APPENDIX D: NOISE OPTIMISATION

KEY MESSAGE

A CDO from ToD will provide substantial fuel, emissions and economic benefits. At lower levels however, typically around airports, the primary environmental impact is noise.

CDOs have been demonstrated to provide noise level reductions of between 1-5dBA, typically at 8-25nm from the runway threshold, when compared to a non-CDO flight.

While CDO operations have a great potential for reducing fuel consumption and emissions when operated from ToD or higher intermediate levels, at lower altitudes the primary environmental impact, especially at and around airports, is noise. This is nominally 7,000ft and below. Therefore, the mitigation of noise should also be prioritised whenever noise at and below 7,000ft is an issue at local level. In such cases, the noise CCO and noise CDO may be considered the optimum way of measuring CCO and CDO performance. It should be noted that if speed limits are below 230kts to separate a departure flow on the same routings, these flights will have to be flown partly with flaps extended, resulting in low climb rates and high noise levels.

It should however be noted that optimal climb profiles for noise reduction might be, at least for certain aircraft types, punishing in terms of additional fuel burn. It is therefore recommended that airlines carefully consider which Noise Abatement Departure Procedure (NADP) to fly as the different procedures may not actually reduce noise in the geographical location where it is required while also resulting in unwanted excess fuel burn.

In order to minimise the noise impact, it is important to understand how to support noise optimised approaches and the energy management of arriving aircraft, as well as the limits of how the performance can or cannot be monitored.

In addition to engine noise on arrival, aerodynamic noise is a significant contributor to the total noise emission of an aircraft depends strongly on airspeed.

The noise benefit of CDO varies on the altitude and duration of a level flight segment associated with flights not flying CDO. Further benefits can be gained when Flight Crews can design their approach paths on the low-energy side and, whenever possible, avoid using speed brakes or extending the landing gear early at low altitudes.

It is well understood that an undisturbed CDO decreases noise levels under the arrival route in areas that are located a few nautical miles beyond the final glide slope interception location. In these areas, noise mitigation can be up to 5 dB.[23]

Environmental regulations applied at airports usually refer to noise areas within, for example, Lden contours. The noise contours representing noise levels usually extend far beyond the point where aircraft join the glide path guidance of the final approach. For example, in cases where the vertical guidance of the final approach is intercepted around 2,000-4,000ft, the benefits can typically be reached within at 6 - 15nm from the runway threshold. At a majority of such airports, the CDO, if understood as a geometrically continuous descending profile, affects only the noise levels outside these noise areas.

In reality, the noise mitigation at some locations may be even greater, depending on the baseline operation that represents the benchmarking level. For instance, Finavia estimated that a long level flight segment at 2,000ft, related to independent

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parallel operations as the benchmarking level, could result in a 15 dB difference compared to a well-optimised CDO profile. On the other hand, the noise mitigation potential may also be more limited as the long segment of level flight may have been introduced for safety reasons.

Noise can be further reduced by combining CDO with the Low Power / Low Drag method (LP/LD). This means that the lowest noise configuration for a given speed and altitude is flown during the approach, when more flaps are selected close to the minimum speed defined for the configuration and landing gear is extended as late as possible.

It should be emphasised that even aircraft with a geometrically optimised CDO profile, but with high speeds, early landing gear and early high lift device extensions and use of drag e.g. speed brakes, is far from noise optimised.

In cases where only the vertical flight path is being monitored, it must be noted that in high-energy situations apparent continuous descents may have been flown with excess drag, i.e. speed brakes out and with landing gear extended, when the arrival is far from noise optimal.

While efficient alternative means for monitoring CDO may be difficult to find, it is worth noting that requiring strict compliance with CDO vertical profiles may lead to situations where the arrivals are still not noise optimal. This is where the LP/LD procedures may be of particular benefit.

With LP/LD procedures, it is possible to reduce noise levels by approximately 2-5 dB in areas that are located approximately 3-10 nautical miles before the runway threshold. Under certain conditions, the area of reduced noise may even extend to the runway threshold. Again, the baseline operational conditions play a significant role in how much noise benefit can be achieved by LP/LD.

CDOs close to the ground should be flown preferably at low speed to avoid high drag devices for speed reduction. In a noise optimised CDO with LP/LD elements, the aircraft approaches the airport in a clean configuration which allows the aircraft to use either idle or low thrust settings with configuration to be deployed according to specific speeds.

The use of slower speeds usually makes it possible to delay the extension of the landing gear until a later moment during the approach. The scheduled speed profile should be such that the noise sensitive areas are overflown with intermediate high lift device settings, without deployment of landing gear and spoilers, and with speeds towards the lower end of the configuration's specific speed window. Prior to glideslope interception however, configurations for maintaining speeds below 220kts can increase noise levels on the ground especially on long transitions in level flight.

From a performance-engineering point of view, LP/LD should be understood as a sum of net thrust and drag. This sum should be minimised over all locations of interest. When merging LP/LD with CDO it should be noted that, at the same time, the altitude should be as high as possible. An aircraft's drag is roughly a function of True Air Speed (TAS) to the power of two. In addition, the noise energy is roughly a function of TAS to the power of 5-7. These facts lead to the conclusion that, in a (noise optimised) combined CDO and LP/LD procedure, over approximately the last 15 nautical miles, the speeds should be slower than typically flown today by most of the operators.

