RNP Approach
Runway 05
Queenstown, New Zealand

Version 1.2

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RNP Approach RWY 05 NZQN

The video *This is why we fly…* was recorded on a GoPro camera and uploaded to You Tube by MrGoodViews Person (probably a QANTAS pilot) on October 23, 2013. It is an amazing and acclaimed video. In increased speed mode, it features a Boeing 737-800, descending through 8 octas of low and dense cloud between the rugged mountain ranges surrounding Queenstown, New Zealand. The aircraft is making an approach to runway 05, employing the latest in aviation navigational system, tipped to replace the ILS approach at all airports. For me this video is a constant source of inspiration for flight simulation engagement in general and the achievement of that 'as real as it gets' experience in particular. I never tire of watching it.

I posted the video in the then Aussie Star Flight Simulation Google + Community in January 2014. In March 2014 I made a crude re-creation of the same approach in FSX (Figure 1). That was before I became aware of the development of improved navigation systems enabling the experience shown in the video to be flown in total safety and accuracy – using Required Navigation Performance (RNP).

Place and time
Select airport: Dunedin, New Zealand NZDN
Season: Winter
Time: 0630 local time
Weather
Select User defined weather> Customise> Advanced weather
Cloud type stratus
Cloud coverage overcast (8/8)
Tops MSL 4000
Base MSL 2000
Flight plan
Taxi to and takeoff rwy 23
Climb to 7000 feet
Track ATHOL waypoint to on top, HDG 260
At ATHOL, turn right HDG 327 and track to AFTON waypoint
Descend to 6000 feet
At AFTON, turn right HDG 031, track to SH05 waypoint
Commence descent to 1500 feet
When runway in sight, land rwy 5.

Figure 1: Early FSX re-creation flight plan

Renewed interest in the *This is why we fly* video prompted me to investigate further and delve deeper into the making of the video. I also wanted to learn of the development of RNP technology and how it has made landing in places such as Queenstown where terrain is a challenge can now be achieved with absolute safety.

What is RNP?

The international committee on Future Navigation Systems (FANS) initially developed the concept of **Required Navigation Performance Capability (RNPC)** as "a parameter describing lateral deviations from assigned or selected

track as well as along track position fixing accuracy on the basis of an appropriate containment level".[1] ICAO approved the RNCPC concept and assigned it to the Review of the General Concept of Separation Panel (RGCSP) for further work.

With evolving navigation systems, in 1990 the RGCSP realised that capability and performance were distinctly different. Since airspace planning is dependent on measured performance rather than designed capability, the RNPC was changed to Required Navigation Performance (RNP).[2] The International Civil Aviation Organization (ICAO) has since specified that Required Navigational Performance (RNP) as an aspect of Performance-based Navigation (PBN) as an essential element of communications navigation surveillance and air traffic management and encouraged early implementation in the enroute environment.

Required Navigation Performance (RNP) then, represents the latest navigation techniques, allowing aircraft to fly precisely along a predefined route using state-of-the-art onboard navigation systems and the Global Positioning System (GPS), resulting in improved efficiency, capacity and environmental performance for the global air transportation system. This flight procedure is particularly suited to areas where operations are limited by terrain, infrastructure availability or airspace constraints such as parallel, converging or adjacent airport operations. Flexible flight paths allow aircraft to be directed around obstacles or restricted noise areas – even on final approach – while keeping the mist direct routing possible.[3]

The advantages of RNP are demonstrated in Figure 2 below which illustrates the efficiencies to be gained in the use of the RNAV approach over conventional routes and the optimised use of airspace gained through the use of RNP navigation.

