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FLIGHT INSPECTION OF RNAV PROCEDURES
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ABSTRACT

Today, flight inspection of RNAV procedures is based upon "the soundness of the procedure". This paper will show how NORMARC is in the stage of implementing a system that will be able to flight inspect, in the traditional sense, an RNAV procedure and then merge all data (ATM/CNS) into to one evaluating environment.

PURPOSE

The purpose of this paper is to look at some aspects of RNAV procedures, and flight inspection of these. This will become a very important activity in flight inspection community in the years to come. In addition, a look on what will become the new flight inspection tool from Normarc Flight Inspection Systems.

BACKGROUND

Flight inspection of procedures will become increasingly important in the flight inspection community over the next years. The shift from traditional flight inspection, which bases its result on measurable signal in space, will subside and will eventual be replaced by "flight inspection" of self-contained navigation aids procedures.
Since there will be RNAV procedures that are based upon VOR/DME DME/DME, in years to come, there is still a need to perform flight inspection of the facilities that are used in these procedures.

There are different navigation infrastructures available for RNAV procedures. Among them are:

- **RNAV**: means that both DME/DME and Basic GNSS (GPS) may be used.
- **RNAV(DME/DME)** means that only DME/DME may be used.
- **RNAV(GNSS)** means that only Basic GNSS (GPS) may be used.
- **RNAV(Except Class A GNSS)** means that both DME/DME and Class B and C Basic GNSS (GPS) may be used, i.e, not stand alone GPS.
- **RNP(X)** means that the procedure is for RNP-x capable aircraft only, where x denotes RNP value, e.g. RNP (0.3).

According to the FAA 8200.1, "The flight inspection of RNAV procedures will evaluate the soundness of the procedures."

According to DOC 8071: "The flight inspection should determine that the procedure is flyable and safe."

JAA TGL-3:"A conventional missed approach must be available based on traditional navigation."

This is an example of tolerances that applies to an RNAV procedure:

Parameter	Ref. Para.	Tolerance/ Limit
Procedure Design		
Routes **True Bearing** to next WP Distance to next WP	209.4	± 1° ± 0.1 nm
Initial/Intermediate Approach Segment **True Bearing** to next WP Distance to next WP	209.4	± 1° ± 0.1 nm
Final Approach Segment **True Bearing to next WP** Distance to next WP	209.4	± 1° ± 0.1 nm
Missed Approach Segment **True Bearing to next WP** Distance to next WP	209.4	± 1° ± 0.1 nm
Vertical Path	209.32	± 0.1°
FMS/GPS		
Satellites Tracked		RAIM
DME-Supported Waypoint	209.32	Lock-On
Loran-C		
Course Structure	209.4	Within ± 0.3 nm of the desired track during all approach segments.
Cycle Slip	209.4	None allowed
Electromagnetic Spectrum	209.4	Interference shall not affect receiver performance or accuracy
Position Accuracy	209.4	Within ± 0.3 nm
Signal-to-Noise Ratio	209.4	+3 dB or greater

Figure 1 Tolerances of RNAV procedures according to FAA 8200.1A

As can be seen from Figure 1 above tolerance limits apply only for true bearing to next waypoint and distances to next waypoint. As to the "soundness" of the procedure, it is very difficult to see how to apply these tolerances.

The Authority or service provider must take the responsibility that a flight check of relevant procedures has been "successfully completed to ensure correctness of data and flyability." What are the criteria for a successful flight check? Well, right now it depends upon who is flying it. However, it comes down to the pilot flying the procedure, and the system onboard the aircraft. There is no doubt that a pilot assessment is needed, but since there are more to an RNAV procedure then just the flyability of it, a more comprehensive inspection should be done.

SUBJECT

Let us look at what is done today when a new RNAV procedure is introduced.

The request to create a new procedure can come either from an airport authority, a company, or from the procedure department themselves. According to PANS-OPS there is no hard requirement that a new procedure shall be flight checked, but there is a recommendation thereof. In practice, all new procedures will be flight check in some way. After the flight checks are performed, the new procedure will be published in an AIP. Database suppliers will "pick up" the new procedure and process aeronautical data according to ED-76/DO200-A, and deliver these data to the FMS manufacturers. So far so good, but lets look at the flight inspection and the basis for an approval of the new procedure.

Both the ICAO DOC 8071 and the FAA Order 8200.1A states that the flight check should cover the soundness, flyability and safeness of the procedure, but will those "requirement" guarantee that the procedure is safe, sound and flyable in all conditions? The key point here is that there is a dependence upon a very qualified pilot that must judge the flyability of the new procedure using the good old "Mark I Eyeball", but it also contain a direct link to the FMS system onboard the flight inspection aircraft. This will again lead to a system specific dependent result.

Lets look at a definition of the two "components" involved:

FMS: *An onboard-computerized management system, which integrates aircraft performance information procedure and positional information derived from navigation sensors with stored flight plan details and AIS data, together with manual inputs, to provide piloting instruction.*

RNAV: *Area Navigation: A method of navigation which permits aircraft operation on any desired flight path within the coverage of station referenced navigation aids or within the limits of the capabilities of*

self-contained aids, or a combination of these methods.

