Reducing the Environmental Impacts of Ground Operations and Departing Aircraft

An Industry Code of Practice

Executive Summary

1. This voluntary Code of Practice has been compiled by a group representing aerospace manufacturers, airlines, airports, air traffic control (ATC) and the Civil Aviation Authority's Environmental Research and Consultancy Department (ERCD). It gives advice on four operational techniques aimed at improving the environmental impacts of aircraft operations during the ground operations and departure phases of flight, and includes the use of Fixed Electrical Ground Power (FEGP) and Preconditioned Air (PCA) rather than running aircraft Auxiliary Power Units (APUs); taxi with less than all engines operating; Continuous Climb Operations (CCO); and Airport Collaborative Decision Making (A-CDM).

Introduction

2. Following the success of the Arrivals Code of Practice, it was felt that it would be beneficial to carry out a similar exercise for departing aircraft. The Departures & Ground Operations Code of Practice working group first met in late 2007, and included representatives from British Airways, BAA Heathrow, BAA Stansted, NATS and Virgin Atlantic Airways, with the Manchester Airports Group, Gatwick Airport Ltd, ERCD, DfT and ADS (formerly the Society of British Aerospace Companies) becoming involved as the exercise progressed.

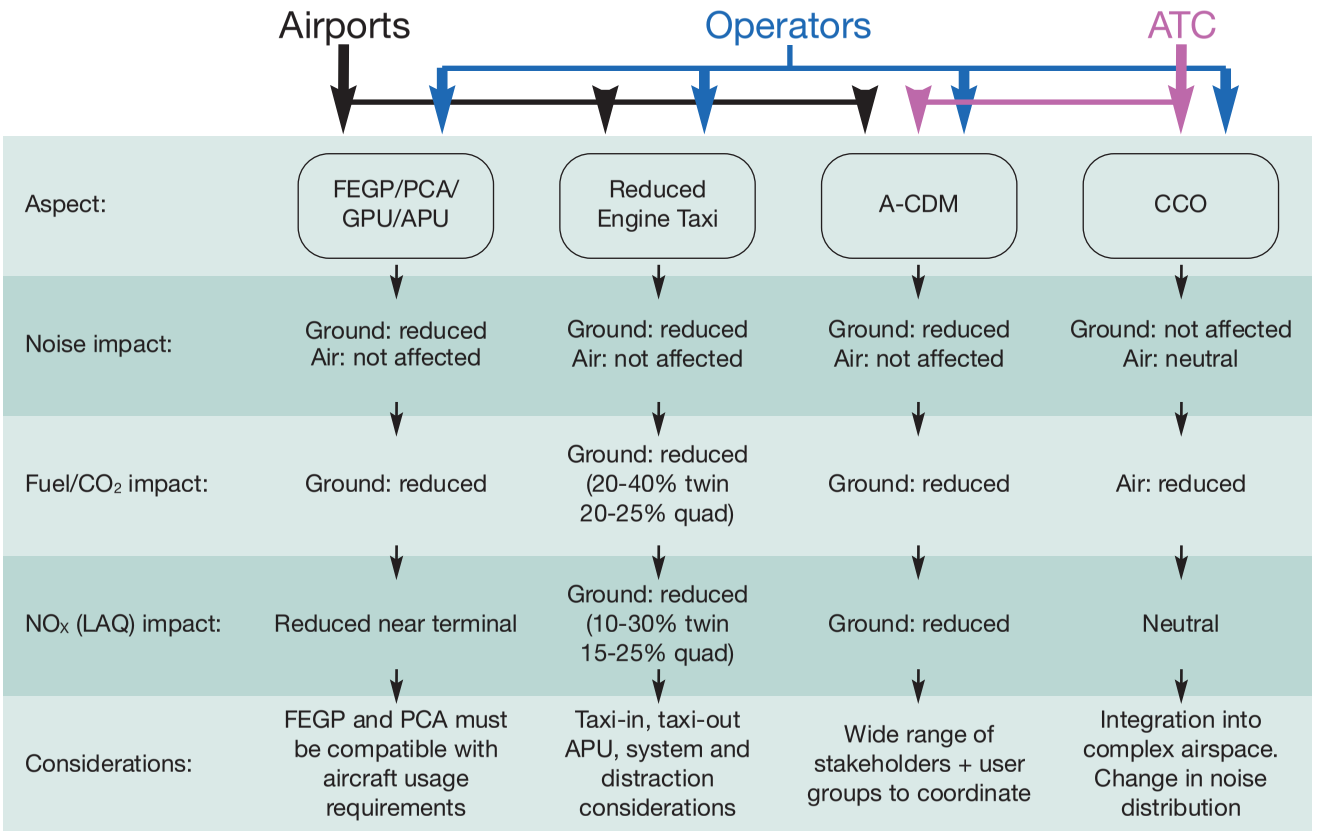
3. The study has identified four primary environmental mitigation techniques for departing aircraft that are the basis of this code along with recommendations for key stakeholder groups, a summary of this is illustrated in Figure 1, and combines the interim Departures Codes of Practice that have been published earlier.

