EUROPEAN AVIATION SAFETY AGENCY
AGENCE EUROPÉENNE DE LA SÉCURITÉ AÉRIENNE
EUROPÄISCHE AGENTUR FÜR FLUGSICHERHEIT

PBN – Airworthiness Compliance

How have my aeroplane capabilities been assessed?

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PBN Manual: Navigation Specifications

RNAV 10 (RNP-10)	→ AMC 20-12
RNAV 5 (BRNAV)	→ AMC 20-4
RNAV 2	--
RNAV 1 (~PRNAV)	→ JAA TGL-10 Rev. 1
RNP 4	--
RNP 2	--
RNP 1	--
Advanced RNP	--
RNP APCH:	
LNAV / LNAV/VNAV	→ AMC 20-27
LP / LPV	→ AMC 20-28 (LPV Only)
RNP AR APCH	→ AMC 20-26
RNP 0.3	--

PBN: Aircraft Qualification

- ICAO Nav. Specs, EASA AMCs and FAA ACs all require that the following aspects to be considered:
  - Continuity
  - Integrity
  - Functional criteria
  - Performance
  - Aeroplane Flight Manual (AFM)

PBN: Aircraft Qualification

- Continuity:
  - Continuity requirements define the allowable probability of failure conditions that lead to *loss of a function*.
  - Requires an applicant to perform both quantitative and qualitative assessments as per CS/FAR XX.1309 and associated guidance material.
  - Continuity is usually not a major issue in certification of aircraft for PBN.

PBN: Aircraft Qualification

- Integrity:
  - Integrity requirements define the allowable probability of failure conditions that lead to *output (and display) of erroneous information*.
  - Requires an applicant to perform both quantitative and qualitative assessments as per CS/FAR XX.1309 and associated guidance material.
  - Integrity is often a major concern with certification of aircraft for RNP AR (details to follow) and sometimes LPV.

PBN: Aircraft Qualification

- Functional Criteria:
  - Requirements for functional criteria address both the *functional capabilities* of the aeroplane and the *pilot-machine interface*: Displays, controls etc.
  - Display of deviations from the path, in particular vertical deviations, are often reason for concern. Some designs are deemed marginally acceptable.
  - Mitigation by procedure (not ideal).
  - Industry to improve.

PBN: Aircraft Qualification

- Performance:
  - Performance requirements address the track-keeping capability of the aeroplane.
  - Often defined as*:"…within ( ) NM for 95% of the time*".
  - Where applicable these include vertical performance, for instance Baro-VNAV.
  - RNP AR criteria demand that the performance of the aeroplane under failure conditions be assessed.

PBN: Aircraft Qualification

- Aeroplane Flight Manual (AFM):
  - Contains both an overview of standards for which the aeroplane was qualified and flight crew procedures.
  - Both the qualifications and the procedures need to be accurate and clear and match the design.
  - RNP AR: The AFM will often refer to a separate document, e.g.:
    - Airbus: Airworthiness Compliance Document
    - Boeing: RNP Capabilities Document

PBN: Aircraft Qualification

- Aeroplane Flight Manual (AFM):
  - If compliance with a TGL or AMC is stated in the AFM, EASA will have verified airworthiness compliance of the aircraft against the applicable criteria.
  - E.g. sections 5 through 9 of AMC 20-27

PBN: Aircraft Qualification

- Absence of EASA AMC:
  - Not all ICAO Nav. Specs have matching TGLs or AMCs
  - Certification Review Item (CRI) process may provide solution in those cases.
  - The AFM will not refer to a TGL or AMC but instead to the ICAO concept, e.g. RNAV 2, RNP 4 etc.
  - Alternatively, the AFM may refer to an existing FAA AC, e.g. AC 20-138C.

PBN: Specific Aspects to Consider

- Baro-VNAV
  - Aircraft certified to older standards.
- RNP AR
  - Low RNP operations (RNP < 0.3 NM)

PBN: Specific Aspects to Consider

- Baro-VNAV Operations
  - Most aircraft have been certified to standards that date back to the 1950s: ICAO PBN Manual, FAA AC 20-129.
  - Not consistent with PANS-OPS criteria.
  - AMC 20-27 and FAA AC 20-138C are more stringent and match PANS OPS.
  - Not necessarily a problem, IATA/AEA study: Operations can safely be conducted to aerodromes with field elevation of 6000 ft MSL or less.
  - Limited number of aerodromes affected.

PBN: Specific Aspects to Consider

- Baro-VNAV Operations
  - When considering approval of AC 20-129 certified aircraft:
    - Functional criteria of AMC 20-27, in particular display of deviations, need to be considered in the OPS approval process.
  - EASA Safety Information Bulletin (SIB) in preparation.

PBN: Specific Aspects to Consider

- RNP AR with RNP < 0.3 NM:
  - FMS software qualification of many aeroplanes does not comply with integrity requirements for low RNP OPS.
  - Otherwise aeroplanes are very capable (Performance)
  - AFM will contain certified values (e.g. 0.3 NM)
  - Airworthiness Compliance Document or similar document may state demonstrated values (e.g. 0.15 NM)

PBN: Specific Aspects to Consider

- RNP AR with RNP < 0.3 NM:
  - RNP AR, or SAAAR in the early days, started as special operations with specific approvals, limited in numbers.
  - Mostly in mountainous terrain.
  - Today however, AR operations have become much more commonplace. (Hundreds of procedures in US)
  - Quite often for noise abatement or traffic separation.

PBN: Specific Aspects to Consider

- RNP AR with RNP < 0.3 NM:
  - The differentiation between certified and demonstrated values reflects this trend:
  - *Certified* values:
    - Recognition of more generic nature of most current AR procedures.
    - Simplifies the Flight Operations Safety Assessment (FOSA)
  - *Demonstrated* values:
    - Recognition of special nature of a more limited number of procedures
    - Comprehensive FOSA required.

PBN: Specific Aspects to Consider

- RNP AR with RNP < 0.3 NM:
  - Example: Atlantic Airways, Vagar, Faroer.

PBN: Specific Aspects to Consider

- RNP AR with RNP < 0.3 NM.
  - Procedure: RNP 0.1 NM, MA < 1 NM
  - Aeroplane: A319
    - Certified to RNP 0.3
    - Demonstrated RNP: 0.1
  - Very extensive FOSA, considers a.o:
    - Flight crew training and excellent knowledge of terrain and weather conditions (home base)
    - Verification of *effectiveness* of TAWS*
    - Use of ground infrastructure for verification (DME distance)
  - Operational Approval granted.

(Courtesy Danish CAA)

PBN: Specific Aspects to Consider

- RNP AR with RNP < 0.3 NM:
  - * TAWS as mitigation (airworthiness):
    - TAWS was developed as a safety-net.
    - In order to generically serve as an effective means of mitigation, the TAWS should:
      - Be independent (positioning).
      - Be demonstrated to provide timely alerts, *when required*.
    - Issues:
      - Grid sizes too large
      - Terrain Database integrity

    - No applicant had been able to comply.
    - But: TAWS may have value in specific cases.

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Thank you.

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