Revisiting Noise Abatement Departure Procedures (NADP) Application

Toward Data-Driven, Aircraft-Specific Departure Procedures

By Francisco Hoyas (EUROCONTROL)

Due to increasing traffic and stricter legislation regarding noise linked to air traffic movements, there is a growing interest shown by operational stakeholders in reviewing the current usage of Noise Abatement Departure Procedures (NADPs). Some NADPs may have been in place for many years and do not reflect the latest improvements in engine and airframe technologies meaning that todays aircraft generate far less noise than their counterparts when the NADPs were implemented. These reasons, together with the future expected integration of Unmanned Aerial Systems (UAS) that needs to be assessed, highlight the need to review the use of NADP 1 or 2, to support discussions with local communities around airports regarding the trade-off between noise and emissions.

The impacts of noise or fuel / emissions share a delicate equilibrium depending on which stakeholder is concerned. The interdependencies they share is often misunderstood as always being one against the other, whereas in reality there are situations where an operational response to reduce one impact may also deliver benefits for the other.

At least this is one of the conclusions of a EUROCONTROL study using a similar approach as in ICAO Circular 317[1], to study the effects on noise and emissions of different NADPs, in this case updated with more modern aircraft (3 Airbus types, 3 Boeing, 2 Embraer and 1 CRJ). The study was performed at a theoretical level using the EUROCONTROL's noise and emissions modelling tool called IMPACT. In line with ICAO_Doc_9911[2] and ECAC_Doc 29[3], the study did not focus on absolute values but rather on relative ones – e.g. noise level differences between different flight procedures.

Noise Abatement Departure Procedures

ICAO PANS-OPS established two different types of procedures in order to minimise noise impacts around airports more than 30 years ago. ICAO A was the departure procedure to avoid noise close to the airport and ICAO B to avoid noise further away from the airport. They were fixed procedures regarding the altitudes to be used for thrust reduction and acceleration, mainly decided by airports, without taking into account which type of aircraft was used and the conditions under which the departure was performed.

These procedures were reviewed and amended in 2001 by the Committee on Aviation Environmental Protection (CAEP)[4]. This review proposed a shift from two very specific and fixed procedures (A and B) to a more flexible approach where it was the aircraft user, not the aerodrome, who

1 ICAO Circular 317. Effects of PANS-OPS Noise Abatement Departure Procedures on Noise and Gaseous Emissions.
2 ICAO Doc.9911 Recommended Method for Computing Noise Contours Around Airports
3 ECAC Doc.29 Report on Standard Method of Computing Noise Contours around Civil Airports
4 For related provisions, see Annex 16, Volume I, and Annex 6, Part I and ICAO Doc 8168, Section 7

defined the specific procedure to be used, depending on current local circumstances. With the new NADP 1 and 2, there were still 2 possibilities to minimise the noise either close or further from the airport, but with these new procedures, the aircraft operator was the one responsible for defining the values (regarding altitude and speeds, within a given margin) at which each aircraft type should reduce thrust, clean the aircraft or accelerate along the horizontal departure track, once all other affecting parameters are considered.

These changes were reflected specifically in Edition 5 to Doc 8168[5], where the proposed procedures changed their names from Procedure A to NADP1 and Procedure B to NADP2. The major changes in the procedures themselves were:

- Procedure A to NADP1: initial thrust reduction altitude was 1500 feet AGL; in the new NADP1, the procedure establishes a minimum altitude of 800 feet – as opposed to a concrete altitude value - with the operator defining which concrete value it uses, based on the aircraft type.
- Procedure B to NADP2: initial acceleration to V_{ZF} (zero flap speed) changes from 1000 feet AGL to a minimum on 800 feet.

Both NADP 1 and NADP 2 reduce noise, but at different distances from the airport. Moreover, these distances vary with the type of airplane and most importantly, with the weight of the aircraft and current atmospheric conditions (essentially temperature and pressure), so that the distance at which one procedure is better than the other for noise avoidance fluctuates daily. By choosing a single procedure for all departures, airplanes are actually less noise efficient and in most conditions burning more fuel.

