



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

**ICAO RECOMMENDATIONS ON THE PUBLICATION OF INSTRUMENT PROCEDURES**

(Presented by IATA - LAN Airlines)

Summary	
<p>This working paper presents the text contained in Amendment 3 to Doc 8168, PANS OPS, Vol. II, I-2-I, paragraph 1.1, which proposes the need for instrument procedure designers to take into account certain variables to mitigate some of the problems users face when coding the navigation database.</p>	
<b>References:</b> <ul style="list-style-type: none"><li>• Annex 11 to the ICAO Convention</li><li>• Annex 4 to the ICAO Convention</li><li>• Doc 8168 Vol. 2</li></ul>	
<b>ICAO strategic objectives:</b>	<i>A – Safety</i> <i>C – Environmental protection</i> <i>D - Efficiency</i>

**1. Background**

1.1 Amendment 3 to Doc 8168 Vol. 2, PANS-OPS, effective 18 November 2010, modifies design criteria provisions to address coding issues of the navigation database of instrument flight procedures that appear in the aeronautical information publications (AIPs) of each country.

1.2 The text contained in Vol. 2, Part I, Section 2, Chapter 1, 1.1 states the following: “The introduction of, and growing demand for, RNAV procedures has been such that many pilots normally execute all instrument flight procedures using a guide based on the aircraft navigation database, regardless of whether the procedures are published as RNAV or as conventional procedures. However, not all conventional procedures may be coded in the navigation databases. This is especially true for departure procedures. In order to mitigate this problem and ensure a better capacity for conducting the flight, procedure designers should:

- a) Design all procedures as simple as possible;
- b) Develop RNAV instead of conventional procedures, whenever possible;
- c) Closely coordinate with navigation database providers each time conventional departure procedures are introduced;
- d) Ensure continuity between SIDs and the en-route structure, and between the en-

- route structure and the STARs and approaches, using a common reference and altitudes compatible with the interface;
- e) Avoid the use of duplicated segments, that is, a segment declared as part of a STAR and as part of an approach; and;
  - f) Avoid the use of segments with courses that intercept VOR radials with turns of less than 30°.”

1.3 Forty years have elapsed since a commercial aircraft equipped with a navigation database crossed the airspace for the first time in the early 70’s. Therefore, it seems relevant and appropriate to take into account the recommendations of the IFPP panel.

## 2. Analysis

2.1 For navigation database users, the aforementioned text contained in Amendment 3 reflects the problems that exist with many conventional procedures. Although the pilot has the duty to always check the procedure charts in paper format, it is also true that an on-board comprehensive and reliable database is the aspiration of every operator, since, in addition to routes and instrument procedures, it provides information on airports, runways, control frequencies, special use airspaces, and much more.

1.1 Existing regulations assign the operator the responsibility of documenting the navigation database validation process for operations based on PBN specifications. This process is essential for conducting a safe flight and is similar to the one carried out by the operator every 28 days to perform the coded conventional procedures in order to determine what procedures can or cannot be performed in an automated way. When performing this task, the operator must always consider that the coding process is very vulnerable and, although strict protocols and processes certified by the FAA and EASA are used, electronic data exchange between ANSPs and database coders is not yet available in the Region.

2.2 During these periodic checks, differences and inconsistencies have been identified between “paper charts” and the displays on the aircraft primary navigation screen, which, in the most serious cases, may result in confusion amongst the crew with respect to ATC clearances.

2.3 Furthermore, the storage capacity of older databases is very small, forcing the operator to select the information he/she wants or can store in it. Consequently, as new procedures and routes are published, the ANSPs must also make an effort to eliminate, in common agreement with the users and the ATC, those procedures no longer used.

2.4 Finally, problems get worse when instrument procedure charts and ATS route charts do not follow the recommendations of Annex 11 and Doc 8168 on the publication and content of each procedure (SID, STAR and IAC) for proper coding of both conventional and RNAV procedures.

