Civil Aviation Authority

Report of the CAA's Post Implementation Review of the implementation of RNAV-1 Standard Instrument Departures at Gatwick Airport

Annex 6: CAA IFP Recommendations report

Annex 6 to CAP 1346

Published by the Civil Aviation Authority, 2015

The latest version of this document is available in electronic format at www.caa.co.uk

Contents

Contents 3

CAA IFP Recommendations report: Implementation of RNAV-1 SIDs at Gatwick Airport 4

The remit of the P-RNAV SID trial which commenced in 2007 4

PBN SID replication 4

Gatwick Trial P-RNAV SID Revisions 5

Technical Analysis and Design Recommendation of the Gatwick Airport Standard Instrument Departures (SIDs) 5

General 5

Review of Existing Conventional SIDs 6

Limitations of a SID trial 7

NPR compliance monitoring swathe compliance 7

Route 1 8

Route 2 9

Route 3 12

Route 4 16

Route 5 32

Route 6 35

Route 7 36

Route 8 42

Route 9 43

Appendix A

Gatwick Trial P-RNAV SID Revisions 44

CAA IFP Recommendations report: Implementation of RNAV-1 SIDs at Gatwick Airport

The remit of the P-RNAV SID trial which commenced in 2007

1 The SID trial related to four conventional SIDs that had been redesigned using P-RNAV design criteria. The P-RNAV SIDs were designed to replicate the nominal track of the conventional SIDs with the advantage of additional waypoints to assist with NPR compliance.

2 The four P-RNAV SIDs that were the subject of the trials were:

- Runway 26L CLN 8M (P-RNAV SID Designated CLN 2X) (one of the Route 4 SIDs)
- Runway 26L SAM 2M (P-RNAV SID Designated SAM 1X) (one of the Route 1 SIDs)
- Runway 08R SAM 3P (P-RNAV SID Designated SAM 2Z) (one of the Route 3 SIDs)
- Runway 08R SFD 8P (P-RNAV SID Designated SFD 2Z) (one of the Route 2 SIDs)

PBN SID replication

3 Note: Since the designs of the trial SIDs have been in use, and the full suite of RNAV-1 SIDs were subsequently implemented in November 2013, a Performance Based Navigation (PBN) SID replication policy has been developed and published on the CAA website: http://www.caa.co.uk/application.aspx?catid=33&pagetype=65&appid=11&mode=detail&id=5728 This policy states that the definition of a PBN SID replication is:

> "The design of an RNAV or RNP procedure that follows the path over the ground of the nominal tracks of the existing conventional procedure as closely as possible". *Note: it is the path over the ground of the designed conventional procedure and not the nominal centreline of the associated NPR or the current traffic concentration.*

4 Following the publication of the PBN SID replication policy, it was recognised that when replicating the track of certain departures, the replication may not reflect the historical track of the conventional SID.

5 In some circumstances circumstance magnetic variation has caused unintentional changes to conventional SID tracks flown compared to the nominal track of the conventional SIDs. Designing RNAV-1 SIDs to replicate the tracks currently flown on

the conventional SIDs could lead to a permanent and unintentional location of the nominal tracks of RNAV-1 SIDs. (See Route 4)

6 Therefore, when designing RNAV-1 SIDs, the design should reflect an RNAV design which produces a track over the ground which is as close as possible to the designed nominal track of the conventional SID.

Gatwick Trial P-RNAV SID Revisions

7 As part of the routine maintenance of instrument flight procedures, aerodrome obstacles surveys are required in order to ensure the data used to inform designs is accurate and up-to-date. Therefore when the trial of the P-RNAV SIDs was completed and prior to the SIDs being promulgated in the Aeronautical Information Publication (AIP), data from the 2012/13 Gatwick aerodrome obstacle surveys highlighted some anomalies associated with the elevation values for the departure end of Runway 26 and some new obstacles affecting the climb gradient. Consequently, the RNAV designs were modified to accommodate these revised criteria. In most cases this resulted in a minor change in climb gradients and consequently in vertical profile for the Runway 26 SIDs. This had little or no impact on the lateral parameter. Full detail of these changes and the rational for the chosen altitude constraints are explained in detail in Appendix A at the end of this report.

Technical Analysis and Design Recommendation of the Gatwick Airport Standard Instrument Departures (SIDs)

General

8 In the Gatwick Airport operating environment, the majority of the aircraft fleet are large air transport types with multi-sensor navigation systems with both GNSS and radio updating of aircraft position supplemented by Inertial Reference System (IRS).

9 It is noted that the conventional SIDs as published in the AIP are being flown by operators with the aid of an RNAV coded overlay. This is a navigation database coding that is not provided by the State and is where the normal RNAV design criteria rules are not necessarily applied when aiming to provide a replication of the conventional procedure which is then used as a navigational guidance tool for flight crew. Different operators are likely to be using different overlay coding versions depending which navigation database provider supplied the database and coding therein. This variation is likely to add to the spread of tracks when operators are cleared by ATC on a conventional departure. The parameters that can be varied in the coding are the use of waypoint type (i.e. Fly-over or Fly-by), waypoint position, path terminator and use of speed restriction any or all of which could be tailored for an individual operator or fleet type and FMS. Therefore any conventional procedure that is replicated using RNAV design criteria and a navigation database coding

provided by the CAA and published in the UK AIP will ultimately provide flight tracks that are in a more consistent and therefore concentrated swathe than that provided by the conventional equivalent SID.

10 While it is commonly understood that different speeds have an effect on the procedure track flown, it must also be appreciated that the impact of this variation in speed depends on whether the procedure is conventional or an RNAV 1 SID. On the initial departure an aircraft is still accelerating towards the published maximum speed constraint of 220 KIAS. In the conventional SID, where the turn is predicated on a fix defined by a DME distance, the aircraft speed has no bearing on where the aircraft will commence the turn – it will turn at the DME distance. But in the RNAV-1 SID case, the turn is predicated on the placement of a Fly-by waypoint. With the aircraft speed less than the maximum constraint of 220 KIAS the aircraft will be closer to the turning waypoint before the turn is commenced than if it were at the maximum speed based on the turn anticipation logic. Therefore the ground track can be quite different between the conventional and RNAV 1 SIDs, even though the RNAV 1 procedure is a nominal replication of the conventional design using PBN design criteria. An example of this can be seen in the Route 4 analysis below.

11 Further information on Waypoint types and Sequencing can be found in CAA's PIR Operational and Technical report at paragraph 19 et seq.

Review of Existing Conventional SIDs

12 During the SID analysis of both the RNAV 1 and conventional SIDs it has become apparent that the lack of speed constraints other than a generic max 250 KIAS below FL100 on the conventional SIDs is a cause of deviation from the nominal track of the conventional SID (and on occasions even from the 3km wide NPR compliance monitoring swathe.

13 In the UK the CAA has implemented an ICAO requirement where all IFPs published in the UK AIP are required to be reviewed on a 5 yearly basis. This review is where the procedure design criteria, obstacles data, altitude and speed restriction, magnetic variations data, noise abatement and airspace containment requirements and any other operational requirements are assessed and the outcome incorporated into the design to ensure the IFP continues to be fit for purpose.

14 This 5 year periodic review is now overdue at Gatwick. CAA IFP's recommendations include that this must be carried out on all conventional SID routes, see detailed recommendations below.

15 On completion of this ACP process, including conclusion of the PIR, the PIR requirements below, and CAA's subsequent analysis of Gatwick's actions in response to those, the CAA may suggest that Gatwick propose to CAA it withdraw all conventional SIDs.

Limitations of a SID trial

16 In order to assess the flyability of instrument flight procedures (IFP) the CAA allows a process known as a “trial” where a new IFP is trialled by a number of aircraft types under controlled conditions and the results assessed. A trial can be used to provide comprehensive flight validation data but by its very nature that the number of aircraft participating in the trial is limited and being conducted for a fixed period of time it cannot be guaranteed that all issues that may impact an IFP will be captured. As the number of aircraft that participated in the Gatwick trials was small compared to the total number of aircraft departing from Gatwick on a daily basis, the trial had limited ability to collect large amounts of data.

NPR compliance monitoring swathe compliance

17 Other than as indicated in Column 3 of the tables below, all RNAV-1 SIDs are contained within that Route’s associated NPR compliance monitoring swathe.

18 The term “ballooning” as used in this document refers to where the track flown by an aircraft in a turn deviates from the expected l track. A method of reducing this issue is to reduce the maximum speed allowed to be used in the turn and maintain this speed until the turn has been completed and the aircraft is established onto the next track. This can be achieved by reducing the speed restriction at a waypoint in the turn and the next waypoint after the turn. The impact of “ballooning” can be seen during the analysis of the routes.

19 The following is an assessment of the Gatwick RNAV 1 SIDs and a summary of IFP’s recommendations to CAA is presented by Route rather than by individual SID. The analysis includes comparison between data gathered from the conventional aircraft tracks (flown using a coded overlay), P-RNAV trial aircraft tracks and RNAV 1 SIDs aircraft tracks. Data from the CAA’s PIR Route Analysis report and PIR Environmental Analysis report used to reach the conclusions identified in this IFP Recommendations report are listed in column (2) below. Column (7) presents the recommendations after analysis and extensive discussions.

