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THE CIVIL AVIATION ACT,
(CAP. 80)

REGULATIONS

THE CIVIL AVIATION (ENVIRONMENTAL PROTECTION - AIRCRAFT NOISE)
REGULATIONS, 2026

ARRANGEMENT OF REGULATIONS

Regulation *Title*

PART I
PRELIMINARY PROVISIONS

1. Citation.
2. Application.
3. Interpretation.

PART II
AIRCRAFT NOISE CERTIFICATION
(a) Administration

4. Noise certification.

(b) Subsonic Jet Aeroplanes
(Application for Type Certificate submitted before 6 October 1977)

5. Noise evaluation measure.
6. Noise measurement points
7. Maximum noise levels.
8. Trade-offs.
9. Test procedures.

(c) Subsonic Jet Aeroplanes

10. Application.

11. Noise measurement.
12. Noise Measurement for monitoring purpose.
13. Noise measurement points.
14. Maximum noise levels.
15. Trade-offs.
16. Noise certification reference procedures.
17. Test procedures.

(d) Subsonic Jet Aeroplanes and Propeller-Driven Aeroplanes

18. Application.
19. Noise measurement.
20. Reference noise measurement points.
21. Maximum noise levels.
22. Noise certification reference procedures.
23. Test procedures.
24. Certification.

(e) Propeller-Driven Aeroplanes

25. Application.
26. Noise measurement.
27. Noise measurement points.
28. Derermination of maximum noise levels with noise evaluation method.
29. Trade-offs.
30. Noise certification reference procedures.
31. Test procedures.

(f) Propeller-Driven Aeroplanes Not Exceeding 8618 Kilograms

32. Application.
33. Noise evaluation measure.
34. Determination of maximum noise levels.
35. Noise certification reference procedures.
36. Test procedures.

(g) Helicopters

37. Noise evaluation measure.

38. Reference noise measurement points.
39. Maximum noise levels.
40. Trade-offs.
41. Noise certification reference procedures.
42. Test procedures.

*(h) Installed Auxiliary Power Units And Associated Aircraft Systems
During Ground*

43. Noise certification for installed auxiliary power unit and associated aircraft systems.

*(i) Propeller-Driven Aeroplanes Not Exceeding 8618 Kilograms
(Application for Type Certificate or Certification of Derived Version
submitted on or after 17 November 1988)*

44. Noise evaluation measure.
45. Reference noise measurement point.
46. Maximum noise levels.
47. Noise certification reference procedures.
48. Test procedures.

*(j) Helicopters Not Exceeding 3175 Kilograms Maximum Certified
Take-Off Mass*

49. Noise evaluation measure.
50. Reference noise measurement points.
51. Maximum noise levels.
52. Noise certification reference procedures.
53. Test procedures.

(k) Supersonic Aeroplanes

54. Supersonic aeroplanes-Application for Type Certificate submitted before 1 January 1975.
55. Supersonic aeroplanes-Application for Type Certificate submitted on or after 1 January 1975.

(l) Tilt-Rotors

56. Noise evaluation measure.

57. Noise measurement reference points.
58. Maximum noise levels.
59. Trade-offs.
60. Noise certification reference procedures.
61. Test procedures.

(m) Subsonic Jet Aeroplanes and Propeller-Driven Aeroplanes

62. Application.
63. Noise evaluation measure.
64. Reference noise measurement points.
65. Maximum noise levels.
66. Noise certification reference procedures.
67. Test procedures.
68. Certification.

PART III
NOISE MEASUREMENT FOR MONITORING PURPOSES AND
ASSESSMENT OF AIRPORT NOISE

69. Noise Measurement for monitoring purposes.
70. Assessment of airport noise.

PART IV
BALANCED APPROACH TO NOISE MANAGEMENT

71. Balanced approach to noise management.

PART V
EXEMPTIONS

72. Requirements for application for exemption.
73. Review and publication.
74. Evaluation of request.

PART VI
MISCELLANEOUS PROVISIONS

75. Suspension and revocation.

76. Offences and penalties.

SCHEDULES

- before 31 December 2020;
- (f) propeller-driven aeroplanes with maximum certificate take-off mass over 8 618 kg and less than 55000 kilograms, application for type certificate submitted on or after 1 January 2006 and before 31 December 2020;
 - (g) propeller-driven aeroplanes over 8618 kilograms, application for type certificate submitted before 1 January 1985;
 - (h) propeller-driven aeroplanes not exceeding 8618 kilograms, application for type certificate submitted before 17 November 1988;
 - (i) propeller-driven STOL aeroplanes;
 - (j) helicopters;
 - (k) propeller-driven aeroplanes not exceeding 8618 kilograms, application for type certificate or Certification of Derived Version submitted on or after 17 November 1988;
 - (l) helicopters not exceeding 3175 kilograms maximum certificated take-off mass;
 - (m) supersonic aeroplanes;
 - (n) tilt-rotors;
 - (o) subsonic jet aeroplanes and propeller-driven aeroplanes with maximum certificated take-off mass 55000 kilograms and over, application for type certificate submitted on or after 31 December 2017;
 - (p) subsonic jet aeroplanes with maximum certificated take-off mass less than 55000 kilograms, application for type certificate submitted on or after 31 December 2020; and
 - (q) propeller-driven aeroplanes with maximum certificated take-off mass over 8 618 kg and less than 55000 kilograms, application for type certificate submitted on or after 31 December 2020.

Interpretation

3. In these Regulations, unless the context otherwise requires-
“aeroplane” means 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” has the meaning ascribed to it under the Act;
- “Associated aircraft systems” means those aircraft systems drawing electrical or pneumatic power from an auxiliary power unit during ground operations;
- “Authority” has the meaning ascribed to it under the Act;
- “Auxiliary Power Unit” means a self-contained power unit on an aircraft providing electrical or pneumatic power to aircraft systems during ground operations or in flight, separate from the propulsion engine;
- “bypass ratio” means 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;
- “certification” means 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;
- “helicopter” means 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” means human capabilities and limitations, which have an impact on the safety and efficiency of aeronautical operations;
- “powered-lift” means 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 for lift during horizontal flight;
- “state of design” means the State having jurisdiction over the organization responsible for the type design;
- “State of Registry” has the meaning ascribed to it under the Act;
- “tilt-rotor” means 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 nonrotating aerofoil for lift during high-speed flight; and
“type certificate” means 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;

PART II
AIRCRAFT NOISE CERTIFICATION
(a) *Administration*

Noise
certification

4.-(1) Noise certification shall be granted or validated by the Authority on the basis of satisfactory evidence that the aircraft complies with requirements that are at least equal to the applicable standards specified in these Regulations.

(2) Where noise recertification is requested, it shall be granted or validated by the Authority on the basis of satisfactory evidence that the aircraft complies with requirements that are at least equal to the applicable standard specified in these Regulations.

(3) The date used by a certifying authority to determine the certification basis shall be the date of acceptance of the first application for certification.

(4) The Authority shall approve documents attesting noise certification and these documents shall be carried on the aircraft.

(5) Where the document, or a suitable statement attesting noise certification contained in another document approved by state of registry, is issued in a language other than English, it shall be accompanied by certified English translation.

GN.No.
57 of 2017

(6) The documents attesting noise certification for an aircraft shall contain information as prescribed in the Civil Aviation (Airworthness) Regulations.

(7) Item headings on the noise certification documents shall be uniformly numbered in Arabic numerals, as indicated in subregulation (6), so that on any noise certification document the number shall, under any arrangement, refer to

GN.No.
57 of 2017

the same item heading, except where the information in Items 1 to 6 and Items 18 to 20 is given in the certificate of airworthiness, in which case the numbering system of the Certificate of Airworthiness according to Civil Aviation (Airworthiness of aircraft) Regulations shall prevail.

(8) The Authority shall issue a Noise Certificate based on the manufacturer noise certification in accordance with procedures prescribed by the Authority and further tests shall not be performed by the Authority.

(9) The Authority 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 these Regulations.

(10) The Authority 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 these Regulations.

(11) Unless otherwise specified in these Regulations, the date to be used by the Authority in determining the applicability of these Regulations shall be the date of application for-

- (a) a type certificate in case of a new type submitted to the state of design; or
- (b) the date of submission under an equivalent application procedure prescribed by the certifying authority of the state of design.

(12) For Derived versions where the provisions governing the applicability of these Regulations refer to the application for the certification of the change in type design, the date to be used by the Authority in determining the applicability of these Regulations 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.

(13) An application shall be effective for the period specified in the the Civil Aviation (Airworthiness) Regulations appropriate to the aircraft type, except in special cases where the certifying authority accepts an extension of

GN.No.
57 of 2017

this period.

(14) Where the period of effectivity is exceeded, the date to be used in determining the applicability of these Regulations 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.

(b) Subsonic Jet Aeroplanes

(Application for Type Certificate submitted before 6 October 1977)

Noise
evaluation
measure

5. The noise evaluation measure for subsonic jet aeroplanes for which application for type certificate was submitted before 6 October 1977 shall be the effective perceived noise level in EPNdB as specified in the First Schedule.

Noise
measurement
points

6. The noise measurement points for aeroplanes when tested in accordance with the flight test procedures of test procedures, shall not exceed the noise levels specified in maximum test levels at the following points:

- (a) lateral noise measurement point: the point on a line parallel to and 650 meters from the runway centre line, or extended runway centre line, where the noise level is at 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 kilometer 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 meters or 394 feet vertically below the 3° descent path originating from a point 300 meters beyond the threshold, on level ground this corresponds to a position 2000 meters from the threshold.

Maximum
noise levels

7.-(1) The maximum noise levels of aeroplanes shall be determined in accordance with the noise evaluation method specified in the First Schedule and shall not exceed the following:

- (a) at lateral and approach noise measurement points:

108 EPNdB for aeroplanes with maximum certificated take-off mass of 272000 kilograms 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 34000 kilograms, after which the limit remains constant; and

- (b) at flyover noise measurement point: 108 EPNdB for aeroplanes with maximum certificated take-off mass of 272000 kilograms 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 34000 kilograms, after which the limit remains constant.

(2) The maximum noise levels of the aeroplanes when determined in accordance with the noise evaluation method specified in the First Schedule, shall not exceed the following point:

- (a) at lateral noise measurement point, 106 EPNdB for aeroplanes with maximum certificated take-off mass of 400000 kilograms or over, decreasing linearly with the logarithm of the mass down to 97 EPNdB at 35000 kilograms, after which the limit remains constant;
- (b) at flyover noise measurement point-
 - (i) aeroplanes with two engines or less: 104 EPNdB for aeroplanes with maximum certificated take-off mass of 325000 kilograms 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;
 - (ii) aeroplanes with three engines as (i) but with 107 EPNdB for aeroplanes with maximum certificated take-off mass of 325000 kilograms or over whichever is the lower; and
 - (iii) aeroplanes with four engines or more as specified in (i) of this section but with 108 EPNdB for aeroplanes with maximum certificated take-off mass of 325000

kilograms or over whichever is the lower.

- (c) at approach noise measurement point, 108 EPNdB for aeroplanes with maximum certificated take-off mass of 280000 kilograms or over, decreasing linearly with the logarithm of the mass down to 101 EPNdB at 35000 kilograms, after which the limit remains constant.,

Trade-offs

8.-(1) The maximum noise level for for aeroplanes at each of the three measurement points shall not be less than 1 EPNdB below the corresponding maximum permitted noise level as follows:

- (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.

Test procedures

9.-(1) Take-off test procedure-

- (a) average take-off thrust shall be used from the start of take-off to the point at which a height of at least 210 meters (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 percent;
- (b) 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; and
- (c) 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) Approach test procedure-

- (a) the aeroplane shall be stabilized and following a $3^{\circ} \pm 0.5^{\circ}$ glide path;
- (b) 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; and
- (c) the configuration of the aeroplane shall be with maximum allowable landing flap setting.

(c) Subsonic Jet Aeroplanes

Application

10. The provisions of this Subpart shall apply to subsonic jet aeroplanes- application for type certificate submitted on or after 6 October 1977 and before 1 January 2006 and propeller-driven aeroplanes over 8618 kilograms - application for type certificate submitted on or after 1 January 1985 and before 1 January 2006

Noise measurement

11. The noise evaluation measure shall be the effective perceived noise level in EPNdB, as described in Second Schedule.

Noise measurement for monitoring purpose

12. Where the measurement of aircraft noise is made for monitoring purposes, the method specified in the Third Schedule may be used.

Noise measurement points

13.-(1) For reference noise measurement points, an aeroplane, when tested in accordance with these Regulations, shall not exceed the noise levels specified in regulation 14 at the following points:

- (a) lateral full-power reference noise measurement point-
 - (i) for jet-powered aeroplanes: the point on a line parallel to and 450 meters from the runway centre line, where the noise level is a maximum during take-off;
 - (ii) for propeller-driven aeroplanes: the point on the extended centre line of

the runway 650 meter vertically below the climb-out flight path at full take-off power, as defined in regulation 16 (2); and

(iii) until 19 March 2002, the requirement for lateral noise in paragraph (a) (i) shall alternatively be permitted;

(b) for flyover reference noise measurement point the point on the extended centre line of the runway and at a distance of 6.5 kilometers from the start of roll;

(c) for approach reference noise measurement point the point on the ground, on the extended centre line of the runway, 2000 meter from the threshold;

(d) subject to paragraph (c), on level ground this corresponds to a position 120 meters or 394 feet vertically below the 3° descent path originating from a point 300 meters beyond the threshold.

(2) Where 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) Sufficient lateral test noise measurement points shall be used to demonstrate to the certificating authority that the maximum noise level on the appropriate lateral line has been clearly determined.

(4) 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.

(5) 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 meters parallel with the axis of the runway on the opposite side of the runway.

Maximum
noise levels

14. The maximum noise levels, when determined in accordance with the noise evaluation method specified in the Second Schedule, shall not exceed the following point:

- (a) 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 400000 kilograms and over and decreasing linearly with the logarithm of the mass down to 94 EPNdB at 35000 kilograms, after which the limit remains constant;
- (b) at flyover reference noise measurement point-
 - (i) aeroplanes with two engines or less, 101 EPNdB for aeroplanes with maximum certificated take-off mass, at which the noise certification is requested, of 385000 kilograms 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;
 - (ii) aeroplanes with three engines, aeroplanes with three engines as (i) above but with 104 EPNdB for aeroplanes with maximum certificated take-off mass of 385000 kilograms and over; and
 - (iii) aeroplanes with four engines or more, aeroplanes with four engines or more as (i) but with 106 EPNdB for aeroplanes with maximum certificated take-off mass of 385000 kilograms and over.
- (c) at approach reference noise measurement point, 105 EPNdB for aeroplanes with maximum certificated take-off mass, at which the noise certification is requested, of 280000 kilograms or over, and decreasing linearly with the logarithm of the mass down to 98 EPNdB at 35000 kilograms, after which the limit remains constant.

Trade-offs

15. Where 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.

Noise
certification
reference
procedures

16.-(1) The noise certification reference procedures for aeroplanes shall meet the following general conditions-

- (a) the reference procedures shall comply with the appropriate airworthiness requirements;
- (b) the calculations of reference procedures and flight paths shall be approved by the certificating authority;
- (c) except in conditions specified in paragraph (d) of this regulation, the take-off and approach reference procedures shall be those defined in subregulations (2) and (3) respectively;
- (d) when it is shown by the applicant that the design characteristics of the aeroplane would prevent flight being conducted in accordance with subregulations (2) and (3), the reference procedures shall-
 - (i) depart from the reference procedures defined in subregulation (2) and (3) only to the extent demanded by those design characteristics which make compliance with the procedures impossible; and
 - (ii) be approved by the certificating authority.
- (e) the reference procedures shall be calculated under the following reference atmospheric conditions:
 - (i) atmospheric pressure at sea level of 1013.25 hPa, decreasing with altitude at a rate defined by the ICAO Standard Atmosphere;
 - (ii) ambient air temperature at sea level of 25°C, decreasing with altitude at a rate defined by the ICAO Standard Atmosphere which is 0.65°C per 100 meters;
 - (iii) constant relative humidity of 70 per cent;
 - (iv) zero wind;
 - (v) for the purpose of defining the reference take-off profiles for both take-off and lateral noise measurements, the runway

- gradient is zero; and
- (vi) the reference atmosphere in terms of temperature and relative humidity is considered to be homogeneous, that is ambient temperature 25°C and relative humidity 70 per cent, for the purpose of calculating:
 - (aa) the reference sound attenuation rate due to atmospheric absorption; and
 - (bb) the reference speed of sound used in the calculation of the reference sound propagation geometry.
- (2) For Take-off reference procedure-
- (a) take-off reference flight path shall be calculated as follows:
 - (i) 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-
 - (aa) aeroplanes with two engines or less -300 meters or 984 feet;
 - (bb) aeroplanes with three engines - 260 meters or 853 feet; and
 - (cc) aeroplanes with four engines or more - 210 meters or 689 feet;
 - (b) upon reaching the height specified in paragraph (a), the thrust or power shall not be reduced below that required to maintain-
 - (i) a climb gradient of 4 per cent; or
 - (ii) in the case of multi-engine 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-
 - (i) 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, and V_2 is defined in accordance with the applicable airworthiness requirements;
- (ii) 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, and — V_2 is defined in accordance with the applicable airworthiness requirements;
 - (iii) for those aeroplanes for which the applicable airworthiness requirements do not define V_2 , the take-off speed at 15 meters or 50 feet plus an increment of at least 19 km/h or 10 kt but not greater than 37 km/h or 20 kt or the minimum climb speed, whichever speed is greater, and
 - (iv) this speed shall be attained as soon as practicable after lift-off and be maintained throughout the take-off noise certification test, and Take-off speed at 15 meters or 50 feet 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;
 - (f) 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 Auxiliary Power Unit is operating, and whether air bleeds

- and power off-takes are operating;
- (g) the mass of the aeroplane at the brake release shall be the maximum take-off mass at which the noise certification is requested;
 - (h) 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 and noise measurements made during certification tests shall be corrected to this standard; and
 - (i) take-off thrust or 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 subregulation (1) (e).
- (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 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;;
 - (b) 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;
 - (c) the mass of the aeroplane at the touchdown shall be the maximum landing mass permitted in the approach configuration defined in paragraph (c) at which noise certification is requested; and
 - (d) the most critical 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 and this configuration includes all those items listed in the Second Schedule that will contribute to the noisiest continuous state at the maximum landing mass in normal operation.

(e) the most critical, which produces the highest noise levels, configuration at the mass at which certification is requested shall be used.

(4) The noise certification reference procedures shall be calculated under the following reference atmospheric conditions:

- (a) atmospheric pressure at sea level of 1013.25 hPa, decreasing with altitude at a rate defined by the ICAO Standard Atmosphere; and
- (b) ambient air temperature at sea level of 25°C, decreasing with altitude at a rate defined by the ICAO Standard Atmosphere.

Test
procedures

17.-(1) The test procedures shall be acceptable to the airworthiness and noise certifying authority of the state issuing the certificate.

(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 specified in the Second Schedule.

(3) Acoustic data shall be adjusted by the methods outlined in the Second Schedule to the reference conditions specified in this Part and adjustments for speed and thrust shall be made as described in the Second Schedule.

(4) Where 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.

(5) 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.

(6) The necessary EPNL adjustment for variations in approach flight path from the reference flight path shall not exceed 2 EPNdB.

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

(8) Where 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.

(9) 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 regulation 14.

(10) For take-off, lateral, and approach conditions, the variation in instantaneous indicated airspeed of the aeroplane shall be maintained within ± 3 per cent of the average airspeed between the 10 dB-down points.

(11) The Instantaneous indicated airspeed shall be determined by reference to the pilot's airspeed indicator.

(12) Where 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.

(c) *Subsonic Jet Aeroplanes and Propeller-Driven Aeroplanes*

Application

18. This part shall apply to-

- (a) subsonic jet aeroplanes and propeller-driven aeroplanes with maximum certificated take-off mass 55000 kilograms and over- application for type certificate submitted on or after 1 January 2006 and before 31 December 2017;
- (b) subsonic jet aeroplanes with maximum certificated take-off mass less than 55 000 kilograms- application for type certificate submitted on or after 1 January 2006 and before 31 December 2020; and
- (c) propeller-driven aeroplanes with maximum certificated take-off mass over 8 618 kilograms and less than 55000 kilogram-application for type certificate submitted on or after 1 January 2006 and before 31 December 2020

Noise measurement

19. The noise evaluation measure shall be the effective perceived noise level in EPNdB as specified in the Second Schedule.

Reference noise measurement points	<p>20.-(1) An aeroplane, when tested in accordance with these Regulations, shall not exceed the maximum noise level specified in regulation 19, at the points specified in regulations 13.</p> <p>(2) For test noise measurement points the provisions of regulation 13, relating to test noise measurement points shall apply.</p>
Maximum noise levels	<p>21.-(1) The maximum permitted noise levels specified in regulation 14, shall not be exceeded at any of the measurement points.</p> <p>(2) The sum of the differences at all three measurement points between the maximum noise levels and the maximum permitted noise levels specified in regulation 14, shall not be less than 10 EPNdB.</p> <p>(3) The sum of the differences at any two measurement points between the maximum noise levels and the corresponding maximum permitted noise levels specified in regulation 14, shall not be less than 2 EPNdB.</p>
Noise certification reference procedures	<p>22. The noise certification reference procedures shall be as specified in regulation 15.</p>
Test procedures	<p>23. The test procedures shall be as specified in regulation 17.</p>
Certification	<p>24. For aeroplanes specified in regulation 2(f), certification shall be granted on the basis that the evidence used to determine compliance with this Part is as satisfactory as the evidence associated with aeroplanes specified in regulation 2 (d) and (e).</p>
Application	<p><i>(e) Propeller-Driven Aeroplanes</i></p> <p>25. The provisions of this subpart shall apply to propeller-driven aeroplanes over 8618 kilograms application for type certificate submitted before 1 January 1985.</p>
Noise measurement	<p>26. The noise evaluation measure shall be the effective perceived noise level in EPNdB as specified in the Second Schedule.</p>

Noise
measurement
points

27.-(1) For reference noise measurement points an aeroplane, when tested in accordance with these Regulations, shall not exceed the noise levels specified in regulation 28 at the following points:

- (a) lateral reference noise measurement point, the point on a line parallel to and 450 meters from the runway centre line, or extended runway centre line, where the noise level is a maximum during take-off;
- (b) flyover reference noise measurement point, the point on the extended centre line of the runway and at a distance of 6.5 kilometers from the start of roll; and
- (c) approach reference noise measurement point, the point on the ground, on the extended centre line of the runway, 2000 meters from the threshold on level ground this corresponds to a position 120 meters or 394 feet vertically below the 3° descent path originating from a point 300 meters beyond the threshold.

(2) For Test noise measurement points-

- (a) where 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;
- (b) sufficient lateral test noise measurement points shall be used to demonstrate to the certificating authority that the maximum noise level on the appropriate lateral line has been clearly determined; and
- (c) simultaneous measurements shall be made at one test noise measurement point at a symmetrical position on the other side of the runway.

(3) Subject to subregulation (1) and (2), the applicant shall demonstrate to the certificating authority that during flight test, lateral and flyover noise levels were not separately optimized at the expense of each other.

Determinatio

28. The maximum noise levels, when determined in

n of
maximum
noise levels
with noise
evaluation
method

accordance with the noise evaluation method specified in the Second Schedule, shall not exceed the following:

- (a) at lateral reference noise measurement point, 96 EPNdB constant limit for aeroplanes with maximum take-off mass, at which the noise certification is requested, up to 34000 kilograms and increasing linearly with the logarithm of aeroplane mass at the rate of 2 EPNdB per doubling of mass from that point until the limit of 103 EPNdB is reached, after which the limit is constant;
- (b) at flyover reference noise measurement point, 89 EPNdB constant limit for aeroplanes with maximum take-off mass, at which the noise certification is requested, up to 34000 kilograms and increasing linearly with the logarithm of aeroplane mass at the rate of 5 EPNdB per doubling of mass from that point until the limit of 106 EPNdB is reached, after which the limit is constant; and
- (c) at approach reference noise measurement point, 98 EPNdB constant limit for aeroplanes with maximum take-off mass, at which the noise certification is requested, up to 34000 kilograms and increasing linearly with the logarithm of aeroplane mass at the rate of 2 EPNdB per doubling of mass from that point until the limit of 105 EPNdB is reached, after which the limit is constant.

Trade-offs

29. The trade-offs shall be as specified under regulation 15.

Where 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.

Noise
certification
reference
procedures

30.-(1) The noise certification reference procedures shall meet the following general conditions-

- (a) the reference procedures shall comply with the appropriate airworthiness requirements;
- (b) the calculations of reference procedures and flight paths shall be approved by the certifying authority;
- (c) except in conditions specified in paragraph (d), the take-off and approach reference procedures shall be those defined in subregulation (2) and (3), respectively;
- (d) when it is shown by the applicant that the design characteristics of the aeroplane would prevent flight being conducted in accordance with subregulation (2) and (3), the reference procedures shall-
 - (i) depart from the reference procedures defined in subregulation (2) and (3) only to the extent demanded by those design characteristics which make compliance with the procedures impossible; and
 - (ii) be approved by the certifying authority;
- (e) the reference procedures shall be calculated under the following reference atmospheric conditions:
 - (i) atmospheric pressure at sea level of 1013.25 hPa, decreasing with altitude at a rate defined by the ICAO Standard Atmosphere;
 - (ii) ambient air temperature at sea level of 25°C, decreasing with altitude at a rate defined by the ICAO Standard Atmosphere except that at the discretion of the certifying authority, an alternative ambient air temperature at sea level of 15°C may be used;
 - (iii) constant relative humidity of 70 per cent;
 - (iv) zero wind; and
 - (v) the reference atmosphere in terms of temperature and relative humidity is

considered to be homogeneous which is ambient temperature 25°C and relative humidity 70 per cent for the purpose of calculating:

- (aa) the reference sound attenuation rate due to atmospheric absorption; and
- (bb) the reference speed of sound used in the calculation of the reference sound propagation geometry.

(2) For take-off reference procedure; the take-off flight path shall be calculated as follows:

- (a) average take-off power shall be used from the start of take-off to the point where at least the height above runway level shown below is reached;
- (b) subject to paragraph (a), the take-off 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 subregulation (1)(e);
 - (i) aeroplanes with two engines or less, 300 meters or 984 feet;
 - (ii) aeroplanes with three engines, 260 meters or 853 feet;
 - (iii) aeroplanes with four engines or more, 210 meters or 689 feet;
- (c) upon reaching the height specified in paragraphs (a) and (b) above, the power shall not be reduced below that required to maintain-
 - (i) a climb gradient of 4 per cent; or
 - (ii) in the case of multi-engined aeroplanes, level flight with one engine inoperative; whichever power is the greater;
- (d) the speed shall be 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) and which shall be attained as soon as practicable after lift-off and be maintained throughout the take-off noise certification test;
- (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; and
- (f) the mass of the aeroplane at the brake release shall be the maximum take-off mass at which the noise certification is requested.
- (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) 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 power stabilized during approach and over the measuring point and continued to a normal touchdown;
 - (c) the constant approach configuration used in the airworthiness certification test, 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 paragraph (c) at which noise certification is requested; and
 - (e) the most critical, which produces the highest noise levels, configuration at the mass at which certification is requested shall be used.

Test
procedures

31.-(1) The test procedures shall be acceptable to the airworthiness and noise certificating authority of the state issuing the certificate.

(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 specified in the Second Schedule.

(3) Acoustic data shall be adjusted by the methods outlined in the Second Schedule to the reference conditions specified in this Part.

(4) Subject to subregulations (3), adjustments for speed and thrust shall be made as specified in the Second Schedule.

(5) Where 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.

(6) 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.

(7) The necessary EPNL adjustment for variations in approach flight path from the reference flight path shall not exceed 2 EPNdB.

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

(9) Where 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.

(10) 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 not be within 2 EPNdB of the limit noise levels specified in regulation 28.

(f) Propeller-Driven Aeroplanes Not Exceeding 8618 Kilograms

Application

32. The provisions of this subpart shall apply to propeller-driven aeroplanes not exceeding 8618 kilograms for which the application for type certificate was submitted before 17 November 1988.

Noise evaluation measure

33. The noise evaluation measure shall be a weighted overall sound pressure level as defined in International Electrotechnical Commission Publication No. 179 as amended and the weighting applied to each sinusoidal component of the sound pressure shall be given as a function of frequency by the standard reference curve called "A".

Determination of maximum noise levels

34. For aeroplanes specified in the Second Schedule, the maximum noise levels, when determined in accordance with the noise evaluation method specified in the Fourth Schedule, shall not exceed a 68 dB (A) constant limit up to an aeroplane mass of 600 kilograms, varying linearly with mass

from that point to 1500 kilograms, after which the limit is constant at 80 dB(A) up to 8618 kilograms.

Noise certification reference procedures

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

- (a) atmospheric pressure at sea level of 1013.25 hPa, decreasing with altitude at a rate defined by the ICAO Standard Atmosphere; and
- (b) ambient air temperature at sea level of 25°C, decreasing with altitude at a rate defined by the ICAO Standard Atmosphere.

Test procedures

36.-(1) Either of the test procedures described in subregulation (2) and (3) or equivalent test procedures approved by the certificating authority shall be used.

(2) Tests to demonstrate compliance with the maximum noise levels of specified in regulation 34 shall consist of a series of level flights overhead the measuring station at a height of

$$300 \begin{matrix} +10 \\ -30 \end{matrix} \text{ m } (984 \begin{matrix} +30 \\ -100 \end{matrix} \text{ ft})$$

the aeroplane shall pass over the measuring point within $\pm 10^\circ$ from the vertical.

(3) Overflight shall be performed at the highest power in the normal operating range, normally indicated in the aeroplane flight manual and on the flight instruments, stabilized airspeed and with the aeroplane in the cruise configuration.

(g) Helicopters

Noise evaluation measure

37. The noise evaluation measure shall be the effective perceived noise level in EPNdB as described in the Second Schedule.

Reference noise measurement points

38. A helicopter, when tested in accordance with these Regulations, shall not exceed the noise levels specified in regulation 39 at the following points:

- (a) take-off reference noise measurement points-
 - (i) a flight path reference point located on the ground vertically below the flight path defined in the take-off reference procedure and 500 meters horizontally in the direction of flight from the point at which transition to climbing flight is initiated in the reference procedure prescribed in regulation 37 (2); and
 - (ii) two other points on the ground symmetrically disposed at 150 meters on both sides of the flight path defined in the take-off reference procedure and lying on a line through the flight path reference point;
- (b) overflight reference noise measurement points-
 - (i) a flight path reference point located on the ground 150 meters or 492 feet vertically below the flight path defined in the overflight reference procedure specified in regulation 41 (3)(a); and
 - (ii) two other points on the ground symmetrically disposed at 150 meters on both sides of the flight path defined in the overflight reference procedure and lying on a line through the flight path reference point;
- (c) approach reference noise measurement points-
 - (i) a flight path reference point located on the ground 120 meters or 394 feet vertically below the flight path defined in the approach reference procedure specified in regulation 41 (4) and on level ground, this corresponds to a position 1140 meters from the intersection of the 6.0° approach path with the ground plane; and
 - (ii) two other points on the ground symmetrically disposed at 150 meters on both sides of the flight path defined in the approach

reference procedure and lying on a line through the flight path reference point.

