VANGUARDIA

A BURO HAPPOLD COMPANY

Dublin Airport North Runway

Response to Submissions on Draft APB Decision - Noise

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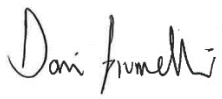
signature	
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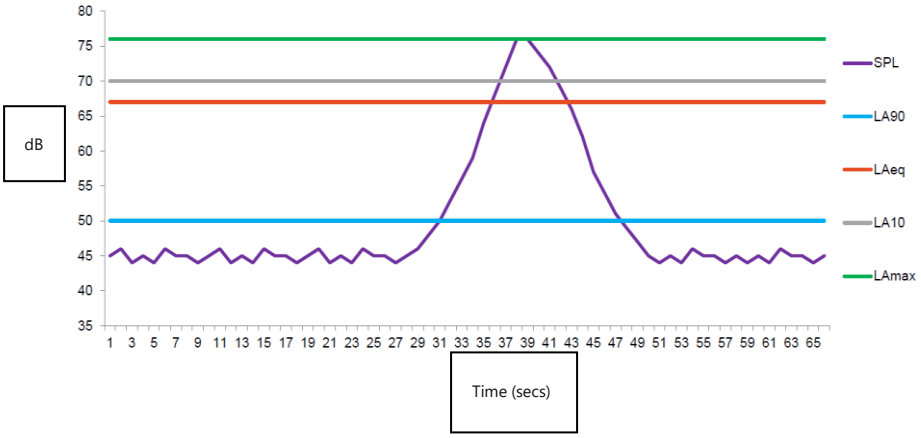
Glossary

Term	Definition
'A' Weighting	'A' Weighting is a standard weighting of the audible frequencies designed to reflect the response of the human ear to noise. The 'A' Frequency Weighting network is the most widely used and is used to represent the response of the human ear to loudness. Measurements made with this frequency weighting will be displayed as dB(A) or dBA. For example, as $L_{Aeq,T}$ $L_{AFmax,T}$ etc. where the A shows the use of 'A' Weighting.
ATM	An Air Traffic Movement is a landing (arrival) or take-off (departure) of an aircraft at a specific airport
Decibel (dB)	The decibel is a relative unit of measurement equal to one tenth of a bel (B). Decibels are used to measure sound pressure levels because the lowest sound pressure which can be heard by humans is called the hearing threshold, the highest which can be endured is known as the pain threshold. Sound pressure at the pain threshold is a million times greater than that at the hearing threshold e.g. hearing threshold sound pressure is 0.000002 Pascals and the auditory pain threshold is 20 Pascals. To avoid having to consider such a massive range of pressure values sound is measured using decibels with the threshold of hearing at 0 decibels and the threshold of pain at 120 decibels. One decibel (0.1 bel) equals 10 times the common logarithm of the power ratio of a sound pressure level under investigation and a reference sound pressure of 20 micropascals (20 µPa), or 0.02 mPa. Because decibel values are added together on a logarithmic scale, the result differs from that on a linear scale. If two equally strong sound sources are added together, the combined sound pressure level does not double but increases by three decibels.
Fast and Slow Time Weightings	The Time Weightings of Fast and Slow are defined by the standards to which the instrument are designed, such as IEC 61672, and they determine the "speed" at which the instrument responds to changing noise levels. For example, an instrument set to Fast will respond quickly to changes in the noise level, whereas an instrument set to Slow will respond less quickly. If the noise level is constant, both instruments will display the same level. Measurement parameters that use these time weightings will show this, for example, as L_{AFmax} which shows that the values are the maximum A-Weighted Fast Time Weighted sound levels.
Equivalent Continuous Sound Level (L_{eq})	$L_{eq,T}$ is the equivalent continuous sound level and represents the hypothetical level of constant sound which would have the same equivalent total energy to the real varying level of sound during a defined period T. $L_{eq,T}$ is often described as the "average" noise level during a noise measurement which although not technically correct, is often the easiest way to think of $L_{eq,T}$, albeit it's an average that tends to be biased towards the highest noise level that occurs during the period T. $L_{eq,T}$ values should be written with a Frequency Weighting, such as dB(A) and also the measurement duration T. For example, $L_{Aeq,8\,hr}$ = 55 dB
$L_{AFmax,T}$	The maximum Sound Level with 'A' Frequency weighting and Fast Time weighting (125 millisecs) during the measurement period T. It can be used to assess the probability of sleep disturbance due to individual noise events.
$L_{ASmax,T}$	The maximum Sound Level with 'A' Frequency weighting and Slow Time weighting (1 sec) during the measurement period T.
L_{den}	Day-evening-night level. It is a descriptor of noise level based on energy equivalent noise level (L_{eq}) over a whole 24 hour day with a penalty of 10 dB(A) for night time noise (23.00-7.00) and an additional penalty of 5 dB(A) for evening noise (i.e. 19.00-23.00).

