DDH Avionics Considerations

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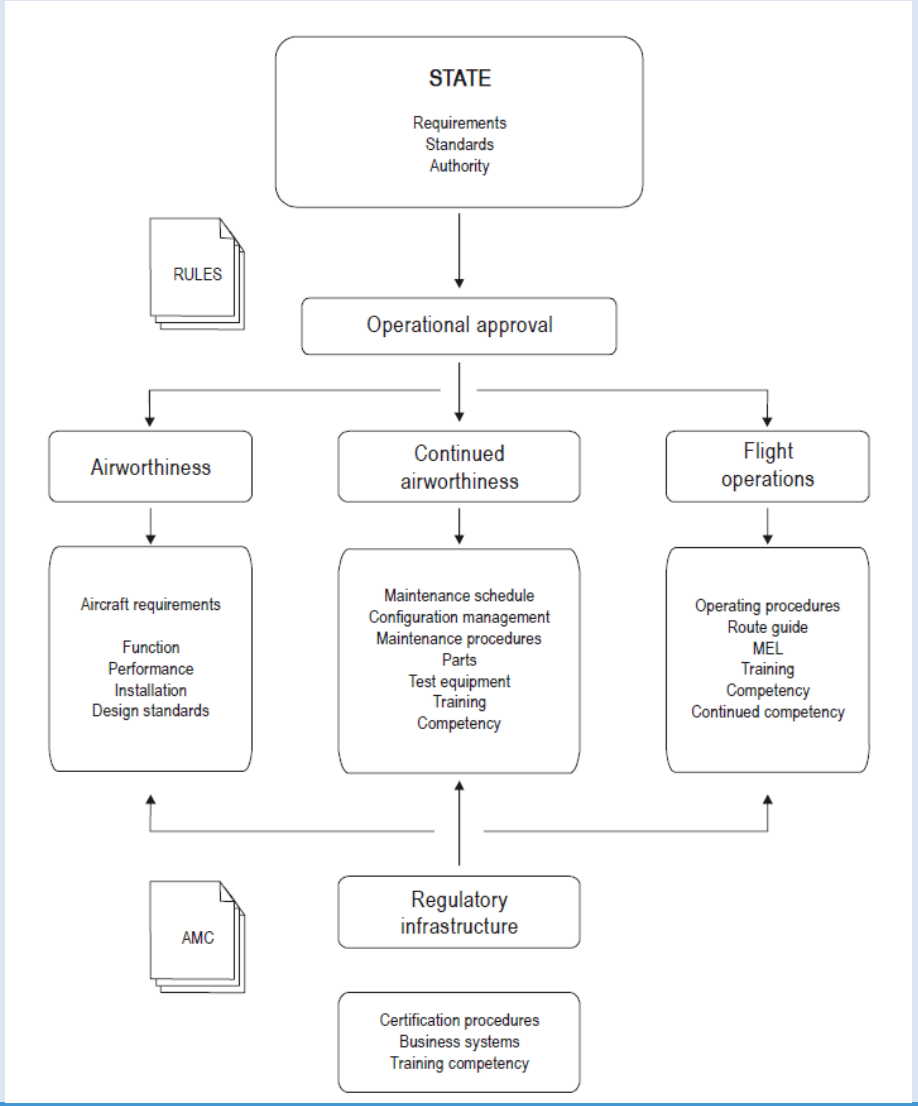
PBN – No ATD, 146 Approval Process, Installed Performance

ADS-B – Major vs Not Major Design Change

Feedback – IA and PT 66 Refresher Courses

Under NSS

The future of IFR Navigation will be PBN



PBN Approvals

- Up until now PBN approvals in New Zealand have been based on GNSS installed by T/C or ATD such as STCs
- Therefore the aircraft should have an approved Statement of Compliance in the Flight Manual or Supplement
- Therefore there is evidence that the performance of the GPS and the Installed performance is acceptable to conduct PBN operations
- The Vast Majority of GPS IFR approvals have been similar

Example of a Navigation Statement of Compliance

OPERATIONAL APPROVALS

G1000 GNSS (GPS/SBAS) NAVIGATION SYSTEM EQUIPMENT APPROVALS

The Garmin G1000 Integrated Avionics GNSS navigation system installed in this airplane is a GPS system with a Satellite Based Augmentation System (SBAS) comprised of two TSO-C145a Class 3 approved Garmin GIA 63Ws, TSO-C146a Class 3 approved Garmin GDU 104X and GDU 1500 Display Units, GARMIN GA36 and GA37 antennas, and GPS software version 3.2 or later approved version. The G1000 GNSS navigation system in this airplane is installed in accordance with AC 20-138C.