Maximum
noise levels

39.-(1) For helicopters specified in this Part, the maximum noise levels, when determined in accordance with the noise evaluation method specified in the Second Schedule, shall not exceed the following:

- (a) for take-off: 109 EPNdB for helicopters with maximum certificated take-off mass, at which the noise certification is requested, of 80000 kilograms and over and decreasing linearly with the logarithm of the helicopter mass at a rate of 3 EPNdB per halving of mass down to 89 EPNdB after which the limit is constant;
- (b) for overflight: 108 EPNdB for helicopters with maximum certificated take-off mass, at which the noise certification is requested, of 80000 kilograms and over and decreasing linearly with the logarithm of the helicopter mass at a rate of 3 EPNdB per halving of mass down to 88 EPNdB after which the limit is constant; and
- (c) for approach: 110 EPNdB for helicopters with maximum certificated take-off mass, at which the noise certification is requested, of 80000 kilograms and over and decreasing linearly with the logarithm of the helicopter mass at a rate of 3 EPNdB per halving of mass down to 90 EPNdB after which the limit is constant.

(2) For all helicopters, for which the application for the type certificate was submitted on or after 21 March 2002, the maximum noise levels, when determined in accordance with the noise evaluation method specified in the Second Schedule, shall not exceed the following:

- (a) for take-off: 106 EPNdB for helicopters with maximum certificated take-off mass, at which the noise certification is requested, of 8000 kilograms and over and decreasing linearly with the logarithm of the helicopter mass at a rate of 3 EPNdB per halving of mass down to 86 EPNdB after which the limit is constant;

- (b) for overflight: 104 EPNdB for helicopters with maximum certificated take-off mass, at which the noise certification is requested, of 80000 kilograms and over and decreasing linearly with the logarithm of the helicopter mass at a rate of 3 EPNdB per halving of mass down to 84 EPNdB after which the limit is constant; and
- (c) for approach: 109 EPNdB for helicopters with maximum certificated take-off mass, at which the noise certification is requested, of 80000 kilograms and over and decreasing linearly with the logarithm of the helicopter mass at a rate of 3 EPNdB per halving of mass down to 89 EPNdB after which the limit is constant.

Trade-offs

40. Where the noise level limits are exceeded at one or two measurement points-

- (a) the sum of excesses shall not be greater than 4 EPNdB;
- (b) any excess at any single point shall not be greater than 3 EPNdB; and
- (c) any excess shall be offset by corresponding reductions at the other point or points.

Noise certification reference procedures.

41.-(1) The noise certification reference procedures shall meet the following general conditions-

- (a) the reference procedures shall comply with the appropriate airworthiness requirements;
- (b) the reference procedures and flight paths shall be approved by the certifying authority;
- (c) except in conditions specified in paragraph (d), the take-off, overflight and approach reference procedures shall be those defined in subregulations (2), (3) and (4) respectively;
- (d) when it is shown by the applicant that the design characteristics of the helicopter would prevent flight being conducted in accordance with subregulations (2), (3) or (4), the reference procedures shall-
 - (i) depart from the reference procedures defined in subregulations (2), (3) or (4)

- only to the extent demanded by those design characteristics which make compliance with the reference procedures impossible; and
- (ii) be approved by the certificating authority;
- (e) the reference procedures shall be calculated under the following reference atmospheric conditions:
- (i) constant atmospheric pressure of 1013.25 hPa;
 - (ii) constant ambient air temperature of 25°C;
 - (iii) constant relative humidity of 70 per cent; and
 - (iv) zero wind;
- (f) in subregulations (2) (c), (3) (c) and (4) (c) the maximum normal operating rpm shall be taken as the highest rotor speed for each reference procedure corresponding to the airworthiness limit imposed by the manufacturer and approved by the certificating authority;
- (g) where a tolerance on the highest rotor speed is specified, the maximum normal operating rotor speed shall be taken as the highest rotor speed about which that tolerance is given;
- (h) where the rotor speed is automatically linked with flight condition, the maximum normal operating rotor speed corresponding with the reference flight condition shall be used during the noise certification procedure; and
- (i) where the rotor speed can be changed by pilot action, the maximum normal operating rotor speed specified in the flight manual limitation section for the reference conditions shall be used during the noise certification procedure.
- (2) The take-off reference flight procedure shall be established as follows:
- (a) the helicopter shall be stabilized at the maximum take-off power corresponding to minimum installed engine specification power available for the reference ambient conditions or gearbox torque limit, whichever is lower, and along a path starting

from a point located 500 meters prior to the flight path reference point, at 20 meters (65 ft) above the ground;

- (b) the best rate of climb speed, V_Y , or the lowest approved speed for the climb after take-off, whichever is the greater, shall be maintained throughout the take-off reference procedure;
 - (c) the steady climb shall be made with the rotor speed stabilized at the maximum normal operating rpm certificated for take-off;
 - (d) a constant take-off configuration selected by the applicant shall be maintained throughout the take-off reference procedure with the landing gear position consistent with the airworthiness certification tests for establishing the best rate of climb speed, V_Y ;
 - (e) the mass of the helicopter shall be the maximum take-off mass at which noise certification is requested; and
 - (f) the reference take-off path is defined as a straight-line segment inclined from the starting point, 500 meters prior to the centre microphone location and 20 meters (65 ft) above ground level, at an angle defined by best rate of climb and V_Y for minimum specification engine performance.
- (3) The overflight reference procedure shall be established as follows:
- (a) the helicopter shall be stabilized in level flight overhead the flight path reference point at a height of 150 meters (492 ft);
 - (b) a speed of $0.9 V_H$ or $0.9 V_{NE}$ or $0.45 V_H + 120$ km/h ($0.45 V_H + 65$ kt) or $0.45 V_{NE} + 120$ km/h ($0.45 V_{NE} + 65$ kt), whichever is the least, shall be maintained throughout the overflight reference procedure;
 - (c) the overflight shall be made with the rotor speed stabilized at the maximum normal operating rpm certificated for level flight;
 - (d) the helicopter shall be in the cruise configuration; and
 - (e) the mass of the helicopter shall be the maximum

take-off mass at which noise certification is requested.

(4) The value of V_H or V_{NE} used for noise certification shall be quoted in the approved flight manual.

(5) The approach reference procedure shall be established as follows-

- (a) the helicopter shall be stabilized and following a 6.0° approach path;
- (b) the approach shall be made at a stabilized airspeed equal to the best rate of climb speed, V_Y , or the lowest approved speed for the approach, whichever is the greater, with power stabilized during the approach and over the flight path reference point, and continued to a normal touch down;
- (c) the approach shall be made with the rotor speed stabilized at the maximum normal operating rpm certificated for approach;
- (d) the constant approach configuration used in airworthiness certification tests, with the landing gear extended, shall be maintained throughout the approach reference procedure; and
- (e) the mass of the helicopter at touchdown shall be the maximum landing mass at which noise certification is requested.

Test
procedures

42.-(1) The test procedures shall be acceptable to the airworthiness and noise certificating authority of the state issuing the certificate.

(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 specified in the Second shedule.

(3) Test conditions and procedures shall be closely similar to reference conditions and procedures, or the acoustic data shall be adjusted, by the methods outlined in the Second Schedule, to the reference conditions and procedures specified in this Part.

(4) Adjustments for differences between test and reference flight procedures shall not exceed-

(a) for take-off: 4.0 EPNdB, of which the arithmetic sum of Δ_1 and the term $-7.5 \log (QK/QrKr)$ from Δ_2 shall not in total exceed 2.0 EPNdB; and

(b) for overflight or approach: 2.0 EPNdB.

(5) During the test the average rotor rpm shall not vary from the normal maximum operating rpm by more than ± 1.0 per cent during the 10 dB-down period.

(6) The helicopter airspeed shall not vary from the reference airspeed appropriate to the flight demonstration by more than ± 9 km/h (± 5 kt) throughout the 10 dB-down period.

(7) The number of level overflights made with a headwind component shall be equal to the number of level overflights made with a tailwind component.

(8) The helicopter shall fly within $\pm 10^\circ$ or ± 20 meters, whichever is greater, from the vertical above the reference track throughout the 10 dB-down period (refer the Figure below).

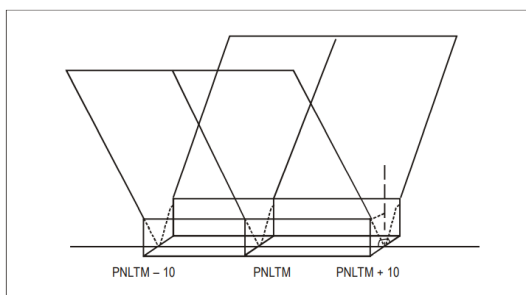


Figure 1: Helicopter lateral deviation tolerances

(9) The helicopter height shall not vary during overflight from the reference height at the overhead point by more than ± 9 meters (± 30 ft).

(10) During the approach noise demonstration, the helicopter shall be established on a stabilized constant speed approach within the airspace contained between approach angles of 5.5° and 6.5° .

(11) Tests shall be conducted at a helicopter mass not less than 90 per cent of the relevant maximum certificated mass and may be conducted at a mass not exceeding 105 per cent of the relevant maximum certificated mass.

(12) For each of the three flight conditions, at least one test shall be completed at or above this maximum certificated mass.

(h) *Installed Auxiliary Power Units and Associated Aircraft Systems During Ground Operations*

Noise certification for installed auxiliary power unit and associated aircraft systems

43. The procedures for noise certification of the installed auxiliary power units and associated aircraft systems shall be prescribed in the technical guidance material issued by the Authority.

(i) *Propeller-Driven Aeroplanes Not Exceeding 8 618 Kilograms — Application for Type Certificate or Certification of Derived Version Submitted on or After 17 November 1988*

Noise evaluation measure

44. The noise evaluation measure shall be the maximum A-weighted noise level (LAS_{max}) as specified in Fifth Schedule.

Reference noise measurement points

45.-(1) An aeroplane, when tested in accordance with these Regulations, shall not exceed the noise level specified in regulation 46 at the take-off reference noise measurement point.

(2) The take-off reference noise measurement point is the point on the extended centre line of the runway at a distance of 2500 meters from the start of take-off roll.

Maximum noise levels

46. The maximum noise levels determined in accordance with the noise evaluation method specified in the Fifth Schedule shall not exceed the following:

- (a) for aeroplanes specified in regulation 2 (k), a 76 dB(A) constant limit up to an aeroplane mass of 600 kilograms varying linearly from that point with the logarithm of aeroplane mass until at 1400 kilograms the limit of 88 dB(A) is reached after which the limit is constant up to 8 618 kilograms; and
- (b) for aeroplanes specified in regulation 2 (k), a 70 dB(A) constant limit up to an aeroplane mass of 570 kilograms increasing linearly from that point with the logarithm of aeroplane mass until at 1500

kilograms the limit of 85 dB(A) is reached after which the limit is constant up to 8 618 kilograms.

Noise
certification
reference
procedures

47.-(1) The noise certification reference procedures shall meet the following general conditions-

- (a) the calculations of reference procedures and flight paths shall be approved by the certifying authority;
- (b) except in conditions specified in paragraph (c), the take-off reference procedure shall be that defined in subregulation (2);
- (c) when it is shown by the applicant that the design characteristics of the aeroplane would prevent flights being conducted in accordance with subregulation (2), the reference procedures shall-
 - (i) depart from the reference procedures defined only to the extent demanded by those design characteristics which make compliance with the procedures impossible; and
 - (ii) be approved by the certifying authority.

(2) The reference procedures shall be calculated under the following atmospheric conditions:

- (i) atmospheric pressure at sea level of 1013.25 hPa, decreasing with altitude at a rate defined by the ICAO Standard Atmosphere;
- (ii) ambient air temperature at sea level of 15°C, decreasing with altitude at a rate defined by the ICAO Standard Atmosphere;
- (iii) constant relative humidity of 70 per cent; and
- (iv) zero wind.

(3) The acoustic reference atmospheric conditions shall be the same as the reference atmospheric conditions for flight.

(4) For Take-off reference procedure, the take-off flight path shall be calculated taking into account the following two phases:

- (a) first phase-

- (i) take-off power shall be used from the brake release point to the point at which the height of 15 meters (50 ft) above the runway is reached;
 - (ii) a constant take-off configuration selected by the applicant shall be maintained throughout this first phase;
 - (iii) the mass of the aeroplane at the brake release shall be the maximum take-off mass at which the noise certification is requested; and
 - (iv) the length of this first phase shall correspond to the length given in the airworthiness data for a take-off on a level paved runway.
- (b) second phase-
- (i) the beginning of the second phase corresponds to the end of the first phase;
 - (ii) the aeroplane shall be in the climb configuration with landing gear up, if retractable, and flap setting corresponding to normal climb throughout this second phase;
 - (iii) the speed shall be the best rate of climb speed, V_Y ;
 - (iv) take-off power and, for aeroplanes equipped with variable pitch or constant speed propellers, rpm shall be maintained throughout the second phase;
 - (v) where airworthiness limitations do not permit the application of take-off power and rpm up to the reference point, then take-off power and rpm shall be maintained for as long as is permitted by such limitations and thereafter at maximum continuous power and rpm;
 - (vi) limiting of time for which take-off power and rpm shall be used in order to comply with this chapter shall not be permitted; and
 - (vii) the reference height shall be calculated

assuming climb gradients appropriate to each power setting used.

Test procedures

48.-(1) The test procedures shall be acceptable to the airworthiness and noise certifying authorities of the State issuing the certificate.

(2) The test procedures and noise measurements shall be conducted and processed in an approved manner to yield the noise evaluation measure in units of L_{ASmax} as specified in the Fifth Schedule.

(3) Acoustic data shall be adjusted by the methods outlined in the Sixth Schedule to the reference conditions specified in this Part.

(4) Where equivalent test procedures are used, the test procedures and all methods for correcting the results to the reference procedures shall be approved by the certifying authority.

(j) Helicopters Not Exceeding 3175 Kilograms Maximum Certificated Take-Off Mass

Noise evaluation measure

49. The noise evaluation measure shall be the sound exposure level L_{AE} as specified in the Sixth Schedule.

Reference noise measurement points

50. A helicopter, when tested in accordance with these Standards, shall not exceed the noise levels specified in regulation 51 at a flight path reference point located on the ground 150 meters (492 ft) vertically below the flight path defined in the overflight reference procedure specified in regulation 52 (2) (a).

Maximum noise level

51.-(1) For helicopters specified in regulation 2(j), the maximum noise levels, when determined in accordance with the noise evaluation method specified in the Sixth Schedule, shall not exceed 82 dB(A) for helicopters with maximum certificated take-off mass, at which the noise certification is requested, of up to 788 kilograms and increasing linearly with the logarithm of the helicopter mass at a rate of 3 decibels per doubling of mass thereafter.

(2) For all helicopters for which the application for the

type certificate was submitted on or after 21 March 2002, the maximum noise levels, when determined in accordance with the noise evaluation method specified in the Sixth Schedule, shall not exceed 82 dB(A) for helicopters with maximum certificated take-off mass, at which the noise certification is requested, of up to 1 417 kilograms and increasing linearly with the logarithm of the helicopter mass at a rate of 3 decibels per doubling of mass thereafter.

Noise
certification
reference
procedures

52.-(1) The noise certification reference procedures shall meet the following general conditions-

- (a) the reference procedure shall comply with the appropriate airworthiness requirements and shall be approved by the certifying authority;
- (b) except as otherwise approved, the overflight reference procedures shall be as defined in subregulation (2);
- (c) when it is shown by the applicant that the design characteristics of the helicopter would prevent flight being conducted in accordance with subregulation (2) the reference procedure shall be permitted to depart from the standard reference procedure, with the approval of the certifying authority, but only to the extent demanded by those design characteristics which make compliance with the reference procedures impossible;
- (d) the reference procedures shall be established for the following reference atmospheric conditions:
 - (i) constant atmospheric pressure of 1013.25 hPa;
 - (ii) constant ambient air temperature of 25°C;
 - (iii) constant relative humidity of 70 per cent; and
 - (iv) zero wind.
- (e) the maximum normal operating rpm shall be taken as the highest rotor speed corresponding to the airworthiness limit imposed by the manufacturer and approved by the certifying authority for overflight;
- (f) where a tolerance on the highest rotor speed is

specified, the maximum normal operating rotor speed shall be taken as the highest rotor speed about which that tolerance is given;

- (g) where rotor speed is automatically linked with flight condition, the maximum normal operating rotor speed corresponding with the reference flight condition shall be used during the noise certification procedure; and
- (h) where rotor speed can be changed by pilot action, the maximum normal operating rotor speed specified in the flight manual limitation section for the reference conditions shall be used during the noise certification procedure.

(2) Reference procedure-

- (a) the reference procedure shall be established as follows:
 - (i) the helicopter shall be stabilized in level flight overhead the flight path reference point at a height of 150 meters \pm 15 meters (492 ft \pm 50 ft);
 - (ii) a speed of $0.9 V_H$ or $0.9 V_{NE}$ or $0.45 V_H + 120$ km/h (65 kt) or $0.45 V_{NE} + 120$ km/h (65 kt), whichever is the least, shall be maintained throughout the overflight procedure;
 - (iii) for noise certification purposes, V_H is defined as the airspeed in level flight obtained using the torque corresponding to minimum engine installed, maximum continuous power available for sea level pressure (1013.25 hPa), 25°C ambient conditions at the relevant maximum certificated mass;
 - (iv) the overflight shall be made with the rotor speed stabilized at the maximum normal operating rpm certificated for level flight;
 - (v) the helicopter shall be in the cruise configuration; and

- (vi) the mass of the helicopter shall be the maximum take-off mass at which noise certification is requested.

(3) The value of V_H or V_{NE} used for noise certification shall be quoted in the approved flight manual.

(4) For the purpose of this regulation " V_{NE} " means the not-to-exceed airworthiness airspeed imposed by the manufacturer and approved by the certifying authority.

Test
procedures

53.-(1) The test procedures shall be acceptable to the airworthiness and noise certifying authorities of the State issuing the certificate.

(2) The test procedure and noise measurements shall be conducted and processed in an approved manner to yield the noise evaluation measure designated as sound exposure level (L_{AE}), in A-weighted decibels integrated over the duration time, as specified in the Sixth Schedule.

(3) Test conditions and procedures shall be closely similar to reference conditions and procedures, or the acoustic data shall be adjusted, by the methods outlined in the Sixth Schedule, to the reference conditions and procedures specified in this Part.

(4) During the test, flights shall be made in equal numbers with tailwind and headwind components.

(5) Adjustments for differences between test and reference flight procedures shall not exceed 2.0 dB(A).

(6) During the test, the average rotor rpm shall not vary from the normal maximum operating rpm by more than ± 1.0 per cent during the 10 dB-down period.

(7) The helicopter airspeed shall not vary from the reference airspeed appropriate to the flight demonstration as specified in the Sixth Schedule by more than ± 5.5 km/h (± 3 kt) throughout the 10 dB-down period.

(8) The helicopter shall fly within $\pm 10^\circ$ from the vertical above the reference track through the reference noise measurement position.

(9) Tests shall be conducted at a helicopter mass not less than 90 per cent of the relevant maximum certificated mass and may be conducted at a mass not exceeding 105 per cent of the relevant maximum certificated mass.

(k) *Supersonic Aeroplanes*

Supersonic aeroplanes

—
Application for Type Certificate submitted before 1 January 1975

54.-(1) The requirements of Part, II (b) with the exception of the maximum noise levels specified in regulation 7, shall be applicable to all supersonic aeroplanes, including their derived versions, for which the application for the Type Certificate was submitted before 1 January 1975, and for which a certificate of airworthiness for the individual aeroplane was first issued after 26 November 1981.

(2) The maximum noise levels of those aeroplanes covered by subregulation (1), when determined in accordance with the noise evaluation method specified in the First Schedule, shall not exceed the measured noise levels of the first certificated aeroplane of the type.

Supersonic aeroplanes

—
Application for Type Certificate submitted on or after 1 January 1975

55.-(1) The requirements for these aeroplanes have not been developed.

(2) Notwithstanding subregulation (1), the maximum noise levels of the Part that would be applicable to subsonic jet aeroplanes may be used as a guideline.

(3) Notwithstanding subregulation (1), acceptable levels of sonic boom have not been established and compliance with subsonic noise Standards may not be presumed to permit supersonic flight.

(l) *Tilt-Rotors*

Noise evaluation measure

56.-(1) The noise evaluation measure shall be the effective perceived noise level in EPNdB as specified in the Second Schedule.

(2) The correction for spectral irregularities shall start at 50Hz in accordance with the Second Schedule.

Noise measurement reference points

57. A tilt-rotor, when tested in accordance with the reference procedures of regulation 60 and the test procedures of regulation 51, shall not exceed the noise levels specified in regulation 58 at the following reference points:

(a) take-off reference noise measurement points-

(i) a flight path reference point located on the ground vertically below the flight path

- defined in the take-off reference procedure specified in regulation 60 (2) and 500 meters or 1640 feet horizontally in the direction of flight from the point at which transition to climbing flight is initiated in the reference procedure; and
- (ii) two other points on the ground symmetrically disposed at 150 meters or 492 feet on both sides of the flight path defined in the take-off reference procedure and lying on a line through the flight path reference point;
- (b) overflight reference noise measurement points-
- (i) a flight path reference point located on the ground 150 meters or 492 feet vertically below the flight path defined in the overflight reference procedure specified in regulation 60 (3); and
 - (ii) two other points on the ground symmetrically disposed at 150 meters or 492 feet on both sides of the flight path defined in the overflight reference procedure and lying on a line through the flight path reference point;
- (c) approach reference noise measurement points-
- (i) a flight path reference point located on the ground 120 meters or 394 feet vertically below the flight path defined in the approach reference procedure specified in regulation 60(4), on level ground, this corresponds to a position 1140 meters or 3740 feet from the intersection of the 6.0° approach path with the ground plane; and
 - (ii) two other points on the ground symmetrically disposed at 150 meters or 492 feet on both sides of the flight path defined in the approach reference procedure and lying on a line through the flight path reference point.

Maximum

58. For tilt-rotors specified in regulation 2(1)(n) the

- noise levels maximum noise levels, when determined in accordance with the noise evaluation method specified in the Second Schedule for helicopters, shall not exceed the following:
- (a) for take-off: 109 EPNdB for tilt-rotors in VTOL/conversion mode with maximum certificated take-off mass, at which the noise certification is requested, of 80000 kilograms and over and decreasing linearly with the logarithm of the tilt-rotor mass at a rate of 3 EPNdB per halving of mass down to 89 EPNdB after which the limit is constant;
 - (b) for overflight: 108 EPNdB for tilt-rotors in VTOL/conversion mode with maximum certificated take-off mass, at which the noise certification is requested, of 80000 kilograms and over and decreasing linearly with the logarithm of the tilt-rotor mass at a rate of 3 EPNdB per halving of mass down to 88 EPNdB after which the limit is constant VTOL/conversion mode is all approved configurations and flight modes where the design operating rotor speed is that used for hover operations; and
 - (c) for approach: 110 EPNdB for tilt-rotors in VTOL/conversion mode with maximum certificated take-off mass, at which the noise certification is requested, of 80000 kilograms and over and decreasing linearly with the logarithm of the tilt-rotor mass at a rate of 3 EPNdB per halving of mass down to 90 EPNdB after which the limit is constant.

- Trade-offs **59.** Where the maximum noise levels are exceeded at one or two measurement points:
- (a) the sum of excesses shall not be greater than 4 EPNdB;
 - (b) any excess at any single point shall not be greater than 3 EPNdB; and
 - (c) any excess shall be offset by corresponding reductions at the other point or points.

- Noise **60.**-(1) The noise certification reference procedures

certification
reference
procedures

shall meet the following general conditions-

- (a) the reference procedures shall comply with the appropriate airworthiness requirements;
- (b) the reference procedures and flight paths shall be approved by the certifying authority;
- (c) except in conditions specified in paragraph (d), the take-off, overflight and approach reference procedures shall be those defined in subregulations (2), (3) and (4), respectively;
- (d) when it is shown by the applicant that the design characteristics of the tiltrotor would prevent a flight from being conducted in accordance with subregulations (2), (3) or (4), the reference procedures shall-
 - (i) depart from the reference procedures defined in subregulation (2), (3) or (4) only to the extent demanded by those design characteristics which make compliance with the reference procedures impossible; and
 - (ii) be approved by the certifying authority;
- (e) the reference procedures shall be calculated under the following reference atmospheric conditions:
 - (i) constant atmospheric pressure of 1013.25 hPa;
 - (ii) constant ambient air temperature of 25°C, i.e. ISA + 10°C;
 - (iii) constant relative humidity of 70 per cent; and
 - (iv) zero wind;
- (f) in subregulation (2) (d), (3) (d) and (4) (c), the maximum normal operating rpm shall be taken as the highest rotor speed for each reference procedure corresponding to the airworthiness limit imposed by the manufacturer and approved by the certifying authority;
- (g) where a tolerance on the highest rotor speed is specified, the maximum normal operating rotor speed shall be taken as the highest rotor speed about which that tolerance is given;
- (h) where the rotor speed is automatically linked with

the flight condition, the maximum normal operating rotor speed corresponding with the reference flight condition shall be used during the noise certification procedure; and

- (i) where the rotor speed can be changed by pilot action, the maximum normal operating rotor speed specified in the flight manual limitation section for the reference conditions shall be used during the noise certification procedure.
- (2) The take-off reference flight procedure shall be established as follows:
 - (a) a constant take-off configuration, including nacelle angle, selected by the applicant shall be maintained throughout the take-off reference procedure;
 - (b) the tilt-rotor shall be stabilized at the maximum take-off power corresponding to minimum installed engine specification power available for the reference ambient conditions or gearbox torque limit, whichever is lower, and along a path starting from a point located 500 meters (1640 ft) prior to the flight path reference point, at 20 meters (65 ft) above the ground;
 - (c) the nacelle angle and the corresponding best rate of climb speed, or the lowest approved speed for the climb after take-off, whichever is the greater, shall be maintained throughout the take-off reference procedure;
 - (d) the steady climb shall be made with the rotor speed stabilized at the maximum normal operating rpm certificated for take-off;
 - (e) the mass of the tilt-rotor shall be the maximum take-off mass at which noise certification is requested; and
 - (f) the reference take-off path is defined as a straight-line segment inclined from the starting point (500 meters (1640 ft) prior to the centre noise measurement point and 20 meters (65 ft) above ground level) at an angle defined by best rate of climb and the best rate of climb speed corresponding to the selected nacelle angle and for

minimum specification engine performance.

(3) The overflight reference procedure shall be established as follows:

- (a) the tilt-rotor shall be stabilized in level flight overhead the flight path reference point at a height of 150 meters (492 ft);
- (b) a constant configuration selected by the applicant shall be maintained throughout the overflight reference procedures;
- (c) the mass of the tilt-rotor shall be the maximum take-off mass at which noise certification is requested;
- (d) in the VTOL/conversion mode, the nacelle angle at the authorized fixed operation point that is closest to the lowest nacelle angle certificated for zero airspeed, a speed of $0.9 V_{CON}$ and a rotor speed stabilized at the maximum normal operating rpm certificated for level flight shall be maintained throughout the overflight reference procedure;
- (e) for noise certification purposes, V_{CON} is defined as the maximum authorized speed for VTOL/conversion mode at a specific nacelle angle;
- (f) in the aeroplane mode, the nacelles shall be maintained on the down-stop throughout the overflight reference procedure, with:
 - (i) rotor speed stabilized at the rpm associated with the VTOL/conversion mode and a speed of $0.9 V_{CON}$;
 - (ii) rotor speed stabilized at the normal cruise rpm associated with the aeroplane mode and at the corresponding $0.9 V_{MCP}$ or $0.9 V_{MO}$, whichever is lesser, certificated for level flight;
 - (iii) for noise certification purposes, V_{MCP} is defined as the maximum operating limit airspeed for aeroplane mode corresponding to minimum engine installed, maximum continuous power available for sea level pressure (1 013.25 hPa), 25°C ambient conditions at the relevant maximum

- certificated mass; and V_{MO} is the maximum operating limit airspeed that may not be deliberately exceeded; and
- (iv) the values of V_{CON} and V_{MCP} or V_{MO} used for noise certification shall be quoted in the approved flight manual.
- (4) The approach reference procedure shall be established as follows:
- (a) the tilt-rotor shall be stabilized and follow a 6.0° approach path;
- (b) the approach shall be in an airworthiness approved configuration in which maximum noise occurs, at a stabilized airspeed equal to the best rate of climb speed corresponding to the nacelle angle, or the lowest approved airspeed for the approach, whichever is the greater, and with power stabilized during the approach and over the flight path reference point, and continued to a normal touchdown;
- (c) the approach shall be made with the rotor speed stabilized at the maximum normal operating rpm certificated for approach;
- (d) the constant approach configuration used in airworthiness certification tests, with the landing gear extended, shall be maintained throughout the approach reference procedure; and
- (e) the mass of the tilt-rotor at touchdown shall be the maximum landing mass at which noise certification is requested.

Test
procedures

61.-(1) The test procedures shall be acceptable to the airworthiness and noise certificating authority of the State issuing the certificate.

(2) The test procedures and noise measurements shall be conducted and processed in an approved manner to yield the noise evaluation measure designated in regulation 56.

(3) Test conditions and procedures shall be similar to reference conditions and procedures, or the acoustic data shall be adjusted, by the methods outlined in the Second Schedule for helicopters, to the reference conditions and procedures specified in this Part.

(4) Adjustments for differences between test and reference flight procedures shall not exceed-

(a) for take-off: 4.0 EPNdB, of which the arithmetic sum of Δ_1 and the term $-7.5 \log QK/QrKr$ from Δ_2 shall not in total exceed 2.0 EPNdB; and

(b) for overflight or approach: 2.0 EPNdB.

(5) During the test the average rotor rpm shall not vary from the normal maximum operating rpm by more than ± 1.0 per cent throughout the 10 dB-down period.

(6) The airspeed of the tilt-rotor shall not vary from the reference airspeed appropriate to the flight demonstration by more than ± 9 km/h (± 5 kt) throughout the 10 dB-down period.

