Assessing the environmental impacts of aircraft noise

Dr Clyton Moyo (1), Mark Latimore (1), Belinda Fenner (1) and Paul Zissermann (1)

(1) Environment and Community Branch, Air Navigation Services Group, Airservices Australia, Canberra, Australia.

ABSTRACT

Aircraft noise is one of the most community-recognised environmental effects of aviation, with the potential to cause community annoyance and adverse effects on health. Airservices is required under the Commonwealth Environmental Protection and Biodiversity Conservation (EPBC) Act to assess the potential environmental significance of any 'actions' it takes including changes to air traffic management (ATM) practices. However, the EPBC Act does not prescribe any thresholds for potential environmental significance in relation to aircraft noise. Consequently, Airservices has developed its own internal criteria for the environmental impact assessment of proposed changes to aircraft operations, in order to determine if these impacts will be potentially significant (within the meaning of the EPBC Act) and if they will be potentially noticeable to local communities. The purpose of the criteria is to prescribe a standardised environmental impact assessment process for all changes to aircraft operations implemented by Airservices, and to inform Airservices community engagement process. This paper describes in detail Airservices current criteria for environmental significance in relation to proposed ATM changes.

1 INTRODUCTION

Aviation provides extensive economic and social benefits to Australia. However, aircraft noise is one of the unwanted by-products of aviation activities. Aircraft noise is known to cause community annoyance, disrupt sleep, adversely affect academic performance of children, and could increase the risk of cardiovascular disease of people living in the vicinity of airports (Basner et al, 2017). Data from Australia's Bureau of Infrastructure, Transport and Regional Economics (BITRE) show that over the past decade, the total number of aircraft movements in Australia has increased from 1,256,952 in the 2007-2008 financial year to 1,474,995 in the 2017-2018 financial year, a 17% increase (BITRE, 2019). This substantial rise in aircraft movements has resulted in increased exposure to aircraft noise, particularly on communities close to airports and underneath flight paths. This is despite reduced noise emissions from newer types of aircraft.

The most widespread subjective response to noise is annoyance, which may include fear and mild anger, relating to a belief that one is being avoidably harmed (Cohen and Weinstein, 1981). Noise is also seen as intrusive into personal privacy, which may be particularly important in urban settings. As a result of issues associated with aviation activities, environmental impact assessments of changes to aircraft operations are required to meet Airservices obligations under sections 28 and 160 of the Commonwealth Environmental Protection and Biodiversity Conservation (EPBC) Act, 1999.

2 THE EPBC ACT

Chapter 2, Part 3, Division 1 of the EPBC Act outlines the requirement for approval of activities with a significant impact on matters of national environmental significance (MNES). These include impacts on listed threatened species and ecological communities, migratory species protected under international agreements, Ramsar wetlands of international importance, as well as National and World Heritage Places.

As an Australian Commonwealth agency, Airservices is required (by section 28 of the EPBC Act) to assess the potential environmental significance of any 'actions' it takes – this is taken to include any changes to Airservices Air Traffic Management (ATM) practices. Section 160 of the EPBC Act also requires Airservices to consider the

Commonwealth Environment Minister's advice "before giving authorisation in relation to the adoption or implementation of a plan for aviation airspace management, involving aircraft operations that are likely to have a significant impact on the environment".

Changes to ATM practices may include a new, or amendment to an existing instrument approach or departure procedure, a flight path, an air route or re-classification of airspace. Other ATM changes may include a change to a preferred runway or a change in time of day of aircraft operation (eg. amendments to tower hours may alter the flight path used by an aircraft and when it is used); or a change that allows use of a flight path or airspace by a different type or number of aircraft. A tactical decision of an air traffic controller to alter the track of an individual aircraft does not constitute a proposed change to ATM practices.

3 ENVIRONMENTAL IMPACT ASSESSMENT CRITERIA

Airservices detailed environmental impact assessment process comprises of an assessment of the potential impacts of the proposed change on all values prescribed within the EPBC Act (including impacts on heritage issues, natural and physical resources, biodiversity and carbon emissions). There are currently no quantitative criteria prescribed by the Department of Environment and Energy (the Department) for determining the significance of aircraft noise impact. As such, each case is required to be assessed separately, and where appropriate referral made to seek advice from the responsible Commonwealth Minister. The referral decision can then be used as precedent to inform future decisions of similar impact or environment. The Commonwealth Environment Minister's primary role under the EPBC Act is to protect matters of national environmental significance (MNES), in accordance with the guiding principles of the EPBC Act.

