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Area Navigation in Terminal Airspace - Database Coding Issues

A short overview about RNAV procedure coding versus conventional procedure coding

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Historical Review

- Databases in use for more than 25 Years
- Developed to support Flight Management Systems
- Storage Capacity of the Onboard Computers was (is) limited
- Coding Procedures were incomplete
- FMS originally certified as advisory Systems
- Enroute, the only computer guided phase of flight
- Lack of Standards

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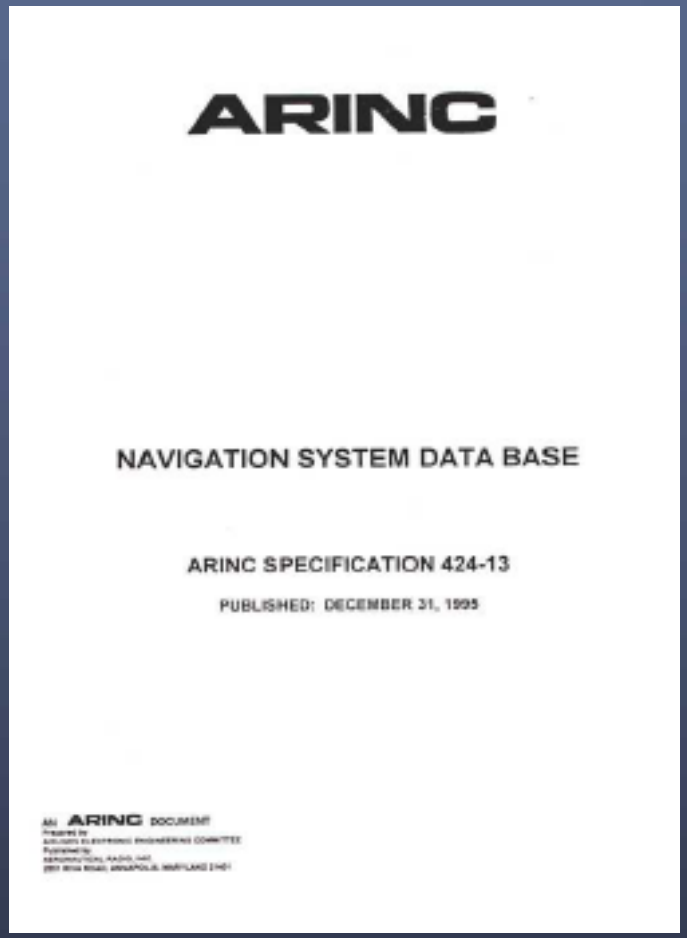
Navigation System Database



ARINC Specification 424

- Standard for Preparation and Transmission of Data for assembly of Airborne Navigation System Databases.
- Specification for navigation data files. It defines the file format, content and the specific coding rules.

Operational Environment Changed

- Data Reliability and Integrity better than ever before
- Evolution of Computer Technology
- Global Navigation Satellite Systems (GNSS)
- New Approach Systems and Technologies
- Improved Availability of Aeronautical Reference Data

Use of ARINC 424 Versions

- ARINC 424 data files are used to support a wide variety of different FMS systems
- The ARINC 424 is updated with supplements by a user committee - result : different versions in use *(currently ARINC 424-15; version 16 in preparation)*
- Different avionics manufacturers and database suppliers may use different ARINC 424 versions, especially when they have to support older equipment.

ARINC 424 - Terminal Procedures

- The Path and Terminator Concept is a means to permit coding of SID, STAR and Approach Procedures w/o proliferating the number of Waypoints

- The path of an aircraft is defined with the so called "path terminators". They include flying to fixes (direct or on a fixed course), fly on a course or heading until reaching an altitude or distance and more.