The Garmin G1000 Integrated Avionics GNSS navigation system as installed in this airplane complies with the requirements of AC 20-138C and is approved for navigation using GPS and GPS/SBAS (within the coverage of a Satellite Based Augmentation System signals complying with ICAO Annex 10) for IFR en route, terminal area, non-precision approach, and approach procedures with vertical guidance operations.

The Garmin G1000 Integrated Avionics GNSS navigation system as installed in this airplane complies with the equipment, performance, and functional requirements to conduct RNAV and RNP operations in accordance with the following table:

Compliance

Specification	Reference Documents	ICAO Flight Plan Code	Notes
P-RNAV (Europe)	FAA AC 90-96A CHG 1, JAA TGL 10 Rev 1	D2	This does not constitute an operational approval.
RNP 4 (Oceanic)	FAA Order 8400.33	L1	Primary means of Class II navigation in oceanic and remote navigation without reliance on other long-range navigation systems when used in conjunction with the G1000 WFDE Prediction program, part number 006-A0154-01 (010-G1000-00) or later approved version. Additional equipment may be required to obtain operational approval to utilize RNP-4 performance. This does not constitute an operational approval. Part 91, Part 91 subpart K, 121, 125, and 135 operators require operational approval.
RNP 1	FAA AC 90-105	O2	Includes RNP terminal departure and arrival procedures. For airplanes that have system software 0985.07 or later installed, this includes procedures with RF (radius to fix) legs. In accordance with AC 90-105, Part 91 operators (except subpart K) following the aircraft and training guidance in AC 90-105 are authorized to fly RNP 1 procedures. Part 91 subpart K, 121, 125, 129, and 135 operators require operational approval.
RNP APCH LNAV minima	FAA AC 90-105, EASA AMC 20-27	S1	Includes non-precision approaches based on conventional navigation aids with "or GPS" in the title and area navigation approaches titled "GPS", "RNAV(GPS)", and "RNAV(GNSS)". For airplanes with system software 0985.07 or later installed, this includes procedures with RF (radius to fix) legs. In accordance with AC 90-105, Part 91 operators (except subpart K) following the aircraft and training guidance in AC 90-105 are authorized to fly RNP APCH LNAV minima procedures. Part 91 subpart K, 121, 125, 129, and 135 operators require operational approval.

No ATD - 146 PBN Design Change

- **STC – including if changing an existing STC**

- Key Components –
  - STC CAA AC 21-8
  - Navigation Capability, Statement of Compliance
  - FAA AC 20-138D Compliance
  - **Installed performance** testing FAA AC 20-138D
  - CAA ACs 91-21, 91-7, 91-8 & 91-10

Installed Performance

What installed performance isn't

- GPS Accuracy – From FAA AC 20-138D
- "*The accuracy of GNSS equipment is not a function of the installation, and should not be evaluated for each GNSS. The accuracy of the GNSS equipment will be demonstrated during the sensor evaluation as part of a TSO etc.*"
- Therefore you are testing the performance of the aircraft against the accuracy of the GPS
- **Can the aircraft actually follow the GPS**

