



ICAO

International Standards
and Recommended Practices

Annex 16 to the Convention on International Civil Aviation

Environmental Protection

Volume I — Aircraft Noise
Eighth Edition, July 2017



This edition supersedes, on 1 January 2018, all previous editions of Annex 16, Volume I.

For information regarding the applicability of the Standards and Recommended Practices, see the Foreword.

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Published in separate English, Arabic, Chinese, French, Russian
and Spanish editions by the
INTERNATIONAL CIVIL AVIATION ORGANIZATION
999 Robert-Bourassa Boulevard, Montréal, Quebec, Canada H3C 5H7

For ordering information and for a complete listing of sales agents
and booksellers, please go to the ICAO website at www.icao.int.

First edition 1981
Seventh edition 2014
Eighth edition 2017

Annex 16 — Environmental Protection
Volume I — Aircraft Noise

Order Number: AN16-1
ISBN 978-92-9258-260-9

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AMENDMENTS

Amendments are announced in the supplements to the *Products and Services Catalogue*; the Catalogue and its supplements are available on the ICAO website at www.icao.int. The space below is provided to keep a record of such amendments.

RECORD OF AMENDMENTS AND CORRIGENDA

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Document ID: 123456789

FOREWORD

Historical background

Standards and Recommended Practices for Aircraft Noise were first adopted by the Council on 2 April 1971 pursuant to the provisions of Article 37 of the Convention on International Civil Aviation (Chicago, 1944) and designated as Annex 16 to the Convention. The Annex was developed in the following manner:

The Sixteenth Session of the Assembly, Buenos Aires, September 1968, adopted the following Resolution:

A16-3: Aircraft Noise in the Vicinity of Airports

Whereas the problem of aircraft noise is so serious in the vicinity of many of the world's airports that public reaction is mounting to a degree that gives cause for great concern and requires urgent solution;

Whereas the noise that concerns the public and civil aviation today is being caused by increase in traffic of existing aircraft;

Whereas the introduction of future aircraft types could increase and aggravate this noise unless action is taken to alleviate the situation;

Whereas the Fifth Air Navigation Conference of ICAO held in Montreal in November 1967 made certain recommendations, based on the principal conclusions of the International Conference on the Reduction of Noise and Disturbance Caused by Civil Aircraft ("The London Noise Conference") held in London in November 1966, with the object of reaching international solutions to the problem through the machinery of ICAO; and

Whereas the Assembly has noted the action being taken by the Council, in consultation with States and the appropriate international organizations, to give effect to the recommendations of the Fifth Air Navigation Conference, as reported to the Assembly by the Secretary General;

THE ASSEMBLY RESOLVES to instruct the Council:

- 1) to call an international conference within the machinery of ICAO as soon as practicable, bearing in mind the need for adequate preparation, to consider the problem of aircraft noise in the vicinity of airports;
- 2) to establish international specifications and associated guidance material relating to aircraft noise;
- 3) to include, in appropriate existing Annexes and other relevant ICAO documents and possibly in a separate Annex on noise, such material as the description and methods of measurement of aircraft noise and suitable limitations on the noise caused by aircraft that is of concern to communities in the vicinity of airports; and
- 4) to publish such material on a progressive basis, commencing at the earliest possible time.

In response to Assembly Resolution A16-3, a Special Meeting on Aircraft Noise in the Vicinity of Aerodromes was convened in Montréal (November–December 1969) to examine the following aspects related to the problems of aircraft noise:

- a) procedures for describing and measuring aircraft noise;
- b) human tolerance to aircraft noise;
- c) aircraft noise certification;

- d) criteria for establishment of aircraft noise abatement operating procedures;
- e) land-use control; and
- f) ground run-up noise abatement procedures.

Based on the recommendations of the Special Meeting on Aircraft Noise in the Vicinity of Aerodromes, draft International Standards and Recommended Practices for Aircraft Noise were developed and, after amendment following the usual consultation with the Contracting States of the Organization, were adopted by the Council to form the text of this Annex.

With the development of Standards and Recommended Practices dealing with the control of aircraft engine emissions, it was felt that all provisions relating to environmental aspects of aviation should be included in a single document. Accordingly, as part of the Resolution adopting Amendment 5, it was agreed that Annex 16 should be retitled as “Environmental Protection” and Volume I of the Annex should contain the existing provisions (Third Edition) of Annex 16 — *Aircraft Noise* as amended by Amendment 5, and Volume II should contain the provisions related to aircraft engine emissions.

Several Assembly and Council sessions have addressed the issue of aircraft noise since the Special Meeting on Aircraft Noise in the Vicinity of Aerodromes, focusing on the various aspects related to the problems of aircraft noise identified at the Special Meeting. The Thirty-third Session of the Assembly, Montréal, 25 September to 5 October 2001, in Resolution A33-7, issued a Consolidated Statement of Continuing ICAO Policies and Practices Related to Environmental Protection to, in significant part, “incorporate new ICAO policies and guidance material regarding aircraft noise” and to reflect the concept of a “balanced approach” to noise management, which had developed over time.

As defined in Appendix C to Assembly Resolution A33-7, the balanced approach to noise management consists of identifying the noise problem at an airport and then analysing the various measures available to reduce noise through the exploration of four principal elements, namely reduction at source, land-use planning and management, noise abatement operational procedures and operating restrictions, with the goal of addressing the noise problem in the most cost-effective manner.

In addition to providing additional detail on the balanced approach concept, Assembly Resolution A33-7 urges States to adopt a balanced approach to noise management.

The principal elements of the balanced approach are addressed in various places in Annex 16, Volume I, and in guidance adopted by ICAO. Reduction of noise at source through aircraft noise certification is addressed in Annex 16, Volume I, Part II. References to the other elements of the balanced approach are contained in Part V.

Table A shows the origin of amendments to the Annex over time together with a list of the principal subjects involved and the dates on which the Annex and the amendments were adopted by the Council, when they became effective and when they became applicable.

Applicability

Part I of Volume I of Annex 16 contains definitions and Part II contains Standards, Recommended Practices and guidelines for noise certification applicable to the classification of aircraft specified in individual chapters of that part, where such aircraft are engaged in international air navigation.

Note.— Chapters 2, 3, 4, 5 and 14 exclude aeroplanes having short take-off and landing (STOL) capabilities which, pending the development by ICAO of a suitable definition, are described for the purpose of this Annex as those requiring a runway (with no stopway or clearway) of 610 m or less at the maximum certificated mass for airworthiness.

Parts III, IV and V of Volume I of Annex 16 contain Standards and Recommended Practices and guidance material for use by States with a view to promoting uniformity in measurement of noise for monitoring purposes, assessing noise around airports, and regarding the balanced approach to noise management.

Action by Contracting States

Notification of differences. The attention of Contracting States is drawn to the obligation imposed by Article 38 of the Convention by which Contracting States are required to notify the Organization of any differences between their national regulations and practices and the International Standards contained in this Annex and any amendments thereto. Contracting States are invited to extend such notification to any differences from the Recommended Practices contained in this Annex, and any amendments thereto, when the notification of such differences is important for the safety of air navigation. Further, Contracting States are invited to keep the Organization currently informed of any differences which may subsequently occur, or of the withdrawal of any differences previously notified. A specific request for notification of differences will be sent to Contracting States immediately after the adoption of each amendment to this Annex.

The attention of States is also drawn to the provisions of Annex 15 related to the publication of differences between their national regulations and practices and the related ICAO Standards and Recommended Practices through the Aeronautical Information Service, in addition to the obligation of States under Article 38 of the Convention.

Use of the Annex text in national regulations. The Council, on 13 April 1948, adopted a resolution inviting the attention of Contracting States to the desirability of using in their own national regulations, as far as is practicable, the precise language of those ICAO Standards that are of a regulatory character and also of indicating departures from the Standards, including any additional national regulations that were important for the safety or regularity of international air navigation. Wherever possible, the provisions of this Annex have been written in such a way as to facilitate incorporation, without major textual changes, into national legislation.

Status of Annex components

An Annex is made up of the following component parts, not all of which, however, are necessarily found in every Annex; they have the status indicated:

1.— *Material comprising the Annex proper:*

- a) *Standards and Recommended Practices* adopted by the Council under the provisions of the Convention. They are defined as follows:

Standard: Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as necessary for the safety or regularity of international air navigation and to which Contracting States will conform in accordance with the Convention; in the event of impossibility of compliance, notification to the Council is compulsory under Article 38.

Recommended Practice: Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as desirable in the interest of safety, regularity or efficiency of international air navigation, and to which Contracting States will endeavour to conform in accordance with the Convention.

- b) *Appendices* comprising material grouped separately for convenience but forming part of the Standards and Recommended Practices adopted by the Council.
- c) *Provisions* governing the applicability of the Standards and Recommended Practices.

- d) *Definitions* of terms used in the Standards and Recommended Practices which are not self-explanatory in that they do not have accepted dictionary meanings. A definition does not have an independent status but is an essential part of each Standard and Recommended Practice in which the term is used, since a change in the meaning of the term would affect the specification.
- e) *Tables and Figures* which add to or illustrate a Standard or Recommended Practice and which are referred to therein, form part of the associated Standard or Recommended Practice and have the same status.