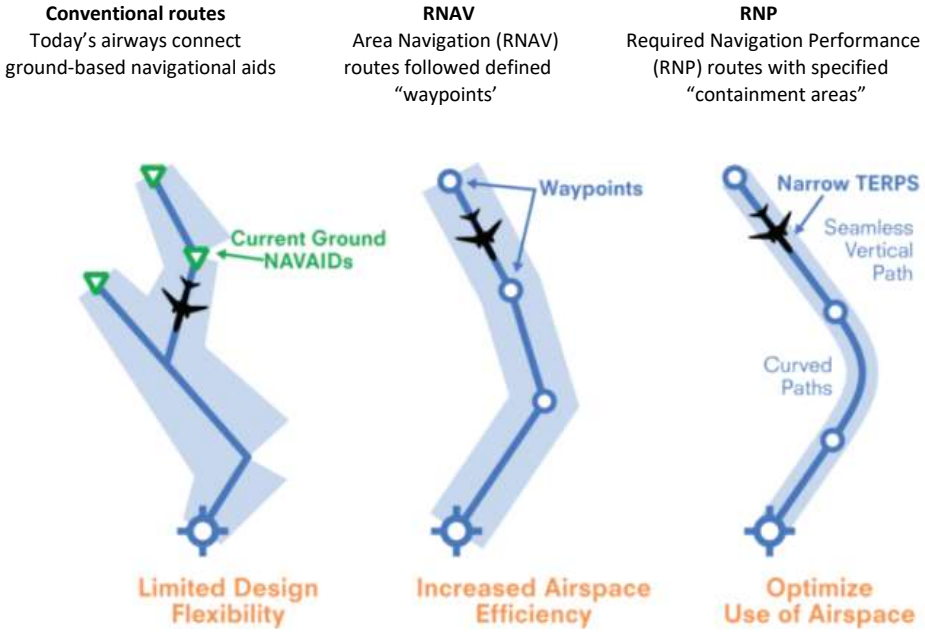

Figure 2: Conventional, RNAV and RNP Routes

Source: Universal Avionics Systems Corporation (2013) *Understanding Required Navigation Performance (RNP) and Area Navigation (RNAV) Operations*, White Paper, page 2

RNP also refers to the level of performance required for a specific procedure or a specific block of airspace. An RNP value of 10 means that a navigation system must be able to calculate its position to within a circle with a radius of 10 nautical miles. An RNP of 0.3 means the onboard systems must be able to calculate the aircraft's position to within a circle with a radius of 3-tenths of a mile, and so on.

An RNP-AR (Authorisation Required) approach is an enhanced concept of RNP defined as an approach procedure that requires lateral Total System Error (TSE) lower than the standard RNP values on any segment of the approach procedure. The lowering of the RNP values down below 0.3, down to 0.1, allows the reduction of obstacle protections (no buffer), to fly curved flight paths after the Final Approach Fix (FAF) thus enabling flight paths through congested airspace, around noise sensitive areas, or through difficult terrain.[4]

The RNP / RNP-AR values of navigational accuracy are shown in the table below.

Approach type	Performance requirements	Old designation
RNP	Allows an accuracy of 0.3	RNAV/GNSS
RNP-AR	Allows an accuracy of 0.3 – 0.1	RNP-SAAAR

The RNP-AR concept is not limited to approach procedures; it can also apply to missed approaches, Standard Instrument Departure and engine-out Standard Instrument Departure procedures.

The photo opposite shows a QANTAS 737-800 flying an RNP departure from Queenstown, New Zealand
Figure 2 illustrates the RNP-AR approach tracks into Cajamarca, Peru (upper) and La Serra, Chile (lower). This demonstrates the benefits of precise lateral and vertical navigation to airports located in mountainous regions.

Figure 3: A QANTAS 737-800 leaving Queenstown, New Zealand, with an RNP departure
Source: NewZealandView.Com, photo by Atreides8080

RNAV and RNP systems are fundamentally similar. The key difference between them is that RNP systems require on-board navigation and alerting, referred to as RNP specification. In addition, flight crew are required to be trained and rated on system operation. Aircraft not equipped with this requirement is referred to as an RNAV specification.[3]

A related term is **Actual Navigation Performance (ANP)**. ANP refers to the current *performance* of a navigation system while RNP refers to the *accuracy* required in a given block of airspace or a minimum instrument procedure. Some oceanic airspace has an RNP of 4 or 10. The level of RNP an aircraft is capable of determines the separation requirement between aircraft.