4. This document has evolved from a number of studies and measurements. These are available along with more information on the background to the techniques and procedures identified, in a complementary Technical Background Document, at www.dft.gov.uk.

Future Collaboration to Minimise the Impacts of Aircraft Operations on the Environment

5. The aviation industry has consistently delivered improvements to limit the impact of its operations on the environment. Even as this code is published, it is clear that quieter, more fuel-efficient technologies are being incorporated into current and next generation aircraft. Improvements in airspace design, navigational accuracy and operational procedures all offer strong potential to reduce the environmental impacts of aviation further. Consequently, the member organisations responsible for this and the Arrivals Code of Practice have agreed to review and update both documents. The aspiration is to create a universal code of practice.

Figure 1: Effects Of Recommended Procedures On Environmental Performance



Scope

6. This Code of Practice has been produced with the experience and knowledge of all participants to identify steps that could reduce the environmental impacts arising from departing aircraft and aircraft ground operations. It is a technical document which is primarily written for flight planners, pilots, ground handling agents, air traffic controllers and airport operators but may also include advice relevant to regulators and other groups.

7. This Code covers aircraft operations at the terminal, aircraft taxi operations from runway to terminal, CCO and A-CDM. Interaction between, and requirements of, the airline operators, ground handlers, airport authorities and air traffic controllers are considered for each. Although noise is covered by this Code, additional environmental impacts of aircraft operations are also considered including fuel-burn/CO_2 and local air quality impacts of NO_X.

8. Although this Code has been developed without a specific aircraft or airport in mind, it is recognised that the greatest benefits are likely to be achieved with large aircraft at busy airports. However, the reductions in noise, fuel burn and associated emissions will be of significance for all airports and operators regardless of aircraft type or airport and associated facilities.

9. **Nothing in this Code shall take precedence over the requirement for safe operation and control of aircraft at all times. For the avoidance of doubt, all recommendations are to be read as being subject to the requirements of safety.**

Background

10. During the period 1994-99, the feasibility of setting arrivals noise limits was considered in depth by the DfT's Aircraft Noise Monitoring Advisory Committee's (ANMAC) technical working group. Following the publication of their report Noise from Arriving Aircraft: Final Report of the ANMAC Technical Working Group at the end of 1999, the then Aviation Minister decided against setting arrivals noise limits, but announced that a Code of Practice should be established to address this issue. This Code of Practice was later published as Noise from Arriving Aircraft, An Industry Code of Practice, in 2004 and updated in 2006.

11. When it became clear that the Arrivals Code of Practice was proving to be a success, and the instance of Continuous Descent Approaches (CDAs) into the London airports was increasing, a similar exercise for departing aircraft was proposed. In late 2007, a group of industry specialists was convened to develop this code.

12. Developing this code has proved more difficult for a number of reasons. First, there was a lack of relevant technical background documentation, as previously provided by ANMAC to the Arrivals group. Also, the environmental impacts that are generally all beneficial for arrivals, result in numerous environmental trade-offs when departing aircraft are considered.

13. This code now contributes to a suite of voluntary agreements and codes that reduce the impact of aviation on the environment. These include the Arrivals Code of Practice developed in the UK and at the global level, other documentation such as ICAO's Circular 303, Operational Opportunities to Minimize Fuel Use and Reduce Emissions.

1 – Use of airport terminal-based power and pre-conditioned air sources

14. It is recommended that operators and ground handling agents follow the ground power hierarchy of using airport terminal-based FEGP and PCA (where available) first; then mobile ground-based Ground Power Units (GPUs) and air conditioning trucks; followed by aircraft APUs.

15. Significant savings may be possible as APUs burn about six times as much fuel as a GPU. GPUs, in turn, burn more fuel and thus emit more CO_2 than terminal-based FEGP (the actual value depends on the aircraft supply requirements).

16. It is essential that airport authorities, aircraft operators and ground handling agents work together to ensure that relevant personnel are adequately trained in the use of ground, and terminal-based facilities, to ensure that they are properly and safely used. It is also important that all sources of ground power and air conditioning are adequate, fit for purpose and well maintained.

Operational Issues for Flight Crew

17. On arrival at final parking position, operating crews should switch off main engines and APUs as soon as ground power becomes available and it is safe to do so. For departure, APUs should not be started until the last possible moment consistent with safety and environmental conditions. Main engine start should similarly be delayed until the last possible time during the pushback sequence.

18. Whilst on stand, the aircraft should be configured to draw the lowest load, e.g. by turning off In Flight Entertainment (IFE), Environmental Control System (ECS) and unnecessary electrical loading, consistent with the safety and welfare of passengers and personnel working on and around the aircraft. When possible, cabin blinds should be shut to help reduce heat build up in the cabin during turnarounds at hot locations, or where the aircraft is in full sun.

19. Where appropriate, operator's Standard Operating Procedures (SOPs) should contain information highlighting the importance and benefits of using ground-based power and air supplies when available. This should be backed up with adequate guidance that ideally should be incorporated into the normal training provided for flight crews.

20. Operators should explore the inclusion of automatic engine starts as part of their SOPs. For aircraft with four engines, the potential for starting two engines at the same time should also be investigated, ensuring that any safety concerns are met.