Route 1

(1) Route No.	(2) SID/Data used during analysis	(3) Issue	(4) Initial Options from SARG IFP For PIRG to Consider	(5) Impact of Issue & Initial Options	(6) Outcome of PIRG Final Review of Route Issues & SARG IFP Options	(7) SARG IFP Recommendations
1	Rwy 26 SAM 26SAM Altitude Bands. & Density Ppttx	The concentrations of flight tracks into a narrower swathe can be seen with the RNAV 1 SID as compared to the conventional SIDs. The track and NPR adherence is what was expected.	No changes recommended.	N/A	Accepted - no design change required.	RNAV 1 SID is a satisfactory replication. No modification recommended.

Route 2

(1) Route No.	(2) SID/Data used during analysis	(3) Issue	(4) Initial Options from SARG IFP For PIRG to Consider	(5) Impact of Issue & Initial Options	(6) Outcome of PIRG Final Review of Route Issues & SARG IFP Options	(7) SARG IFP Recommendations
2	Rwy 08 SFD 08SFD Altitude Bands. & Density Ppttx ERCD 08SFD Speed _ Data+	The concentrations of flight tracks into a narrower swathe can be seen with the RNAV 1 SID as compared to the conventional SIDs. The core of the RNAV 1 flight track swathe is slightly east of the NPR but well within the NPR swathe. This is very likely to be speed related where the turn at KKE03 is commencing closer to the WP than had been anticipated.	1. The max 220 KIAS speed restriction could remain until KKS08 to help prevent the speed acceleration in the turn resulting in a wider turn at KKE03. The slight ballooning of the a/c as it sequences KKE03 could be reduced by applying a max 220KIAS speed constraint to KKS08. The max 250KIAS speed constraint should then be applied to KKS12. This is allowing the a/c as it sequences KKS08 to accelerate to max 250KIAS. 2. Similarly applying a max 220KIAS speed constraint to	1. Chart and coding table to be amended to amend the speed constraints at KKS08. ERCD to gather ground speed data around turn at KKE03 and provide 'gate' analysis to SARG IFP. SARG IFP to analyse data to determine compliance with NPR swathe before and after RNAV design implemented. SARG IFP to determine whether a	1. The analysis of the ERCD gate speed data provided evidence that the average speed before KKE03 was 203Kts and 263Kts after KKE03. This indicates that aircraft are accelerating in the turn at KKE03 which is confirmed with the slight "ballooning" in the turn. Therefore the track keeping around the first turn at KKE03 could be improved with a speed restriction of 220KIAS max applied to the following waypoint at KKS08. This would prevent the potential for some 'ballooning' of some aircraft types during the turn and would be consistent with speed restrictions applied on other SIDs with similar turning characteristics. 2. If the conventional SID is to be	RNAV 1 SID is a satisfactory replication but could be improved by applying the following options: 1. In the RNAV 1 SID applying a max 220KIAS speed constraint to KKS08 and 250KIAS to KKS12 would minimise the potential of any 'ballooning' in the turn at KKE03 of some aircraft types and would be consistent with speed restrictions applied on other SIDs with similar turning characteristics. 2. If the conventional SID is to be retained, the same

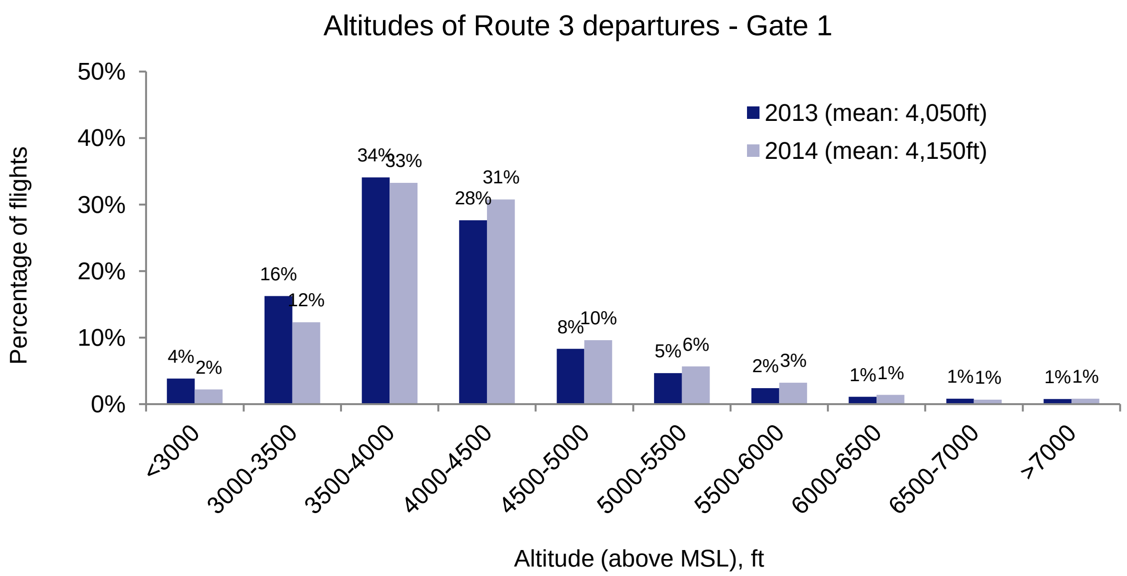
(1) Route No.	(2) SID/Data used during analysis	(3) Issue	(4) Initial Options from SARG IFP For PIRG to Consider	(5) Impact of Issue & Initial Options	(6) Outcome of PIRG Final Review of Route Issues & SARG IFP Options	(7) SARG IFP Recommendations
2 (cont)	Wind Analysis		the conventional SID would improve its track and NPR adherence.	max speed restriction of 220kts is appropriate for KKS08 or at an earlier position 3. Validate that the speed change has the expected impact in a flight simulator.	retained, the same rationale can be applied in the conventional SID by applying a max 220KIAS speed constraint to SFD D21 and max 250KIAS to SFD D17.	rationale can be applied in the conventional SID, by applying a max 220KIAS speed constraint to SFD D21 and max 250KIAS to SFD D17. 3. Validate the SIDs in a flight simulator to ensure that the speed changes have the expected impact. A robust validation will be required where the flyability of the remedial SID is assessed in both Airbus and Boeing flight simulators. The parameters used to assess and stress the procedures must be recorded and must be agreed with the CAA before the validation (flyability assessment)

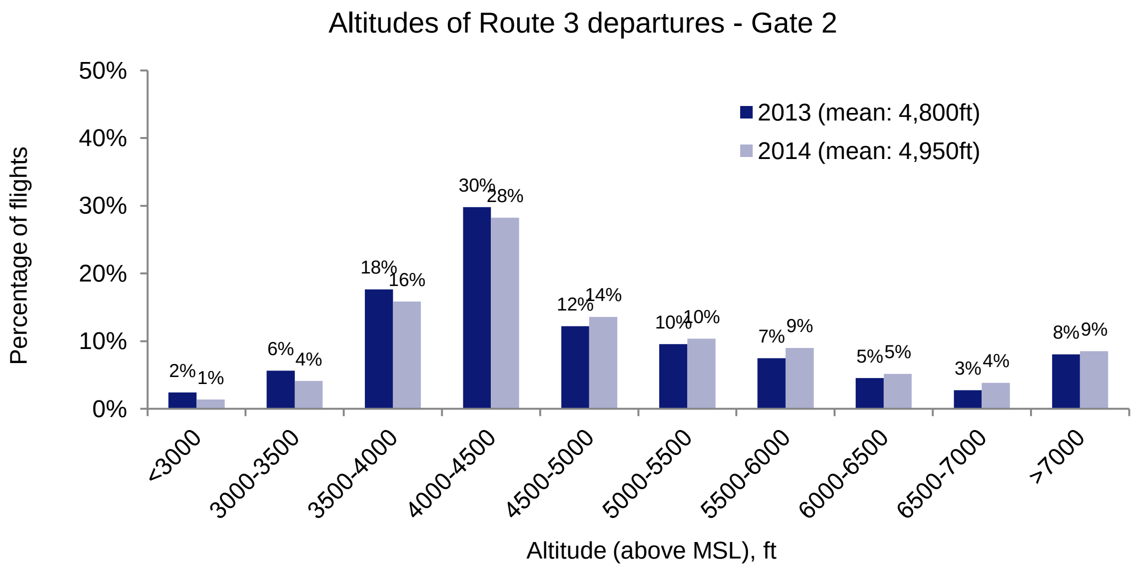
(1) **Route No.**	**(2)** **SID/Data used during analysis**	**(3)** **Issue**	**(4)** **Initial Options from SARG IFP For PIRG to Consider**	**(5)** **Impact of Issue & Initial Options**	**(6)** **Outcome of PIRG Final Review of Route Issues & SARG IFP Options**	**(7)** **SARG IFP Recommendations**
2 (cont)						process commences.

