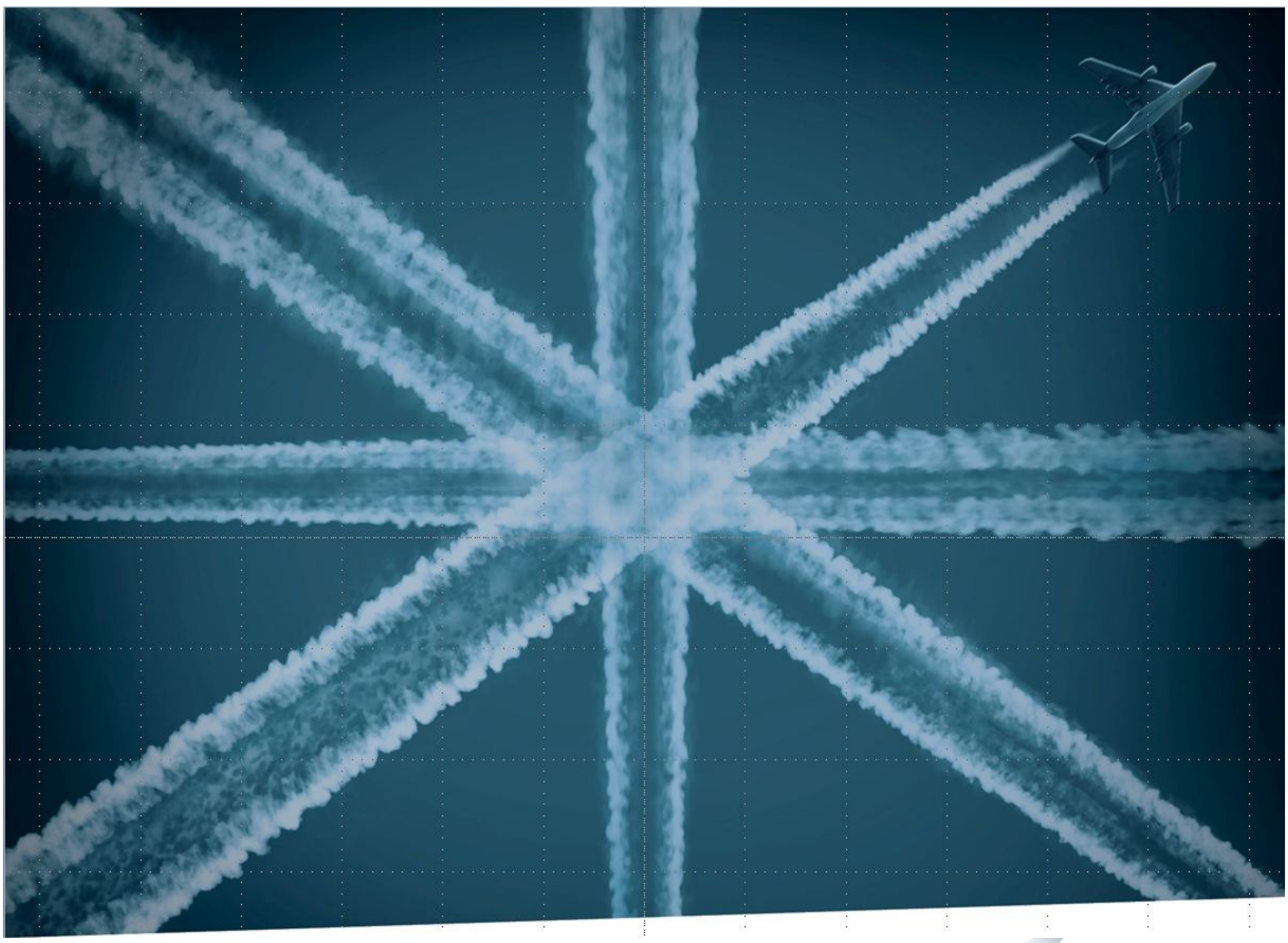
RNP1 (RF) Trial

London Stansted Airport



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1. Introduction

London Stansted has evolved over recent decades to become London's 3rd largest airport since its redevelopment in the early 1990's. The airport currently has planning permission for 35 million passengers per annum and 264,000 Air Traffic Movements.

Since the airport came under the ownership of Manchester Airports Group it has returned to significant growth. With this growth comes a responsibility to manage and mitigate where possible the noise impacts relating to aircraft operations.

London Stansted is a noise designated airport and as such noise controls are set by UK Government, including the establishment of Noise Preferential Routes (NPRs) for departing aircraft. This has been the case since the early 1990's as a result of public consultation.

London Stansted has a long established track record of managing aircraft noise and currently has a strong track-keeping compliance rate in excess of 99% for all departing aircraft remaining within the designated Noise Preferential Routes, which are 3km wide for reporting purposes. This has been achieved through working closely with our aircraft operators to refine their departure procedures to improve NPR compliance.

A trial was developed to improve further still the track keeping accuracy of departing aircraft by utilising modern satellite navigation and Standard Instrument Departures (SID) design technology. The trial was developed through a partnership between the Civil Aviation Authority Safety and Regulation Group (CAA-SARG), aircraft operators, NATS (Air Navigation Services Provider) and with the support of the Stansted Airport Consultative Committee (STACC)

This report has been written to present the findings and analysis of the two trial departure routes that were designed to Required Navigational Performance of 1 nautical mile (RNP1) standard with Radius to Fix (RF) Path Terminators. The trial SIDs will be referred to as RNP1 (RF) for the remainder of this document.

2. Background and Objectives

As stated in the introduction, Stansted Airport Limited (STAL) has a strong departure track keeping compliance record in excess of 99%. This has been achieved over many years through working closely with aircraft operators and regulators using detailed track data from the airports Noise and Track Keeping System, ANOMS.

London Stansted has 6 Noise Preferential Routes that encompass the low level initial section of the Standard Instrument Departure Routes (SIDs) before they diverge. E.g., the runway 22 BZD NPR encompasses the initial part of the 22 Buzad, Compton and Barkway SIDs. A map of the 6 existing NPRs is shown in Appendix A.

Departing aircraft are deemed compliant when they remain within a NPR corridor up to 3km wide (narrower closer to the runway) until they have achieved a minimum height, usually 4,000ft amsl, when they can be vectored onto a more direct heading to destination by Air Traffic Control (ATC). Vectoring aircraft is often used to maximise the safe, orderly and expeditious flow of air traffic and reduce fuel burn and associated emmissions.

Historically there has been a wide spread of departure tracks within these 3km NPRs due to a range of factors influencing the position of an aircraft within the NPR including airframe type, departure weight, wind speed and direction, temperature, Flight Management System(FMS) capability and Noise Abatement Departure Procedures (NADP).

To compound this variation across departure tracks, the SID database encoding for an aircraft's FMS can vary greatly between database providers. It is through working collaboratively with aircraft operators and their database providers that gradual improvements have come to fruition by providing regular departure track images and NPR compliance statistics. This in turn has created an almost bespoke solution for each operator and aircraft type to maintain departure track keeping compliance within the NPR.

An example of this traditional variation within an NPR is shown in Images 1a and 1b, Image 1a: Typical departure tracks across runway 22 Clacton NPR

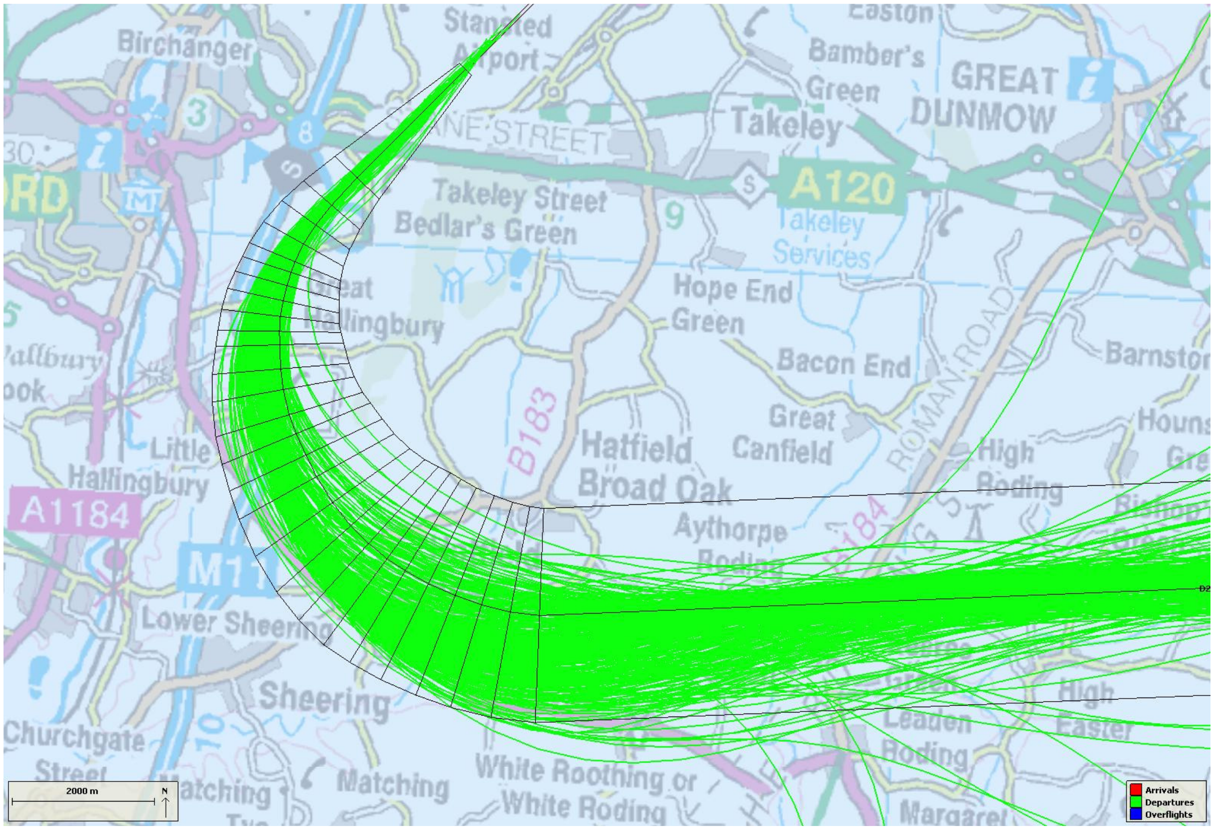
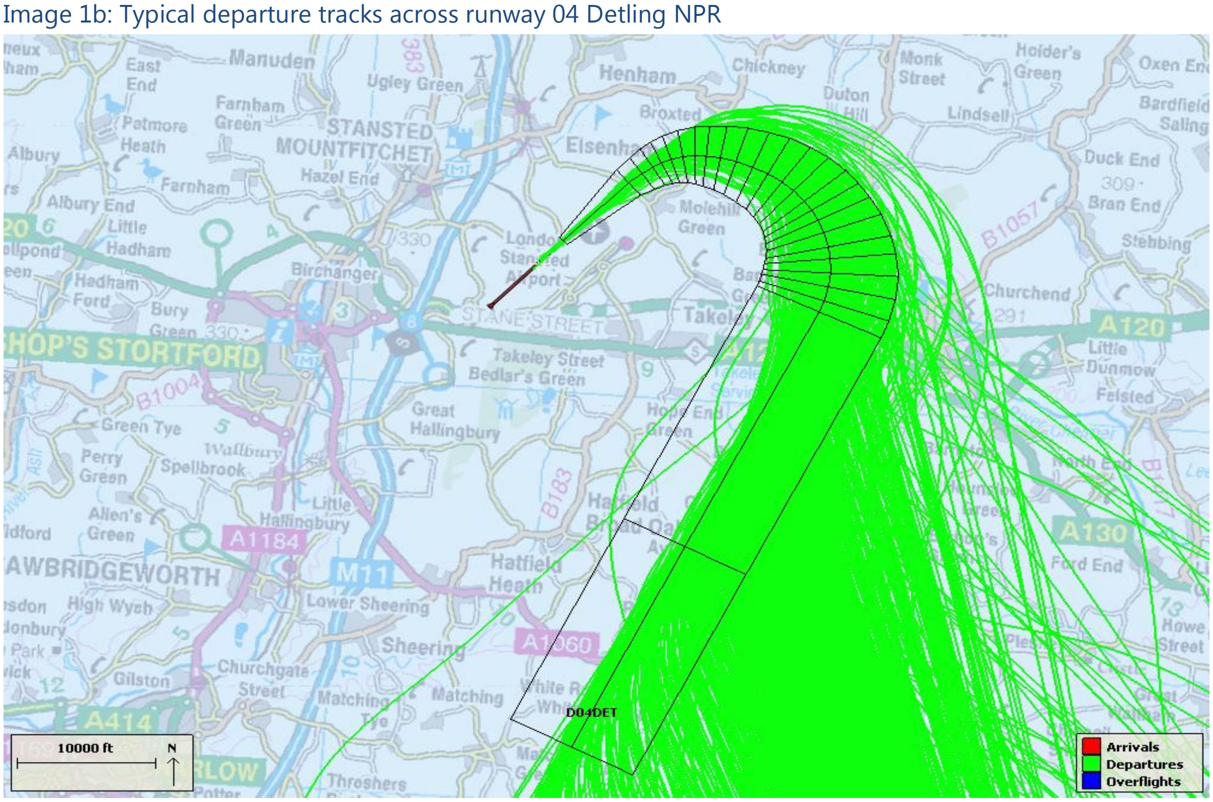


Image 1b: Typical departure tracks across runway 04 Detling NPR



In November 2011 representatives from CAA-SARG, London Stansted Airport and the Stansted Airport Consultative Committee met to explore what technology was available to further improve the accuracy of departure track keeping.

The recommendation from the CAA–SARG was to conduct a departure track keeping trial with procedures designed to RNP1 standard using Radius to Fix Path Terminators for the turns within the Noise Preferential Route.

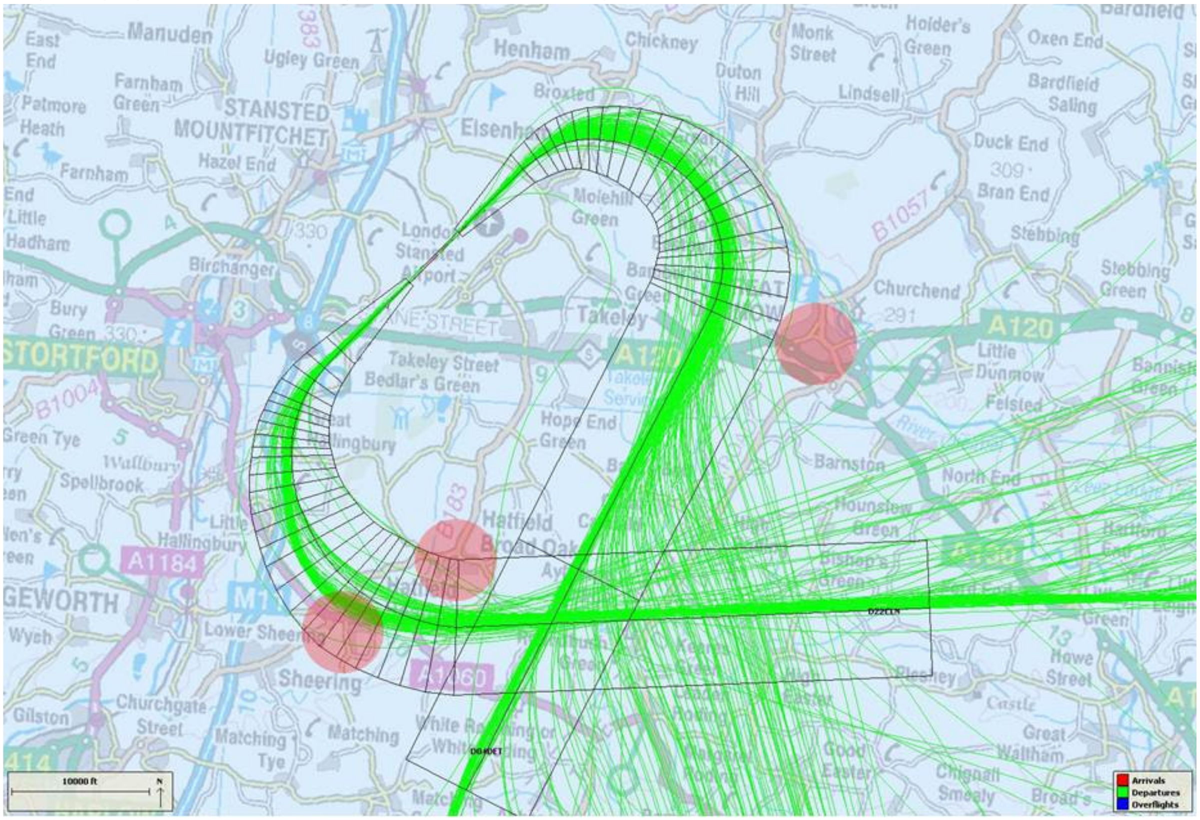
The objective of the RNP1 (RF) SID design was to replicate the existing standard SID as closely as possible to enable concentration of the departing aircraft as close to the centre of the existing SID as possible.

