Alternative Compliance with Required Navigation Performance Authorization Required (RNP AR) Database Validation Requirements

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Agenda

- Background
- Traditional Database Validation Model
- Automated Database Validation Model
- Jeppesen RNP AR Quality Checks
- Garmin Feedback Verification Process
- Garmin CRC Verification
- RNP AR Validation Check Exemption
- Next Steps
Alternative Path

- Recognized an industry need and developed a solution
  - October 2010: First aircraft with G5000 and RNP AR capability announced
  - December 2011: First floated idea with FAA
  - August 2013: Jeppesen received approval letter
  - December 2013: Garmin received approval letter
- Garmin & Jeppesen devised alternative path for the industry
- Process open to all avionics OEMs
- Avionics OEMs need to obtain FAA approval on own RNP AR Validation process
Background
AC 90-101A Database Validation

Background

- Acknowledges importance of data quality in RNP AR operations
- Appendix 3, paragraph 3 directs operator (or contractor) to perform navigation database (NDB) validation before flying RNP AR in instrument conditions
- Paragraph 3.a. requires an accuracy check in which the RNP AR procedures in the packed NDB are compared against government source (8260-3 and -10 in the U.S. or AIP in foreign countries)
  - Most operators do not have the expertise or access to government source to properly perform such validation, so accuracy check is contracted to outside entity
  - Paragraph 3.a does not consider quality control measures already in place inside AC 20-153A aeronautical database Type 1 and 2 LOA-holding organizations
Traditional Database Validation Model
Traditional Database Validation Model

AC 90-101A RNP AR NDB Validation

- Government Source
  - Jeppesen Codes
  ➡️ ARINC 424 File
  ➡️ Packed Binary NDB File
  ➡️ NDB Data in Unit
  ➡️ Operator Loads

AC 90-101A directs operator (or contractor) to compare data related to RNP AR procedures from the packed navigation database (NDB) to the original government source documentation of those procedures.

- Paragraph 3.a. does not take necessary data translation from coding and packing processes into consideration within prescribed parameters and tolerances – some are impossible to perform as directed.
Parameter Tolerance Validation Issues

- **Government Source Does Not Include All Parameters**
  - e.g., Transition Name, Recommended Navaid – not explicitly sourced on FAA 8260-3
  - Coding analyst applies ARINC 424 coding rules
  - **Issue**: Operator unable to check all parameters against government source

- **Equipment Does Not Always Display Parameters That Must Be Checked**
  - Garmin units do not display all parameters that must be checked
  - **Issue**: Operator unable to check all parameters in database directly on equipment display
  - **Issue**: Garmin must provide operator with report that includes all parameters that must be checked

AC 90-101A Appendix 3 Parameters Spreadsheet available at http://www.faa.gov/about/office_org/headquarters_offices/avs/offices/afs/afs400/afs470/rnp/media/ac90-101a_app3parameters.xls
Typical AC 90-101A Database Validation Example

- Every RNP AR procedure leg requires accuracy checks on twenty parameters
- Typical RNP AR procedure requires over 350 accuracy checks
- Over 4,500 accuracy checks per year for a single procedure if checks performed on all 13 database cycles
- For operators that fly only 3 RNP AR procedures, this effort quickly multiplies to over 10,000 accuracy checks per year
Automated Database Validation Model
Automated Database Validation Model

Government Source → ARINC 424 File → Packed Binary NDB File → NDB Data in Unit

Jeppesen Codes → Garmin Packs → Operator Loads

Jeppesen’s Additional RNP AR Quality Checks
Feedback Verification in Packing Process
Entire Database CRC Verification Performed on Power-up
Automated Database Validation Overview

- FAA RNP AR data parameters are automatically verified, using the specified tolerances, within Jeppesen’s RNP AR Quality Checks and Garmin’s Feedback Verification Process
  - Details in Jeppesen- and Garmin-specific slides
- Appendix 3, paragraph 4, “Database Updates”, are automatically handled through:
  - Jeppesen RNP AR Quality Checks every time a procedure is added or changed, and
  - Garmin Feedback Verification Process every database update cycle
Jeppesen
RNP AR Quality Checks
Jeppesen RNP AR Quality Checks