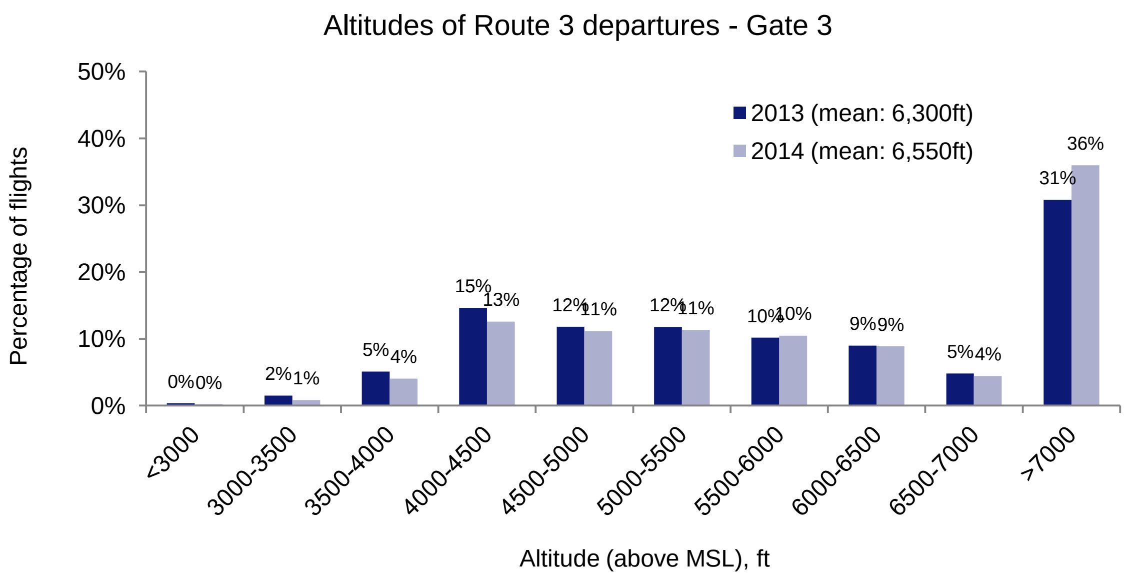
Route 3

(1) Route No.	(2) SID/Data used during analysis	(3) Issue	(4) Initial Options from SARG IFP For PIRG to Consider	(5) Impact of Issue & Initial Options	(6) Outcome of PIRG Final Review of Route Issues & SARG IFP Options	(7) SARG IFP Recommendations
3	Rwy 08 SAM/ KENET 08 KEN Altitude Bands. & Density Ppttx ERCD Route 3 Gate Analysis	The concentrations of flight tracks into a narrower swathe can be seen with the RNAV 1 SID as compared to the conventional SIDs. The cores of the flight track swathes are similar and this is due in part that the conventional SID first turn point coincides with where the majority of a/c are commencing the turn on the RNAV 1 SID. It appears that the later the turn point on a conventional SID the use of a fly-by WP is effective. 10 Jul 15. Head AAA has requested AR & SARG IFP to consider implications for raising the SID profile to 4000ft earlier in the procedure. Altitude attainment from the GAL PIR data is to be re-examined, and SARG IFP is to advise whether the design profile can be raised. This was an issue raised by public feedback. Whilst initial views are that the 3000ft	1. No changes recommended as the PIR evidence demonstrates this SID is a good replication of the conventional SID and the impact is as expected. 2. In response to the altitude attainment query ERCD will gather ground speed and altitude data at KKN09 and KKW19 to produce 'gate' data and provide details to SARG IFP.	1. No design changes required to be made to the RNAV 1 SID. 2. While the altitude constraints at KKN09 and KKW19 could be considered to be amended, the Route 3 gate analysis provided by ERCD indicates higher altitudes are being attained than the altitude restrictions of 3000ft on the SID procedure. 79% of departures were at/above 4000ft by south abeam Reigate (the midpoint gate in	PIRG having discussed the issues and the outcome of gate data analysis it was decided that no design change was required.	RNAV 1 SID is a satisfactory replication. No modification recommended.

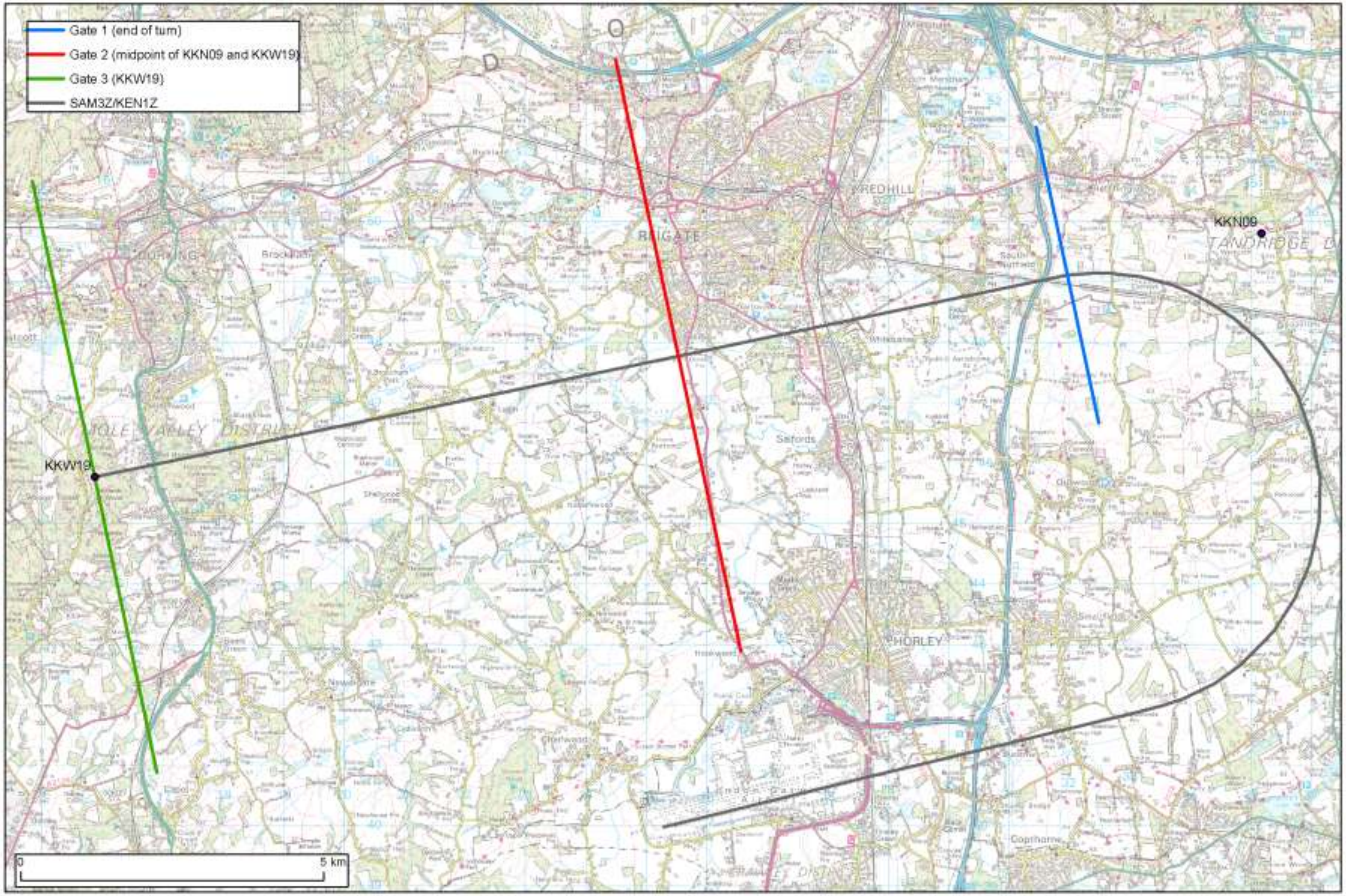
(1) Route No.	(2) SID/Data used during analysis	(3) Issue	(4) Initial Options from SARG IFP For PIRG to Consider	(5) Impact of Issue & Initial Options	(6) Outcome of PIRG Final Review of Route Issues & SARG IFP Options	(7) SARG IFP Recommendations
3 (cont)		restriction at KKW19 is due to interaction with Heathrow Rwy 09 MID SIDs, initial re-examination of the altitude attainment diagrams (see below) indicates a/c are climbed above 4000ft significantly earlier on the SID profile The documented level restriction rationale of the RNAV 1 SID is as follows: • KKE05 +2500: Noise Abatement • KKN09 @3000: Noise Abatement • KKW19 @3000: Airspace Containment and Separation against EGLL DVR SID • KKW26 @4000: Airspace Containment and Separation against EGLL MID SID		the analysis), average alt 4950ft amsl, and 95% were at/above 4000ft amsl by KKW19 with an average altitude of 6550ft AMSL. Therefore in reality altitude attainment of above 3000ft is not an issue.		


