Validation & Implementation Considerations

Module 14 – Activities 11 to 17

European Airspace Concept Workshops for PBN Implementation

Objective

- This module provides an overview airspace and Flight Procedure validation. It addresses Implementation considerations for PBN Airspace Concepts/

Why Do Validation?

- Validate Airspace concept and resulting Procedure
- Assess if ATM objectives are achieved
- Confirm flyability of Instrument Flight Procedures
- Identify possible problems and develop mitigations
- Provide evidence design is safe
- Validation is an ongoing process

Caution

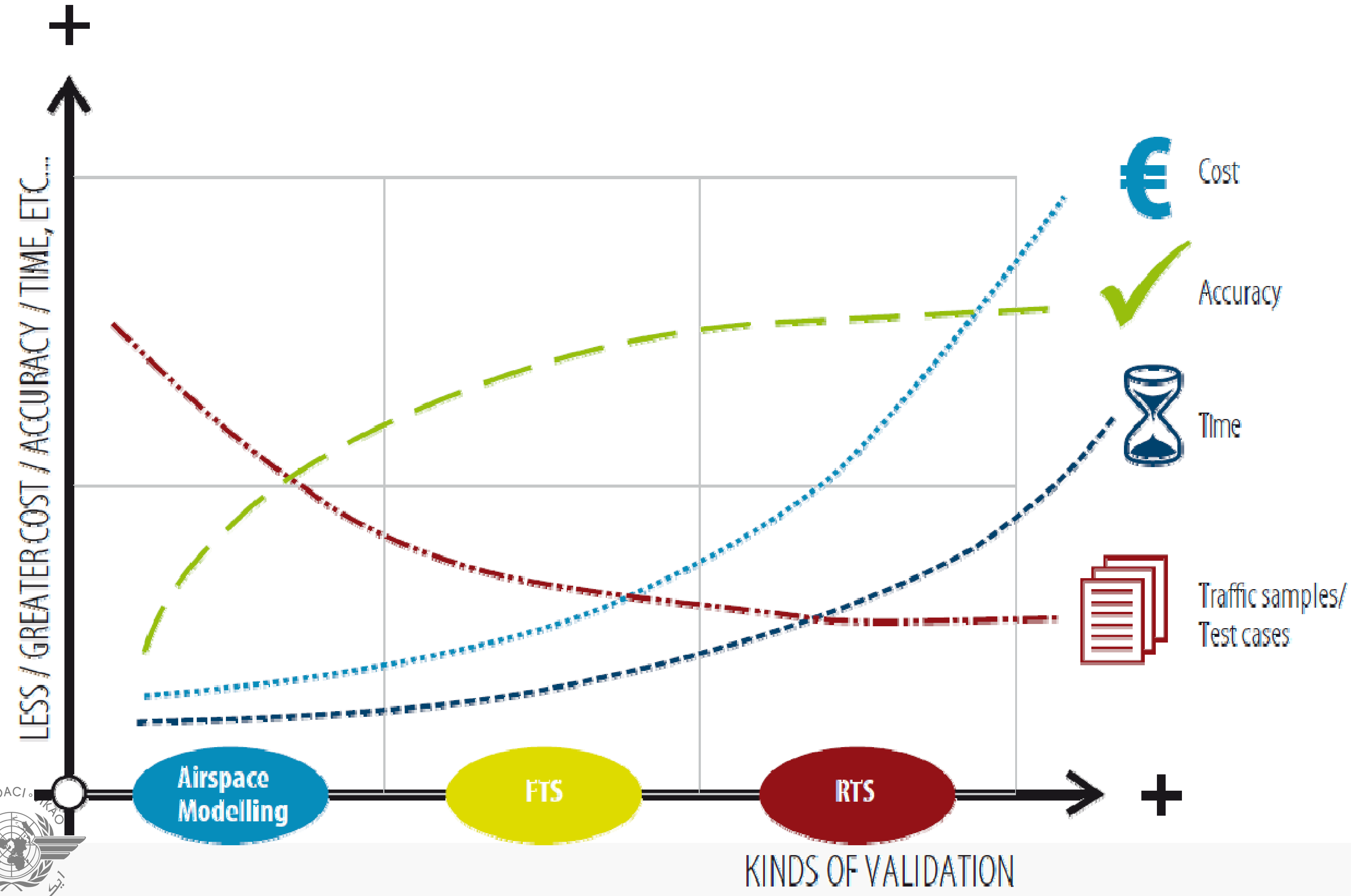
RUBBISH IN RUBBISH OUT!!!

Validation methods

- Airspace
- Chalk and talk (pencil and paper)
- Modelling
- FTS
- RTS
- Flight Procedures
- Ground checks
- PC based simulation
- Full Flight simulators
  - FMS simulator (Smiths)
- Live trials

