GATWICK ROUTE 5 MODIFIED RNAV-1 SID TRACK ANALYSIS

INTRODUCTION

1. The original Post Implementation Review (PIR) Track analysis for the Gatwick RNAV-1 SIDs Airspace Change Proposal (ACP) in 2013 is published on the CAA website as: Annex 1 Route 5 to CAP 1346. In the Annex 1, the CAA provided a guide to interpret PIR track data. That guide is still valid for the purposes of this document and to avoid repetition, interested parties should click on the above link to refresh themselves on how to interpret the diagrams which have been provided by GAL for this modified RNAV-1 SID PIR. However, we have copied essential track data descriptions from the CAP 1346 Annex 1 into Table 1 below to ease comparison with the modified RNAV-1 SID PIR data (at Columns (a) – (f)), and then added appropriate descriptions of the modified RNAV-1 SID traffic patterns for the period of May 2017 which is representative of the 6 months data from April to September 2017.

NOTES RELATING TO THE DATA IN THE TABLES

Col (a) Is the traffic sample.

Col (b) Note 1. Reference to Consultation Document (Con Doc) and ACP diagrams. Month of PIR review period and number of conventional SIDs flown is inserted. Comments provided on conventional SID track dispersion.

Col (c) Note 2. Reference to Consultation Document (Con Doc) and ACP diagrams. Month of PIR review period and number of RNAV SIDs flown inserted. Comments provided on RNAV SID track dispersion.

Col (d) Note 3. Comments provided on impact of the 2013 change compared with that portrayed in GAL consultation and ACP submission.

Col (e) Note 4. Observations on any discernible variance with tactical radar vectoring by ATC post RNAV SID replication implementation. The altitude when vectoring is permitted by Air Traffic Control is illustrated at the top of the column. It is important to note that as notified by the Secretary of State for Transport in the UK Aeronautical Information Package[1] (AIP), that aircraft which have attained the altitudes specified in the UK AIP Note 8, (either 3000ft or 4000ft AMSL) may be directed by air traffic controllers onto a different heading and commanders complying with any such direction will not by reason of so complying be deemed to have departed from the Noise Preferential Routeing. This information was included in the consultation document.:

The altitude of 4000ft applies to:

- All routes during the night - period 2330-0600 local time;
- Rwy 26 Routes 4,7,8,9 during the day period 0600-2330 local time.
- Rwy 08 Route 2 during the day period 0600-2330 local time.

The altitude of 3000ft applies during the day period 0600-2330 local time to:

- Rwy 26 Route 1 and to Rwy 08 Routes 3, 5 and 6.

Col (f) Note 5. Any remarks.

Col (g) Shows the CAA comparison of and impact of the modified Route 5 2017 RNAV-1 SID design.

Note 6. Altitude Slice Bands show a different traffic sample (one week) in the original PIR comparison period, however, for the modified RNAV-1 SID May 2017 sample, the number of departures is approximately 5 times greater than the 2014 sample as it is for the complete month.

Table 1 - ROUTE 5 – RWY 08 CLN / DVR / BIG – Comparison Jul 13 (Conv) v Jun 14 (RNAV) v Modified RNAV May 17

[1] The UK AIP is the methodology for publishing all aeronautical information, e.g. airways route alignment, Standard Instrument Departure procedures, aerodrome procedures and noise abatement procedures, to mention just a few.

