International Civil Aviation Organization
South American Regional Office

SECOND WORKSHOP/MEETING OF THE SAM IMPLEMENTATION GROUP (SAM/IG/2)
REGIONAL PROJECT RLA/06/901

Lima, Peru, 3 to 7 November 2008

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

RESULTS OF THE WORK ON PBN DONE BY PROJECT RLA/06/901

(Presented by the PBN Expert, Regional Project RLA/06/901)

Summary

The purpose of this working paper is to present the PBN work done by Project RLA/06/901, including the PBN Implementation Project for En-route Operations, the Model Implementation Project for TMA and Approach Operations, and the results of the tasks that should be completed at the SAM/IG/2 Meeting.

References:

- Project RLA/06/901
- Report of the SAM/IG/1 Meeting

ICAO Strategic objectives

Strategic Objective A *Safety*
Strategic Objective C *Environmental Protection*
Strategic Objective D *Efficiency*

1 Background

1.1 The SAM/IG/1 Meeting took note 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) Collection of data on, and analysis of air traffic movement in order to identify the main flows;

c) Collection of data on, and analysis of air navigation infrastructure (communications, navigation, surveillance, meteorology, AIS).

1.2 These tasks may 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, the SAM/IG/1 Meeting concluded that a work programme should be drawn up in order to fulfil the initial tasks. The consultant should study and process the aforementioned information and prepare a document clearly describing the current situation in the States that are participating in the Project and, insofar as possible, in all the States in the South American Region with regard to the cited matters. The updated work programme of the consultant appears in **Appendix A** to this working paper and is in line with tasks 1.1 of Project RLA/06/901.

2 Discussion

2.1 En-route PBN - RNAV-5 Implementation Project

2.1.1 PBN implementation for en-route operations will require extensive participation by SAM States and will depend upon the completion of specific tasks for which Regional Project RLA/06/901 will be responsible. In light of the need for the harmonization and correct interpretation of each of the tasks connected with PBN implementation, Project RLA/06/901 developed an en-route PBN Implementation Project 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. The En-route PBN Implementation Project is presented in **Appendix B** to this working paper.

2.1.2 The PBN Implementation Project establishes 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 working paper.

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

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

2.2.1.1 The Airspace Concept provides the scheme for operations within an airspace and is developed to meet explicit 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.

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

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 even a coherent route implementation/realignment/elimination “package.”

b) Complete restructuring of the CAR/SAM 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.

2.2.1.3 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 working paper and are submitted to the Meeting for analysis, any changes deemed necessary, and approval, in order to complete the task.

2.2.2 Collect traffic data in order to understand traffic flows in a given airspace

2.2.2.1 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, which were not included in the sample, probably because flights cross the boundaries of the Ezeiza FIR before reaching FL 290.

2.2.2.2 **Appendix B, Attachment 2** to this working paper contains graphs representing air traffic movement on the main ATS routes, by FIR. **Appendix B, Attachment 3** to this working paper 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 work of the States in identifying 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.

2.2.2.3 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.

2.2.3 Establish a document format at the SAM PBN website

2.2.3.1 The Web is an important mechanism for disseminating PBN documentation among all those involved in its implementation. The SAM/IG Meeting shall decide upon the website format, in order to make it possible to post PBN supporting documentation. The South American Regional Office of the International Civil Aviation Organization already has a PBN website: **http://www.lima.icao.int/submenu1.asp?Url=/ICAOSAMNET/AirNav-eDocumentsMenu.asp**. However, it appears to be "hidden" and does not facilitate access by those involved in regional PBN implementation. The ICAO SAM Regional Office will be in charge of establishing the SAM PBN website format.

2.2.4 Assess PBN implementation in automated ATC systems in light of amendment 1 to the PANS/ATM (FPLSG).

2.2.4.1 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 177th 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.

2.2.4.2 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.

2.2.4.3 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 a 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 working paper contains further considerations about the subject.

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

2.2.5.1 Project RLA/99/901 (Regional Safety Oversight Cooperation System) will be responsible for this task, which will be analyzed in a specific working paper.

2.2.6 Assess the regulations for GNSS use and, if appropriate, proceed to their publication.

2.2.6.1 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.

2.2.6.2 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.

2.2.6.3 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 7** to this working paper.

2.2.7 Prepare a model AIC to report PBN implementation.

2.2.7.1 It is essential to report RNAV-5 implementation for en-route operations, particularly if an airspace volume is considered for exclusive use by equipped aircraft. A model AIC is shown in **Appendix C** to this working paper for consideration by SAM States in preparing the AIC they will use to report on RNAV-5 application for en-route operations.

2.3 Status of the main tasks started at the SAM/IG/1 Meeting.

2.3.1 Analyze aircraft fleet navigation capacity

2.3.1.1 The aircraft fleet navigation capacity analysis will depend upon the information to be collected by civil aviation authorities and IATA. In this connection, Project RLA/99/901 will present a specific working paper containing a survey to be conducted by CAAs in order to develop a database of aircraft approvals in the SAM Region.

2.3.1.2 As in the case of RVSM, it will be 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 4** to this working paper. 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.

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

2.3.2.1 **Appendix B,** 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 determine adequacy for supporting RNAV-5 operations. If coverage is not adequate 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.

2.4 Model PBN implementation project for TMA and approach operations

2.3.1 Regional Project RLA/06/901 developed a Model PBN Implementation Project for TMA and Approach operations, similar to that prepared for PBN en-route 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 project timetables. **Appendix D** to this working paper contains the Model PBN Implementation Project for TMA and Approach Operations.

2.3.2 The Model PBN Implementation Project 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 D** of this working paper, 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.

3 **Suggested action**

3.1 The Meeting is invited to:

a) Study, make the changes deemed necessary, and approve the following:

i) PBN Implementation Project – En-route Operations, as shown in Appendix B to this working paper.
ii) Proposal of Initial AIC for RNAV-5 Implementation, shown in Appendix C to this working paper.
iii) Model PBN Implementation Project – TMA and Approach Operations, which is attached to this working paper as Appendix D.

b) Assess the strategies for developing the Airspace Concept for RNAV-5 Implementation – En-route Operations, contained in paragraph 2.2.1.2.

c) Study the need for preparing an air traffic movement database, in order to identify ATS routes that should be realigned/eliminated and the main flows for en-route and TMA operations, as indicated in paragraph 2.2.2.3.

d) Discuss the strategy for implementing amendment 1 to the PANS/ATM concerning the flight plan, with a view towards instituting automation for PBN implementation.

e) Assess the information contained in Appendix B, Attachment 7, status of regulations on the use of GNSS and update, as needed.

f) Analyze the current status of GNSS regulations in the SAM Region and propose ways of implementing the system as a primary means of air navigation.

g) Study the need for creating an air traffic movement database, in order to identify the percentage/number of operations approved for the Navigation Applications to be implemented.

h) Assign Project RLA/06/901 the task of assessing VOR and DME coverage to support RNAV-5 operations.

* * * * * *

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).	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: a) Available CNS infrastructure, with the corresponding coverage and plans for future facilities; b) Characteristics of available ATM automated systems and future automation plans; 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; d) Airworthiness and operational approval capabilities; e) Airports that might derive operational benefits from the use of RNAV and/or RNP; f) Status of implementation of WGS 84; g) Existing SIDs and STARs connecting international airports to ATS routes; h) Real-time and accelerated simulation of operations; i) Cost-benefit analysis of facilities; j) Safety assessment models; k) Regulation of GNSS use (secondary, primary means)	ATM Expert, RO

Results	Activities	Party responsible for each activity
	l) Documentation concerning the training of air traffic controllers; m) Evaluate the impact .of PBN implementation in ATC automated systems. n) Analyse existing data on air traffic movement, with a view to: i. cost-benefit analysis ii. fleet capacity assessment iii. identification of main traffic flows iv. safety assessment o) Identify the need for collection and additional data analysis. Start up date: week 1 Estimated duration: 2 weeks	

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 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 a less complex route network, thus reducing controller workload 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.

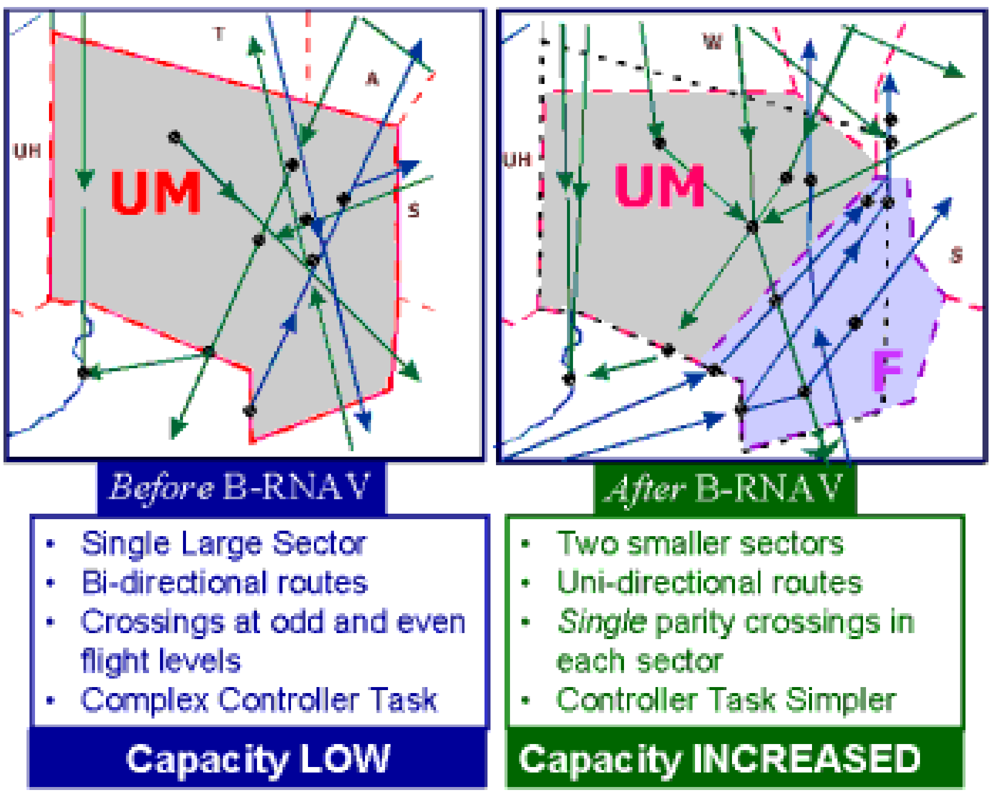
d) Efficiency - RNAV-5 application will improve operational efficiency through:
- ✓ Improvements in airspace management via the repositioning of intersections
- ✓ Better use of available airspace by means of a route structure that will allow for the establishment of:
  - o More direct routes (double and parallel, if necessary) to accommodate a larger air traffic flow
  - o A “bypass” route for aircraft overflying TMAs with high air traffic density
  - o Alternate or contingency routes
  - o Optimum in-flight holding positions
  - o 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.

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 4**. 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, as may be seen in **Attachment 5**:

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. **Attachment 6** 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 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 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 7** 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. This chapter of Doc 7030 is included as **Attachment 8.**

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 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.

8.5. Hold seminars designed 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 in keeping with established navigation specifications, within an appropriate period of time, by presenting the objectives and benefits to be attained through the planned 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 should be held to evaluate these three key points and reach a final decision to implement.

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

9.1. Evaluate the available operational documentation (ATS, OPS/AIR).

9.2. Evaluate 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 SAM Region will enter the pre-operational phase for a one-year period. At the end of this period, if the evaluation is positive, the Region may embark upon the operational phase. During this period, a post-implementation operations monitoring programme must be established, primarily to assess safety. Even so, a performance assessment system shall also be implemented, as stipulated in item 2 of the Action Plan. Both the safety assessment and the performance evaluation shall be carried out as a single unit and on a permanent basis. The SAM/IG meetings must discuss the viability and way of implementing a performance assessment programme on a permanent basis.

10.1. Prepare a post-implementation monitoring system for en-route operations.

10.2. Carry out a post-implementation monitoring programme for en-route operations.

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)

1.	**Airspace concept**	**Start**	**End**	**Responsible party**	**Remarks**
1.1	Establish and prioritize strategic objectives (safety, capacity, environment, etc.)	June/2008	SAM/IG/2	SAM/PBN/IG (Project RLA/06/901)	
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)	
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	

2.	**Develop a performance measurement plan**	**Start**	**End**	**Responsible party**	**Remarks**
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)	

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

3	Safety assessment	Start	End	Responsible party	Remarks
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	
3.2	Develop a data collection programme to assess airspace safety	SAM/IG/2	SAM/IG/4	CARSAMMA	
3.3	Prepare the preliminary airspace safety assessment	SAM/IG/2	SAM/IG/4	CARSAMMA	
3.4	Prepare the final airspace safety assessment	SAM/IG/4	Nov/2010	CARSAMMA	

4	Establish a collaborative decision-making process (CDM)	Start	End	Responsible party	Remarks
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	
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	**Establish a collaborative decision-making process (CDM)**	**Start**	**End**	**Responsible party**	**Remarks**
4.3	Establish the documentation format in the SAM PBN website	SAM/IG/1	SAM/IG/2	SAM Regional Office	
4.4	Report planning and implementation progress to the corresponding Regional Office	SAM/IG/2	SAM/IG/4	SAM/PBN/IG States	

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

6	**Aircraft and operator approval**	**Start**	**End**	**Responsible party**	**Remarks**
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	
6.2	Publish national regulations for the implementation of the RNAV-5 navigation specification	SAM/IG/2	SAM/IG/3	States	
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	

7	Standards and procedures	Start	End	Responsible party	Remarks
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	
7.2	Finalize WGS-84 implementation	TBD	TBD		
7.3	Develop an AIC model to report PBN implementation plans	June/2008	SAM/IG/2	SAM/PBN/IG (Project RLA/06/901)	
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)	
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)	

8.	**Training**	**Start**	**End**	**Responsible party**	**Remarks**
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	

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

10. Performance monitoring system	**Start**	**End**	**Responsible party**	**Remarks**
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	
Pre-operational implementation date	Nov/2010	N/A		
Definitive implementation date	Nov/2011	N/A		

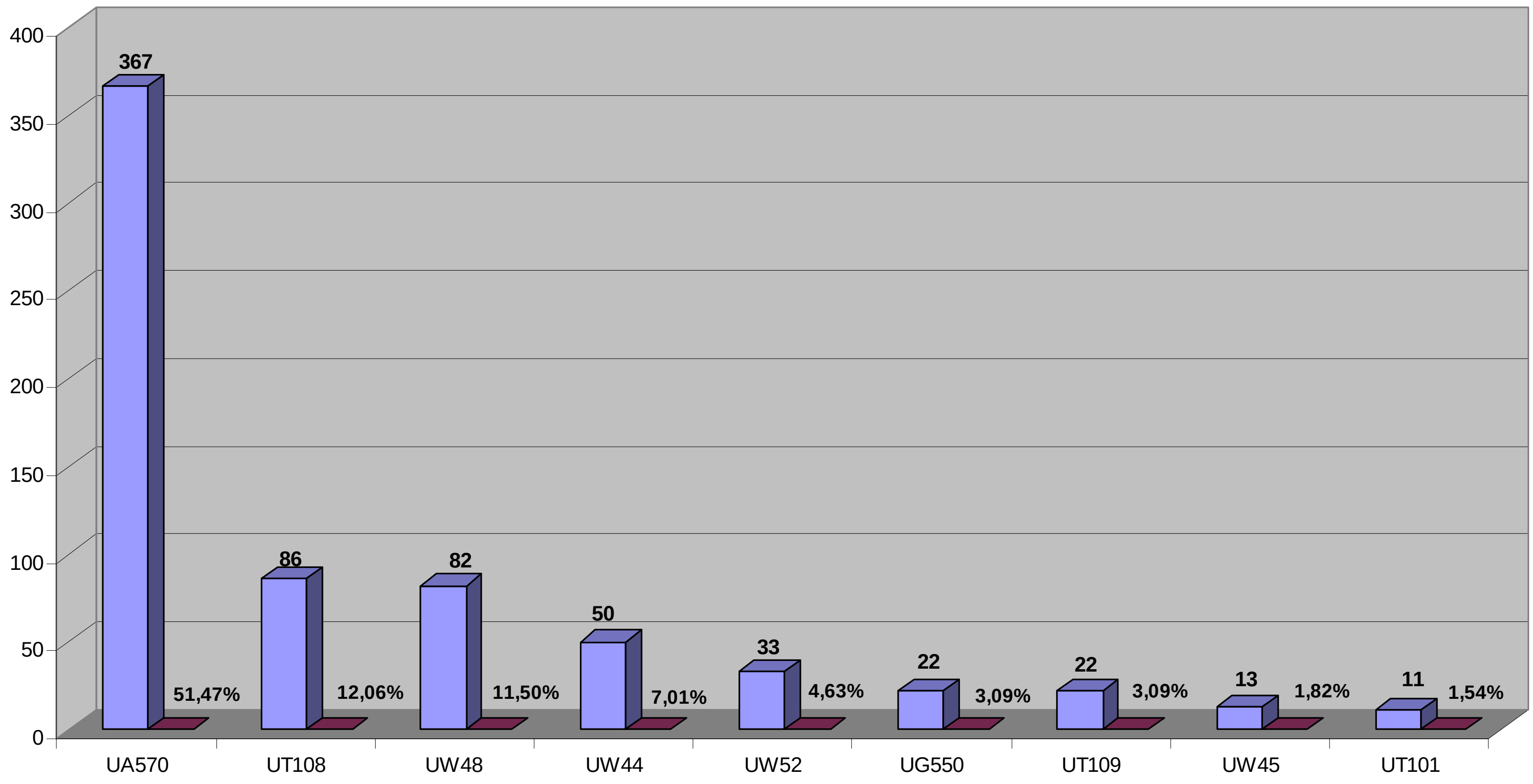
- - - - -

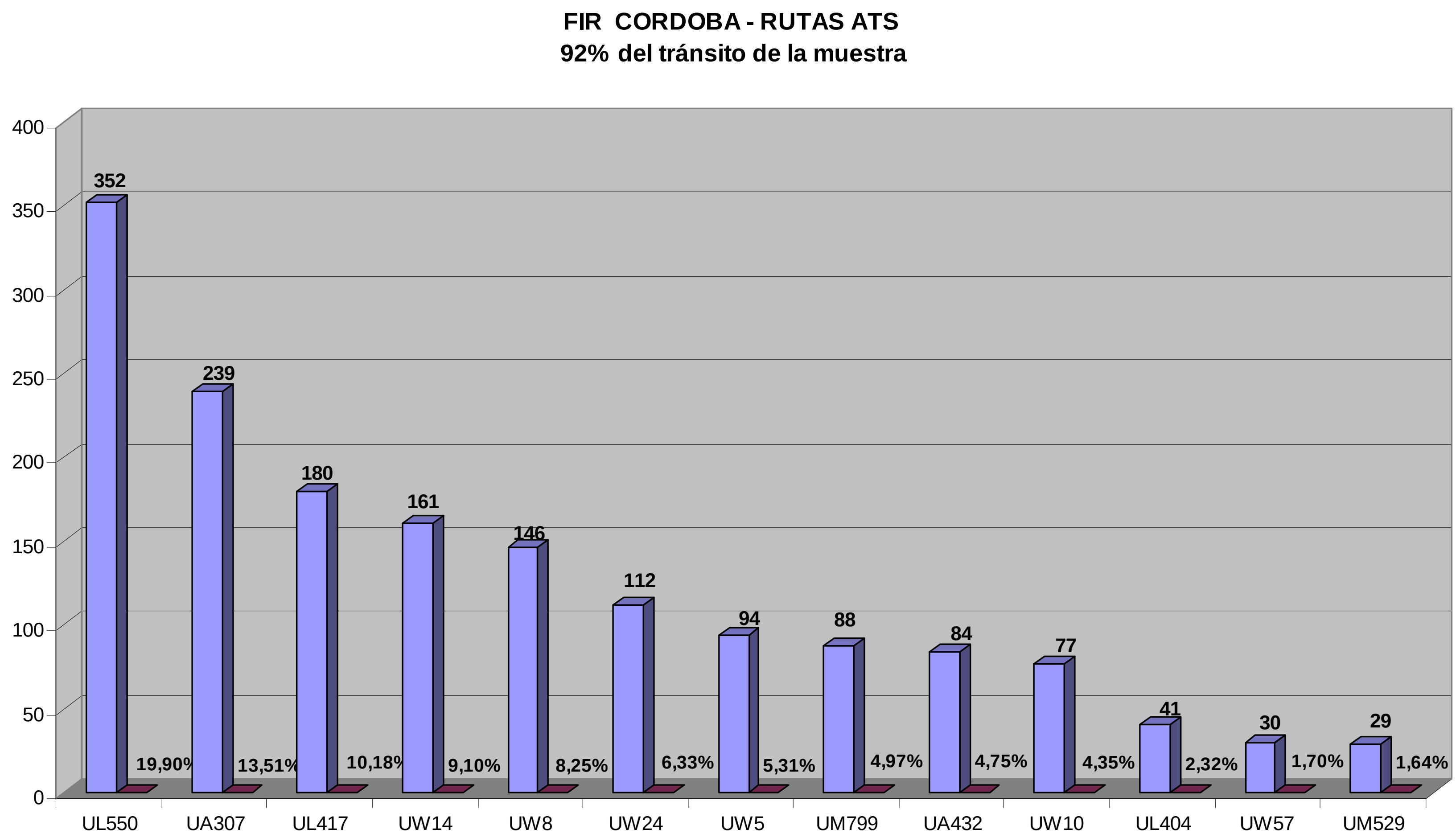
ADJUNTO 2 AL APÉNDICE B / ATTACHMENT 2 TO APPENDIX B

ATS ROUTES – SAM REGION / RUTAS ATS - REGIÓN SAM

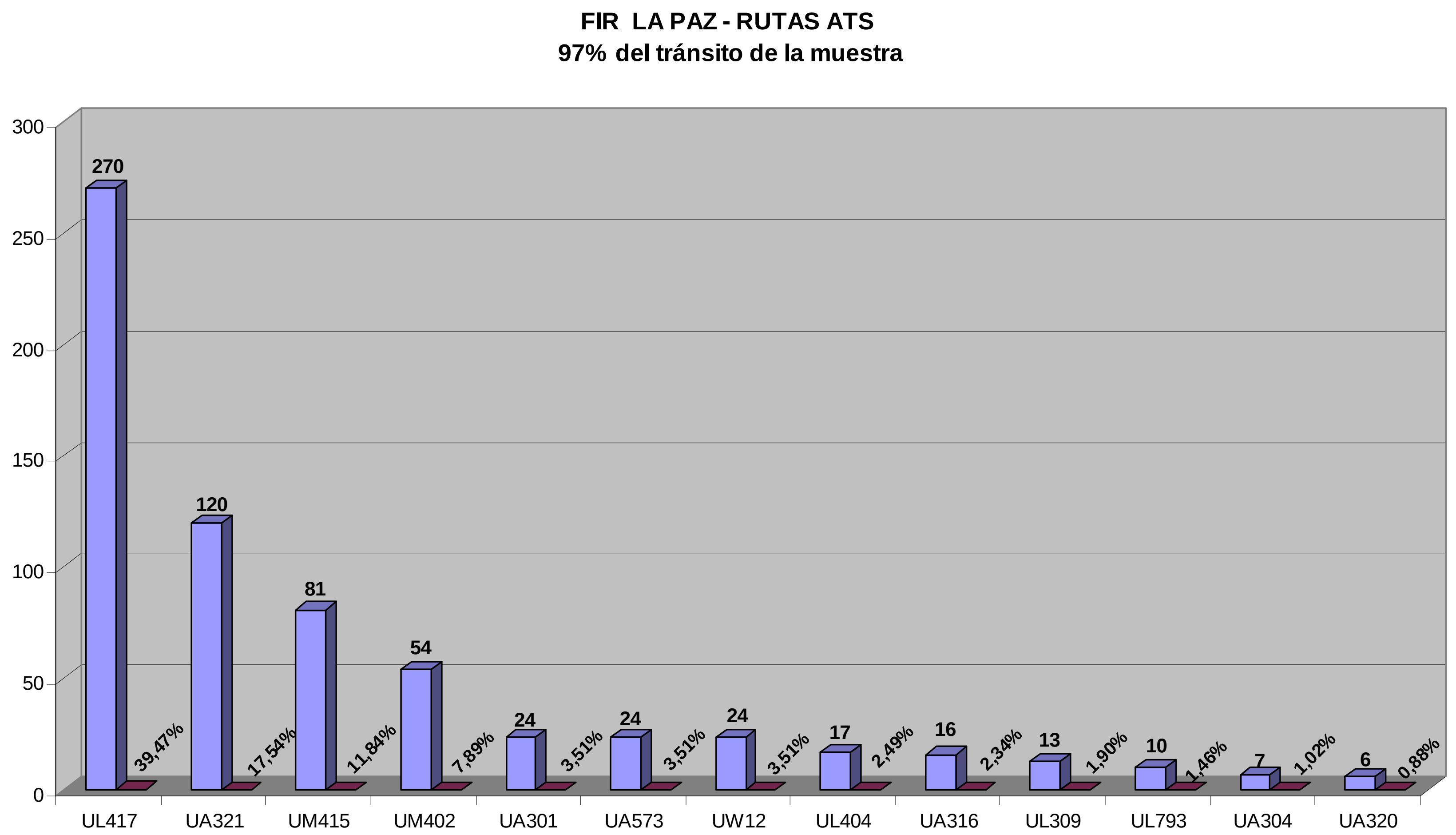
ARGENTINA

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

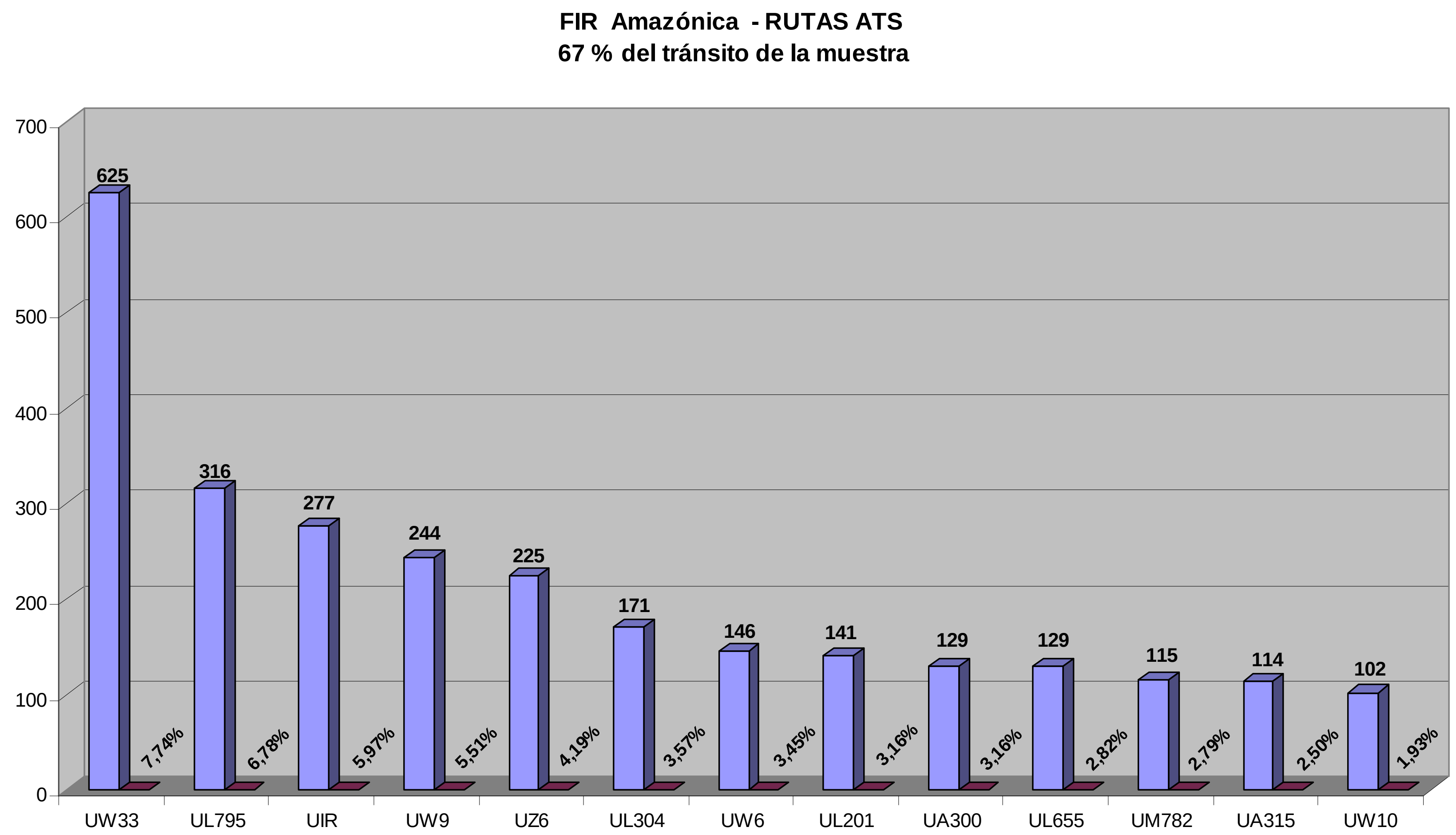


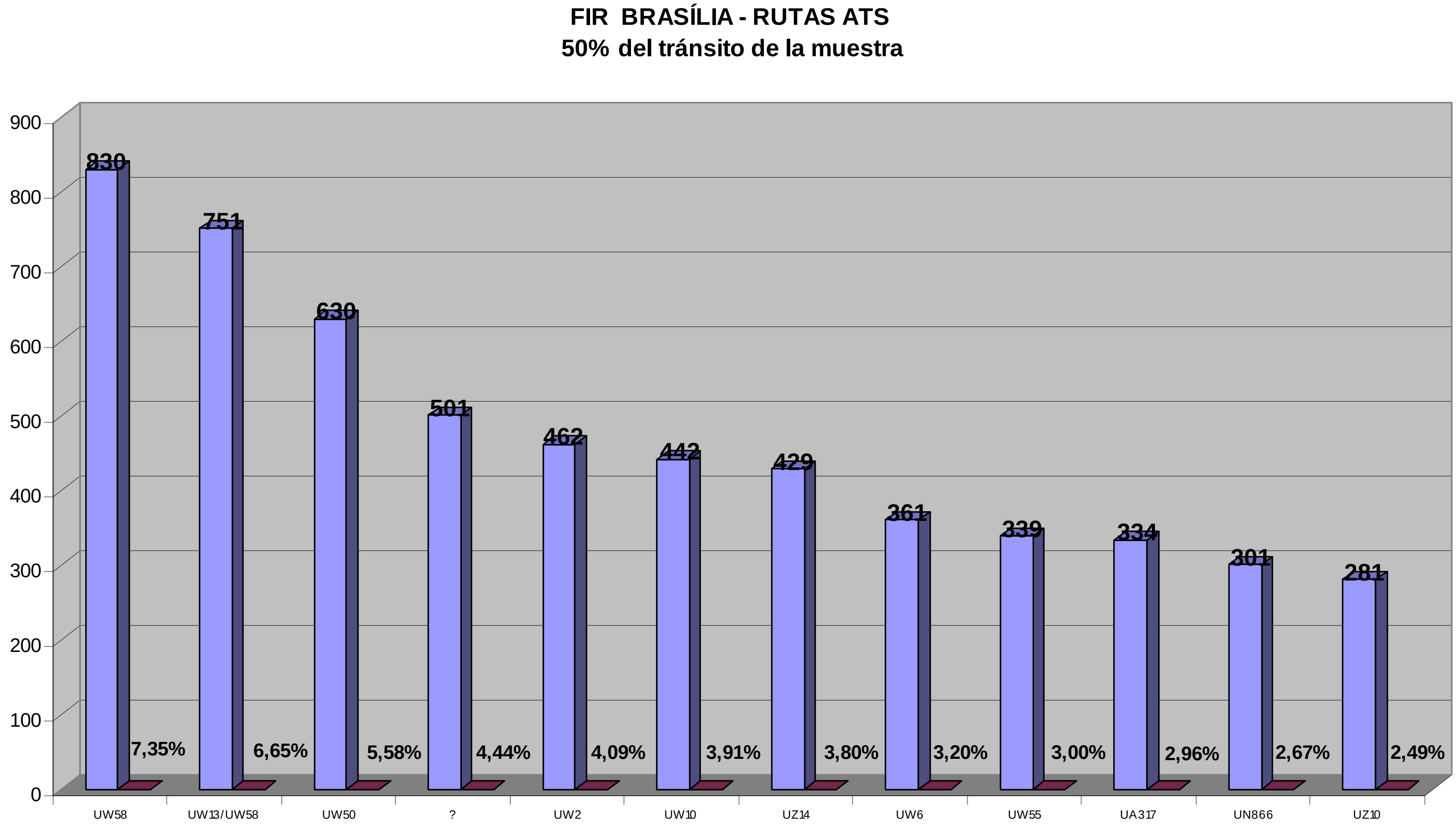

FIR CORDOBA - RUTAS ATS
92% del tránsito de la muestra
0
50
100
150
200
250
300
350
400
352
239
180
161
146
112
94
88
84
77
41
30
29
19,90%
13,51%
10,18%
9,10%
8,25%
6,33%
5,31%
4,97%
4,75%
4,35%
2,32%
1,70%
1,64%
UL550
UA307
UL417
UW14
UW8
UW24
UW5
UM799
UA432
UW10
UL404
UW57
UM529

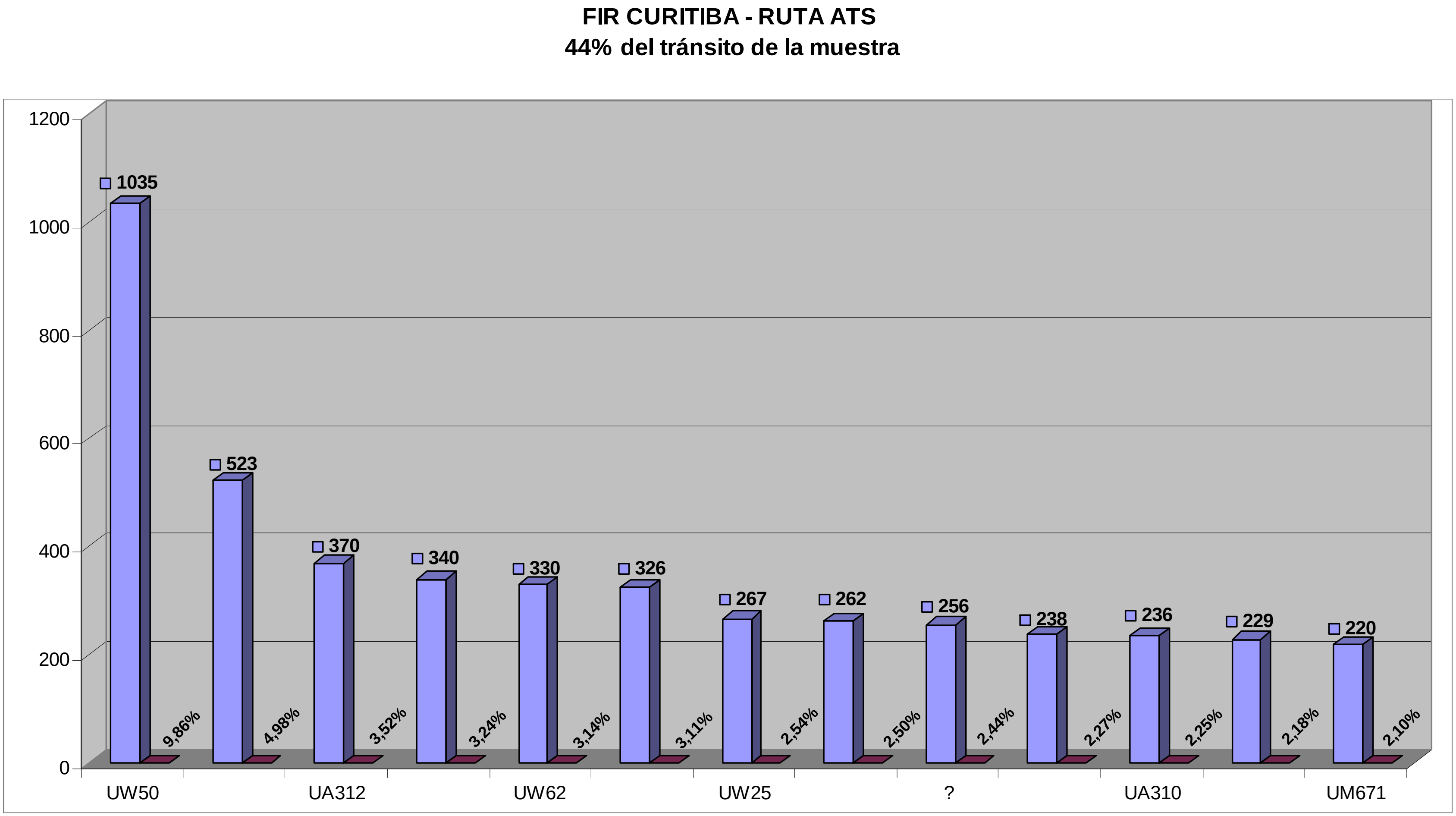
BOLIVIA

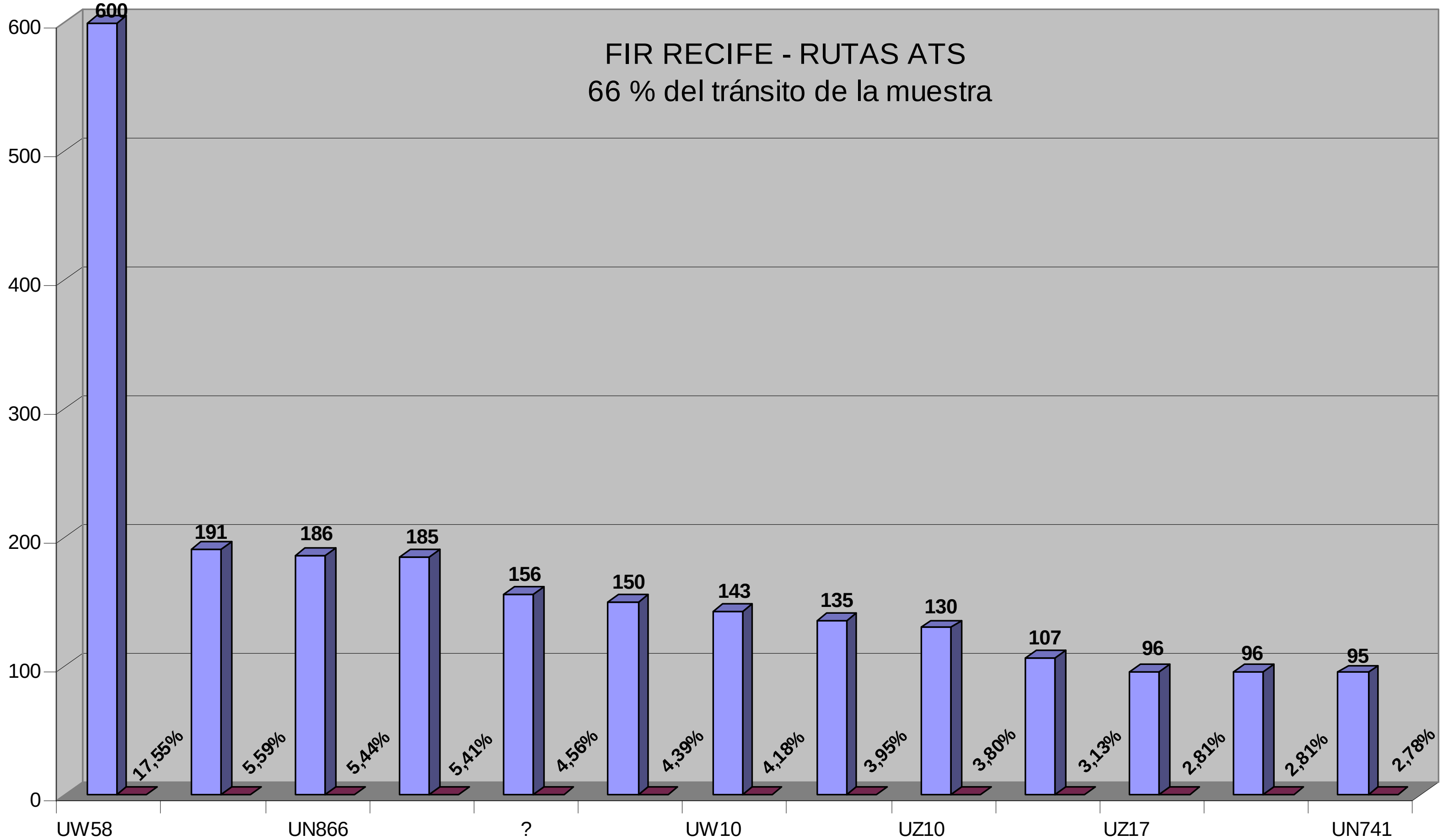

FIR LA PAZ - RUTAS ATS
97% del tránsito de la muestra
300
250
200
150
100
50
0
270
120
81
54
24
24
24
17
16
13
10
7
6
39,47%
17,54%
11,84%
7,89%
3,51%
3,51%
3,51%
2,49%
2,34%
1,90%
1,46%
1,02%
0,88%
UL417
UA321
UM415
UM402
UA301
UA573
UW12
UL404
UA316
UL309
UL793
UA304
UA320

