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**International Civil Aviation Organization  
South American Regional Office**

**THIRD WORKSHOP/MEETING OF THE SAM IMPLEMENTATION GROUP  
(SAM/IG/3)  
REGIONAL PROJECT RLA/06/901**

**Lima, Peru, 20 to 24 April 2009**

**Agenda Item 3: Implementation of performance-based navigation (PBN) in the SAM Region**

**WGS-84 HORIZONTAL REFERENCE SYSTEM**

(Presented by the Secretariat)

**Summary**

This working paper presents information on the utilisation of horizontal reference (geodetic) for air navigation and its importance for performance based navigation (PBN).

**References:**

- Annex 4
- Annex 11
- Annex 14
- Annex 15
- Aeronautical Information Services Manual – Doc 8126
- World Geodetic System – 1984 – Doc 9674
- Performance Based Navigation (PBN) Manual (Doc 9613)

**1 Introduction**

1.1 Geodetic problems in air navigation were identified for the first time in the early 70s during the preparation of multi-radar follow-up systems, in processing radar trace data from radars located in different European countries, which hindered a visualisation of tracks, aimed at air traffic controllers. It was verified that the differences in radar trades came from incompatible geographical coordinates.

1.2 Also, in the mid 70s, during the trajectory experiments with the French System SAVVAN, (air navigation aids automatic flight check system) position changes were observed in switching between DME transponders located in different States. Once again, it was verified that errors arose from the incompatibility between ground aids coordinates.

1.3 Studies carried out upon this incompatibility agreed in indicating that if location coordinates of ground-based radars are obtained using two or more different geodetic references, the aircraft position in the horizontal plane shall be determined with two or more different latitude and longitude value sets. This could lead to the situation in which an aircraft near the boundary between two States, having different geodetic references, could be observed by the radars of both States as though it occupied different positions, and to the possibility that separation between aircraft were erroneously interpreted as well as safety limits regarding restricted areas.

1.4 Therefore, the main source of system errors comes from the lack of using a geodetic common reference to determine radar positions. The solution consists in obtaining the radar positions with a common geodetic reference system.

## 2 Discussion

2.1 From the above, it emerges that States have prepared their own geodetic references which usually differ from those of adjacent States. As requirements increased regarding the determination of distances further than national boundaries, new requirements emerged at a continental scale, as regards differences.

2.2 Observing the current situation in a route environment, the use of aids for ground-based navigation, with different reference frameworks, does not influence in a significant manner, since primary means for navigation, continue to be the signals of VOR or NDB, which define radial tracks to or from the radio beacon, with the turn points either in the beacon or to a distance determined by the DME.

2.3 In such circumstances, the coordinates published of the navigation aid do not influence in the aircraft track. However, this will dramatically change either in approach phase or landing phase or when reduced lateral separation between aircraft is applied; i.e., RNAV and RNP systems which present more strict precision and integrity requirements. Therefore, these discrepancies may not be tolerated and demand the introduction of a common geodetic reference system in civil aviation.

2.4 For this reason, ICAO Council, during its 26<sup>th</sup> period of sessions held during the month of March 1989, approved Recommendation 3/2 from the Fourth Meeting of the Special Committee on Future Air Navigation Systems (FANS/4) related to the adoption of the world geodetic system – 1984 (WGS-84) as a standard of geodetic reference for navigation of international civil aviation.

2.5 This Recommendation indicates that such standard should be incorporated into Annexes 4 and 15, so as to ensure a fast and complete implementation of the WGS-84 geodetic reference system. Further, during 1995, it was incorporated into Annexes 11 and 14.

2.6 In view of the above and complying with consecutive amendments in the above mentioned annexes, the body in charge of the aeronautical information service of States issues in its AIS publication, and also in its maps and electronically keeps in its databases, when applicable, the values of geographical coordinates and the vertical component, based on WGS-84.

2.7 First, two independent scopes may be used, or combined methods to transform the data of a topographic collection into WGS-84, presented in coordinates of adequate precision:

- a) Topographic survey of at least three control stations covering the area under study to obtain WGS-84 coordinates and determine the reference parameters between the local reference framework and the WGS-84.
- b) Determine, for all the remaining points, WGS-84 coordinates through the reference transforming estimate.