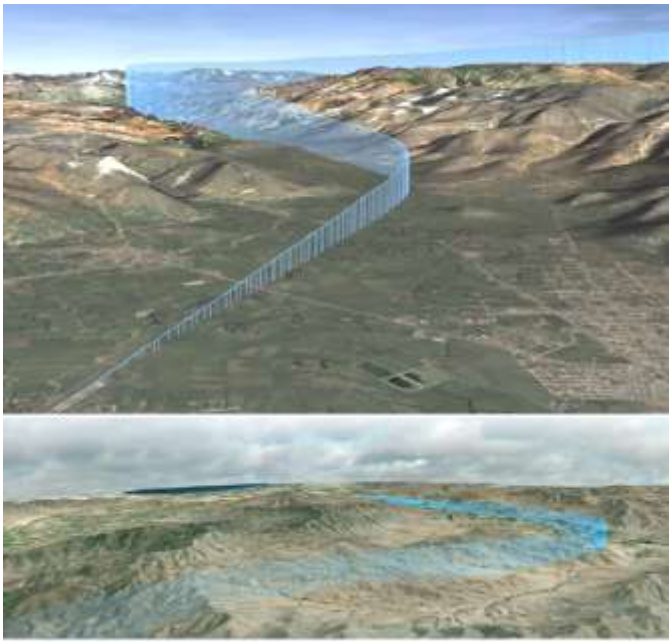

Figure 4: RNP-AR approach tracks
Source: "RNP Track 3D" by LAN Airlines – LAN Airlines. Licensed under CC BY-SA3.0 via WikimediaCommonshttp://commons.wikimedia.org/wiki/File:RNP_Track_3D.png#/media/File:RNP_Track_3D.png

If you wish to delve further into the technical application and specifications of RNP, RNP-AR and ANP processes, Boeing's *Equipping a Fleet for Required Navigation Performance*, and Universal Avionics Systems Corporation's *Required Navigation Performance (RNP) and Area Navigation (RNACV) Operations* or the ICAO *Required Navigation Performance Authorization Required (RNP AR) Procedure Design Manual* publications are recommended.

Origins

The RNP approach was devised by Alaska Airlines pilot and innovator Steve Fulton whose nerve-wracking night landings in Alaska gave him the inspiration for the RNP. This new navigation innovation was developed by GE Aviation, for whom Fulton now works.[5] Subsequently the first airline to utilise an RNP approach was Alaska Airlines with its approach down the Gastineau Channel into Juneau in 1966. Since then a progression of airline systems have adopted and implemented the RNP approach into an increasing number of airports around the world.[6]

One such example is the introduction of the system at the Linzi Airport in Tibet. The airport, located in the Yalung Tsangpo River valley, is at a height of 9,700 feet and is regarded as one of the most difficult airports in the world to reach. The approach route is 95 miles long between 13,000 feet high mountains usually covered by cloud and fog. In some places separation between ridges is only 2.5 miles. Prior to the introduction of RNP navigation into Linzhi, it was accessible on only about 100 days a year, and only in daylight.[7]

Air China introduced the RNP system here in 2006. The first flight into Linzhi was in an Air China Boeing 757 on 12 July and can be viewed on a You Tube video. Passenger services commenced six weeks later and a video of the inaugural flight with Steve Fulton onboard can be seen.

QANTAS, using the Boeing 737-800 NG under the command of Captain Alex Passerini, the project pilot, and supported by Steve Fulton, was the first to fly the NZQN approaches in 2004. Due to operating the NG, which has a far better RNP capability, they were also the first to be approved to operate below RNP 0.3. The GE Aviation Systems flight management computer on the 737 does the flight path computations and creates lateral and vertical path guidance from a stored set of navigation data in an onboard database, to create a "highway in the sky", as shown in Figure 5. Air New Zealand was about six months behind in gathering the required number of approaches before commencing RNP operations. Since then, QANTAS has rapidly accelerated the RNP program and are way ahead of Air New Zealand with the Boeing 738 and the number of RNP operations, while New Zealand concentrated on A320 approvals and getting Airbus into the program.[8]