Altitudes of Route 3 departures - Gate 1
2013 (mean: 4,050ft)
2014 (mean: 4,150ft)
Percentage of flights
Altitude (above MSL), ft
<3000 4% 2%
3000-3500 16% 12%
3500-4000 34% 33%
4000-4500 28% 31%
4500-5000 8% 10%
5000-5500 5% 6%
5500-6000 2% 3%
6000-6500 1% 1%
6500-7000 1% 1%
>7000 1% 1%


Altitudes of Route 3 departures - Gate 2
2013 (mean: 4,800ft)
2014 (mean: 4,950ft)
Percentage of flights
Altitude (above MSL), ft
<3000 2% 1%
3000-3500 6% 4%
3500-4000 18% 16%
4000-4500 30% 28%
4500-5000 12% 14%
5000-5500 10% 10%
5500-6000 7% 9%
6000-6500 5% 5%
6500-7000 3% 4%
>7000 8% 9%


Altitudes of Route 3 departures - Gate 3
2013 (mean: 6,300ft)
2014 (mean: 6,550ft)
Percentage of flights
Altitude (above MSL), ft
<3000 0% 0%
3000-3500 2% 1%
3500-4000 5% 4%
4000-4500 15% 13%
4500-5000 12% 11%
5000-5500 12% 11%
5500-6000 10% 10%
6000-6500 9% 9%
6500-7000 5% 4%
>7000 31% 36%

Route 3 Gate layout



Route 4

(1) Route No.	(2) SID/Data used during analysis	(3) Issue	(4) Initial Options from SARG IFP For PIRG to Consider	(5) Impact of Issue & Initial Options	(6) Outcome of PIRG Final Review of Route Issues & SARG IFP Options	(7) SARG IFP Recommendations
4	Rwy 26 LAM/ CLN/ DVR/ BIG 26LAM Altitude Bands. & Density Ppttx ERCD Route 4 Ground Speed analysis+	Due to the limitations of RNAV design criteria it was not possible to fully replicate the conventional SID (which also deviated from the NPR) and remain inside the NPR swathe. This was accepted at the time of the P-RNAV trial and subsequent RNAV 1 SID introduction. It was envisaged/planned that the NPR swathe would be realigned to encompass both the conventional and RNAV1 SIDs, which did not occur. For both the conventional and RNAV 1 SIDs the nominal track if flown at 220 KIAS leaves the NPR swathe at approximately 1.4 NM before KKN06. The nominal track of the RNAV 1 SID after KKE14 towards SUNAV is outside of the NPR swathe by approximately 0.12 NM. It is displaced north from the conventional SID nominal track by an approximate distance of 0.16 NM when both	1. The conventional SIDs should be reviewed and realigned with the NPR. Then any changes to the RNAV 1 SIDs should be based on the reviewed conventional SID for replication purposes. 2. During the review of the conventional SIDs, speed constraints (as required) should be applied to the SIDs. This is to overcome the fact that the only speed constraint on the conventional SIDs is a maximum 250 KIAS below FL100. This will ensure better track/NPR adherence	1. Review the conventional SIDs before any changes to the RNAV 1 design. 2. Amend the conventional SID design and consider the application of a speed restriction as required (220KIAS max) being applied on first turn. An interim step could be for an AIC to cover SID speed adherence. 3. Temporary	**Route 4 Long Term Options** **Long term Option 1 – Review Conventional SID** **Pros** If the conventional SID is to be retained by GAL it will be required to be reviewed under the normal instrument flight procedure (IFP) 5 year periodic review process as this review is now due. This review is where the procedure design criteria, obstacles data, altitude and speed restriction, magnetic variations data, noise abatement and airspace containment requirements and any other operational requirements are	RNAV 1 SID is not a satisfactory replication. CAA IFP recommends Interim Option 1 and Long Term options 1 to 5 as a means of provided a better RNAV 1 replication Long term Option 6 could be considered when the Gatwick aircraft fleet are RNP 1 compliant.

(1) Route No.	(2) SID/Data used during analysis	(3) Issue	(4) Initial Options from SARG IFP For PIRG to Consider	(5) Impact of Issue & Initial Options	(6) Outcome of PIRG Final Review of Route Issues & SARG IFP Options	(7) SARG IFP Recommendations
4 (cont)	Wind data v2	SIDs are flown at 220 KIAS and affected by the same winds. The conventional SID when flown at 220 KIAS also leaves the NPR swathe at approximately the same point as the RNAV 1 SID (approximately 1.4 NM before KKN06). On the conventional SID when the aircraft is established on the radial towards ACORN it will begin to re-enter the NPR swathe at approximately 1.2 NM before the Redhill area (KKE14 in the RNAV 1 SID), whereas the RNAV 1 SID does not. Therefore in the RNAV 1 SID the two straight leg segments after KKN06 are north of both the conventional SID and NPR swathe. The NPR on the Route 4 SIDs is predicated on the DET VOR R258.18°T; with magnetic variation of 0.7°W applied, this results in R259°M. This indicates a discrepancy of 1° with what is published today in the AIP of R260°M. This will have an impact such that the nominal tracks of the conventional SIDs on this route will be north of the NPR by	especially before, during and after any turns. 3. The RNAV SID could be temporarily suspended until a revised RNAV design could be implemented which would better replicate the conventional SID. 4. A remedial design should put emphasis on the early phase of the departure where a speed slower than the max procedure speed is being used. The design may need to reflect the average speed flown on the early phase of departure before allowing speeds of 220KIAS etc max. A solution using WP/path terminators types other than those used in the current design should also	suspension of the RNAV 1 SID would have all a/c on Route 4 fly the conventional SID which is also known to be outside of northern section of the NPR swathe. 4. Design an RNAV 1 SID to better replicate the reviewed conventional SID. This may involve changes to the existing design or a complete change of design using different WP types, WP placement and path terminators with applicable speed	assessed and the outcome incorporated into the design to ensure the IFP continues to be fit for purpose. It will allow the conventional SID to be retained for use by non RNAV 1 operators unless and until the conventional SID is permanently withdrawn. **Cons -** None **Long term Option 2 – Modify existing RNAV 1 SID design** Alternative design options for different waypoints and path terminators should be considered during the RNAV 1 redesign process, along with the application of an additional speed restriction of 220kts max until KKE14 or a waypoint placed between KKN06 and KKE14 to better replicate the	

(1) Route No.	(2) SID/Data used during analysis	(3) Issue	(4) Initial Options from SARG IFP For PIRG to Consider	(5) Impact of Issue & Initial Options	(6) Outcome of PIRG Final Review of Route Issues & SARG IFP Options	(7) SARG IFP Recommendations
4 (cont)		approximately 0.5 NM. The effect of speed on the conventional and RNAV 1 SIDs can have very different impacts on the track flown. On the initial departure an aircraft has not yet accelerated to a speed of 220 KIAS. In the conventional SID this does not impact on where the aircraft will commence the turn north to intercept the DET VOR radial R260, as the turn point is predicated on a Fly-over waypoint at the D2.3 ILS DME. So an aircraft at a speed of <220 KIAS will commence the turn at D2.3 and then turn to intercept the DET radial and will be tighter than if the aircraft speed is at 220 KIAS. In the RNAV 1 SID the effect of a speed < 220KIAS will cause the aircraft to commence the turn closer to the Fly-by waypoint KKW04(after the D2.3 ILS DME fix) and this will place the aircraft towards the outer edge of the NPR swathe as demonstrated in the various heat plots. Therefore, in the initial departure of the RNAV	be examined. With the speed variations experienced flying the RNAV 1 SIDs and the associated impacts, design options should be explored which better provide adherence to the NPR in the turns where the speed flown may be less than the procedure max speed. The current RNAV 1 SIDs which primarily use WPs with TF (track to fix) path terminators, are impacted when the speed flown is less than 220KIAS max by causing the turn to commence closer to the first WP. Depending which RNAV design criteria is implemented in a future RNAV 1 remedial design, in order to ensure no speed	restrictions. A redesign of the RNAV 1 SID will need to address the impact of variable speeds on the flight tracks over the ground. 5. Re-issue of both conventional and RNAV SID charts and coding tables with new speed constraints. Issue NOTAM during interim period until a permanent design solution is provided. 6. SARG IFP to have a pre-design meeting with the APD organisation engaged by GAL to understand	conventional SID. **Pros** If successful, will reduce dispersion outside the NPR swathe during the first and second turn; A revised design could bring the eastbound track further south after the completion of the first 2 turns (therefore displaced slightly south of the westbound track of the Runway 08 Route 3 SID); **Cons** It could be up to 9 months before a revision can be implemented taking into account the time required to design a modification to the SID, obtain regulatory approval, complete the validation the flyability assessments of the SID and promulgation in the UK AIP.	

