Airways Future Navigation Aid Strategy

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1 Introduction

In alignment with the Regional and National Navigation Strategies, PBN will provide the backbone navigation infrastructure for IFR operations within NZ for the future. While within the PBN framework, there are several paths for compliance available to operators, the primary means is normally GNSS.

There will however be a need for Airways New Zealand to maintain a terrestrial navigation capability for the foreseeable future. While it is important that the infrastructure provided meets the needs of users, Airways must also ensure that what is provided is cost effective.

This paper reviews the long term needs of Navaids supporting en-route and terminal operations in NZ. It does not consider the provision or support of ILS and associated infrastructure as this is will be location specific.

2 GNSS and PBN

The implementation of PBN in NZ is based on GNSS capability supporting RNP 2, RNAV 2, RNP 1[1] and RNAV 1 procedures. The publication of AC91-21 has provided certainty to operators for equipage and the NZ PBN plan is based on specifications which should support operations for the medium to long term.

While alternative navigation sources can satisfy the PBN requirements, within NZ the only other acceptable source is DME/DME/IRU on specified routes. It should be noted that while DME/DME is acceptable under the ICAO framework, the infrastructure here is insufficient to support these types of operations. As such DME/DME only operations are specifically excluded from the NZ PBN plan.

The robustness of GNSS as sole source for navigation has been subject to some criticism and was investigated through the Safety assessment (O'Keefe report) commissioned by CAA. The report concluded that TSO-145/146 receivers provide significant advantages and should be the basis of the development of procedures to support GNSS only means of navigation. This has been reflected in the publication of the AC where flights wishing to operate IFR to an aerodrome without a terrestrial navaid must have 2 x TSO compliant GNSS.

[1] Previously referred to as Basic RNP1

There is however still no means for GNSS sole source navigation in New Zealand and all operations must maintain access to an alternative source. There is also a distinct difference between commercial (RPT style) operations and the General Aviation community requirements. NZ CAA is currently reviewing the issues and hopes to refine the future position for GNSS for all of aviation in the next 12 months.

While TSO-145/146 will slowly become more readily available, in NZ few aircraft currently have this capability with the overwhelming majority still using TSO-129 type GNSS. There are significant costs and logistics in upgrading and without a compelling business case to equip or a mandate from CAA to do so, this is expected to be the case for some time yet (10 years plus). The system has proven to be extremely reliable over the last two decades since civilian restrictions were removed. There is however a lack of redundancy in the event of a catastrophic failure of the system. Until such time as the industry is satisfied with the robustness, of the system there is going to be a need for an alternative source of navigation.

3 DME/DME/IRU

The use of DME/DME/IRU can support both en-route and terminal procedures (arrival and departure procedures). It does not however support instrument approach (including missed approach) procedures.

In NZ currently DME/DME/IRU navigation is available on designated routes only. This is to support the daily operation of a small number of ANZ B733 aircraft (approximately 7 aircraft) which are not GNSS capable and also as a back-up source in the event of a RAIM outage. The ability to use DME/DME/IRU navigation is however only available to suitably equipped aircraft. While most modern jets utilise as a failure mode for GNSS, few other aircraft can comply with the requirements.

An assessment conducted by ACNZ (28 Apr 2011) indicated that using only the existing infrastructure, significant gaps in coverage existed. While high level ops (30000ft and above) were mostly supported, medium level coverage (10000ft) would have some limitations and terminal coverage (3000ft and 6000ft) would be extremely limited.

The report indicated that to provide the necessary infrastructure to facilitate complete DME/DME coverage in the defined service volumes (30000ft+/10000ft+ en-route and 6000ft+/3000ft+ terminal operations) would require the addition of approximately 28 new DME sites. The estimated cost of this was nearly NZD $6.0 million (as at 2011 costs) with an annual OPEX of approximately NZD $160K. These figures are estimates only and do not include acquisition of sites, resource consents and associated costs.

The operational need to provide full DME/DME coverage however must be questioned. The small numbers of aircraft that use DME/DME/IRU as a primary means are scheduled to be retired by the end of 2015 and after that, it will only be used in a

contingency mode in the event of a GNSS failure or RAIM outage (possible scenarios include solar storms, jamming and unserviceability of on-board equipment).

The provision of full DME/DME coverage will however require significant investment and it still does not provide full contingency navigation capability. It will be necessary to maintain terrestrial navaids such as VOR and NDBs to support instrument and missed approaches, aircraft unable to revert to DME/DME/IRU (i.e. Regional turbo-props) and non-PBN capable operations. As such while full DME/DME coverage will enable continuation of en-route PBN operations in the event of a GNSS failure or RAIM outage, it will still be necessary to maintain a substantial investment in traditional type navaids. Developing and maintaining a full DME/DME/IRU capability will in no way reduce the required alternative navaid infrastructure; it is in addition to required terrestrial capabilities.