SID Sample (a)	Conventional SID Comments (Note 1) (b)	RNAV 1 SID Comments (Note2) (c)	Impact of RNAV SID Replication (as shown in original PIR traffic sample (Note 3) (d)	Observations on Vectoring (Note 4) (e)	Remarks (Note 5) (f)	Comparison of and impact of Modified Route 5 RNAV SID based on May 2017 traffic sample (g)
	Con Doc Fig 5 ACP Fig 10	Con Doc Fig 6 ACP Fig 3	The forecast impact for this route was based on the impact shown in Con Doc Fig 6 and ACP Fig 3 which was predicated on the results of the Trial of Route 1. As the RNAV SID replicated the con SID it was forecast by GAL and the CAA that the mean track of the RNAV deps over the ground would be unchanged other than a more concentrated dispersion similar to that demonstrated during the RNAV Trial for Route 1. The RNAV SID CL was designed so that it would be directly aligned with the Conv SID CL. As shown in Con Doc Fig 7 the RNAV CL was co-located with the Conv SID CL. It was however recognised that there was also potential for RNAV departures to be slightly south of the conv SID departures, but until the RNAV SID was introduced, this could not be determined. The Environmental analysis of the impact was at CAP 1346 Annex 2.	For all Route 5 SIDs, aircraft may be vectored off the SID when reaching 3000ft amsl daytime, or 4000ft night time		
Diagram CLN1Z	**Month** **Jul 13** / **Number** **2076**	**Month** **Jun 14** / **Number** **1903**				**Month** **May 17** / **Number** **1991**
At 4000 ft	**See 01 CLACTON 4000 ft comparison** **SLIDE 8** Deps spread evenly across the NPR CL occupying approx 30% of the width of the NPR swathe. After passing the A22, the concentrated departure dispersion splits into 2 parts; vectoring appears to be evident for either the DVR or CLN routing, although ac may be following the DVR SID alignment. The majority of deps are reaching 4000ft before Dormansland.	**See 01 CLACTON 4000 ft comparison** **SLIDE 9** In the main, the dispersion of deps is spread evenly across the NPR CL occupying approx 20% of the width of the NPR swathe. After passing the A22, the concentrated departure dispersion splits into 2 parts - vectoring evident for either the DVR or CLN routing although ac may be following the DVR SID alignment. DVR SIDs appear to be slightly further south towards/ over Dormansland. The majority of deps are reaching 4000ft before Dormansland. In this traffic sample, there appear to be fewer deps over Lingfield using these SIDs compared with the conv SID. Note: in sample 2 with approx 50% less deps, this is not as evident.	The RNAV SID dispersion has slightly reduced compared with the width of the conv SID departure track dispersion, but shortly after passing the A22, there are 2 evident flight paths for the DVR and Clacton routes. Whilst ac are probably being vectored for the CLN routing, traffic on the DVR SID would either be following the SID procedure or being vectored by ATC. It was recognised as part of the ACP analysis, that there was a possibility that RNAV deps could be slightly south of the conv SID departures. This now appears evident from these traffic samples with the result that RNAV deps using the DVR SIDs are slightly further south towards / over Dormansland. The deps are slightly more concentrated than the conventional SID dispersion which was the aim of the RNAV SID replication, although the impacts of this are short in duration given the splitting of deps onto 2 routes, and the amount of vectoring by ATC to position the RNAV deps routing via Clacton.	There is a slight reduction in the spread of deps arising from vectoring.	RNAV track concentration as expected. RNAV sample is - 173 deps less.	**See 01 CLACTON 4000 ft comparison** **SLIDE 10** The traffic sample is almost a like for like comparison with the 2014 samples. The traffic pattern is similar up to the A22, however, the slight turn to the right towards Dormansland and Mark Beech is later. After the A22, some departure are turning right overflying the northern part of Lingfield racecourse and passing north of the cross-roads at Dormansland (the Dormans High Street/ Plough Road/Dormans Road junction). Other departures appear to continue to fly straight ahead whilst some vectoring is evident by ATC when aircraft are taken off the SID for ATC tactical reasons. A wide spread traffic pattern is apparent and is similar to the traffic pattern of the conventional SID. **In Slide 10**, the modified 2017 RNAV SID design delayed the turn which was previously at KKE 02 (not shown here) and introduced a new waypoint at KKE 04 as shown. With the introduction of KKE04, in the May 2017 RNAV SID traffic pattern, the radar tracks can be seen to better reflect the conventional radar track distribution as they pass between Lingfield and Dormansland as seen on the 2013 data plot (Slide 8). **Conclusion:** As aircraft pass between Lingfield and Dormansland, we believe the modified 2017 SID produces a traffic pattern which is more aligned to that of the 2013 conventional SID traffic pattern, and is closer to the NPR; thus, we consider that a better replication of the 2013 SID traffic pattern has been achieved up to 4000ft.

