Common Agreement Document

of the

A380 Airport Compatibility Group

Version 2.1

December, 2002
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I. Introduction

I.1. AACG Terms of Reference

The AACG is an informal group, consisting of a number of European Aviation Authorities, Airport and Industry representatives.

It was formed to agree and promote a common position among the group members on the application of ICAO requirements, with respect to the A380 aircraft, for infrastructure and operations at existing major European airports that currently do not meet the requirements.

Recognising that the ideal for A380 operations would be to provide a level of aerodrome infrastructure at least equal to the generic ICAO Requirements (contained within ICAO Annexes and ADM), the AACG should, in particular:

- Agree and promote that any deviations from these ICAO Requirements should be supported by appropriate aeronautical studies and relevant risk analyses;

- Report its work and findings to ICAO through the appropriate channels so that the latter may use such data for the development of future provisions and enable the work of the group to be disseminated globally;

- Seek to promote the application of the agreed lesser requirements for the A380 aircraft within national regulatory frameworks; and

- Co-operate with other international organisations and working groups dealing with NLA operations.

I.2. Purpose of the document

The purpose of common agreement document is:

- to list the items of aerodrome infrastructure that may be affected by the introduction of the Airbus A380 aircraft;
- to examine the ICAO Recommended Practices relating to those items;
- to show the level of compliance of an aerodrome’s infrastructure with those recommendations; and
- for those areas of non-compliance, to show appropriate mitigation, if required, proposed by the AACG to ensure the safe operation of the A380 aircraft at aerodromes currently unable to meet ICAO Code F Aerodrome Standards and Recommendations.

The AACG emphasises its position as an informal group proposing recommendations to the relevant authorities. However, it is stressed that the authority to approve any deviation from ICAO Requirements shall rest solely with the state having jurisdiction over the aerodrome.

No provision contained herein shall be construed so as to have a binding effect on any such Authority with the respect to the approval of any such deviation.
I.3. Primary conditions of application

a) The A380 requirements discussed and agreed by the AACG and listed in this document apply only to the Airbus A380 Family as defined in Appendix 2. The wingspan of the A380 aircraft should be less than 80m and the outer main wheel span should be less than 14.4m.

b) The application of the different level of aerodrome infrastructure recommendations for A380 operations compared to code F is subject to:

- For runway width and runway separations items (§III.2 & §III.4), the A380 aircraft being certified to operate on a runway of Code E (minimum 45m) width for each type of operation (autoland, flight director and manual modes).

- For taxiway separations items (§III.5), where reduced margins exist compared to Code F recommendations, proper guidance such as centre line lights or equivalent guidance (e.g. marshaller, etc.) to be provided for night, or low visibility operations. It may be permissible to operate with lower separation margins than agreed in this document if an aeronautical study taking into account local conditions indicates that such lower margins would not adversely affect the safety or significantly affect the regularity of operations of the A380.

c) Aerodromes intending to handle aircraft operations requiring Code F facilities as specified in Annex 14 Volume 1 may, with approval of the appropriate authority, provide the inferior facilities specified in this document for the operation of A380 aircraft. However, facilities meeting Code F requirements should be provided in full on all relevant parts of the movement area where possible on new constructions or whenever major redevelopment of the movement area are undertaken. When planning such construction or redevelopment, it may be prudent to consider the requirements of future aircraft types needing facilities in excess of Code F.

I.4. Abbreviations

[Std] = ICAO Standard
ADM Pt2 = Aerodrome Design Manual part 2
Rwy = Runway
Twy = Taxiway
NLA = New Large Aircraft
CRI = Certification Review Item
FOD = Foreign Object Damage
OPS = Operations
ARFF = Aircraft Rescue and Fire Fighting
OFZ = Obstacle Free Zone
OLS = Obstacle Limitation Surface
OCP = Obstacle Clearance Panel
IIWG = International Industry Working Group
JAR 25 = Joint Aviation Requirements for Large Aeroplane
JAR AWO = Joint Aviation Requirements All Weather Operations
OCA/H = Obstacle Clearance Altitude/Height
RTO = Rejected Take-Off
WP = Working Paper
II. Methodology Overview

The methodology that the AACG proposed for establishing operational requirements and infrastructure needs might be applicable to any type of NLA. In this case, it has been developed and applied specifically to A380 aircraft (refer to Terms of Reference).

The same simple philosophy (a safety analysis) in four steps has been used for each infrastructure item that may be affected by the introduction of the A380: runways, taxiways, runway separations, taxiway separations and other items (refer to Chapter III Airfield Items Review and Appendix 5 for some more detailed safety analyses).

These four steps are as follows:

- ICAO baseline identification
- Hazard analysis
- Risk assessment
- Conclusion

II.1. ICAO baseline identification

ICAO baseline identification aims at reviewing ICAO SARPs and ICAO Justification Materials relating to an infrastructure item.

II.2. Hazard analysis

Hazard analysis applied in this context is the identification of undesirable events and hazards linked to an infrastructure item using experience and operational judgement.

Analysis has been made:

- in terms of accident causal factors and critical events with a simple causal analysis, based on experience and accident data base analyses. The accident information come from different databases: ICAO (ADREP), FAA (NTSB), aircraft manufacturers (Boeing, Airbus) and some airlines (see Appendix 1); and

- in terms of severity with a simple consequences analysis, based on experience and accident data base analyses

The following risk definitions are derived from JAR - FAR 25.1309 and are used in the infrastructure item safety analyses to define severity level of the different risks.

<table>
<thead>
<tr>
<th>Severity level</th>
<th>Effect on aircraft and occupants</th>
</tr>
</thead>
<tbody>
<tr>
<td>CATASTROPHIC</td>
<td>- Multiple fatalities</td>
</tr>
<tr>
<td></td>
<td>- Loss of the airplane</td>
</tr>
<tr>
<td>HAZARDOUS</td>
<td>- Large reduction in safety margins</td>
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<tr>
<td></td>
<td>- Physical distress or higher workload such that the flight crew cannot be relied upon to perform</td>
</tr>
<tr>
<td></td>
<td>their tasks accurately or completely</td>
</tr>
<tr>
<td></td>
<td>- Serious or fatal injury to a small number of occupants</td>
</tr>
<tr>
<td>MAJOR</td>
<td>- Significant reduction in safety margins</td>
</tr>
<tr>
<td></td>
<td>- Significant increase in crew workload</td>
</tr>
<tr>
<td></td>
<td>- Passenger injuries</td>
</tr>
<tr>
<td>MINOR</td>
<td>- Slight reduction in safety margins</td>
</tr>
<tr>
<td></td>
<td>- Slight increase in crew workload</td>
</tr>
<tr>
<td></td>
<td>- Inconvenience to occupants</td>
</tr>
</tbody>
</table>
Moreover, JAR defines safety objectives based on the principle that there should be an inverse relationship between the severity of the effect of a failure and the probability of its occurrence (risk tolerability).

JAR safety objectives are normally confined to aeroplane system failure analysis and not to a significant event in which all accident factors have been included. Therefore, particular accident factor rates cannot be simply linked with the global safety target level. A global risk assessment is most of the time problematic and not always relevant because the (statistically) most prominent contributor - human factors - is difficult to assess.

These are the reasons why JAR safety objectives have not been considered entirely relevant at this stage.

AACG members preferred, for most of the infrastructure items, simple qualitative analyses. Quantitative safety target level and risk models have only been used, at least for the moment, for specific risks well adapted to modelling.

II.3. Risk assessment

Once each undesirable event is identified and analysed in terms of causes and consequences, the main remaining question is: “Are all identified risks under control?”

Depending on the nature of the risks, three methods for risk assessment can be identified to respond to this question:

- **Type A:**
  For certain hazards, risk assessment strongly depends on specific aircraft performance and handling qualities. The safety level is achieved by the suitability between aircraft performance and handling qualities and infrastructure characteristics. Risk assessment, then, should be essentially based on the aircraft design and certification and on simulation results still to come.

- **Type B:**
  For other hazards, the aircraft behaviour is not really linked with specific aircraft performance and handling qualities, and can be calculated from existing aircraft measurements. Risk assessment, then, should be based on statistics (e.g. deviations) for existing aircraft or accident analyses, and development of generic quantitative risk models can be well adapted.

- **Type C:**
  In this case, a “risk assessment study” is not needed. In such a case, a simple geometric argument is sufficient to calculate infrastructure requirements without waiting for certification results or collecting deviation statistics for existing aircraft.

II.4. Conclusions

Where possible, the result of a risk assessment should be the establishment of operational criteria to mitigate for the non-compliance of Code F facilities. These criteria should be regarded as minimum conditions with an aim to achieve similar operations at different airports. However, specific local conditions at an airport may prohibit the provision or application of the minimum conditions. In this case additional control measures should be implemented in order to provide an equivalent level of safety.

In a few cases, the result of the risk assessment is dependent upon on going work of other bodies or working groups; therefore the outcome will be deferred until the results are known.
III. Airfield Items Review

III.1. Introduction

The items of aerodrome infrastructure that may be affected by the introduction of the Airbus A380 aircraft have been identified as follows:

- Runways (§III.2.)
  - Runway width
  - Width of runway shoulder

- Taxiways (§III.3.)
  - Width of straight taxiway
  - Width of curved taxiway
  - Straight and curved taxiway shoulders

- Runway Separations (§III.4.)
  - Runway to parallel taxiway separation
  - Obstacle Free Zone
  - Runway holding positions

- Taxiway & Taxilane Separations (§III.5.)
  - Parallel taxiway separation (straight and curved)
  - Taxiway / Apron taxiway to object separation
  - Aircraft stand taxilane to object separation (including service road)

- Other Items (§III.6.)
  - Clearance at the gate
  - Visual aid implications
  - Taxiway on bridges

Those infrastructure items are presented into tables (see below) and reviewed according to four points:

- ICAO SARPs and ADM:
  Standards and Recommended Practices contained in Annex 14 and material from the Aerodrome Design Manual issued by ICAO

- ICAO Justification Material:
  Information and formula used to elaborate the ICAO SARPs and ADM (applicable to code F aircraft as defined in Annex 14 Chapter I)

- AACG Agreement:
  Common position among AACG members on the application of ICAO Requirements with respect to the A380 aircraft, for infrastructure and operations at existing major European airports that currently do not meet the requirements

- AACG Justification Material:
  Major information used for the safety analyses found in Appendix 5
### III.2. Runways

<table>
<thead>
<tr>
<th>Item</th>
<th>Runway width</th>
<th>Width of Runway shoulder</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICAO SARPs and ADM</td>
<td>The width of a rwy should be not less than 45m where the code letter is E, 60m where the code letter is F. [RP] A14 P3.1.9&lt;br&gt;Strength of rwys: A rwy should be capable of withstanding the traffic of aeroplanes the rwy is intended to serve. [RP] A14 P3.1.20</td>
<td>The rwy shoulders should extend symmetrically on each side of the rwy so that overall width of rwy and its shoulders is not less than 60m where the code letter is E and 75m where the code letter is F. [RP] A14 P3.2.3&lt;br&gt;Strength of rwy shoulders: A rwy shoulder should be prepared or constructed so as to be capable, in the event of an aeroplane running off the rwy, of supporting the aeroplane without inducing structural damage to the aeroplane and of supporting ground vehicles which may operate on the shoulder. [RP] A14 P3.2.5&lt;br&gt;In some cases, the bearing strength of the natural ground may be sufficient, without special preparation, to meet the requirements for shoulders. ADM Pt1 P5.2.2&lt;br&gt;Attention should also be paid when designing shoulders to prevent the ingestion of stones or other objects by turbine engines. ADM Pt1 P5.2.3&lt;br&gt;In case of special preparation, visual contrast between rwy and rwy shoulders may be needed. ADM Pt1 P5.2.5</td>
</tr>
</tbody>
</table>

| ICAO Justification Material | - Planning to accommodate future aircraft developments ADM Pt1 P6<br>- Impossible to confirm existence of the “1981 study”<br>- NASA Ames study on 747 RTO not conclusive | No specific justification material available on rwy shoulders to AACG |

| AACG Agreement | A minimum central 45m of pavement of full load bearing strength shall be provided. * | - Compliance with the minimum 75m ICAO Code F runway + shoulders width<br>- Minimum of 2x15m wide shoulders on existing 45m wide rwys: *
  - At least 2x7.5m wide “inner” portion of rwy shoulders (definitions according to ICAO documents – see above)
  - Additional “outer” portion of rwy shoulders prepared for jet blast protection, engine ingestion protection, and for supporting ground vehicles.
- Minimum of 2x7.5m wide “outer” portion of rwy shoulders on existing 60m wide rwys<br>- Depending on local conditions, decision on the composition and thickness of rwy shoulders by each national authority and/or airport operator.<br>- If relevant to local conditions, snow removal and ice control as recommended by ICAO (Doc 9137-AN/898) |

| AACG Justification Material | - A380 Certification on 45m wide rwy | - A380 Engines position<br>- A380 Jet blast velocity & temperature contours at take-off thrust |

