



**Agenda Item 2: Review of global and CAR/SAM CNS/ATM developments**

**USE OF ADS-B AT THE MACAÉ – CUENCA DE CAMPOS TMA**

(Presented by Brazil)

**SUMMARY**

This working paper contains information about the restructuring of air navigation services provided in the oceanic region of the Macaé - Cuenca de Campos TMA involving the use of ADS-B in the provision of ATS for off shore operation of helicopters supporting oil production platforms in the oceanic area.

**1. Introduction**

1.1. The project for the restructuring of air navigation services at Cuenca de Campos developed by the Brazilian Administration is aimed mainly at meeting air traffic requirements of helicopters that support the activities on oil platforms in the oceanic area.

1.2. The solution envisaged includes the use of elements foreseen in the CNS/ATM concept, including the use of GNSS for the en-route and approach phases, ADS-B for low-altitude surveillance, and ATM automation in support of terminal approach control. Improvements in other systems, such as COM/AIS/MET, supplement the requirements for the Macaé TMA.

1.3. The Macaé TMA will be the first Brazilian airspace to implement an ADS-B-based surveillance system. The operational concept for the aforementioned TMA requires the ADS-B system to have the capability of supporting 5NM separations between aircraft. The system will also provide data to support initial studies for the implementation of ADS-B in continental airspace.

1.4. An important characteristic of the project is the requirement for collaborative participation of the various organisations concerned, starting with studies on the development of the operational concept up to decisions on system implementation. The participating organisations represent the ATM community, that is: the aeronautical authority, the air traffic service (ATS) provider, aircraft operators, the main oil company, and the industry.

1.5. Coordination of this project started on the second quarter of 2008, and contemplates the use of the ADS-B service for the provision of ATS, including aircraft separation, taking into account exclusionary airspace, by the end of 2012. During this implementation period, services will gradually be implemented to ensure safety.

**2. Discussion**

**2.1. Initial Project Scenario**

2.1.1. Cuenca de Campos covers an area of about 100 thousand square kilometres, and currently accounts for more than 80% of domestic oil production.

2.1.2. Oil exploration and production activities are carried out on offshore platforms and the main support infrastructure on the continental area is located on the coastal cities of Macaé and São Tomé, on the northeast of the State of Rio de Janeiro. This generates a significant movement of helicopters that carry freight and mainly passengers from the aerodrome of Macaé and the heliport of São Tomé to the offshore platforms and vessels.

2.1.3. Airspace organisation in Cuenca de Campos is defined by the Macaé terminal control area, according to ARC Macaé 1, shown in **Appendix A**, which was used up until December 2008. The Macaé TMA comprises the following airspaces: Macaé CTR, the Central Area, the São Tomé Area, the Albacora Area, the Marlim Area, and the Enchova Area, where ATS is provided by the corresponding units.

2.1.4. The Macaé APP operates with two control sectors: Sector 1 is responsible for all the continental area and part of the Central Area, covering a radio of 35NM around the MAC VOR/DME; and Sector 2 is responsible for the remainder of the TMA, which includes the oceanic area without radar coverage. The Enchova, Marlim, and Albacora radio stations provide flight information and alert services from platforms PCE-1, P-20 and P-25 respectively.

#### 2.1.5. **Air Traffic Statistics**

2.1.5.1. **Appendix B** presents the distribution of air traffic movement on a peak day, taken in September 2008. Movements were calculated using the movement average in a one-hour interval, with samples every 10 minutes.

2.1.5.2. Aircraft movement at the Macaé TMA is characterised by daytime VFR flights, with morning and afternoon peaks, reaching almost 30 movements per hour. Nighttime flights are not authorised to/from offshore platforms, except for helicopters conducting SAR missions or transporting sick or injured passengers.

2.1.5.3. Regarding operations at the Macaé TMA, it is important to note some interesting characteristics:

- a) During the 2003-2008 period, aircraft movement under the jurisdiction of the Macaé APP grew at an average of 6.2% per year;
- b) Average flight time in the TMA is approximately 50 minutes;
- c) 93,7% of flights in the Macaé TMA are carried out by helicopters in the oceanic area to/from the platforms;
- d) Only 34% of flights use radar surveillance services, due to limited coverage in the oceanic region (low-altitude flights); and
- e) 87,6% of flights apply visual flight rules (VFR).