### 3. **Suggested action**

3.1 The relevant organisations, instrument procedure designers, AIS, airspace planners and all those involved in this task are invited to adopt and follow ICAO recommendations on this issue. It is most likely that a large percentage of discrepancies that now exist between databases and instrument procedure charts will disappear with this action alone. Appendix A to this paper presents a compilation of recommendations, with the reference to the respective Annex or document. It also provides some examples that will facilitate the identification of problems, with a view to defining opportunities for improvement that may benefit the aeronautical community as a whole.

3.2 It is also suggested that the necessary steps be taken to allow ANSPs and regular operators to work together in each State to identify and resolve this and other problems that may arise in relation to the design and publication of instrument procedures. There is no doubt that the outcome of this effort will be excellent for all stakeholders.

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## Appendix A

### COMPILATION OF ICAO RECOMMENDATIONS ON THE DESIGN AND PUBLICATION OF INSTRUMENT PROCEDURES

#### 1. Annex 11 “Air Traffic Services”, Appendix 3 “Principles governing the identification of standard departure and arrival routes and associated procedures”

*“2.1.1 The plain language designator of a standard departure or arrival route shall consist of:*

- a) a basic indicator; followed by*
- b) a validity indicator; followed by*
- c) a route indicator, where required; followed by*
- d) the word “departure” or “arrival”; followed by*
- e) the word “visual”, if the route has been established for use by aircraft operating in accordance with the visual flight rules (VFR).*

*2.1.2 The basic indicator shall be the name or name-code of the significant point where a standard departure route terminates or a standard arrival route begins.*

*2.1.3 The validity indicator shall be a number from 1 to 9.*

*2.1.4 The route indicator shall be one letter of the alphabet. The letters “I” and “O” shall not be used.*

*3.1 Each route shall be assigned a separate designator.*

*3.2 To distinguish between two or more routes that relate to the same significant point (and therefore are assigned the same basic indicator), a separate route indicator as described in 2.1.4 shall be assigned to each route.*

*4.1 A validity indicator shall be assigned to each route to identify the route that is currently in effect.*

*4.2 The first validity indicator to be assigned shall be the number “1”.*

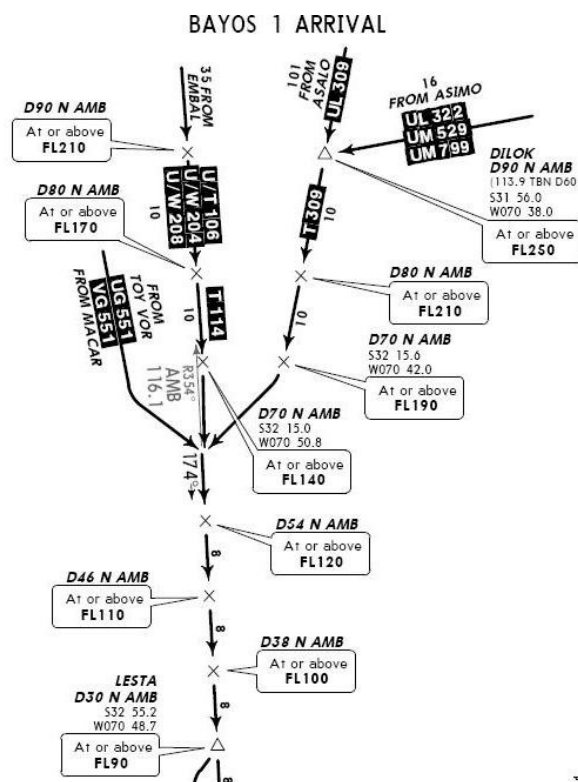
*4.3 Whenever a route is amended, a new validity indicator, consisting of the next higher number, shall be assigned. The number “9” shall be followed by the number “1”.*

**Example 1.A:** List of STARs in effect at an AD:

VOR/DME RWY 09 PIRA 5-POCOS 9 (STAR)  
VOR/DME RWY 09 PIRA 6-POCOS 10 (STAR)  
VOR/DME RWY 27 PIRA 7-POCOS 11 (STAR)  
RNAV (GNSS) RWY 09 PIRA 8-POCOS 12 (STAR)  
RNAV (GNSS) RWY 09 PIRA 9-POCOS 13(STAR)  
RNAV (GNSS) RWY 27 PIRA 10-POCOS 14 (STAR)