* See §I.3.b)
### III.3. Taxiways

<table>
<thead>
<tr>
<th>Item</th>
<th>Width of straight taxiway</th>
<th>Width of curved taxiway</th>
<th>Straight and curved taxiway shoulders</th>
</tr>
</thead>
</table>
| **ICAO SARPs and ADM** | Unless otherwise indicated, the requirements are applicable to all types of twys. A14 P3.8 Note | Curves to ensure that when cockpit over twy centre-line, outer main wheel edge maintains 4.5m clearance from twy edge. [RP] A14 P3.8.5 | Overall width of twy + shoulders on straight portion: 
- 44m where code letter is E  
- 60m where code letter is F. [RP] A14 P3.9.1 |
| | Minimum clearance between outer main wheel and twy edge: 4.5m for both E and F. [RP] A14 P 3.8.3 | ADM Pt2 p1.2.9 and ADM Pt2 p1.2.22 + tables 1-1 and 1-3 | The surface should be so prepared as to resist erosion and ingestion of the surface material by aeroplane engines. [RP] A14 P3.9.2 |
| | Width of a straight portion: 
- 23m where code letter is E  
- 25m where code letter is F [RP] A14 P 3.8.4 | - Origin of the 4.5m clearance distance unknown to AACG | Intended to protect an a/c operating on the twy and to reduce the risk of damage to an a/c running off the twy. ADM Pt2 p1.6.1 ADM Pt2 p1.6.2+ table 1-1 |

### ICAO Justification Material

- Twy width = 2 x clearance distance from wheel to pavement edge + max wheel track  
  - Code E: 23m = 2x4.5m+14m  
  - Code F: 25m = 2x4.5m+16m  
  - ADM Pt2 p1.2.7+ table 1-1  
- Origin of the 4.5m clearance distance unknown to AACG

### AACG Agreement

- Minimum of 23m

### AACG Justification Material

- Twy deviation statistics on straight section, based on existing and on going studies  
- A380 Landing gear wheel span and cockpit visibility

- Wheel-to-edge minimum clearance of 4.5m for code E and F aircraft

- On straight portions, Code F compliant: 60m wide strip to be protected against shoulder erosion and engine ingestion (paved or natural surface)  
- Depending on local conditions, decision on:  
  . the width for curved portions,  
  . the composition and thickness for straight and curved portions by each national authority and/or airport operator

- No specific justification needed (same rules as more critical aircraft such as A340-600 and 777-300ER)

- A380 Engine position  
- A380 Jet blast velocity & temperature contours at break-away thrust
### III.4. Runway separations

<table>
<thead>
<tr>
<th>Item</th>
<th>RWY to parallel TWY separation</th>
<th>Obstacle Free Zone</th>
<th>Runway holding positions</th>
</tr>
</thead>
</table>
| **ICAO SARPS and ADM** | 190m for instrument rwy or 115m for non-instrument runway (may be reduced subject to aeronautical study). [RP] A 14 P3.8.7 + table 3-1 columns 5 & 9 | OFZ half width =  
- 60m where code letter is E  
- 77.5m where code letter is F  
Then inner transitional surface slope 1:3  
[Std] A14 P4.1.11 & 4.1.12 + 4.1.17 to 24, Table 4-1 | Take-off rwy, non-instrument & non-precision approach minimum holding position distances - no change compared with code E (75m). Precision approaches all CATs: Minimum holding position distances increased to 107.5m for Code F (90m for Code E). [RP] A14 table 3-2 footnote ‘c’ A/C at precision approach holds – not to interfere with the operation of Nav. Aids [Std] A14 P3.11.6 |
| **ICAO Justification Material** | - Separation = ½ wing span + ½ strip width:  
Code E: 182.5m = ½×65m+½×300m  
Code F: 190m = ½×80m+½×300m for instrument rwy  
ADM Pt2 p1.2.19+ table 1-5  
- Origin of the 300m rwy strip width unknown to AACG | - No justification material in ICAO official publications  
- Justifications in OCP meetings materials:  
155m (Code F) = 120m (Code E) + 20m (wingspan increase from initial Code E 60m to Code F 80m) + 15m (rwy width increase from code E 45m to code F 60m)  
- 107.5m based on Code F OFZ definition and on an aircraft with 24m tail height, 62.2m distance nose-highest tail part, 10m nose height, 45° or more holding |
| **AACG Agreement** | Collision risk:  
- For non-instrument runways, ICAO SARPs to be followed (115m for code F).  
- For instrument runways, no generic operational agreement. *  
190m regarded as conservative  
ILS effects:  
- Need for specific runway studies to evaluate ILS interference risks in all cases. | Pending on-going studies (OCP), possibility of reduced Code F OFZ width (155m) for A380 operations on 45m wide runways. * | Collision risk:  
- For take off, non-instrument & non-precision approach runways, minimum ICAO SARPs to be followed (75m). In some complex airport layouts (parallel runways, intermediate taxiways used to cross runways,...), rwy holding positions may be specifically studied when rwys are used by A380.  
- Possibility of reduced Code F minimum holding point distances for collision risk reasons (OFZ). *  
ILS effects:  
- Need for specific runway studies to evaluate ILS interference risks in all cases |
| **AACG Justification Material** | Collision risk:  
- Common Accident/Incident database (ICAO, NTSB, Airbus, Boeing, Airlines, Press)  
- NCAA/AEA report for code F rwy strip width: “90m+aircraft half span” (only relevant to collision risk, not to ILS interference)  
ILS effects:  
- ADP study  
- Park Air Systems study (based on an A380 vertical tail in metal) | - ICAO OCP - OFZ study, preliminary 747 results in autoland mode  
- ADP investigation on OFZ for A380 operations on 45m wide rwy  
- St Petersburg formula for A380 ops on 45m wide rwys  
- NCAA/AEA report | Collision risk:  
- Investigation by ADP on OFZ for A380 ops on 45m wide rwy  
ILS effects:  
- ADP study  
- Park Air Systems study (based on an A380 vertical tail in metal) |

* See §I.3.b)
### III.5. Taxiway and Taxilane separations

<table>
<thead>
<tr>
<th>Item</th>
<th>Parallel Taxiway Separation</th>
<th>Taxiway / Apron taxiway to Object Separation</th>
<th>Aircraft Stand Taxilane to Object Separation (including service road)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ICAO SARPS and ADM</strong></td>
<td>Code F twy centreline to twy centreline separation = 97.5m. Possibility to operate with lower separation distances based on an aeronautical study. [RP] A14 P3.8.7 + table 3-1 column 10</td>
<td>Code F twy centreline to object separation = 57.5m. Possibility to operate with lower separation distances based on an aeronautical study. [RP] A14 P3.8.7 + table 3-1 column 11</td>
<td>Taxiilane centreline to object separation = 50.5m. Possibility to operate with lower separation distances based on an aeronautical study. [RP] A14 P3.8.7 + table 3-1 column 12</td>
</tr>
<tr>
<td></td>
<td>No specific safety buffers for curved portion. A14 Note 3.8</td>
<td>The taxiway strip should provide an area clear of objects which may endanger a/c [RP] A14 3.10.3</td>
<td>The distance shown (above) may need to be increased if jet exhaust likely to be hazardous. [RP] A14 P 3.8.7 note 4</td>
</tr>
<tr>
<td><strong>ICAO Justification Materials</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
- Separation = wing span + max lateral deviation + increment Code E: 80m = 65m+4.5m+10.5m ADM P12 p1.2.13 + p1.2.15 + tables 1-1 and 1-4 + Figure 1-4 Code F calculation: 97.5m = 80m+4.5m+13m 
- Origin of the buffer increase from Code E (15m) to Code F (17.5m) unknown to AACG | 
- Separation twy to object = ½wing span + max lateral deviation + increment Code E: 47.5m = ½x65m+4.5m+10.5m ADM P12 p1.2.13 to p1.2.18 + tables 1-1 and 1-4 + Figure 1-4 Code F calculation: 57.5m = ½x80m+4.5m+13m 
- Origin of the buffer increase from Code E (15m) to Code F (17.5m) unknown to AACG | 
- Separation = ½ wingspan + max. dev. + increment Code E : 42.5m = ½ x 65 m + 2.5m + 7.5m ADM P12 p1.2.13 to p1.2.17 + table 1-1 and 1-4 + Figure 1-4 Code F : 50.5m = ½ x 80m + 2.5m + 8m 
- Origin of the buffer increase from Code E (10m) to Code F (10.5m) unknown to AACG |
| **AACC Agreement** | 
- Minimum of 91m on straight twy and the same tip-tip margin (11m) for curved section * | 
- Minimum of 49m on straight twy and the same tip-tip margin (9m) for curved section * | 
- Minimum of 47,5m on straight taxilane and the same tip-tip margin (7.5m) for curved section * |
| **AACC Justification Materials** | 
- Air Navigation Plan – ICAO European Region – Reduced Separation Distances for NLA operations (the same 11m buffer as 747-400). 
- Taxiway deviation statistics analysis (existing and on going analyses) 
- A380 Cockpit visibility | 
- Air Navigation Plan – ICAO European Region – Reduced Separation Distances for NLA operations (the same 9m buffer as 747-400). 
- Taxiway deviation statistics analysis (existing and on going analyses) 
- A380 Cockpit visibility | 
- Air Navigation Plan – ICAO European Region – Reduced Separation Distances for NLA operations (the same 7.5m buffer as 747-400). 
- Taxiway deviation statistics analysis (existing and on going analyses) 
- A380 Cockpit visibility |

* See I.3.b)
### III.6. Other items

<table>
<thead>
<tr>
<th>Item</th>
<th>Clearance at the gate</th>
<th>Visual aid implications</th>
<th>Taxiway on bridges</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICAO SARPS and ADM</td>
<td>Minimum distance between a/c and obstacle = 7.5m but special circumstances on nose-in stands may permit reduction a) between terminal (including fixed pax bridge) and a/c nose and b) over any portion of stand provided with azimuth guidance by a visual docking guidance system. [RP] A14 P3.12.6</td>
<td>Elevated rwy lights shall be frangible + clear of propellers &amp; engine pods. [Std] A14 P5.3.1.6 Surface (inset) lights shall withstand being run over by aircraft. [Std] A14 P5.3.1.7 Rwy edge lights shall be placed along the edge of the area declared for the use as rwy or outside by less than 3m. [Std] A14 P5.3.9.4 Signals shall be frangible + clear of propellers &amp; engine pods. [Std] A14 P.5.4.1.3 Where a PAPI or APAPI is installed on rwy without ILS or MLS they shall be sited to ensure guidance for the most demanding aircraft regularly using the rwy. Where a PAPI or APAPI is installed on rwy with ILS or MLS they should be sited to provide guidance for those aircraft regularly using the rwy. A14 Chap 5 Figure 5-15 P a) &amp; b), &amp; A14 Chap 5 Table 5-2 footnote a. The location of PAPI units depends on eye-to-wheel height of the group of aircraft that use the system regularly &amp; by using the most demanding aircraft of the group. A14 Chap 5 Table 5-2 note a. Wheel clearances may be reduced subject to aeronautical study but not less than values indicated in Table 5-2 column 3. A14 Chap 5 Table 5-2 note c</td>
<td>The width of the portion of a taxiway bridge capable of supporting aeroplanes, as measure perpendicularly to the taxiway centreline, shall not be less than the width of the graded area of the strip provided for that taxiway, unless a proven method of lateral restraint is provided which shall not be hazardous for aeroplanes for which the taxiway is intended [Std] A14 P3.8.19 &amp; ADM Pt 2 P1.4.4 Access should be provided for ARFF vehicles to intervene in both directions. [RP] A14 P3.8.20 If a/c engines overhang the bridge structure, protection of adjacent areas below the bridge from engine blast may be required. [RP] &amp; [Std] A14 P3.8.20 Note ADM Pt2 p1.4.4</td>
</tr>
</tbody>
</table>

| ICAO Justification Materials | Origin of the 7.5m clearance distance unknown to AACG | Work of ICAO Visual Aids Panel | No specific justification available on taxiway on bridge |

| AACG Agreement | - ICAO SARPs to be followed - Possibility of reduced distance with appropriate measure * | - For rwy edge lighting position, ICAO SARPs to be followed (placed along the edge of the area declared for the use as rwy or outside by less than 3m) - Inset rwy edge lights; possibility of elevated lights according to preliminary engine outputs. Snow clearance to be considered in the choice. - PAPI : No specific A380 requirement, ICAO compliant | - Not less than 49m for the width of the portion capable of supporting the A380 and for passenger evacuation - 60m for jet blast protection width - Possibility of reduced width margin if proven method of lateral restraint is provided - Alternative path for ARFF vehicles (whatever bridge width) |


* See §I.3.b)
IV. AACG Members Participation

This document reflects the common position of AACG members, listed above, namely European Aviation Authorities, Airport Authorities and Operators, ACI, Airbus and IATA, on the application of ICAO requirements with respect to the A380 aircraft.

