NATS Support to the Airports Commission

Appraisal Module 15: Operational Risk: Airspace Resilience

Purpose

This briefing note responds to the Commission's request for NATS to report on the potential impact on the resilience of the London TMA that could arise from implementing the three Long Term Measures being considered by the Airports Commission.

Context

Resilient services are delivered within the London Terminal Manoeuvring Area (TMA) when all aspects of the service delivery chain operate to designed and expected capabilities. In this context, the term 'resilient' means the ability to provide and maintain an acceptable level of service despite the existence of failures or limitations of some aspects of the network or the environment within which it is operating.

In this case, the service delivery chain is the delivery of traffic from the London TMA to the London airports and vice versa. Due to the inter-related and serial nature of air traffic operations, limitations at the airports (e.g. ground congestion) could have a consequential impact on the TMA operation. Similarly, inefficiencies or limitations in the London TMA operation (e.g. tactical restrictions on departure routes) may result in the airport not being fully utilised.

The resilience of the overall operation is maximised when all stakeholders – airport operators, airline operators and Air Traffic Service providers - work together (both tactically and strategically) to ensure that the aspect of the service they provide delivers the most effective outcomes possible. Unexpected limitations or weaknesses can result in the overall system not delivering the type or level of service planned, resulting in bottlenecks and inefficiencies in the ATC and/or airport systems.

The airport operator is responsible for resilient service delivery at the airport (e.g. terminal facilities, power, fuel and infrastructure required to meet the declared capacity). Another transport consultancy has been instructed by the Airports Commission to assess the future ground-based operations that would result from a Heathrow Airport North West Runway, a Heathrow Airport Northern Runway Extension and a Gatwick Airport Second Runway. NATS has engaged with that consultancy to ensure that any limitations (such as limitations in taxiways or aircraft ground holding areas as seen in some proposals) that may affect the resilience of the airspace operation are identified and fully understood.

The development of an operating schedule that enables efficient airport operations is the responsibility of the airport operator, working closely with airlines operators and the Air Traffic Service provider. With the additional traffic levels expected to be supported by the London TMA in the timeframe being considered, a more holistic approach to airport scheduling than currently exists may be required, specifically ensuring that published movement rates can be supported by

the airport infrastructure, including sufficient aircraft stand/satellite facilities, effective passenger management and an efficient taxiway system that does not impact runway utilisation.

The Commission will be aware that the CAA has recently undertaken and published a report on the current and near-term operational resilience of Heathrow and Gatwick airports[1].

A key determinant of delivering resilient services is the airspace structure supporting the London TMA. This will be revised over the forthcoming years (irrespective of whether or where an additional runway is delivered) under a major airspace redesign programme being progressed by NATS called the London Airspace Management Programme (LAMP), established to increase the capability of the TMA operation and thus improve the resilience of the services provided.

The LAMP investment will deliver a revised airspace design based on the existing runway configurations. An additional runway at either Gatwick airport or Heathrow airport will require further investment to ensure that the additional traffic levels expected can be safely accommodated within the London TMA and surrounding en-route airspace in a manner that does not result in an unacceptable increase in delays nor result in unacceptably inefficient flight profiles (both when the additional runway becomes operational and as the airport reaches capacity).

Whilst NATS believes that solutions to these challenges could be found, there are many aspects outside NATS control that would need to be addressed before the enhanced airspace infrastructure could be ultimately delivered, including:

- A satisfactory outcome from the public consultations on revised noise profiles (as required by whatever Airspace Change Process may exist at that time);
- Approval by the CAA for the revised arrival and departure route structures;
- Political commitment and willingness approval by the Department for Transport to implement these; and,
- Approval from the CAA and European Commission under whatever Performance Regime may exist at that time to allow recovery of the investment costs and operating costs through increased user charges.

The ability for the industry to work constructively to deliver these changes will be vital to ensure that the scale of airspace changes required to accommodate a new runway is delivered. Recent experience shows that these can be challenging activities and the support and commitment of the airport operators, the CAA and the Department for Transport will be required to deliver the outcomes required.

[1] Review of Operational Resilience at Heathrow and Gatwick, Workstream 3: Developing CAA Guidance, Final Report, July 2014.