L_{night}	L_{night}, the A-weighted, L_{eq} (equivalent noise level) over the 8 hour night period of 23:00 to 07:00 hours, also known as the night noise indicator. There is no penalty as it focusses on the 8 hour period of night time.
Sound Exposure level (SEL)	This is an $L_{eq,T}$ normalised to a period of 1 second. It can be used to compare the energy of noise events which have different durations. For example, if a noise level of 90 dB lasts for 1 second then the SEL = 90 dB. If the same noise event lasted 10 seconds the SEL would be 100 dBA. If it lasted 20 seconds the SEL would be 103 dBA and so on. SEL can be used to assess the probability of sleep disturbance due to individual noise events and calculate the overall L_{eq} for a period T of a number of events e.g. ATMs, each of different duration shorter than T.
Sound Pressure Level (dB)	Sound pressure level (SPL) is the pressure level of a sound, measured in decibels (dB). It is equal to 20 x the Log_{10} of the ratio of the Root Mean Square (RMS) of sound pressure to the reference of sound pressure (the reference sound pressure in air is 2 x 10-5 N/m2, or 0,00002 Pa). SPL is the base unit used in the measurement of noise metrics by a sound level meter. The microphone measures instantaneous fluctuations in sound pressure level (SPL) every 125 milliseconds (Fast time weighting) or 1 second (Slow time weighting), converts these to a varying electrical signal, and the meter's electronics apply a range of filters and weightings to calculate, display and record the desired range of noise metrics. The figure below shows how measurements of the varying sound pressure level (SPL) of a noise event e.g. an aircraft approaching the microphone to its closest approach and then moving away, can be processed to derive a range of noise metrics. 

1 Introduction

Vanguardia Ltd have been commissioned to provide acoustic support to An Bord Pleanála (ABP) in relation to the appeal reference An Bord Pleanála: PL06F.314485 of the Fingal County Council (FCC) Decision F20A/0668 to grant permission to amend and replace two planning conditions, namely conditions no. 3(d) and 5 of the North Runway Planning Permission (FCC: Reg. Ref. No. F04A/1755; ABP Ref. No.: PL06F.217429, 'the North Runway Permission').

The proposed Relevant Action (RA) relates to the night-time use of the runway system at Dublin Airport. It involves the amendment of the operating restriction set out in condition no. 3(d) and the replacement of the operating restriction in condition no. 5 of the North Runway Permission, as well as proposing new noise mitigation measures. Conditions no. 3(d) and 5 came into effect when the operation of the North Runway commenced on 24th August 2022.

The proposed RA, would result in the following changes to how the airport operates:

1. Remove the numerical cap on the number of flights (Air Traffic Movements – ATMs) permitted between the hours of 11pm (2300 hrs) and 7am (0700 hrs) daily that is due to come into effect in accordance with the North Runway Permission.
2. Replace the cap on number of flights at night with an annual night-time noise quota between the hours of 11.30pm and 6am (amended by the FCC decision to apply from 2300 to 0700 hrs).
3. Allow flights to take off from and/or land on the North Runway (Runway 10L 28R) for an additional 2 hours between 2300 hrs to 2400hrs and 0600 hrs to 0700 hrs.

Overall, these changes would allow for an increase in the number of Air Traffic Movements (ATMs) taking off and/or landing at Dublin Airport between 2300 hrs and 0700 hrs over and above the number stipulated in condition no. 5 of the existing North Runway Permission i.e. no more than 65, in accordance with the proposed annual night-time noise quota (The Table 1 of the introduction of the revised EIAR indicates that the study assumes that with the scheme operating the number of ATMs at night would be around 98 and the information regarding the QC system implies around 87 ATMs at night).

The proposed RA does not seek any amendment of conditions of the North Runway Permission governing the general operation of the runway system (i.e., conditions which are not specific to night-time use, namely conditions no. 3 (a), 3(b), 3(c) and 4 of the North Runway Planning Permission) or any amendment of permitted annual passenger capacity of the Terminals at Dublin Airport. Condition no. 3 of the Terminal 2 Planning Permission (Fingal County Council Reg. Ref. No. F04A/1755; ABP Ref. No. PL06F.220670) and condition no. 2 of the Terminal 1 Extension Planning Permission (Fingal County Council Reg. Ref. No. F06A/1843; ABP Ref. No. PL06F.223469) provide that the combined capacity of Terminal 1 and Terminal 2 together shall not exceed 32 million passengers per annum (MPPA).

Vanguardia provided an initial and then an addendum noise report to ABP which considered the revised and supplementary EIARs for the RA and the applicant's response to the Board's request for further information. These previous reports will be referred to here as the "initial report" and the "addendum report".

1.1 Aims of this report

The aim of this report are as follows:

1. Explain how the cap on the number of ATMs at night in the addendum report was derived from the documentation submitted as part of the application opinions on the DAA and IAA submissions.

