Airport Noise Management: Benchmarking of 12 International Airports

Jean-Pierre CLAIRBOIS¹ and Nico VAN OOSTEN²

¹ A-Tech / Acoustic Technologies, Belgium
² Anotec Engineering, Spain

ABSTRACT

Aircraft movements can drastically degrade the quality of the environment around airports. Looking toward better airport management strategies could improve both the development of airport activities and the integrated development of urban projects around. “Brussels-Environment”, the relevant authority for the Brussels-Capital Region, has decided to establish a benchmarking. The present study sums up the different airport noise strategies applied by 12 international airports: Arlanda, Brussels, Charleroi (Brussels-South), Liège, Manchester, Munich, Portland, Sydney, Toulouse, Vienna, Vancouver and Amsterdam (Schiphol). The benchmarking concerns 5 main fields of data: general, land-use planning, noise abatement procedures, operational restrictions and noise management strategies. Interesting correlation have been shown between the different ways those airports are applying the “Balanced Approach” (as defined by the ICAO) and the amount of complaints expressed.

Keywords: Community noise control, Airport noise, Balanced Approach

I-INCE Classification of Subjects Number(s): 52.2, 68.5

1. INTRODUCTION

More than the “technical abilities” of an airport, it is its “environmental ability” that rules its future air traffic growth capacity…

In Europe, the European Noise Directive (1) requests that the Member States establish action plans based upon strategic noise-mapping results, with a view to preventing and reducing environmental noise where necessary and particularly where exposure levels can induce harmful effects on human health and to preserving environmental noise quality where it is good: airports surroundings should be part of those action plans.

As many other cities having very close international airports, Brussels is strongly affected by the noise of numerous aircraft take-offs and landings: this noise significantly impacts the quality of life and the “life ability” of its surroundings. Considering this, “Brussels-Environment”, the relevant authority for the Brussels-Capital Region, has decided to establish a benchmarking considering several international airports. The aim of this benchmarking was: to better understand how different airports are managing their (noise) impact on the environment. The initial target was to consider about 10 international airports. Finally, 12 airports have been considered: 9 European (Arlanda, Brussels, Charleroi / “Brussels-South”, Liège, Manchester, Munich, Toulouse, Vienna, and Amsterdam / Schiphol) and 3 non-European (Portland, Sydney and Vancouver).

Based on a detailed survey kindly replied by the relevant airport authorities, and / or supplemented by additional researches, this benchmarking shows how every airport applies the “Balanced Approach” as defined by the ICAO (2): this paper shows how far the way of applying the “Balanced Approach” could correlate the amount of complaints expressed in the surroundings, and thus the capacity of the airport to sustain a future traffic growth…

¹ jpc@atech-acoustictechnologies.com
² nico@anotecengineering.com
2. METHODOLOGY

2.1 Objectives

The objectives were to list and analyze the different tools that the airports use in order to prevent and reduce the environmental noise of their activities: one had first to select a list of airports.

2.2 Ranking of Brussels-National airport (BRU) in terms of airport activities

In terms of airport activities, Brussels-National airport (BRU) ranks as shown in table 1.

Table 1 – Activities of different airports similar to BRU (data from 2010 to 2014, depending on the airport)

<table>
<thead>
<tr>
<th>Airport code</th>
<th>Closest city</th>
<th>Country</th>
<th>Movements / yr</th>
<th>PAX / yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZRH</td>
<td>Zurich</td>
<td>Suisse</td>
<td>265 000</td>
<td>24 000 000</td>
</tr>
<tr>
<td>LGW</td>
<td>London (Gatwick)</td>
<td>UK</td>
<td>250 000</td>
<td>35 000 000</td>
</tr>
<tr>
<td>CPH</td>
<td>Copenhagen</td>
<td>Denmark</td>
<td>245 000</td>
<td>24 000 000</td>
</tr>
<tr>
<td>SVO</td>
<td>Sheremetevo</td>
<td>Russia</td>
<td>243 000</td>
<td>29 000 000</td>
</tr>
<tr>
<td>BRU</td>
<td>Brussels</td>
<td>Belgium</td>
<td>235 000</td>
<td>22 000 000</td>
</tr>
<tr>
<td>VIE</td>
<td>Vienna</td>
<td>Austria</td>
<td>231 000</td>
<td>22 000 000</td>
</tr>
<tr>
<td>ORY</td>
<td>Paris (Orly)</td>
<td>France</td>
<td>230 000</td>
<td>29 000 000</td>
</tr>
<tr>
<td>ARN</td>
<td>Stockholm</td>
<td>Sweden</td>
<td>217 000</td>
<td>20 700 000</td>
</tr>
<tr>
<td>TXL</td>
<td>Berlin (Tegel)</td>
<td>Germany</td>
<td>175 000</td>
<td>20 000 000</td>
</tr>
<tr>
<td>NCE</td>
<td>Nice</td>
<td>France</td>
<td>175 000</td>
<td>12 000 000</td>
</tr>
</tbody>
</table>

