

50 years of Annex 16 – the Special Meeting on Aircraft Noise in the Vicinity of Airports

By ICAO Secretariat

INTRODUCTION

In 1968, the 16th ICAO Assembly instructed the ICAO Council to establish international specifications and associated guidance material relating to aircraft noise; and to include, in appropriate existing Annexes and other relevant ICAO documents, and possibly in a separate Annex on aircraft noise, such material as the description and methods of measurement of aircraft noise and suitable limitations on the noise caused by aircraft that was of concern to communities in the vicinity of airports.

In the three years that followed, technical specifications were defined and a “Special Meeting on Aircraft Noise in the Vicinity of Aerodromes”, was convened (Montréal from 25 November to 17 September 1969¹). This new technical work led to the ICAO Council, in August 1971, adopting the first edition of Annex 16 – Aircraft Noise, the first environmental Standard to be applicable to new aeroplane designs.

This article describes the seminal importance of this Special Meeting to ICAO’s work on environmental aspects associated with international civil aviation, as well as major accomplishments during the past 50 years.

HISTORY OF THE SPECIAL MEETING ON AIRCRAFT NOISE IN THE VICINITY OF AERODROMES

The Special Meeting was attended by 161 representatives of 28 ICAO Contracting States, one non-contracting State and nine international organizations. The meeting considered the question of whether the Standards relating to the noise certification scheme should appear in a new and separate Annex to the Chicago Convention. After considering the applicability and limitations of the various existing Annexes, in particular Annexes 6 (Operation of Aircraft) and Annex 8 (Airworthiness of Aircraft), the meeting agreed that the noise certification Standards “should be issued in a new and separate Annex, which should deal exclusively with aircraft noise and which should therefore also include, to the extent practicable, related noise specifications and, as necessary, supplementary guidance dealing with other aspects of noise”. This agreement was captured under Recommendation 3/1 of the Special Meeting, which recommended the issuance of the new “Annex X” dealing exclusively with Aircraft Noise. This was the original recommendation underlying the establishment of Annex 16.

1 The report of the meeting can be found in ICAO Doc 8857.

ANNEX 16 AND THE SPECIAL MEETING RECOMMENDATIONS

Nine Recommendations from the Special Meeting referred to proposals for Standards and Recommended Practices. After review by the Air Navigation Commission and the Council, these proposals were structured to form the complete text of Annex 16, as follows:

- Part I - Definitions,
- Part II - Standards adopted as applicable to all subsonic jet aeroplanes of over 5 700 kg weight, except aeroplanes with short take-off and landing (STOL) capabilities,
- Parts III, IV and V - Recommended Practices and Guidance Material for use by States with a view to promoting uniformity in: measurement of noise for monitoring purposes; use of an international noise exposure reference unit for land-use planning, and establishment of noise abatement operating procedures,

- Appendixes 1, 2 and 3 - technical information, grouped separately for convenience,
- Attachments A, B and C - supplementary material and guidance.

The relationship between these sections of Annex 16 (1st Edition) and the Special Meeting Recommendations are provided in Table 1.

NOISE CERTIFICATION METRIC

One important issue that the Special Meeting considered was the noise metric to be used in aeroplane noise certification. There are three main factors that influence the human perception of a noisy event (such as an aeroplane overflight): the amplitude (or volume), the frequency content (high/low pitch), and the duration of the event. Therefore, the challenge faced by the Special Meeting was to define a metric that would capture these variables and represent appropriately the human response to the noise