The Schemes Being Considered

The three schemes being considered by the Airports Commission are:

1. A Gatwick Airport Second Runway located to the south of the existing runway delivering an additional 300k ATMs pa with an overall peak flow of 98 ATMs/hr;

2. A Heathrow Airport North West Runway located to the north west of the existing runways delivering an additional 260k ATMs pa, with an overall peak flow of 128 ATMs/hr; and,

3. A Heathrow Airport Northern Runway Extension to provide a runway of sufficient length to support simultaneous arrival and departures delivering an additional 220k ATMs pa, with an overall peak flow of 130 ATMs/hr.

Factors Common to All Schemes

NATS will be able to continue to provide the required type and quality of service as agreed with its customers for any of the three schemes being considered by the Airports Commission, although there are some factors that will test the resilience of the London TMA operation, some of which that are common to all schemes and some that are scheme/location specific.

The future operating environment and advanced operational concepts set out in our Airspace Efficiency report[2] will help NATS deliver services to the standards required when supporting the additional traffic levels (both hourly peak and annual) envisaged by the scheme promoters.

Impact of Strong Headwinds

The use of Time Based Separation (TBS) will enable the partial recovery of otherwise lost movements during instances of strong headwind conditions at both Heathrow and Gatwick airports. TBS is expected to be able to recover up to five movements an hour an hour at Heathrow airport; corresponding analysis has not yet been undertaken for Gatwick airport.

Typically weather related arrival ATFM (Air Traffic Flow Management) causes more than 400k minutes of delay of a year, based on 2012 figures. Strong wind typically affects 65 days annually and Low Visibility Procedures (LVPs) applied on 20 days.

On a normal day at Heathrow a landing rate of 40-45 arrival an hour is regularly delivered. On strong wind days (such as 9th October 2014) landing rates are reduced to 32-38 per hour. Once the landing rate drops below 36 per hour, airlines have to cancel flights and we see increased airborne holding. Applying a flow rate of 36 per hour typically generates more than 11,000 minutes of delay over the course of a day.

The monitoring value for Gatwick is 30 arrivals per hour, however due to the nature of the operation and the various changes to scheduled demand, an arrival demand greater than 30 per hour is rare. The landing rate fluctuates during the day with the first wave being departure biased

[2] Appraisal Module 14: Operational Efficiency: Airspace Efficiency Report.

with low arrival demand. The arrival spacing is managed on a tactical basis throughout the day to make optimum use of the runway and caters for changes in arrival and/or departure demand. The Gatwick operation is not significantly impacted by strong wind as the gaps are managed to provide the optimum Arrival-Departure-Arrival sequence.

Arrival delays can have a resulting impact on departures as there is limited flexibility in the aircraft's rostered schedule to fully absorb arrival delays, with disembarkation, aircraft preparation and passenger embarkation all taking a fixed amount of time. Effective stand and satellite management is also predicated upon a planned throughput of traffic and delayed departures may result in stands being unavailable for delayed arriving traffic.

In its first delivery at Heathrow, Time Based Separation will only be applied between wake vortex pairs (i.e. between two aircraft where wake separation is greater than radar separation – see table below)[3] at Heathrow in 2015. The delivery of TBS at Gatwick by c.2020 will see TBS used between all pairs of aircraft, improving efficiency and runway utilisation, as well as resilience to headwind conditions.

		Follower					
		Super Heavy	Heavy	Upper Medium	Lower Medium	Small	Light
Leader	Super Heavy	4	6	7	7	7	8
	Heavy	4	4	5	5	6	7
	Upper Medium	*	*	3	4	4	6
	Lower Medium	*	*	*	*	3	5
	Small	*	*	*	*	3	4
	Light	*	*	*	*	*	*

* = No wake vortex constraint exists but the minimum radar separation applies.

[3] Approximately 40% of the pairs of aircraft operating into Heathrow.

Impact of Low Visibility Conditions

Low Visibility conditions can have a significant detrimental impact on airport operations, resulting in arrival and departure delays. Annex A sets out some historical information about the application of Low Visibility Procedures at Heathrow and Gatwick airports. All three schemes propose to use the Instrument Landing System at Category 3B capability[4] to enable landing during reduced visibility conditions. The continued use of such a capability will not have a detrimental impact on the resilience of the TMA operation. In the timeframes being considered, Ground-Based Augmentation Systems supporting that also support a Category 3B (GBAS CAT3) landing capability will potentially be delivered to improve/protect resilience.