(1) Route No.	(2) SID/Data used during analysis	(3) Issue	(4) Initial Options from SARG IFP For PIRG to Consider	(5) Impact of Issue & Initial Options	(6) Outcome of PIRG Final Review of Route Issues & SARG IFP Options	(7) SARG IFP Recommendations
4 (cont)		1 SID the aircraft commences the turn later as the speed is <220 KIAS. Then during the noise abatement (acceleration) phase of flight as the aircraft accelerates to the maximum of 220 KIAS, the radii of the turn increases causing the aircraft to fly even closer to the edge, and even deviate from the NPR swathe. Then at KKN06 where the speed increases at the bisector (mid-way through the turn) of the waypoint to a maximum 250 KIAS, the radii of turn increases still further to the point where the aircraft will be north of the expected nominal track. This effect will be further exacerbated when there is a strong wind from the south west which will provide a tailwind component to aircraft flying north towards KKN06 and subsequent waypoints on the SID. Ground speed can therefore easily exceed the procedure design allowance of 30 knots tailwind component. While the navigation systems will endeavour to correct to the intended track this can be limited and without further flight crew intervention by way of speed	acceleration occurs during the turn, a WP with a speed constraint must be placed at a suitable distance after the turn WP (between KKN06 & KKE14) to allow the aircraft to become established on the next track and be wings level before speed can be increased. This will help to minimise ballooning in/out of the turn at KKN06 for example. 5. Flight crews should gain an appreciation of the protections that instrument flight procedure design criteria afford them and when wind conditions are outside these (e.g., tailwind component exceeds 30 Knots as used in the design) and they should expect to	the impact of the options are being explored at the earliest possible stage. 7. Design an RNP SID as another PBN option for operators approved for RNP 1 operations. **8.** A robust validation will be required where the flyability of the remedial SID is assessed in both Airbus and Boeing flight simulators. This assessment must be conducted in an objective manner where the methodology	**Long term Option 3 – Add Information Note to RNAV 1 SID Chart** A note regarding crew intervention could be considered to be included on the revised RNAV 1 SID chart (if applicable to the design adjustments to be implemented) during south westerly high wind conditions exceeding 20 kts. **Pros** By ensuring that operators are aware of the issues than can have an impact of the track adherence it should help to minimise deviations from the published nominal track. **Cons** None **Long term Option 4- Provide advice to Approved Procedure**	

(1) Route No.	(2) SID/Data used during analysis	(3) Issue	(4) Initial Options from SARG IFP For PIRG to Consider	(5) Impact of Issue & Initial Options	(6) Outcome of PIRG Final Review of Route Issues & SARG IFP Options	(7) SARG IFP Recommendations
4 (cont)		reduction the aircraft flight path will be wider and north of the intended tracks. It should be noted that airspeed has to be checked prior to the turn, as deceleration is difficult once the effect of the tailwind is encountered. Aircraft configuration is also a factor as the 220 KIAS is designed to allow a clean configuration for the narrow body aircraft to be achieved. If a lower speed has to be maintained, this will likely necessitate retention of one stage of flap during the turn manoeuvre. Ground speed and altitude data obtained from ERCD was assessed. The analysis was based on conventional, P-RNAV trial, and RNAV 1 SIDs where it was found that the average ground speed of aircraft at the I-WW D2.3 (ILS DME) conventional turn point varied between 185 to 195 knots. This ground speed concurs with the flights tracks of the RNAV 1 SID and explains why the RNAV 1 SID turn commences later than on the conventional SID as explained above.	have to intervene and reduce the procedure maximum speed as published and or coded. This affects and applies to both conventional and RNAV instrument flight procedure designs. Given the minimum stabilisation distance afforded between KKW04 and KKN06 and the vulnerability under strong southerly or south westerly wind conditions, include a note to flight crews on SID charts that when departing in such conditions i.e., typically above 20 knots on the airfield from this quadrant, that flight crew intervention of speed control may be required for adherence to the SID nominal track. 6. SARG IFP should have a	employed will assess and stress test the SID and ascertain at what point crew intervention is required and by what means. The parameters used to assess and stress the procedures must be recorded and must be agreed with the CAA before the validation (flyability assessment) process commences.	**Designer (APD) engaged by GAL** SARG IFP will provide advice to the APD engaged by GAL on issues which have come to light during the PIR. A pre-design meeting should be arranged between CAA, GAL and the APD at the earliest possible stage to explore the design options being considered. **Pros** This will ensure that all stakeholders in the redesign process are aware of the issues of route 4 existing RNAV 1 design and that the result of the redesign will be a better replication of the conventional SID. **Cons** None **Long Term Option 5 - SID Validation Requirements (both**	

(1) Route No.	(2) SID/Data used during analysis	(3) Issue	(4) Initial Options from SARG IFP For PIRG to Consider	(5) Impact of Issue & Initial Options	(6) Outcome of PIRG Final Review of Route Issues & SARG IFP Options	(7) SARG IFP Recommendations
4 (cont)		While the RNAV 1 SIDs are behaving in a manner that would be expected and in line with the way the procedure is executed by the aircraft navigation system, the extent of the impact is greater than was anticipated. Regardless of the track that conventional SIDs have achieved over the ground, and the design of the conventional SID, the situation has not been helped by a lack of corrective measures to address changes in magnetic variation. As the PIR Route analysis report demonstrates, the replication of Route 4 has therefore had impacts which were not anticipated,	pre-design meeting with the APD organisation engaged by GAL to understand what options are being explored and their impacts at the earliest possible stage. 7. Design a Radius to Fix (RF) SID option to bring the dispersion around the first and second turns further back inside the NPR swathe so at least those RF equipped aircraft can at least achieve better track keeping. It should be noted that this option will be more tolerant to strong southerly and south westerly winds due to a defined path around the turn, but as a consequence will produce a narrow concentrated swathe of flight tracks over areas affected.		**Conventional and RNAV-1) – (Mandatory)** Validate the SIDs in a flight simulator to ensure that the changes have the expected impact. A robust validation will be required where the flyability of the revised SID is assessed in both Airbus and Boeing flight simulators. The parameters used to assess and stress the procedures must be recorded and must be agreed with the CAA before the validation (flyability assessment) process commences. **Pros** This process will ensure that the revised RNAV 1 SID is flyable in the various wind conditions that can be expected at Gatwick. It would be expected that by assessing the SID in both Airbus and Boeing flight	

(1) Route No.	(2) SID/Data used during analysis	(3) Issue	(4) Initial Options from SARG IFP For PIRG to Consider	(5) Impact of Issue & Initial Options	(6) Outcome of PIRG Final Review of Route Issues & SARG IFP Options	(7) SARG IFP Recommendations
4 (cont)			However, efforts can be made within the RF design to place the tracks such as to minimise over flight of populated areas. 8. A robust validation will be required where the flyability of the remedial SID is assessed in both Airbus and Boeing flight simulators.		simulators issues of SID execution by aircraft FMS along with track adherence can be assessed to ensure no issues exist. This is a robust methodology to assess and ensure the revised SID is a satisfactory replication before being promulgated in the AIP. **Cons** None **Long term Option 6 – Introduce an RNP1 SID** An RNP 1 SID design including RF legs could be considered as an additional option to add to the available PBN SID designs at Gatwick. An RF RNP1 design would be another option to improve track keeping, but used in conjunction with an RNAV 1 would provide some dispersion within the NPR	

(1) **Route No.**	**(2)** **SID/Data used during analysis**	**(3)** **Issue**	**(4)** **Initial Options from SARG IFP For PIRG to Consider**	**(5)** **Impact of Issue & Initial Options**	**(6)** **Outcome of PIRG Final Review of Route Issues & SARG IFP Options**	**(7)** **SARG IFP Recommendations**
4 (cont)					swathe. **Pros** Operators that are approved for RNP 1 operations would be able to use an RNP 1 SID which would be able to provide better track adherence in a wider variance of wind conditions. Used in conjunction with an RNAV 1 SID it would provide some dispersion within the NPR swathe as the nominal track would differ from the RNAV 1 nominal track. **Cons** As RNP 1 operations will provide good track adherence it must be noted that an RNP 1 SID will provide narrow swathes of tracks. So while fewer communities may be affected by noise, the concentrations of a/c that affect	

(1) Route No.	(2) SID/Data used during analysis	(3) Issue	(4) Initial Options from SARG IFP For PIRG to Consider	(5) Impact of Issue & Initial Options	(6) Outcome of PIRG Final Review of Route Issues & SARG IFP Options	(7) SARG IFP Recommendations
4 (cont)					these communities will be greater. **Route 4 Interim Options** **Interim Option 1 – Leave current RNAV 1 SID in place** (i.e. do nothing in the interim, pending long term fix/modification). **Pros** – Maintains existing operational practice for ATC clearance delivery and retains crew familiarity with flight planning for departure. **Cons** – Not a satisfactory replication of the conventional SID, as impact was different to that expected ;greater deviation from NPR compliance monitoring swathe than was anticipated; overflies AONB more so than conventional SID; public	