21. Operating crews should be made aware of the non-availability of FEGP and/or PCA at the airport at an early stage before arriving on stand after landing, or before arriving at the aircraft for departure.

22. Both flight and ground crews are encouraged to promptly report any unserviceable FEPG or PCA systems.

Operational Issues for Ground Handling Agents

23. Studies by IATA for ICAO CAEP Air Quality Modelling Guidance (Doc 9889), have estimated the fuel burn and NO_X emissions for groups of APUs. These have been simplified here for normal running of the APU supplying conditioned air to the aircraft systems only:

Table 1: Approximate APU Fuel flows and NO_X emissions for different aircraft types

Aircraft Type	Fuel burn(kg/hr)	NO_X emissions(kg/hr)
Small (less than 200 seats)	90 to 110	0.452 to 1.064
Medium (200 to 300 seats)	180	1.756
Large (greater than 300 seats)	240 to 300	2.071 to 2.892

24. GPUs offer reduced fuel consumption and emissions production over APUs. One airline has reported that an APU fitted to their B747 aircraft burned six times more fuel than a GPU supplying the same load.

25. Operators and Handling Agents should review their Operating Procedures to ensure that they use electrical and pneumatic power to the following hierarchy:

    1st Airport Terminal, or ground-based facilities such as FEGP and PCA, should always be used where provided.

    When they are not available –

2nd GPUs and air-conditioning units should be used as these provide a reduction in fuel, emissions and noise levels over APUs.

When FEGP, PCA or GPUs are not available –

3rd APUs, associated generators and air bleeds should be used.

26. Ground Handling Agents should ensure that adequate awareness training is carried out for ground-crews to ensure that they are aware of the importance and benefits of using ground-based power and air supplies.

27. Early reporting of the non-availability of ground-based systems by Ground Handling Agent's crews should be encouraged to ensure that availability levels and confidence in the use of the systems are kept high.

Operational Issues for Airport Operators

28. In considering ways to reduce the environmental impacts of aircraft operations at the terminal, there is a clear benefit to using airport terminal-based facilities such as FEGP and PCA. In this respect it is recommended that airport operators work with ground handlers, manufacturers and aircraft operators to ensure that the facilities are adequate and fit for purpose.

29. Where supplied, it is imperative that the ground-based facilities are kept well maintained and serviceability rates are very high. It is also important to ensure that the facilities are adequate and fit for service, and that proper training for ground staff is provided. This will, in turn, provide the operating crews and ground handlers with confidence in the continuing availability of the supply.

30. To ensure that the maximum use and confidence in the availability of these systems is maintained, it is recommended that an efficient and effective fault-reporting system be put in place. This system should also include regular reviews between the airport operators, aircraft operators and Ground Handling Agents.

31. A useful addition would be the ability to identify and display the state of the systems' serviceability or non-serviceability to ground handlers and operating crews at an early stage.

32. Sufficient training is vitally important for the correct operation and use of ground-based facilities. In this respect, airports should work with aircraft operators and ground handling agents to ensure adequate focussed training is provided to ensure that these facilities are used efficiently, safely and to their maximum potential.

2 – Taxi Operations with less than all engines operating

33. It is recommended that aircraft operators should review their SOPs in order to help promote taxiing with less than all engines operating for aircraft taxiing-in from the runway to the airport terminal. Adherence to this technique should then be encouraged as long as all safety and procedural concerns can be met.

34. Shutting down an engine during taxi-in operations should be planned in advance, and accomplished as early as possible during the taxi to obtain the maximum reduction of fuel burn and environmental benefit. Reductions of 20% to 40% of the ground level fuel burn and CO_2, and 10% to 30% of ground-emitted NO_X emissions, may be realised dependant on aircraft type and operator technique.

General Advice For Aircraft Operators

35. A number of studies have shown that there is a reduction of the amount of fuel burned and the production of ground-level emissions from aircraft taxi-in with less than all engines operating. However, these reductions have been shown to be less than simply reducing the rate of production by the ratio of the number of engines not operating. The importance of incorporating the effects of APU operation, which is often required when following this technique, is important in establishing the actual benefits.

36. Studies by IATA for ICAO CAEP, and individual operator members of the Departures Code of Practice group, have identified savings in both fuel and NO_X emissions through the use of shutting down an engine during taxi-in. The amount saved depends mainly on the aircraft type, whether an APU is required, and the fraction of the taxi where the engine was shut down.

37. Fuel burn reductions were shown to be between 20% and

Chart 1: Reported stabilised fuel flow reductions for taxi with one engine (OEO) and two engines (TEO) shut down, from IATA 2005 study – APU fuel burn not included.