2.— *Material approved by the Council for publication in association with the Standards and Recommended Practices:*

- a) *Forewords* comprising historical and explanatory material based on the action of the Council and including an explanation of the obligations of States with regard to the application of the Standards and Recommended Practices ensuing from the Convention and the Resolution of Adoption.
- b) *Introductions* comprising explanatory material introduced at the beginning of parts, chapters or sections of the Annex to assist in the understanding of the application of the text.
- c) *Notes* included in the text, where appropriate, to give factual information or references bearing on the Standards or Recommended Practices in question, but not constituting part of the Standards or Recommended Practices.
- d) *Attachments* comprising material supplementary to the Standards and Recommended Practices, or included as a guide to their application.

Selection of language

This Annex has been adopted in six languages — English, Arabic, Chinese, French, Russian and Spanish. Each Contracting State is requested to select one of those texts for the purpose of national implementation and for other effects provided for in the Convention, either through direct use or through translation into its own national language, and to notify the Organization accordingly.

Editorial practices

The following practice has been adhered to in order to indicate at a glance the status of each statement: *Standards* have been printed in light face roman; *Recommended Practices* have been printed in light face italics, the status being indicated by the prefix **Recommendation**; *Notes* have been printed in light italics, the status being indicated by the prefix *Note*.

It is to be noted that in the English text the following practice has been adhered to when writing the specifications: Standards employ the operative verb “shall” while Recommended Practices employ the operative verb “should”.

The units of measurement used in this document are in accordance with the International System of Units (SI) as specified in Annex 5 to the Convention on International Civil Aviation. Where Annex 5 permits the use of non-SI alternative units these are shown in parentheses following the basic units. Where two sets of units are quoted it must not be assumed that the pairs of values are equal and interchangeable. It may, however, be inferred that an equivalent level of safety is achieved when either set of units is used exclusively.

Any reference to a portion of this document which is identified by a number includes all subdivisions of that portion.

Coordination with ISO activity

In the provisions related to certification procedures, extensive use is made of the related specifications developed by the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC). In most cases these specifications have been incorporated by direct reference. However, in some cases it has been found necessary to modify the specifications to suit ICAO requirements and in such cases the modified material is included in full in this document. The assistance provided by ISO in the development of detailed specifications is recognized.

Table A. Amendments to Annex 16

Amendment	Source(s)	Subject(s)	Adopted Effective Applicable
1st Edition	Special Meeting on Aircraft Noise in the Vicinity of Aerodromes (1969)		2 April 1971 2 August 1971 6 January 1972
1	First Meeting of the Committee on Aircraft Noise	Noise certification of future production and derived versions of subsonic jet aeroplanes and updating of terminology used to describe aircraft weight.	6 December 1972 6 April 1973 16 August 1973
2	Third Meeting of the Committee on Aircraft Noise	Noise certification of light propeller-driven aeroplanes and subsonic jet aeroplanes of 5 700 kg and less maximum certificated take-off weight and guidance on discharge of functions by States in the cases of lease, charter and interchange of aircraft.	3 April 1974 3 August 1974 27 February 1975
3 (2nd Edition)	Fourth Meeting of the Committee on Aircraft Noise	Noise certification Standards for future subsonic jet aeroplanes and propeller-driven aeroplanes, other than STOL aeroplanes, and guidelines for noise certification of future supersonic aeroplanes, propeller-driven STOL aeroplanes and installed APUs and associated aircraft systems when operating on the ground.	21 June 1976 21 October 1976 6 October 1977
4 (3rd Edition)	Fifth Meeting of the Committee on Aircraft Noise	Introduction of a new parameter viz, number of engines in the noise certification Standards for subsonic jet aeroplanes, improvements in detailed test procedures to ensure that the same level of technology is applied to all types of aircraft, and editorial changes to simplify the language and eliminate inconsistencies.	6 March 1978 6 July 1978 10 August 1978
5 (Annex 16, Volume I — 1st Edition)	Sixth Meeting of the Committee on Aircraft Noise	<ol style="list-style-type: none"> Annex retitled <i>Environmental Protection</i> and to be issued in two volumes as follows: Volume I — <i>Aircraft Noise</i> (incorporating provisions in the third edition of Annex 16 as amended by Amendment 5) and Volume II — <i>Aircraft Engine Emissions</i>. Introduction in Volume I of noise certification Standards for helicopters and for future production of existing SST aeroplanes, updating of guidelines for noise certification of installed APU and associated aircraft systems and editorial amendments including changes to units of measurement to bring the Annex in line with Annex 5 provisions. 	11 May 1981 11 September 1981 26 November 1981
1	Third Meeting of the Operations Panel	Introduction of SARPs for noise abatement operating procedures and transfer of detailed procedures to PANS-OPS, Volume I.	30 March 1983 29 July 1983 24 November 1983
2	Seventh Meeting of the Committee on Aircraft Noise	<ol style="list-style-type: none"> improvements in the noise certification procedures; and relaxation of maximum noise limits for helicopters. 	6 March 1985 29 July 1985 21 November 1985

<i>Amendment</i>	<i>Source(s)</i>	<i>Subject(s)</i>	<i>Adopted Effective Applicable</i>
3 (Annex 16, Volume I — 2nd Edition)	First Meeting of the Committee on Aviation Environmental Protection; study by the Air Navigation Commission following a recommendation of the Obstacle Clearance Panel	a) further improvements in the noise certification procedures; b) introduction of a new Chapter 10 for propeller-driven aeroplanes not exceeding 9 000 kg maximum certificated take-off mass; and c) editorial changes in Part V cross-referencing the relevant provisions in the PANS-OPS (Doc 8168).	4 March 1988 31 July 1988 17 November 1988
4 (3rd Edition)	Second Meeting of the Committee on Aviation Environmental Protection; Seventh Meeting of the Committee on Aircraft Noise; and Fifth Meeting of the Operations Panel	a) improvements in the noise certification procedures; b) introduction of a new Chapter 11 for light helicopters; c) expansion of Appendix 2 to include helicopters and replacement of Appendix 4; and d) introduction of guidance on applicability.	24 March 1993 26 July 1993 11 November 1993
5	Third Meeting of the Committee on Aviation Environmental Protection	a) simplification and clarification of the noise certification schemes in Chapter 3 for propeller-driven aircraft; b) harmonization of the helicopter Standards in Chapters 8 and 11 with national codes; and c) alignment of the take-off mass in Chapter 10 with airworthiness limits.	19 March 1997 21 July 1997 6 November 1997
6	Fourth Meeting of the Committee on Aviation Environmental Protection	a) introduction of a new definition for human performance in Chapter 1; b) increase in stringency of Chapter 10 noise requirements for light single-engine propeller-driven aeroplanes; c) changes of a detailed technical nature that are intended to improve the consistency of Chapters 3, 8 and 11 as well as Appendices 2 and 4; d) new provisions concerning Human Factors in Part V; and e) changes that have arisen from the ongoing harmonization of the European Joint Aviation Requirements (JARs) and the United States Federal Aviation Regulations (FARs).	26 February 1999 19 July 1999 4 November 1999
7	Fifth Meeting of the Committee on Aviation Environmental Protection; Annex 6, Amendment 26	a) increase in stringency of the turbojet and heavy propeller-driven aeroplane noise requirements (new Chapter 4 — existing Chapter 4 becomes Chapter 12); b) new provision relating to the recertification of Chapter 3 aeroplanes; c) increase in stringency of the helicopter noise requirements of Chapters 8 and 11; d) change to clarify or redefine existing certification procedures, align with harmonized JAR/FAR requirements, introduce new provisions relating to digital instrumentation; e) introduction of guidance material on tilt-rotor aircraft noise certification; and f) inclusion of an English language version of the noise certification documents.	29 June 2001 29 October 2001 21 March 2002

Amendment	Source(s)	Subject(s)	Adopted Effective Applicable
8 (4th Edition)	Sixth Meeting of the Committee on Aviation Environmental Protection	<ul style="list-style-type: none"> a) ambient noise correction procedure including definitions for “background noise”, “ambient noise” and “broadband noise”; b) allowable wind speed limits during testing; c) applicability language clarification including temporary changes in type design and provisions to allow the recertification of Chapter 5 aeroplanes to Chapter 4; d) rotorcraft-related technical issues; and e) new Attachments G and H containing guidelines for the administration of noise certification documentation and guidelines for obtaining helicopter noise data for land-use planning purposes, respectively. 	23 February 2005 11 July 2005 24 November 2005
9 (5th Edition)	Seventh Meeting of the Committee on Aviation Environmental Protection	<ul style="list-style-type: none"> a) introduction of new text to Attachment H containing guidelines for obtaining helicopter noise data for land-use planning purposes by providing the option for additional microphone positions; b) change to Note 2 of the definition of “derived version of a helicopter” to clarify that it applies to Chapter 11 as well as Chapter 8 helicopters; c) noise certification procedures for helicopters amended to ensure that the maximum operational rotor speed will be used; d) clarification of the definitions relating to wind speeds during tests; e) update of the International Electrotechnical Commission (IEC) references; f) clarification regarding the increment to be added to the V_2 speed to determine the climb speed to be used during certification training; g) amendment of the applicability provisions to align them with similar provisions in other ICAO documents; and h) minor editorial changes. 	7 March 2008 20 July 2008 20 November 2008
10 (6th Edition)	Eighth meeting of the Committee on Aviation Environmental Protection (CAEP/8); Secretariat with the assistance of the Aerodrome Meteorological Observation and Forecast Study Group (AMOFSG)	<ul style="list-style-type: none"> a) amendments to applicability provisions in order to remove unnecessary complexity, repetition and redundancy in the text while improving clarity and harmonization amongst different chapters; b) an update to the references to the <i>Environmental Technical Manual</i> (Doc 9501), Volume I — <i>Procedures for the Noise Certification of Aircraft</i>; c) new text in Chapter 3 to clarify noise certification take-off reference speed for cases where airworthiness certification take-off speed is not specified; d) improved readability and clarification of previously vague or incomplete guidance including the calculation of effective perceived noise level (EPNL), the adjustment of aircraft noise data to reference conditions using the simplified and integrated methods, measurement and characterization of atmospheric sound attenuation, and miscellaneous technical issues and editorial errors; 	4 March 2011 18 July 2011 17 November 2011

