

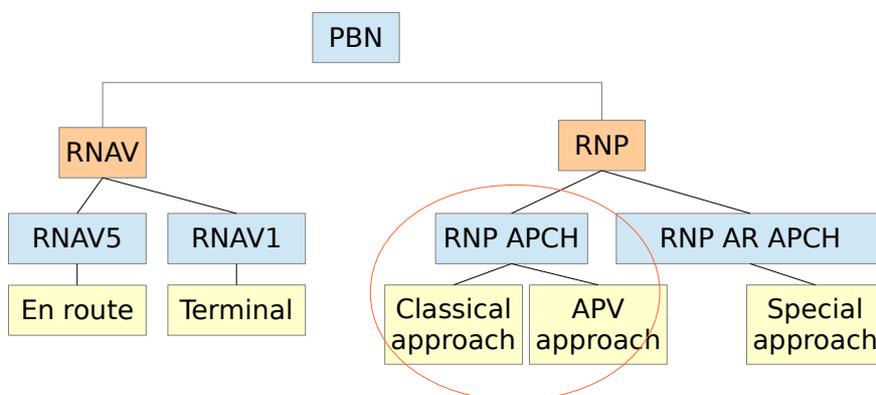
Testing the Majestic Software MJC8



Introduction

I always try to assess the accuracy of a simulation by trying some RNP APCH (often known in regionalised languages RNAV(GNSS)) and RNP AR APCH (also charted RNAV(RNP)).

Required Navigation Performance operations are the other category of Performance-Based Navigation along with the RNAV operations. They require more performance of navigation. RNP will be used not only for approaches but also for routes currently only in RNAV, although the implementation will be evolutionary. Nowadays, RNP approaches are set up all over the world since ICAO A37-11 resolution from October 2010.



The main difference with RNAV is that RNP requires a performance monitoring system. The aircraft must be equipped with a system that checks the integrity of input signals (satellites, nav aids) and alert the crew if the integrity or the required performance is lost.

There are two different types of RNP approaches : RNP APCH (basic RNP) and RNP AR APCH (with special authorisation for crew and aircraft). In the later type, only radius to fix (RF) legs (a special way of turning around a fix) and track to fix (TF) legs are part of the path whereas basic RNP APCH have only straight segments but with more leg types allowed (exactly 9 of 23, those 9 “path terminators” being the ones that confer the best reliable and repeatable flight path). RNP AR APCH may be RNP-0,1 while basic RNP APCH are RNP-0,3.

In the simulation the challenge is the accuracy of the simulated aircraft. Some simulation have a too loopy autopilot to perform RNP APCH operations. In those airplanes you will restrict yourself to radio navaid-based approaches or manually fly the bird. Therefore each simulation of an aircraft has to be tested to assess if RNP operations are achievable.

You can read my previous review (<http://gf3.myriapyle.net/aero/embraer-feelthere-E-Jets-transatvia.com.php>) of the Embraer 170/190 for FS2004 and FSX where I am also dealing with the RNP simulation.

Here I am discussing the RNP operations such as RNP APCH and RNP AR APCH applied to the MJC8.

Material : Cycle 1511 from NavdataPro (and Navigraph), Windows 7, Prepar3d 2.5. Aircraft is the MJC8 1.017 RC1 Pilot edition.

Objective 1 : try to see how an RNP APCH can be conducted with a Dash-8.