Chalk and Talk

Concept Validation



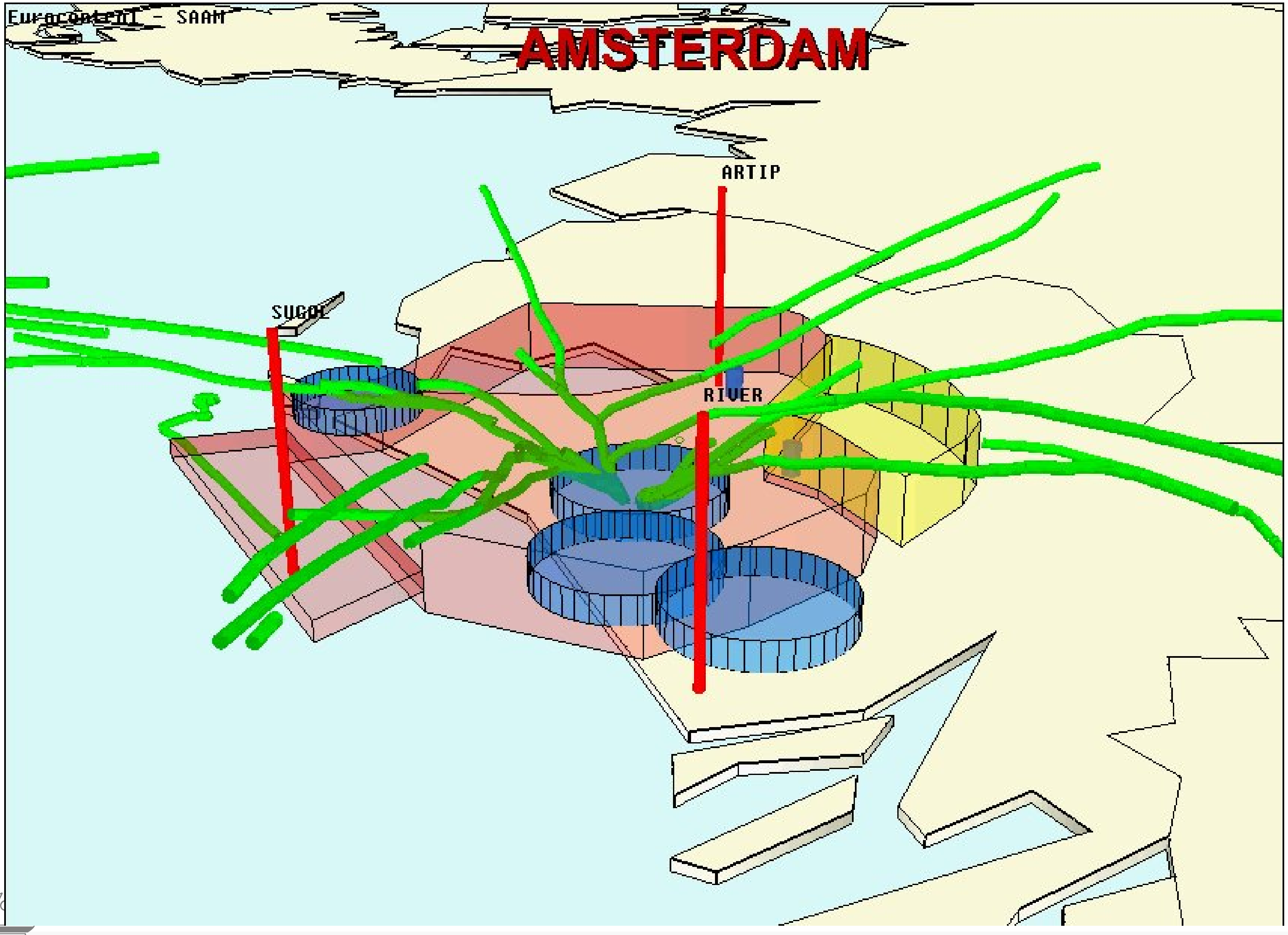
Airspace Concept Validation

- General Considerations
  - Aircraft performance
  - Sterile environment
  - Special events

Airspace Modelling - Advantages

- Great flexibility
- Simple
- ‘What if’ investigations
- Easy to test large number of traffic samples
- Data derived from real traffic and ATC environment

Example



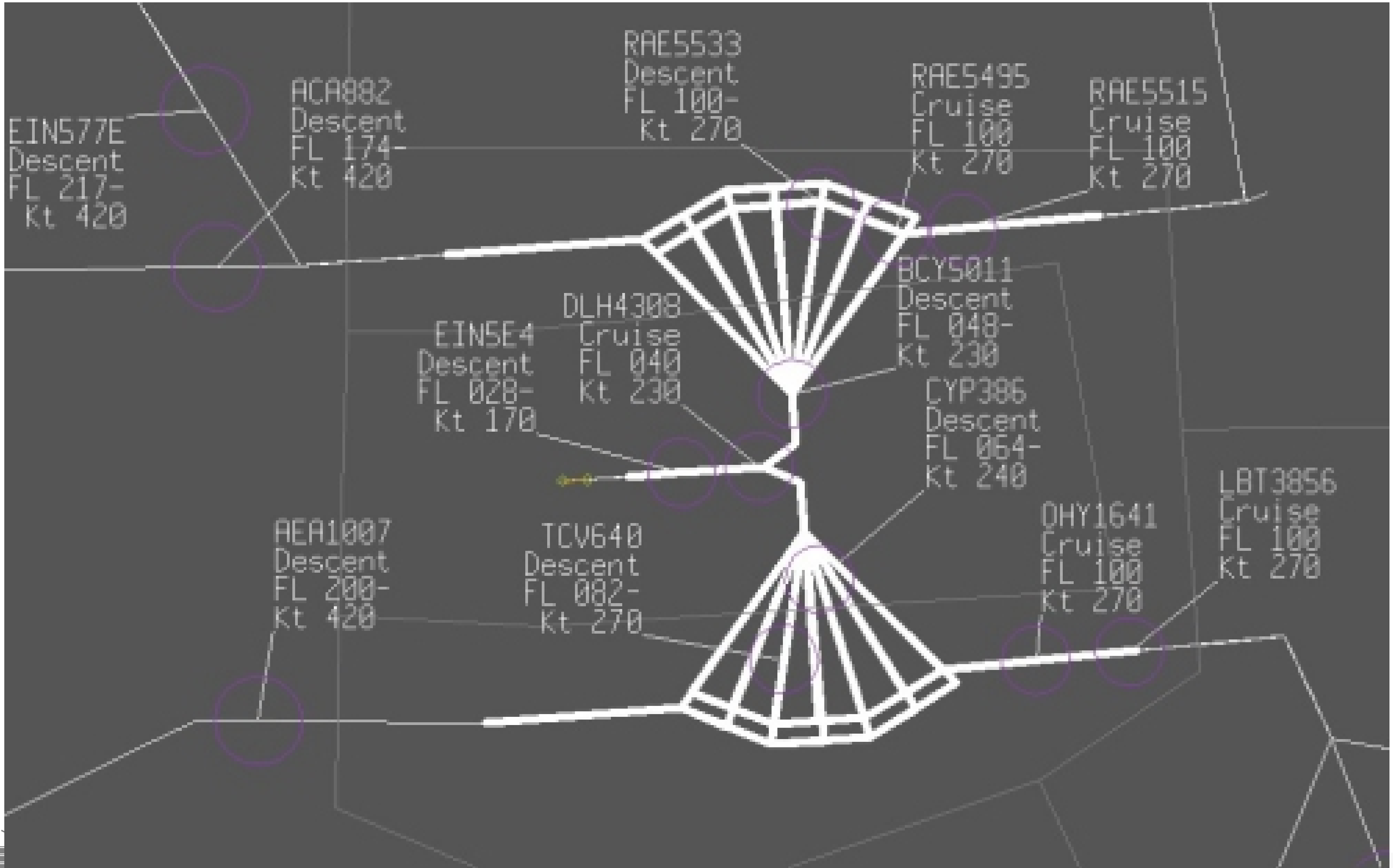
Airspace Modelling - Disadvantages

- Crude
- Only high level data
- Basic aircraft performance
- Does not replicate controller interventions
- Simplified
- No representation of METEO
- Subjective

Fast Time Simulation

- Used for sector capacity
- Quality data
- Flexible
- Good acceptance of results
- Evaluate TLS
- Used for Safety Case

FTS


EIN577E
Descent
FL 217-
Kt 420
ACA882
Descent
FL 174-
Kt 420
RAE5533
Descent
FL 100-
Kt 270
RAE5495
Cruise
FL 100
Kt 270
RAE5515
Cruise
FL 100
Kt 270
BCY5011
Descent
FL 048-
Kt 230
DLH4308
Cruise
FL 040
Kt 230
EIN5E4
Descent
FL 028-
Kt 170
CYP386
Descent
FL 064-
Kt 240
AEA1007
Descent
FL 200-
Kt 420
TCV640
Descent
FL 082-
Kt 270
OHY1641
Cruise
FL 100
Kt 270
LBT3856
Cruise
FL 100
Kt 270

FTS - Disadvantages

- Simplified model
- Only statistical data
- No active controller interaction during FTS
- Accuracy of models is key
- Aircraft performance
- Low representation of METEO conditions