Amendment	Source(s)	Subject(s)	Adopted Effective Applicable
		<ul style="list-style-type: none"> e) harmonization of language for noise certification procedures of tilt-rotors with that of helicopters already adopted in Chapters 8 and 11 of Annex 16, Volume I, in order to clarify that the maximum rotor revolutions per minute (RPM) corresponding with the reference flight condition shall be used; f) clarification that the maximum noise levels applicable to subsonic jet aeroplanes may be used as a guideline for supersonic aeroplanes; g) consequential amendment arising from Amendment 17 to Annex 5 replacing “km/h” by “m/s” as the SI unit to measure wind speed; and h) minor editorial changes. 	
11-A	Twelfth meeting of the Operations Panel Working Group of the Whole (OPSP/WG/WHL/12)	Amendment concerning the development of aircraft operating procedures for noise abatement.	3 March 2014 14 July 2014 13 November 2014
11-B (7th Edition)	Ninth meeting of the Committee on Aviation Environmental Protection (CAEP/9)	<ul style="list-style-type: none"> a) increase in stringency of the turbojet and heavy propeller-driven aeroplane noise requirements, applicable to aeroplanes for which the application for a Type Certificate was submitted on or after 31 December 2017, and on or after 31 December 2020 for aeroplanes less than 55 000 kg in mass (new Chapter 14); b) introduction of noise certification requirements for tilt-rotors, applicable to aircraft for which the application for a Type Certificate was submitted on or after 1 January 2018 (new Chapter 13 — existing Attachment F guidance material remains for reference purposes); c) harmonization of sections on noise data validity and the scheduling of sound pressure level calibrations, and with regard to updating the specifications in the light of advances in audio recording technology; d) correction to the wind speed values given in m/s used for the definition of the noise certification test window; e) upgrade of the language in the title of Attachment A, and associated consequential amendments to equations for the calculation of maximum permitted noise levels as a function of take-off mass (i.e. including maximum permitted); and f) minor editorial changes to nomenclature, symbols and units. 	3 March 2014 14 July 2014 1 January 2015
12 (8th Edition)	Tenth meeting of the Committee on Aviation Environmental Protection (CAEP/10)	<ul style="list-style-type: none"> a) harmonization of language used to define the reference atmosphere; b) removal of references to outdated flight path measurement techniques; c) corrections to guidelines for noise certification of tilt-rotors; and d) correction of miscellaneous technical editorial issues and an amalgamation of all symbols and units into one section. 	3 March 2017 21 July 2017 1 January 2018

INTERNATIONAL STANDARDS AND RECOMMENDED PRACTICES

PART I. DEFINITIONS, NOMENCLATURE: SYMBOLS AND UNITS

Aeroplane. A power-driven heavier-than-air aircraft, deriving its lift in flight chiefly from aerodynamic reactions on surfaces which remain fixed under given conditions of flight.

Aircraft. Any machine that can derive support in the atmosphere from the reactions of the air other than the reactions of the air against the earth's surface.

Associated aircraft systems. Those aircraft systems drawing electrical/pneumatic power from an auxiliary power unit during ground operations.

Auxiliary power unit (APU). A self-contained power unit on an aircraft providing electrical/pneumatic power to aircraft systems during ground operations or in flight, separate from the propulsion engine(s).

Bypass ratio. The ratio of the air mass flow through the bypass ducts of a gas turbine engine to the air mass flow through the combustion chambers calculated at maximum thrust when the engine is stationary in an international standard atmosphere at sea level.

Derived version of a helicopter. A helicopter which, from the point of view of airworthiness, is similar to the noise certificated prototype but incorporates changes in type design which may affect its noise characteristics adversely.

Note 1.— In applying the Standards of this Annex, a helicopter that is based on an existing prototype but which is considered by the certifying authority to be a new type design for airworthiness purposes shall nevertheless be considered as a derived version if the noise source characteristics are judged by the certifying authority to be the same as the prototype.

Note 2.— “Adversely” refers to an increase of more than 0.30 EPNdB in any one of the noise certification levels for helicopters certificated according to Chapter 8 and 0.30 dB(A) in the certification level for helicopters certificated according to Chapter 11.

Derived version of an aeroplane. An aeroplane which, from the point of view of airworthiness, is similar to the noise certificated prototype but incorporates changes in type design which may affect its noise characteristics adversely.

Note 1.— Where the certifying authority finds that the proposed change in design, configuration, power or mass is so extensive that a substantially new investigation of compliance with the applicable airworthiness regulations is required, the aeroplane should be considered to be a new type design rather than a derived version.

Note 2.— “Adversely” refers to an increase of more than 0.10 dB in any one of the noise certification levels unless the cumulative effects of changes in type design are tracked by an approved procedure in which case “adversely” refers to a cumulative increase in the noise level in any one of the noise certification levels of more than 0.30 dB or the margin of compliance, whichever is smaller.

External equipment (helicopter). Any instrument, mechanism, part, apparatus, appurtenance, or accessory that is attached to or extends from the helicopter exterior but is not used nor is intended to be used for operating or controlling a helicopter in flight and is not part of an airframe or engine.

Helicopter. A heavier-than-air aircraft supported in flight chiefly by the reactions of the air on one or more power-driven rotors on substantially vertical axes.

Human performance. Human capabilities and limitations which have an impact on the safety and efficiency of aeronautical operations.

Powered-lift. A heavier-than-air aircraft capable of vertical take-off, vertical landing, and low-speed flight, which depends principally on engine-driven lift devices or engine thrust for the lift during these flight regimes and on non-rotating aerofoil(s) for lift during horizontal flight.

Recertification. Certification of an aircraft with or without a revision to its certification noise levels, to a Standard different to that to which it was originally certificated.

Self-sustaining powered sailplane. A powered aeroplane with available engine power which allows it to maintain level flight but not to take off under its own power.

State of Design. The State having jurisdiction over the organization responsible for the type design.

State of Registry. The State on whose register the aircraft is entered.

Subsonic aeroplane. An aeroplane incapable of sustaining level flight at speeds exceeding flight Mach number of 1.

Tilt-rotor. A powered-lift capable of vertical take-off, vertical landing, and sustained low-speed flight, which depends principally on engine-driven rotors mounted on tiltable nacelles for the lift during these flight regimes and on non-rotating aerofoil(s) for lift during high-speed flight.

Type Certificate. A document issued by a Contracting State to define the design of an aircraft, engine or propeller type and to certify that this design meets the appropriate airworthiness requirements of that State.

Note.— In some Contracting States a document equivalent to a Type Certificate may be issued for an engine or propeller type.

NOMENCLATURE: SYMBOLS AND UNITS

Note.— Many of the following definitions and symbols are specific to aircraft noise certification. Some of the definitions and symbols may also apply to purposes beyond aircraft noise certification.

1.1 Velocity

<i>Symbol</i>	<i>Unit</i>	<i>Meaning</i>
C_R	m/s	<i>Reference speed of sound.</i> Speed of sound at reference conditions.
M_{ATR}	—	<i>Helicopter rotor reference advancing blade tip Mach number.</i> The sum of the reference rotor rotational tip speed and the reference speed of the helicopter, divided by the reference speed of sound.
M_H	—	<i>Propeller helical tip Mach number.</i> The square root of the sum of the square of the propeller test rotational tip speed and the square of the test airspeed of the aeroplane, divided by the test speed of sound.
M_{HR}	—	<i>Propeller reference helical tip Mach number.</i> The square root of the sum of the square of the propeller reference rotational tip speed and the square of the reference speed of the aeroplane, divided by the reference speed of sound.
Best R/C	m/s	<i>Best rate of climb.</i> The certificated maximum take-off rate of climb at the maximum power setting and engine speed.
V_{AR}	km/h	<i>Adjusted reference speed.</i> On a non-standard test day, the helicopter reference speed adjusted to achieve the same advancing tip Mach number as the reference speed at reference conditions.
V_{CON}	km/h	<i>Maximum airspeed in conversion mode.</i> The never-exceed airspeed of a tilt-rotor when in conversion mode.
V_G	km/h	<i>Ground speed.</i> The aircraft velocity relative to the ground.
V_{GR}	km/h	<i>Reference ground speed.</i> The aircraft true velocity relative to the ground in the direction of the ground track under reference conditions. V_{GR} is the horizontal component of the reference aircraft speed V_R .
V_H	km/h	<i>Maximum airspeed in level flight.</i> The maximum airspeed of a helicopter in level flight when operating at maximum continuous power.
V_{MCP}	km/h	<i>Maximum airspeed in level flight.</i> The maximum airspeed of a tilt-rotor in level flight when operating in aeroplane mode at maximum continuous power.
V_{MO}	km/h	<i>Maximum operating airspeed.</i> The maximum operating limit airspeed of a tilt-rotor that may not be deliberately exceeded.