4 VOR, NDB and DME

The traditional terrestrial navaid network is based on both aerodrome and en-route navaids using the following combinations, VOR/DME, NDB/DME or NDB. In NZ, most aerodrome navaids also support an en-route function and there are only a few enroute only navaids.

In the broadest sense, there will be an on-going requirement to maintain aerodrome based navaids for the foreseeable future. These navaids not only provide back up in the event of a GNSS outage but also are required to enable IFR operations for the majority of aircraft who operate without dual fit TSO certifiedGNSS equipment (as per AC91-21). While the few remaining en-route only navaids do provide some operational advantages, the benefits as we transition to PBN style operations must be put into context against the cost of maintaining extra navaids. NZ is relatively small geographically and it is likely that the maintenance of aerodrome based navaids will also provide sufficient en-route coverage in most cases.

NDBs are a relatively dated technology with many of the NDBs installed within NZ more than 30 years old. While continuity of service is not currently a major issue, it may become one at some locations. This includes associated infrastructure such as aerials, particularly at risk at coastal locations.

On new aircraft delivered, NDB capability (ADFs) are generally now optional items no longer fitted as standard. It is expected that this will become more prevalent over the latter part of this decade, particularly with the commercial jet fleet. For locations where we must ensure that the terrestrial navaid provided supports the operational needs of the local users, this may in some cases mean a change of technology is required (i.e. VOR replacing an NDB).

While VORs offer significant advantages over NDB, they are also still significantly more costly. The justification in standardising to VORs must be countered with the infrastructure costs involved. It is still likely that NDBs will continue to be sufficient for many regional applications for some time to come.

The operational running cost of providing many of these terrestrial facilities is relatively low. As such it is not expected that navaids deemed unnecessary will be withdrawn immediately, rather that they be flagged for withdrawal and will either be retired:

- at an opportune time or
- if/when there is significant expenditure required
- on lease expiry
- with the charting cycle (may be part of PBN roll out)

The continuation of every navaid however, must be justified by a defined operational need while also ensuring a reasonable return on investment. Justification will generally be based on type of operations, regularity of use, aircraft type, offset against user charges, etc.

Note that parts of the proposed terrestrial navaid plan are dependent on CAA's final decision with respect to the use of GNSS as discussed earlier.

5 Maintenance of Equipment

While the navaids themselves will become increasingly used only for contingency purposesby the majority of operators, the non-availability of a navaid could still significantly impact day to day operations.

In the short term, most operators approval to operate GNSS approaches will be dependent on the presence of the terrestrial navaids without some form of exemption from the regulator. In the longer term however, operators with approved GNSS equipage (dual fit TSO145/146) will likely need regulatory approval for certain aspects of their operations (i.e. extraction procedures). While procedures already exist in the event of a specific navaid failing, including time for remediation, it will be necessary to ensure that planned outages (i.e. maintenance) are also well coordinated and managed. It needs to be remembered that maintenance is a requirement to ensure continuity of service and must be catered for between all stakeholders in their planning.

Factors to consider for planning maintenance include:

- timeliness of notification (e.g. may need to schedule/ coordinate maintenance with at least 4-6 month's notice)
- hours of planned outages (e.g. conduct maintenance out of hours where able)
- ability to flight check (i.e. need VMC, hence overnight maintenance may require early morning flight check)

- meteorological condition (i.e. agree conditions for each location well above en-route MSA/MRA for actual and forecast to ensure availability of Visual Approach)
- traffic schedules (i.e. avoid RPT traffic where able)
- availability of surveillance coverage (i.e. surveillance monitoring until transitioned into visual segment).

It may be necessary to allow more time to conduct maintenance at some locations where the ability to withdraw the aid from service will be reliant on suitable weather conditions being prevalent. Operators and the regulator may also need to ensured pre-planned GNSS extraction procedures for all locations where a single navaid exists to ensure continuity of operations in the event of a failure or during maintenance.

It is recommended that ACNZ review existing procedures for conduct of maintenance with major operators and revise as appropriate.

6 Instrument Flight Procedures

The intention is to continue to provide adequate IFP at all aerodromes serviced by PBN and conventional approaches. It should be noted that where VOR/DME and NDB/DME approaches are available VOR only and NDB only approaches will be removed.

While the operational running cost of providing most conventional terrestrial facilities is relatively low. It should be recognised that this does not take into account the costly requirement for regular review of IFP, associated ATS routes and flight checking requirements.