As can be seen from the definition of RNAV, it will refer to a method of navigating by the use of "traditional" navigation equipment on the ground, and/or the use of self-contained equipment. This must again lead to the question: "is it possible to fly the prescribed procedure if the self contained navigation aid fails?" The answer is of course, … yes, as long as the ground stations, communication, radars, airborne receiving system, flight technical system computation and distance from reference facility, they all are within its tolerance, the procedure design tool shall guarantee you that this is the case.

An RNAV procedure is a very complex "entity", combining most of the know CNS elements. Today these elements are inspected separately one by one, and sometimes by different quality organizations. The question mark must be put on the efficiency, quality and traceability of all data used in the process of creating, verifying and safeguarding a RNAV procedure.

THE SOLUTION

Normarc Airspace Inspection Tool, NAIT, will include the capability of flight inspecting not only the flyability, safeness and human factors, but also the tolerances of each sub system like the traditional ground based navigation aids, communication, radars, OCS, cross track error, along track error, bearing deviation, distance deviation etc involved in a RNAV procedure. NAIT is capable of flight inspecting RNAV departure, arrival and approach procedures.

The system consists of a navigation capability trough the use of an ARINC-424 database, supplied with data from a procedure department, and traditional flight inspection capabilities.

To navigate according to the prescribed procedure, the system uses centimeter accuracy to fly to the waypoints taken from the ARINC-424 database, presented to the pilot on a CDI, and will fuse all data from the ground, such as communication, navigation aids, radar data, and ATC function to give a total picture of the specific RNAV procedure. See Figure 2 below.

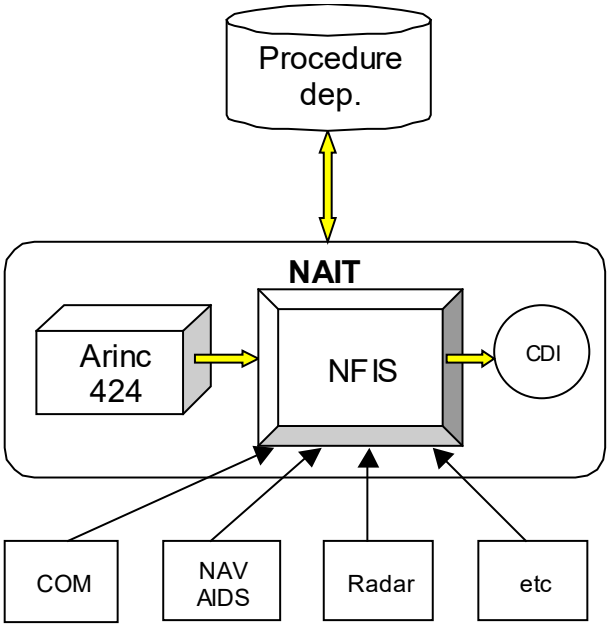

Figure 2 Normarc Airspace Inspection Tool

Since data from a procedure department can be delivered to the NAIT system and formatted to ARINC-424 format, it is not required to load the data into a FMS in the flight inspection aircraft. *[In the case that data are loaded into the FMS, a direct comparison of the flight tracks from the FMS and the NAIT system will be done. This will then be FMS system specific data.]*
When ARINC-424 data is loaded into the NAIT system, there is no reason to load an approved release into the flight inspection aircraft FMS. The NAIT system uses the loaded data to guide the pilot through the procedure, and at the same time, the flight inspector can check for coverage of all CNS elements involved in the procedure. This will increase the efficiency of the flight inspection and the procedure department can design multiple RNAV procedures for one airport, and get them flight inspected faster. Likely important is the fact that this system will merge all data from the

airspace function, and pass it to one centralized environment.
The effect of this is that all data collected during the flight inspection are managed by only one organization and one system. This will clearly have an impact on quality assurance and traceability of data.

The possibility of exporting data from NAIT is also readily available so that the procedure department design tool can have formatted ready to use NAIT data, and use this to create a very powerful procedure design tool. Historical data of all ground-based system can then be used as an input to the design of a new RNAV procedure.

Obstacle clearance is measured by using laser ranging or radio/radar altimeter. Any penetration of the OCS will be recorded.

Subjective assessments from the pilot, of the flyability, runway markings, lighting and so on are included in the final "report". The "report" uses PANS OPS and TERPS documentation as well as DOC 8071 and 8200.1A to assess the procedure.

As can be seen from Figure 2 above, the NAIT environment will have the ability to inspect all CNS segments related to the RNAV procedure, in one integrated tool.

CONCLUSIONS

In the process of further developing our existing system, we saw the problem flight inspection organization had when they where asked to flight inspect RNAV procedures. In the process we tried to focus on the questions ask regarding the efficiency, the traceability and the quality assurance of using data collected from different "players" in the process of inspecting and verifying a RNAV procedure. The goal was to develop a system that could combine all of the above "uncertainties" in one tool, at the same time provide flight data back to the procedure department, so as to integrate the world of procedural design and flight inspection.

It is possible to flight inspect an RNAV procedure using traditional flight inspection methods, but the efficiency, quality, traceabillity and operation of these systems are not optimized for the multi CNS environment that RNAV philosophy requires.

The NAIT system will merge all data from the airspace function, and pass it to a centralized environment. In this way, both the service providers and the users will benefit.

NAIT is not as much just one tool, but an integrated environment that can be used by all "players" in the ATM/CNS environment.

REFERENCES

1. ICAO Doc 8168 VOL II.
2. FAA Order 8200.1A FIM.
3. FAA Order 8260.48
4. FAA Order 8260.44 CHG1