Path and Terminator

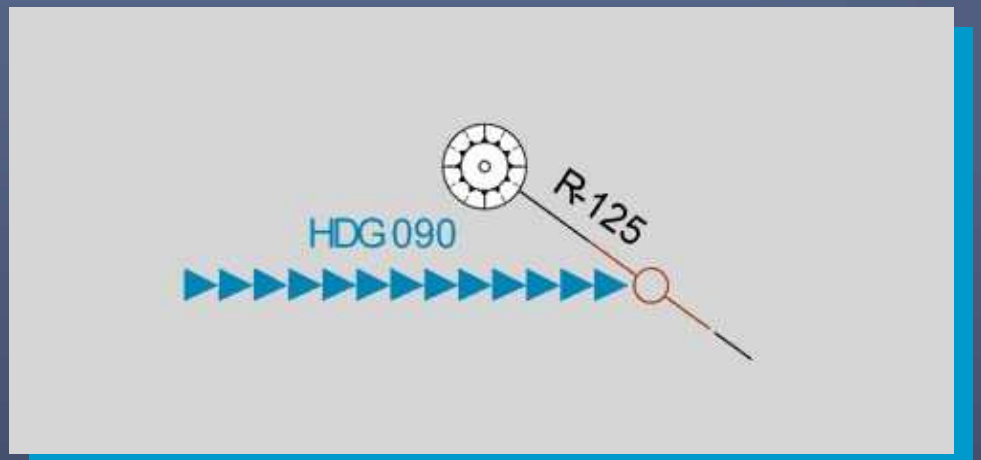
- **Path**
  - how do you get there *(Heading, Course etc.)*
- **Terminator**
  - the event or condition that causes leg sequencing *(Radial, Altitude, Distance,etc.)*

Note: Permitted leg sequences within individual procedures are defined !

- *At present 23 different Path Terminators exist*

Path Terminator Samples

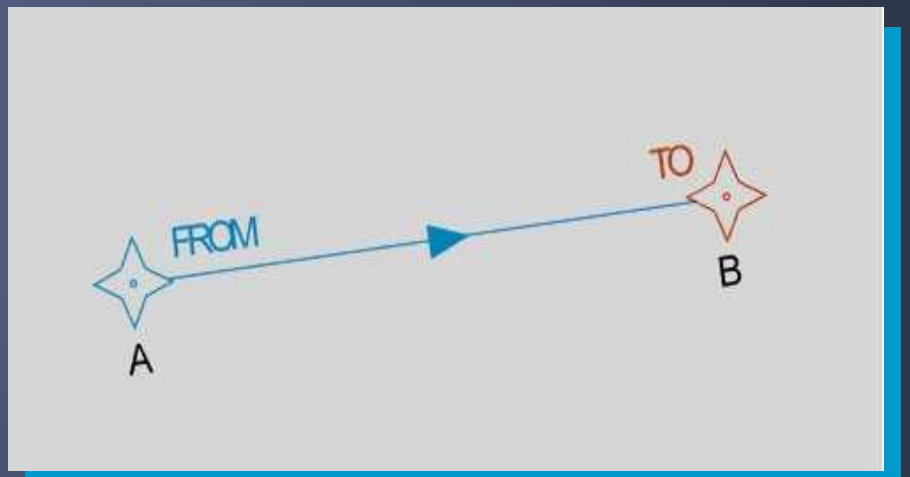
- Heading to a Radial Termination



VR leg

Path - Heading 090°
Terminator - Crossing the VOR 125 Radial

- Track between two Fixes

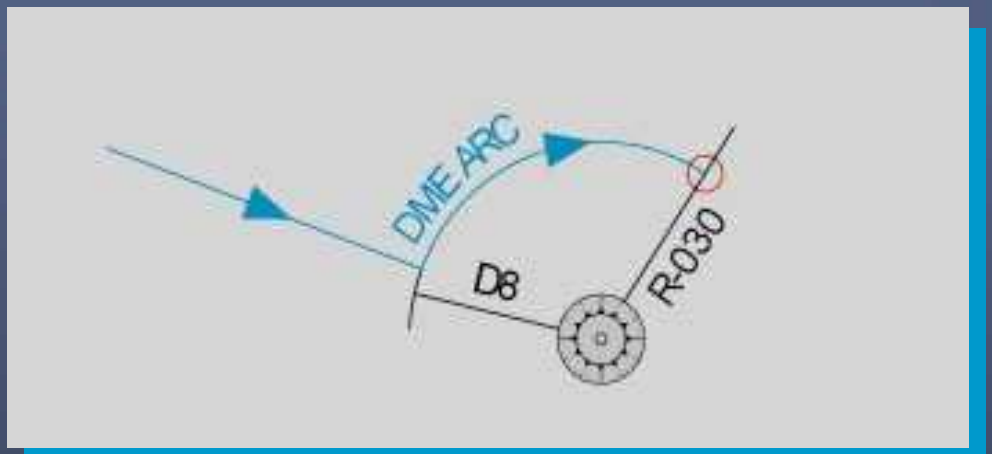


TF leg

Path - Great Circle Course between Waypoints
Terminator - Passing the “To” Waypoint

