Farnborough Airport

Airspace Change Proposal

Appendix A

Comms, Nav, Surveillance

Radar coverage and separation standards

Radio telephone coverage

Navigational aid coverage

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1. Radar coverage and separation standards

1.1. Farnborough has a PSR known as the 'ASR10'. It has no SSR of its own.

1.2. Farnborough uses the Heathrow 10cm SSR and Pease Pottage SSR feeds.

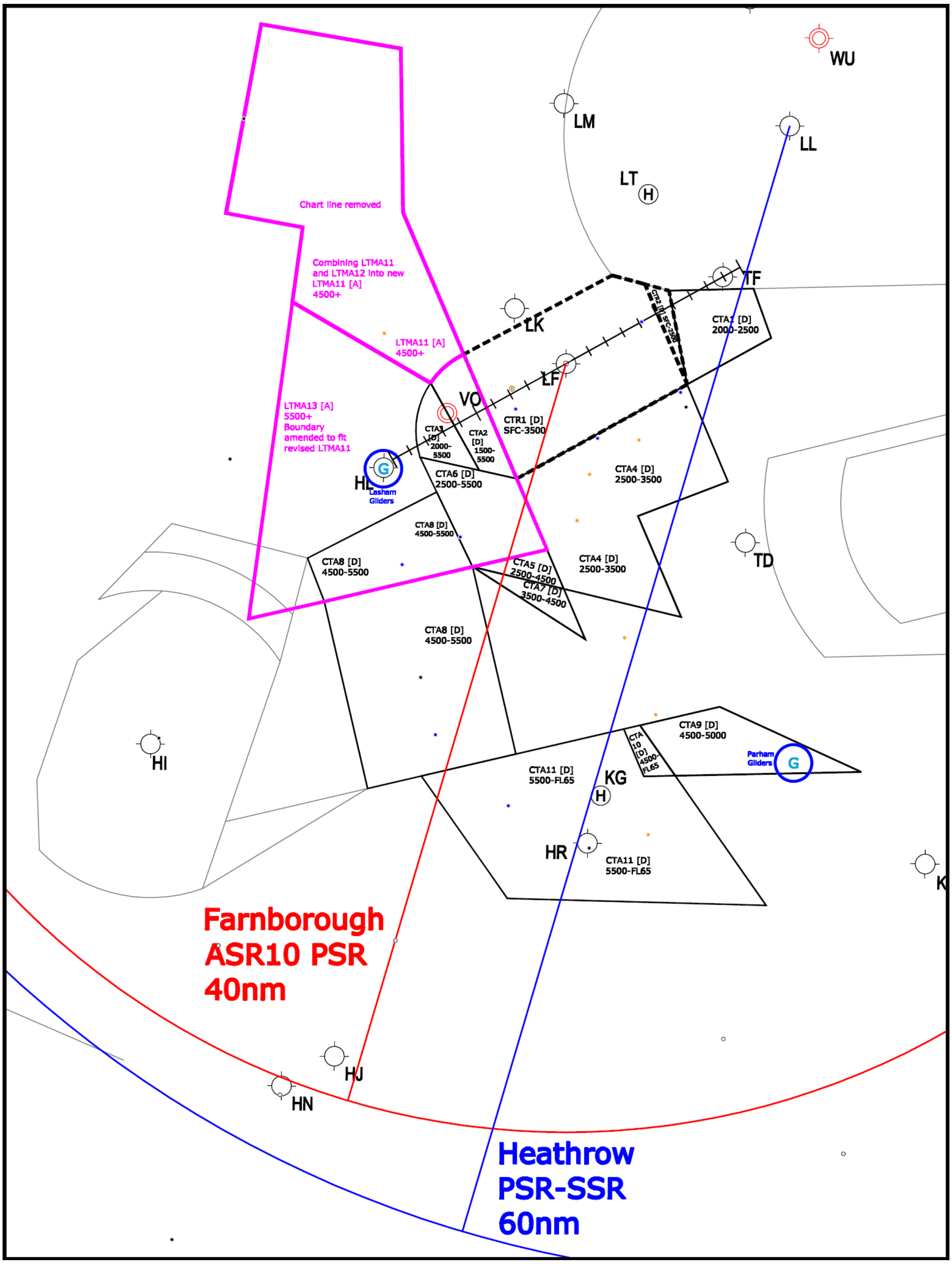


Figure 1 Proposed Option 34 CAS with relevant radar head coverage arcs

3nm separation standard

1.3. The Farnborough MATS Part 2 says that this pair of SSR feeds (when associated with the Farnborough ASR10) allows for 3nm separation standards provided that aircraft are identified, operating below FL195 and are within 40nm of the Farnborough ASR10 PSR head (and subject to vortex wake spacings).

1.4. Figure 1 shows a chart of the proposed Option 34 CAS.

1.5. It also shows a 40nm arc from Farnborough (in red), which fully encloses the proposed CAS.

1.6. We therefore conclude that 3nm separation is authorised by Farnborough for this CAS up to FL195.

Farnborough ASR10 PSR Failure – Current 5nm Standard

1.7. In the unlikely event of a failure of their ASR10 PSR, Farnborough Radar uses the combined Heathrow 10cm PSR/SSR to provide 5nm separation.

1.8. If the 3nm proposal below is rejected, this would remain the case.

Farnborough ASR10 PSR Failure – Proposed 3nm Standard

1.9. The proposed CAS is already very small and is designed around the 3nm standard.
Any prolonged ASR10 outage would cause delays due to the increased 5nm standard (above).

1.10. Farnborough proposes that, should their ASR10 PSR fail, 3nm separation should still be authorised for use.

1.11. This would allow Farnborough, should a critical PSR failure occur, to continue providing a safe service using the smaller separation standard.

1.12. The executive summary of the Heathrow PSR/SSR separation standards report (embedded below) recommends that the maximum safe range at which 3nm and 5nm separation can be applied are both 60nm from the Heathrow PSR/SSR head.

1.13. Figure 1 shows a 60nm arc (in blue) from Heathrow, which fully encloses all the proposed areas of Farnborough CAS.

1.14. Farnborough already receives both PSR and SSR feeds as per the current radar failure (5nm) scenario above.

1.15. Therefore Farnborough proposes that it is reasonable to authorise continued 3nm separation should their ASR10 fail, assuming prompt switchover to the Heathrow feeds.
This was approved for the London 2012 Olympics using similar volumes of CAS(T).
We also propose to remove the 5nm standard from the MATS Part 2, leaving only the 3nm standard.

1.16. The embedded documents below are the formal separation standards report and flight trial report for the Heathrow 10cm PSR/SSR combination following its replacement in 2008:

LL PSR SSR Sepn   LL PSR SSR FltTrial

NOTE these may not be clickable here, see the Attachments pane of the PDF.

Military vs Civilian 3nm separation standard

1.17. Normally 5nm is the separation standard between military and civilian units.

1.18. Extract from letter to Farnborough from DAATM SO2 Sqn Ldr L P Mullineux (dated 04 June 2015), para 7b:

MAA regulation regarding lateral separation both within and outside controlled airspace (Classes A-E) would currently preclude RAF Odiham from providing 3nm separation within the proposed CAS.

The MAA confirmed on 20 May that the MoD can anticipate a rule change to remove the current 'military to military' caveat which should resolve this issue. Other proposals by Farnborough and RAF Odiham to maximise their airspace sharing procedures were deemed to be sound, provided both parties provide robust Safety Assessments and, if applicable, alternative means of compliance to current regulations.

1.19. We conclude that 3nm military-civilian radar separation would be authorised, subject to the caveats above.

2. Radio telephone coverage

2.1. The following figures show the predicted field strength plots for both the 134.350MHz and 130.050MHz antennae at Farnborough, at different CAS base altitudes.

