Airways New Zealand Uniform SMART Approach Trial Report

Version 1

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Authorised by:

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Glossary of Terms

A320	Airbus model A320 airliner
A388	Airbus model A380 airliner
AIAL	Auckland International Airport Ltd
Airways	Airways Corporation of New Zealand Limited
ASBU	Aviation System Block Upgrade
AMAN	Approach MANager (air traffic control sequencing decision assistance tool)
ANCCG	Airport Noise Community Consultative Group
B738	Boeing model 737 series 800 airliner
B777	Boeing model 777 series 200 and 300 airliners
B789	Boeing model 787 series 900 airliner
BARNZ	Board of Airline Representatives, New Zealand
CAANZ	Civil Aviation Authority of New Zealand
CANSO	Civil Air Navigation Services Organisation (air traffic control industry group)
CAR	Civil Aviation Rule (CAANZ)
GANP	Global Air Navigation Plan (ICAO)
GHG	Green House Gas (CO2 emissions)
IATA	International Air Transport Association (airline industry group)
ICAO	International Civil Aviation Organisation
NAANP	National Airspace and Air Navigation Plan (NZ)
OLS	Obstacle Limiting Surface (e.g. trees, terrain, buildings)
PBN	Performance Based Navigation (satellite navigation using built-in performance checking)
RWY	Runway
SMART	Generic NZ term to describe PBN satellite referenced instrument approach procedure
STAR	Standard Arrival Route (arrival flight path that connects to an instrument approach)

Contents

1 Executive Summary

At the request of member airlines of the Board of Airline Representatives NZ (BARNZ) and in collaboration with Auckland International Airport Ltd (AIAL) and the Aircraft Noise Community Consultative Group (ANCCG), Airways NZ Limited (Airways) participated in a SMART approach trial at Auckland Airport between the 1st of Sept 2015 and 31st of August 2016. From an Airways air traffic systems management and objectives perspective the SMART approach trial has successfully met its objectives. It is a demonstration of the value of collaboration, and brings measurable and sustainable efficiencies and environmental benefits.

This was an operational trial of a new instrument approach procedure for jet aircraft (utilising accurate satellite based technology) arriving from the north of Auckland's Runway 23Left. The trial was conducted over a 12-month period from the 1st of Sept 2015 to the 31st of August 2016. Note, this approach was not available in Feb and Mar when AIAL runway works resulted in a displaced threshold.

The Uniform SMART approach was developed to integrate Airways-designed enroute and approach procedures with an objective to reduce greenhouse gas (GHG) emissions, fuel burn and CO2 emissions.

The principles followed stem from the International Civil Aviation Organisation (ICAO) Global Air Navigation Plan (GANP), ICAO Aviation System Block Upgrades (ASBUs) and ICAO Performance Based Navigation (PBN) documents. They link with NZ's Airspace Policy and the (draft) NZ National Airspace and Air Navigation Plan (NAANP). The industry representative bodies - Civil Air Navigation Services Organisation (CANSO) and International Air Transport Association (IATA) - also endorse that new approaches use satellite based technology and existing aircraft on-board avionics to achieve improved levels of flight safety and efficiency and reduced environmental effects such as GHG emissions and noise. The adoption of ICAO PBN standards ensures that high levels of safety and accuracy can be repeatedly achieved through on-board aircraft system monitoring that alerts crew when any part of the navigation system is out of tolerance.

When designing the SMART procedures Airways considered the effects of aircraft noise. To reduce those potential effects, ground paths were oriented to overfly water east of the Auckland Eastern Beaches where possible. Care was taken to utilise the existing standard arrival (STAR) path network, to ensure that the profiles would be contained to current areas of aircraft overflight, except those associated with the actual SMART approach paths.

Fig 1, from the ICAO GANP document, depicts a key aim of the SMART approach trial process through PBN Continuous Descent Operations (CDO). The use of a continuous descent path from cruise altitude to the airport would contribute to reducing noise experienced on the ground when the aircraft were much lower, as aircraft would not need to use high power settings for long periods to maintain level flight.