CIVIL AVIATION AUTHORITY OF NEW ZEALAND

Installed Performance

Current Ground NAVAIDs

Limited Design Flexibility

RNAV

Increased Airspace Efficiency

RNP

Optimized Use of Airspace

Installed Performance

RNAV 1

1 Nautical Mile 95% of flight time

Track Centerline

1 Nautical Mile 95% of flight time

RNP 1 Alert to Pilot

1 Nautical Mile 99.999% of flight time

1 Nautical Mile 95% of flight time

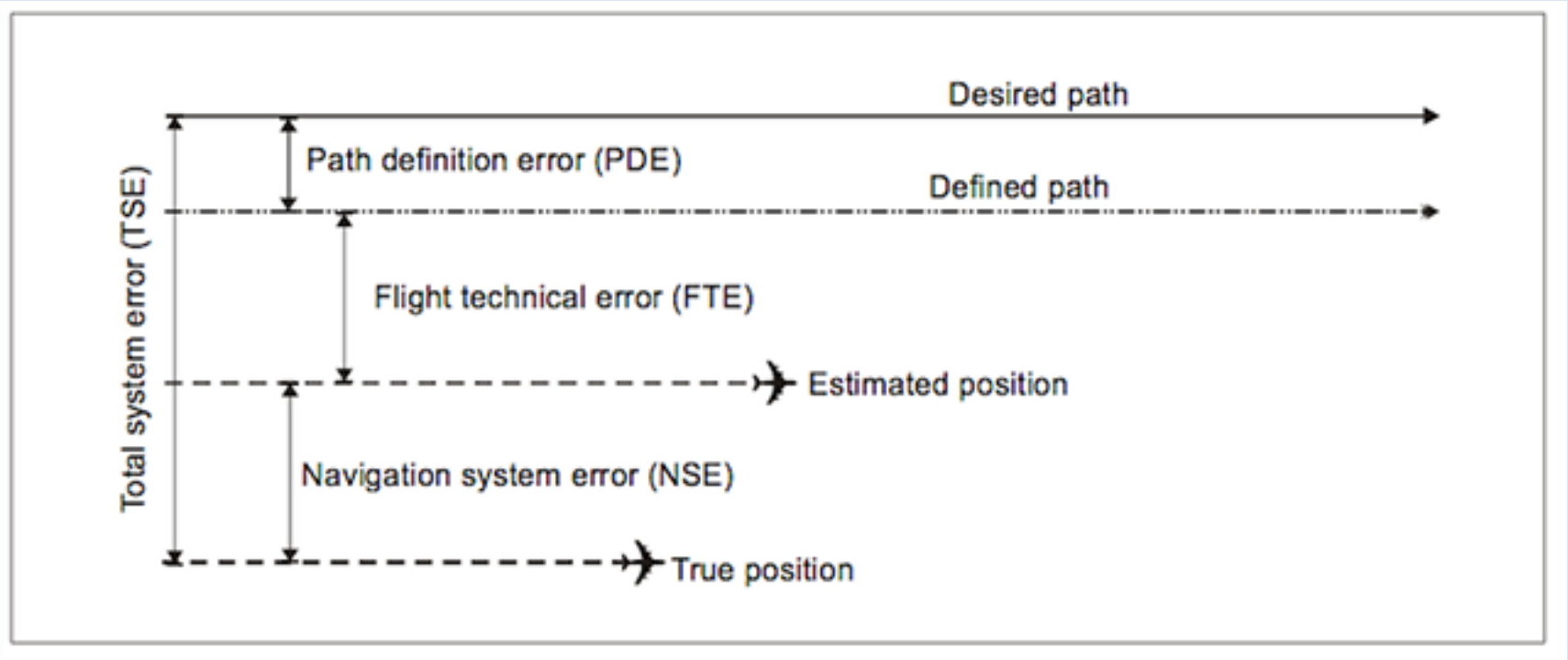
Track Centerline

1 Nautical Mile 95% of flight time

1 Nautical Mile 99.999% of flight time

The Key Difference:
On-board Performance Monitoring and Alerting

MINIMUM DEMONSTRATED RNP VERSUS MODE OF FLIGHT				
Mode of Flight	**Demonstrated RNP**			
	FMC Update U7.2 / U7.3 U8.1 / U8.3		FMC Update U7.4 / U7.5 U8.4 / U8.5 U10 and later	
	GPS Installed and Enabled	No GPS or GPS NOT Enabled	GPS Installed and Enabled	No GPS or GPS NOT Enabled
LNAV with A/P Engaged	0.3 nm	1.0 nm	0.11 nm	0.19 nm
LNAV with F/D	0.5 nm	2.0 nm	0.15 nm	0.24 nm
Manual Control with EFIS MAP display only	1.0 nm	4.0 nm	0.64 nm	0.72 nm
Manual Control with HSI display only	**PROHIBITED**			