2.1.6. For many years, the existing air navigation infrastructure, including ATS, has supported the safety and efficiency requirements of air operations in Cuenca de Campo. However, air traffic growth and the limitations of existing systems, especially offshore surveillance, have resulted in operational restrictions for aircraft operators, mainly affecting the efficiency of operations.

2.1.7. The Macaé APP has a PSR/SSR radar station that supports the ATS surveillance service in the TMA. Nevertheless, since most oil platforms are located more than 60NM from Macaé and helicopter flights are carried out at low altitude, the ATS provided on most of the oceanic area is based on non-radar procedures, which reduces significantly airspace capacity and the efficiency of air operations, especially for operations applying instrument flight rules (IFR).

2.1.8. Consequently, VFR operations are preferred whenever possible. This creates a significant concentration of air traffic in the area where platforms are located, clearly pointing to the need for evolving the existing flight information and alert service provided in the airspace concerned.

2.1.9. Furthermore, low-altitude flights are affected by fog while flying over water, and by the fact that most of the flight time occurs in an unfavourable position with respect to the sun (E/W). This results in a significant reduction of visibility, increased pilot and controller workload, and concerns regarding maintaining safety at the required levels.

2.1.10. All of the above revealed the need for restructuring air navigation services at Cuenca de Campos, even considering the possibility of using current technologies, especially for navigation and surveillance of low-altitude flights in the oceanic area. New ATM automation, communications, and meteorology systems will also be required.

**2.2. Evolution to the Current Scenario**

2.2.1. A survey of the capacity of the helicopter fleet that operates at Cuenca de Campos, which appears in **Appendix C**, showed the feasibility of using GNSS navigation in the short term. The 64 aircraft of the fleet had the following airworthiness levels:

Number of aircraft	% of the fleet	Level of approval
9	14,1	0 – Only VFR
8	12,5	1 - En-route IFR
3	4,7	2 - En-route and terminal area IFR
4	68,8	3 -En-route, terminal area, and non-precision approach (NPA) IFR

2.2.2. In December 2008, the operation of the PRS/SSR ATCR-33/SIR-7 (Selenia) radar was replaced with the new PRS/SSR, STAR 2000/RSM-970S (Thales), radar system and an automated system with two operational positions STVD X-4000 (Atech). This significantly improved APP operation, and facilitated the implementation of a new (RNAV) ATS route structure based on GNSS (see **Appendix D - ARC Macaé 2**), as long as the configuration with two control sectors is maintained.

2.2.3. The new GNSS route structure became effective in January 2009, and allowed for a better airspace organisation, and a more convenient flow of helicopters in Sector 2 of the Macaé APP.

2.2.4. Although the ARC Macaé 2 has established the most direct routes to the existing platforms, the new flow increases the segments to be flown due to the need to follow specific paths. In this case, the decision was made to ensure safety with some loss of efficiency, which can be restored with the support of a surveillance system for the oceanic area.

**2.3. Scenario Foreseen**

2.3.1. The greatest demand for air navigation services at Cuenca de Campos involves support for helicopter operations in the oceanic area, and also in Macaé and São Tomé.

2.3.2. The oceanic area has a homogeneous airspace flown by aircraft with similar characteristics, and a large concentration of air traffic at low altitude. This permits the application of an ADS-B OUT restricted airspace to supplement radar coverage and provide an ATS of better quality.

2.3.3. The use of ADS-B and GNSS navigation (RNAV) will permit more direct routes between the continent and the platforms, reduced flight time, and more efficiency. It will also be necessary to introduce major improvements to SMA systems, offshore weather stations, ground/ground (ground/platform) data communication networks, automated systems with additional operational positions, new audio system, *inter alia*.

2.3.4. Using ADS-B, it will be possible to control and separate all flights at Cuenca de Campos, except for flights between platforms. For flights between platforms, aircraft will continue flying VFR and receiving flight information and alert services, which will improve significantly with the use of ADS-B. Likewise, in the future, when all traffic is visualised, aircraft will also be able to use ADS-B IN to improve pilot situational awareness.