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Density Plot	See 02 CLACTON Density comparison SLIDE 8 Deps occupy approx. 10% of the width of the NPR swathe after departure and after passing the A22, there is a split in density dispersion into a number of single 'mini' concentrations. There is a wide pattern of vectoring shortly after passing the A22.	See 02 CLACTON Density comparison SLIDE 9 Deps occupy approx. 10% of the width of the NPR swathe after departure and after passing the A22, there is a single concentrated dispersion over Dormansland towards Mark Beach, then passing south of Penshurst. There is a wide pattern of vectoring shortly after passing the A22.	The RNAV SID dispersion has slightly reduced compared with the width of the conv SID deps. After the A22 the pattern of the RNAV deps is noticeably different from that of the conv deps. Whilst the conv deps showed two distinct eastbound concentrated tracks (one over Lingfield and one to the north of Dormansland), the RNAV pattern shows a single concentration that has moved further south such that it is closer to / above Dormansland. It was noted that the RNAV SIDs are turning earlier compared with the conv SIDs, with the turn commencing before the A22. This RNAV SID has resulted in a concentrated dispersion, although the impacts of the RNAV SID have been reduced by a continued wide spread vectoring practice when above NPR vectoring restrictions. Prior to vectoring, the deps are more concentrated than the conventional SID dispersion which was the aim of the RNAV SID replication.	There is a slight reduction in the spread of deps arising from vectoring. Vectoring has continued, however, it is apparent that traffic is further south of Edenbridge compared to the vectoring swathe of the conv SID.	RNAV track concentration as expected. RNAV sample is 173 deps less.	See 02 CLACTON Density comparison SLIDE 10 The traffic sample (i.e. number of flights) is almost a like for like comparison with the 2014 RNAV (slide 9) samples. It should be noted that the coloured Density Key has changed regarding the number of aircraft per colour (e.g. the densest, is now 200 aircraft plus as opposed to 500 aircraft plus (see track density explanation on slides). **This analysis is split into a number of segments.** For all segments, Wide spread vectoring is apparent and is similar to the traffic pattern of the conventional SID. **SEGMENT 1 TO THE A22 / KKE04** The traffic pattern is similar to the conventional traffic pattern up to the A22, however, the slight turn to the right towards Dormansland and Mark Beech is later when compared with the June 2014 RNAV-1 sample; this is due to the repositioning and replacement of the original waypoint KKE02 with KKE04. Conclusion: The delayed turn is more aligned with the traffic pattern of the 2013 conventional SID; hence this is a better replication. **SEGMENT 2 – A22 TO LINGFIELD / DORMANSLAND** After the A22, the main core of departure are turning right overflying the northern part of Lingfield racecourse and passing north of the cross-roads at Dormansland (the Dormans High Street/Plough Road/Dormans Road junction), compared to flying over the junction. It is difficult to measure the displacement, however, the modified RNAV design has moved the main concentrated core pattern (the May 2017 RNAV 1 sample) to the north, and is more similar to the southerly core pattern of the conventional SID (where the published SID was originally designed to be on the NPR). However, we have been able to estimate this shift as approximately 250m. Other departures appear to continue to fly straight ahead whilst some vectoring is evident by ATC when aircraft are taken off the SID for ATC tactical reasons. **Conclusion:** As aircraft pass Dormansland, we believe the modified SID produces a traffic pattern which is more aligned to that of the 2013 conventional SID traffic pattern, thus, we consider that a better replication of the SID traffic pattern as far as Dormansland has been achieved. **SEGMENT 3 DORMANSLAND TO PENSHURST (end of the NPR monitoring swathe)** **Passing Mark Beech:** As the concentrated traffic pattern passes overhead Mark Beech, there is a slight displacement further north of the centre of the Mark Beech village cross roads, whereas with

