MAYOR OF LONDON

Transport for London

Inner Thames Estuary Feasibility Study

Response to Airports Commission Call for Evidence

The Mayor of London's Submission:

Supporting technical documents

23 May 2014

Title: **Runway utilisation**

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Purpose of paper: **To provide an overview of how runway utilisation is determined and provide several examples of utilisation levels from airports around the world.**

Key messages:

- Runway utilisation—the standard industry metric of assessment—is determined by comparing theoretical daytime capacity with how intensively it is used in practice.
- Utilisation is affected by a variety of factors such as aircraft size and radar separation requirements.
- Utilisation provides a rough understanding of potential delays and level of resilience to prevent and/or recover from delays.

Mayor's Aviation Works Programme - New Hub Airport

Technical Note – Runway Utilisation

Transport for London

May 2014

Plan Design Enable

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Summary

Runway utilisation at an airport should be no more than 70 - 75% to deliver a resilient operation.

- This is supported by IATA recommendations and benchmarking of European Airports.
- There is a strong correlation between high runway utilisation and delays.
- London needs a four runway hub utilised at no more than 75% (with runways capable of independent operation) to provide sufficient capacity and resilience to meet future traffic demand
- Runway utilisation of the various options, compared with the theoretical capacity is assessed as follows
  - Runway utilisation at Heathrow is currently 96% of declared runway capability
  - Runway utilisation at Gatwick is currently 73% of declared runway capability
  - Runway utilisation at Heathrow with 3 runways is planned to be 91%
  - Runway utilisation at Heathrow Hub with 3 runways is planned to be 82%
  - Runway utilisation at Gatwick with 2 runways is planned to be 77%
  - Runway utilisation at the Isle of Grain is planned to be no greater than 75%

1. Introduction

A runway's declared hourly capacity is theoretical, but site specific, and is used for scheduling purposes. A runway's declared capacity is fundamentally defined by both its physical configuration and the surrounding airspace management. A runway's declared capacity takes into account the 'fire breaks' an airport considers appropriate to maintain resilience to respond to delay and aid recovery. It is also affected by the aircraft mix and their sequencing to and from the runway. Different separations are required between movements depending on aircraft size, with fewer larger and heavier aircraft capable of being handled than smaller/lighter aircraft in a given period. In Europe the declared runway capacity is assessed using instrument flight rules (IFR).

Runway utilisation is the standard industry metric to assess how intensively a runway is used over a year compared with its declared hourly capability. Runway utilisation is defined in this paper as the percentage of the airport's declared runway capacity actually used. It is typically measured as the % of the annual daytime runway declared capacity (when the runway is operating closest to its maximum capacity) actually used. It is argued in this paper that it could be used as a rough guide as to the level of delays that might be anticipated, and the level of resilience provided to avoid or recover from those delays.

There is no standard agreement as to the definition of daytime; each airport has its own definition, so each airport's individual definition of daytime has been used in this paper.

The minimum distance allowed between arriving aircraft is based on the wake vortex effect between different aircraft types and radar separation requirements, and is related to runway geometry. The following table provides an overview of the current separation minima in the UK which are applied by NATS. The distances are given in the Table 1 below. The shaded cells represent combinations where the distance requirement is based on minimum radar separation rather than wake vortex. There is also provision in favourable conditions to allow 2.5NM separations for some combinations of aircraft where the wake turbulence criterion does not apply. Reliance on these reduced separations in declaring runway scheduling limits however makes an airport more vulnerable to delays in deteriorating weather conditions.