All 6 departures routes were considered. It was in turn decided that the most benefit would derive from replicating the runway 22 Clacton and 04 Detling SIDs[1]. The reasons behind that decision are as follows (these are also demonstrated in Image 2):

- Replicating a SID on each end of the runway would allow data gathering irrespective of which runway was in use due to wind direction;
- Replicating the 22 Clacton SID would help alleviate community concerns by potentially reducing the over-flight of the Hatfield Heath and Hatfield Broad Oak Communities;
- Replicating the 04 Detling SID would hopefully improve departure track-keeping compliance, as this has traditionally been the least compliant SID at London Stansted due to the tight 160^{o} + wrap around turn after departure at 0.8nm; and
- Replicating the 04 Detling SID would potentially reduce the over-flight of Great Dunmow.

[1] In May 2014 the two Dover SIDs were truncated and renamed to Detling. For the purposes of this report, all references are to Detling as both are identical in all aspects associated with this trial.

Image 2: highlighted areas where it may be possible to avoid overflights with the RNP1 (RF) SID design



It was agreed at this meeting that the CAA-SARG procedure designers would investigate and report if it was possible to replicate these 2 SIDs.

OBJECTIVE 1: CAA-SARG to report by the end of 2011 as to the feasibility of replicating the 22 Clacton and 04 Detling SIDs with RNP1 (RF)

This objective was achieved as CAA-SARG reported by the end of 2011 that the two SIDs could be replicated with RNP1 using Radius to Fix Path Terminators.

Following this, a second objective was set to engage an airline partner with RNP1 regulatory approval to assist with simulator testing the SID designs. This was to evaluate the aircraft flyability on a training flight simulator where a variety of parameters can be adjusted to replicate different operating conditions.

OBJECTIVE 2: CAA-SARG to design the 22 Clacton and 04 Detling SIDs with RNP1 (RF) and with STAL to engage an aircraft operator to assist with simulator flyability testing

This objective was also achieved as the CAA-SARG were able to produce two replicated RNP1 (RF) SID designs that closely followed the existing SID. The distance between each of the conventional SIDs and the RNP1 (RF) SIDs is detailed in sections 3 and 4 of this report. London Stansted and the CAA-SARG have a close working relationship with easyJet who offered their assistance and expertise in testing the two RNP1 (RF) SID designs and appropriate A320 simulator testing time.

Once the simulator testing and safety evaluation was completed a trial was to be conducted to prove the RNP1 (RF) concept.

OBJECTIVE 3: CAA-SARG / STAL to launch trial of the 22 Clacton and 04 Detling SIDs with RNP1 (RF) and collect data for validation purposes at ICAO

A formal trial could not commence until after the London 2012 Olympics. It was deemed prudent to wait until after the anticipated uplift in aircraft movements associated with the London 2012 Olympic Games and the removal of temporary controlled airspace at other local airports in the London Terminal Manoeuvring Area (LTMA) before any trial could be undertaken. After a full regulatory review was undertaken, an appropriate Aeronautical Information Publication (AIP) supplement was published following a double Aeronautical Information Regulation and Control (AIRAC) cycle and a launch date for the trial set for 7th May 2013.

The trial would initially commence with easyJet for a period not less than 1 month to allow initial data gathering and feedback before inviting other operators with RNP1 approval to participate. Both these objectives were achieved with the publication of an AIP supplement detailing the commencement of the RNP1 (RF) trial on 7th May 2013.

Once the trial RNP1 (RF) SIDs had been successfully flown operationally by easyJet for a period of 1 month, other operators at Stansted with RNP1 regulatory approval were approached to participate in the trial.

London Stansted and the CAA-SARG are grateful for the co-operation and assistance from easyJet, German Wings, FEDEX, UPS, AtlasAir, Global Supply Systems, Pegasus and Fayair who have all flown the RNP1(RF) SIDs with a variety of airframe types.
Also, this trial would have not evolved withpout the extensive support of NATS. Similarly, the EIG have been supportive of this initiative.

A full set of data containing aircraft operators and types flying each RNP1 (RF) SID can be found in appendix D.

It was agreed that STAL would monitor closely the results of the trial and present the findings and analysis of the two trial departure routes that were designed to RNP1 standard with Radius to Fix Path Terminators.

This report has been based on a dataset from the period May 2013 to November 2014.

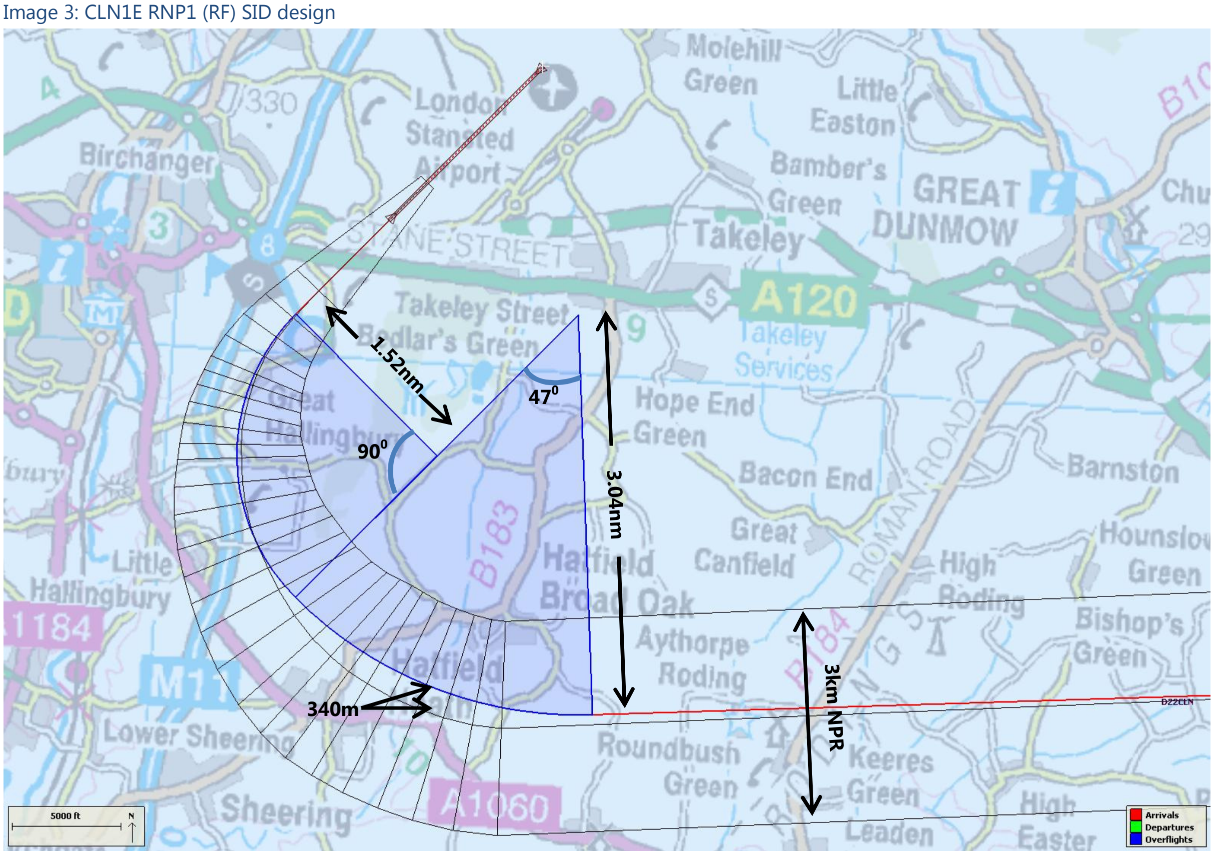
At the time of writing this report the trial remains on-going for the purposes of gathering further RNP1 (RF) data from other aircraft operators and aircraft types until the procedures are adopted permanently though an appropriate airspace change process.

3. Clacton 1E Design and Trial Results

The CLN1E RNP1 (RF) SID was designed with two RF arcs to better replicate the existing Clacton 8R SID. The first arc was designed with a 90^0 turn with a radius of 1.52nm with the initial turn point set at 1.2nm Distance Measuring Equipment (DME). The second arc is a 47^0 turn with a 3.04nm radius.

The maximum distance between the RNP1 (RF) SID and the existing conventional SID is 340m, around the midpoint of the second RF arc. The RNP1 (RF) SID was also designed with a 210kt Indicated Air Speed (IAS) limit for the 2 RF turns to better enable track keeping compliance. Immediately after the RF turns the IAS restriction is 250kts as per the UK standard below FL100.

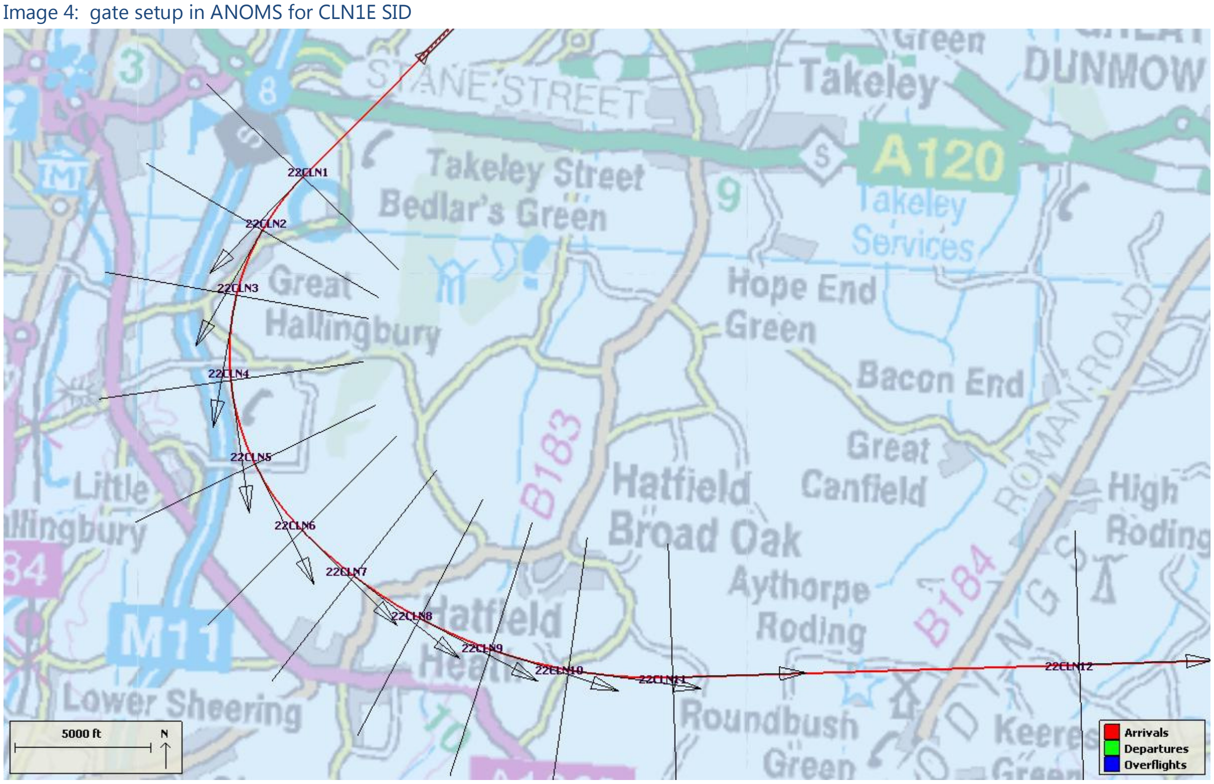
Image 3: CLN1E RNP1 (RF) SID design



A full diagram and encoding table of the CLN1E RNP1 (RF) SID can be found in Appendix B

The Airport's Noise and Track Keeping system ANOMS[2], was set up with a series of 'gates' centred on the designed RNP1 (RF) SID to analyse the height, speed and most importantly the lateral variation of the designed procedure as shown in image 4 below.

Image 4: gate setup in ANOMS for CLN1E SID



The first monitoring gate was at 4,700m from the Start of Roll (SOR), which correlated to the first waypoint forming the first of the RF arcs, as shown previously in image 3. A series of additional gates were placed at intervals around this first arc up to and including gate 6 at 9200m from SOR, which is located where the first RF arc ends and the second RF arc commences. Another series of gates are set around this second RF arc ending at gate 11 which is approximately 13,900m from SOR.

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[2] The accuracy of data within the ANOMS system can be found in the ERCD report 0906 http://www.caa.co.uk/docs/33/ERCD0906.pdf

Images 5 and 6 below show the 1333 operations that requested the CLN1E SID during the monitoring period May 2013 – November 2014.