2.3.5. The Albacora, Marlim, and Enchova radio stations, currently located on platforms, will be transferred to operational positions at the Macaé APP, and will be capable of visualising ADS-B based air traffic.

2.3.6. In order to improve the level of service and adjust controller workload, the Macaé TMA will have a new airspace structure with seven operating sectors, as shown in **Appendix E**.

### 2.3.7. **Communications**

2.3.7.1 Direct pilot-controller communications will be based on VHF. The VHF system will provide coverage starting at 1000ft MSL, up to the boundary of the TMA (FL145). In the area of the platforms, communications will have uniform coverage starting at 500ft, which is the flight level between platforms, and will also ensure coverage at the heliports on the platforms.

2.3.7.2 The VHF system will be made up by stations at several remote sites on the continent and on some platforms.

2.3.7.3 AFS communications between the platforms and the Macaé APP will use primarily the Petrobrás existing fiber optics network. Some segments will be able to use high-capacity radio link as the main link or as back-up.

2.3.7.4 Fixed data communications will be based on the ATN IPS (IPv4) in support of AMHS, AIDC, ADS-B, meteorological data, and AIS applications.

### 2.3.8 **Navigation**

2.3.8.1. The main means of navigation in the Cuenca de Campos airspace will be GNSS (GPS), enabling the use of RNAV routes (already in operational use), IFR approach and departure procedures for aerodromes and heliports in the Macaé TMA. In the oceanic area, *point-in-space* approaches (PinS) are foreseen in support of approaches to nearby platforms.

2.3.8.2. The ground aid structure shall be maintained as an alternative to GNSS until GPS is duly supplemented with other systems (GLONASS, GALILEO) or its reliability demonstrated for operations in the airspace of Cuenca de Campos, even during solar interference peaks. The existing VOR/DME MAC, at Macaé, will be replaced with a new D-VOR/DME. Likewise, a D-VOR/DME will be installed in São Tomé to support the procedures at the new aerodrome being built on that location.

### 2.3.9 Surveillance

2.3.9.1. Surveillance in the oceanic area will be ADS-B OUT, based on air-ground data link 1090ES (Extended Squitter). The ADS-B system in the continent and in the oceanic area (platforms) will consist of remote receiver stations, data communication network (ATN IPS) and the central processing station.

2.3.9.2. ADS-B stations receive information from each aircraft, and send it to the central processing station of the ADS-B system, located in the technical room of the Macaé APP. The central station will then send the information to the APP Data Processing and Display System (STVD) using the Asterix 21 protocol.

2.3.9.3. In order to use the ADS-B system, all aircraft must be duly equipped with a transponder or transmitter with ADS-B capability for the transmission of messages in Mode S Extended Squitter, on the 1090MHz frequency, according to the requirements contained in Annex 10, Volume IV, and Doc 9871 – “Technical Provisions for Mode S Services and Extended Squitter”.

2.3.9.4. ADS-B surveillance data will be integrated with data from the Macaé, Aldeia, and Santa Teresa radars, thus extending display capabilities of the Macaé APP and providing information on aircraft not equipped with ADS-B at the boundaries of the ADS-B restricted area, which will basically comprise the oceanic airspace of the Macaé TMA below radar coverage.

2.3.9.5. ADS-B has the same coverage requirement as the VHF system in the airspace between the continent and the oceanic boundary of the TMA. **Appendix F** shows the estimated coverage for 100ft and 500ft MSL, taking into account that the following sites shall initially be part of the ADS-B system: Macaé, São Tomé and platforms PCE-1, PGP-1, P-20 and P-25. However, if necessary, other sites may be added to supplement the coverage required.

2.3.9.6. The ground/platform ADS-B system will be capable of receiving information as per the Extended Squitter Version 0 or Extended Squitter Version 1 message. Version 0 was the initial standard for Extended Squitter and is consistent with RTCA//DO-260 – “Minimum Operational Performance Standard for 1090 MHz Automatic Dependent Surveillance – Broadcast (ADS-B)”. Version 1 is consistent with RTCA DO-260A – “Minimum Operational Performance Standard for 1090 MHz Automatic Dependent Surveillance – Broadcast (ADS-B) and Traffic Information Services – Broadcast (TIS-B)”.