Following aircraft	**Leading Aircraft**					
	Super heavy (A380-800)	Heavy	Upper medium	Lower medium	Small	Light
Super heavy (A380-800)	#	#	#	#	#	#
Heavy	6	4	#	#	#	#
Upper medium	7	5	3	#	#	#
Lower medium	7	5	4	#	#	#
Small	7	6	4	3	3	#
Light	8	7	6	5	4	#

Derived from NATS Aeronautical Information Circular P 3/2014
Signifies that separation for wake turbulence reasons alone is not necessary

Table 1-1 Distance based separation minima (in NM)

A number of factors can impact an airport's ability to reach its optimum potential. These include;

- Operating restrictions such as night curfews, planning restrictions or agreements that limit or stop operations during sensitive times
- Infrastructure deficiencies such as insufficient or poorly located rapid exit taxiways
- Airport layout weaknesses such as aircraft crossing active runways
- Management decisions such as the provision of 'fire breaks' to provide resilience during the day to accommodate delays
- Adverse weather conditions (principally headwind and/or low visibility)
- Airspace and aircraft 'flow' management to and from the runway amongst a myriad of other factors

A runway's normal hourly scheduling limit takes into account a number of factors;

- The runway operating configuration depending on whether it is a single runway or multiple runways operating in segregated, dependent, independent or mixed mode.
- The proposed traffic mix, hence Gatwick's runway capacity is higher than Heathrow in part because it has only 10% heavy aircraft compared with 40% heavy aircraft at Heathrow.
- Variations by time of day to recognise different sizes of aircraft and to provide resilience.
- The average level of re-sequencing and delay that airlines are prepared to accept

2. Benchmarking current runway utilisation

In the UK the agreed scheduling limit, at coordinated airports, is declared by the Airport, after consultation with ACL, NATS and the airlines having regard to the analysis of anticipated holding delay by NATS. This could be described as the realistic movements per hour. For European airports the scheduling declarations are those from the individual airports. The following are the current 2014 typical hourly declarations at key airports, although these will vary slightly by time of day.

London Heathrow	80 average daytime movements/hour on 2 independent segregated runways (with up to 44 arrivals or 45 departures peak in a single hour)
London Gatwick	50 average daytime movements/hour on a single mixed mode runway (with up to 55 peak in a single hour)
Manchester	49 average daytime movements/hour (with up to 61 peak movements on 2 close parallel runways)
Paris Charles de Gaulle	97 average daytime movements/hour with 117 peak movements/hour on 2 pairs of close parallel runways (with up to 62 arrivals or 67 departures in a single hour)
Frankfurt	98 -100 daytime movements/hour on 4 runways (with 55 peak departures or arrivals movements). Infrastructure is already in place to permit runway movements to increase over time to 120 movements/hour.
Madrid Barajas	98 peak movements/hour (with 48 arrivals and 50 departures movements)
Dubai International	62 peak combined movements/hour on 2 close parallel runways (with36 departures and 33 arrivals movements)

The theoretical annual maximum figure under IFR conditions is based on a 100% take up of the theoretically available ATMs, i.e. Hourly runway movements x Number of operating hours a day x 365 days a year = theoretical ATM capacity.

IATA proposes in their Airport Design Reference Manual 9th edition 2004 C1.5.17 that a realistic design expectation level for runway utilisation over the year would be **70%.**

2.1. London Heathrow LHR (2013)

With a total of 470,000 actual ATMs split approximately 465,000 actual between 06.00 and 22.30 UTC and 5,000 actual movements between 22.30 and 05.00 UTC

Daytime runway utilisation = 465,000 ATMs / (80 x 17.5hrs x 365days = 511,000ATMs)

Current runway utilisation = 92% but most of the spare capacity at Heathrow is in the half hour starting at 22.00UTC. Analysis of Heathrow's operational data for July 2013 showed there was only 1 fight a week scheduled in this period (22.00-22.30 UTC) so if this half hour were discounted and the utilisation were measured over 17 hours the runway utilisation would be 94%. If the number of flights in 2030 increased to 475,000 ATMs (with 5,000 remaining in the night) in the 17 hour day the runway utilisation would be 96%.

(Heathrow is also restricted to 480,000 ATMs per annum but runway utilisation is not measured against this constraint.)