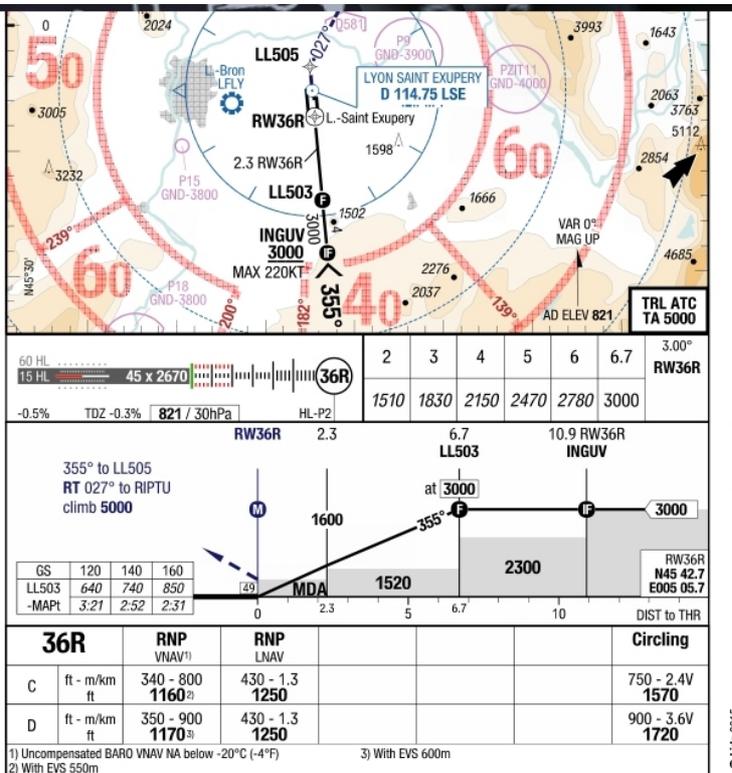
Objective 2 : spot the limitations of the simulated Dash-8, namely the MJC8, compared to the real world model.

What is the reliability of RNP operations in the simulation ? Do we have to take the ILS every time in the simulated aircraft ?



Part I : the RNAV(GNSS) approach to runway 36R in LFLL

I tried the RNAV(GNSS) approach to runway 36R in LFLL.



For reference, this is how the approach is charted on the State chart :

MNM AD : distances verticales en pieds, RVR et VIS en mètres. / Vertical distances in feet, RVR and VIS in metres. REF HGT : ALT THR

CAT	LPV		LNAV/VNAV		OCH LPV et/and LNAV-VNAV	LNAV OCH : 429		MVL/Circling		TMNM Baro-VNAV : -20°C							
	DA (H)	RVR	DA (H)	RVR		MDA (H)	RVR	MDA (H)	VIS	DIST RW36R							
A	1140 (320)	700	1140 (320)	700	311			1300 (480)	1500	NM	6	5	4	3	2		
B	1150 (330)	800	1150 (330)	800	321	1250 (430)	1300	1410 (590)	1600	ALT	2780	2460	2145	1825	1505		
C	1160 (340)	800	1160 (340)	800	331			1570 (750)	2400	(HGT)	(1959)	(1639)	(1324)	(1004)	(684)		
D	1170 (350)	900	1170 (350)	900	341			1720 (900)	3600								
FAF - THR		6.7 NM		70 kt 5 min 45		85 kt 4 min 44		100 kt 4 min 01		115 kt 3 min 30		130 kt 3 min 06		160 kt 2 min 31		185 kt 2 min 10	
VSP (ft/min)				370		450		525		605		685		845		975	



API	IDENT	VSS
X	X	X

AMDT 13/14 CHG : 1ère édition.

© SIA

Action : the approach is selected on the FMS, and loaded.

Observations : the sequence of the approach is correct, as well as the vertical navigation associated to it. (Look at the IF LL503, specified AT 3000).



The charts states two minimums : RNP VNAV and RNP LNAV. I would use RNP LNAV if using Vertical Speed (selected guidance) to follow the glide path. Instead, here, I took the RNP VNAV minimums, because the aircraft is certified to use BaroVNAV (managed guidance) to follow the glide path.

Action : VNAV is used from the FMS as described in the system manual (Chapter 16.10.9. VNAV function, page ¹²⁵/₁₃₃, "Should the crew decide to utilize the VNAV Approach to descend on the glide, the VNAV can be re-engaged (...).") and armed on the control panel.

Observations : when the final approach FMS-generated vertical path is reached, the AFCS switches to VNAV PATH (as expected). We are able to follow the approach from FL250 to the minimums in auto-pilot and LNAV/VNAV PATH.