List of AACG Participants

<table>
<thead>
<tr>
<th>COMPANY</th>
<th>NAME</th>
<th>POSITION</th>
</tr>
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<tbody>
<tr>
<td>Airports and their Authorities</td>
<td></td>
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<tr>
<td><strong>France</strong></td>
<td></td>
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<tr>
<td>ADP</td>
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<td>Studies and Development - Air traffic Operations</td>
</tr>
<tr>
<td>ADP</td>
<td>Philippe Laborie</td>
<td>Chief Engineer Master planning</td>
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<tr>
<td>DGAC</td>
<td>Kim Nguyen</td>
<td>Deputy Director, Air Base Department – SBA</td>
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<td>DGAC</td>
<td>Pierre Théry</td>
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<td>DGAC</td>
<td>Brigitte Verdier</td>
<td>Regulation Office - Aerodrome Division – DNA</td>
</tr>
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<td>Aude Malige</td>
<td>Airports and Airforce Bases Engineering – Airport Planning – STBA</td>
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<td><strong>Germany</strong></td>
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<td>FRAPORT</td>
<td>Ibrahim Zantout</td>
<td>Head Airport Infrastructure</td>
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<td>FRAPORT</td>
<td>Oliver Kohlbacher</td>
<td>Infrastructure Project Manager, Airside Infrastructure – Traffic &amp; Retail</td>
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<td>Director of Planning (and Chairman of IIWG New Large Aircraft Study Group)</td>
</tr>
<tr>
<td>HMWVL</td>
<td>Egon Grosslein</td>
<td>Head of Section – CAA Aerodromes, Technical Affairs, Airport Operations, Security</td>
</tr>
<tr>
<td>BMVBW</td>
<td>Klaus Albrecht</td>
<td>Federal Regulatory Authority</td>
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<tr>
<td><strong>Netherlands</strong></td>
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<tr>
<td>AMS</td>
<td>Dick Meerman</td>
<td>Business Unit Airlines</td>
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<td>AMS</td>
<td>Rob ten Hove</td>
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<td>CAA Netherlands</td>
<td>Sietse Jager</td>
<td>Division Aerodromes and Airspace (and Chairman of ADSG Project Team 4)</td>
</tr>
<tr>
<td><strong>United Kingdom</strong></td>
<td></td>
<td></td>
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<tr>
<td>AOA/BAA</td>
<td>Andrew Badham</td>
<td>Senior Operations Manager</td>
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<td>MAN</td>
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<td>CAA UK</td>
<td>Geoff Caton</td>
<td>Head Aerodrome Standards Department – Safety Regulation Group</td>
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<tr>
<td>CAA UK</td>
<td>Paul Fleming</td>
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<td><strong>International bodies &amp; Industry</strong></td>
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<tr>
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<td>Director Facilitation &amp; Technical / Safety</td>
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<tr>
<td>AIRBUS (Secretary and Technical Advisor)</td>
<td>Jean-Paul Genottin</td>
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<tr>
<td>IATA (Advisor)</td>
<td>Ton Van Der Veldt</td>
<td>Assistant Director - Operations &amp; Infrastructure</td>
</tr>
</tbody>
</table>
ANNEX 1

Recommendation Letter from the 4 AACG Aviation Authorities

- FRANCE
- GERMANY
- NETHERLANDS
- UNITED KINGDOM
référence : N° 030119 DG

Monsieur le Secrétaire Général,


Les représentants des autorités européennes de l’aviation civile des pays représentés dans l’AACG estiment que les orientations de ce document constituent une base solide d’adaptation de leur réglementation pour faciliter l’accueil de l’A380 sur ces aérodromes dans le respect d’une utilisation harmonisée et sûre.

Ce document est donc proposé à l’OACI en vue d’alimenter les travaux à venir (sur les spécifications NLA). Nous souhaiterions également qu’il fasse l’objet d’une diffusion par les services de l’OACI auprès des autorités de l’aviation civile ayant des aéroports susceptibles d’accueillir l’A380. En outre, il peut constituer une contribution très utile pour d’autres organisations internationales et groupes de travail qui traitent de la question des NLA.

Monsieur le Secrétaire Général
de l’Organisation de l’Aviation Civile Internationale
999, University Street
Montréal, Québec
Canada H3C 5H7

Copie : Monsieur le Président du Conseil, Monsieur le Président de la Commission de navigation aérienne

50, rue Henri Farman 75720 PARIS CEDEX 15 – Tél. 01.58.09.36.90 – Télécopie : 01.58.09.38.64

Je vous prie de croire, Monsieur le Secrétaire Général, à l’assurance de ma haute considération.

[Signature]
Dear Sir,

The Common Agreement Document of the A380 Airport Compatibility Group (AACG), developed by a number of European Aviation Authorities, Airport, Industry and Airport Council International representatives, reflects a common position on the application of ICAO requirements with respect to the introduction of the Airbus A380 aircraft, for infrastructure and operations at existing airports that currently do not meet the code F requirements.

Accordingly, the representatives of the European Aviation Authorities in the AACG consider that the recommendations and guidance material contained in the document (version 2.1) constitute a sound basis for any adaptation of their respective regulations, to facilitate the introduction of the A380 for safe and harmonised operations into existing airports.

This document is proposed to ICAO to assist in its further deliberations on NLA requirements and for dissemination, as may seem appropriate, to all Aviation Authorities having jurisdiction on airports planned to have A380 operations. In addition, it could be seen as a valuable contribution to other international organisations and working groups dealing with NLA operations.

AACG activities and extracts of the AACG documentation have been presented to the ICAO Air Navigation Commission on 20th November 2002.

Yours faithfully,

Michel Wachenheim
Recommendation Letter

The Common Agreement Document of the A380 Airport Compatibility Group (AACG), developed by a number of European Aviation Authorities, Airport, Industry and Airport Council international representatives, reflects a common position on the application of ICAO requirements with respect to the introduction of the Airbus A380 aircraft, for infrastructure and operations at existing airports that currently do not meet the Code F requirements.

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AACG activities and extracts of the AACG documentation have been presented to the ICAO Air Navigation Commission on 20th November 2002.

On behalf of the
Federal Ministry of Transport,
Building and Housing, Germany
- DGCA -

(Gernot Riediger)
Director Airport Policies
Date
20 January 2003

Our reference
DL/Infra/03.540063

Subject
Recommendation Letter

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AACG activities and extracts of the AACG documentation have been presented to the ICAO Air Navigation Commission on 20th November 2002.

The policy as announced in the Common Agreement Document of the AACG is regarded as interim policy with respect to the introduction of the Airbus A380 aircraft, for infrastructure and operations at existing airports that currently do not meet the Code F requirements. The policy will be applicable until ICAO issues SARPs on this subject.

For the design of new airports or the extension of existing airports intended for the operation of the A380 aircraft, the Annex 14 code 4F criteria are applicable.

MINISTER OF TRANSPORT, PUBLIC WORKS AND WATER MANAGEMENT,

On his behalf,

THE MANAGING DIRECTOR CHIEF INSPECTOR OF THE CIVIL AVIATION AUTHORITY,
NETHERLANDS,

On his behalf,

The Deputy Head Division Aerodromes and Airspace,

Ing. J.H. Wilbrink

Civil Aviation Authority Netherlands
Division Aerodromes and Airspace
P.O. Box 575, 2130 AN Hoofddorp, the Netherlands
Saturnustraat 50, Hoofddorp

Telephone +3123 566 30 00
Fax +3123 566 30 01
Recommendation Letter

The Common Agreement Document of the A380 Airport Compatibility Group (AACG), developed by a number of European Aviation Authorities, Airport, Industry and Airport Council International representatives, reflects a common position on the application of ICAO requirements with respect to the introduction of the Airbus A380 aircraft, for infrastructure and operations at existing airports that currently do not meet the Code F requirements.

Accordingly, the representatives of the European Aviation Authorities in the AACG consider that the recommendations and guidance materials contained in the document (version 2.1) constitute a sound basis for any adaption of their respective regulations, to facilitate the introduction of the A380 for safe and harmonised operations into existing airports.

This document is proposed to ICAO to assist in its further deliberations on NLA requirements and for dissemination, as may seem appropriate, to all Aviation Authorities having jurisdiction on airports planned to have A380 operations. In addition, it could be seen as a valuable contribution to other international organisations and working groups dealing with NLA operations.

AACG activities and extracts of the AACG documentation have been presented to the ICAO Air Navigation Commission on 20 November 2002.

The policy stated in the Common Agreement Document of the AACG is regarded by the United Kingdom as interim policy with respect to the introduction of the Airbus 380 aircraft for infrastructure and operations at existing airports that currently do not meet the Code F requirements. For the design of new airports or the extension of existing airports intended for the operation of the A380 aircraft, Annex 14 Code 4 F criteria are applicable.

G Caton
Head of Aerodrome Standards Department
Safety Regulation Group
United Kingdom Civil Aviation Authority
ANNEX 2

National Supplements

France
For taxiway width item, currently under discussion

Germany
No National Supplements

Netherlands
In the Netherlands the application of a deviation of 2.5 m for code F aircraft instead of 4.5 m is allowed after an approval by the appropriate authority.

United Kingdom
No National Supplements
APPENDIX 1

Current Operations in Today's Airports

Appendix 1 provides examples of Boeing 747 current operations at today’s aerodromes and extracts from databases (without analyses, modifications or extrapolations)

Part A: Minimum infrastructure items observed for Boeing 747 operations in today’s airports that do not meet Code E / Group V SARPs

Part B: Common Accident/Incident lateral runway excursions database (Narrow Bodies and Wide Bodies)

Part C: Common Accident/Incident lateral taxiway excursions database (Narrow Bodies and Wide Bodies)

Part D: Preliminary data of the on-going taxiway deviation study at CDG
APPENDIX 2

Physical Characteristics of A380 Family Aircraft

Appendix 2 contains A380 basic physical characteristics including wing span and outer main gear wheel span

Part A: A380-800 / 747-400 Geometric Comparisons
Part B: Runway Situation
Part C: Taxiway Situation
Part D: Bridge Situation
Part E: A380 Ground Visibility
Part F: ARFF Vehicles and Evacuation slides
Part G: Extract of “A380 Characteristics for Airport Planning” (Scope, aeroplane description, ground manoeuvring and operating conditions)
Part H: A380 short distance jet blast contours
Part I: Jet blast contours of other aircraft (747-400, 777-200LR/300ER, A340-500/600)
APPENDIX 3

Performance of A380 Family Aircraft

Appendix 3 focuses on A380 specific performance and handling qualities in flight

Part A: Certification objectives for operations from 45m wide runways
Part B: A380 Flight Handling Qualities
Part C: Autoland System Design
Part D: Landing incidence/attitude and cockpit visibility
Part E: Position of A380 Glide Path Antenna
APPENDIX 4

Studies, Analyses, Working Papers and Reports

Appendix 4 provides available documentation pertaining to aircraft operations

Documentation on taxiways


Documentation on runways


Part I: “Fatal Accident Analysis” – Extract of the Statistical Aviation Safety Summary by the National Aerospace Laboratory (NLR) for CAA NTH and analysis of fatal accident of the common Accident/Incident database by Airbus


Part L: “Investigation on the OFZ for A380 Operations on 45m wide runways” ADP – June 2002

Part M: “Sensitive Areas for NORMAC ILS Localizer due to effect of Airbus 380” By Park Air Systems – April 2002
APPENDIX 5

Safety Analyses of Airfield Items

Appendix 5 develops the safety analyses that lead to the AACG conclusions

Part A: Runways
Part B: Taxiways
Part C: Runway separations
Part D: Taxiway separations
Part E: Other items
APPENDIX 5

Safety Analyses of Airfield Items

INTRODUCTION

PART A: RUNWAYS

Runway width
Runway shoulder width

PART B: TAXIWAYS

Taxiway width
Taxiway shoulder width

PART C: RUNWAY SEPARATIONS

PART D: TAXIWAY SEPARATIONS

PART E: OTHER ITEMS

Runway visual aids
Taxiway on bridges

VERSION 2.1
INTRODUCTION

1. Methodology

The methodology that the AACG proposed for establishing operational requirements and infrastructure needs might be applicable to any type of NLA. In this case, it has been developed and applied specifically to A380 aircraft (refer to Terms of Reference). The same simple philosophy (a safety analysis) in four steps has been used for each infrastructure item that may be affected by the introduction of the A380: runways, taxiways, runway separations, taxiway separations and other items (refer to Chapter III Airfield Items Review and Appendix 5 for some more detailed safety analyses).