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						the original RNAV design the main concentration was slightly south of the cross roads. This shift takes the core of the May 2017 concentrated pattern slightly closer towards where the southerly 'mini concentration of the 2013 conventional SID traffic pattern passed to the north of Mark Beech. **Passing south of Penshurst (the B2188)** As the concentrated traffic pattern passes the B2188 south of Penshurst (using the bend in the road to the north of the Long Bridge as a reference point which is just visible on the track plots), there is a slight displacement to the south which is similar to the original RNAV (2014) design. At this point the core of the May 2017 concentrated pattern remains slightly further south compared with both the southerly 'mini concentration of the 2013 conventional SID traffic pattern, and the northerly 'mini concentration which passed directly overhead Penshurst. At this point, from the altitude plots the height of aircraft is in the 4-5000ft band, but the majority are in the 5-7000ft band but there could be some higher aircraft which are not evident in these track plots. **In Slide 8,** the 2013 main core of radar tracks appear to be routing via TUNBY (not shown here but it is where the two concentrated patterns converge) rather than on the nominal track of the published conventional SID. It should be noted the intent of the published SID was for aircraft to track a DVR radial and on that radial at 39NM before DVR aircraft were to be at 5000' or above and this fix was called TUNBY. It would appear with the coded overlays of the conventional aircraft are flying via TUNBY with a LAT/Long or on the radial that TUNBY was on at the time, instead of flying on a radial 272 degrees as published to DVR. **In Slide 9** the 2014 RNAV SID design shifts traffic patterns to the south of the centre of NPR but it is a good replication of the published conventional SID. **In Slide 10,** the modified 2017 RNAV SID design delayed the turn which was previously at KKE 02 (not shown here) and introduced a new waypoint at KKE 04 as shown. With the introduction of KKE04, in the May 2017 RNAV SID traffic pattern, the traffic patterns can be seen to better reflect the conventional traffic patterns as they pass between Lingfield and Dormansland as seen on the 2013 data plot (Slide 8). After passing Dormansland the main core of traffic tracks towards KKE10 southwest of Penshurst. This section of the Route 5 SID was not amended by the RNAV 2017 SID. **Conclusion:** Therefore, taking all the segments into consideration, there is a better replication in the vicinity of Dormansland, there is a slight improvement as departures pass Mark Beech, however, the traffic pattern remains similar to the original 2014 RNAV-1 SID pattern as it passes Penshurst although this results in a shift of the pattern further away from Penshurst by approximately 500m compared with the 2013 conventional SID traffic pattern.

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Alt Slice Diagrams	Period Number **1-31 Mar 14 476**	Period Number **1-7 Sep 14 411**				Period Number **1-31 May 2017 1991**
Alt 4-5000ft	**See 03 CLACTON Altitude Bands comparison** **SLIDE 2** Deps using approx 20-25% of the width of the NPR swathe spread across the NPR CL; however, vectoring occurring before the track change towards Dormansland. Majority of ac reaching 4000ft before the turn.	**See 03 CLACTON Altitude Bands comparison** **SLIDE 3** Deps using approx 10% of the width of the NPR swathe; however, vectoring occurring before the track change towards Dormansland. Majority of ac reaching 4000ft before the turn.	A slightly reduced spread of traffic with ac more concentrated, although vectoring is creating dispersion away from the RNAV SID CL both to the north and the south. The main concentration is slightly further south and now over Dormansland. It was noted that the RNAV SIDs are turning earlier compared with the conv SIDs, with the turn commencing before the A22.	No significant change in vectoring.	Traffic above 4000ft was not assessed in the ACP analysis as deps may be tactically vectored when reaching 3000/4000ft. RNAV sample is 65 deps less.	**See 03 CLACTON Altitude Bands comparison** **SLIDE 4** Note 6: the May 2017 traffic sample is approx. 4 times the size of the conventional SID sample of March 2014 and almost 5 times the size of the post implementation RNAV traffic sample of September 2014. Wide spread vectoring is apparent and is similar to the traffic pattern of the conventional SID. Considering the May 2017 traffic sample is vastly increased, the displacement towards the north as departures pass Dormansland is clearly visible, and therefore a better replication has been achieved. There is a slight displacement to the north compared with the original RNAV-1 SID as departures pass Mark Beech although the pattern is still slightly further south of the conventional traffic pattern. The pattern remains similar in the vicinity of Penshurst to that of the original RNAV-1 SID as the 2017 RNAV-1 design did not look to amend this section of the 2014 P RNAV SID. **Conclusion:** Therefore, there is a better replication in the vicinity of Dormansland, there is a slight improvement as departures pass Mark Beech, however, the traffic pattern remains similar to the original RNAV-1 SID as it passes Penshurst.
Alt 5-6000ft	**See 03 CLACTON Altitude Bands comparison** **SLIDE 8** Deps using approx 20-25% of the width of the NPR swathe spread across the NPR CL; however, increased vectoring evident in this alt band. Majority of ac reaching 5000ft before Lingfield racecourse. Widespread vectoring before the racecourse - presumably for the CLN SIDs	**See 03 CLACTON Altitude Bands comparison** **SLIDE 9** Deps using approx 10% of the width of the NPR swathe; however, increased vectoring evident in this alt band. Majority of ac reaching 5000ft before Lingfield racecourse. Widespread vectoring before the racecourse.	As the CLN SIDs are being vectored after passing the A22, the impact of the RNAV SID is somewhat negligible as there is little change in dispersion due to vectoring. For the DVR SIDs, the main concentration is slightly further south. This RNAV SID have resulted in a concentrated dispersion, although the impacts of the RNAV SID have been reduced by a continued wide spread vectoring practice when above NPR vectoring restrictions. The deps are more concentrated than the conventional SID dispersion which was the aim of the RNAV SID replication but impact less than evident in consultation due to vectoring.	Less vectoring evident although sample is -65 deps.	Traffic above 4000ft was not assessed in the ACP analysis as deps may be tactically vectored when reaching 3000/4000ft. RNAV sample is 65 deps less.	**See 03 CLACTON Altitude Bands comparison** **SLIDE 10** Note 6: the May 2017 traffic sample is approx. 4 times the size of the conventional SID sample of March 2014 and almost 5 times the size of the post implementation RNAV-1 traffic sample of September 2014. Wide spread vectoring is apparent and is similar to the traffic pattern of the conventional SID. Considering the May 2017 traffic sample is vastly increased, the displacement towards the north as departures pass Dormansland is clearly visible, hence the main core of departures has moved back to where they were before the change. Therefore, a better replication has been achieved at this location. There is a slight displacement to the north as departures pass Mark Beech. The pattern remains similar in the vicinity of Penshurst to that of the original RNAV-1 SID as the 2017 RNAV 1 did not look to amend this section of the 2014 P RNAV SID.