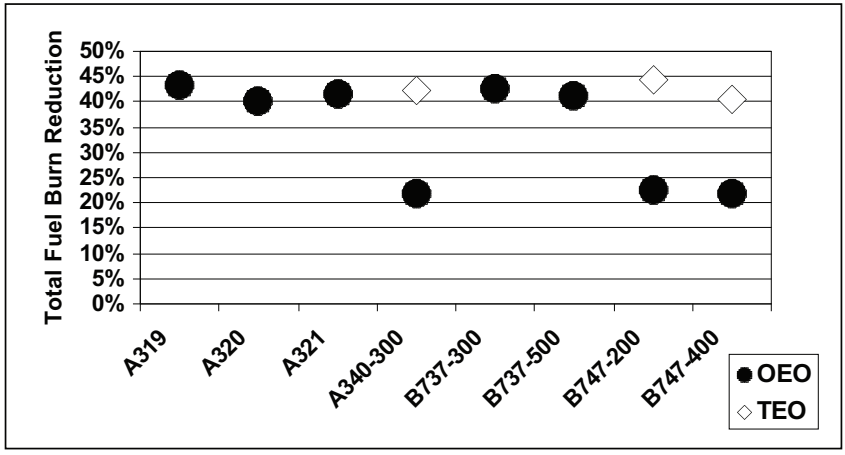
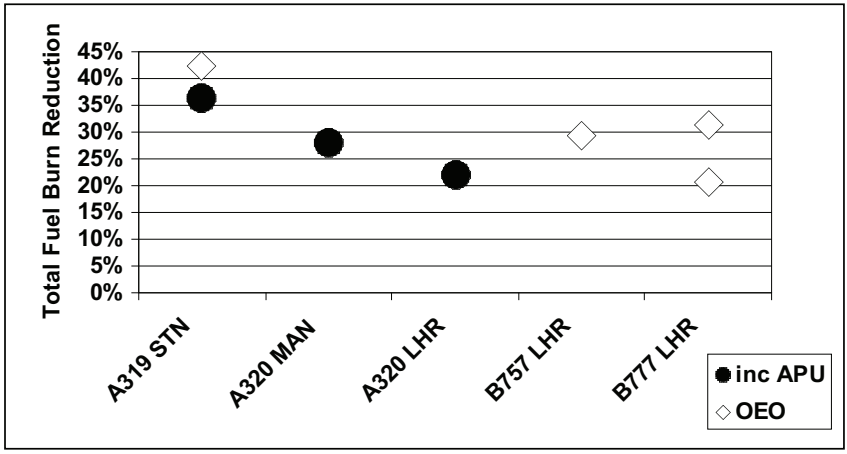


Chart 2: Reported fuel burn reductions for taxi with engines shut down, from a 2008/09 study including APU contribution where appropriate.



40%; and associated NO_X emissions reductions between 10% and 30%, using the recorded fuel burns and NO_X EI values from the ICAO Engine Emissions Data Bank.

38. For some aircraft types, the residual engine thrust is quite high and little or no additional power is required to taxi the aeroplane with an engine not operating. However for others significant additional thrust may be required to keep the aircraft rolling. This is another reason for the variation in fuel and NO_X savings observed.

39. A brief analysis of APU fuel flows when running at the no-load condition (i.e. as a systems back-up) suggests that they are approximately 10 to 20% of the fuel flow of a main engine at idle, therefore reductions achieved by shutting an engine down will be reduced by this amount if the APU is required.

Operational Issues for Flight Crew

40. Aircraft operators are encouraged to review their SOPs in order to help promote taxiing with less than all engines operating for aircraft taxiing-in from the runway to the airport terminal. Adherence to this technique should then be promoted as long as all safety and procedural concerns can be met.

41. It is important to take into account issues associated with taxiing with engines shut down and adhere to recommended procedures or manufacturer's advice, including engine cool-down period requirements. A comprehensive risk assessment should be undertaken and advice may also be sought from the appropriate regulatory authority.

42. There are a number of considerations other than fuel burn and emissions that have to be taken into account before deciding to taxi with one or more engines shut down. These generally fall under the four categories of:

    a. Crew workload
    Engine shut-down requires the attention of the flight crew, and taxiing with an engine not operating may require additional system checks to be carried out during the taxi-in. To ensure that additional taxiway congestion is avoided, it is also important that the aircraft is able to taxi at speeds that would be possible with all engines operating.

    b. Aircraft systems implications
    Different aircraft types have different system requirements and during engine-out taxi, some types may have some non-powered or degraded systems. As a result, when following this practice, there may be a loss of system redundancy. This may require the APU to be operating on these types in order to power these systems or provide adequate redundancy in the event of a systems failure. Careful

application and review of the aircraft's MEL before considering taxiing with engine(s) shut down is also essential.

c. Breakaway thrust levels (jet blast issues)

For large engined, heavy aircraft (e.g. A330, A380, B777 etc.) excessive thrust may be required to start the aircraft moving, or for steering when negotiating sharp turns with engines not operating. There may also be an increased chance of debris being picked up from the ground resulting in Foreign Object Damage (FOD), with higher thrust levels, especially from the aircraft types mentioned above. For this reason, it may be prudent to place a maximum weight limit for taxiing with an engine shut down for these types. Aircraft with less than all engines operating must be able to taxi without the requirement to use excessive thrust creating a jet blast risk from the remaining engine(s). Note that at airports where short radius turns at slow forward speed are required, there may be an implication for smaller aircraft types as well.

d. Other operational implications

Other potential issues that have to be taken into account when considering taxiing with less than all engines operating include: the surface state of the taxiways in terms of braking action; weather dependency in icing or hot conditions; excessive taxiway slopes requiring higher thrust levels; negotiating runway crossings where aircraft may need full power available, tight corners and congested manoeuvring areas, etc.