Impact of Airport Closures

It is rare for local situations or emergencies to result in an airport having to temporarily close (e.g. the temporary closures of Heathrow airport on 24th May 2013[5] and Gatwick airport on 24th July 2009[6]).

However whilst rare, they have the potential to have a significant and disruptive impact on the surrounding airspace infrastructure, necessitating the suspension of departures, diversions to alternate airports and increased airborne holding. The London TMA operation is configured to be able to continue to provide safe operations in the event of both expected (e.g. forecast snow) and unexpected (e.g. aircraft incident) runway and/or airport closures.

The closure of either a two runway Gatwick airport or a three runway Heathrow airport (as proposed by either schemes) would have a significant adverse impact on the London TMA and surrounding en-route airspace. The impact of this would be most pronounced during peak traffic flows due to the volume of traffic being controlled within the London TMA that would need to either be held in airborne holding stacks or diverted to alternative airports.

The closure of the two single runway main London airports (i.e. Stansted and Luton) would also have a significant impact on the London TMA. This would in part be mitigated by the additional runway capacity that would be available at either Heathrow or Gatwick, although the ability to accommodate diverting traffic would depend upon available spare capacity, and which will reduce over time as demand grows (i.e. there will come a point when the capacity provided by the additional runway is fully utilised). The temporary closure of London City and non-London airports would have only a minimal impact on the services provided to traffic operating within the London TMA.

[4] ILS CAT 3B enables landing with a zero Decision Height and a Runway Visual Range of 150 feet. A decision height (DH) is a specified lowest height in the approach descent at which, if the required visual reference to continue the approach (such as the runway markings or runway environment) is not visible to the pilot, the pilot must initiate a missed approach. The Runway Visual Range is the distance over which a pilot of an aircraft on the centerline of the runway can see the runway surface markings delineating the runway or identifying its center line.

[5] Heathrow was temporarily closed on 24th May 2013 due to the emergency landing of a BA flight outbound to Oslo returning to and making an emergency landing at Heathrow due to a technical fault.

[6] Gatwick was temporarily closed on 24th July 2009 when a Cardiff-bound DASH8 aircraft from Paris Charles de Gaulle made an emergency landing following the detection of smoke inside the cabin.

Scheme-specific Issues: Gatwick Airport Second Runway

NATS LAMP investment to increase the capacity and resilience of the London TMA will deliver revised airspace designs based upon the existing number of runways at the London airports. Deployment of the Gatwick Airport Second Runway scheme will require a further redesign on the airspace supporting Gatwick airport to ensure that the additional traffic levels and revised airport operation can be accommodated.

Instances of runway or airport unavailability will result in all available airborne holding concepts being used until the restrictions are removed and, depending upon the expected duration of the outage, necessitating some aircraft diverting to an alternative airport. Arrival flows at Gatwick will use Point Merge linear holding concepts, supported by orbital holding stacks when the maximum amount of delay that can be absorbed by the point merge arc exceeds available runway capacity.

Instances of 'go-arounds' managed through Missed Approach Procedures at Gatwick operating two runways may be more complex than those that currently exist to support the single runway operation. Missed Approach Procedures that do not result in a less resilient operation being provided will need to be developed; these are the responsibility of the airport operator supported by the airport air traffic control service provider. Should an increase in instances of Missed Approaches occur, then resilience of the TMA operation will be tested as traffic aborting landings will need to be de-conflicted with other arriving/departing traffic in the vicinity of the airports and then re-integrated into the arrival stream.

The loss of the second runway at Gatwick would result in single runway operations. A single runway would not be able to accommodate peak level demand and airborne holding would certainly be required and diversions would be expected. Such a situation would have a significant impact on the London TMA and surrounding airports.

Scheme-specific Issues: Heathrow Airport North West Runway

NATS LAMP investment to increase the capacity and resilience of the London TMA will deliver revised airspace designs based upon the existing number of runways at the London airports. Deployment of the Heathrow Airport North West Runway will require a further redesign on the airspace supporting Heathrow airport to ensure that the additional traffic levels and revised airport operation can be accommodated.

