**Time Based Separation**

- Separate arriving aircraft by time instead of distance
- Reduction in separation in medium/strong headwind
  - turbulent decay in-ground/near-ground
- Increase in separation in still/light winds
- Improved *management* of wake turbulence risk

<table>
<thead>
<tr>
<th>Nautical Miles</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>TBS equivalent (seconds)</td>
<td>68</td>
<td>90</td>
<td>113</td>
<td>135</td>
<td>158</td>
<td>180</td>
</tr>
</tbody>
</table>
**TBS Landing Rate Recovery**

Normal Landing Rate – Light Headwind

Reduced Landing Rate – Strong Headwind

TBS Landing Rate – Strong Headwind
Heathrow Headwind Delay

Headwinds cause c.40% of Heathrow arrival ATFM delays

Heathrow Delays by Cause:
Local TBS Deployment

• Applied with NATS 6 category system
• Initial deployment for Heathrow
• Keeping it simple:

minimum change from current operations to realise benefit
... to TBS Implementation
Agile Development

- Focused incremental delivery of a working system
- Prioritised development
- Integrated user involvement
- Concept refinement & Working system increments

> Resolving the challenge of traditional sequential process
What’s to do?

- Concept Development
- Define a Validated Met capability
- Engineering & Development
- Safety Assurance
- Tool Implementation, verification
- Training & transition
- Safety Case
- Supporting safety evidence
- Regulatory Approval
- Operational monitoring

Technical* challenges:
  * Other Challenges exist!!!

- AMAN Sequence not sufficient
- No mature Met capability from SESAR
- Safety Assurance

Project Mantra: Keep it Simple!!
TBS Tool Overview

Separation Indicators for Final Approach and Tower

<table>
<thead>
<tr>
<th>DBS</th>
<th>TBS Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>3.8</td>
</tr>
<tr>
<td></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>4.6</td>
</tr>
<tr>
<td></td>
<td>5.4</td>
</tr>
<tr>
<td></td>
<td>6.1</td>
</tr>
<tr>
<td></td>
<td>6.9</td>
</tr>
</tbody>
</table>

Rules Change

MATS I
H – H 90s
H – UM 113s

MATS II
H – LM 113s
....

Wind Conditions

<table>
<thead>
<tr>
<th>Final Approach Sequence Order</th>
</tr>
</thead>
<tbody>
<tr>
<td>4   BAW284    LM    BIG     13:09</td>
</tr>
<tr>
<td>3   SHT3N     LM    BNN     13:07</td>
</tr>
<tr>
<td>2   JAL401    HH    LAM     13:05</td>
</tr>
<tr>
<td>1   VIR901    HH    LAM     13:04</td>
</tr>
</tbody>
</table>

Time Based Separation System
Concept Development

Adaptive Auto-Sequence

Wake Only Indicators

Spacing

FLT001 & FLT002
Quick Look Tools

Distance indicators
- TBS indicator distance
- Actual distance from indicator

Aircraft/indicator pairing
**TBS Met.**

TBS Separation minima defined by headwind impact on Ground Speed

Groundspeed impact over the separation distance to 4DME is forecast

- **Glideslope Wind Condition Service (GWCS)**
- **Consistent time separation delivered at 4DME**

Mode-S DAPS used to provide Met observations

- **Subject to quality checking & smoothing**
- **Simple system was more effective than complex solution (e.g. incorporating forecast models)**
- **Validation over 1 year data set**

**Interim** Performance: >10Kts over-estimate 0.03%

- Equivalent HH (4NM) distance effect of 10 Kts ~ 0.25NM
- Errors predominantly in strong wind conditions (low WTE risk)

Algorithm has been refined & performance characterised:

- **Over-estimates of Wind used in safety assurance**
Impact of Met Uncertainty

- Indicator position assured knowing that precise wind conditions will not be known in advance
- Define uncertainty due to Met in this way
- Under normal operating conditions (excluding failure)
Safety Evidence

Safety Argument: “No Degradation in Safety”
  > Relative Approach using ‘Reasonable Worst Case’
  > Normal, Abnormal & failure cases
  > All regions of approach for applicable TBS Separation

Wake only indicators => wake only WTE safety evidence

Safety Evidence:
  > Lidar IGE/NGE & OGE
  > Wake modelling support to safety arguments (eg glide and intercept)
  > Reported Wake Encounter (including extrapolation)
  > Sensitivity analysis relating to GWCS performance
  > Estimated Impact on Reported Wake Encounter

HazId / HESAP:
  > Controller skill retention with wake only
  > Indicator not presented when on downwind improves WTC check
Project Status

- Iterative Development phase
- Significant progress in tool development
- Operational Engineering in progress
- Project Safety Assessment Report being prepared
- Safety Evidence being produced

- Operational Deployment in Spring 2015
Video
Questions ?