BRAZIL / BRASIL

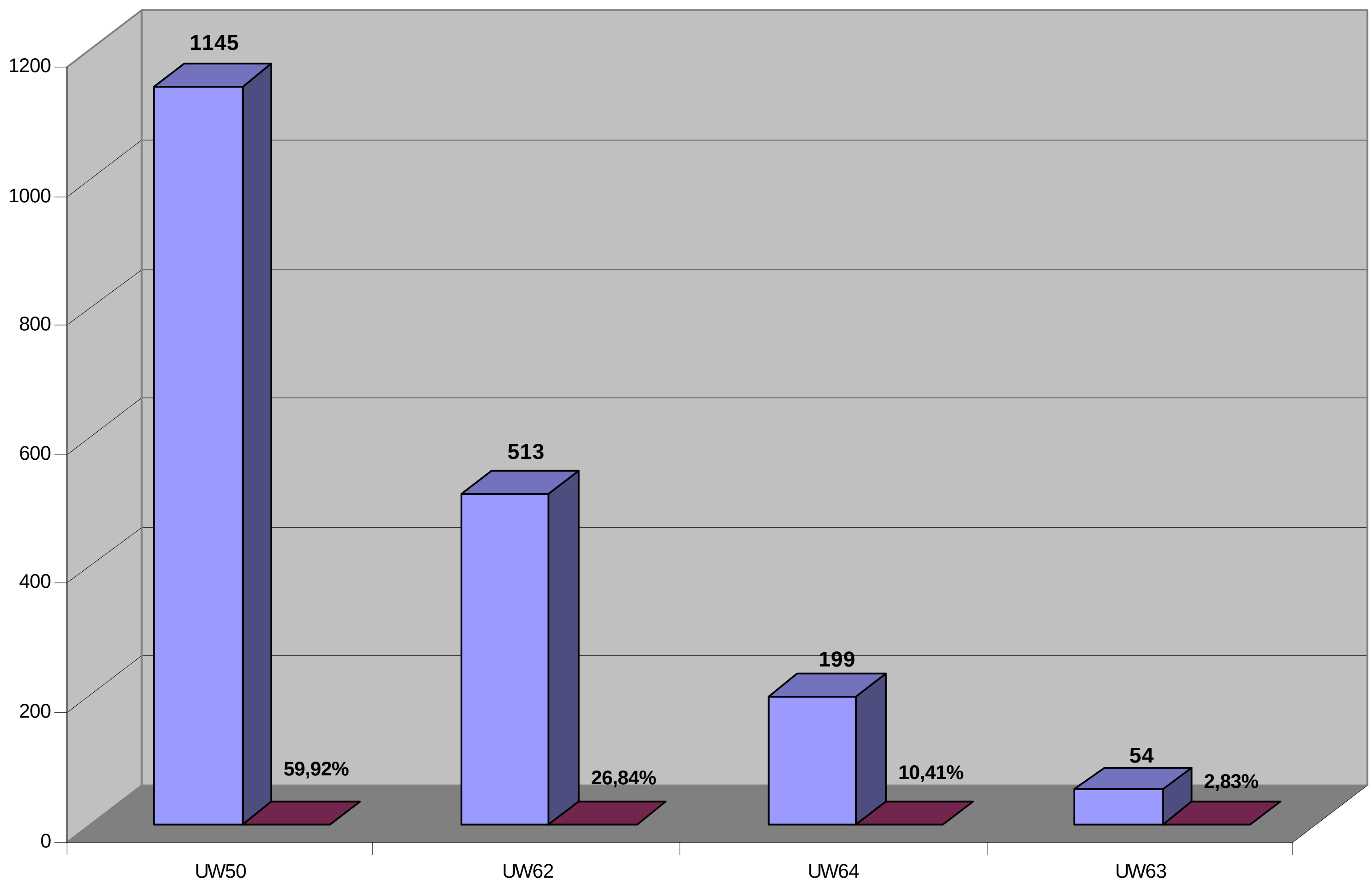



FIR BRASÍLIA - RUTAS ATS
50% del tránsito de la muestra
900
800
700
600
500
400
300
200
100
0
830
751
630
501
462
442
429
361
339
334
301
281
7,35%
6,65%
5,58%
4,44%
4,09%
3,91%
3,80%
3,20%
3,00%
2,96%
2,67%
2,49%
UW58
UW13/UW58
UW50
?
UW2
UW10
UZ14
UW6
UW55
UA317
UN866
UZ10


FIR CURITIBA - RUTA ATS
44% del tránsito de la muestra
1200
1000
800
600
400
200
0
1035
523
370
340
330
326
267
262
256
238
236
229
220
9,86%
4,98%
3,52%
3,24%
3,14%
3,11%
2,54%
2,50%
2,44%
2,27%
2,25%
2,18%
2,10%
UW50
UA312
UW62
UW25
?
UA310
UM671

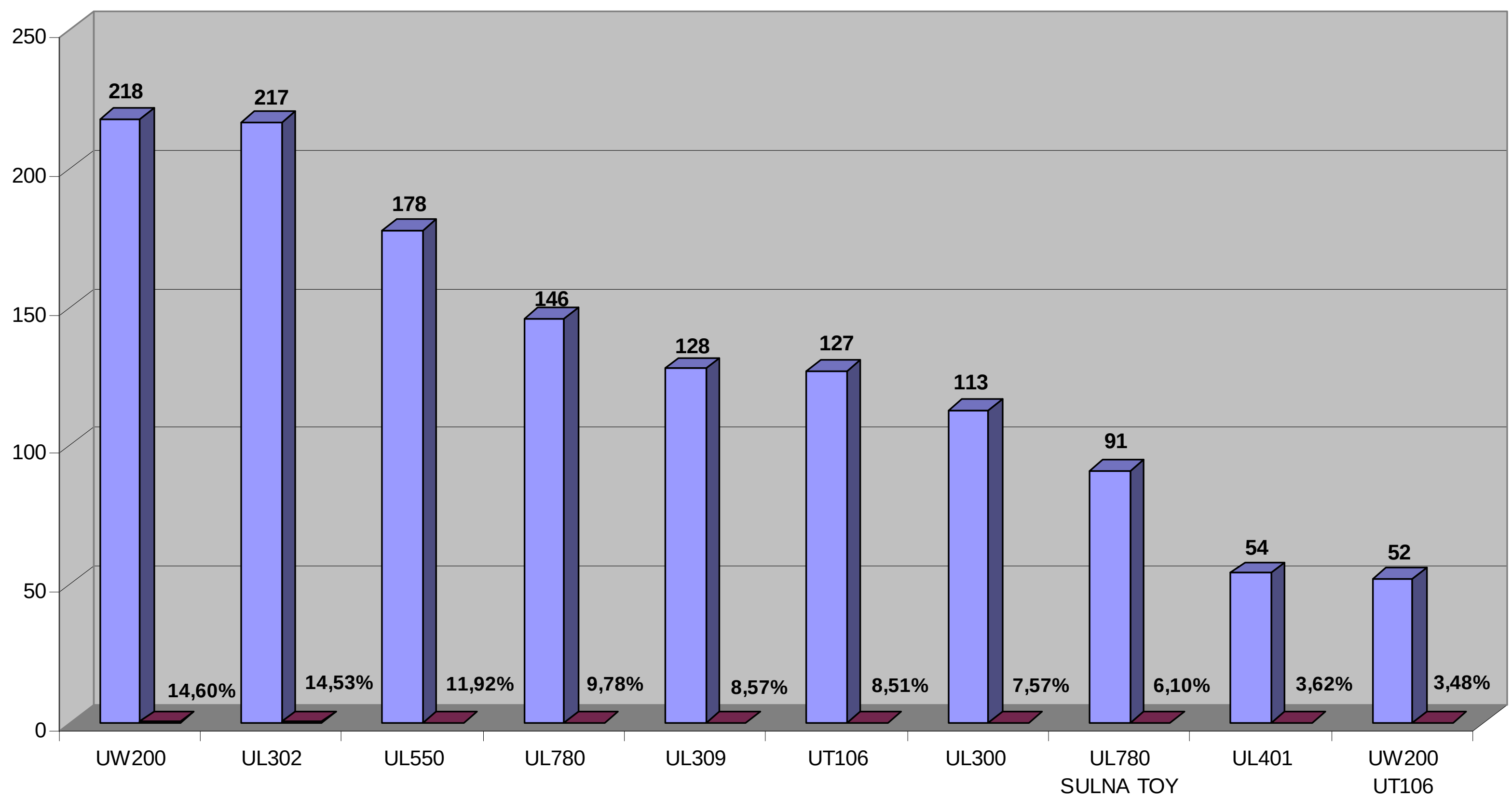

FIR RECIFE - RUTAS ATS
66 % del tránsito de la muestra
600
500
400
300
200
100
0
600
191
186
185
156
150
143
135
130
107
96
96
95
17,55%
5,59%
5,44%
5,41%
4,56%
4,39%
4,18%
3,95%
3,80%
3,13%
2,81%
2,81%
2,78%
UW58
UN866
?
UW10
UZ10
UZ17
UN741

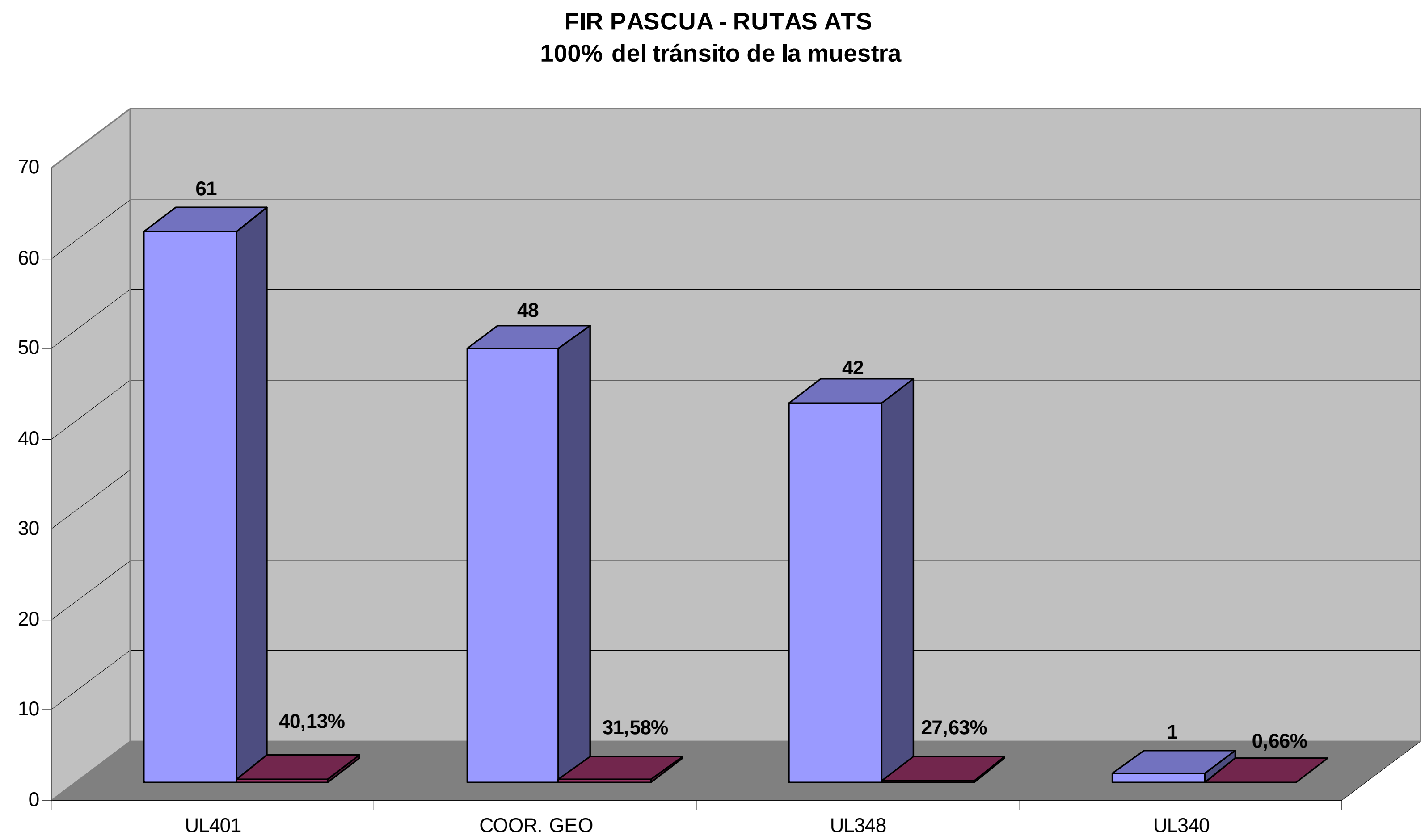
TMA SÃO PAULO - RUTAS ATS
100% del tránsito de la muestra

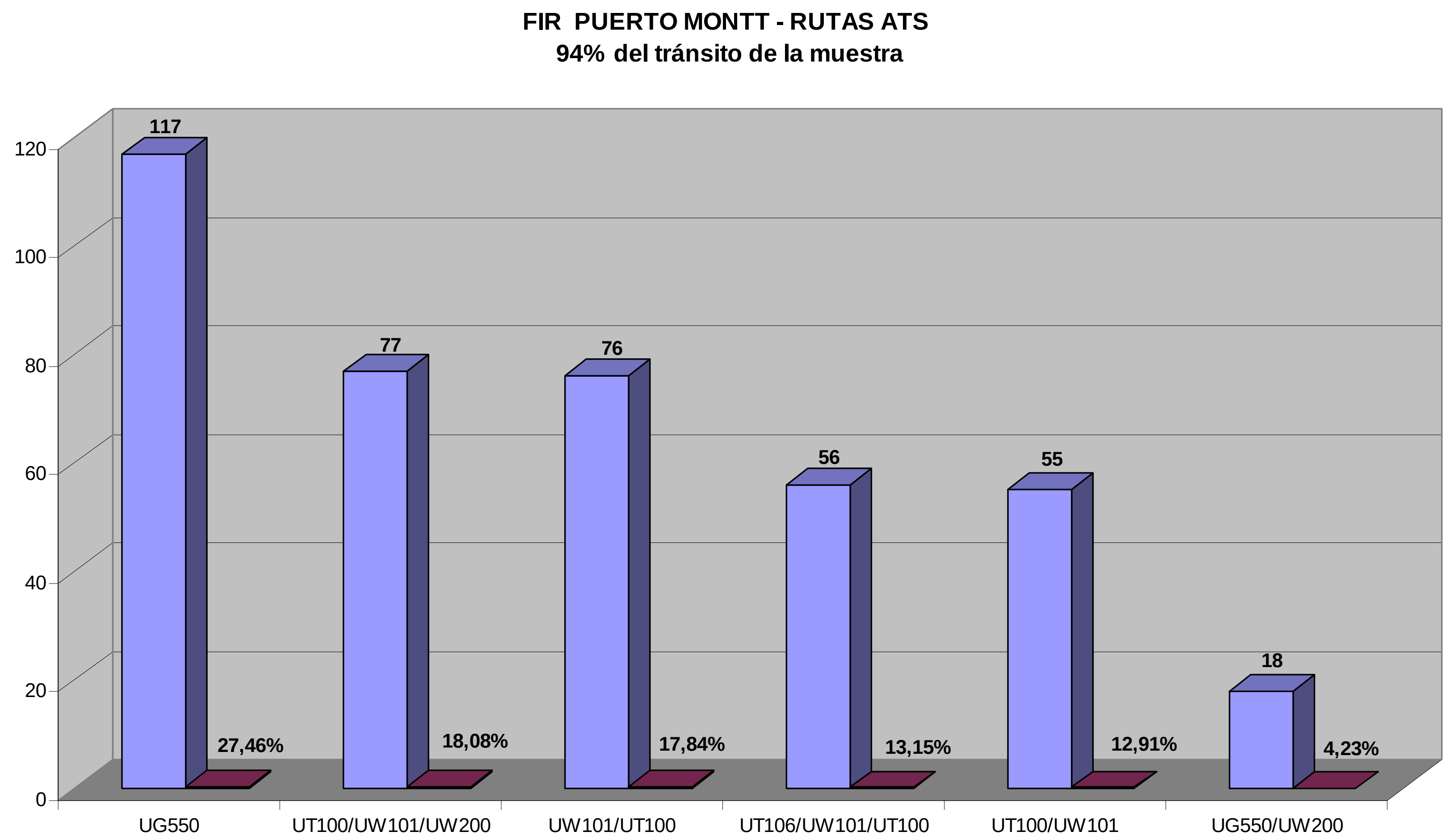


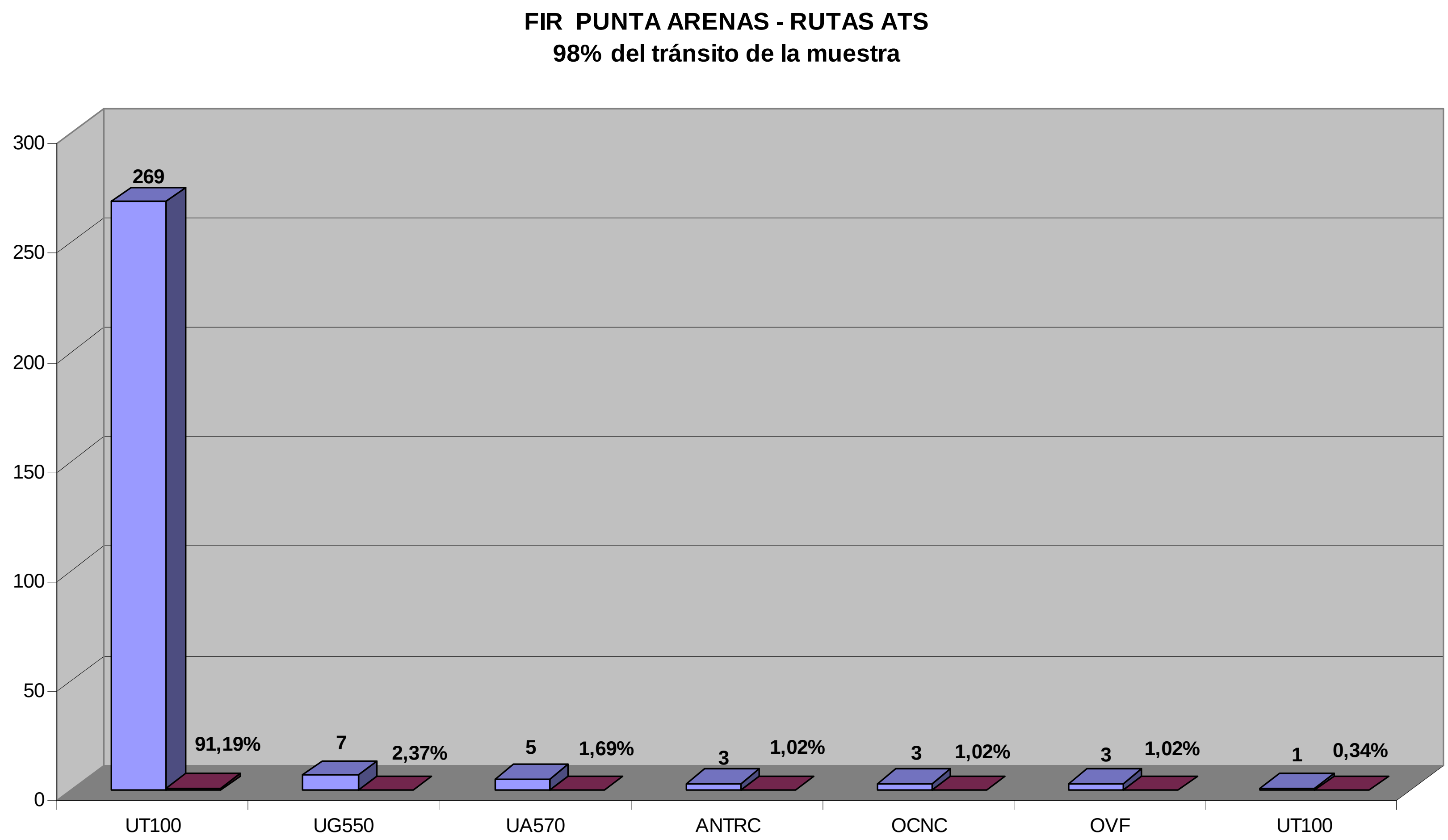
CHILE

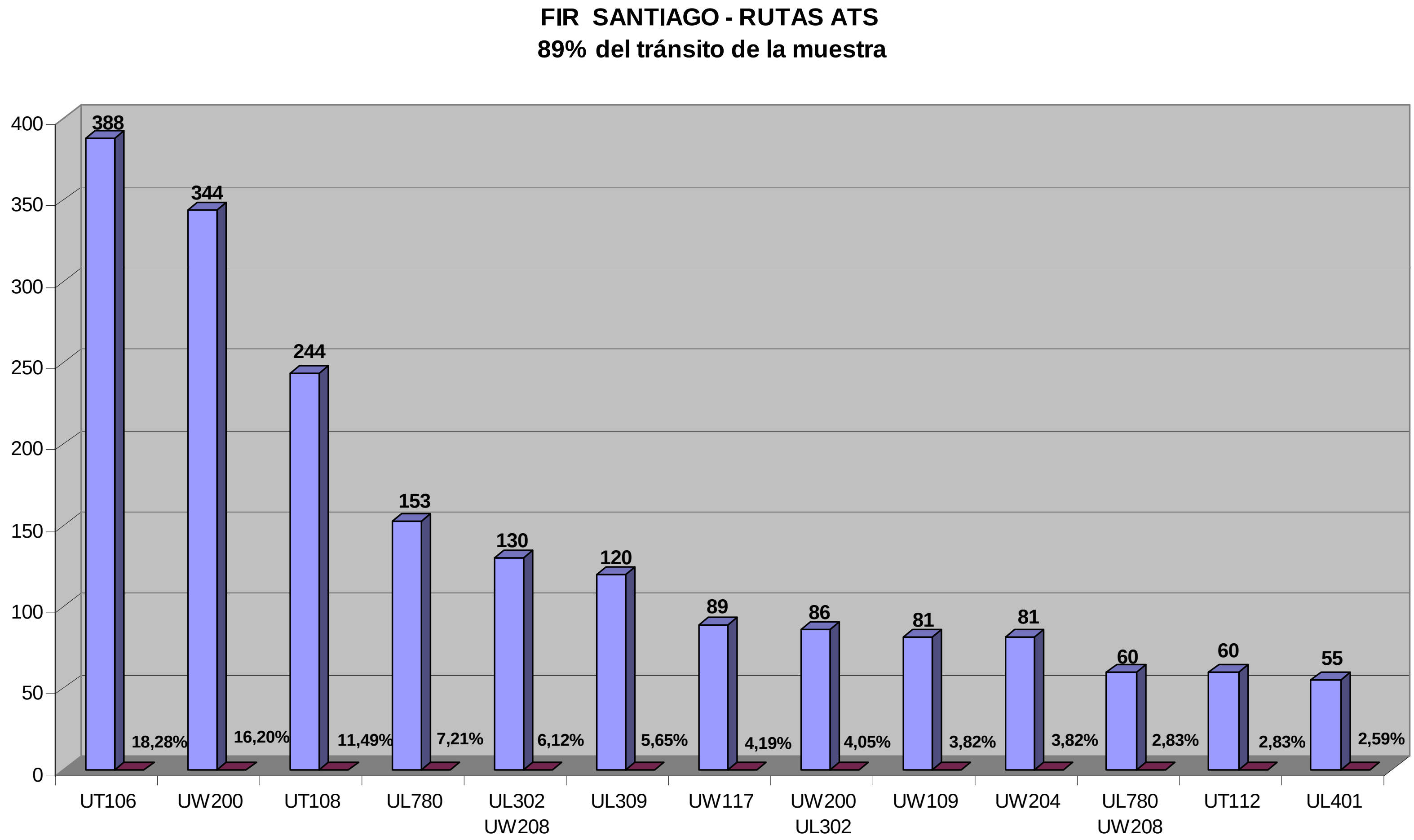
FIR ANTOFOGASTA - RUTAS ATS
89% del tránsito de la muestra



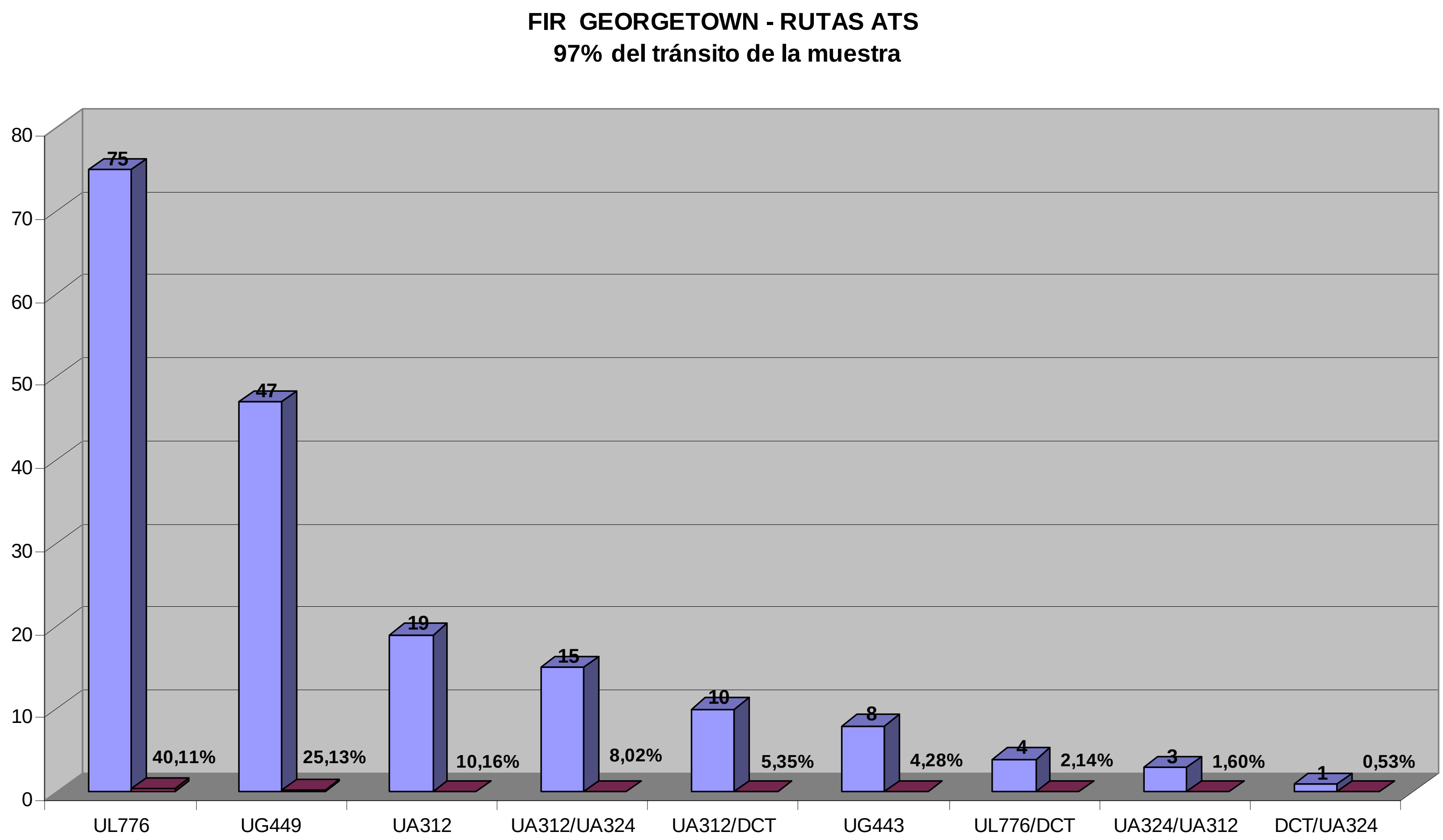

FIR PASCUA - RUTAS ATS
100% del tránsito de la muestra
70
60
50
40
30
20
10
0
61
40,13%
48
31,58%
42
27,63%
1
0,66%
UL401
COOR. GEO
UL348
UL340


FIR PUERTO MONTT - RUTAS ATS
94% del tránsito de la muestra
0
20
40
60
80
100
120
117
27,46%
77
18,08%
76
17,84%
56
13,15%
55
12,91%
18
4,23%
UG550
UT100/UW101/UW200
UW101/UT100
UT106/UW101/UT100
UT100/UW101
UG550/UW200

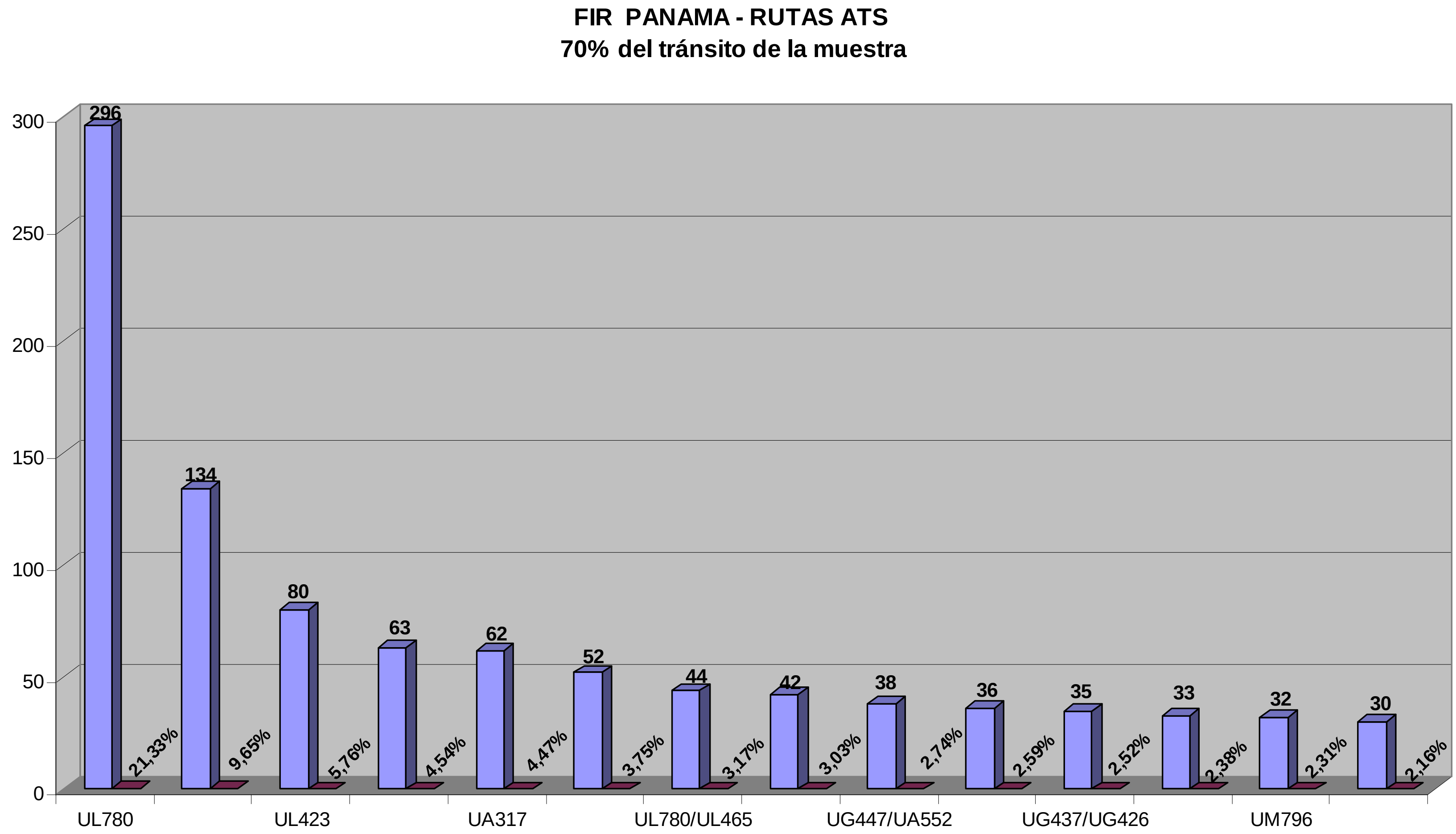

FIR PUNTA ARENAS - RUTAS ATS
98% del tránsito de la muestra
300
250
200
150
100
50
0
269
91,19%
7
2,37%
5
1,69%
3
1,02%
3
1,02%
3
1,02%
1
0,34%
UT100
UG550
UA570
ANTRC
OCNC
OVF
UT100


FIR SANTIAGO - RUTAS ATS
89% del tránsito de la muestra
0
50
100
150
200
250
300
350
400
388
344
244
153
130
120
89
86
81
81
60
60
55
18,28%
16,20%
11,49%
7,21%
6,12%
5,65%
4,19%
4,05%
3,82%
3,82%
2,83%
2,83%
2,59%
UT106
UW200
UT108
UL780
UL302 UW208
UL309
UW117
UW200 UL302
UW109
UW204
UL780 UW208
UT112
UL401

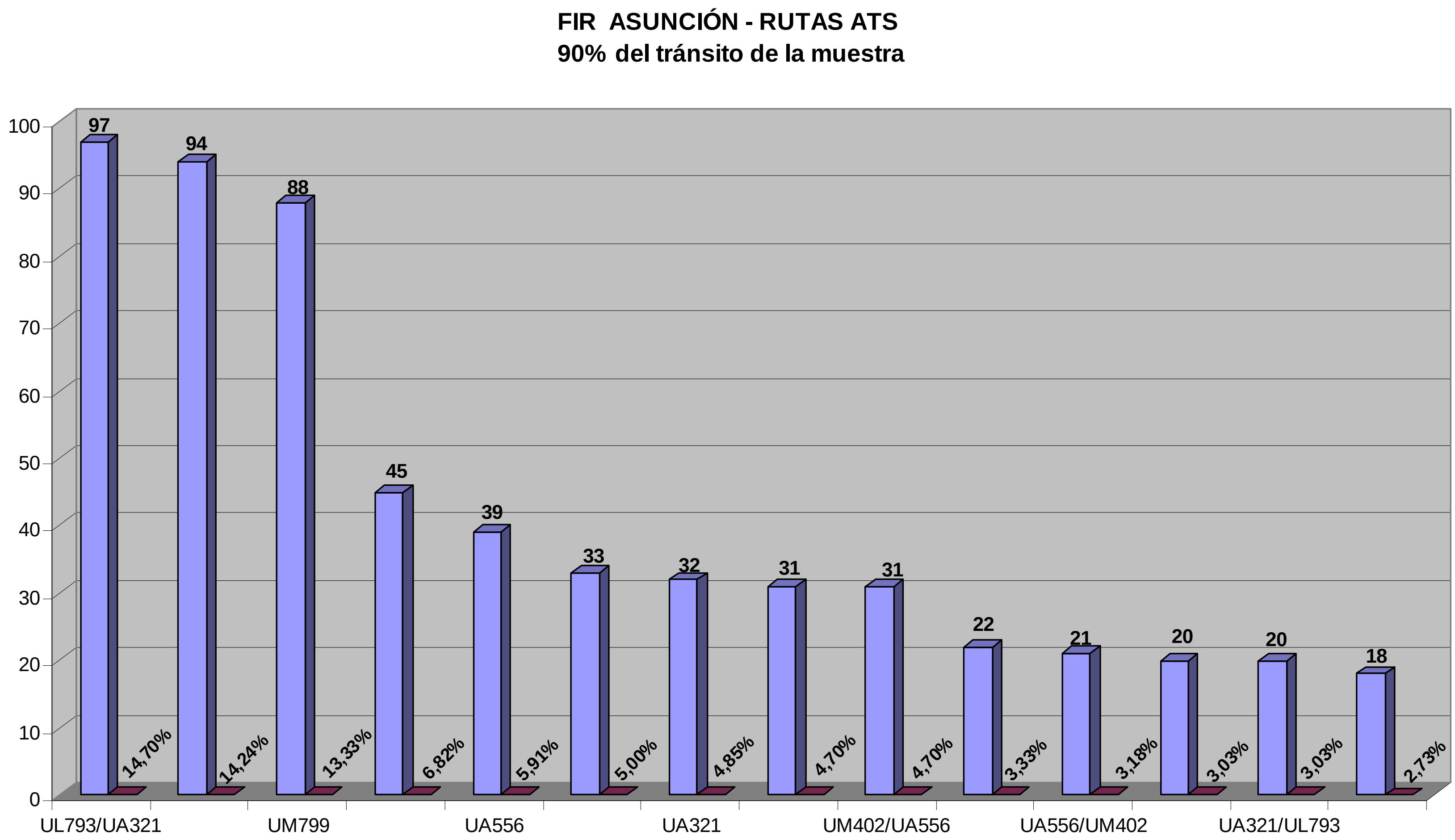
GUYANA


FIR GEORGETOWN - RUTAS ATS
97% del tránsito de la muestra
80
70
60
50
40
30
20
10
0
75
40,11%
47
25,13%
19
10,16%
15
8,02%
10
5,35%
8
4,28%
4
2,14%
3
1,60%
1
0,53%
UL776
UG449
UA312
UA312/UA324
UA312/DCT
UG443
UL776/DCT
UA324/UA312
DCT/UA324