2. Provide opinions on the DAA and IAA submissions.

2 How was the cap on the number of ATMs in Vanguardia's reports derived?

The RA proposes doing away with the existing cap on the total number of ATMs been 2300 and 0700 hrs of no more than 65; and replacing this cap with a Quota Count system (QC).

Notwithstanding the existing cap on the number of ATMS at night, the Mott Macdonald report "Dublin Airport Operating Restrictions September 2023 Addendum v1.0 Quantification of Impacts on Future Growth Addendum to the Analysis of June 2021 (Report version 1.3.1) September 2023 Addendum v1.0" in the table on page 6 shows there were 116 ATMs at night in 2019 and 138 ATMs are predicted at night in 2025 if the RA is approved and the current cap is removed. This indicates that the current cap on ATMs at night is being breached by a substantial margin and would be exceeded more so if the RA goes ahead.

Table 1 of the introduction of the revised EIAR indicates the study assumed that with the RA operating the number of ATMs at night would be around 98, and the information regarding the QC system implies around 87 ATMs at night (see later in this section for explanation of how this estimate of numbers of ATMs at night has been derived).

The Quota Count (QC) system originated to regulate night-time noise from ATMs at Heathrow, Gatwick and Stanstead airports in the UK. In addition, movement limits for each of these airports restricts the total number of aircraft that can take off or land during the night. The QC system at Heathrow, Gatwick and Stanstead gives a choice to airport operators and airlines between fewer noisy movements or a greater number of less noisy movements, up to a maximum cap on the number of movements.

The QC system allows each ATM to be individually counted against an overall noise quota (or noise budget) for an airport according to the QC rating ranked using the ICAO noise certification scheme in EPN dB. Aircraft are classified based on their noise data (adjusted as appropriate) into nine QC categories. The categories are as follows[1]:

Noise Level EPN dB[2]	***Quota Count Value***
More than 101.9	*16*
99 to 101.9	*8*
96 to 98.9	*4*
93 to 95.9	*2*
90 to 92.9	*1*
87 to 89.9	*0.5*
84 to 86.9	*0.25*
81 to 83.9	*0.125*
Less than 80.9	*0*

Table 1: QC bandings.

[1] See Dublin Airport Development of Proposed Noise Measures. Document: 3870-Development of Proposed Noise Measures Date: September 2021 Version: vF2

[2] EPN dB is Effective Perceived Noise Level in decibels, it is a measure of the relative noisiness of an individual aircraft pass-by event. It is used for aircraft noise certification and allows comparison of how noisy individual aircraft compared to others, it does describe the exposure of a community to noise from an airport.

Under the QC system, each aircraft type, including different versions of the same model, is assigned a QC value according to its noise performance, separately for arrival and departure. For example, a business jet, such as a Cessna Citation II, is QC 0 on arrival so there is no restriction on this aircraft. A modern commercial passenger jet, such as an Airbus A320neo, is QC 0.125 on arrival, and an older larger passenger jet such as a Boeing 747-400 is QC2 on arrival. So, a single Boeing 747-400 arrival could be replaced by 16 Airbus A320neo arrivals, as the overall QC value would be the same.

The noise classification in the Quota Count system is based on the noise ranking of each aircraft using the International Civil Aviation Organisation's (ICAOs) noise categorisation method which measures noise using the EPNdB metric in a standardised manner as aircraft approach and depart from an airport and to the side (lateral) of the runway. This is an effective way of ranking how noisy different aircraft are but does not necessarily reflect how much noise will affect a community beyond the permitter of a specific airport. Because planes can be flown differently from the standardised manner in the ICAO test method, and the EPNdB is not correlated to population response and cannot be reliably converted to A-weighted noise metrics that are.

It can be argued that a QC system with an ATM cap does not provide the same degree of incentive for airlines to use less noisy aircraft because if an airport is near or at its permitted capacity, the airlines don't get the benefit of more flights if they do so. However, long standing treaty obligations[3] mean aircraft are progressively becoming less noisy and there is a medium to long term trend for this to happen organically rather than be driven primarily by operating restrictions at individual airports. Furthermore, other controls such as differential i.e. lower, airport charges per aircraft tend to have a more immediate impact on airlines thinking on how noise considerations may influence their fleet choices (along with many other considerations including fuel and maintenance costs etc.).

Most of the world, including Ireland and the rest of EU, and in the UK for the purposes of strategic noise mapping, regard night as being an at least an 8 hour period within the period between 2200 and 0800 hrs, typically between 2300 and 0700 hrs. However, to facilitate long haul flights the definition of the night-time period for management of noise at night for airports in the UK has been more flexible e.g. for Heathrow the core hours of 2330 to 0600 hrs are regarded as night-time and 2300 to 2330 and 0600 to 0700 as "shoulder periods". The noisiest aircraft in terms of their QC are excluded from the period between 2300 and 0700 hrs and no aircraft of QC 4 or above can operate between 2330 and 0600 hrs. As shown in the image below.