2.2. The plots are <u>identical</u> for both frequencies.
Only one plot is shown to avoid unnecessary duplication.

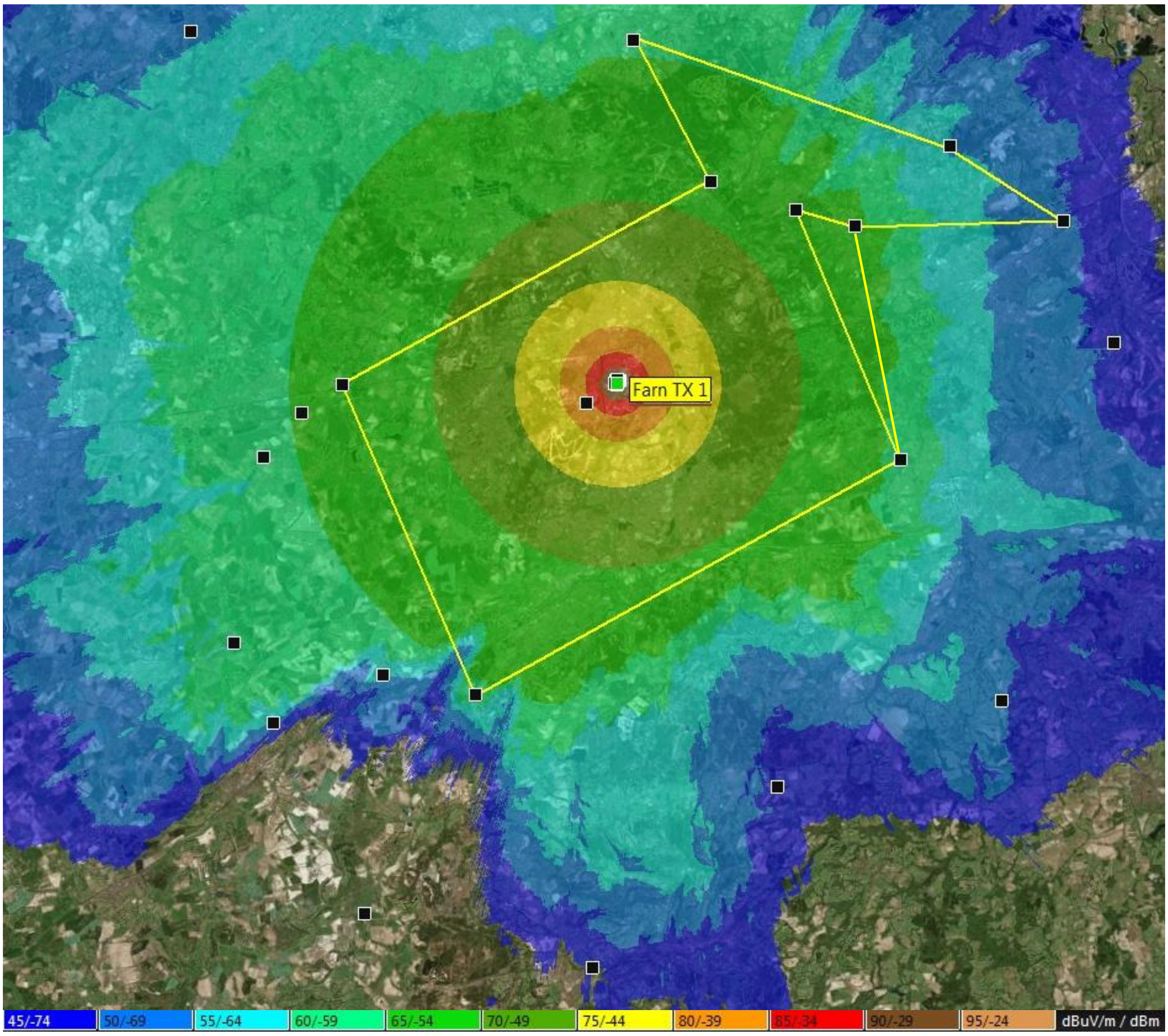
2.3. Each plot also shows an outline of the associated CAS base, providing evidence that all CTR/CTAs are covered by both frequencies at their base altitudes.

2.4. The CAA normally requires 45dBµV or greater field strength within the designated operational area of the service.

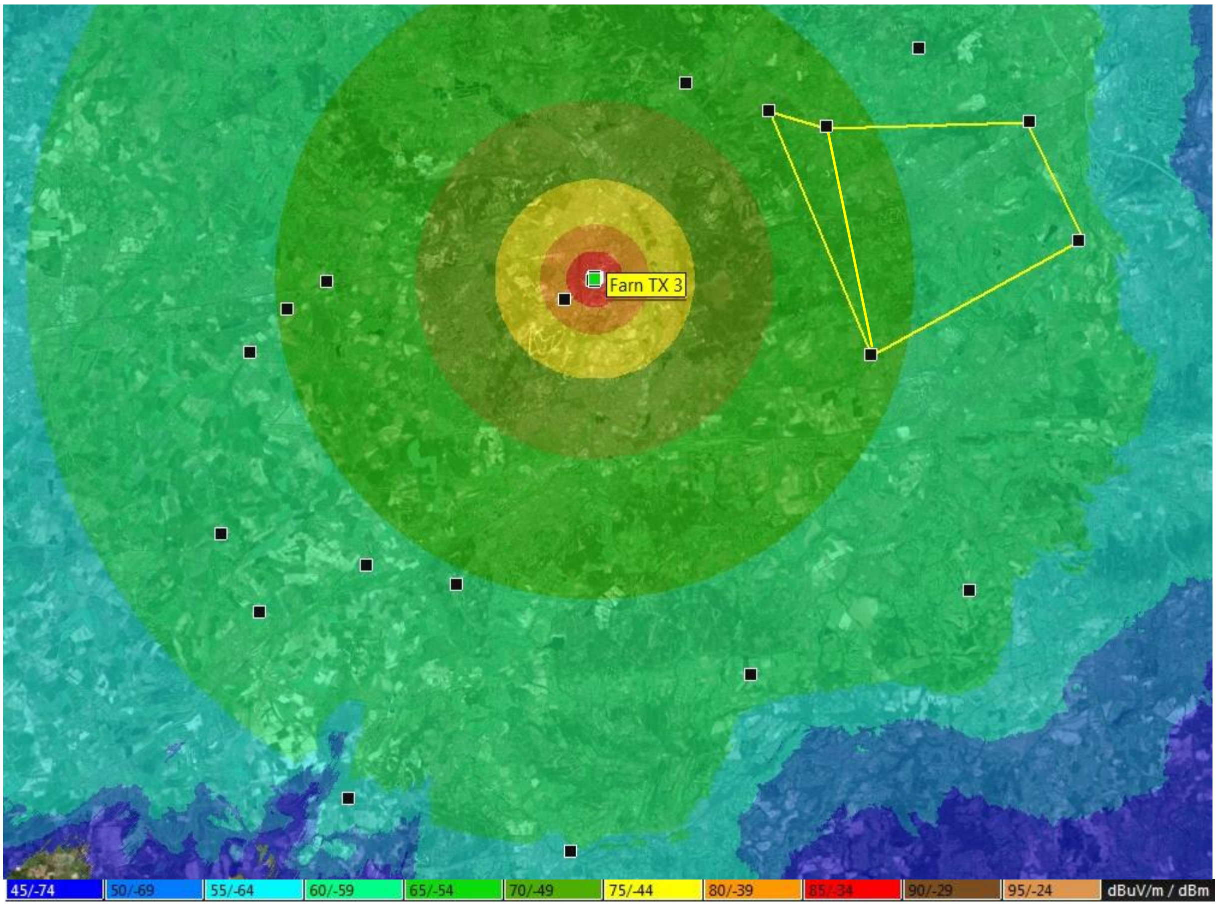
2.5. The field strength at the southeastern fringe is below 45dBµV at 5,500ft in CTA11.

2.6. It is known that these frequencies can, in practice, be used in that area at lower altitudes than the 5,500ft shown above, plus it is expected that LTC would not transfer arriving traffic to Farnborough frequencies until further north within the 45dBµV area. This is not expected to be an issue.