V_{NE}	km/h	<i>Never-exceed airspeed.</i> The maximum operating limit airspeed that may not be deliberately exceeded.
V_R	km/h	<i>Reference speed.</i> The aircraft true velocity at reference conditions in the direction of the reference flight path. <i>Note.— This symbol should not be confused with the symbol commonly used for aeroplane take-off rotation speed.</i>
V_{REF}	km/h	<i>Reference landing airspeed.</i> The speed of the aeroplane, in a specific landing configuration, at the point where it descends through the landing screen height, in the determination of the landing distance for manual landings.
V_S	km/h	<i>Stalling airspeed.</i> The minimum steady airspeed in the landing configuration.
V_{tip}	m/s	<i>Tip speed.</i> The rotational speed of a rotor or propeller tip at test conditions, excluding the aircraft velocity component.
V_{tipR}	m/s	<i>Reference tip speed.</i> The rotational speed of a rotor or propeller tip at reference conditions, excluding the aircraft velocity component.
V_Y	km/h	<i>Speed for best rate of climb.</i> The test airspeed for best take-off rate of climb.
V_2	km/h	<i>Take-off safety speed.</i> The minimum airspeed for a safe take-off.

1.2 Time

<i>Symbol</i>	<i>Unit</i>	<i>Meaning</i>
t_0	s	<i>Reference duration.</i> The length of time used as a reference in the integration equation for computing EPNL, where $t_0 = 10$ s.
t_R	s	<i>Reference reception time.</i> The reference time of reception calculated from time of reference aircraft position and distance between aircraft and microphone used in the integrated procedure.
Δt	s	<i>Time increment.</i> The equal time increment between one-third octave band spectra, where $\Delta t = 0.5$ s.
δt_R	s	<i>Reference time increment.</i> The effective duration of a time increment between reference reception times associated with PNL points used in the integrated method.

1.3 Indices

Symbol	Unit	Meaning
i	—	<i>Frequency band index.</i> The numerical indicator that denotes any one of the 24 one-third octave bands with nominal geometric mean frequencies from 50 to 10 000 Hz.
k	—	<i>Time increment index.</i> The numerical indicator that denotes any one of the 0.5 second spectra in a noise time history. For the integrated method, the adjusted time increment associated with each value of k will likely vary from the original 0.5 second time increment when projected to reference conditions.
k_F	—	<i>First time increment identifier.</i> Index of the first 10 dB-down point in the discrete measured PNLT time history.
k_{FR}	—	<i>Reference first time increment identifier.</i> Index of the first 10 dB-down point in the discrete PNLT time history for the integrated method.
k_L	—	<i>Last time increment identifier.</i> Index of the last 10 dB-down point in the discrete measured PNLT time history.
k_{LR}	—	<i>Reference last time increment identifier.</i> Index of the last 10 dB-down point in the discrete PNLT time history for the integrated method.
k_M	—	<i>Maximum PNLTM time increment index.</i> Time increment index of PNLTM.
t	s	<i>Elapsed time.</i> The length of time measured from a reference zero.
t_1	s	<i>Time of first 10 dB-down point.</i> The time of the first 10 dB-down point in a continuous function of time. (See k_F .)
t_2	s	<i>Time of last 10 dB-down point.</i> The time of the last 10 dB-down point in a continuous function of time. (See k_L .)

1.4 Noise metrics

Symbol	Unit	Meaning
EPNL	EPNdB	<i>Effective perceived noise level.</i> A single-number evaluator for an aircraft pass-by, accounting for the subjective effects of aircraft noise on human beings, consisting of an integration over the noise duration of the perceived noise level (PNL) adjusted for spectral irregularities (PNLT), normalized to a reference duration of 10 seconds. (See Appendix 2, Section 4.1 for specifications.)
EPNL _A	EPNdB	<i>Approach EPNL.</i> Effective perceived noise level at the aeroplane approach reference measurement points.
EPNL _F	EPNdB	<i>Flyover EPNL.</i> Effective perceived noise level at the aeroplane flyover reference measurement points.

<i>Symbol</i>	<i>Unit</i>	<i>Meaning</i>
EPNL _L	EPNdB	<i>Lateral EPNL</i> . Effective perceived noise level at the aeroplane lateral reference measurement points.
L _{AE}	dB SEL	<i>Sound exposure level (SEL)</i> . A single event noise level for an aircraft pass-by, consisting of an integration over the noise duration of the A-weighted sound level (dBA), normalized to a reference duration of 1 second. (See Appendix 4, Section 3 for specifications.)
L _{AS}	dB(A)	<i>Slow A-weighted sound level</i> . Sound level with frequency weighting A and time weighting S for a specified instance in time.
L _{ASmax}	dB(A)	<i>Maximum slow A-weighted sound level</i> . The maximum value of L _{AS} over a specified time interval.
L _{ASmaxR}	dB(A)	<i>Reference maximum slow A-weighted sound level</i> . The maximum value of L _{AS} over a specified time interval corrected to reference conditions.
LIMIT _A	EPNdB	<i>Approach EPNL limit</i> . The maximum permitted noise level at the aeroplane approach reference measurement points.
LIMIT _F	EPNdB	<i>Flyover EPNL limit</i> . The maximum permitted noise level at the aeroplane flyover reference measurement points.
LIMIT _L	EPNdB	<i>Lateral EPNL limit</i> . The maximum permitted noise level at the aeroplane lateral reference measurement points.
<i>n</i>	noy	<i>Perceived noisiness</i> . The perceived noisiness of a one-third octave band sound pressure level in a given spectrum.
<i>N</i>	noy	<i>Total perceived noisiness</i> . The total perceived noisiness of a given spectrum calculated from the 24 values of <i>n</i> .
PNL	PNdB	<i>Perceived noise level</i> . A perception-based noise evaluator representing the subjective effects of broadband noise received at a given point in time during an aircraft pass-by. It is the noise level empirically determined to be equally as noisy as a 1 kHz one-third octave band sample of random noise. (See Appendix 2, Section 4.2 for specifications.)
PNLT	TPNdB	<i>Tone-corrected perceived noise level</i> . The value of the PNL of a given spectrum adjusted for spectral irregularities.
PNLT _R	TPNdB	<i>Reference tone-corrected perceived noise level</i> . The value of PNLT adjusted to reference conditions.
PNLTM	TPNdB	<i>Maximum tone-corrected perceived noise level</i> . The maximum value of PNLT in a specified time history, adjusted for the bandsharing adjustment Δ _B .
PNLTM _R	TPNdB	<i>Reference maximum tone-corrected perceived noise level</i> . The maximum value of PNLTM _R in a specified time history, adjusted for the bandsharing adjustment Δ _B in the simplified method and Δ _{BR} in the integrated method.

Symbol	Unit	Meaning
SPL	dB	<i>Sound pressure level.</i> The level of sound, relative to the reference level of 20 μ Pa, at any instant of time that occurs in a specified frequency range. The level is calculated as ten times the logarithm to the base 10 of the ratio of the time-mean-square pressure of the sound to the square of the reference sound pressure of 20 μ Pa. <i>Note/ — Typical aircraft noise certification usage refers to a specific one-third octave band, e.g. SPL(i,k) for the i-th band of the k-th spectrum in an aircraft noise time-history.</i>
SPL _R	dB	<i>Reference sound pressure level.</i> The one-third octave band sound pressure levels adjusted to reference conditions.
SPL _S	dB	<i>Slow weighted sound pressure level.</i> The value of one-third octave band sound pressure levels with time weighting S applied.
Δ_1	TPNdB	<i>PNLTM adjustment.</i> In the simplified adjustment method, the adjustment to be added to the measured EPNL to account for noise level changes due to differences in atmospheric absorption and noise path length, between test and reference conditions at PNLTM.
	dB(A)	For propeller-driven aeroplanes not exceeding 8 618 kg, the adjustment to be added to L _{ASmax} to account for noise level changes due to the difference between test and reference aeroplane heights.
Δ_2	TPNdB	<i>Duration adjustment.</i> In the simplified adjustment method, the adjustment to be added to the measured EPNL to account for noise level changes due to the change in noise duration, caused by differences between test and reference aircraft speed and position relative to the microphone.
	dB(A)	For propeller-driven aeroplanes not exceeding 8 618 kg, the adjustment to be added to L _{ASmax} to account for the propeller helical tip Mach number.
Δ_3	TPNdB	<i>Source noise adjustment.</i> In the simplified or integrated adjustment method, the adjustment to be added to the measured EPNL to account for noise level changes due to differences in source noise generating mechanisms, between test and reference conditions.
	dB(A)	For propeller-driven aeroplanes not exceeding 8 618 kg, the adjustment to be added to L _{ASmax} to account for engine power.
Δ_4	dB(A)	<i>Atmospheric absorption adjustment.</i> For propeller-driven aeroplanes not exceeding 8 618 kg, the adjustment to be added to the measured L _{ASmax} for noise level changes due to the change in atmospheric absorption, caused by the difference between test and reference aeroplane heights.
Δ_B	TPNdB	<i>Bandsharing adjustment.</i> The adjustment to be added to the maximum PNLT to account for possible suppression of a tone due to one-third octave bandsharing of that tone. PNLTM is equal to the maximum PNLT plus Δ_B .