2.3.9.7. The ADS-B system will provide the STVD with NIC/NAC/SIL (Version 1) or NUC (Version 0) quality indicators associated to the position and speed of each aircraft.

2.3.9.8. The ADS-B system will also validate integrity, using an independent measuring methodology to detect aircraft position errors in the ADS-B message. The independent measurement can be done using time difference of arrival (TDOA) techniques or multi-sector antennae at the remote stations.

2.3.9.9. Each ADS-B remote station site will use a site monitor to simulate the existence of an aircraft and know the available integrity parameters (GNSS performance), while there is no real aircraft in the proximity of the station. Quality indicators will be processed by the STVD and will alert the controller if quality falls below the established minimum level.

### 2.3.10 **Meteorology**

2.3.10.1. The approach procedure for *point-in-space* in the oceanic area will require a meteorological observation structure capable of providing the main parameters for IFR operations at the APP control position. To this end, observations must be made on platforms located near the initial approach fix.

2.3.10.2. The meteorological system at Cuenca de Campos will consist of eight automatic remote meteorological stations located on platforms near the arrival routes to the oceanic area with the greatest concentration of platforms.

2.3.10.3. Remote monitoring of stations from the Macaé APP meteorological office will permit the use of these data for TMA weather forecasts.

### 2.4. **Implementation Phases**

2.4.1. The project for the restructuring of air navigation services at Cuenca de Campos was divided into four main implementation phases:

#### 2.4.1.1. **Phase 1** (December 2008)

- Implementation of the new GNSS-based route structure in the oceanic area of Cuenca de Campos.

#### 2.4.1.2. **Phase 2** (December 2009)

- Introduction of improvements to the SMA for oceanic areas, which include:
  - extended coverage for the frequency of the current sector 2 of the Macaé APP; and
  - extended coverage for the frequencies of the (FIS) Albacora, Marlim, and Enchova (FIS) radio stations, to provide pilot-controller communications at the heliports on the platforms.
- Installation of two STVD X-4000 operational positions with data from the PRS/SSR STAR 2000/RSM-970S radar system, to replace the ATCR-33/SIR-7.

#### 2.4.1.3. **Phase 3** (December 2010)

- Ground/platform infrastructure for ADS-B OUT;
- Integration of ADS-B and radar data;
- Implementation of the minimum configuration of the APP Macaé to begin ADS-B activities.

#### 2.4.1.4. **Phase 4** (December 2012)

- Safety assessment of the ADS-B OUT system for the provision of 5NM separation minima between aircraft;
- Implementation of the final configuration of the Macaé APP;

- Transfer of the Albacora, Marlim, and Enchova radio stations to operational positions at the Macaé APP;
- Training of controllers for ADS-B operations;
- Implementation of ADS-B on board aircraft operating in Cuenca de Campos, aircraft certification, and operator approval;
- Publication of regulatory material (AIP SUP); and
- Activation of ADS-B restricted airspace in Cuenca de Campos.