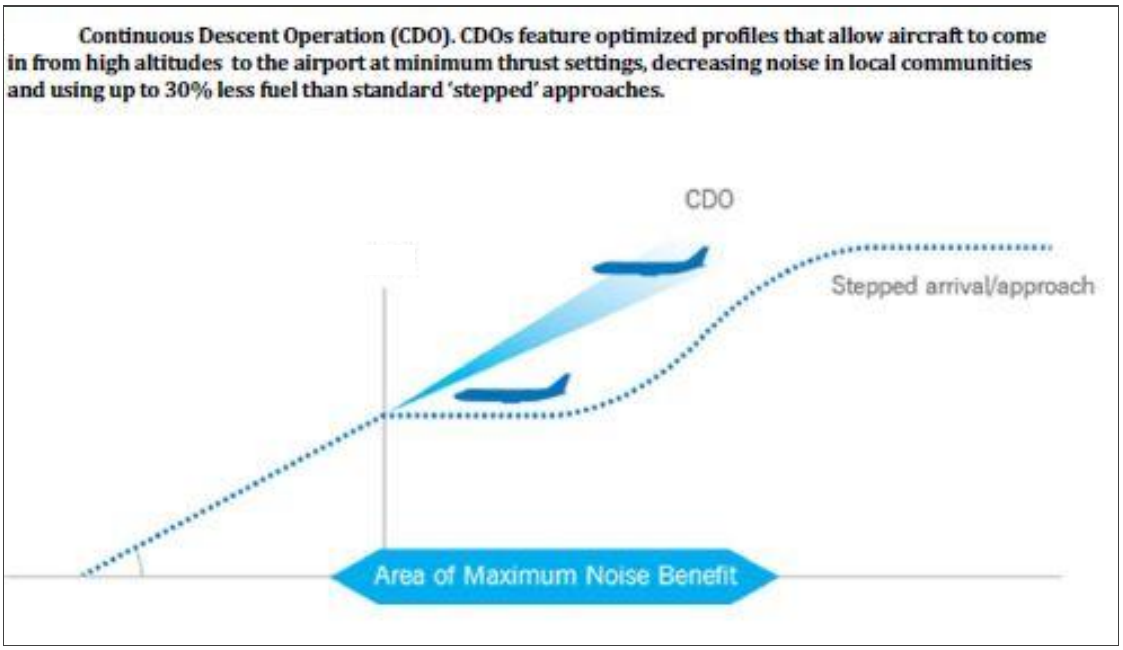


Fig 1.

Airways has authority from Civil Aviation Authority of New Zealand (CAANZ) to design this type of approach procedure. All authorisations and rules associated with instrument flight operations to Auckland were obtained or met.

For the Uniform SMART approach trial, the approach commencement point was raised to 6000ft to allow for Continuous Descent Operations and the approach commenced at a point along the existing conventional procedures and paths.

Airways Objectives for the SMART approach trial:

Be aligned with ICAO GANP 4th Edition	Achieved
Be aligned with ICAO ASBU Block 0 – PBN, CDO, CCO	Achieved
Be aligned with ICAO PBN – Safety, Capacity, Efficiency, Environment, and Access. With a focus on Environment and Access	Achieved
Have alignment with the NZ Govt. MOT Airspace Policy and NZ NAANP documents	Achieved
Operate, validate and integrate SMART approach traffic in ATM real world operations for A320, B738, B777, B789 and A388 types	Achieved
Measure lateral and vertical flight paths for conformance to design profiles	Achieved
In conjunction with AIAL, assess aircraft noise feedback to ensure recorded values are as expected for the trial	Achieved
Determine suitability of SMART approaches for continued use beyond trial period	Achieved

Results/Benefits

The maximum number of flights permitted was 10 per day. At all times flights operated within the standard Auckland airport noise abatement timing of 7am to 10pm daily.

Aircraft using the curved Uniform SMART approach flew approximately 7.3nm less, or for 120 seconds less, when compared to the conventional straight-in approach procedure.