In order to distinguish the routes that start at the same significant point, in the previous example, a number instead of an alphabet letter has been assigned, and a validity indicator has not been included. This could lead to confusion if the operator does not have a clear understanding of the rules of the State publishing these procedures, who upon reviewing the database, which initially only shows a list of names, might think in a first instance that only the PIRA 10 - POCOS 14 STARs should be included in it, since they seem, because of their number, to be the latest versions (even that conclusion is erroneous because the validity indicator ends in the number 9). Likewise, when the authority introduces a significant change to this route, since there is no validity indicator, the change is not manifest just by seeing the name of the STAR, and the validation work becomes more difficult. The most important thing for States when following ICAO recommendations is that the operator must be able to clearly interpret the publications, regardless of the airspace being used.

**Example 1.B: STAR called “BAYOS 1”**



The STAR starts on different airways, thus at different points. None of the fixes associated to these airways is called “BAYOS”. In the navigation database, the coder decided to incorporate “transitions” to the STAR. Consequently, what is registered under “BAYOS 1” is only the common part of the STAR (from D54N). Then, the ATC authorises the “BAYOS 1” STAR and the pilot, knowing from what airway the descent is being initiated, will find the correct transition (MACAR, EMBAL or DILOK). This STAR has routes that start at different points and therefore should also have different names. This procedure has three different routes that are clearly identifiable, and which are used under the name “BAYOS 1”. Each route does not receive a separate name.

## 2. Doc 8168 VOL II, PANS OPS, “Appropriate data to support navigation database coding”

Annex 4 “Aeronautical Charts” indicates: “The appropriate data to **support navigation database coding** will be published on the back of the chart or on a separate sheet, with the appropriate references, according to the Procedures for Air Navigation Services – Aircraft Operations (PANS-OPS, Doc 8168), Volume II, Part III, Section 5, Chapter 2, 2.3, for RNAV procedures, and Volume II, Part I, Section 4, Chapter 9, 9.4.1.3, for non-RNAV procedures.

Volume II, Part I, Section 4, Chapter 9, 9.4.1.3 indicates: “**Aeronautical database requirements.** *For non-RNAV approaches, the following data will be published in table format on the back of the ICAO instrument approach chart or on a separate sheet with the appropriate references:*

- a) *fixes/final approach points and other fixes/essential points contained in the instrument approach procedure, identified with their **geographical coordinates** in degrees, minutes, seconds and tenths of a second;*
- b) *bearings for determining the fixes for instrument approach procedures, rounded off to the closest hundredth of a degree;*
- c) *distance for the determination of fixes for instrument approach procedures, rounded off to the closest hundredth of a nautical mile;*
- d) *for non-precision approaches, the final approach angle of descent rounded off to the closest hundredth of a degree.”*

Items b), c) and d) above are generally published in the approach charts, but lack the necessary resolution to verify that the approach procedure has been well coded. In the navigation database, each point determined in the conventional way by the procedure designer (based on bearings and distances) becomes a geographical coordinate. Since States do not publish them officially, the database coder makes a calculation that may not be 100% consistent with what the designer intended. The differences that have been identified by no means put the aircraft outside of the corresponding obstacle assessment area, but, once again, verification by the operator is made difficult due to lack of this fundamental piece of information.

Volume II, Part III, Section 5, Chapter 2, 2.3 lists the **requirements for the publication of the aeronautical database for RNAV approach procedures**. The cited text recommends that the data be published as a “table or formal descriptive text” on the back of the chart or on a separate sheet with the appropriate references. Volume II, Part III, Section 5, Chapter 1, 1.5 contains examples of how these tables or texts must be published in order to avoid ambiguities and interpretation errors. Items 2.1 and 2.2 contain the data required for the publication of RNAV SIDs and STARs, respectively.

States need to adopt standard methods for making these publications. Given the growing number of RNAV publications, it is very difficult for database operators and coders to fully understand the publication method used by each particular provider. Just as important as standardising the certification or clearance of RNAV procedures is the standardisation of their publication. In an RNAV procedure, not only geographical coordinates are important for interpreting and implementing the procedure originally assessed by the designer.