3. **Suggested Action**

3.1. The Meeting is invited to:

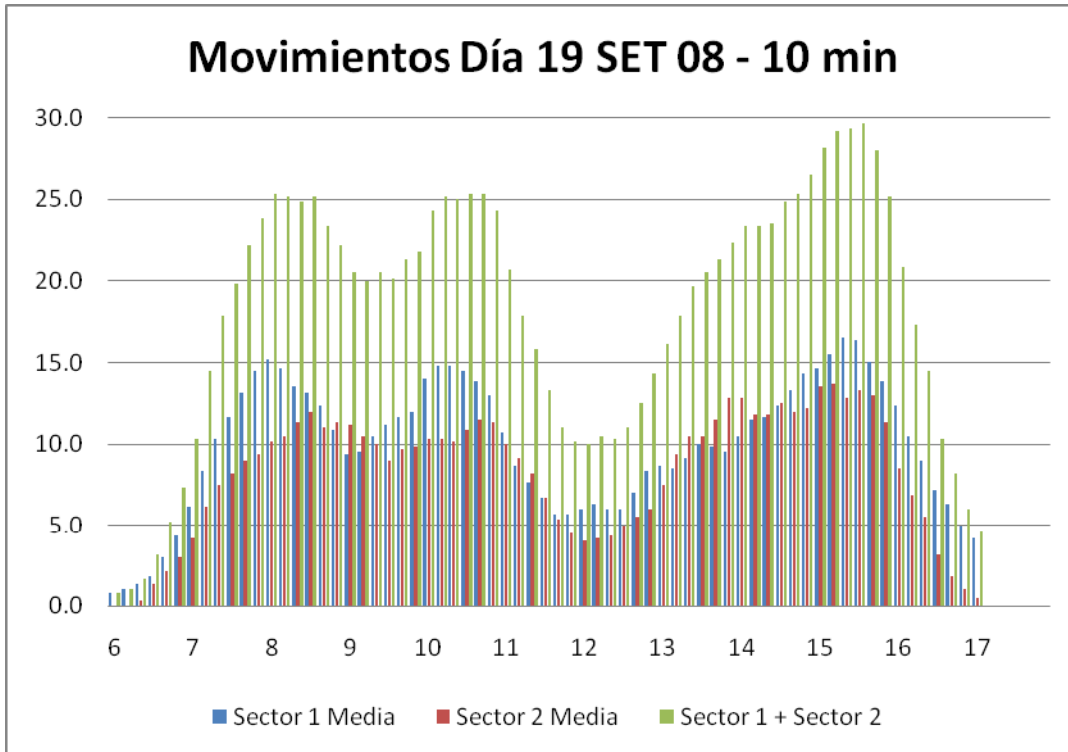
- a) review the information provided in this working paper;
- b) take into account the Brazilian experience, as an example of a collaborative project that should characterise most CNS/ATM systems and, in particular, ATM evolution, in which several organisations (ATM community) participated with the common objective of improving the safety and efficiency of aeronautical operations; and
- c) if deemed advisable, send this working paper to the group or project that will deal with surveillance matters, to be used as reference for the completion of its tasks and/or conduct studies or supplementary activities of relevance for the use of ADS-B OUT in the CAR/SAM Regions.

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**APPENDIX B / APÉNDICE B**

**AIR TRAFFIC MOVEMENTS OF TMA MACAÉ  
MOVIMIENTOS DEL TRÁNSITO AÉREO EN LA TMA MACAÉ**



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## APPENDIX C / APÉNDICE C

**NAVIGATION CAPACITY OF THE FLEET OPERATING IN THE CAMPOS BASIN  
CAPACIDAD DE NAVEGACIÓN DE LA FLOTA QUE OPERA EN LA CUENCA DE CAMPOS**

1- The table hereunder presents the predominant fleet operating at the Campos Basin, updated as of 01AU2008. The “Level” column indicates the type of equipment on board, in accordance with airworthiness approval requirements in ANAC (Agência Nacional de Aviação Civil) CI 21-013.

La tabla siguiente presenta la flota predominante que opera en la Cuenca de Campos, actualizada en 01AGO2008. La columna “Nivel” indica el tipo de instalación del equipo de bordo, de acuerdo con los requerimientos para aprobación de aeronavegabilidad previsto en CI 21-013 del ANAC (Agência Nacional de Aviação Civil).

2- Level 0 – Only VFR; Level 1 – En route IFR; Level 2 – En route and Terminal Area IFR; and Level 3 – Enroute, Terminal Area and non precision approach (NPA) IFR.

Nivel 0 – solamente VFR; Nivel 1 – IFR en ruta; Nivel 2 – IFR en ruta y Área Terminal; y Nivel 3 – IFR en ruta, Área Terminal y aproximación de non precisión (NPA).