43. After consideration of the potential safety and operational issues of taxiing with less than all engines operating, operators are encouraged to implement this technique as their SOP, as it provides useful fuel burn reductions and environmental benefits.

44. In order to obtain the maximum reduction of fuel burn and environmental benefit, shutting down an engine during taxi-in operations should be planned in advance and accomplished as early as possible during the taxi.

Operational Issues for Airport Operators

45. Assessment of potential jet blast issues resulting from aircraft taxiing with less than all engines operating should be undertaken by the airport operators to ensure any health, safety or environmental concerns are responsibly addressed.

46. Specific areas where this is likely to be required are airport work in progress, aircraft manoeuvring within cul de sacs, close to blast fences, around the ramp area and for aircraft movement areas within 30 metres of airside road networks or buildings.

47. It is recommended that the airport operators publicise these in the AIP under Local Traffic Regulations or as a NOTAM or AIP Supplement as appropriate.

48. Additional airport signing of sensitive areas should also be considered.

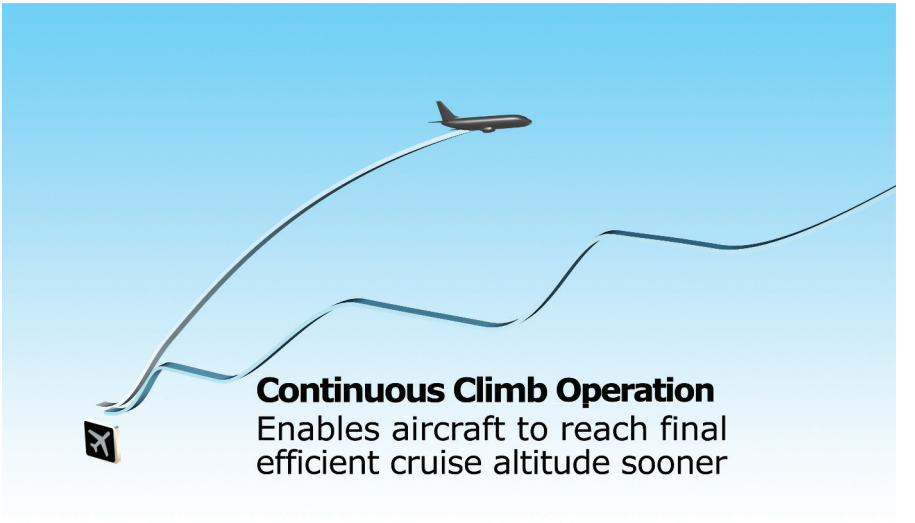
3 – Continuous Climb Operations (CCO)

49. This section identifies the fuel and emissions benefits that can be achieved by avoiding or minimising level flight in the climb phase, referred to here as Continuous Climb Operations. It also describes the scope of CCO, highlights potential fuel and emissions savings, describes timescales for wider adoption and suggests opportunities to apply best practice.

50. CCO are not a new invention: they have always been and continue to be the default practice for airlines and air traffic controllers where airspace structures and traffic conditions allow. The aim of this guidance is to promote the opportunities and benefits for enabling more CCO through procedural and airspace design changes, in order to realise fuel savings and emissions reductions.

51. Stepped climbs are often required to maintain safe separation between aircraft. Stepped climbs can be procedurally designed into the SID climb profile, may arise from airspace standing agreements and the Route Availability Database (RAD) restrictions or may be radar controlled to avoid traffic conflictions.

Figure 2: Illustration of Stepped Versus Continuous Climb Operation.



52. The aim of this chapter is to promote the benefits of CCO and encourage wider uptake. In the short term, this means raising awareness of the benefits and seeking opportunities to make procedural or tactical changes to enable more CCO where airspace and traffic conditions allow.

53. For the mid to long term, achieving more CCO requires structural changes to airspace and further investment in ATC and aircraft technology. Investment in RNAV SIDs and controller tools such as iFACTS as well as major airspace changes are examples of improvements that will enable more CCO.

Scope of Continuous Climb

54. The principle of a CCO is to provide a continuous climb from lift-off to optimum cruise level. However, fuel savings will also be realised by minimising the duration of level flight and/or increasing the altitude at which any necessary level offs are given. Adherence to these techniques should be encouraged as long as all safety and procedural concerns can be met.

Fuel and Emissions Benefits of Continuous Climb Operations

55. Significant improvement to fuel burn and CO_2 emissions can be realised, with the actual value being dependent on aircraft type and operator technique or SOPs. Two examples of the penalty of level offs are provided below for three aircraft types. In the first comparison (one level off at 6,000ft vs CCO to FL240), the savings vary by aircraft size but the average across the aircraft types is 200kg, which equates to 5% of climb fuel. A similar result is seen for the second example, which has two level offs in the climb versus CCO to FL240, with an average across all types of 250kg of fuel, or 6% of climb fuel.

Table 2: Fuel Penalty By Aircraft Type With One Level Off (Source : NATS 2012).