### Table III-5-1-1 Illustration of the formal and abbreviated description method

<i>Descriptor de trayectoria</i>	<i>Identificador de puntos de referencia (Nombre de punto de recorrido)</i>	<i>Sobrevuelo</i>	<i>Rumbo °M (°T)</i>	<i>Dirección de viraje</i>	<i>Altitud</i>	<i>Límite de velocidad</i>	<i>Variación magnética</i>	<i>Ángulo vertical/ altura de franqueamiento del umbral</i>	<i>Performance de navegación</i>
IF	SUSER	—	—	—	+5 000	250	—	—	RNP 1
TF	CV023	—	258 (256,0)	—	4 000	—	—	—	RNP 0,3
TF	CV024	—	348 (345,8)	—	2 680	150	—	—	RNP 0,3
TF	RW35L	S	348 (345,8)	—	370	—	—	-3,0/50	RNP 0,3
FA	RW35L	—	348 (345,8)	—	+770	—	+2,2	—	RNP 0,3
DF	SUSER	S	—	L	+5 000	—	—	—	RNP 1

Directo a ARDAG a 3 000 ft	→ARDAG[A3000 ]	DF	N
Hasta <u>PF035</u> a o por debajo de 2 000 ft	PF035[A2000-]	TF	S
Hasta PF025 a o por debajo de 4 000 ft, continuar con rumbo de la aeronave 265°M y esperar vectores radar	PF025[A4000], [HDG, M265]	TF, VM o FM	N
Hasta OTR en rumbo 090°M a 210 kt	OTR[M090; K210 ]	CF	N
Hasta <u>DF006</u> a 2 000 ft como mínimo, 4 000 ft como máximo, velocidad mínima 210 kt	DF006[A2000+; A4000-; K210+]	TF	S
Hasta PD750 a 250 kt, viraje a la derecha con radio de 3,7 NM hasta PD751	PD750[K250 ]-PD751[R, 3.7, 0543451.2N 0021234.7E]	TF, RF	N, N
Hasta <u>STQ</u> en o por encima de FL 100, viraje a la izquierda directo a WW039 en o por encima de FL 070, hasta WW038 a o por encima de 5 000 ft	STO[F100+; L]→WW039[F070+]-WW038[A5000+]	TF, DF, TF	S, N, N

Table III-5-1-2 Illustration of the table description method

### 3. Doc 8168 VOL II PANS OPS, “Denomination of procedures for arrival and approach charts” (Vol. II, Part I, Section 4, Ch. 9, 9.5)

A summary of the recommendations contained in the aforementioned chapter and that directly affect the way in which the name of the approach procedure is presented to the operator in the navigation database, follows. As stated in the PANS OPS, these recommendations only try to “avoid



ambiguities between charts, electronic displays in the cockpit, and ATC clearances”:

- The procedure identification must only contain the name describing the type of radio aid that provides **lateral guidance in the final approach**.
- If two radio navigation aids are used as lateral guidance in the final approach, the title shall only include the **last radio navigation aid** used, for example: if an NDB is used as final approach fix and a VOR is used as the last navigation aid during the final approach to runway 06, the procedure will be identified as **VOR RWY 06**. If a VOR is used for the initial approach and then an NDB is used for the final approach to runway 24, the procedure shall be identified as **NDB RWY 24**.
- If additional navigation aids are required for the approach procedure, the corresponding **additional equipment** requirements shall be specified in the chart plan view, not in its title. For example: “ADF required” in a VOR approach, “DME required” in a VOR approach.
- Double identification of procedures. When two or more procedures to the same runway are not distinguishable by the type of radio navigation aid, a one-letter suffix will be used, starting with the letter Z, after the corresponding type of radio navigation aid, for example: ILS Y RWY19, ILS Z RWY 19, VOR Y RWY20, VOR Z RWY20. Since some avionic systems are only capable of containing **one approach for each type of aid in each runway**, States should make sure that they identify the preferred approach with the suffix Z.