In Figure 22 a comparison of the sound exposure levels of three different profiles is presented for the ground track under a typical narrow-body jet aircraft. The compared procedures are depicting:

1. A typical relatively high speed approach with 2000ft glide slope interception and early landing gear extension;
2. A CDO approach with high speed and early landing gear extension; and,
3. A good noise-optimised approach with CDO and LP/LD elements.

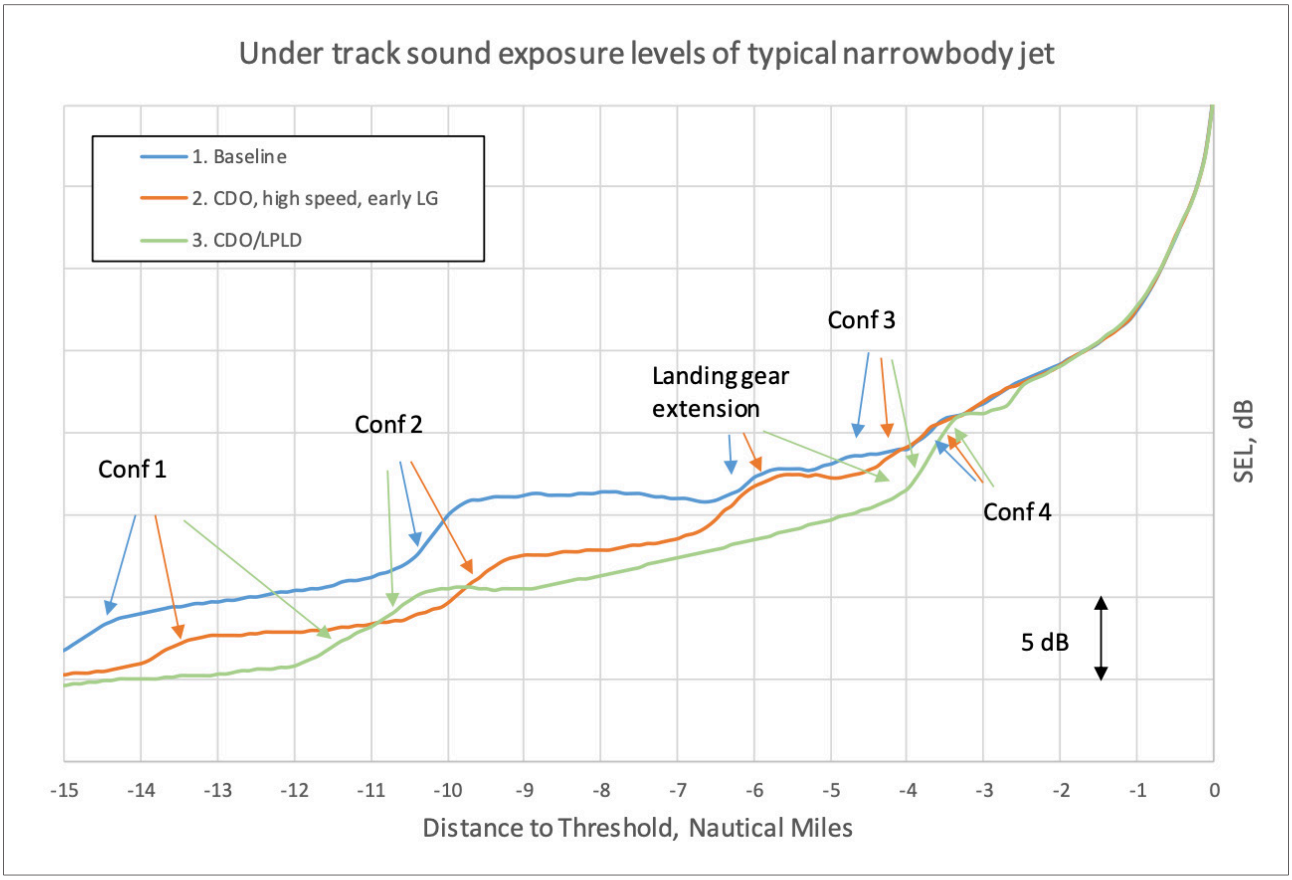

Figure 22: A comparison of three different approach profiles of a narrow-body jet under track sound exposure levels.

Figure 22 shows an approximate reduction of 3-5 dB in the well-optimised CDO LP/LD procedure when the baseline is the high speed, early landing gear, 2,000ft glide slope interception approach.

It should be noted that in the well noise-optimised CDO LP/LD procedure the intermediate configuration should be selected earlier than in comparative procedures. This is due to the relatively low noise profile of the intermediate high lift device configuration, and also due to the fact that in the intermediate configuration the aircraft is able to fly with slower speeds.

Most narrow-body jet aircraft also have a decreasing speed tendency in the intermediate configuration, without landing gear. Slower speed means lower aerodynamic noise and the possibility to delay landing gear extension. From an airport's noise capacity perspective, the reduction of 3 dB would mean that the number of operations could be doubled in order to reach the same noise exposure. However, for an extremely noise-optimised approach, the overall fuel consumption may be slightly higher than for a fuel use optimised profile.

Collaboration among airports, ANSPs and airlines is vital when the aim is to apply CDO and LP/LD procedures in everyday operations. In the beginning, it may be useful to primarily focus on their introduction during low traffic hours or at night. However, it may also be beneficial to look at applying changes during peak hours, as this is when noise improvements may have a strong impact on perceived noise levels and make for recognised noise improvement for the neighbours.