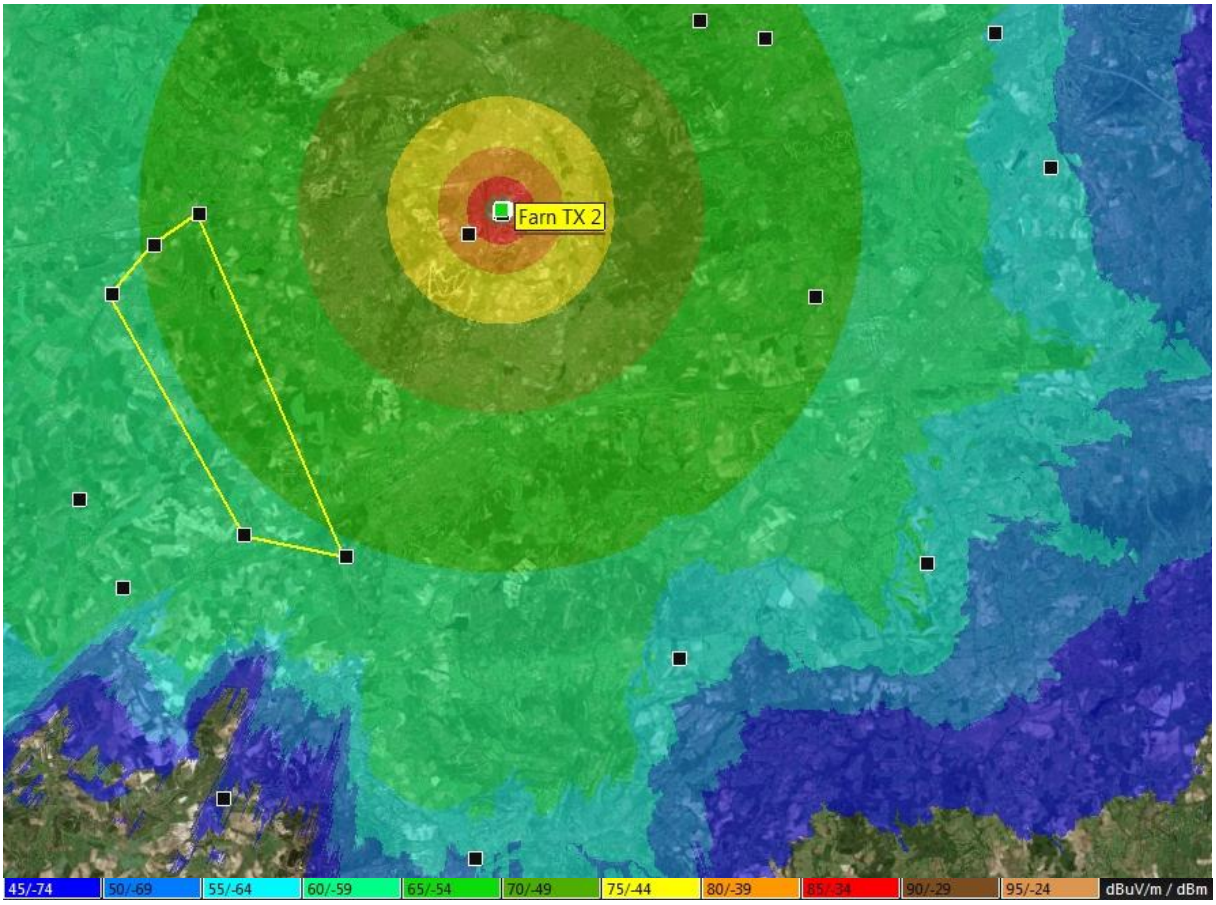
2.7. Existing Farnborough LARS RT coverage on 125.250MHz would be unchanged and is demonstrably adequate. The LARS areas of responsibility would not change.



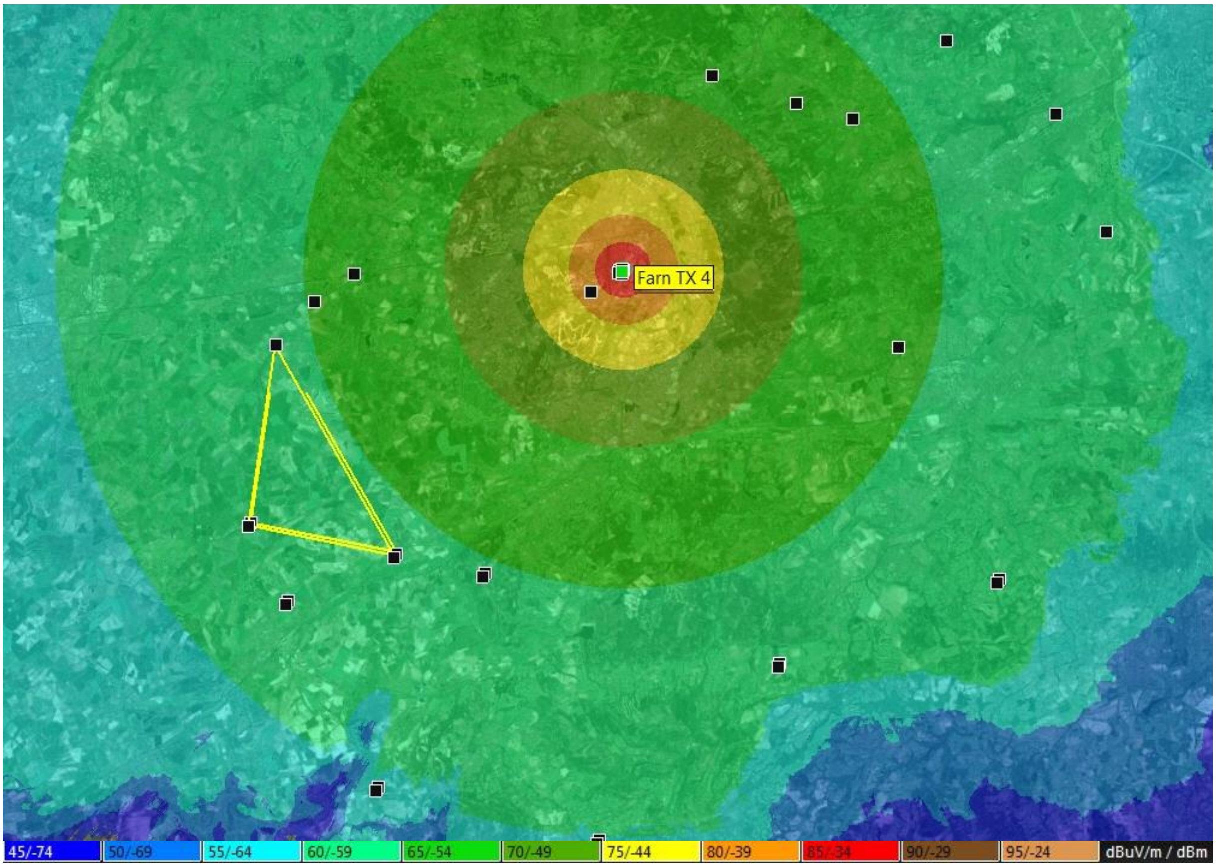
CTR and Delegated Area (measured at 1,000ft)



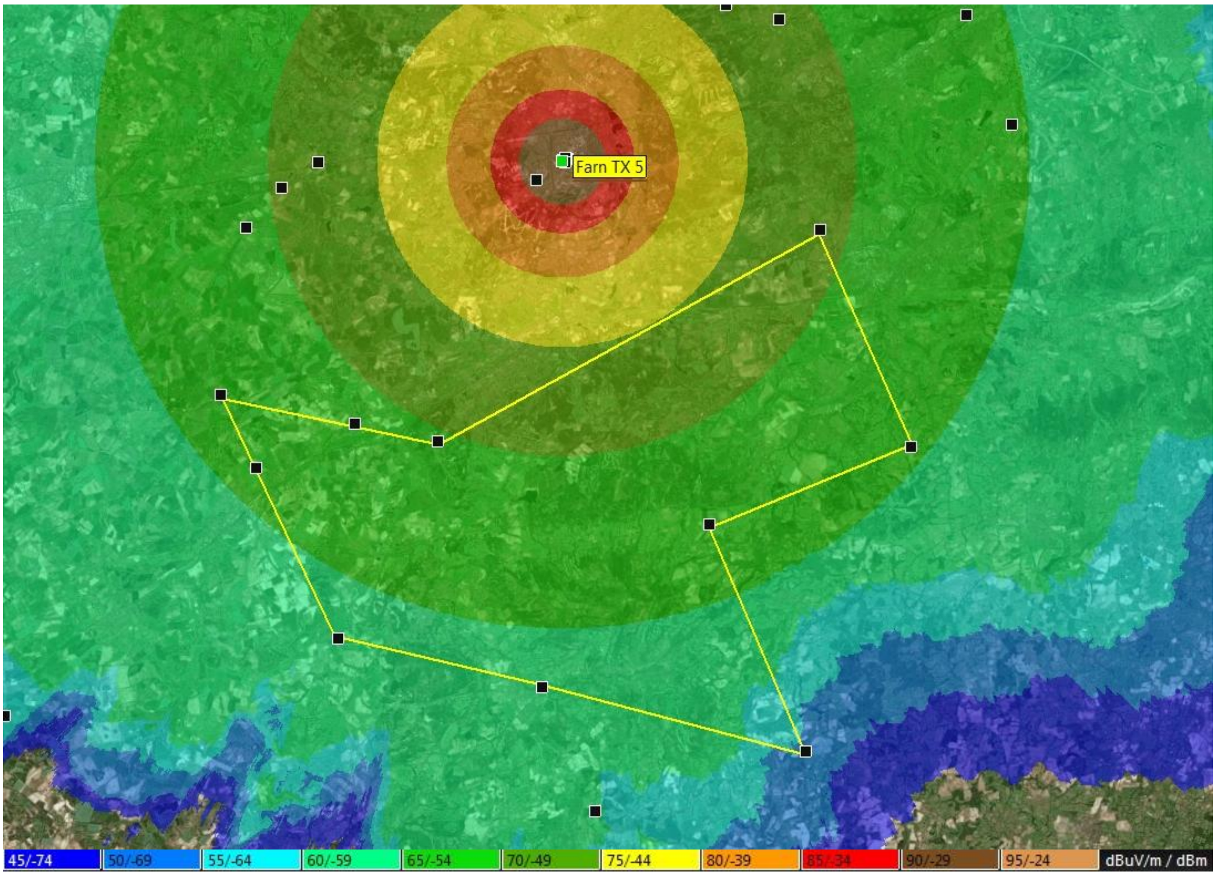
CTA1 (measured at 2,000ft)