Instances of runway or airport unavailability could result in all available airborne holding concepts being used until the restrictions are removed and, depending upon the expected duration of the outage, requiring some aircraft to divert to an alternative airport. Arrival flows at Heathrow will use Tromboning linear holding concepts, supported by orbital holding stacks when the maximum amount of delay that can be absorbed by the trombone arrival route exceeds available runway capacity.

Instances of 'go-arounds' managed through Missed Approach Procedures at Heathrow operating three runways may be more complex than those that currently exist to support the two runway operation. Missed Approach Procedures that do not result in a less resilient operation being provided will need to be developed; these are the responsibility of the airport operator supported by the airport air traffic control service provider. Should an increase in instances of Missed Approaches occur, then resilience of the TMA operation will be tested as traffic aborting landings will need to be de-conflicted with other arriving/departing traffic in the vicinity of the airports and then re-integrated into the arrival stream.

The loss of a single runway at an expanded Heathrow under this scheme would have an impact on the London TMA operation, with the impact being most profound if the outage occurred during peak operating hours.

Under this proposal, irrespective of which runway was unavailable, departures could be temporarily suspended to enable the remaining two runways to be used for landing. There is also flexibility to use the remaining runways for departures if inbound demand was low or one runway for landing and one for departure similar to the current operation. The loss of two runways would result in single runway operations. A single runway would not be able to accommodate peak level demand and airborne holding would certainly be required and diversions would be expected. Such a situation would have a significant impact on the London TMA and surrounding airports.

Scheme-specific Issues: Heathrow Airport Northern Runway Extension

NATS LAMP investment to increase the capacity and resilience of the London TMA will deliver revised airspace designs based upon the existing number of runways at the London airports. Deployment of the Heathrow Airport Northern Runway Extension will require a further redesign on the airspace supporting Heathrow airport to ensure that the additional traffic levels and revised airport operation can be accommodated.

Instances of runway or airport unavailability could result in all available airborne holding concepts being used until the restrictions are removed and, depending upon the expected duration of the outage, requiring some aircraft to divert to an alternative airport. Arrival flows at Heathrow will use Tromboning linear holding concepts, supported by orbital holding stacks when the maximum amount of delay that can be absorbed by the trombone arrival route exceeds available runway capacity.

Instances of 'go-arounds' managed through Missed Approach Procedures at Heathrow operating three runways may be more complex than those that currently exist to support the two runway operation. Missed Approach Procedures that do not result in a less resilient operation being provided will need to be developed; these are the responsibility of the airport operator supported by the airport air traffic control service provider. Should an increase in instances of Missed Approaches occur, then resilience of the TMA operation will be tested as traffic aborting landings will need to be de-conflicted with other arriving/departing traffic in the vicinity of the airports and then re-integrated into the arrival stream.

The loss of a single runway at an expanded Heathrow as the result of this scheme would have an impact on the London TMA operation, with the impact being most profound if the outage occurred during peak operating hours.

Under this proposal, the loss of the southerly runway would result in only one runway being available for landing traffic as the current northerly runway and the extended runway could not both be used to support landing traffic at the same time. Under such a circumstance, the loss of the southerly runway would result in only one runway being available for arrivals. If only either the current northerly runway or the extended runway was unavailable, then there would still be two runways to accept arriving traffic. The loss of any two runways would result in single runway operations and would have a significant adverse impact on the London TMA. A single runway would not be able to accommodate peak level demand and airborne holding would certainly be required and diversions would be expected. Such a situation would have a significant impact on the London TMA and surrounding airports.

Conclusions

Future technological and airspace changes will enable NATS to improve the resilience of the services it provides within the London TMA. Before the additional runway becomes operational, the London TMA would have been substantially redesigned by the London Airspace Management Programme (LAMP), based on the existing number of runways operated by the London airports, and will be supported by advanced operational concepts (such as trajectory-based operations) and redesigned airspace structures (including the linear holding techniques of Point Merge and Tromboning). Further airspace redesigns will be required to ensure that the increased traffic levels enabled by the additional runway can be effectively integrated into the London TMA operation.

As traffic levels increase to the maximum traffic levels envisaged by the scheme promoters (both hourly and annually), a major factor that currently tests the resilience of the system (i.e. strong headwind conditions) will be mitigated by the use of Time Based Separation in the Final Approach phase of flight at both Gatwick and Heathrow airports.