Research Real Time Simulator

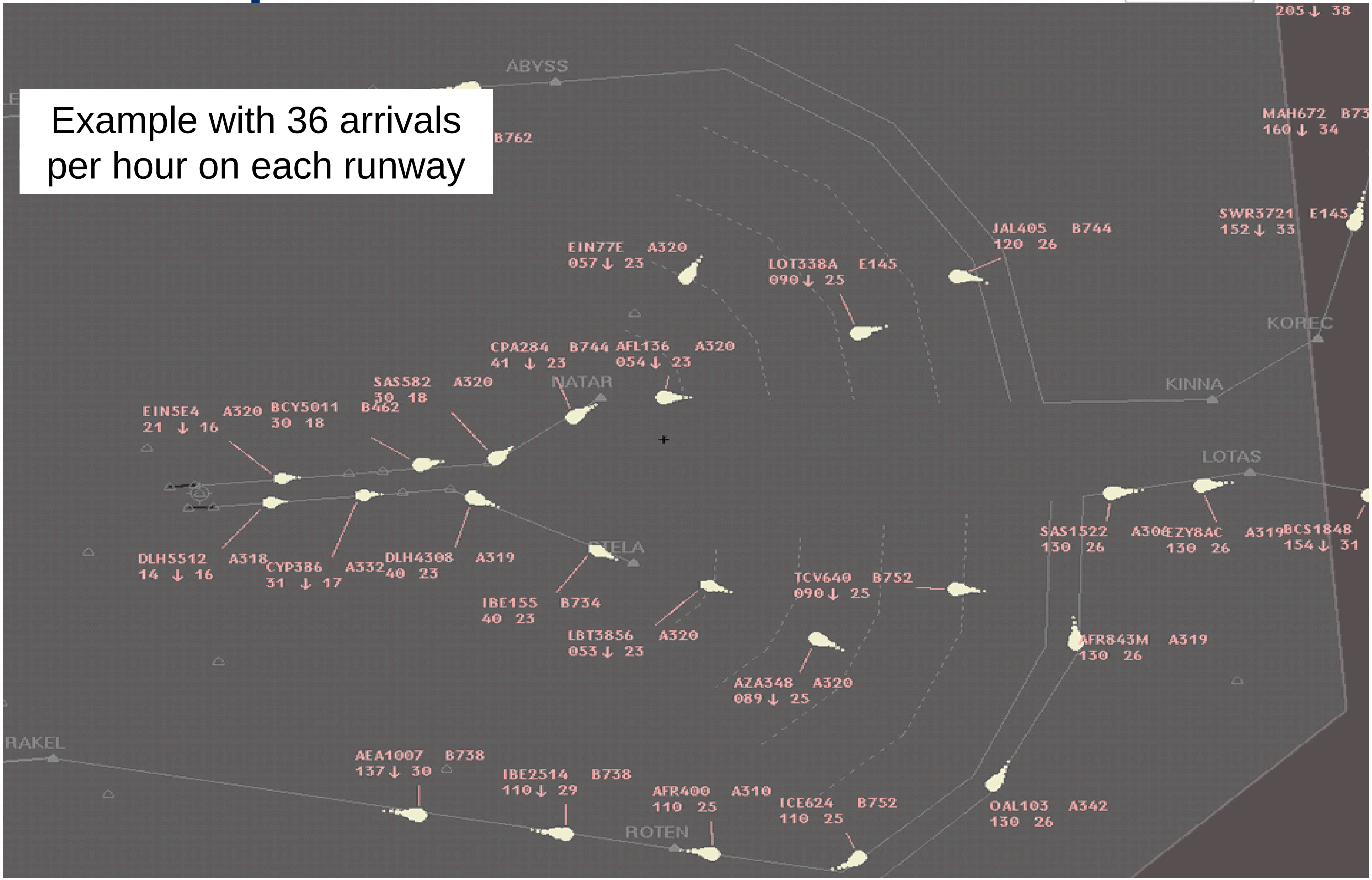
- Best method to simulate ATC trials
- High quality data
- Feed controllers/ pseudo pilots
- Human factor
- Can be part of Safety Case
- No risk to live ops
- Unlimited scope

Training Real Time Simulator

- Limited scope
- Designed for training ATC
- Aircraft performance not representative
- HMI
- Not designed for post simulation evaluation needed for Airspace concept evaluation

Example

Example with 36 arrivals per hour on each runway



Flight Simulator

- High quality data
- Confirm design aspects
  - Fly-ability
  - Efficiency
  - Met impact
- Possible link to RTS

Flight Simulator

- But
  - Manual data collection
  - For range of aircraft types/meteo conditions time consuming and expensive
  - Pilots

Live ATC trials

- Most accurate
- Real data
- Feedback from all users

But

- Safety
- High detail required – large effort for a concept evaluation
- Limited scope
- Limited flexibility

Project Checkpoint

Project Checkpoint: Implementation Decision

Are we ‘Good to Go’?

Procedure Validation

Finalisation of Procedure Design

- Design according to Doc 8168
- Procedure ground validation
  - Obstacle
  - Data
  - Infrastructure
  - Fly ability
  - Evaluate
- Flight inspection
- ATC system considerations
- Awareness and Training material

Procedure Validation

- Ground Validation
  - Obstacle clearance
  - Charting
  - Coding
  - Flyability
- Flight Validation
  - Obstacle verification (optional)
  - Flyability (workload, charting, manoeuvring)
  - Infrastructure
- Database Validation

Instrument Flight Procedure Validation

- Always undertaken
  - Review of design
  - Impact on flight operations
- Qualitative assessment (ICAO Doc 9906)
  - Obstacle
  - Terrain
  - Navigation data
  - Flyability
  - Charting

Ground Validation

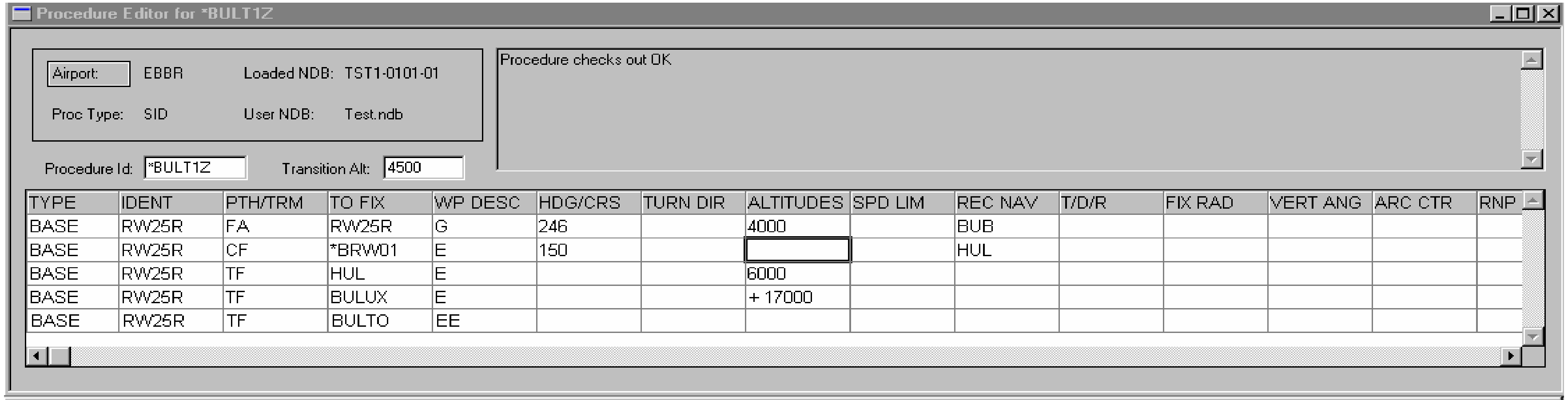
- Obstacle clearance
  - Independent review by procedure designer
- Charting
  - Independent review
- Coding
  - Software tool (e.g. Smiths PDT) or
  - Expert review
- Flyability – software tools (from PC-based to full flight simulator)
  - Not necessarily an issue with standard procedures (e.g. 'T' approaches), but critical for some aircraft types
  - Range of aircraft and meteo conditions