Example fuel penalty of one level off at 6,000ft for 10nm.					
Aircraft Type	Fuel Burn with level off @ 6,000 for 10nm then climb to FL240 (kg)	Fuel Burn with continuous climb to FL240 (kg)	Fuel Difference (kg)	CO_2 Difference (kg)	% Difference
A320	1,475	1,425	50	150	3%
B738	1,700	1,625	75	250	4%
B744	6,475	6,000	475	1,500	7%

Table 3: Fuel Penalty By Aircraft Type With Two Level Offs (Source: NATS 2012).

Example fuel penalty of two level offs, one at 6,000ft for 10nm and another at FL195 for 5nm.					
Aircraft Type	Fuel Burn with level off @ 6,000 for 10nm and second level off @ FL195 for 5nm then climb to FL240 (kg)	Fuel Burn with continuous climb to FL240 (kg)	Fuel Difference (kg)	CO_2 Difference (kg)	% Difference
A320	1,500	1,425	75	250	5%
B738	1,725	1,625	100	325	6%
B744	6,525	6,000	525	1,675	8%

Measurement and Reporting Of CCO Achievement Rates

56. There are a number of methods available for measuring and reporting CCO achievement rates. These would normally include an automatic data capture system based on radar track and altitude reporting. However, radar systems vary in capability and the data and reporting needs of each stakeholder may also vary.

Noise Implications of CCO

57. Initial analysis of a variety of CCO scenarios suggests an overall neutral effect on noise or, potentially, an overall small benefit. This is dependent on the difference between the new CCO and previous practice as well as local population distribution.

58. The main difference between a stepped climb and a CCO is that in a CCO the aircraft does not level-off at an intermediate altitude and reduce its thrust setting while awaiting a further climb. During the period of level flight, less noise is created from a lower thrust setting but less noise is attenuated (absorbed) by the atmosphere due to the lower altitude of the aircraft.

59. Further along the flight path, this effect is reversed and noise impacts from CCO are less than for a stepped climb as the aircraft will be at a higher altitude.

General Implications Of CCO

60. The reductions in fuel burn and CO_2 emissions of a CCO versus a stepped climb departure can be significant and in general, increase the lower the aircraft would otherwise have been held.

61. For air quality, the impact of an aircraft's emissions at or above 3,000 ft on NO_X ground level concentrations is very small, and ICAO notes that 1,000 ft is the typical limiting altitude for ground level NO_X concerns.

62. The fuel penalty for levelling off at lower altitudes can be severe, with percentage fuel burn increase being generally greater for smaller types. However in terms of absolute levels, the larger the aircraft the greater the fuel burn penalty.

Advice for Air Traffic Controllers

63. Air Navigation Service Providers (ANSPs) have a role in enabling CCO, through the design of airspace that minimises conflicting traffic flows to enable continuous climbs.

64. Where safe to do so, ATC can offer tactical CCO on an opportunity basis. This may require coordination with operating Flight Crew to select routeings, radar headings or adjust rates of climb to facilitate an overall continuous climb profile.

65. It is recommended that when a level-off is required during the climb phase, ATC offer the highest altitude available for use by the aircraft operating crews, for the shortest time practical.

66. Coordinating between ATC sectors can prevent levelling off and additional fuel burn. Additionally, offering climb at an altered rate or keeping the pilot informed if the climb will be stepped will help the pilot make an informed choice to optimise the aircraft's rate of climb.

67. When climbing through airspace below FL100 there is normally a speed restriction of 250kts. Some aircraft types are unable to maintain 250kts without flap/slats deployed, with a consequent negative impact on fuel efficiency. Controllers are encouraged to facilitate climbs at an airspeed which allows flight in a clean configuration.

Advice for Flight Crew

68. Aircraft operators should note the following points in relation to the provision of CCO:

a. Aircraft Separation
ATC separation standards and the guidance on response to TCAS alerts remain unchanged.

b. Flight Management Computer (FMC) – Cost Index
Flight Crew are encouraged to use the most fuel efficient Cost Index for the climb portion of the flight. This creates a fuel optimum climb profile, thus taking maximum advantage of the CCO profile.

c. Climbing at reduced rate of climb
In busy airspace ATC controllers may recommend flying with a reduced rate of climb in order to facilitate a smooth, continuous climb where a temporary level-off might otherwise be required.

Operational Issues for Airport Operators

69. Airport Operators should be aware that whilst CCO offer overall environmental benefits and the potential for a small noise benefit, CCO may result in a redistribution of noise.

70. The effect referred to above should be studied on an airport-by-airport basis.

4 – Airport – Collaborative Decision Making (A-CDM)

71. It is recommended that A-CDM is introduced at all major airports. Using A-CDM can reduce the environmental impact of aircraft operations as well as improving the resilience of the airport operation. Benefits include improved taxi times and reduced emissions by alleviating congestion and waiting times on the airfield. A-CDM also offers an optimised use of people and ground resources as well as improved recovery times from disruption.

72. A-CDM is a joint initiative between all airport partners including aircraft operators, handling agents, the ANSP and the airport operator. The initiative brings together live operational data such as the expected arrival and departure times of aircraft, any ATC restrictions and other critical information to create a single picture of the live airport operation.