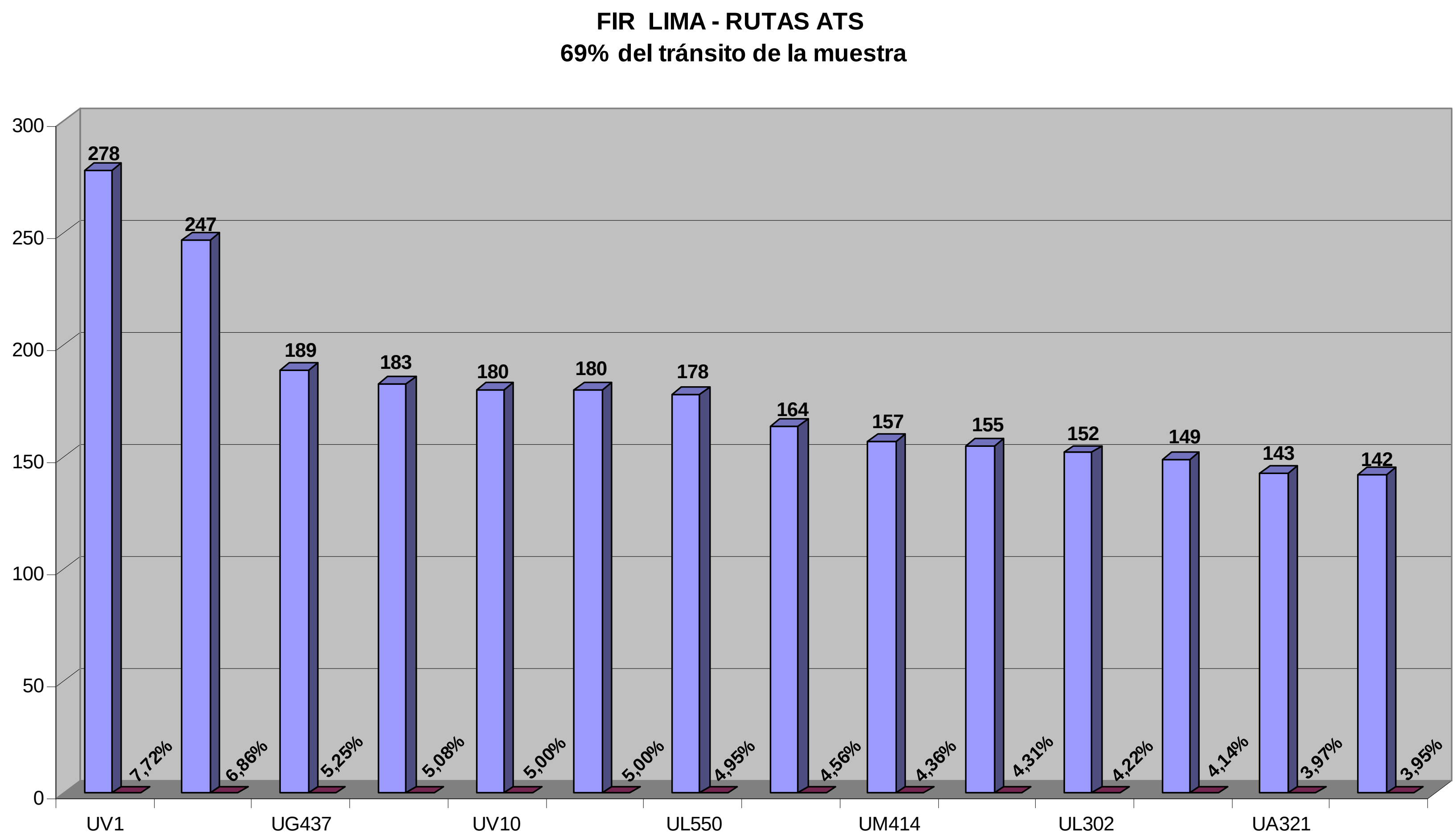
PANAMA


FIR PANAMA - RUTAS ATS
70% del tránsito de la muestra
300
250
200
150
100
50
0
296
134
80
63
62
52
44
42
38
36
35
33
32
30
21,33%
9,65%
5,76%
4,54%
4,47%
3,75%
3,17%
3,03%
2,74%
2,59%
2,52%
2,38%
2,31%
2,16%
UL780
UL423
UA317
UL780/UL465
UG447/UA552
UG437/UG426
UM796

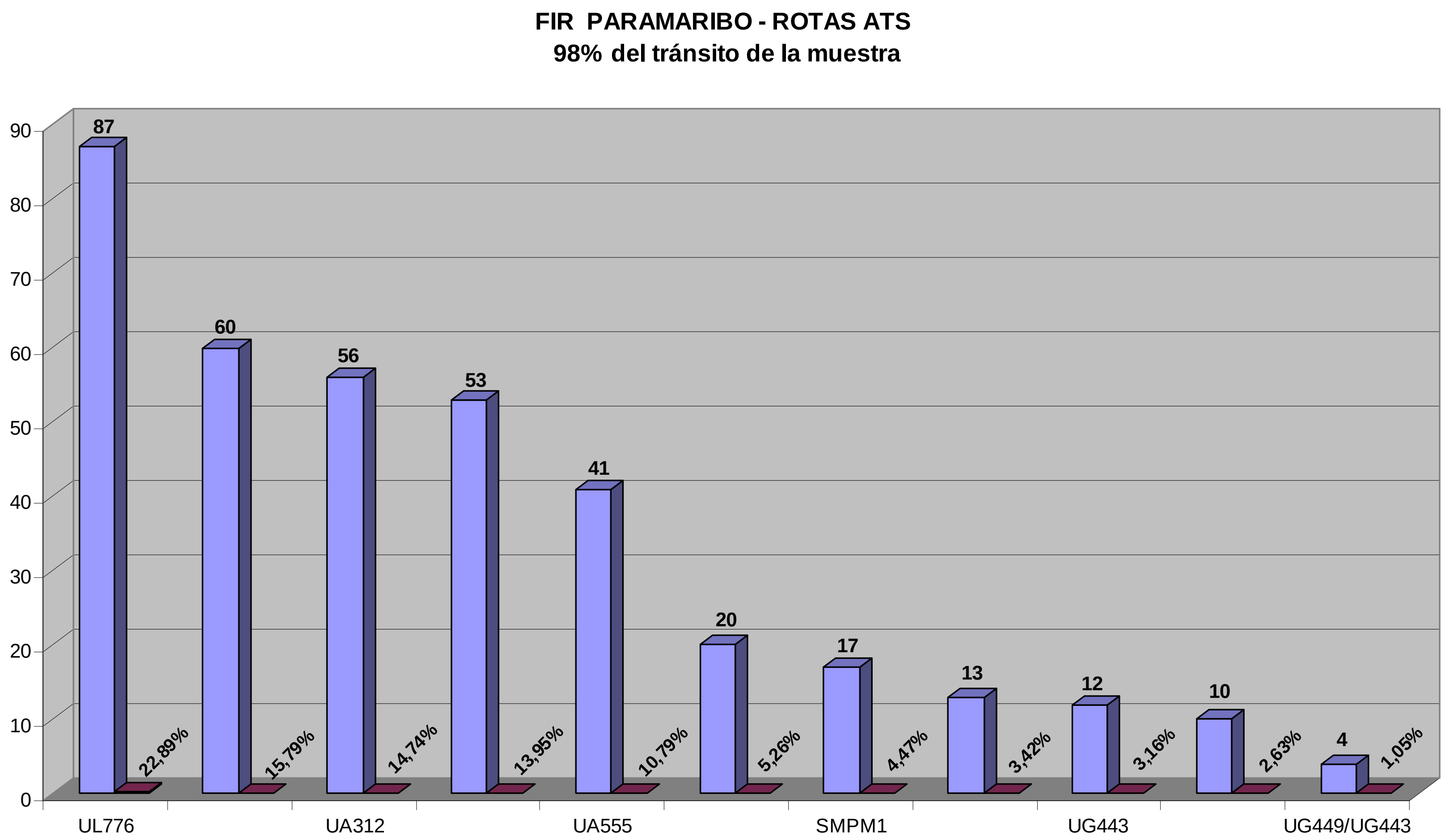
PARAGUAY


FIR ASUNCIÓN - RUTAS ATS
90% del tránsito de la muestra
100
90
80
70
60
50
40
30
20
10
0
97
94
88
45
39
33
32
31
31
22
21
20
20
18
14,70%
14,24%
13,33%
6,82%
5,91%
5,00%
4,85%
4,70%
4,70%
3,33%
3,18%
3,03%
3,03%
2,73%
UL793/UA321
UM799
UA556
UA321
UM402/UA556
UA556/UM402
UA321/UL793

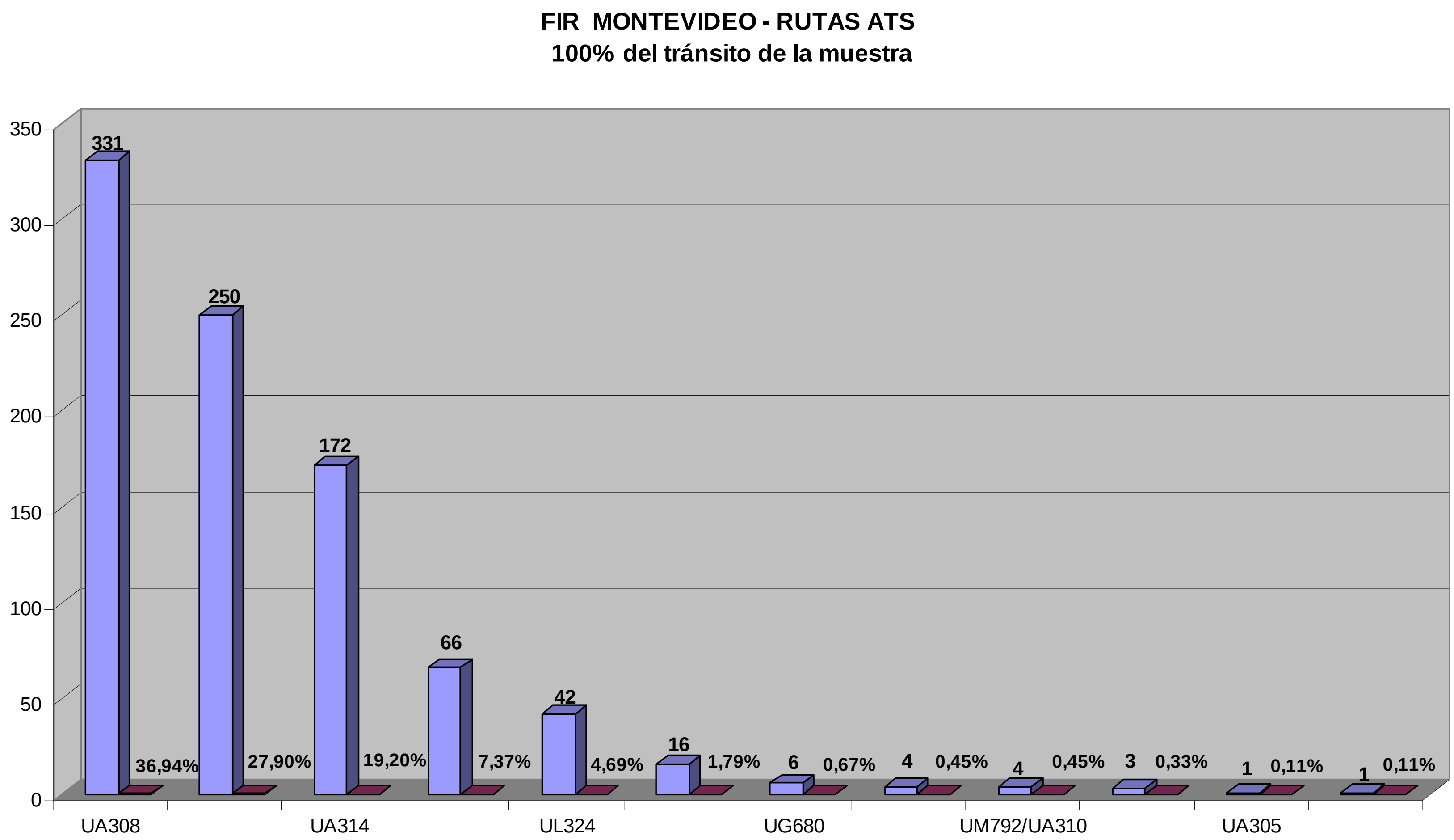
PERU


FIR LIMA - RUTAS ATS
69% del tránsito de la muestra
300
250
200
150
100
50
0
278
247
189
183
180
180
178
164
157
155
152
149
143
142
7,72%
6,86%
5,25%
5,08%
5,00%
5,00%
4,95%
4,56%
4,36%
4,31%
4,22%
4,14%
3,97%
3,95%
UV1
UG437
UV10
UL550
UM414
UL302
UA321

SURINAME


FIR PARAMARIBO - ROTAS ATS
98% del tránsito de la muestra
0
10
20
30
40
50
60
70
80
90
87
60
56
53
41
20
17
13
12
10
4
22,89%
15,79%
14,74%
13,95%
10,79%
5,26%
4,47%
3,42%
3,16%
2,63%
1,05%
UL776
UA312
UA555
SMPM1
UG443
UG449/UG443

URUGUAY


FIR MONTEVIDEO - RUTAS ATS
100% del tránsito de la muestra
350
300
250
200
150
100
50
0
331
36,94%
250
27,90%
172
19,20%
66
7,37%
42
4,69%
16
1,79%
6
0,67%
4
0,45%
4
0,45%
3
0,33%
1
0,11%
1
0,11%
UA308
UA314
UL324
UG680
UM792/UA310
UA305

- - - - - - -

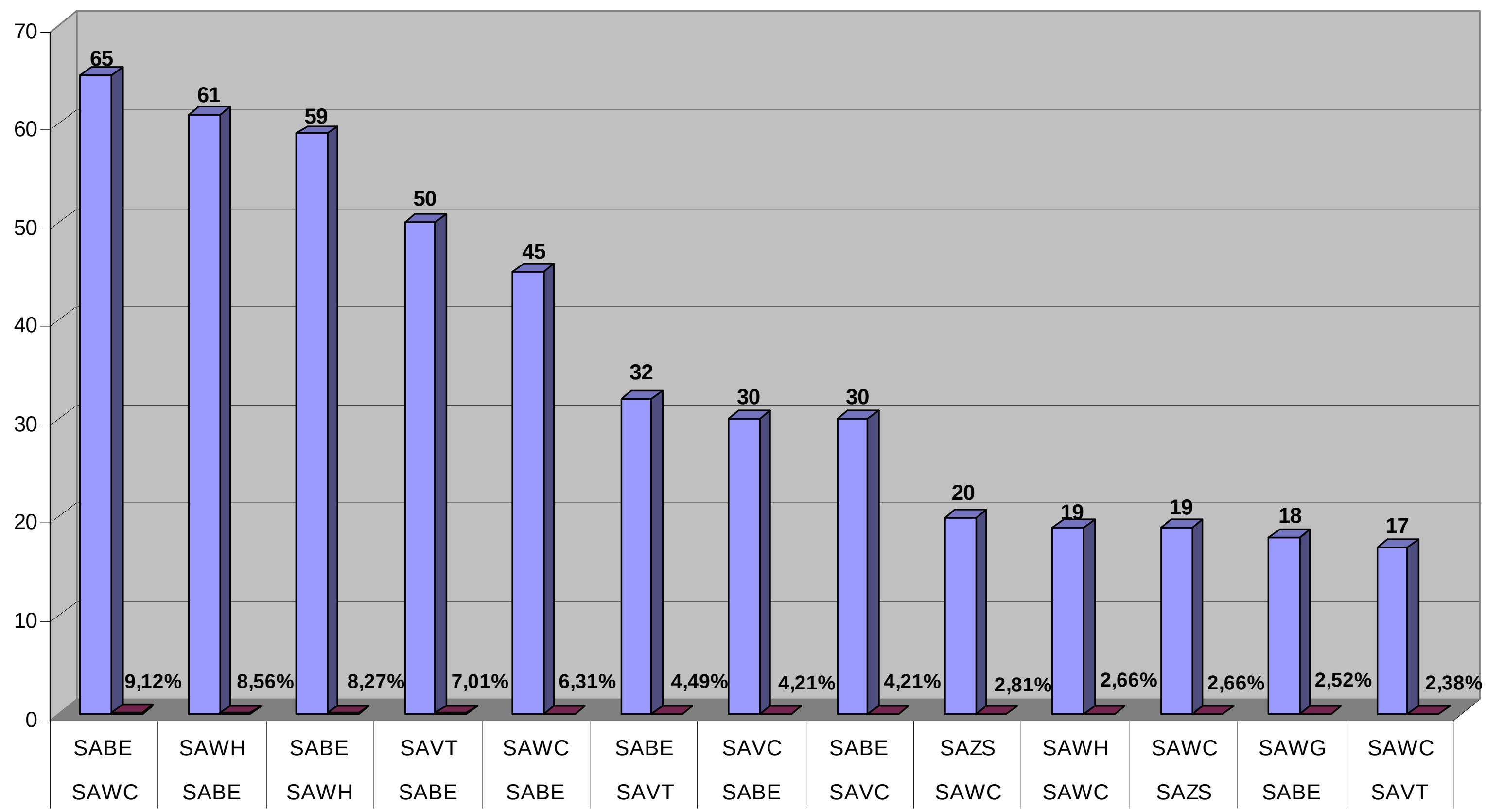
ADJUNTO 3 AL APENDICE B / ATTACHMENT 3 TO APPENDIX B

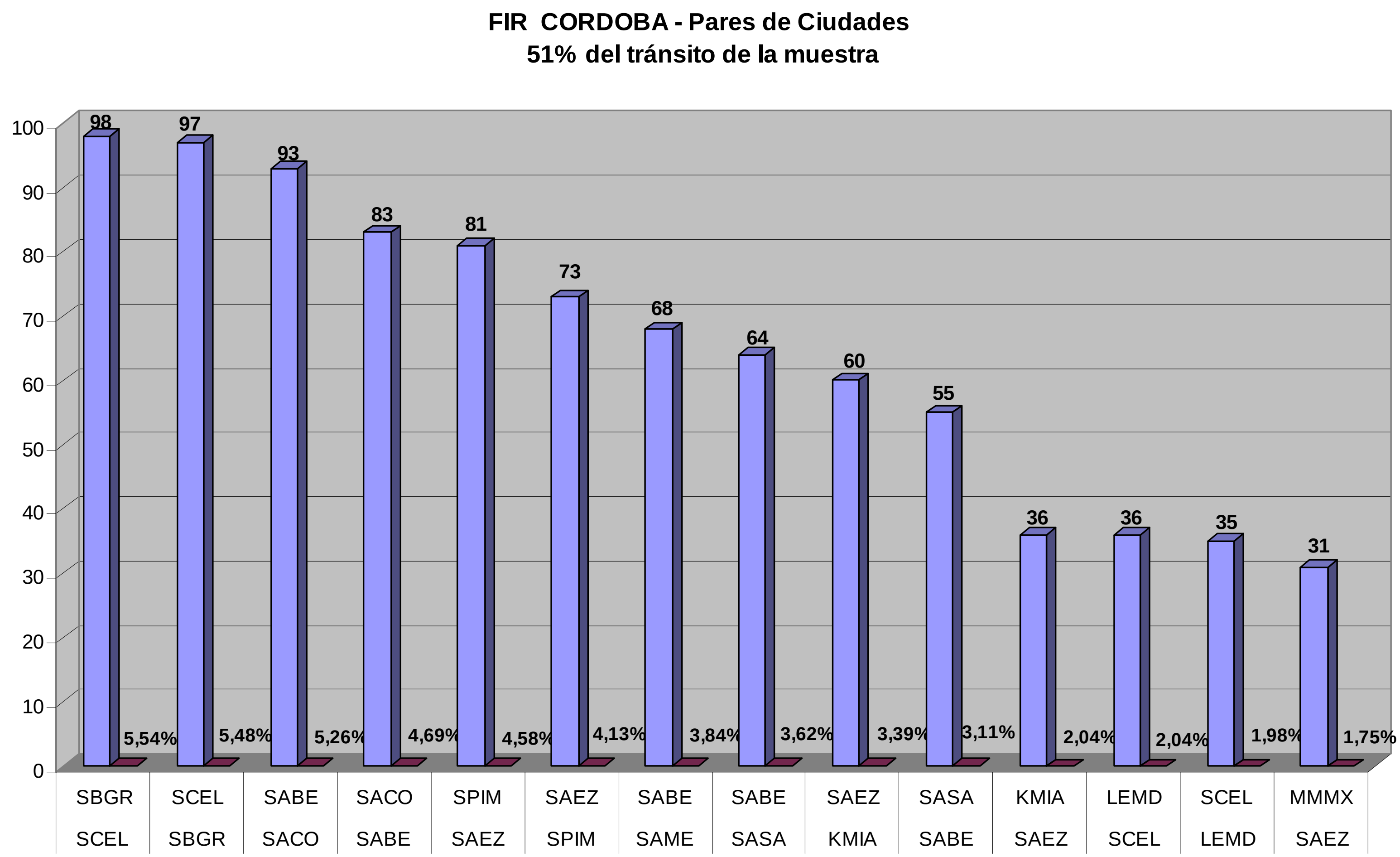
Región SAM
Pares de Ciudades

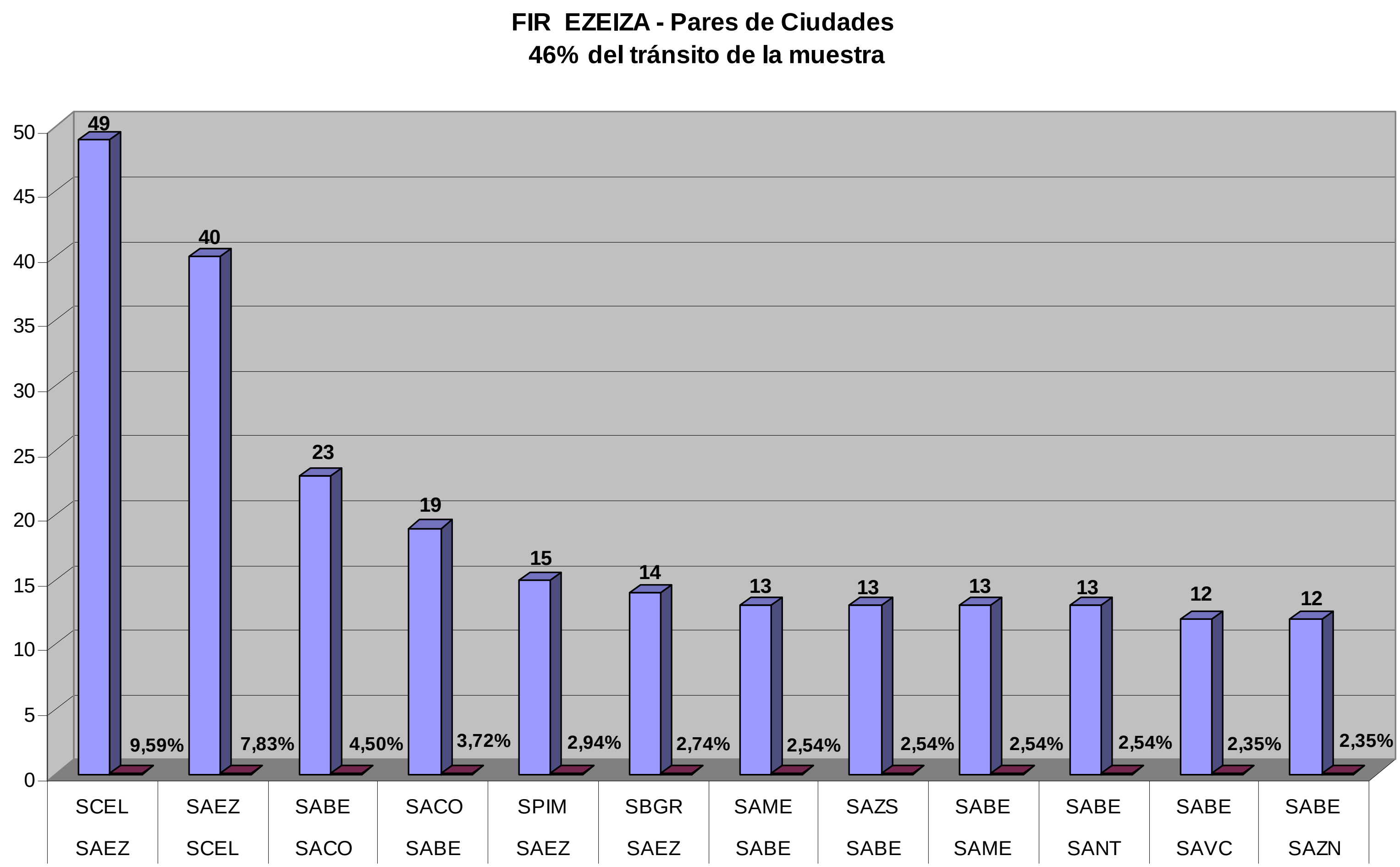
SAM Region
Pairs of Cities

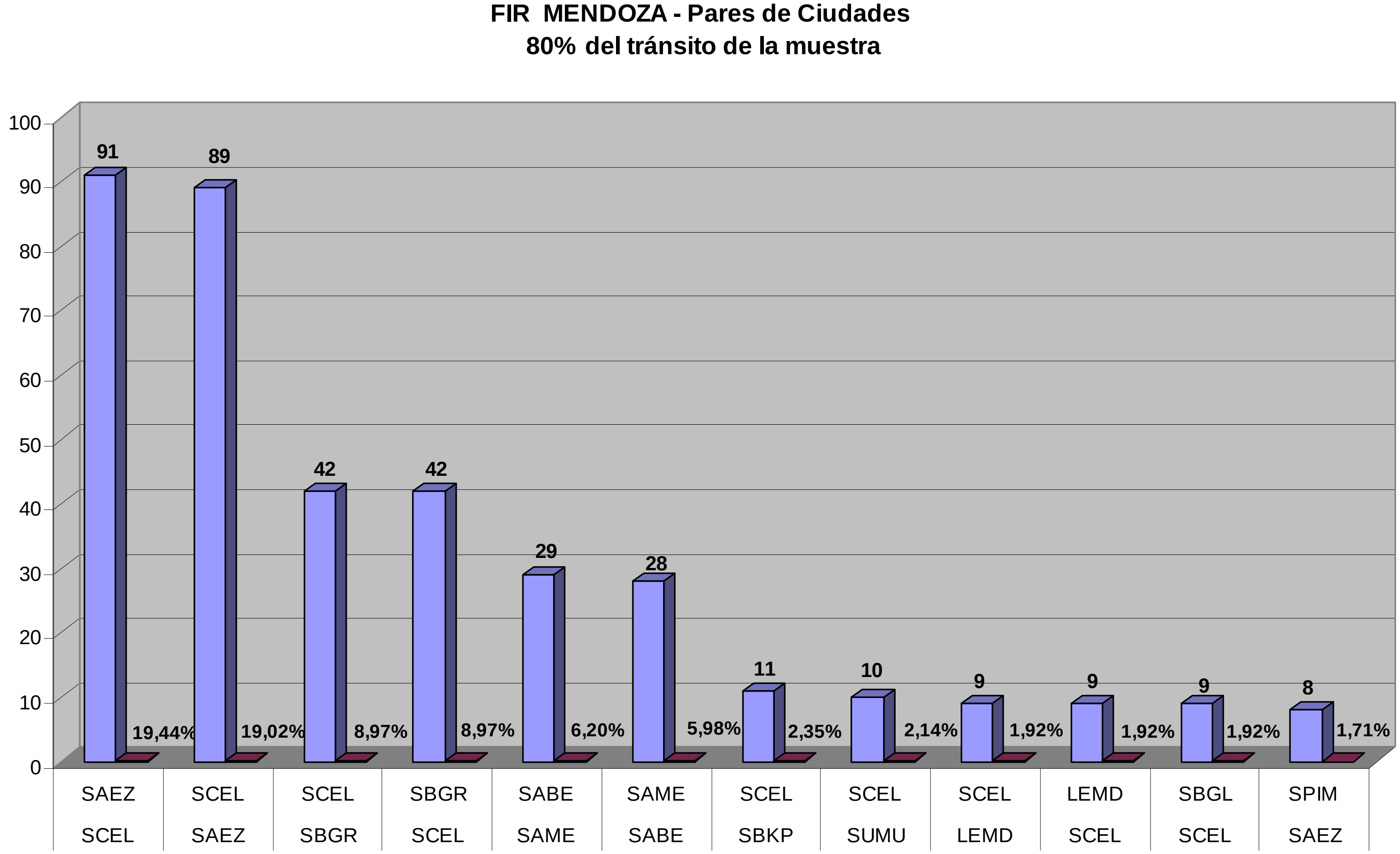
ARGENTINA

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

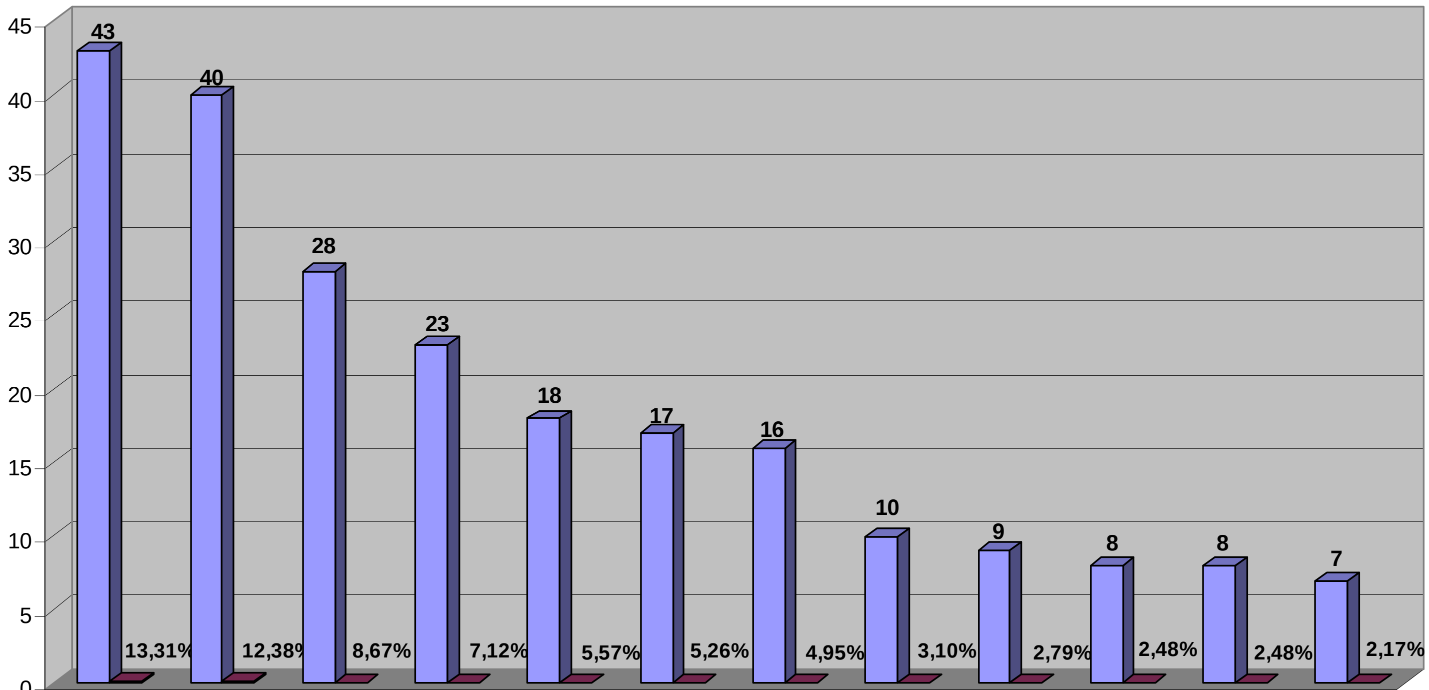



FIR CORDOBA - Pares de Ciudades
51% del tránsito de la muestra
100
90
80
70
60
50
40
30
20
10
0
98
97
93
83
81
73
68
64
60
55
36
36
35
31
5,54%
5,48%
5,26%
4,69%
4,58%
4,13%
3,84%
3,62%
3,39%
3,11%
2,04%
2,04%
1,98%
1,75%
SBGR SCEL
SCEL SBGR
SABE SACO
SACO SABE
SPIM SAEZ
SAEZ SPIM
SABE SAME
SABE SASA
SAEZ KMIA
SASA SABE
KMIA SAEZ
LEMD SCEL
SCEL LEMD
MMMX SAEZ


FIR EZEIZA - Pares de Ciudades
46% del tránsito de la muestra
0
5
10
15
20
25
30
35
40
45
50
49
9,59%
40
7,83%
23
4,50%
19
3,72%
15
2,94%
14
2,74%
13
2,54%
13
2,54%
13
2,54%
13
2,54%
12
2,35%
12
2,35%
SCEL SAEZ
SAEZ SCEL
SABE SACO
SACO SABE
SPIM SAEZ
SBGR SAEZ
SAME SABE
SAZS SABE
SABE SAME
SABE SANT
SABE SAVC
SABE SAZN

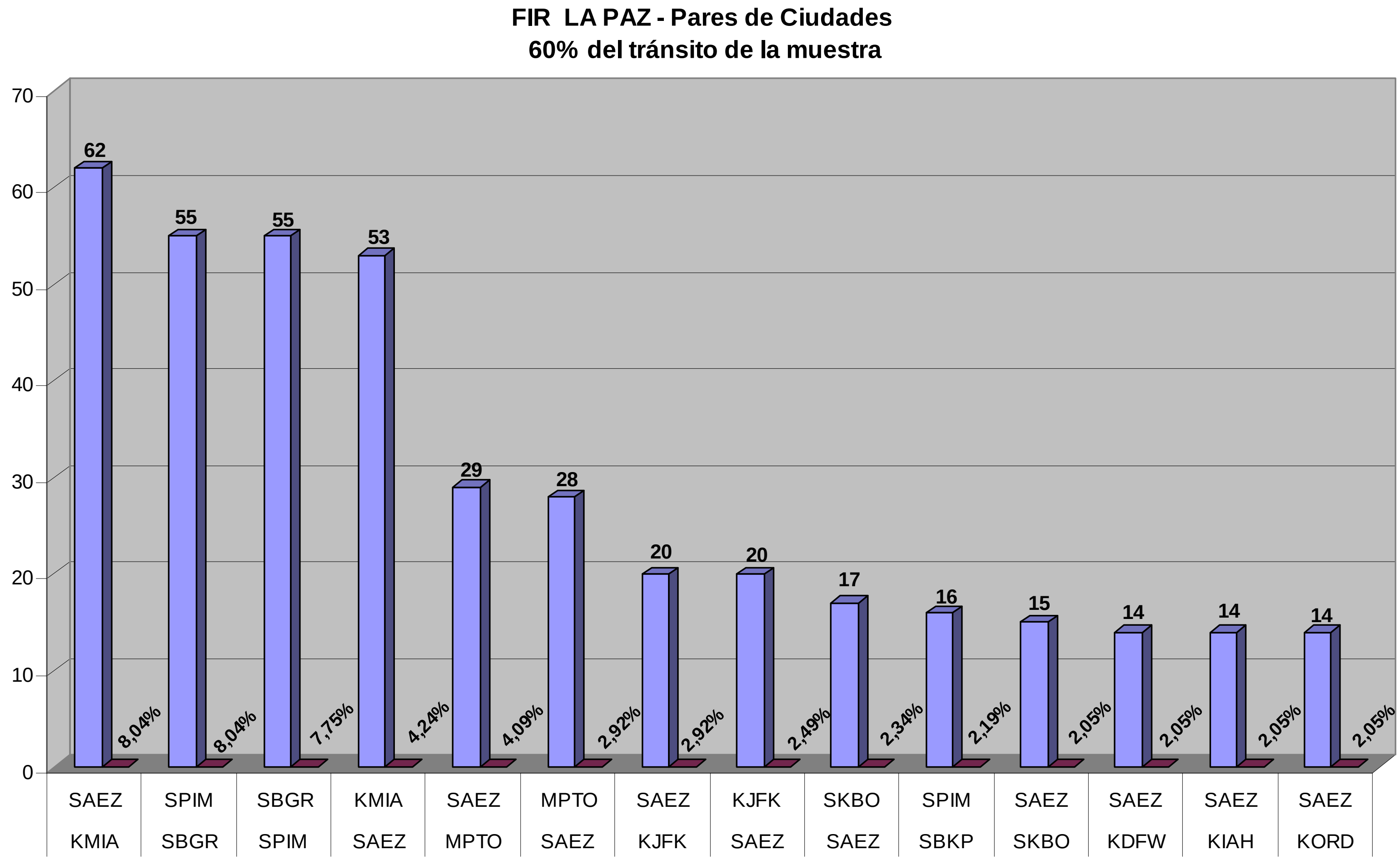

FIR MENDOZA - Pares de Ciudades
80% del tránsito de la muestra
100
90
80
70
60
50
40
30
20
10
0
91
89
42
42
29
28
11
10
9
9
9
8
19,44%
19,02%
8,97%
8,97%
6,20%
5,98%
2,35%
2,14%
1,92%
1,92%
1,92%
1,71%
SAEZ SCEL
SCEL SAEZ
SCEL SBGR
SBGR SCEL
SABE SAME
SAME SABE
SCEL SBKP
SCEL SUMU
SCEL LEMD
LEMD SCEL
SBGL SCEL
SPIM SAEZ