Independent review – can be part of same organisation

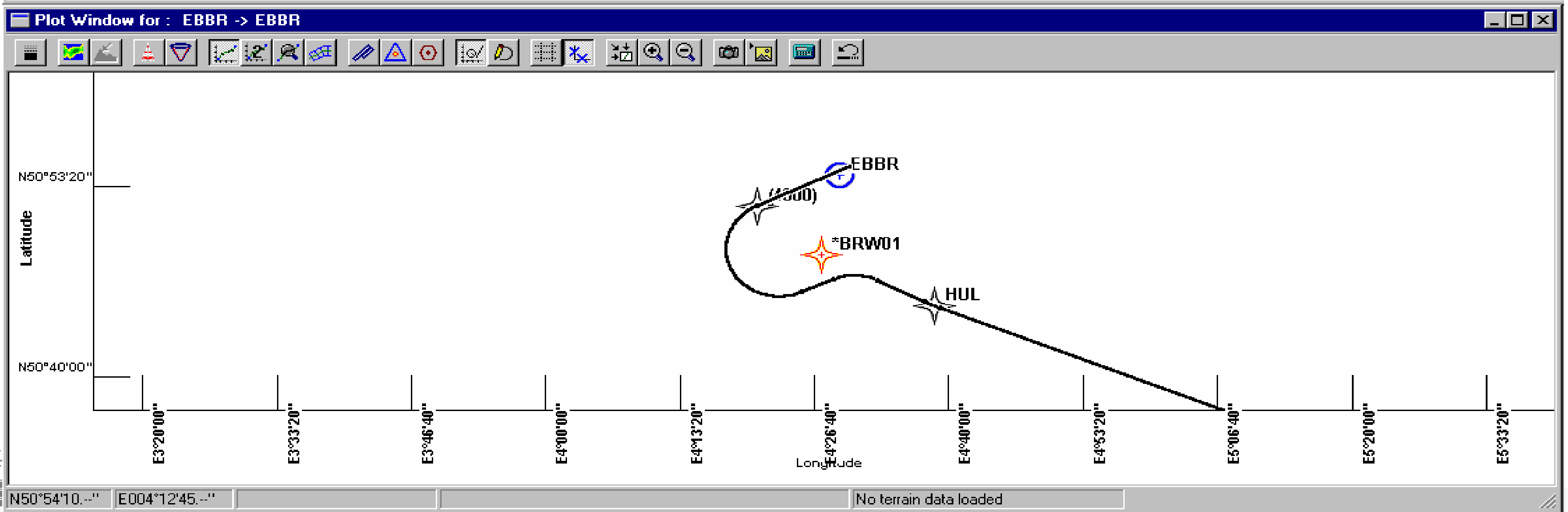
Ground Validation: Validate the Procedure

- Independent assessment
- Use of validation tools
- Use of aircraft simulators
  - more than one type
- Flight checks
- Initial operational checks

Ground Validation:
Validate the Procedure Flyabilty



TYPE	IDENT	PTH/TRM	TO FIX	WP DESC	HDG/CRS	TURN DIR	ALTITUDES	SPD LIM	REC NAV	T/D/R	FIX RAD	VERT ANG	ARC CTR	RNP
BASE	RW25R	FA	RW25R	G	246		4000		BUB					
BASE	RW25R	CF	*BRW01	E	150				HUL					
BASE	RW25R	TF	HUL	E			6000							
BASE	RW25R	TF	BULUX	E			+ 17000							
BASE	RW25R	TF	BULTO	EE										



Ground Validation:
Validate Again with Different Conditions

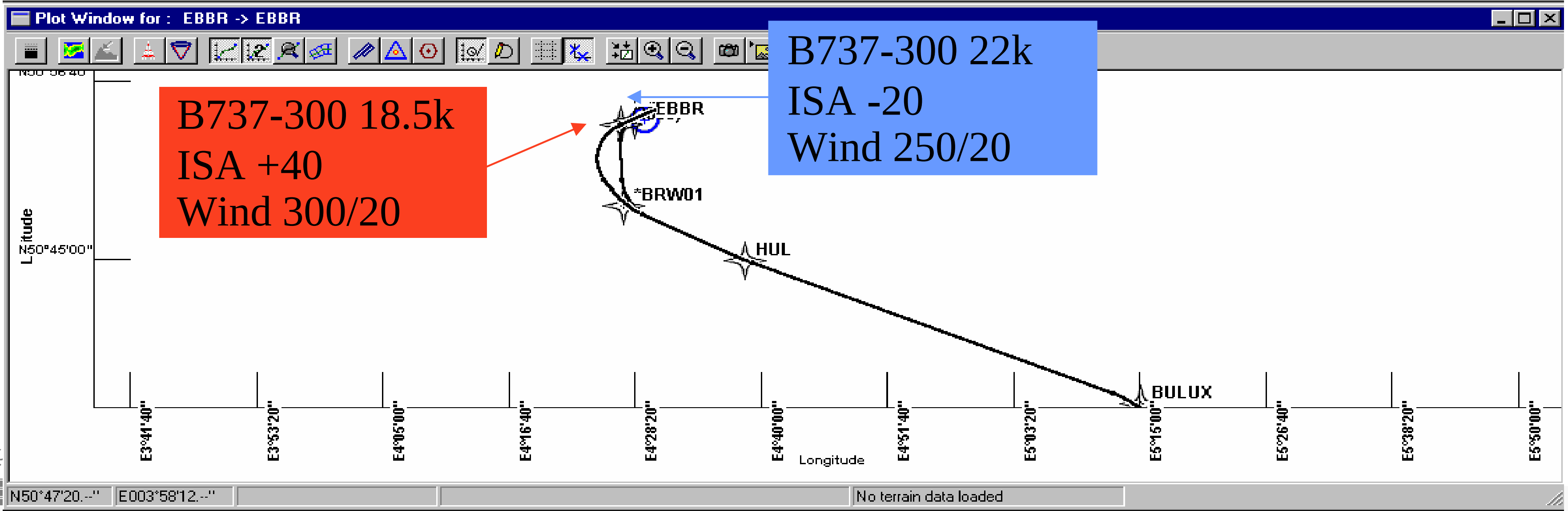
Procedure Editor for *BULT1Z

Airport: EBBR   Loaded NDB: TST1-0101-01
Proc Type: SID   User NDB: Test.ndb

Procedure Id: *BULT1Z   Transition Alt: 4500

Procedure checks out OK

TYPE	IDENT	PTH/TRM	TO FIX	WP DESC	HDG/CRS	TURN DIR	ALTITUDES	SPD LIM	REC NAV	T/D/R	FIX RAD	VERT ANG	ARC CTR	RNP
BASE	RW25R	FA	RW25R	G	246		2000		BUB					
BASE	RW25R	DF	*BRW01	E										
BASE	RW25R	TF	HUL	E			6000							
BASE	RW25R	TF	BULUX	E			+ 17000							
BASE	RW25R	TF	BULTO	EE										



Ground Validation: Different Aircraft Performance

CODING:
CA 500’ AGL; DF LL001; TF FARKS; TF….