<i>Symbol</i>	<i>Unit</i>	<i>Meaning</i>
Δ_{BR}	TPNdB	<i>Reference bandsharing adjustment.</i> The adjustment to be added to the maximum $PNLT_R$ in the integrated method to account for possible suppression of a tone due to one-third octave bandsharing of that tone. $PNLTM_R$ is equal to the maximum $PNLT_R$ plus Δ_{BR} .
Δ_{peak}	TPNdB	<i>Peak adjustment.</i> The adjustment to be added to the measured EPNL for when the PNL for a secondary peak, identified in the calculation of EPNL from measured data and adjusted to reference conditions, is greater than the PNL for the adjusted PNLTM spectrum.

1.5 Calculation of PNL and tone correction

<i>Symbol</i>	<i>Unit</i>	<i>Meaning</i>
C	dB	<i>Tone correction factor.</i> The factor to be added to the PNL of a given spectrum to account for the presence of spectral irregularities, such as tones.
f	Hz	<i>Frequency.</i> The nominal geometric mean frequency of a one-third octave band.
F	dB	<i>Delta-dB.</i> The difference between the original sound pressure level and the final broadband sound pressure level of a one-third octave band in a given spectrum.
$\log n(a)$	—	<i>Noy discontinuity coordinate.</i> The $\log n$ value of the intersection point of the straight lines representing the variation of SPL with $\log n$.
M	—	<i>Noy inverse slope.</i> The reciprocals of the slopes of straight lines representing the variation of SPL with $\log n$.
s	dB	<i>Slope of sound pressure level.</i> The change in level between adjacent one-third octave band sound pressure levels in a given spectrum.
Δs	dB	<i>Change in slope of sound pressure level.</i>
s'	dB	<i>Adjusted slope of sound pressure level.</i> The change in level between adjacent adjusted one-third octave band sound pressure levels in a given spectrum.
$\bar{s}$	dB	<i>Average slope of sound pressure level.</i>
$SPL(a)$	dB	<i>Noy discontinuity level.</i> The SPL value at the discontinuity coordinate of the straight lines representing the variation of SPL with $\log n$.
$SPL(b)$ $SPL(c)$	dB	<i>Noy intercept levels.</i> The intercepts on the SPL-axis of the straight lines representing the variation of SPL with $\log n$.
$SPL(d)$	dB	<i>Noy discontinuity level.</i> The SPL value at the discontinuity coordinate where $\log n$ equals -1 .

Symbol	Unit	Meaning
SPL(<i>e</i>)	dB	<i>No discontinuity level.</i> The SPL value at the discontinuity coordinate where log <i>n</i> equals log 0.3.
SPL'	dB	<i>Adjusted sound pressure level.</i> The first approximation to broadband sound pressure level in a one-third octave band of a given spectrum.
SPL''	dB	<i>Final broadband sound pressure level.</i> The second and final approximation to broadband sound pressure level in a one-third octave band of a given spectrum.

1.6 Flight path geometry

Symbol	Unit	Meaning
H	m	<i>Height.</i> The aircraft height when overhead or abeam of the centre microphone.
H _R	m	<i>Reference height.</i> The reference aircraft height when overhead or abeam of the centre microphone.
X	m	<i>Aircraft position along the ground track.</i> The position coordinate of the aircraft along the x-axis at a specific point in time.
Y	m	<i>Lateral aircraft position relative to the reference ground track.</i> The position coordinate of the aircraft along the y-axis at a specific point in time.
Z	m	<i>Vertical aircraft position relative to the reference ground track.</i> The position coordinate of the aircraft along the z-axis at a specific point in time.
θ	degrees	<i>Sound emission angle.</i> The angle between the flight path and the direct sound propagation path to the microphone. The angle is identical for both the measured and reference flight paths.
ψ	degrees	<i>Elevation angle.</i> The angle between the sound propagation path and a horizontal plane passing through the microphone, where the sound propagation path is defined as a line between a sound emission point on the measured flight path and the microphone diaphragm.
ψ _R	degrees	<i>Reference elevation angle.</i> The angle between the reference sound propagation path and a horizontal plane passing through the reference microphone location, where the reference sound propagation path is defined as a line between a sound emission point on the reference flight path and the reference microphone diaphragm.

1.7 Miscellaneous

<i>Symbol</i>	<i>Unit</i>	<i>Meaning</i>
antilog	—	<i>Antilogarithm to the base 10.</i>
D	m	<i>Diameter.</i> Propeller or rotor diameter.
D ₁₅	m	<i>Take-off distance.</i> The take-off distance required for an aeroplane to reach 15 m height above ground level.
e	—	<i>Euler's number.</i> The mathematical constant that is the base number of the natural logarithm, approximately 2.71828.
log	—	<i>Logarithm to the base 10.</i>
N	rpm	<i>Propeller speed.</i>
N ₁	rpm	<i>Compressor speed.</i> The turbine engine low pressure compressor first stage fan speed.
RH	%	<i>Relative humidity.</i> The ambient atmospheric relative humidity.
T	°C	<i>Temperature.</i> The ambient atmospheric temperature.
u	m/s	<i>Wind speed along-track component.</i> The component of the wind speed vector along the reference ground track.
v	m/s	<i>Wind speed cross-track component.</i> The component of the wind speed vector horizontally perpendicular to the reference ground track.
α	dB/100 m	<i>Test atmospheric absorption coefficient.</i> The sound attenuation rate, due to atmospheric absorption, that occurs in a specified one-third octave band for the measured ambient temperature and relative humidity.
α_R	dB/100 m	<i>Reference atmospheric absorption coefficient.</i> The sound attenuation rate, due to atmospheric absorption, that occurs in a specified one-third octave band for a reference ambient temperature and relative humidity.
μ	—	<i>Engine noise performance parameter.</i> For jet aeroplanes, typically the normalized low pressure fan speed, normalized engine thrust, or engine pressure ratio used in the calculation of the source noise adjustment.

PART II. AIRCRAFT NOISE CERTIFICATION

CHAPTER 1. ADMINISTRATION

1.1 The provisions of 1.2 to 1.6 shall apply to all aircraft included in the classifications defined for noise certification purposes in Chapters 2, 3, 4, 5, 6, 8, 10, 11, 12, 13 and 14 of this part where such aircraft are engaged in international air navigation.

1.2 Noise certification shall be granted or validated by the State of Registry of an aircraft on the basis of satisfactory evidence that the aircraft complies with requirements that are at least equal to the applicable Standards specified in this Annex.

1.3 If noise recertification is requested, it shall be granted or validated by the State of Registry of an aircraft on the basis of satisfactory evidence that the aircraft complies with requirements that are at least equal to the applicable Standards specified in this Annex. The date used by a certifying authority to determine the recertification basis shall be the date of acceptance of the first application for recertification.

1.4 The documents attesting noise certification shall be approved by the State of Registry and shall be required by that State to be carried on the aircraft.

Note.— See Annex 6, Part I, 6.13, concerning the translation into English of documents attesting noise certification.

1.5 The documents attesting noise certification for an aircraft shall provide at least the following information:

- Item 1. Name of State.
- Item 2. Title of the noise document.
- Item 3. Number of the document.
- Item 4. Nationality or common mark and registration marks.
- Item 5. Manufacturer and manufacturer's designation of aircraft.
- Item 6. Aircraft serial number.
- Item 7. Engine manufacturer, type and model.
- Item 8. Propeller type and model for propeller-driven aeroplanes.
- Item 9. Maximum take-off mass in kilograms.
- Item 10. Maximum landing mass, in kilograms, for certificates issued under Chapters 2, 3, 4, 5, 12 and 14 of this Annex.

- Item 11. The chapter and section of this Annex according to which the aircraft was certificated.
- Item 12. Additional modifications incorporated for the purpose of compliance with the applicable noise certification Standards.
- Item 13. The lateral/full-power noise level in the corresponding unit for documents issued under Chapters 2, 3, 4, 5, 12 and 14 of this Annex.
- Item 14. The approach noise level in the corresponding unit for documents issued under Chapters 2, 3, 4, 5, 8, 12, 13 and 14 of this Annex.
- Item 15. The flyover noise level in the corresponding unit for documents issued under Chapters 2, 3, 4, 5, 12 and 14 of this Annex.
- Item 16. The overflight noise level in the corresponding unit for documents issued under Chapters 6, 8, 11 and 13 of this Annex.
- Item 17. The take-off noise level in the corresponding unit for documents issued under Chapters 8, 10 and 13 of this Annex.
- Item 18. Statement of compliance, including a reference to Annex 16, Volume I.
- Item 19. Date of issuance of the noise certification document.
- Item 20. Signature of the officer issuing it.

1.6 Item headings on the noise certification documents shall be uniformly numbered in Arabic numerals, as indicated in 1.5, so that on any noise certification document the number will, under any arrangement, refer to the same item heading, except where the information in Items 1 through 6 and Items 18 through 20 is given in the certificate of airworthiness, in which case the numbering system of the certificate of airworthiness according to Annex 8 shall prevail.

1.7 An administrative system for implementation of noise certification documentation shall be developed by the State of Registry.

Note.— See Attachment G for guidance on the format and structure of noise certification documentation.

1.8 Contracting States shall recognize as valid a noise certification granted by another Contracting State provided that the requirements under which such certification was granted are at least equal to the applicable Standards specified in this Annex.