(1) Route No.	(2) SID/Data used during analysis	(3) Issue	(4) Initial Options from SARG IFP For PIRG to Consider	(5) Impact of Issue & Initial Options	(6) Outcome of PIRG Final Review of Route Issues & SARG IFP Options	(7) SARG IFP Recommendations
4 (cont)					dissatisfied with over flight (in their view) of areas not previously overflown; more noise issues raised by members of the public than conventional SID due to the wider turns on departure; After the 180 degree turn Route 4 RNAV 1 SID is now virtually co-incident (in a lateral sense) with the Route 3 Runway 08 opposite direction SID. **Interim Option 2 – Revert to conventional SID and suspend RNAV-1 Route 4 SIDs** **Pros** – The conventional SID has remained published in the AIP and available for operation and is being used by non RNAV 1 operators since the RNAV 1 SIDs were introduced, so it will still be available in the aircraft FMS navigation database for use by all operators. Therefore, usage of	

(1) Route No.	(2) SID/Data used during analysis	(3) Issue	(4) Initial Options from SARG IFP For PIRG to Consider	(5) Impact of Issue & Initial Options	(6) Outcome of PIRG Final Review of Route Issues & SARG IFP Options	(7) SARG IFP Recommendations
4 (cont)					the conventional SID could be implemented immediately for operational use if the RNAV1 SID is temporarily suspended, (if this option was adopted, it would be prudent for GAL to check with the FLOPSC that operators have the conventional SID available in their navigation database before this option was implemented). **Cons** – There is the possibility of confusion over which is the extant departure, in particular when there are a series of changes in quick succession. There is a significant workload associated with any change and as a consequence doing it only once is highly preferable to two changes in a short period of time. The conventional SID is still not consistent with NPR and also	

(1) **Route No.**	**(2)** **SID/Data used during analysis**	**(3)** **Issue**	**(4)** **Initial Options from SARG IFP For PIRG to Consider**	**(5)** **Impact of Issue & Initial Options**	**(6)** **Outcome of PIRG Final Review of Route Issues & SARG IFP Options**	**(7)** **SARG IFP Recommendations**
4 (cont)					results in flight tracks outside the NPR compliance monitoring swathe below 4000ft albeit with fewer deviations compared with the RNAV 1 SID. The conventional SID is overdue for review under the normal instrument flight procedure (IFP) 5 year periodic review process. This review is where the procedure design criteria, obstacles data, altitude and speed restriction, magnetic variations data, noise abatement and airspace containment requirements and any other operational requirements are assessed and the outcome incorporated into the design to ensure the IFP continues to be fit for purpose. **Interim Option 3 – Speed restrict existing Conventional SIDs and**	

(1) Route No.	(2) SID/Data used during analysis	(3) Issue	(4) Initial Options from SARG IFP For PIRG to Consider	(5) Impact of Issue & Initial Options	(6) Outcome of PIRG Final Review of Route Issues & SARG IFP Options	(7) SARG IFP Recommendations
4 (cont)					**suspend RNAV-1 SIDs pending modification** **Pros –** This option may improve track adherence within the NPR compliance monitoring swathe and may help to reduce the deviation outside the NPR compliance monitoring swathe during the first and second turn below 4000ft. This option could be implemented by NOTAM which would enable immediate use by operators. **Cons** – Published speed restrictions could have unanticipated and unintended consequences. Changes such as speed restrictions may have impacts regarding how some operators fly the existing conventional SID and could result in	

(1) Route No.	(2) SID/Data used during analysis	(3) Issue	(4) Initial Options from SARG IFP For PIRG to Consider	(5) Impact of Issue & Initial Options	(6) Outcome of PIRG Final Review of Route Issues & SARG IFP Options	(7) SARG IFP Recommendations
4 (cont)					more noise and wider track dispersion, but there is no way of knowing the impact until such a change is implemented. **Interim Option 4 – Suspend Route 4 completely (no Conventional or RNAV SID)** **Pros** – Currently 15% of aircraft exceed the NPR compliance monitoring swathe. If the SIDs on this route were all suspended this would cease until SIDs on this route were re-implemented **Cons** – It would make it very difficult for Gatwick to operate. This is a high use route. If route was suspended aircraft would be routed via Route 9 SIDs. It would cause:	

(1) Route No.	(2) SID/Data used during analysis	(3) Issue	(4) Initial Options from SARG IFP For PIRG to Consider	(5) Impact of Issue & Initial Options	(6) Outcome of PIRG Final Review of Route Issues & SARG IFP Options	(7) SARG IFP Recommendations
4 (cont)					• Severe operational issues to the safe and efficient operation of all traffic in the London Terminal Control Area (LTMA) ; • An impact to the existing flow rates as these could not be maintained due to the fact that they would cause unacceptable flight operational impacts and flight safety hazards to ATC and airline crews operations, hence, there would have to be severe flow restrictions required to mitigate these impacts which would have a knock on effect throughout the LTMA; • Increased delays to the arrivals and departures at Gatwick and potentially cause additional delays to other UK traffic flows which would subsequently impact traffic flow in Europe and potential to transatlantic traffic; • Delays to schedules at all world-wide airports which are operating flights to and from Gatwick; this could cause severe disruption to	

(1) **Route No.**	**(2)** **SID/Data used during analysis**	**(3)** **Issue**	**(4)** **Initial Options from SARG IFP For PIRG to Consider**	**(5)** **Impact of Issue & Initial Options**	**(6)** **Outcome of PIRG Final Review of Route Issues & SARG IFP Options**	**(7)** **SARG IFP Recommendations**
4 (cont)					passengers who would be subjected to lengthy delays. • A disproportionate response in terms of impact on airlines. • A redistribution of aircraft noise to the area overflown by Route 9.	

Route 5

(1) Route No.	(2) SID/Data used during analysis	(3) Issue	(4) Initial Options from SARG IFP For PIRG to Consider	(5) Impact of Issue & Initial Options	(6) Outcome of PIRG Final Review of Route Issues & SARG IFP Options	(7) SARG IFP Recommendations
5	Rwy 08 DVR/ CLN/ BIG 08CLN Altitude Bands. & Density Ppttx	The track dispersion of the RNAV SID is slightly further south of the conventional SID dispersion and the RNAV 1 tracks now over Dormansland. The NPR is based on the DVR VOR R269.99°T and by applying the DVR VOR mag var of 0.3°W results in a R270.3°M, whereas the published radial is R271°M. Therefore the conventional SID nominal track as flown would place an a/c approx 0.45nm north of the NPR. In the RNAV 1 SID the aerodrome mag var of 0.9°W is applied to the true track of 089.6°T which results in a track of 091°M. But as the turn commences before the turn point of the NPR R269.99°T, the track of the RNAV 1 SID is approx 0.24nm south of the NPR and over Dormansland.	1. Delay the first turn by moving the first WP slightly further to the northeast. Or investigate if a FO WP in the same position as KKE02 would achieve the roll out onto the NPR. 2. The conventional SID should be reviewed and the nominal track realigned with the NPR.	Design a remedial RNAV 1 SID where the first turn on the SID places the a/c on a track that is coincident with the NPR. 2. Review the conventional SID and realign with the NPR. 3. Validate that the change has the expected impact in a flight simulator.	1. In order to achieve a better replication of the conventional SID the placement of waypoint KKE02 is likely to be required to be re-positioned. During the design process an APD will need to consider the merits of using a fly over (FO) waypoint at either current KKE02 position or at a repositioned fly by (FB) KKE02 WP. 2. If the conventional SID is to be retained for use by GAL the SID is required to be reviewed. During the review process the nominal track of the SID would need to be realigned with the NPR.	RNAV 1 SID is a satisfactory replication but could be improved by applying the following options: 1. GAL should advise their APD to consider the design options in Column 6 and determine which is optimal to improve the PBN replication. 2. If the conventional SID is to be retained for use by GAL the SID is required to be

(1) Route No.	(2) SID/Data used during analysis	(3) Issue	(4) Initial Options from SARG IFP For PIRG to Consider	(5) Impact of Issue & Initial Options	(6) Outcome of PIRG Final Review of Route Issues & SARG IFP Options	(7) SARG IFP Recommendations
5 (cont)						reviewed. During the review process the nominal track of the SID would need to be realigned with the NPR. 3. Validate that the change has the expected impact in a flight simulator. A robust validation will be required where the flyability of the remedial SID is assessed in both Airbus and Boeing flight simulators. The parameters used to assess and stress the procedures must be recorded and must be agreed with the

(1) Route No.	(2) SID/Data used during analysis	(3) Issue	(4) Initial Options from SARG IFP For PIRG to Consider	(5) Impact of Issue & Initial Options	(6) Outcome of PIRG Final Review of Route Issues & SARG IFP Options	(7) SARG IFP Recommendations
5 (cont)						CAA before the validation (flyability assessment) process commences.