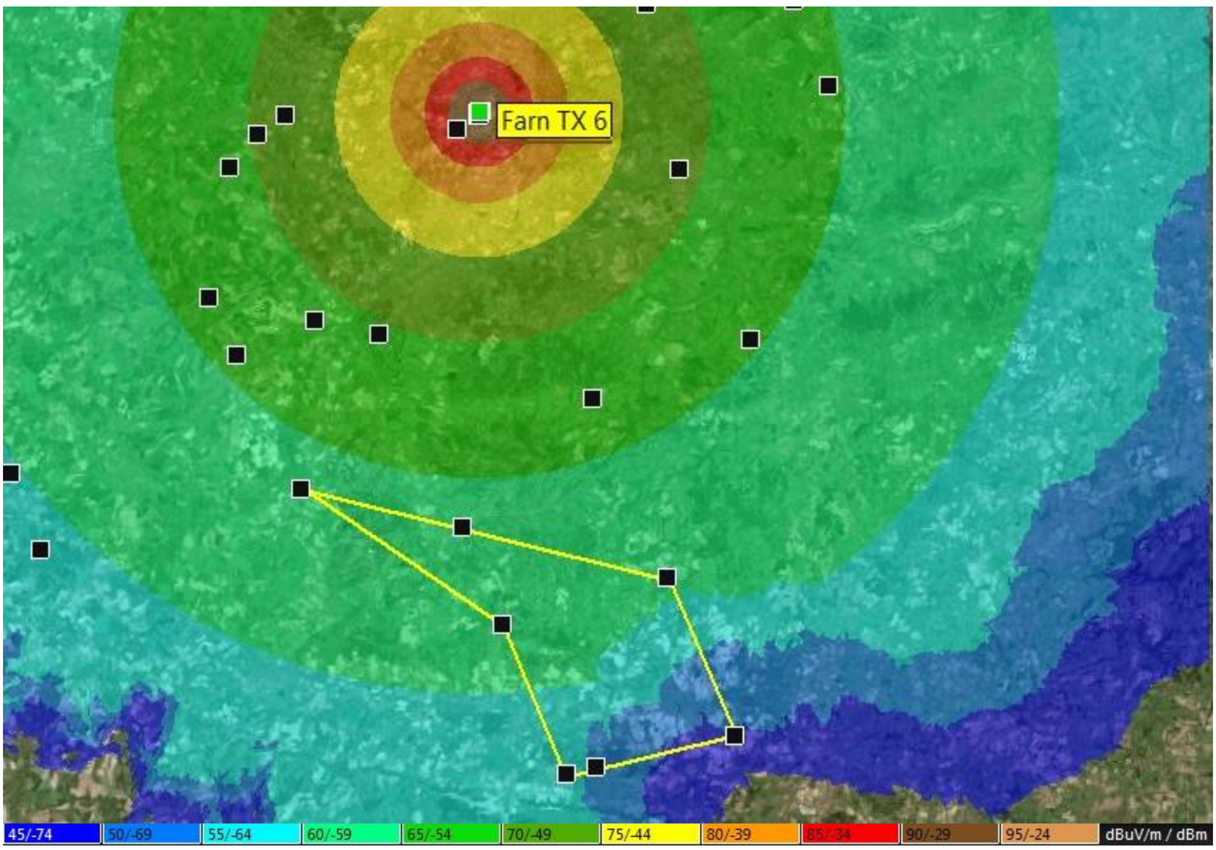
CTA2 (measured at 1,500ft)



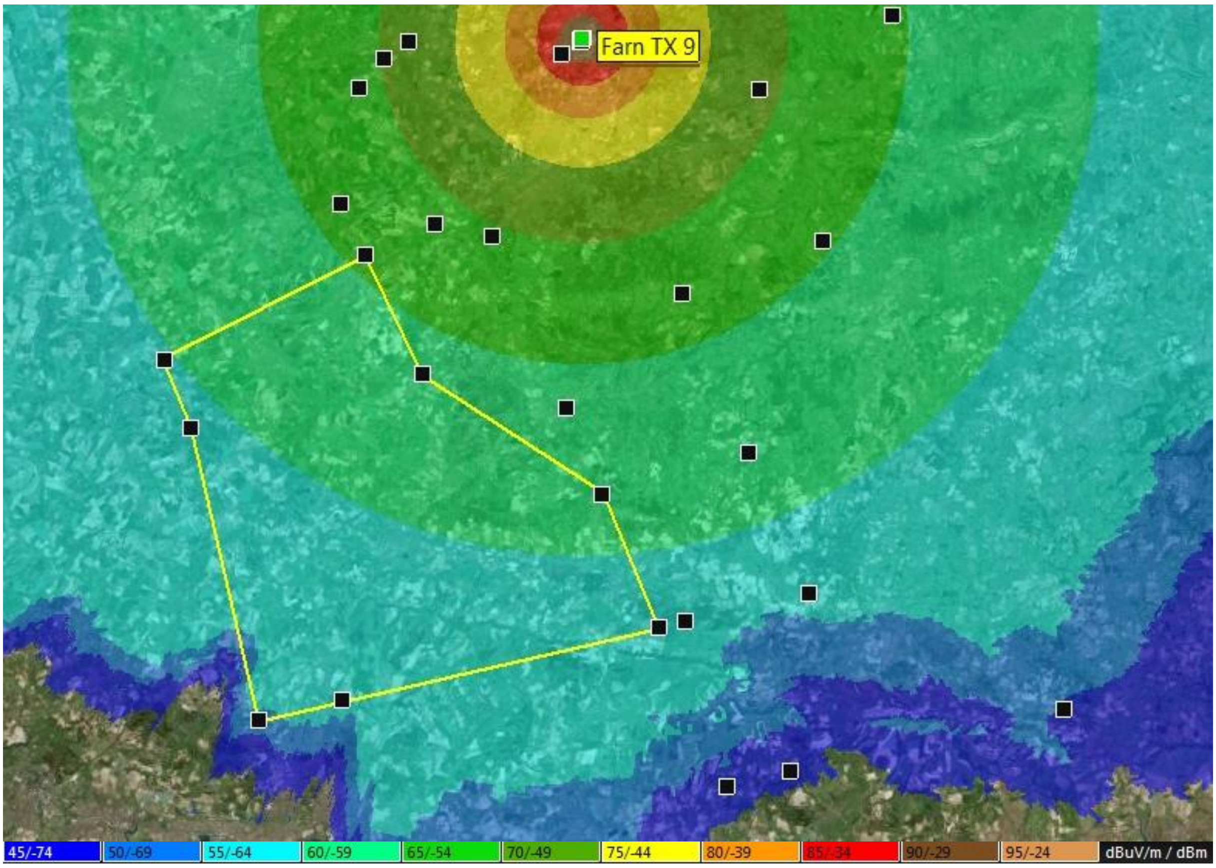
CTA3 (measured at 2,000ft)