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						Conclusion: Therefore, there is a better replication in the vicinity of Dormansland, there is a slight improvement as departures pass Mark Beech, however, the traffic pattern remains similar to the original RNAV-1 SID as it passes Penshurst.
Alt 6-7000ft	See 03 CLACTON Altitude Bands comparison SLIDE 14 Deps using approx 20-25% of the width of the NPR swathe spread across the NPR CL; however, increased vectoring evident in this alt band. Majority of ac reaching 6000ft by Dormansland. Widespread vectoring initiated before the railway line to East Grinstead – presumably for the CLN SIDs.	See 03 CLACTON Altitude Bands comparison SLIDE 15 Deps using approx 10% of the width of the NPR swathe; however, increased vectoring evident in this alt band. Majority of ac reaching 6000ft by Dormansland. Widespread vectoring initiated before the railway line to East Grinstead – presumably for the CLN SIDs.	As the CLN SIDs are being vectored after passing the A22, the impact of the RNAV SID is somewhat negligible as there is little change in dispersion due to vectoring. For the DVR SIDs, the main concentration is slightly further south. This RNAV SID has resulted in a concentrated dispersion, although the impacts of the RNAV SID have been reduced by a continued wide spread vectoring practice when above NPR vectoring restrictions. The deps are more concentrated than the conventional SID dispersion which was the aim of the RNAV SID replication but impact less than evident in consultation due to vectoring.	Less vectoring evident although sample is -65 deps.	Traffic above 4000ft was not assessed in the ACP analysis as deps may be tactically vectored when reaching 3000/4000ft. RNAV sample is 65 deps less.	See 03 CLACTON Altitude Bands comparison SLIDE 16 Note 6: the May 2017 traffic sample is approx. 4 times the size of the conventional SID sample of March 2014 and almost 5 times the size of the post implementation RNAV traffic sample of September 2014. Wide spread vectoring is apparent and is similar to the traffic pattern of the conventional SID. Considering the May 2017 traffic sample is vastly increased, the displacement towards the north as departures pass Dormansland is clearly visible, hence the main core of departures has moved back to where they were before the change. Therefore, a better replication has been achieved at this location. There is a slight displacement to the north as departures pass Mark Beech although this is difficult to discern given the density of the track plot. The pattern remains similar in the vicinity of Penshurst to that of the original RNAV-1 SID, as the 2017 RNAV 1 did not look to amend this section of the 2014 P RNAV SID. **Conclusion:** Therefore, there is a better replication in the vicinity of Dormansland, there is a slight improvement as departures pass Mark Beech, however, the traffic pattern remains similar to the original RNAV-1 SID as it passes Penshurst.