Government Source ➔ ARINC 424 File

Jeppesen Codes

Jeppesen’s Additional RNP AR Quality Checks
Jeppesen RNP AR Quality Checks

Jeppesen creates an initial ARINC 424 file using its Type 1 LOA-approved internal production tools. Using that file, Jeppesen performs the following steps to validate RNP AR Procedures:

- The ARINC 424 data for all new RNP AR procedures are isolated in a Comparison Tool.
- The Comparison Tool displays the appropriate data to verify for each RNP AR Procedure each cycle.
- An Analyst retrieves the source for the respective RNP AR procedures and compares it to the added/changed data elements displayed in the Comparison Tool.
- Once the Analyst confirms the accuracy of RNP AR procedure data elements against source it is approved and sent to a second Analyst to verify.
Jeppesen RNP AR Quality Checks

• The Verifier confirms the accuracy of the RNP AR procedures to the source using the same steps as the Analyst within the Comparison Tool.
• If an error is detected during this process, it is updated and the ARINC data is re-analyzed using the same process steps described above.

• Additionally, Jeppesen provides a Header Record, which contains a File CRC value.
  • The CRC value is used to confirm that the data content of the file hasn’t been changed during the transit of the file.
Jeppesen Approval Letter

- Per Jeppesen RNP Validation Letter, dated August 26th, 2013:
  "...you demonstrated compliance with the tool qualification objectives applicable to a verification tool as specified in DO-178B, Software Considerations in Airborne Systems and Equipment Certification. You also demonstrated acceptable integration of this tool into your existing Type 1 Letter of Acceptance (LOA) navigation data processing procedures.

  We have found Jeppesen Sanderson’s procedures satisfactorily verify the ARINC 424 data file matches the government source. Subscribers to Jeppesen’s ARINC 424 data validation and comparison service, must perform the additional accuracy check of ensuring the navigation database (in binary format) satisfies the tolerance requirements specified by AC 90-101A, Appendix 3, paragraph 3a."

- Jeppesen’s ARINC 424 validation and comparison service is expandable to other avionics OEMs with minor development effort. For further information on this subject, OEMs are requested to contact their Jeppesen Representative.
Garmin Feedback
Verification Process
Garmin Feedback Verification Process

ARINC 424 File → Packed Binary NDB File

Garmin Packs

Feedback Verification in Packing Process
Garmin Feedback Verification Process

• Type 2 LOA-approved processes and tools pack binary navigation database (NDB) from Jeppesen CRC-wrapped ARINC 424 source file

• Feedback verification tool compares binary NDB and ARINC 424 file and verifies original ARINC data was not degraded or altered unintentionally during packing process
  • RNP AR procedure parameter tolerances based on AC 90-101A Appendix 3 Parameters Spreadsheet
  • Feedback verification tool run every cycle regardless of whether any procedures have changed since previous cycle

• Any verification errors must be resolved before binary NDB is released for distribution to end-users
  • Obtain a new ARINC 424 file from Jeppesen with modified data or erroneous procedure omitted
  • Release a NavData Alert in conjunction with Jeppesen that notifies the RNP AR procedure is not useable for the AIRAC cycle
Garmin
CRC Verification
Garmin CRC Verification

- Binary NDB “wrapped” with a 32-bit CRC to provide high assurance that NDB data is read into a unit as it was packed and without corruption
  - Units will not use NDB if CRC test fails
- Entire binary NDB protected by this mechanism, not just RNP AR procedures
RNP AR Validation
Check Exemption
RNP AR Validation Check Exemption

- Per Garmin RNP Validation Letter, dated December 5, 2013:

  “Aircraft operators that obtain binary databases produced under the processes referenced in this letter and used within Garmin avionics systems approved for RNP AR operations are relieved of the responsibility to check the accuracy of included RNP AR data as specified in AC 90-101A, Appendix 3, paragraph 3.a.”
Benefits to Operators

• Reduced RNP AR validation cost
• No resources for validation of RNP AR procedures each cycle
• No need for additional contracted RNP AR validation services
• Opens additional airports and procedures to operators
  • Better minimums
  • Fuel/time savings
Next Steps

• Garmin RNP AR Validation process will be used by planned Garmin G3000/G5000 RNP AR certification
• RNP AR navigation database subscriptions available for download by end customers from either Garmin or Jeppesen
• Crew training and certification
• This RNP AR validation process is available for all avionics OEMS
• To participate in the process, avionics OEMs will need necessary FAA approval