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AREA NAVIGATION POSSIBILITIES IN EUROPEAN ATM SYSTEM

Summary. This paper attempts to offer the reader a consistent overview of P-RNAV and also of other variations of Area Navigation and its role and possibilities in European Airspace. An interesting question is, if it has any chance in fragmented European ATM System. Possibilities in countries like Slovak Republic are also mentioned.

MOŻLIWOŚCI OBSZARÓW NAWIGACYJNYCH W EUROPEJSKIM SYSTEMIE ATM

Steszczenie. Referat podejmuje próbę dostarczenia czytelnikowi spójnego przeglądu P-RNAV a także innych rodzajów nawigacji obszarowej i ich roli oraz możliwości ich wykorzystania w europejskim systemie lotnictwa. Interesującym zagadnieniem jest to, czy będzie to miało jakąś szansę w rozczłonkowanym europejskim systemie ATM. Wspomniano również o możliwościach w takich krajach jak Republika Słowacji.

1. AREA NAVIGATION FUNDAMENTALS

When speaking about Precision Area Navigation, it must be noted that P-RNAV is the natural progression from RNAV or Basic RNAV which became mandatory in European airspace in April 1998. Therefore, the paper explains what RNAV is, provides some basic facts about its development, system structure and mainly its benefits.

ICAO defines RNAV as ,,a method of navigation which permits aircraft operation on any desired flight path within the coverage of the station - referenced navigation aids (NAVAIDS) or within prescribed limits of the capability of self-contained aids, or a combination of these”. [1]

An RNAV system can be viewed as a computer model which draws a picture of the world and allows the placement of an aircraft’s position in this computed model of the world. In order to accurately place or locate the aircraft’s position in this world model, the RNAV system automatically accepts inputs from various sources. These navaids can be VOR, DME, LORAN-C, Global Navigation Satellite System (GNSS), Inertial Navigation System (INS) and Inertial Reference Systems (IRS). Single-sensor RNAV systems use only one source of navigation data, such as DME stations, while multi-sensor RNAV systems monitor a number of navaid systems to determine the best source of navigation data. [1], [2]

Routes and procedures using RNAV provide improved access and flexibility through point-to-point navigation and are not restricted to the location of ground based NAVAIDS. The target level of safety is achieved through a combined use of aircraft navigation accuracy, radar monitoring, automatic dependent surveillance (ADS) and/or additional separation buffers [2].

An RNAV system has access to a sophisticated on-board navigation database containing details of the pre-programmed routes, the airspace through which the routes pass, the navaids servicing this airspace and the departure, destination and planned diversion aerodromes. The system identifies the next waypoint on the planned route, selects the most appropriate navaids to determine the aircraft position and usually provides steering inputs to the autopilot.

It is possible to fly an RNAV route without the RNAV system being coupled to the autopilot. RNAV system outputs displayed on the flight director or the course deviation indicator (CDI) can, in most cases, provide adequate indication of imminent changes in track, altitude and speed to allow the pilot time to respond. As an RNAV procedure can be flown coupled or uncoupled, the procedure should be designed to accommodate both methods. Where a procedure requires the RNAV system to provide vertical guidance, or where a high degree of accuracy is required, autopilot coupling may be mandatory [4].

The navigation accuracy that can be expected from the RNAV equipment is of considerable importance to the controller. The basic – RNAV (B-RNAV) – defines European RNAV operations in the en route phase which satisfy a required track keeping accuracy of ±5NM for at least 95% of the flight time. This level of navigation accuracy can be achieved by conventional navigation techniques based on VOR/DME. Precision equipment – RNAV (P-RNAV), on the other hand, refers to a track keeping accuracy of 1NM or less.

RNAV provide benefits to airspace operators and service providers in the areas of safety, airport and airspace access, capacity and environmental impacts. Conventional navigation methods lead to less efficient routes, procedures and airspace. Inefficiency is also driven by large airspace separation buffers that are required to reduce the operational risks due to inaccuracies associated with conventional navigation methods. There are also other indirect benefits, for example continuous descent approach procedures enabled by RNAV at many airports could reduce the risk of controlled flight into terrain (CFIT) accidents.