Airservices has developed criteria for environmental impact assessment of changes to aircraft operations to determine if the noise impacts are potentially significant (under the EPBC Act), and if they are potentially noticeable to local communities. The criteria have evolved over time, with a number of reviews carried out as part of Airservices' continuous improvement process and changes in community expectations. The purpose of the criteria is to prescribe a standardised environmental impact assessment process for all changes to aircraft operations implemented by Airservices. The criteria factor in a precautionary approach, by calculating the number of movements based on the 90th percentile 'busy day' and recognising the particular sensitivities of night time noise, as well as paying due regard to background noise levels.

To identify potentially 'significant impact', trigger levels have been developed against a suite of metrics including the number of noise events above 60dB(A) and 70dB(A), as well as the change in the number of events, expressed as a percentage increase over the current state, or up to a total numbers of flights.

This paper describes in detail Airservices Referral Criteria for Environmental Impact Assessment of Changes to Aircraft Operations and their application to ATM changes in order to comply with the requirements of the EPBC Act. The criteria have been developed based on current experience, and on both Australian and international literature sources on best practice approaches to noise prediction and management.

3.1 Environmental impact assessment process

Effective environmental impact assessment of changes to ATM practices by Airservices involves identifying the potential environmental impacts associated with the proposed change (including noise, emissions and biodiversity impacts), to determine if the proposed change needs to be referred to the Commonwealth Environment Minister for advice.

The environmental impact assessment process also includes collating social analysis data related to the proposed change, to inform Airservices community engagement process. This may include impact assessment of the population and dwelling numbers that may be affected by the proposed change, and any potential impacts on sensitive receivers, such as schools and hospitals. The potential noise noticeability of the proposed change is also assessed to inform community engagement, however noticeability does not trigger Airservices thresholds for potential significance under the EPBC Act. The potential noticeability of noise and visual impacts is not described in detail in this paper.

Modelling of aircraft noise levels and developing noise contours is conducted using software packages such as the United States Federal Aviation Administration (US FAA) Aviation Environmental Design Tool (AEDT) or the

Integrated Noise Model (INM). A number of metrics used in the impact assessment process are described below. The significance thresholds for emissions are not described in this paper, as the focus is on aviation noise criteria.

4 METRICS

The calculation of aircraft noise levels may be based on one or more of a number of metrics depending on the magnitude of the change. Not all metrics are directly comparable and different metrics are often used for different classifications or types of noise, having varying characteristics. The commonly used metrics in assessing the environmental impacts of aircraft noise are described below.

4.1 LAmax

The LAmax is the maximum noise level from a single noise event which may be modelled or measured. LAmax is also reported graphically in 60dB(A) and 70dB(A) noise contours, representing the geographical area within which the maximum noise of a single over flight event is likely to be at or above these threshold levels.

For example, 70dB(A) is considered to be the external sound level below which no difficulty with reliable communication from radio, television or conversational speech is expected in a typical room with windows open (AS 2021, 2015); while 60dB(A) equates to the indoor design guide level of 50dB(A) specified in Australian Standard AS2021:2015 Acoustics – Aircraft noise intrusion – Building siting and construction for sleeping areas with windows open.

In circumstances where a proposed change in ATM practices results in an increase in aircraft noise levels, the impact is assessed by Airservices in accordance with published literature, as shown in Table 1 below.

Table 1: Subjective effect of changes in sound pressure level (Bies and Hansen, 1996).

