

Review of Arrival Noise Controls

CAP 1554



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Chapter 1

Introduction

Whilst departure noise limits have been in place as long ago as 1959 in the case of Heathrow airport, no formal limits or penalties have applied to arrival noise at the designated airports. It has been long-standing Government policy that controls and penalties to manage arrivals noise could incentivise unsafe behaviour. The rationale for this is that an arrival is generally a more safety critical period of flight than a departure and that, especially in the busy London Terminal Control Area, pilot workload is high during the approach phase of flight.

Going as far back as the 1970s, CAA studies¹ have instead focused on encouraging best practice measures to reduce arrival noise in the form of Continuous Descent Operations (CDO), which aim at keeping aircraft flying higher for longer during their approach, and Low Power/Low Drag (LP/LD) procedures, maintaining a 'cleaner' aircraft configuration for longer. A CDO is commonly referred to as a Continuous Descent Approach (CDA) in the UK, which typically starts from an altitude of 6,000 feet. However, the term CDO is used throughout this report in keeping with international usage.

During the 1990s the Government considered the feasibility of setting noise limits for arriving aircraft through its Aircraft Noise Monitoring Advisory Committee (ANMAC²). ANMAC advises the Department for Transport on technical and policy aspects of aircraft noise mitigation and track-keeping policies at Heathrow, Gatwick and Stansted airports. Its membership includes representatives of Heathrow, Gatwick and Stansted, those airports' consultative committees, the three airport scheduling committees, the CAA, NATS and the Department for Environment, Food and Rural Affairs (Defra).

The work was published by the Department of the Environment, Transport and the Regions (DETR) in 1999, which concluded that it was impracticable to set approach noise limits similar to those for departing aircraft³. Instead, the ANMAC report set out a range of options to reduce noise including a new code of practice to promote the use of CDOs and closer industry co-operation. *Noise from Arriving Aircraft; An Industry Code of Practice* was subsequently published in 2002 and later updated in 2006⁴. After the publication of the

¹ [The Noise Benefits Associated With Use of Continuous Descent Approach and Low Power/Low Drag Approach Procedures at Heathrow Airport](#), CAA Paper 78006, Civil Aviation Authority, April 1978

² ANMAC is currently known as the Aircraft Noise Management Advisory Committee, the name changing from Aircraft Noise Monitoring Advisory Committee in 2010/11.

³ *Noise from Arriving Aircraft: Final Report of the ANMAC technical working group*, Department of the Environment, Transport and the Regions (DETR), December 1999

⁴ *Noise from Arriving Aircraft: An Industry Code of Practice*, 2nd Edition, Department for Transport (DfT) et al., November 2006

DETR report, the requirement to fly a continuous descent arrival was incorporated into the designated London airports' Noise Abatement Procedures⁵.

The voluntary Code was compiled and produced by a group representing airlines, air traffic control (NATS), airports, the CAA and the Department for Transport. Whilst the Code recognises the benefits of LP/LD approach procedures as a means of reducing noise, the key factor identified is the noise benefit that can be obtained from greater achievement of CDOs, the objective being to ensure aircraft remain as high as possible for as long as possible. In addition to reducing noise, CDOs and LP/LD procedures also reduce fuel burn and emissions, thereby producing an overall environmental benefit.

The code of practice has contributed to enhanced arrivals noise mitigation, and in particular CDO, in the UK and also worldwide. However, recognising that noise disturbance is still a key concern for many residents living under the approach routes to airports, the Government announced in its March 2013 Aviation Policy Framework that ANMAC would review the departure and arrivals noise abatement procedures, including noise limits and use of penalties, to ensure that these remain appropriately balanced and effective. This report summarises the work completed in respect of approach noise.

Much of the work in support of this review was carried out by the CAA's Environmental Research and Consultancy Department (ERCD) in close collaboration with other members of the ANMAC Technical Working Group (TWG), whose membership is listed below.

TWG membership	
CAA ERCD (Chair and Secretariat)	Heathrow Scheduling Committee
Department for Transport	Technical Adviser to the Scheduling Committees
Heathrow Airport	Gatwick Airport Consultative Committee (GATCOM)
Gatwick Airport	Stansted Airport Consultative Committee (STACC)
Stansted Airport	NATS

The TWG's terms of reference were:

- Identify, as far as practically possible, the principal reasons for failing to achieve a CDO at the designated airports. Review and assess the difficulties that are likely to occur in applying penalties for not achieving a CDO.
- Review and assess the extent to which LP/LD techniques are applied at the designated airports, whilst having due regard to safety, capacity and other constraints.