The following SMART approach trial information was recorded:

Uniform SMART Approaches	Total
Number Flown	435
Distance saved (nm)	3,175.5
Time saved (mins)	870
Fuel not burned (kg)	76,536
CO2 emissions reduced (kg)	241,852

MONTH	Airways Data – number flown per month:
Sep-15	19
Oct-15	30
Nov-15	25
Dec-15	17
Jan-16	15
Feb-16	0
Mar-16	0
Apr-16	19
May-16	64
Jun-16	111
Jul-16	80
Aug-16	55

Note: The maximum number of Uniform approaches flown on a day was 9. This occurred on the 18th and 19th of June.

2 Purpose of Report

This report provides feedback to the SMART Approach trial partners - BARNZ, AIAL and the ANCCG - of Airways assessment of the trial.

2.1 Objectives

Airways' key objective was to ensure that the SMART trial procedures could be successfully developed and safely integrated into the existing air traffic management system without affecting the pre-existing airport and airspace capacities. In addition, Airways would act as an advisor and design authority to the SMART trial partners and draw upon its experience and expertise in air traffic management to blend the requirements of the airline partners with those of the airport company and ANCCG. ICAO GANP, ASBU and PBN doctrines were referenced to support the aims of the SMART approach trial. In addition, the NZ Govt. MOT Airspace Policy and NAANP and its pre-emptor and the relevant CAANZ Rule Parts were referenced for conformance, alignment and policy direction.

2.2 Customer Requirements

Airways is a certified CAANZ Rule Part 173 Instrument Procedure design office. Airways was asked by its airline customers and AIAL to design this additional instrument approach procedure to Auckland airport that provided a similar path to that of a visual approach manoeuvre, and the safer and more accurate lateral and vertical path guidance that comes from satellite based PBN technology. This PBN technology allows very specific pathways to be flown repeatedly in a predictable and safe manner under all weather conditions, meaning that airlines could achieve flight efficiencies that were not weather dependent. The expectation was that with good design a significant reduction in the track miles flown would be achieved, especially when compared to the longer path to a conventional straight-in instrument approach procedures. The SMART approach procedure is compatible with the PBN certified aircraft types being operated by the stakeholder airlines (or future types that they might operate).

2.3 Roles and Responsibilities

The role of Airways is to provide safe, orderly, expeditious and cost efficient air traffic services. In addition, during the SMART approach trial Airways:

- Collaborated in designing and providing technical expertise for the development of the SMART approaches, including advice on possible ground paths from the STAR end points to the runways;
- Provided air traffic management assurance that the SMART approaches could be safely integrated with the existing air traffic control system while maintaining capacities;
- Collaborated with technical expertise relating to Civil Aviation Rules compliance as it relates to design, noise abatement procedures, and authority;

- Reviewed and collaborated on ICAO GANP, ASBU and ICAO PBN doctrines, reference NZ Govt. aviation related documents (ANP, NAANP, CAANZ) with other trial partners;
- Implemented the Uniform SMART approach trial in accordance with the agreed implementation authority document from AIAL, as it related to daily flight number limits and noise abatement procedures;
- Provided, as necessary, feedback to AIAL regarding flight path conformance where any discrepancy was reported;
- Ensured that participating airlines were appropriately qualified to participate in the SMART approach trial;
- Provided an internet-based information portal for the public on the official Airways New Zealand website, with links to other trial partner websites;
- Submit an end of trial report to the other SMART approach trial stakeholders at the conclusion of the trial.

2.4 Background to the Uniform SMART Approach Trial

The Uniform approach was an additional RNP approach developed following the initial SMART approach trial in 2014. "SMART Approach" is a generic name used to describe the satellite based technology used for navigational guidance by suitably equipped aircraft, to fly highly accurate vertical and horizontal profiles from a point in space to a runway.