These four steps (see § 2 “Methodology Overview” of the AACG Common Agreement Document for more details) are as follows:
- ICAO baseline identification
- Hazard analysis
- Risk assessment
- Conclusion

2. Risk assessment

Depending on the nature of the risks, three methods for risk assessment can be identified to respond to this question:

- Type A:
  For certain hazards, risk assessment strongly depends on specific aircraft performance and handling qualities. The safety level is achieved by the suitability between aircraft performance and handling qualities and infrastructure characteristics. Risk assessment, then, should be essentially based on the aircraft design and certification and on simulation results still to come.

- Type B:
  For other hazards, the aircraft behaviour is not really linked with specific aircraft performance and handling qualities, and can be calculated from existing aircraft measurements. Risk assessment, then, should be based on statistics (e.g. deviations) for existing aircraft or accident analyses, and development of generic quantitative risk models can be well adapted.

- Type C:
  In this case, a “risk assessment study” is not needed. In such a case, a simple geometric argument is sufficient to calculate infrastructure requirements without waiting for certification results or collecting deviation statistics for existing aircraft.

The application of the different level of aerodrome infrastructure recommendations for A380 operations compared to code F is subject to:

- For runway width and runway separations items (§III.2 & §III.4), the A380 aircraft being certified to operate on a runway of Code E (minimum 45m) width for each type of operation (autoland, flight director and manual modes).
- For taxiway separations items (§III.5), where reduced margins exist compared to Code F recommendations, proper guidance such as centre line lights or equivalent guidance (e.g. marshaller, etc.) to be provided for night, or low visibility operations. It may be permissible to operate with lower separation margins than agreed in this document if an aeronautical study taking into account local conditions indicates that such lower margins would not adversely affect the safety or significantly affect the regularity of operations of the A380.

4. Abbreviations:

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>[Std]</td>
<td>ICAO Standard</td>
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<tr>
<td>ADM Pt2</td>
<td>Aerodrome Design Manual part 2</td>
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<td>Rwy</td>
<td>Runway</td>
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<tr>
<td>Twy</td>
<td>Taxiway</td>
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<td>NLA</td>
<td>New Large Aircraft</td>
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<td>CRI</td>
<td>Certification Review Item</td>
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<td>FOD</td>
<td>Foreign Object Damage</td>
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<td>OPS</td>
<td>Operations</td>
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<td>Aircraft Rescue and Fire Fighting</td>
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<td>OFZ</td>
<td>Obstacle Free Zone</td>
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<tr>
<td>OLS</td>
<td>Obstacle Limitation Surface</td>
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<td>Obstacle Clearance Panel</td>
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<td>International Industry Working Group</td>
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<td>JAR 25</td>
<td>Joint Aviation Requirements for Large Aeroplane</td>
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<td>JAR AWO</td>
<td>Joint Aviation Requirements All Weather Operations</td>
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<tr>
<td>OCA/H</td>
<td>Obstacle Clearance Altitude/Height</td>
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<td>RTO</td>
<td>Rejected Take-Off</td>
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<tr>
<td>WP</td>
<td>Working Paper</td>
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# PART A: RUNWAYS

## RUNWAY WIDTH

### SYNOPSIS

The width of a rwy should be not less than 45m where the code letter is E, 60m where the code letter is F.

[RP] A14 P3.1.9

Strength of rwys: A rwy should be capable of withstanding the traffic of aeroplanes the rwy is intended to serve.

[RP] A14 P3.1.20

Planning to accommodate future aircraft developments. ADM Pt1 P6

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<th>Hazard identification</th>
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<th>Risk 2</th>
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<td>Lateral runway excursion at take-off</td>
<td>Lateral runway excursion at landing</td>
</tr>
<tr>
<td>Main causes and accident factors</td>
<td>- Human factors (crew, maintenance, balance, payload security)</td>
<td>- Human factors (crew, maintenance)</td>
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<tr>
<td></td>
<td>- Powerplant (engine failure, ingestion)</td>
<td>- Aircraft (landing gear, control surfaces, hydraulic system, brakes, tyres)</td>
</tr>
<tr>
<td></td>
<td>- Surface conditions (aquaplaning, snow)</td>
<td>- Powerplant (reverse)</td>
</tr>
<tr>
<td></td>
<td>- Aircraft (control surfaces, hydraulic system, tyres)</td>
<td>- Surface conditions (aquaplaning, snow)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Weather conditions (cross wind, visibility, inaccurate meteorological information)</td>
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### HAZARD ANALYSIS

**Theoretical Severity**

Major to Catastrophic depending on the aircraft speed

By considering the In-Service experience of Airbus aircraft fleet, a joint JAA/FAA/Airbus discussion is on-going to define the severity of the event according to the aircraft speed at veer-off. According to the common accident/incident database from ICAO ADREP, FAA NTSB, Airbus, Boeing, Airlines and press accounts, no 747 fatal accidents due to veer-off alone were reported from 1980 to 2000.

### Detailed hazard analysis within certification process

**Main technical material**

- A380 Certification criteria on 45m wide rwy: critical failure conditions for veer-off at take-off, $V_{MCG}$ criteria, envelope of environmental conditions covered by aircraft certification, works on 45m wide rwy CRI (on-going),…
- A380 Outer engines with no reverse (reverses often mentioned in documented rwy veer-offs) (see Appendix 3)

- A380 Certification criteria on 45m wide rwy: critical failure conditions for veer-off at landing, envelope of environmental conditions covered by aircraft certification, works on 45m wide rwy CRI (on-going),…
- A380 Outer engines with no reverse (reverses often mentioned in documented rwy veer-offs)
- A380 Final approach speed
- A380 Autoland & Flight handling quality
- A380 Landing incidence/attitude and cockpit visibility (see Appendices 2 & 3)

### CONCLUSIONS

A minimum central 45m of pavement of full load bearing strength shall be provided.

* See Introduction Part 3
ICAO BASELINE

See previous synopsis for the recommendations.

The only location in current ICAO material where a 60m wide runway is justified for code F aircraft is the ADM Chapter 6 “Planning to accommodate future aircraft developments”.

In this chapter, it is mentioned that the runway width for aircraft with large main gear wheel spans may be represented by the expression:

$$W_R = T_M + 2C$$

where

- $W_R$ = Runway width
- $T_M$ = Outer main gear wheel span
- $C$ = Clearance between the outer main gear wheel and the runway edge

Using the present value of $C$ for a 747 on a runway of 45m width (i.e. 16m) and the increased main gear wheel span of 20m, the formula comes out with a runway width of 52m. The ICAO manual concludes that “however, other factors, which are not included in this rationale indicate that it might be advisable, for planning purposes, to consider a width of up to 60m.”

It is also apparent that when applied to a 14m outer main wheel span (13.99m is the upper limit of code E aircraft), the geometric formula yields a runway width of 46m, which is inconsistent with Annex 14 recommended practice on code E runway width.

HAZARD ANALYSIS

1. Hazard identification

The main hazard linked to runway width is lateral runway excursion at take-off or landing.

2. Causal analysis

The main causes and accident factors are listed as follows:

- For take-off:
  - Human factors (crew, maintenance, balance, payload security)
  - Powerplant (engine failure, ingestion)
  - Surface conditions (aquaplaning, snow)
  - Aircraft (control surfaces, hydraulic system, tyres)

- For landing:
  - Human factors (crew, maintenance)
  - Aircraft (landing gear, control surfaces, hydraulic system, brakes, tyres)
  - Powerplant (reverse)
  - Surface conditions (aquaplaning, snow)
  - Weather conditions (cross wind, visibility, inaccurate meteorological information)

An analysis of lateral runway excursion reports (see Appendix 1 Part B) shows that accident mechanisms are not the same for take-off and for landing. Mechanical failures are, for instance, a frequent accident factor for take-off veer-off, while bad weather conditions are often reported for landing veer-off.

A review of 747 lateral runway excursions indicates that a significant factor of 747 accidents/incidents was the influence of engine reverse or thrust lever mechanical linkages (see Appendix 4 Part I).

Safety analyses (Functional Hazard Assessment, System Safety Assessment, Environmental Conditions Hazard Assessment,…) on landing and take-off operations will be made for aircraft certification.

Lateral runway excursion is one of the risks explicitly taken into account by Airbus in the aircraft design process (see Appendix 3 Part A): This event is especially studied by the JAA Team in a Certification Review Item (CRI) on 45m wide runway. Critical failure conditions for A380 lateral runway excursion risk at take-off and at landing is covered in the certification process.
3. Consequences analysis

Lateral runway excursion hazard could be classified as major to catastrophic risk depending on the aircraft speed.

By considering the In-Service experience of Airbus aircraft fleet, a joint JAA/FAA/Airbus discussion is on-going to define the severity of the event according to the aircraft speed at veer-off.

According to the common accident/incident database gathering reports from ICAO ADREP, FAA NTSB, Airbus, Boeing, Airlines and press accounts, there were no 747 fatal accidents due to veer-off alone reported from 1980 to 2000 (see Appendix 4 Part I).

A review of this accident/incident database also revealed that only 1.3 % of the total number of on board fatalities from 1980 to 1998 occurred after lateral runway excursions:

- 1.0 % occurred with narrow body aircraft
- 0.3 % occurred with wide body aircraft
- 0.0 % occurred with 747

**RISK ASSESSMENT**

The lateral runway excursion risk is clearly linked to specific aircraft characteristics (wheel span, cockpit visibility and height, engine thrust reverser arrangements,...) and performance/handling qualities (approach speed, approach attitude, aircraft manoeuvrability and stability, control surface characteristics, ...).

Therefore, this type of risk comes under “type A” risk assessment category, mainly based on aircraft performance and handling qualities. So, the geometric argument of the ICAO manual (see ICAO Baseline) which would result in a runway width of a little more than 46m for A380 outer gear wheel span, is not relevant to assess the A380 lateral runway excursion risk.

Therefore, performances and handling qualities aspects are only taken into account and are developed below.

Some information about A380 performance objectives are already available and allow to be quite confident in the future A380 handling qualities:

- **A380 Final approach speed** (Appendix 3 Part D)
The A380 final approach speed is intended to be around 145kt (less than the 747 aircraft).

- **A380 Flight handling quality** (Appendix 3 Part B)
The main design objective is to get the A380 manoeuvrability and operational speeds similar to the A340.
- **A380 Landing incidence/attitude and cockpit visibility** (Appendix 3 Part D)
The A380 landing incidence/attitude is planned to be lower that of 747; and according to its cockpit geometry, the A380 cockpit visibility at approach phase is intended to be better than the 747.
- **A380 Outer engines are not fitted with reverses** (Appendix 4 Part I)
The A380 design has no outboard thrust reversers, or mechanically linked engine controls. The aircraft would not therefore be subject to the related thrust reverser and linkage failure modes.

Nevertheless, the “core” risk assessment study which is a “type A” study (aircraft performance) will be made during aircraft certification process (safety analysis, flight test, simulations, ...).