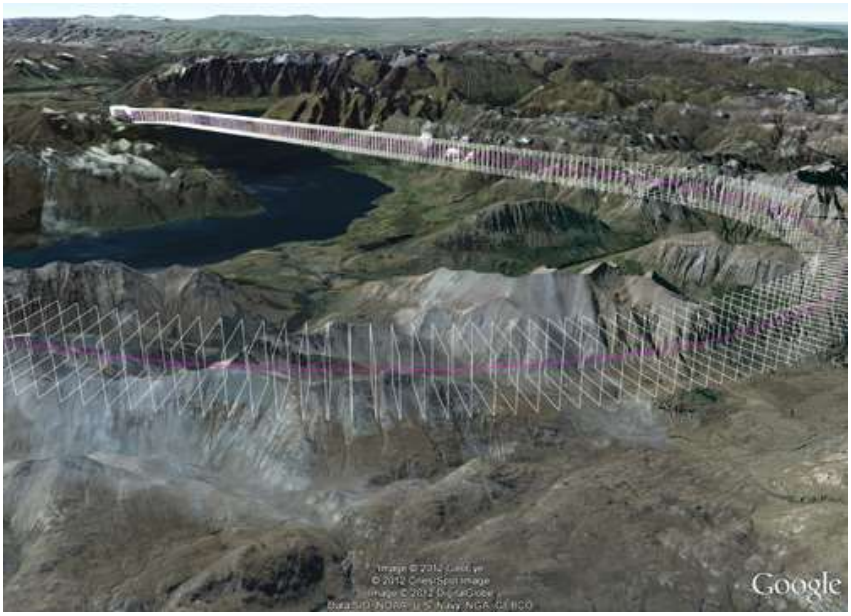

Figure 5: GE engineers designed this "highway in the sky" approach into Queenstown, New Zealand.
Source: GE Reports, http://www.gereports.com/post/75375269775/no-room-for-error-pilot-and-innovator-steve

RNP-AR Approach RWY 05 Queenstown

Flying into Queenstown, New Zealand, particularly into runway 05, is clearly a dramatic experience. The surrounding mountain range known as The Remarkables towers 7,500 feet above sea level. On a clear day, its dramatic peaks are reflected in the glassy waters of Lake Wakatitu. In winter the region's beauty is enhanced by a mystical blanket of snow which attracts thousands of snow sport enthusiasts which swells the incoming commercial and general aviation air traffic.

The airport is nestled in a natural basin at an elevation of 1,171 feet. Surrounded by peaks and ridges, the terrain is not the only challenge for pilots. Winds swirl around the basin and can vary significantly in both speed and direction at different levels. Even on a crystal clear day, the combination of traffic and terrain can make manoeuvring an airliner challenging; so any deterioration of weather conditions can exacerbate the demands of making an approach or departure.

In Queenstown's case terrain is the most limiting factor. Due to restrictions, ILS approaches are not possible and conventional VOR/DEM approaches have descent restrictions more than 2,000 feet above airport level.[9] The use of

conventional VOR approaches and departures are a very challenging task requiring higher instrument approach minimas which equate to less assurance of being able to become visual when weather descends upon the airfield.

The best case scenario for a normal VOR approach minima into Queenstown is 4,600 feet, or 3,000 feet AGL. By comparison, the RNP-AR 0.1 approach into runway 05 provides a minimum altitude of 1,451 feet, or a mere 291 feet AGL. Further more, the RNP-AR approach establishes are aircraft on final, stable and aligned with the runway. Again by comparison, the VOR approach still requires some challenging manoeuvring within the basin to ultimately achieve the landing as the final approach leaves the aircraft well above profile to effect a straight-in landing.[9]

In addition to the safety factor, the introduction of RNP navigation at Queenstown has had economic benefits. With increasing passenger numbers, the accuracy of the RNP paths allows air traffic control to confidently manage up to twelve aircraft per hour, compared to five prior to the introduction of RNP.[10] Prior to the introduction of RNP, in the event of low ceilings Queenstown-bound flights had to be diverted frequently to Invercargill which is on the coast south of Queenstown. Passengers would then have to board a bus for a 2 hour 15 minute trip north to Queenstown.

RNP and flight simulation

So, is RNP possible with flight simulation software such as FSX and Prepar3D? The short answer is, yet it is. However, like real world aircraft, there is a requirement to have the right navigational equipment onboard, and that means a flight management computer (FMC) and an operational computer display unit (CDU). Further there is the need to have the FMC up to date with flight management systems (FMS) data. *Navigraph* is the most popular source of this data. *Navigraph* has been providing the international flight simulation community with tools and software like those available to the aviation industry since 2006. In addition to FMS Data, their products include airport charts, enroute charts, and a wide range of video tutorials.