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

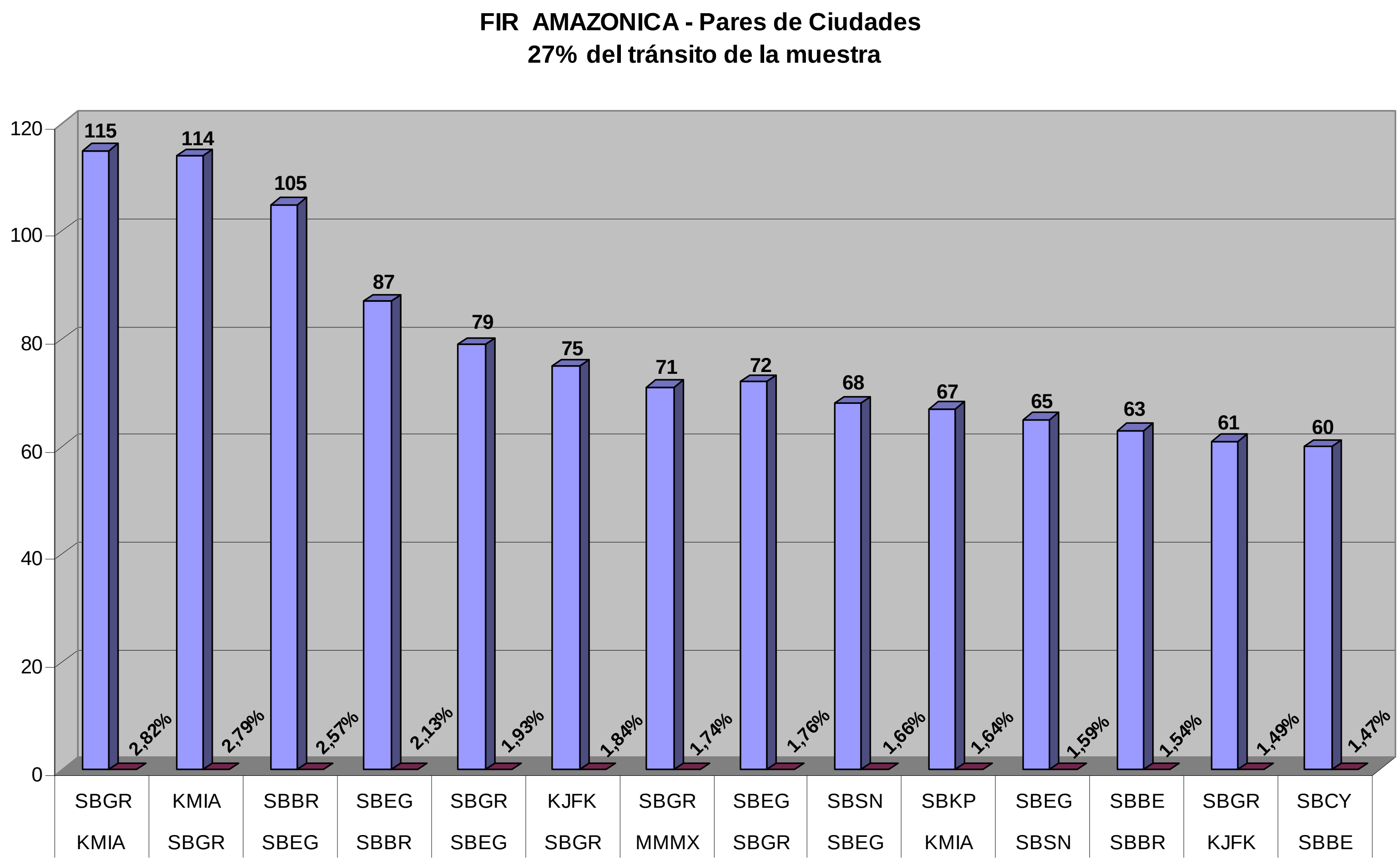


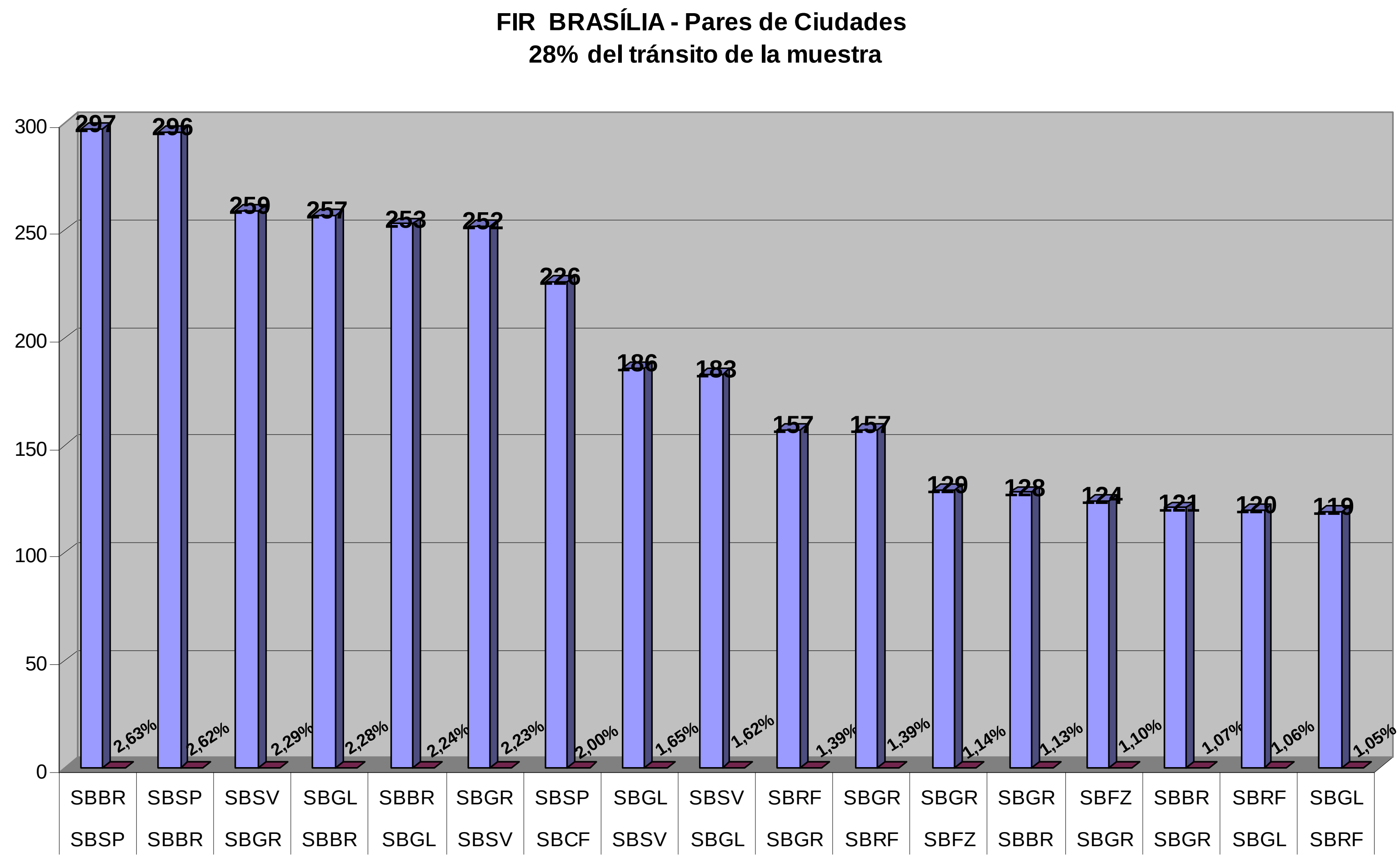
43	40	28	23	18	17	16	10	9	8	8	7
SCEL	SBGR	SARI	SABE	SAEZ	SAEZ	SGAS	KMIA	SCEL	SAEZ	LEMD	SARE
SBGR	SCEL	SACO	SARI	LEMD	SGAS	SAEZ	SAEZ	LEMD	KJFK	SCEL	SABE

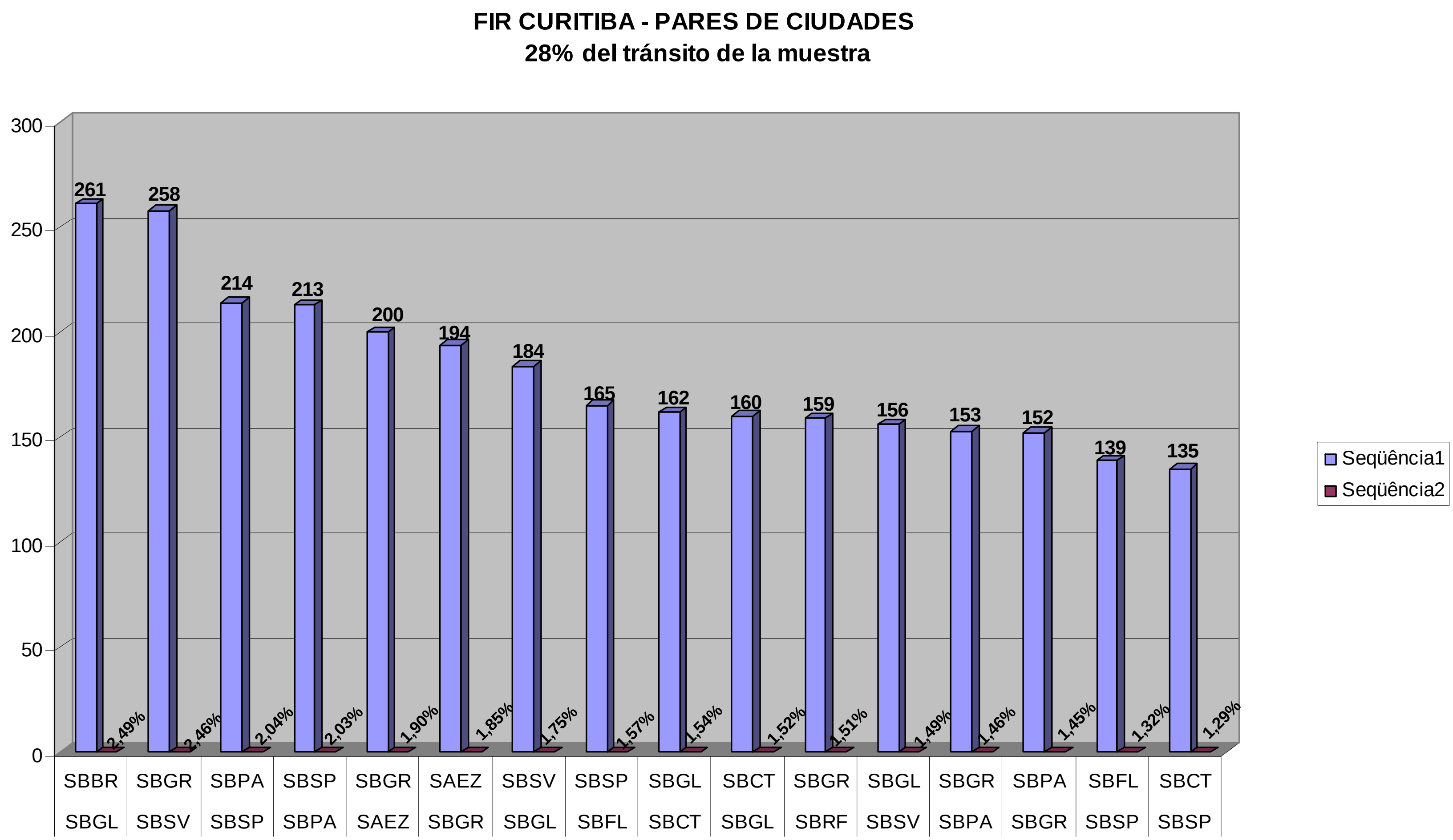
BOLIVIA

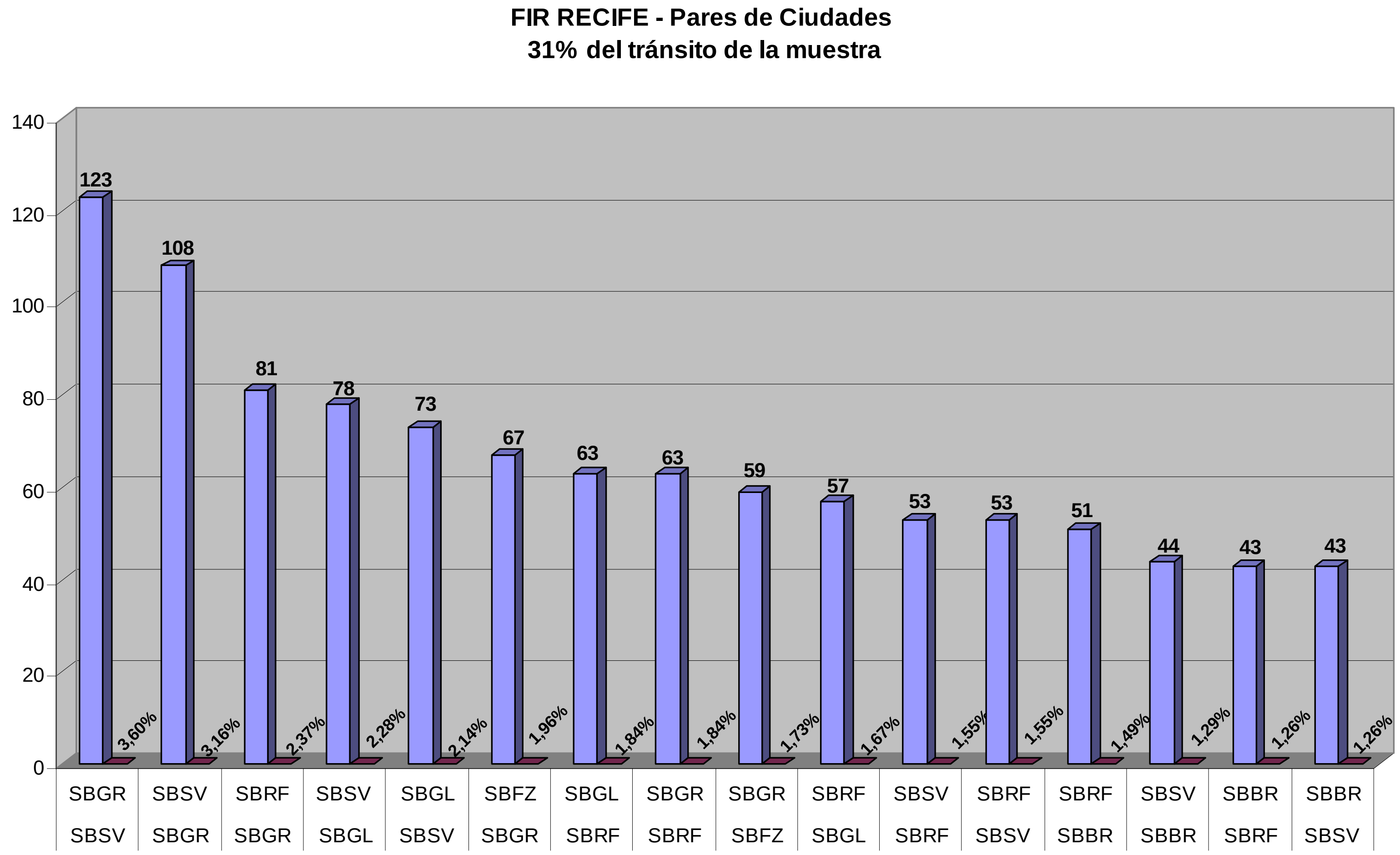

FIR LA PAZ - Pares de Ciudades
60% del tránsito de la muestra
70
60
50
40
30
20
10
0
62
55
55
53
29
28
20
20
17
16
15
14
14
14
8,04%
8,04%
7,75%
4,24%
4,09%
2,92%
2,92%
2,49%
2,34%
2,19%
2,05%
2,05%
2,05%
2,05%
SAEZ KMIA
SPIM SBGR
SBGR SPIM
KMIA SAEZ
SAEZ MPTO
MPTO SAEZ
SAEZ KJFK
KJFK SAEZ
SKBO SAEZ
SPIM SBKP
SAEZ SKBO
SAEZ KDFW
SAEZ KIAH
SAEZ KORD

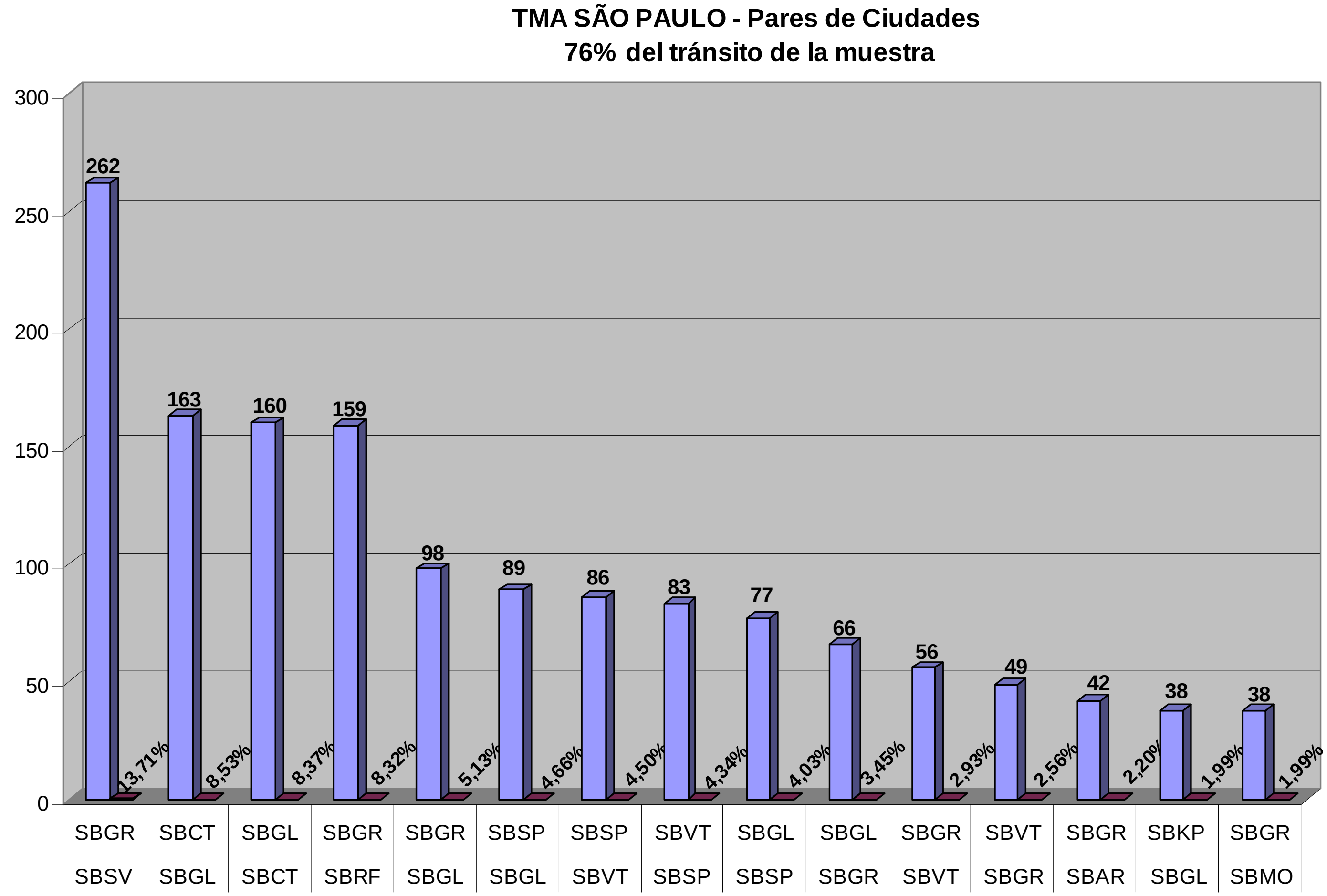
BRAZIL


FIR AMAZONICA - Pares de Ciudades
27% del tránsito de la muestra
120
100
80
60
40
20
0
115
114
105
87
79
75
71
72
68
67
65
63
61
60
2,82%
2,79%
2,57%
2,13%
1,93%
1,84%
1,74%
1,76%
1,66%
1,64%
1,59%
1,54%
1,49%
1,47%
SBGR KMIA
KMIA SBGR
SBBR SBEG
SBEG SBBR
SBGR SBEG
KJFK SBGR
SBGR MMMX
SBEG SBGR
SBSN SBEG
SBKP KMIA
SBEG SBSN
SBBE SBBR
SBGR KJFK
SBCY SBBE

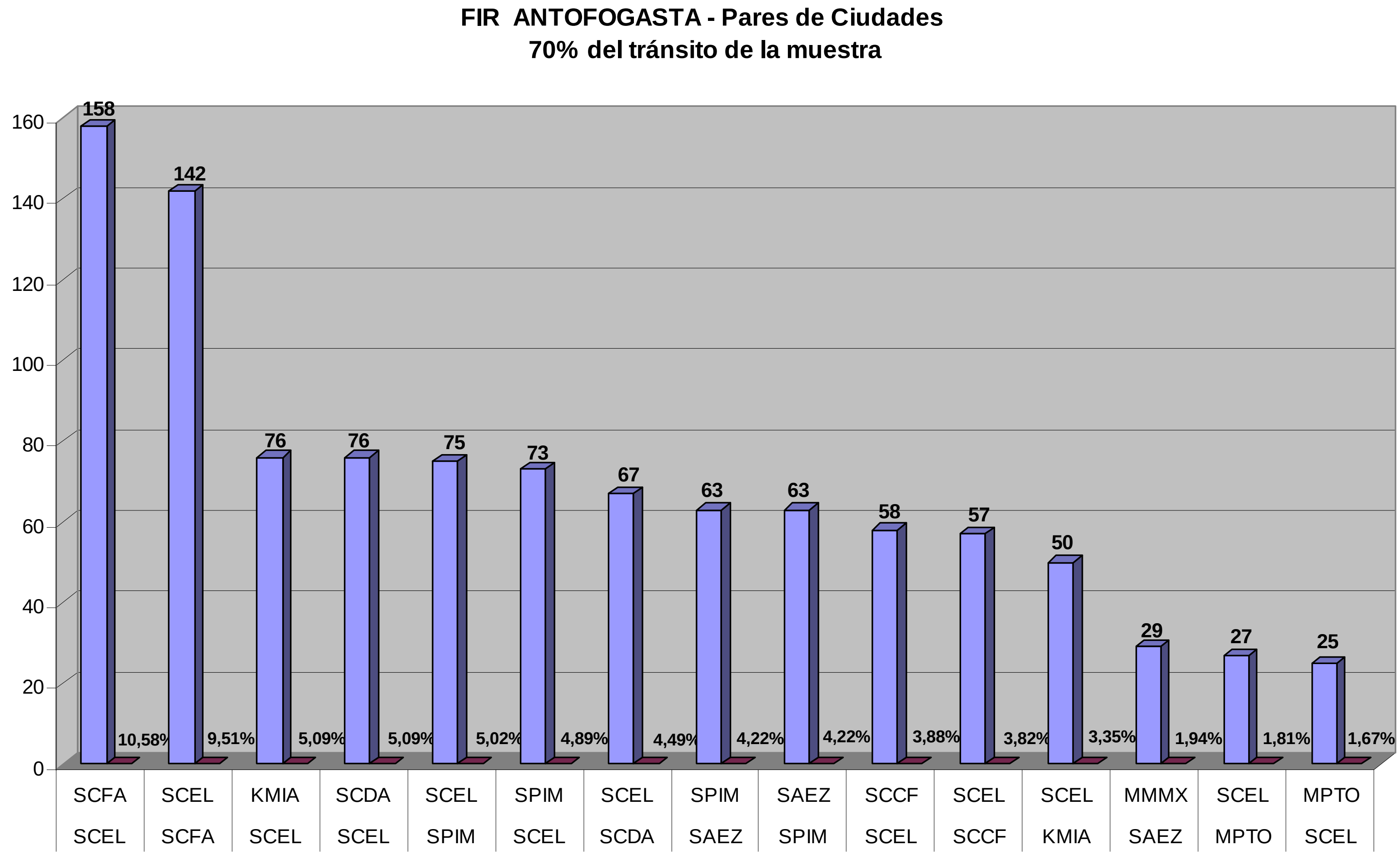

FIR BRASÍLIA - Pares de Ciudades
28% del tránsito de la muestra
300
250
200
150
100
50
0
297
296
259
257
253
252
226
186
183
157
157
129
128
124
121
120
119
2,63%
2,62%
2,29%
2,28%
2,24%
2,23%
2,00%
1,65%
1,62%
1,39%
1,39%
1,14%
1,13%
1,10%
1,07%
1,06%
1,05%
SBBR SBSP
SBSP SBBR
SBSV SBGR
SBGL SBBR
SBBR SBGL
SBGR SBSV
SBSP SBCF
SBGL SBSV
SBSV SBGL
SBRF SBGR
SBGR SBRF
SBGR SBFZ
SBGR SBBR
SBFZ SBGR
SBBR SBGR
SBRF SBGL
SBGL SBRF

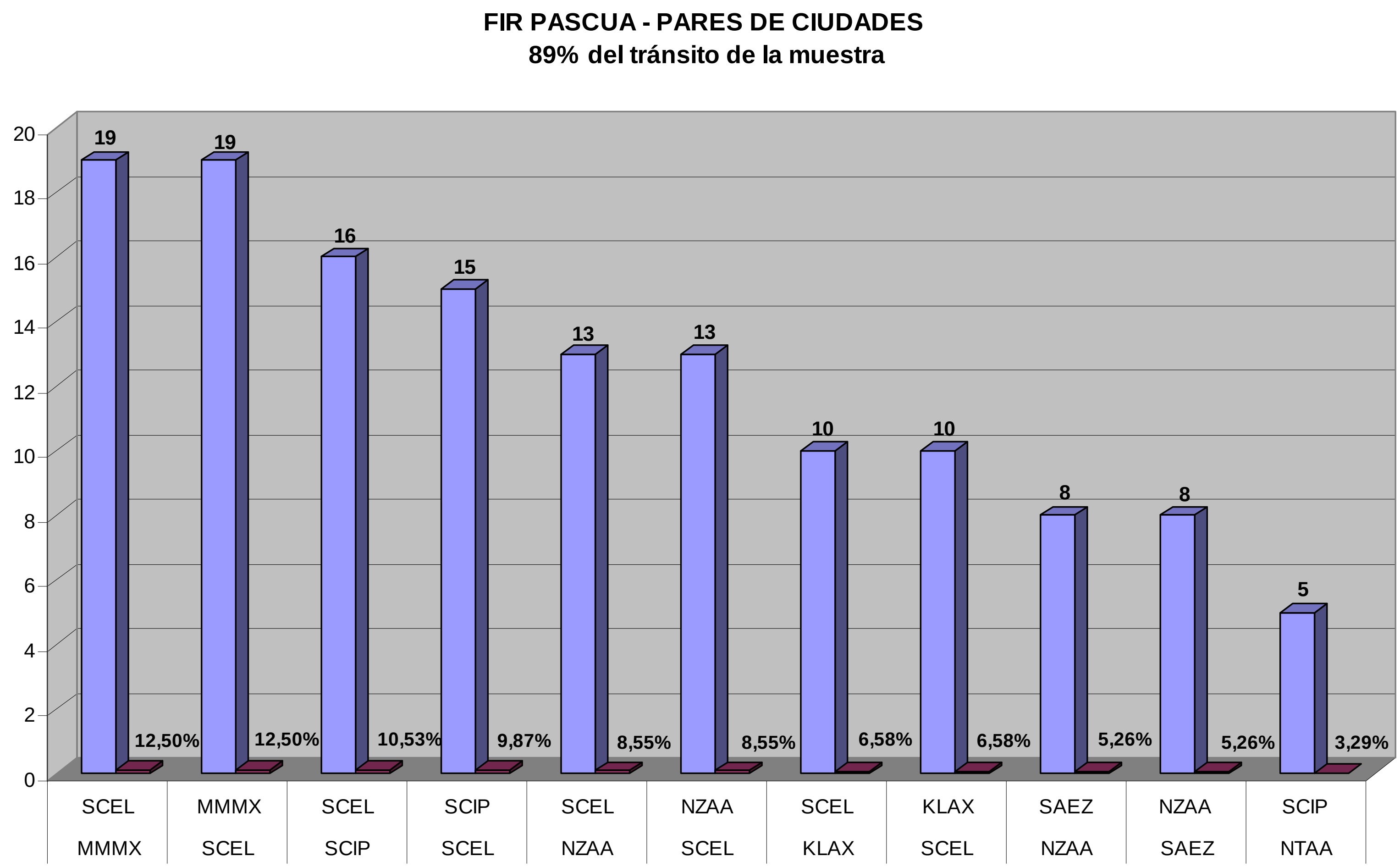

FIR CURITIBA - PARES DE CIUDADES
28% del tránsito de la muestra
300
250
200
150
100
50
0
261
258
214
213
200
194
184
165
162
160
159
156
153
152
139
135
2,49%
2,46%
2,04%
2,03%
1,90%
1,85%
1,75%
1,57%
1,54%
1,52%
1,51%
1,49%
1,46%
1,45%
1,32%
1,29%
SBBR SBGL
SBGR SBSV
SBPA SBSP
SBSP SBPA
SBGR SAEZ
SAEZ SBGR
SBSV SBGL
SBSP SBFL
SBGL SBCT
SBCT SBGL
SBGR SBRF
SBGL SBSV
SBGR SBPA
SBPA SBGR
SBFL SBSP
SBCT SBSP
Seqüência1
Seqüência2

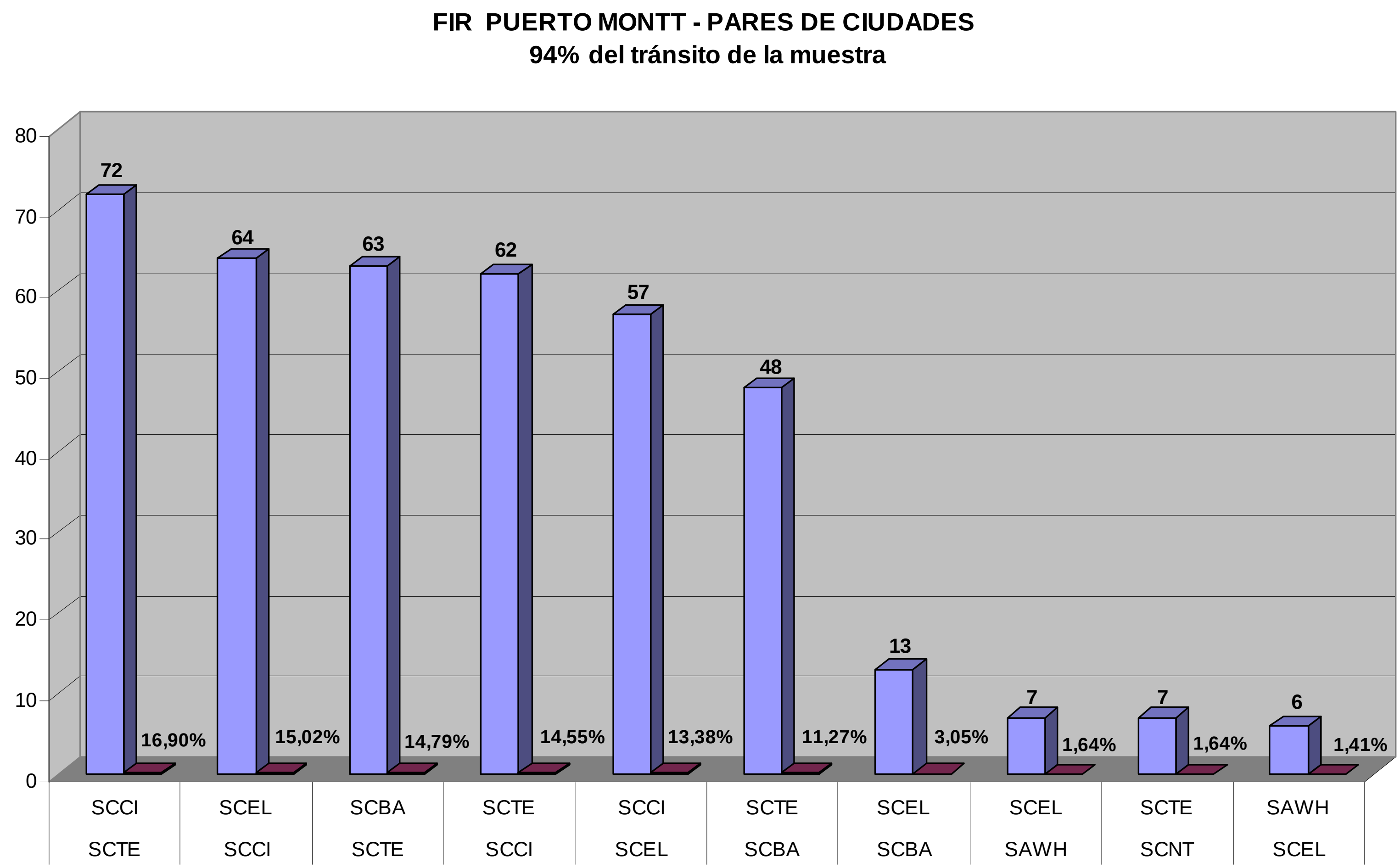

FIR RECIFE - Pares de Ciudades
31% del tránsito de la muestra
140
120
100
80
60
40
20
0
123
108
81
78
73
67
63
63
59
57
53
53
51
44
43
43
3,60%
3,16%
2,37%
2,28%
2,14%
1,96%
1,84%
1,84%
1,73%
1,67%
1,55%
1,55%
1,49%
1,29%
1,26%
1,26%
SBGR SBSV
SBSV SBGR
SBRF SBGR
SBSV SBGL
SBGL SBSV
SBFZ SBGR
SBGL SBRF
SBGR SBRF
SBGR SBFZ
SBRF SBGL
SBSV SBRF
SBRF SBSV
SBRF SBBR
SBSV SBBR
SBBR SBRF
SBBR SBSV

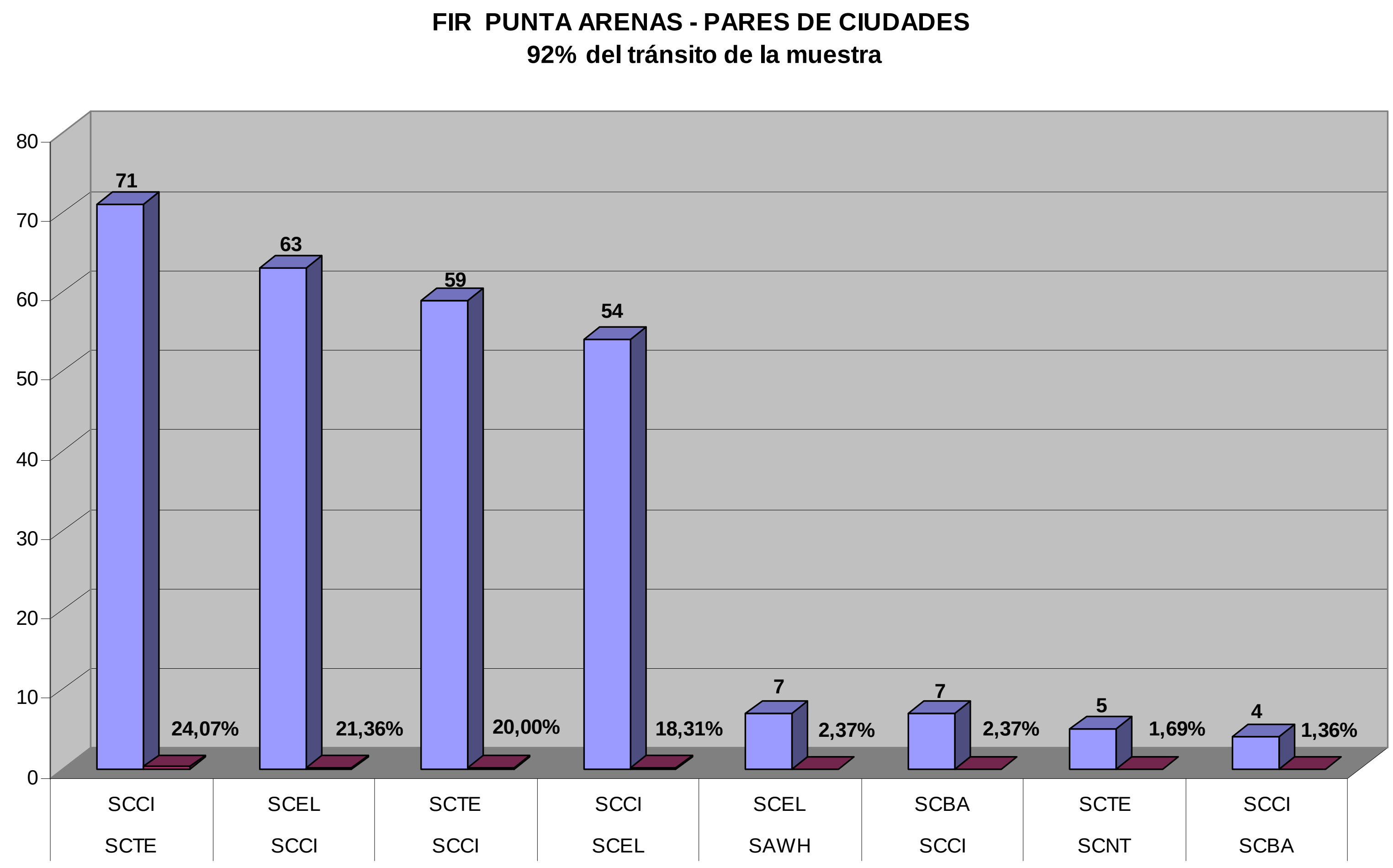

TMA SÃO PAULO - Pares de Ciudades
76% del tránsito de la muestra
300
250
200
150
100
50
0
262
163
160
159
98
89
86
83
77
66
56
49
42
38
38
13,71%
8,53%
8,37%
8,32%
5,13%
4,66%
4,50%
4,34%
4,03%
3,45%
2,93%
2,56%
2,20%
1,99%
1,99%
SBGR SBSV
SBCT SBGL
SBGL SBCT
SBGR SBRF
SBGR SBGL
SBSP SBGL
SBSP SBVT
SBVT SBSP
SBGL SBSP
SBGL SBGR
SBGR SBVT
SBVT SBGR
SBGR SBAR
SBKP SBGL
SBGR SBMO

CHILE

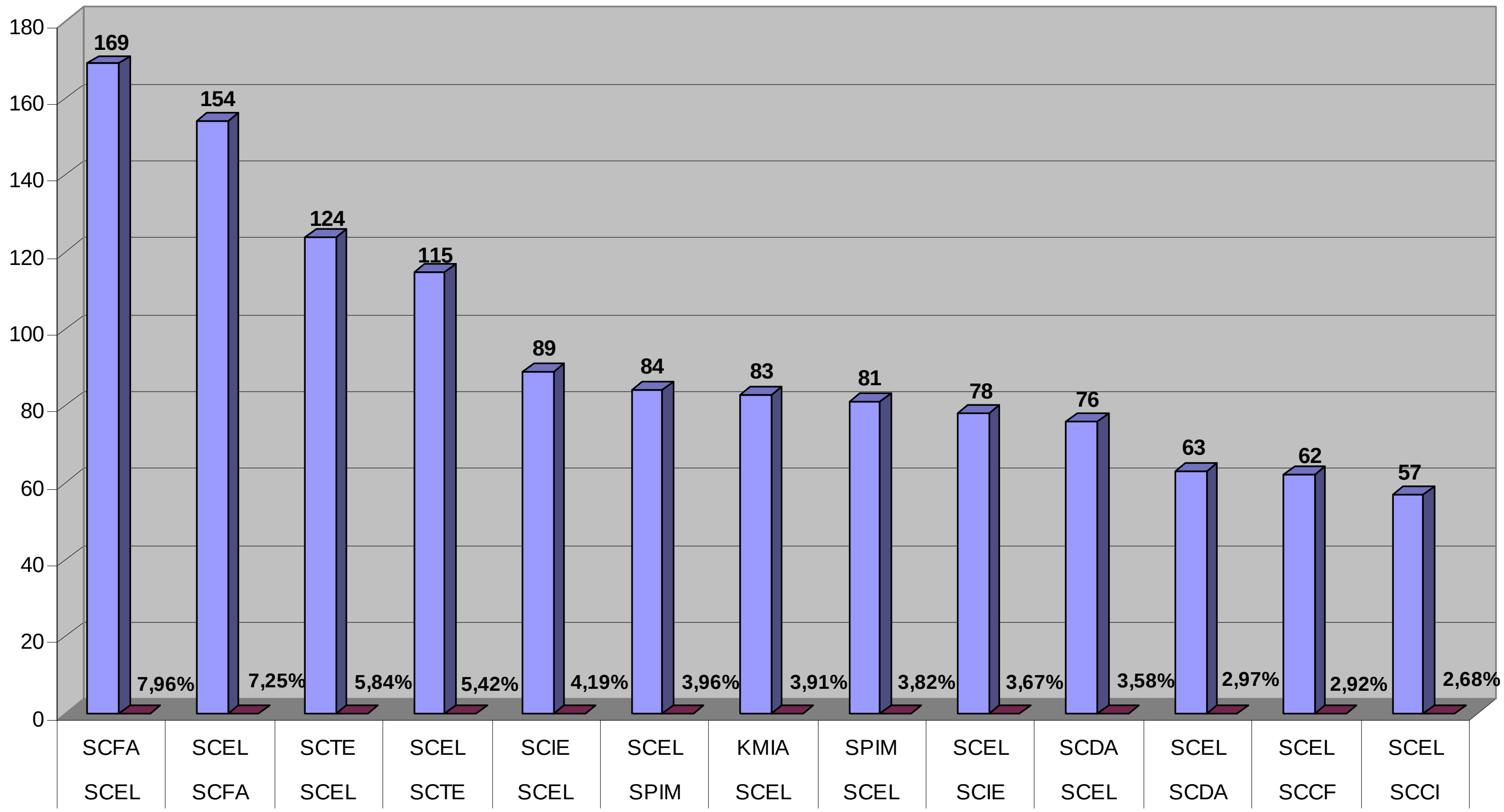

FIR ANTOFOGASTA - Pares de Ciudades
70% del tránsito de la muestra
0
20
40
60
80
100
120
140
160
158
142
76
76
75
73
67
63
63
58
57
50
29
27
25
10,58%
9,51%
5,09%
5,09%
5,02%
4,89%
4,49%
4,22%
4,22%
3,88%
3,82%
3,35%
1,94%
1,81%
1,67%
SCFA SCEL
SCEL SCFA
KMIA SCEL
SCDA SCEL
SCEL SPIM
SPIM SCEL
SCEL SCDA
SPIM SAEZ
SAEZ SPIM
SCCF SCEL
SCEL SCCF
SCEL KMIA
MMMX SAEZ
SCEL MPTO
MPTO SCEL