Action : test of the vertical and lateral accuracy of this FMS-generated approach by following the approach on autopilot and disconnecting only at minimums.

Observation 1 : At that time the VDEV (vertical deviation) is only of 64 feet from the FMS glide path. We are within a "125 feet margin box", so on vertical path. The angle is however nearer of -4° than of -3° as I would have expected, maybe because the charted 3° flight path angle is based on crossing the runway threshold at 50 feet, while the set up of the VNAV PATH in the Q400 was set slightly differently with the VNAV TO function by the pilot.



Observation 2 : at that time the LDEV (Lateral deviation) is of 0.0 nm ! So we are on lateral path with no deviation.

Observation 3 : the FMS must enter the approach mode to display the correct RNP. You have to select ARM APPROACH on the NAV page prior to entering the approach segment of the flight plan. Regarding the actual navigation performance, it is stated as ANP 0.14 which allow to do RNP operation within RNP.3 containements.

Conclusion : the RNAV(GNSS) approach went very well. The fact that the wind was calm ($2^{14}/4$) made impossible to test whether the MJC8 auto-pilot is able to keep the lateral accuracy seen here in gusty or lateral wind conditions.

Part 3 : the RNP APCH to runway 09 at EGGD

I did the RNP APCH to runway 09 (the so-called RNAV(GNSS) 09) to EGGD.

Initialization

- **Flight plan**

As you can see in the flight plan below, I elected to fly an arrival route from EXMOR, in order to be able to shoot one of the RNP APCH initial approach fix with an RNAV STAR.

DEP=LOWI, DEPTIME=1813, SPEED=N250, LEVEL=F230

ROUTE=MOGTI P66 KPT L856 AKABI UL856 HOC UL613 KOTUN UQ220 KESAX UT421 KUNAV T421 BIG L9 NORRY Q41 SAM L620 GIBSO DCT EXMOR