(7) The number of level overflights made with a headwind component shall be equal to the number of level overflights made with a tailwind component.

(8) The tilt-rotor shall fly within $\pm 10^\circ$ or ± 20 m (± 65 ft), whichever is greater, from the vertical above the reference track throughout the 10 dB-down period as specified in in regulation 42 (8).

(9) The height of the tilt-rotor shall not vary during overflight from the reference height throughout the 10 dB-down period by more than ± 9 m (± 30 ft).

(10) During the approach noise demonstration, the tilt-rotor shall be established on a stabilized constant speed approach within the airspace contained between approach angles of 5.5° and 6.5° throughout the 10 dB-down period.

(11) Tests shall be conducted at a tilt-rotor mass not less than 90 per cent of the relevant maximum certificated mass and may be conducted at a mass not exceeding 105 per cent of the relevant maximum certificated mass.

(12) For each of the flight conditions, at least one test shall be completed at or above this maximum certificated mass.

(m) Subsonic Jet Aeroplanes and Propeller-Driven Aeroplanes

Application

- 62.** The provisions of this subpart shall apply to-
- (a) subsonic jet aeroplanes and propeller-driven aeroplanes with maximum certificated take-off mass 55000 kilograms and over-application for type certificate submitted on or after 31 December 2017;
 - (b) subsonic jet aeroplanes with maximum certificated take-off mass less than 55000 kilograms-application for type certificate submitted on or after 31 December 2020;
 - (c) propeller-driven aeroplanes with maximum certificated take-off mass over 8 618 kilograms and less than 55 000 kilograms- application for type certificate submitted on or after 31 December 2020.

Noise evaluation measure

63. The noise evaluation measure shall be the effective perceived noise level in EPNdB as specified in the Second Schedule.

Reference noise measurement points

64.-(1) An aeroplane, when tested in accordance with these Regulations, shall not exceed the maximum noise level specified in regulation 65 of the noise measured at the points specified in regulation 13.

(2) The requirements of regulation 15, relating to test noise measurement points shall apply.

Maximum noise levels

65. The maximum noise levels, when determined in accordance with the noise evaluation method specified in the Second Schedule, shall not exceed the following:

- (a) 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 400000 kilograms and over, decreasing linearly with the logarithm of the mass down to 94 EPNdB at 35000 kilograms, after which the limit is constant to 8618 kilograms, where it decreases linearly with the logarithm of the mass down to 88.6 EPNdB at 2000 kilograms;

- (b) at the flyover reference noise measurement point:
 - (i) aeroplanes with two engines or less: 101 EPNdB for aeroplanes with maximum certificated take-off mass, at which the noise certification is requested, of 385000 kilograms and over, decreasing linearly with the logarithm of the mass at the rate of 4 EPNdB per halving of mass down to 89 EPNdB, after which the limit is constant to 8618 kilograms, where it decreases linearly with the logarithm of the mass at a rate of 4 EPNdB per halving of mass down to 2000 kilograms, after which the limit is constant; after which the limit is constant;
 - (ii) aeroplanes with three engines: As aeroplanes with two engines or less but with 104 EPNdB for aeroplanes with maximum certificated take-off mass of 385000 kilograms and over; and
 - (iii) aeroplanes with four engines or more: As aeroplanes with two engines or less but with 106 EPNdB for aeroplanes with maximum certificated take-off mass of 385000 kilograms and over;
- (c) at the approach reference noise measurement point: 105 EPNdB for aeroplanes with maximum certificated take-off mass, at which the noise certification is requested, of 280000 kilograms and over, decreasing linearly with the logarithm of the mass down to 98 EPNdB at 35000 kilograms, after which the limit is constant to 8618 kilograms, where it decreases linearly with the logarithm of the mass down to 93.1 EPNdB at 2000 kilograms, after which the limit is constant;
- (d) the sum of the differences at all three measurement points between the maximum noise levels and the maximum permitted noise levels specified in paragraphs (a), (b) and (c), shall not be less than 17 EPNdB; and
- (e) the maximum noise level at each of the three measurement points shall not be less than 1

EPNdB below the corresponding maximum permitted noise level specified in paragraphs (a), (b) and (c).

Noise certification reference procedures

66. The noise certification reference procedures shall be as specified in Regulations 17.

Test procedures

67. The test procedures for part shall be as specified in regulation 17.

Certification

68. For aeroplanes specified in the Second Schedule, certification shall be granted on the basis that the evidence used to determine compliance with this Part is as satisfactory as the evidence associated with aeroplanes specified in the Second Schedule.

PART III

NOISE MEASUREMENT FOR MONITORING PURPOSES AND ASSESSMENT OF AIRPORT NOISE

Noise Measurement for monitoring purposes

69. Where the measurement of aircraft noise is made for monitoring purposes, the method specified in the Third Schedule to these regulations shall apply.

Assessment of airport noise

70.-(1) Where international comparison of noise assessment around airports is undertaken, the methodology prescribed by the authority for Computing Noise Contours Around Airports shall be used.

(2) Subject to subregulation (1), where the appropriate authority has not yet adopted, or are considering changing a national noise assessment methodology, shall use the methodology for Computing Noise Contours Around Airports prescribed by the Authority.

PART IV

BALANCED APPROACH TO NOISE MANAGEMENT

Balanced approach to noise

71.-(1) Aircraft operating procedures for noise abatement shall be introduced by the authority, after

management appropriate studies and consultation determines that a noise problem exists.

(2) Aircraft operating procedures for noise abatement shall be developed in consultation with operators that use the aerodrome concerned.

(3) The factors to be taken into consideration in the development of appropriate aircraft operating procedures for noise abatement should include the following:

(a) the nature and extent of the noise problem including-

- (i) the location of noise-sensitive areas; and
- (ii) critical hours;

(b) the types of aircraft affected, including aircraft mass, aerodrome elevation, temperature considerations;

(c) the types of procedures likely to be most effective;

(d) obstacle clearances; and

(e) human performance in the application of the operating procedures.

(4) The Authority shall develop guideline to assist planning authorities in taking appropriate measures and guidelines to ensure compatible land-use management around airports to the benefit of both the airport and the surrounding communities.

PART V EXEMPTIONS

Requirements
for
application
for exemption

72.-(1) A person may apply to the Authority for an exemption from any provision of these Regulations.

(2) Save for cases of emergency, a person requiring exemptions from any of these Regulations shall make an application to the Authority at least sixty days prior to the proposed effective date, giving the following information:

(a) name and contact address including electronic mail and fax if any;

(b) telephone number;

(c) a citation of the specific requirement from which the applicant apply for exemption;

(d) justification for the exemption;

- (e) a description of the type of operations to be conducted under the proposed exemption;
- (f) the proposed duration of the exemption;
- (g) an explanation of how the exemption would be in the public interest;
- (h) a detailed description of the alternative means by which the applicant will ensure a level of safety equivalent to that established by the regulation in question;
- (i) a safety risk assessment carried out in respect of the exemption applied for;
- (j) where the applicant handles international operations and seeks to operate under the proposed exemption, an indication whether the exemption would contravene any provision of these Regulations; and
- (k) any other information that the Authority may require.

(3) Where the applicant applies the emergency processing of an application for exemption, the application shall contain supporting facts and reasons for not filing the application within the time specified in subregulation (2) and satisfactory reason for deeming the application an emergency.

(4) The Authority may, in writing, refuse an application made under subregulation (3), where the Authority is not satisfied with the reasons given for the emergency.

(5) The application for exemption shall be accompanied by a fee to be prescribed by the Authority.

Review and
publication

73.-(1) The Authority shall review the application for exemption made and upon being satisfied that the application complies with the requirements of regulation 67, publish a detailed summary of the application for comments, within a prescribed time, in either-

- (a) the *Gazette*;
- (b) aeronautical information circular; or
- (c) widely circulated newspaper.

(2) Where application requirements have not been fully complied with, the Authority shall request the applicant in writing, to comply with the necessary requirements prior to

publication or making a decision.

(3) Where the request is for emergency relief, the Authority shall publish the decision as soon as possible after processing the application.

Evaluation of request

74.-(1) Where the application requirements have been satisfied, the Authority shall conduct an evaluation of the request to-

- (a) determine whether an exemption is in the public interest;
- (b) determine, after a technical evaluation, whether the applicant's proposal would provide a level of safety equivalent to that established by the relevant regulation, although where the Authority decides that a technical evaluation of the request would impose a significant burden on the Authority's technical resources, and the Authority may deny the exemption on that basis;
- (c) determine of whether the grant of the exemption would contravene these Regulations; and
- (d) grant or deny the exemption based on the preceding elements, and with or without conditions..

(2) The Authority shall notify the applicant in writing of, the decision to grant or deny the request and publish a detailed summary of its evaluation and decision.

(3) The summary referred to in subregulation (2) shall specify the duration of the exemption and any conditions or limitations of the exemption.

(4) Where the exemption affects a significant population of the aviation community of the United Republic of Tanzania the Authority shall publish the summary in aeronautical information circular.

PART VI MISCELLANEOUS PROVISIONS

Suspension and revocation

75. (1) The Authority may, where a person contravenes any condition prescribed in the noise

certificate or exemption document granted under these Regulations, revoke or suspend such certificate or document.

(2) The Authority shall, before suspending or revoking the certificate or exemption document, issue fourteen days' notice, to holder in writing stating its intention to suspend or revoke the certificate, or exemption document and the reasons thereof.

(3) A holder of the certificate, or exemption document may, within fourteen days from the receipt of notice, submit his response to the Authority.

(4) The Authority may, where a holder of the certificate or exemption document fails to respond within prescribed period or provide unsatisfactory response, continue to suspend or revoke the acceptance certificate or exemption document, as the case may be.

Offences and penalties

76. A person who contravenes any provision of these Regulations commits an offence and on conviction shall be liable to a penalty provided in the Act.

FIRST SCHEDULE

(Made under regulation 5, 7(1) and (2) and 54(2))

EVALUATION METHOD FOR NOISE CERTIFICATION OF SUBSONIC JET AEROPLANES — Application for Type Certificate submitted before 6 October 1977

Note 1.— Refer Part 3

Note 2.— The procedures in this Schedule also apply to certain aircraft types covered in Part 6 and 13.

1. INTRODUCTION

Note 1.— This noise evaluation method includes-

- (a) noise certification test and measurement conditions;*
- (b) measurement of aeroplane noise received on the ground;*
- (c) calculation of effective perceived noise level from measured noise data; and*

(d) reporting of data to the certificating authority and correcting measured data.

Note 2.— The instructions and procedures given in the method are clearly delineated to ensure uniformity during compliance tests, and to permit comparison between tests of various types of aeroplanes, conducted in various geographical locations. It applies only to aeroplanes within the applicability clauses of Part 3.

Note 3.— A complete list of symbols and units, the mathematical formulation of perceived noisiness, a procedure for determining atmospheric attenuation of sound, and detailed procedures for correcting noise levels from non-reference to reference conditions are included in Sections 6 to 9 of this Schedule.

2. NOISE CERTIFICATION TEST AND MEASUREMENT CONDITIONS

2.1 General

This section prescribes the conditions under which noise certification tests shall be conducted and the measurement procedures that shall be used.

Note. — Many applications for a noise certificate involve only minor changes to the aeroplane type design. The resultant changes in noise can often be established reliably without the necessity of resorting to a complete test as outlined in this Schedule. For this reason, certificating authorities are encouraged to permit the use of appropriate “equivalent procedures. Also, there are equivalent procedures that may be used in full certification tests, in the interest of reducing costs and providing reliable results. Guidance material on the use of equivalent procedures in the noise certification of subsonic jet aeroplanes is provided in the Environmental Technical Manual (Doc 9501), Volume I— Procedures for the Noise Certification of Aircraft.

2.2 General test conditions

2.2.1 Tests to show compliance with established noise certification levels shall consist of a series of take-offs and landings during which measurements shall be taken at the measuring points specified by the certificating authority. These points are typically-

- (a) the flyover noise measurement point;¹
- (b) the approach noise measurement point; and
- (c) the lateral noise measurement point(s),²

which for noise certification purposes are specified in Part 3, to ensure that the maximum subjective noise level along the lateral is obtained, a sufficient number of lateral stations shall be used, to establish whether any asymmetry exists in the noise field at least one measuring station shall be located along the alternative lateral on each test take-off simultaneous measurements shall be made at the lateral measuring points on both sides of the runway and also at the take-off flyover measuring point.

¹ . Sometimes referred to as the take-off noise measurement point.

² . Sometimes referred to as the sideline measurement point(s).

2.2.2 Locations for measuring noise from an aeroplane in flight shall be surrounded by relatively flat terrain having no excessive sound absorption characteristics such as might be caused by thick, matted or tall grass, shrubs or wooded areas, no obstructions which significantly influence the sound field from the aeroplane shall exist within a conical space above the measurement position, the cone being defined by an axis normal to the ground and by a half-angle 75° from this axis and if the height of the ground at any measuring point differs from that of the nearest point on the runway by more than 6 meters (20 ft), corrections shall be made.

Note. — *Those people carrying out the measurements could themselves constitute such obstructions.*

2.2.3 The tests shall be carried out under the following atmospheric conditions:

- (a) no precipitation;
- (b) relative humidity not higher than 90 per cent or lower than 30 per cent;
- (c) ambient temperature not above 30°C and not below 2°C at 10 m (33 ft) above ground;
- (d) average wind speed not exceeding 5.1 m/s (10 kt) and average crosswind component not exceeding 2.6 m/s (5 kt) at 10 meters (33 ft) above ground, a 30-second averaging period spanning the 10 dB-down time interval is recommended:

Note. — *The noise certification test windows for wind speed expressed in m/s are the result of converting historically used values expressed in knots using a conversion factor consistent with the, Civil Aviation (Units of Measurements to be used in air and ground operations) Regulations, and rounded to 0.1 m/s. The values as given here, expressed in either unit, are considered equivalent for establishing adherence to the wind speed test windows for noise certification purposes.*

- (e) no temperature inversion or anomalous wind conditions that would significantly affect the noise level of the aeroplane when the noise is recorded at the measuring points specified by the certifying authority.

2.3 Aeroplane testing procedures

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

2.3.2 The aeroplane testing 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 Section 4 of this Schedule.

2.3.3 The aeroplane height and lateral position relative to the extended centre line of the runway shall be determined by a method independent of normal flight

instrumentation, such as radar tracking, theodolite triangulation or photographic scaling techniques, to be approved by the certifying authority.

2.3.4 The aeroplane position along the flight path shall be related to the noise recorded at the noise measurement locations by means of synchronizing signals, the position of the aeroplane shall be recorded relative to the runway from a point at least 7.4 kilometers (4 NM) from threshold during the approach and at least 11 km (6 NM) from the start of roll during take-off.

2.3.5 If the take-off test is conducted at a mass different from the maximum take-off mass at which noise certification is requested, the necessary EPNL correction shall not exceed 2 EPNdB. If the approach test is conducted at a mass different from the maximum landing mass at which noise certification is requested, the EPNL correction shall not exceed 1 EPNdB. 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.

2.4 Measurements

2.4.1 Position and performance data required to make the corrections referred to in Section 5 of this Schedule shall be automatically recorded at an approved sampling rate. The position of the aeroplane shall be recorded relative to the runway from a point at least 7.4 kilometers (4 NM) from threshold to touchdown during the approach and at least 11 kilometers (6 NM) from the start of roll during the take-off. Measuring equipment shall be approved by the certifying authority.

2.4.2 Position and performance data shall be corrected by the methods outlined in Section 5 of this appendix to the meteorological reference conditions specified in 5.3 a).

2.4.3 Acoustic data shall be corrected by the methods outlined in Section 5 of this appendix to the meteorological reference conditions specified in 5.3 a) 1), 2) and 3), acoustic data corrections shall also be made for variations of the test minimum distance from the reference minimum distance between the aeroplane's approach path and the approach measuring point, a take-off path vertically above the flyover measuring point and for differences of more than 6 meters (20 ft) in elevation of measuring locations relative to the elevation of the nearest point of the runway.

2.4.4 The aerodrome tower or another facility shall be approved for use as the central location at which measurements of atmospheric parameters are representative of those conditions existing over the geographical area in which aeroplane noise measurements are made, however, the surface wind velocity and ambient air temperature shall be measured near the microphone position at the approach, sideline, and take-off measurement locations, and the tests shall not be acceptable unless the conditions conform to Section 2 of this schedule.

3. MEASUREMENT OF AEROPLANE NOISE RECEIVED ON THE GROUND

3.1 General

3.1.1 The measurements shall provide the data for determining one-third octave band noise produced by aeroplanes during flight, at any required observation stations, as a function of time.

3.1.2 Methods for determination of the distance from the observation stations to the aeroplane shall include theodolite triangulation techniques, scaling aeroplane dimensions on photographs made as the aeroplane flies directly over the measurement points, radar altimeters, and radar tracking systems and the method used shall be approved by the certificating authority.

3.1.3 Sound pressure level data for noise evaluation purposes shall be obtained with approved acoustical equipment and measurement practices that conform to the specifications given hereunder (in 3.2 to 3.4).

3.2 Measurement system

3.2.1 The acoustical measurement system shall consist of approved equipment equivalent to the following:

- (a) a microphone system with frequency response compatible with measurement and analysis system accuracy as stated in 3.3;
- (b) tripods or similar microphone mountings that minimize interference with the sound being measured;
- (c) recording and reproducing equipment characteristics, frequency response, and dynamic range compatible with the response and accuracy requirements of 3.3;
- (d) acoustic calibrators using sine wave or broadband noise of known sound pressure level. If broadband noise is used, the signal shall be described in terms of its average and maximum root-mean-square (rms) value for non-overload signal level;
- (e) analysis equipment with the response and accuracy requirements of 3.4.

3.3 Sensing, recording and reproducing equipment

3.3.1 The sound produced by the aeroplane shall be recorded in such a way that the complete information, time history included, is retained.

3.3.2 The characteristics of the system shall comply with the recommendations given in International Electrotechnical Commission (IEC) Publication No. 179³ with regard to the sections concerning microphone and amplifier characteristics.

3.3.3 The response of the complete system to a sensibly plane progressive sinusoidal wave of constant amplitude shall lie within the tolerance limits specified in IEC Publication No. 179 as amended from time to time, over the frequency range 45 to 11 200 Hz.

³ . As amended.

3.3.4 If limitations of the dynamic range of the equipment make it necessary, high frequency pre-emphasis shall be added to the recording channel with the converse de-emphasis on playback. The pre-emphasis shall be so applied that the instantaneous recorded sound pressure level between 800 and 11 200 Hz of the maximum measured noise signal does not vary more than 20 dB between the levels of the maximum and minimum one-third octave bands.

3.3.5 The equipment shall be acoustically calibrated using facilities for acoustic free-field calibration and electronically calibrated as stated in 3.4.

3.3.6 A windscreen shall be employed with the microphone during all measurements of aeroplane noise when the wind speed is in excess of 3 m/s (6 kt). Corrections for any insertion loss produced by the windscreen, as a function of frequency, shall be applied to the measured data and the corrections applied shall be reported.

3.4 Analysis equipment

3.4.1 A frequency analysis of the acoustical signal shall be performed in a manner equivalent to using one-third octave filters complying with the recommendations given in IEC Publication No. 225 as amended from time to time.

Note.— The text and specifications of IEC Publication No. 225⁵ entitled “Octave, Half-Octave and Third-Octave Band Filters Intended for the Analysis of Sounds and Vibrations” are incorporated by reference into this appendix and are made a part hereof.⁴

3.4.2 A set of 24 consecutive one-third octave filters or its equivalent shall be used. The first filter of the set shall be centred at a geometric mean frequency of 50 Hz and the last shall be centred at a geometric mean frequency of 10 kHz.

3.4.3 The analyser indicating device shall be analogue, digital, or a combination of both. The preferred sequence of signal processing shall be—

- (a) squaring the one-third octave filter outputs;
- (b) averaging or integrating; and
- (c) linear to logarithmic conversion.

The indicating device shall have a minimum crest factor capacity of 3 and shall measure, within a tolerance of ± 1.0 dB, the true root-mean-square (rms) level of the signal in each of the 24 one-third octave bands. If other than a true rms device is utilized, it shall be calibrated for nonsinusoidal signals and time varying levels. The calibration shall provide means for converting the output levels to true rms values.

3.4.4 The dynamic response of the analyser to input signals of both full-scale and 20 dB less than full-scale amplitude shall conform to the following two requirements:

- (a) the maximum output value shall read $4 \text{ dB} \pm 1 \text{ dB}$ less than the value obtained for a steady-state signal of the same frequency and amplitude when a

⁴ . This publication was first issued in 1966 by the Central Office of the International Electrotechnical Commission, 3 rue de Varembe, Geneva, Switzerland.

sinusoidal pulse of 0.5 s duration at the centre frequency of each one-third octave band is applied to the input;

- (b) the maximum output value shall exceed the final steady-state value by 0.5 ± 0.5 dB when a steady-state sinusoidal signal at the geometrical mean frequency of each one-third octave band is suddenly applied to the analyser input and held constant.

3.4.5 A single value of the rms level shall be provided every 0.5 ± 0.01 s for each of the 24 one-third octave bands. The levels from all of the 24 one-third octave bands shall be obtained within a 50 ms period. No more than 5 ms of data from any 0.5 s period shall be excluded from the measurement.

3.4.6 The amplitude resolution of the analyser shall be 0.50 dB or less.

3.4.7 Each output level from the analyser shall be accurate within ± 1.0 dB with respect to the input signal, after all systematic errors have been eliminated. The total systematic errors for each of the output levels shall not exceed ± 3 dB. For contiguous filter systems, the systematic correction between adjacent one-third octave channels shall not exceed 4 dB.

3.4.8 The dynamic range capability of the analyser for display of a single aeroplane noise event shall be at least 45 dB in terms of the difference between full-scale output level and the maximum noise level of the analyser equipment.

3.4.9 The complete electronic system shall be subjected to a frequency and amplitude electrical calibration by the use of sinusoidal or broadband signals at frequencies covering the range of 45 to 11 200 Hz, and of known amplitudes covering the range of signal levels furnished by the microphone and if broadband signals are used, they shall be described in terms of their average and maximum rms values for a non-overload signal level.

3.5 Noise measurement procedures

3.5.1 The microphones shall be oriented in a known direction so that the maximum sound received arrives as nearly as reasonable in the direction for which the microphones are calibrated. The microphones shall be placed so that their sensing elements are approximately 1.2 meters (4 ft) above ground.

3.5.2 Immediately prior to and after each test, a recorded acoustic calibration of the system shall be made in the field with an acoustic calibrator for the two purposes of checking system sensitivity and providing an acoustic reference level for the analysis of the sound level data.

3.5.3 For the purpose of minimizing equipment or operator error, field calibrations shall be supplemented whenever practicable with the use of an insert voltage device to place a known signal at the input of the microphone, just prior to and after recording aeroplane noise data.

3.5.4 Background noise, including ambient noise and electrical noise of the measurement systems, shall be recorded and determined in the test area with the system

gain set at levels which will be used for aeroplane noise measurements. If aeroplane sound pressure levels do not exceed background sound pressure levels by at least 10 dB in any significant one-third octave band, approved corrections for the contribution of background sound pressure level to the observed sound pressure level shall be applied.

4. CALCULATION OF EFFECTIVE PERCEIVED NOISE LEVEL FROM MEASURED NOISE DATA

4.1 General

4.1.1 The basic element in the noise certification criteria shall be the noise evaluation measure designated effective perceived noise level, EPNL, in units of EPNdB, which is a single number evaluator of the subjective effects of aeroplane noise on human beings, the EPNL shall consist of instantaneous perceived noise level, PNL, corrected for spectral irregularities (the correction, called "tone correction factor", is made for the maximum tone only at each increment of time) and for duration.

4.1.2 Three basic physical properties of sound pressure shall be measured: level, frequency distribution, and time variation, the instantaneous sound pressure level in each of 24 one-third octave bands of the noise shall be required for each one-half second increment of time during the aeroplane flyover.

4.1.3 The calculation procedure which utilizes physical measurements of noise to derive the EPNL evaluation measure of subjective response shall consist of the following five steps:

- (a) the 24 one-third octave bands of sound pressure level are converted to perceived noisiness by means of a noy table,⁵ the noy values are combined and then converted to instantaneous perceived noise levels, $PNL(k)$;
- (b) a tone correction factor, $C(k)$, is calculated for each spectrum to account for the subjective response to the presence of spectral irregularities;
- (c) the tone correction factor is added to the perceived noise level to obtain tone corrected perceived noise levels, $PNLT(k)$, at each one-half second increment of time:

$$PNLT(k) = PNL(k) + C(k)$$

The instantaneous values of tone corrected perceived noise level are derived and the maximum value, PNLTM, is determined;

- (a) a duration correction factor, D , is computed by integration under the curve of tone corrected perceived noise level versus time;
- (b) effective perceived noise level, EPNL, is determined by the algebraic sum of the maximum tone corrected perceived noise level and the duration correction factor:

$$EPNL = PNLTM + D.$$

⁵ . Refer Table A1-1.

4.2 Perceived noise level

Instantaneous perceived noise levels, $PNL(k)$, shall be calculated from instantaneous one-third octave band sound pressure levels, $SPL(i,k)$, as follows:

Step 1. Convert each one-third octave band, $SPL(i,k)$, from 50 to 10 000 Hz, to perceived noisiness, $n(i,k)$, by reference to Table A1-1, or to the mathematical formulation of the noy table given in Section 7.

Step 2. Combine the perceived noisiness values, $n(i,k)$, found in Step 1 by the following formula:

$$\begin{aligned} N(k) &= n(k) + 0.15 \left\{ \left[\sum_{i=1}^{24} n(i,k) \right] - n(k) \right\} \\ &= 0.85 n(k) + 0.15 \sum_{i=1}^{24} n(i,k) \end{aligned}$$

where $n(k)$ is the largest of the 24 values of $n(i,k)$, and $N(k)$ is the total perceived noisiness.

Step 3. Convert the total perceived noisiness, $N(k)$, into perceived noise level, $PNL(k)$, by the following formula:

$$PNL(k) = 40.0 + \frac{10}{\log 2} \log N(k)$$

which is plotted in Figure A1-1. $PNL(k)$ may also be obtained by choosing $N(k)$ in the 1 000 Hz column of Table A1-1 and then reading the corresponding value of $SPL(i,k)$ which, at 1 000 Hz, equals $PNL(k)$.

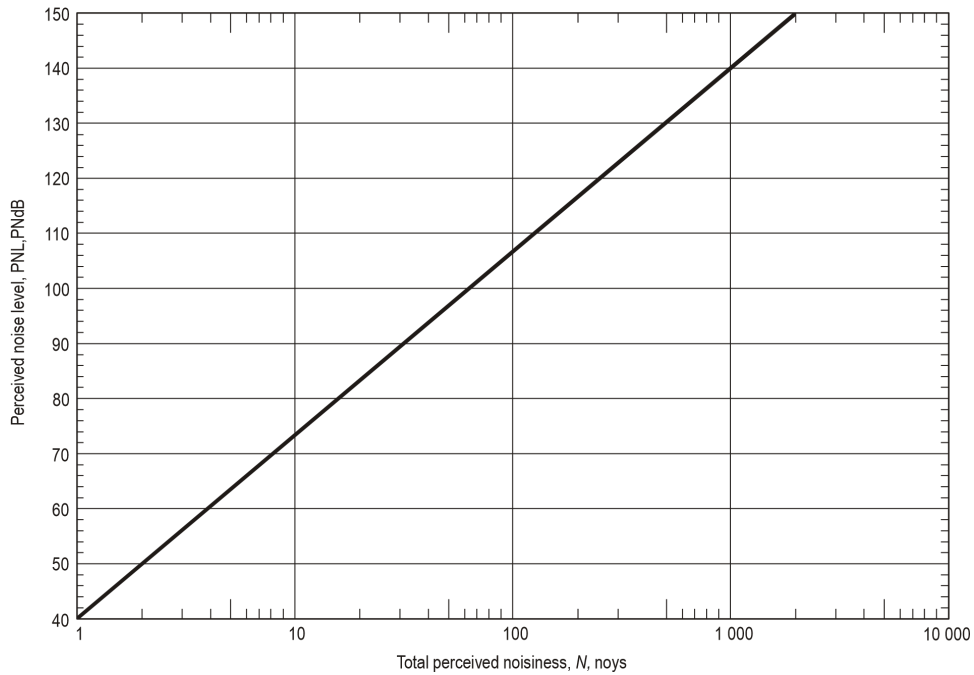


Figure A1-1. Perceived noise level as a function of total perceived noisiness

4.3 Correction for spectral irregularities

Noise having pronounced spectral irregularities (for example, the maximum discrete frequency components or tones) shall be adjusted by the correction factor, $C(k)$, calculated as follows:

Step 1. Starting with the corrected sound pressure level in the 80 Hz one-third octave band (band number 3), calculate the changes in sound pressure level (or “slopes”) in the remainder of the one-third octave bands as follows:

$$s(3,k) = \text{no value} \quad s(4,k) = \text{SPL}(4,k) - \text{SPL}(3,k)$$

$$s(i,k) = \text{SPL}(i,k) - \text{SPL}[(i-1),k] \quad \bullet$$

$$s(24,k) = \text{SPL}(24,k) - \text{SPL}(23,k)$$

Step 2. Encircle the value of the slope, $s(i,k)$, where the absolute value of the change in slope is greater than five; that is, where:

$$|\Delta s(i,k)| = |s(i,k) - s[(i-1),k]| > 5$$

Table A1-1. Noys as a function of sound pressure level (29<SPL<89)

The Civil Aviation (Environmental Protection - Aircraft Noise)

GN. NO.51 (Contd.)