FIR PASCUA - PARES DE CIUDADES
89% del tránsito de la muestra
20
18
16
14
12
10
8
6
4
2
0
19
19
16
15
13
13
10
10
8
8
5
12,50%
12,50%
10,53%
9,87%
8,55%
8,55%
6,58%
6,58%
5,26%
5,26%
3,29%
SCEL MMMX
MMMX SCEL
SCEL SCIP
SCIP SCEL
SCEL NZAA
NZAA SCEL
SCEL KLAX
KLAX SCEL
SAEZ NZAA
NZAA SAEZ
SCIP NTAA

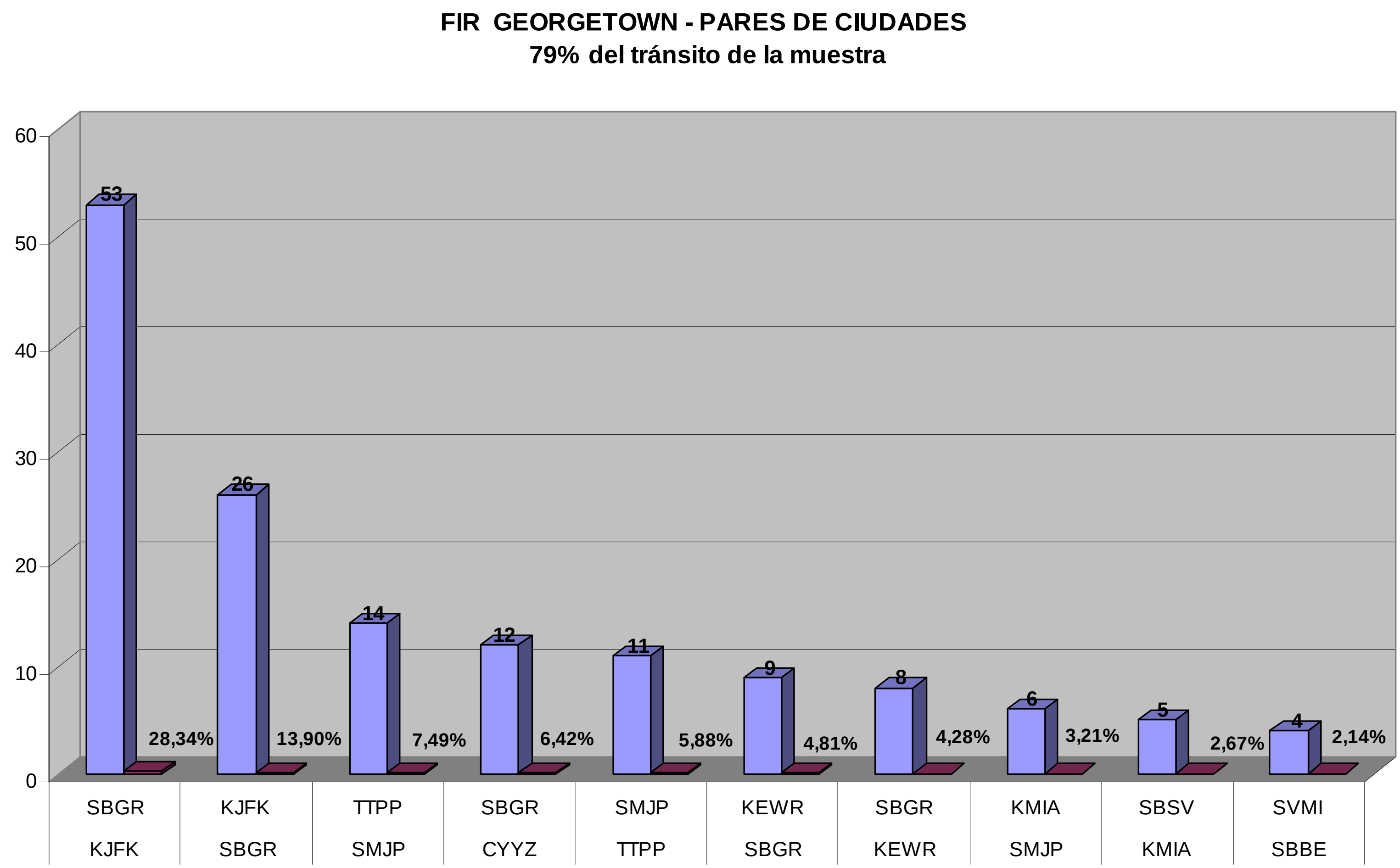

FIR PUERTO MONTT - PARES DE CIUDADES
94% del tránsito de la muestra
80
70
60
50
40
30
20
10
0
72
64
63
62
57
48
13
7
7
6
16,90%
15,02%
14,79%
14,55%
13,38%
11,27%
3,05%
1,64%
1,64%
1,41%
SCCI SCTE
SCEL SCCI
SCBA SCTE
SCTE SCCI
SCCI SCEL
SCTE SCBA
SCEL SCBA
SCEL SAWH
SCTE SCNT
SAWH SCEL


FIR PUNTA ARENAS - PARES DE CIUDADES
92% del tránsito de la muestra
80
70
60
50
40
30
20
10
0
71
63
59
54
7
7
5
4
24,07%
21,36%
20,00%
18,31%
2,37%
2,37%
1,69%
1,36%
SCCI SCTE
SCEL SCCI
SCTE SCCI
SCCI SCEL
SCEL SAWH
SCBA SCCI
SCTE SCNT
SCCI SCBA

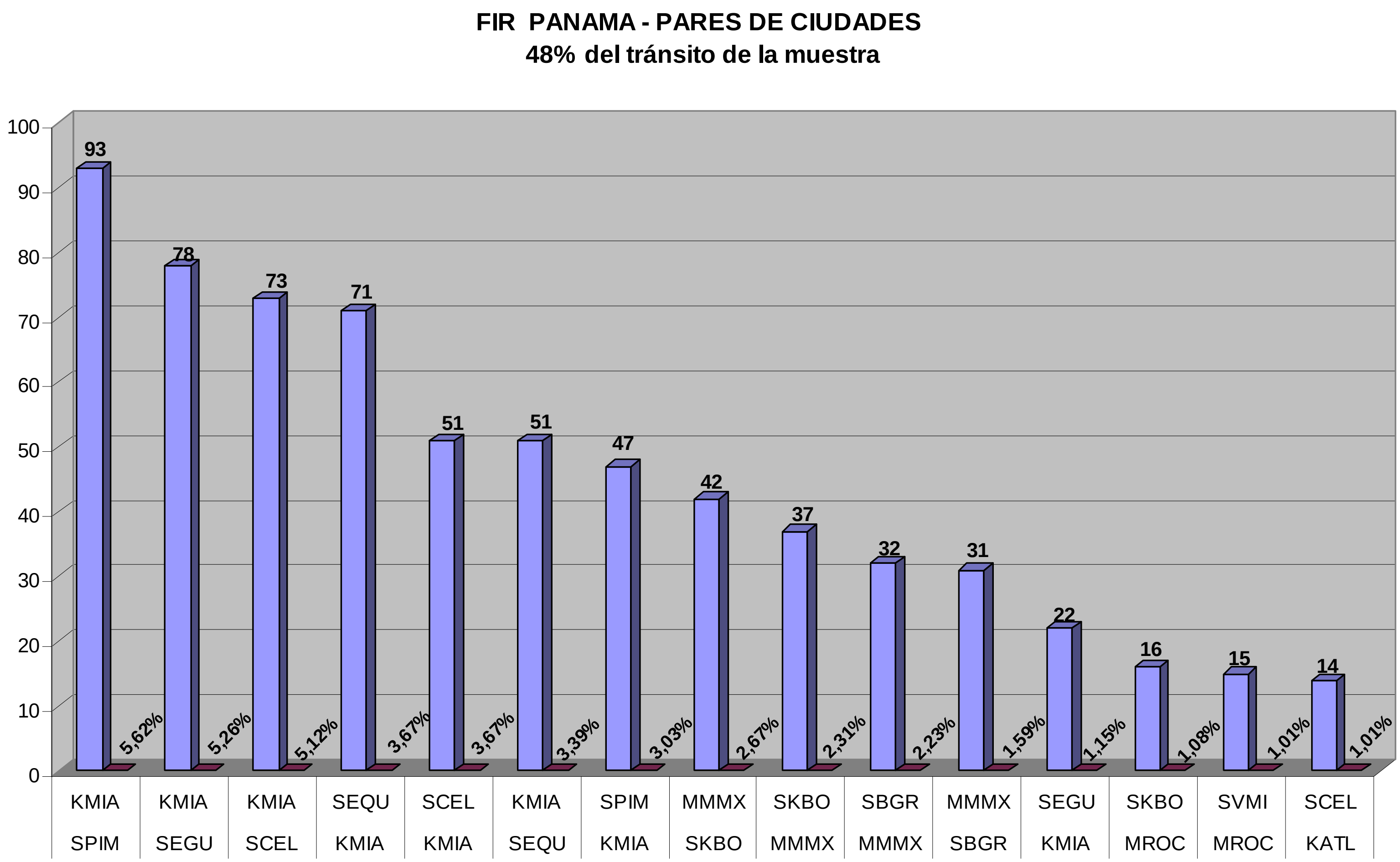
FIR SANTIAGO - PARES DE CIUDADES
58% del tránsito de la muestra



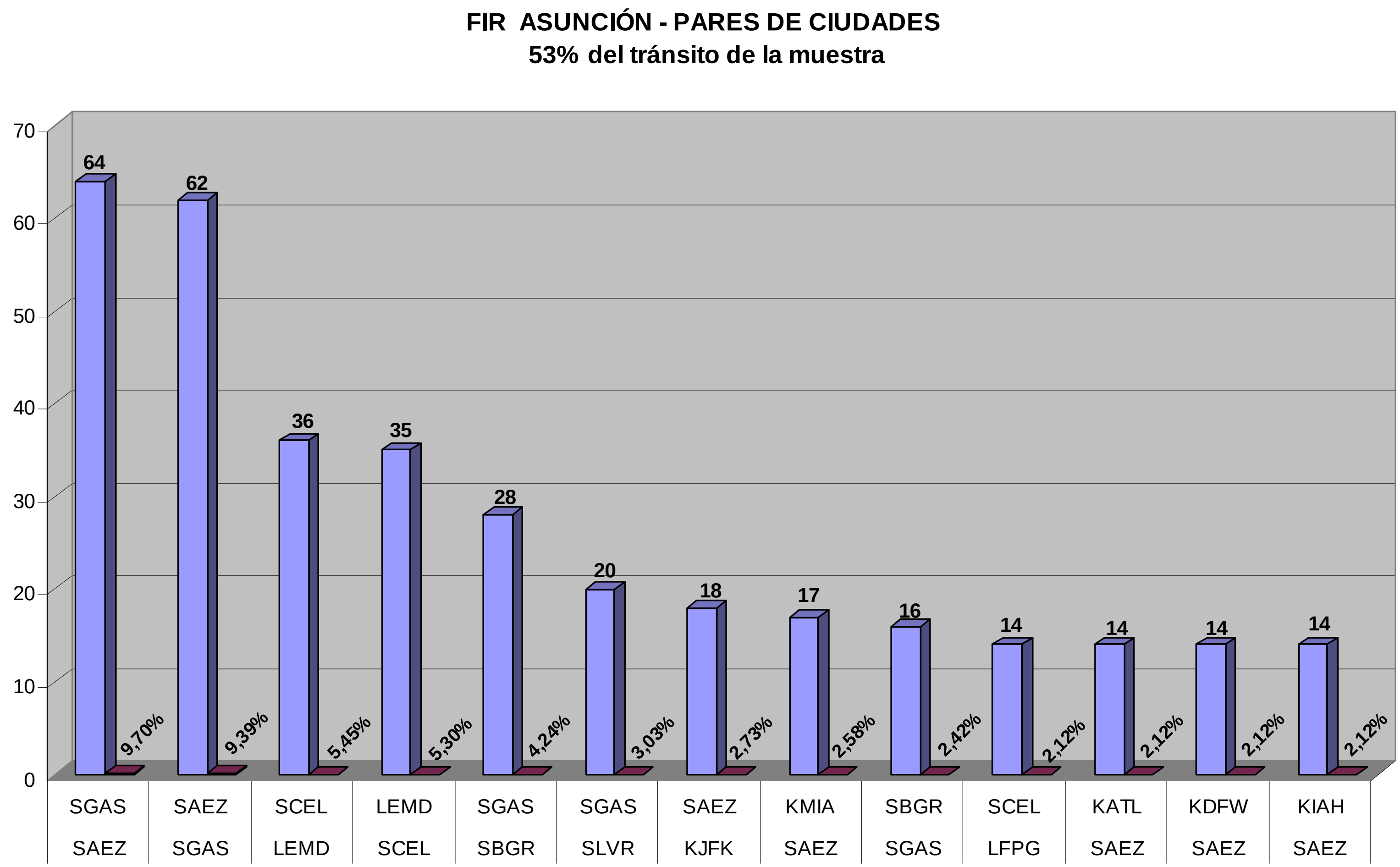
GUYANA


FIR GEORGETOWN - PARES DE CIUDADES
79% del tránsito de la muestra
60
50
40
30
20
10
0
53
28,34%
26
13,90%
14
7,49%
12
6,42%
11
5,88%
9
4,81%
8
4,28%
6
3,21%
5
2,67%
4
2,14%
SBGR KJFK
KJFK SBGR
TTPP SMJP
SBGR CYYZ
SMJP TTPP
KEWR SBGR
SBGR KEWR
KMIA SMJP
SBSV KMIA
SVMI SBBE

PANAMA

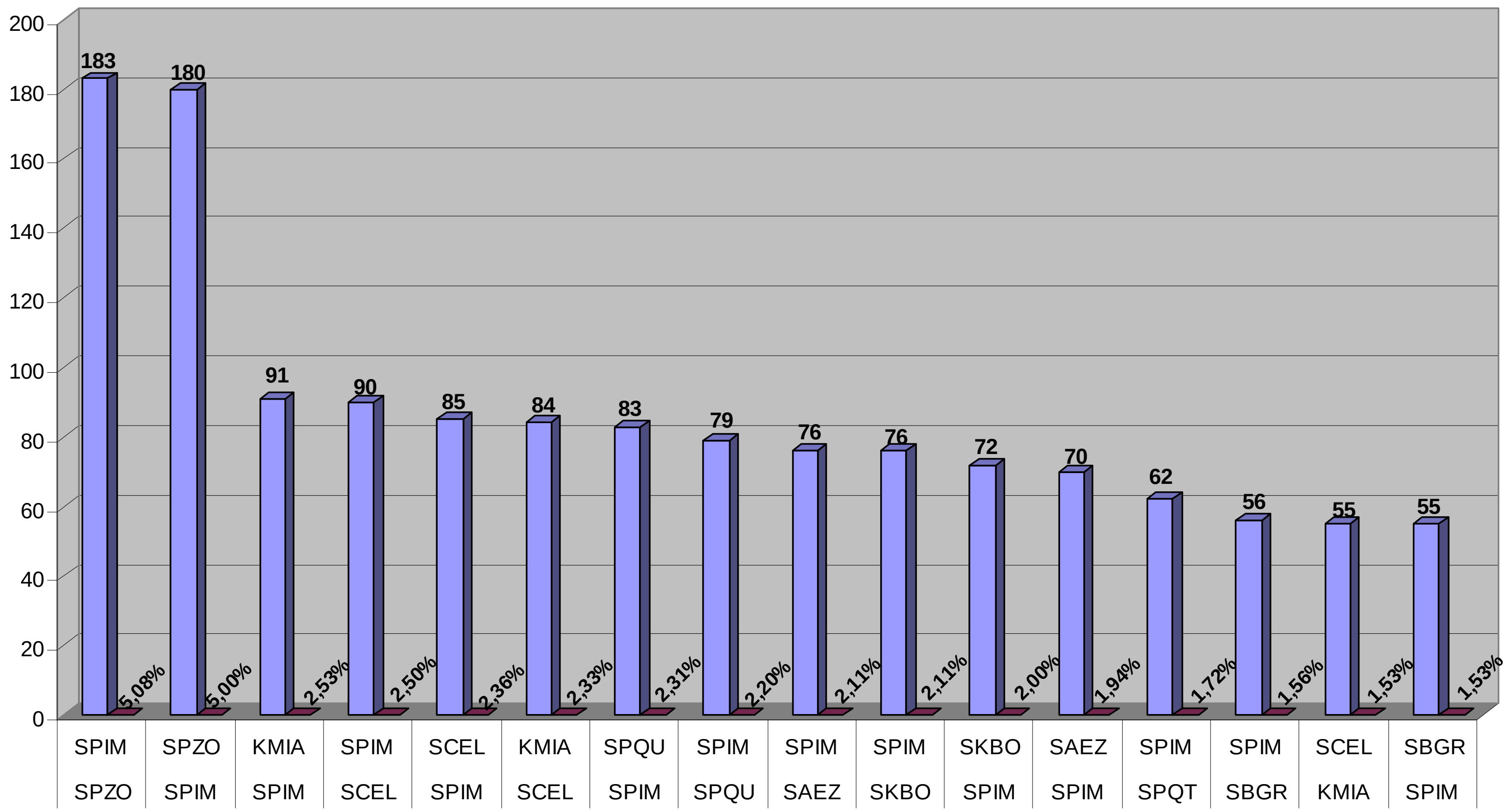

FIR PANAMA - PARES DE CIUDADES
48% del tránsito de la muestra
100
90
80
70
60
50
40
30
20
10
0
93
78
73
71
51
51
47
42
37
32
31
22
16
15
14
5,62%
5,26%
5,12%
3,67%
3,67%
3,39%
3,03%
2,67%
2,31%
2,23%
1,59%
1,15%
1,08%
1,01%
1,01%
KMIA SPIM
KMIA SEGU
KMIA SCEL
SEQU KMIA
SCEL KMIA
KMIA SEQU
SPIM KMIA
MMMX SKBO
SKBO MMMX
SBGR MMMX
MMMX SBGR
SEGU KMIA
SKBO MROC
SVMI MROC
SCEL KATL

PARAGUAY

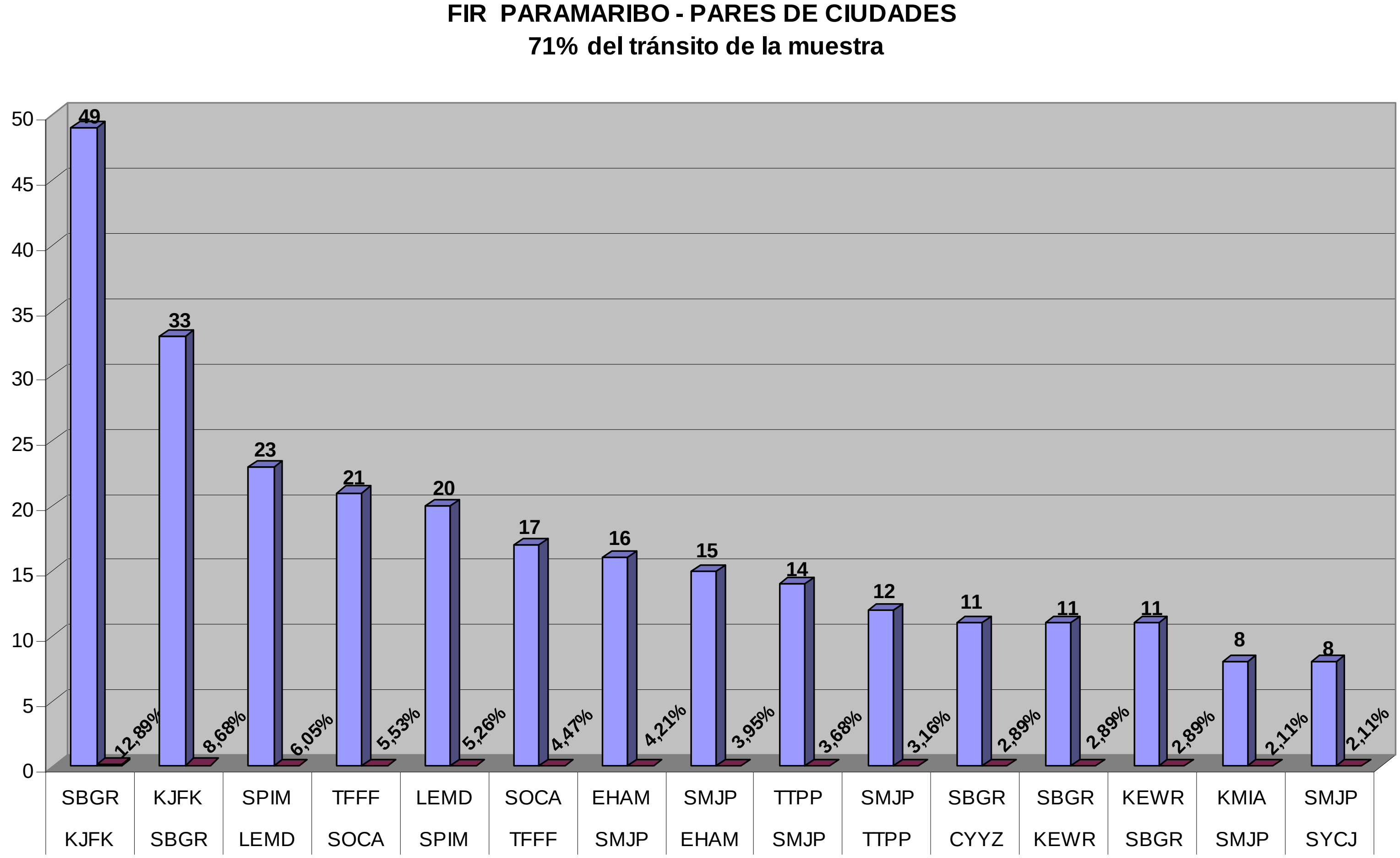

FIR ASUNCIÓN - PARES DE CIUDADES
53% del tránsito de la muestra
70
60
50
40
30
20
10
0
64
62
36
35
28
20
18
17
16
14
14
14
14
9,70%
9,39%
5,45%
5,30%
4,24%
3,03%
2,73%
2,58%
2,42%
2,12%
2,12%
2,12%
2,12%
SGAS SAEZ
SAEZ SGAS
SCEL LEMD
LEMD SCEL
SGAS SBGR
SGAS SLVR
SAEZ KJFK
KMIA SAEZ
SBGR SGAS
SCEL LFPG
KATL SAEZ
KDFW SAEZ
KIAH SAEZ

PERU

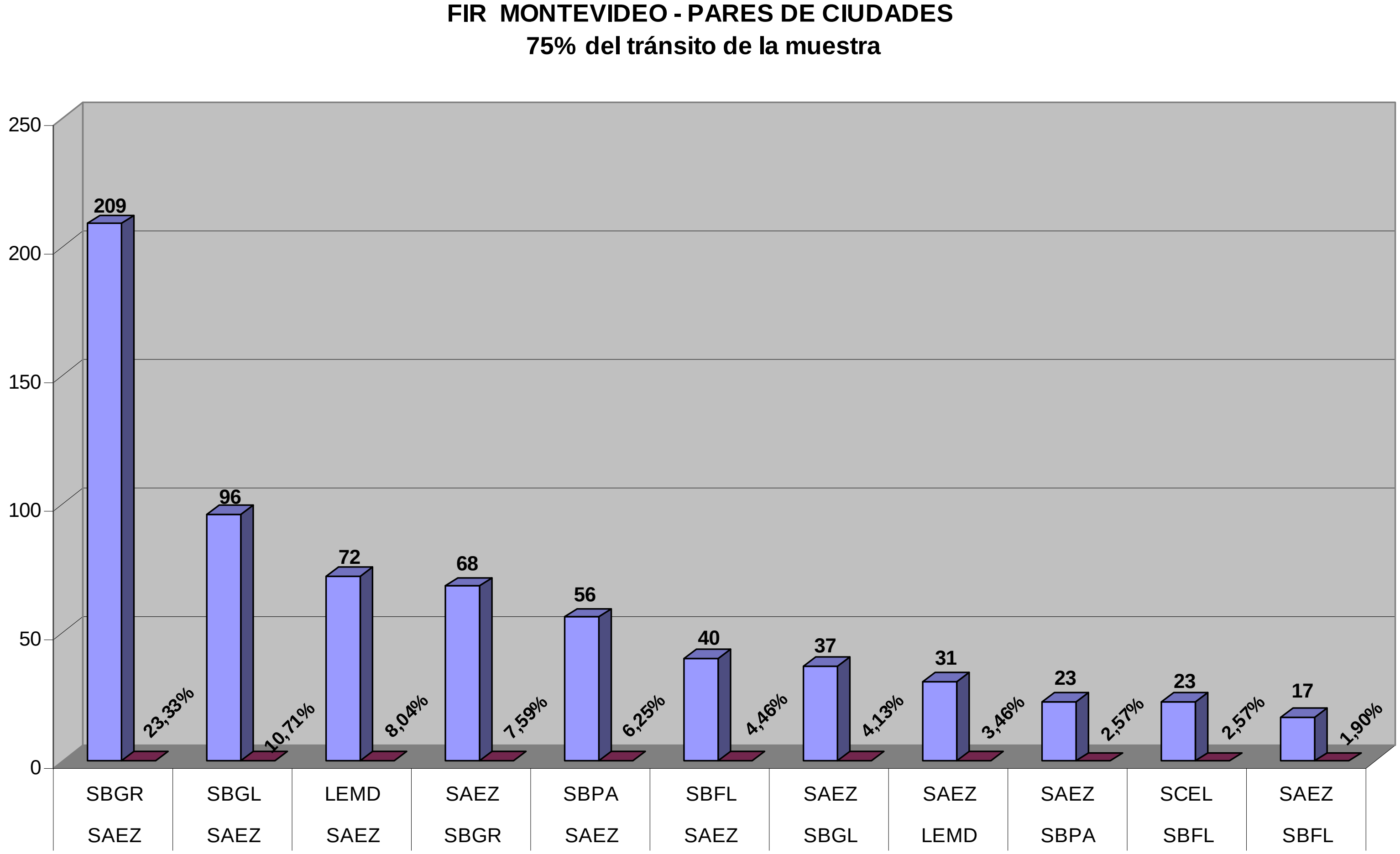
FIR LIMA - PARES DE CIUDADES
39% del tránsito de la muestra



SURINAME


FIR PARAMARIBO - PARES DE CIUDADES
71% del tránsito de la muestra
50
45
40
35
30
25
20
15
10
5
0
49
33
23
21
20
17
16
15
14
12
11
11
11
8
8
12,89%
8,68%
6,05%
5,53%
5,26%
4,47%
4,21%
3,95%
3,68%
3,16%
2,89%
2,89%
2,89%
2,11%
2,11%
SBGR KJFK
KJFK SBGR
SPIM LEMD
TFFF SOCA
LEMD SPIM
SOCA TFFF
EHAM SMJP
SMJP EHAM
TTPP SMJP
SMJP TTPP
SBGR CYYZ
SBGR KEWR
KEWR SBGR
KMIA SMJP
SMJP SYCJ

URUGUAY

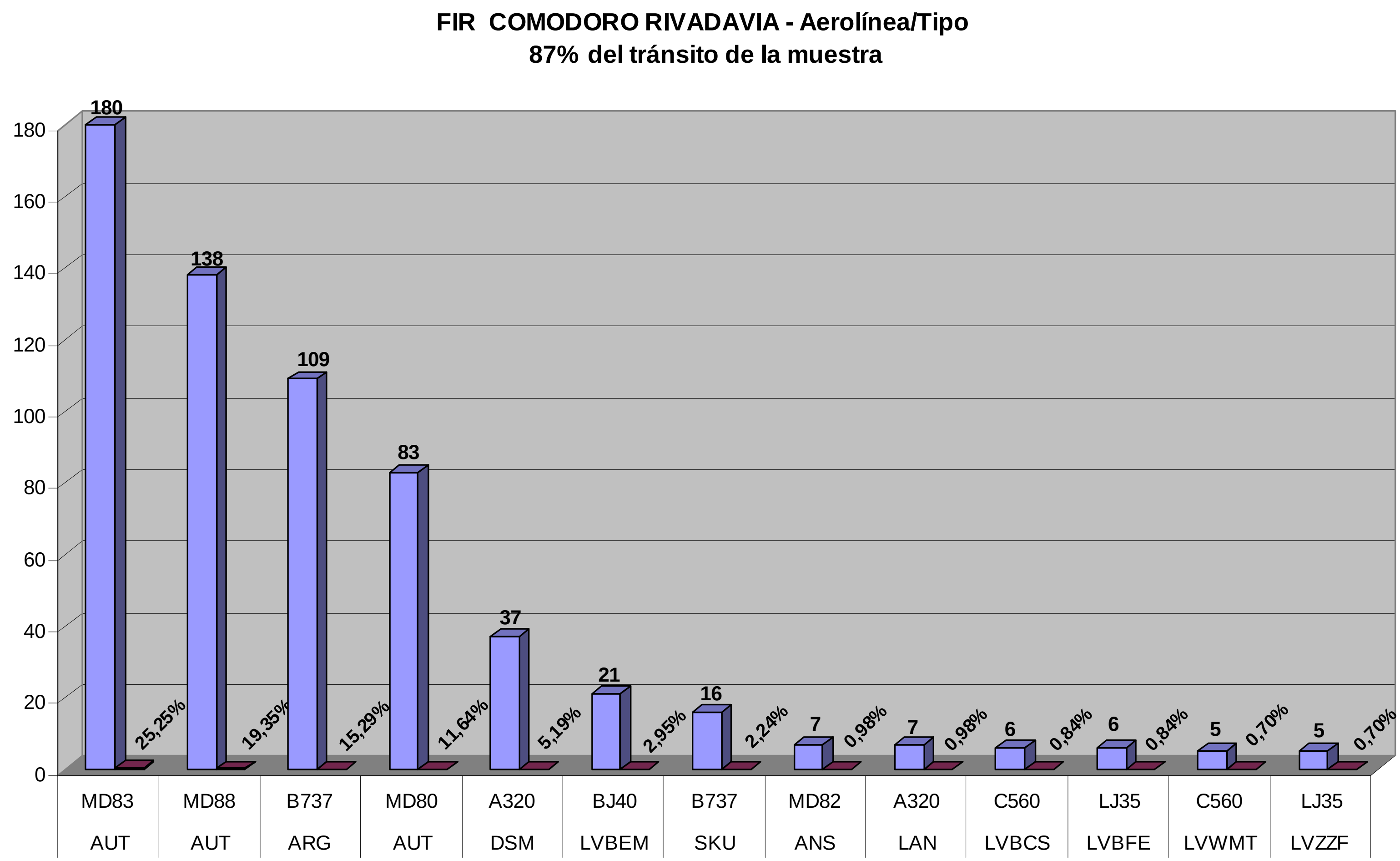

FIR MONTEVIDEO - PARES DE CIUDADES
75% del tránsito de la muestra
250
200
150
100
50
0
209
23,33%
96
10,71%
72
8,04%
68
7,59%
56
6,25%
40
4,46%
37
4,13%
31
3,46%
23
2,57%
23
2,57%
17
1,90%
SBGR SAEZ
SBGL SAEZ
LEMD SAEZ
SAEZ SBGR
SBPA SAEZ
SBFL SAEZ
SAEZ SBGL
SAEZ LEMD
SAEZ SBPA
SCEL SBFL
SAEZ SBFL