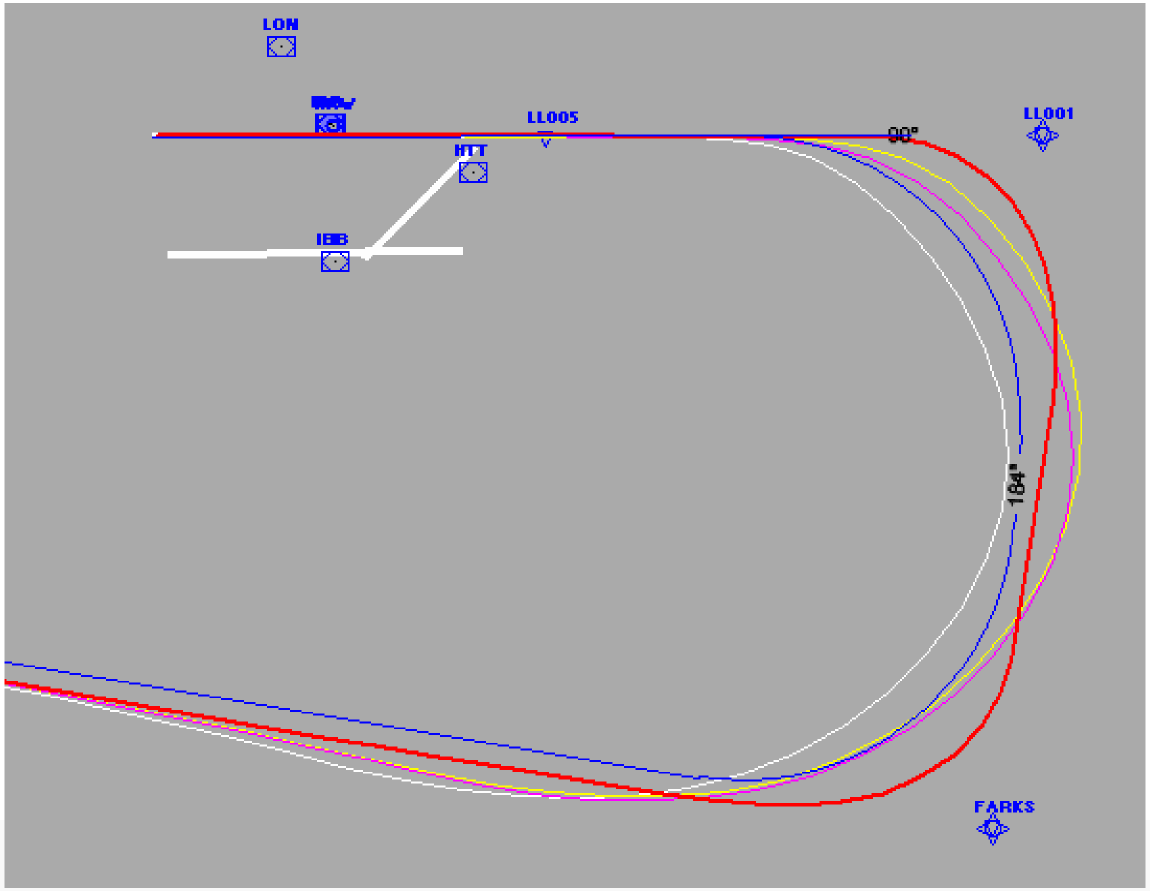
No Wind

A319

B737-400

B747-400

A340-300



Ground Validation: Wind Effect

CODING:
CA 500’ AGL; DF LL001; TF FARKS; TF…. .

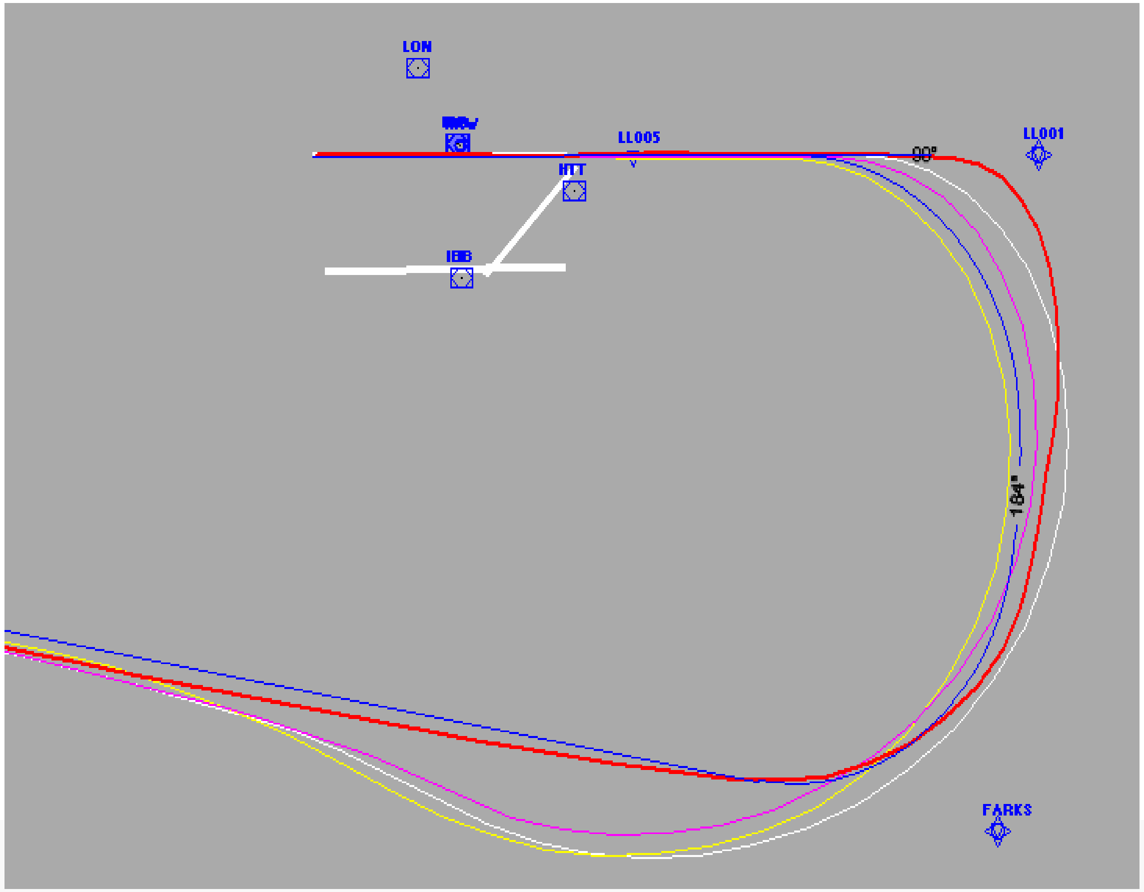
ICAO Wind from 045°

A319

B737-400

B747-400

A340-300



Ground Validation: Countered by Speed Restriction

CODING:
CA 500’ AGL; DF LL001; TF FARKS [210kts]; TF….

