Non Precision Approach (NPA)

Status and Evolution

NPAs are still the scene of an important number of accidents. This statement was particularly true for Airbus during the past 12 months. That is the reason why it has been decided to dedicate one full day of the 22nd Airbus Flight Safety Conference held in Bangkok this year to this specific subject. You will find in this document an extract of what Airbus has presented on this topic during the conference.

1. NPA - CASE STUDY

First, we will come back on one of these events that occurred in 2015 with fortunately no fatalities (only some light injuries) but with the loss of the aircraft (beyond economical repair). The following points are generally encountered in most of the accidents occurring during Non-Precisions Approaches (and this is actually the case for the event we are focusing on in this article):

- An inappropriate use of Auto Flight System
- Challenging meteorological conditions
- Poor visual references at or below MDA
- Late Go Around decision
- Impacts far from ideal touch down point, and
- No EGPWS alert (outside the EGPWS envelope)

This event involved an A330 aircraft that was conducting a RNP AR (0.3NM) approach during day light (early morning) with Autopilot (AP1) and both FDs engaged. After 45mn of holding and one Go-Around due to bad visibility (fog), the aircraft initiated a second approach following an improvement of visibility (above minima) announced by the tower. At minima, the Captain who was Pilot Flying (PF) decided to continue a little bit below with AP1 ON as he had most likely no visual reference of the runway. At 50ft RA, the Captain said “Appearing” and disconnected the AP1 at 14ft, i.e. 1sec before touch down. The aircraft performed a hard landing and touched down about 400m after the runway threshold on the LH side of the runway axis with the left Main L/G outside the pavement area. Then, TOGA thrust was selected during 1sec before the thrust levers were retarded to IDLE and set to REV MAX. The aircraft finally stopped at about 1400m from the threshold with both Main L/G outside the runway and with the nose laid on the ground (NLG collapsed). Only one person was injured during the emergency evacuation. Aircraft was declared Hull Loss.

During the analysis of this event, it was found out that the coordinates of the runway threshold coded in the FMS NAV Database of the involved aircraft were wrong (not on the runway centerline, but offset from about 26m on the left of the runway centerline). By construction, the RNP AR approach is anchored to the runway threshold.

Before recalling what are the Standard Operating Procedures (SOPs) and the best practices that should be applied to safely fly a Non-Precision Approach (NPA) let’s quickly review what are the different designs of NPAs that can be encountered today.

2. NPA - DESIGN EVOLUTIONS

2.1 DEFINITION

Let’s start by a definition or at least an explanation on why these approaches are called Non-Precision Approaches (NPAs). In the 70’s, this king of approaches were called “Non-Precision Approach” compare to “Precision Approach” because:

- It does not provide vertical guidance

- The precision of the Nav Aids that are used to position the aircraft on the lateral trajectory is not very accurate.

2.2 FIRST NPA DESIGNS

In the 70's, these approaches were actually designed based on lateral course or pattern supported by radio Nav Aids (VOR, NDB, DME) with a step down or even no vertical path. These approaches, build using old technology now but that still exist, are by construction more demanding to fly for a flight crew than a "Precision Approach" for the following reasons:

- Minimum Descent Altitude (MDA) leading to level-off and destabilization (Dive and Drive)
- Missed Approach Point (MAP) not located at Runway Threshold
- Final segment not aligned with the runway
- Poor accuracy to compute the aircraft position (through Nav Aids)
- Not straightforward monitoring of the vertical trajectory

However, technology has evolved. What was true 40 years ago is not necessarily the case now and the distinction between "Precision" and "Non-precision" is no longer so clear now.

2.3 NPA DESIGN EVOLUTIONS

The introduction of Flight Management Systems (FMS) in the 80's has allowed to construct lateral and vertical profile independent of Nav Aids. Coupled with the deployment of Inertial Reference System (IRS), the FMS provides also more accurate positioning and flight planning. But it is in the 90's that a significant breakthrough was made regarding accuracy in aircraft positioning with the implementation on the GPS (12m accuracy and worldwide coverage). The GPS allows now very precise positioning.

This technology has allowed to design a new type of approaches that does no longer use Nav Aids (i.e. ground based information) but aircraft based information with enough accuracy to enable lateral and vertical guidance. These approaches are called RNP Approaches (also called RNAV (GNSS) approach on charts) or RNP AR approaches (called RNAV (RNP) approach on charts).

This new type of NPAs has several advantages compared to conventional NPAs (i.e. NPAs based on Nav Aids):

- A Continuous Descent Final Approach (CDFA),
- A Missed Approach Point (MAP) at Runway Threshold,
- Allows much more accurate track to be flown,
- Enables fully managed guidance along the lateral and vertical trajectory,
- Makes the monitoring of the vertical flight path easier.