Route 6

(1) Route No.	(2) SID/Data used during analysis	(3) Issue	(4) Initial Options from SARG IFP For PIRG to Consider	(5) Impact of Issue & Initial Options	(6) Outcome of PIRG Final Review of Route Issues & SARG IFP Options	(7) SARG IFP Recommendations
6	Rwy 08 LAM (DTY on slide) 08DTY Altitude Bands. & Density Ppttx	The concentrations of flight tracks into a narrower swathe can be seen with the RNAV 1 SID as compared to the conventional SIDs. However, after the first turn, both conventional and RNAV 1 SID tracks very slightly deviate from the NPR but are well within the NPR swathe.	1. A speed restriction of 220KIAS max at KKE02 and move the 250KIAS max to the next WP could be considered. This may further improve the adherence to the NPR.	1. Minor adjustment to RNAV SID design coding. 2. Design coding action which would need to be assessed in a simulator before AIP implementation.	PIRG discussed the NPR adherence and proposed option. It was decided that the very slight deviation which also occurs in the conventional SID did not warrant change. Therefore the design has been accepted as a satisfactory PBN replication and no design change is required.	RNAV 1 SID is a satisfactory replication. No modification recommended

Route 7

(1) Route No.	(2) SID/Data used during analysis	(3) Issue	(4) Initial Options from SARG IFP For PIRG to Consider	(5) Impact of Issue & Initial Options	(6) Outcome of PIRG Final Review of Route Issues & SARG IFP Options	(7) SARG IFP Recommendations
7	Rwy 26 BOGNA/ HARDY 26BOG Altitude Bands. & Density Ppttx ERCD 26BOG Speed _ Data+ Wind Analysis	The PIR comments suggested that Slinfold now experiences more a/c flying in closer proximity. The concentrations of flight tracks into a narrower swathe can be seen with the RNAV 1 SID as compared to the conventional SIDs, which would be expected from an RNAV 1 SID. The RNAV 1 flight tracks show a better adherence to the NPR than the conventional flight tracks during the early stage of the departure up to KKW06. After KKW06 the track dispersions due to the altitude of the a/c are more likely to be due to ATC vectoring than the track adherence of the SID. In the conventional SIDs it is noted that at the first turn south there are 2 distinctive concentrations of a/c in the turn. This could be attributed to a/c at different speeds in the turn. The concentrations of the more westerly flight	1. If the flight tracks were generally acceptable to the local communities prior to the introduction of the RNAV 1 SIDs, could NATS revert to the vectoring practice prior to the RNAV 1 SID introduction? 2. Take no design action as the RNAV 1 SID is a good replication of the existing conventional SID.	1. According to NATS once the aircraft is above 4000ft it can be vectored and this policy has not changed.	1. Vectoring restrictions were discussed; it was concluded that the resulting track provides a good replication up to a point that vectoring predominates and that no design change or restrictions in vectoring were required. 2. The advice from ERCD was that there is no significant noise change in the vicinity of Slinfold as traffic is generally well above 4,000ft, but accepting that the noise impact for residents in that location may have changed because the greater concentration of RNAV traffic on the southbound segment means that more aircraft are closer to Slinfold as they fly south than appears to be the case for conventional traffic. In addition, based upon track diagrams	RNAV 1 SID is a satisfactory replication. No modification recommended.

(1) Route No.	(2) SID/Data used during analysis	(3) Issue	(4) Initial Options from SARG IFP For PIRG to Consider	(5) Impact of Issue & Initial Options	(6) Outcome of PIRG Final Review of Route Issues & SARG IFP Options	(7) SARG IFP Recommendations
7 (cont)		tracks in the first turn are very similar in position to the flight tracks of the RNAV 1 SIDs. It appears that the a/c on the conventional SIDs (Slide 8&9 of 26BOG Altitude Bands) are being vectored earlier in the turn that in the RNAV 1 SIDs. Both of these slides also show that the a/c are mainly being vectored when the a/c are abeam Slinfold and that they are not adhering to either the conventional or RNAV 1 SIDs. Groundspeed and altitude data obtained from ERCD was assessed, this data has shown that at KKW06 a/c are approaching 5000ft and are above 7000ft at KKS11. At these altitudes and above, ATC are permitted to vector the a/c for operational and tactical reasons. From the altitude bands track plots it can be seen that a/c are no longer adhering to the NPR after the first turn and due to the track dispersions analysed and at this stage it is highly likely that a/c are being vectored.			presented for the PIR, there appears to be a slight increase in the number of tactically vectored RNAV aircraft to the east of the SID, above Slinfold. ERCD to gather ground speed and altitude data around the turn at KKW08 to produce ‘gate’ data and provide details to SARG IFP. After gate analysis no design action recommended as the a/c are above 4000ft and are being vectored.	

(1) Route No.	(2) SID/Data used during analysis	(3) Issue	(4) Initial Options from SARG IFP For PIRG to Consider	(5) Impact of Issue & Initial Options	(6) Outcome of PIRG Final Review of Route Issues & SARG IFP Options	(7) SARG IFP Recommendations
7 (cont)		Coded overlay data of the conventional SIDs that was made available to the CAA and from this data the following was noted: Operator A and Operator B coded overlays would place the a/c 0.12nm and 0.22nm respectively east of the RNAV 1 SID nominal track which in both cases is closer to Slinfold. Operator B (using a different coding provider from above) coded overlay would place the a/c on the same track as the RNAV 1 SID nominal track. From the analysis above it appears that a change of vectoring practice could be the primary reason for more a/c being closer to Slinfold. But in any case the aircraft flying either the conventional or RNAV 1 SID will be vectored when above 4000ft and the track adherence of either SID is not causing the issue of aircraft flying closer to Slinfold.				
		10 Jul 15. Subsequent Input from Head AAA		While a modification	3. PIRG having considered the	

(1) Route No.	(2) SID/Data used during analysis	(3) Issue	(4) Initial Options from SARG IFP For PIRG to Consider	(5) Impact of Issue & Initial Options	(6) Outcome of PIRG Final Review of Route Issues & SARG IFP Options	(7) SARG IFP Recommendations
7 (cont)		In light of recent debate on Route 7 and feedback from Slinfold (examination of feedback from members of public) and the Slinfold Parish Council, Head AAA requested SARG IFP to advise whether a modification of the design could be considered to replicate the wider turns of the conventional SID to take the aircraft slightly further west of Slinfold. Would a modification of the waypoints KKW06 and KKW08 be feasible, and could the speed be increased to 250KTS before the turn towards KKS11 is completed?		to the existing design could be considered, with the vectoring currently in existence and where most of the aircraft are above 4000ft prior to the initial left turn, the PIRG felt that any modifications would not be implemented in reality as the aircraft will already be vectored. As the WPs in the design are FB WPs this means that increasing the max speed at KKW06 and/or KKW08 will cause a/c to commence the turn at KKW08 earlier. If	Route 7 issues and possible options it was decided that due to most aircraft being above 4000ft prior to the initial turn which means that most aircraft are being vectored no change will be made to the RNAV 1 SID.	

(1) Route No.	(2) SID/Data used during analysis	(3) Issue	(4) Initial Options from SARG IFP For PIRG to Consider	(5) Impact of Issue & Initial Options	(6) Outcome of PIRG Final Review of Route Issues & SARG IFP Options	(7) SARG IFP Recommendations
7 (cont)				anything this is likely to cause a/c to be closer to the Slinfold area. The segment length between KKW08 and KKS11 is only 2.2nm and if the speed is increased this segment length would need to be increased. PIRG to get further information on the NATS vectoring practice and then reconsider what other options may be available. The information received from NATS is that there was no change in the		

(1) Route No.	(2) SID/Data used during analysis	(3) Issue	(4) Initial Options from SARG IFP For PIRG to Consider	(5) Impact of Issue & Initial Options	(6) Outcome of PIRG Final Review of Route Issues & SARG IFP Options	(7) SARG IFP Recommendations
7 (cont)				vectoring policy : "*The broad facts of the matter are that the rules intrinsic in the procedure remain unchanged, as such no vectoring is permitted (under standard practice – safety, unusual circumstances and weather requests will always over-ride this) below altitude 4000ft and we must also follow restrictions concerning Horsham".*		

Route 8

(1) Route No.	(2) SID/Data used during analysis	(3) Issue	(4) Initial Options from SARG IFP For PIRG to Consider	(5) Impact of Issue & Initial Options	(6) Outcome of PIRG Final Review of Route Issues & SARG IFP Options	(7) SARG IFP Recommendations
8	Rwy 26 SFD 26SFD Altitude Bands. & Density Ppttx	The concentrations of flight tracks into a narrower swathe can be seen with the RNAV 1 SID as compared to the conventional SIDs. Due to the speed restriction of 220KIAS max up to KKW11 the track to the centre of the NPR between KKW06 and KKW11 is better than on the conventional SID for the same segments. **This SID is used for night operations instead of BOGNA SID.**	1. No changes recommended to the RNAV SID. 2. During the review of the conventional SID a speed restriction of 220KIAS max should be applied at I-WW D6.8 and SFD D25 for better track and NPR adherence.	2. Review of conventional SID.	1. No design change of the RNAV SID is required as it is an acceptable RNAV SID replication. 2. If the conventional SID is retained, then a review of the SID will be required and a speed constrain of 220kts max should be applied at I-WW D6.8 and SFD D25 for better track and NPR adherence.	1. RNAV 1 SID is a satisfactory replication. No modification recommended. 2. If the conventional SID is retained it will be required to be reviewed. During the review speed restrictions of max 220KIAS at I-WW D6.8 and SFD D25 should be introduced.