Image 5: All CLN1E Operations May2013 – November 2014

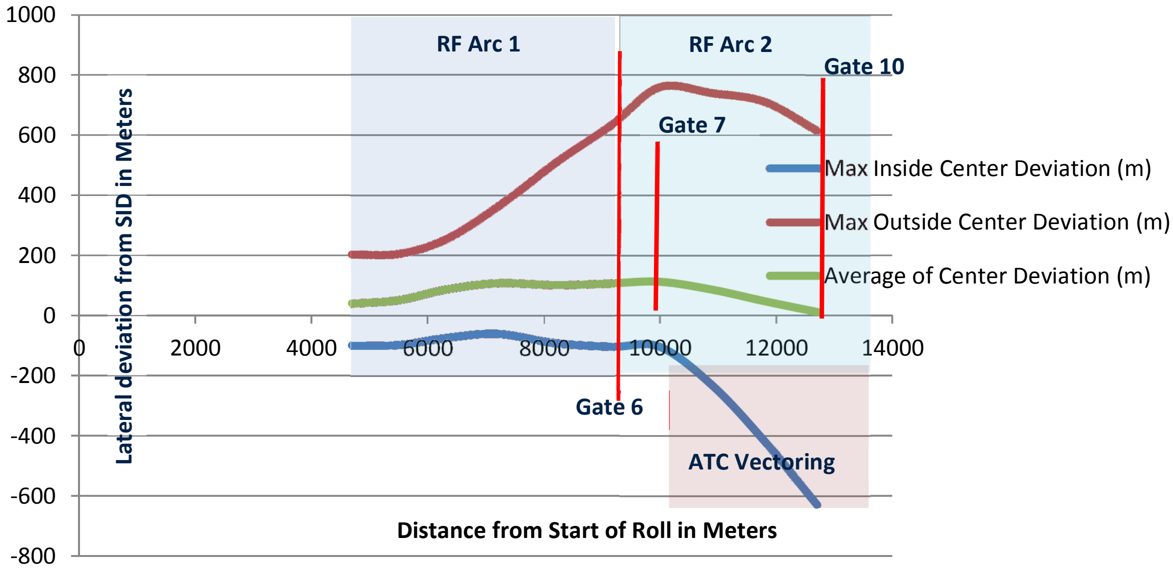
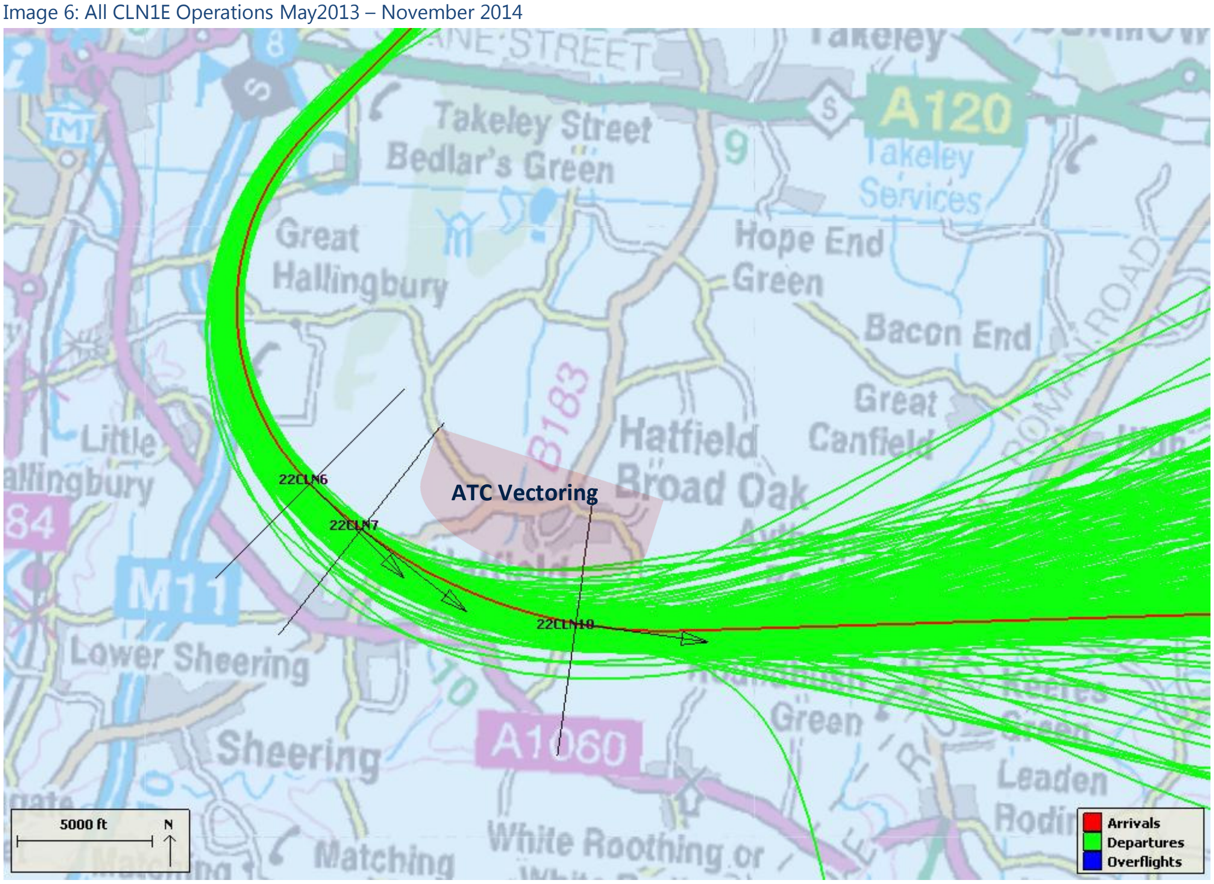


Image 6: All CLN1E Operations May2013 – November 2014



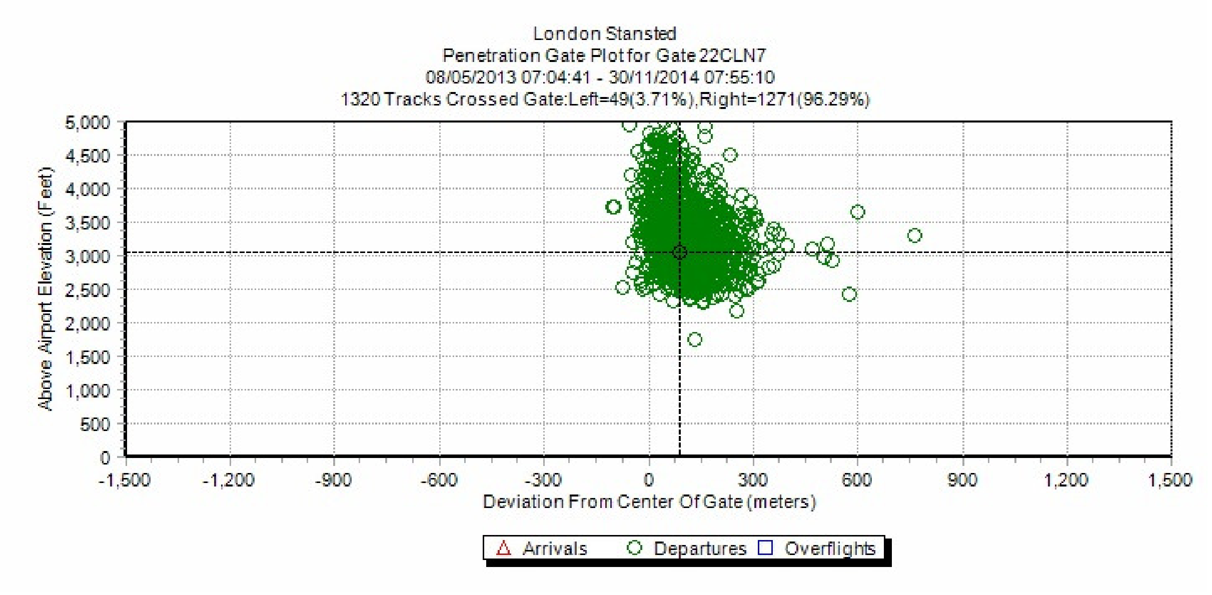
It is noticeable that beyond gate 7 at 10,000m from SOR there is a marked effect in the results with the deviation inside the SID growing from -104m to -629m which is due to vectoring by Air Traffic Control. At this distance from SOR , aircraft are usually above 4,000ft amsl and can be vectored on to a more direct heading to destination. This is where we would expect vectoring to commence irrespective of flying the RNP1 (RF) or the conventional SID.

As shown in Image 7 below, the maximum deviation recorded during the 18 months of monitoring was +760m at gate 7 (10,000m SOR). *This particular departure is detailed further in section 6 of this report.*

At this point along the SID where the largest deviation occurred and no apparent vectoring had influenced results, only 23 departures (1.7%) had exceeded +300m from the designed SID. Another 127 departures (9.5%) were within the range +200m to +300m from the designed SID. 1183 departures (88.8%) were within -104m to +199m of the designed SID at this monitoring point, a swathe of 303 meters wide.

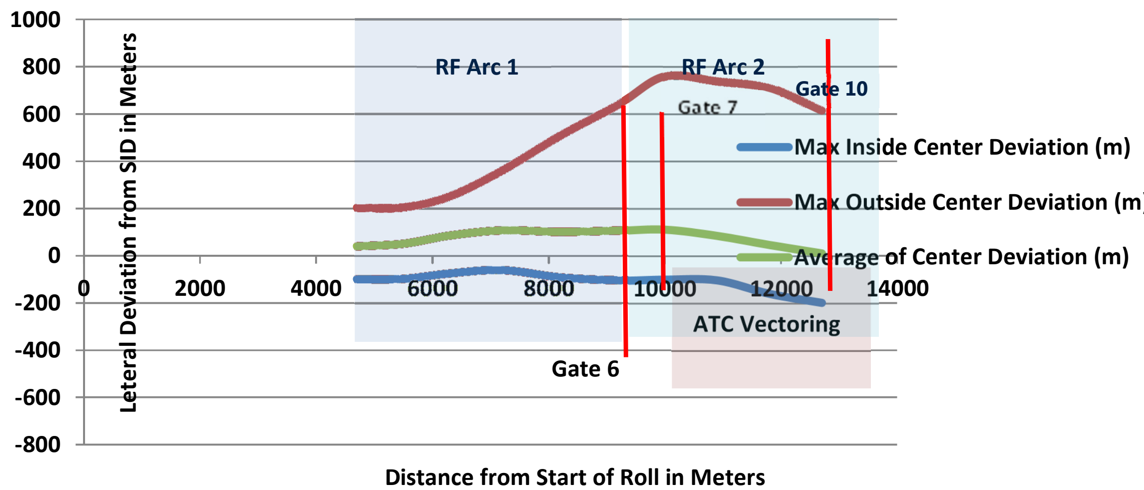
1310 departures (98.3 %) were between -104m to +300m; a swathe of 404 meters wide. The average deviation from the SID was also at its largest at this point at +112m.

Image 7: All CLN1E Operations May2013 – November 2014 Gate 7 penetration (13 aircraft exceeded 5,000ft at this point)



To better demonstrate the results, Image 8 below is shown with the most apparent ATC vectoring influences removed. It shows a marked improvement, as expected, towards the end of the second RF arc beyond monitoring gate 7. The data range now shows a deviation range inside the SID between -60m and now -197m at gate 10,the latter figure still influenced but to a lesser extent by ATC vectoring at gate 10.

Image 8: All CLN1E Operations May 2013 – November 2014



At gate 10, located at 12,700m SOR, the maximum deviation is shown at +615m from the SID. There were only 4 aircraft that now exceeded a deviation of +300m. Without vectoring, the results of the 1314 departures analysed now show that 1310 of departures (99.7%) were within the range -197m to + 293m of the designed SID at 12,700m SOR, a swathe of 490 meters. This is shown in Image 9 below. Within these figures there were 19 departures (1.4%) between +200m and +300m , leaving 1291 departures (98.2%) within -197m to +199m, a swathe of just 396 meters.

The gate penetration and location of gate 10 are shown in Images 9 and 10 below.

Image 9: All CLN1E Operations May2013 – November 2014 (without vectoring) Gate 10 Penetration.

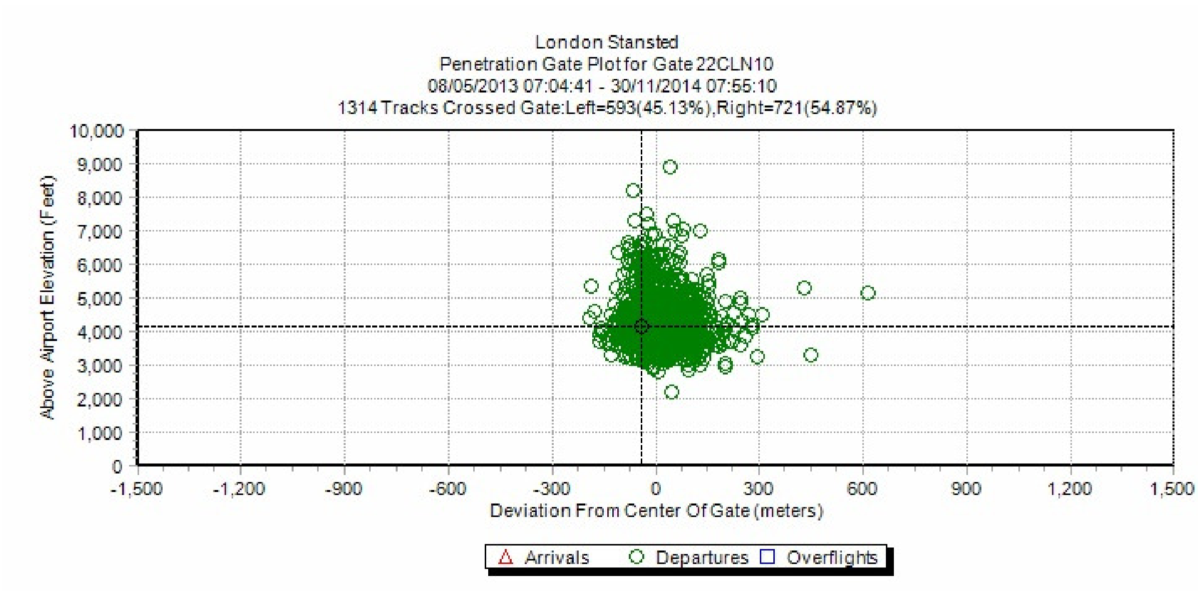
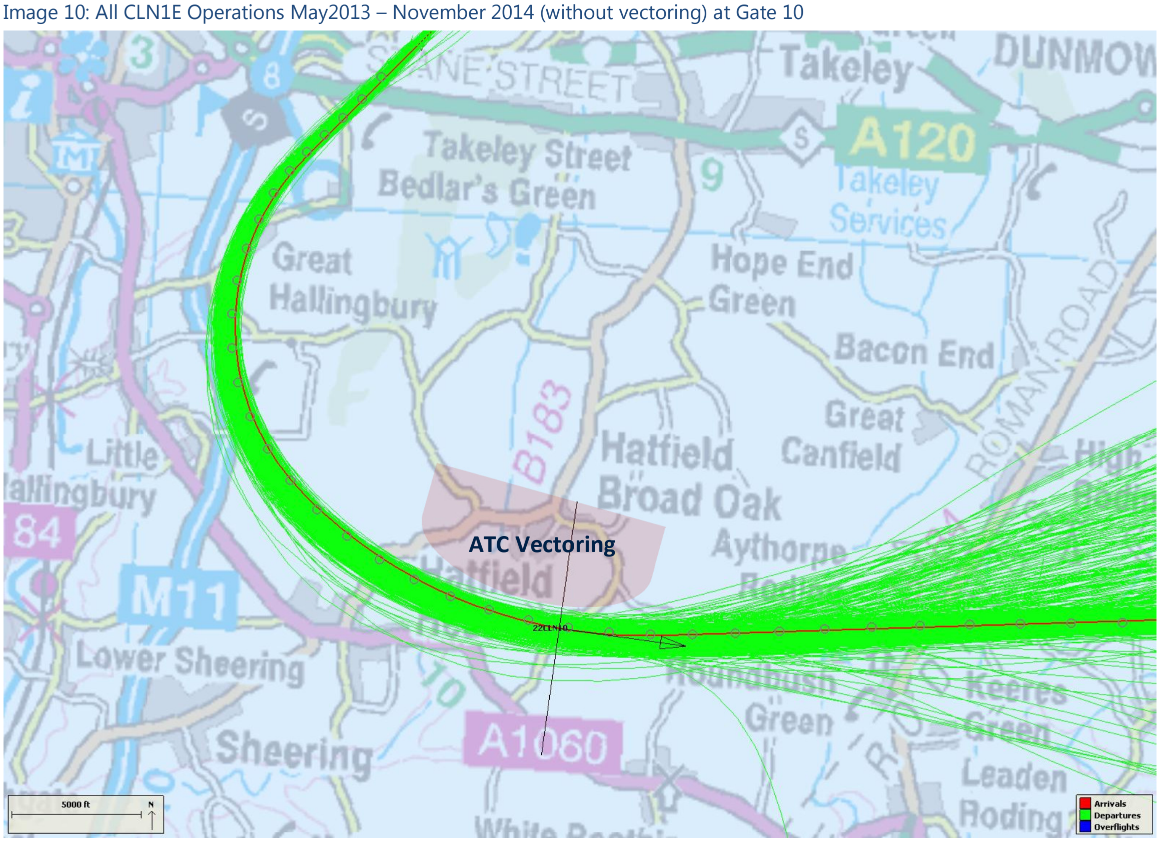