SPL (dB)	50	63	80	100	125	160	200	250	315	400	One-third octave band centre frequencies (Hz)				1250	1600	2000	2500	3150	4000	5000	6300	8000	10000							
											500	630	800	1000																	
29																		1.00	1.00												
30																	1.00	1.07	1.07	1.00											
31																	1.07	1.15	1.15	1.07	1.00										
32																	1.00	1.15	1.23	1.23	1.15	1.07									
33																	1.07	1.23	1.32	1.32	1.23	1.15									
34															1.00	1.15	1.32	1.41	1.41	1.32	1.23										
35															1.07	1.23	1.41	1.51	1.51	1.41	1.32										
36															1.15	1.32	1.51	1.62	1.62	1.51	1.41										
37															1.23	1.41	1.62	1.74	1.74	1.62	1.51	1.00									
38														1.00	1.32	1.51	1.74	1.86	1.86	1.74	1.62	1.10									
39														1.07	1.41	1.62	1.86	1.99	1.99	1.86	1.74	1.21									
40									1.00	1.00	1.00	1.00	1.00	1.15	1.51	1.74	1.99	2.14	2.14	1.99	1.86	1.34									
41									1.07	1.07	1.07	1.07	1.07	1.23	1.62	1.86	2.14	2.29	2.29	2.14	1.99	1.48	1.00								
42									1.00	1.15	1.15	1.15	1.15	1.32	1.74	1.99	2.29	2.45	2.45	2.29	2.14	1.63	1.10								
43									1.07	1.23	1.23	1.23	1.23	1.41	1.86	2.14	2.45	2.63	2.63	2.45	2.29	1.79	1.21								
44								1.00	1.15	1.32	1.32	1.32	1.32	1.52	1.99	2.29	2.63	2.81	2.81	2.63	2.45	1.99	1.34								
45									1.08	1.24	1.41	1.41	1.41	1.41	1.62	2.14	2.45	2.81	3.02	3.02	2.81	2.63	2.14	1.48							
46								1.00	1.16	1.33	1.52	1.52	1.52	1.52	1.74	2.29	2.63	3.02	3.23	3.23	3.02	2.81	2.29	1.63							
47									1.08	1.25	1.42	1.62	1.62	1.62	1.62	1.87	2.45	2.81	3.23	3.46	3.46	3.23	3.02	2.45	1.79						
48							1.00	1.17	1.34	1.53	1.74	1.74	1.74	1.74	2.00	2.63	3.02	3.46	3.71	3.71	3.46	3.23	2.63	1.98							
49								1.08	1.26	1.45	1.64	1.87	1.87	1.87	2.14	2.81	3.23	3.71	3.97	3.97	3.71	3.46	2.81	2.15							
50									1.17	1.36	1.56	1.76	2.00	2.00	2.00	2.00	2.30	3.02	3.46	3.97	4.26	4.26	3.97	3.02	2.40						
51								1.00	1.26	1.47	1.68	1.89	2.14	2.14	2.14	2.14	2.46	3.23	3.71	4.26	4.56	4.56	4.26	3.97	2.63						
52									1.08	1.36	1.58	1.80	2.03	2.30	2.30	2.30	2.64	3.46	3.97	4.56	4.89	4.89	4.56	4.26	2.81						
53							1.00	1.18	1.47	1.71	1.94	2.17	2.46	2.46	2.46	2.46	2.83	3.71	4.26	4.89	5.24	5.24	4.89	4.56	3.02						
54								1.09	1.28	1.58	1.85	2.09	2.33	2.64	2.64	2.64	2.64	3.03	3.97	4.56	5.24	5.61	5.61	5.24	4.89	3.23					
55									1.18	1.38	1.71	2.00	2.25	2.50	2.83	2.83	2.83	2.83	3.25	4.26	4.89	5.61	6.01	6.01	5.61	5.24	4.26	3.46			
56									1.00	1.29	1.50	1.85	2.15	2.42	2.69	3.03	3.03	3.03	3.03	3.48	4.56	5.24	6.01	6.44	6.44	6.01	5.61	4.56	3.71		
57									1.09	1.40	1.63	2.00	2.33	2.61	2.88	3.25	3.25	3.25	3.25	3.73	4.89	5.61	6.44	6.90	6.90	6.44	6.01	4.89	3.97		
58									1.18	1.53	1.77	2.15	2.51	2.81	3.10	3.48	3.48	3.48	3.48	4.00	5.24	6.01	6.90	7.39	7.39	6.90	6.44	5.24	4.26		
59									1.29	1.66	1.92	2.33	2.71	3.03	3.32	3.73	3.73	3.73	3.73	4.29	5.61	6.44	7.39	7.92	7.92	7.39	6.90	5.61	4.56		
60									1.00	1.40	1.81	2.08	2.51	2.93	3.26	3.57	4.00	4.00	4.00	4.00	4.59	6.01	6.90	7.92	8.49	8.49	7.92	7.39	6.01	4.89	
61									1.10	1.53	1.97	2.26	2.71	3.16	3.51	3.83	4.29	4.29	4.29	4.29	4.92	6.44	7.39	8.49	9.09	9.09	8.49	7.92	6.44	5.24	
62									1.21	1.66	2.15	2.45	2.93	3.41	3.78	4.11	4.59	4.59	4.59	4.59	5.28	6.90	7.92	9.09	9.74	9.74	9.09	8.49	6.90	5.61	
63									1.32	1.81	2.34	2.65	3.16	3.69	4.06	4.41	4.92	4.92	4.92	4.92	5.66	7.39	8.49	9.74	10.4	10.4	9.74	9.09	7.39	6.01	
64									1.00	1.45	1.97	2.54	2.88	3.41	3.98	4.38	4.73	5.28	5.28	5.28	5.28	6.06	7.92	9.09	10.4	11.2	11.2	10.4	9.74	7.92	6.44
65									1.11	1.60	2.15	2.77	3.12	3.69	4.30	4.71	5.08	5.66	5.66	5.66	5.66	6.50	8.49	9.74	11.2	12.0	12.0	11.2	10.4	8.49	6.90
66									1.22	1.75	2.34	3.01	3.39	3.98	4.64	5.07	5.45	6.06	6.06	6.06	6.06	6.96	9.09	10.4	12.0	12.8	12.8	12.0	11.2	9.09	7.39
67									1.35	1.92	2.54	3.28	3.68	4.30	5.01	5.46	5.85	6.50	6.50	6.50	6.50	7.46	9.74	11.2	12.8	13.8	13.8	12.8	12.0	9.74	7.92
68									1.49	2.11	2.77	3.57	3.99	4.64	5.41	5.88	6.27	6.96	6.96	6.96	6.96	8.00	10.4	12.0	13.8	14.7	14.7	13.8	12.8	10.4	8.49
69									1.65	2.32	3.01	3.88	4.33	5.01	5.84	6.33	6.73	7.46	7.46	7.46	7.46	8.57	11.2	12.8	14.7	15.8	15.8	14.7	13.8	11.2	9.09
70									1.82	2.55	3.28	4.23	4.69	5.41	6.31	6.81	7.23	8.00	8.00	8.00	8.00	9.19	12.0	13.8	15.8	16.9	16.9	15.8	14.7	12.0	9.74
71									2.02	2.79	3.57	4.60	5.09	5.84	6.81	7.33	7.75	8.57	8.57	8.57	8.57	9.85	12.8	14.7	16.9	18.1	18.1	16.9	15.8	12.8	10.4
72									2.23	3.07	3.88	5.01	5.52	6.31	7.36	7.90	8.32	9.19	9.19	9.19	9.19	10.6	13.8	15.8	18.1	19.4	19.4	18.1	16.9	13.8	11.2
73									2.46	3.37	4.23	5.45	5.99	6.81	7.94	8.50	8.93	9.85	9.85	9.85	9.85	11.3	14.7	16.9	19.4	20.8	20.8	19.4	18.1	14.7	12.0

The Civil Aviation (Environmental Protection - Aircraft Noise)

GN. NO.51 (Contd.)

74	2.72	3.70	4.60	5.94	6.50	7.36	8.57	9.15	9.59	10.6	10.6	10.6	10.6	10.6	12.1	15.8	18.1	20.8	22.3	22.3	20.8	19.4	15.8	12.8
75	3.01	4.06	5.01	6.46	7.05	7.94	9.19	9.85	10.3	11.3	11.3	11.3	11.3	11.3	13.0	16.9	19.4	22.3	23.9	23.9	22.3	20.8	16.9	13.8
76	3.32	4.46	5.45	7.03	7.65	8.57	9.85	10.6	11.0	12.1	12.1	12.1	12.1	12.1	13.9	18.1	20.8	23.9	25.6	25.6	23.9	22.3	18.1	14.7
77	3.67	4.89	5.94	7.66	8.29	9.19	10.6	11.3	11.8	13.0	13.0	13.0	13.0	13.0	14.9	19.4	22.3	25.6	27.4	27.4	25.6	23.9	19.4	15.8
78	4.06	5.37	6.46	8.33	9.00	9.85	11.3	12.1	12.7	13.9	13.9	13.9	13.9	13.9	16.0	20.8	23.9	27.4	29.4	29.4	27.4	25.6	20.8	16.9
79	4.49	5.90	7.03	9.07	9.76	10.6	12.1	13.0	13.6	14.9	14.9	14.9	14.9	14.9	17.1	22.3	25.6	29.4	31.5	31.5	29.4	27.4	22.3	18.1
80	4.96	6.48	7.66	9.85	10.6	11.3	13.0	13.9	14.6	16.0	16.0	16.0	16.0	16.0	18.4	23.9	27.4	31.5	33.7	33.7	31.5	29.4	23.9	19.4
81	5.48	7.11	8.33	10.6	11.3	12.1	13.9	14.9	15.7	17.1	17.1	17.1	17.1	17.1	19.7	25.6	29.4	33.7	36.1	36.1	33.7	31.5	25.6	20.8
82	6.06	7.81	9.07	11.3	12.1	13.0	14.9	16.0	16.9	18.4	18.4	18.4	18.4	18.4	21.1	27.4	31.5	36.1	38.7	38.7	36.1	33.7	27.4	22.3
83	6.70	8.57	9.87	12.1	13.0	13.9	16.0	17.1	18.1	19.7	19.7	19.7	19.7	19.7	22.6	29.4	33.7	38.7	41.5	41.5	38.7	36.1	29.4	23.9
84	7.41	9.41	10.7	13.0	13.9	14.9	17.1	18.4	19.4	21.1	21.1	21.1	21.1	21.1	24.3	31.5	36.1	41.5	44.4	44.4	41.5	38.7	31.5	25.6
85	8.19	10.3	11.7	13.9	14.9	16.0	18.4	19.7	20.8	22.6	22.6	22.6	22.6	22.6	26.0	33.7	38.7	44.4	47.6	47.6	44.4	41.5	33.7	27.4
86	9.95	11.3	12.7	14.9	16.0	17.1	19.7	21.1	22.4	24.3	24.3	24.3	24.3	24.3	27.9	36.1	41.5	47.6	51.0	51.0	47.6	44.4	36.1	29.4
87	10.0	12.1	13.9	16.0	17.1	18.4	21.1	22.6	24.0	26.0	26.0	26.0	26.0	26.0	29.0	38.7	44.4	51.0	54.7	54.7	51.0	47.6	38.7	31.5
88	11.1	13.0	14.9	17.1	18.4	19.7	22.6	24.3	25.8	27.9	27.9	27.9	27.9	27.9	32.0	41.5	47.6	54.7	58.6	58.6	54.7	51.0	41.5	33.7
89	12.2	13.9	16.0	18.4	19.7	21.1	24.3	26.0	27.7	29.9	29.9	29.9	29.9	29.9	34.3	44.4	51.0	58.6	62.7	62.7	58.6	54.7	44.4	36.1

Table A1-1 (cont.). Noys as a function of sound pressure level (90<SPL<150)

SPL (dB)	50	63	80	100	125	160	200	250	315	400	One-third octave band centre frequencies (Hz)				1600	2000	2500	3150	4000	5000	6300	8000	10000	
											500	630	800	1000										
90	13.5	14.9	17.1	19.7	21.1	22.6	26.0	27.9	29.7	32.0	32.0	32.0	32.0	32.0	36.8	47.6	54.7	62.7	67.2	67.2	62.7	58.6	47.6	38.7
91	14.9	16.0	18.4	21.1	22.6	24.3	27.9	29.9	31.8	34.3	34.3	34.3	34.3	34.3	39.4	51.0	58.6	67.2	72.0	72.0	67.2	62.7	51.0	41.5
92	16.0	17.1	19.7	22.6	24.3	26.0	29.9	32.0	34.2	36.8	36.8	36.8	36.8	36.8	42.2	54.7	62.7	72.0	77.2	77.2	72.0	67.2	54.7	44.4
93	17.1	18.4	21.1	24.3	26.0	27.9	32.0	34.3	36.7	39.4	39.4	39.4	39.4	39.4	45.3	58.6	67.2	77.2	82.7	82.7	77.2	72.0	58.6	47.6
94	18.4	19.7	22.6	26.0	27.9	29.9	34.3	36.8	39.4	42.2	42.2	42.2	42.2	42.2	48.5	62.7	72.0	82.7	88.6	88.6	82.7	77.2	62.7	51.0
95	19.7	21.1	24.3	27.9	29.9	32.0	36.8	39.4	42.2	45.3	45.3	45.3	45.3	45.3	52.0	67.2	77.2	88.6	94.9	94.9	88.6	82.7	67.2	54.7
96	21.1	22.6	26.0	29.9	32.0	34.3	39.4	42.2	45.3	48.5	48.5	48.5	48.5	48.5	55.7	72.0	82.7	94.9	102	102	94.9	88.6	72.0	58.6
97	22.6	24.3	27.9	32.0	34.3	36.8	42.2	45.3	48.5	52.0	52.0	52.0	52.0	52.0	59.7	77.2	88.6	102	109	109	102	94.9	77.2	62.7
98	24.3	26.0	29.9	34.3	36.8	39.4	45.3	48.5	52.0	55.7	55.7	55.7	55.7	55.7	64.0	82.7	94.9	109	117	117	109	102	82.7	67.2
99	26.0	27.9	32.0	36.8	39.4	42.2	48.5	52.0	55.7	59.7	59.7	59.7	59.7	59.7	68.6	88.6	102	117	125	125	117	109	88.6	72.0
100	27.9	29.9	34.3	39.4	42.2	45.3	52.0	55.7	59.7	64.0	64.0	64.0	64.0	64.0	73.5	94.9	109	125	134	134	125	117	94.9	77.2
101	29.9	32.0	36.8	42.2	45.3	48.5	55.7	59.7	64.0	68.6	68.6	68.6	68.6	68.6	78.8	102	117	134	144	144	134	125	102	82.7
102	32.0	34.3	39.4	45.3	48.5	52.0	59.7	64.0	68.6	73.5	73.5	73.5	73.5	73.5	84.4	109	125	144	154	154	144	134	109	88.6
103	34.3	36.8	42.2	48.5	52.0	55.7	64.0	68.6	73.5	78.8	78.8	78.8	78.8	78.8	90.5	117	134	154	165	165	154	144	117	94.9
104	36.8	39.4	45.3	52.0	55.7	59.7	68.6	73.5	78.8	84.4	84.4	84.4	84.4	84.4	97.0	125	144	165	177	177	165	154	125	102
105	39.4	42.2	48.5	55.7	59.7	64.0	73.5	78.8	84.4	90.5	90.5	90.5	90.5	90.5	104	134	154	177	189	189	177	165	134	109
106	42.2	45.3	52.0	59.7	64.0	68.6	78.8	84.4	90.5	97.0	97.0	97.0	97.0	97.0	111	144	165	189	203	203	189	177	144	117
107	45.3	48.5	55.7	64.0	68.6	73.5	84.4	90.5	97.0	104	104	104	104	104	119	154	177	203	217	217	203	189	154	125
108	48.5	52.0	59.7	68.6	73.5	78.8	90.5	97.0	104	111	111	111	111	111	128	165	189	217	233	233	217	203	165	134
109	52.0	55.7	64.0	73.5	78.8	84.4	97.0	104	111	119	119	119	119	119	137	177	203	233	249	249	233	217	177	144
110	55.7	59.7	68.6	78.8	84.4	90.5	104	111	119	128	128	128	128	128	147	189	217	249	267	267	249	233	189	154
111	59.7	64.0	73.5	84.4	90.5	97.0	111	119	128	137	137	137	137	137	158	203	233	267	286	286	267	249	203	165
112	64.0	68.6	78.8	90.5	97.0	104	119	128	137	147	147	147	147	147	169	217	249	286	307	307	286	267	217	177
113	68.6	73.5	84.4	97.0	104	111	128	137	147	158	158	158	158	158	181	233	267	307	329	329	307	286	233	189
114	73.5	78.8	90.5	104	111	119	137	147	158	169	169	169	169	169	194	249	286	329	352	352	329	307	249	203
115	78.8	84.4	97.0	111	119	128	147	158	169	181	181	181	181	181	208	267	307	352	377	377	352	329	267	217
116	84.4	90.5	104	119	128	137	158	169	181	194	194	194	194	194	223	286	329	377	404	404	377	352	286	233
117	90.5	97.0	111	128	137	147	169	181	194	208	208	208	208	208	239	307	352	404	433	433	404	377	307	249
118	97.0	104	119	137	147	158	181	194	208	223	223	223	223	223	256	329	377	433	464	464	433	404	329	267
119	104	111	128	147	158	169	194	208	223	239	239	239	239	239	274	352	404	464	497	497	464	433	352	286

The Civil Aviation (Environmental Protection - Aircraft Noise)

GN. NO.51 (Contd.)

120	111	119	137	158	169	181	208	223	239	256	256	256	256	256	294	377	433	497	533	533	497	464	377	307
121	119	128	147	169	181	194	223	239	256	274	274	274	274	274	315	404	464	533	571	571	533	497	404	329
122	128	137	158	181	194	208	239	256	274	294	294	294	294	294	338	433	497	571	611	611	571	533	433	352
123	137	147	169	194	208	223	256	274	294	315	315	315	315	315	362	464	533	611	655	655	611	571	464	377
124	147	158	181	208	223	239	274	294	315	338	338	338	338	338	388	497	571	655	702	702	655	611	497	404
125	158	169	194	223	239	256	294	315	338	362	362	362	362	362	416	533	611	702	752	752	702	655	533	433
126	169	181	208	239	256	274	315	338	362	388	388	388	388	388	446	571	655	752	806	806	752	702	571	464
127	181	194	223	256	274	294	338	362	388	416	416	416	416	416	478	611	702	806	863	863	806	752	611	497
128	194	208	239	274	294	315	362	388	416	446	446	446	446	446	512	655	752	863	925	925	863	806	655	533
129	208	223	256	294	315	338	388	416	446	478	478	478	478	478	549	702	806	925	991	991	925	863	702	571
130	223	239	274	315	338	362	416	446	478	512	512	512	512	512	588	752	863	991	1062	1062	991	925	752	611
131	239	256	294	338	362	388	446	478	512	549	549	549	549	549	630	806	925	1062	1137	1137	1062	991	806	655
132	256	274	315	362	388	416	478	512	549	588	588	588	588	588	676	863	991	1137	1219	1219	1137	1062	863	702
133	274	294	338	388	416	446	512	549	588	630	630	630	630	630	724	925	1062	1219	1306	1306	1219	1137	925	752
134	294	315	362	416	446	478	549	588	630	676	676	676	676	676	776	991	1137	1306	1399	1399	1306	1219	991	806
135	315	338	388	446	478	512	588	630	676	724	724	724	724	724	832	1062	1219	1399	1499	1499	1399	1306	1062	863
136	338	362	416	478	512	549	630	676	724	776	776	776	776	776	891	1137	1306	1499	1606	1606	1499	1399	1137	925
137	362	388	446	512	549	588	676	724	776	832	832	832	832	832	955	1219	1399	1606	1721	1721	1606	1499	1219	991
138	388	416	478	549	588	630	724	776	832	891	891	891	891	891	1024	1306	1499	1721	1844	1844	1721	1606	1306	1062
139	416	446	512	588	630	676	776	832	891	955	955	955	955	955	1098	1399	1606	1844	1975	1975	1844	1721	1399	1137
140	446	478	549	630	676	724	832	891	955	1024	1024	1024	1024	1024	1176	1499	1721	1975			1975	1844	1499	1219
141	478	512	588	676	724	776	891	955	1024	1098	1098	1098	1098	1098	1261	1606	1844				1975	1606	1306	
142	512	549	630	724	776	832	955	1024	1098	1176	1176	1176	1176	1176	1351	1721	1975						1721	1399
143	549	588	676	776	832	891	1024	1098	1176	1261	1261	1261	1261	1261	1448	1844							1844	1499
144	588	630	724	832	891	955	1098	1176	1261	1351	1351	1351	1351	1351	1552	1975							1975	1606
145	630	676	776	891	955	1024	1176	1261	1351	1448	1448	1448	1448	1448	1664									1721
146	676	724	832	955	1024	1098	1261	1351	1448	1552	1552	1552	1552	1552	1783									1844
147	724	776	891	1024	1098	1176	1351	1448	1552	1664	1664	1664	1664	1664	1911									1975
148	776	832	955	1098	1176	1261	1448	1552	1664	1783	1783	1783	1783	1783	2048									
149	832	891	1024	1176	1261	1351	1552	1664	1783	1911	1911	1911	1911	1911										
150	891	955	1098	1261	1351	1448	1664	1783	1911	2048	2048	2048	2048	2048										

N.G.T.E. 22 NOV. 1967

Step 3.

- (a) if the encircled value of the slope $s(i,k)$ is positive and algebraically greater than the slope $s[(i-1),k]$, encircle $SPL(i,k)$;

- (b) if the encircled value of the slope $s(i,k)$ is zero or negative and the slope $s[(i-1),k]$ is positive, encircle $SPL[(i-1),k]$; and
- (c) for all other cases, no sound pressure level value is to be encircled.

Step 4.

Omit all $SPL(i,k)$ encircled in Step 3 and compute new adjusted sound pressure levels, $SPL\Box(i,k)$, as follows:

- (a) or non-encircled sound pressure levels, let the new sound pressure levels equal the original sound pressure levels, $SPL\Box(i,k) = SPL(i,k)$;
- (b) for encircled sound pressure levels in bands 1 to 23 inclusive, let the new sound pressure level equal the arithmetic average of the preceding and following sound pressure levels:

$$SPL\Box(i,k) = (1/2) \{SPL[(i-1),k] + SPL[(i+1),k]\}$$

- (a) if the sound pressure level in the highest frequency band ($i = 24$) is encircled, let the new sound pressure level in that band equal:

$$SPL\Box(24,k) = SPL(23,k) + s(23,k)$$

Step 5. Recompute new slopes $s\Box(i,k)$, including one for an imaginary 25th band, as follows:

$$\begin{aligned} s\Box(3,k) &= s\Box(4,k) \\ s\Box(4,k) &= SPL\Box(4,k) - SPL\Box(3,k) \\ s\Box(i,k) &= SPL\Box(i,k) - SPL\Box[(i-1),k] \\ s\Box(24,k) &= \\ &= SPL\Box(24, \\ &k) - \\ &= SPL\Box(23, \\ &k) \\ s\Box(25,k) &= \\ s\Box(24,k) \end{aligned}$$

Step 6. For i from 3 to 23, compute the arithmetic average of the three adjacent slopes as follows:

$$s^-(i,k) = (1/3) \{s\Box(i,k) + s\Box[(i+1),k] + s\Box[(i+2),k]\}$$

Step 7. Compute final one-third octave-band background sound pressure levels, $SPL\Box(i,k)$, by beginning with band number 3 and proceeding to band number 24 as follows:

$$\begin{aligned} SPL\Box(3,k) &= SPL(3,k) \\ SPL\Box(4,k) &= SPL\Box(3,k) + s^-(3,k) \end{aligned}$$

$$\begin{aligned} \text{SPL}\square(i,k) &= \text{SPL}\square[(i-1),k] + s^-(i-1),k] \\ \text{SPL}\square(24,k) &= \text{SPL}\square(23,k) + s^-(23,k) \end{aligned}$$

Step 8. Calculate the differences, $F(i,k)$, between the original sound pressure level and the final background sound pressure level as follows:

$$F(i,k) = \text{SPL}(i,k) - \text{SPL}\square(i,k)$$

and note only values equal to or greater than three.

Step 9. For each of the relevant one-third octave bands (3 to 24), determine tone correction factors from the sound pressure level differences, $F(i,k)$, and Table A1-2.

Step 10. Designate the largest of the tone correction factors, determined in Step 9, as $C(k)$. An example of the tone correction procedure is given in Table A1-3.

Tone corrected perceived noise levels $\text{PNLT}(k)$ shall be determined by adding the $C(k)$ values to corresponding $\text{PNL}(k)$ values, that is:

$$\text{PNLT}(k) = \text{PNL}(k) + C(k)$$

For any i -th one-third octave band, at any k -th increment of time, for which the tone correction factor is suspected to result from something other than (or in addition to) an actual tone (or any spectral irregularity other than aeroplane noise), an additional analysis shall be made using a filter with a bandwidth narrower than one-third of an octave. If the narrow band analysis corroborates these suspicions, then a revised value for the background sound pressure level, $\text{SPL}\square(i,k)$, shall be determined from the narrow band analysis and used to compute a revised tone correction factor for that particular one-third octave band.

4.4 Maximum tone corrected perceived noise level

4.4.1 The maximum tone corrected perceived noise level, PNLTM , shall be the maximum calculated value of the tone corrected perceived noise level $\text{PNLT}(k)$. It shall be calculated in accordance with the procedure of 4.3 to obtain a satisfactory noise time history, measurements shall be made at half-second time intervals.

Note.— Figure A1-2 is an example of a flyover noise time history where the maximum value is clearly indicated.

4.4.2 If there are no pronounced irregularities in the spectrum, even when examined by a narrow band analysis, then the procedure of 4.3 shall be disregarded since $\text{PNLT}(k)$ would be identically equal to $\text{PNL}(k)$. For this case, PNLTM shall be the maximum value of $\text{PNL}(k)$ and would equal PNLM .

4.5 Duration correction

4.5.1.3 If PNLTM is less than 90 TPNdB, the duration correction shall be taken as equal to 0.

4.5.2 Since PNLTM is calculated from measured values of SPL, there will, in general, be no obvious equation for PNLTM as a function of time. Consequently, the equation shall be rewritten with a summation sign instead of an integral sign as follows:

$$D = 10 \log \left[\left(\frac{1}{T} \right) \sum_{k=0}^{\frac{d}{\Delta t}} \Delta t \cdot \text{antilog} \frac{\text{PNLT}(k)}{10} \right] - \text{PNLTM}$$

where Δt is the length of the equal increments of time for which PNLTM(k) is calculated and d is the time interval to the nearest 1.0 second during which PNLTM(k) remains greater or equal either to PNLTM - 10 or to 90 according to the cases specified in 4.5.1.1 to 4.5.1.3.

Table A1-3. Example of tone correction calculation for a turbofan engine

Band (i)	f Hz	SPL S dB	S dB Step 1	S dB Step 2	SPL' dB Step 4	S' dB Step 5	* dB Step 6	SPL'' dB Step 7	F dB Step 8	C dB Step 9
1	50	—	—	—	—	—	—	—	—	—
2	63	—	—	—	—	—	—	—	—	—
3	80	70	—	—	70	-8	-2½	70	—	—
4	100	62	-8	—	62	-8	+3½	67½	—	—
5	125	70	+8	16	71	+9	+6½	71	—	—
6	160	80	+10	2	80	+9	+2½	77½	—	—
7	200	82	+2	8	82	+2	-1½	80½	—	—
8	250	83	+1	1	79	-3	-1½	79	4	0.61
9	315	76	-7	8	76	-3	+½	77½	—	—
10	400	80	+4	11	78	+2	+1	78	—	0.17
11	500	80	0	4	80	+2	0	79	—	—
12	630	79	-1	1	79	-1	0	79	—	—
13	800	78	-1	0	78	-1	-½	79	—	—
14	1000	80	+2	3	80	+2	-¾	78¾	—	—
15	1250	78	-2	4	78	-2	-½	78	—	—
16	1600	76	-2	0	76	-2	+½	77½	—	—

The Civil Aviation (Environmental Protection - Aircraft Noise)

GN. NO.51 (Contd.)

17	2 000	79	+3	5	79	+3	+1	78	—	
18	2 500	65	+6	3	79	0	-1/3	79	6	2
19	3 150	79	-6	12	79	0	-2 2/3	78 2/3	—	
20	4 000	78	-1	5	78	-1	-6 1/3	76	—	
21	5 000	71	-7	6	71	-7	-8	69 2/3	—	
22	6 300	60	-11	4	60	-11	-8 2/3	61 2/3	—	
23	8 000	54	-6	5	54	-6	-8	53	—	
24	10 000	45	-9	3	45	-9	—	45	—	
						-9				

Step 1	$3 (i) - 3 (i-1)$	Step 6	$\frac{[7 (i) + (i+1) + 7 (i+2)]}{3}$
Step 2	$4 (i) - 4 (i-1)$	Step 7	$9 (i-1) + 8 (i-1)$
Step 3	see instructions	Step 8	$13 (i) - 9 (i)$
Step 4	see instructions	Step 9	see Table A1-2
Step 5	$6 (i) - 6 (i-1)$		

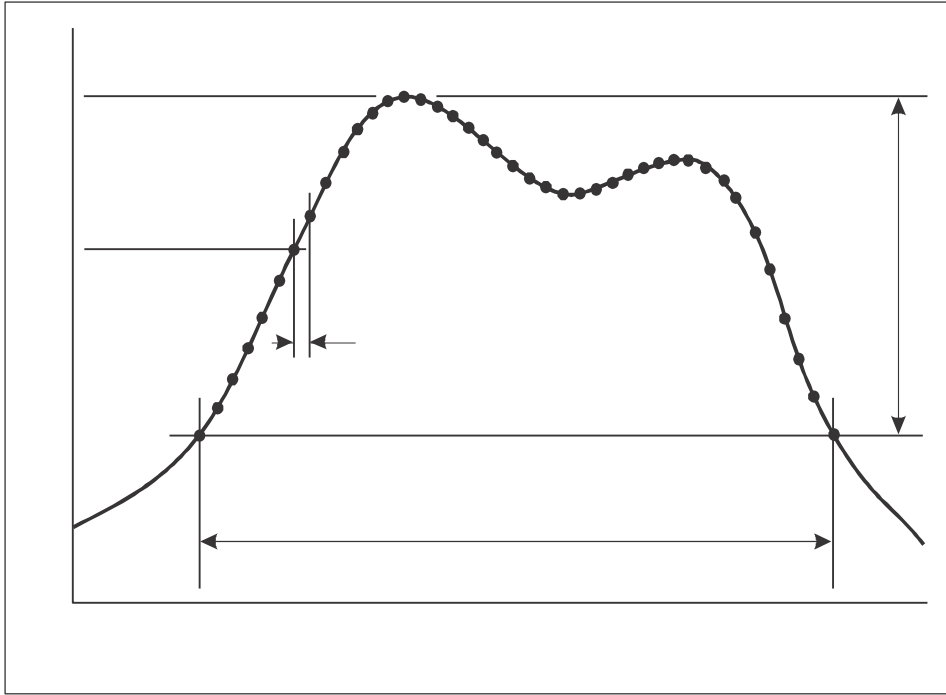


Figure A1-2. Example of perceived noise level corrected for tones as a function of aircraft flyover time

4.5.3 To obtain a satisfactory history of the perceived noise level,

- (a) half-second time intervals for Δt , or
- (b) a shorter time interval with approved limits and constants,

shall be used.