Airbus decided to design the A380 so that the aircraft could operate on existing 45m wide runways like any other wide body aircraft (see Appendix 3 Part A):
The capability to operate safely will be demonstrated during the type certification activities based on JAR25 and JAR AWO.
To ensure visibility by the Airport Authorities, the relevant Aviation Authorities, the International Organisations and the Airline world that the A380 will be able to land and take off on 45m / 150ft - wide runways without additional limitations, Airbus will:

- base the A380 nominal performance/handling qualities on 45 meter runway width;
- base the safety analyses on 45 meter runway width;
- state the 45 meter runway width as nominal for A380 operations within the Flight Manual, to which the type certificate data sheet (TCDS) refers (Chapter Limitations);
- report this nominal 45 meter runway width within the FCOM, (ex : Chapter General Limitations, Airport Operations);

A Certification Review Item (CRI) on the runway width has been opened by the JAA Team in charge of A380 certification: the JAA Team may complete, if necessary, aircraft certification specifications to check all manufacturer objectives (including safe operations on 45m wide runway) are effectively met by the aircraft whatever operating mode (autoland, flight director and manual mode).

The certification documents will include a clear documentation of “airport’s reference conditions” taken into account during certification process: this is necessary to establish a direct link between aircraft performances/handling qualities (certification results) and infrastructure needs (runway width). This specification should state the manufacturer’s reference values in terms of:

- Maximum demonstrated crosswind at takeoff and landing (stabilized conditions and gust)
- Runway conditions (dry/wet/contaminated, maximum transverse mean runway slope)
- Pressure altitude, temperature
- Maximum wind conditions for Cat II or Cat III automatic approach (Head wind, Tail wind and Cross wind)
- Minimum and maximum ILS slope angles demonstrated

The question of interactions between different accident factors (and above all airport accident factors) is also addressed in certification safety analysis.

**CONCLUSIONS**

A minimum central 45m of pavement of full load bearing strength shall be provided. *

* See Introduction Part 3
**RUNWAY SHOULDER WIDTH**

### SYNOPSIS

The rwy shoulders should extend symmetrically on each side of the rwy so that overall width of rwy and its shoulders is not less than 60m where the code letter is E and 75m where the code letter is F. [RP] A14 P3.2.3

Strength of rwy shoulders:
- A rwy shoulder should be prepared or constructed so as to be capable, in the event of an aeroplane running off the rwy, of supporting the aeroplane without inducing structural damage to the aeroplane and of supporting ground vehicles which may operate on the shoulder. [RP] A14 P3.2.5
- A rwy shoulder should be prepared or constructed so as to minimise any hazard to an aeroplane running off the rwy. ADM Pt1 P5.2.2
- In some cases, the bearing strength of the natural ground may be sufficient, without special preparation, to meet the requirements for shoulders. ADM Pt1 P5.2.3
- Attention should also be paid when designing shoulders to prevent the ingestion of stones or other objects by turbine engines. ADM Pt1 P5.2.4
- In case of special preparation, visual contrast between rwy and rwy shoulders may be needed. ADM Pt1 P5.2.5

### HAZARD ANALYSIS

<table>
<thead>
<tr>
<th>Hazard Identification</th>
<th>Risk 1</th>
<th>Risk 2</th>
<th>Risk 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shoulder erosion and engine ingestion (snow and ice ingestion included) at landing or take-off</td>
<td>Powerplant (engine position, engine power)</td>
<td>Aircraft wingspan, engine position</td>
<td>No A380 specific issue</td>
</tr>
<tr>
<td></td>
<td>Shoulder width and cohesion</td>
<td>Shoulder width and bearing capability</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Runway centreline deviation factors (see previous item)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Location and height of snow banks</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Severity</th>
<th>Theoretical Potentially major</th>
<th>Major to catastrophic</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-service</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### RISK ASSESSMENT

**Main causes and accident factors**
- Powerplant (engine position, engine power)
- Shoulder width and cohesion
- Runway centreline deviation factors (see previous item)
- Location and height of snow banks

**Main technical materials**
- A380 engine position
- A380 jet blast velocity & temperature contours at take-off thrust
- Information about lateral deviation from runway centreline (see Appendix 2)

**Risk assessment category**
- C (geometric argument)
- C (geometric argument)

**Risk assessment**
- A380 engine position
- A380 wingspan and engine position (see Appendix 2)

### AACG CONCLUSIONS

- Compliance with the minimum 75m ICAO Code F runway + shoulders width
- Minimum of 2x15m wide shoulders on 45m wide runways: *
  - At least 2x7.5m wide “inner” portion of rwy shoulders (definitions according to ICAO documents)
  - Additional “outer” portion of rwy shoulders prepared for jet blast protection, engine ingestion protection, and for supporting ground vehicles.
- Minimum of 2x7.5m wide “outer” portion of rwy shoulders on existing 60m wide runways
- Depending on local conditions, decision on the composition and thickness of rwy shoulders by each national authority and/or airport operator.
- If relevant to local conditions, snow removal and ice control as recommended by ICAO (Doc 9137-AN/898)

* See Introduction Part 3
HAZARD ANALYSIS

1. Hazard identification

Runway shoulders have three main functions:
- To provide jet blast protection and to prevent engine ingestion
- To support ground vehicles traffic (ARFF vehicles in particular)
- To support occasional aircraft incursions without inducing structural damage to the aeroplane

Therefore, the hazards linked to runway shoulder characteristics (width, cohesion, bearing capability) are:
1. Shoulder erosion and engine ingestion: it seemed relevant to deal with snow and ice ingestion risk at the same time, even if it is not really linked to runway shoulder characteristics.
2. Difficulties for ARFF services to access a damaged aircraft on the runway
3. Aircraft damage after incursion onto runway shoulder

Hazards 1 and 2 could be effectively related to NLA characteristics (engine position, engine thrust, and wingspan).

Concerning hazard 3:
- the shoulder width should not be regarded as a specific NLA issue: 7.5m “hard” wide shoulders shall be provided to allow pilots to steer the aircraft back onto runway in case of minor lateral excursion, whatever the aircraft code letter is.
- the shoulder composition and thickness may actually vary with aircraft types to ensure an occasional bearing capability for all of them. Therefore, composition of 7.5m wide inner shoulders may be a NLA issue, but other aircraft than NLA may have stronger impact on runway shoulders (depending on aircraft weight per wheel). AACG members decided to focus on geometric issues; so this pavement aspect is not developed here. Decisions on shoulders composition and thickness will be made by each national authority and/or airport operator.

For this reason, only jet blast protection, engine ingestion and ARFF vehicles traffic issues are considered here.

2. Causal analysis

Main causes and accident factors are:
- Powerplant characteristics (engine position and engine power)
- Shoulder width and cohesion
- Runway centreline deviations (see runway veer-off risk)

In addition to this, in case of snowfalls, location and height of snow banks could induce an ice ingestion risk.

With regard to the ARFF vehicle traffic, the specific NLA issues are:
- Aircraft wingspan, engine position
- Shoulder width and bearing capability
3. Consequences analysis

Certification requirements define FOD risks on wheel tyres and engines as potentially major risks. Delay on ARFF operations could be classified as major to catastrophic.

As a geometric argument combined with A380 jet blast characteristics is relevant to calculate infrastructure requirements relative to shoulder erosion, engine ingestion and ARFF vehicles traffic issues (cf. risk assessment), a detailed hazard analysis is not needed for this item.

**RISK ASSESSMENT**

As AACG members agreed to a 75m overall width of runway+shoulders in compliance with Annex 14 (see Conclusions), this section was not in theory absolutely necessary. Nevertheless, to guarantee consistency among the document, the same method has been developed in this case as well.

Shoulder erosion, engine ingestion and ARFF vehicles traffic issues are geometric issues and come under “type C” risk assessment category (geometric argument).

1. Jet blast issue

Information about outer engine position and jet blast velocity contour at take-off (see Appendix 2 Parts C, D & E) is needed to calculate the required width for jet blast protection. The lateral deviation from runway centreline must be taken into account.

The margin between the A380 outer engine axis when the aircraft is on the runway centreline and the edge of a 75m wide jet blast protection is 11.80m.

The margin between 747 outer engine axis when the aircraft is on the runway centreline and the edge of a 60m wide jet blast protection is only 9.15m.

This geometric argument (increase of the margin between outer engine axis and edge of jet blast protection shoulders) combined with jet blast drawings (see Appendix 2 Parts C&D) allows a conclusion that the 75m wide jet blast protection recommended by ICAO for the overall runway+shoulders Code F width will avoid shoulder erosion for A380 operations with an improved level of safety.

Concerning the engine ingestion risk, additional data on ingestion tendency in front of A380 outer engines at take-off thrust are, in theory, needed before the conclusion. Nevertheless, considering the geometric comparison with current large aircraft operations on current runways, there are:

- A significant increase (35%) in the margin between outer engine axis and edge of shoulder and,
- An increase of 10% in the distance from the outer engine to the ground in comparison with 747,

It seems reasonable that a 75m total width will minimise the A380 engine ingestion risk.

2. ARFF vehicles intervention

The comparison with current large aircraft on current runways (see Appendix 2 Parts A & F) allows a conclusion that an overall runway width of 75m for occasional ARFF vehicles traffic allows firemen intervention to an A380 at least as easy as for a 747 on a code E runway (because of the increase of the margin between outer engine axis and edge of runway shoulder).
CONCLUSIONS

- Compliance with the minimum 75m ICAO Code F runway + shoulders width
  - Minimum of 2x15m wide shoulders on 45m wide runways: *
    - At least 2x7.5m wide “inner” portion of rwy shoulders (definitions according to ICAO documents)
    - Additional “outer” portion of rwy shoulders prepared for jet blast protection, engine ingestion protection, and for supporting ground vehicles.
  - Minimum of 2x7.5m wide “outer” portion of rwy shoulders on existing 60m wide runways
  - Depending on local conditions, decision on the composition and thickness of rwy shoulders by each national authority and/or airport operator.
  - If relevant to local conditions, snow removal and ice control as recommended by ICAO (Doc 9137-AN/898)

* See Introduction Part 3
### PART B: TAXIWAYS

#### TAXIWAY WIDTH

Since the A380 is not the critical aircraft for fillet extension, only taxiway width on straight section is considered here.

### SYNOPSIS

<table>
<thead>
<tr>
<th>ICAO BASELINE</th>
<th>Unless otherwise indicated, the requirements are applicable to all types of twys. A14 P3.8 Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum clearance between outer main wheel and twy edge: 4.5m for both E and F. [RP] A14 P 3.8.3</td>
<td></td>
</tr>
<tr>
<td>Width of a straight portion: 23m where code letter is E and 25m where code letter is F. [RP] A14 P 3.8.4</td>
<td></td>
</tr>
</tbody>
</table>

#### HAZARD ANALYSIS

<table>
<thead>
<tr>
<th>Hazard Identification</th>
<th>Risk 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lateral taxiway excursion in straight section</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Main causes and accident factors</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanical failure affecting steering capability (hydraulic system)</td>
<td></td>
</tr>
<tr>
<td>Surface conditions (aquaplaning, loss of control on ice-covered surface...)</td>
<td></td>
</tr>
<tr>
<td>Loss of visual taxiway guidance system (markings and lights covered by snow,...)</td>
<td></td>
</tr>
<tr>
<td>Pilot precision and attention (directional control)</td>
<td></td>
</tr>
</tbody>
</table>

#### Severity

<table>
<thead>
<tr>
<th>Theoretical</th>
<th>Potentially major</th>
</tr>
</thead>
</table>

| In-service | Minor (no cases reported with injuries on straight section over 20 years according to the common accident/incident database from ICAO ADREP, FAA NTSB, Airbus, Boeing, Airlines and press accounts) |

#### RISK ASSESSMENT

<table>
<thead>
<tr>
<th>Risk assessment category</th>
<th>B (generic risk model)</th>
<th>C (geometric argument)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Main technical materials</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Taxiway deviation statistics analysis (existing and on going studies)</td>
<td>- A380 geometric characteristics (cockpit height and visibility, 14.3m wheel span)</td>
</tr>
<tr>
<td>(see Appendix 4)</td>
<td>(see Appendix 2)</td>
</tr>
</tbody>
</table>

#### AACG CONCLUSIONS

- Minimum of 23m
**ICAO BASELINE**

See previous synopsis

**HAZARD ANALYSIS**

1. Hazard identification

The hazard is a lateral taxiway excursion in straight section.

2. Causal analysis

The causes of such an event could be classified as:

- Mechanical failure (hydraulic system failure)
- Surface conditions (aquaplaning, loss of control on ice-covered surface)
- Loss of visual taxiway guidance system (markings and lights covered by snow)
- Pilot precision and attention (directional control, orientation error, …)

3. Consequences analyses

Consequences are, in theory, potentially major. In practice, according to the common accident/incident lateral taxiway excursions database of reports from ICAO ADREP, FAA NTSB, Airbus, Boeing, Airlines and press accounts (see Appendices 1 part C), no taxiway excursion on a straight section with passenger injuries have been reported for the last 20 years.