Image 10: All CLN1E Operations May2013 – November 2014 (without vectoring) at Gate 10

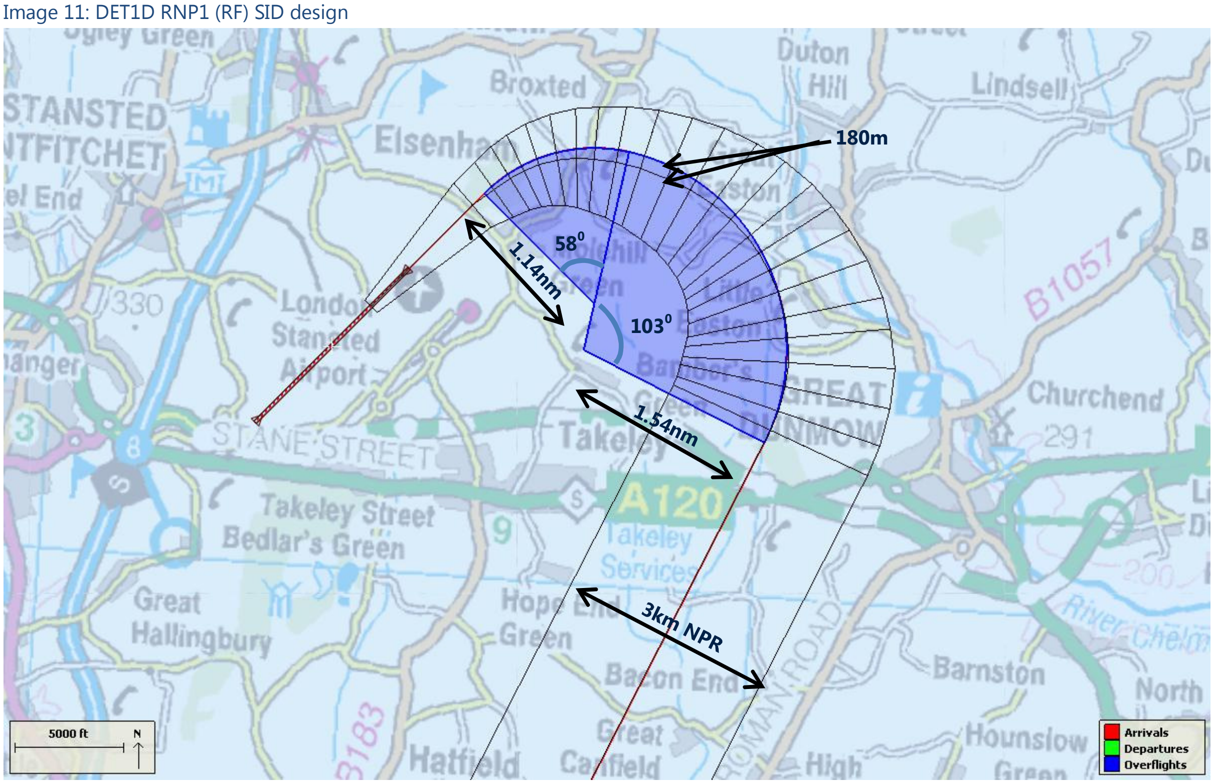


4. Detling 1D Design and Trial Results

The Detling 1D RNP1 (RF) SID was also designed with two RF arcs to better replicate the existing Detling 1S SID. The first arc was designed with a 58^0 turn with a radius of 1.14nm with the initial turn point set at 0.8DME. The second arc is a 103^0 turn with a 1.54nm radius.

The maximum distance between the RNP1 (RF) SID and the existing conventional SID is 180m, at the beginning of the second RF arc. The RNP1 (RF) SID was also designed with a 200kt IAS limit for the 2 RF turns to better enable track keeping compliance due to the tight turn at 0.8DME. Immediately after the second RF turn the IAS restriction is 250kts as per the UK standard below FL100.

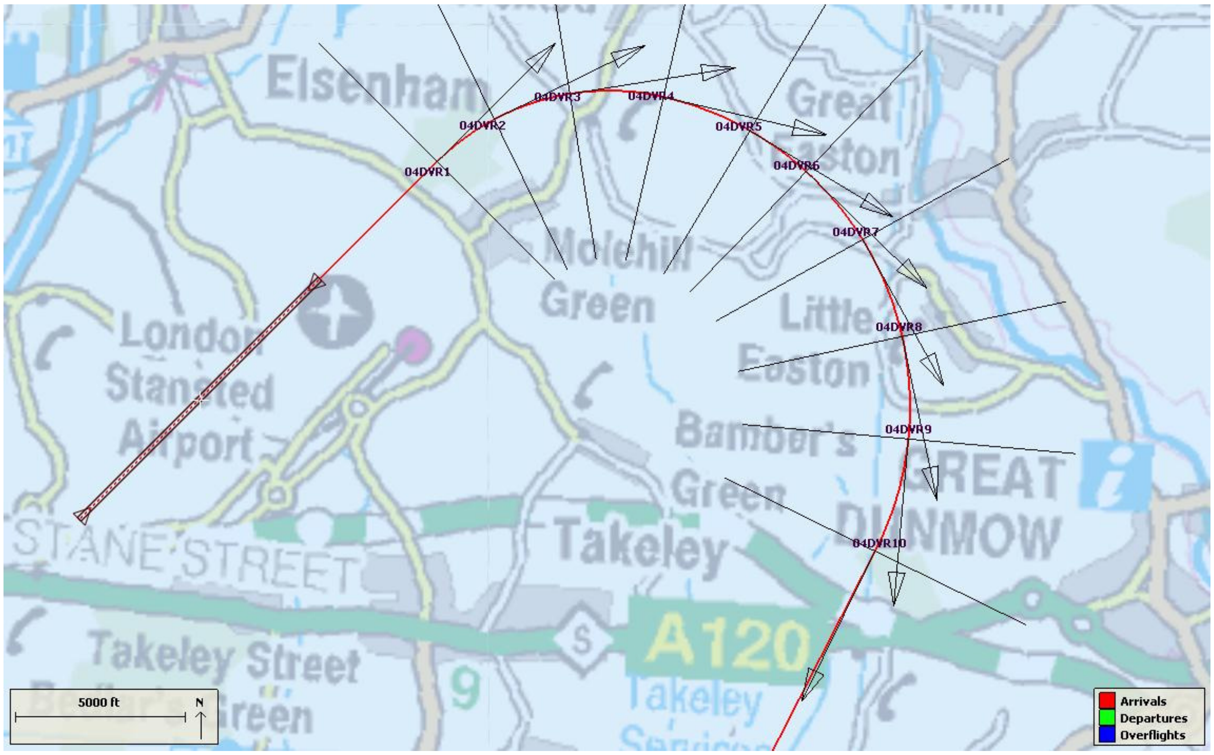
Image 11: DET1D RNP1 (RF) SID design



A full diagram and encoding table of the DET1D RNP1 (RF) SID can be found in Appendix C

Again, the Airport's Noise and Track Keeping System ANOMS, was set up with a series of 'gates' centred on the designed SID to analyse the height, speed and most importantly the lateral variation of the designed procedure as shown in Image 12 below.

Image 12: gate setup in ANOMS for DETID SID



The first monitoring gate was at 4,400m from the Start of Roll (SOR), which correlated to the first waypoint forming the first of the RF arcs, as shown previously in Image 11. A series of additional gates were placed at intervals around this first arc up to and including gate 4 at 6500m from SOR, which is located where the first RF arc ends and the second RF arc commences. Another series of gates are set around this second RF arc ending at gate 10 which is approximately 11,700 from SOR.

During the 18 months monitoring on which this report is based there were 763 departures on the DET1D RNP1 (RF) SID. 2 departures have been excluded for analysis purposes due to issues with the aircrafts FMS immediately after take-off, leaving 761 departures for reporting purposes.

These 2 departures are detailed further in section 6 of this report.

Images 13 and 14 show 761 of the 763 operations that requested the DET1D SID during the monitoring period May 2014 – November 2014.

Image 13: All DET1D Operations May 2013 – November 2014

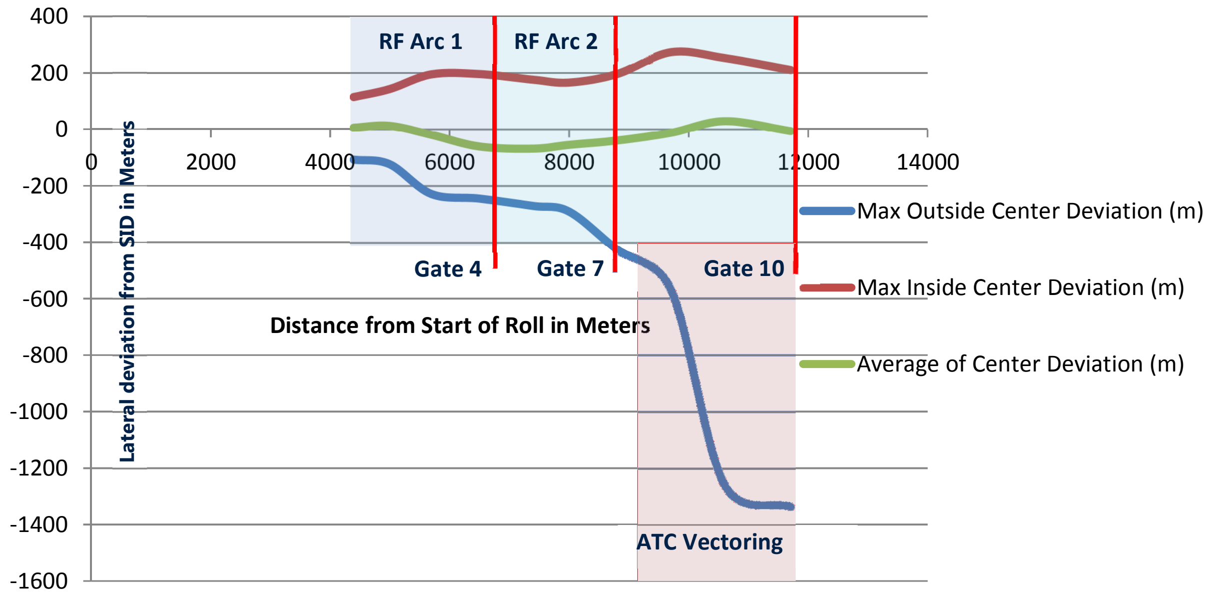
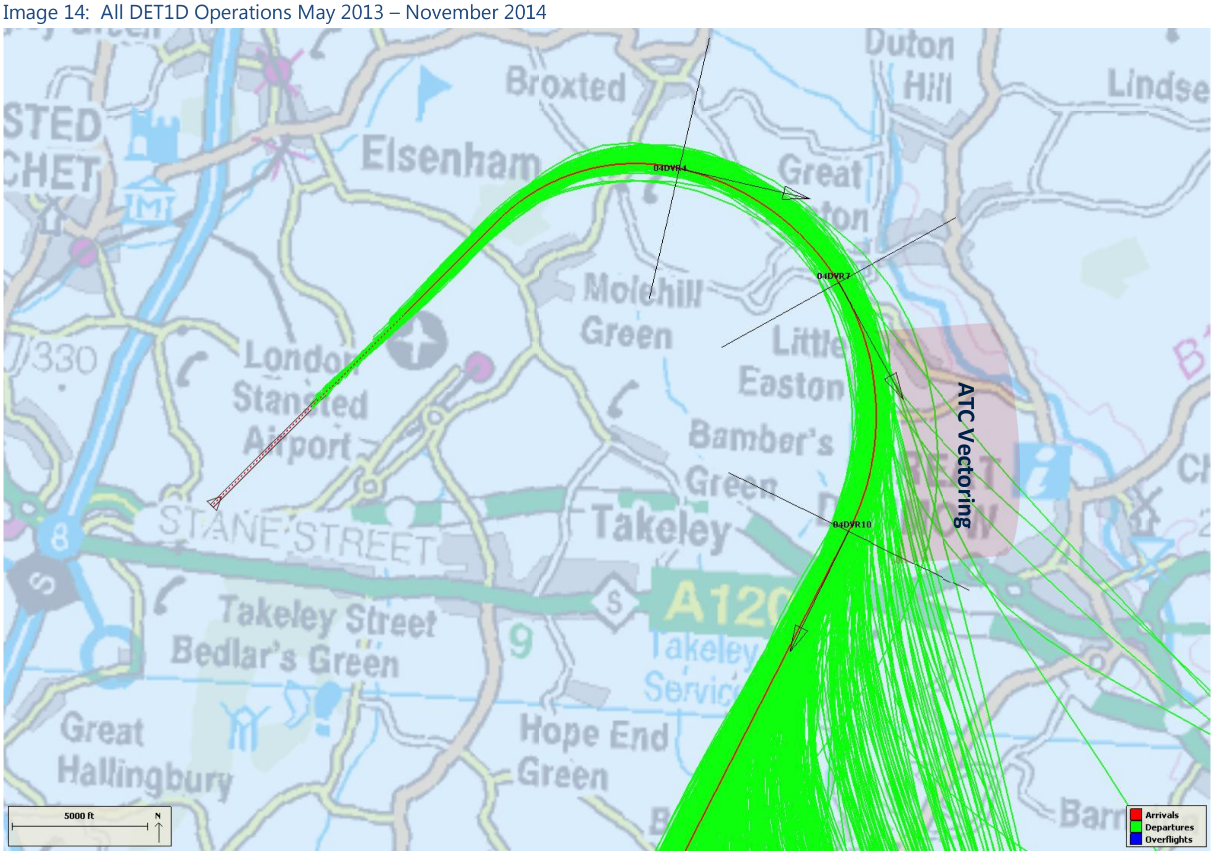
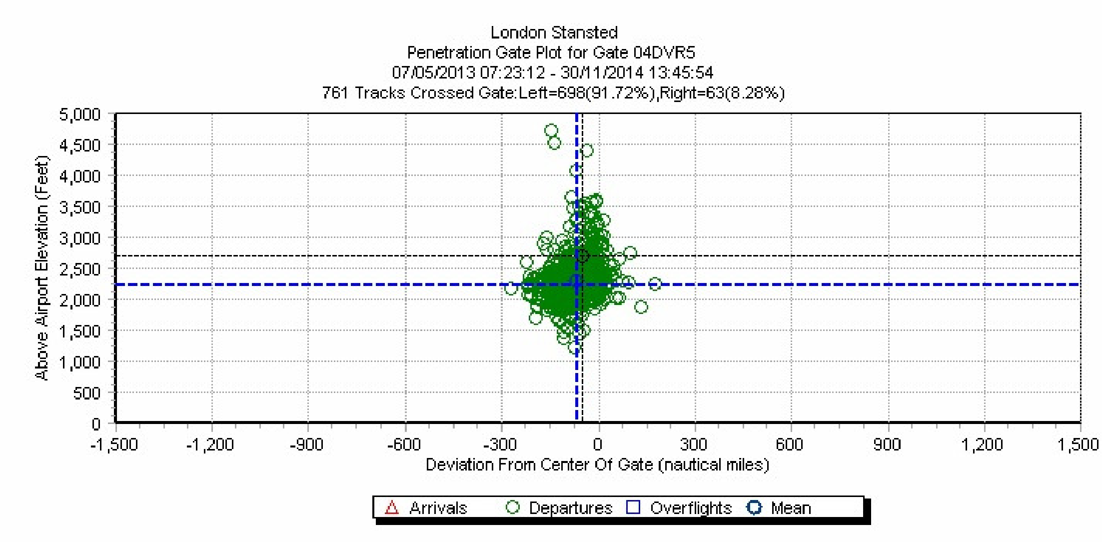