Navigraph releases FSM Data according to the AIRAC cycle which is numbered YYNN (where YY is the last two digits of the year and NN is the cycle number). A cycle is 28 days, thus there are 13 cycles in a year. Downloading the data is via the provided FMS Data Manager, a client software which allows you to effortlessly download and install data to desktop computer on hand-held device.

A list of purchase subscription options is detailed on the *Navigraph* website. The most expensive option is the 1 year subscription to *Navigraph Ultimate*, a bundle subscription of unlimited access to all charts and FMS Data services, including all revisions, for EUR 64.90 or AUD 92.39. The *FMS Data* only option for 1 year costs EUR 13.90 or AUD 19.79.[11]

Although the aeronautical data used in these products originates from suppliers within the real world aviation industry and may seem identical to the real thing, it has been down-sampled, merged and interpolated to meet the needs of flight simulation users. Therefore, it should ***never*** be used for real world flight navigation.

Learning how to fly an RNP approach

There a number of useful; resources, including You Tube video tutorials, which will assist with learning about RNP approaches. The first worth viewing is NZ RNP 05 by Simon Walker, 2012. As the title suggests it shows a real RNP approach into runway 05 Queenstown with flight deck conversations. Unfortunately, the camera is dislodged just before landing, but it's worth a look.

A good general tutorial on RNP navigation in FSX is Jeremy Bucholz's (2013) iFly 737NG RNP AR Tutorial video which provides a detailed account of an RNP application flying into Burbank, California.

A second tutorial video specifically related to New Zealand is Queenstown ZQN/NZQN RNP Approach Tutorial – Aerosoft Airbus by Alex from Jetstar Virtual (2014). This shows the RNP approach into runway 23. A real world video that supports this is Queenstown RNP-AR 23 Approach by Mike Walden (2014).

It is always useful of course to have the appropriate charts at hand when flying instrument approaches. New Zealand charts are available from AIP New Zealand. Figure 6 shows the RNAV (RNP) Y RWY 05 approach. The chart shows the characteristic arc of the RNP approach from the initial approach fix (IAF) at IBABU through to the final approach fix (FAF) at OMUBO.