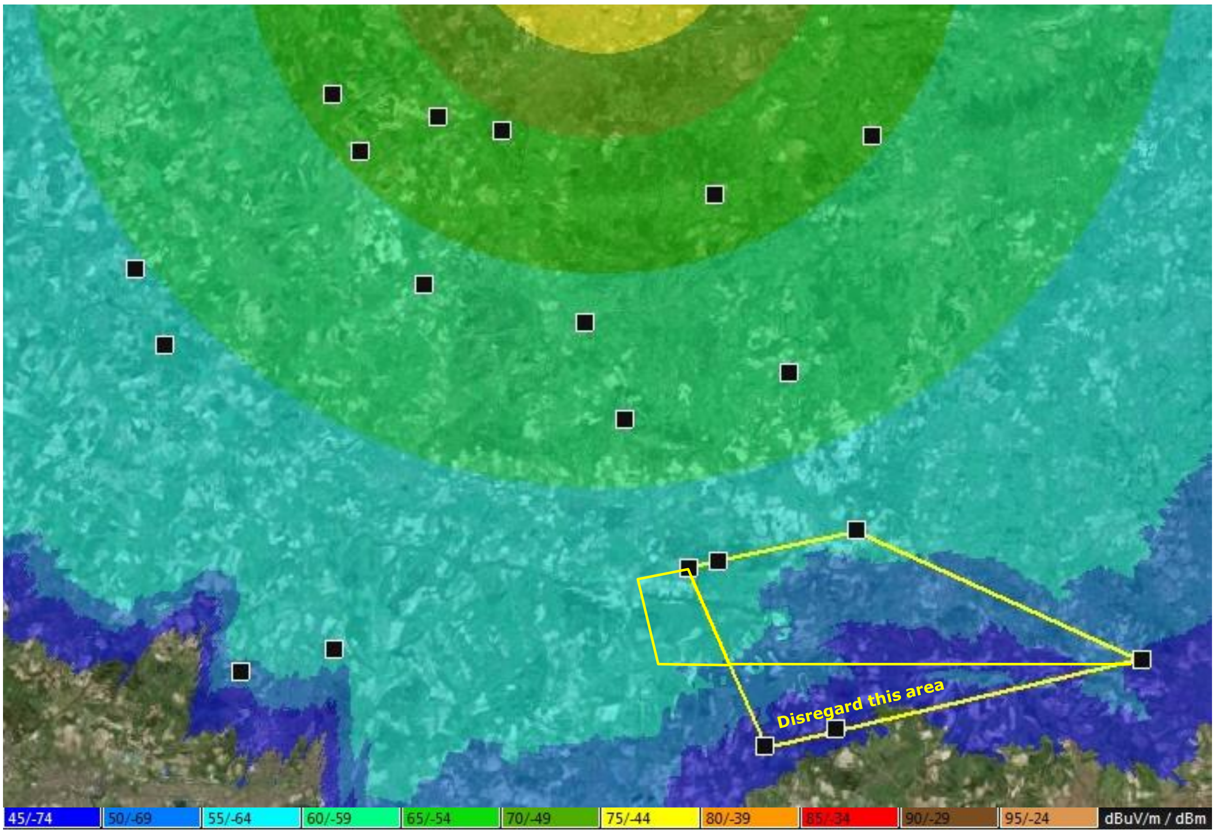
CTA4-5-6 (measured at 2,500ft)



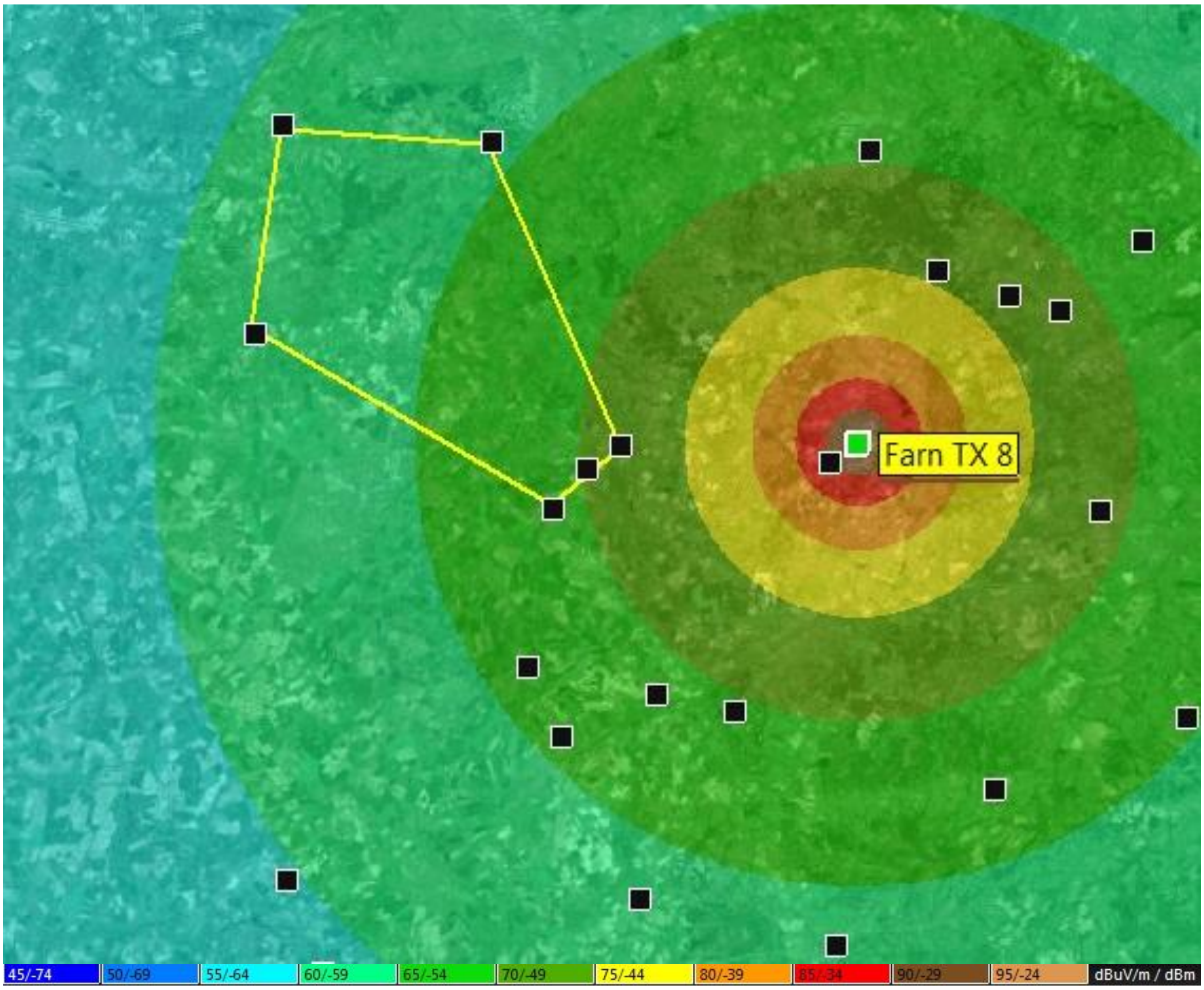
CTA7 plus local LTMA (measured at 3,500ft)



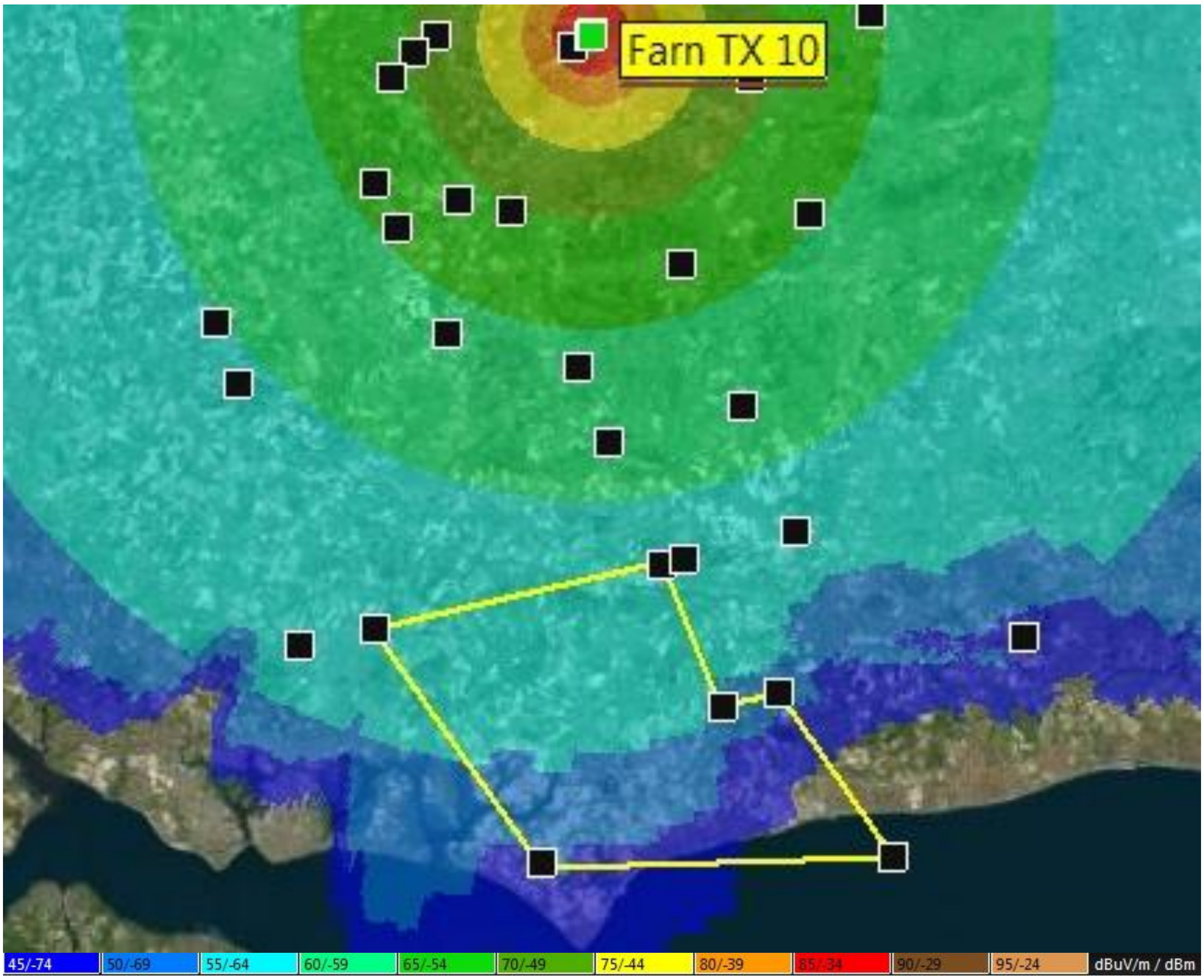
CTA8 plus local LTMA (measured at 4,500ft)