Image 14: All DET1D Operations May 2013 – November 2014



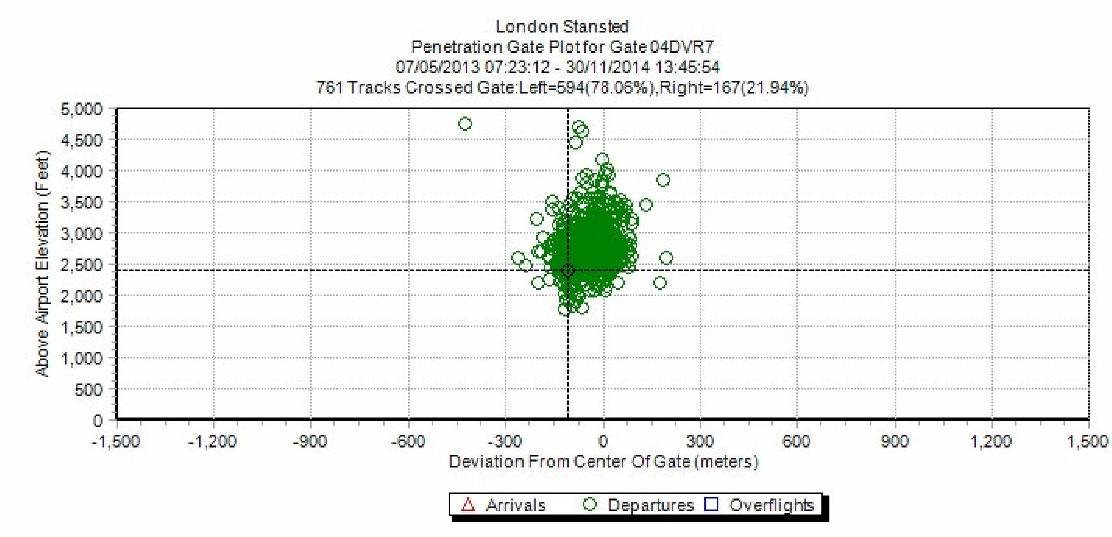
At gate 4, 6,500m from SOR, the track distribution ranged from +196m inside the turn of the designed SID to -244m to the outside of the designed SID, with the average deviation just -60m. There were only 2 departures that exceeded +100m, with the remaining 759 departures (99.7%) are contained within a swathe of 344 meters.
All 761 departures were contained within a swathe of 440 meters.

Image 15: All DET1D Operations May 2013 – November 2014 at Gate 4



At monitoring gate 7, at 8,800m SOR there remains a tight concentration of tracks, as shown in Image 16 below, with just one MD11 aircraft wide in the turn at -425m. *This departure is detailed further in section 6 of this report.*

Image 16: All DET1D Operations May 2013 – November 2014 at Gate 7

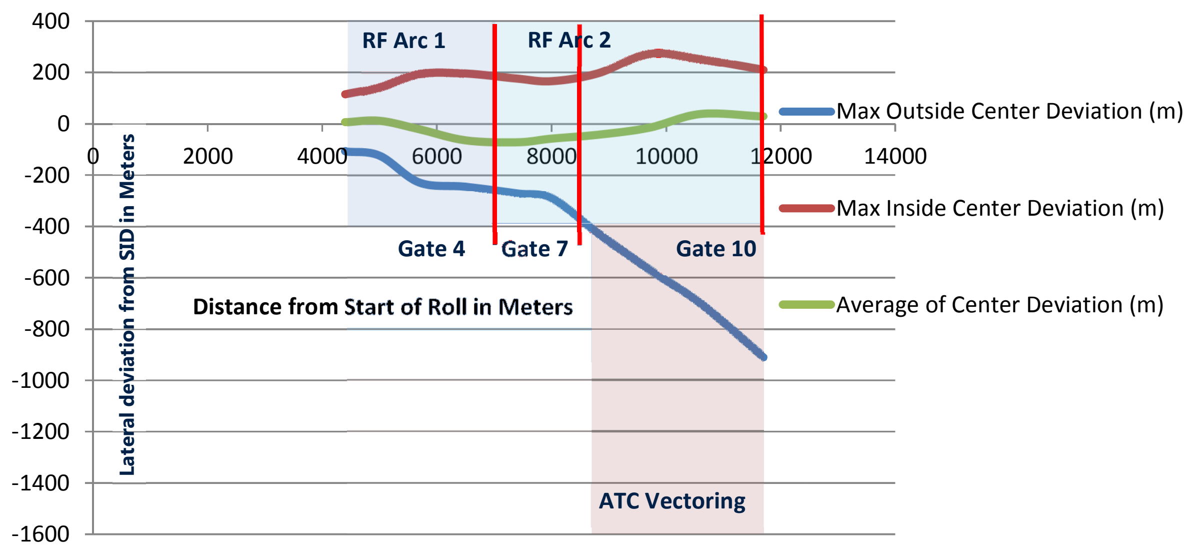


The other 760 departures (99.9%) are contained within -263m to +196m, a swathe of 459m. The average deviation at this point is just -68m from the designed SID.

Like the CLN1E SID there is noticeable vectoring, coincidentally, beyond monitoring gate 7 at 8,800m SOR which is approximately the mid-point of the 2nd RF Arc, as shown earlier in Image 14. Again, this is where we would expect vectoring to commence irrespective of flying the RNP1 (RF) or the conventional SID.

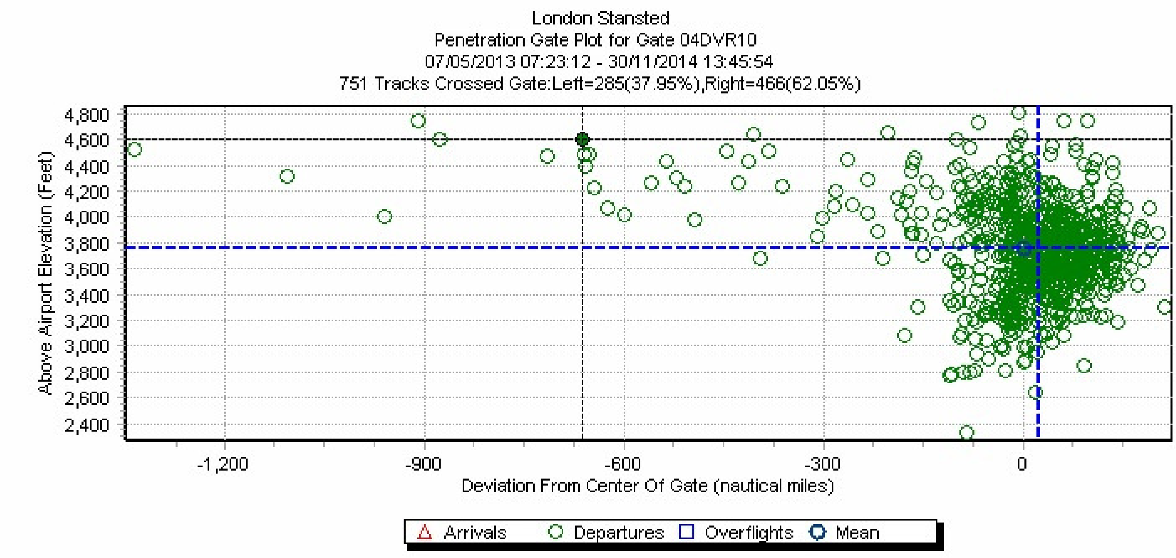
Whilst the results are no longer influenced by vectoring, the wide turning MD11 is still captured which has a significant effect on the results, but to a much lesser extent than vectoring, as shown in Image 17 below.

Image 17: All DET1D Operations May 2013 – November 2014 (without vectoring)



At the end of 2nd RF arc, at gate 10 which is 11,700m SOR, the gate penetration plot shows a wide distribution of aircraft tracks, as described earlier, influenced by the expected ATC vectoring, as aircraft are above the minimum 4,000amsl, and the single MD11 which was at -910m from the designed SID, as shown in Image 18.

Image 18: All DET1D Operations May 2013 – November 2014 with vectored aircraft



With ATC vectoring removed for analysis purposes the track distribution changes significantly, as shown in Images 19 and 20 below. The distribution of the tracks that penetrated gate 10 that were not vectored, and with the MD11 excluded which was at -910m, the track distribution of non-vectored departures was -204m to +210m, with an average deviation of +30m. This represents a swathe of just 414m for 689 departures, (99.8%).

Image 19: All DET1D Operations May 2013 – November 2014 (no vectoring)

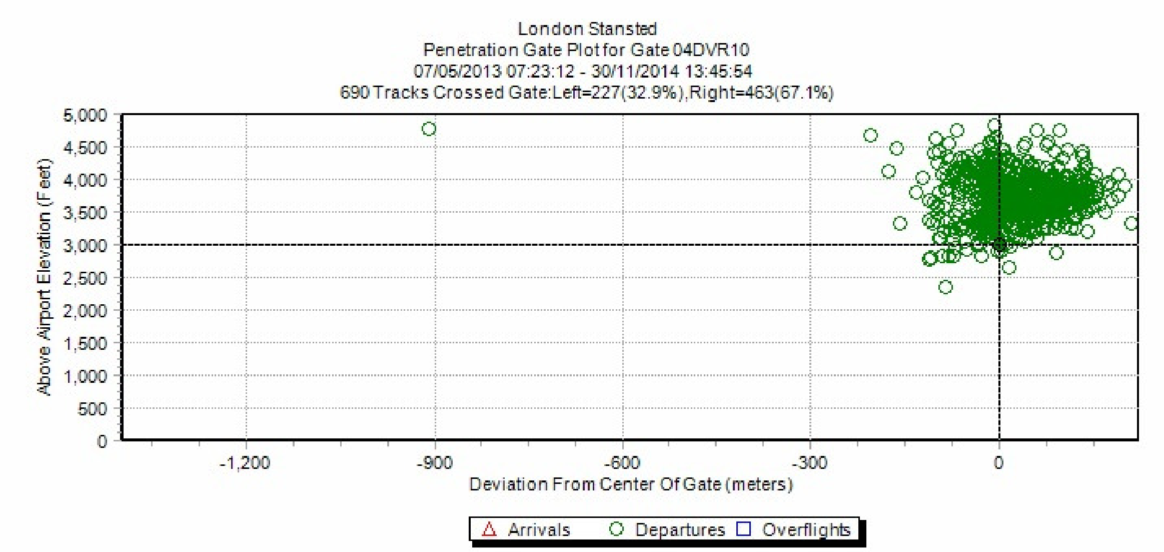
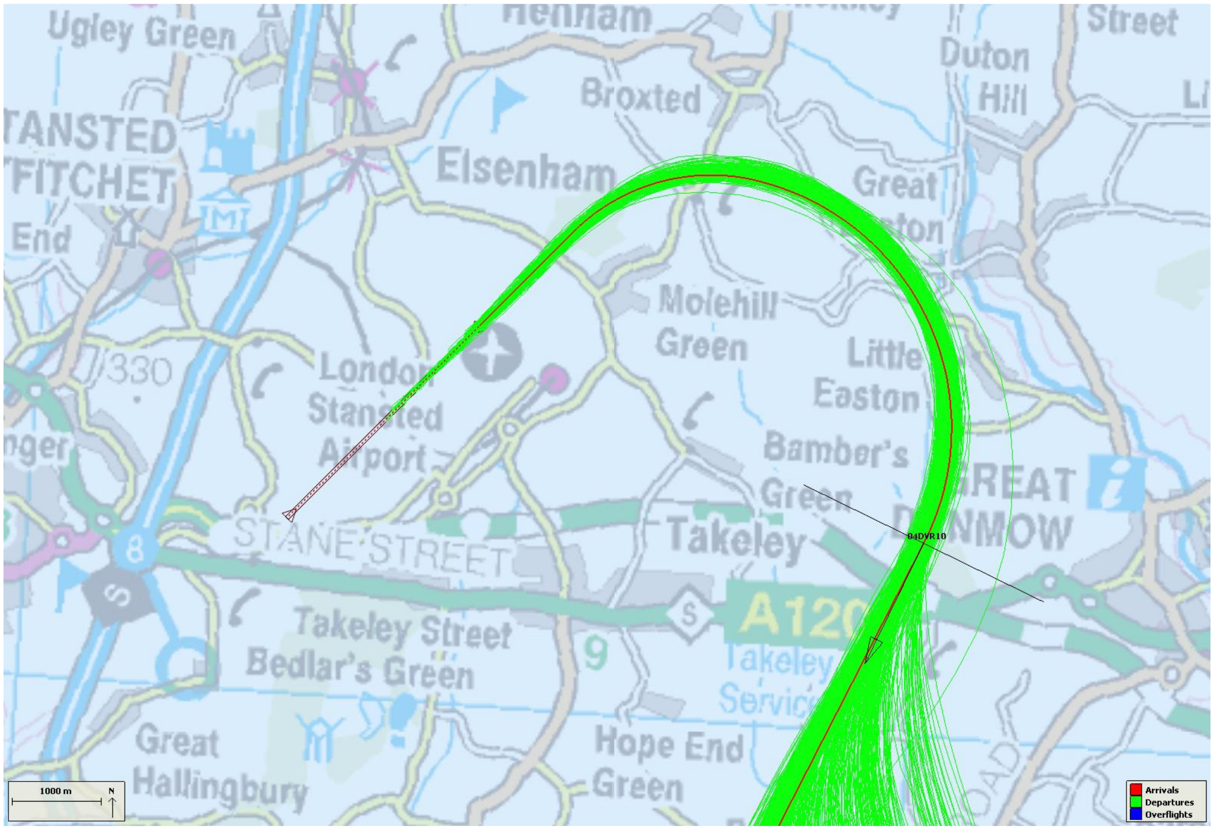


Image 20: All DET1D Operations May 2013 – November 2014 (no vectoring)



5. Wind Data

During the 18 month trial monitoring period the surface wind conditions are shown in the two images below. Image 21 shows the frequency and distribution of wind direction with Image 22 showing the average wind speed. The numbers of operations on each RNP1 (RF) SID and the wind data are in proportion to our usual 70% south-westerly to 30% north-easterly runway modal split.