However, instead of looking just at airport activities, one finally preferred to consider the airport sustainability, including not only noise impacts, but all aspects of sustainability (technical, social, environmental and economics): the survey kept a list of airports that, in function of their needs, do apply the “Balanced Approach” (2) in different ways and with different successes.

2.3 Selection of airports applying the “Balanced Approach”

The European regulation EU No 598/2014 specifies that the airports have to apply the “Balanced Approach” (2), case by case: most of European airports have, to some extent, already implemented this approach. The following 12 international airports have then been selected for this survey (see table 2).

Table 2 – The 12 selected airports and their activities (data 2013 / 2014, depending on the airport)

<table>
<thead>
<tr>
<th>Airport code</th>
<th>Closest city</th>
<th>Country</th>
<th>Movements / yr</th>
<th>PAX / yr</th>
<th>Cargo, T/ yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARN</td>
<td>Stockholm</td>
<td>Sweden</td>
<td>220 000</td>
<td>20 700 000</td>
<td>130 000</td>
</tr>
<tr>
<td>BRU</td>
<td>Brussels</td>
<td>Belgium</td>
<td>232 000</td>
<td>21 900 000</td>
<td>454 000</td>
</tr>
<tr>
<td>CRL</td>
<td>Charleroi</td>
<td>Belgium</td>
<td>76 000</td>
<td>6 400 000</td>
<td>24</td>
</tr>
<tr>
<td>LGG</td>
<td>Liège</td>
<td>Belgium</td>
<td>42 000</td>
<td>30 000</td>
<td>591 000</td>
</tr>
<tr>
<td>MAN</td>
<td>Manchester</td>
<td>UK</td>
<td>163 000</td>
<td>22 000 000</td>
<td>96 000</td>
</tr>
<tr>
<td>MUC</td>
<td>Munich</td>
<td>Germany</td>
<td>382 000</td>
<td>38 700 000</td>
<td>288 000</td>
</tr>
<tr>
<td>PDX</td>
<td>Portland</td>
<td>USA</td>
<td>210 000</td>
<td>15 000 000</td>
<td>212 000</td>
</tr>
<tr>
<td>SYD</td>
<td>Sydney</td>
<td>Australia</td>
<td>322 000</td>
<td>36 900 000</td>
<td>806 000</td>
</tr>
<tr>
<td>TLS</td>
<td>Toulouse</td>
<td>France</td>
<td>96 000</td>
<td>7 600 000</td>
<td>61 000</td>
</tr>
<tr>
<td>VIE</td>
<td>Vienne</td>
<td>Austria</td>
<td>247 000</td>
<td>22 000 000</td>
<td>256 000</td>
</tr>
<tr>
<td>YVR</td>
<td>Vancouver</td>
<td>Canada</td>
<td>251 000</td>
<td>17 600 000</td>
<td>228 000</td>
</tr>
<tr>
<td>AMS</td>
<td>Amsterdam</td>
<td>Netherlands</td>
<td>438 000</td>
<td>54 900 000</td>
<td>1 633 000</td>
</tr>
</tbody>
</table>
2.4 Survey questionnaire

In order to compare the different airports, one had to assemble a lot of data: a list of the necessary technical facts and figures has been established, and all the questionnaires (all in English) have been circulated. Most of the data of the questionnaire concern the “Balanced Approach”: that is the reason why chapter 3 first summarizes the BA, while the questionnaire is presented later, in chapter 4.

2.5 Population (noise) exposure indicator

As soon as we have to compare the noise exposure around different airports, it is important to use a significant and relevant indicator: such one has not only to quantify / compare the noise exposure of different airports, but it could also be used in order to compare different scenarios of action plans while targeting minimized ground noise impacts.

In that way, the aggregated indicator \( L_{\text{den}, \text{pop}} \) has been used: a detailed description is given by the European Environment Agency in (4) and the corresponding formula is:

\[
L_{\text{den}, \text{pop}} = 10 \log \left( \sum_{i=1}^{n} 10^{L_{\text{den},i}/10} \right)
\]

Where: \( n \) is the total number of inhabitants, and \( L_{\text{den},i} \) is the \( L_{\text{den}} \) specific to every inhabitant \( i \).