Change in sound level (dB)	Change in power		Change in apparent loudness
	Decrease	Increase	
3	1/2	2	Just perceptible
5	1/3	3	Clearly noticeable
10	1/10	10	Half or twice as loud
20	1/100	100	Much quieter or louder

4.2 ‘Number above’ metrics

‘Number Above’ metrics (also known as ‘N Contours’ or Nxx events) are an aircraft noise characterisation mechanism used to map noise ‘zones’ around an airport or heliport. They show the number of noise events per day (or other time period), with LAmax levels above a specified value. These metrics are also useful in assessing the impact of a change in noise exposure, which may involve a change in the number of events exceeding a given noise level. The magnitude of the change can be expressed as the percentage change in N60, N70 or another relevant noise value.

4.3 LAeq

LAeq is the A-weighted equivalent continuous sound level in decibels, measured over a stated period of time. As Airservices noise impact assessment criteria have evolved over time, cumulative metrics such as LAeq (which were previously used as triggers for significance) are no longer considered as appropriately sensitive descriptors of community annoyance to changes in aircraft noise.

5 CASE STUDY

To help explain how Airservices significance criteria are applied to environmental impacts assessments of changes to ATM practices, a theoretical case study for the community of Whyalla (in South Australia) has been

created for this paper as an example. Note that the example case study is not associated with any current or proposed future flight paths.

In the hypothetical current situation, the Runway 17 arrival flight path tracks over the highy populated communities of Whyalla (flight paths shown in white lines in Figure 1). Due to noise concerns, the hypothetically impacted communities suggest a new flight path to move aircraft noise away from the highly populated areas. The hypothetical proposed new flight path tracks further north of the city over the steelworks industrial area, resulting in an increase in the tracking distance of 4NM. The hypothetical proposed new flight path has been chosen to limit the impact of noise on surrounding residential areas, but within the bounds of operational guidelines and safety standards. In this hypothetical study, there are currently 7,500 arrivals per year on the two runways at Whyalla Airport, split between Runway 17 (60%) and Runway 35 (40%). This includes arrivals by the large twin-engine turboprop aircraft, the SAAB 340, which carries out scheduled operations twice a week. A hypothetical case study was set up to show how Airservices impact assessment criteria are applied.