The ICAO body provides governance and guidance to 190 member states, and New Zealand is a member and signatory. Within the framework of ICAO documentation lies GANP which sets the overall global framework and ASBUs of which there are four blocks spaced 5 years apart, (Block 0 commenced in 2013). The base tenets of ASBU Block 0 are the adoption of Performance Based Navigation (PBN); Continuous Descent Operations (CDO) and Continuous Climb Operations (CCO) using existing aircraft on-board avionics. Within each ASBU Block there are threads that provide common linkage and also tie the base tenets of the ASBUs together so that the plan and the result are cohesive, and measureable.

PBN technology is used world-wide and New Zealand has been an early adopter of the capability and the ASBU Block 0 upgrades. A key outcome of PBN capability is reduced track mileage. The SMART approach trial has shown that even a few minutes saving after a 10-hour flight contributes substantially to the overall flight efficiency equation.

There is a worldwide shift to satellite or Performance Based Navigation (PBN)-based navigation. In line with ICAO recommendations, the New Zealand government approved the National Airspace and Air Navigation Plan - New Southern Sky, which recognises the step-change to PBN.

Auckland's SMART Approach flight paths continue the global move toward PBN. Such paths are part of a worldwide drive by regulators and the aviation industry to improve flight path

efficiencies & safety. They also contribute to international aviation carbon dioxide-emission reduction proposals.

- Most international flights arriving to Auckland have already taken advantage of the enroute ASBUs using PBN to navigate more freely away from the fixed air route structure while being able to dynamically change paths to follow the best "winds" in mid-flight in order to gain the most advantage of time, fuel savings and GHG emission reductions;

- The final 30nm of flight is when the fuel burn and waste can be at its highest, because jet engines use more fuel at lower levels, and will emit more GHG and low level noise, if it is not able to follow a predetermined CDO path to the runway. If this enroute efficiency is combined with a SMART approach each part of a journey (taxi-out, climb, cruise, descent, approach, and taxi-in) has contributed to the most fuel and time efficient journey possible – if you like, the SMART approach is the exclamation mark of the efficiency process.

- A comparative would be the savings water consumers make in Auckland by fixing dripping taps or turning off the faucet when brushing their teeth. A single household saves little in water and money, but when multiplied across a city or country this saving is huge, as are the benefits.

Procedures designed using PBN provide very accurate horizontal and vertical flight path guidance that enables greater access into geographically constrained airports. The airport most recognised for this in New Zealand is Queenstown, where jet aircraft are guided between the high mountains that surround Lake Wakatipu to a safe landing. The technology is also used at Rotorua, Christchurch and Wellington to achieve efficiencies that are of significant benefit for large jet aircraft – and their airline operators.

At Queenstown, Air New Zealand, QANTAS, Jetstar and Virgin Australia all have suitably equipped and crewed jet aircraft that utilise the PBN technology to guide them every day. These airlines also saw the potential benefits of this type of safe and accurate approach guidance at "flat earth" airports such as Auckland. Here they combine the efficiency of reduced track miles from pilot-flown visual (nice weather) approaches, with the all-weather vertical and horizontal instrument guidance of PBN and the safety of a fully designed instrument flown using the automation within the aircraft cockpits.

In order to capture true overall efficiency, the STAR paths to Runway 23L were modified vertically to feed directly into the shorter distance Uniform SMART approach procedure. This methodology meant that arriving international jet aircraft could utilise a large amount of the existing STAR path and yet still be correctly considered by the AMAN system and then sequenced from before they began descent to achieve a continuous descent path (CDO) to the runway (SMART approach) – all specified ICAO ASBU Block 1 and PBN aims.

2.5 Authorisations and Procedure Design Criteria

Airways are an accredited instrument procedure design organisation and are certified by CAANZ under Rule Part 172. For the Auckland airport Uniform SMART approach, the prevailing Obstacle Clearance Surfaces (OLS) were used in the design of the curved SMART approaches, these OLS have traditionally been applied to linear procedure design and are the responsibility of the airport operator.

All instrument procedures at Auckland airport are designed to international standards. In addition, jet procedures at Auckland airport must conform to specific noise abatement criteria already in place – under CAANZ Rule Part 93.