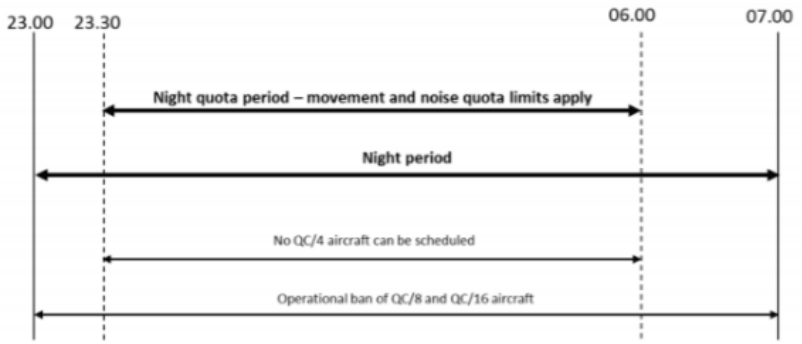


Figure 1: QC time periods at Heathrow.

[3] E,g, one of the four pillars of the ICAO "balanced approach" is reduction of noise at source.

The use by the UK of a core night period that is shorter than the 2300 to 0700 period normally used elsewhere in the world and for strategic noise mapping in the UK has been criticized, and some stakeholders continue to object as they see it as underplaying impacts. Arguably this is true as sleep disturbance is more likely in the early and later stages of night when people are in the lighter stages of the sleep cycle which are more susceptible to noise than the deeper stages of sleep. This can cause interruption and extension of the light sleep stages which in turn means that onset of sleep can be delayed or awakening occur early, and for sleep quality to suffer as less time is spent in the deeper stages of sleep when most of the restorative benefits occur.

The original application proposed that the QC system would only apply during the hours 2330 to 0600 with a total budget of 7990.

The ANCA queried the times of operation of the proposed QC regime and the proposal was changed so the QC system would cover the whole of the night period from 2300 to 0700 hrs. This was a significant improvement in the proposed scheme as it now helps to control how noisy ATMs are over the whole of the night period from 2300 to 0700 rather than only the core period of 2330 to 0600 e.g. it prohibits the noisiest aircraft for the whole of the night rather than just the core period.

Because the QC period now extends from 2300 to 0700 hrs the QC budget is substantially larger at 16,260 compared to the original 7990. This is because the greatest numbers of ATMs per hour at night are expected to take place between 2300 and 0000 hrs and 0600 and 0700 hrs[4]. With the RA operational, between 0000 hrs and 0600 hrs there will be ATMs at a reduced number per hour, albeit using the Southern Runway only.

A potential issue with a QC system without a cap on the number ATMs is that negligible to minor reductions in how noisy aircraft are can be traded against substantial increases in the number of ATMs without the QC budget being exceeded. This produces a nil to negligible change in the Percentage of the exposed population Highly Sleep Disturbed (%HSD) assessed using the L_{night} noise level averaged over the 8 hour period from 2300 to 0700. As this metric assumes that numbers of aircraft and the loudness of aircraft can be interchanged so there is no overall increase in noise energy averaged over the whole of the 8 hours of the night period. Consequently, there is no change in the L_{night} noise level or the resulting % Highly Sleep Disturbed. However, an Additional Awakening (AA) assessment[5] of such an increase in numbers of ATMs based on the L_{Amax} of each flight could show a significant adverse effect i.e. an increase in persons likely to suffer at least one additional awakening as a result of the RA compared to if the scheme is not permitted. This is more likely where a negligible to minor reduction in how noisy each individual aircraft over flight is results in peak L_{Amax} noise levels of 60 decibels or more.

As discussed above, the original proposal was for the QC scheme to apply to only between 2330 and 0600 hrs. However, in response to the request from ANCA to extend the QC to the whole of the night from 2300 to 0700 hrs in the document ANCA: Further information request: Appendix A: Dublin Airport Night Quota System Proposal – DRAFT RFI Update, the DAA Calculated an 8h equivalent Annual Noise Quota and the proposed 16,260 NQ budget was introduced, as shown in the extracts below.

[4] See diurnal ATM profiles in the Mott Macdonald report "Dublin Airport Operating Restrictions September 2023 Addendum v1.0 Quantification of Impacts on Future Growth Addendum to the Analysis of June 2021 (Report version 1.3.1) September 2023 Addendum v1.0." pages 8 & 9.

[5] See the initial and addendum reports for discussion of "Additional Awakenings".