Image 21: May 2013 – November 2014 wind direction and frequency

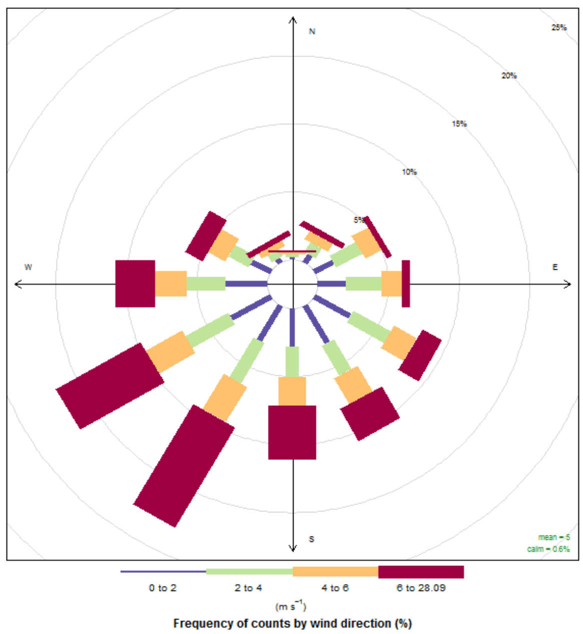
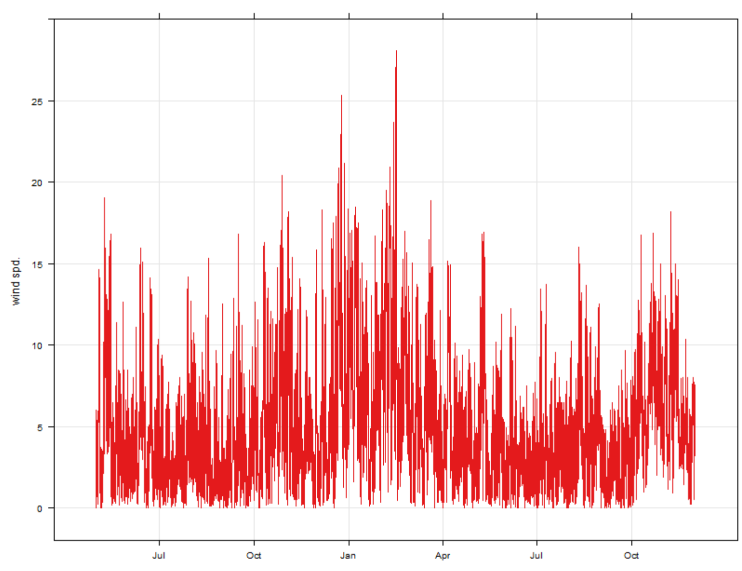


Image 22: May 2013 – November 2014 wind speed average per hour

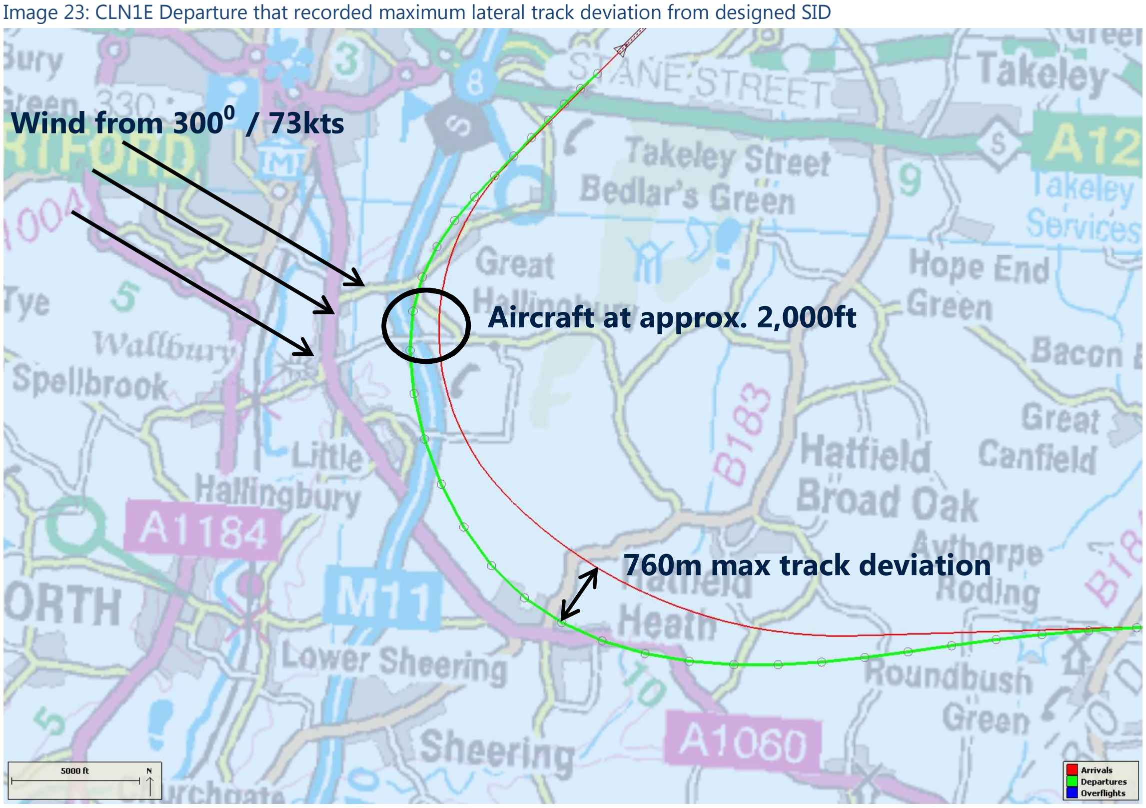


6. Specific Operations noted in Sections 3 & 4

In section 3 of this report, an operation was highlighted that was noticeably wider of the expected lateral flight track than had previously been observed. The operator was approached for feedback from the crew.
The feedback received was as follows; "*Captain said the 2000ft wind was about 300 degrees at 73kts so no doubt would have pushed it slightly wide. He said the biggest cross track error the plane said was 0.3 of a mile.*"

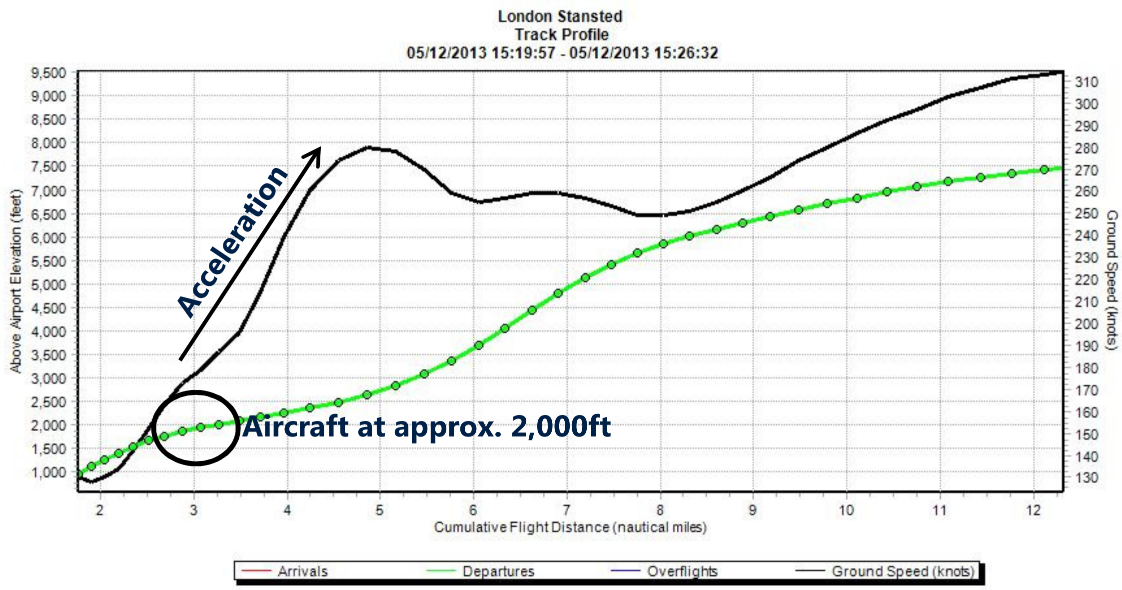
Image 23 below shows this specific departure in more detail. The maximum deviation from the designed SID was recorded in the ANOMS system at +760m. This would equate to a deviation of 0.41nm.

Image 23: CLN1E Departure that recorded maximum lateral track deviation from designed SID



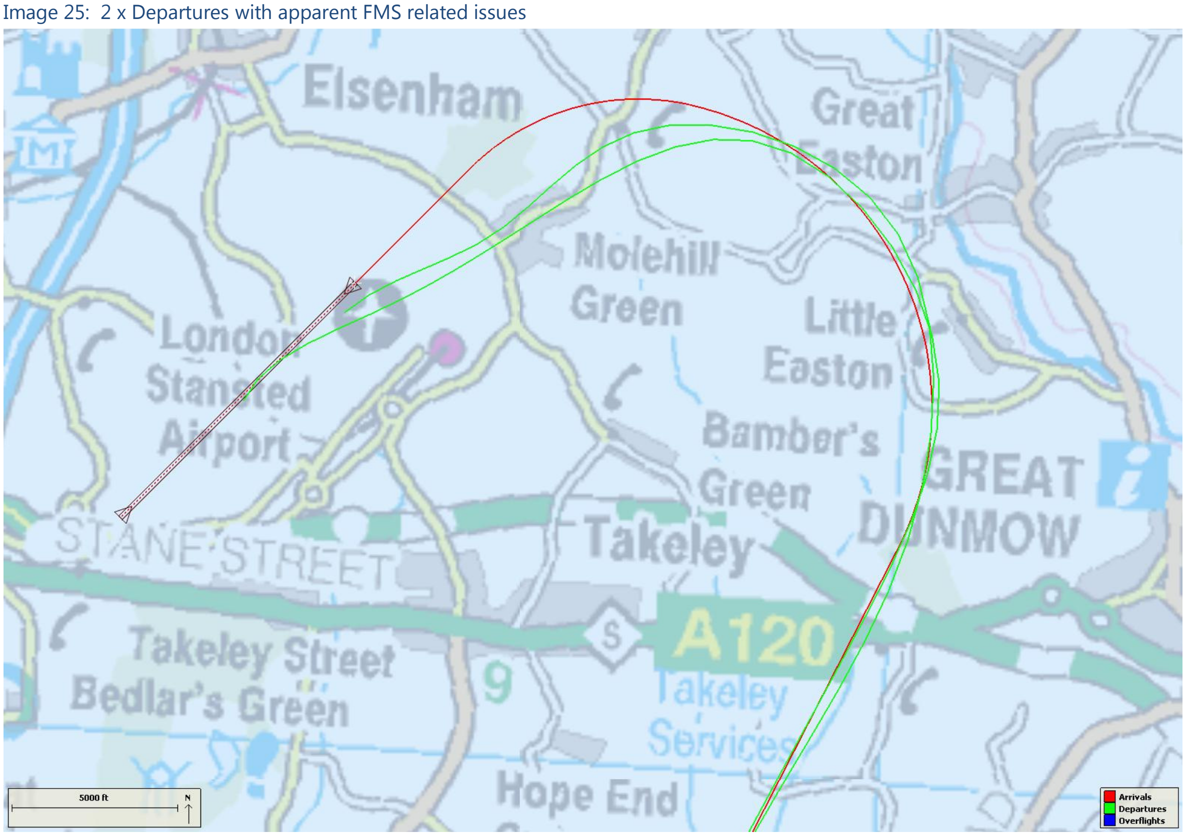
The rapid acceleration at 2,000ft as a result of 73kt wind from 300^{o} is shown in image 24.

Image 24: CLN1E Departure that recorded maximum lateral track deviation from designed RNP1 (RF) SID



The two aircraft that were excluded from the DET1D analysis are shown below in image 25.

Image 25: 2 x Departures with apparent FMS related issues

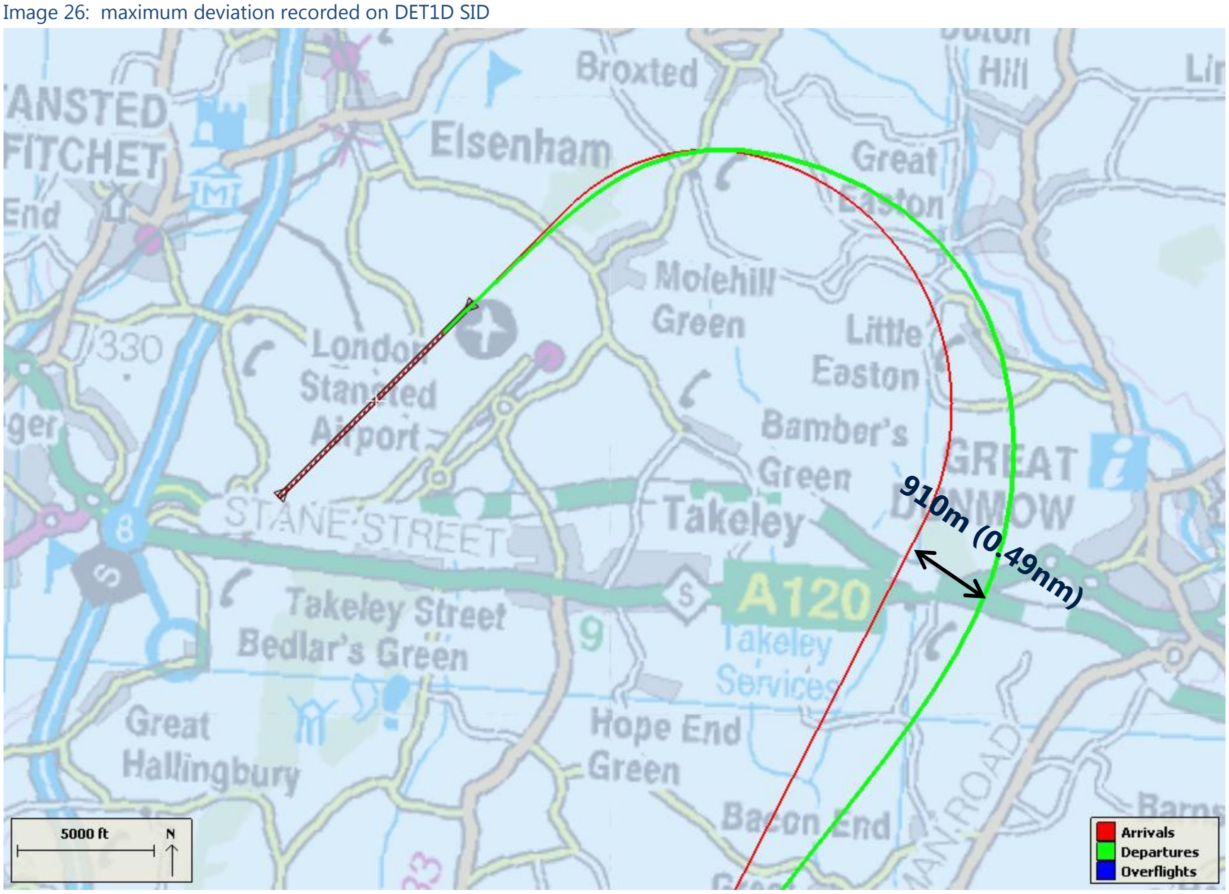


Comment received from the operator states *"Runway 04 was in use because of the moderate north-westerly winds, the crew decided to use the RNP1 SID DET1D, this being the first time that both flight crew members had flown these procedures. After a normal take-off sequence, the Pilot Flying followed the flight director bars in managed NAV mode during moderate cross winds. At a height of 300-500ft, the flight director bars ordered a slight right turn, although the SID chart states that there are no turns allowed below 850ft and the runway heading has to be followed to the first turn point (SSN01). In the meantime, the autoflight system was engaged at 0.28DME and the aircraft turned left to towards SSN01. At this time the ND showed an offset to the right of track even during stronger wind conditions. After the initiation of the planned turn overhead SSN01, the lateral departure profile was followed without any significant offset."*

It is worth noting that both aircraft shown in the image have operated the RNP1 (RF) SID on several other occasions without any issues. On those two occasions shown above ,they did in fact correct back onto the designed SID.