Path Terminators Sample (cont,d)

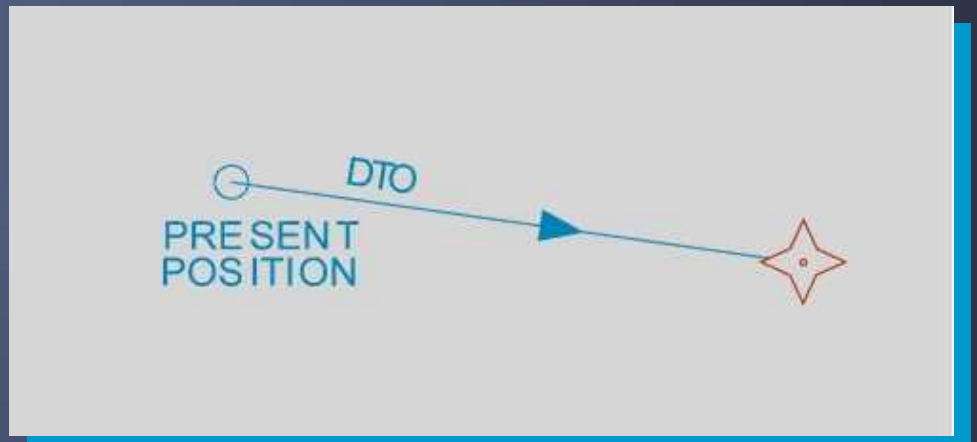
- Constant DME Arc to a Fix



AF leg

Path - DME Arc
Terminator - Fix at Terminating Radial

- Computed Track Direct to a Fix

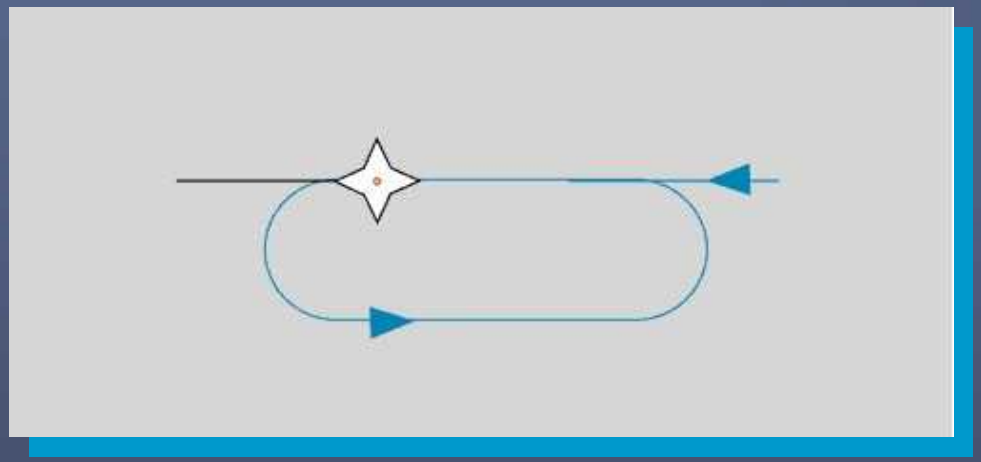


DF leg

Path - Great Circle Course from Present Position to the "To" Waypoint
Terminator - passing the "To" Waypoint

Path Terminators Samples (cont,d)