⁵ EGLL AD 2.21, EGKK AD 2.21 and EGSS AD 2.21, UK Aeronautical Information Publication (AIP).

- Review and assess the difficulties in monitoring arrival noise, especially prior to glide path intercept. Review to what extent noise monitoring can and cannot be used to identify non-CDO and/or non-LP/LD approaches.

Chapter 2 summarises the operational factors that can affect noise from arriving aircraft. Chapter 3 provides an overview, for information purposes, of other factors affecting approach noise that were outside the TWG's terms of reference. Chapter 4 reviews the factors in monitoring arrivals noise and the extent to which noise monitoring can be used to identify non-CDO and/or non-LP/LD approaches. Chapter 5 presents the conclusions of the study.

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Chapter 2

Operational factors affecting approach noise

Background

Modern aircraft generate significantly less noise on departure and arrival than their predecessors as a result of technological innovation and the use of noise abatement operating procedures. The impact of approach noise has become relatively more important due to the following factors:

- The heights of aircraft on final approach are determined by the Instrument Landing System⁶ (ILS), which involves aircraft flying at lower altitudes compared to departures at equivalent distances from the airport, albeit requiring lower levels of thrust.
- The increasing size of aircraft with the increased airframe noise that this can generate, which can be a significant component of the total approach noise when engine power is low.
- The increase in the number of movements at airports.

As mentioned in Chapter 1, the 1999 ANMAC arrivals report concluded that it was impracticable to set approach noise limits similar to those for departing aircraft. Government therefore decided against imposing operational noise limits for arrivals and in February 2000 announced that it would ask the aviation industry to develop a code of practice to promote the use of CDO, which the report had identified as the primary means of reducing noise experienced on the ground.

Following initial publication of the code in 2002, the designated airports commenced regular monitoring and reporting of CDO performance through the use of their Noise and Track Keeping systems (NTK), along with an engagement programme with airline operators and NATS to promote CDOs and outline the benefits in terms of noise and fuel burn. As a result, CDO performance has improved significantly across the three London airports since the introduction of the Code. At Heathrow for example, daytime CDO compliance in 2015 was 87 percent, compared to 76 percent in 2001. CDO procedures are now widely used at airports throughout the world.

⁶ A ground-based system that provides lateral (the localiser) and vertical (the glide path) guidance to an aircraft approaching and landing on a runway.

Continuous Descent Operation

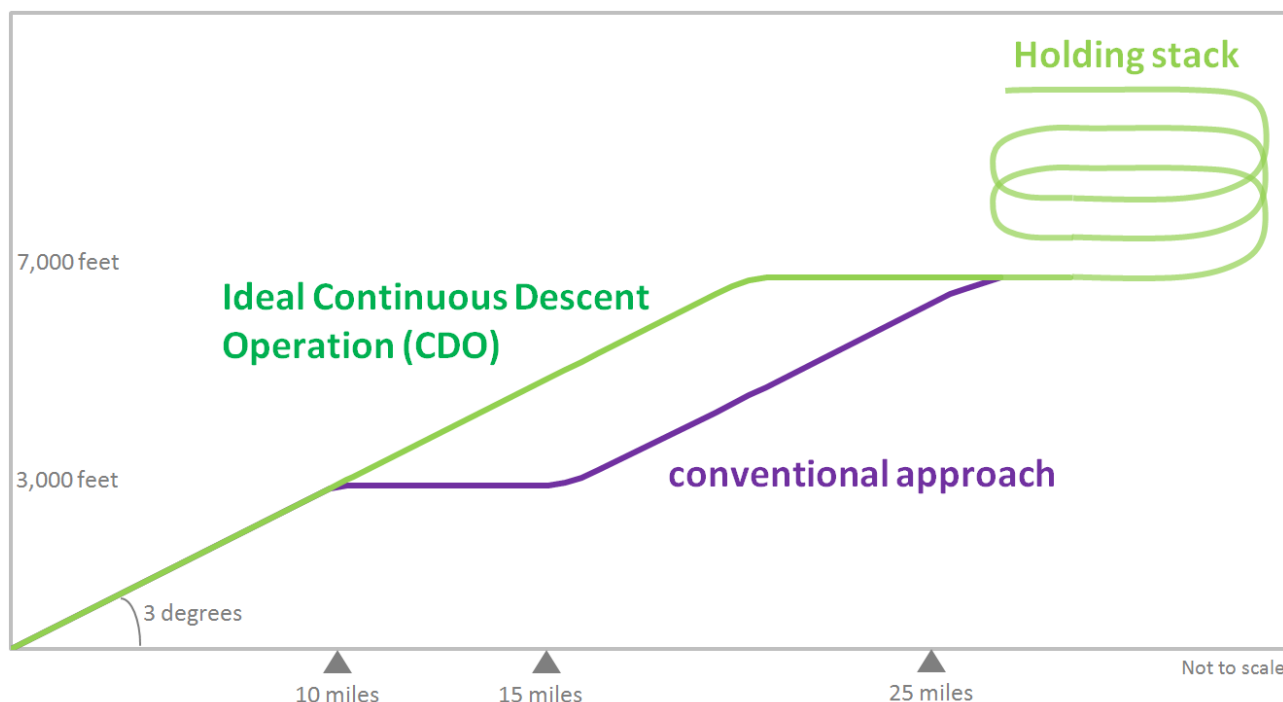
The arrivals code of practice defines an arrival as a CDO if it contains, below an altitude of 6,000 feet:

- no level flight; or
- one phase of level flight not longer than 2.5 nautical miles (NM)

In order to set aircraft up for approach to landing, Air Traffic Control (ATC) descend aircraft and reduce their speed. During busy periods, arriving aircraft can be directed by ATC to holding stacks. A holding stack is a fixed circling pattern in which aircraft fly whilst they wait to land.

With a conventional (non-CDO) aircraft approach, an aircraft would be given clearance by ATC from the bottom level of the holding stack (normally a Flight Level equivalent to 7,000 feet) to descend to an altitude of typically 3,000 feet. The aircraft would then be required to fly level for several miles before intersecting the 3 degree glide path to the runway. During this period of level flight, additional engine power would be required to maintain level flight at a constant speed (**Figure 1**).

Figure 1 Comparison between a CDO and a conventional approach

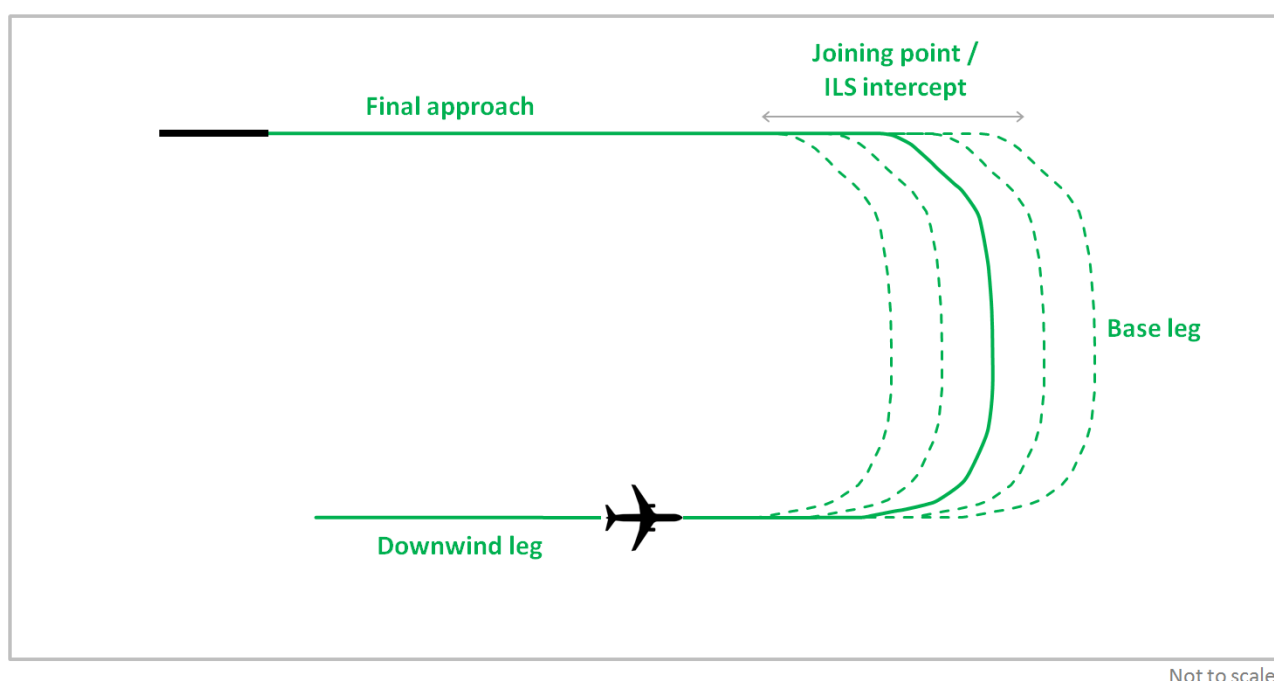


In contrast to a conventional approach, when a CDO procedure is flown the aircraft stays higher for longer, descending continuously from the level of the bottom of the stack (or higher if possible) and avoiding any extended level segments of flight prior to intercepting the 3 degree glide path. A continuous descent also requires significantly less engine thrust than required for level flight. CDO descent rates vary, such that an optimal CDO will require idle power from the engines, whereas in some cases CDO is achieved by applying