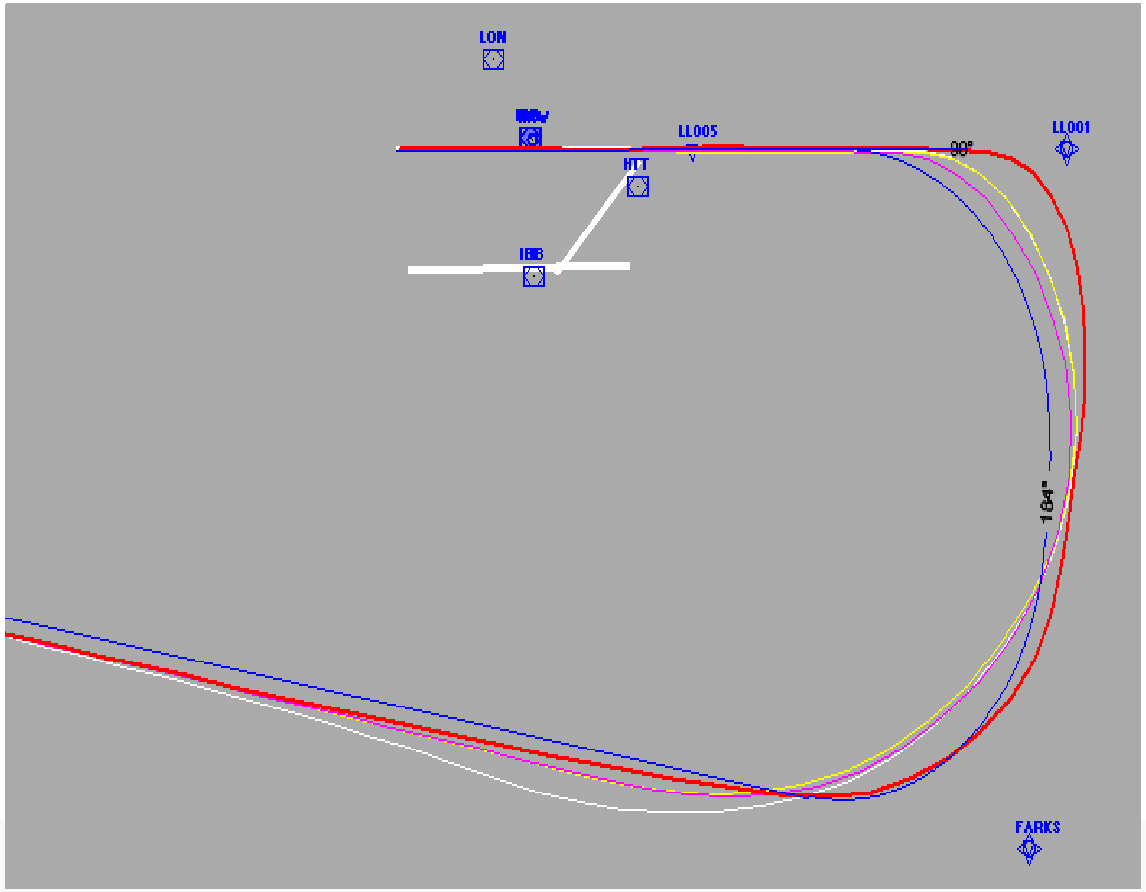
ICAO Wind from 045°

A319

B737-400

B747-400

A340-300



Ground Validation:
Leg Length Too Short

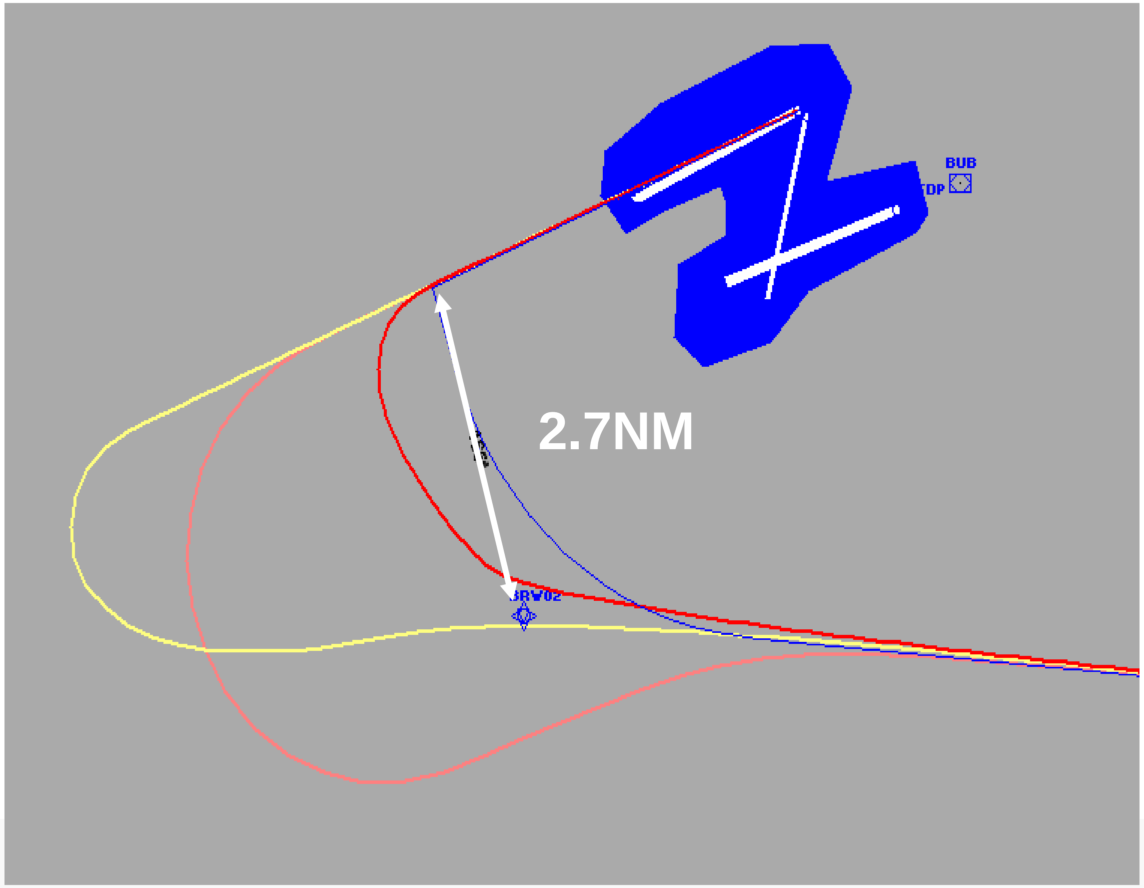
CODING:
CA 2000' AGL; DF BRW02; TF HUL…

No Wind

ATR42

B747-400

A340-300



Ground Validation:
Leg Length Acceptable

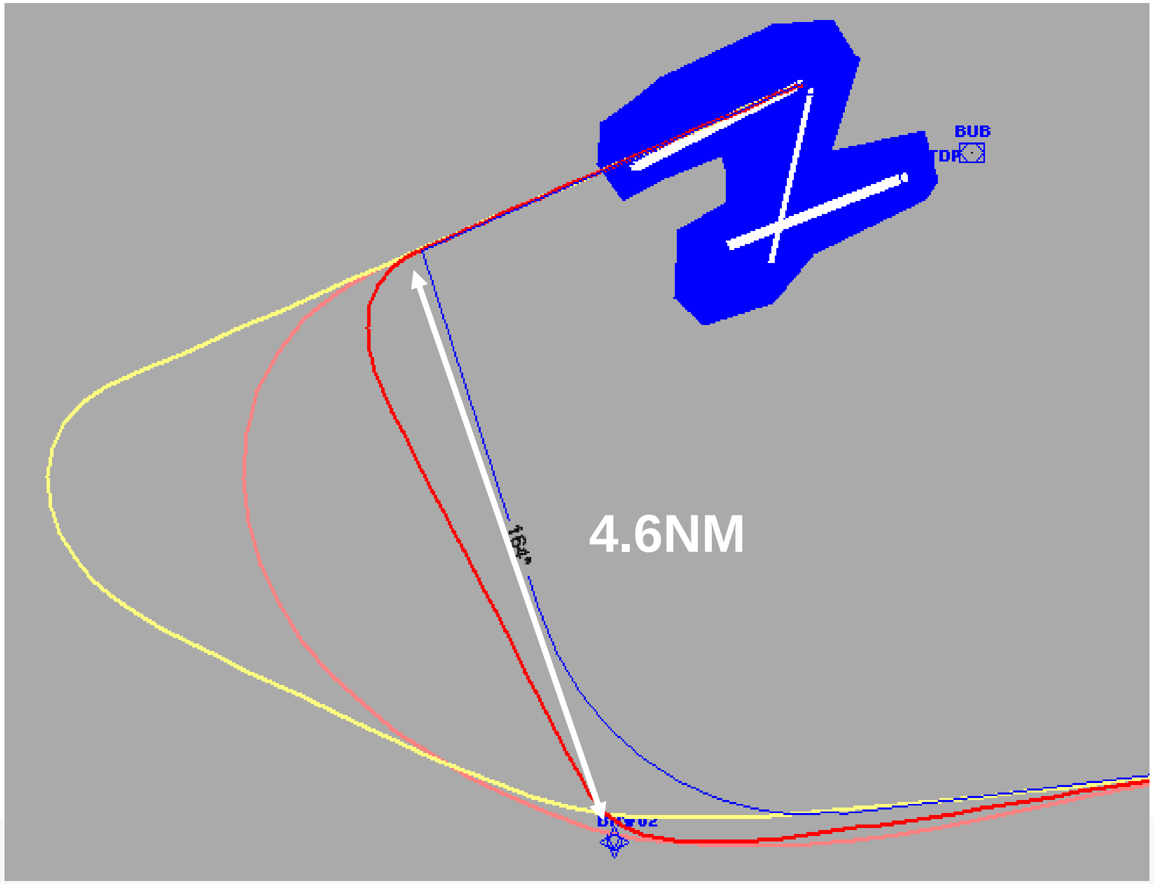
CODING:
CA 2000' AGL; DF BRW02; TF HUL…

No Wind

ATR42

B747-400

A340-300



Flight Validation

- Obstacle verification
  - Necessary where full obstacle survey cannot be assured
- Flyability
  - Detailed workload and charting assessments, but
  - High level qualitative assessment of manoeuvring only (rely mainly on Ground Validation)
- Infrastructure assessment
  - Runway markings, lighting, communications, navigation etc

Flight Inspection

- Flight inspection determined by:
  - Infrastructure assessment
  - Identified in Activity 6 and validation process
- Undertaken in accordance with ICAO Doc 8071
  - Checking NAVAIDs in compliance with SARPS

Flight Inspection

- Flight Inspection addresses:
  - Navaid performance for DME/DME RNAV
  - Unintentional interference for GNSS

DME Tasks

- Need to confirm valid DME pairs
  - Expected coverage and field strength
    - If gaps are present, need to know exact area
  - Range accuracy within Annex 10
- Need to identify DME's that degrade the navigation solution
  - Propagation distortions
    - Either effect can be removed (small local reflector) or
    - Pilot needs to deselect

RNAV DME Flight Inspection Planning

- Infrastructure Assessment preparation to make inspection efficient
- Identify:
  - Candidate DME pairs and associated coverage