**RISK ASSESSMENT**

The A380 wheel span is 14.33m and Code E upper boundary is 14.00m (but not included). Despite the reduced difference of 33cm (i.e. 16.5cm on each side of the A380 wheel span), the risk assessment is required.

Mechanical failure, surface conditions and loss of visual taxiway guidance system have a low dependency on the type of aircraft: the aircraft is likely to go out of the taxiway, no matter how wide its landing gear base is.

Pilot precision and attention is a key issue since it is heavily related to the margin between the outer gear and the taxiway edge. This is a type B case (generic risk model): all functioning aircraft respond reliably to pilot directional inputs when taxiing at ordinary speeds: A380 behaviour could be deduced from measurements made on existing aircraft.

As existing measurements on a straight section tend to show that the bigger the aircraft, the smaller the taxiway deviation (see Appendices 1 Part D and 4 Part E), the extrapolation of available data on taxiway deviation for the A380 seems quite conservative. One of the reasons of this deviation tendency is described as the pilot awareness of taxiing a large aircraft on a given taxiway width. The pilot may pay more attention when taxiing larger aircraft on a given taxiway.

In addition to this, geometric argument (type C) depending on pilot visibility from cockpit can be developed (see Appendix 2 Part B). The A380 cockpit height (7.2m) is lower than the 747 one (8.7m).
So, several kinds of study could be made:

- To use taxiway deviation statistics to calculate the A380 taxiway excursion probability depending on taxiway width. The impact of taxiway guidance systems, weather and surface conditions on taxiway excursion probability should be assessed whenever possible. Several taxiway deviation trials have already been conducted and their final reports are available (see Appendix 4 Parts A, B, C & D). Trials are being conducted (see Appendix 1 Parts D&E and Appendix 4 Parts E&F) at a number of aerodromes (JFK, ANC, AMS, LHR, CDG, FRA & SYD) to determine the extent of deviation from the taxiway centreline when taxiing large aircraft in order to show that movement of an A380 on Code E width (23m) taxiways is feasible. The data collection is taking place throughout 2002-2003 and final reports are to be issued in 2003-2004. A common analysis is managed by IIWG.

- To study the visual reference cockpit cutoff angle over the nose for the intended taxiing operations (i.e. the angle under which the taxiway centre line marking or lights are seen from the cockpit when the aircraft is displaced from the centre line of the taxiway - see figure in Appendix 2 Part B). Considering geometric argument, the A380 cockpit cutoff angle is lower than the cockpit cutoff angle of 747 which improves the cockpit view.

A380 external cameras could not be conclusive for a risk assessment: this is because external cameras shall not prevent the A380 from dispatching in case of camera system failure (see Appendix 2 Part B). However A380 external cameras will be used in training phase to assist A380 pilots in learning A380 geometry and taxiing behaviour. A380 external cameras will also improve taxiing accuracy for the majority of the operational cases.

CONCLUSIONS

- Minimum of 23m
## SYNOPSIS

**ICAO BASELINE**

Overall width of twy + shoulders on straight portion: 44m where code letter is E and 60m where code letter is F. [RP] A14 P3.9.1

The surface should be so prepared as to resist erosion and ingestion of the surface material by aeroplane engines. [RP] A14 P3.9.2

Intended to protect an a/c operating on the twy and to reduce the risk of damage to an a/c running off the twy. ADM Pt2 p1.6.1 and ADM Pt2 p1.6.2+ table 1-1

<table>
<thead>
<tr>
<th>Hazard Identification</th>
<th>Risk 1</th>
<th>Risk 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Shoulder erosion and engine ingestion at taxiing</td>
<td>Aircraft damage after incursion onto taxiway shoulder</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Main causes and accident factors</th>
<th>Theoretical</th>
<th>In-service</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minor except if undetected and followed by engine failure at take-off (potentially major)</td>
<td>No A380 specific issue</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Risk assessment category</th>
<th>Main technical materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>C (geometric argument)</td>
<td>- A380 Engine position</td>
</tr>
<tr>
<td></td>
<td>- A380 Jet blast velocity &amp; temperature contours at break-away thrust</td>
</tr>
<tr>
<td></td>
<td>- Information about lateral deviation from taxiway centreline (see Appendices 2&amp;4)</td>
</tr>
</tbody>
</table>

## CONCLUSIONS

- On straight portions, Code F compliant: 60m wide strip to be protected against shoulder erosion and engine ingestion (paved or natural surface)
- Depending on local conditions, decision on the width for curved portions, composition and thickness for straight and curved portions by each national authority and/or airport operator
HAZARD ANALYSIS

1. Hazard identification

The main purposes of the provision of taxiway shoulders are twofold:
- to prevent jet engines that overhang the edge of a taxiway from ingesting stones or other objects that might damage engine and
- to prevent erosion of the area adjacent to the taxiway (hazard 3).

In addition to this, the risk of damage to an aircraft running off the taxiway should be, in theory, taken into account for taxiway shoulder design. Concerning this hazard:
- the shoulder width should not be regarded as a specific NLA issue: taxiway shoulders should be, in theory, designed to allow pilots to steer the aircraft back onto taxiway in case of minor lateral excursion, whatever the aircraft code letter is.
- the shoulder composition and thickness may be a NLA issue, but other aircraft than NLA may have stronger impact on taxiway shoulders (depending on aircraft weight per wheel). AACG members decided to focus on geometric issues, this pavement aspect is not developed here. Decisions on taxiway shoulders composition and thickness will be made by each national authority and/or airport operator.

Additionally, the current low frequency and low severity of taxiway veer-off case in straight sections does not justify any further evaluation of this risk.

These are the reasons why only shoulder erosion and engine ingestion are considered here.

2. Causal analysis

The main causes and accident factors for FOD are:
- Powerplant characteristics (engine position, engine power)
- Taxiway shoulder width and cohesion
- Taxiway centreline deviation factors (see taxiway veer-off risk)

3. Consequences analysis

The erosion and ingestion hazard when taxiing could be classified as a minor risk except if it is undetected by crew and followed by engine failure at take-off (potentially major).

As a geometric argument is relevant to establish infrastructure requirements relative to jet blast and engine ingestion issues (cf. risk assessment), a detailed hazard analysis is not needed for this item.

RISK ASSESSMENT

Shoulder erosion and engine ingestion issues come under “type C” risk assessment category (geometric argument).
As AACG members agreed for a 60m total taxiway+shoulders width in compliance with Annex 14 (see Conclusions), this section was not in theory absolutely necessary. Nevertheless, to guarantee consistency among document, the same method has been also developed in this case.

Information about engine position and jet blast velocity contour at breakaway allows deducing the need in terms of jet blast protection at taxiing. A lateral deviation from taxiway centreline must be taken into account.
The margin between A380 outer engine axis when the aircraft is on the taxiway centreline and the edge of a 60m wide jet blast protection is 4.30m. The margin between 747 outer engine axis when the aircraft is on the taxiway centreline and the edge of a 44m wide jet blast protection is only 1.15m.

This geometric argument (increase of the margin between outer engine axis and edge of jet blast protection) combined with jet blast drawings at breakaway thrust (see Appendix 2 Parts C&D) allows a conclusion that a 60m wide taxiway jet blast protection will avoid shoulder erosion and engine ingestion risks for A380 taxiing with a level of safety better that the current one.

**CONCLUSIONS**

AACG members agree that:

- On straight portions, Code F compliant: 60m wide strip to be protected against shoulder erosion and engine ingestion (paved or natural surface)
- Depending on local conditions, decision on the width for curved portions, composition and thickness for straight and curved sections by each national authority and/or airport operator.
## PART C: RUNWAY SEPARATIONS

### SYNOPSIS

<table>
<thead>
<tr>
<th>ICAO BASELINE</th>
<th><strong>ICAO BASELINE</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>- Runway to Parallel Taxiway Separation: 190m for instrument rwy or 115m for non-instrument rwy (may be reduced subject to aeronautical study). [RP] A14 P3.8.7 + table 3-1 columns 5 &amp; 9</td>
<td>- Ofz: OFZ half width = 60m where code letter is E and 77.5m where code letter is F then inner transitional surface slope 1:3 [Std] A14 P4.1.11 &amp; 4.1.12 + 4.1.17 to 24, Table 4-1</td>
</tr>
<tr>
<td>- Runway Holding Positions Take-off rwy, non-instrument &amp; non-precision approach minimum holding position distances - no change compared with code E (75m). Precision approaches all CATs: Minimum holding position distances increased to 107.5m for Code F (90m for Code E). [RP] A14 table 3-2 footnote 'c’</td>
<td>- A/C at precision approach holds – not to interfere with the operation of Nav. Aids. [Std] A14 P3.11.6</td>
</tr>
</tbody>
</table>

### HAZARD IDENTIFICATION

<table>
<thead>
<tr>
<th>Hazard Identification</th>
<th>Risk 1</th>
<th>Risk 2</th>
<th>Risk 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collision between an aircraft in flight and an object (fixed or mobile) on the airport</td>
<td>Human factors (crew, ATS) - Weather conditions (visibility) - Aircraft: mechanical failure (engine, hydraulic system, flight instruments, control surfaces,…), wingspan - Airport layout and facilities: location of holding points and parallel taxiway, radar system - Obstacle density (taxiing aircraft included), marking, lighting and publication</td>
<td>Runway veer-off causes and accident factors (see runway veer-off risk) - Lateral veer-off distance - Aircraft size - Airport layout: location of holding points and parallel taxiway - Obstacle density (taxiing aircraft included)</td>
<td>Perturbation of ILS signal by a taxing or stopped aircraft</td>
</tr>
</tbody>
</table>

### RISK ASSESSMENT

<table>
<thead>
<tr>
<th>Risk assessment category</th>
<th>Main technical materials</th>
<th>Severity</th>
<th>Theoretical Catastrophic</th>
<th>In-service</th>
<th>Potentially catastrophic</th>
<th>Potentially major</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (aircraft performance) - B (generic risk model) &amp; C (geometric argument)</td>
<td>OFZ on going studies (OCP): balked landing simulation (autoland mode and flight director mode), collision risk model - St Petersburg formula for A380 operations on 45m wide rwys - NCAA/AEA risk analysis - ADP investigation on OFZ for A380 ops on 45m wide rwys (see Appendix 4)</td>
<td>No known cases reported in-service</td>
<td>B (generic risk model)</td>
<td>Generic risk assessment not feasible</td>
<td>- ADP study - Park Air Systems study (based on an A380 vertical tail in metal) (see Appendix 4)</td>
<td></td>
</tr>
</tbody>
</table>

### AACG CONCLUSIONS

- Runway to parallel taxiway separation:
  - For non instrument runways, ICAO SARPs to be followed (115m for code F)
  - For instrument runways, no generic operational agreement. * 190m regarded as conservative
  - Need for specific runway studies to evaluate ILS interference risks in all the cases
- Ofz:
  - Pending on-going studies (OCP), possibility of reduced Code F OFZ width for A380 operations on 45m wide rwys. *
- Runway holding positions
  - For take off, non-instrument & non-precision approach runways, minimum ICAO SARPs to be followed (75m). In some complex airport layouts (parallel runways, intermediate taxiways used to cross runways,…), rwy holding positions may be specifically studied when rwys are used by A380.
  - Possibility of reduced Code F minimum holding point distances for collision risk reasons (OFZ). *
  - Need for specific runway studies to evaluate ILS interference risks in all cases

* See Introduction Part 3
ICAO BASELINE

See previous synopsis

HAZARD ANALYSIS

1. Hazard identification

The hazards linked to runway separation requirements are:
- Collision risk between an aircraft in flight and an object (fixed or mobile) on the airport
- Collision risk between an aircraft which runs off the runway and an object (fixed or mobile) on the airport
- Perturbation of ILS signal by a taxiing or stopped aircraft

2. Causal analysis

Main causes and accident factors could be defined as follows:

- Collision between an aircraft in flight and an object (fixed or mobile) on the airport
  - Human factors (crew, ATS)
  - Weather conditions (visibility)
  - Aircraft: mechanical failure (engine, hydraulic system, flight instruments, control surfaces,…), wingspan
  - Airport layout and facilities: location of holding points and parallel taxiway, radar system
  - Obstacle density (taxiing aircraft included), marking, lighting and publication

- Collision between an aircraft veering off the runway and an object (fixed or mobile) on the airport
  - Runway veer-off causes and accident factors (see runway veer-off risk)
  - Lateral veer-off distance
  - Aircraft size
  - Airport layout: location of holding points and parallel taxiway
  - Obstacle density (taxiing aircraft included)

- Perturbation of ILS signal by a taxiing or stopped aircraft
  - Aircraft position / navaids
  - Aircraft characteristics (height, shape, component,…)
  - Obstacle density

The common accident/incident database of reports from ICAO ADREP, FAA NTSB, Airbus, Boeing, Airlines and press accounts (see Appendix 1 Part B) deals with lateral runway excursions and does not include accident reports relative to in-flight collision and ILS signal interference. Therefore, the causes and accident factors identified for runway separation issues (see the table before) are mainly supported by airport experience.