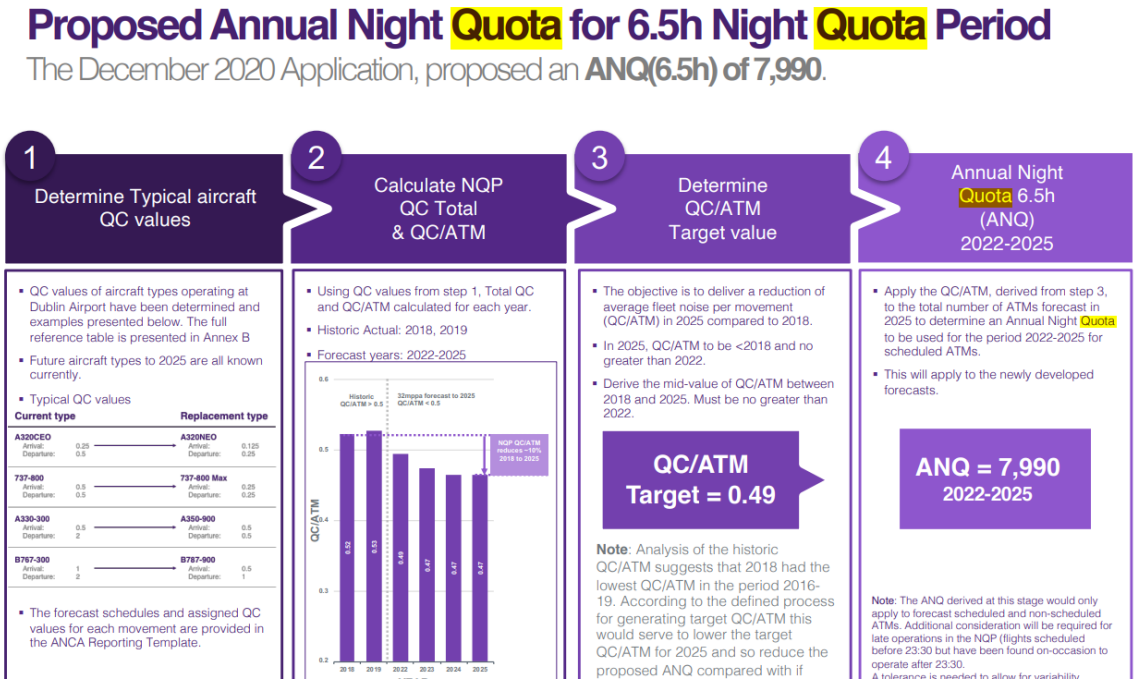


Figure 2: Calculation of the QC budget for the original proposal to cover 6.5 hours from 2330 to 0600 hrs

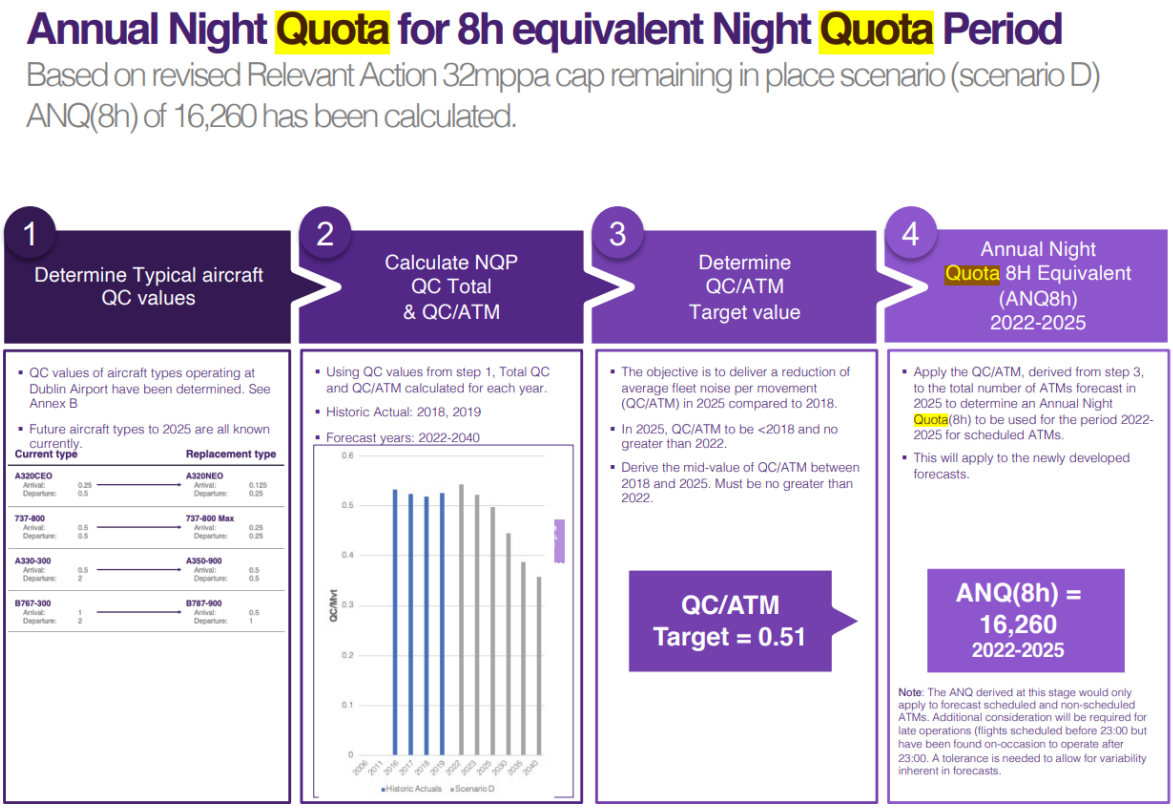


Figure 3: Calculation of the QC budget for the revised proposal to cover 8 hours from 2300 to 0700 hrs