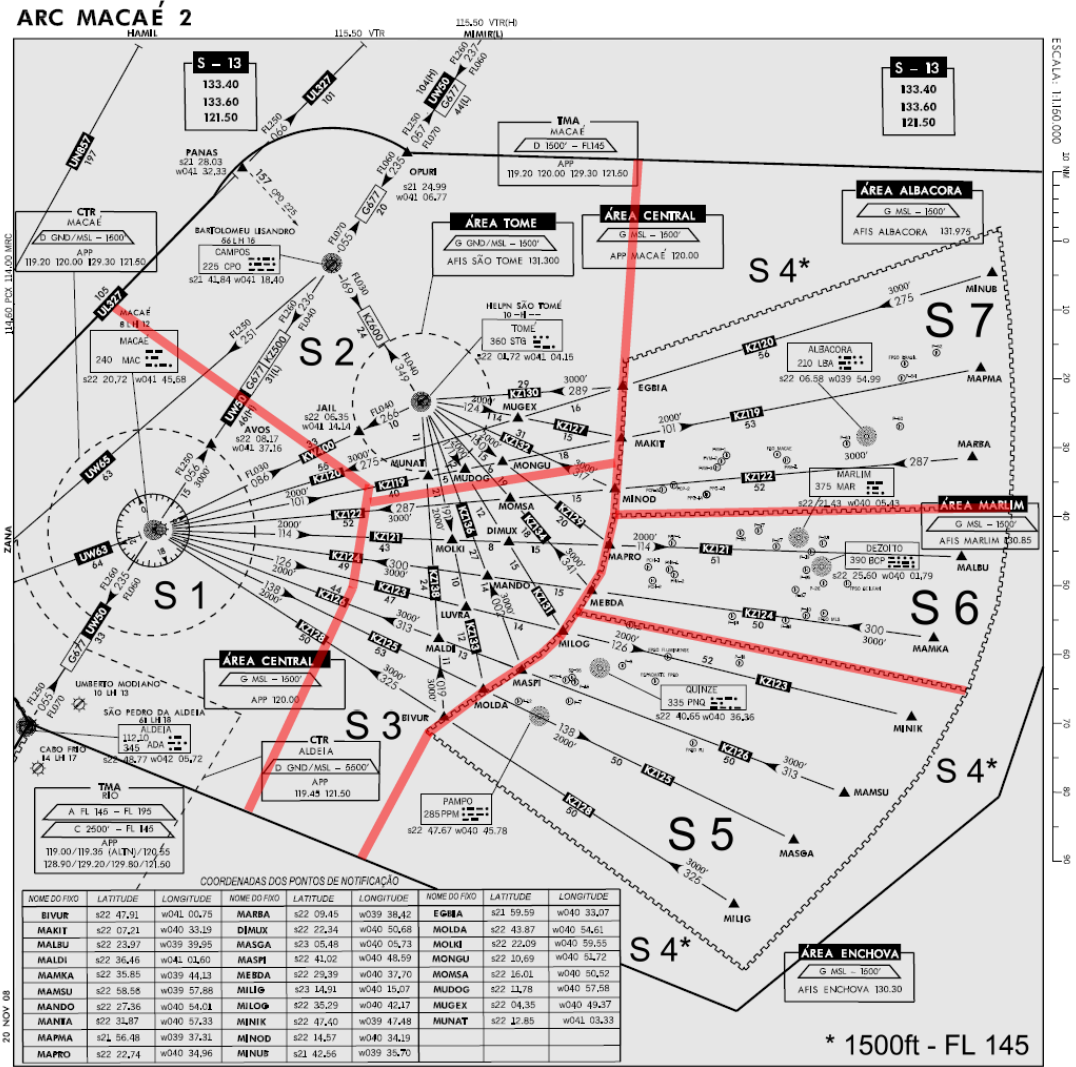
<b>Airline/ Empresa Aérea</b>	<b>Fleet/ Flota</b>	<b>Model/ Modelo</b>	<b>Level/ Nivel</b>
AERÓLEO	2	AS332L1	1
AERÓLEO	5	S76A	1
Atlas	1	S76A	0
BHS	2	AS332L2	3
BHS	2	S76A <sup>++</sup>	3
BHS	1	S76A <sup>++</sup>	2
BHS	2	S76C	2
BHS	7	S76C <sup>++</sup>	3
Castle	1	AS365N2	3
Helivia	2	AS365N3	3
Lider	1	Bell 212	0
Lider	1	Bell 412	0
Lider	2	S76A	0
Lider	1	S76A	1
Lider	10	S76C <sup>+</sup>	3
Lider	8	S76C <sup>++</sup>	3
OMNI	1	AS365N	0
OMNI	2	AS365N3	3
OMNI	1	Bell 222	0
OMNI	1	EC135	0
OMNI	1	S76A	0
Sênior	3	AS365N3	3
Sênior	3	AW139	3
Sênior/Castle	4	S76C <sup>+</sup>	3
<b>Total</b>	<b>64</b>	<b>Aircraft/Aeronaves</b>	