CTA9-10 (measured at 4,500ft)



LTMA12 (measured at 4,500ft) (would become LTMA11)



CTA11 (measured at 5,500ft)

2.8. We conclude that adequate RT communications exists for the proposed CAS at their base altitudes.

3. Navigational aid coverage

3.1. The following pages are the contents of a document produced by NATS Navigation Systems Engineering.

3.2. It provides evidence that RNAV1 DME-DME coverage is adequate for the proposed procedures.

Introduction

NATS are designing a new set of SID and STAR procedures for Farnborough Airport and this document provides the required assessment of the NATS en-route ground navigation position-fix capability. The four SIDS are arranged in complimentary pairs, servicing both Rwy 24 and 06 departures, with each pair having end-points at HAZEL and GWC. These are all designed to the RNAV1 specification.

The four STARS are also arranged in complimentary pairs which terminate at hold points PEPIS and VEXUB. The PEPIS STARS are designed to the RNAV5 specification whereas the VEXUB STARS are designed to the RNAV1 specification.

Assumptions

Provision of RNAV 5 capability from UK based navigational aids is sufficient to satisfy the navigation performance requirements of the proposed new STAR procedures to the PEPIS hold point.

RNAV 5 capability may be supported either by DME/DME or VOR/DME position-fixing in terms of ground infrastructure.

Provision of RNAV 1 capability from UK based navigational aids is sufficient to satisfy the navigation performance requirements of the proposed new STAR procedures to the VEXUB hold point.

Provision of RNAV 1 capability from UK based navigational aids is sufficient to satisfy the navigation performance requirements of the proposed new SID procedures (both HAZEL and GWC).

RNAV 1 capability may be supported only by DME/DME in terms of ground infrastructure.

A further procedure segment to the SAM waypoint is included in the assessment of the proposed SIDS although this is currently optional and does not form part of the formal SID designs.

Assurance of adequate navigation performance provision at the base level of the areas of interest means that performance will be adequate for the entire airspace volume of interest.

In this case, 'full' and 'excessive' redundancy in terms of position-fixing performance in the figures shown equate to the same adequate level of navigation performance.

RNAV Performance Key

The navigation assessments within this document have been carried out using a software named DEMETER which is provided by Eurocontrol for the purpose of modelling ground navigation position-fixing performance in support of PBN procedures. The DEMETER tool presents assessments based on levels of redundancy regarding RNAV coverage within areas of airspace. These are represented by means of a simple colour coding as follows:

No colour	-	*No DME/DME coverage*
Red	-	*No DME/DME redundancy (single pair of DMEs in view)*
Yellow	-	*Limited DME/DME redundancy (more than one DME pair in view but all pairs have a single common 'critical' DME*
Green/Blue	-	*Full redundancy (at least two independent DME pairs in view)*

Results – VEXUB / PEPIS STARs

As stated in the assumptions it is possible to provide compliant ground navigation support for RNAV 5 procedures based either on VOR/DME or DME/DME position-fixing. RNAV 1 can only be supported by a DME/DME position-fix. With this in mind, figures 1 and 2 provide an assessment of ground navigation support from VOR/DME co-located beacons, and figures 3 and 4 provide an assessment of support from DME beacons only, providing DME/DME position-fixing capability.

All figures show both the PEPIS and VEXUB STARs.

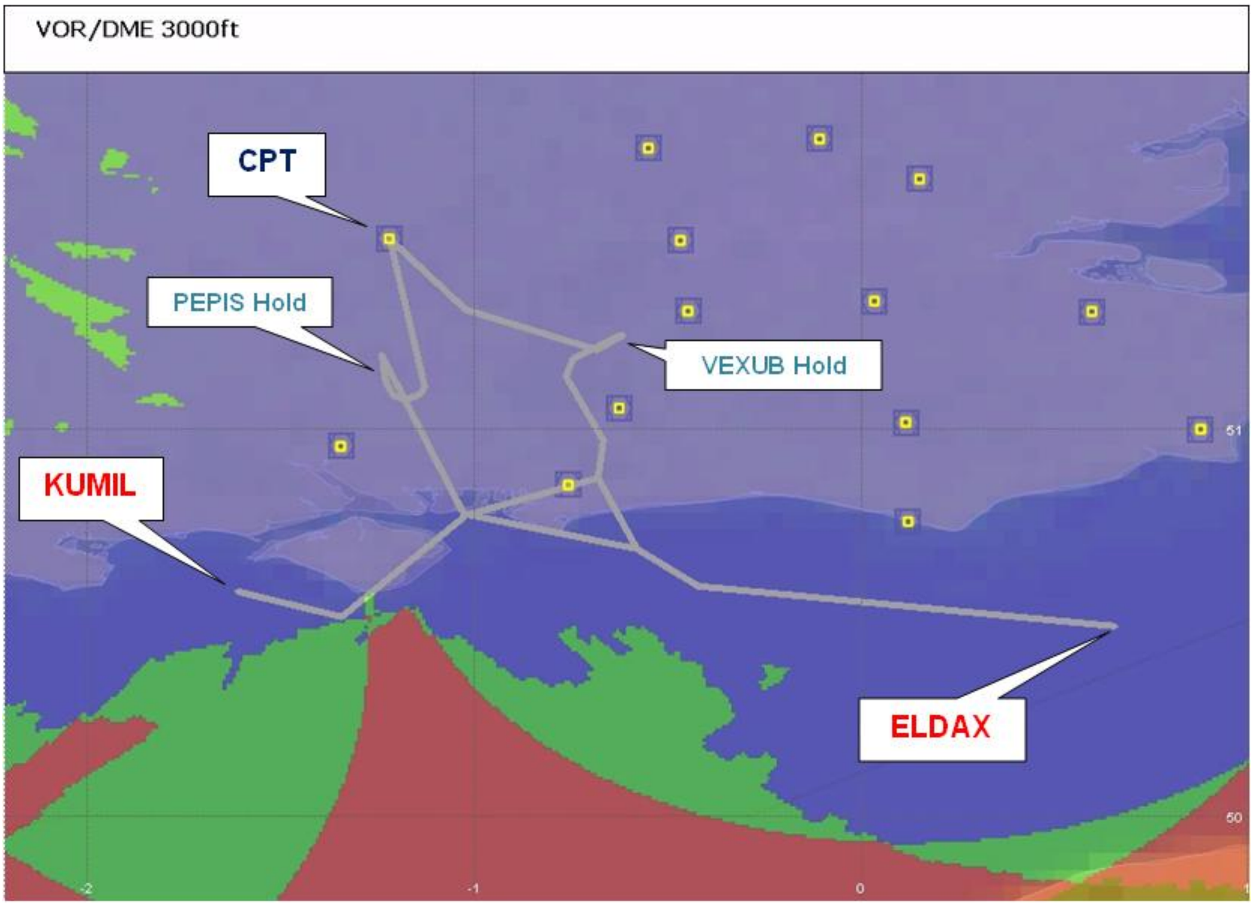


Figure 1: Current VOR/DME Position-Fixing Capability from NATS en-route ground-based Navigational Aids supporting the new Farnborough STARs (3000 ft)