73. The success of A-CDM relies on partners working together more efficiently and transparently to maximise operational efficiency and provide accurate information, in a timely manner. In this context it cannot work in the absence of a universally accepted code of practice between all parties.

74. With everyone having access to the same accurate, timely information, there is much better awareness of the wider situation, meaning better decisions can be made that, in turn, improve the predictability of events and optimise the use of resources. Partners also have advanced warning of potential delays, giving more opportunity to take corrective action, thus enhancing the robustness of the operation.

Fuel and Emissions Benefits of A-CDM

75. Experience from European airports and analysis at UK airports indicate that significant savings in aircraft taxi times and consequent fuel and emissions savings are possible.

76. One large UK airport estimates these benefits to be a two-minute reduction of taxi time on each departure. Whilst not reflected in the table of fuel and CO_2 savings below, an additional reduction of 30 seconds taxi time can be expected on each arrival.

Table 4: Potential Fuel and CO_2 savings of a two-minute reduction in average departure taxi time at a large UK airport (Source: NATS, 2012).

2010 total departures	Average departure taxi time before reductions (minutes)	Total fuel saved by a two-minute reduction in average departure taxi time (tonnes)	Total CO_2 saved by a two-minute reduction in average departure taxi time (tonnes)
227,000*	16	9,000*	30,000*

*Figures rounded to nearest 1,000.

Operational Issues for Air Traffic Controllers

77. The following operational issues are noted for ATC:

a. Target Off Block Time (TOBT)
The TOBT is derived from the Flight Plan, unless the departure time has been amended by the Aircraft Operator or Ground Handler. ATC will normally take responsibility for the coordination of an aircraft's departure once it has reported ready to depart at its TOBT.

b. Target Start-Up Approval Time (TSAT)
Aircraft are normally issued with a TSAT. The TSAT is calculated by taking into account various factors including the TOBT, wake vortex, SID routeing, variable taxi times and the overall airport situation.

Operational Issues for Flight Crew

78. The following operational issues are noted for Flight Crew:

a. TOBT
Aircraft should aim to be fully ready to depart at the TOBT.

b. Amended Departure Time
It is recommended that the TOBT be updated for any anticipated changes to departure time. This includes both early and delayed departures. This will generate a new TSAT.

Operational Issues for Airport Operators

79. Stand numbers must be made available to all airport partners with the intention of minimising the number of changes. Ideally, 100% of stands should be allocated no later than 20 minutes prior to aircraft arrival.

Non-operational factors – Communications

80. There is a general obligation amongst airport partners to co-operate fully and to participate actively in the project. Partners must also commit to continuous process improvement through ongoing feedback and review to realise the benefits that A-CDM brings.

Departures Code of Practice Membership

- ADS Group Ltd
- BAA Heathrow
- BAA Stansted
- British Airways
- Civil Aviation Authority, Environmental Research and Consultancy Department
- easyJet
- Gatwick Airport Ltd
- Manchester Airports Group
- NATS
- Sustainable Aviation
- Virgin Atlantic Airways

The group would also like to acknowledge the invaluable advice and support received from the following:

- Air Contractors
- Civil Aviation Authority, Directorate of Airspace Policy
- Department of Transport, Aviation Environmental Division
- Eurocontrol
- IFALPA
- Zurich Airport

Useful weblinks

www.dft.gov.uk
www.caa.co.uk
www.icao.int
www.nats-uk.ead-it.com
www.sustainableaviation.co.uk

References

ICAO Circular 303: Operational opportunities to minimize fuel use and reduce emissions

ICAO Workshop on the Aviation Operational Measures for Fuel and Emissions Reduction, Ottawa, Canada, 2002

ICAO Document 9889: Airport Air Quality Guidance Manual

ICAO Document 8168: Procedures for Air Navigation: Operations (PANS-OPS)

CAP 168: Licensing of Aerodromes

Noise from Arriving Aircraft: An Industry Code of Practice

Glossary of terms

Note that in some cases a simplified, more descriptive explanation of terms is given here, rather than the official technical definition, in order to assist the lay reader to better understand the terms used.

A-CDM	Airport – Collaborative Decision Making
ADD	Acceptable Deferred Defect – an aircraft defect for which the MEL (see page 23) allows rectification to be deferred
AIP	Aeronautical Information Publication; colloquially known as the Air Pilot
ANMAC	Aircraft Noise Monitoring Advisory Committee
ANSP	Air Navigation Service Provider