DEST=EGGD, EET=0214, ALT=EGSS, PBN/A1B1C1D1L1O1S2

WX ARR EGGD 191 750Z AUTO 01 005KT 9999 OVC041 $\frac{14}{09}$ Q1026

- **Aircraft**

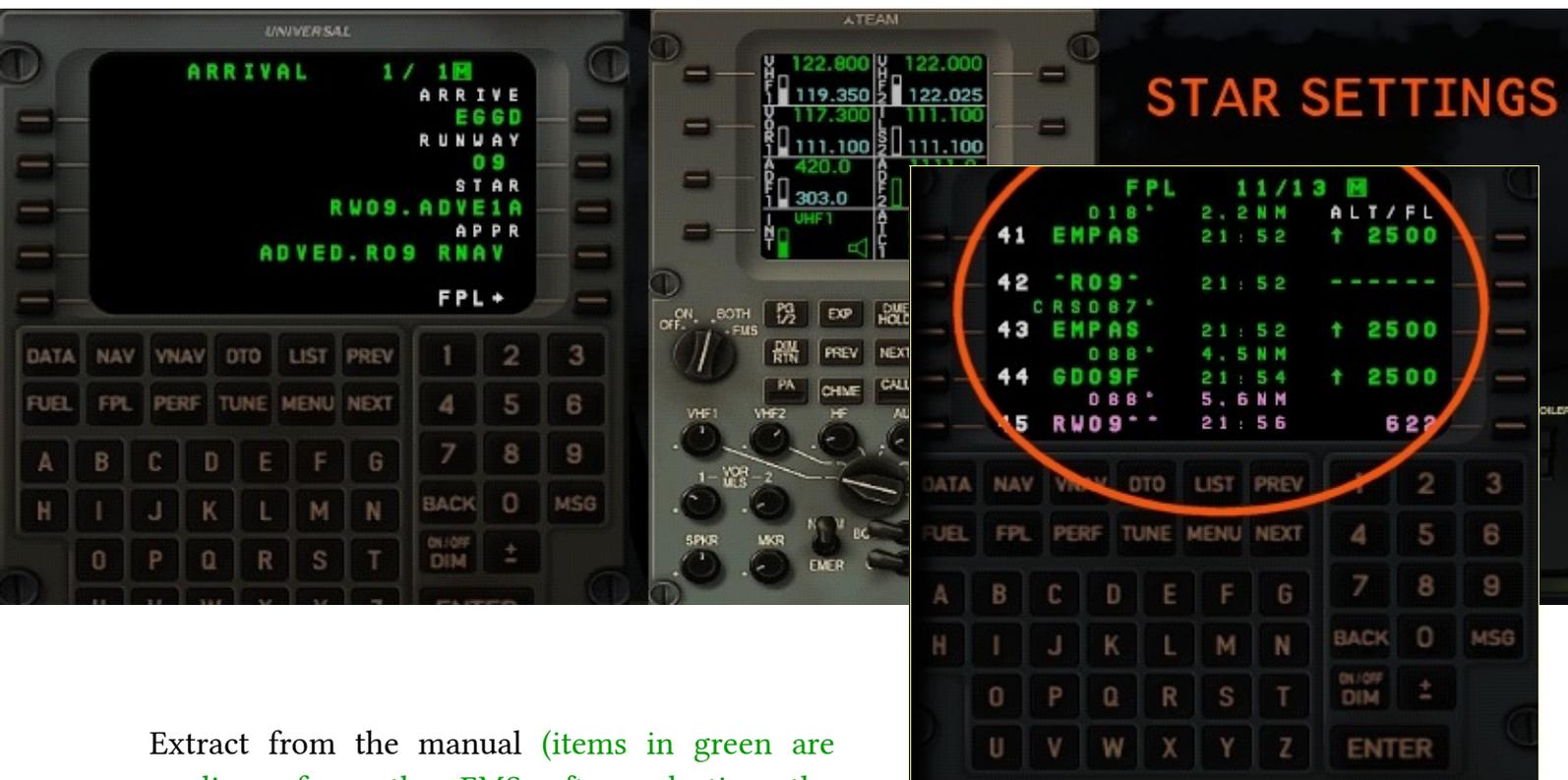
ESTIMATED ZFW/ZFM 19 000 LAW/LM 21500 TOW/TOM 24 200 (KG), VREF F35 : 107 kts

- **FMS configuration for arrival - lateral path and radios**

In the picture below you will see that :

- a) we selected ADVE1A to RNAV 09 TRANS.ADVED at EGGD
- b) we tuned the radio to nothing significant : the radios are not tuned and ARCDU are not yet in the FMS configuration. Conceptually we are planning to do an approach which is not based on ground nav aids.





Extract from the manual (items in green are readings from the FMS after selecting the approach) :

After the procedures have been entered, the following discontinuities will be added automatically :

STAR	EXMOR -> ADVED
NO LINK	*NO LINK*
IAP (transition)	EMPAS -> *R09*
NO LINK	*NO LINK*
IAP	EMPAS -> GDF09 -> R09**
NO LINK	*NO LINK*
MISSED APPROACH	
NO LINK	
ARRIVAL AIRPORT	

The usual procedure is to erase the *NO LINK* in front of the STAR after ensuring that it properly links into the flight plan, but leave the *NO LINK* ahead of the first approach point (IAP), until the ATC clearance for performing the approach is received.
(...)

After selecting an RNP approach (ie without any relevant navaid or associated frequency, per definition) we have to arm (and tune, until 1.017RC1) the approach in the FMS to get LNAV APPR mode and APPR for RNP accuracy and not only LNAV and TERM for RNP accuracy.

After arming the approach you are going to be prompted to tune the approach in 1.017 RC1 (This seems not realistic since our RNP APCH are decorrelated from nav aids). . This is fixed



in the 1.017 final version. From now on the TUNE prompt will appear for ILS approaches only.