The MD11 noted in section 4 was the largest non-vectored deviation from the designed SID, recorded at 910m. This equates to 0.49nm, just within the +/- 0.5nm standard as shown in Image 26.

Image 26: maximum deviation recorded on DET1D SID



Feedback from the crew,

"We flew this SID the other night. Winds were out of the north west. Once airborne we remained .3-.7 nm downwind of the magenta line throughout the entire SID."

Once again, this aircraft flew the same SID 8 days later and mirrored the designed DET1D SID.

7. Summary

RNP1 (RF) departures have not been tested in UK airspace before this trial. The opportunity to conduct this trial has been welcomed by London Stansted Airport, NATS, operators that have regulatory RNP1 approval and the Airports Consultative Committee though the EIG. Along with the CAA-SARG, all have been proactive in providing advice though their areas of expertise where appropriate and fully supportive of the trial. Notably, NATS even upgraded an area of their EFPS system to better support some aircraft operators participating in this trial.

The results have shown a high degree of accuracy in terms of lateral track keeping when analysed against the designed RNP1 (RF) SID. It is clear that the benefits of RF turns as afforded by the RNP1 design prove to be extremely accurate and flyable, with in excess of 98%+ of operations contained within a swathe of just 400 meters. What is most noticeable about the design is how track keeping accuracy has been achieved with a wide range or aircraft types. Accurate track keeping has been demonstrated irrespective of aircraft size with aircraft from a Gulfstream GV(SP) G550 to a Boeing 747-8F operating on the RNP1 (RF) SIDs and also irrespective of FMS and database provider which has traditionally contributed to track variation with conventional SIDs .

The departures on the trial that did noticeably deviate from the concentrated majority were in the most part due to wind conditions, although still remaining within the +/-0.5nm tolerance, with the exception of two aircraft that had FMS issues.

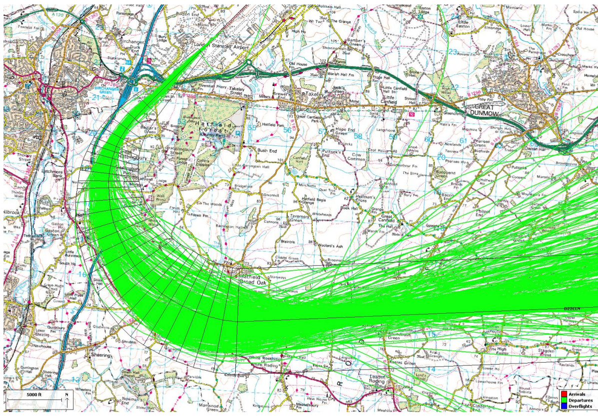
Historically, the 04 Detling departure route has proven to be the least compliant in terms of track keeping within the NPR due to its tight wraparound turn immediately after departure, but neither of the RNP1 (RF) SIDs have resulted in any track deviations from the 3km NPR.

The utilisation of RF turns in the SID design also better enable a Performance Based Navigation (PBN) replication of existing SIDs that could not otherwise be achieved through RNAV1 or conventional non PBN SIDs. We also belive the speed within the RNP1 (RF) designed SIDs is likely to have contributed significantly to track keeping accuracy.

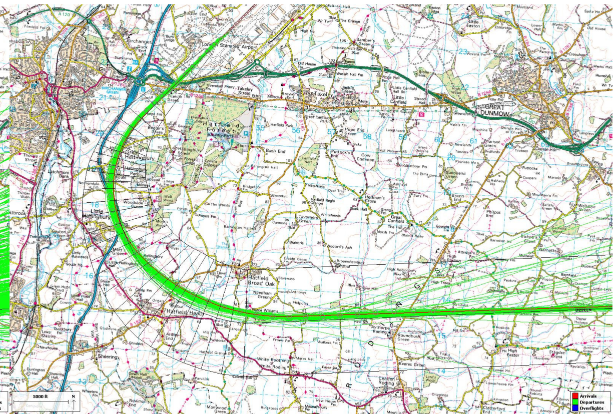
Reducing ATC vectoring would improve further still the concentration of lateral tracks of the trial RNP1 (RF) SIDs at lower height for a longer period of the departure.

Data from the trial suggests that the 22Clacton RNP1 (RF) SID non vectored track distribution at the end of the two RF turns is as low as 490m with a 99.7% certainty and 98.2% of aircraft within a 396m swathe, as shown in the images below.

Standard SID encoding track distribution 22Clacton

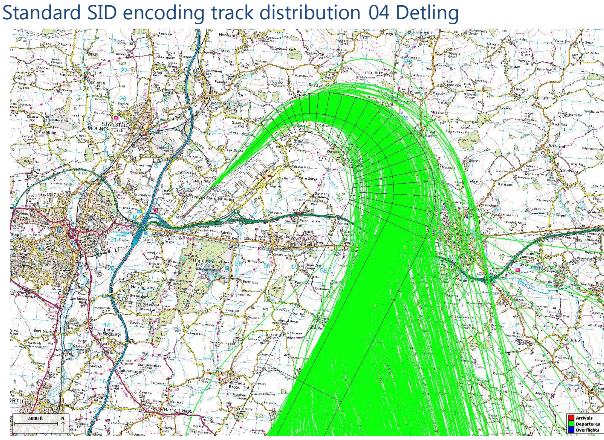


CLN1E RNP1 (RF) Departures

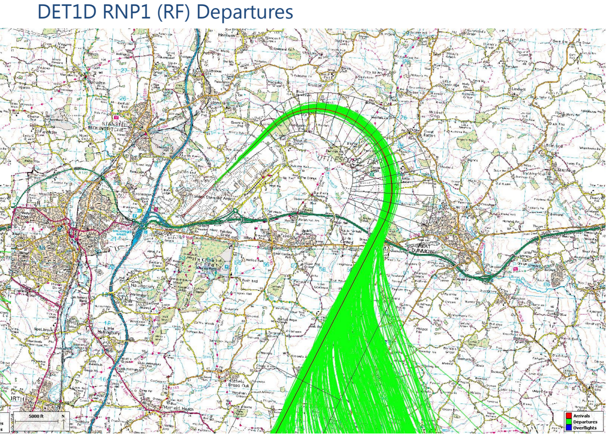


The 04 Detling data suggests 99.8% of aircraft that have not been vectored would be within a swathe of 414m.

Standard SID encoding track distribution 04 Detling



DET1D RNP1 (RF) Departures



As RNP1 regulatory approval and equipage for operators grows, the PBN operating environment will be enhanced significantly through RNP1 with RF turns.

The implementation of this technology should be encouraged to improve the safe operation of aircraft through increased navigational accuracy.
For an airport such as London Stansted, where it has been possible due to the relatively rurual location to design NPRs that avoid overflying larger areas of population, the benefits that RNP1 through the RF capability will enable us to reduce still further the impact of

aircraft noise. It can also significantly reduce the numbers of people currently overflown by reducing the width of the current NPRs and providing a high degree of certainty to the track keeping compliance of the designed SID.

Reducing the width of NPRs by utilising RNP1 with RF turns contributes significantly to the Governments stated Aviation Policy Framework[3] objective on aircraft noise which is "to limit and where possible reduce the number of people in the UK significantly affected by aircraft noise."

Once again, Stansted Airport would like to extend their thanks to the CAA- SARG, easyJet, NATS, other operators that have flown and supported the trial RNP1 SIDs and the Stansted Airport Consultative Committee through the Chairman of their Environmental Issues Group.

It has only been with the significant support from all those mentioned that this trial has been able to come to fruition.

[3] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/153776/aviation-policy-framework.pdf page 11

8. Additional Comments and Feedback

During the trial feedback has been sought from operators and community representatives.

"EasyJet has invested heavily in the most modern and technologically advanced aircraft fleet. These new aircraft are equipped with the latest avionics and navigation and the RNP1 trial has enabled us to fully utilise and benefit from this investment.
The track keeping accuracy achieved through the RNP1 trial shows clearly where the Aviation Industry can significantly reduce the impact of its operations. Having departures designed with the latest technology available should be embraced and easyJet are delighted to lead and assist in bringing this trial to an operational level through working collaboratively with the UK Regulator, NATS and Stansted Airport. We fully support the use of RNP1 procedures which share benefits with local communities and the aviation industry alike. EasyJet supports making these trial RNP1 procedures permanent"
Captain George Hutton

easyJet Base Captain and Pilot Manager - London Stansted Airport

"It has for many years been clear that modern aircraft navigation capabilities should be utilised to the full to route departing aircraft over areas of least disturbance to the communities surrounding Stansted Airport. My environmental committee has worked with the airport and the CAA, who in turn have worked with the airlines, resulting in two trial departures designed to modern standards. These have proved extremely successful in improving the accuracy of departing 'tracks' for those aircraft using the trial specification. It is our intention to replicate the process over all of the departure routes at Stansted over time. It has been a long, and sometimes pedestrian, process, but safety considerations and regulatory approvals all take their time. We hope we are now at the right stage for our local communities to benefit from the improvement that have been made."
Keith Artus,
Chairman - Environmental Issues Group of the Stansted Airport Consultative Committee

"For the RNP1 ops: We didn't get to try a lot of repetitions due to the routes we fly not being the ones that were issued the trial departures. However, feedback from those events that we did use was very positive. The RNP1 Ops worked extremely well for FedEx MD11s. These procedures are easy to load from the database which cuts down on pilot error, the airplane can maintain the designated track, and in the end that ensures compliance with the desired routing. We enthusiastically support the use of RNP1 procedures."
Captain Cynthia H. Berwyn

Manager, MD-11/10 Flight Training, FedEx.

"My feedback is RF is great, aircraft was very stable throughout the RF legs; we had no issues & please keep trial in place!! "

Captain Jonathan Bonds
Manager, Flight Safety, UPS

"We look forward to permanent RNP SID(s). Our 747 -8 aircraft use the RNP SID to the fullest extent. It has greatly enhanced track compliance; it is simple and transparent to the crews and it has mitigated tracking issues with earlier versions of our 747 -8 Flight Management Computer (FMC) software, which was problematic. The FMC issues have since been corrected. Our 747-400 aircraft will eventually have Next Generation FMC's installed whereby we will be able to take full advantage of RNP SIDs."

Atlas Air

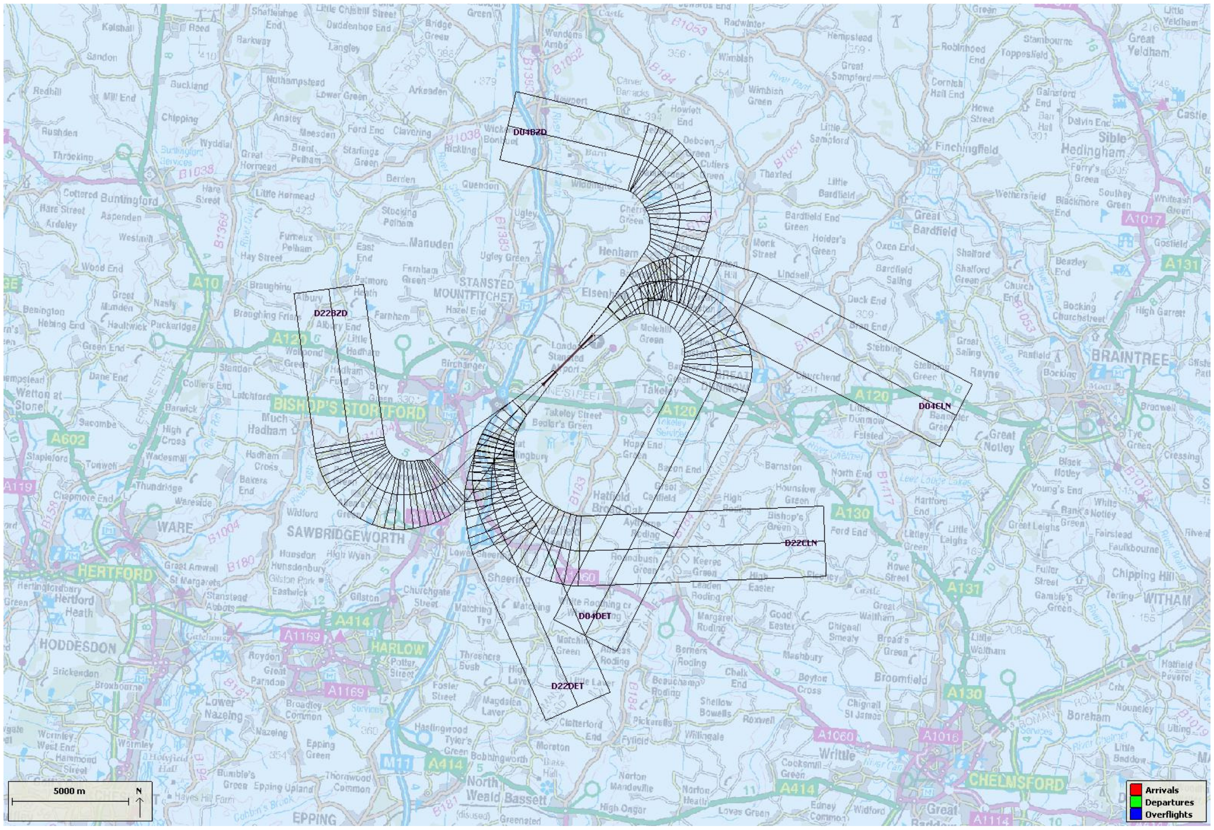
From Captain of the B 747-400/-8F fleet

"We at Fayair are encouraged by the time given to us by NATS to evaluate the RNP1 departures from London Stansted. When the opportunity has existed, we have found the RNP1 departures to be extremely accurate and this is borne out by the track depictions passed on to us each month. More RNAV/RNP1 arrivals and departures would enhance the safety and efficiency of aircraft operating within the Stansted airspace."