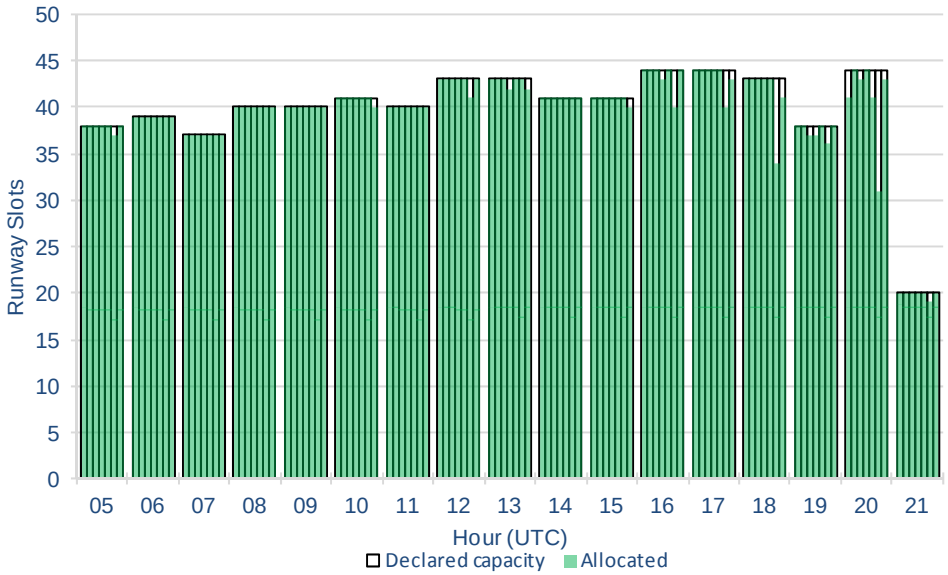

Figure 2-1 Heathrow runway movements allocations summer 2014 - Arrivals

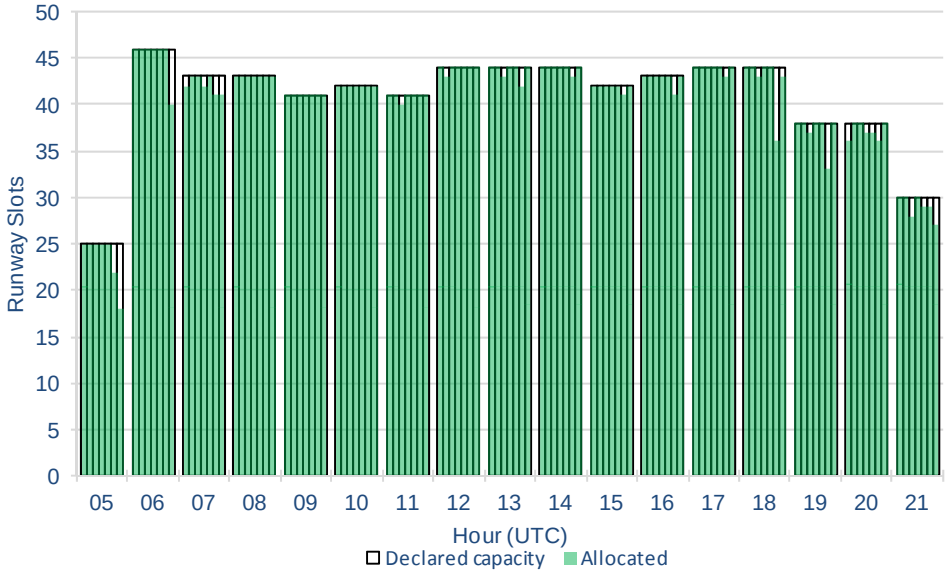

Figure 2-2 Heathrow runway movements allocations summer 2014 - Departures

2.2. London Gatwick LGW (2013)

244,000 actual overall ATMs split approximately 232,000 daytime and 12,000 night time movements

Daytime runway utilisation = 232,000 ATMs / (50 x 17.5hrs x 365days = 319,000ATMs)