In this connection, ICAO has issued in Sept 2010 the Resolution A37-11 that provides recommendations to urge all States to implement RNAV and RNP operations for en route but also for terminal areas in accordance with the ICAO Performance-Based Navigation (PBN) concept. Airbus promotes and actively supports the implementation of safe and efficient PBN operations worldwide.

The PBN concept allows the design of safer and more efficient instrument flight approach procedures. However such approaches are very "Data dependent" meaning that they strongly rely on the accuracy of the published Aeronautical Data and on the correct coding of the FMS Nav Data Base (DB). Even if the FMS Nav BD issue was not the main root case of the accident, the first case study presented in this article is however an eloquent example of this dependence.

Therefore, one of the safety challenges of this new type of approaches is to ensure that Nav DB inserted in the FMS of each aircraft is correctly coded with the accurate data. This requires the implementation and the strict application of a robust FMS Nav DB checking process.

Let's see now what are the main points in the Standard Operating Procedures (SOPs) that allow to safely fly a NPA.

3. NPA - SOP BEST PRACTICES

3.1 APPROACH BREIFING

Preparing a NPA starts on ground before flight. The validation of the FMS NAV database and the check of the GPS PRIMARY availability at destination (if the approach requiring GPS is expected) are usually done by the Flight Operations (OCC).

Most of the actions to prepare the approach are performed during Descent Preparation. A good and comprehensive preparation is one of the key points for the safe conduct of the approach. Indeed, an approach not fully briefed and rushed due to ATC or weather constraints is most of the time one of the significant contributors to incidents or even accidents during NPAs (where the workload is high).

What are the main and specific points that should be reviewed at the Descent Preparation when a NPA is planned to be flown:

- The aircraft capability to fly the planned type of Approach (FINAL APP, FLS, etc…),
- The consistency between MCDU F-PLN page and Approach Chart with a special check on the final segment, i.e. FAF position and altitude, final course, FPA, Missed Approach Point (MAP) and minima,
- The strategy for the vertical guidance : Selected or Managed,
- Approach Briefing including Missed Approach strategy.

Of note is that to be allowed to fly a NPA in vertical managed mode, the approach stored in the Navigation Database must be either:

- Produced by an approved supplier compliant with ED76/DO200A requirements, or(*)
- Validated and approved by the Operator.

Note (*): For RNP AR (i.e. RNAV (RNP)) procedures both conditions should be fulfilled.

Then, during the Descent, the flight crew has to check the Navigation Accuracy and manage potential degraded navigation situation. Let's see more in details the approach itself in the next chapter.

3.2 APPROACH PROCEDURE

Among other actions, the NPA procedure asks the flight crew for the following actions:

- Check arming and engagement of the lateral mode
- Check that the FAF is flown according to the chart (with associated callout)
- Check arming and engagement of the vertical mode
- Respect the approach chart and in particular the published MSA
- Monitor the vertical profile and the flight parameters
- The PM role is crucial in this monitoring
- At minima respect the Golden Rule : "If no or insufficient visual references, go around"
- If visual references are lost below minima, go around.

4. CONCLUSION

To conclude, we can say that:

- NPAs are still the scene of an important number of accidents,
- NPAs are evolving in a safer way,

- Performance Based Navigation (PBN) implementation allows to fly safer and more efficient Approach Procedures,
- But a robust FMS Nav DB checking process becomes critical, and
- As always, adherence to SOPs and respect of Minima remain crucial.

Author

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He started, in 1998, as a "Flight Ops Engineer" in a French charter airline ("STAR Airlines", now named "XL Airways France"), being responsible of the development of the Airline Operational documentation (AOM, MEL, etc…), the aircraft performance computation (takeoff & landing performance) and monitoring (ageing performance) and also being in charge to draw up and follow up all the operational authorization requests (AWO, RVSM, ETOPS...) with local Authorities.

Then, he moved to the Quality Assurance Department of the Operator as the "Operational Quality Manager" in charge of the supervision of the JAR OPS 1 regulation for the Operator side and JAR FCL 1 regulation for the Type Rating Training Organization (TRTO).

Thomas has joined Airbus in 2006 in the Flight Operations Support Department, as a "Flight Ops Engineer" for the A320 and A330/340 aircraft family. At this position, he was in charge of the technical support to Airlines in terms of operational documentation (FCOM, QRH and FCTM) and procedures. He was also involved in coordinating this activity with the Airbus Training Policy Department.

Then, he took the position of "Safety Enhancement & Policy Manager" within the Flight Operations Support Department. As such, he was responsible to coordinate the activities linked to the Airbus Product Safety Process for all Airbus aircraft types (i.e. enhancement of the safety of flight operations and operational procedures).

Thomas has joined the Airbus Product Safety Department in 2013 as an "Accident and Incident Investigator". In this position, he is leading the Airbus investigation, coordinating the in-depth Airbus analysis and supporting technically Investigation Boards in their investigations.