The huge variety and the complexity of accident factors for collision risk must be emphasised.

3. Consequences analysis

The first two hazards are potentially catastrophic and the third one is potentially major.
RISK ASSESSMENT

- Collision between an aircraft in flight and an object (fixed or mobile) on the airport

Two different approaches could be assessed:
- Based on aircraft performance (types A&B): assessment of the ability of the aircraft to follow the runway centreline when doing a balked landing
- Based on geometric aspects (type C): use of formula to determine the Code F OFZ width for NLA operations on 45m wide runways.

- Balked landing simulations

The object of the balked landing simulation study is to determine whether the improvements in avionics and aircraft performance over the last 20 to 30 years have led to a quantifiable decrease in the expected aircraft deviations from the desired track when landing or executing a balked landing. This decrease, if it exists, might be used to justify reducing Code F requirements for certain types of airspace, particularly the OFZ, for these state of the art aircraft.

The ICAO OCP is in charge of a study for NLA operations (see Appendix 4 Parts J, K & L).

As some simulation tests are still to be done before analyses and final conclusions for all aircraft operating modes (Autoland and Flight Director) are reached, the geometric method, that is regarded as conservative according to the first outputs of the balked landing simulation study, could be considered as a first step pending the final OCP results.

- OFZ formula

One example of geometrical calculation is the use of St Petersburg formula :

\[
\text{OFZ inner approach surface} = \text{landing aircraft wing span} - \text{landing aircraft wheel span} + \text{runway width} + \text{buffer}
\]

Then the inner transitional surface slope is 1:3 (33%).

An investigation by ADP for A380 operations on 45m wide runway is available in Appendix 4 Part L.

- Collision between an aircraft veering off the runway and an object (fixed or mobile) on the airport

Two different lateral runway excursions database analyses (see Appendix 4 Parts G&H) comes out with the following outputs:
- Veer-off distances\(^1\) (centre of gravity) do not increase in proportion to aircraft size. That means that this collision risk comes under “type B” (generic risk model) risk assessment category (ie extrapolation of current accident database to future aircraft seems relevant).
- Taxiing deviation effect is relatively of little consequence.
- Lateral runway excursion risk (frequency and veer-off distances) is not lower for non-instrument approach and take-off than for instrument approach. That means that, in theory, to provide a uniform level of safety, requirements to mitigate collision risk in case of aircraft veer-off should be as strict for non-instrument and take-off runways as for instrument runways.

For that reason, code F ICAO SARPs relative to runway-taxiway separation distances for non-instrument runway (115m) and to runway holding positions for take-off and non-precision approach runway (75m) should be regarded as a strict minimum for A380 operations.

In some complex airport layouts (parallel runways, intermediate taxiways used to cross runways,...), a specific study may be needed to evaluate runway holding positions when runways are used by A380.

Concerning instrument runways, according to accident database analyses (see Appendix 4 part G) and the experience of current operations in today’s airports (see Appendix 1 Part A), ICAO SARPs relative to code F runway-taxiway distance seems conservative in terms of collision risk after an aircraft veer-off.

\(^1\) The veer-off distance is defined here as the maximum lateral deviation distance reported during a veer-off between the aircraft centre of gravity and the runway centreline.
Perturbation of ILS signal by a taxiing or stopped aircraft

A generic risk assessment on this topic did not seem feasible: ILS signal distortion risk should be assessed in a case-by-case study base taking into account specific airport layout and traffic density. These case-by-case studies could take advantage of several on-going generic studies dealing with A380 geometry effects on ILS safety area:

- A preliminary study from Park Air Systems (see Appendix 4 Part M) calculates for Normac ILS the difference between A380 and 747 Sensitive Areas. The output indicates that the Sensitive Area for a CAT III approach is approximately 30-40% wider for an A380 than for a 747. However, it must be noticed that the A380 was modelled with a metal vertical tail (like the 747 one) instead of a carbon fibre one.
  
  According to ILS specialists, the carbon fibre that is used for A380 vertical tail could lead to a decrease in ILS signal perturbation versus metal.
  
- A study is currently considered by ADP to assess the impact of carbon fibre versus metal on ILS signal perturbations by making real tests at CDG with A310 fitted with the two kinds of tail material (carbon fibre and metal).

For the moment, it seems difficult to reach a generic agreement because of lack of material:

- Runway holding position distance may need to be increased to avoid interference with radio navigation aids.
- Even if code F runway-taxiway distance seems conservative in terms of collision risk, considering potential effects on ILS signal, it did not appear conclusive enough to define a generic reduced runway-taxiway separation distance for A380 operations on instrument runways.

CONCLUSIONS

- Runway to parallel taxiway separation:
  
  o For non instrument runways, ICAO SARPs to be followed (115m for code F)
  o For instrument runways, no generic operational agreement. * 190m regarded as conservative
  o Need for specific runway studies to evaluate ILS interference risks in all the cases

- OFZ:
  
  o Pending on-going studies (OCP), possibility of reduced Code F OFZ width for A380 operations on 45m wide rwys.*

- Runway holding positions
  
  o For take off, non-instrument & non-precision approach runways, minimum ICAO SARPs to be followed (75m). In some complex airport layouts (parallel runways, intermediate taxiways used to cross runways,...), rwy holding positions may be specifically studied when rwys are used by A380.
  
  o Possibility of reduced Code F minimum holding point distances for collision risk reasons (OFZ). *
  o Need for specific runway studies to evaluate ILS interference risks in all cases

* See Introduction Part 3
PART D: TAXIWAY SEPARATIONS

SYNOPSIS

<table>
<thead>
<tr>
<th>ICAO BASELINE</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>- Parallel Taxiway Separation Code F taxiway centreline to taxiway centreline separation = 97.5m. Possibility to operate with lower separation distances based on an aeronautical study. [RP] A14 P3.8.7 + table 3-1 column 10 No specific safety buffers for curved portion. A14 Note 3.8</td>
<td></td>
</tr>
<tr>
<td>- Taxiway / Apron Taxiway to Object Separation Code F taxiway centreline to object separation = 57.5m. Possibility to operate with lower separation distances based on an aeronautical study. [RP] A14 P3.8.7 + table 3-1 column 11 The taxiway strip should provide an area clear of objects which may endanger a/c [RP] A14 3.10.3</td>
<td></td>
</tr>
<tr>
<td>- Aircraft Stand Taxi Lane to Object Separation (including service road and height limited object) Taxi Lane centreline to object separation = 50.5m. Possibility to operate with lower separation distances based on an aeronautical study. [RP] A14 P3.8.7 + table 3-1 column 12 The distance shown (above) may need to be increased if jet exhaust likely to be hazardous. [RP] A14 P 3.8.7 note 4</td>
<td></td>
</tr>
<tr>
<td>- Clearance at the gate : Minimum distance between a/c and obstacle = 7.5m but special circumstances on nose-in stands may permit reduction between terminal (including fixed pax bridge) and a/c nose and over any portion of stand provided with azimuth guidance by a visual docking guidance system. [RP] A14 P3.12.6</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>HAZARD ANALYSIS</th>
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<tr>
<td>Hazard Identification</td>
<td>Collision between two aircraft or between an aircraft and an object (fixed or mobile)</td>
</tr>
<tr>
<td>Main causes and accident factors</td>
<td>- Human factors (crew, marshaler, taxi routing error,..) - Weather conditions</td>
</tr>
<tr>
<td>Severity</td>
<td>Theoretical</td>
</tr>
<tr>
<td>In-service</td>
<td>Potentially major</td>
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<tr>
<th>RISK ASSESSMENT</th>
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<tbody>
<tr>
<td>Risk assessment category</td>
<td>B (generic risk model)</td>
</tr>
<tr>
<td>Main technical materials</td>
<td>- Taxiway deviation statistics analysis (existing and on going analyses) - Air Navigation Plan – ICAO European Region – Reduced Separation Distances for NLA operations - A380 Cockpit visibility (see Appendix 4)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>AACG CONCLUSIONS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>- Parallel Taxiway Separation Minimum of 91m on straight taxiway and the same tip-tip margin (11m) for curved section *</td>
<td></td>
</tr>
<tr>
<td>- Taxiway / Apron Taxiway to Object Separation Minimum of 49m on straight taxiway and the same tip-tip margin (9m) for curved section *</td>
<td></td>
</tr>
<tr>
<td>Aircraft Stand Taxi Lane to Object Separation (including service road and height limited object) Minimum of 47.5m on straight taxiway and the same tip-tip margin (7.5m) for curved section * Depending on local conditions, decision on reduced margins for height limited objects by each authority and/or airport operator.</td>
<td></td>
</tr>
<tr>
<td>- Clearance at the gate : ICAO SARPs to be followed. Possibility of reduced distance with appropriate measure *</td>
<td></td>
</tr>
</tbody>
</table>
* See Introduction Part 3
ICAO BASELINE
See previous synopsis

HAZARD ANALYSIS

1. Hazard identification

The separation distances during taxiing are intended to limit the risk of collision between two aircraft (taxiway/taxiway separation) and between an aircraft and an object (taxiway/object, taxilane/object separations, and clearance at the gate).

2. Causal analysis

The common accident/incident database (see Appendix 1 Part C) includes only two accident reports relative to collision on taxiing. Therefore, the causes and accident factors identified for taxiway separation issue are mainly supported by experience and not by accident database analysis. The causes of such an event could be classified as:

- Mechanical failure (hydraulic system failure)
- Surface conditions (aquaplaning, loss of control on ice-covered surface)
- Loss of visual taxiway guidance system (markings and lights covered by snow)
- Pilot precision and attention (directional control, orientation error, …)

3. Consequences analysis

Consequences of collision on taxiing are potentially major.

RISK ASSESSMENT

As the collision hazard at taxiing does not depend on specific aircraft performances but on human factors, the expected A380 behaviour could be inferred from existing aircraft behaviour. As existing measurements in straight section tend to show that the bigger the aircraft, the smaller the taxiway deviation (see Appendix 1 Part D and Appendix 4 Part E), the extrapolation of available data on taxiway deviation for the A380 seems quite conservative.

This statement means that taxiway separation distances issue comes under “type B” risk assessment category (generic risk model).

Accordingly, two kinds of argument could be developed:

- Use taxiway deviation statistics to assess the collision risk between two aircraft or between an aircraft and an object. Several taxiway deviation studies (see Appendix 1 Parts D&E and Appendix 4 Parts A to F) are available or in progress on different airports world-wide (JFK, ANC, AMS, LHR, CDG, FRA & SYD). Common analysis is currently managed by IIWG, and final reports are not yet available (first planned in 2003-2004).
- Take advantage of the experience of some major airports that applied lower separation distances specified in the ICAO Air Navigation Plan of European Region for 747-400 operations (see Appendix 4 Part A). ICAO European ANP defines specific measures to apply these reduced wingtip margins on existing infrastructures for generic NLA operations based on 747-400 experience (e.g. centreline lighting or equivalent guidance (i.e. marshaller) for night, winter and low visibility operations, objects marking and lighting, good surface friction conditions, publication in AIP, …).

As risk collision when taxiing is a “type B” hazard (generic risk model), the reduced separation distances used at some major airports for 747-400 with no adverse effect on the safety could be extrapolated for A380 operations, with the same specific measures as for the 747-400 aircraft.
CONCLUSIONS

AACG agree that, subject to specific measures (e.g. centreline lighting or equivalent guidance (i.e. marshaller) for night, winter and low visibility operations, objects marking and lighting, good surface friction conditions, publication in AIP,...), A380 could operate with the existing 747-400 wing tip margins as specified in ICAO Air Navigation Plan of European Region for NLA operations.