3. THE BALANCED APPROACH

As defined by ICAO (2), the “Balanced Approach” corresponds to a list of principles that could help airports to better manage their ground noise impact: following their own needs, every airport can apply all or parts of this list: while many are applying the “Balanced Approach”, the success is not the same for all the airports. Figure 1 sums up the 4 pillars of the “Balanced Approach”.

4. THE SURVEY QUESTIONNAIRE

Figure 2 shows what were the main fields of data requested in the questionnaire: General data, Land-use planning (& management), Noise abatement (operational) procedures, Operational restrictions, and how the airport manages the noise, day by day (Noise management). One directly notices the part of the questionnaire that relates to the 3 pillars of the “Balanced Approach” that are under the responsibility of the airport authorities.
4.1 General information
The general information includes important historical data about the number of movements of the previous years, while future perspective were also very welcome. Other data concern: the runways, the distance to the closest (main) city center, the existing noise regulation, the noise maps, the amount of population impacted from category 45-50, up to over 70 dB(A) for the day / evening / night and den periods, if available, the current noise action plans in place, and the noise indexes used.

4.2 Land-use planning and management (BA)
This part of the questionnaire was divided in 3 parts: the zoning around the airport (land zones and actions taken as buying back houses / land, building codes for new houses, valuation of houses and land…), the allocated budgets, and the legislation.

4.3 Noise abatement operational procedures (BA)
This concerns the way the airport is managing its operational procedures in order to reduce its noise impact, it includes: preferential runways, preferential routes, use of PRNAV, respite periods, flight procedures, design criteria (optimization method for minimizing the ground noise impact, noise exposure index, other indicators as quota counts…), noise emissions trade-off…

4.4 Operational restrictions (BA)
Operational restrictions could have an important financial impact. For that reason, ICAO recommends to avoid those as much as possible, and to consider those when, and only when, all the other possibilities have been used / optimized.

The classic operational restrictions are: curfews, restrictions / phase-out of aircraft types, operating quota / fines, the engine run-up, the use of APU…

4.5 Additional noise management strategies (advised by BA)
Other important data have been collected about: the noise monitoring systems, the (house) soundproofing strategies, the financial tools and the community outreach.
5. THE RESULTS

Every filled questionnaire has been compiled into a tabular format in order to ease further analysis. In addition to the questionnaire replies, we added 2 interesting data (when available): the amount of complaints, to some extent significant of the people’s perception, and the $L_{den, pop}$ that has been calculated for the European airports, thanks to the reported results of the official results of the strategic noise mapping (1): the $L_{den, pop}$ is a good aggregated indicator that allows comparisons between the airport noise exposures.

Even if the results contain many other ways of analysis that could still be done in a further researches, the present survey results were concentrated on the 3 major fields: the general information, the noise exposure, and the implementation of the “Balanced Approach”.

5.1 Results airport by airport

Figure 3 shows an example of geographic location of one of the airports and its associated $L_{den}$ noise map, while figure 4 and 5 show summaries of the results of the same airport for the 3 major fields of analysis with, in red, the airport’s position in the corresponding ranking.

![Figure 3](image1.png)

**Figure 3** – Example of geographic presentation of an airport / $L_{den}$ noise map (© A-Tech / ANOTEC).

<table>
<thead>
<tr>
<th>GENERAL</th>
<th>Year</th>
<th>2013</th>
<th>Pax</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nº movements</td>
<td>Total</td>
<td>247 281</td>
<td></td>
</tr>
<tr>
<td>Nº % Night flights</td>
<td>Total</td>
<td>7%</td>
<td></td>
</tr>
<tr>
<td>Nº pax</td>
<td>Total</td>
<td>22 000 000</td>
<td></td>
</tr>
<tr>
<td>Freight (T)</td>
<td>Total</td>
<td>256 194</td>
<td></td>
</tr>
<tr>
<td>Noise Action Plan in place</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nº of complaints per year</td>
<td>8 300</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

![Table](image2.png)

**Figure 4** – Example of general information data of a specific airport (© A-Tech / ANOTEC).

One directly see the results corresponding to the 3 field of analysis: general (movements / PAX / Cargo, action plans, complaints), noise (population per $L_{den}$ and $L_{night}$ categories, $L_{den, pop}$), and implementation of the “Balanced Approach” (with a percentage of implementation of the listed Balanced Approach tool, as well as a weighted overall BA implementation ratio).
Much more than the size of activities of each airport, it is important to compare the airport noise exposure in its surroundings with all the actions taken in order to better manage the ground noise impact: this is the key of an optimized sustainable management; figure 5 shows an example of this.