A QC budget of 16260 with an average QC to ATM ratio of 0.51 is equivalent to around 87 ATMs per night i.e. a QC budget of 16260 multiplied by a QC/ATM ratio of 0.51 divided by 365 days a year = 87.3 ATMs.

87 ATMs a night between 2300 and 0700 hrs is 22 ATMs i.e. 39% more than allowed in the condition 5 of the existing permission for the northern runway i.e. no more than 65 ATMs at night. But is 31 ATMs i.e. 26% less than the average number of ATMs that took place each night in 2018 and is 51 ATMs i.e. 37% less than the average number of ATMs at night predicted in 2035[6].

Under a QC system the exchange of a number of aircraft in a QC band for twice the number in the QC band below or even four times as many in the QC band below that, means the overall QC limit is not breached. Consequently, an assessment of potential difference in % Highly Sleep Disturbed would not indicate any change, as the overall energy averaged L_{night} level would not be altered. However, there is a substantial increase in the number of only marginally to moderately less noisy ATMs, which is likely to lead to an increase in Additional Awakenings[7] based on the L_{Amax} peak noise level of each ATM and the number of ATMs, as this method is more sensitive to changes in the number of intermittent noise events where the L_{Amax} of the ATMs is already indicating adverse effect on sleep i.e. more than 60 dB L_{Amax}. Consequently, a QC system is best used in conjunction with an overall cap on the number of flights, as for example at Heathrow, Stansted and Gatwick airports where the system originated.

A difference in noise levels of 3 decibels between QC bands represents a doubling or halving of noise energy. Consequently, a QC system based on 3 decibel bands means it works on the principle that an aircraft classified QC/1 has half the noise energy as an aircraft classified QC/2 and twice the noise energy as aircraft classified QC/0.5 (although the difference in loudness is marginal as most people can only just detect a difference in 3 dB in the noise level of different aircraft). However, this is only approximate as, for example, aircraft rated at 90.1 EPN dB are in the bottom of QC 1 and those rated at 95.9 EPN dB are at the top of QC 2 and would differ by 5.8dB, representing almost a four-fold difference in noise energy that most people would clearly notice, but a difference in QC of only 1. This can lead to an underestimation of the impact, although the aircraft will comply with the QC system as the overall QC "budget" is not breached. A cap on the number of ATMs at night would reduce the risk of this happening.

The rationale behind maintenance of an increased cap on ATMs at night (87 with the RA compared to the current 65 ATMs) has been explained above.

The submissions from the IAA and DAA have not changed the view that such a cap is necessary.

However, the choice of a value for any ATM cap is challenging when considering that the submitted information from the applicant confirms that a) the existing cap on ATMs at night of 65 is exceeded; and b) the number of predicted ATMs if the RA is approved is expected to exceed the increased number suggested to ABP.

[6] See Mott Macdonald report "Dublin Airport Operating Restrictions September 2023 Addendum v1.0 Quantification of Impacts on Future Growth Addendum to the Analysis of June 2021 (Report version 1.3.1) September 2023 Addendum v1.0" in the table on page 6.

[7] As part of normal sleep physiology, we have on average around 23 awakenings a night independent of any noise events, extra awakenings due to noise are "additional". See the initial and addendum reports for more discussion of assessing noise impacts on sleep and the concept of additional awakenings.

3 Submission from the Irish Aviation Authority (IAA)

This response focusses on the key issue from the submission of the IAA, as follows:

3.1 L_{night} should be the only metric used to assess impacts on sleep

The initial and addendum Vanguardia reports provide discussion and evidence of the need to supplement assessment of aviation noise impacts at night using the L_{night} metric which averages noise from discrete ATMs over the whole 8 hour period from 2300 to 0700 hrs, including the majority of this time when there are no ATMs and therefore no noise. This is fundamental to the recommendations in the initial and addendum reports that a cap on the number of ATMs at night is required as well as the proposed QC system, and that there should be a further criterion for noise insulation based on peak noise levels from ATMs at night exceeding 80 dB L_{Amax}.

The IAA submission makes the case that the EU directives and Irish regulations covering airport noise mean that only the L_{night} noise metric should be used to assess and regulate impacts of aviation noise at night.