Note

It would be an error to edit the path to reflect more closely the approach chart. This would void the approach and the FMS would no more be able to enter into this mode. I manually edited the flight plan as shown below (EXMOR -> ADVED -> EMPAS ->



GD09)

As a result we cannot arm the approach any more :



Page 326 of the real UNS1-E manual states :



"[...] A capture fix waypoint may be the same waypoint as the last waypoint in the approach transition and, therefore will be listed twice in the flightplan. This is correct for the UASC FMS systems; do not delete one of these waypoints. The approach segment must NOT be edited or it will void the approach. An edited approach, including approach label and * EOA * , will violate the integrity of the approach segment and these waypoints can no longer be flown as an FMS approach."

As shown below, once activated, with the ARCDU placed into FMS position (1.017RC1), I was able to switch into approach phase with RNP accuracy displayed in the PFD, and also LNAV APPR on the FMA.





What did the system tune with 1.017RC1 ? There is no relevant navaids on the chart ! I really wondered. To answer to this question, I had a look at the ARCDU. We can spot the 110.15 frequency on nav one. After parsing my charts, I found it is the ILS associated to this runway end in Bristol, in no way relevant to this RNAV(GNSS) procedure ! This should be now fixed with 1.017 final edition. As already said above from now on the TUNE prompt should appear for ILS approaches only.



Part 3 : the RNP AR APCH Runway 26 at LOWI.

This time I practiced the RNP AR APCH Runway 26 at LOWI. What you get if you arm and tune the approach, is the following screen.



Observations (½):

- LNAV APPR and VNAV Path are leading my aircraft on the FMS-generated path down to minimums (exactly as we already observed on step 1). There is no significant deviation.
- RNP is in APPR accuracy, RNP 0.50. I cannot reselect the RNP0.30 once the approach is activated however. Normally I should have set it to 0.30 but I couldn't due to time.



Observations (2/2) :

- This approach is a RNAV AR APCH or RNAV(RNP) because it has some characteristics which make it divergent from an RNP APCH or RNAV(GNSS). It is required to have the capacity to follow RF-legs as stated on the chart. You have such a leg in the missed approach part between W10007 and W1008.
- The FMS LEGS page shows the ARC leg.
- The navigation display is not able to display an arc and draw a line between W1007 and W1008.
- The representation on the ND is evolving toward a mess as soon as we arrive near the curved RF-leg.
- Finally the aircraft turn right, instead of left and is not able to handle the turn.

Action : I change the navigation database from Aerosoft(TM) Navdatapro (c) to Navigraph's one.

Nom	Modifié le	Type	Taille
NDP_Feelthere_back	16/10/2015 10:00	Dossier de fichiers	
routes	18/10/2015 18:48	Dossier de fichiers	
cycle_info.txt	07/10/2015 21:09	Document texte	1 Ko
nd.ldb	18/10/2015 21:09	Fichier LDB	1 Ko
nd.mdb	07/10/2015 20:12	Fichier MDB	166 488 Ko

Nom	Modifié le	Type	Taille
NDP_Feelthere_back	16/10/2015 10:00	Dossier de fichiers	
routes	18/10/2015 18:48	Dossier de fichiers	
cycle_info.txt	12/10/2015 20:13	Document texte	2 Ko
nd.ldb	17/10/2015 23:21	Fichier LDB	1 Ko
nd.mdb	12/10/2015 20:29	Fichier MDB	169 848 Ko

cycle_info.txt - Bloc-notes

Fichier Edition Format Affichage ?

AIRAC cycle : 1511
Version : 1
Valid (from/to): 15/OCT/2015 - 11/NOV/2015
Forum : <http://forum.navigraph.com>

Data provided by Navigraph - www.navigraph.com - Source data copyri
This data may be used for ground based recreational computer game

cycle_info.txt - Bloc-notes

Fichier Edition Format Affichage ?

Aerosoft NavDataPro

AIRAC cycle : 1511
Revision : 1
Valid (from/to): 15/OCT/2015 - 11/NOV/2015

Observations :



- the list of SID available for LOWI R26 departure is now reduced to 1, MOGTI 1H. All other SID found in the LIDO dataset, including RNAV SID for R26 are not in the FMS.
- the curved RF-leg is now correctly displayed between W1007 and W1008.