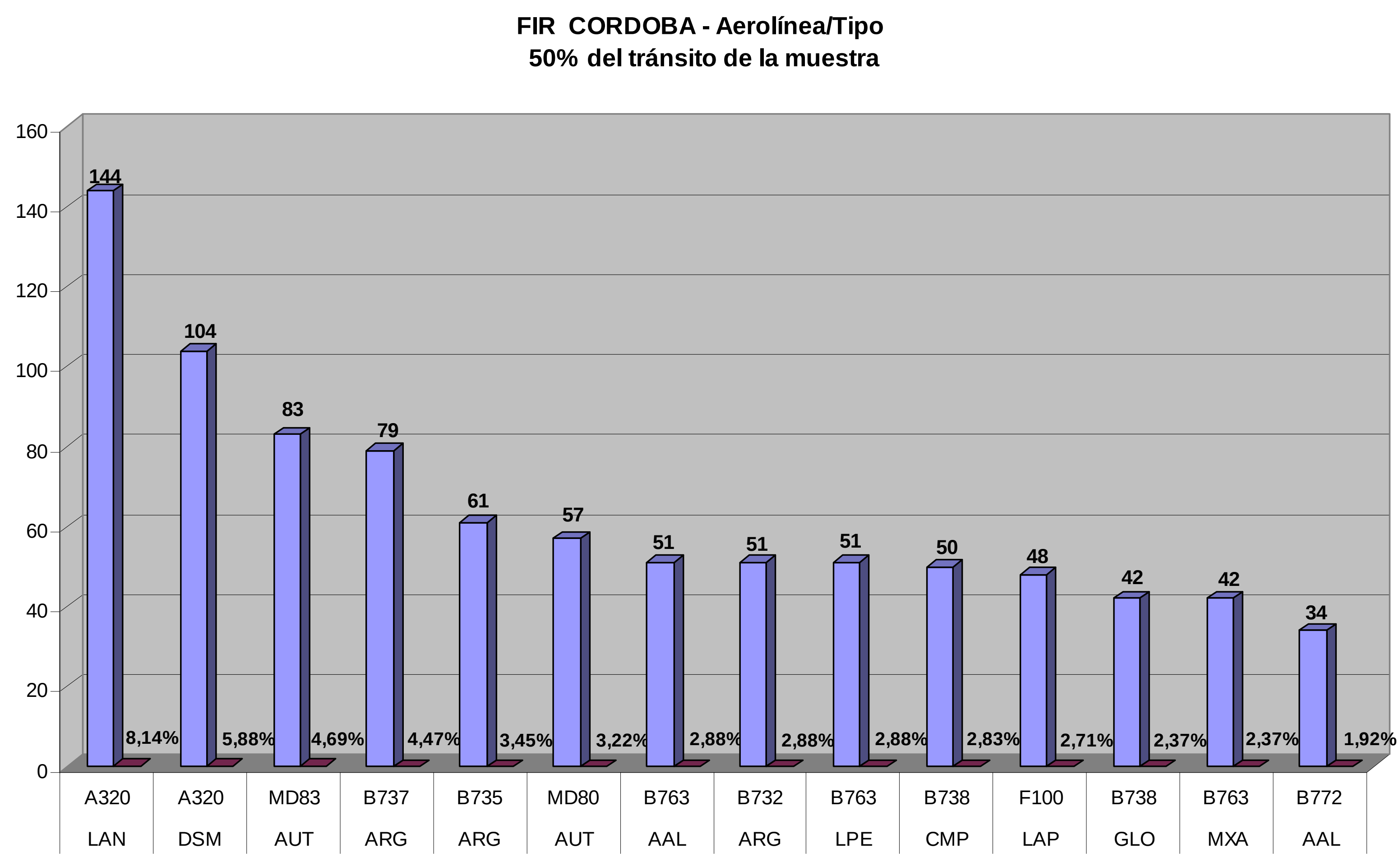
ADJUNTO 4 AL APENDICE B / ATTACHMENT 4 TO APPENDIX B

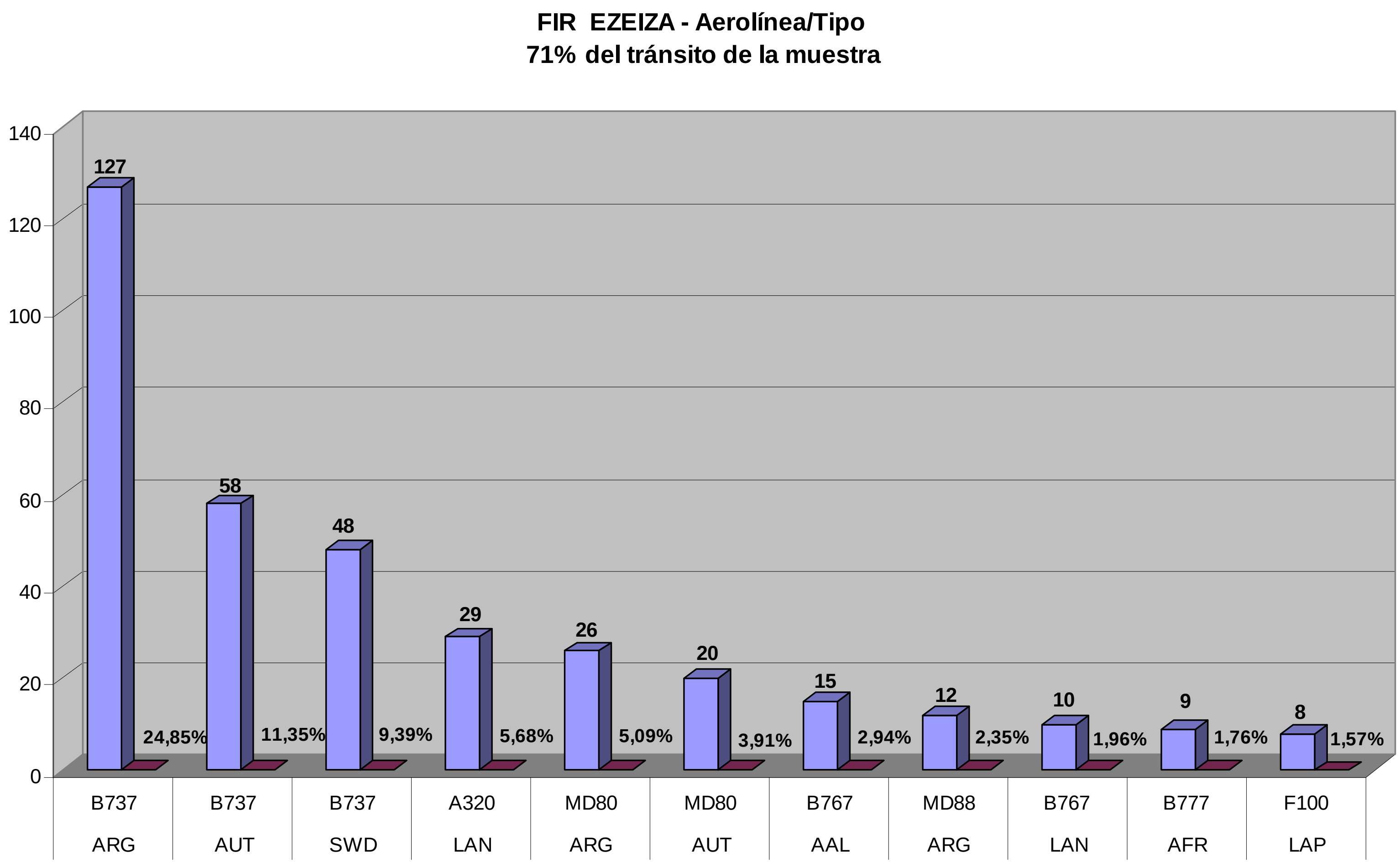
Región SAM
Aerolínea/Tipo/

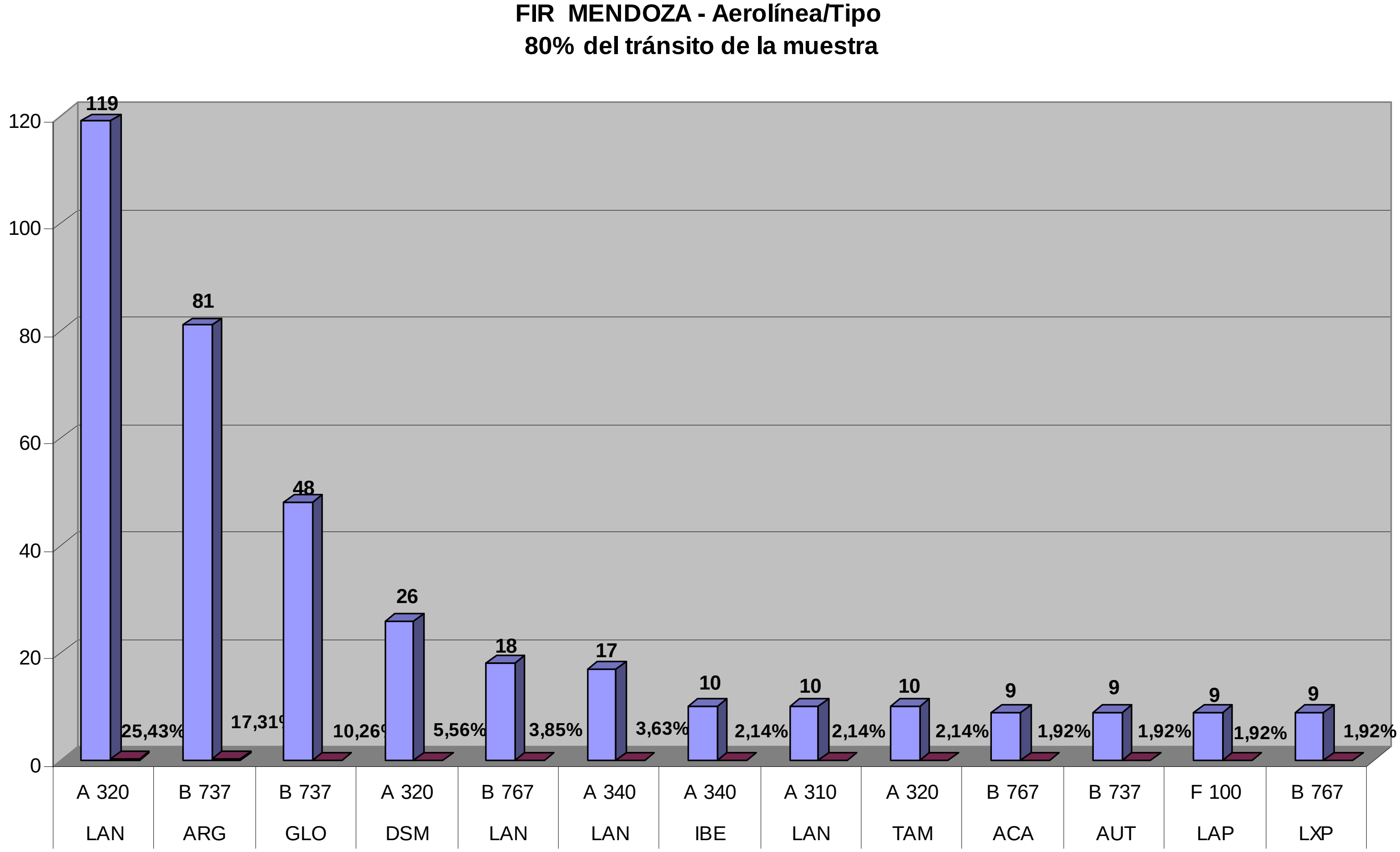
SAM Region
Airline/Type

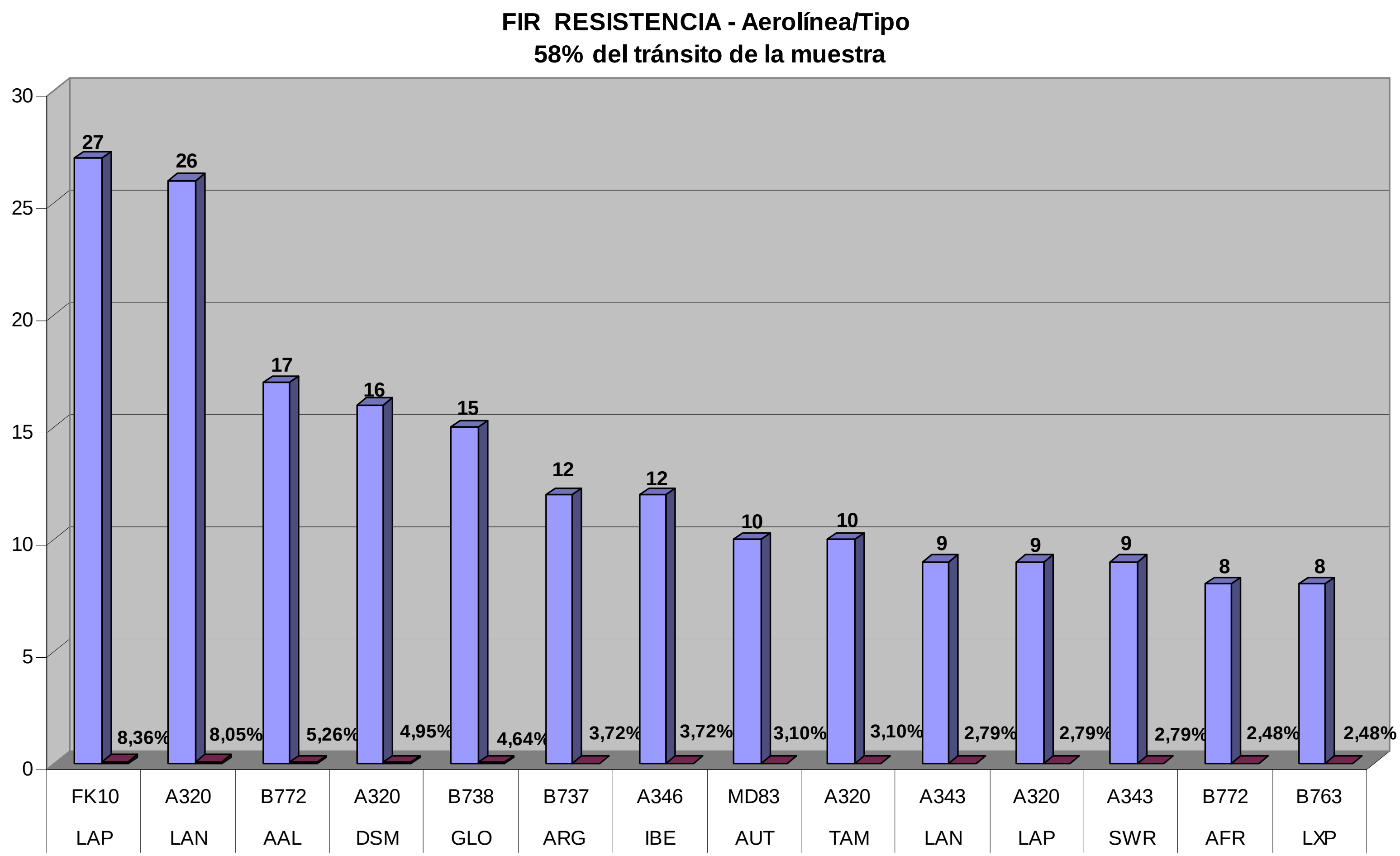
ARGENTINA


FIR COMODORO RIVADAVIA - Aerolínea/Tipo
87% del tránsito de la muestra
0
20
40
60
80
100
120
140
160
180
180
25,25%
138
19,35%
109
15,29%
83
11,64%
37
5,19%
21
2,95%
16
2,24%
7
0,98%
7
0,98%
6
0,84%
6
0,84%
5
0,70%
5
0,70%
MD83 AUT
MD88 AUT
B737 ARG
MD80 AUT
A320 DSM
BJ40 LVBEM
B737 SKU
MD82 ANS
A320 LAN
C560 LVBCS
LJ35 LVBFE
C560 LVWMT
LJ35 LVZZF

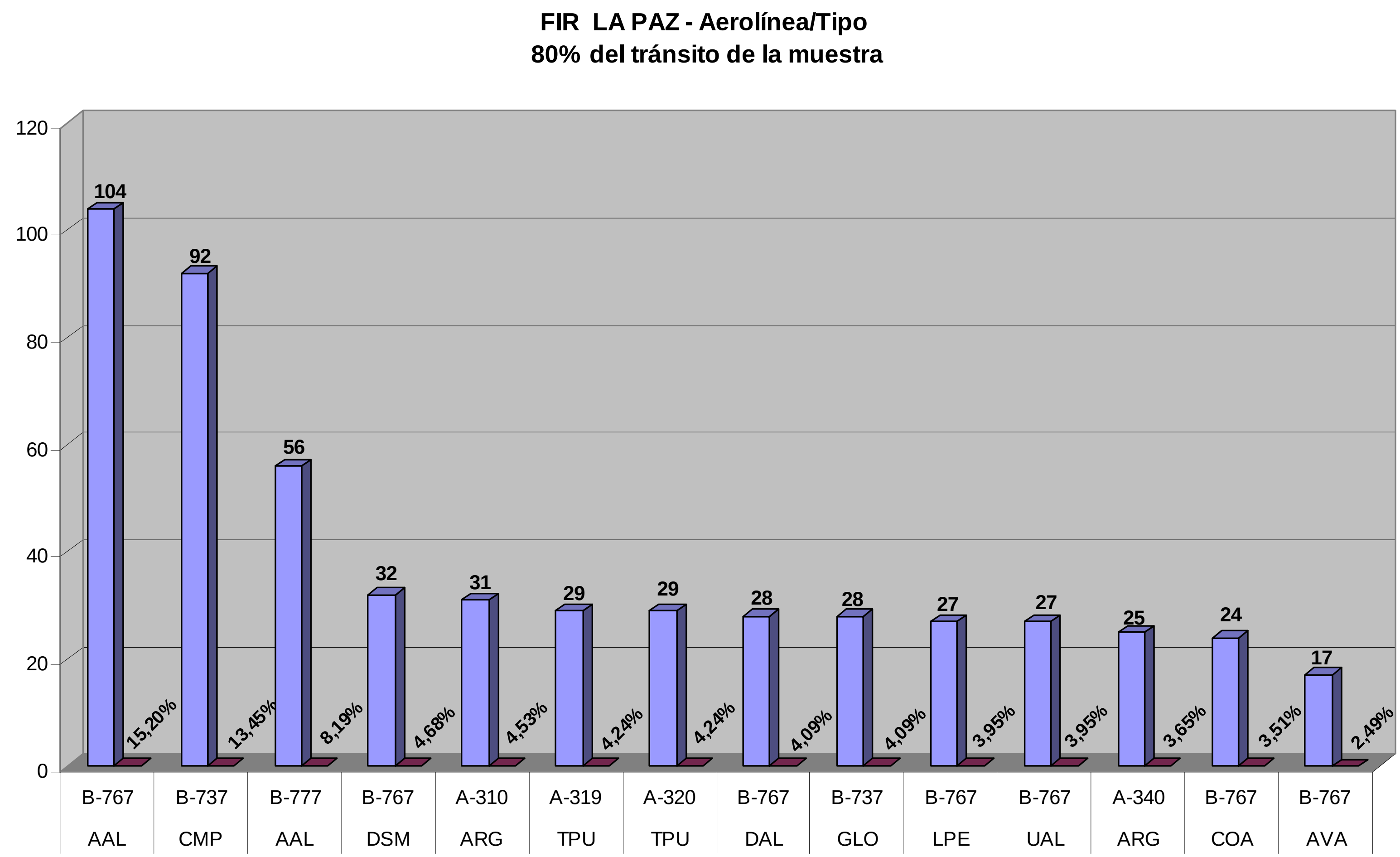

FIR CORDOBA - Aerolínea/Tipo
50% del tránsito de la muestra
160
140
120
100
80
60
40
20
0
144
104
83
79
61
57
51
51
51
50
48
42
42
34
8,14%
5,88%
4,69%
4,47%
3,45%
3,22%
2,88%
2,88%
2,88%
2,83%
2,71%
2,37%
2,37%
1,92%
A320 LAN
A320 DSM
MD83 AUT
B737 ARG
B735 ARG
MD80 AUT
B763 AAL
B732 ARG
B763 LPE
B738 CMP
F100 LAP
B738 GLO
B763 MXA
B772 AAL


FIR EZEIZA - Aerolínea/Tipo
71% del tránsito de la muestra
0
20
40
60
80
100
120
140
127
24,85%
58
11,35%
48
9,39%
29
5,68%
26
5,09%
20
3,91%
15
2,94%
12
2,35%
10
1,96%
9
1,76%
8
1,57%
B737 ARG
B737 AUT
B737 SWD
A320 LAN
MD80 ARG
MD80 AUT
B767 AAL
MD88 ARG
B767 LAN
B777 AFR
F100 LAP

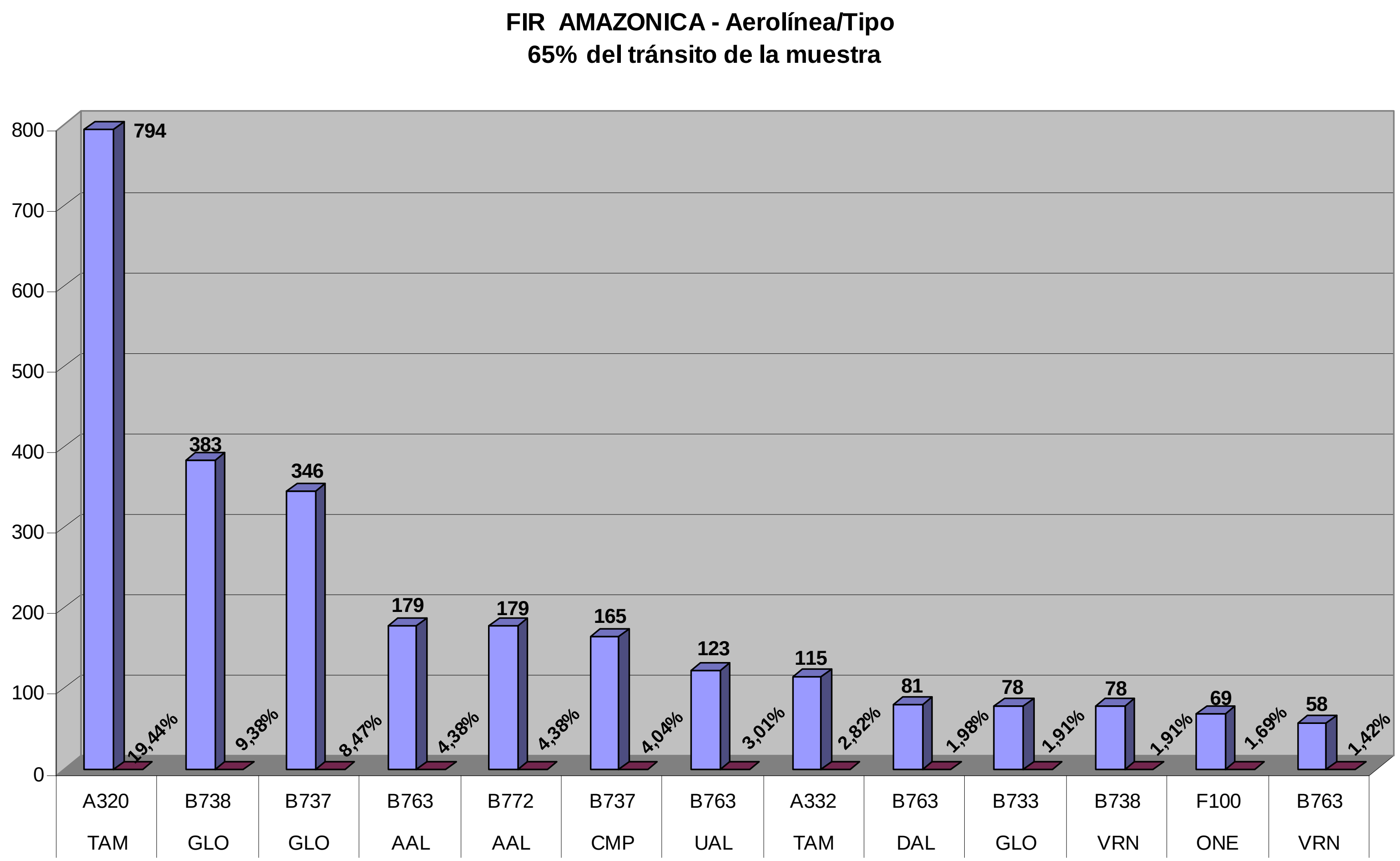

FIR MENDOZA - Aerolínea/Tipo
80% del tránsito de la muestra
120
100
80
60
40
20
0
119
81
48
26
18
17
10
10
10
9
9
9
9
25,43%
17,31%
10,26%
5,56%
3,85%
3,63%
2,14%
2,14%
2,14%
1,92%
1,92%
1,92%
1,92%
A 320 LAN
B 737 ARG
B 737 GLO
A 320 DSM
B 767 LAN
A 340 LAN
A 340 IBE
A 310 LAN
A 320 TAM
B 767 ACA
B 737 AUT
F 100 LAP
B 767 LXP

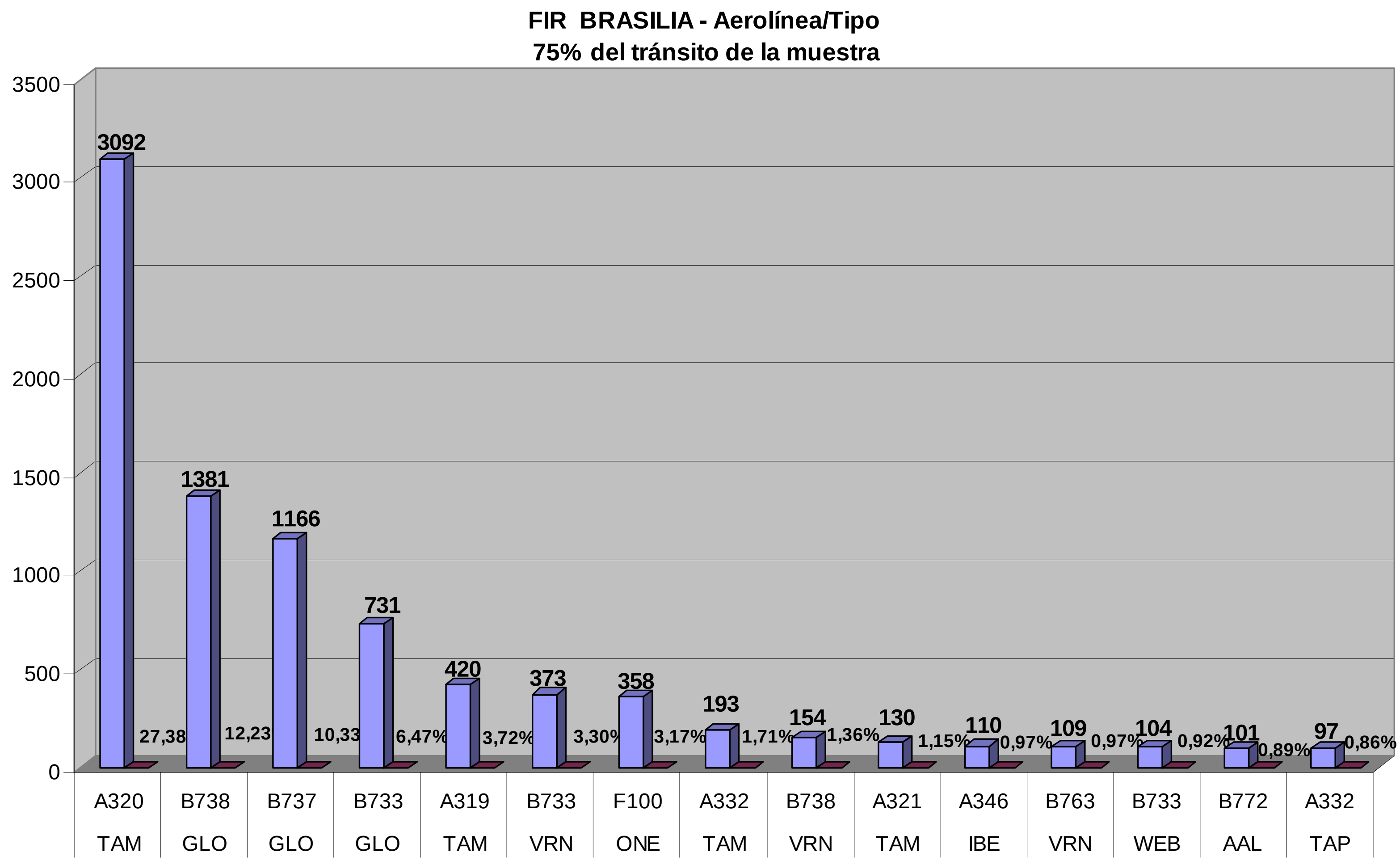

FIR RESISTENCIA - Aerolínea/Tipo
58% del tránsito de la muestra
0
5
10
15
20
25
30
27
26
17
16
15
12
12
10
10
9
9
9
8
8
8,36%
8,05%
5,26%
4,95%
4,64%
3,72%
3,72%
3,10%
3,10%
2,79%
2,79%
2,79%
2,48%
2,48%
FK10 LAP
A320 LAN
B772 AAL
A320 DSM
B738 GLO
B737 ARG
A346 IBE
MD83 AUT
A320 TAM
A343 LAN
A320 LAP
A343 SWR
B772 AFR
B763 LXP

BOLIVIA

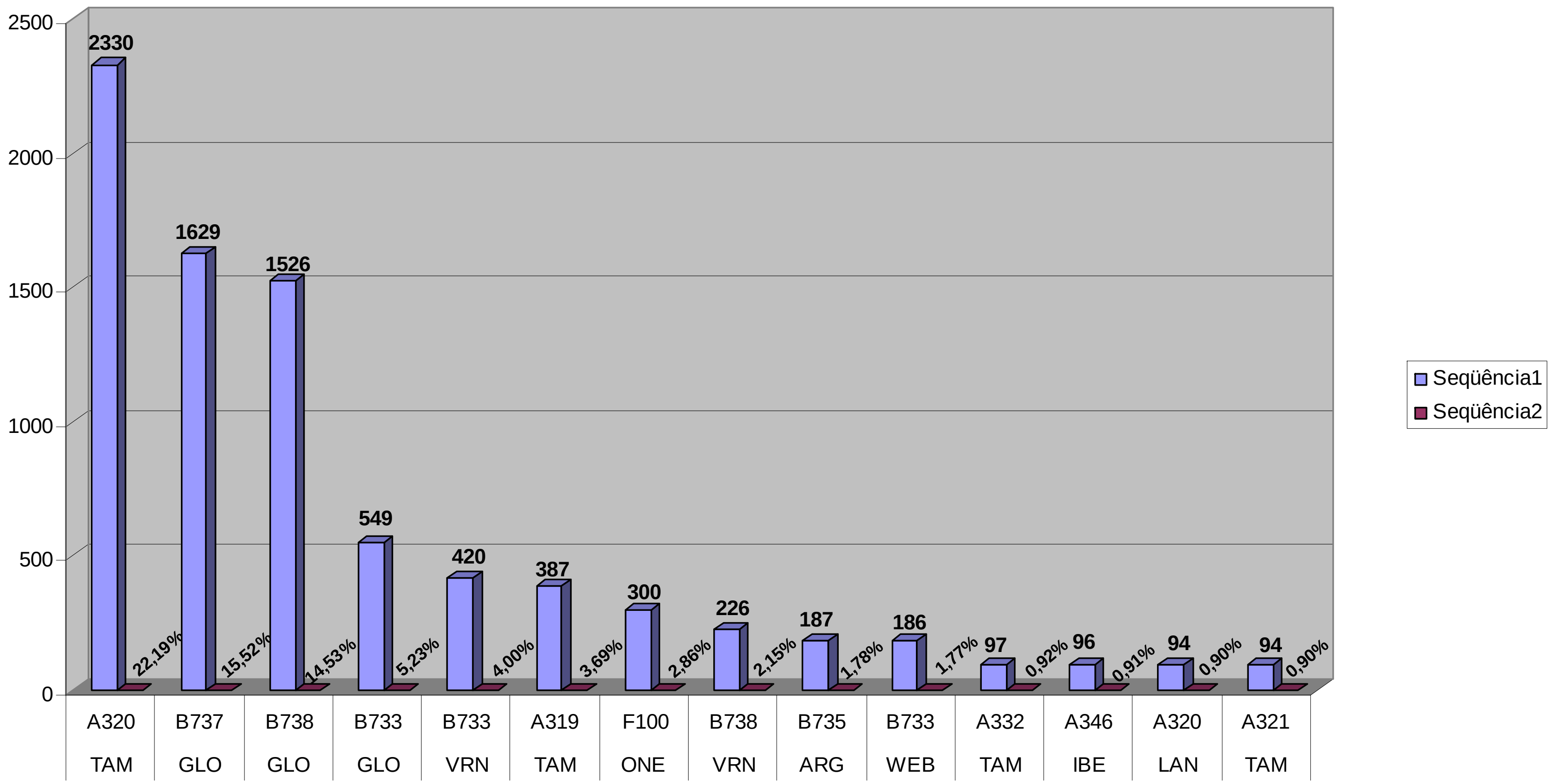

FIR LA PAZ - Aerolínea/Tipo
80% del tránsito de la muestra
120
100
80
60
40
20
0
104
15,20%
92
13,45%
56
8,19%
32
4,68%
31
4,53%
29
4,24%
29
4,24%
28
4,09%
28
4,09%
27
3,95%
27
3,95%
25
3,65%
24
3,51%
17
2,49%
B-767 AAL
B-737 CMP
B-777 AAL
B-767 DSM
A-310 ARG
A-319 TPU
A-320 TPU
B-767 DAL
B-737 GLO
B-767 LPE
B-767 UAL
A-340 ARG
B-767 COA
B-767 AVA

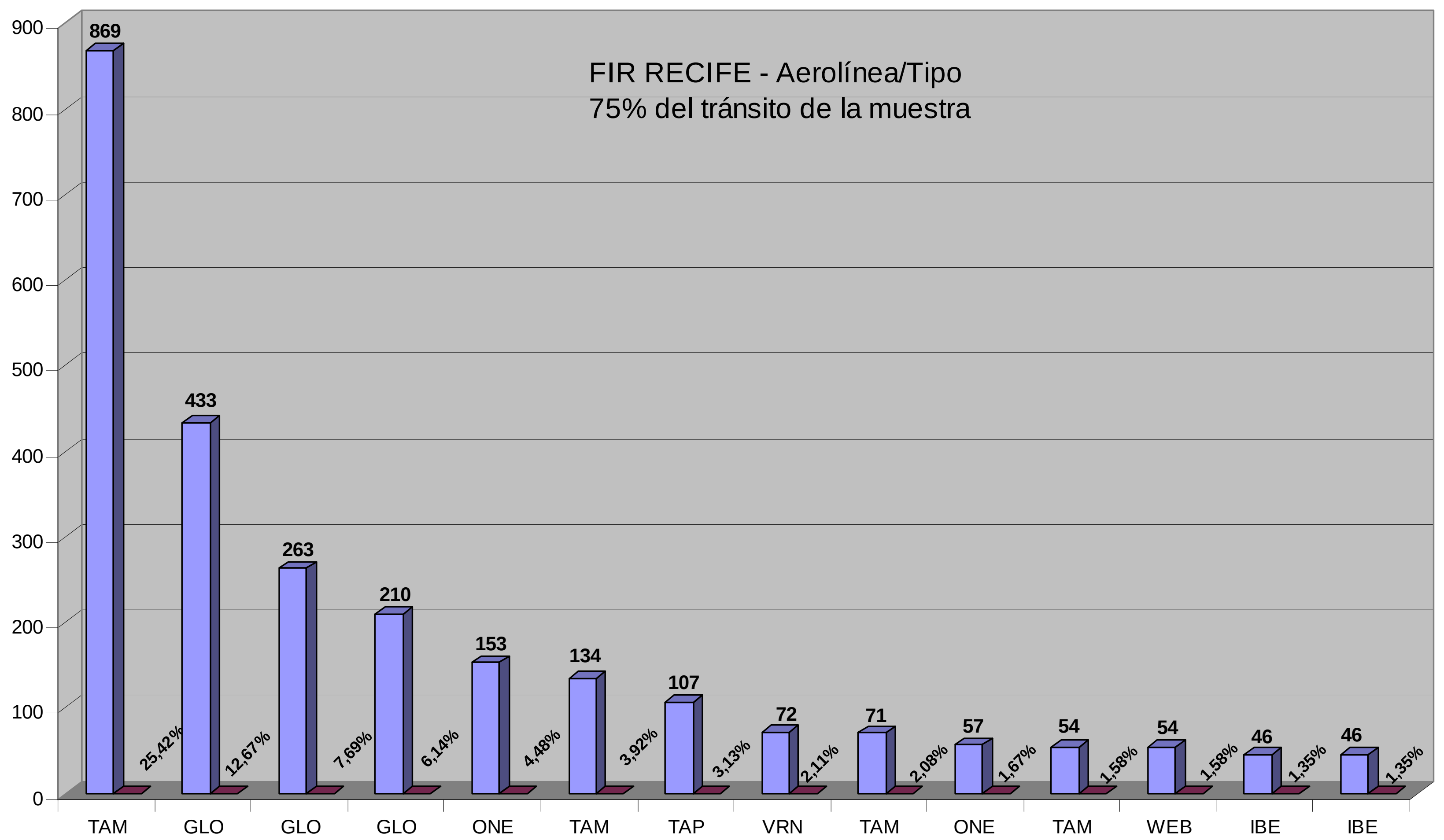
BRAZIL

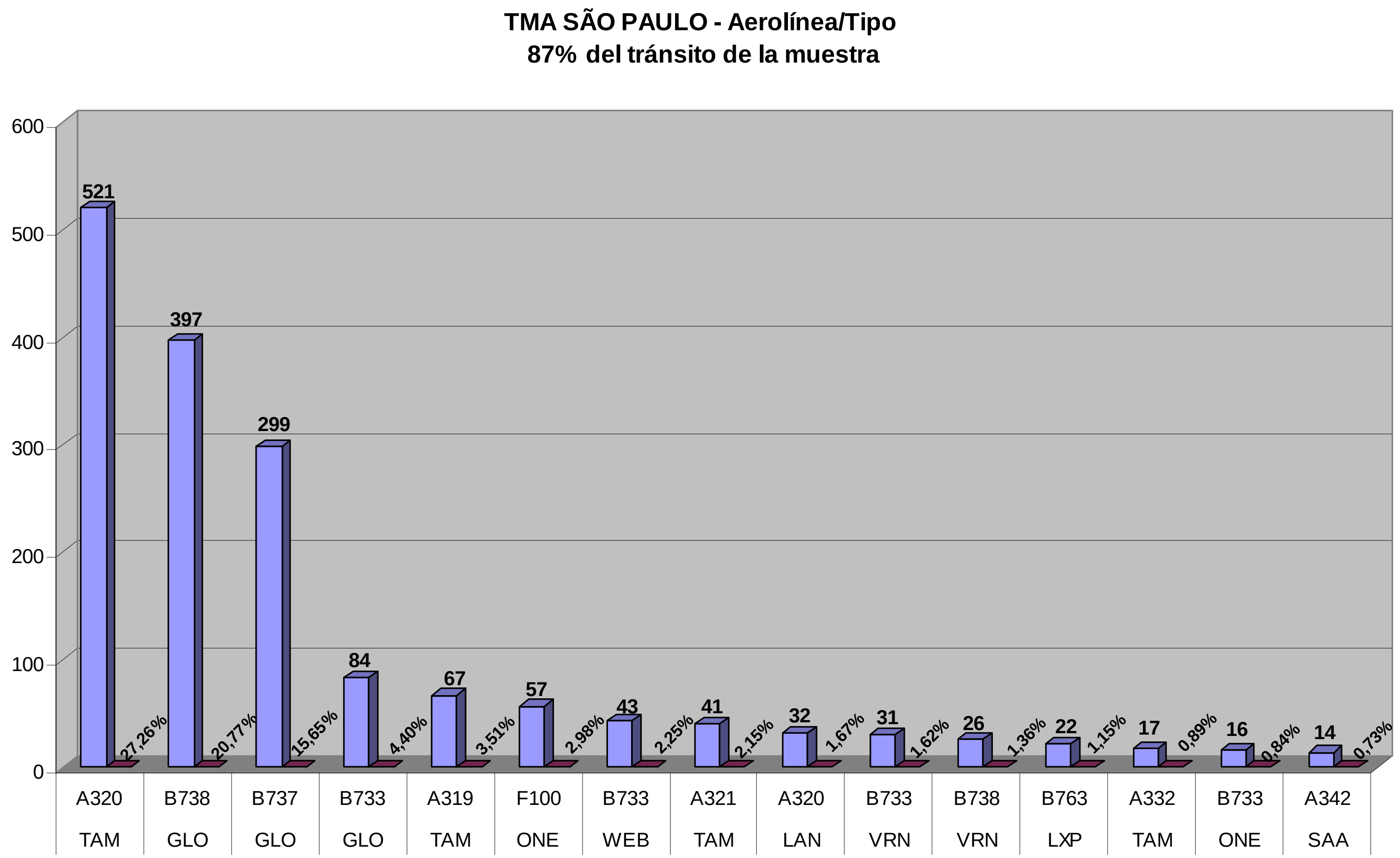

FIR AMAZONICA - Aerolínea/Tipo
65% del tránsito de la muestra
0
100
200
300
400
500
600
700
800
794
383
346
179
179
165
123
115
81
78
78
69
58
19,44%
9,38%
8,47%
4,38%
4,38%
4,04%
3,01%
2,82%
1,98%
1,91%
1,91%
1,69%
1,42%
A320 TAM
B738 GLO
B737 GLO
B763 AAL
B772 AAL
B737 CMP
B763 UAL
A332 TAM
B763 DAL
B733 GLO
B738 VRN
F100 ONE
B763 VRN


FIR BRASILIA - Aerolínea/Tipo
75% del tránsito de la muestra
3500
3000
2500
2000
1500
1000
500
0
3092
1381
1166
731
420
373
358
193
154
130
110
109
104
101
97
27,38
12,23
10,33
6,47%
3,72%
3,30%
3,17%
1,71%
1,36%
1,15%
0,97%
0,97%
0,92%
0,89%
0,86%
A320 TAM
B738 GLO
B737 GLO
B733 GLO
A319 TAM
B733 VRN
F100 ONE
A332 TAM
B738 VRN
A321 TAM
A346 IBE
B763 VRN
B733 WEB
B772 AAL
A332 TAP

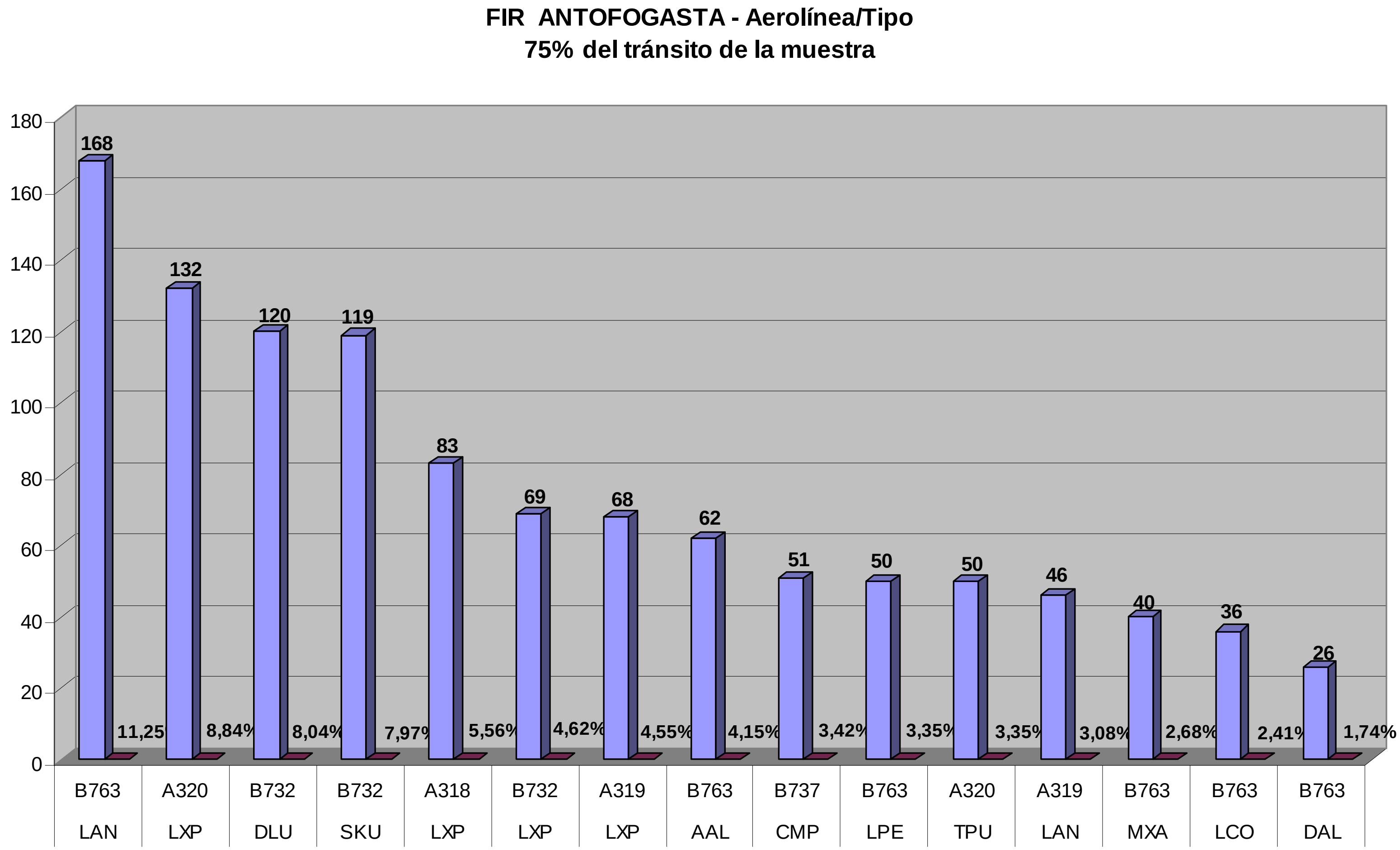
FIR CURITIBA - Aerolínea/Tipo
77% del tránsito de la muestra