In Figure 1, the Procedure A (used as NADP1) is represented for all studied aircraft. As it can be seen, the profiles and altitudes at each specific distance from the airport are completely different for each aircraft type. Noise levels vary widely with aircraft size. One size doesn't fit all.

The majority of airports still impose a specific NADP or even the old ICAO A/B procedures, without taking into account the traffic mix and the noise performance of new aircraft.

Many aircraft operators also use the old procedures A or B, due to the lack of proper tools or awareness that would allow them to correctly assess which would be the best aircraft type tailored procedure to be applied for the particular conditions of each take off, like atmospheric conditions, mainly wind, aircraft type and take-off weight, among others. Of course, this needs to be done with sufficiently detailed noise and fuel performance data supplied by manufacturers.

The noise difference between NADP1 and 2 can be very small under certain conditions, compared to the amount of fuel burn saved by using NADP 2. Some of the profiles

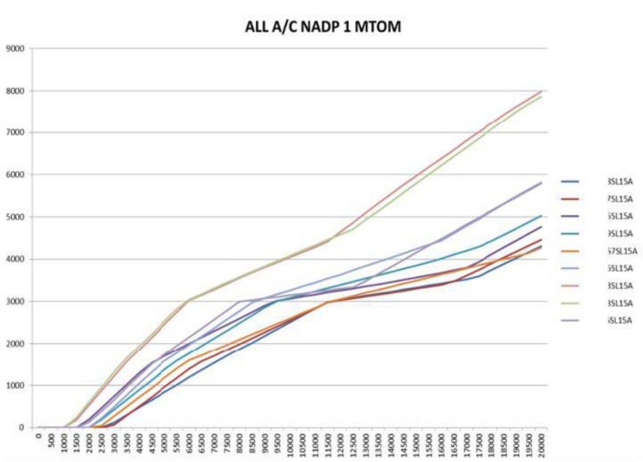

FIGURE 1: NADP1 profiles of 9 different aircraft.

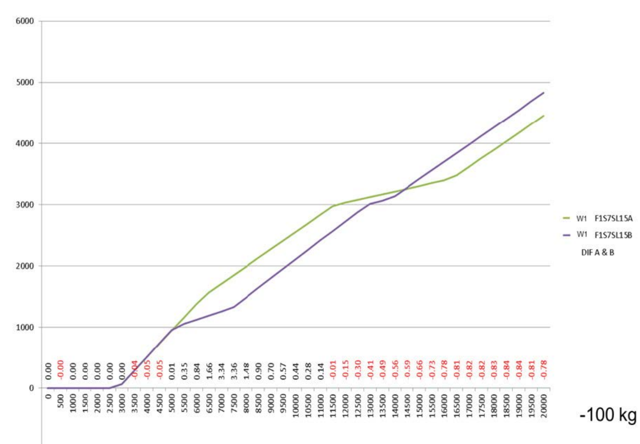

FIGURE 2: Wide Body NADP 2 versus NADP 1 with thrust reduction at after clean

5 ICAO Doc. 8168 v1. Procedures for Air Navigation Services, Flight Procedures.

studied showed a difference as low as less than 1 dB, which means that there is no real noise benefit using either of them. Whilst such small noise benefits are still welcomed, it is only useful if they occur at a distance from the airport where perceived noise is sensitive.

If the distance from the airport where noise benefits are experienced is lowly- / un- populated then the noise reduction might not be of value with fuel burn / emissions increased unnecessarily. It is very important to address the correct distance from the runway where noise is perceived as 'very sensitive' in order to optimise the noise abatement procedure (that is depending on aircraft type, weight and atmospheric conditions).

As with most of the other aircraft performance indicators, the main factor influencing the flight profile is the weight. When comparing the noise values of different profile procedures, the noise differences barely exceed 3dB. However, when looking at the same type, same procedure, same airport altitude and temperature, but different weights; noise levels increase on ranges that go from +5 to +11 dB when the aircraft is fully loaded. Weight makes a huge difference when looking at which procedure would be best for a specific distance from the aerodrome, which reinforces the idea that daily changes in aircraft weight, together with other daily changing atmospheric factors should be taken into account when seeking the ad-hoc most efficient procedure to apply.