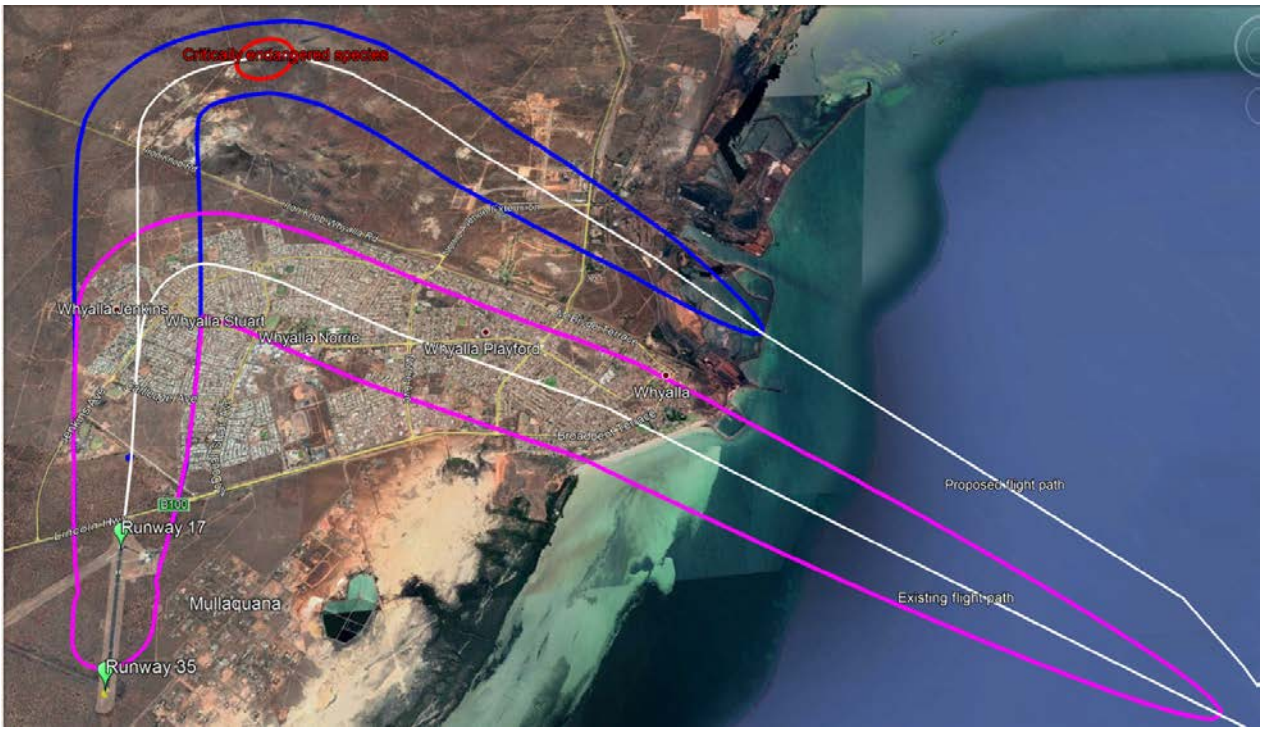

Figure 1: Modelled SAAB 340 LAmax 60dB(A) arrival noise contours for Runway 17 at Whyall Airport, for a hypothetical existing procedure (magenta) and a hypothetical proposed new procedure (blue). The associated existing and proposed hypothetical flight tracks are shown as white lines. The red circle shows a hypothetical habitat of a critically endangered species. (*Background image sourced from Google Earth, accessed 26 September 2019).*

The following process shows the steps that Airservices would take to assess the potential significance of any environmental impacts associated with this hypothetical change to aircraft operations. The first step is to determine aircraft noise levels associated with the proposed change. This may include LAmax or number above metrics. This is followed by identifying a sample of applicable Noise Sensitive Receivers (NSRs) as well as categorising areas impacted by the change as either ‘rural’ or ‘urban’ based on state, territory or local government land use zoning definitions. Finally, a comparison is made between the expected number of aircraft noise events arising from the change with the thresholds described in Table 2 and Table 3.

5.1 Calculation of the movement numbers

Aircraft movement numbers were calculated for the existing scenario and for the proposed change, for both day-time and night-time movements (if applicable). The 90th percentile 'busy day' movements were calculated using the most recent twelve months' aircraft movement data, and applied to the noisiest aircraft type (SAAB 340) affected by the proposed change, during 'day-time' and 'night-time' periods. Based on 60% arrivals to Runway 17, it was calculated that there were 4,500 arrivals or an average of 12 movements per day, with a 90th percentile 'busy day' number of 18 arrivals per day. For the purposes of this hypothetical environmental impact assessment, the noise profile and calculated number of movements were based on the SAAB 340, the noisiest aircraft type arriving to Runway 17.

5.2 Calculation of the noise levels

Noise levels were calculated for the existing hypothetical scenario and for the proposed change, for both daytime and night-time movements taking into account seasonal variations. These noise levels were used in conjunction with any change in movement numbers to determine if Airservices significance criteria were exceeded due to the percentage increase in the number of noise events for exposed communities.

Modelled LAmax contours for the current situation and for the proposed change are shown in Figure 1. Tables 2 and 3 below show Airservices criteria for assessing potentially significant aircraft noise impacts arising from proposed changes to ATM practices, to determine whether advice must be sought from the Commonwealth Environment Minister (in compliance with the EPBC Act). As per Airservices criteria, if the proposed number of aircraft movements associated with ≥ 60dB(A) noise events (as a result of the change) will be ≥10 per day, or N70 ≥5 per day (Table 2), then the threshold for potential significance is triggered if there is an increase of >20% in number of noise events above 60dB(A) or 70dB(A) (Table 3).

Based on Figure 1, and Tables 2 and 3 below, Airservices significance criteria will be not triggered by the proposed change, as there are no NSRs that will be exposed to any increase in Nxx events above 20% as shown in Table 3. As such, the hypothetical proposed change is not considered to be potentially significant by Airservices, and a referral to the Commonwealth Environment Minister is not required (in relation to noise impacts on communities). However, further environmental assessment will still be conducted to determine if the change in noise triggers the significance criteria in relation to other EPBC Act values such as potential impacts on heritage issues, natural and physical resources, biodiversity.

Table 2: Airservices noise thresholds for seeking advice under the EPBC Act – total number of aircraft noise events (Airservices, 2019).