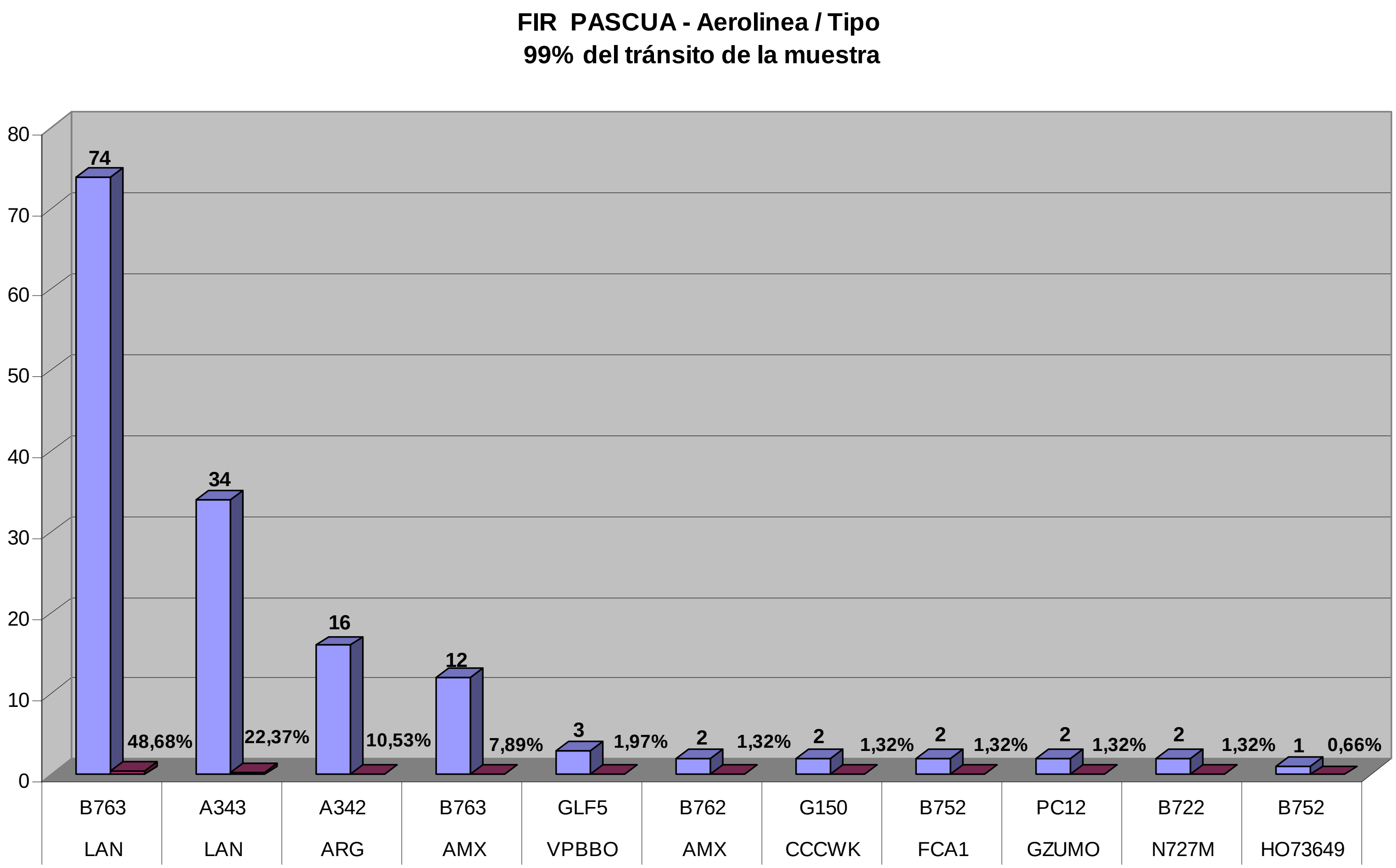


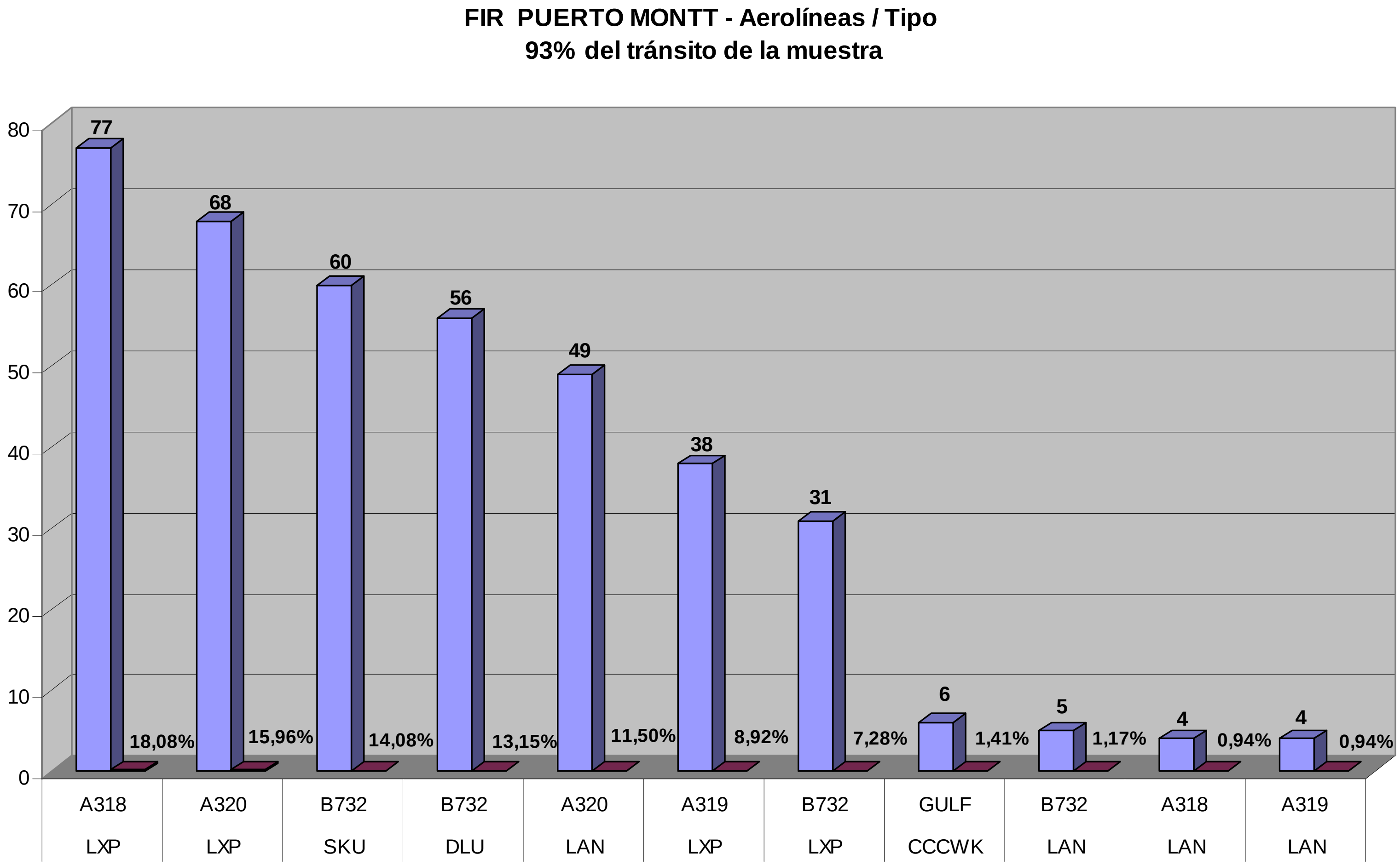

FIR RECIFE - Aerolínea/Tipo
75% del tránsito de la muestra
0
100
200
300
400
500
600
700
800
900
869
433
263
210
153
134
107
72
71
57
54
54
46
46
25,42%
12,67%
7,69%
6,14%
4,48%
3,92%
3,13%
2,11%
2,08%
1,67%
1,58%
1,58%
1,35%
1,35%
TAM
GLO
GLO
GLO
ONE
TAM
TAP
VRN
TAM
ONE
TAM
WEB
IBE
IBE

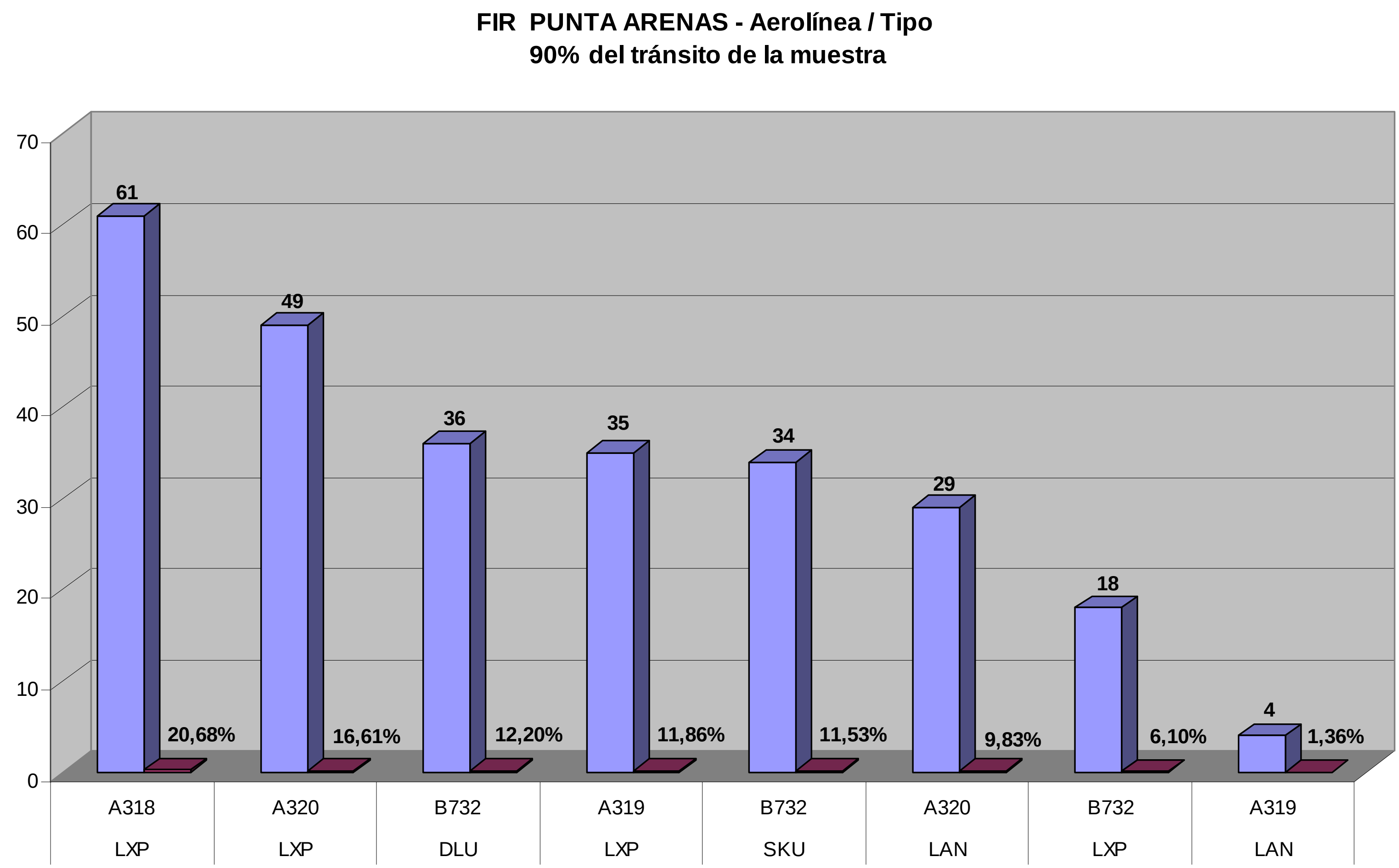

TMA SÃO PAULO - Aerolínea/Tipo
87% del tránsito de la muestra
600
500
400
300
200
100
0
521
397
299
84
67
57
43
41
32
31
26
22
17
16
14
27,26%
20,77%
15,65%
4,40%
3,51%
2,98%
2,25%
2,15%
1,67%
1,62%
1,36%
1,15%
0,89%
0,84%
0,73%
A320 TAM
B738 GLO
B737 GLO
B733 GLO
A319 TAM
F100 ONE
B733 WEB
A321 TAM
A320 LAN
B733 VRN
B738 VRN
B763 LXP
A332 TAM
B733 ONE
A342 SAA

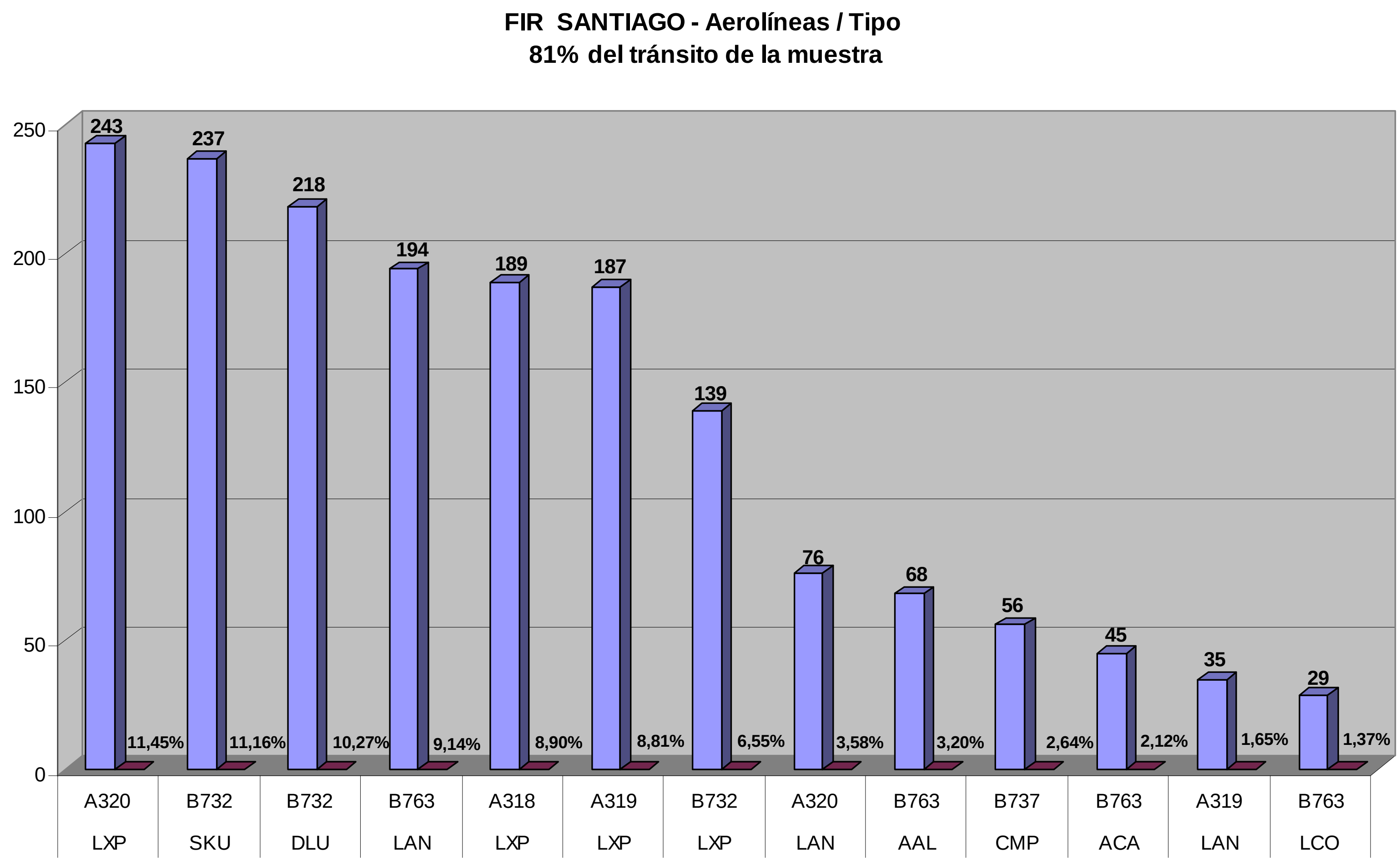
CHILE


FIR ANTOFOGASTA - Aerolínea/Tipo
75% del tránsito de la muestra
180
160
140
120
100
80
60
40
20
0
168
132
120
119
83
69
68
62
51
50
50
46
40
36
26
11,25
8,84%
8,04%
7,97%
5,56%
4,62%
4,55%
4,15%
3,42%
3,35%
3,35%
3,08%
2,68%
2,41%
1,74%
B763 LAN
A320 LXP
B732 DLU
B732 SKU
A318 LXP
B732 LXP
A319 LXP
B763 AAL
B737 CMP
B763 LPE
A320 TPU
A319 LAN
B763 MXA
B763 LCO
B763 DAL

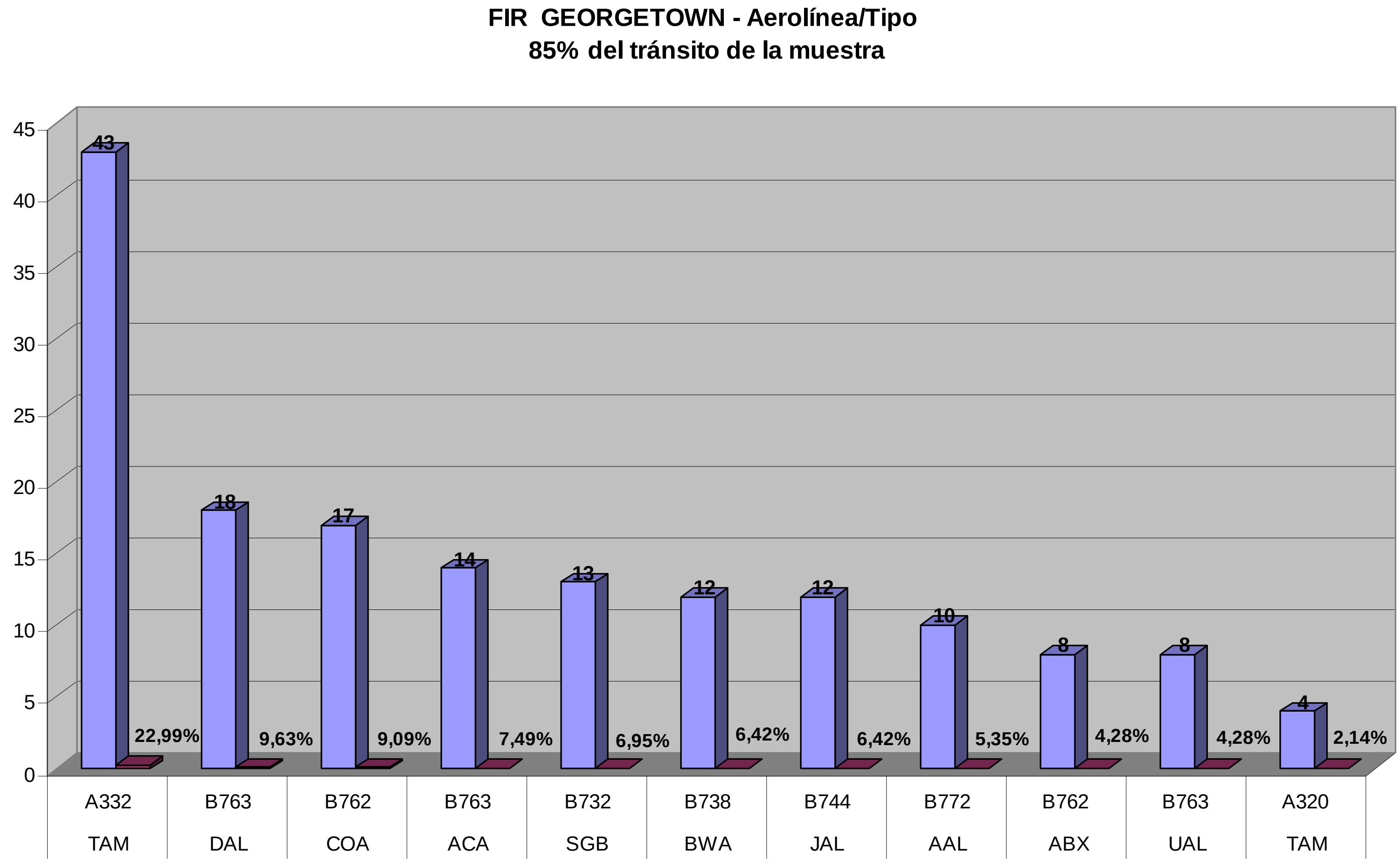

FIR PASCUA - Aerolinea / Tipo
99% del tránsito de la muestra
80
70
60
50
40
30
20
10
0
74
48,68%
34
22,37%
16
10,53%
12
7,89%
3
1,97%
2
1,32%
2
1,32%
2
1,32%
2
1,32%
2
1,32%
1
0,66%
B763 LAN
A343 LAN
A342 ARG
B763 AMX
GLF5 VPBBO
B762 AMX
G150 CCCWK
B752 FCA1
PC12 GZUMO
B722 N727M
B752 HO73649


FIR PUERTO MONTT - Aerolíneas / Tipo
93% del tránsito de la muestra
80
70
60
50
40
30
20
10
0
77
68
60
56
49
38
31
6
5
4
4
18,08%
15,96%
14,08%
13,15%
11,50%
8,92%
7,28%
1,41%
1,17%
0,94%
0,94%
A318 LXP
A320 LXP
B732 SKU
B732 DLU
A320 LAN
A319 LXP
B732 LXP
GULF CCCWK
B732 LAN
A318 LAN
A319 LAN


FIR PUNTA ARENAS - Aerolínea / Tipo
90% del tránsito de la muestra
70
60
50
40
30
20
10
0
61
20,68%
49
16,61%
36
12,20%
35
11,86%
34
11,53%
29
9,83%
18
6,10%
4
1,36%
A318 LXP
A320 LXP
B732 DLU
A319 LXP
B732 SKU
A320 LAN
B732 LXP
A319 LAN

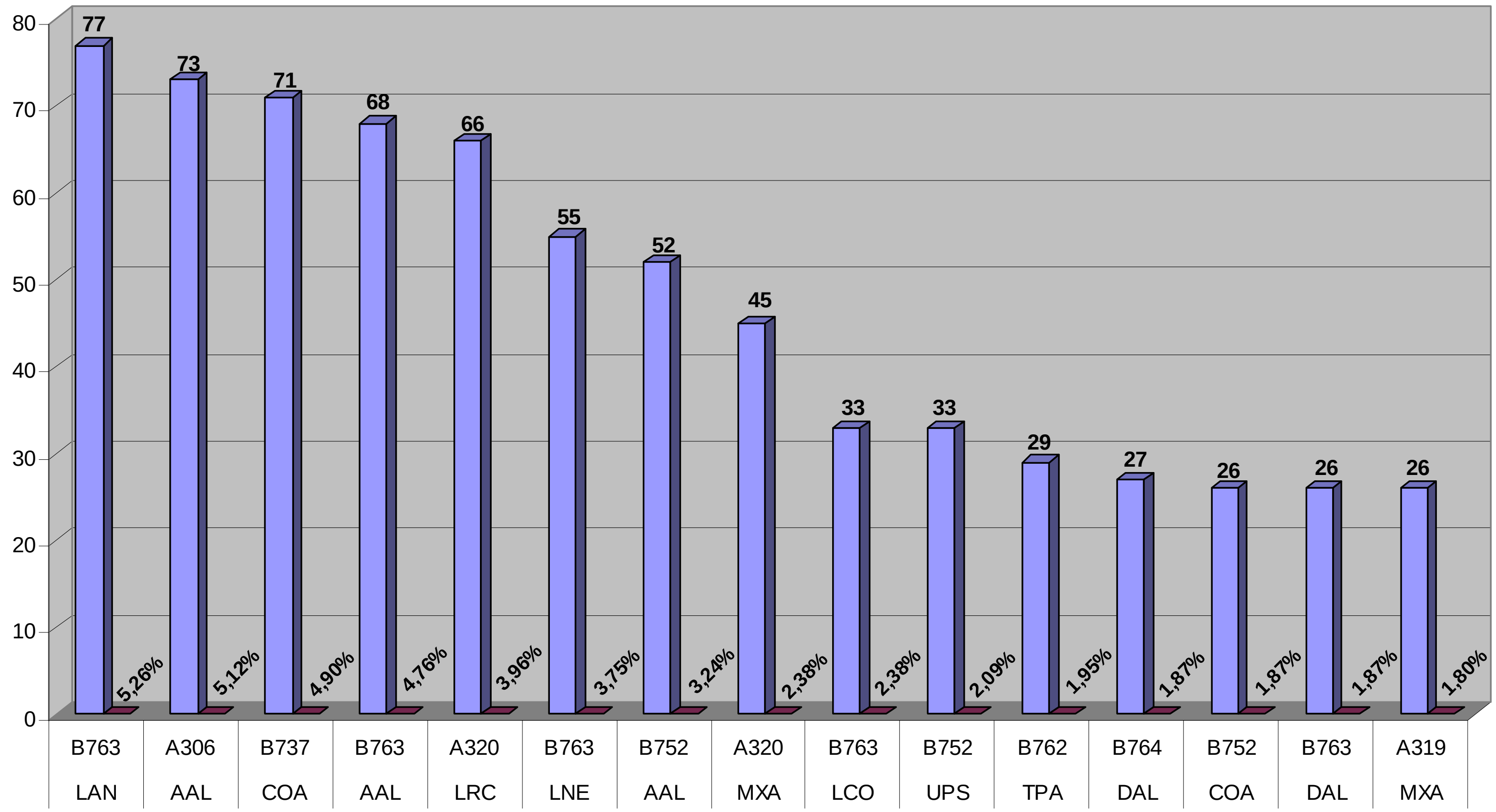

FIR SANTIAGO - Aerolíneas / Tipo
81% del tránsito de la muestra
250
200
150
100
50
0
243
237
218
194
189
187
139
76
68
56
45
35
29
11,45%
11,16%
10,27%
9,14%
8,90%
8,81%
6,55%
3,58%
3,20%
2,64%
2,12%
1,65%
1,37%
A320 LXP
B732 SKU
B732 DLU
B763 LAN
A318 LXP
A319 LXP
B732 LXP
A320 LAN
B763 AAL
B737 CMP
B763 ACA
A319 LAN
B763 LCO

GUYANA

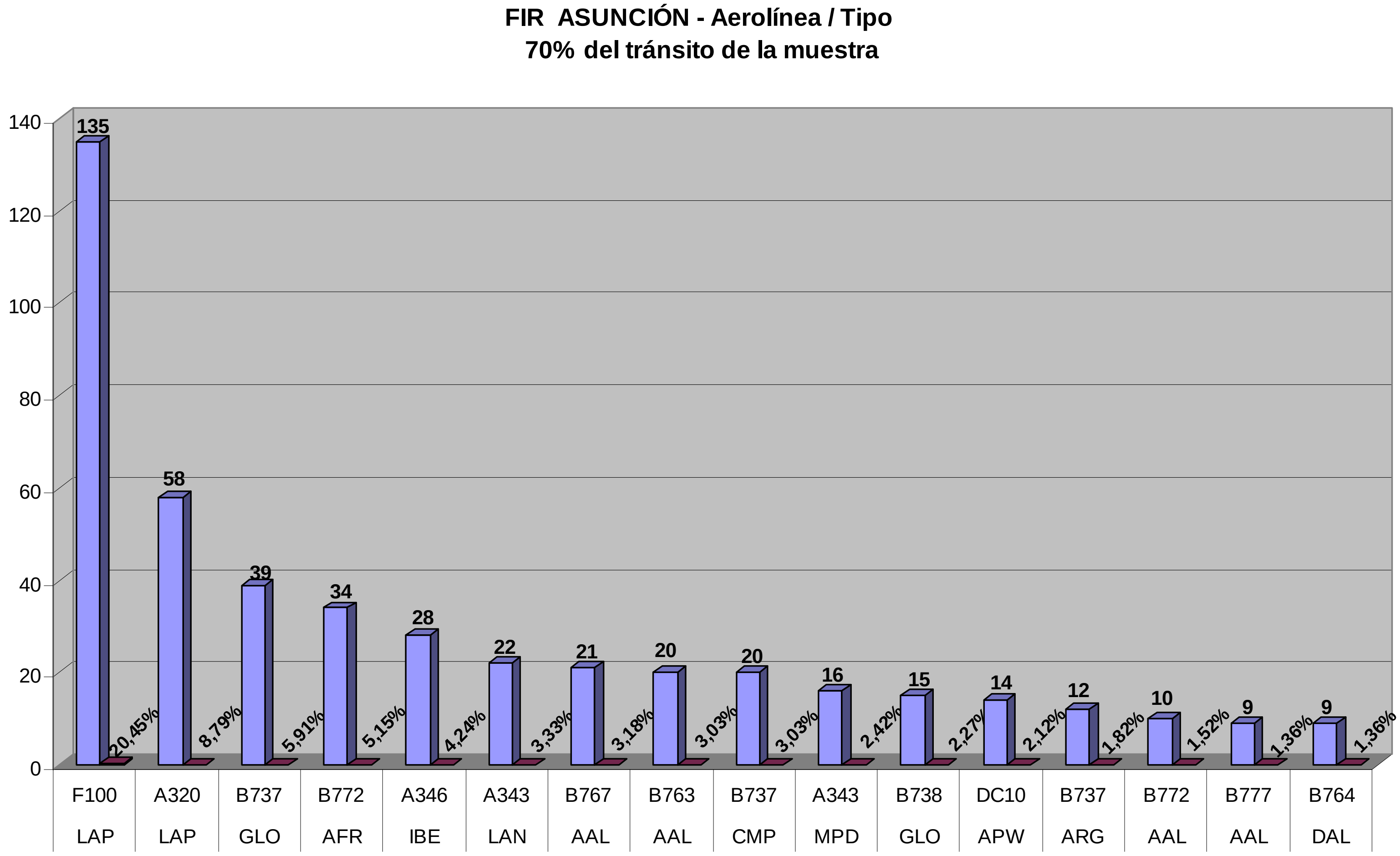

FIR GEORGETOWN - Aerolínea/Tipo
85% del tránsito de la muestra
45
40
35
30
25
20
15
10
5
0
43
18
17
14
13
12
12
10
8
8
4
22,99%
9,63%
9,09%
7,49%
6,95%
6,42%
6,42%
5,35%
4,28%
4,28%
2,14%
A332 TAM
B763 DAL
B762 COA
B763 ACA
B732 SGB
B738 BWA
B744 JAL
B772 AAL
B762 ABX
B763 UAL
A320 TAM

PANAMA

FIR PANAMA - Aerolínea / Tipo
51% del tránsito de la muestra

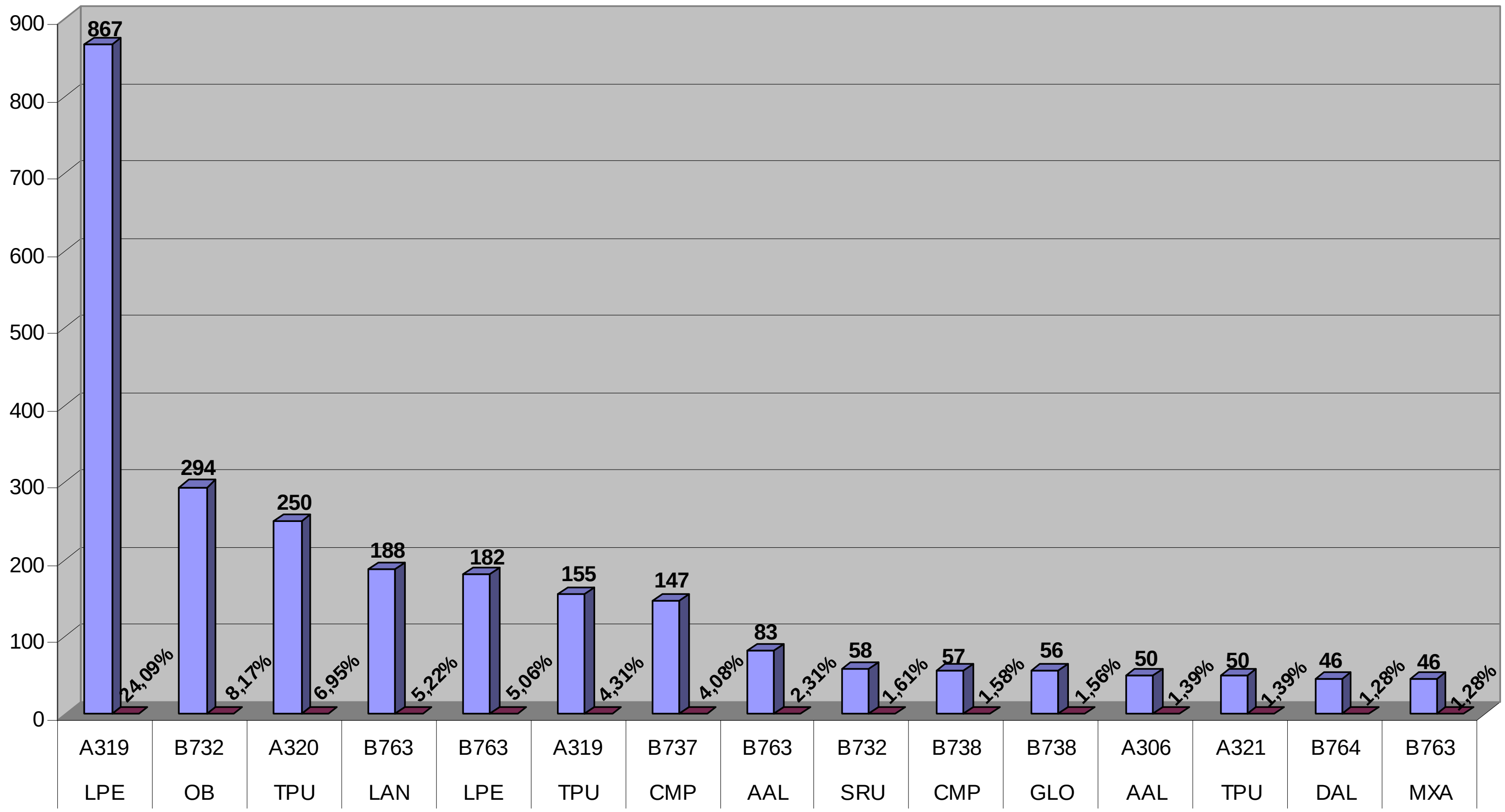


PARAGUAY

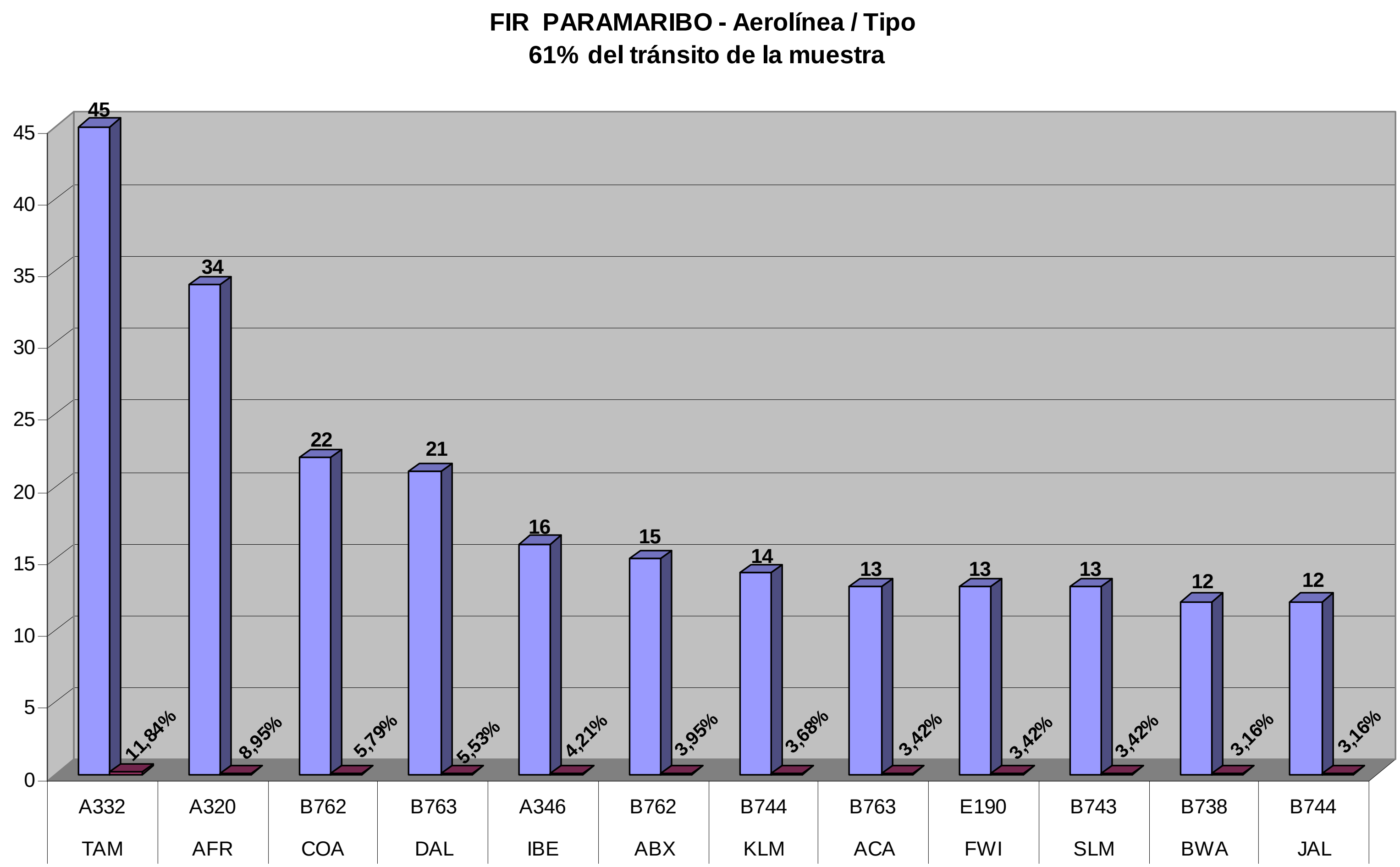

FIR ASUNCIÓN - Aerolínea / Tipo
70% del tránsito de la muestra
0
20
40
60
80
100
120
140
135
58
39
34
28
22
21
20
20
16
15
14
12
10
9
9
20,45%
8,79%
5,91%
5,15%
4,24%
3,33%
3,18%
3,03%
3,03%
2,42%
2,27%
2,12%
1,82%
1,52%
1,36%
1,36%
F100 LAP
A320 LAP
B737 GLO
B772 AFR
A346 IBE
A343 LAN
B767 AAL
B763 AAL
B737 CMP
A343 MPD
B738 GLO
DC10 APW
B737 ARG
B772 AAL
B777 AAL
B764 DAL

PERU

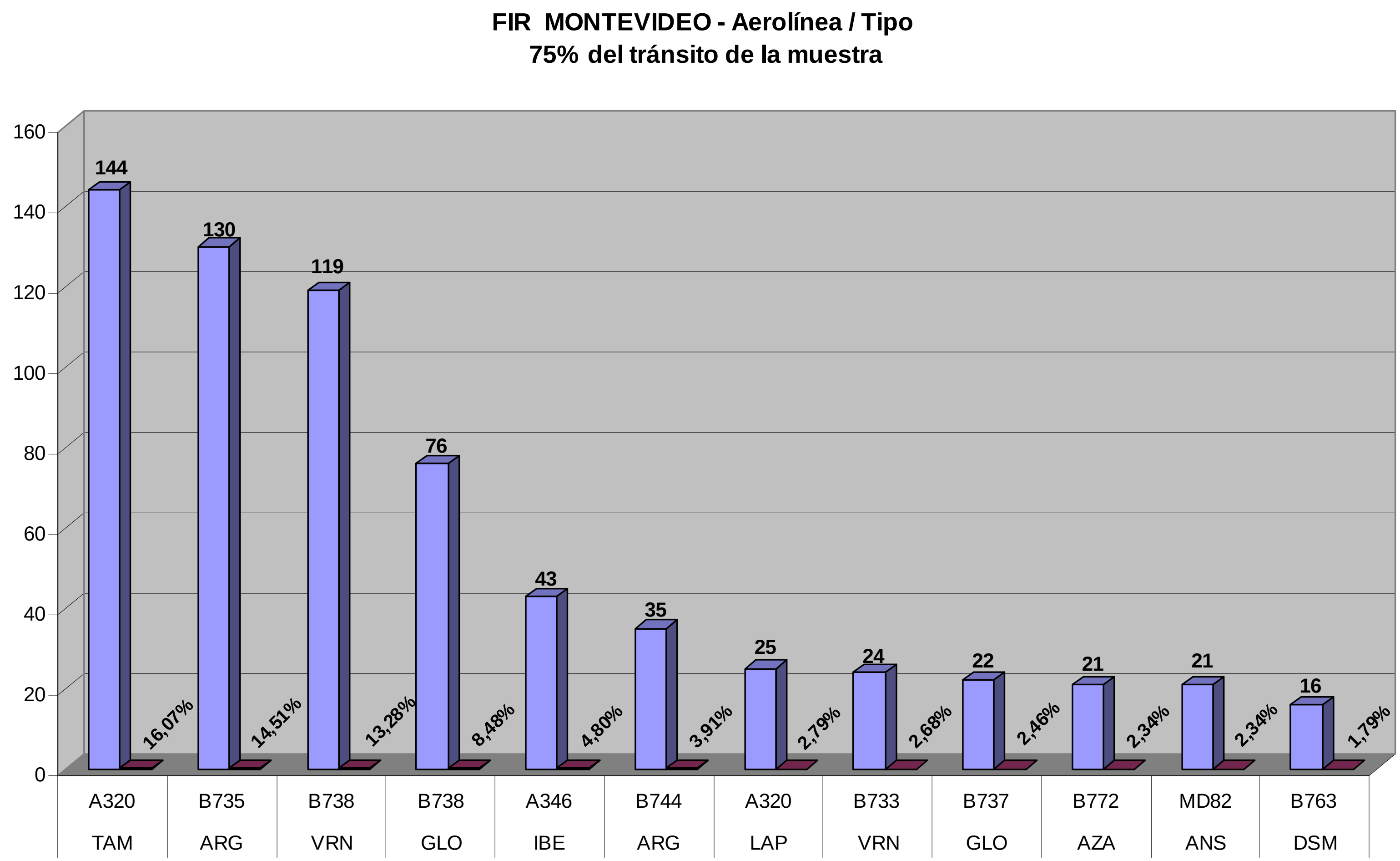
FIR LIMA - Aerolínea / Tipo
70% del tránsito de la muestra



SURINAME


FIR PARAMARIBO - Aerolínea / Tipo
61% del tránsito de la muestra
0
5
10
15
20
25
30
35
40
45
45
34
22
21
16
15
14
13
13
13
12
12
11,84%
8,95%
5,79%
5,53%
4,21%
3,95%
3,68%
3,42%
3,42%
3,42%
3,16%
3,16%
A332 TAM
A320 AFR
B762 COA
B763 DAL
A346 IBE
B762 ABX
B744 KLM
B763 ACA
E190 FWI
B743 SLM
B738 BWA
B744 JAL

URUGUAY


FIR MONTEVIDEO - Aerolínea / Tipo
75% del tránsito de la muestra
160
140
120
100
80
60
40
20
0
144
130
119
76
43
35
25
24
22
21
21
16
16,07%
14,51%
13,28%
8,48%
4,80%
3,91%
2,79%
2,68%
2,46%
2,34%
2,34%
1,79%
A320 TAM
B735 ARG
B738 VRN
B738 GLO
A346 IBE
B744 ARG
A320 LAP
B733 VRN
B737 GLO
B772 AZA
MD82 ANS
B763 DSM

GUIDANCE TO STATES ON BASIC RNAV ROUTE SPACING

(as approved by ANT/12, with slight editorial amendments)

1. INTRODUCTION

1.1 This guidance material describes minimum spacings between parallel Basic RNAV route centre lines applicable in ECAC airspace. The basis for this material consists of existing ICAO material and additional studies performed by EUROCONTROL in the framework of EATCHIP.