    - Including expected gaps in coverage, if any
  - Candidates for exclusion:
    - Propagation path near horizon or significant terrain
    - Second DME on same channel within line of sight
    - ILS/DME facilities (offset bias?)
  - Minimum/maximum height profile for Navaid coverage validation
- PANS-OPS, ATC Operations, Engineering and Flight Inspection Organisation jointly plan inspection flight

Publication and Coordination with Data houses

RNAV Procedure Description

- Procedures are currently published as charts and as textual descriptions.
- The charts are used by the pilots and ATC.
- Database providers require clear, and unambiguous procedure descriptions and use the charts to validate/check.

RNAV Procedure Description

- RNAV procedures defined by:
  - Sequence of waypoints
    - Identifier
    - Co-ordinates
    - Fly-over/fly-by/fixed radius
  - Path Terminators - ARINC 424
  - Altitude restrictions
  - Speed restrictions
  - Direction of turn
  - Required navaid

Procedure Description for Pilots

Waypoint sequence

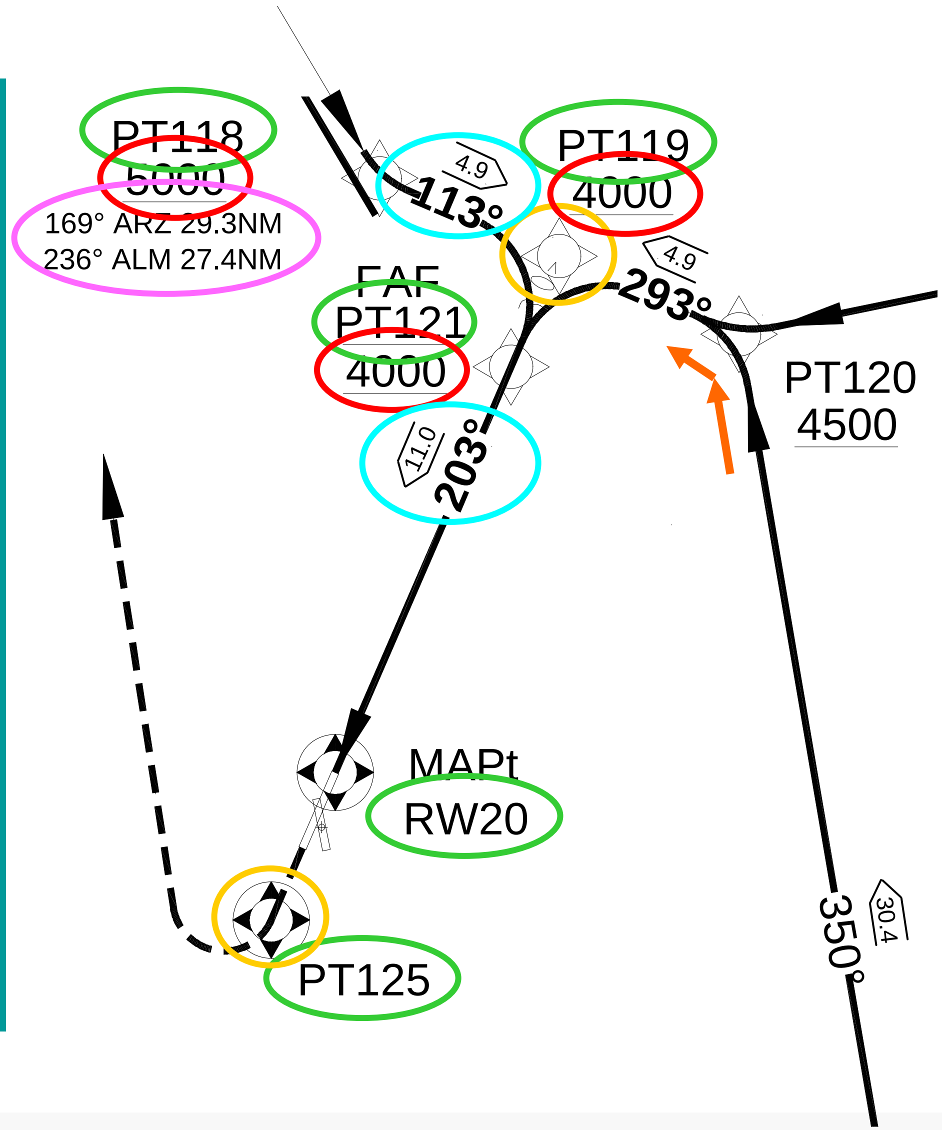
Fly-over/fly-by/fixed radius

Speed/Altitude Restrictions

Leg distance & magnetic track

Fix information

Turn direction



Procedure Description for Database Providers

- Textual description is usually used to provide formal statement of procedure.
  - Often open to interpretation.
- RNAV procedures require more specific details including path terminators.
  - Can result in lengthy descriptions.
  - Alternative descriptive methods were adopted by OCP (now IFPP):
    - Tabular layout
    - Formalised textual description ← preferred by data houses
    - Formalised short-hand description