4.5.4 The following values for T and Δt shall be used in calculating D in the procedure given in 4.5.2:

$$T = 10 \text{ s, and}$$

$$\Delta t = 0.5 \text{ s}$$

Using the above values, the equation for D becomes

$$D = 10 \log \left[\sum_{k=0}^{2d} \text{antilog} \frac{\text{PNLT}(k)}{10} \right] - \text{PNLTM} - 13$$

where the integer d is the duration time defined by the points corresponding to the values PNLTM – 10 or 90 as the case may be.

4.5.5 If in the procedures given in 4.5.2, the limits of PNLTM – 10 or 90 fall between the calculated PNL $T(k)$ values (the usual case), the PNL $T(k)$ values defining the limits of the duration interval shall be chosen from the PNL $T(k)$ values closest to PNLTM – 10 or 90 as the case may be.

(d) 4.6 Effective perceived noise level

The total subjective effect of an aeroplane flyover, designated “effective perceived noise level”, EPNL, shall be equal to the algebraic sum of the maximum value of the tone corrected perceived noise level, PNLTM, and the duration correction, D . That is:

$$\text{EPNL} = \text{PNLTM} + D$$

where PNLTM and D are calculated in accordance with the procedures given in 4.2, 4.3, 4.4 and 4.5 and if the duration correction D is negative and greater than PNLTM – 90 in absolute values, D shall be taken as equal to 90 – PNLTM.

5. REPORTING OF DATA TO THE CERTIFICATING AUTHORITY AND CORRECTING MEASURED DATA

(e) 5.1 General

Data representing physical measurements or corrections to measured data shall be recorded in permanent form and appended to the record except that corrections to measurements for normal equipment response deviations need not be reported and all other corrections shall be approved. Attempts shall be made to keep to a minimum the individual errors inherent in each of the operations employed in obtaining the final data.

(f) 5.2 Data reporting

5.2.1 Measured and corrected sound pressure levels shall be presented in one-third octave band levels obtained with equipment conforming to the Standards described in Section 3 of this appendix.

5.2.2 The type of equipment used for measurement and analysis of all acoustic aeroplane performance and meteorological data shall be reported.

5.2.3 The following atmospheric environmental data, measured immediately before, after, or during each test at the observation points prescribed in Section 2 of this appendix shall be reported:

- (a) air temperature and relative humidity;
- (b) maximum, minimum and average wind velocities;
- (c) atmospheric pressure.

5.2.4 Comments on local topography, ground cover, and events that might interfere with sound recordings shall be reported.

5.2.5 The following aeroplane information shall be reported:

- (a) type, model, serial numbers (if any) of aeroplane and engines;
- (b) gross dimensions of aeroplane and location of engines;
- (c) aeroplane gross mass for each test run;
- (d) aeroplane configuration such as flap and landing gear position;
- (e) indicated airspeed in kilometres per hour (knots);
- (f) engine performance in terms of net thrust, engine pressure ratios, jet exhaust temperatures and fan or compressor shaft rotational speeds as determined from aeroplane instruments and manufacturer's data;
- (g) aeroplane height above ground determined by a method independent of cockpit instrumentation, such as radar tracking, theodolite triangulation or photographic scaling techniques, to be approved by the certificating authorities.

5.2.6 Aeroplane speed and position and engine performance parameters shall be recorded at an approved sampling rate sufficient to correct to the noise certification reference conditions prescribed in this section and shall be synchronized with the noise measurement.

5.2.6.1 Lateral position relative to the extended centre line of the runway, configuration and gross mass shall be reported.

(g) 5.3 Noise certification reference conditions

Aeroplane position and performance data and the noise measurements shall be corrected to the following noise certification reference conditions:

- a) meteorological conditions:
 - 1) sea level atmospheric pressure of 1 013.25 hPa;
 - 2) ambient air temperature of 25°C, i.e. ISA + 10°C except that, at the discretion of the certificating authority, an alternative reference ambient air temperature of 15°C, i.e. ISA may be used;

- 3) relative humidity of 70 per cent; and
 - 4) zero wind;
- b) aeroplane conditions:
- 1) maximum take-off mass and landing mass at which noise certification is requested;
 - 2) approach angle of 3°; and
 - 3) aeroplane height of 120 meters (394 ft) above the approach noise measuring station.

(h) 5.4 Data correction

5.4.1 The noise data shall be corrected to the noise certification reference conditions as stated in 5.3. The measured atmospheric conditions shall be those obtained in accordance with Section 2 of this appendix, atmospheric attenuation of sound requirements are given in Section 8 of this appendix and if a reference ambient air temperature of 15°C is used (refer 5.3 a) 2)), a further correction of +1 EPNdB shall be added to the noise levels obtained at the flyover measurement point.

5.4.2 The measured flight path shall be corrected by an amount equal to the difference between the applicant's predicted flight paths for the test conditions and for the noise certification reference conditions.

Note.— Necessary corrections relating to aeroplane flight path or performance may be derived from approved data other than certification test data.

5.4.2.1 The flight path correction procedure for approach noise shall be made with reference to a fixed aeroplane reference height and the reference approach angle and the effective perceived noise level correction shall be less than 2 EPNdB to allow for-

- (a) the aeroplane not passing vertically above the measuring point;
- (b) the difference between the reference height and the height of the aeroplane's ILS antenna from the approach measuring point; and
- (c) the difference between the reference and the test approach angles.

Note.— Detailed correction requirements are given in Section 9 of this appendix.

5.4.3 Test results on specific measurement shall not be accepted if the difference in EPNL computed from measured data and that corrected to reference conditions exceeds 15 EPNdB.

5.4.4 If aeroplane sound pressure levels do not exceed the ambient sound pressure levels by at least 10 dB in any onethird octave band, approved corrections for the contribution of ambient sound pressure level to the observed sound pressure level shall be applied.

(d)5.5 Validity of results

5.5.1 Three average EPNL values and their 90 per cent confidence limits shall be produced from the test results, each such value being the arithmetical average of the corrected acoustical measurements for all valid test runs at the appropriate measurement point (take-off, approach or sideline) and if more than one acoustic measurement system is used at any single measurement location (such as for the symmetrical sideline measuring points), the resulting data for each test run shall be averaged as a single measurement.

5.5.2 The minimum sample size acceptable for each of the three certification measuring points shall be six. The samples shall be large enough to establish statistically for each of the three average noise certification levels a 90 per cent confidence limit not exceeding ± 1.5 EPNdB, no test result shall be omitted from the average process unless otherwise specified by the certifying authorities.

5.5.3 The average EPNL values and their 90 per cent confidence limits obtained by the foregoing process shall be those by which the noise performance of the aeroplane is assessed against the noise certification criteria, and shall be reported.

6. NOMENCLATURE

(e)6.1 Symbols and units

Note.— The meanings of the various symbols in this appendix are as follows. It is recognized that differences may exist in the units and meanings of similar symbols in Appendix 2.

Symbol	Unit	Meaning
antilog	—	Antilogarithm to the base 10.
$C(k)$	dB	Tone correction factor. The factor to be added to PNL(k) to account for the presence of spectral irregularities such as tones at the k -th increment of time.
d	s	Duration time. The length of the significant noise time history being the time interval between the limits of $t(1)$ and $t(2)$ to the nearest second.
D	dB	Duration correction. The factor to be added to PNLTM to account for the duration of the noise.
EPNL	EPNdB	Effective perceived noise level. The value of PNL adjusted for both the spectral irregularities and the duration of the noise. (The unit EPNdB is used instead of the unit dB.)
$f(i)$	Hz	Frequency. The geometrical mean frequency for the i -th one-third octave band.

$F(i,k)$	dB	<i>Delta-dB</i> . The difference between the original sound pressure level and the final background sound pressure level in the i -th one-third octave band at the k -th interval of time.
h	dB	<i>dB-down</i> . The level to be subtracted from PNLTM that defines the duration of the noise.
H	%	<i>Relative humidity</i> . The ambient atmospheric relative humidity.
i	—	<i>Frequency band index</i> . The numerical indicator that denotes any one of the 24 one-third octave bands with geometrical mean frequencies from 50 to 10 000 Hz.
k	—	<i>Time increment index</i> . The numerical indicator that denotes the number of equal time increments that have elapsed from a reference zero.
log	—	<i>Logarithm to the base 10</i> .
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 .
$M(b), M(c)$, etc.	—	<i>Noy inverse slope</i> . The reciprocals of the slopes of straight lines representing the variation of SPL with log n .
n	noy	<i>Perceived noisiness</i> . The perceived noisiness at any instant of time that occurs in a specified frequency range.
$n(i,k)$	noy	<i>Perceived noisiness</i> . The perceived noisiness at the k -th instant of time that occurs in the i -th one-third octave band.
$n(k)$	noy	<i>Maximum perceived noisiness</i> . The maximum value of all of the 24 values of $n(i)$ that occurs at the k -th instant of time.
$N(k)$	noy	<i>Total perceived noisiness</i> . The total perceived noisiness at the k -th instant of time calculated from the 24 instantaneous values of $n(i,k)$.
$p(b), p(c)$, etc.	—	<i>Noy slope</i> . The slopes of straight lines representing the variation of SPL with log n .
PNL	PNdB	<i>Perceived noise level</i> . The perceived noise level at any instant of time. (The unit PNdB is used instead of the unit dB.)
PNL(k)	PNdB	<i>Perceived noise level</i> . The perceived noise level calculated from the 24 values of SPL(i,k) at the k -th increment of time. (The unit PNdB is used instead of the unit dB.)
PNLM	PNdB	<i>Maximum perceived noise level</i> . The maximum value of PNL(k). (The unit PNdB is used instead of the unit dB.)

PNLT	TPNdB	<i>Tone corrected perceived noise level.</i> The value of PNL adjusted for the spectral irregularities that occur at any instant of time. (The unit TPNdB is used instead of the unit dB.)
PNLT(k)	TPNdB	<i>Tone corrected perceived noise level.</i> The value of PNL(k) adjusted for the spectral irregularities that occur at the k -th increment of time. (The unit TPNdB is used instead of the unit dB.)
PNLTM	TPNdB	<i>Maximum tone corrected perceived noise level.</i> The maximum value of PNLT(k). (The unit TPNdB is used instead of the unit dB.)
$s(i,k)$	dB	<i>Slope of sound pressure level.</i> The change in level between adjacent one-third octave band sound pressure levels at the i -th band for the k -th instant of time.
$\Delta s(i,k)$	dB	<i>Change in slope of sound pressure level.</i>
$s^{\square}(i,k)$	dB	<i>Adjusted slope of sound pressure level.</i> The change in level between adjacent adjusted one-third octave band sound pressure levels at the i -th band for the k -th instant of time.
$s^{-}(i,k)$	dB	<i>Average slope of sound pressure level.</i>
SPL	dB re 20 μ Pa	<i>Sound pressure level.</i> The sound pressure level at any instant of time that occurs in a specified frequency range.
SPL(a)	dB re 20 μ Pa	<i>Noy discontinuity coordinate.</i> The SPL value of the intersection point of the straight lines representing the variation of SPL with $\log n$.
SPL(b)	dB re 20 μ Pa	<i>Noy intercept.</i> The intercepts on the SPL-axis of the straight lines representing the variation of SPL with $\log n$.
SPL(c)	dB re 20 μ Pa	<i>Sound pressure level.</i> The sound pressure level at the k -th instant of time that occurs in the i -th one-third octave band.
SPL(i,k)	dB re 20 μ Pa	<i>Adjusted sound pressure level.</i> The first approximation to background sound pressure level in the i -th one-third octave band for the k -th instant of time.
SPL(i)	dB re 20 μ Pa	<i>Maximum sound pressure level.</i> The sound pressure level that occurs in the i -th one-third octave band of the spectrum for PNLTM.
SPL(i) _c	dB re 20 μ Pa	<i>Corrected maximum sound pressure level.</i> The sound pressure level that occurs in the i -th one-third octave band of the spectrum for PNLTM corrected for atmospheric sound absorption.
SPL(i) \square (k)	dB re 20 μ Pa	<i>Final background sound pressure level.</i> The second and final approximation to background sound pressure level in the i -th one-third octave band for the k -th instant of time.

t	s	<i>Elapsed time.</i> The length of time measured from a reference zero.
t_1, t_2	s	<i>Time limit.</i> The beginning and end of the significant noise time history defined by h .
Δt	s	<i>Time increment.</i> The equal increments of time for which PNL(k) and PNLT(k) are calculated.
T	s	<i>Normalizing time constant.</i> The length of time used as a reference in the integration method for computing duration corrections, where $T = 10$ s.
$t(^{\circ}\text{C})$	$^{\circ}\text{C}$	<i>Temperature.</i> The ambient atmospheric temperature.
$\alpha(i)$	dB/100 m	<i>Test atmospheric absorption.</i> The atmospheric attenuation of sound that occurs in the i -th one-third octave band for the measured atmospheric temperature and relative humidity.
$\alpha(i)_o$	dB/100 m	<i>Reference atmospheric absorption.</i> The atmospheric attenuation of sound that occurs in the i -th one-third octave band for a reference atmospheric temperature and relative humidity.
β	degrees	<i>First constant* climb angle.</i>
γ	degrees	<i>Second constant** climb angle.</i>
δ	degrees	<i>Thrust cutback angles.</i> The angles defining the points on the take-off flight path at which thrust reduction is started and ended, respectively.
ϵ	degrees	
η	degrees	<i>Approach angle.</i>
η_r	degrees	<i>Reference approach angle.</i>
θ	degrees	<i>Take-off noise angle.</i> The angle between the flight path and noise path for take-off operations. It is identical for both measured and corrected flight paths.
λ	degrees	<i>Approach noise angle.</i> The angle between the flight path and the noise path for approach operations. It is identical for both measured and corrected flight paths.
Δ_1	EPNdB	<i>PNLT correction.</i> The correction to be added to the EPNL calculated from measured data to account for noise level changes due to differences in atmospheric absorption and noise path length between reference and test conditions.
Δ_2	EPNdB	<i>Noise path duration correction.</i> The correction to be added to the EPNL calculated from measured data to account for noise level changes due to the noise duration because of differences in flyover altitude between reference and test conditions.

Δ_3 EPNdB *Mass correction.* The correction to be added to the EPNL calculated from measured data to account for noise level changes due to differences between maximum mass and actual mass of the test aeroplane.

* Gear up, speed of at least $V_2 + 19$ km/h ($V_2 + 10$ kt), take-off thrust. ** Gear up, speed of at least $V_2 + 19$ km/h ($V_2 + 10$ kt), after cutback.

Δ_4 EPNdB *Approach angle correction.* The correction to be added to the EPNL calculated from measured data to account for noise level changes due to differences between the reference and the test approach angles.

ΔAB metres *Take-off profile changes.* The algebraic changes in the basic parameters defining the take-off profile due to differences between reference and test conditions.

$\Delta\gamma$ degrees
 $\Delta\delta$ degrees
 $\Delta\varepsilon$ degrees

(f) **6.2 Flight profile identification positions**

<i>Position</i>	<i>Description</i>
	A Start of take-off roll
B	Lift-off.
C	Start of first constant climb.
D	Start of thrust reduction.
E	Start of second constant climb.
	E_c Start of second constant climb on corrected flight path.
F	End of noise certification take-off flight path.
	F_c End of noise certification corrected take-off flight path.
G	Start of noise certification approach flight path.
	G_r Start of noise certification approach on reference flight path.
H	Position on approach path directly above noise measuring station.
	H_r Position on reference approach path directly above noise measuring station.
I	Start of level-off.
	I_r Start of level-off on reference approach flight path.
J	Touchdown.
K	Flyover noise measurement point.
L	Lateral noise measurement point(s) (not on flight track).
M	End of noise certification take-off flight track.
N	Approach noise measurement point.
O	Threshold of approach end of runway.

- P Start of noise certification approach flight track.
- Q Position on measured take-off flight path corresponding to apparent PNLTM at station K. (Refer 9.2.)
- Q_c Position on corrected take-off flight path corresponding to PNLTM at station K. (refer paragraph 9.2.)
- R Position on measured take-off flight path nearest to station K.

Position	Description
R _c	Position on corrected take-off flight path nearest to station K.
S	Position on measured approach flight path corresponding to PNLTM at station N.
S _r	Position on reference approach flight path corresponding to PNLTM at station N.
T	Position on measured approach flight path nearest to station N.
T _r	Position on reference approach flight path nearest to station N.
X	Position on measured take-off flight path corresponding to PNLTM at station L.

6.3 Flight profile distances

Distance	Unit	Meaning
AB	metres	<i>Length of take-off roll.</i> The distance along the runway between the start of take-off roll and liftoff.
AK	metres	<i>Take-off measurement distance.</i> The distance from the start of roll to the take-off noise measurement station along the extended centre line of the runway.
AM	metres	<i>Take-off flight track distance.</i> The distance from the start of roll to the take-off flight track position along the extended centre line of the runway for which the position of the aeroplane need no longer be recorded.
KQ	metres	<i>Measured take-off noise path.</i> The distance from station K to the measured aeroplane position Q.
KQ _c	metres	<i>Corrected take-off noise path.</i> The distance from station K to the corrected aeroplane position Q _c .
KR	metres	<i>Measured take-off minimum distance.</i> The distance from station K to point R on the measured flight path.
KR _c	metres	<i>Corrected take-off minimum distance.</i> The distance from station K to point R _c on the corrected flight path.
LX	metres	<i>Measured sideline noise path.</i> The distance from station L to the measured aeroplane position X.
NH	metres (feet)	<i>Aeroplane approach height.</i> The height of the aeroplane above the approach measuring station.
NH _r	metres (feet)	<i>Reference approach height.</i> The height of the reference approach path above the approach measuring station.
NS	metres	<i>Measured approach noise path.</i> The distance from station N to the measured aeroplane position S.
NS _r	metres	<i>Reference approach noise path.</i> The distance from station N to the reference aeroplane position S _r .
NT	metres	<i>Measured approach minimum distance.</i> The distance from station N to point T on the measured flight path.

NT_r metres *Reference approach minimum distance.* The distance from station N to point T_r on the corrected flight path.

ON metres *Approach measurement distance.* The distance from the runway threshold to the approach measurement station along the extended centre line of the runway.

Distance Unit Meaning

OP metres *Approach flight track distance.* The distance from the runway threshold to the approach flight track position along the extended centre line of the runway for which the position of the aeroplane need no longer be recorded.

7. MATHEMATICAL FORMULATION OF NOY TABLES

Note 1.— The relationship between sound pressure level and perceived noisiness given in Table A1-1 is illustrated in Figure A1-3. The variation of SPL with log n for a given one-third octave band is expressed by either one or two straight lines depending upon the frequency range. Figure A1-3 a) illustrates the double line case for frequencies below 400 Hz and above 6 300 Hz and Figure A1-3 b) illustrates the single line case for all other frequencies.

The important aspects of the mathematical formulation are:

- a) *the slopes of the straight lines p(b) and p(c);*
- b) *the intercepts of the lines on the SPL-axis, SPL(b) and SPL(c); and*
- c) *the coordinates of the discontinuity, SPL(a) and log n(a).*

Note 2.— Mathematically the relationship is expressed as follows:

Case 1: Figure A1-3 a): f < 400 Hz f > 6 300 Hz

$$\text{SPL}(a) = \frac{p(c) \text{SPL}(b) - p(b) \text{SPL}(c)}{p(c) - p(b)}$$

$$\log n(a) = \frac{\text{SPL}(c) - \text{SPL}(b)}{p(b) - p(c)}$$

- a) SPL < SPL(a)

$$n = \text{antilog} \frac{\text{SPL} - \text{SPL}(b)}{p(b)}$$

- b) SPL ≥ SPL(a)

$$\text{SPL} - \text{SPL}(c)$$

$$n = \text{antilog} \frac{\quad}{p(c)}$$

c) $\log n < \log n(a)$

$$\text{SPL} = p(b) \log n + \text{SPL}(b)$$

d) $\log n \geq \log n(a)$

$$\text{SPL} = p(c) \log n + \text{SPL}(c)$$

Case 2: Figure A1-3 b): $400 \leq f \leq 6300$ Hz

$$n = \text{antilog} \frac{\text{SPL} - \text{SPL}(c)}{p(c)}$$

$$\text{SPL} = p(c) \log n + \text{SPL}(c)$$

Note 3.— If the reciprocals of the slopes are defined as:

$$M(b) = 1/p(b)$$

$$M(c) = 1/p(c)$$

the equations in Note 2 can be written,

Case 1: Figure A1-3 a): $f < 400$ Hz $f > 6300$ Hz

$$\text{SPL}(a) = \frac{M(b) \text{SPL}(b) - M(c) \text{SPL}(c)}{M(b) - M(c)}$$

$$\log n(a) = \frac{M(b) M(c) [\text{SPL}(c) - \text{SPL}(b)]}{M(c) - M(b)}$$

a) $\text{SPL} < \text{SPL}(a)$

$$n = \text{antilog} M(b) [\text{SPL} - \text{SPL}(b)]$$

b) $\text{SPL} \geq \text{SPL}(a)$

$$n = \text{antilog} M(c) [\text{SPL} - \text{SPL}(c)]$$

c) $\log n < \log n(a)$

$$\text{SPL} = \frac{\log n}{\quad} + \text{SPL}(b)$$

$M(b)$

d) $\log n \geq \log n(a)$

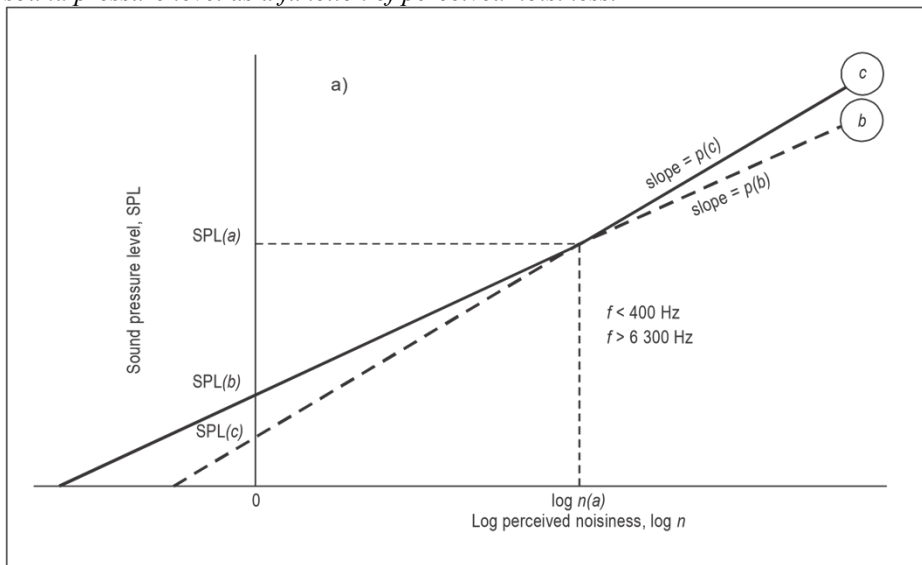
$$\text{SPL} = \frac{\log n}{M(c)} + \text{SPL}(c)$$

Case 2: Figure A1-3 b): $400 \leq f \leq 6300 \text{ Hz}$

$$n = \text{antilog } M(c) [\text{SPL} - \text{SPL}(c)]$$

$$\text{SPL} = \frac{\log n}{M(c)} + \text{SPL}(c)$$

Note 4.— Table A1-4 lists the values of the important constants necessary to calculate sound pressure level as a function of perceived noisiness.



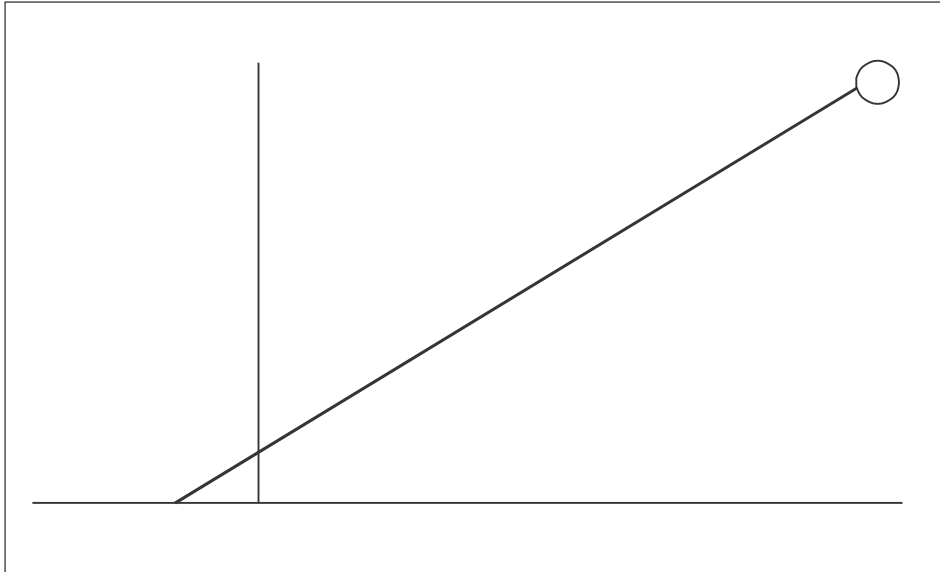


Figure A1-3. Sound pressure level as a function of perceived noisiness

Table A1-4. Constants for mathematically formulated noy values

Band (i)	f Hz	M(b)	SPL(b) dB	SPL(a) dB	M(c)	SPL(c) dB
1	50	0.043478	64	91.0	0.030103	52
2	63	0.040570	60	85.9		51
3	80	0.036831	56	87.3		49
4	100	"	53	79.9		47
5	125	0.035336	51	79.8		46
6	160	0.033333	48	76.0		45
7	200	"	46	74.0		43
8	250	0.032051	44	74.9		42
9	315	0.030675	42	94.6		41
10	400	—	—	—		40
11	500	—	—	—		40
12	630	—	—	—		40
13	800	—	—	—		40
14	1 000	—	—	—		40
15	1 250	—	—	—	0.030103	38
16	1 600	—	—	—	0.029960	34
17	2 000	—	—	—		32
18	2 500	—	—	—		30
19	3 150	—	—	—		29
20	4 000	—	—	—		29
21	5 000	—	—	—		30
22	6 300	—	—	—		31
23	8 000	0.042285	37	44.3		34
24	10 000	0.042285	41	50.7	0.029960	37

8. SOUND ATTENUATION IN AIR

8.1 The atmospheric attenuation of sound shall be determined in accordance with the procedure presented below.

8.2 The relationship between sound attenuation, frequency, temperature and humidity is expressed by the following equations:

$$\alpha(i) = 10[2.05 \log (f_0/1000) + 1.1394 \times 10^{-30} - 1.916984] + \eta(\delta) \times 10[\log (f_0) + 8.42994 \times 10^{-30} - 2.755624]$$

$$\delta = \sqrt{\frac{1010}{f_0}} 10^{(\log H - 1.328924 + 3.179768 \times 10^{-2}\theta)} \times 10(-2.173716 \times 10^{-4}\theta^2 + 1.7496 \times 10^{-6}\theta^3)$$

where:

$\eta(\delta)$ is given by Table A⁶-5 and f_0 by Table A1-6;

$\alpha(i)$ being the attenuation coefficient in dB/100 m;

θ being the temperature in °C; and

H being the relative humidity.

8.3 The equations given in 8.2 are convenient for calculation by means of a computer. For use in other cases, numerical values determined from the equations are given in Tables A1-7 to A1-16.