AIAL is responsible for airport noise management under the requirements of the Auckland District Plan. The airport also liaises directly with the elected community body the ANCCG. The ANCCG and AIAL met with airlines and Airways during the development phase of the SMART approaches and were briefed on the proposed trial. From this and subsequent meetings, approval was obtained to proceed with the SMART approach trial.

AIAL are the licenced airport operator and are authorised under CAANZ Rule Part 139, a sub-part of that authority is a requirement to approve the design and implementation of any instrument procedures for Auckland airport. Under CAANZ Rule Part 173.201b AIAL duly authorised Airways to design and implement the procedures contained in the SMART approach trial. This authority was contained in a letter of Authorisation between AIAL and Airways and specified the requirements on each party to conduct the trial.

AIAL is the decision maker for any continuance of SMART approaches beyond the end of the trial.

2.6 Instrument Flight Arrival Procedures at Auckland

Auckland airport has a pre-existing network of arrival and departure paths that guide aircraft to the two runways at Auckland. These paths have grown over the years as the types of aircraft, navigation capability of aircraft and necessary air traffic management tools and needs have changed or adapted to handle aircraft safely.

The main factors that determine the flight paths are:

- runway orientation;
- position of destinations;
- types of aircraft using the airport;
- demand between destinations;
- controlled airspace design;
- location of nearby airports (Ardmore, Whenuapai and North Shore);
- existing flight paths in use;

- air traffic management requirements and technology;
- air traffic control separation criteria;
- procedure design limitations;
- airport and airline requirements.

Since 2000, aircraft have been flying the same basic pathways, with some minor variations as aircraft navigation capabilities and air traffic management requirements have been adjusted to meet demands. For the period Sept 2015 and Aug 2016 (the complaint period) there was no change in procedures for the non-SMART arrivals that would affect altitude or track alignment over the Epsom/Royal Oak and Howick area, in comparison with the previous 12 months.

The instrument arrival procedures for Auckland airport can be considered in two parts, the STAR path that bring aircraft from well beyond 50nm to very close in to the airport (often overflying Auckland city's residential areas) and the instrument approach procedures (IAP), which are traditionally oriented with the runway alignment but for the SMART approaches and visual approaches can curve in from the sides. All IAPs are short length procedures that are nominally between 10-15nm long, they are designed to join the enroute arrival with the runways.

3 Capacity Calculations

The process for determining the number of flights that could use the SMART approach each day was factored from a mixture of airline schedules, noise abatement periods, air traffic management capability, number of airlines participating in the trial and data from MDA consultants regarding effects on the airport noise boundaries from repeated flights along a path (refer MDA report section 3.2).

The daily limit of 10 aircraft is the same as that allowed on the RNAV X-ray approaches for both RWY 05 and 23.

3.1 Uniform SMART Approach Trial Operational Performance

The following is the Uniform SMART Approach performance information:

- The 12-month trial operated between 1st Sept 2015 and the 31st August 2016;
- Due to AIAL works on Taxiway A1A the approach was not available during Feb and Mar 2016.
- The trial timing window coincided with the existing noise abatement criteria used by AIAL and Airways. The window was more restrictive than the CAANZ Rule Part 93, opening at 7am and closing at 10pm;
- Only approved airlines, with designated aircraft types (A320, B738, B777, B789 and A388), and qualified crews were permitted to fly the Uniform SMART approach;
- SMART approach trial flights were conducted under instrument flight rules, at all times. Participating aircraft were not permitted to transition to visual approaches, to ensure that the SMART approach vertical and horizontal paths were complied with;
- The maximum number of daily flights remained at 10 for the duration of the trial.
- Initial uptake of the Uniform Approach was slow by pilots. This was mainly due to pilots only briefing for two arrivals into AA, the conventional ILS approach or the shorter X-ray SMART approach. This changed in May 2016 when in agreement with Operators, aircraft from North Australia/Asia would brief for the ILS and Uniform Approach and those from Sydney or South Australia would brief for the ILS and X-ray Approach.
- With the proposed introduction of Time Based Flow Management (TBFM) associated with the new Air Traffic Management Platform in 2019 it is anticipated that Air Traffic Controllers will be able to facilitate the use of this approach more readily than current equipment allows. This, along with the agreement reached with operators in May 2016, means there is likely to be a demand for up to 10 Uniform approaches per day to go along with the 10 X-ray approaches that currently exists.