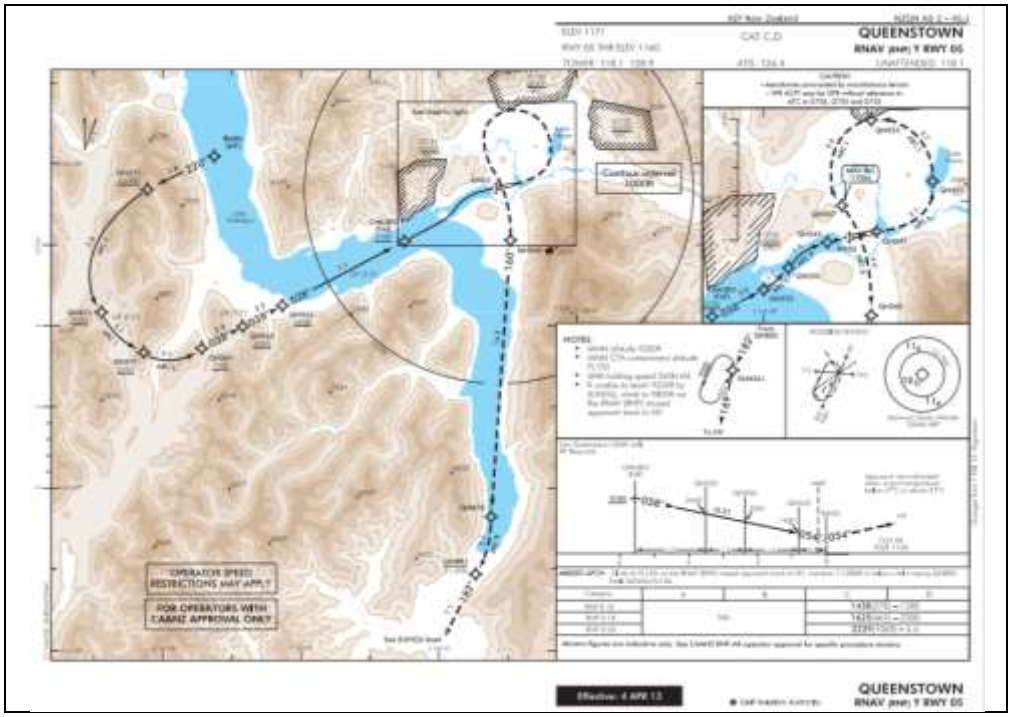

Figure 6: Queenstown RNAV (RNP) Y RWY 05 chart

Conclusion

The acclaimed video *This is why we fly…* with nearly 2 million views, has been the catalyst for an investigation into the development and implementation of Required Navigation Performance (RNP) developed in the mid 1990s. Based on the Global Positioning System (GPS) and state of art onboard navigation systems, it is rapidly being introduced to many airports throughout the world and will eventually replace the commonly used ILS approach system. Its most dramatic impact on aviation is being seen in areas previously inaccessible due to unfriendly terrain and higher instrument approach minimas. However, its effectiveness is also being seen at airports of limited infrastructure availability, airspace constraints such as parallel runway operations, and where noise constraints exist. It is a more cost effective and environmentally friendly system providing a smooth continual descent and approach rather than employing the traditional step down approach, reducing the need for engine thrust.

In the world of virtual aviation, RNP can equally be applied. Just as in real world flying, it is contingent upon having the necessary systems onboard. For the flight simmer this means possessing the more sophisticated add-on aircraft that feature an operational FMC and functional CDU. Supported by up-to-date flight management data from *Navigraph* this will enable the desktop pilot, with sufficient application and practice, fly challenging approaches with ease.

The crude approach flight plan shown at the beginning of this article, attempting to recreate the *This is why we fly* video is a far cry from reality. However, fascination with the video has led to a more expansive understanding of what the video is all about – not only a demonstration of the majesty of flying, but the application of ever increasing sophistication of continually advancing navigation systems. For the flight simmer, it is yet another step in achieving that 'as real as it gets' experience.

Endnotes

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   http://www.wing.com.ua/images/stories/library/ovd/9613.pdf

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   http://www.iasa.com.au/folders/Breaking_News/RNP-1.html

3. Airbus Industries
   http://www.airbus.com/innovation/proven-concepts/in-operations/required-navigation-performance/

4. GE Aviation
   http://www.geaviation.com/systems/products-and-services/air-traffic-optimization-services/performance-based-navigation/pbn-learning-center.html

5. *No Room For Error: Pilot and Innovator Steve Fulton Talks about the "Alarm and Frustration" That Gave Birth to a Revolution in Aircraft Navigation*
   http://www.gereports.com/post/75375269775/no-room-for-error-pilot-and-innovator-steve

6. Wikipedia
   http://en.wikipedia.org/wiki/Required_navigation_performance

7. GE Aviation
   http://www.geaviation.com/press/systems/systems_20150323.html

8. AIP New Zealand
   http://www.aip.net.nz/

9. Owen Zupp, An aviation blog
   http://www.owenzupp.com/_blog/Owen_Zupp/post/Queenstown_The_Remarkable_Challenge_of_RNP_%28Part_One%29_An_Aviation_Blog_by_Owen_Zupp/#sthash.amahBFeK.dpuf

10. AustralianAviation.com
    http://australianaviation.com.au/2013/05/new-rnp-flightpaths-unveiled-in-queenstown-boost-capacity/

11. Navigraph
    https://www.navigraph.com

You Tube Videos

[FSX] PMDG 737 NGX | Queenstown (NZQN) RNAV (RNP) Y approach runway 05 (by Captain Nav)
https://www.youtube.com/watch?v=q7XjnCMCYNU

PMDG B737NGX RNP RWY 05 at NZQN (by Roger Lowery)
https://www.youtube.com/watch?v=776kFR7i4R8

Access on Top of the World: Linzhi (Air China Test Flight (by wkpan)https://www.youtube.com/watch?v=PdSMk01l2wQ

Flying RNP into Linzhi Tibet aboard Air China B757 (by dgerrity629)
https://www.youtube.com/watch?v=ZqgvAmf0grE


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