Waypoint Identification

- Significant points
  - identified by co-located navaid or by unique five-letter pronounceable “name-code” (5LNC).
- Some waypoints (Tactical Waypoints) in the terminal area used for vectoring for sequencing and must be easy to enter in an RNAV system.
  - 5LNCs not appropriate for this (ALECS, ALEKS, ALEX).
  - No information on order in procedure for “Go Direct”.
  - Naming confusion
- IFPP introduced concept of strategic and tactical waypoints

RNAV Procedure Identification

- RNAV RWY 23
- RNAV(DME/DME) RWY 23
- ~~RNAV(GNSS) RWY 23~~ RNP RWY 23
- ~~RNAV(RNP) RWY 23~~ RNP RWY 23 (AR)

STATE LETTER – SL24/2013 proposes changes:

Charting Altitude Restrictions

An altitude window :	FL220 10,000
An "at or above" altitude:	7000
A "hard" altitude :	3000
An "at or below" altitude :	5000

FMS/RNAV Limitations

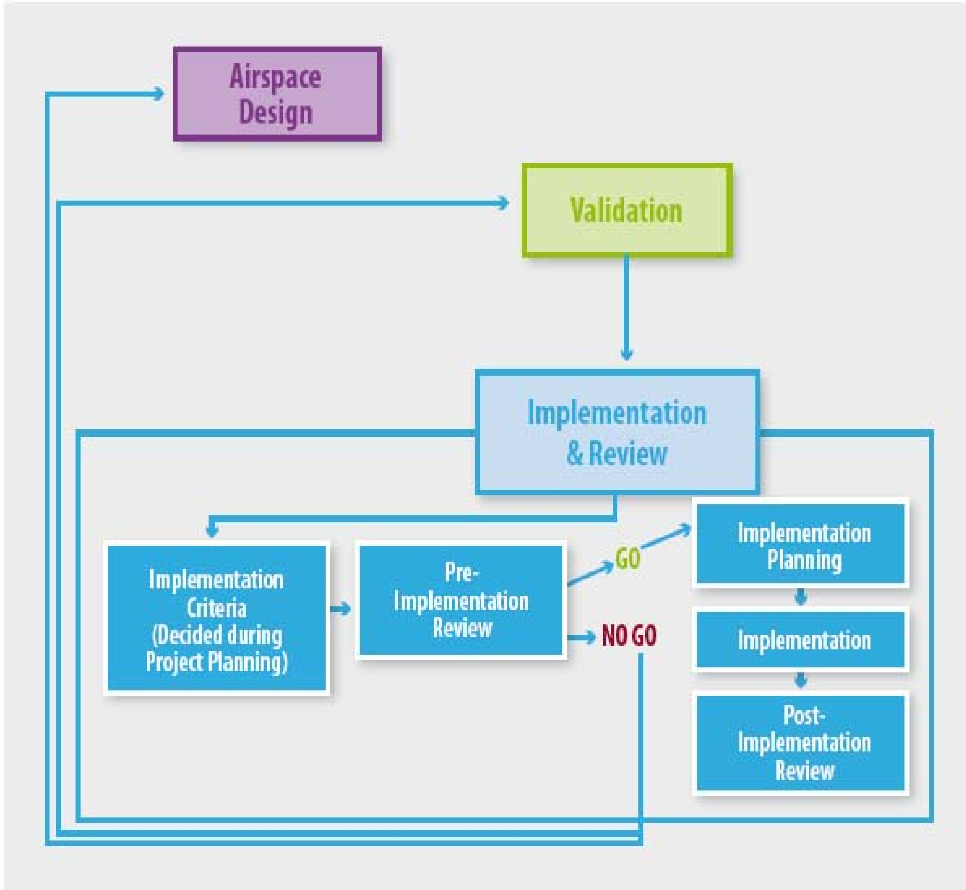
- Airspace Design often wants STARS to a metering fix and STARs to join to initial approach Fix for each runway
- Cannot have two STARs in FMS
- Airway and approach transitions needed

Implementation

Go/No Go Decision

Pre-Implementation Review

- Are goals met?
- Does design meet needs?
- Safety and performance requirements met?
- Are training requirements established?
- Are changes to ATM system and AIP needed?



ATC System Integration Considerations

- May be required
- Could include:
  - Modifying FDP
  - Changes to RDP
  - Changes to ATC situation display
  - New or modified ATC support tools
  - Alterations on issuance of NOTAMS

Awareness and Training

- Success relies on good understanding
- Must address all involved stakeholders
- Nav Specs provide training requirements for:
  - Flight Crew
  - ATCos
- Must be timely but not rushed
- Use Implementation team as ‘champions’

Implementation

- Team members to support OPS
  - At least 2 days prior
  - During
  - A minimum of one week after
- Monitor process
  - Redundancy or contingency procedures
  - Support controllers and pilots
- Keep LOG system for Post Implementation review

Post Implementation Review

- Keep LOG system Post Implementation review
  - Determine if objectives are met
  - Mitigate any unforeseen events
  - Measure!
  - Collect Evidence for System Safety Assessment
  - Demonstrate Safety of System assured
    - i.a.w. ICAO Safety Management Manual Doc 9859

DO NOT FORGET

- POST IMPLEMENATION ASSESSMENT
  - Objectives met
  - Safety issues
  - Improvements
  - Quality process

Lessons Learned

- B-RNAV
  - Phased
  - Connectivity
- P-RNAV
  - Chicken and the egg
  - Capable versus approved
- TMA projects

THANK YOU

Tabular Description

RNAV Approach									
Path Terminator	Waypoint Name	Fly Over	Course/Track/ Heading ºM (ºT)	Turn Direction	Altitude Constraint	Speed Constraint	Required Navaid	Bearing/ Range to Navaid	VPA/ TCH
IF	SUSER	-	-	-	+5000	250	-	LOM 262/29	-
TF	CV023	-	-	-	4000	-	-	-	-
CF	CV024	-	348º (347.8º)	-	2680	150	OKE	-	-
TF	RW35L	Y	-	-	370	-	-	-	-3º/50
FA	RW35L	-	348º (347.8º)	L	770	-	OKE	-	-
DF	SUSER	Y	-	-	5000	-	-	-	-

RNAV SID									
Path Terminator	Waypoint Name	Fly Over	Course/Track/ Heading ºM (ºT)	Turn Direction	Altitude Constraint	Speed Constraint	Required Navaid	Bearing/ Range to Navaid	Vertical Path Angle
FA	RW20	-	201º (203.3º)	R	400	-	-	-	-
DF	FOKSI	-	-	-	-	250	-	-	-
TF	PF213	Y	345º (346.8º)	-	+5000	250	-	OKE 330/30	-

Strategic Waypoint

- A waypoint in the terminal area which is:
  - Of such significance to the ATS provider that it must be easily remembered and stand out on any display, or
  - Used as an ‘activation point’ to generate a message between computer systems when an aircraft passes it.
- Strategic waypoints are identified with 5LNCs unless they are co-located with a navaid, when the 3 letter navaid ID is used.

Tactical Waypoint

- Tactical: a waypoint which is defined solely for use in the specific terminal area and has not been designated a strategic waypoint.
- Identified as AAXNN, where:
  - AA - the last two characters of the aerodrome location indicator;
  - X - a numeric code from 0 to 9 (N, E, W and S may be used instead if a State has a requirement for quadrantal information)
  - NN - a numeric code from 00 to 99.