3.2 SMART Approach Trial Findings

The following were findings from the SMART approach trial:

- From an Airways air traffic systems management and objectives perspective the Uniform SMART approach trial has successfully met its objectives. It is a demonstration of the value of collaboration, and brings measurable and sustainable efficiencies and environmental benefits.
- A total of 435 Uniform Approaches were flown;
- In total that equates to 3,175.5nm of distance saved by factoring the accumulated mileage difference between the Uniform SMART approach and conventional approach paths;
- 76,536kg of fuel was not burned, and there were 241,852kg of reduced carbon emissions as a result of airlines using the Uniform SMART approach instead of the conventional approach paths into Auckland;
- An average of 43 flights per month used the Uniform Approach when it was available;
- The highest utilisation month was June, with 111 flown;
- Initially four operators, Air NZ, Qantas (Jet Connect), Virgin and JetStar participated and were joined by Emirates in Nov 2015;
- All Uniform SMART Approach flights operated within the daily time window of 7am to 10pm;
- The permitted number of daily flights (10) was never exceeded;
- The ICAO GANP, ASBU Block 0 and PBN doctrines were able to be achieved and the NZ Govt. MOT ANP and NAANP was correctly referenced and considered during the SMART approach trial and also for any future long term initiatives.

3.3 SMART Approach Trial Objectives and Conclusions

The following are objectives and conclusions:

- Airways Objectives for the SMART approach trial were met:

Be aligned with ICAO GANP 4th Edition	Achieved
Be aligned with ICAO ASBU Block 0 – PBN, CDO, CCO	Achieved
Be aligned with ICAO PBN – Safety, Capacity, Efficiency, Environment, and Access. With a focus on Environment and Access	Achieved
Have alignment with the NZ Govt. MOT Airspace Policy and NZ NAANP documents	Achieved
Operate, validate and integrate SMART approach traffic in ATM real world operations for A320, B738, B777, B789 and A388 types	Achieved
Measure lateral and vertical flight paths for conformance to design profiles	Achieved
In conjunction with AIAL, assess aircraft noise feedback to ensure recorded values are as expected for the trial	Achieved
Determine suitability of the Uniform SMART approach for continued use beyond trial period	Achieved

- The Uniform SMART approach was designed to optimise low noise operations by implementing a steeper descent path angle AND an increase in the procedure design speeds;

3.4 SMART Approach Trial Recommendations

Airways recommendations are:

- To recommence Uniform SMART approaches from the north of Auckland airport with, AIAL agreement, using the existing SMART procedure as designed.
- To keep the daily maximum allowed at 10 per day;