- Parallel Taxiway Separation
Minimum of 91m on straight taxiway and the same tip-tip margin (11m) for curved section *

- Taxiway / Apron Taxiway to Object Separation
Minimum of 49m on straight taxiway and the same tip-tip margin (9m) for curved section *

- Aircraft Stand Taxilane to Object Separation (including service road and height limited object)
Minimum of 47.5m on straight taxiway and the same tip-tip margin (7.5m) for curved section *
Depending on local conditions, decision on reduced margins for height limited objects by each authority and/or airport operator.

- Clearance at the gate :
ICAO SARPs to be followed. Possibility of reduced distance with appropriate measure *

* See Introduction Part 3
**PART E: OTHER ITEMS**

**RUNWAY VISUAL AIDS**

### SYNOPSIS

Elevated rwy lights shall be frangible + clear of propellers & engine pods. [Std] A14 P5.3.1.6

Surface (inset) lights shall withstand being run over by aircraft. [Std] A14 P5.3.1.7

Elevated rwy lights shall be placed along the edge of the area declared for the use as rwy or outside by less than 3m. [Std] A14 P5.3.9.4

Signals shall be frangible + clear of propellers & engine pods. [Std] A14 P.5.4.1.3

Where a PAPI or APAPI is installed on rwy without ILS or MLS they shall be sited to ensure guidance for the most demanding aircraft regularly using the rwy. Where a PAPI or APAPI is installed on rwy with ILS or MLS they should be sited to provide guidance for those aircraft regularly using the rwy. A14 Chap 5 Figure 5-15 P a) & b), & A14 Chap 5 Table 5-2 footnote a.

The location of PAPI units depends on eye-to-wheel height of the group of aircraft that use the system regularly & by using the most demanding aircraft of the group. A14 Chap 5 Table 5-2 note a.

Wheel clearances may be reduced subject to aeronautical study but not less than values indicated in Table 5-2 column 3. A14 Chap 5 Table 5-2 note c.

### HAZARD ANALYSIS

#### Hazard Identification

- Risk 1
  - Elevated edge lights damaged by jet blast

- Risk 2
  - PAPI guidance not adapted for an aircraft in approach

- Risk 3
  - Aircraft damage caused by elevated lights after a veer-off

#### Main causes and accident factors

- Powerplant (engine position, engine power)
- Elevated edge lights strength
- Aircraft (rotation angle at take-off)
- Runway centreline deviation factors (see runway veer-off risk)

#### Severity

<table>
<thead>
<tr>
<th>Theoretical</th>
<th>In-service</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potentially major if undetected before take-off and followed by engine ingestion and tire bursting risks</td>
<td>No A380 specific issue</td>
</tr>
</tbody>
</table>

#### Risk assessment category

- C (geometric argument)

#### Main technical materials

- A380 Engine position
- A380 Short distance jet blast velocity contours
- A380 Rotation angle (see Appendix 2)

#### AACG CONCLUSIONS

- For rwy edge lighting position, ICAO SARPs to be followed (placed along the edge of the area declared for the use as rwy or outside by less than 3m)
- Inset rwy edge lights; possibility of elevated runway edge lights according to preliminary engine outputs. Snow clearance to be considered in the choice.
- PAPI : No specific A380 requirement; ICAO compliant
HAZARD ANALYSIS

1. Hazard identification

Three potential hazards linked to runway visual aids characteristics could be identified:

1. Elevated edge lights damaged by aircraft jet blast
2. PAPI guidance not adapted for an aircraft in approach
3. Aircraft damage caused by elevated lights after an aircraft veer-off

Hazards 1 and 2 could effectively be related to NLA characteristics (engine position, engine thrust, eye-to-wheel height, landing attitude,…). However, hazard 3 is not a specific NLA issue. The frangibility characteristic of elevated edge lights is a mitigating measure potentially useful for all kind of aircraft (and probably more for smallest aircraft: the bigger the gear wheel, the more the frangibility) in case of runway veer-off.

PAPI guidance issues are linked to aircraft characteristics but considering A380 eye-to-wheel height in approach configuration (see Appendix 3 Part E), Annex 14 requirements should be sufficient to determine PAPI guidance for A380. This is not a specific A380 item.

In addition to these three hazards, it could be relevant to study the risk of centreline lights damage caused by aircraft rolling on surface lights: the A380 is not the most critical aircraft in term of weight per boggy.

Hence, only jet blast effects on runway edge lights has been considered here for the A380.

2. Causal analysis

Main causes and accident factors for elevated runway edge lights damages risk are:

- Powerplant characteristics (engine position, engine power)
- Elevated edge lights strength
- Aircraft rotation angle at take-off
- Runway centreline deviation factors (see runway veer-off risk)

3. Consequences analysis

Edge lights damages could potentially have major consequences if undetected before take-off and followed by engine ingestion and tire bursting.

RISK ASSESSMENT

Runway edge lights damage

Jet blast hazards are typical geometric issues and come under “type C” risk assessment category (geometric argument).

First A380 short distance jet blast contours are now available (see Appendix 2 Part D) and could be compared to other existing aircraft short distance jet blast contours.

The preliminary output of comparative studies indicates that runway edge lights are already subject to jet blast velocities similar to the expected A380 ones. The outboard engine positions would be about the same distance laterally from the lights, the 747 engines inside and the A380 engines outside the line of lights.
Moreover, based on mechanical strength values of elevated runway lights requirements, preliminary simulation results of theoretical study would show that the elevated lights should withstand the A380 jet blast.

A study based on experimental tests may be carried out in order to determine mechanical and/or aerodynamic strength limits of some existing elevated runway lights.

Others analysis linked to the characteristics of the lights are in progress:
- Photometry tests in laboratory conditions show that the luminous output of runway edge inset lights is compliant with the minimum intensity defined by Annex 14 (even though lower than the luminous output of elevated light).
- The inset lights are only bi-directional and they cannot be used for providing circling guidance and be shown at all angles in azimuth (Annex 14 §5.3.9.8). If there is a need for circling guidance, two inset lights should be installed: the runway edge inset light and an inset light with omnidirectional luminous output.
- The level of maintenance required with inset fittings is higher than the one with elevated lights: from replacement of a lamp on site to the replacement of the whole inset light by a spare and the maintenance in a workshop (stripping down of the fitting and cleaning of the lens and replacement of the lamp and seals,...)

CONCLUSIONS

- For rwy edge lighting position, ICAO SARPs to be followed (placed along the edge of the area declared for the use as rwy or outside by less than 3m)
- Inset rwy edge lights; possibility of elevated runway edge lights according to preliminary engine outputs. Snow clearance to be considered in the choice.
- PAPI : No specific A380 requirement; ICAO compliant
### TAXIWAY ON BRIDGES

#### SYNOPSIS

The width of the portion of a taxiway bridge capable of supporting aeroplanes, as measure perpendicularly to the taxiway centreline, shall not be less than the width of the graded area of the strip provided for that taxiway, unless a proven method of lateral restraint is provided which shall not be hazardous for aeroplanes for which the taxiway is intended. [Std] A14 P3.8.19 & ADM Pt 2 P1.4.4

Access should be provided for ARFF vehicles to intervene in both directions. [RP] A14 P3.8.20

If a/c engines overhang the bridge structure, protection of adjacent areas below the bridge from engine blast may be required. [RP] A14 P3.8.20 Note & ADM Pt2 P1.4.4

#### HAZARD IDENTIFICATION

<table>
<thead>
<tr>
<th>Hazard identification</th>
<th>Risk 1 Taxiway veer off on the bridge and aircraft falls from the bridge</th>
<th>Risk 2 Evacuation slides falling past the edge</th>
<th>Risk 3 Difficulties for fire fighting intervention</th>
<th>Risk 4 Blast under the bridge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk of aircraft veer off the bridge and aircraft falls from the bridge</td>
<td>- See taxiway veer-off risk (taxiway width %)</td>
<td>- Aircraft stop away from taxiway centreline - Width of the bridge - Evacuation slides configuration</td>
<td>- Width of the bridge - Wingspan and outer engine span</td>
<td>- Engine position, engine power - Width of jet blast protection on the bridge - Taxiway deviation factors (see. taxiway veer-off risk)</td>
</tr>
</tbody>
</table>

#### MAIN CAUSES AND ACCIDENT FACTORS

- See taxiway veer-off risk (taxiway width %)
- Width of the bridge

#### HAZARD ANALYSIS

<table>
<thead>
<tr>
<th>Severity</th>
<th>Theoretical</th>
<th>Catastrophic</th>
<th>Hazardous</th>
<th>Major to catastrophic</th>
<th>Major for other traffic (not for the aircraft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-service</td>
<td>No cases reported</td>
<td>No cases reported</td>
<td>No cases reported</td>
<td>Major to catastrophic</td>
<td>Major for other traffic (not for the aircraft)</td>
</tr>
</tbody>
</table>

#### RISK ASSESSMENT

<table>
<thead>
<tr>
<th>Risk assessment category</th>
<th>C (predominant geometric issues)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main technical materials</td>
<td>- Comparison with margins for a 747 on a code E bridge (see Appendix 2) - Firemen practices A380 wingspan and outer engine span (see Appendix 2) - A380 outer engine span - Taxiing jet blast contours (see Appendix 2)</td>
</tr>
</tbody>
</table>

#### AACG CONCLUSIONS

- Not less than 49m for the width of the portion capable of supporting the A380 and for passenger evacuation
- 60m for jet blast protection width
- Possibility of reduced width margin if proven method of lateral restraint is provided
- Alternative path for ARFF vehicles (whatever bridge width)
ICAO BASELINE

See previous synopsis

HAZARD ANALYSIS

1. Hazard identification

The following hazards have been identified:
   1) A gear leg veering off the bearing surface
   2) In case of an emergency evacuation, deployment of an escape slide with its end outside the bridge
   3) Impossibility for fire emergency vehicles to drive around the aircraft
   4) Jet blast on whatever is under the bridge

2. Causal analysis

See previous synopsis

3. Consequences analysis

The hazards, under the FAR/JAR scale, would be classified as « major » to « catastrophic »

RISK ASSESSMENT

For these hazard mechanisms, a «type C» analysis is adequate (geometric argument), i.e. one in which the geometric characteristics of the aircraft are predominant. Safety levels could be defined through a comparison with code E requirements and 747 characteristics (see Appendix 2 Part A).

1) Considering the risk of a veer-off is a function of the margin between the main gear legs and the bridge edge:
   a. For a 747-400 (12.6m wheel span), this margin on a code E-compliant bridge (44m width) is:
      44m/2 - 12.6m/2 = 15.7m
   b. For an A380 (14.3m wheel span), if this 15.7m deviation is applied, this would lead to a minimum bridge bearing strength width of:
      15.7m x 2 + 14.3m = 45.7m
   A 46m wide taxiway bridge allows the same taxiway excursion for an A380 as for a 747 on a code E-compliant bridge.

2) It is considering herein that the risk of a slide falling outside the bridge is a function of the margin between the position of the outermost slide (when the aircraft is on the centreline) and the bridge edge.
   a. For a 747-400 (outermost slide at 14.4m from aircraft axis) this margin on a code E bridge is:
      44m/2 - 14.4m = 7.6m
   b. For the A380 (outermost slide at 16.7m from aircraft axis), if this 7.6m margin is applied, this would lead to a minimum bridge bearing strength width of:
      7.6m x 2 + 16.7m x 2 = 48.6m
   A 49m wide taxiway bridge allows the same margin for passenger evacuation for an A380 as for a 747 on a code E-compliant bridge.

Therefore, the minimum width of the portion capable of supporting A380 and for passenger evacuation is the greater of these two values that is to say: 49m
3) For fire intervention, it is necessary to provide fire-fighting vehicles with routes allowing access to both sides of the aircraft, so that they could fight a fire using the best angle (according to wind direction).

It should be noted that the wing of a 80m aircraft will in all cases exceed the width of a bridge. According to firecrew practices, the most important point (rather than an increased bridge width implying a passage under the wing) is to have another bridge nearby for access to the “other” side of an aircraft. This is available when bridges are paired (parallel taxiways) or when there is a service road in the vicinity. Ground on the bypass routes should also be stabilized where it is unpaved.

4) For blast protection under the bridge, the outer engine of an A380 is notably farther out than that of any existing code E aircraft. Therefore a 60m width for blast protection is needed for taxiway bridges used by A380. This requirement for jet blast protection under a taxiway bridge is consistent with taxiway shoulder width.

**Conclusions**

- Not less than 49m for the width of the portion capable of supporting the A380 and for passenger evacuation
- 60m for jet blast protection width
- Possibility of reduced width margin if proven method of lateral restraint is provided
- Alternative path for ARFF vehicles (whatever bridge width)