- this leg is flown as expected with the aircraft (tested with IAS< 165kts as required)
- With 1,017RC1 we still have to click on "tune approach" to get LNAV APPR, which seems a weird action for an RNP approach, otherwise it is only LNAV
- RNP is 0.50, but was manually selected to RNP 0.30 before activating the approach

Conclusion :

1/ The set of available procedures is different in LIDO (Aerosoft) and JEPPESEN (Navigraph).

2/ The simulation works better with the Navigraph dataset than with the Aerosoft's one. NavDataPro is incompatible with the Q400 due to differences in procedure coding.

Recommandation for the MJC8 :



If you use Navdatapro

Select ILS or RNAV(GNSS) approaches. Reject RNAV(RNP) approaches since we cannot safely perform RNP AR APCH due to aircraft "certification". This inability to follow RNP AR APCH operations with radius-to-fix is well known with the type of database that the MJC8 use when provided by Aerosoft. It was already reported with the Embraer E-Jets for FS2004/FSX which share the common database.

The proposed equipment and certification for the simulation is :
ADF DME ILS INS VOR GNSS + RNP based on BaroVNAV : SDFHIRGWY/EB2
PBN/A1B1C1D1L1O1S2

If you use Navigraph

Select ILS or RNAV(GNSS) approaches or RNAV(RNP) approaches.

The proposed equipment and certification for the simulation is :
ADF DME ILS INS VOR GNSS + RNP AR based on BaroVNAV : SDFHIRGWY/LB2
PBN/A1B1C1D1L1O1S2T1 NAV/RNP WITH RF

General comment

Regarding the real aircraft the local carrier in LOWI is "only" flying Special Loc 26/ Loc 26 and RNAV Gns Y o8 (not able loc Romeo 26 or RNAV RNP 26, which e.g. the Niki E190 were certified for.)



FMS guideline

The approach segment must NOT be edited or it will void the approach. An edited approach, including approach label and * EOA *, will violate the integrity of the approach segment and these waypoints can no longer be flown as an FMS approach.

$$DH_{CAT I} = \max \{200 \text{ ft} ; OCH\} \rightarrow \text{DA} \quad (\text{regulations})$$

$$DH_{CAT II} = \max \{100 \text{ ft} ; OCH\} \leq 200 \text{ ft} \quad (\text{regulations})$$

ACFT	NPA (NDB)	NPA (RNP APCH, VOR, VOR/DME, LOC)	Cat I + LPV *	Cat II
Dash-8 Q400	As published. Comply with DH ≥ 350 ft → MDA	As published. Comply with DH ≥ 300 ft → MDA RVR ≥ 800 m	As published. LPV not authorised ** Comply with DH ≥ 200 ft converted into DA and RVR ≥ 400 m	As published. Comply with 100 ≤ DH (RA) ≤ 200 ft RVR ≥ 300 m
	Autopilot operation: Disengaged at MDA at the latest		Autopilot operation: Disengaged at DH minus 40 ft at the latest	Autopilot operation: Disengaged at DH minus 20 ft at the latest

* Single policy for all types of CAT I approved approaches and for RNP LPV (APV SBAS)

** except for dual UNS₁-Ew with Localizer Performance with Vertical Guidance and qualified crew.

ACFT	Cat IIIA		Cat IIIB	
Dash-8 Q400 (Tail-passive)	DH 50 (RA) RVR 200 m Not authorised *	One engine operative Not authorised Revert to CAT II	Not authorised	
	Autopilot operation : Disengaged at 50 ft at the latest **			

* except for HEADUP GUIDANCE SYSTEM equipped ACFT and qualified crew.

** hand-flown approach from 50 ft at the latest but from 500 ft recommended, then captain takes over controls at 50 ft.



ven. 30 octobre 2015

Mots : 2396

Caractères : 13 308

Nom : RNP

Pages : 16