Current runway utilisation = **73%**

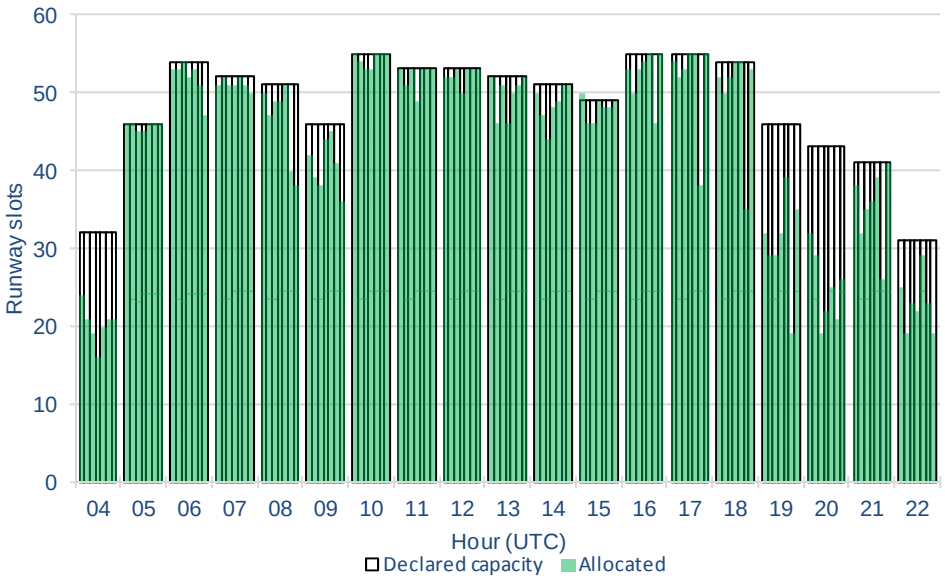

Figure 2-1 Gatwick runway movements allocations summer 2014 – Two-way

2.3. Frankfurt FRA (2013)

473,000 actual overall ATMs with 473,000 actual daytime and 0 night time movements

Daytime runway utilisation = 473,000 ATMs / (98 x 18.0hrs x 365days = 644,000ATMs)

Current runway utilisation = **73%**

(The 4 runways are claimed to be capable of handling 120 movements/hour in future)