Noise Metric	Total number of aircraft noise events
N70 (24 hr)	≥ 5
N60 (24 hr)	≥ 10
N60 (11pm – 6am[i])	≥ 2

Table 3: Airservices noise thresholds for seeking advice under the EPBC Act – increase in flight numbers (Airservices, 2019).

Noise Metric	% change from existing situation
N60, N70 (24 hr)	> 20%
N60, N70 (11pm – 6am)	> 2 flights or > 20% (whichever is larger)

5.3 Matters of National Environmental Significance (MNES)

The Commonwealth Protected Matters Search Tool is used to identify all Biodiversity Sensitive Receivers (BSRs) in the area of the proposed change. In this hypothetical example, a MNES (namely a population of a critically endangered species) was identified using the search tool. As per Airservices criteria for potentially significant impacts on BSRs (see Table 4, below), if the proposed number of aircraft movements associated with ≥ 60dB(A) noise events (as a result of the change) will be ≥10 per day, the threshold for potential significance is triggered if there is an increase of >20% in number of aircraft movements above 60dB(A).

As shown in Figure 1, a population of a critically endangered species was identified under the proposed new flight path. This population is not currently exposed to any overflights but under the new proposal, it may be exposed by up to 18 aircraft movements (noise events) above 60dB(A) on a typical 'busy day'. As such, the proposed change triggers Airservices criteria for potential significance under the EPBC Act, due to its potentially significant impact on a critically endangered species below the new flight path.

Table 4: Assessment of Potentially Significant Impacts on Biodiversity Sensitive Receivers (BSRs), as a result of proposed change to aircraft overflights (Airservices, 2019).

Trigger Criteria
Increase of >20% in number of aircraft movements above 60dB(A).
Increase of >20% in number of aircraft movements above 70dB(A).
Substantial increase in area of BSR in local area* exposed to noise ≥ 60dB(A).

* The 'local area' is considered to be a 10km zone either side of the nominal track of the proposed flight path/s.

5.4 Environmental assessment outcome

The proposed new flight path triggers Airservices threshold for potential environmental significance, due to its likely impact on a BSR. Under the Airservices environmental impact assessment process, all proposed changes that trigger the significance threshold should be avoided wherever practicable, through flight path redesign. Where this is not reasonably practicable, (due to safety or operational reasons), Airservices must refer the proposed change to the Commonwealth Environment Minister for advice, prior to implementing the change (in accordance with Sections 28 and 160 of the EPBC Act). In this hypothetical example, Airservices would most likely re-design the proposed new flight path to avoid both the highly-populated areas of Whyalla and the critically endangered species.

6 SUMMARY

Airservices environmental significance criteria provide a standardised and rigorous approach to assessing the potential environmental impacts of changes to aircraft operations, ensuring compliance with the EPBC Act and the provision of information for community consultation purposes. Potential environmental impacts are identified, assessed and appropriate recommendations made. The environmental impact assessment analyses the relevant values prescribed within the EPBC Act (including potential impacts on heritage issues, natural and physical resources, biodiversity and emissions), any of which could trigger Airservices criteria for potential significance. Airservices environmental significance criteria will continue to evolve based on the results of new research, international best practice and changing community expectations.

REFERENCES

Airservices 2019. National Operating Standard - Environmental Management of Changes to Aircraft Operations.

Australian Standard AS2021:2015. Acoustics—Aircraft noise intrusion—Building siting and construction.

Basner M, C Clark, A Hansell, J Hileman, S Janssen, K Shepherd, and V Sparrow. 2017. Aviation Noise Impacts: State of the Science.

Bies, D and C Hansen. 1996. Engineering noise control: theory and practice, 2nd ed., E & FN Spon, London.

BITRE 2019. https://www.bitre.gov.au/publications/ongoing/airport_traffic_data.aspx.

Cohen, S and N Weinstein. 1981. Nonauditory effects of noise on behavior and health. Journal of Social Issues, 37(1), 36-700.

Environment Protection and Biodiversity Conservation Act 1999 (Cth). https://www.legislation.gov.au/Series/C2004A00485.