1.9 A Contracting State shall suspend or revoke the noise certification of an aircraft on its register if the aircraft ceases to comply with the applicable noise Standards. The State of Registry shall not remove the suspension of a noise certification or grant a new noise certification unless the aircraft is found, on reassessment, to comply with the applicable noise Standards.

1.10 The amendment of this volume of the Annex to be used by a Contracting State shall be that which is applicable on the date of submission to that Contracting State for:

- a) a Type Certificate in the case of a new type; or
- b) approval of a change in type design in the case of a derived version; or
- c) in either case, under an equivalent application procedure prescribed by the certifying authority of that Contracting State.

Note.— As each new edition and amendment of this Annex becomes applicable (according to Table A of the Foreword) it supersedes all previous editions and amendments.

1.11 Unless otherwise specified in this volume of the Annex, the date to be used by Contracting States in determining the applicability of the Standards in this Annex shall be the date the application for a Type Certificate was submitted to the State of Design, or the date of submission under an equivalent application procedure prescribed by the certifying authority of the State of Design.

1.12 For derived versions where the provisions governing the applicability of the Standards of this Annex refer to “the application for the certification of the change in type design”, the date to be used by Contracting States in determining the applicability of the Standards in this Annex shall be the date the application for the change in type design was submitted to the Contracting State that first certified the change in type design, or the date of submission under an equivalent application procedure prescribed by the certifying authority of the Contracting State that first certified the change in type design.

Note 1.— Unless otherwise specified in this volume of the Annex, the edition of the Environmental Technical Manual (Doc 9501), Volume I — Procedures for the Noise Certification of Aircraft, to be used as guidance on the use of acceptable means of compliance and equivalent procedures by a Contracting State should be that which is in effect on the date the application for a Type Certificate or the change in type design is submitted to that Contracting State.

Note 2.— The means of compliance and the use of equivalent procedures are subject to the acceptance of the certifying authority of the Contracting State.

1.13 An application shall be effective for the period specified in the designation of the airworthiness regulations appropriate to the aircraft type, except in special cases where the certifying authority accepts an extension of this period. When this period of effectivity is exceeded, the date to be used in determining the applicability of the Standards in this Annex shall be the date of issue of the Type Certificate or approval of the change in type design, or the date of issue of approval under an equivalent procedure prescribed by the State of Design, less the period of effectivity.

CHAPTER 2. SUBSONIC JET AEROPLANES — Application for Type Certificate submitted before 6 October 1977

2.1 Applicability

Note.— See also Chapter 1, 1.10, 1.11, 1.12 and 1.13.

2.1.1 The Standards of this chapter shall be applicable to all subsonic jet aeroplanes for which the application for a Type Certificate was submitted before 6 October 1977, except those aeroplanes:

- a) requiring a runway length¹ of 610 m or less at maximum certificated mass for airworthiness; or
- b) powered by engines with a bypass ratio of 2 or more and for which a certificate of airworthiness for the individual aeroplane was first issued before 1 March 1972; or
- c) powered by engines with a bypass ratio of less than 2 and for which the application for a Type Certificate was submitted before 1 January 1969, and for which a certificate of airworthiness for the individual aeroplane was first issued before 1 January 1976.

2.1.2 The maximum noise levels of 2.4.1 shall apply except for derived versions for which the application for certification of the change in type design was submitted on or after 26 November 1981, in which case the maximum noise levels of 2.4.2 shall apply.

2.1.3 Notwithstanding 2.1.1 and 2.1.2, it may be recognized by a Contracting State that the following situations for jet aeroplanes, and propeller-driven aeroplanes over 8 618 kg maximum certificated take-off mass on its registry do not require demonstration of compliance with the provisions of the Standards of Annex 16, Volume I:

- a) gear down flight with one or more retractable landing gear down during the entire flight;
- b) spare engine and nacelle carriage external to the skin of the aeroplane (and return of the pylon or other external mount); and
- c) time-limited engine and/or nacelle changes, where the change in type design specifies that the aeroplane may not be operated for a period of more than 90 days unless compliance with the provisions of Annex 16, Volume I, is shown for that change in type design. This applies only to changes resulting from a required maintenance action.

2.2 Noise evaluation measure

The noise evaluation measure shall be the effective perceived noise level in EPNdB as described in Appendix 1.

1. With no stopway or clearway.

2.3 Noise measurement points

An aeroplane, when tested in accordance with the flight test procedures of 2.6, shall not exceed the noise levels specified in 2.4 at the following points:

- a) *lateral noise measurement point*: the point on a line parallel to and 650 m from the runway centre line, or extended runway centre line, where the noise level is a maximum during take-off;
- b) *flyover noise measurement point*: the point on the extended centre line of the runway and at a distance of 6.5 km from the start of roll; and
- c) *approach noise measurement point*: the point on the ground, on the extended centre line of the runway, 120 m (394 ft) vertically below the 3° descent path originating from a point 300 m beyond the threshold. On level ground this corresponds to a position 2 000 m from the threshold.

2.4 Maximum noise levels

2.4.1 The maximum noise levels of those aeroplanes covered by 2.1.1, when determined in accordance with the noise evaluation method of Appendix 1, shall not exceed the following:

- a) *at lateral and approach noise measurement points*: 108 EPNdB for aeroplanes with maximum certificated take-off mass of 272 000 kg or over, decreasing linearly with the logarithm of the mass at the rate of 2 EPNdB per halving of the mass down to 102 EPNdB at 34 000 kg, after which the limit remains constant;
- b) *at flyover noise measurement point*: 108 EPNdB for aeroplanes with maximum certificated take-off mass of 272 000 kg or over, decreasing linearly with the logarithm of the mass at the rate of 5 EPNdB per halving of the mass down to 93 EPNdB at 34 000 kg, after which the limit remains constant.

Note.— See Attachment A for equations for the calculation of maximum permitted noise levels as a function of take-off mass.

2.4.2 The maximum noise levels of those aeroplanes covered by 2.1.2, when determined in accordance with the noise evaluation method of Appendix 1, shall not exceed the following:

2.4.2.1 At lateral noise measurement point

106 EPNdB for aeroplanes with maximum certificated take-off mass of 400 000 kg or over, decreasing linearly with the logarithm of the mass down to 97 EPNdB at 35 000 kg, after which the limit remains constant.

2.4.2.2 At flyover noise measurement point

- a) *Aeroplanes with two engines or less*

104 EPNdB for aeroplanes with maximum certificated take-off mass of 325 000 kg or over, decreasing linearly with the logarithm of the mass at the rate of 4 EPNdB per halving of mass down to 93 EPNdB, after which the limit remains constant.

b) *Aeroplanes with three engines*

As a) but with 107 EPNdB for aeroplanes with maximum certificated take-off mass of 325 000 kg or over

or

as defined by 2.4.1 b), whichever is the lower.

c) *Aeroplanes with four engines or more*

As a) but with 108 EPNdB for aeroplanes with maximum certificated take-off mass of 325 000 kg or over

or

as defined by 2.4.1 b), whichever is the lower.

2.4.2.3 *At approach noise measurement point*

108 EPNdB for aeroplanes with maximum certificated take-off mass of 280 000 kg or over, decreasing linearly with the logarithm of the mass down to 101 EPNdB at 35 000 kg, after which the limit remains constant.

Note.— See Attachment A for equations for the calculation of maximum permitted noise levels as a function of take-off mass.

2.5 Trade-offs

If the maximum noise levels are exceeded at one or two measurement points:

- a) the sum of excesses shall not be greater than 4 EPNdB, except that in respect of four-engined aeroplanes powered by engines with a bypass ratio of 2 or more and for which the application for a certificate of airworthiness for the prototype was accepted, or another equivalent prescribed procedure was carried out by the certifying authority, before 1 December 1969, the sum of any excesses shall not be greater than 5 EPNdB;
- b) any excess at any single point shall not be greater than 3 EPNdB; and
- c) any excesses shall be offset by corresponding reductions at the other point or points.

2.6 Test procedures

2.6.1 Take-off test procedure

2.6.1.1 Average take-off thrust² shall be used from the start of take-off to the point at which a height of at least 210 m (690 ft) above the runway is reached, and the thrust thereafter shall not be reduced below that thrust which will maintain a climb gradient of at least 4 per cent.

2. Take-off thrust representative of the mean characteristics of the production engine.

2.6.1.2 A speed of at least $V_2 + 19$ km/h ($V_2 + 10$ kt) shall be attained as soon as practicable after lift-off and be maintained throughout the take-off noise certification test.

2.6.1.3 A constant take-off configuration selected by the applicant shall be maintained throughout the take-off noise certification demonstration test except that the landing gear may be retracted.

2.6.2 Approach test procedure

2.6.2.1 The aeroplane shall be stabilized and following a $3^\circ \pm 0.5^\circ$ glide path.

2.6.2.2 The approach shall be made at a stabilized airspeed of not less than $1.3 V_S + 19$ km/h ($1.3 V_S + 10$ kt) with thrust stabilized during approach and over the measuring point and continued to a normal touchdown.

2.6.2.3 The configuration of the aeroplane shall be with maximum allowable landing flap setting.

Note.— Guidance material on the use of equivalent procedures is provided in the Environmental Technical Manual (Doc 9501), Volume I — Procedures for the Noise Certification of Aircraft.

CHAPTER 3.