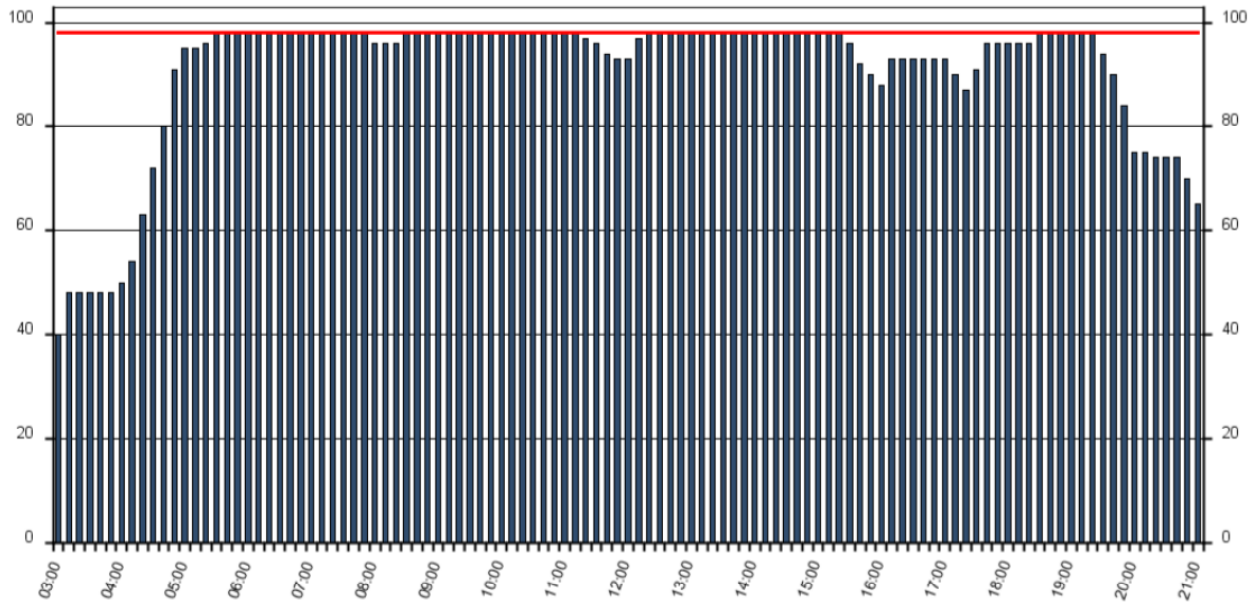

Figure 2-2 Frankfurt 2014 start of summer season runway allocation

2.4. Paris Charles de Gaulle CDG (2013)

472,000 actual overall ATMs split approximately 452,000 daytime and 20,000 night time movements

Daytime runway utilisation = 452,000 ATMs / (97 x 19hrs x 365days = 672,000ATMs)

Current runway utilisation = **67%**

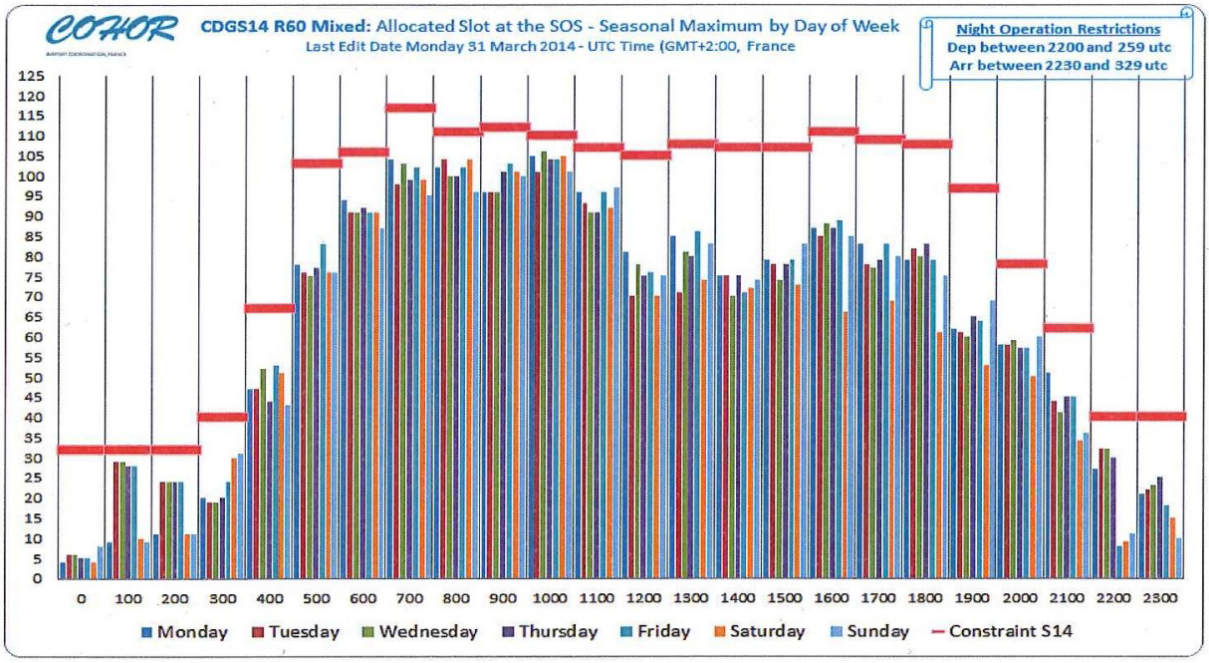

Figure 2-5 Charles de Gaulle 2014 start of summer season runway allocation

2.5. Amsterdam Schiphol AMS (2013)

426,000 overall ATMs split 391,000 daytime and 35,000 night time movements

Daytime runway utilisation = 391,000 ATMs / (106/110 x 16.0hrs x 365days = 631,000ATMs)

Current runway utilisation = **62%**

(Environmental considerations currently limit the runway to 510,000 movements/annum. 20 or 30 minute fire breaks are incorporated into the schedule between departures and arrivals peaks. Declared slots available for winter 2013/summer 2014 are 464,400ATMs).