2.8 It should also be kept in mind the knowledge of geoid undulation to obtain aerodrome surveys, the runway thresholds, and touchdown and lift-off (TLOF) or of threshold of final approach and take-off (FATO) areas in heliports.

2.9 As regards actions carried out in the CAR/SAM Regions for WGS-84 utilization, during mid 90s, GREPECAS, with the support of the Aeronautical Information Services Subgroup defined the technical and administrative aspects aimed at facilitating regional implementation by CAR/SAM States, of the World Geodetic System 1984 (WGS-84) and the production of IFR/VFR aeronautical charts through geographical coordinates based on this system.

2.10 To date, States have made great efforts for the implementation of such system, and even so, the full use of the geodetic system by States has not been concreted. Taking into consideration such situation and keeping in mind that it is of utmost importance that the WGS-84 is the geodetic system to work with values of geographical coordinates and the vertical component, it is necessary to establish which the real situation in these matters is. To this end, **Appendix A** to this working paper proposes a form to make a survey to provide such information.

### 3 **Suggested action**

3.1 The meeting is invited to analyse the form and complete the information required, if necessary.

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## APÉNDICE A / APPENDIX A

## SEGUIMIENTO DE LA IMPLANTACIÓN WGS/84 EN LA REGIÓN SAM / FOLLOW UP WGS/84 IMPLEMENTATION – SAM REGION

ESTADOS /STATES	ARG	BOL	BRA	CHI	COL	ECU	GUY	FGU	PAN	PAR	PER	SUR	URU	VEN
<b>Parte I – Información General / Part I – General Information</b>														
1. ¿Actualmente su administración dispone de una base de datos nacional que incluya información de coordenadas WGS-84? / Does your administration currently have a national database including information on WGS-84 coordinates?		S		*					*				Y	
2. ¿El método de levantamiento topográfico utilizado para calcular las coordenadas geográficas WGS-84 que garantice la precisión e integridad requerida se realizó con por lo menos tres estaciones de control para determinar los parámetros de referencia entre el marco de referencia local y el WGS-84? / Was the topographic method used to estimate WGS-84 coordinates to ensure accurateness and integrity required, made with at least three control stations to determine referential parameters in the local referential framework and the WGS-84?		S		Sí*					Y				Y	
<b>Parte II – Coordenadas WGS84 de interés para la navegación aérea / Part II – WGS-84 coordinates of interest for air navigation</b>														
<b>Coordenadas de zonas/en ruta / Area coordinates/en-route</b>														
1. Puntos en ruta ATS/RNAV / ATS/RNAV en-route fix		S		Sí					Y				Y	
2. Puntos de referencia en ruta, /en-route reference fix		S		Sí					Y				Y	
Punto de espera; y / Holding pattern Fixed; and				Sí					Y					
puntos STAR/SID / STAR/SID fixed		P		Sí					Y					

ESTADOS /STATES	ARG	BOL	BRA	CHI	COL	ECU	GUY	FGU	PAN	PAR	PER	SUR	URU	VEN
3. Radioayuda para la navegación en ruta/ en-route radio navigation aids		S							Y				Y	
4. Zonas restringidas/prohibidas/peligrosas Restricted/Prohibited/Dangerous areas		S		Sí					Y				Y	
5. Obstáculos en ruta/ En-route obstacles		S		Sí					Y				N/P	
6. Límites de la FIR / FIR boundaries		S		Sí					Y				Y	
7. Límites de CTA / CTA boundaries CTZ		S		Sí					Y				Y	
8.Otros puntos significativos que tengan relación con zonas / en ruta / Other significant points having relationship with en-route areas		N		Sí					Y				N	
<b>Coordenadas de aeródromos/heliporto / Aerodromes-heliport coordinates</b>														
1. Puntos de referencia de aeródromo/ heliporto / Aerodrome-heliport reference point		S		Sí					**					
2. Umbrales de pista / Runway thresholds		S		Sí					Y					
3. Extremo de pista (punto de alineación de la trayectoria de vuelo)/ Runway end (flight trajectory alignment fix		S		Sí					Y					
4. Área de aproximación final y de despegue (FATO) / Approach and departure final area (FATO)		N		N/A					****					
Umbrales de la FATO / FATO thresholds		N		N/A					**** *					