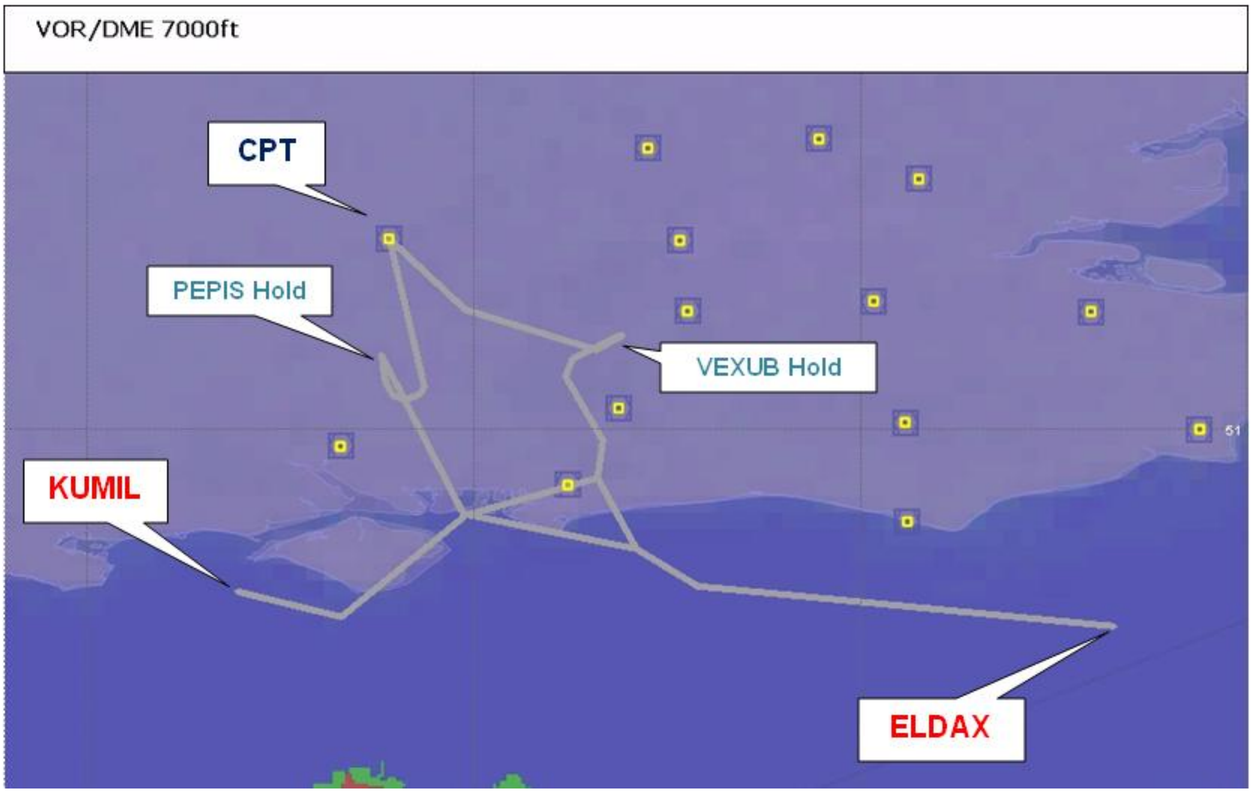


Figure 2: Current VOR/DME Position-Fixing Capability from NATS en-route ground-based Navigational Aids supporting the new Farnborough STARs (7000 ft)

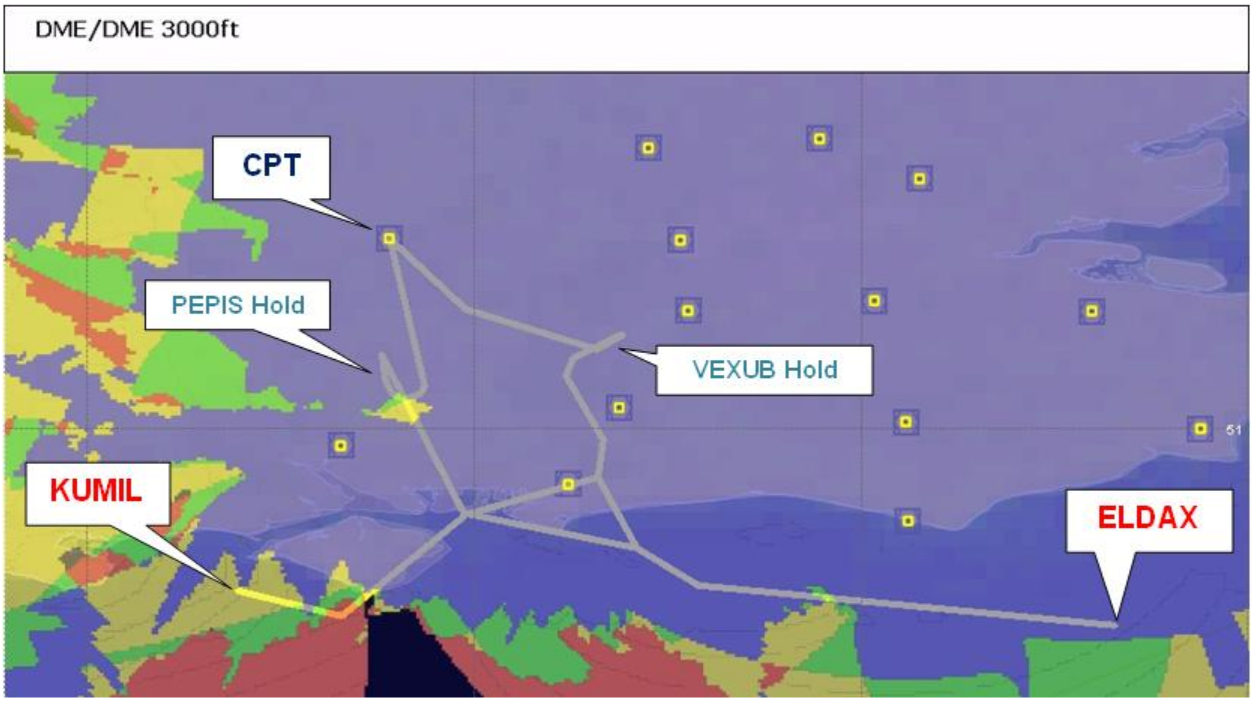


Figure 3: Current DME/DME Position-Fixing Capability from NATS en-route ground-based Navigational Aids supporting the new Farnborough STARs (3000 ft)

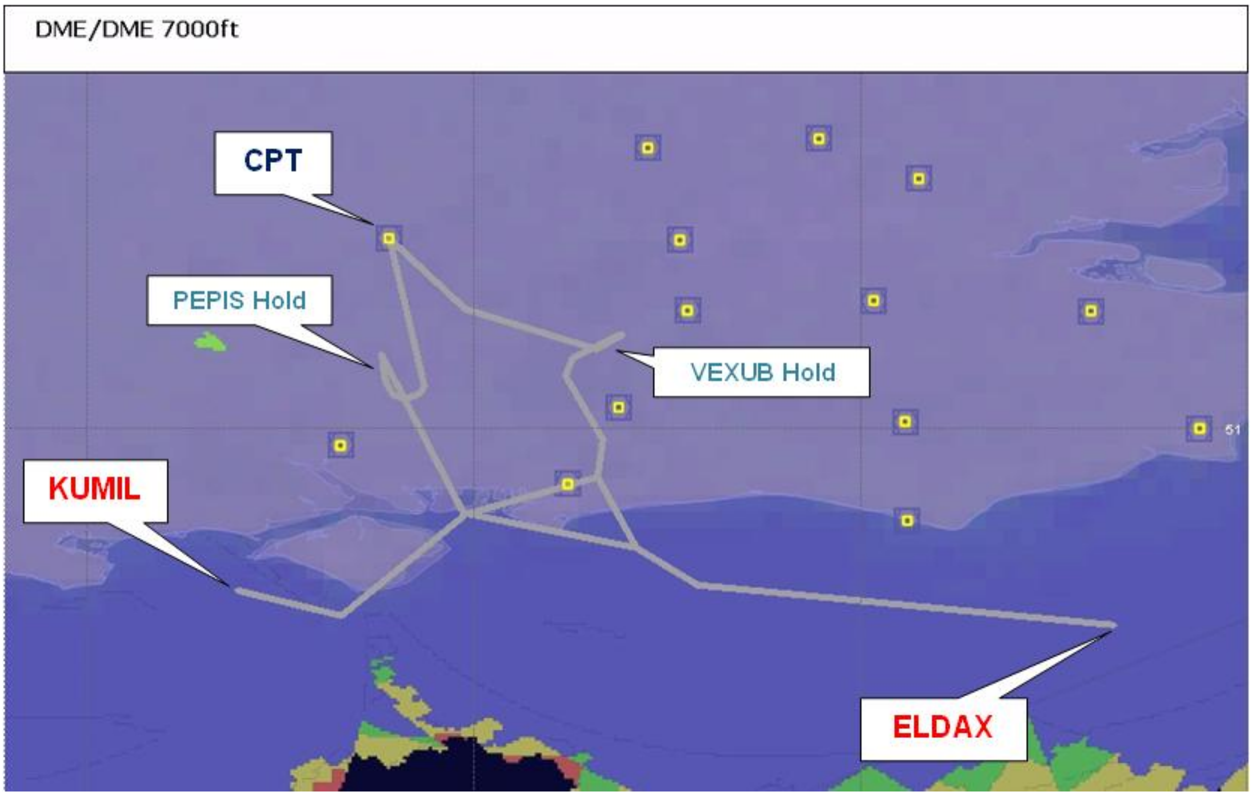


Figure 4: Current DME/DME Position-Fixing Capability from NATS en-route ground-based Navigational Aids supporting the new Farnborough STARs (7000 ft)

A point to note related to the figures above is that the base levels for the STAR procedures are 3000 ft down to approximately the southern UK coastline, and then 7000 ft beyond this to the South.