2.6. Dubai DXB (2013)

370,000 overall ATMs spread over 24hrs a day

Runway utilisation = 370,000 ATMs/ (62 x 24hrs x 365days = 543,000ATMs)

Current runway utilisation = **68%**

(A new 5 runway airport DWC is currently being developed and traffic progressively migrated)

3. Benchmarking resilience and delays

The following Table 3-1 is derived from Airport level – ANS performance monitoring 2013 published by Eurocontrol.

	Arrivals				Departures	
Airport	**Total ATFM Delay**	**ATMs**	**ATFM[1] Average Delay**	**ASMA[2] additional time**	**Taxi out additional time**	**Runway Utilisation**
	Minutes	**'000s**	**Minutes**	**Minutes**	**Minutes**	
London Heathrow	612,200	235	2.59	9.2	8.3	92%
London Gatwick	70,923	122	0.57	2.7	4.8	73%
Frankfurt	207,600	237	0.88	2.9	4.1	73%
Paris Charles de Gaulle	158,869	226	0.66	0.9	4.5	67%
Amsterdam Schiphol	292,065	213	1.34	1.4	3.0	62%

Source: Eurocontrol

Table 3-1 Airport Level – ANS performance monitoring 2013

The table can be taken as an illustration of delays increasing with high runway utilisation rates. The vast majority of the cause of these delays is weather and so this is a clear illustration of the effect of un-planned situations on resilience at high of levels of runway utilisation.

The following Table 3-2 is derived from the CODA Digest – Delays to Air Transport in Europe Annual 2013 published by Eurocontrol for the European Commission.

	Departures		Arrivals	
Airport	**Average Delay**	**EU Rank**	**Average Delay**	**EU Rank**
London Heathrow	13.1 minutes	2	14.1 minutes	1
London Gatwick	12.8 minutes	3	12.9 minutes	3
Paris Charles de Gaulle	12.2 minutes	6	9.6 minutes	18
Frankfurt	#	Not in worst 20	#	Not in worst 20
Amsterdam Schiphol	#	Not in worst 20	#	Not in worst 20

Source: Eurocontrol

Table 3-2 CODA Digest – Delays to Air Transport in Europe Annual 2013

Table 3-2 includes delays from all causes (reactionary, airline, airport and weather). It illustrates that once a delay is incurred with high levels of utilisation it can be more difficult to recover.

The above airports, excepting Heathrow, have reduced their traffic levels and improved their overall delay record in 2013 compared with 2012 while Heathrow has increased traffic volumes and delays in 2013 compared with 2012.

The above tables clearly demonstrate that there is a significant increase in delays with very high runway utilisations.

[1] ATFM – This delay is when special airport arrival regulations have to be put in place due to adverse weather etc.
[2] ASMA – Arrival Sequencing and Metering Area. It is measuring additional flying time for inbound aircraft, and is directly related to demand above landing capacity, resulting in airborne holding.

4. Future runway capability

Based on the above benchmarking the following assumptions are made about theoretical hourly runway capability under IFR conditions for future options.

- An independent mixed mode runway (or multiple runways sufficiently spaced to operate in mixed mode) is considered to be capable of handling an average of 50 movements an hour throughout the day (benchmark London Gatwick)
- A close parallel segregated dependent pair of runways are considered to be capable of handling 60 movements an hour throughout the day (benchmarks Paris Charles de Gaulle & Manchester)
- A wide spaced segregated pair of runways are considered to be capable of handling 80 movements an hour throughout the day (benchmark London Heathrow)

These above assumptions are used consistently throughout the following calculations.