TABLE 1: Annex 16 and the Special Meeting Recommendations

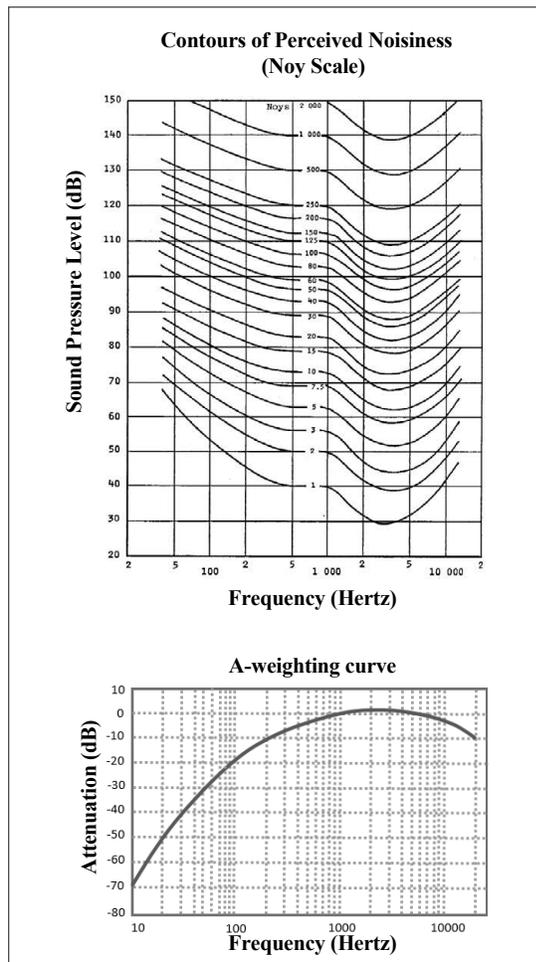
First Edition of Annex 16	Special Meeting Recommendations
Part I - Definitions	3/7 - Definitions
Part II - Aircraft Noise Certification	3/2 - Administrative Part of Annex "X" 3/6 - Technical part of Annex "X"
Part III - Noise Measurement for Monitoring Purposes	1/2 - Noise Measurement for Monitoring Purposes
Part IV - International. Noise Exposure Reference Unit for Land-Use Planning	1/4 - Adoption of an International Noise Exposure Reference Unit
Part V - Aircraft Noise Abatement Operating Procedures	4/1 - Guidance material Relating to Safety considerations in the Establishment of Aircraft Noise Abatement Operating Procedures
Appendix 1 - Noise Evaluation Method for Aeroplane Noise Certification	3/6 - Technical part of Annex "X" 1/1 Noise Measurement for Aircraft Design Purposes
Appendix 2 - Monitoring Aircraft Noise on and in the Vicinity of Aerodromes	1/2 - Noise Measurement for Monitoring Purposes
Appendix 3 - Total Noise Exposure Level (TNEL) Produced by a Succession of Aircraft	1/4 - Adoption of an International Noise Exposure Reference Unit
Attachment A - Approximate Methods For Determining Effective Perceived Noise Level (EPNL)	5/1 - Guidance Material for Approximating EPNL from measurements
Attachment B - Suggested Methods for Weighting Total Noise Exposure Levels for Daily and Seasonal Factors (referenced in Appendix 3)	2/2 - Weighting Factors for Use with the International Noise Exposure Reference Unit
Attachment C - Guidance Material Relating to Safety Considerations in the Establishment of Aircraft Noise Abatement Operating Procedures	4/1 - Guidance material Relating to Safety considerations in the Establishment of Aircraft Noise Abatement Operating Procedures

from one aeroplane overflight. Since the main objective of the certification Standards is to compare technology levels of different designs, the Special Meeting agreed that the noise metric to be used should have maximum accuracy and validity in representing the human response to noise.

The Special Meeting considered the use of existing noise metrics at the time, however it was agreed that traditional noise metrics lacked the precision required for aeroplane noise certification. As a consequence, a new noise metric was proposed, the EPNL (Effective Perceived Noise Level), which takes into account all the physical variables associated with human perception of aeroplane noise: the different response to sounds of different frequencies and intensities, the presence of predominant irregularities in the frequency spectrum (“pure tones”), and the duration of the event.

Traditional noise metrics such as the A-weighted noise level (dB(A)) are based on the addition of an attenuation factor to the measured sound pressure levels, in an attempt to represent the variable sensitivity of the human ear to sounds of different frequencies. However, the dB(A) representation of the human ear includes some simplifications to facilitate its electronic implementation in sound metering devices. On the other hand, the EPNL correlates sound pressure levels with perceived noisiness by means of the Noy Scale, which provides a more accurate representation of the human sensitivity to noise. Figure 1 below illustrates how the dB(A) and the Noy scale represents the variability of human ear sensitivity to frequency. It can be seen that the Noy Scale (on the top) presents a much more refined representation of the human ear response.

FIGURE 1: Noy Scale and A-weighting curve
(sources: Annex 16 First edition / IEC 61672)



LAND USE PLANNING AND OPERATING PROCEDURES

In Parts III, IV and V, the first edition of Annex 16 already included Recommendations on land use planning and operating procedures for the mitigation of aircraft noise impacts. Many years later, in 2001 the ICAO Assembly included these elements as two of the pillars of the “ICAO Balanced Approach to Aircraft Noise Management”; the main overarching ICAO policy on aircraft noise, which contains details on all the elements that can be employed to achieve noise reductions. The Balanced Approach is described in detail in ICAO Doc 9829.

OTHER OUTCOMES FROM THE SPECIAL MEETING

The Special Meeting recommended the establishment of an appropriate body to examine additional aspects that could not be fully dealt with during the Meeting, such as development of noise certification Standards for other classes of aircraft such as supersonics and light aircraft. As a response to this recommendation, the Council agreed to establish the Committee on Aircraft Noise (CAN) to work on these tasks.