The benefits of RNAV apply to airspace operators and service providers alike. Predefined procedures enhance confidence and consistency and reduce the risk of communication errors due to communication reduced by 30% to 50%. It brings improved airport and airspace access in all weather conditions and the ability to meet environmental and obstacle clearance and constraints through the application of optimised RNAV-based flight tracks. Reduced lateral separation criteria and more accurate path keeping, more precise arrival, approach and departure procedures, which reduces dispersion and facilitate smoother traffic flows, can be seen as a result. When speaking about benefits for operators and providers together, we have to mention reduction of delays at airports and in airspace with certain level of density through the application of new parallel routes, newly enabled ingress and egress points around busy terminal areas and improved flight re-routing capabilities which can lead to an average time saving 2 – 4 min per flight. RNAV enables flexible routes such as wind-optimal and great circle routes when beneficial and use of environmentally beneficial arrival and departure procedures that allow the aircraft systems to manage flight performance; the horizontal inefficiency can be lowered by an average distance saving of 13 – 15 nm per flight. Benefits also include reduced fuel emissions and environmentally-tailored noise footprints [5].

2. PRECISION AREA NAVIGATION

P-RNAV procedures are designed to a common set of design principles specific to RNAV equipped aircraft. These P-RNAV procedures will replace the current multitude of overlay procedures many of which are unsuitable for a wide range of aircraft types [3].

In other words, P-RNAV allows terminal airspace RNAV operations that are consistent in various European States, based on a common set of design and operation principles, ensuring consistent levels of flight safety. This in contrast to the current situation, where the variations in RNAV approval requirements, the variations in procedure design and procedure publication/charting, and the variations in navigation data integrity, have been recognised to be not without safety implications.

The required level of navigation accuracy for P-RNAV can be achieved using DME/DME, GPS or VOR/DME. It can also be maintained for short periods using IRS. In this case, the length of time that a particular IRS can be used to maintain P-RNAV accuracy without external update is determined at the time of certification [1].

P-RNAV procedures are designed, validated and flight checked to a common standard. In a full P-RNAV environment, all aircrafts are certified acc. to the same criteria and have the same functional capability. In addition, ATC procedures and R/T phraseology are standardised. This harmonised approach will enable all aircraft to fly accurate and consistent flight paths in the terminal area. The current situation is that many existing aircraft can achieve P-RNAV capability without additional onboard equipment. This, however, is not enough to reach full harmonisation with P-RNAV in short term [3].

Compared to the current situation, the most important aspect that P-RNAV offers is the consistency in RNAV procedure design and execution. This in itself provides a safety benefit, and is the main driver for the introduction of P-RNAV procedures in ECAC Terminal Airspace. Considering P-RNAV as the appropriate requirement for Terminal Airspace RNAV operations, it becomes the enabler for RNAV operations in Terminal Airspace providing all the associated RNAV benefits.

3. P-RNAV IMPLEMENTATION POSSIBILITIES

It is obvious that benefits of P-RNAV, also in Terminal Airspace, are indisputable. It brings increased flexibility, capacity and all other benefits. But there are also negative factors, which are usually different for each state. For example in the Slovak environment, there is a probable increase in ATCO workload, because of traffic mix. They have to distinguish conventional SID/STAR, or radar vectored, or P-RNAV procedures. An important aspect is that in terminal airspace of the largest Slovak airport (LZIB), there is no need to increase the capacity by P-RNAV implementation because the traffic volume does not require any improvements and they are also not anticipated in the next few years. There is also another limiting factor on this airport: the proximity of Malacky prohibited area and proximity of Czech FIR, Austria FIR and Hungarian FIR. It is partly the reason why new possible routes have to copy conventional routes in most cases (and probably not only in the first phases of implementation) and the benefits would be only for pilots, because of ATCO high workload in traffic mix.

4. FMS

The interchangeable use of the terms RNAV and FMS is very common and is inaccurate. In an attempt to discourage this erroneous fusion of terms and any confusion which may arise as a result of this, a description of FMS is provided.

The FMS is an important part of the automatic flight guidance system that is used for flight planning in all modern aircrafts. The FMS has introduced operational advantages and significant cost savings, e.g. through offering the possibility of an automatic, fuel-efficient flight from take-off to landing and reducing pilots' workload. However, the FMS with its high level of automation has changed the pilots' role considerably. This has caused problems with respect to human factors. Shortcomings and the most dominant problems of the present FMS are the deterioration of the crew's situational awareness when out of the standard procedures, a poor ergonomic computer-human interface, and the missing ability for rapid flight plan changes [5].

There are some ideas how to improve the current system; one of them is shortly explained thereinafter. The main scope is to replace alphanumerical flight plan by a graphical interface. Some difficulties in the current system or functions, which are not very user-friendly (flight plan translation, small buttons etc.), have been mentioned above. A team from Germany have developed new software and evaluated it. This technology was tested by 10 pilots and conclusions are that pilots can imagine using such a system in the future. It is obviously, that necessary simulations and data evaluation takes time. But experiments like this are evidence, that also dogma like FMS can be changed [6].

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