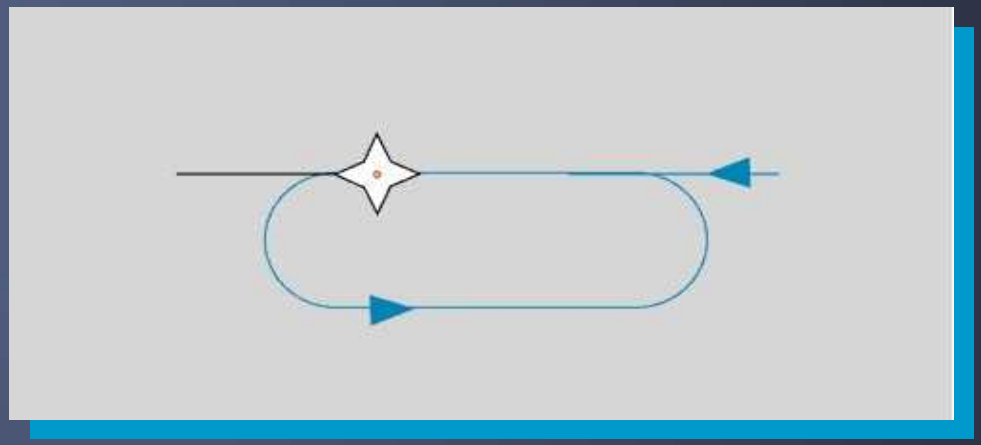
- Hold to a Fix



HF leg

Path - Holding Pattern
Terminator - 2nd Fix Crossing
(One Circuit in the Hold)

- Hold to an Altitude



HA leg

Path - Holding Pattern
Terminator - Terminating Altitude
(e.g. Climb in the Holding Pattern)

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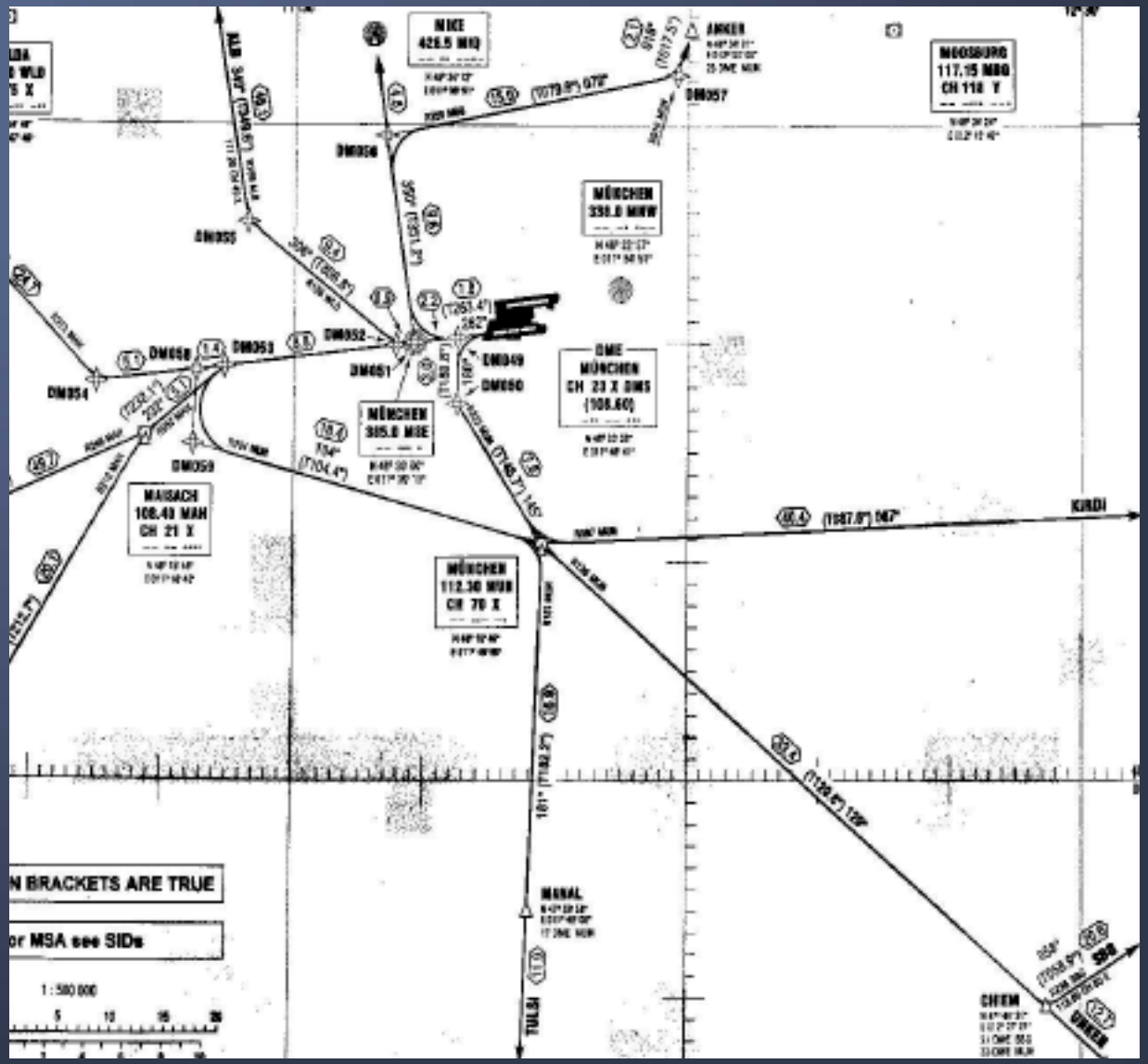
Coding of RNAV Procedures