Route 9

(1) Route No.	(2) SID/Data used during analysis	(3) Issue	(4) Initial Options from SARG IFP For PIRG to Consider	(5) Impact of Issue & Initial Options	(6) Outcome of PIRG Final Review of Route Issues & SARG IFP Options	(7) SARG IFP Recommendations
9	Rwy 26 TIGER/ WIZAD/ DAGGA 26WIZ Altitude Bands. & Density Ppttx	The concentrations of flight tracks into a narrower swathe can be seen with the RNAV 1 SID as compared to the conventional SIDs. The RNAV 1 SID maintains the NPR better than the conventional SID.	1. No changes recommended to the RNAV SID.	N/A	1. No design change of the RNAV SID is required as it is an acceptable RNAV SID replication.	RNAV 1 SID is a satisfactory replication. No modification recommended.

APPENDIX A

Gatwick Trial P-RNAV SID Revisions

During the design of the RNAV 1 SIDs revisions were required due to updated aerodrome obstacle data that became available after the aerodrome annual obstacle survey. The impacts of this new data on the SIDs are described below:

Version 1.0 – 27/02/2013: BIG 1X, BOGNA 1X, DAGGA 1X

This assessment included 2011 aerodrome obstacle data.

BIG 1X

Procedure Level Restrictions

This procedure has an “at or below 4000” restriction at KKE14 followed by an “at 5000” restriction at SUNAV. The climb gradient required to meet the level restrictions is therefore the gradient from 5m above DER to 5000ft AMSL at SUNAV.

The altitudes an aircraft would achieve at the nominal waypoint locations have been calculated assuming a constant climb from 5m above DER to 5000ft AMSL at SUNAV.

Comparison and Recommendation

The level restrictions do not ensure the aircraft meet either the procedure design gradient requirements or the noise abatement procedure requirements. In order to ensure that aircraft meet these requirements, it would be necessary to add an “at or above 2000” restriction at KKW04 and an “at or above 3000” restriction at KKN06. Note: The requirement to be 1000ft AAL 6.5km from start of roll requires an extremely high climb gradient if calculated from 5m above DER. The level restrictions proposed above do not force an aircraft to meet this requirement but do ensure that aircraft are above the 4% climb profile that follows the 1000ft AAL point by the time they reach the first waypoint.

Level Restriction Rationale

- KKW04 +2000: Obstacle Clearance and Noise Abatement
- KKN06 +3000: Airspace Containment and Noise Abatement
- KKE16 -4000: Unknown
- SUNAV @5000: Airspace Containment?
- KKE38 @6000: Unknown

In July 2013 the SIDs were further assessed using the 2012 aerodrome obstacle data from the aerodrome survey and this necessitated the increase of the altitude restriction at KKW04 to +2500 on the route 4 SIDs.

Obstacle Data

The following obstacle data sources were used for obstacle clearance calculations:

- London Gatwick CAP232 Survey from 2012
- UKMOD Digital Vertical Obstruction File (DVOF) data within 30NM of the EGKK ARP as of 12 February 2013
- SRTM Digital Elevation Model (DEM) data within 30NM of the EGKK ARP
- Ordnance Survey Vector Map (OSVM) Spot Heights within 30NM of the EGKK ARP

Note: Between the initial design and the redesign using the February DVOF, the location of some DVOF obstacles has changed slightly. If the controlling obstacle remained as the same DVOF obstacle then the obstacle label may still point to the centre of the original obstacle rather than the revised location.

26L DER Elevation

The surveyed elevation of the 26L_TODA_END point has decreased by 1.08m from 61.93m to 60.85m. The Latitude, Longitude, Easting, and Northing of this point remain the same. This is due to an error in the 2009 full survey of the airport. It was found that the near field monitor for the 26L localiser had been repositioned and the antenna was surveyed at both the ground and the top. The elevation of the 26L TODA End point was incorrectly entered as the elevation of the top of the antenna. This was corrected in the 2012 survey.

This change in elevation has several, relatively minor, impacts on the vertical profile of the 26L procedures:

The reduced DER elevation increases the distance required to reach 500ft AAL to comply with UK SID requirements. The location of the “703ft @ 3.3%” point has been adjusted to reflect this and any straight climb obstacle calculations have been reassessed.

The reduced DER elevation increases the climb gradient required to reach 1000ft AAL at 6.5km from start of roll to comply with the Noise Abatement procedures. This has been reflected in the noise abatement procedure paragraphs for each procedure below.

The reduced DER elevation decreases the altitude at each waypoint in the “MSD” calculations. (Calculated based on a “point-to-point” 7% climb gradient from 5m above DER to the nominal waypoint.) This results in the minimum stabilisation distance (MSD) for each waypoint reducing slightly and therefore reduces the minimum segment length (MSL) for each leg. As all legs lengths were already greater than the previously calculated MSL there are no changes required.

The reduced MSD altitude at each waypoint reduces the turn radius at each waypoint. The nominal track has been redrawn using the revised radii.

The reduced DER elevation decreases the altitude at each waypoint in the “Straight” calculations. (Calculated based on a “point-to-point” 10% climb gradient from 5m above DER to the nominal waypoint.) This results in the early and late turn points becoming slightly later. In order to accommodate this change, the turn protection at every waypoint for all 26L procedures would have had to be reconstructed. However, as the magnitude of the change is never greater than 5m (waypoint DAGGA on the DAGGA 1X SID) and all wind spirals were drawn at the turn altitude rounded up to the next 100ft this was not felt to be necessary.

The reduced Straight altitude at each waypoint reduces the wind spiral size at each waypoint. As all wind spirals were drawn at the Straight altitude rounded up to the next 100ft there are no changes required.

Nominal Tracks

Nominal tracks have been drawn based on the currently published conventional SIDs. Waypoints were placed to replicate the currently published conventional SIDs as closely as possible while adhering to the minimum segment lengths calculated according to PANS-OPS / CAP778.

Speed Restrictions

Where necessary, a speed restriction of 220KIAS has been applied to the first waypoints of a procedure. This is necessary in order to meet the minimum segment length criteria while attempting to replicate the existing conventional SIDs as closely as possible.

Noise Abatement Procedures on Route 4 SIDs

The distance from DER at which an aircraft is required to reach 1000ft AAL has been calculated as 1.67NM. (This equates to a climb gradient of 9.7%.) The distance at which an aircraft would reach 3000ft AMSL at 4.0% has been calculated as 9.07NM. The nominal track of this procedure leaves the NPR approximately 1.4NM before KKN06. This reflects the tightest turn that could be designed based on RNAV1 criteria with a 220kt IAS speed restriction. This turn has not been changed from the turn being flown as part of the CLN 2X trial SID.

Procedure Level Restrictions

Version 1.1 of this procedure had the following level restrictions:

- “At or below 4000” at KKE14
- “At 5000” at SUNAV
- “At 6000” at KKE38

The climb gradients required to meet these level restrictions are:

- DER to SUNAV: 2.76%
- SUNAV to KKE38: 1.55%
- The climb gradient from DER to SUNAV is less than the procedure design climb gradient of 7.9%

  and these level restrictions therefore do not ensure that aircraft meet the obstacle clearance requirements.

- The “At or below 4000” at KKE14 level restriction sets an upper limit on the climb gradient from

  DER to KKE14 of 4.17% but does not affect a continuous climb from DER to SUNAV at 2.76%.

Comparison and Recommendation

The level restrictions on version 1.1 did not ensure that aircraft met either the procedure design gradient requirements or the noise abatement procedure requirements. In order to ensure that aircraft meet these requirements the following new level restrictions have been added:

- “At or above 2500” at KKW04
- “At or above 3000” at KKN06

The climb gradients required with the addition of these level restrictions are:

- DER to KKW04: 9.48%
- KKW04 to KKN06: 2.01%
- KKN06 to SUNAV: 1.61%
- SUNAV to KKE38: 1.55%

The “At or below 4000” at KKE14 level restriction sets an upper limit on the climb gradient from KKN06 to KKE14 of 2.39% but does not affect a continuous climb from KKN06 to SUNAV at 1.61%.

Revised Waypoint Placement Rationale

- KKW04: Unchanged from P-RNAV SID Trial
- KKN06: Unchanged from P-RNAV SID Trial

- KKE14: Unchanged from P-RNAV SID Trial
- SUNAV: Unchanged from P-RNAV SID Trial
- KKE38: Placed at BIG R125 D18 as per BIG 7M
- BIG VOR: Placed at BIG VOR co-ordinates as per AIP ENR 4.1

Revised Level Restriction Rationale

- KKW04 +2500: Obstacle Clearance and Noise Abatement
- KKN06 +3000: Airspace Containment
- KKE14 -4000: Separation against EGLL DVR SID
- SUNAV @5000: Airspace Containment
- KKE38 @6000: Airspace Containment and Separation against SE-bound Leg from SUNAV