2. REFERENCE MATERIAL

2.1 ICAO Annex 11

2.1.1 ICAO Annex 11, Attachment B contains guidance material on route spacing. §2.3 of the Attachment B refers to the spacing between parallel routes (RNAV/RNAV and RNAV/conventional).

2.2 EUROCONTROL studies

2.2.1 EUROCONTROL safety studies into RNAV route spacing minima included theoretical collision risk assessments based solely on the navigation capability of the aircraft, as well as studies in which an ATC intervention capability and related theoretical radar controller intervention rates were calculated .

2.2.2 Results of these studies (including the applied assumptions) have been assessed on their operational merit and applicability, in order to ensure appropriate perception of the results.

2.3 ICAO Airspace Planning Manual

2.3.1 In 1997 the ICAO Document “Airspace Planning Methodology for Determining Separation Minima” (also called the Airspace Planning Manual) will become available, which gives guidance on the aspects which influence the safety of route spacing and separation minima, and on how to take these aspects into account. The document does not include separation or route spacing minima which would be applicable world-wide, although examples of safety assessments have been included.

2.3.2 As many of the safety assessment aspects in the Manual were derived from European (and EUROCONTROL/EATCHIP) activities, the methods applied within European safety assessments can be considered to be compatible with the contents of the Airspace Planning Manual. However, the Airspace Planning Manual is to be considered as a valuable overview of methods which have been applied for air traffic separation safety assessments throughout the world, and as a possible basis for safety assessments for application in particular air traffic environments.

2.4 ECAC Strategy

2.4.1 As reflected in the ECAC strategy, ECAC Airspace can be regarded as a radar environment, in which radar ATC service is provided. The provision of radar ATC service implies some form of radar monitoring of air traffic.

3. BASIC RNAV ROUTE SPACING IN ECAC AIRSPACE

3.1 ICAO Annex 11 material gives guidance on RNAV route spacing in §2.3 of Attachment B. That paragraph refers to VOR parallel route spacing as being applicable also to RNAV parallel route spacing. Attachment A states that the VOR route spacing values should only be applied after study of the underlying safety assessment and assumptions. For application in ECAC airspace this has been carried out in the context of EUROCONTROL studies.

3.2 EUROCONTROL considerations (theoretical risk assessment as well as an operational appreciation of assumptions and application) have concluded that the following route spacings are applicable in ECAC Basic RNAV airspace, without any additional ATC workload for correcting deviations due to inaccuracies of the navigation system:

- 18 NM for opposite direction routes,
- 16.5 NM for same direction routes, and
- 15 NM if the aircraft on adjacent (opposite direction) routes are not assigned the same flight levels, and the percentage of climbing and descending traffic is 40% or less.

4. REDUCTION OF BASIC RNAV ROUTE SPACING

4.1 Route spacing reductions to 10 - 15 NM are expected to be possible in ECAC Basic RNAV airspace by putting higher reliance on the radar ATC intervention capabilities. The circumstances in which such a reduction of route spacing is applied, will need to be assessed on a case by case basis.

4.2 It should be recognised that when route spacing is reduced through increased reliance on radar monitoring and radar intervention capabilities, acceptable ATC workload plays a primary role. This aspect depends largely on local ATC conditions, procedures and systems, and should therefore be subject to local appreciation, not different from existing operations and implicit responsibilities. In this context reference is made to material in ICAO Doc 4444 (PANS/RAC), PART VI on Radar Services, especially to §7.2: “Use of radar in the air traffic control service”.

4.3 In support of the assessment of acceptable Basic RNAV route spacing in ECAC airspace, results from EUROCONTROL studies into the theoretical radar ATC intervention rate for RNP 5 RNAV route spacings have been presented as guidance in Appendix A.

4.3.1 The results of the theoretical studies should be seen in the light of the assumptions made. First of all, the actual navigation performance in ECAC Basic RNAV airspace is expected to be much better than the theoretical 100% RNP 5 performance, which will significantly reduce the required controller intervention rate. Secondly, the number of required interventions will be reduced if the aircraft on adjacent (opposite direction) routes are not assigned the same flight levels. Moreover, the theoretical ATC intervention modes to correct navigational deviations which have been assumed in the study may often not be required due to early anticipation of undesirable traffic situations and due to implicitly required interaction with air traffic as part of normal radar supported ATM.

4.3.2 It is expected that in those situations where a specific route spacing smaller than 15 NM is currently applied, the mere introduction of Basic RNAV in 1998 on that same route system will not involve a sudden increase in the number of required ATC interventions, given that currently an estimated 80% of aircraft apply some form of RNAV navigation on the VOR/DME route network.

4.3.3 Nevertheless, an important aspect to be recognised is that the results of the study indicate that when in a Basic RNAV environment the route spacing is reduced towards 10 NM, the number of required interventions would rise significantly. Depending on the acceptability of this, States may consider the application of ATC supporting tools like deviation alerts.

5. VOR/DME VERSUS RNAV NAVIGATION

5.1 One of the starting points for the requirements for Basic RNAV was that navigation performance of Basic RNAV would be similar to that currently achieved on VOR/DME defined routes. Considering this and several other reasons, RNP 5 was considered the appropriate RNP type to be associated with Basic RNAV in ECAC airspace. In general practice, however, it is expected that the navigation accuracy of Basic RNAV equipped aircraft is better than RNP 5. On the other hand it has been recognised that navigation solely through the use of RNAV equipment might show navigation errors which were not present when navigating on VOR/DME. These navigation errors include operational errors as related to the use of the on-board RNAV equipment. The safety assessment work undertaken by EUROCONTROL has indicated that the collision risk associated with closely spaced parallel routes is very sensitive to the frequency of these types of large errors and the efficiency with which ATC is able to detect and correct them. Currently not enough information on these errors is available.

5.2 Although, as stated previously (see §4.3.2), the introduction of RNAV in 1998 is not expected to introduce an instant increase in navigational errors, it is still deemed appropriate to define a method of obtaining data on actual RNAV performance in ECAC airspace. This data will be applied to assess the cause of errors and deviations, in order to take remedial action if required, e.g. by introducing flight deck and/or ATC procedures to prevent operational errors which are related to the use of RNAV equipment. Which method is best for this purpose is still under consideration by EUROCONTROL.

6. SUMMARY AND CONCLUSIONS

6.1 The following route spacings are applicable in ECAC Basic RNAV (RNP 5) airspace, without any additional ATC workload for correcting deviations due to inaccuracies of the navigation system:

- 18 NM for opposite direction routes,
- 16.5 NM for same direction routes, and
- 15 NM if the aircraft on adjacent (opposite direction) routes are not assigned the same flight levels, and the percentage of climbing and descending traffic is 40% or less.

6.2 Route spacing reductions to 10 - 15 NM are expected to be possible in ECAC Basic RNAV airspace by putting higher reliance on the radar ATC intervention capabilities. The reduced route spacing to be used will have to be determined on a case by case basis, i.e. should be based on the capabilities of the individual ATC centres. Before implementation, States should verify that the route spacing does not unduly affect controller workload.

6.3 Data on actual RNAV performance is required to assess RNAV specific causes for navigation deviations, as a basis for defining remedial actions, if so required.

APPENDIX A
THEORETICAL ATC INTERVENTION RATES

This Appendix briefly outlines the results of a EUROCONTROL study into the theoretical ATC intervention rates in a Basic RNAV parallel route system. The study was performed to derive information on the effect which the reduction of route spacing may have on the required controller intervention rate.

The EUROCONTROL study into the theoretical intervention rate for Basic RNAV route spacing has been based on a number of assumptions. These assumptions include:

- 100% RNP 5 performing aircraft (i.e. 5 NM, 95%)
- The ATC sector contains a parallel route system of 100 NM in length
- The ATC sector contains 7 flight levels
- Aircraft are assigned the same flight levels on both (parallel) tracks
- The traffic flow is 25 aircraft per hour per track (divided over the 7 flight levels)
- Two intervention modes are considered:
    1. deviation mode:
        The controller intervenes to prevent an aircraft from entering the 5 NM wide middle zone between the two route centre lines.
    2. conflict mode:
        The controller intervenes to prevent a pair of aircraft to come within a 5 NM distance from each other.

The Table below contains the resulting theoretical ATC intervention rates, for route spacings of 10, 12 and 14 NM. Any change in the traffic flow or track length would produce a proportional change in intervention rates.

Table - Estimates of the ATC Intervention Rates (per hour) for closely spaced parallel B-RNAV/RNP5 Routes.

Track Spacing - →	10 NM	12 NM	14 NM
↓ Type of ATC Intervention ↓			
Conflict Mode - Same Direction	0.2 to 0.3	0.08 to 0.1	0.02 to 0.03
- Opposite Direction	3 to 5	1 to 1.5	0.3 to 0.5
Deviation Mode	11 to 16	6 to 10	3 to 5

Considering these results, due account should be taken of:

1. the fact that the underlying assumptions can be regarded as a worst case scenario, and
2. the comments in § 4.3 of the body of the guidance material.

- END -

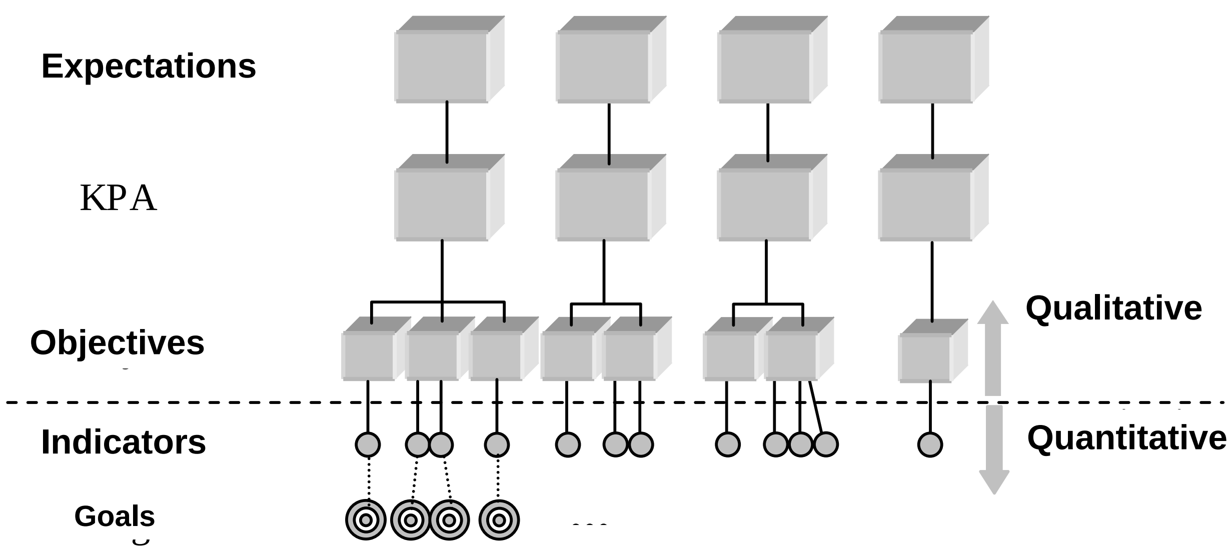
ATTACHMENT 6 TO APPENDIX B

PERFORMANCE-BASED ATM

Performance-Based Air Traffic Management is structured on the basis of the principle that ATM community expectations can best be met by quantifying those needs. A series of performance objectives, goals and indicators shall therefore be established to make it possible to objectively justify projects oriented towards improving the performance of the air traffic management system.

The application of performance-based ATM requires the establishment of mechanisms for assessing and measuring performance goals. The figure below illustrates the process of transforming ATM community expectations into objectives and goals. The following Key Performance Areas (KPA) are usually considered:

a) access and equity;
b) capacity;
c) cost-effectiveness;
d) efficiency;
e) environmental protection;
f) flexibility;
g) global interoperability;
h) ATM community participation;
i) predictability;
j) safety; and
k) security.



The objective is fulfilled when the indicator meets or exceeds the established goal.

Process of Quantifying ATM Community Expectations

KPAs provide general guidance for the classification of performance improvement needs, to be served through the establishment of specific performance objectives adapted to the specific needs of each Region/State. The scope of these objectives shall be clearly established in such a way that they can be expressed in events and quantities, including the desired trend in the performance indicator (*e.g.,* reduction of ATM cost per kilometre flown).

Performance objectives shall be stated in qualitative terms in the definition of the goals to be accomplished. A typical example of a performance objective is "improvement in arrivals at the scheduled time," which can be one of the objectives of the KPA "Efficiency."

Performance objectives shall have the following characteristics:

a) be specific and expressed in terms of objectives and events that effectively represent air traffic and the operating environment;
b) be measurable in such a way that they can be associated with one or more clearly-established performance indicators, making is possible to establish a process of data collection and comparison of results;
c) be feasible in light of time parameters and resources available for their fulfilment;
d) be relevant, in the sense that they must be defined at points where performance problems and/or opportunities for better fulfilment of ATM community expectations are expected; and
e) be timely, in the sense that they must be attained at the proper moment.

Performance management shall be based on specific performance objectives measured through performance indicators. These indicators must be defined in order to quantify the degree of compliance with performance objectives. When describing performance indicators, the metrics to be used shall be defined, as well as the way they are to be collected. One example of a performance indicator is the "average delay per flight in opening aircraft doors upon arrival," which can be established to check the degree of fulfilment of the performance objective "improvement in arrivals at the scheduled time."

In order to estimate this performance objective, data must be collected about the planned and actual times doors are opened in arriving aircraft. Using these data, values may be determined for the total length of the delay (supporting metrics) which, divided by the number of arrivals (supporting metrics), will make it possible to estimate the established indicator.

Demand forecasts shall be used as a parameter for some performance goals. The capacity goal for a given operating environment (ACC, APP, airspace volume, etc.), for example, will depend upon the demand forecast. This forecast shall produce the necessary information for gaining a better understanding of traffic characteristics.

This qualitative forecast is an important tool for ATM system planning. Demand forecasts containing only the number of flights and aircraft size, based on the number of seats, are not sufficient for analyzing the impact of performance improvements based on the installation of equipment on aircraft, for example. The analysis of required future performance could demand information about the aircraft mix or about the percentage of the fleet with specific equipment installed on aircraft, among other things.

Demand forecasts may have different time and scope horizons. These characteristics shall be driven by the requirements established in the performance goals. An ACC capacity planning for the following year may require a more detailed demand forecast, for example, than that needed for strategic planning at 20 years. Forecasting methods may also differ in accordance with the time horizon and the geographic region involved. Pure statistical methods will normally be used for a forecast for the following year that involves a single ATS unit, while a forecast for long-term planning involving a country will employ a specific economic analysis and different scenarios.

The system current performance shall be checked at regular intervals through the measurement of operational data and by estimating the performance indicators for the following purposes:

a) to establish the system baseline performance; and
b) to monitor progress in accomplishing performance objectives by comparing performance indicators with the established performance goals.

ATTACHMENT 7 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 Nº 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.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 Nº 0709 of 19 April 2004) regulates the installation of GPS systems on board aircraft with Chilean registry.

Norm DAN 06 21 (Exempt Resolution Nº 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 8 AL APÉNDICE B / ATTACHMENT 8 TO APPENDIX B

17.0 PROCEDURES FOR AREA NAVIGATION (RNAV) OPERATIONS

17.1 Application of RNAV procedures

17.1.1 *Terminal control area operations*

17.1.1.1 Except as detailed in 17.1.1.2 and 17.1.1.3, only RNAV-equipped aircraft having a lateral track-keeping accuracy of ±1 NM (2 SD) together with an ability to determine horizontal position to an accuracy sufficient to support the track-keeping requirement and having appropriate functionality and operational approval may operate under IFR on RNAV terminal area procedures.[2] Such RNAV equipment is designated hereafter as precision area navigation (P-RNAV).

Note.— The functional and operational approval requirements appropriate to P-RNAV are set out in Joint Aviation Authorities (JAA) Temporary Guidance Leaflet (TGL) No. 10, or equivalent.

17.1.1.2 Aircraft equipped with RNAV equipment having a lateral track-keeping accuracy of ±5 NM (2 SD) with an ability to determine horizontal position to an accuracy sufficient to support the track-keeping requirement and having appropriate functionality, hereafter designated as basic area navigation (B-RNAV), may use RNAV (segments) of arrival and departure routes where these meet the following criteria:

a) the B-RNAV portion of the route must:

1) be above the appropriate minimum flight altitude (MFA) (e.g.: minimum radar vectoring altitude (MRVA) and minimum sector altitude (MSA)); and

2) be in accordance with established PANS-OPS criteria for en-route operations; and

3) conform to B-RNAV en-route design principles;

Note.— For minimum flight altitude, see Annex 11, 2.21.

b) the departure procedures must be conventional (non-RNAV) up to a conventional fix (or a minimum altitude). Beyond that fix (or minimum altitude) a B-RNAV procedure can be provided in accordance with the criteria in a) above; and

c) the B-RNAV portion of an arrival route must terminate at a conventional fix in accordance with the criteria given above. Beyond that fix, the arrival shall be completed by a conventional (non-RNAV) procedure, or by the provision of radar vectors; and

d) due regard must have been taken of those operating procedures of the users that may affect system performance. Examples include, but are not limited to, initial position fixing on runway and minimum automatic flight control system (AFCS) engagement altitudes; and

e) arrival and departure procedures, which can be flown by B-RNAV equipment, shall be identified explicitly as approved for application of B-RNAV.

Note.— To meet the requirements of B-RNAV, aircraft need to be approved in accordance with JAA ACJ 20X4 (previously known as TGL no. 2, rev. 1), or equivalent.

17.1.1.3 Aircraft equipped with GNSS-based RNAV equipment may be used only on RNAV area procedures designated for GNSS and where it is identified that P-RNAV approval is not required to operate on the procedure.

Note.— To meet the requirement of GNSS-based RNAV, aircraft need to be approved in accordance with JAA ACJ 20X5 (previously known as TGL no. 3, rev. 1), or equivalent.

17.1.2 *En-route operations*

17.1.2.1 Only aircraft approved for B-RNAV operations may plan for operations under IFR on the ATS routes of the flight information regions/upper flight information regions (FIRs/UIRs) identified in 17.2.2. Aircraft not equipped with RNAV but having a navigation accuracy meeting RNP 5 will be restricted to operations on ATS routes which States may designate within their lower airspace in accordance with 17.1.2.2.

17.1.2.2 For the period until at least 2005 or until such time as VHF omnidirectional radio range (VOR) facilities cease to be available, the carriage of a single RNAV system not meeting an average continuity of service of 99.99 per cent of flight time may be approved for B-RNAV operations if the aircraft is also carrying VOR and DME equipment.

Note.— States may designate domestic routes within their lower airspace to be available for aircraft not fitted with RNAV equipment but having a navigation accuracy meeting RNP 5.

17.2 Area of applicability

17.2.1 The provisions in respect of P-RNAV shall be applied whenever RNAV terminal area procedures, excluding the final and missed approach segments, are used.

Note.— The carriage of P-RNAV equipment has not yet been mandated in the EUR Region.

17.2.2 The above provisions in respect of en-route operations shall apply to all such operations conducted under IFR on the entire ATS route network as notified by the appropriate authorities in the following FIRs/UIRs:

Amsterdam, Ankara, Athinai, Barcelona, Berlin, Bodø, Bordeaux, Bratislava, Bremen, Brest, Brindisi, Bruxelles, Bucuresti, Budapest, Canarias (AFI area of applicability), Casablanca, Chisinau, DŸsseldorf, France, Frankfurt, Hannover, Istanbul, Kharkiv, København, Kyiv, Lisboa, Ljubljana, London, L'viv, Madrid, Malta, Marseille, Milano, MŸnchen, Nicosia, Odessa, Oslo, Paris, Praha, Reims, Rhein, Riga, Roma, Rovaniemi, Scottish, Shannon, Simferopol', Skopje, Sofia, Stavanger, Sweden, Switzerland, Tallinn, Tampere, Tbilisi, Tirana, Trondheim, Tunis (FL 245 and above), Varna, Vilnius, Warszawa, Wien, Yerevan, Zagreb.

17.3 Means of compliance

17.3.1 Conformance to the navigation requirement shall be verified by the State of Registry or the State of Operator as appropriate.

Note.— Guidance material concerning navigation requirements associated with B-RNAV operations is contained in JAA ACJ 20X4 and for P-RNAV in JAA Temporary Guidance Leaflet No. 10.

17.4 Identification of RNAV routes

(A11, Appendix 1 – 2.2.1 and Appendix 3;
A4, Chapters 9 and 10)

17.4.1 All RNAV standard instrument arrival and departure procedures shall be suitably designated as RNAV in accordance with Doc 8168 and Annex 11, Appendix 3.

17.4.2 All other RNAV routes shall be designated in accordance with Annex 4 and Annex 11, Appendix 1.

17.5 Flight planning

17.5.1 Operators of aircraft approved for B-RNAV operations, as set out in 17.1.1.2, shall insert the designator "R" in Item 10 of the flight plan.

17.5.2 In addition to the requirement of 17.5.1, operators of aircraft approved for P-RNAV operations, as set out in 17.1.1.1, shall, in addition to the designator "R", also insert the designator "P" in Item 10 of the flight plan.

Note.— The attention of operators is drawn to 3.5.1.2 in respect of requirements for the filing of equipment information in RPLs.

17.5.3 *Instructions for completion of the flight plan*
(A2 – 3.3; P-ATM, Chapter 4, Section 4
and Appendix 2, Section 2)

17.5.3.1 Where a failure or degradation results in the aircraft being unable to meet the P-RNAV functionality and accuracy requirements of 17.1.1.1 before departure, the operator of the aircraft shall not insert the designator "P" in Item 10 of the flight plan. Subsequently, for a flight for which a flight plan has been submitted, an appropriate new flight plan shall be submitted and the old flight plan cancelled. For a flight operating based on a repetitive flight plan (RPL), the RPL shall be cancelled, and an appropriate new flight plan shall be submitted.

17.5.3.2 In addition, where a failure or degradation results in the aircraft being unable to meet the B-RNAV functionality and accuracy requirements of 17.1.1.2 before departure, the operator of the aircraft shall not insert the designators "S" or "R" or "P" in Item 10 of the flight plan. Since such flights require special handling by ATC, Item 18 of the flight plan shall contain STS/RNAVINOP. Subsequently, for a flight for which a flight plan has been submitted, an appropriate new flight plan shall be submitted and the old flight plan cancelled. For a flight operating based on an RPL, the RPL shall be cancelled, and an appropriate new flight plan shall be submitted.

17.6 Minimum flight altitudes for operations on RNAV routes
(A2 – 5.1.2; P-ATM, 4.10.3. and 8.6.5.2)

17.6.1 Unless an IFR aircraft is receiving navigation guidance in the form of radar vectors from ATC, the pilot is responsible for obstacle clearance. Therefore, the use of RNAV does not relieve pilots of their responsibility to ensure that any ATC clearance or instruction is safe in respect to obstacle clearance. ATC shall assign levels that are at or above established minimum flight altitudes.

17.7 Procedures for operation on RNAV routes

17.7.1 Correct operation of the aircraft RNAV system shall be established before joining and during operation on an RNAV route. This shall include confirmation that:

a) the routing is in accordance with the clearance; and

b) the RNAV navigation accuracy of the aircraft meets the navigation accuracy requirements of the RNAV route and arrival or departure procedure, as applicable.

17.7.2 When an aircraft cannot meet the requirements as specified in either 17.1.1.1 or 17.1.1.2, as required by the RNAV route or procedure, as a result of a failure or degradation of the RNAV system, a revised clearance shall be requested by the pilot.

Note.— See 17.8.1 for relevant RTF phraseology.

17.7.3 Subsequent ATC action in respect of an aircraft that cannot meet the requirements as specified in either 17.1.1.1 or 17.1.1.2, due to a failure or degradation of the RNAV system, will be dependent upon the nature of the reported failure and the overall traffic situation. Continued operation in accordance with the current ATC clearance may be possible in many situations. When this cannot be achieved, a revised clearance, as specified in 17.8, may be required to revert to VOR/DME navigation.

17.7.4 For operation on RNAV arrival and departure routes, where clearance is given by ATC for an RNAV procedure for which the aircraft is not approved, the pilot is to advise ATC who will then seek to provide an alternative routing.

Note.— See 17.8.1 for relevant RTF phraseology.

17.7.5 If an aircraft cannot meet the requirements as specified in 17.1.1.2 due to a failure or degradation of the RNAV system that is detected before departure from an aerodrome where it is not practicable to effect a repair, the aircraft concerned should be permitted to proceed to the nearest suitable aerodrome where the repair can be made. When granting clearance to such aircraft, ATC should take into consideration the existing or anticipated traffic situation and may have to modify the time of departure, flight level or route of the intended flight. Subsequent adjustments may become necessary during the course of the flight.

17.8 ATC procedures

17.8.1 *RTF phraseology*
(P-ATM, Chapter 12)

17.8.1.1 If an RNAV arrival or departure procedure which has been assigned cannot be accepted by the pilot, for reasons of either the RNAV equipment or circumstances associated with its operational use, the pilot shall inform ATC immediately by use of the phrase:

UNABLE (*designator*) DEPARTURE [*or* ARRIVAL] DUE RNAV TYPE

17.8.1.2 If, for any other reason, the pilot is unable to comply with an assigned terminal area procedure, the pilot shall inform ATC immediately by use of the phrase:

UNABLE (*designator*) DEPARTURE [*or* ARRIVAL] (*reasons*)

17.8.1.3 If ATC is unable to assign an RNAV arrival or departure procedure requested by a pilot, for reasons associated with the type of on-board RNAV equipment indicated in the FPL/CPL, ATC shall inform the pilot by use of the phrase:

UNABLE TO ISSUE (*designator*) DEPARTURE [*or* ARRIVAL] DUE RNAV TYPE

17.8.1.4 If, for any other reason, ATC is unable to assign an arrival or departure procedure requested by the pilot, ATC shall inform the pilot by use of the phrase:

UNABLE TO ISSUE (*designator*) DEPARTURE [*or* ARRIVAL] (*reasons*)

17.8.1.5 As a means for ATC to confirm the ability of a pilot to accept a specific RNAV arrival or departure procedure, ATC shall use the phrase:

ADVISE IF ABLE (*designator*) DEPARTURE [*or* ARRIVAL]

17.8.2 *Degradation of RNAV systems*

17.8.2.1 If, as a result of a failure or degradation of the RNAV system,

a) detected after departure, the aircraft cannot meet the requirements of 17.1.1.1, or,

b) detected before or after departure, the aircraft cannot meet the requirement of 17.1.1.2,

the following ATC procedures are applicable.

17.8.2.2 *Coordination messages*
(P-ATM, 11.4.2.3)

a) *Computer-assisted coordination of estimate messages.* In the case of automated messages not containing the information provided in Item 18 of the flight plan, the sending ATC unit shall inform the receiving ATC unit by supplementing the ACT message verbally with the phrase "RNAV OUT OF SERVICE" after the call sign of the aircraft concerned.

b) *Verbal coordination of estimate messages.* When a verbal coordination process is being used, the sending ATC unit shall include the phrase "RNAV OUT OF SERVICE" at the end of the message.

17.8.2.3 *RTF phraseology*
(P-ATM, Chapter 12)

17.8.2.3.1 The phrase "UNABLE RNAV DUE EQUIPMENT" shall be included by the pilot immediately following the aircraft call sign upon occurrence of the RNAV degradation or failure and whenever initial contact on an ATC frequency is subsequently established.

17.8.2.4 *ATC clearances*
(A11 – 3.7; P-ATM, 4.5.4, 4.5.7, 6.3.2
and 11.4.2.5.2.1)

17.8.2.4.1 With respect to the degradation/failure in flight of an RNAV system, while the aircraft is operating on an ATS route requiring the use of B-RNAV,

a) aircraft should be routed via VOR/DME-defined ATS routes; or

b) if no such routes are available, aircraft should be routed via conventional navigation aids, i.e. VOR/DME; or

c) when the above procedures are not feasible, the ATC unit should, where practicable, provide the aircraft with radar vectors until the aircraft is capable of resuming its own navigation.

Note.— Aircraft routed in accordance with a) or b) may, where practicable, require continuous radar monitoring by the ATC unit concerned.

17.8.2.4.2 With respect to the degradation/failure in flight, of an aircraft's RNAV system, while the aircraft is operating on an arrival or departure procedure requiring the use of RNAV,

a) the aircraft should be provided with radar vectors until the aircraft is capable of resuming its own navigation, or

b) the aircraft should be routed by conventional navigation aids, i.e. VOR/DME.

17.9 ATC procedures for State aircraft not equipped with RNAV but having a navigation accuracy meeting RNP 5

17.9.1 *Instructions for the completion of the flight plan*
(A2 – 3.3.3; P-ATM, 4.4 and Appendix 2, 2)

17.9.1.1 Operators of State aircraft not equipped with RNAV shall not insert the designators "S" or "R" or "P" in Item 10 of the flight plan.

17.9.1.2 Since such flights require special handling by ATC, Item 18 of the flight plan shall contain STS/NONRNAV.

17.9.2 *Coordination messages*
(P-ATM, 11.4.2.3)

17.9.2.1 *Computer-assisted coordination of estimate messages*

17.9.2.1.1 In the case of automated messages not containing the information provided in Item 18 of the flight plan, the sending ATC unit shall inform the receiving ATC unit by supplementing the ACT message verbally with the phrase "NEGATIVE-RNAV" after the call sign of the aircraft concerned.

17.9.2.2 *Verbal coordination of estimate messages*

17.9.2.2.1 When a verbal coordination process is being used, the sending ATC unit shall include the phrase "NEGATIVE-RNAV" at the end of the message.

17.9.2.3 *Phraseology*

17.9.2.3.1 The phrase "NEGATIVE-RNAV" shall be included by the pilot immediately following the aircraft call sign whenever initial contact on an ATC frequency is established.

17.9.2.4 *ATC clearances*
(A11 – 3.7; P-ATM, 4.5.4, 4.5.7, 6.3.2 and 11.4.2.5.2.1)

17.9.2.4.1 Within TMAs, State aircraft may only be routed via RNAV terminal area procedures if they are equipped with the appropriate RNAV equipment (17.1.1.1 and 17.1.1.2 apply).

17.9.2.4.2 For such aircraft operating en route, the following procedures apply:

a) State aircraft should be routed via VOR/DME-defined ATS routes; or

b) if no such routes are available, State aircraft should be routed via conventional navigation aids, i.e. VOR/DME.

Note.— State aircraft routed in accordance with a) or b) above may require continuous radar monitoring by the ATC unit concerned.

17.9.2.4.3 When the above procedures cannot be applied, the ATC unit shall provide State aircraft with radar vectors until the aircraft is capable of resuming its own navigation.

APPENDIX C

INITIAL AIC MODEL FOR RNAV-5 IMPLEMENTATION

Telephone: **Fax:** **E-mail:** **Sitatex:** **Telex:**	**STATE** **AERONAUTICAL INFORMATION SERVICE**	**AIC N°** **DATE**

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" or require double air 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.

4. **RNAV-5 operations within the ______________FIR.**

4.1. Starting on __ November 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 the _________ FIR in accordance with the Regional Air Navigation Agreements. The State of the Operator or State of Registry, as the case may be, will be responsible for granting the airworthiness and operations approval under national regulations. These regulations will be based on the contents of the RNAV-5 navigation specification stipulated in the PBN Manual (Doc. 9613).

4.3. Recent documentation and information about RNAV-5 implementation in the ICAO SAM Region 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. For inquiries about the aircraft and operator approval process, related ATC matters, or additional information, please consult the following contacts:

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

- - - - -

APPENDIX D

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.

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 D

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

1.	**Airspace concept**	**Start**	**End**	**Responsible party**	**Remarks**
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	

2.	**Develop a performance measurement plan**	**Start**	**End**	**Responsible party**	**Remarks**
2.1	Draft a plan to measure performance, including gas emissions, safety, efficiency, etc.			States	
2.2	Implement the performance measurement plan			States	

3	**Safety assessment**	**Start**	**End**	**Responsible party**	**Remarks**
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	

3	**Safety assessment**	**Start**	**End**	**Responsible party**	**Remarks**
3.4	Prepare the final airspace safety assessment			States	

4	**Establish a collaborative decision-making process (CDM)**	**Start**	**End**	**Responsible party**	**Remarks**
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	

5	**ATC automated systems**	**Start**	**End**	**Responsible party**	**Remarks**
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	

6. Aircraft and operator approval	Start	End	Responsible party	Remarks
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	

7. Standards and procedures	Start	End	Responsible party	Remarks
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	

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

8.	Training	Start	End	Responsible party	Remarks
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	

9.	Implementation decision	Start	End	Responsible party	Remarks
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	

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

- - - - -

ATTACHMENT 2 TO APPENDIX D

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

1.	**Airspace concept**	**Start**	**End**	**Notes**
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.			

2.	**Develop a performance measurement plan**	**Start**	**End**	**Notes**
2.1	Draft a plan to measure performance, including gas emissions, safety, efficiency, etc.			
2.2	Implement the performance measurement plan			

3.	**Safety assessment procedure**	**Start**	**End**	**Notes**
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)			

4	**Establish a collaborative decision-making process (CDM)**	**Start**	**End**	**Notes**
4.1	Coordinate planning and implementation requirements with air navigation service			

4	**Establish a collaborative decision-making process (CDM)**	**Start**	**End**	**Notes**
	providers, regulators, users, aircraft operators and military authorities			
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			

5	**ATC automated systems**	**Start**	**End**	**Notes**
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			

6.	**Aircraft and operator approval**	**Start**	**End**	**Notes**
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)			

7. Standards and procedures		Start	End	Notes
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			

8.	Training	Start	End	Notes
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			

9. Implementation decision	**Start**	**End**	**Notes**
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			

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

- - - - - -