a reduced rate of descent, requiring thrust above idle. This applies even for an aircraft in turning flight.

Because, generally in the UK, there are no mandatory flight paths between the holds and joining the final approach it is the responsibility of ATC to instruct pilots to fly specific headings at appropriate times. This is a process known as vectoring, which occurs prior to aircraft being directed into the arrival sequence and intercepting the ILS, and means the track distance covered during the approach will vary from flight to flight (**Figure 2**). To enable pilots to manage their descent, a CDO procedure therefore requires ATC to pass on accurate 'range from touchdown' information to the air crew.

Figure 2 Illustrative ILS approach procedure



The downwind and base leg portions of the approach path can be more complex than those indicated in **Figure 2**, sometimes appearing as an 'S' shape. The point at which aircraft intercept the ILS is known as the joining point and whilst the precise joining location can vary significantly from flight-to-flight depending on operational conditions, each airport generally has its own minimum height and distance requirements (which can also vary depending on the time of day). A study of arrival joining point and its effect on flight path concentration was outside the scope of the TWG review. However, recent evidence is available that shows how the average joining points at Heathrow and Gatwick have varied over time due to a variety of operational reasons^{7,8}.

⁷ Gatwick Airport Independent Arrivals Review, Report and Recommendations, Bo Redeborn and Graham Lake, Jan. 2016. <http://www.gatwickairport.com/business-community/aircraft-noise-airspace/airspace/arrivals-review/> (accessed 19 June 2017).

⁸ LHR Joining Point Distance Analysis for 2015, Heathrow Airport Limited, May 2016. <http://www.heathrow.com/noise/facts,-stats-and-reports/reports> (accessed 19 June 2017).

It is sometimes not possible to achieve a CDO due to a range of factors, including ATC instructions and information, airspace constraints, overriding safety requirements and weather. An analysis of CDO achievement rates over a period of several years may show seasonal peaks and troughs in performance. Non-achievement has been shown to be due to extended vectoring below the monitoring height threshold for a variety of reasons. Variations in performance can also be affected by runway direction due to interaction of departing traffic and air traffic from other airports. In addition, when flying a CDO an aircraft may still require a short segment of level flight in order to reduce speed and/or reconfigure. Thus without knowledge of the associated ATC voice instructions to flight crew (the monitoring of which would be impracticable), any instances of non-CDO could not automatically be attributed to the flight crew, making it difficult to apply financial or other penalties for not achieving a CDO.

The noise benefit of a CDO will vary depending on the altitude and length of level flight associated with a non-CDO, as well as the descent rate and associated thrust settings of the CDO flight. Previous analysis has shown that a typical non-CDO has approximately 5 NM of level flight at altitudes from 3,000 to 6,000 feet. Compared to a perfect CDO, this results in noise increases of up to 2.5 to 5 dB, varying over distances from touchdown of 10 to 20 NM (**Figure 3**).