Figure 5 – Example of noise and BA implementation data of a specific airport (© A-Tech / ANOTEC).

### 5.2 Results for all airports

The database of all the results of all the 12 airports is huge: figure 6 first summarizes hereafter the traffic data (number of movements, PAX, and Cargo) and the $L_{den,pop}$ results for all the airports where the data were available.

One will directly notice the importance of the traffic at Amsterdam airport (Schiphol / AMS), as well as at Sydney (SYD) and Munich (MUC) airports, while their $L_{den,pop}$ have no (direct) relation with those traffics. In the same way, while Liège airport (LGG) is the “smallest” airport in terms of total number of movements, it has the second most important cargo traffic (if we except AMS) after SYD: moreover, LGG is a nighttime cargo hub that drastically increases its $L_{den,pop}$ at the second most exposed position. Finally, Charleroi airport (Brussels South / CRL) is a passenger only daytime airport that is implemented in inhabited area in such a way that it is the 3rd most exposed airport.

However, $L_{den,pop}$ is not the only important indicator of good management: one also has to look at how the Balanced Approach is effectively implemented: the most exposed airport could even be the best managed ones with almost no complaints. This is the future key of the airports sustainability!
Figure 6 – aggregated results for traffic and noise exposure (© A-Tech / ANOTEC).

About the implementation of the “Balanced Approach”, figure 7 regroups all the results under a radar plot form: when applying neither Land-use planning, nor Sound insulation schemes, Brussels has to apply operational restrictions (remember that operational restrictions is the ICAO BA least advised tool).

Figure 7 – aggregated results about the “Balanced Approach” implementation (© A-Tech / ANOTEC).

Considering the amount of complaints as a possible (while sometime questionable) indicator of a good airport management, the most important (and logically expected) result of this survey is:

The higher the ground noise exposure, the higher the % of implementation of the BA tools has to be.

In such a way, and thanks to their far location / favorable orientation, the least exposed airports (Arlanda ARN, Munich MUC, Vienna VIE, and even Portland PDX, while not calculated here), need much less accompanying measures than the other airports. Figure 8 shows how the BA is implemented at those less exposed airports: about only 50 to 60%, while they have no big problems.
Manchester airport MAN is one of the best managed airports with the highest percentage of BA implementation (87%), while it still keeps 838 complaints a year. Liège airport LGG and Charleroi “Brussels-South” airport CRL (both managed by the same airport authority) are as good as Manchester MAN: while having the second and third highest ground noise exposures, thanks to their excellent management (86% of BA implementation), their numbers of complaints / year are surprisingly low (26 for LGG, and 87 for CRL). Toulouse TLS has about the same return, i.e.: 87 complaints / year.

![Figure 8](https://example.com/figure8.png)

Figure 8 – the higher the ground noise exposure, the higher the implementation of the BA tools has to be (© A-Tech / ANOTEC).

Finally, figures 8 also demonstrates how important the percentage of BA implementation has to be for the most exposed airports: being the most exposed airport of this survey, Brussels-National airport BRU should have to apply the maximum of the BA. However, this airport is the one applying the less of the “Balanced Approach”: no wonder that, with about 10.000 complaints / year, Brussels BRU reaches many difficulties…

6. CONCLUSIONS

The “Balanced Approach” is a concept that consider a list of several tools to be applied case by case, taken every single airport particularity into account: the present survey clearly shows the diversity of combinations of BA tools that are used by every reported airport.

More than “simply” reducing the noise, the most important is to correctly manage the noise nuisances: optimizing the combinations of tools applicable to the airport specificities in order to prevent or to reduce the effect of the ground noise impact following a multicriteria approach, foreseeing and anticipating every possible future evolution, avoiding possible future problematic changes, really willing to solve the problem in a holistic approach, involving all the stakeholders.

The “Balanced Approach” provides a list of tools that help airports to manage their ground noise impact: applying few of those tools can be, sometimes enough, sometimes not enough: the most important conclusion of this survey was logically the one expected, but it is also clearly demonstrated: The higher the ground noise exposure, the higher the % of implementation of the BA tools has to be.

Airports could have high ground noise impact but, well managed, could finally have no further problem: this very important conclusion is a real message of hope for future integrated airports, combining economic growth, urban growth, and fully controlled management.

ACKNOWLEDGEMENTS

This survey has been done for “Brussels-Environment”, the relevant authority for the environment within the Brussels-Capital region.
REFERENCES