Desired path
Path definition error (PDE)
Defined path
Total system error (TSE)
Flight technical error (FTE)
Estimated position
Navigation system error (NSE)
True position

FAA AC 20-138D

- The advisory circular (AC) provides guidance material for the airworthiness approval of installed positioning and navigation equipment
- Chapter 19 and 20 are of particular importance
- Chapter 19 describes the documentation requirements that will support your STC
- Chapter 20 starts the process of explaining what is required for the installed performance testing

Installed Performance Flight test

- All ground test requirements have satisfied
- All flight testing requirements have been identified –other equipment - PBN
- Approval of the flight test
- Reclassify the aircraft to experimental
- Only necessary people on the flight, must have PBN experience/knowledge
- Fly the navigations procedures and requirements as laid down in the flight test schedule

Communications Environment **(airworthiness requirement)**	RNP1 requires comms commensurate with operational considerations such as route spacing, traffic density, complexity and contingency procedures. All aircraft must have dual communication systems to ensure continued pilot-controller communications.
Procedure Accuracy (TSE): **(airworthiness requirement)**	RNP 1 Lateral/along track total system error must be within +/- 1nm for at least 95% of the total flight time. *Note pilots of an aircraft with RNP input selection capability should select a navigation accuracy of 1nm.*
RNP1 Continuity **(operational requirement that may affect system and airworthiness requirements)**	Continuity: for RNP 1 operations the loss of function is minor if the operator can revert to a different navigation system and proceed to a suitable airport. If no alternate means exist then the loss of functions considered Major.
Flight Technical Error **(airworthiness requirement)**	Flight technical error shall not exceed 0.5nm. This must be demonstrated by the pilot being able to operate the aircraft within the FTE utilizing displays, autopilot or flight guidance.
Continuing Airworthiness **(airworthiness requirement)**	The operator must submit continuing airworthiness instructions for the aircraft configuration, including a reliability program for monitoring equipment. A means to verify and accept subsequent changes or service bulletins to the aircraft does not invalidate the operational approval.

CIVIL AVIATION AUTHORITY OF NEW ZEALAND

146 Responsibility VS Operators Responsibility

- 146 needs to get the aircraft to the point of a statement of compliance in the AFMS i.e. the aircraft is approved for RNP/RNAV
- Noting this is not a PBN approval
- The operator in the end is the responsible party applying for the PBN approval
- However the operator will be relying on the installed performance flight testing, FAA AC 20-138D and aspects of the CAA AC 91- 21 compliance

ADS-B Major vs Not Major

ADS-B Major vs Not Major

- CAA deemed that ADS-B was definitely a Major Design Change and/or Modification only until such time as the rules were released
  - GPS - Navigation
  - Integration

- Also, so we had full visibility of what ADS-B systems were being fitted so we had confidence that systems should meet NZ ADS-B requirements

- There have been some proposed systems installed that would have not met the intended requirements

ADS-B Major vs Not Major

- GPS – Navigation will remain a major design change and/or modification
- Transponder itself could be a not major
- Transponder with integral GPS could be a not major
- Unproven Combinations major design change
- **ADS-B Rule above FL245, Notice and AC should be released very soon for NPRM**

Industry feedback - Modifications

LAME I/A feedback - Modifications

- LAMEs good at supplying installation instructions and failure effects when a devices fails i.e. the modification, part 43 stuff
- LAMEs limited SSA no 1309, FHA, unaware of misleading faults i.e. - the part 21 design change stuff
- Industry perception of 146 organisations rubber stamping work that the LAME are doing
- 146 organisations need to show the work they are doing to justify cost in terms of SSA FHA 1309 etc

Industry Feedback

There are only 10 types of people in the world, those that understand binary and those that don't.

-unknown-