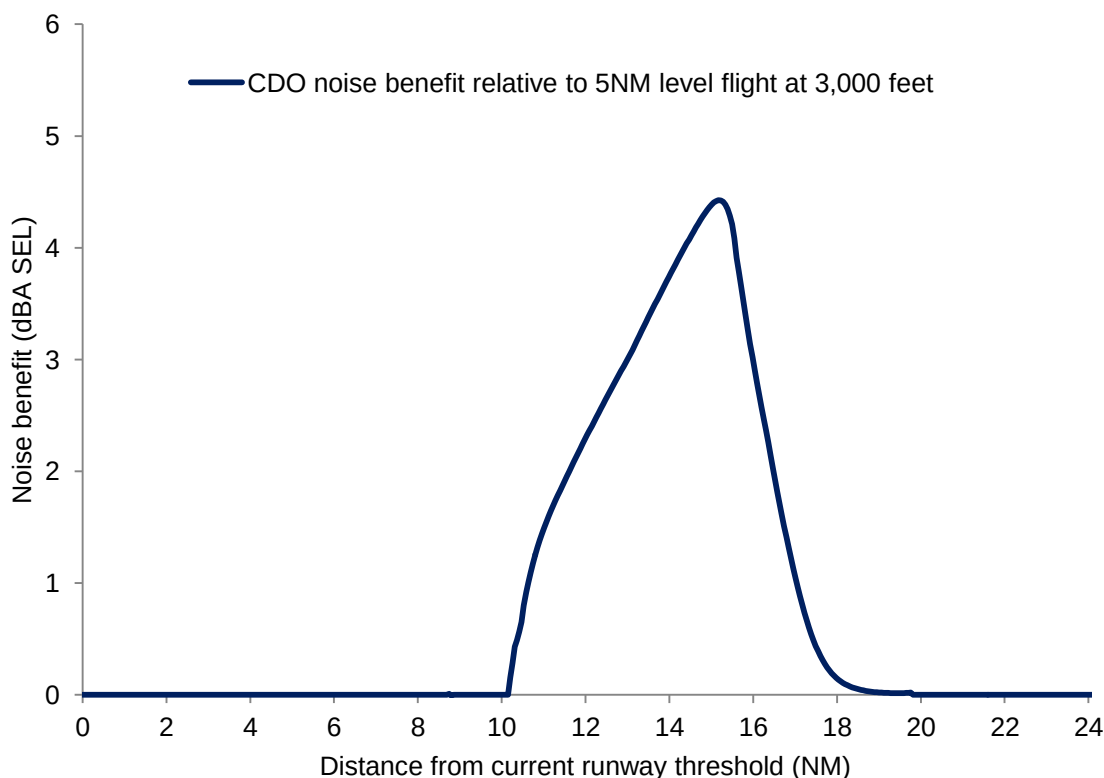
Since the minimum Flight Level of aircraft in the holding stacks around the London airports is equivalent to 7,000 feet, for practical reasons the arrivals code of practice considered the noise benefits of CDOs below 6,000 feet⁹. One outcome from Gatwick Airport's recent Independent Arrivals Review was for the minimum altitude for the commencement of CDO to be increased to 7,000 feet, with a further increase to 8,000 feet when feasible. Gatwick is currently working with NATS to take the necessary measures to raise the commencement of CDO from 6,000 feet¹⁰, although it is unclear at this time whether such changes will result in any measureable noise reduction on the ground. At UK airports outside of the London area, NATS has been working alongside Sustainable Aviation to improve CDO performance from higher altitudes (up to 25,000 feet) in order to save fuel and reduce CO₂ emissions as well as to reduce noise¹¹.

⁹ The code of practice recognised that, given the constraints of the airspace in the London area, the highest practicable level a CDO can commence for Heathrow, Gatwick and Stansted was 6,000 feet.

¹⁰ Gatwick Arrivals Review, Overview and Final Action Plan, Gatwick Airport Limited, June 2016.
<http://www.gatwickairport.com/business-community/aircraft-noise-airspace/airspace/arrivals-review/> (accessed 19 June 2017).

¹¹ Cleaner, Quieter and Smarter! Continuous Descent campaign delivers tangible improvements, NATS, 18 August 2015.
<http://nats.aero/blog/2015/08/cleaner-quieter-and-smarter-continuous-descent-campaign-delivers-tangible-improvements/> (accessed 19 June 2017).

Figure 3 Noise benefit of Continuous Descent Operation for one aircraft type (Boeing 777)



Low power/low drag

For the vast majority of arrivals, aircraft speeds are controlled by ATC instructing pilots to fly at set speeds. As an aircraft reduces speed during the intermediate approach phase (after leaving the holding stack) to comply with ATC instructions, flaps are deployed to allow the aircraft to fly slower and prepare the aircraft for landing. For a given aircraft type and mass, each flap setting has a minimum safe flight speed. Landing gear is typically deployed in the final approach phase in accordance with safety criteria, and for some aircraft its deployment can also be linked to a flap setting.

Low power/low drag is the collective term used for describing the lowest noise configuration for a given speed and/or altitude during the approach. Selecting more flap than is required for a given speed will typically lead to more airframe noise, higher engine power due to greater drag and thus higher noise. The effect is however small, typically no more than 1 dB.

In contrast deployment of the landing gear significantly increases aircraft drag and airframe noise, and to maintain the flight path requires increases in engine power and thus also engine noise. The combined effect may be as much as 5 dB.

Landing gear are deployed in accordance with airline and manufacturer safety requirements and standard procedures, which vary by aircraft type. This translates into