- Point to point navigation - coding of these procedures is easy, assumed source data are complete
- ARINC 424 - there is only one way to code a given procedure
- High accuracy - used path terminators reflect best government source
- Concept accommodates performance capabilities of various aircraft types

Example of RNAV SID

- *After take-off, the aircraft flies from point to point.*
- *All waypoints are named and published.*



Conventional Procedure Coding

- Deficiencies:
  - Common Waypoint name for several single locations
  - Unnamed/ incorrect named Fixes
  - DME Fixes without Waypoint Names
  - Final Approach Capture Fixes unnamed
  - Some trajectories or conditions are impossible to code
  - Waypoints/ Fixes need to be calculated

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Conventional Procedure Coding

⇨ Different interpretations possible:

- Use of calculated Waypoints
- Use of different Path Terminators
- Conditions such as “which ever is earlier” or “whichever is later”
- Performance data, if other than ARINC standard, often missing *(speed, bank angle, climb rate etc.)*

Conventional Procedure Coding

⇨ Different interpretations possible *(cont'd)*:

- Interception procedures/ length of outbound legs not specified

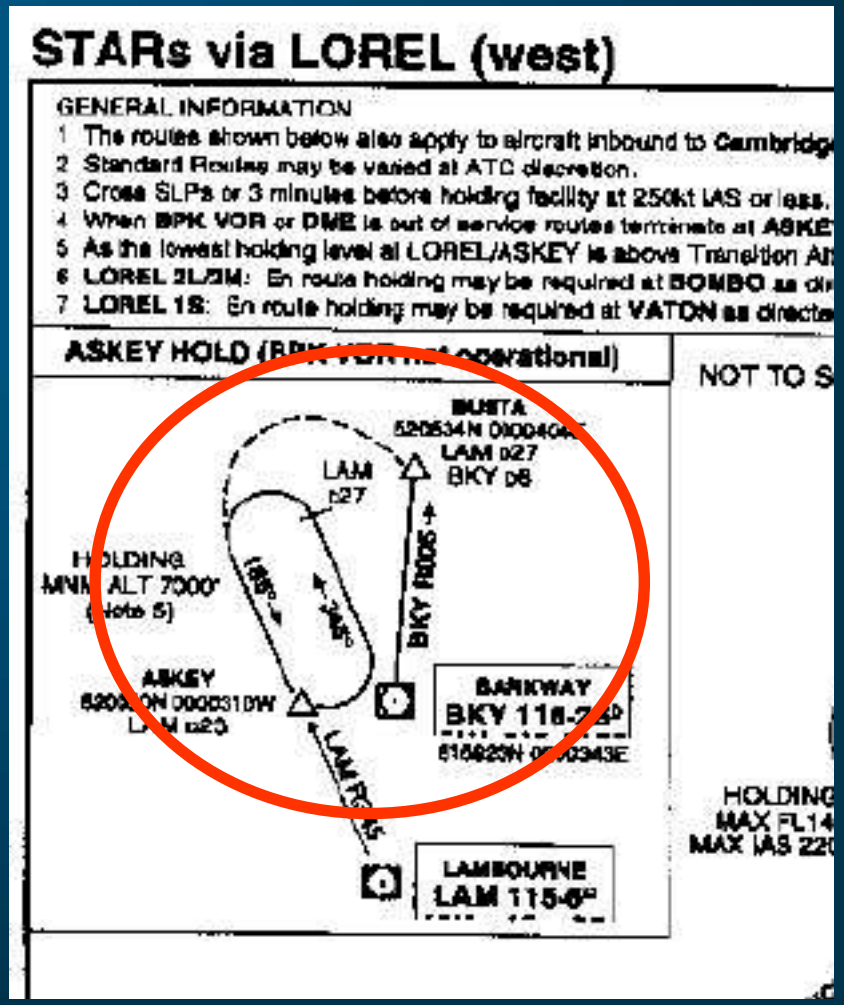
- Creation of different database identifiers