Several years later, the same concept was used by the ICAO Council with the creation of the Committee on Aircraft Engine Emissions (CAEE), which developed the first

edition of Annex 16, Volume II – Aircraft Engine Emissions, resulting in an expanded scope of environmental impacts addressed by Annex 16.

As many measures taken to mitigate aircraft noise could have implications on engine emissions, the interdependencies between noise and emissions needed to be properly considered. As a consequence, in 1983 the Council agreed to merge CAN and CAEE into a single committee, the Committee on Aviation Environmental Protection (CAEP), which to date is the main technical body assisting the Council in formulating new policies and adopting new Standards and Recommended Practices (SARPs) related to aviation environmental impacts.

Some elements of the Terms of Reference adopted for CAEP can also be traced back to the Special Meeting conclusions: when discussing the noise limits to be included as part of Annex 16 Standards, the Special Meeting agreed that the prescribed maximum noise levels would be limited by what is “technically feasible and economic reasonable”. In line with that, the CAEP Terms of Reference state that the CAEP work shall take into account the “effectiveness and reliability of certification schemes from the viewpoint of technical feasibility, economic reasonableness and environmental benefit to be achieved”, as well as the interdependencies between measures. This conclusion of the Special Meeting had therefore a paramount importance, laying down the basis of ICAO action on environmental matters for the next 50 years.

EVOLUTION OF ANNEX 16

In these five decades, Annex 16 has been subject to several changes and SARPs have been incorporated that are associated with other environmental impacts associated with aviation, such as local air quality and climate change.

Specifically on noise, the scope of Annex 16 was expanded to encompass helicopters, light aeroplanes, supersonics (with Type Certification submitted before 1 January 1975) and tiltrotors. Regarding Emissions, Annex 16, Volume II now addresses the various pollutants emitted by aircraft engines, such as NO_x, HC, CO, and non-volatile particulate matters (nvPM). On climate change, Annex 16, Volume III was adopted to cover aeroplane CO₂ emissions, and

the more recent Annex 16, Volume IV is dedicated to the Carbon Offsetting and Reduction Scheme for International Aviation (CORSA).

A brief overview of this evolution is provided in Table 2.

CONCLUSIONS

ICAO has been successfully addressing the environmental impacts associated with international civil aviation, with the important contribution of the environmental Standards laid out in Annex 16 to the Chicago Convention. In this regard, the importance cannot be understated of the “Special Meeting on Aircraft Noise in the Vicinity of Airports”, which was convened 50 years ago, in setting the initial direction for ICAO work on environmental matters. Nor can the crucial work that has taken place since then in developing the completed suite of ICAO environmental SARPs on aircraft noise and emissions.

Moving into the future, new innovative technologies and energy sources for aviation are under development at a fast pace, and much work by ICAO will be required to keep pace with the timely environmental certification of such new technologies, as appropriate. Therefore, Annex 16 SARPs will continue to be of fundamental importance to consolidate ICAO Policies on environment for many more years to come.

TABLE 2: Evolution of Annex 16

Meeting	Year	Key recommendation on Annex 16 SARPs
Special Meeting on Aircraft Noise in the vicinity of airports	1969	First Edition of Annex 16 – Aircraft Noise
CAN2	1972	Noise Standards for light aeroplanes
CAN6	1980	Noise Standards for helicopters and supersonics with Type Certification submitted before 1 January 1975
CAEE2	1981	First Edition of Annex 16, Volume II - Aircraft Engine Emissions
CAEP1	1986	Noise Standards for light propellers
CAEP2	1991	Noise Standards for light helicopters
CAEP2	1991	Increase in Stringency of NO _x Emissions
CAEP4	1998	Increase in Stringency of NO _x Emissions
CAEP5	2001	Increase in stringency for turbojet and heavy-propeller noise Standards (Chapter 4)
CAEP6	2004	Increase in Stringency of NO _x Emissions
CAEP8	2010	Increase in Stringency of NO _x Emissions
CAEP9	2013	Increase in stringency for turbojet and heavy-propeller noise Standards (Chapter 14) Noise Standards for Tiltrotors (Chapter 13)
CAEP10	2016	nvPM engine emissions Standard
CAEP10	2016	First Edition of Annex 16, Volume III - Aeroplane CO₂ Emissions
CAEP Steering Group	2017	First Edition of Annex 16, Volume IV (CORSA)
CAEP11	2019	nvPM mass and number emission Standard

Legend:

Noise	Local Air Quality	Climate Change
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