The regulations the IAA rely on to support their position are listed below:

- DIRECTIVE 2002/49/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 25 June 2002 relating to the assessment and management of environmental noise ("The END Directive")
- REGULATION (EU) No 598/2014 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 16 April 2014
- COMMISSION DIRECTIVE (EU) 2015/996
- EUROPEAN COMMUNITIES (ENVIRONMENTAL NOISE) REGULATIONS 2018
- Aircraft Noise (Dublin Airport) Regulation Act 2019

The above regulations and directives interconnect and cross reference. At first sight of these statutes the L_{night} metric appears to be the preferred primary metric for describing and assessing airport noise at night.

However, closer inspection of the directives and regulations shows there is justification for and specific reference to use of the L_{Amax} noise index to calculate and to assess noise from aircraft as a supplementary noise indicator.

For example, Annex 1 of DIRECTIVE 2002/49/EC discusses supplementary noise indicators and states that:

"*In some cases, in addition to L_{den} and L_{night}, and where appropriate L_{day} and $L_{evening}$, it may be advantageous to use special noise indicators and related limit values*."

Some examples are given in Annex 1 where this might be appropriate which include the following:

"*the noise source under consideration operates only for a small proportion of the time (for example, less than 20 % of the time over the total of the day periods in a year, the total of the evening periods in a year, or the total of the night periods in a year*),".

The RA will permit the northern runway to operate for two single hour periods at the beginning and end of the night period i.e. for considerably less than the 8 hours covered by the L_{night} noise indicator between 2300 and 0700 hrs. Consequently, this element of the directive supports the use of special noise indicators e.g. L_{Amax} to supplement the L_{night} metric.

Annex 1 of the Directive goes on to provide the following additional example of a where a special noise indicator might be appropriate:

"*L_{Amax}, or SEL (sound exposure level) for night period protection in the case of noise peaks*,".

The same stipulations as described above regarding special noise indicators are transposed into Irish law in part III of S.I. No. 549 of 2018: EUROPEAN COMMUNITIES (ENVIRONMENTAL NOISE) REGULATIONS 2018.

Based on the above, and the technical analysis in the initial and addendum reports, the view that use of the L_{Amax} noise indicator as well as the L_{night} metric to evaluate the impact of the proposed RA a night is maintained.

4 Submission from the Dublin Airport Authority

Responses to the key elements of the DAA submission are provided in this section.

4.1 Compliance with the Noise Abatement Objective (NAO)

The DAA submission states that the Vanguardia addendum report agrees that the NAO for the airport will be met. However, its important to note that the comment on compliance with the NAO in the addendum report is qualified with the following observations (section 7.1 of the addendum).

"A Noise Abatement Objective (NAO) has been set for Dublin Airport which seeks to "*Limit and reduce the long term adverse effects of aircraft noise on health and quality of life, particularly at night, as part of the sustainable development of Dublin Airport*.".

The NAO objective described above would be achieved if the RA is not implemented. This is because the airport is operating at nearly the full capacity possible within the current planning permission (notwithstanding the issue of numbers of ATMs at night and condition 5), and there is limited scope for increasing ATMs, and going forward airlines will renew and update their fleets with modern aircraft that are progressively becoming less noisy. Consequently, compared to nowadays the area covered by the airport's noise contours will shrink. Consequently, noise levels will reduce, and the number of persons significantly adversely effected by aircraft noise would be fewer in future if the airport continues to operate as currently permitted.

Both the revised and supplementary EIARs show that the NAO objective to "*Limit and reduce the long term adverse effects of aircraft noise on health and quality of life, particularly at night, as part of the sustainable development of Dublin Airport*" is predicted to be achieved if the RA is permitted.

However, the RA was screened by ANCA, and they have determined that a noise problem would arise from the application due to three aspects:

"*1. The Application proposes an increase in aircraft activity at night, when referenced against the situation that would otherwise pertain, which may result in higher levels of human exposure to aircraft noise.*

2. The Application proposes a situation where some people will experience elevated levels of night time noise exposure for the first time which may be considered harmful to human health.

3. The EIAR accompanying the Application indicates that the proposed relevant action will give rise to significant adverse nighttime noise effects."

The issues identified above arise because although future aircraft will be less noisy than currently, the resulting reduction in noise for those already significantly adversely effected by aircraft noise, would be offset by the increase in the number of ATMs at night and the exposure of persons currently not exposed to, or currently exposed to low levels of aircraft noise at night, this RA would cause if permitted.

In short, although in future the NAO objective to "*Limit and reduce the long term adverse effects of aircraft noise on health and quality of life, particularly at night, as part of the sustainable development of Dublin Airport*." would be achieved to a different degrees with or without the RA. But, if this RA comes into effect, it would hinder the health and

quality of life benefits of individual aircraft becoming less noisy as technology improves, so that although fewer persons would be affected in future, substantially more people would be significantly adversely effected by aircraft noise at night compared to if the airport continued as it currently operates. Not least the benefits of aircraft becoming less noisy could be offset by the disbenefit of more aircraft using the airport.