- 1.— **SUBSONIC JET AEROPLANES — Application for Type Certificate submitted on or after 6 October 1977 and before 1 January 2006**
- 2.— **PROPELLER-DRIVEN AEROPLANES OVER 8 618 kg — Application for Type Certificate submitted on or after 1 January 1985 and before 1 January 2006**

3.1 Applicability

Note 1.— See also Chapter 1, 1.10, 1.11, 1.12 and 1.13.

Note 2.— See Attachment E for guidance on interpretation of these applicability provisions.

3.1.1 The Standards of this chapter shall, with the exception of those propeller-driven aeroplanes specifically designed and used for agricultural or firefighting purposes, be applicable to:

- a) all subsonic jet aeroplanes, including their derived versions, other than aeroplanes which require a runway¹ length of 610 m or less at maximum certificated mass for airworthiness, for which the application for a Type Certificate was submitted on or after 6 October 1977 and before 1 January 2006; and
- b) all propeller-driven aeroplanes, including their derived versions, of over 8 618 kg maximum certificated take-off mass, for which the application for a Type Certificate was submitted on or after 1 January 1985 and before 1 January 2006.

3.1.2 Notwithstanding 3.1.1, it may be recognized by a Contracting State that the following situations for jet aeroplanes, and propeller-driven aeroplanes over 8 618 kg maximum certificated take-off mass on its registry do not require demonstration of compliance with the provisions of the Standards of Annex 16, Volume I:

- a) gear down flight with one or more retractable landing gear down during the entire flight;
- b) spare engine and nacelle carriage external to the skin of the aeroplane (and return of the pylon or other external mount); and
- c) time-limited engine and/or nacelle changes, where the change in type design specifies that the aeroplane may not be operated for a period of more than 90 days unless compliance with the provisions of Annex 16, Volume I, is shown for that change in type design. This applies only to changes resulting from a required maintenance action.

3.2 Noise measurements

3.2.1 Noise evaluation measure

The noise evaluation measure shall be the effective perceived noise level in EPNdB as described in Appendix 2.

1. With no stopway or clearway.

3.3 Noise measurement points

3.3.1 Reference noise measurement points

An aeroplane, when tested in accordance with these Standards, shall not exceed the noise levels specified in 3.4 at the following points:

a) *lateral full-power reference noise measurement point*

- 1) for jet-powered aeroplanes: the point on a line parallel to and 450 m from the runway centre line, where the noise level is a maximum during take-off;
- 2) for propeller-driven aeroplanes: the point on the extended centre line of the runway 650 m vertically below the climb-out flight path at full take-off power, as defined in 3.6.2. Until 19 March 2002, the requirement for lateral noise in 3.3.1 a) 1) shall alternatively be permitted;

Note.— For aeroplanes specified in 3.1.1 b) for which the application for a Type Certificate was submitted before 19 March 2002, the lateral noise requirement specified in 3.3.1 a) 1) is permitted as an alternative.

b) *flyover reference noise measurement point*: the point on the extended centre line of the runway and at a distance of 6.5 km from the start of roll;

c) *approach reference noise measurement point*: the point on the ground, on the extended centre line of the runway, 2 000 m from the threshold. On level ground this corresponds to a position 120 m (394 ft) vertically below the 3° descent path originating from a point 300 m beyond the threshold.

3.3.2 Test noise measurement points

3.3.2.1 If the test noise measurement points are not located at the reference noise measurement points, any corrections for the difference in position shall be made in the same manner as the corrections for the differences between test and reference flight paths.

3.3.2.2 Sufficient lateral test noise measurement points shall be used to demonstrate to the certifying authority that the maximum noise level on the appropriate lateral line has been clearly determined. For jet-powered aeroplanes simultaneous measurements shall be made at one test noise measurement point at a symmetrical position on the other side of the runway. In the case of propeller-driven aeroplanes, because of their inherent asymmetry in lateral noise, simultaneous measurements shall be made at each and every test noise measurement point at a symmetrical position (within ± 10 m parallel with the axis of the runway) on the opposite side of the runway.

3.4 Maximum noise levels

3.4.1 The maximum noise levels, when determined in accordance with the noise evaluation method of Appendix 2, shall not exceed the following:

3.4.1.1 *At the lateral full-power reference noise measurement point*

103 EPNdB for aeroplanes with maximum certificated take-off mass, at which the noise certification is requested, of 400 000 kg and over and decreasing linearly with the logarithm of the mass down to 94 EPNdB at 35 000 kg, after which the limit remains constant.

3.4.1.2 At flyover reference noise measurement point

a) *Aeroplanes with two engines or less*

101 EPNdB for aeroplanes with maximum certificated take-off mass, at which the noise certification is requested, of 385 000 kg and over and decreasing linearly with the logarithm of the aeroplane mass at the rate of 4 EPNdB per halving of mass down to 89 EPNdB, after which the limit is constant.

b) *Aeroplanes with three engines*

As a) but with 104 EPNdB for aeroplanes with maximum certificated take-off mass of 385 000 kg and over.

c) *Aeroplanes with four engines or more*

As a) but with 106 EPNdB for aeroplanes with maximum certificated take-off mass of 385 000 kg and over.

3.4.1.3 At approach reference noise measurement point

105 EPNdB for aeroplanes with maximum certificated take-off mass, at which the noise certification is requested, of 280 000 kg or over, and decreasing linearly with the logarithm of the mass down to 98 EPNdB at 35 000 kg, after which the limit remains constant.

Note.— See Attachment A for equations for the calculation of maximum permitted noise levels as a function of take-off mass.

3.5 Trade-offs

If the maximum noise levels are exceeded at one or two measurement points:

- a) the sum of excesses shall not be greater than 3 EPNdB;
- b) any excess at any single point shall not be greater than 2 EPNdB; and
- c) any excesses shall be offset by corresponding reductions at the other point or points.

3.6 Noise certification reference procedures

3.6.1 General conditions

3.6.1.1 The reference procedures shall comply with the appropriate airworthiness requirements.

3.6.1.2 The calculations of reference procedures and flight paths shall be approved by the certifying authority.

3.6.1.3 Except in conditions specified in 3.6.1.4, the take-off and approach reference procedures shall be those defined in 3.6.2 and 3.6.3, respectively.

3.6.1.4 When it is shown by the applicant that the design characteristics of the aeroplane would prevent flight being conducted in accordance with 3.6.2 and 3.6.3, the reference procedures shall:

- a) depart from the reference procedures defined in 3.6.2 and 3.6.3 only to the extent demanded by those design characteristics which make compliance with the procedures impossible; and
- b) be approved by the certifying authority.

3.6.1.5 The reference procedures shall be calculated under the following reference atmospheric conditions:

- a) atmospheric pressure at sea level of 1 013.25 hPa, decreasing with altitude at a rate defined by the ICAO Standard Atmosphere;
- b) ambient air temperature at sea level of 25°C, decreasing with altitude at a rate defined by the ICAO Standard Atmosphere (i.e. 0.65°C per 100 m);
- c) constant relative humidity of 70 per cent;
- d) zero wind;
- e) for the purpose of defining the reference take-off profiles for both take-off and lateral noise measurements, the runway gradient is zero; and
- f) the reference atmosphere in terms of temperature and relative humidity is considered to be homogeneous (i.e. ambient temperature 25°C and relative humidity 70 per cent) for the purpose of calculating:
 - 1) the reference sound attenuation rate due to atmospheric absorption; and
 - 2) the reference speed of sound used in the calculation of the reference sound propagation geometry.

Note 1.— Details for calculating the variation of reference atmospheric pressure with altitude are given in the section of the Environmental Technical Manual (Doc 9501), Volume I — Procedures for the Noise Certification of Aircraft, concerning the ICAO Standard Atmosphere.

Note 2. —The characteristics of the ICAO Standard Atmosphere are provided in the Manual of the ICAO Standard Atmosphere (extended to 80 kilometres (262 500 feet) (Doc 7488/3).

3.6.2 Take-off reference procedure

Take-off reference flight path shall be calculated as follows:

- a) average engine take-off thrust or power shall be used from the start of take-off to the point where at least the following height above runway level is reached:
 - 1) aeroplanes with two engines or less — 300 m (984 ft);
 - 2) aeroplanes with three engines — 260 m (853 ft);
 - 3) aeroplanes with four engines or more — 210 m (689 ft);

- b) upon reaching the height specified in a) above, the thrust or power shall not be reduced below that required to maintain:
 - 1) a climb gradient of 4 per cent; or
 - 2) in the case of multi-engined aeroplanes, level flight with one engine inoperative;
 whichever thrust or power is greater;
- c) for the purpose of determining the lateral full-power noise level, the reference flight path shall be calculated on the basis of using full take-off power throughout without a thrust or power reduction;
- d) the speed shall be:
 - 1) for those aeroplanes for which the applicable airworthiness requirements define V_2 , the all-engines operating take-off climb speed selected by the applicant for use in normal operation, which shall be at least $V_2 + 19$ km/h ($V_2 + 10$ kt) but not greater than $V_2 + 37$ km/h ($V_2 + 20$ kt) and which shall be attained as soon as practicable after lift-off and be maintained throughout the take-off noise certification test. The increment applied to V_2 shall be the same for all reference masses of an aeroplane model unless a difference in increment is substantiated based on performance characteristics of the aeroplane.

Note.— V_2 is defined in accordance with the applicable airworthiness requirements.