Figures 1 and 2 show that all areas of the STAR procedures to PEPIS, (from both KUMIL and ELDAX), are fully supported by VOR/DME position-fixing support (Blue area).

Figures 3 and 4 show that all areas of the four STAR procedures are also fully supported by DME/DME position-fixing support (Blue area). The extremities of the STAR procedures out to KUMIL are shown to pass through areas without fully redundant DME/DME position-fixing support (Red and Yellow areas), however this is mitigated by the fact that the minimum operational base levels in this area are set at 7000 ft. This is represented in figure 4 and it can be clearly seen that at this altitude the STAR segments are provided with fully redundant DME/DME position-fixing support (Blue area).

Results – HAZEL / GWC SIDs

As stated in the assumptions it is possible to provide compliant ground navigation support for RNAV 1 procedures based on DME/DME position-fixing, (VOR/DME does not provide sufficient accuracy to support this navigation specification). Therefore, figures 5 and 6 provide an assessment of support from DME beacons only, providing DME/DME position-fixing capability.

All figures show both the HAZEL and GWC SIDs (24-06), and also include the additional segment out to SAM, which is currently not part of the formal SID design.

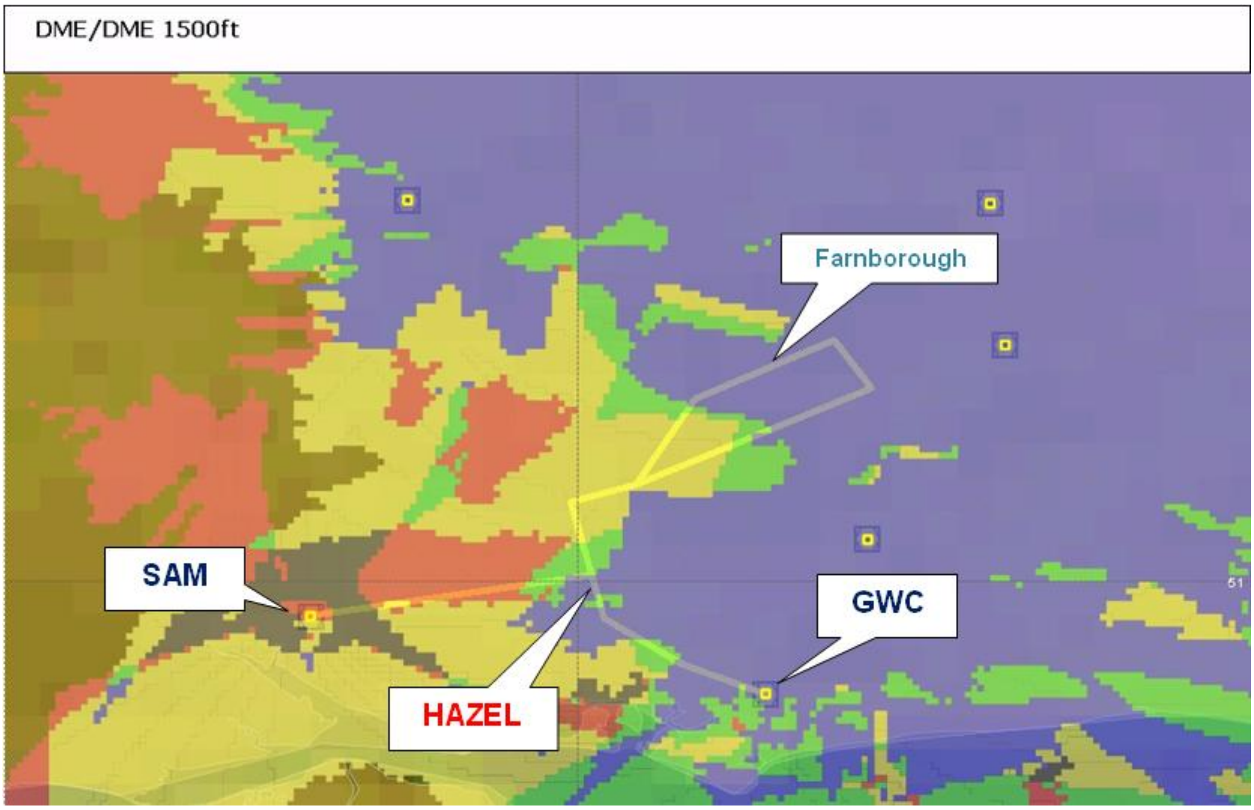


Figure 5: Current DME/DME Position-Fixing Capability from NATS en-route ground-based Navigational Aids supporting the new Farnborough SIDs (1500 ft)

Figure 6: Current DME/DME Position-Fixing Capability from NATS en-route ground-based Navigational Aids supporting the new Farnborough SIDs (3000 ft)

When considering the figures above it should be noted that a generic rationale has been developed and endorsed by the CAA in their PBN implementation guidance documentation (Implementing PBN Solution, Edition #1, UK CAA)which introduces the requirement for aircraft undertaking DME/DME SID procedures to carry an inertial system with an automatic runway updating capability. This then becomes a pre-requisite for any aircraft operating this type of procedure and should be duly noted on the SID chart.

This is mainly to mitigate the common difficulty in achieving low-level DME performance which is true across most of the UK, and also takes consideration for the high equipage rate for such an on-board inertial system. This rationale within the CAA guidance document means that DME coverage is required at 3000 ft above airfield level which takes into account average aircraft climb profiles and DME aircraft acquisition times.

With this in mind, figures 5 and 6 illustrate the DME/DME position-fixing capability at 1500 ft and 3000 ft to illustrate the potential issues at low-level, as well as characterise the performance at the 3000 ft point.

Figure 5 illustrates that there may be a potential issue especially regarding Rwy 24 departures if the requirement for auto updating inertial systems is not enforced. Here there are areas of limited redundancy (yellow areas), which would potentially reduce the availability of the procedures with the introduction of 'critical' DMEs. With this in place however, figure 6 demonstrates that there is fully redundant DME position-fixing support at 3000 ft AMSL for the area of interest.

Conclusions

NATS en-route ground-based navigational aids provide fully redundant VOR/DME and DME/DME position-fix capabilities to all areas of the new proposed Farnborough STARs ending at PEPIS. This fully supports the RNAV 5 specification.

NATS en-route ground-based navigational aids provide a fully redundant DME/DME position-fix capability to all areas of the new proposed Farnborough STARs ending at VEXUB. This fully supports the RNAV 1 specification.

NATS en-route ground-based navigational aids provide a fully redundant DME/DME position-fix capability which is adequate to support an RNAV 1 specification as applied to the new proposed Farnborough SIDs (HAZEL and GWC).

The further SID segment from HAZEL to SAM is also fully supported by NATS en-route ground navigation infrastructure as per the RNAV 1 specification, should implementation of this be required.

The requirement for carriage of an inertial system with runway auto-updating capabilities must be applied to all non-GNSS aircraft wishing to use the new Farnborough SIDs. This should be marked on the SID chart.

The on-board equipage rates (for suitable inertial equipment) for non-GNSS aircraft should be considered as part of the implementation of these proposed SIDs at Farnborough.

3.3. This document is evidence that the proposed RNAV1 and RNAV5 procedures have adequate coverage. Runway auto-updating capabilities will be marked on the SID chart.

4. Conclusion

4.1. Radar coverage and separation standards, Radio telephone coverage and Navigational aid coverage has been shown to be adequate for this proposal.