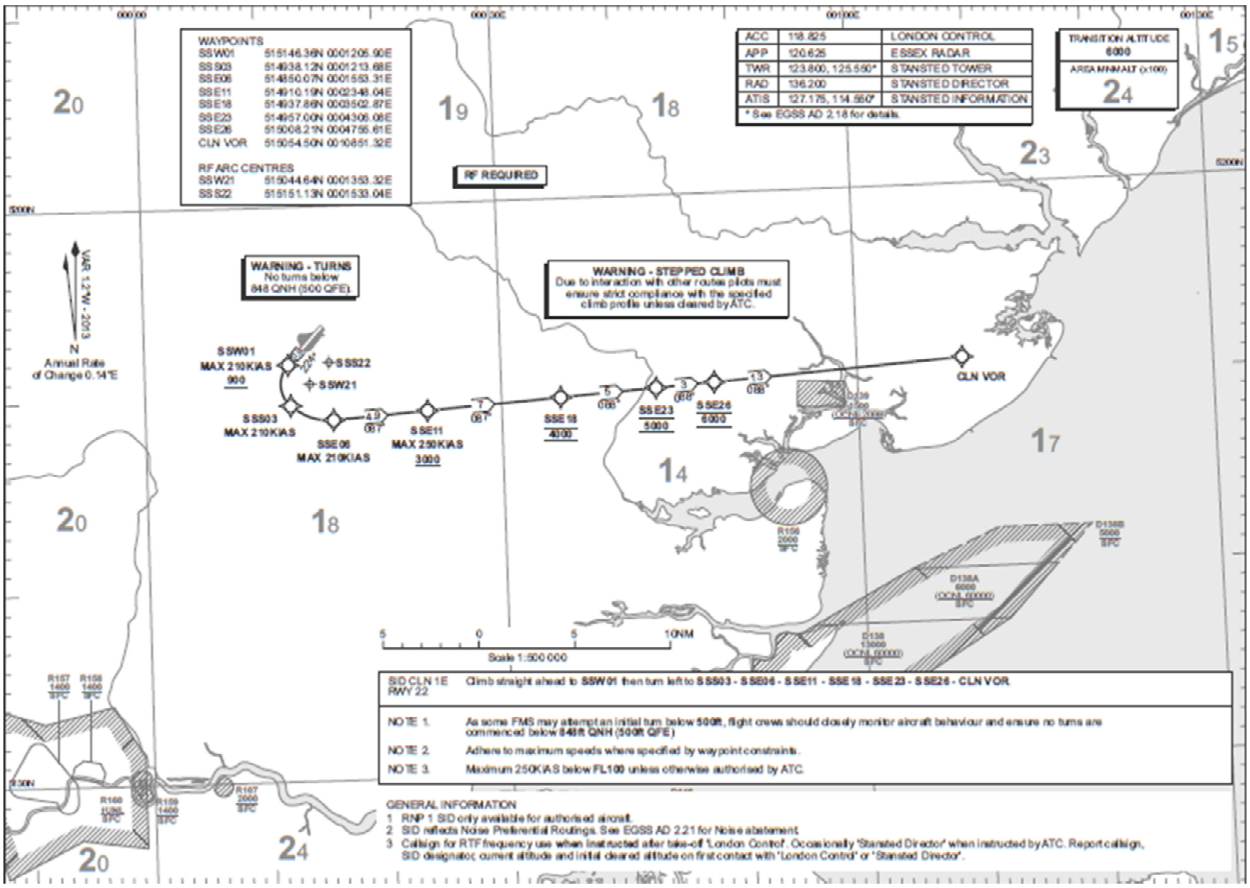
Laurence Printie

Fayair (Jersey) Co Limited

Appendix A: London Stansted Noise Preferential Routes



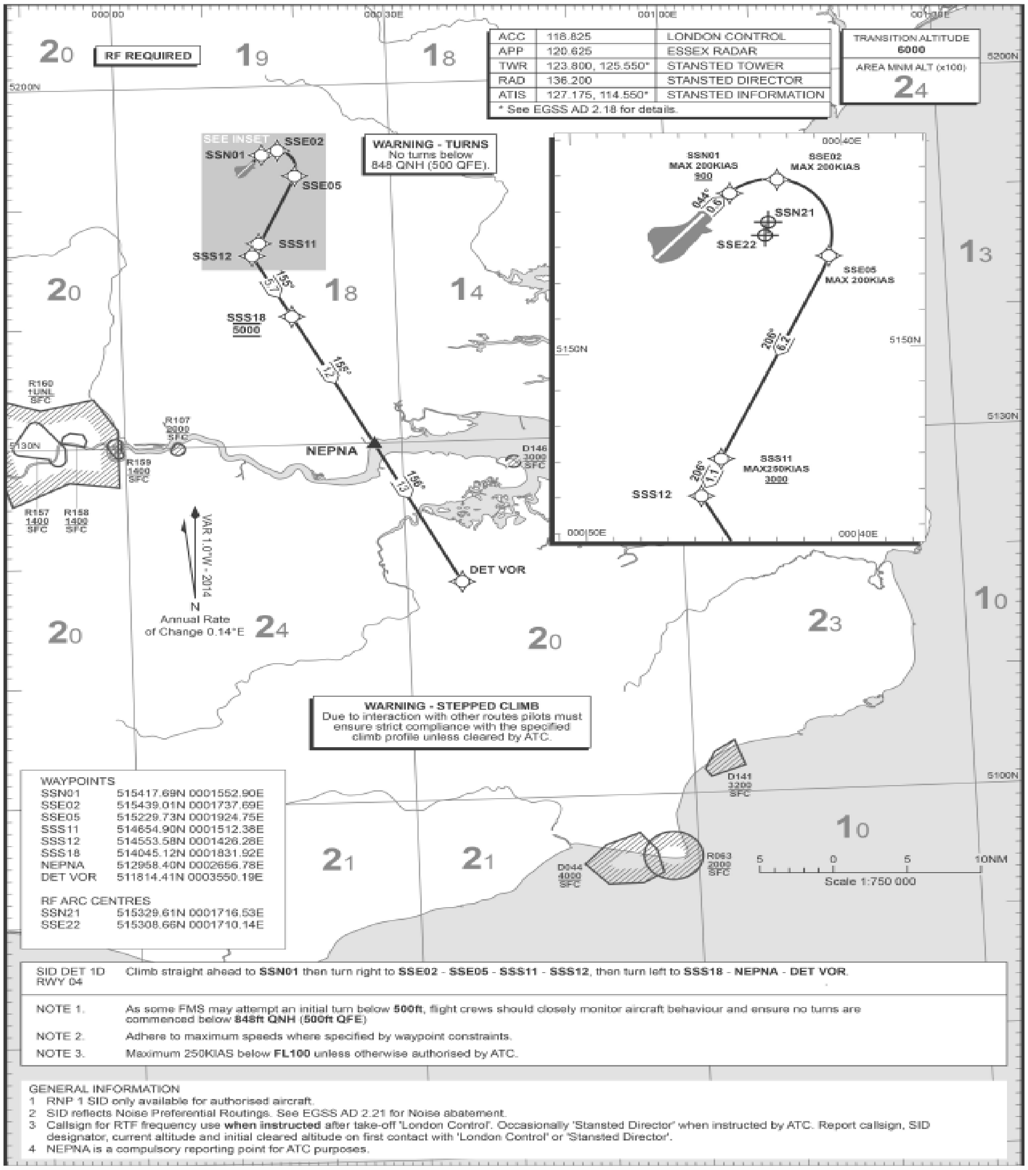
Appendix B: CLN1E RNP1 (RF) SID



London Stansted Runway 22 CLN 1E

Designator	Sequence Number	Path Terminator	Waypoint Name	Waypoint Co-ordinates	Arc Centre Name	Arc Centre Co-ordinates	Flyover	Course/ Track °M (°T)	Magnetic Variation	Distance (NM)	Turn Direction	Level Constraint	Speed Constraint (KT)	Navigation Performance
CLN 1E	001	CF	SSW01	515146.36N 0001205.90E	-	-	N	224° (222.9°)	1.2	0.9	-	+900	210	RNP 1
CLN 1E	002	RF	SSS03	514938.12N 0001213.68E	SSW21	515044.64N 0001353.32E	N	-	1.2	-	Left	-	210	RNP 1
CLN 1E	003	RF	SSE06	514850.07N 0001553.31E	SSS22	515151.13N 0001533.04E	N	-	1.2	-	Left	-	210	RNP 1
CLN 1E	004	TF	SSE11	514910.19N 0002348.04E	-	-	N	087° (086.0°)	1.2	4.9	-	+3000	250	RNP 1
CLN 1E	005	TF	SSE18	514937.86N 0003502.87E	-	-	N	087° (086.1°)	1.2	7.0	-	4000	250	RNP 1
CLN 1E	006	TF	SSE23	514957.00N 0004306.08E	-	-	N	088° (086.3°)	1.2	5.0	-	5000	250	RNP 1
CLN 1E	007	TF	SSE26	515008.21N 0004755.61E	-	-	N	088° (086.4°)	1.2	3.0	-	6000	250	RNP 1
CLN 1E	008	TF	CLN	515054.50N 0010851.32E	-	-	N	088° (086.5°)	1.2	13.0	-	-	250	RNP 1

Appendix C: DET1D RNP1 (RF) SID



London Stansted Runway 04 DET 1D

Designator	Sequence Number	Path Terminator	Waypoint Name	Waypo nt Co-ordinates	Arc Centre Name	Arc Centre Co-ordinates	Flyover	Course/ Track °M (°T)	Magnetic Variation	Distance (NM)	Turn Direction	Level Constraint	Speed Constraint (KT)	Navigation Performance
DET 1D	001	CF	SSN01	515417.69N 0001552.90E	-	-	N	044° (042.9°)	1.0	0.6	-	+900	200	RNP 1
DET 1D	002	RF	SSE02	515439.01N 0001737.69E	SSN21	515329.61N 0001716.53E	N	-	1.0	-	Right	-	200	RNP 1
DET 1D	003	RF	SSE05	515229.73N 0001924.75E	SSE22	515308.66N 0001710.14E	N	-	1.0	-	Right	-	200	RNP 1
DET 1D	004	TF	SSS11	514654.90N 0001512.38E	-	-	N	206° (205.1°)	1.0	6.2	-	+3000	250	RNP 1
DET 1D	005	TF	SSS12	514553.58N 0001426.28E	-	-	N	206° (205.0°)	1.0	1.1	Left	-	250	RNP 1
DET 1D	006	TF	SSS18	514045.12N 0001831.92E	-	-	N	155° (153.7°)	1.0	5.7	-	5000	250	RNP 1
DET 1D	007	TF	NEPNA	512958.40N 0002656.78E	-	-	N	155° (153.7°)	1.0	12.0	-	-	250	RNP 1
DET 1D	008	TF	DET	511814.41N 0003550.19E	-	-	N	156° (154.5°)	1.0	13.0	-	-	250	RNP 1

Appendix D: Aircraft Operators and Airframe Types by SID

CLN1E

Operator	Aircraft Type	Number of RNP Departures
easyJet	Airbus A319/320	939
Global Supply Systems	Boeing 747-8F	12
Fayair	Gulfstream GV(SP) G550	1
AltasAir	Boeing 747-8F	1
German Wings	Airbus A319/320	365
Pegasus	Boeing 737-800	3
UPS	Boeing 767-300F	12
Total		**1333**

DET1D

Operator	Aircraft Type	Number of RNP Departures
easyJet	Airbus A319/320	609
Global Supply Systems	Boeing 747-8F	1
Fayair	Gulfstream GV(SP) G550	8
AltasAir	Boeing 747-8F	17
German Wings	Airbus A319/320	93
Pegasus	Boeing 737-800	6
UPS	Boeing 767-300F	22
FEDEX	MD11F	5
Thomas Cook	Airbus A321	1
Bahrain Amiri Flight	Boeing 747-SP	1
Total		**763**

Appendix E: Dataset for CLN1E analysis

Data for all 1333 CLN1E operations

Gate	Distance from SOR(m)	Max Inside Centre Deviation (m)	Max Outside Centre Deviation (m)	Average of Centre Deviation (m)	Average of Height (ft.)	Average of Ground Speed (Kts)
22CLN1	4700	-99	203	40.30	1664.27	151.02
22CLN2	5500	-97	205	51.44	1906.64	165.20
22CLN3	6300	-74	252	86.25	2119.43	177.19
22CLN4	7200	-60	361	107.92	2372.91	191.02
22CLN5	8200	-91	509	101.55	2661.55	206.33
22CLN6	9200	-103	640	107.26	2964.75	219.29
22CLN7	10000	-104	760	112.12	3227.10	226.60
22CLN8	10900	-232	740	85.82	3525.63	231.07
22CLN9	11800	-418	711	47.34	3943.49	232.10
22CLN10	12700	-629	615	11.77	4312.61	232.65

Data for all CLN1E operations with vectored aircraft removed

Gate	Distance from SOR(m)	Max Inside Centre Deviation (m)	Max Outside Centre Deviation (m)	Average of Centre Deviation (m)	Average of Height (ft.)	Average of Ground Speed (Kts)
22CLN1	4700	-99	203	40.24	1660.99	151.06
22CLN2	5500	-97	205	51.60	1903.20	165.26
22CLN3	6300	-74	252	86.58	2115.51	177.25
22CLN4	7200	-60	361	108.38	2367.99	191.04
22CLN5	8200	-91	509	101.99	2655.73	206.35
22CLN6	9200	-103	640	107.77	2960.21	219.32
22CLN7	10000	-99	760	112.94	3222.47	226.63
22CLN8	10900	-102	740	87.23	3521.99	231.12
22CLN9	11800	-159	711	49.92	3937.88	232.09
22CLN10	12700	-197	615	15.92	4307.81	232.61

Appendix F: Dataset for DET1D analysis

Data for all 761 DET1D operations

Gate	Distance from SOR(m)	Max Outside Centre Deviation (m)	Max Inside Centre Deviation (m)	Average of Centre Deviation (m)	Average of Height (ft.)	Average of Ground Speed (Kts)
04DET1	4400	-107	115	6.73	1382.98	152.71
04DET2	5000	-123	143	13.29	1621.43	158.65
04DET3	5700	-228	195	-19.15	1832.92	166.61
04DET4	6500	-244	196	-60.60	2057.17	180.26
04DET5	7400	-270	176	-68.15	2287.94	197.22
04DET6	8000	-290	166	-54.75	2474.42	205.43
04DET7	8800	-425	196	-39.39	2732.07	207.59
04DET8	9700	-568	273	-11.90	3066.45	205.08
04DET9	10600	-1259	252	29.73	3404.82	209.51
04DET10	11700	-1335	210	-5.73	3756.71	219.25

Data for all DET1D operations with vectored aircraft removed

Gate	Distance from SOR(m)	Max Outside Centre Deviation (m)	Max Inside Centre Deviation (m)	Average of Centre Deviation (m)	Average of Height (ft.)	Average of Ground Speed (Kts)
04DET1	4400	-107	115	6.28	1357.77	152.86
04DET2	5000	-123	143	12.33	1594.75	158.85
04DET3	5700	-228	195	-20.95	1802.51	166.84
04DET4	6500	-244	196	-63.68	2021.38	180.30
04DET5	7400	-270	176	-71.33	2247.11	197.57
04DET6	8000	-290	166	-57.11	2438.47	206.14
04DET7	8800	-425	196	-42.24	2685.05	208.50
04DET8	9700	-568	273	-14.78	3019.33	205.05
04DET9	10600	-701	252	38.64	3362.00	208.71
04DET10	11700	-910	210	28.68	3722.05	218.49

Appendix G: Glossary of Terms

AMSL	Above Mean Sea Level
AIP	Aeronautical Information Publication
ANOMS	Airport Noise and Operations Monitoring System
ATC	Air Traffic Control
CAA	Civil Aviation Authority
CLN1E	Clacton 1 Echo – Clacton Trial Departure SID
CLN8R	Clacton 8 Romeo – conventional runway 22 Clacton SID
DET1D	Detling 1 Delta – Detling Trial Departure SID
DET1S	Detling 1 Sierra – conventional runway 04 Detling SID
DME	Distance Measuring Equipment
EFPS	Electronic Flight Progress Strip
EIG	Environmental Issues Group (sub group of STACC)
FL	Flight Level
FMS	Flight Management System
IAS	Indicated Air Speed
LTMA	London Terminal Manoeuvring Area
NADP	Noise Abatement Departure Procedures
NATS	NATS Services Limited (air navigation services provider)
NERL	NATS En Route Limited
NM	Nautical Mile
NPR	Noise Preferential route
PBN	Performance Based Navigation
RF	Radius to Fix
RNP1	Required Navigational Performance of 1nm
SARG	Safety and Airspace Regulation Group (formerly Directorate of Airspace Policy)
SID	Standard Instrument Departure
SOR	Start of Roll
STACC	Stansted Airport Consultative Committee
STAL	Stansted Airport Limited