ESTADOS /STATES	ARG	BOL	BRA	CHI	COL	ECU	GUY	FGU	PAN	PAR	PER	SUR	URU	VEN
5. Radioayuda para la navegación en el área terminal/ radio navigation aids in terminal areas		S		Sí					Y					
6. Radioayuda situada en el aeródromo/helipuerto/ Radio navigation aids located in the aerodrome/heliport		S		Sí					Y					
7. Puntos FAF; /Fixed FAF		S		Sí					**					
FAP; y/FAP and		S		Sí					**					
otros IAP esenciales/Other Essential IAP		S		Sí					**					
8. Puntos en el eje de pista/ Runway centerline points		N		Sí					N					
9. Puntos de eje de calle de rodaje/taxiway centerline points		N		Sí					Y					
10. Puntos de rodaje aéreo / air taxiing		N		N/A					N					
11. Puntos de vías de transito/air traffic points		N		N/A					N					
12. Puestos de estacionamiento de aeronaves/Aircraft parking position		P		Sí					Y					
13. Punto de verificación INS /INS checking fix		P		Sí					N					
14. Obstáculos en el área de circuito y en el aeródromo/helipuerto/ Obstacles in the circuit area and in the aerodrome-heliport		P		Sí					***					

ESTADOS /STATES	ARG	BOL	BRA	CHI	COL	ECU	GUY	FGU	PAN	PAR	PER	SUR	URU	VEN
15. Puntos de referencia y otros puntos esenciales para la aproximación final comprendido el procedimiento de aproximación por instrumentos/ Reference points and other Essentials fixes for final approach including instrument approach procedure		S		Sí					**					

Y = Yes/Sí  
 \* = Ver comentarios / See comments  
 N = No  
 P = Parcialmente / Partially  
 N/A = Not applicable / No aplicable  
 S/R = Without answer / sin respuesta

### COMENTARIOS DE LOS ESTADOS / COMMENTS BY STATES

ESTADOS / STATES	COMENTARIOS / COMMENTS
ARGENTINA	
BOLIVIA	STARs no publicadas./ STARs not published.
BRAZIL	
CHILE	1. La información se encuentra en WGS-84, pero aún no existe una base de datos nacional consolidada/Information Is in WGS-84 but there is not a consolidated nacional database yet. 2. Los levantamientos se han realizado en base a puntos pertenecientes a la red geodésica nacional del Instituto Geográfico Militar de Chile/Collegion of information has been made base don points belonging to geodetical network from the Military Geographical Institute of Chile. 4, 10, 11 No se aplica, pero de ser necesario se pueden obtener en WGS-84 / 4, 10, 11, Not applicable but if necessary, they may be obtained in WGS-84.
COLOMBIA	
ECUADOR	
GUYANA	
FRENCH GUYANA	

ESTADOS / STATES	COMENTARIOS / COMMENTS
PANAMA	<p>*TENEMOS LA INFORMACIÓN DE LOS LEVANTAMIENTOS, NO TENEMOS BASE DE DATO ELECTRÓNICA CON LA INFORMACIÓN. DE LOS AERÓROMOS./ We have the information on t he Collection, we do not have Electronic database with the information on aerodromes</p> <p>** PUNTOS TRANSFORMADOS EN MESA, PROGRAMA GEOTRANS V2.2.5./Points converted in GEOTRANS V2.2.5 programme</p> <p>*** SON OBJETO DE LEVANTAMIENTO LOS OBSTÁCULOS DENTRO DEL AEROPUERTO./Obstacles in the airport are subject to Collection.</p> <p>**** LOS HELIPUERTOS NACIONALES EL USUARIO PROPORCIONA LAS COORDENADAS WGS-84 Y NO PODEMOS ASEGURAR LA INTEGRIDAD Y PRECISIÓN/NATIONAL HELIPOINTS. the user provides WGS-84 coordinates and we may not ensure integrity and accurateness.</p>
PARAGUAY	
PERU	
SURINAME	
URUGUAY	<p>Por los ajustes en la red Sudamericana SIRGAS se entiende conveniente actualizar los datos para la verificación In view of adjustments in SIRGAS South American network it is pertinent to update data for verification.</p>
VENEZUELA	