation progress to the SAM Regional Office			

<b>5</b>	<b>ATC automated systems</b>	<b>Start</b>	<b>End</b>	<b>Notes</b>
5.1	Assess PBN implementation in ATC automated systems, taking into account amendment 1 to the PANS/ATM (FPLSG).			
5.2	Implement the necessary changes in ATC automated systems			

<b>6.</b>	<b>Aircraft and operator approval</b>	<b>Start</b>	<b>End</b>	<b>Notes</b>
6.1	Analyze aircraft and operator approval requirements (pilots, dispatchers and maintenance personnel) in keeping with the PBN manual, and develop the necessary documentation.			
6.2	Publish national regulations for the implementation of the navigation specification			
6.3	Begin the approval of aircraft and operators			
6.4	Establish and keep up to date a registry of approved aircraft and operators			
6.5	Verify the operation of the continuous monitoring programme (aircraft and procedures)			

<b>7.</b>	<b>Standards and procedures</b>	<b>Start</b>	<b>End</b>	<b>Notes</b>
7.1	Assess and, if applicable, publish the regulations on the use of GNSS.			
7.2	Finalize WGS-84 implementation			
7.3	Ground validation and in-flight inspection of approach procedures			

7.4	Establish the navigation database validation requirements and procedures			
7.5	Develop an AIC model to report PBN implementation plans			
7.6	Publish the AIC reporting PBN implementation plans			
7.7	Develop an AIP Supplement model containing applicable standards and procedures, including the corresponding in-flight contingencies			
7.8	Publish the AIP Supplement containing applicable standards and procedures, including the corresponding in-flight contingencies			
7.9	Review the Procedural Handbook of the ATS units involved			
7.10	Update the letters of agreement between ATS units			
7.11	Review practices and procedures to improve fuel consumption management and environmental protection			

<b>8. Training</b>	<b>Start</b>	<b>End</b>	<b>Notes</b>
8.1 Develop a training and documentation programme for operators (pilots, dispatchers and maintenance personnel)			
8.2 Develop a training and documentation programme for air traffic controllers and AIS operators			
8.3 Develop a training programme for regulators (aviation safety inspectors)			
8.4 Conduct training programmes			
8.5 Conduct seminars for operators, explaining plans and expected operational and economic benefits			

<b>9. Implementation decision</b>	<b>Start</b>	<b>End</b>	<b>Notes</b>
9.1 Assess the available operational documentation (ATS, OPS/AIR)			
9.2 Assess the percentage of approved aircraft and operators (non-exclusionary airspace)			
9.3 Analyze the results of the safety assessment			

<b>10. Performance monitoring system</b>	<b>Start</b>	<b>End</b>	<b>Notes</b>
10.1 Develop a post-implementation approach operations monitoring programme			
10.2 Implement a post-implementation approach operations monitoring programme			
<b>Pre-operational implementation date</b>			
<b>Definitive implementation date</b>			

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