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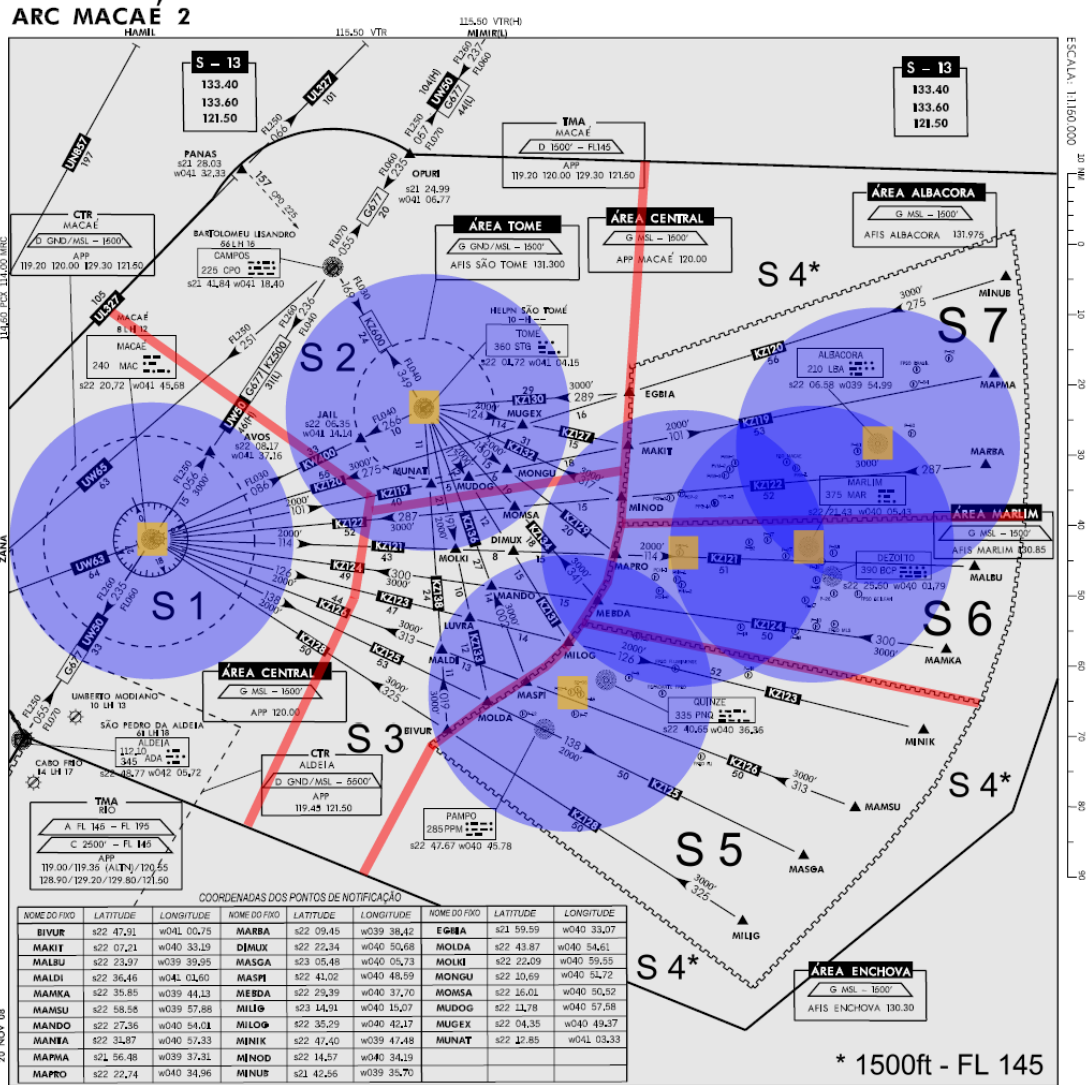
APPENDIX E / APÉNDICE E