The operational concepts envisaged by all three schemes align with NATS expected future concepts and none sets out proposals or concepts that would result in NATS being unable to provide resilient services or would prevent NATS being able to react to adverse operating circumstances such as temporary airport & runway outages.

The resilience of the network will depend on the level of demand placed upon it at instances of total or partial failure. When the additional runway opens, it can be expected that the network would be more resilient to failures that result in the closure of individual runways as the additional runway will provide the ability to land arriving flights. There is however the possibility that the interactions of the runways at the airport where that additional runway is provided may result in a less resilient airport operation being delivered (e.g. potentially caused by runway / taxiway interactions that make that airport more susceptible to failures or inefficiencies) and this could have an knock-on impact earlier on and later on in the service delivery chain. However, the implementation of TBS and GBAS technologies has the potential to improve the situation.

It is not possible at this stage to assert that an additional runway would necessarily lead to a more resilient operation within the London TMA: whilst it would provide additional runway capacity, it could also increase the quantity of failure modes which could have an impact on the overall network. It is reasonable to expect that when the new runway opens the network will be more resilient but that as traffic levels increase the level of resilience could reduce (as the system will become more stressed through increased demand).

It should also be noted that during situations of runway or airport outages, the application of European network management procedures will mitigate the impact on all affected stakeholders.

Glossary & Abbreviations

ACP	Airspace Change Process – the formal process that proposers, assessors and approvers are required to follow when seeking to revise the airspace structure (as set out in Civil Aviation Publication 725)
ATM	Air Transport Movements
DH	Decision Height - a specified lowest height in the approach descent at which, if the required visual reference to continue the approach (such as the runway markings or runway environment) is not visible to the pilot, the pilot must initiate a missed approach.
GBAS	Ground Based Augmentation System - a ground based navigation aid to support the landing phase of flight
ILS	Instrument Landing System – a ground based navigation aid to support the landing phase of flight
IRVR	Instrumented Runway Visual Range
LAMP	London Airspace Management Programme – the major redesign of the London TMA that will deliver a revised airspace structure based upon the existing locations and quantity of runways within the London TMA
LVP	Low Visibility Procedure
Performance Regime	The required set of service delivery outcomes placed upon NATS (En-Route) plc as part of its licence conditions
Point Merge	Point Merge is a linear holding technique that streams aircraft from multiple directions into a single line without the need for air traffic control instruction
RVR	Runway Visual Range - the distance over which a pilot of an aircraft on the centerline of the runway can see the runway surface markings delineating the runway or identifying its center line
TBS	Time Based Separation
Tromboning	Also knows as 'Path Stretching', tromboning is a linear holding technique whereby aircraft absorb delay by following a finite route under their own navigation, thereby avoiding the need for air traffic control intervention.
TMA	Terminal Manoeuvring Area

Annex A: Instances of Application of Low Visibility Procedures at Heathrow & Gatwick Airports

LVPs are designed to protect the runway from intrusion by vehicles or other aircraft when aircraft are departing or landing during periods of reduced visibility.

CAT II/III ILS Procedures require that the Localiser Sensitive Area (LSA), and therefore the ILS Localiser Signal, is protected when aircraft are carrying out ILS approaches/landings and departing during periods of reduced visibility and/or low cloud cover.

At both Heathrow and Gatwick airports, LVPs are triggered when Instrument Runway Visual Range (IRVR) is less than 600 metres or Cloud Ceiling is less than 200 feet.

Operational Impact

Final Approach Spacing and Landing Rates

At Heathrow during LVPs final approach spacing is usually 6nm with 10nm spacing behind an A380. This will result in a typical landing rate of 24 an hour.

At Gatwick during LVPs final approach spacing is usually either 5nm or 8nm. This will result in a typical landing rate of between 10 and 15 inbounds an hour.

Number of days when LVPs are in force

NATS currently has basic data around LVPs. We do not keep a record of whether LVPs have been triggered by IRVR (Visibility) or Cloud Ceiling. The data for Heathrow and Gatwick for the last three years is in the table below.

Heathrow		**Gatwick**	
Year	Days LVP Invoked	Year	Days LVP Invoked
2010	18	2010	46
2011	13	2011	38
2012	21	2012	19
2013	14	2013	23
Average	17.33	Average	34.33