4.2 Additional Awakenings and Use of metrics other than L_{night}

Section 2.6.3 of the submission on behalf of the DAA seeks to constrain the evaluation of the impact of the RA on sleep at night to the sole use of the L_{night} metric and downplay the appropriateness of using L_{Amax} and additional awakenings as not endorsed by the NAO. The response above to the similar submissions by the IAA apply here as well.

This section of the DAA submission goes on to seek to justify the sole use of the L_{night} metric and rejection of the L_{Amax} indicator for evaluation of additional awakenings. However, these submissions have not persuaded Vanguardia to change the position expressed in the initial and addendum reports in support of this approach.

4.3 Additional awakenings and NQS

The DAA mis-characterise Vanguardia's position when they state that our "*report characterises L_{night} as not appropriate because people do not experience aircraft noise in an averaged manner and therefore L_{Amax} based metric is inherently preferable.*"

Vanguardia's position is that the sole use of L_{night} and assessing the % Highly Sleep Disturbed is less effective at providing a comprehensive evaluation of aircraft noise impact on sleep than combining such an approach with an evaluation of additional awakenings using L_{Amax} as a supplementary metric. Both metrics have a role.

Vanguardia's position is in part based on comments in the review underpinning the WHO 2018 Guidelines on the use of energy averaging and maximum noise level metrics to evaluate noise impacts on sleep as follows[8]:

"*Equivalent noise levels are often used in surveys and epidemiologic studies as long-term average exposure metrics, and are therefore also often found in legislative and policy contexts. For example, the Night Noise Guidelines for Europe of the World Health Organization (WHO) define effects of nocturnal noise based on annual average outdoor Lnight ranges [36]. The value of equivalent noise levels in describing the effects of noise on sleep is more limited, as different noise scenarios may calculate to the same equivalent noise level, but differ substantially in their sleep disturbing properties [25]. There is general agreement that the number and acoustical properties of single noise events better reflect the actual degree of nocturnal sleep disturbance in a single night [35]. It is thus questionable whether Lnight can be used as the only indicator for predicting the effects of noise on sleep and the consequences of noise-induced sleep disturbance, or whether supplemental noise indicators are needed [25]." It can therefore be concluded that on their own average energy noise levels e.g. Lnight, are not sufficient predictors for sleep disturbances, and the number of events and maximum level e.g. LAmax, should be considered as well.*"

Whilst the 2018 WHO guidelines go on to say the following:

"*In many situations, average noise levels like the Lden or Lnight indicators may not be the best to explain a particular noise effect. Single-event noise indicators – such as the maximum sound pressure level (LA,max)6 and its frequency*

[8] From Mathias Basner and Sarah McGuire, WHO Environmental Noise Guidelines for the European Region: A Systematic Review on Environmental Noise and Effects on Sleep Int. J. Environ. Res. Public Health 2018, 15, 519

distribution – are warranted in specific situations, such as in the context of night-time railway or aircraft noise events that can clearly elicit awakenings and other physiological reactions that are mostly determined by LA,max. Nevertheless, the assessment of the relationship between different types of single-event noise indicators and long-term health outcomes at the population level remains tentative. The guidelines therefore make no recommendations for single-event noise indicators."

One reason why Vanguardia are of the view that a combination of L_{night} based assessment of %HSD and Additional Awakening based on the L_{Amax} is appropriate to evaluation of this RA is because the proposed use of the runway at night is for an hour from 2300 to midnight and another hour from 0600 to 0700 hrs i.e. only 2 hours out of the 8 hour night period. Sole use of the L_{night} metric would average the noise produced during these two hours over the whole of the 8 hour night period and this is likely to underestimate the impacts during the much shorter period when the runway was in use. For example, the noise from aircraft using the northern runway would be 6 decibels lower when calculated as the L_{night} metric compared to the average equivalent metric over the two hours when the runway was operating. Supplementing the assessment with an Additional Awakenings evaluation based on the L_{Amax} of each ATM would improve the evaluation of aircraft noise effect on sleep as it would compensate for the mismatch between the much shorter total duration of the operation of the runway compared to the much longer time averaging period in the L_{night} metric.

5 Conclusions

The rationale behind maintenance of an increased cap on ATMs at night (87 with the RA compared to the current 65 ATMs) has been explained based on data and information submitted by the applicant regarding the proposed QC scheme. The submissions from the IAA and DAA have not changed the view that such a cap is necessary. However, the choice of a value for any cap is challenging when considering that the submitted information from the applicant confirms that a) the existing cap on ATMs at night of 65 is exceeded; and b) the number of predicted ATMs if the RA is approved is expected to exceed the increased number suggested to ABP.

The submissions from the IAA and DAA have not led to a change in the recommendations provided to ABP in the initial and addendum reports from Vanguardia.

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