- Heading/ Track interpretation

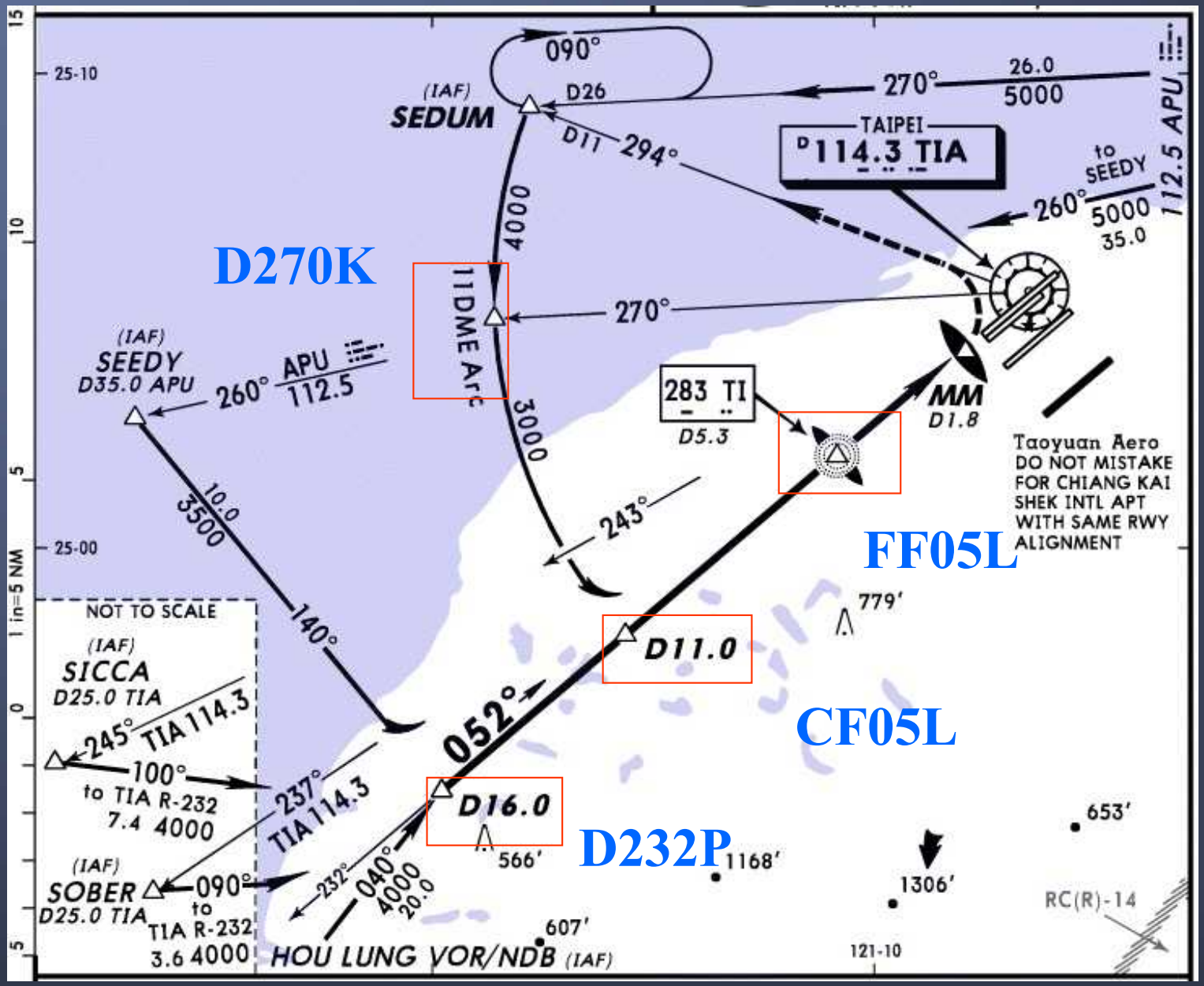
Example of Conventional STAR

Due to the large distance between BUSTA and R 345 LAM, the Radial will be intercepted south of ASKEY, instead north of the holding fix.

(Speed 180 kts; bank angle 25 and intercept angle 45 degrees)



Creation of Database Identifiers



A specific Coding Issue

- SID text

"… on RWY track to 2000 ft or 1.9 DME
RTH whichever is earlier, turn left ..."

- Coding decision

(A 2000) + 1.9 or 1.9 + (A 2000) ?