When these recommendations are not followed as described above, the navigation database does not show the name as published in the chart, and the system is not capable of containing an approach with the name “LCTR ILS DME RWY 29”. Consequently, a new name is generated containing fewer characters and, generally, the navigation aid on which the lateral guidance for final approach is based.

<b>Example:</b>	<b>Procedure denomination</b>	<b>Advanced database</b>	<b>Limited database</b>
	N°1 VOR DME ILS DME RWY 29	ILS29-1	ILS29
	N°2 LCTR ILS DME 29 RWY 29	ILS29-2	Not coded
	N°4 VOR (DME) LO LI RWY 13	VOR13 -4	VOR13 (*)
	Delta 1 RWY 09R VOR/DME	VOR09R1	VOR09R
	Delta 3 RWY 27L VOR	VOR27L3	VOR27L
	Delta 4 RWY 27R VOR	VOR27R4	VOR27R
	Delta 5 RWY 09L VOR/DME	VOR09L5	VOR09L
	ILS Z RWY 27L	ILS27LZ	ILS27L
	CHARLY 7 RWY 27L ILS	ILS27L7	Not coded
	ILS Y RWY 17L	ILS17LY	Not coded
	ILS Z RWY 17L	ILS17LZ	ILS17L

(\*) In this procedure, the lateral guidance for the final approach is provided by the NDB, but the coder, when seeing the title on the State chart, designates it as a VOR procedure.

#### 4. Doc 8168 VOL II PANS OPS, “General” (Vol. II, Part I, Section 2, Ch. 1, 1.1.4)

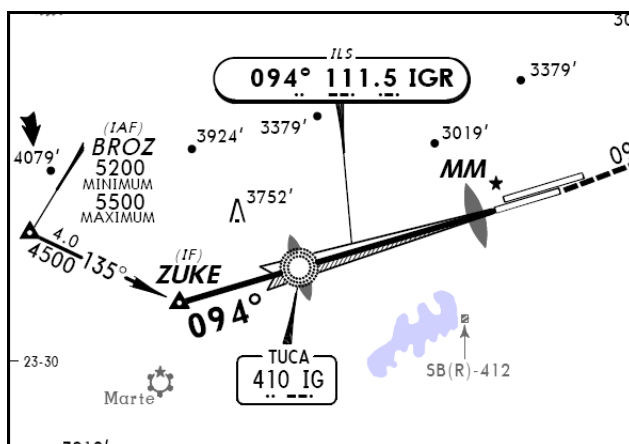
Regarding the recommendations of PANS OPS VOL II on navigation database coding, there are two worth noting, since failure to apply them would result in many procedures being interpreted by the coder, some procedures not being clearly coded, and others simply not being coded. The recommendations are as follows:

*“Ensure the continuity between SIDs and the en-route structure and between the en-route structure and STARs and approaches, using a common reference and consistent altitudes at the interface.”*

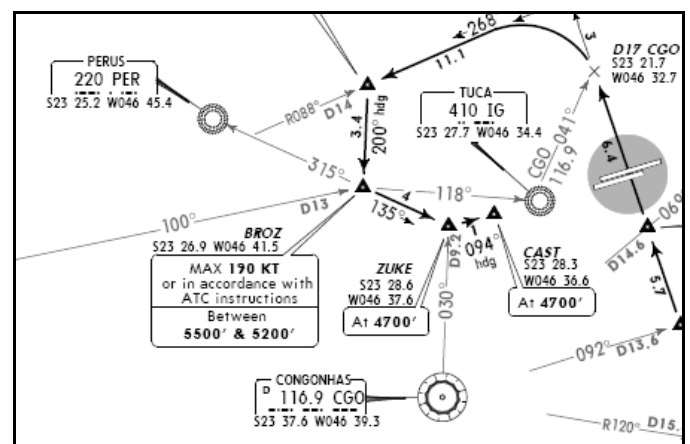
*“Avoid the use of duplicated segments, that is, a segment designated part of a STAR and part of an approach.”*

It is common to find STARs that do not end in the IAF, or SIDs that intercept airways at undefined points, or segments that repeat themselves between a STAR and the approach, even using different altitudes. In order to “understand” the route to be followed, the navigation database must have logical “continuous” data that will allow it, for example, to leave an AWY at a given point and to start a STAR at that point. In that manner, the FMS can properly plan the speeds and points of descent. When there is no continuity between two segments, the pilot must manually intervene in the system, thus wasting on-board planning capabilities, increasing the workload, reducing the possibility of having a consistent flight plan in terms of time and fuel, etc.