APU	Auxiliary Power Unit
ATC	Air Traffic Control
CAEP	ICAO's Committee on Aviation Environmental Protection
CDA	Continuous Descent Approach – a method of avoiding unnecessary periods of level flight on approach, thus reducing engine thrust, fuel burn, emissions and noise
CCO	Continuous Climb Operations
CO_2	Carbon Dioxide – a key Green House Gas (GHG) contributing to climate change
ECS	Environmental Control System – primarily the aircraft's air conditioning system
EI	Emissions index – the mass of pollutant (CO, HC or NO_X), in grams, divided by the mass of fuel used in kilograms
FEGP	Fixed Electrical Ground Power – provided from an airport terminal source
FL	Flight Level – altitude expressed in 100s of feet relative to a datum pressure of 1013.25 hectopascals (e.g. FL100 = 10,000ft true pressure altitude)
FOD	Foreign Object Damage – a term to describe loose debris around the airport area which could cause damage to airframes or engines if ingested
GPU	Ground Power unit – a ground-based mobile generator
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization

iFACTS	Interim Future Area Control Tool Support – based on Trajectory Prediction and Medium Term Conflict Detection, provides decision-making support and helps controllers manage their routine workload, increasing the amount of traffic they can comfortably handle and improving opportunities for climb and descent clearances
IFE	An aircraft's In-Flight Entertainment system
MEL	Minimum Equipment List – a document containing a list of items fitted to the aircraft which are not considered essential for the safety of the flight and may remain inoperative for a limited time
NOTAM	Notice to Airmen – a notice to alert aircraft pilots of any hazards en route or at a specific location
NO_X	Oxides of nitrogen – consisting mainly of nitric oxide (NO) and nitrogen dioxide (NO_2). These have implications for both local air quality and climate change. The NO_X EI (Emissions index) is the amount of NO_X in grams emitted per kg of fuel burnt
PCA	Pre-Conditioned Air – provided from an airport terminal source
SID	Standard Instrument Departure – a standard departure routeing which defines both the lateral and vertical profile for aircraft to fly
SOP	Standard Operating Procedure or Practice
RAD	Route Availability Database
RNAV	A navigation system which permits aircraft operation on any desired flight path within the coverage of station-referenced navigation aids (such as DME or GPS) or within

	the limits of the capability of self-contained aids (such as inertial navigation systems), or a combination of these. An RNAV system may be included as part of a Flight Management System (FMS)
TCAS	Traffic Collision Avoidance System
TOBT	Target Off Block Time – the planned departure time from parking stand
TSAT	Target Start-Up Approval Time – the planned time at which ATC would normally allocate start-up approval

Key Messages 1 – Use of airport terminal-based power and pre-conditioned air sources

1. Aircraft Operators and Handling Agents should review their Operating Procedures to ensure that they use electrical and pneumatic power to the following hierarchy:

   1st Airport Terminal, or ground-based facilities such as FEGP and PCA, and where not available –
   2nd GPU, air-conditioning units and air-start vehicles, and where not available –
   3rd APU and associated generators and air bleeds.

2. Airports should ensure that ground-based facilities are kept well maintained and serviceability rates are high to establish confidence in their continuing availability.

3. Airports should work with aircraft operators and ground handling agents to ensure that airport terminal or ground-based facilities are adequate, fit for purpose, well maintained and that sufficient focussed training is provided to ensure that these facilities are used efficiently and safely.

4. Operators should ensure that their aircraft are maintained to a high standard such that Acceptable Deferred Defects (ADDs) are not allowed to impede the use of FEGP, PCA, GPUs; and APUs.

5. Operators should ensure that their aircraft are kept in a configuration that requires the lowest practical power requirement when at the terminal.

6. MAXIMUM BENEFITS COME FROM USING GROUND-BASED FACILITIES EFFECTIVELY.

Key Messages 2 – Taxi with less than all engines operating

1. Operators should review their SOPs to investigate the feasibility of allowing taxiing with less than all engines operating. This technique should be promoted as long as all safety and procedural concerns can be met.

2. For some aircraft types, advice is available from manufacturers, and may be published in Flight Crew Operating Manuals (FCOMs) or equivalent. For types where there is no such information, it is recommended that manufacturers are involved in the development of engine-out taxi procedures.

3. Shutting down an engine during taxi operations should be planned in advance, and accomplished as early as possible during the taxi to obtain the maximum environmental benefits and reduction of fuel burn.

4. Reductions of 20% to 40% in ground level fuel burn and CO_2, and 10% to 30% in NO_X emissions may be realised, dependent on aircraft type, through the use of this technique.

5. MAXIMUM BENEFITS COME FROM ADVANCED PLANNING AND EARLY ACTION.

Key Messages 3 – Continuous Climb Operations (CCO)

1. CCO reduce aircraft fuel burn and emissions.

2. CCO do not amend aircraft separation standards or the procedures followed by pilots/ATC controllers in a traffic conflict or TCAS warning.

3. Coordination between ATC sectors can improve the provision of CCO.

4. CCO have a neutral or slightly positive overall effect on noise perceived at ground level.

5. EFFECTIVE AIRSPACE DESIGN IS REQUIRED TO DELIVER CONSISTENT CCO.

Key Messages 4 – Airport – Collaborative Decision Making (A-CDM)

1. A-CDM can reduce taxi times, fuel burn and emissions.

2. It is imperative that all stakeholders work in the spirit of co-operation, sharing and updating operational information in a timely manner.

3. A continuous process of improvement through ongoing feedback and review is an important component in realising the full benefits that A-CDM brings.

4. MAXIMUM BENEFITS DEPEND ON WORKING RESPONSIBLY TOGETHER IN ORDER TO PROVIDE ACCURATE, TIMELY OPERATIONAL INFORMATION.

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