Jeppesen Editing Tool

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Operational Requirements

Today, there is greater need for Standardization and for clear and effective Guidance in the Development of Aeronautical Information

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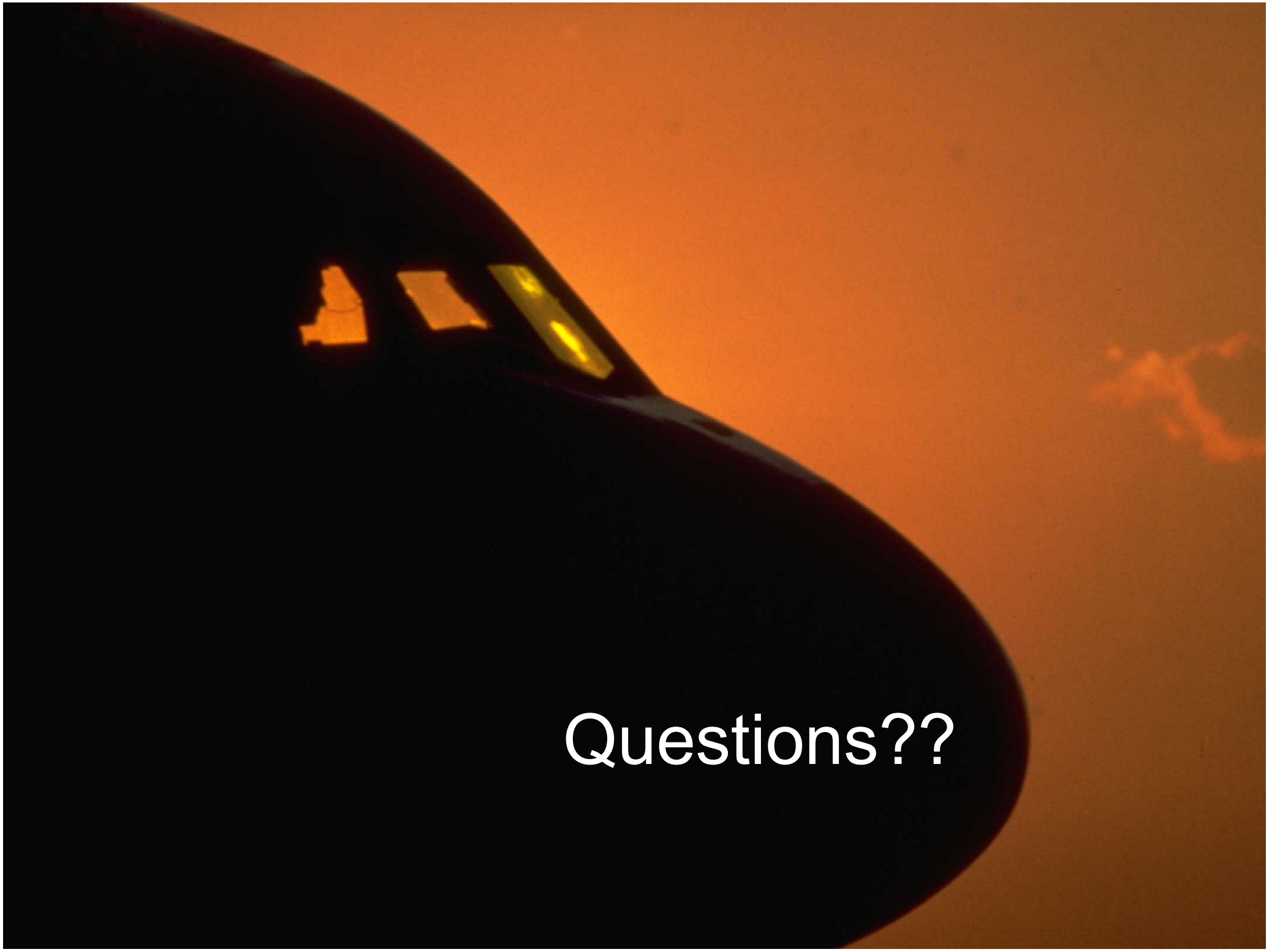
Summary

- Aeronautical Information supporting all Operations especially RNP RNAV Operations
- The Data should be accurate, timely and designed to permit the users to achieve the required navigation performance accuracy
- Knowledge about the manifold connections between aeronautical data, their processing and their application is required


Questions??