#### Example 4.A:

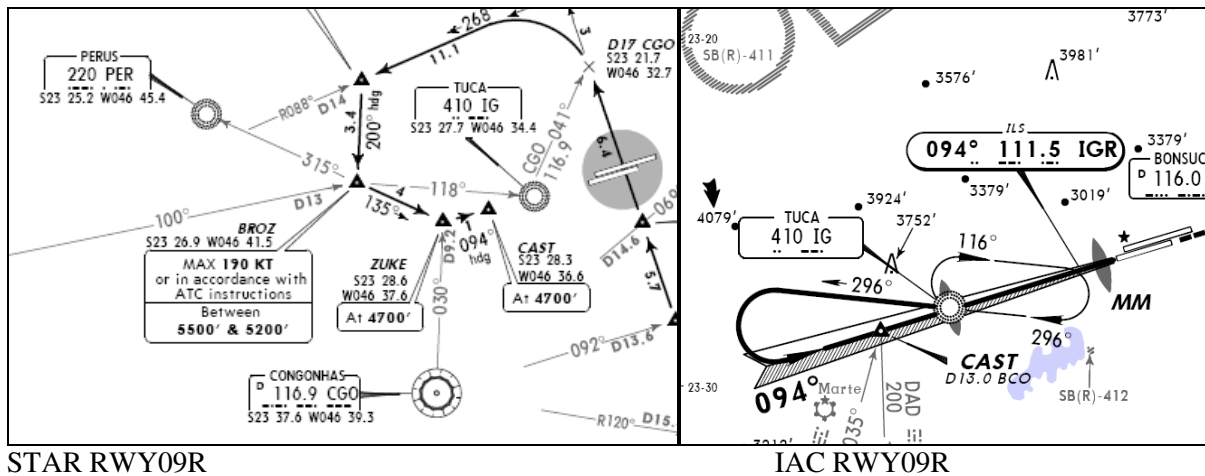


APCH ILS-Z RWY09R



STAR RWY09R

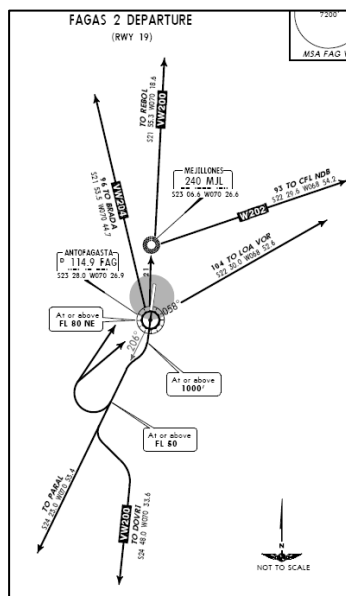
The segment BROZ- ZUKE repeats itself in the STAR and the IAC, but the STAR does not end in BROZ but in CAST, a point that is not described in the approach; the point CAST is described in another approach that does not start in BROZ.



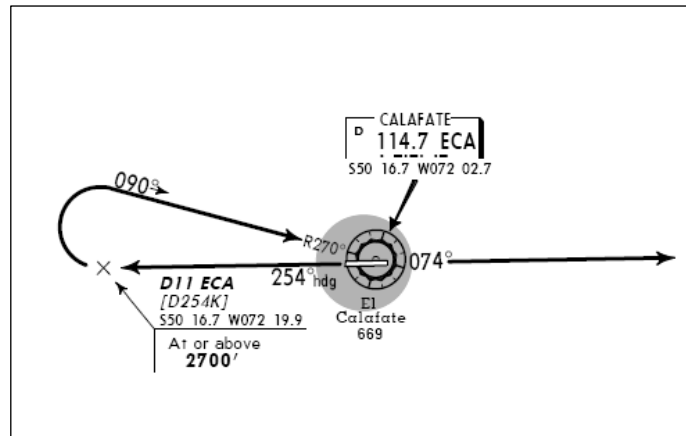
### Example 4.B:

This instrument departure, denominated FAGAS 2, indicates in its text: “*Climb on RWY HDG up to 1000FT then turn right to intercept and climb on R206 FAG VOR/DME up to FL50, **then proceed as authorised by the ATC.***”

The common segment of the SID really ends in FL50, after which there is the possibility of intercepting four different routes towards radio aids or intersections that connect to airways. This cannot be coded in the database, since the interception of each airway is not described and the four different routes to get to them have the same name. Therefore, it is only coded up to FL50. Thus, for the FMS, there is a gap in the information that must be filled manually by the pilot. In summary, this SID is not connected to the AWYs.



**Example 4.C:** This SID states in its text (for both runways) “climb on R074 to 6600FT” and then turn right or left and intercept any of the airways that converge in the TMA. Since the SID does not end in defined points of a route, there is an information gap in the database, reason why the SID is not coded.



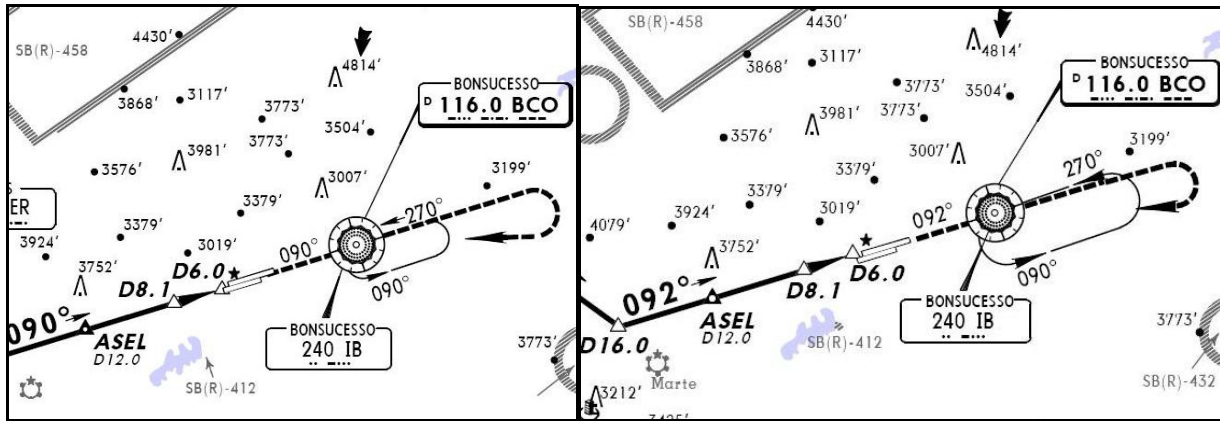
## 5. Annex 11 “Air Traffic Services” Appendix 2 “Principles governing the establishment and identification of significant points”

### 3. “Designators for significant points not marked by the site of a radio navigation aid”

3.1 “Where a significant point is required at a position not marked by the site of a radio navigation aid, and it is used for ATC purposes, the significant point shall be designated by a unique five-letter pronounceable “name-code”. This name-code designator then serves as the name as well as the coded designator of the significant point”.

3.4 “The unique five-letter pronounceable name-code designator **assigned to a significant point shall not be assigned to any other significant point**. Where relocation of a significant point is required, a new name-code designator shall be selected. If the State wants to keep the assignment of specific name-codes to re-use them in a different location, said name-codes will not be used for a period of six months.”

Publications still contain some significant points geographically located in different positions that use the same designator. It is possible to code them in the navigation database by just inserting “some difference” between them to avoid this duplication.

**Example 5:**

ASEL in VOR09R, R270/D12

ASEL in VOR09L, R272/D12

Point ASEL (FAF) is described in two VOR approaches to parallel runways, using the same radio aid: on R272 to one runway, and on R270 to the other. Since their coordinates are different because their geographical locations are different, they are recorded as ASEL1 and ASEL2 in the navigation database.

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