NEW SECTORIZATION WITH ADS-B / NUEVA SECTORIZACIÓN CON ADS-B



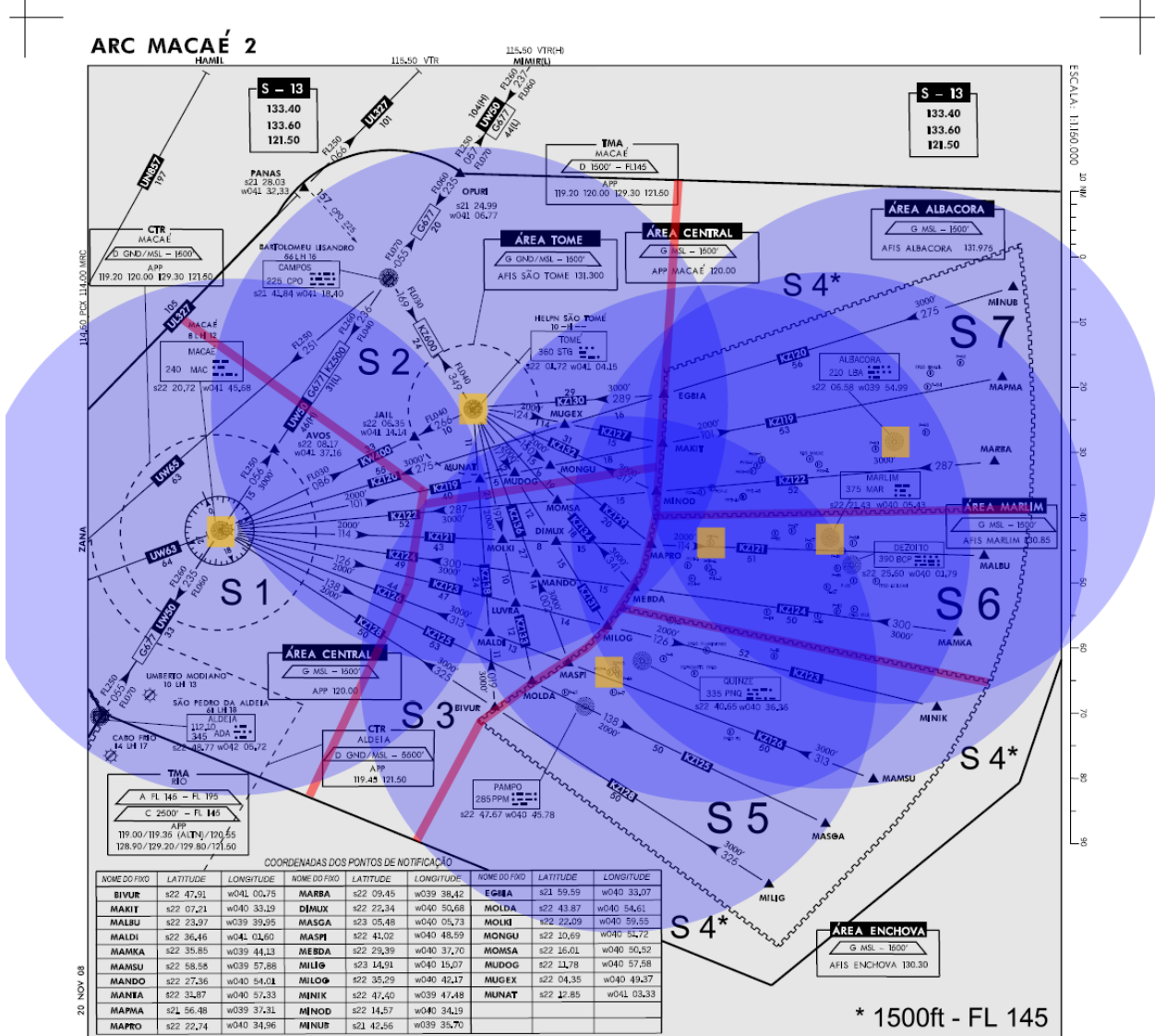
APPENDIX F / APÉNDICE F

ESTIMATED COVERAGE OF ADS-B – 100 FT /  
COBERTURA ESTIMADA DE LA ADS-B - 100FT



- F2 -

**ESTIMATED COVERAGE OF ADS-B – 500 FT /  
COBERTURA ESTIMADA DE LA ADS-B - 500FT**



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