4 Distribution

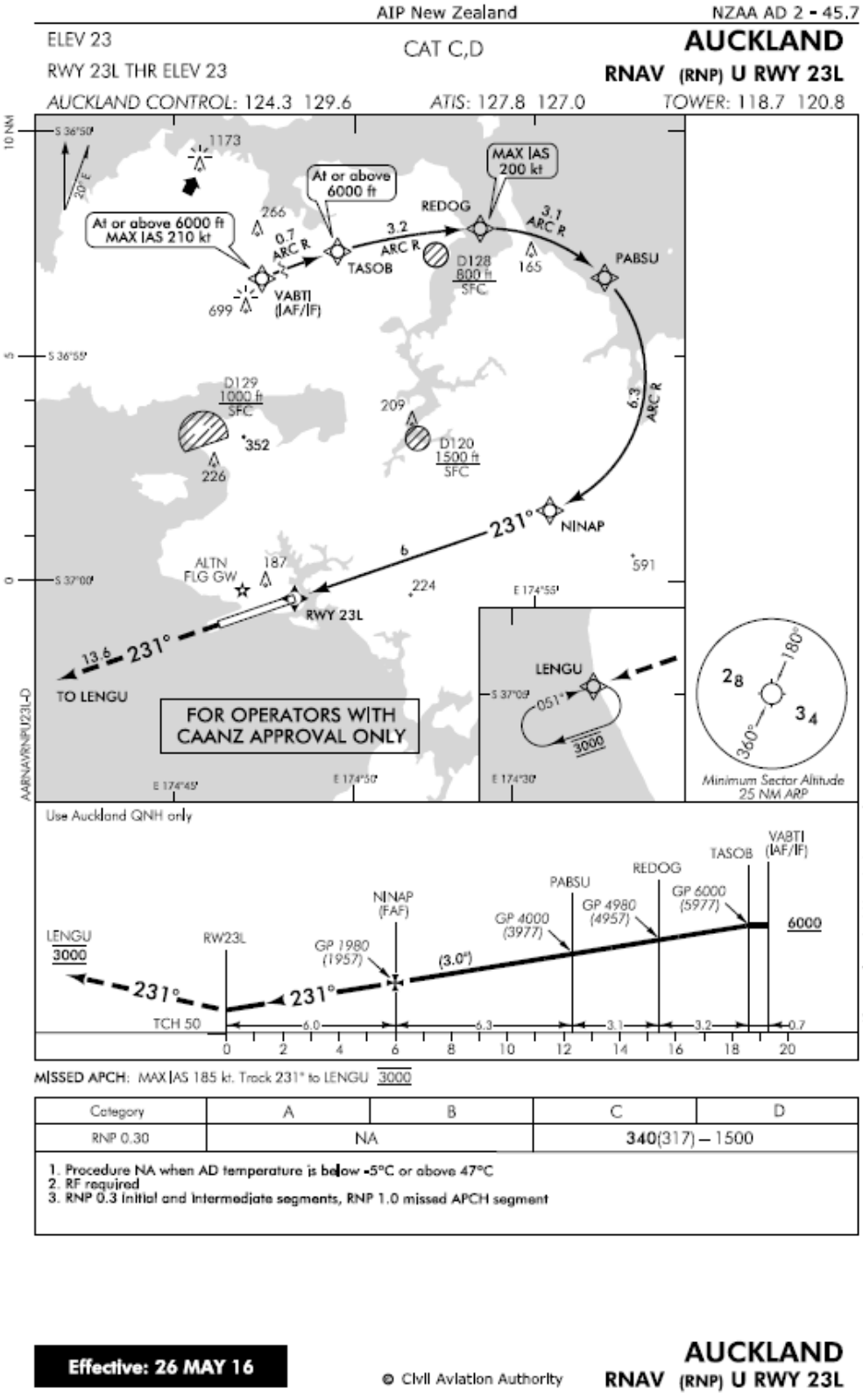
This report is for distribution to:

- Airways Board;
- Airways Executive;
- Airways Service Delivery Management Team;
- SMART Approach Trial Stakeholders;
- Airways Auckland TMA and Auckland Tower Teams;

5 Appendices

- See Appendix A for Auckland RNAV RNP U RWY23 approach chart
- See Appendix B for Approach depiction on GOOGLE Earth
- See Appendix C for Reference documentation