7 Future NZ Navaid Infrastructure

It is proposed that the future NZ Navaid infrastructure will be based fundamentally on the following:

- VOR/DME at specified aerodromes supporting both approach and enroute (VOR's to be refreshed FY14 and FY15)
- NDB/DME and NDB at specified aerodromes supporting both approach and enroute
- DME/DME coverage available for DME/DME/IRU operations where it exists from the above infrastructure
- Selected additional DME locations may be considered based on specific operational requirements to support en-route operations
- Some DME/DME/IRU operations may be dependent on operational surveillance monitoring to compensate for gaps in DME/DME coverage.
- Removal of all en-route only navaids
- Provision of contingency capability on regional basis and/or where combined infrastructure will satisfy

- At locations where the provision of a navaid is not justified on a cost benefit basis, the opportunity will exist for a commercial arrangement with local stakeholders to fund its retention and any associated IFP.

To fulfil this, the table below summarises the plan for navaids.

Note that dates proposed are the earliest for consideration of withdrawal for planning purposes, actual retirement date will be subject to future consultation.

Facility	Plan	Timeline	Comments
VOR/DMEs			
AA	Retain		
CH	Retain		
GS	Retain		
HN	Retain		
NP	Retain		
NR	Retain		
NS	Retain		
NV	Retain		
PM	Retain		
QN	Retain		
RO	Retain		
SW	Retain		Review DN AD requirements associated with HL NDB Extraction procedure for Eagle
WB	Retain		
WN	Retain		
NDB/DMEs			
AP	Retain		Possibly replace with VOR in future to support en-route in central NI
HK	Review	2018	Regional review with WS
HL	Retain		Review DN AD requirements associated with HL NDB
KK	Review	2018	Regional review with KT,WR
KT	Review	2018	Regional review with KK,WR
LX	Withdraw	2014	Discuss with Eagle for extraction NZWF
MO	Withdraw	2015	
PP	Retain		Extraction procedure for Eagle
TG	Retain/Replace		Consider possible replacement with VOR to support RPT ops
TU	Review	2018	Regional review with CH
WK	Review	2018	Regional review with RO and TG
WR	Review	2018	Regional review with KK,KT Discuss with Eagle SID and EFATO extraction procedure
WS	Review	2018	Regional review with HK
WU	Review	2018	Regional review PM

NDBs			
AS	Withdraw	2014	
BE	Withdraw	2015	Subject to satisfactory revision of approach procedures
CC	Withdraw	2015	
CI	Retain		Need to discuss with CVA and assess. Extremely remote location with no other navaid to supplement
FY	Withdraw	2015	Discuss with Eagle for extraction NZMS
GB	Withdraw	2014	
HN	Withdraw	2015	Need to ensure VOR refresh complete
KI	Withdraw	2015	
MI	Withdraw	2015	Subject to satisfactory revision of approach procedures
NL	Withdraw	2015	Subject to satisfactory revision of approach procedures
RD	Withdraw	2015	
SF	Withdraw	2015	Discuss with Eagle SID and EFATO extraction procedure
SY	Withdraw	2015	Consult required for GA IFR as a backup with ARAL and AAAUG
TM	Withdraw	2015	
TY	Withdraw	30 May 13	Consultation complete
WI	Withdraw	2015	Consult required for GA IFR as a backup with ARAL and AAAUG
WO	Withdraw	2014	
DMEs			
OR	Withdraw	2016	Subject to consultation following retirement of B733
RY	Withdraw	2016	Subject to consultation following retirement of B733
TR	Withdraw	2016	Subject to consultation following retirement of B733
YW	Withdraw	2016	Subject to consultation following retirement of B733

The above table is a proposal with the final decision for withdrawal/ retention of specific aid subject to consultation with affected groups. Furthermore the withdrawal of specified NDBs will be subject to the ability to satisfactorily redesigneither the routes for contingency and/or approach procedures with no significant loss of performance. It is expected that all options will be considered as part of the review e.g. there may be justification to remove BE, HL and MI NDBs and replace with a DN VOR.

8 Summary

The proposed plan confirms that the future navigation infrastructure for NZ will largely be based on GNSS capabilities. It also recognises however that there will also be an on-going requirement to provide a terrestrial contingency capability. The provision of a largely VOR/DME network based on controlled aerodromes, supplemented by "regional" navaids (i.e. Northland, West Coast, etc) should provide sufficient network cover for both contingency and non PBN capable operations. This will enable continued PBN operations using DME/DME/IRU in selected areas in the event of on-board equipment failure (supplemented by surveillance coverage where appropriate) and a network of VOR/DME coverage (supplemented by NDB at some locations) providing a national contingency route structure and instrument approach capability at key aerodromes. This proposal will provide a cost effective contingency capability supporting IFR flight operations within NZ for the medium/ long term.