Another aspect sometimes overlooked is the use of Flexible trust, which cannot only change the distances at which a specific altitude is reached, but also the noise produced by the engines while in Take-off thrust. If the intention is to be as efficient as possible in reducing the noise (not to have the aircraft at a higher altitude), take-off thrust is another important aspect that the aircraft operator can play with when choosing how flexible the take-off thrust needs to be and when to reduce it to climb thrust. The fact that the acceleration is done with less power considerably reduces the noise in the first part of the acceleration step. This contradicts some people's belief that the sooner the aircraft climbs, less noise occurs close to the airport, as the reduction of power has a bigger impact, in certain circumstances, than the altitude gain.

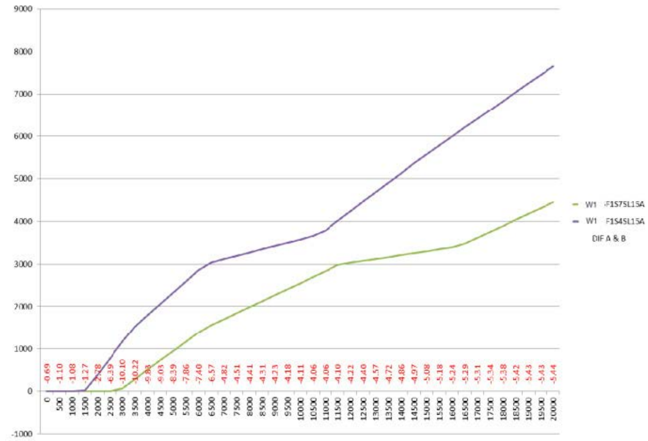

FIGURE 3: Noise difference for same Wide body, same procedure and different weight.

The application of the most appropriate NADP then depends on the inputs from airports - to identify the location of the noise-sensitive areas for each runway and Standard Instrumental Departure - and aircraft operators for the type of aircraft and its weight, not on airport operators imposing a specific procedure for all aircraft users, for all aircrafts and conditions.

The only way to achieve the best optimal noise reduction is by looking into the profiles of each aircraft type and finding those that would result in the minimum noise exposure over those sensitive points. One key way to do this is to avoid a fixed definition of the procedure to be flown and allow the application of the one best adapted to the flying conditions. At the same time noise impact is reduced where really needed, whilst this can also benefit the associated fuel consumption, with the added objective of reducing both noise and emissions, following the requirements of ICAO Doc 9829[6].

If we focus solely on emissions, on average more than 150 kilograms of CO_2 can be saved per flight by performing NADP 2 instead of NADP 1. With actual savings reflecting the aircraft type and ranging between 50-500+kg for commercial medium / heavy aircraft. These figures are calculated for the whole flight, as the chosen NADP has an impact, not only on the point where a certain intermediate altitude is reached (what could be useful for an emissions study point of view close to the airport), but also to the

6 ICAO Doc.9829. Guidance on the balance approach to aircraft noise management.

time at which cruise level is attained, impacting on the final fuel burn.

Many airports still prefer NADP 1 or even ICAO A, without correctly addressing the noise beneficial distance versus the aircraft type, traffic mix and external conditions. To enhance the efficiency of these noise abatement procedures and to understand the impacts of the changes to move away from prescriptive fixed procedures for all airplanes proposed by ICAO in 2001, they should be further reviewed.

Airport Operators should identify the location of the key noise sensitive areas in each standard instrumental departure, and allow the Aircraft Operators to choose which of the two NADP's is the most appropriate one, depending on current atmospheric conditions, times of day and type and weight of aircraft used, with the aid of proper noise modelling tools developed by manufactures (i.e. ADAS: Airbus Departure Analysis Software).

Reference Documents

Annex 6. Operation of Aircraft

EU Regulation 598/2014. Introduction of noise-related operating restrictions at Union airports within a Balanced Approach.