δ	η	δ	η
0.00	0.000	2.30	0.495
0.25	0.315	2.50	0.450
0.50	0.700	2.80	0.400
0.60	0.840	3.00	0.370
0.70	0.930	3.30	0.330
0.80	0.975	3.60	0.300
0.90	0.996	4.15	0.260
1.00	1.000	4.45	0.245
1.10	0.970	4.80	0.230
1.20	0.900	5.25	0.220
1.30	0.840	5.70	0.210
1.50	0.750	6.05	0.205
1.70	0.670	6.50	0.200
2.00	0.570	7.00	0.200
		10.00	0.200

Table A1-5

one-third octave
octave
centre frequency
frequency

Table A1-6

f_o (Hz)	one-third f_o centre
50	50
800	
3	63
1 000	1 000
80	80
1 250	1 250
100	100
1 600	1 600

125	125
2 000	2 000
160	160
2 500	2 500
200	200
3 150	3 150
250	250
4 000	4 000
315	315
5 000	4 500
400	400
6 300	5 600
500	500
8 000	7 100
630	630
10 000	9 000

Table A1-7. Sound attenuation coefficient in dB/100 m

Band centre frequency	Relative humidity = 10%										
	Temperature, °C										
Hz	-10	-5	0	5	10	15	20	25	30	35	40
50	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
63	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.1	0.1	0.1
100	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
125	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
160	0.2	0.2	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1
200	0.2	0.3	0.3	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.2
250	0.2	0.4	0.4	0.4	0.3	0.3	0.2	0.2	0.2	0.2	0.2
315	0.2	0.4	0.5	0.6	0.5	0.4	0.3	0.2	0.2	0.2	0.2
400	0.3	0.5	0.7	0.8	0.6	0.5	0.4	0.3	0.3	0.3	0.3
500	0.3	0.5	0.8	1.0	0.9	0.7	0.6	0.5	0.4	0.4	0.4
630	0.3	0.6	0.9	1.2	1.2	1.0	0.9	0.7	0.6	0.5	0.5
800	0.4	0.6	1.0	1.5	1.7	1.5	1.2	1.0	0.8	0.7	0.6
1 000	0.4	0.7	1.2	1.8	2.1	2.0	1.7	1.4	1.2	1.0	0.9
1 250	0.4	0.8	1.3	2.1	2.6	2.8	2.4	2.0	1.7	1.4	1.2
1 600	0.5	0.9	1.4	2.3	3.3	3.8	3.4	2.9	2.4	2.0	1.7
2 000	0.6	1.0	1.6	2.6	3.9	4.7	4.7	4.1	3.4	2.8	2.3
2 500	0.7	1.1	1.8	2.9	4.5	5.8	6.4	5.6	4.8	4.0	3.3
3 150	0.8	1.2	2.0	3.2	5.1	7.1	8.3	7.7	6.8	5.7	4.8
4 000	0.9	1.4	2.3	3.6	5.7	8.5	10.5	11.0	9.6	8.3	6.9
5 000	1.0	1.6	2.4	3.8	6.1	9.2	11.7	12.8	11.3	9.9	8.3
6 300	1.3	1.9	2.8	4.3	6.8	10.4	14.2	16.4	15.5	13.7	11.7
8 000	1.6	2.3	3.4	5.0	7.7	11.8	17.0	20.8	22.0	19.4	16.8
10 000	2.1	2.9	4.1	6.0	8.9	13.4	19.9	25.9	29.5	27.2	24.1
12 500	2.9	3.7	5.0	7.1	10.3	15.3	22.7	31.2	36.9	37.6	33.4

Table A1-8. Sound attenuation coefficient in dB/100m

Band centre frequency	Relative humidity = 20%										
	Temperature, °C										
Hz	-10	-5	0	5	10	15	20	25	30	35	40
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
63	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1
100	0.1	0.1	0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1
125	0.2	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1
160	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
200	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2
250	0.4	0.3	0.3	0.2	0.2	0.1	0.1	0.1	0.2	0.2	0.2
315	0.4	0.5	0.4	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2
400	0.5	0.6	0.5	0.4	0.3	0.3	0.2	0.2	0.3	0.3	0.3
500	0.6	0.8	0.7	0.6	0.5	0.4	0.3	0.3	0.3	0.3	0.4
630	0.7	1.0	1.0	0.8	0.7	0.5	0.4	0.4	0.4	0.4	0.5
800	0.8	1.2	1.4	1.2	0.9	0.7	0.6	0.5	0.5	0.6	0.6
1 000	0.9	1.4	1.8	1.6	1.3	1.0	0.8	0.7	0.7	0.7	0.8
1 250	0.9	1.6	2.2	2.2	1.8	1.5	1.2	1.0	0.9	0.9	1.0
1 600	1.1	1.9	2.7	3.1	2.6	2.1	1.7	1.4	1.2	1.2	1.3
2 000	1.2	2.0	3.2	3.9	3.6	3.0	2.5	2.0	1.7	1.5	1.6
2 500	1.3	2.3	3.7	4.9	5.0	4.2	3.5	2.8	2.3	2.0	2.0
3 150	1.5	2.5	4.2	6.0	6.8	5.8	4.9	4.0	3.3	2.8	2.7
4 000	1.7	2.9	4.8	7.2	8.7	8.2	7.1	5.9	4.9	4.0	3.6
5 000	1.9	3.1	5.1	7.9	9.8	9.7	8.4	7.0	5.9	4.8	4.2
6 300	2.2	3.5	5.7	9.0	12.0	13.3	11.5	9.9	8.2	6.8	5.8
8 000	2.7	4.1	6.5	10.4	14.8	17.4	16.2	14.1	12.0	10.0	8.3
10 000	3.3	4.9	7.5	11.8	17.7	22.0	23.1	20.1	17.2	14.5	12.1
12 500	4.1	5.9	8.8	13.4	20.5	27.1	30.6	27.5	24.2	20.6	17.4

Table A1-9. Sound attenuation coefficient in dB/100 meters

Band centre frequency	Relative humidity = 30%											
	Temperature, °C											
	Hz	-10	-5	0	5	10	15	20	25	30	35	40
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
63	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1
100	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1
125	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
160	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
200	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2
250	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2
315	0.4	0.3	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2
400	0.6	0.5	0.4	0.3	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3
500	0.7	0.6	0.5	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4
630	0.9	0.9	0.7	0.5	0.4	0.3	0.3	0.4	0.4	0.4	0.4	0.5
800	1.1	1.3	1.0	0.8	0.6	0.5	0.4	0.5	0.5	0.6	0.6	0.6
1 000	1.3	1.6	1.4	1.1	0.9	0.7	0.6	0.6	0.6	0.7	0.7	0.8
1 250	1.5	2.0	1.9	1.6	1.2	0.9	0.8	0.7	0.8	0.9	0.9	1.0
1 600	1.7	2.5	2.7	2.2	1.8	1.4	1.1	1.0	1.0	1.1	1.1	1.3
2 000	1.9	3.0	3.6	3.1	2.5	2.0	1.6	1.4	1.3	1.4	1.4	1.6
2 500	2.1	3.5	4.4	4.2	3.5	2.8	2.2	1.9	1.7	1.8	1.8	2.0
3 150	2.3	4.0	5.5	5.9	4.9	4.0	3.3	2.6	2.3	2.3	2.3	2.5
4 000	2.6	4.5	6.8	7.9	6.9	5.8	4.7	3.8	3.3	3.1	3.1	3.3
5 000	2.8	4.8	7.4	9.0	8.2	6.9	5.7	4.6	3.9	3.6	3.6	3.7
6 300	3.2	5.3	8.6	11.1	11.3	9.6	8.0	6.6	5.4	4.8	4.8	4.7
8 000	3.8	6.1	9.9	13.9	15.6	13.6	11.5	9.5	7.9	6.8	6.8	6.4
10 000	4.5	7.1	11.4	16.9	20.3	19.1	16.6	13.9	11.6	9.7	9.7	8.8
12 500	5.5	8.3	13.0	20.0	25.3	26.6	23.0	19.6	16.4	13.8	13.8	12.1

Table A1-10. Sound attenuation coefficient in dB/100 m

Band centre frequency	Relative humidity = 40%											
	Temperature, °C											
	Hz	-10	-5	0	5	10	15	20	25	30	35	40
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
63	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1
100	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1
125	0.1	0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
160	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
200	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2
250	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2
315	0.3	0.2	0.2	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2
400	0.5	0.4	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3
500	0.6	0.5	0.4	0.3	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.4
630	0.9	0.7	0.5	0.4	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.5
800	1.2	1.0	0.8	0.6	0.4	0.4	0.4	0.5	0.5	0.6	0.6	0.6
1 000	1.4	1.4	1.1	0.8	0.6	0.5	0.5	0.6	0.6	0.7	0.7	0.8

1 250	1.8	1.9	1.5	1.2	0.9	0.7	0.7	0.7	0.8	0.9	1.0
1 600	2.1	2.6	2.1	1.7	1.3	1.0	0.9	0.9	1.0	1.1	1.3
2 000	2.5	3.2	2.9	2.4	1.9	1.5	1.2	1.2	1.3	1.4	1.6
2 500	2.8	4.0	4.1	3.3	2.6	2.1	1.7	1.6	1.7	1.8	2.0
3 150	3.2	4.9	5.6	4.7	3.8	3.0	2.4	2.1	2.1	2.3	2.5
4 000	3.6	5.9	7.2	6.5	5.4	4.3	3.5	3.0	2.8	3.0	3.3
5 000	3.8	6.3	8.1	7.7	6.5	5.2	4.2	3.5	3.3	3.4	3.7
6 300	4.3	7.2	10.0	10.7	9.0	7.3	6.0	4.9	4.4	4.3	4.7
8 000	5.0	8.3	12.3	14.4	12.6	10.6	8.7	7.1	6.1	5.8	6.2
10 000	5.8	9.5	14.8	18.4	17.8	15.2	12.7	10.5	8.8	8.1	8.1
12 500	6.9	10.9	17.2	22.9	24.7	21.2	17.8	14.9	12.4	10.9	10.6

Table A1-11. Sound attenuation coefficient in dB/100 m

Band centre frequency	Relative humidity = 50%											
	Temperature, °C											
	Hz	-10	-5	0	5	10	15	20	25	30	35	40
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
63	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1
100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1
125	0.1	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
160	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
200	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2
250	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2
315	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2
400	0.4	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3
500	0.5	0.4	0.3	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.4
630	0.7	0.6	0.4	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.5
800	1.0	0.8	0.6	0.5	0.4	0.4	0.4	0.4	0.5	0.5	0.6	0.6
1 000	1.4	1.1	0.9	0.6	0.5	0.5	0.5	0.5	0.6	0.6	0.7	0.8
1 250	1.8	1.6	1.2	0.9	0.7	0.6	0.7	0.7	0.8	0.9	0.9	1.0
1 600	2.3	2.2	1.8	1.3	1.0	0.9	0.9	0.9	1.0	1.1	1.1	1.3
2 000	2.8	3.1	2.4	1.9	1.5	1.2	1.1	1.2	1.2	1.3	1.4	1.6
2 500	3.4	4.0	3.4	2.7	2.1	1.6	1.5	1.5	1.7	1.8	1.8	2.0
3 150	4.0	5.1	4.7	3.8	3.0	2.3	2.0	1.9	2.1	2.1	2.3	2.5
4 000	4.6	6.4	6.7	5.5	4.4	3.4	2.8	2.6	2.7	3.0	3.0	3.3
5 000	4.9	7.2	7.9	6.5	5.2	4.2	3.4	3.1	3.1	3.4	3.4	3.7
6 300	5.4	8.6	10.2	8.9	7.3	5.9	4.7	4.1	4.0	4.3	4.3	4.7
8 000	6.2	10.2	13.1	12.5	10.5	8.6	6.9	5.8	5.4	5.7	5.7	6.2
10 000	7.2	11.9	16.4	17.8	15.0	12.4	10.2	8.4	7.5	7.4	7.4	8.1
12 500	8.4	13.6	20.1	23.4	20.6	17.5	14.4	11.9	10.4	9.9	9.9	10.5

Table A1-12. Sound attenuation coefficient in dB/100 m

Band centre frequency	Relative humidity = 60%											
	Temperature, °C											
	Hz	-10	-5	0	5	10	15	20	25	30	35	40
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
63	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1
100	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1
125	0.1	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
160	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
200	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2
250	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2
315	0.2	0.2	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2
400	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3
500	0.5	0.3	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.4
630	0.6	0.5	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.5
800	0.9	0.7	0.5	0.4	0.4	0.4	0.4	0.5	0.5	0.6	0.6
1 000	1.2	1.0	0.7	0.5	0.5	0.5	0.5	0.6	0.6	0.7	0.8
1 250	1.7	1.3	1.0	0.7	0.6	0.6	0.7	0.7	0.8	0.9	1.0
1 600	2.3	1.9	1.5	1.1	0.9	0.8	0.9	0.9	1.0	1.1	1.3
2 000	2.9	2.6	2.1	1.6	1.2	1.1	1.1	1.2	1.3	1.4	1.6
2 500	3.6	3.6	2.9	2.2	1.7	1.4	1.4	1.5	1.7	1.8	2.0
3 150	4.4	5.0	4.1	3.2	2.5	2.0	1.8	1.9	2.1	2.3	2.5
4 000	5.3	6.6	5.7	4.6	3.6	2.8	2.5	2.5	2.7	3.0	3.3
5 000	5.8	7.4	6.8	5.5	4.3	3.4	2.9	2.9	3.1	3.4	3.7
6 300	6.6	9.2	9.3	7.7	6.1	4.9	4.0	3.8	4.0	4.3	4.7
8 000	7.6	11.4	13.0	10.9	8.9	7.2	5.8	5.2	5.2	5.7	6.2
10 000	8.7	13.8	16.9	15.3	12.8	10.4	8.5	7.3	7.0	7.4	8.1
12 500	10.0	16.1	21.1	21.2	18.0	14.8	12.2	10.2	9.5	9.6	10.5

Table A1-13. Sound attenuation coefficient in dB/100 m

Band centre frequency	Relative humidity = 70%										
	Temperature, °C										
	-10	-5	0	5	10	15	20	25	30	35	40
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
63	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1
100	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1
125	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
160	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
200	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.2
250	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.2	0.2	0.2
315	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2
400	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3
500	0.4	0.3	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.4	0.4
630	0.6	0.4	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.5
800	0.8	0.6	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.6	0.6
1 000	1.1	0.8	0.6	0.5	0.4	0.5	0.5	0.6	0.7	0.7	0.8
1 250	1.5	1.1	0.9	0.7	0.6	0.6	0.7	0.7	0.8	0.9	1.0
1 600	2.1	1.7	1.2	0.9	0.8	0.8	0.9	1.0	1.0	1.1	1.3
2 000	2.9	2.3	1.8	1.3	1.0	1.0	1.1	1.2	1.3	1.4	1.6
2 500	3.7	3.2	2.5	1.9	1.5	1.3	1.4	1.5	1.7	1.8	2.0
3 150	4.6	4.4	3.5	2.7	2.1	1.8	1.8	1.9	2.1	2.3	2.5
4 000	5.7	6.3	5.1	4.0	3.1	2.5	2.3	2.5	2.7	3.0	3.3
5 000	6.3	7.3	6.0	4.7	3.7	3.0	2.7	2.9	3.1	3.4	3.7
6 300	7.5	9.3	8.2	6.6	5.2	4.2	3.6	3.6	4.0	4.3	4.7
8 000	8.8	11.8	11.6	9.5	7.6	6.1	5.1	4.9	5.2	5.7	6.2

10 000	10.2	14.8	16.4	13.7	11.1	9.0	7.4	6.8	6.8	7.4	8.1
12 500	11.6	18.0	21.4	18.8	15.7	12.8	10.5	9.2	9.0	9.6	10.5

Table A1-14. Sound attenuation coefficient in dB/100 m

Band centre frequency	Relative humidity = 80%										
	Temperature, °C										
	Hz	-10	-5	0	5	10	15	20	25	30	35
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
63	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1
100	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1
125	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
160	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
200	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2
250	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2
315	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2
400	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3
500	0.3	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.4
630	0.5	0.3	0.3	0.2	0.3	0.3	0.3	0.4	0.4	0.4	0.5
800	0.7	0.5	0.4	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.6
1 000	1.0	0.7	0.5	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.8
1 250	1.3	1.0	0.7	0.6	0.6	0.6	0.7	0.7	0.8	0.9	1.0
1 600	1.9	1.5	1.1	0.8	0.7	0.8	0.9	0.9	1.0	1.1	1.3
2 000	2.6	2.0	1.5	1.1	1.0	1.0	1.1	1.2	1.3	1.4	1.6
2 500	3.6	2.9	2.2	1.6	1.3	1.3	1.4	1.5	1.7	1.8	2.0
3 150	4.7	4.0	3.1	2.4	1.9	1.7	1.8	1.9	2.1	2.3	2.5
4 000	5.9	5.6	4.5	3.4	2.7	2.3	2.3	2.5	2.7	3.0	3.3
5 000	6.6	6.6	5.3	4.1	3.2	2.7	2.6	2.8	3.1	3.4	3.7
6 300	8.1	9.1	7.4	5.9	4.6	3.7	3.4	3.6	4.0	4.3	4.7
8 000	9.8	12.0	10.4	8.4	6.7	5.4	4.8	4.8	5.2	5.7	6.2
10 000	11.5	15.3	14.8	12.2	9.8	7.8	6.7	6.4	6.8	7.4	8.1
12 500	13.3	18.9	20.5	17.0	13.9	11.3	9.4	8.7	8.9	9.6	10.5

Table A1-15. Sound attenuation coefficient in dB/100 m

Band centre frequency	Relative humidity = 90%											
	Temperature, °C											
	Hz	-10	-5	0	5	10	15	20	25	30	35	40
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
63	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1
100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1
125	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
160	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
200	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2
250	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2
315	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2
400	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3
500	0.3	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.4
630	0.4	0.3	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.5
800	0.6	0.4	0.3	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.6	0.6
1 000	0.9	0.6	0.5	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.8	0.8
1 250	1.2	0.9	0.6	0.5	0.6	0.6	0.7	0.7	0.8	0.9	1.0	1.0
1 600	1.7	1.3	0.9	0.7	0.7	0.8	0.9	0.9	1.0	1.1	1.3	1.3
2 000	2.4	1.8	1.3	1.0	0.9	1.0	1.1	1.2	1.3	1.4	1.6	1.6
2 500	3.3	2.6	1.9	1.4	1.2	1.3	1.4	1.5	1.7	1.8	2.0	2.0
3 150	4.6	3.6	2.8	2.1	1.7	1.6	1.8	1.9	2.1	2.3	2.5	2.5
4 000	6.0	5.1	4.0	3.0	2.4	2.2	2.3	2.5	2.7	3.0	3.3	3.3
5 000	6.7	6.0	4.8	3.7	2.9	2.6	2.6	2.8	3.1	3.4	3.7	3.7
6 300	8.3	8.3	6.7	5.2	4.0	3.4	3.3	3.6	4.0	4.3	4.7	4.7
8 000	10.4	11.7	9.5	7.6	6.0	4.9	4.5	4.8	5.2	5.7	6.2	6.2
10 000	12.6	15.4	13.5	11.0	8.8	7.1	6.3	6.3	6.8	7.4	8.1	8.1
12 500	14.8	19.4	18.6	15.4	12.4	10.1	8.7	8.3	8.9	9.6	10.5	10.5

Table A1-16. Sound attenuation coefficient in dB/100 m

Band centre frequency	Relative humidity = 100%											
	Temperature, °C											
	Hz	-10	-5	0	5	10	15	20	25	30	35	40
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
63	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1
100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1
125	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
160	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
200	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2
250	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2
315	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2
400	0.2	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3
500	0.3	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.4	0.4
630	0.4	0.3	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.4	0.5	0.5
800	0.6	0.4	0.3	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.6	0.6
1 000	0.8	0.6	0.4	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.8	0.8
1 250	1.1	0.8	0.6	0.5	0.6	0.6	0.7	0.7	0.8	0.9	1.0	1.0
1 600	1.6	1.2	0.8	0.7	0.7	0.8	0.9	0.9	1.0	1.1	1.3	1.3
2 000	2.2	1.6	1.2	0.9	0.9	1.0	1.1	1.2	1.3	1.4	1.6	1.6

2 500	3.0	2.3	1.7	1.3	1.2	1.3	1.4	1.5	1.7	1.8	2.0
3 150	4.2	3.3	2.5	1.9	1.6	1.6	1.8	1.9	2.1	2.3	2.5
4 000	5.9	4.7	3.6	2.7	2.2	2.1	2.3	2.5	2.7	3.0	3.3
5 000	6.8	5.6	4.3	3.3	2.6	2.4	2.6	2.8	3.1	3.4	3.7
6 300	8.5	7.6	6.0	4.7	3.7	3.3	3.3	3.6	4.0	4.3	4.7
8 000	10.7	10.8	8.7	6.8	5.3	4.5	4.4	4.8	5.2	5.7	6.2
10 000	13.3	15.1	12.5	10.0	7.9	6.5	6.0	6.3	6.8	7.4	8.1
12 500	16.0	19.5	17.2	14.0	11.3	9.2	8.2	8.2	8.9	9.6	10.5

9. DETAILED CORRECTION PROCEDURES

(g) 9.1 Introduction

9.1.1 When the noise certification test conditions are not identical to the noise certification reference conditions, appropriate corrections shall be made to the EPNL calculated from the measured data by the methods of this section.

Note 1.— Differences between reference and test conditions which lead to corrections can result from the following:

- (a) *atmospheric absorption of sound under test conditions different from reference;*
- (b) *test flight path at altitude different from reference; and*
- (c) *test mass different from maximum.*

Note 2. — Negative correction can arise if the atmospheric absorption of sound under test conditions is less than reference and also if the test flight path is at a lower altitude than reference.

The take-off test flight path can occur at a higher altitude than reference if the meteorological conditions permit superior aeroplane performance (“cold day” effect). Conversely, the “hot day” effect can cause the take-off test flight path to occur at a lower altitude than reference. The approach test flight path can occur at either higher or lower altitudes than reference irrespective of the meteorological conditions.

9.1.2 The measured noise values shall be properly corrected to the reference conditions, either by the correction procedures presented as follows or by an integrated programme which shall be approved as being equivalent.

9.1.2.1 Correction procedures shall consist of one or more values added algebraically to the EPNL calculated as if the tests were conducted completely under the noise certification reference conditions.

9.1.2.2 The flight profiles shall be determined for both take-off and approach, and for both reference and test conditions. The test procedures shall require noise and flight path recordings with a synchronized time signal from which the test profile can be delineated, including the aeroplane position for which PNLTM is observed at the noise

measuring station, a flight profile corrected to reference conditions shall be derived from data approved by the certificating authority.

Note. — *For approach, the reference profile is defined by the reference conditions in 5.3.*

9.1.2.3 The differing noise path lengths from the aeroplane to the noise measuring station corresponding to PNLTM shall be determined for the test and reference conditions. The SPL values in the spectrum of PNLTM shall then be corrected for the effects of:

- (a) change in atmospheric sound absorption;
- (b) atmospheric sound absorption on the change in noise path length; and
- (c) inverse square law on the change in noise path length.

9.1.2.4 The corrected values of SPL shall then be converted to PNLT from which PNLTM is subtracted.

Note. — *The difference represents the correction to be added algebraically to the EPNL calculated from the measured data.*

9.1.3 The minimum distances from both the test and reference profiles to the noise measuring station shall be calculated and used to determine a noise duration correction due to the change in the altitude of aeroplane flyover, the duration correction shall be added algebraically to the EPNL calculated from the measured data.

9.1.4 From manufacturer's data (approved by the certificating authority) in the form of curves, tables or in some other manner giving the variation of EPNL with take-off mass and also for landing mass, corrections shall be determined to be added to the EPNL calculated from the measured data to account for noise level changes due to differences between maximum take-off mass and landing mass and test aeroplane mass.

9.1.5 From manufacturer's data (approved by the certificating authority) in the form of curves, tables or in some manner giving the variation of EPNL with approach angle, corrections shall be determined to be added algebraically to the EPNL calculated from measured data to account for noise level changes due to differences between the reference and the test approach angles.

(d)9.2 Take-off profiles

Note.—

(a) *Figure A1-4 illustrates a typical take-off profile. The aeroplane begins the take-off roll at point A, lifts off at point B, and initiates the first constant climb at point C at an angle β . The noise abatement thrust cutback is started at point D and completed at point E where the second constant climb is defined by the angle γ (usually expressed in terms of the gradient in per cent).*

(b) The end of the noise certification take-off flight path is represented by aeroplane position F whose vertical projection on the flight track (extended centre line of the runway) is point M. The position of the aeroplane is recorded for a distance AM of at least 11 km (6 NM).

(c) Position K is the take-off noise measuring station whose distance AK is the specified take-off measurement distance. Position L is the sideline noise measuring station located on a line parallel to and the specified distance from the runway centre line where the noise level during take-off is greatest.

(d) The thrust settings after thrust reduction, if used, under the test conditions are such as would produce at least the minimum certification gradient for the reference conditions of atmosphere and mass.

(e) The take-off profile is associated with the following five parameters: AB, the length of take-off roll; β , the first constant climb angle; γ , the second constant climb angle; and δ and ϵ , the thrust cutback angles. These five parameters are functions of the aeroplane performance, mass and atmospheric conditions (ambient air temperature, pressure, and wind velocity). If the test atmospheric conditions are not equal to the reference atmospheric conditions, the corresponding test and reference profile parameters will be different as shown in Figure A1-5. The profile parameter changes (identified as ΔAB , $\Delta\beta$, $\Delta\gamma$, $\Delta\delta$ and $\Delta\epsilon$) can be derived from the manufacturer's data (approved by the certifying authority) and are used to define the flight profile corrected to the atmospheric reference conditions, the aeroplane mass being unchanged from that of the test. The relationships between the measured and corrected take-off flight profiles can then be used to determine the corrections which are applied to the EPNL calculated from the measured data.

(f) Figure A1-6 illustrates portions of the measured and corrected take-off flight paths including the significant geometrical relationships influencing sound propagation. EF represents the second constant measured flight path with climb angle γ , and $E_c F_c$ represents the second constant corrected flight path at different altitude and with different climb angle $\gamma + \Delta\gamma$.

(g) Position Q represents the aeroplane location on the measured take-off flight path for which PNLTM is observed at the noise measuring station K, and Q_c is the corresponding position on the corrected flight path. The measured and corrected noise propagation paths are KQ and KQ_c , respectively, which are assumed to form the same angle θ with their flight paths. This assumption of constant angle θ is one which may not be valid in all cases. Future refinement shall be sought. However, for the present application of this test procedure, any differences are considered small.

(h) Position R represents the point on the measured take-off flight path nearest the noise measuring station K, and R_c is the corresponding position on the corrected flight path. The minimum distance to the measured and corrected flight paths are indicated by the lines KR and KR_c , respectively, which are normal to their flight paths.

If two peak values of PNLT are observed during flyover which differ by less than 2 TPNdB that noise level which, when corrected to reference conditions, gives the greater value shall

be used in the computation for EPNL at the reference conditions, in that case the point corresponding to the second peak shall be obtained on the corrected flight path by applying manufacturer's approved data.

9.3 Approach profiles

Note. —

(a) *Figure A1-7 illustrates a typical approach profile. The beginning of the noise certification approach profile is represented by aeroplane position G whose vertical projection on the flight track (extended centre line of the runway) is point P. The position of the aeroplane is recorded for a distance PO from the runway threshold O of at least 7.4 km (4 NM).*

(b) *The aeroplane approaches at an angle η , passes vertically over the noise measuring station N at a height of NH, begins the level-off at position I, and touches down at position J.*

(c) *The approach profile is defined by the approach angle η and the height NH which are functions of the aeroplane operating conditions controlled by the pilot. If the measured approach profile parameters are different from the corresponding reference approach parameters (Figure A1-8), corrections are applied to the EPNL calculated from the measured data.*

(d) *Figure A1-9 illustrates portions of the measured and reference approach flight paths including the significant geometrical relationships influencing sound propagation. GI represents the measured approach path with approach angle η , and $G_r I_r$ represents the reference approach flight path at reference altitude and the reference approach angle η_r .*

(e) *Position S represents the aeroplane location on the measured approach flight path for which PNLTM is observed at the noise measuring station N, and S_r is the corresponding position on the reference approach flight path. The measured and corrected noise propagation paths are NS and NS_r respectively, which form the same angle λ with their flight paths.*

(f) *Position T represents the point on the measured approach flight path nearest the noise measuring station N, and T_r is the corresponding point on the reference approach flight path. The minimum distances to the measured and reference flight paths are indicated by the lines NT and NT_r , respectively, which are normal to their flight paths.*

(e) 9.4 PNLT corrections

9.4.1 Whenever the ambient atmospheric conditions of temperature and relative humidity differ from the reference conditions and/or whenever the measured take-off and approach flight paths differ from the reference flight paths respectively, corrections to the EPNL values calculated from the measured data shall be applied. These corrections shall be calculated as described below:

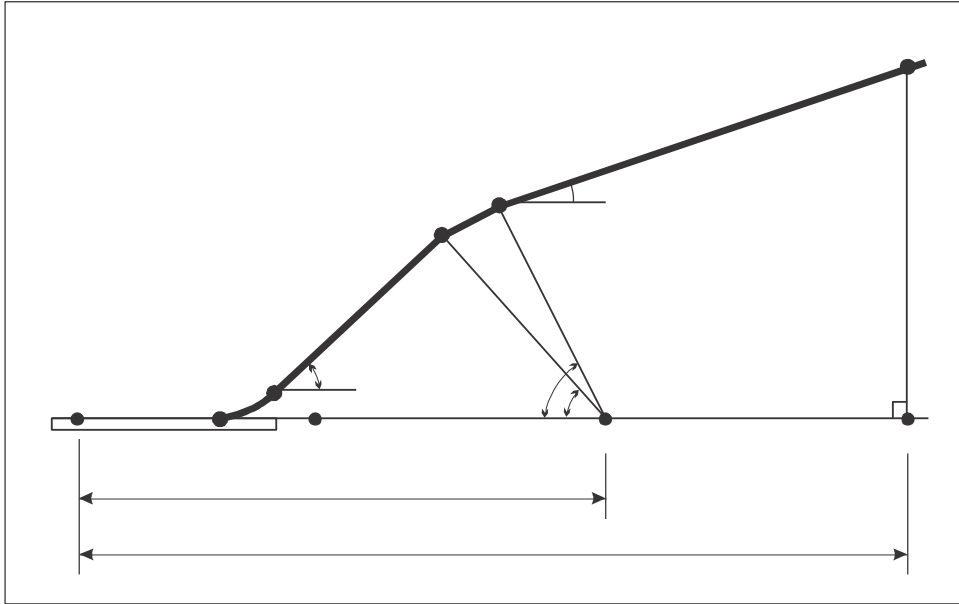


Figure A1-4. Measured take-off profile

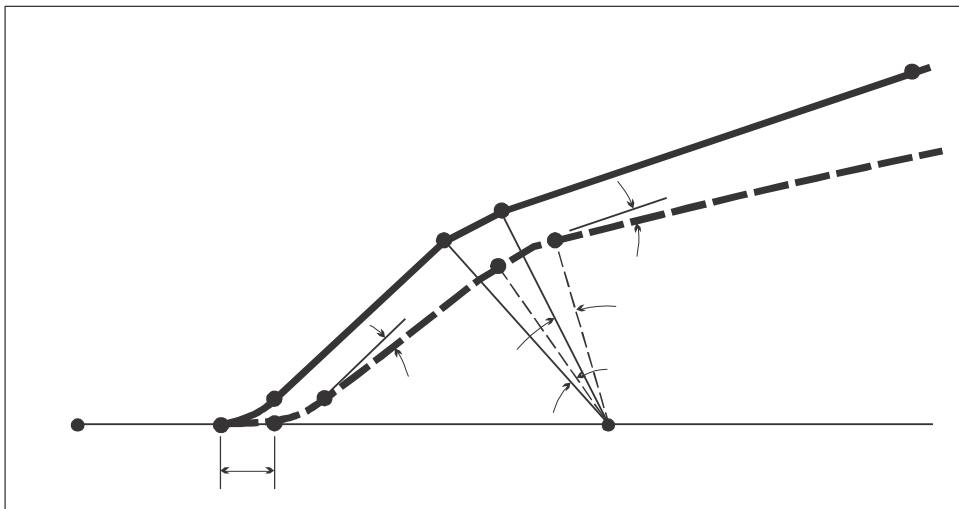


Figure A1-5. Comparison of measured and corrected take-off profiles

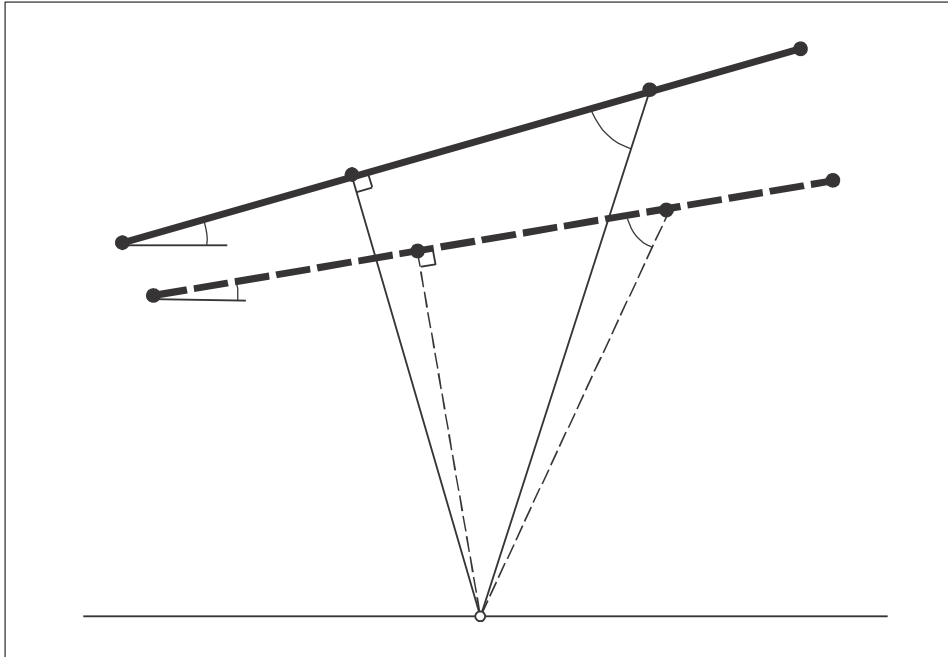


Figure A1-6. Take-off profile characteristics influencing sound level

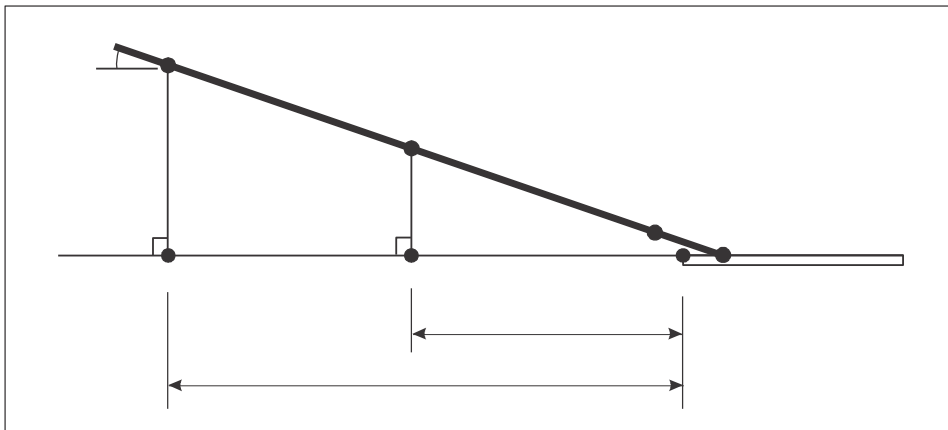


Figure A1-7. Measured approach profile

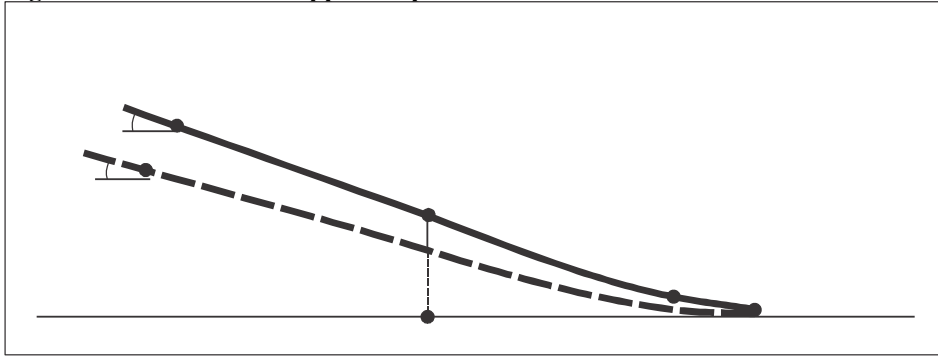


Figure A1-8. Comparison of measured and corrected approach profile

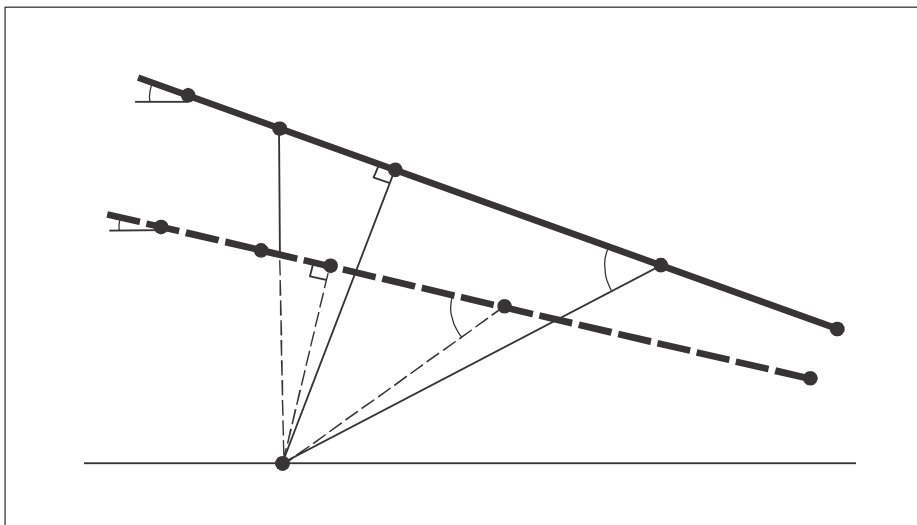


Figure A1-9. Approach profile characteristics influencing sound level

9.4.1.1 *Take-off*

9.4.1.1.1 Referring to a typical take-off flight path shown in Figure A1-6, the spectrum of PNLTM observed at station K, for the aeroplane at position Q, shall be decomposed into its individual SPL(*i*) values. A set of corrected values shall be computed as follows:

$$SPL(i)_c = SPL(i) + 0.01[\alpha(i) - \alpha(i)_o] KQ + 0.01 \alpha(i)_o (KQ - KQ_c) + 20 \log (KQ/KQ_c)$$

— the term $0.01 [\alpha(i) - \alpha(i)_o] KQ$ accounts for the effects of the change in atmospheric sound absorption where $\alpha(i)$ and $\alpha(i)_o$ are the sound absorption coefficients for the test and reference conditions respectively for the i -th one-third octave band and KQ is the measured take-off noise path;

— the term $0.01 \alpha(i)_o (KQ - KQ_c)$ accounts for the effect of atmospheric sound absorption on the change in the noise path length, where KQ_c is the corrected take-off noise path; and

— the term $20 \log (KQ/KQ_c)$ accounts for the effects of the inverse square law on the change in the noise path length.

9.4.1.1.2 The corrected values of $SPL(i)_c$ shall then be converted to PNL_T and a correction term calculated as follows:

$$\Delta_1 = PNL_T - PNL_{TM}$$

which represents the correction to be added algebraically to the EPNL calculated from the measured data.

9.4.1.2 Approach

The same procedure shall be used for the approach flight path except that the values for $SPL(i)_c$ relate to the approach noise paths shown in Figure A1-9 as follows:

$$SPL(i)_c = SPL(i) + 0.01 [\alpha(i) - \alpha(i)_o] NS + 0.01 \alpha(i)_o (NS - NS_r) + 20 \log (NS/NS_r)$$

where NS and NS_r are the measured and reference approach noise paths, respectively. The remainder of the procedure shall be the same as for the take-off flight path.

9.4.1.3 Lateral

The same procedure shall be used for the lateral flight path except that the values for $SPL(i)_c$ relate only to the measured lateral noise path as follows:

$$SPL(i)_c = SPL(i) + 0.01 [\alpha(i) - \alpha(i)_o] LX$$

where LX shall be the measured lateral noise path from station L (Figure A1-4) to position X of the aeroplane for which PNL_{TM} is observed at station L. Only the correction term accounting for the effects of change in atmospheric sound absorption shall be considered, the difference between the measured and corrected noise path lengths shall be assumed negligible for the lateral flight path and the remainder of the procedure shall be the same as for the take-off flight path.

9.5 Duration correction

9.5.1 Whenever the measured take-off and approach flight paths differ from the corrected and reference flight paths, respectively, duration corrections to the EPNL values

calculated from the measured data shall be applied. These corrections shall be calculated as described below:

9.5.1.1 *Take-off*

Referring to the take-off flight path shown in Figure A1-6, a correction term shall be calculated as follows:

$$\Delta_2 = -7.5 \log (KR/KR_c)$$

which represents the corrections to be added algebraically to the EPNL calculated from the measured data. The lengths KR and KR_c shall be the measured and corrected take-off minimum distances, respectively, from the noise measuring station K to the measured and corrected flight paths, the negative sign shall indicate that, for the particular case of a duration correction, the EPNL calculated from the measured data shall be reduced if the measured flight path is at a greater altitude than the corrected flight path.

9.5.1.2 *Approach*

The same procedure shall be used for the approach flight path except that the correction relates to the approach minimum distances shown in Figure A1-9 as follows:

$$\Delta_2 = -7.5 \log (NT/NT_r)$$

where NT is the measured approach minimum distance from the noise measuring station N to the measured flight path.

9.5.1.3 *Lateral*

No duration correction shall be computed for the lateral flight path because the differences between the measured and corrected flight paths are assumed negligible.

9.6 Mass correction

Whenever the aeroplane mass, during either the noise certification take-off or approach test, is different from the corresponding maximum take-off or landing mass, a correction shall be applied to the EPNL value calculated from the measured data, the corrections shall be determined from the manufacturer's data (approved by the certifying authority) in the form of tables or curves such as schematically indicated in Figures A1-10 and A1-11, the manufacturer's data shall be applicable to the noise certification reference atmospheric conditions.

9.7 Approach angle correction

Whenever the aeroplane approach angle during the noise certification approach test is different from the reference approach angle, a correction shall be applied to the EPNL value calculated from the measured data. The corrections shall be determined from the manufacturer's data (approved by the certifying authority) in the form of tables or curves such as schematically indicated in Figure A1-12. The manufacturer's data shall be applicable to the noise certification reference atmospheric conditions and to the test landing mass.

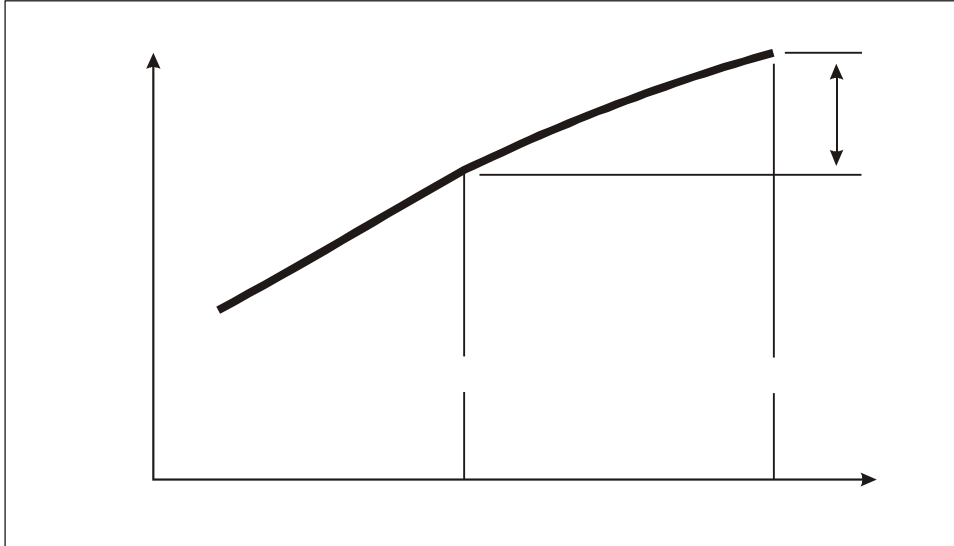


Figure A1-10. Take-off mass correction for EPNL

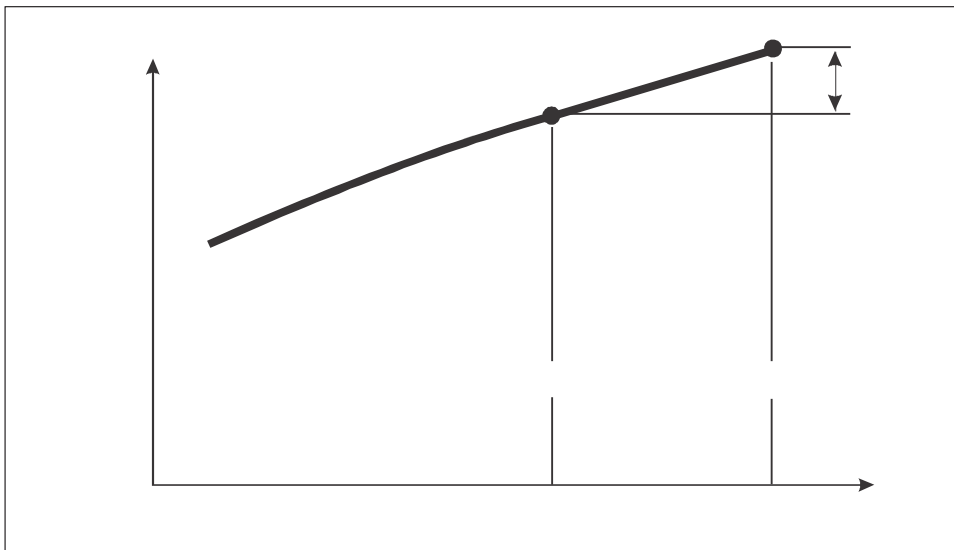


Figure A1-11. Approach mass correction for EPNL

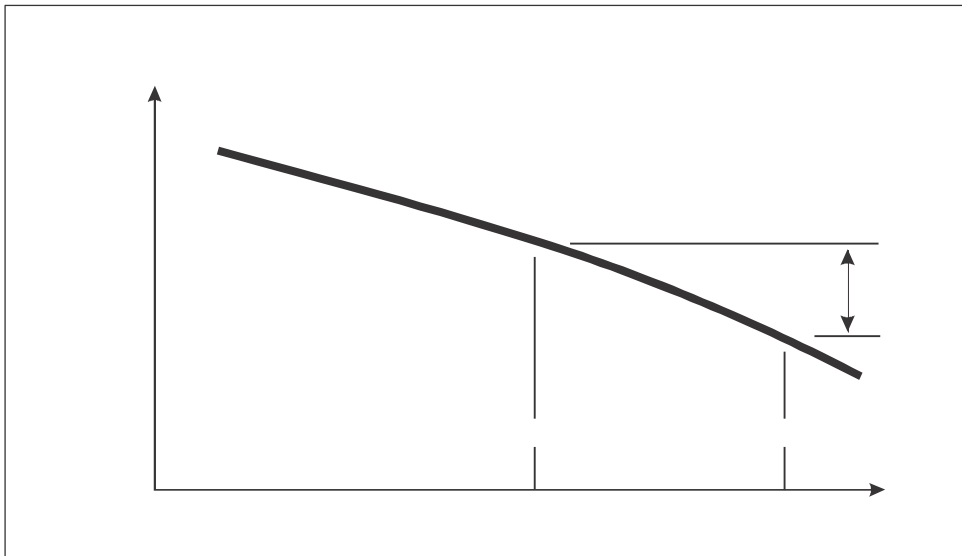


Figure A1-12. Approach angle correction for EPNL

10. SYMBOLS

I. VELOCITY

<i>Symbol</i>	<i>Unit</i>	<i>Meaning</i>
c_R	m/s	<i>Reference speed of sound. Speed of sound at a reference temperature condition (25° C).</i>
c_{HR}	m/s	<i>Reference speed of sound at the altitude of the aeroplane. The reference speed of sound corresponding to the ambient temperature – assuming a lapse rate of 0.65°C per 100 m – for a standard day at the aeroplane reference height above mean sea level.</i>
M_{ATR}	—	<i>Helicopter rotor reference advancing blade tip Mach number. The sum of the reference rotor rotational tip speed and the reference speed of the helicopter, divided by the reference speed of sound.</i>
M_H	—	<i>Propeller helical tip Mach number. 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</i>

		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}	m/s	<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}	m/s	<i>Maximum airspeed in conversion mode.</i> The never-exceed airspeed of a tilt-rotor when in conversion mode.
V_G	m/s	<i>Ground speed.</i> The aircraft velocity relative to the ground.
V_{GR}	m/s	<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	m/s	Maximum airspeed in level flight. The maximum airspeed of a helicopter in level flight when operating at maximum continuous power.
V_{MCP}	m/s	<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}	m/s	<i>Maximum operating airspeed.</i> The maximum operating limit airspeed of a tilt- rotor that may not be deliberately exceeded.
V_{NE}	m/s	<i>Never-exceed airspeed.</i> The maximum operating limit airspeed that may not be deliberately exceeded.
V_R	m/s	<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>

VREF	m/s	<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	m/s	<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	m/s	<i>Speed for best rate of climb.</i> The test airspeed for best take-off rate of climb.
V₂	m/s	<i>Take-off safety speed.</i> The minimum airspeed for a safe take-off.

II. TIME

Sym bol	Unit	Meaning
t₀	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 Δt = 0.5 s.
□t_r	S	<i>Reference time increment.</i> The effective duration of a time increment between reference reception times associated with PNLT points used in the integrated method.

III. INDICES

<i>Symbol</i>	<i>Unit</i>	<i>Meaning</i>
<i>I</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.
<i>K</i>	—	<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 <i>k</i> will likely vary from the original 0.5 second time increment when projected to reference conditions.
<i>k_F</i>	—	<i>First time increment identifier.</i> Index of the first 10 dB-down point in the discrete measured PNL T time history.
<i>k_{FR}</i>	—	<i>Reference first time increment identifier.</i> Index of the first 10 dB-down point in the discrete PNL T time history for the integrated method.
<i>k_L</i>	—	<i>Last time increment identifier.</i> Index of the last 10 dB-down point in the discrete measured PNL T time history.
<i>k_{LR}</i>	—	<i>Reference last time increment identifier.</i> Index of the last 10 dB-down point in the discrete PNL T time history for the integrated method.
<i>k_M</i>	—	<i>Maximum PNL TM time increment index.</i> Time increment index of PNL TM.
<i>T</i>	S	<i>Elapsed time.</i> The length of time measured from a reference zero.
<i>t₁</i>	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. (Refer <i>k_F</i> .)
<i>t₂</i>	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. (Refer <i>k_L</i> .)

IV. NOISE METRICS

<i>Symbol</i>	<i>Unit</i>	<i>Meaning</i>
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EPNL	EPNd B	<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. (Refer the Second Schedule, Section 4.1 for specifications.)
EPNL_A	EPNd B	<i>Approach EPNL.</i> Effective perceived noise level at the aeroplane approach reference measurement points.
EPNL_F	EPNd B	<i>Flyover EPNL.</i> Effective perceived noise level at the aeroplane flyover reference measurement points.
EPNL_L	EPNd B	<i>Lateral EPNL.</i> Effective perceived noise level at the aeroplane lateral reference measurement points.
LAE	dB(A)	<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 (dB(A), normalized to a reference duration of 1 second). (Refer the Sixth Schedule, Section 3 for specifications.)
LAS	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.
LAS_{max}	dB(A)	<i>Maximum slow A-weighted sound level.</i> The maximum value of L _{AS} over a specified time interval.
LAS_{max} R	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	EPNd B	<i>Approach EPNL limit.</i> The maximum permitted noise level at the aeroplane approach reference measurement points.
LIMIT_F	EPNd B	<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. (Refer the Second Schedule, 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 \square_B .
PNLTM_R	TPNdB	<i>Reference maximum tone-corrected perceived noise level.</i> The maximum value of PNLT _R in a specified time history, adjusted for the bandsharing adjustment \square_B in the simplified method and \square_{BR} in the integrated method.
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. The one-third octave band sound pressure levels adjusted to reference conditions.</i>
SPL_S	dB	<i>Slow weighted sound pressure level. The value of one-third octave band sound pressure levels with time weighting S applied.</i>
Δ₁	TPNd B dB(A) dB(A)	<p><i>PNLTM adjustment.</i></p> <p>Under Second Schedule or Attachment F. 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.</p> <p>Under Sixth Schedule. The adjustments to be added to the measured L_{AE} to account for noise level changes for spherical spreading and duration due to the difference between test and reference helicopter height.</p> <p>Under Fifth Schedule. For propeller-driven aeroplanes not exceeding 8618 kilograms, the adjustment to be added to the measured L_{ASmax} to account for noise level changes due to the difference between test and reference aeroplane heights.</p>
Δ₂	TPNd B dB(A) dB(A)	<p><i>Duration adjustment.</i></p> <p>Under Second Schedule or Attachment F. 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.</p> <p>Under Sixth Schedule. The adjustments to be added to the measured L_{AE} to account for</p>

		<p>noise level changes due to the difference between reference and adjusted airspeed.</p> <p>Under Fifth Schedule. For propeller-driven aeroplanes not exceeding 8 618 kilograms, the adjustment to be added to the measured L_{ASmax} to account for the noise level changes due to the difference between test and reference propeller helical tip Mach number.</p>
Δ_3	<p>TPNd B</p> <p>dB(A)</p>	<p><i>Source noise adjustment.</i> Under Second Schedule. 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.</p> <p>Under Fifth Schedule. For propeller-driven aeroplanes not exceeding 8618 kilograms, the adjustment to be added to the measured L_{ASmax} to account for noise level changes due to the difference between test and reference engine power.</p>
Δ_4	dB(A)	<p><i>Atmospheric absorption adjustment.</i> Under Fifth Schedule. For propeller-driven aeroplanes not exceeding 8 618 kilograms, 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.</p>
Δ_B	TPNd B	<p><i>Bandsharing adjustment.</i> The adjustment to be added to the maximum PNL_T to account for possible suppression of a tone due to one-third octave bandsharing of that tone. PNL_{TM} is equal to the maximum PNL_T plus Δ_B.</p>
Δ_{BR}	TPNd B	<p><i>Reference bandsharing adjustment.</i> The adjustment to be added to the maximum PNL_{TR} in the integrated method to account for possible suppression of a tone due to one-third octave bandsharing of that tone.</p>

		PNLTM _R is equal to the maximum PNL _{T_R} plus Δ_{BR} .
Δ_{peak}	TPNd B	<i>Peak adjustment.</i> The adjustment to be added to the measured EPNL for when the PNL _T for a secondary peak, identified in the calculation of EPNL from measured data and adjusted to reference conditions, is greater than the PNL _T for the adjusted PNL _{TM} spectrum.

V. 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 <i>n</i> value of the intersection point of the straight lines representing the variation of SPL with log <i>n</i> .
M	—	<i>Noy inverse slope.</i> The reciprocals of the slopes of straight lines representing the variation of SPL with log <i>n</i> .
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_i	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>Noise 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>Noise 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>Noise discontinuity level.</i> The SPL value at the discontinuity coordinate where $\log n$ equals -1 .
SPL(e)	dB	<i>Noise discontinuity level.</i> The SPL value at the discontinuity coordinate where $\log n$ 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.

VI. FLIGHT PATH GEOMETRY

<i>Symbol</i>	<i>Unit</i>	<i>Meaning</i>
H	m	<i>Height.</i> The aircraft height at the point where the flight path intercepts the vertical geometrical plane perpendicular to the reference ground track at the centre microphone.
H_R	m	<i>Reference height.</i> The reference aircraft height at the point where the reference flight path intercepts the vertical geometrical plane perpendicular to the reference ground track at

		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.

VII. 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.
D15	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>
N₁	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.
A	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.
A. ABBREVIATIONS		
CO		Carbon monoxide
Dp		The mass of any gaseous pollutant emitted during the reference emissions landing and take-off cycle
Fn		Thrust in International Standard Atmosphere (ISA), sea level conditions, for the given operating mode
Foo		Rated thrust (<i>see</i> definition)
F*oo		Rated thrust with afterburning applied
HC		Unburned hydrocarbons (<i>see</i> definition)
NO		Nitric oxide
NO2		Nitrogen dioxide
NOx		Oxides of nitrogen (<i>see</i> definition)
nvPM		Non-volatile particulate matter (<i>see</i> definition)
SN		Smoke Number (<i>see</i> definition)
π_{oo}		Reference pressure ratio (<i>see</i> definition)
AVG		Average
CG		Centre of gravity
CO₂		Carbon dioxide
g0		Standard acceleration due to gravity at sea level and a geodetic latitude of 45.5 degrees, 9.80665 (m/s ²)
Hz		Hertz (cycle per second)
MTOM		Maximum take-off mass (kilograms)

OML		Outer mould line
RG		RGF
RSS		Root sum of squares
SAR		Specific air range (kilometers/kilograms)
TAS		True airspeed (km/h)
Wf		Total aeroplane fuel flow (kg/h)
ACARS		Aircraft Communications Addressing and Reporting System
AOC		Air operator certificate
CERT		CO ₂ Estimation and Reporting Tool
CO₂		Carbon dioxide
CO₂e		Carbon dioxide equivalent
CORSIA		Carbon Offsetting and Reduction Scheme for International Aviation
GHG		Greenhouse gases
IAF		International Accreditation Forum
IEC		International Electrotechnical Commission
ISO		International Organization for Standardization
MRV		Monitoring, Reporting and Verification
MJ		Megajoule
RTK		Revenue Tonne Kilometres

B. Non-SI units for use with SI

<i>Specific quantity</i>	<i>Unit</i>	<i>Symbol</i>	<i>Definition (in terms of SI units)</i>
Mass	tonne	t	1 t = 10 ³ kilograms
Time	hour	h	1 h = 60 min = 3 600 s
Volume	litre	L	1 L = 1 dm ³ = 10 ⁻³ m ³

SECOND SCHEDULE

(Made under regulations 11,14,15(3)(c),16(3),17,19, 26,28, 31(2) (3) and (4),34,37, 39(1) and (2), 42 (2) and (3), 56(1) and (2),58, 61(3),63,65 and 68)

**EVALUATION METHOD FOR NOISE CERTIFICATION OF SUBSONIC JET
AEROPLANES
FOR TYPE CERTIFICATE SUBMITTED ON OR AFTER 6 OCTOBER 1977,
PROPELLER-DRIVEN AEROPLANES OVER 8 618 KILOGRAMS, FOR TYPE
CERTIFICATE SUBMITTED ON OR AFTER 1 JANUARY 1985,
HELICOPTERS AND TILT-ROTORs**

Note. — Refer Part 4, 5, 8, 13 and 14.

1. INTRODUCTION

Note 1.— This noise evaluation method includes:

- (a) noise certification test and measurement conditions;*
- (b) measurement of aeroplane and helicopter noise received on the ground;*
- (c) calculation of effective perceived noise level from measured noise data; and*
- (d) reporting of data to the certifying authority and correcting measured data.*

Note 2. — The instructions and procedures given in the method are clearly delineated to ensure uniformity during compliance tests, and to permit comparison between tests of various types of aircraft conducted in various geographical locations.

2. NOISE CERTIFICATION TEST AND MEASUREMENT CONDITIONS

2.1 General

This section prescribes the conditions under which noise certification tests shall be conducted and the measurement procedures that shall be used.

Note.— Many applications for a noise certificate involve only minor changes to the aircraft type design. The resultant changes in noise can often be established reliably without the necessity of resorting to a complete test as outlined in this appendix. For this reason certifying authorities are encouraged to permit the use of appropriate “equivalent procedures”. Also, there are equivalent procedures that may be used in full certification tests, in the interest of reducing costs and providing reliable results. Guidance material on the use of equivalent procedures in the noise certification of subsonic jet and propeller-

driven aeroplanes and helicopters is provided in the Environmental Technical Manual (Doc 9501), Volume I— Procedures for the Noise Certification of Aircraft.

2.2 Test environment

2.2.1 Microphone locations

Locations for measuring noise from an aircraft in flight shall be surrounded by relatively flat terrain having no excessive sound absorption characteristics such as might be caused by thick, matted, or tall grass, shrubs, or wooded areas. No obstructions which significantly influence the sound field from the aircraft shall exist within a conical space above the point on the ground vertically below the microphone, the cone being defined by an axis normal to the ground and by a half-angle 80° from this axis.

Note.— Those people carrying out the measurements could themselves constitute such obstructions.

2.2.2 Atmospheric conditions

2.2.2.1 Definitions and specifications

For the purposes of noise certification in this section the following specifications apply:

Average crosswind component shall be determined from the series of individual values of the “cross-track” (v) component of the wind samples obtained during the aircraft test run, using a linear averaging process over 30 seconds or an averaging process that has a time constant of no more than 30 seconds, the result of which is read out at a moment approximately 15 seconds after the time at which the aircraft flight path intercepts the vertical geometrical plane perpendicular to the reference ground track at the centre microphone.

Note.— The reference ground track is defined in 8.1.3.5.

Average wind speed shall be determined from the series of individual wind speed samples obtained during the aircraft test run, using a linear averaging process over 30 seconds, or an averaging process that has a time constant of no more than 30 seconds, the result of which is read out at a moment approximately 15 seconds after the time at which the aircraft flight path intercepts the vertical geometrical plane perpendicular to the reference ground track at the centre microphone. Alternatively, each wind vector shall be broken down into its “along-track” (u) and “cross-track” (v) components. The u and v components of the series of individual wind samples obtained during the aircraft test run shall be separately averaged using a linear averaging process over 30 seconds, or an averaging process that has a time constant of no more than 30 seconds, the result of which is read out at a moment approximately 15 seconds after the time at which the aircraft flight path intercepts the vertical geometrical plane perpendicular to the reference ground track at the centre microphone. The average wind speed and direction (with respect to the track) shall then be calculated from the averaged u and v components according to Pythagorean Theorem and “ $\arctan(v/u)$ ”.

Distance constant (or response length). The passage of wind (in metres) required for the output of a wind speed sensor to indicate $100 \times (1-1/e)$ per cent (about 63 per cent) of a step-function increase of the input speed.

Maximum crosswind component. The maximum value within the series of individual values of the “cross-track” (v) component of the wind samples recorded every second over a time interval that spans the 10 dB-down period.

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No. 13

Maximum wind speed. The maximum value within the series of individual wind speed samples recorded every second over a time interval that spans the 10 dB-down period.

Sound attenuation coefficient. The reduction in level of sound within a one-third octave band, in dB per 100 metres, due to the effects of atmospheric absorption of sound. Equations for the calculation of sound attenuation coefficients from values of atmospheric temperature and relative humidity are provided in Section 7.

Time constant (of a first order system). The time required for a device to detect and indicate $100 \times (1-1/e)$ per cent (about 63 per cent) of a step function change. (The mathematical constant, e , is the base number of the natural logarithm, approximately 2.7183 — also known as Euler’s number, or Napier’s constant.)

Wind direction sample (at a certain moment). The value obtained at that moment from a wind direction sensor/system with characteristics as follows:

Wind speed operating range:	1 m/s (2 kt) to more than 10 m/s (20 kt);
Linearity:	±5 degrees over the specified range; and
Resolution:	5 degrees.

Note.— For the entire wind sensing system used to obtain wind speed and direction samples, the combined dynamic characteristics, including physical inertia of the sensor(s), and any temporal processing, such as filtering of the sensor signal(s), or smoothing or averaging of the wind sensor data, shall be equivalent to a first order system (such as an R/C circuit) with a time constant of no greater than 3 seconds at a wind speed of 5 m/s (10 kt).

Wind speed sample (at a certain moment). The value measured at that moment for wind speed using a sensor/system with characteristics as follows:

Range: 1 m/s (2 kt) to more than 10 m/s (20 kt);
 Linearity: ±0.5 m/s (±1 kt) over the specified range; and

Distance constant (response length):	less than 5 metres for systems having dynamic behaviour best characterized by a distance constant; or
Time constant:	less than 3 seconds for wind speeds at or above 5 m/s (10 kt) for systems having dynamic behaviour best characterized by a time constant.