Appendix A Auckland RNAV RNP U RWY23 Approach Chart



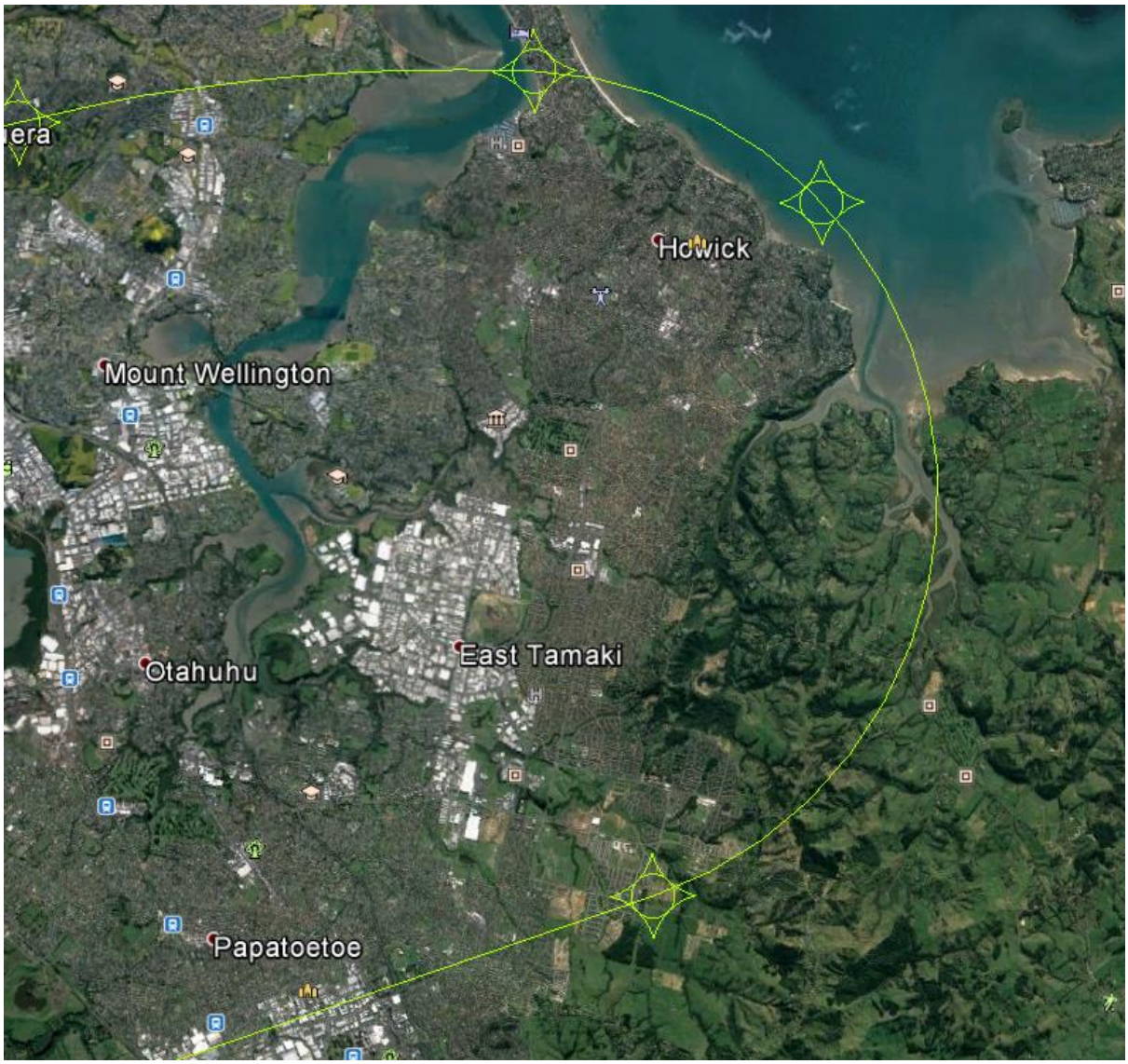
Category	A	B	C	D
RNP 0.30	NA		340(317) – 1500	

1. Procedure NA when AD temperature is below -5°C or above 47°C
2. RF required
3. RNP 0.3 initial and intermediate segments, RNP 1.0 missed APCH segment

Effective: 26 MAY 16

AUCKLAND
RNAV (RNP) U RWY 23L

Appendix B Auckland RNAV RNP U on Google Earth



Appendix C Reference Documentation

ICAO Global Air Navigation Plan (Capacity & Efficiency) 4th Edition

ICAO Aviation System Block Upgrades – Block 0 and Block 1

ICAO Performance Based Navigation, CDO, CCO

New Zealand Government, Ministry of Transport – Airspace Policy & Plan

New Zealand National Airspace and Air Navigation Plan 2013 (Draft)

Civil Aviation Authority of New Zealand Rule Parts 93, 139, 172, 173

Civil Aviation Authority of New Zealand – Aviation Information Publication