4.1. London Heathrow NW (2030+)

Runway configuration - 2 runways in wide spaced segregated mode and 1 in mixed mode

740,000 overall ATMs (735,000 between 06.00 and 22.30 and 5,000 between 22.30 and 05.00 UTC)

Daytime utilisation assuming the period between 22.00 and 22.30 UTC were not scheduled = 735,000 ATMs / [80+50 = 130] x 17hrs x 365days = 806,650ATMs)

Projected runway utilisation = **91%**

4.2. London Heathrow Hub (2030+)

Runway configuration - 2 runways in wide spaced segregated mode and 1 in mixed mode

670,000 overall ATMs (665,000 between 06.00 & 22.30 and 5,000 between 22.30 & 05.00 UTC)

Daytime utilisation 665,000 ATMs / [80+50 = 130] x 17hrs x 365days = 806,650ATMs)

Projected runway utilisation = **82%**

4.3. London Gatwick (2030+)

Runway configuration - 2 runways in mixed mode

502,500 overall ATMs (490,000 between 06.00 & 22.30 and 12,500 between 22.300 & 06.00 UTC)

Daytime runway utilisation = 490,000 ATMs / (100 x 17.5hrs x 365days = 638,750ATMs)

Projected runway utilisation = **77%**

4.4. Isle of Grain (2030+) TfL Proposal

180mppa – Mode 1 &3 operation*

Runway configuration - 4 runways in mixed mode

1,000,000 overall ATMs split approximately 950,000 daytime and 50,000 night time movements

Daytime runway utilisation = 950,000 ATMs/ (200 [4x50] x 17.5hrs x 365days = 1,280,000ATMs)

Projected runway utilisation = **74%**

4.5. Isle of Grain (2030+) Airports Commission Proposal

150mppa – Mode 2 & 3 operation*

Runway configuration – 4 runways in wide spaced segregated mode

830,000 overall ATMs split approximately 800,000 daytime and 30,000 night time movements

Daytime runway utilisation = 800,000 ATMs / (160 [4x40] x 17.5hrs x 365days = 1,020,000ATMs)

Projected runway utilisation = **78%**

4.6. Isle of Grain (2030+) Foster Proposal – Phase 2

150mppa – Modes 1, 3 & 4 operation*

Runway configuration – 1 pair of close parallel runways in dependent segregated mode and two runways in mixed mode

830,000 overall ATMs split approximately 800,000 daytime and 30,000 night time movements

Daytime runway utilisation = 800,000 ATMs/ (160 [2x30 + 2 x 50] x 17.5hrs x 365days = 1,020,000ATMs)

Projected runway utilisation = **78%**

* Mode of Operation as the result of runway geometry or operating restrictions. There are multiple operational options for runways in SOIR configuration with varying capacity limitations. Different sites and different runway spacing lead to different capacities. Depending on configuration capacity will vary by mode of operation.

- Mode 1 – independent parallel approaches
- Mode 2 – dependent parallel approaches
- Mode 3 – independent parallel departures
- Mode 4 – segregated parallel operations

Modes 1 and 3 can also be modified by mixed, or semi -mixed mode parallel operations where individual runways are used for both take offs and landings increasing overall capacity. Modes 1 and 3 offer the greatest capacity and can be further increased by mixed mode operations on each runway; Mode 2 reduces arrivals capacity, while Mode 4 reduces both arrivals and departures throughput and therefore has the lowest capacity.

Notes

Runway capability in this paper is quoted as the scheduling limit for summer 2014.

Annual traffic in this paper is quoted as 2013, whereas Heathrow are quoting ACI figures for 2011 except for Heathrow itself which is quoted as 2013. The ACI figure for Heathrow is over 480,000 movements in 2011.

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