- 2) for those aeroplanes for which the applicable airworthiness requirements do not define V_2 , the take-off speed at 15 m (50 ft) plus an increment of at least 19 km/h (10 kt) but not greater than 37 km/h (20 kt), or the minimum climb speed, whichever speed is greater. This speed shall be attained as soon as practicable after lift-off and be maintained throughout the take-off noise certification test.

Note.— Take-off speed at 15 m (50 ft) and minimum climb speed are defined in accordance with the applicable airworthiness requirements.

- e) a constant take-off configuration selected by the applicant shall be maintained throughout the take-off reference procedure except that the landing gear may be retracted. Configuration shall be interpreted as meaning the conditions of the systems and centre of gravity position and shall include the position of lift augmentation devices used, whether the APU is operating, and whether air bleeds and power off-takes are operating;
- f) the mass of the aeroplane at the brake release shall be the maximum take-off mass at which the noise certification is requested; and
- g) the average engine shall be defined by the average of all the certification compliant engines used during the aeroplane flight tests up to and during certification when operated to the limitations and procedures given in the flight manual. This will establish a technical standard including the relationship of thrust/power to control parameters (e.g. N_1 or EPR). Noise measurements made during certification tests shall be corrected to this standard.

Note.— Take-off thrust/power used shall be the maximum available for normal operations as scheduled in the performance section of the aeroplane flight manual for the reference atmospheric conditions given in 3.6.1.5.

3.6.3 Approach reference procedure

The approach reference flight path shall be calculated as follows:

- a) the aeroplane shall be stabilized and following a 3° glide path;

- b) a steady approach speed of $V_{REF} + 19$ km/h ($V_{REF} + 10$ kt), with thrust or power stabilized, shall be maintained over the measurement point;

Note.— In airworthiness terms V_{REF} is defined as the “reference landing speed”. Under this definition reference landing speed means “the speed of the aeroplane, in a specified landing configuration, at the point where it descends through the landing screen height in the determination of the landing distance for manual landings”.

- c) the constant approach configuration as used in the airworthiness certification tests, but with the landing gear down, shall be maintained throughout the approach reference procedure;
- d) the mass of the aeroplane at the touchdown shall be the maximum landing mass permitted in the approach configuration defined in 3.6.3 c) at which noise certification is requested; and
- e) the most critical (that which produces the highest noise level) configuration with normal deployment of aerodynamic control surfaces including lift and drag producing devices, at the mass at which certification is requested shall be used. This configuration includes all those items listed in 5.2.5 of Appendix 2 that will contribute to the noisiest continuous state at the maximum landing mass in normal operation.

3.7 Test procedures

3.7.1 The test procedures shall be acceptable to the airworthiness and noise certifying authority of the State issuing the certificate.

3.7.2 The test procedures and noise measurements shall be conducted and processed in an approved manner to yield the noise evaluation measure designated as effective perceived noise level, EPNL, in units of EPNdB, as described in Appendix 2.

3.7.3 Acoustic data shall be adjusted by the methods outlined in Appendix 2 to the reference conditions specified in this chapter. Adjustments for speed and thrust shall be made as described in Section 8 of Appendix 2.

3.7.4 If the mass during the test is different from the mass at which the noise certification is requested, the necessary EPNL adjustment shall not exceed 2 EPNdB for take-offs and 1 EPNdB for approaches. Data approved by the certifying authority shall be used to determine the variation of EPNL with mass for both take-off and approach test conditions. Similarly the necessary EPNL adjustment for variations in approach flight path from the reference flight path shall not exceed 2 EPNdB.

3.7.5 For the approach conditions the test procedures shall be accepted if the aeroplane follows a steady glide path angle of $3^\circ \pm 0.5^\circ$.

3.7.6 If equivalent test procedures different from the reference procedures are used, the test procedures and all methods for adjusting the results to the reference procedures shall be approved by the certifying authority. The amounts of the adjustments shall not exceed 16 EPNdB on take-off and 8 EPNdB on approach, and if the adjustments are more than 8 EPNdB and 4 EPNdB, respectively, the resulting numbers shall be more than 2 EPNdB below the noise limits specified in 3.4.

Note.— Guidance material on the use of equivalent procedures is provided in the Environmental Technical Manual (Doc 9501), Volume I — Procedures for the Noise Certification of Aircraft.

3.7.7 For take-off, lateral, and approach conditions, the variation in instantaneous indicated airspeed of the aeroplane must be maintained within ± 3 per cent of the average airspeed between the 10 dB-down points. This shall be determined by reference to the pilot's airspeed indicator. However, when the instantaneous indicated airspeed varies from the average airspeed over the 10 dB-down points by more than ± 5.5 km/h (± 3 kt), and this is judged by the certifying authority representative on the flight deck to be due to atmospheric turbulence, then the flight so affected shall be rejected for noise certification purposes.

CHAPTER 4.

- 1.— SUBSONIC JET AEROPLANES AND PROPELLER-DRIVEN AEROPLANES WITH MAXIMUM CERTIFICATED TAKE-OFF MASS 55 000 kg AND OVER — Application for Type Certificate submitted on or after 1 January 2006 and before 31 December 2017**
- 2.— SUBSONIC JET AEROPLANES WITH MAXIMUM CERTIFICATED TAKE-OFF MASS LESS THAN 55 000 kg — Application for Type Certificate submitted on or after 1 January 2006 and before 31 December 2020**
- 3.— PROPELLER-DRIVEN AEROPLANES WITH MAXIMUM CERTIFICATED TAKE-OFF MASS OVER 8 618 kg AND LESS THAN 55 000 kg — Application for Type Certificate submitted on or after 1 January 2006 and before 31 December 2020**

4.1 Applicability

Note.— See also Chapter 1, 1.10, 1.11, 1.12 and 1.13.

4.1.1 The Standards of this chapter shall, with the exception of those aeroplanes which require a runway¹ length of 610 m or less at maximum certificated mass for airworthiness or propeller-driven aeroplanes specifically designed and used for agricultural or firefighting purposes, be applicable to:

- a) all subsonic jet aeroplanes and propeller-driven aeroplanes, including their derived versions, with a maximum certificated take-off mass of 55 000 kg and over for which the application for a Type Certificate was submitted on or after 1 January 2006 and before 31 December 2017;
- b) all subsonic jet aeroplanes, including their derived versions, with a maximum certificated take-off mass of less than 55 000 kg for which the application for a Type Certificate was submitted on or after 1 January 2006 and before 31 December 2020;
- c) all propeller-driven aeroplanes, including their derived versions, with a maximum certificated take-off mass of over 8 618 kg and less than 55 000 kg, for which the application for a Type Certificate was submitted on or after 1 January 2006 and before 31 December 2020; and
- d) all subsonic jet aeroplanes and all propeller-driven aeroplanes certificated originally as satisfying Annex 16, Volume I, Chapter 3 or Chapter 5, for which recertification to Chapter 4 is requested.

Note.— Guidance material on applications for recertification is provided in the Environmental Technical Manual (Doc 9501), Volume I — Procedures for the Noise Certification of Aircraft.

1. With no stopway or clearway.

4.1.2 Notwithstanding 4.1.1, it may be recognized by a Contracting State that the following situations for jet aeroplanes and propeller-driven aeroplanes over 8 618 kg maximum certificated take-off mass on its registry do not require demonstration of compliance with the provisions of the Standards of Annex 16, Volume I:

- a) gear down flight with one or more retractable landing gear down during the entire flight;
- b) spare engine and nacelle carriage external to the skin of the aeroplane (and return of the pylon or other external mount); and
- c) time-limited engine and/or nacelle changes, where the change in type design specifies that the aeroplane may not be operated for a period of more than 90 days unless compliance with the provisions of Annex 16, Volume I, is shown for that change in type design. This applies only to changes resulting from a required maintenance action.

4.2 Noise measurements

4.2.1 Noise evaluation measure

The noise evaluation measure shall be the effective perceived noise level in EPNdB as described in Appendix 2.

4.3 Reference noise measurement points

4.3.1 An aeroplane, when tested in accordance with these Standards, shall not exceed the maximum noise level specified in 4.4 of the noise measured at the points specified in Chapter 3, 3.3.1 a), b) and c).

4.3.2 Test noise measurement points

The provisions of Chapter 3, 3.3.2, relating to test noise measurement points shall apply.

4.4 Maximum noise levels

4.4.1 The maximum permitted noise levels are defined in Chapter 3, 3.4.1.1, 3.4.1.2 and 3.4.1.3, and shall not be exceeded at any of the measurement points.

4.4.1.1 The sum of the differences at all three measurement points between the maximum noise levels and the maximum permitted noise levels specified in Chapter 3, 3.4.1.1, 3.4.1.2 and 3.4.1.3, shall not be less than 10 EPNdB.

4.4.1.2 The sum of the differences at any two measurement points between the maximum noise levels and the corresponding maximum permitted noise levels specified in Chapter 3, 3.4.1.1, 3.4.1.2 and 3.4.1.3, shall not be less than 2 EPNdB.

Note.— See Attachment A for equations for the calculation of maximum permitted noise levels as a function of take-off mass.

4.5 Noise certification reference procedures

The noise certification reference procedures shall be as specified in Chapter 3, 3.6.

4.6 Test procedures

The test procedures shall be as specified in Chapter 3, 3.7.

4.7 Recertification

For aeroplanes specified in 4.1.1 c), recertification shall be granted on the basis that the evidence used to determine compliance with Chapter 4 is as satisfactory as the evidence associated with aeroplanes specified in 4.1.1 a) and b).