Wind vector (at a certain moment). At least once every second the wind vector shall be determined. Its magnitude will be represented at a certain moment by the wind speed sample at that moment and the direction of the vector shall be represented by the wind direction sample at that moment.

2.2.2.2 Measurement

2.2.2.2.1 Measurements of the ambient temperature and relative humidity shall be made at 10 m (33 ft) above the ground. For aeroplanes the ambient temperature and relative humidity shall also be determined at vertical increments not greater than 30 meters (100 ft) over the sound propagation path, for an aircraft test run to be acceptable, measurements of ambient temperature and relative humidity shall be obtained before and after the test run, both measurements shall be representative of the prevailing conditions during the test run and at least one of the measurements of ambient temperature and relative humidity shall be within 30 minutes of the test run, the temperature and relative humidity data at the actual time of the test run shall be interpolated over time and height, as necessary, from the measured meteorological data.

Note. — *The temperature and relative humidity measured at 10 m (33 ft) are assumed to be constant from 10 m (33 ft) to the ground.*

2.2.2.2.2 Measurements of wind speed and direction shall be made at 10 m (33 ft) above the ground throughout each test run.

2.2.2.2.3 The meteorological conditions at 10 m above the ground shall be measured within 2000 meters (6 562 ft) of the microphone locations, they shall be representative of the conditions existing over the geographical area in which noise measurements are made.

2.2.2.3 Instrumentation

2.2.2.3.1 Instrumentation for the measurement of temperature and humidity between the ground and the aeroplane, including instrumentation for the determination of the height at which these measurements are made, and the manner in which such instrumentation is used shall, to the satisfaction of the certificating authority, enable the sampling of atmospheric conditions at 30 meters (100 ft) vertical height increments or less.

2.2.2.3.2 All wind speed samples shall be taken with the sensor installed such that the horizontal distance between the anemometer and any obstruction is at least 10 times the height of the obstruction. Installation error for the wind direction sensor shall be no greater than 5 degrees.

2.2.2.3.3 The instrumentation for noise and meteorological measuring and aircraft flight path tracking shall be operated within the environmental limitations specified by the manufacturer.

2.2.2.4 *Test window*

2.2.2.4.1 For aircraft test runs to be acceptable, they shall be carried out under the following atmospheric conditions, except as provided in 2.2.2.4.2:

- (a) there shall be no precipitation;
- (b) the ambient air temperature shall not be greater than 35°C and shall not be less than -10°C over the sound propagation path between a point 10 m (33 ft) above the ground and the aircraft;
- (c) the relative humidity shall not be greater than 95 per cent and shall not be less than 20 per cent over the sound propagation path between a point 10 meters (33 ft) above the ground and the aircraft;
- (d) the sound attenuation coefficient in the 8 kHz one-third octave band shall not be more than 12 dB/100 m over the sound propagation path between a point 10 meters (33 ft) above the ground and the height of the aircraft at PNLTM;

Note. — Section 7 of this appendix specifies the method for calculation of sound attenuation coefficients based on temperature and humidity.

- (a) for aeroplanes the average wind speed at 10 meters (33 ft) above the ground shall not exceed 6.2 m/s (12 kt) and the maximum wind speed at 10 meters (33 ft) above the ground shall not exceed 7.7 m/s (15 kt);
- (b) for aeroplanes the average crosswind component at 10 m (33 ft) above the ground shall not exceed 3.6 m/s (7 kt) and the maximum crosswind component at 10 m (33 ft) above the ground shall not exceed 5.1 m/s (10 kt);
- (c) for helicopters the average wind speed at 10 m (33 ft) above the ground shall not exceed 5.1 m/s (10 kt);
- (d) for helicopters the average crosswind component at 10 m (33 ft) above the ground shall not exceed 2.6 m/s (5 kt); and
- (e) there shall be no anomalous meteorological or wind conditions that would significantly affect the measured noise levels.

Note. — The noise certification test windows for wind speed expressed in m/s are the result of converting historically used values expressed in knots using a conversion factor consistent with the Civil Aviation (Units of Measurements to be used in air and ground operations) Regulations, and rounded to 0.1 m/s. The values as given here, expressed in either unit, are considered equivalent for establishing adherence to the wind speed test windows for noise certification purposes.

2.2.2.4.2 For helicopters the requirements of 2.2.2.4.1 b), c) and d) shall only apply at 10 m (33 ft) above the ground.

2.2.2.5 *Layering*

2.2.2.5.1 For each aeroplane test run the sound attenuation coefficient in the 3 150 Hz one-third octave band shall be determined at the time of PNLTM from 10 meters (33 ft) above the ground to the height of the aeroplane, with vertical height increments not greater than 30 meters (100 ft).

2.2.2.5.2 If the individual values of the sound attenuation coefficient in the 3 150 Hz one-third octave band associated with the vertical height increments specified in 2.2.2.5.1 do not vary by more than 0.5 dB/100 m relative to the value determined at 10 m (33 ft), the coefficient to be used in the adjustment of the aeroplane noise levels for each one-third octave band shall be the average of the coefficient calculated from the temperature and humidity at 10 meters (33 ft) above the ground and the coefficient calculated from the temperature and humidity at the height of the test aeroplane.

2.2.2.5.3 If the individual values of the sound attenuation coefficient in the 3 150 Hz one-third octave band associated with the vertical height increments specified in 2.2.2.5.1 vary by more than 0.5 dB/100 m relative to the value determined at 10 m (33 ft), then “layered” sections of the atmosphere shall be used, as described below, in the computation of the coefficient for each one-third octave band to be used in the adjustment of the aeroplane noise levels:

- (a) the atmosphere from the ground to at least the height of the aeroplane shall be divided into layers of 30 m (100 ft) depth;
- (b) for each of the layers specified in 2.2.2.5.3 a), the sound attenuation coefficient shall be determined for each onethird octave band; and
- (c) for each one-third octave band the sound attenuation coefficient to be used in the adjustment of the aeroplane noise levels shall be the average of the individual layer coefficients specified in 2.2.2.5.3 b).

2.2.2.5.4 For helicopters, the sound attenuation coefficient to be used in the adjustment of noise levels for each onethird octave band shall be calculated from the temperature and humidity at 10 m (33 ft) above the ground.

2.3 Flight path measurement

2.3.1 The aircraft spatial position relative to the measurement microphone(s) shall be determined by a method which is approved by the certificating authority and is independent of cockpit flight instrumentation.

Note. — *Guidance material on aircraft position measurement systems is provided in the Environmental Technical Manual (Doc 9501), Volume I — Procedures for the Noise Certification of Aircraft.*

2.3.2 The aircraft position along the flight path shall be synchronized to the noise recorded at the noise measurement locations by means of time-synchronizing signals over a distance and duration sufficient to assure that adequate data is obtained during the period that the noise is within 10 dB of the maximum value of PNLT.

2.3.3 Position and performance data required to make the adjustments referred to in Section 8 of this appendix shall be automatically recorded at an approved sampling rate. Measuring equipment shall be approved by the certifying authority.

3. MEASUREMENT OF AIRCRAFT NOISE RECEIVED ON THE GROUND

3.1 Definitions

For the purposes of this section the following definitions apply:

Ambient noise. The acoustical noise from sources other than the test aircraft present at the microphone site during aircraft noise measurement. Ambient noise is one component of background noise.

Background noise. The combined noise present in a measurement system from sources other than the test aircraft, which can influence or obscure the aircraft noise levels being measured. Typical elements of background noise include (but are not limited to): ambient noise from sources around the microphone site; thermal electrical noise generated by components in the measurement system; magnetic flux noise (“tape hiss”) from analogue tape recorders; and digitization noise caused by quantization error in digital converters. Some elements of background noise, such as digitization noise, can obscure the aircraft noise signal, while others, such as ambient noise, can also contribute energy to the measured aircraft noise signal.

Broadband noise. Noise for which the frequency spectrum is continuous (i.e. energy is present at all frequencies in a given range) and which lacks any discrete frequency components (i.e. tones).

Calibration check frequency. In hertz, the nominal frequency of the sinusoidal sound pressure signal produced by the sound calibrator.

Calibration sound pressure level. In decibels, the sound pressure level produced, under reference environmental conditions, in the cavity of the coupler of the sound calibrator that is used to determine the overall acoustical sensitivity of a measurement system.

Free-field sensitivity level of a microphone system. In decibels, twenty times the logarithm to the base ten of the ratio of the free-field sensitivity of a microphone system and the reference sensitivity of one volt per pascal.

Note.— *The free-field sensitivity level of a microphone system may be determined by subtracting the sound pressure level (in decibels re 20 μ Pa) of the sound incident on the microphone from the voltage level (in decibels re 1 V) at the output of the microphone system, and adding 93.98 dB to the result.*

Free-field sensitivity of a microphone system. In volts per pascal, for a sinusoidal plane progressive sound wave of specified frequency, at a specified sound-incidence angle, the quotient of the root-mean-square voltage at the output of a microphone system and the root-mean-square sound pressure that would exist at the position of the microphone in its absence.

Level difference. In decibels, for any nominal one-third octave midband frequency, the output signal level measured on any level range minus the level of the corresponding electrical input signal.

Level non-linearity. In decibels, the level difference measured on any level range, at a stated one-third octave nominal midband frequency, minus the corresponding reference level difference, all input and output signals being relative to the same reference quantity.

Level range. In decibels, an operating range determined by the setting of the controls that are provided in a measurement system for the recording and one-third octave band analysis of a sound pressure signal. The upper boundary associated with any particular level range shall be rounded to the nearest decibel.

Linear operating range. In decibels, for a stated level range and frequency, the range of levels of steady sinusoidal electrical signals applied to the input of the entire measurement system, exclusive of the microphone but including the microphone preamplifier and any other signal-conditioning elements that are considered to be part of the microphone system, extending from a lower to an upper boundary, over which the level non-linearity is within specified tolerance limits.

Note.— *It is not necessary to include microphone extension cables as configured in the field.*

Measurement system. The combination of instruments used for the measurement of sound pressure levels, including a sound calibrator, windscreen, microphone system, signal recording and conditioning devices, and a one-third octave band analysis system.

Note.— *Practical installations may include a number of microphone systems, the outputs from which are recorded simultaneously by a multi-channel recording/analysis device via signal conditioners as appropriate. For the purpose of this section, each complete measurement channel is considered to be a measurement system to which the requirements apply accordingly.*

Microphone system. The components of the measurement system which produce an electrical output signal in response to a sound pressure input signal, and which generally include a microphone, a preamplifier, extension cables, and other devices as necessary.

Reference direction. In degrees, the direction of sound incidence specified by the manufacturer of the microphone, relative to a sound incidence angle of 0°, for which the free-field sensitivity level of the microphone system is within specified tolerance limits.

Reference level difference. In decibels, for a stated frequency, the level difference measured on a level range for an electrical input signal corresponding to the calibration sound pressure level, adjusted as appropriate, for the level range.

Reference level range. In decibels, the level range for determining the acoustical sensitivity of the measurement system and containing the calibration sound pressure level.

Sound incidence angle. In degrees, an angle between the principal axis of the microphone and a line from the sound source to the centre of the diaphragm of the microphone.

Note. — When the sound incidence angle is 0°, the sound is said to be received at the microphone at “normal (perpendicular) incidence”; when the sound incidence angle is 90°, the sound is said to be received at “grazing incidence”. The principal axis of a measurement microphone is through the centre of the diaphragm and perpendicular to it.

Time-average band sound pressure level. In decibels, ten times the logarithm to the base ten, of the ratio of the time meansquare of the instantaneous sound pressure during a stated time interval and in a specified one-third octave band, to the square of the reference sound pressure of 20 µPa.

Windscreen insertion loss. In decibels, at a stated nominal one-third octave midband frequency, and for a stated sound incidence angle on the inserted microphone, the indicated sound pressure level without the windscreen installed around the microphone minus the sound pressure level with the windscreen installed.

3.2 Reference environmental conditions

The reference environmental conditions for specifying the performance of a measurement system are:

— air temperature	23°C
— static air pressure	101.325 kPa
— relative humidity	50 per cent.

3.3 General

Note. — Measurements of aircraft noise that utilize instruments that conform to the specifications of this section yield one-third octave band sound pressure levels as a function of time, for the calculation of the effective perceived noise level as described in Section 4.

3.3.1 The measurement system shall consist of equipment approved by the certificating authority and equivalent to the following:

- (a) a windscreen (refer paragraph 3.4);
- (b) a microphone system (refer paragraph 3.5);
- (c) a recording and reproducing system to store the measured aircraft noise signals for subsequent analysis (refer paragraph 3.6);
- (d) a one-third octave band analysis system (refer paragraph 3.7); and
- (e) calibration systems to maintain the acoustical sensitivity of the above systems within specified tolerance limits (refer paragraph 3.8).

3.3.2 For any component of the measurement system that converts an analogue signal to digital form, such conversion shall be performed so that the levels of any possible aliases or artefacts of the digitization process will be less than the upper boundary of the linear operating range by at least 50 dB at any frequency less than 12.5 kHz, the sampling rate shall be at least 28 kHz. An anti-aliasing filter shall be included before the digitization process.

3.4 Windscreen

In the absence of wind and for sinusoidal sounds at grazing incidence, the insertion loss caused by the windscreen of a stated type installed around the microphone shall not exceed ± 1.5 dB at nominal one-third octave midband frequencies from 50 Hz to 10 kHz inclusive.

3.5 Microphone system

3.5.1 The microphone system shall conform to the specifications in 3.5.2 to 3.5.4. Various microphone systems may be approved by the certificating authority on the basis of demonstrated equivalent overall electroacoustical performance, where two or more microphone systems of the same type are used, demonstration that at least one system conforms to the specifications in full is sufficient to demonstrate conformance.

Note.— This demonstration of equivalent performance does not eliminate the need to calibrate and check each system as defined in 3.9.

3.5.2 The microphone shall be mounted with the sensing element 1.2 m (4 ft) above the local ground surface and shall be oriented for grazing incidence, i.e. with the sensing element substantially in the plane defined by the predicted reference flight path of the aircraft and the measuring station, the microphone mounting arrangement shall minimize the interference of the supports with the sound to be measured, Figure A2-1 illustrates sound incidence angles on a microphone.

3.5.3 The free-field sensitivity level of the microphone and preamplifier in the reference direction, at frequencies over at least the range of one-third octave nominal

midband frequencies from 50 Hz to 5 kHz inclusive, shall be within ± 1.0 dB of that at the calibration check frequency, and within ± 2.0 dB for nominal midband frequencies of 6.3 kHz, 8 kHz and 10 kHz.

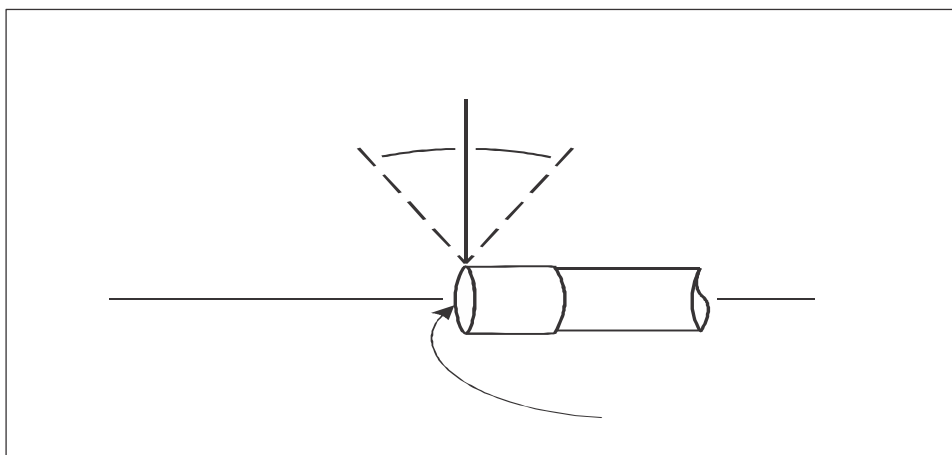


Figure A2-1. Illustration of sound incidence angles on a microphone

3.5.4 For sinusoidal sound waves at each one-third octave nominal midband frequency over the range from 50 Hz to 10 kHz inclusive, the free-field sensitivity levels of the microphone system at sound incidence angles of 30°, 60°, 90°, 120° and 150° shall not differ from the free-field sensitivity level at a sound incidence angle of 0° (“normal incidence”) by more than the values shown in Table A2-1, The free-field sensitivity level differences at sound incidence angles between any two adjacent sound incidence angles in Table A2-1 shall not exceed the tolerance limit for the greater angle.

Table A2-1. Microphone directional response requirements

Maximum difference between the free-field sensitivity level of a microphone system at normal incidence and the free-field sensitivity level Nominal at specified sound incidence angles (dB) midband

frequency kHz	30	60	Sound incidence angle degrees	90	120	150
0.05 to 1.6	0.5	0.5	1.0	1.0	1.0	1.0
2.0	0.5	0.5	1.0	1.0	1.0	1.0
2.5	0.5	0.5	1.0	1.5	1.5	1.5

3.15	0.5	1.0	1.5	2.0	2.0
4.0	0.5	1.0	2.0	2.5	2.5
5.0	0.5	1.5	2.5	3.0	3.0
6.3	1.0	2.0	3.0	4.0	4.0
8.0	1.5	2.5	4.0	5.5	5.5
10.0	2.0	3.5	5.5	6.5	7.5

3.6 Recording and reproducing systems

3.6.1 A recording and reproducing system, such as a digital or analogue magnetic tape recorder, a computer-based system or other permanent data storage device, shall be used to store sound pressure signals for subsequent analysis. The sound produced by the aircraft shall be recorded in such a way that a record of the complete acoustical signal is retained, the recording and reproducing systems shall conform to the specifications in 3.6.2 to 3.6.9 at the recording speeds and/or data sampling rates used for the noise certification tests, conformance shall be demonstrated for the frequency bandwidths and recording channels selected for the tests.

3.6.2 The recording and reproducing systems shall be calibrated as described in 3.9.

Note.— For aircraft noise signals for which the high frequency spectral levels decrease rapidly with increasing frequency, appropriate pre-emphasis and complementary de-emphasis networks may be included in the measurement system. If pre-emphasis is included, over the range of nominal one-third octave midband frequencies from 800 Hz to 10 kHz inclusive, the electrical gain provided by the pre-emphasis network shall not exceed 20 dB relative to the gain at 800 Hz.

3.6.3 For steady sinusoidal electrical signals applied to the input of the entire measurement system exclusive of the microphone system, but including the microphone preamplifier, and any other signal-conditioning elements that are considered to be part of the microphone system, at a selected signal level within 5 dB of that corresponding to the calibration sound pressure level on the reference level range, the time average signal level indicated by the readout device at any one-third octave nominal midband frequency from 50 Hz to 10 kHz inclusive shall be within ± 1.5 dB of that at the calibration check frequency, the frequency response of a measurement system, which includes components that convert analogue signals to digital form, shall be within ± 0.3 dB of the response at 10 kHz over the frequency range from 10 kHz to 11.2 kHz.

Note. — It is not necessary to include microphone extension cables as configured in the field.

3.6.4 For analogue tape recordings, the amplitude fluctuations of a 1 kHz sinusoidal signal recorded within 5 dB of the level corresponding to the calibration sound pressure level shall not vary by more than ± 0.5 dB throughout any reel of the type of

magnetic tape utilized, the conformance to this requirement shall be demonstrated using a device which has time-averaging properties equivalent to those of the spectrum analyser.

3.6.5 For all appropriate level ranges and for steady sinusoidal electrical signals applied to the input of the measurement system exclusive of the microphone system, but including the microphone preamplifier, and any other signal conditioning elements that are considered to be part of the microphone system, at one-third octave nominal midband frequencies of 50 Hz, 1 kHz and 10 kHz, and the calibration check frequency, if it is not one of these frequencies, the level non-linearity shall not exceed ± 0.5 dB for a linear operating range of at least 50 dB below the upper boundary of the level range.

Recommendation. — *Level linearity of measurement system components should be tested according to the methods described in IEC 61265¹ as amended.*

Note. — *It is not necessary to include microphone extension cables as configured in the field.*

3.6.6 On the reference level range, the level corresponding to the calibration sound pressure level shall be at least 5 dB, but no more than 30 dB less than the upper boundary of the level range.

3.6.7 The linear operating ranges on adjacent level ranges shall overlap by at least 50 dB minus the change in attenuation introduced by a change in the level range controls.

Note. — *It is possible for a measurement system to have level range controls that permit attenuation changes of, for example, either 10 dB or 1 dB. With 10 dB steps, the minimum overlap required would be 40 dB, and with 1 dB steps the minimum overlap would be 49 dB.*

3.6.8 Provision shall be made for an overload indication to occur during an overload condition on any relevant level range.

3.6.9 Attenuators included in the measurement system to permit range changes shall operate in known intervals of decibel steps.

3.7 Analysis systems

3.7.1 The analysis system shall conform to the specifications in 3.7.2 to 3.7.7 for the frequency bandwidths, channel configurations and gain settings used for analysis.

3.7.2 The output of the analysis system shall consist of one-third octave band sound pressure levels as a function of time, obtained by processing the noise signals (preferably recorded) through an analysis system with the following characteristics:

- (a) a set of 24 one-third octave band filters, or their equivalent, having nominal midband frequencies from 50 Hz to 10 kHz inclusive;

- (b) response and averaging properties in which, in principle, the output from any one-third octave filter band is squared, averaged and displayed or stored as time-averaged sound pressure levels;

IEC 61265:1995 entitled “Electroacoustics — Instruments for measurement of aircraft noise — Performance requirements for systems to measure onethird-octave band sound pressure levels in noise certification of transport-category aeroplanes”. This IEC publication may be obtained from the Central Office of the International Electrotechnical Commission, 3 rue de Varembé, Geneva, Switzerland.

- (a) the interval between successive sound pressure level samples shall be 500 ms \pm 5 ms for spectral analysis with or without SLOW-time-weighting;
- (b) for those analysis systems that do not process the sound pressure signals during the period of time required for readout and/or resetting of the analyser, the loss of data shall not exceed a duration of 5 ms; and
- (c) the analysis system shall operate in real time from 50 Hz to at least 12 kHz inclusive. This requirement applies to all operating channels of a multichannel spectral analysis system.

3.7.3 The one-third octave band analysis system shall conform to the class 1 performance requirements of IEC 61260-1² as amended, over the range of one-third octave filters having nominal midband frequencies from 50 Hz to 10 kHz inclusive.

Note. — *The certifying authority may allow the substitution of an analysis system that complies with class 2 performance requirements of IEC 61260-1² or with class 1 or class 2 of an earlier version of IEC 61260.*

Recommendation. — *Tests of the one-third octave band analysis system should be made according to the methods described in IEC 61260-3³ or by an equivalent procedure approved by the certifying authority, for relative attenuation, anti-aliasing filters, real-time operation, level linearity, and filter integrated response (effective bandwidth).*

3.7.4 When SLOW-time-averaging is performed in the analyser, the response of the one-third octave band analysis system to a sudden onset or interruption of a constant sinusoidal signal at the respective one-third octave nominal midband frequency shall be measured at sampling instants 0.5, 1, 1.5 and 2 seconds after both the onset and the interruption. The rising response shall be -4 ± 1 dB at 0.5 seconds, -1.75 ± 0.75 dB at 1 second, -1 ± 0.5 dB at 1.5 seconds and -0.5 ± 0.5 dB at 2 seconds relative to the steady-state level. The sum of the rising and corresponding falling shall be -6.5 ± 1 dB, at both 0.5 and 1 seconds, the sum of the rising and falling responses shall be -6.5 dB or less at 1.5 seconds and -7.5 dB or less at 2 seconds, and subsequent times relative to the steady-state levels, this equates to an exponential averaging process (SLOW weighting) with a nominal 1-second time constant.

3.7.5 When the one-third octave band sound pressure levels are determined from the output of the analyser without SLOW-time-weighting, SLOW-time-

weighting shall be simulated in the subsequent processing, Simulated SLOW-weighted sound pressure levels can be obtained using a continuous exponential averaging process by the following equation:

$$\text{SPL}_s(i,k) = 10 \log [(0.60653) 100.1\text{SPL}_s [i,(k-1)] + (0.39347) 100.1\text{SPL}(i,k)]$$

where $\text{SPL}_s(i,k)$ is the simulated SLOW-weighted sound pressure level and $\text{SPL}(i,k)$ is the as-measured 0.5 seconds time average sound pressure level determined from the output of the analyser for the k -th instant of time and the i -th one-third octave band. For $k = 1$, the SLOW-weighted sound pressure $\text{SPL}_s[i,(k-1 = 0)]$ on the right-hand side shall be set to 0 dB.

An approximation of the continuous exponential averaging is represented by the following equation for a four-sample averaging process for $k = 4$:

$$\text{SPL}_s(i,k) = 10 \log [(0.13) 100.1\text{SPL}[i,(k-3)] + (0.21) 100.1\text{SPL}[i,(k-2)] + (0.27) 100.1\text{SPL}[i,(k-1)] + (0.39) 100.1\text{SPL}[i,k]]$$

where $\text{SPL}_s(i,k)$ is the simulated SLOW-weighted sound pressure level and $\text{SPL}(i,k)$ is the as-measured 0.5 seconds time average sound pressure level determined from the output of the analyser for the k -th instant of time and the i -th one-third octave band.

2. IEC 61260-1:2014 entitled “Electroacoustics — Octave-band and fractional-octave-band filters — Part 1: Specifications”. This IEC publication may be obtained from the Central Office of the International Electrotechnical Commission, 3 rue de Varembé, Geneva, Switzerland.
3. IEC 61260-3:2016 entitled “Electroacoustics — Octave-band and fractional-octave-band filters — Part 3: Periodic tests”. This IEC publication may be obtained from the Central Office of the International Electrotechnical Commission, 3 rue de Varembé, Geneva, Switzerland.

The sum of the weighting factors is 1.0 in the two equations, the sound pressure levels calculated by means of either equation are valid for the sixth and subsequent 0.5 seconds data samples, or for times greater than 2.5 seconds after initiation of data analysis.

Note. — The coefficients in the two equations were calculated for use in determining equivalent SLOW-weighted sound pressure levels from samples of 0.5 seconds time average sound pressure levels. The equations should not be used with data samples where the averaging time differs from 0.5 seconds.

- 3.7.6 The instant in time by which a SLOW-time-weighted sound pressure level is characterized shall be 0.75 seconds earlier than the actual readout time.

Note. — The definition of this instant in time is required to correlate the recorded noise with the aircraft position when the noise was emitted and takes into account the averaging period of the SLOW weighting. For each one-half second data record this instant in time

may also be identified as 1.25 seconds after the start of the associated 2-second averaging period.

- 3.7.7 The resolution of the sound pressure levels, both displayed and stored, shall be 0.1 dB or better.

3.8 Calibration instrumentation

3.8.1 All instrumentation used for calibration and determination of corrections shall be approved by the certificating authority.

3.8.2 The sound calibrator shall at least conform to the class 1 requirements of IEC 60942.⁴ The sound pressure level produced in the cavity of the coupler of the sound calibrator shall be calculated for the test environmental conditions using the manufacturer's supplied information on the influence of atmospheric air pressure and temperature, the output of the sound calibrator shall be determined within six months of each aircraft noise measurement by a method traceable to a national standards laboratory, tolerable changes in output from the previous calibration shall be not more than 0.2 dB.

3.8.3 If pink noise is used to determine the corrections for system frequency response in 3.9.7, then the output of the noise generator shall be determined within six months of each aircraft noise measurement by a method traceable to a national standards laboratory, tolerable changes in the relative output from the previous calibration in each one-third octave band shall be not more than 0.2 dB.

3.9 Calibration and checking of system

3.9.1 Calibration and checking of the measurement system and its constituent components shall be carried out to the satisfaction of the certificating authority by the methods specified in 3.9.2 to 3.9.9. All calibration corrections and adjustments, including those for the environmental effects on sound calibrator output level, shall be reported to the certificating authority and applied to the measured one third octave sound pressure levels determined from the output of the analyser, the aircraft noise data collected during an overload condition of any measurement system components in the signal path prior to and including the recorder are invalid and shall not be used and if the overload condition occurred during analysis or at a point in the signal path after the recorder, the analysis shall be repeated with reduced sensitivity to eliminate the overload.

3.9.2 The acoustical sensitivity of the measurement system shall be established using a sound calibrator generating a known sound pressure level at a known frequency. Sufficient sound pressure level calibrations shall be recorded during each test day to ensure that the acoustical sensitivity of the measurement system is known for the prevailing environmental

4. IEC 60942:2003 entitled "Electroacoustics — Sound calibrators". This IEC publication may be obtained from the Central Office of the International Electrotechnical Commission, 3 rue de Varembé, Geneva, Switzerland.

conditions corresponding with each aircraft noise measurement. Measured aircraft noise data shall not be considered valid for certification purposes unless preceded and succeeded

by valid sound pressure level calibrations. The measurement system shall be considered satisfactory if the difference between the acoustical sensitivity levels recorded immediately before and immediately after each group of aircraft noise measurements on a given day is not greater than 0.5 dB. The 0.5 dB limit applies after any atmospheric pressure corrections have been applied to the calibrator output level, the arithmetic mean of the preceding and succeeding calibrations shall be used to represent the acoustical sensitivity level of the measurement system for each group of aircraft noise measurements, the calibration corrections shall be reported to the certificating authority and applied to the measured one-third octave band sound pressure levels determined from the output of the analyser.

3.9.3 For analogue (direct or FM) magnetic tape recorders each volume of recording medium, such as a reel, cartridge, or cassette, shall carry a sound pressure level calibration of at least 10 seconds duration at its beginning and end.

3.9.4 The free-field frequency response of the microphone system may be determined by using an electrostatic actuator in combination with the manufacturer's data or by testing in an anechoic free-field facility. The corrections for frequency response shall be determined within 90 days of each aircraft noise measurement and shall be reported to the certificating authority, they shall be applied to the measured one-third octave band sound pressure levels determined from the output of the analyser.

3.9.5 When the angles of incidence at the microphone of sound emitted from the aircraft are within $\pm 30^\circ$ of grazing incidence (refer Figure A2-1), a single set of free-field corrections based on grazing incidence is considered sufficient for the correction of directional response effects. Otherwise, appropriate corrections for incidence effects shall be determined at the angle of incidence for each one-half second sample, such corrections shall be reported to the certificating authority and applied to the measured one third octave band sound pressure levels determined from the output of the analyser.

3.9.6 The free-field insertion effects of the windscreen for each one-third octave nominal midband frequency from 50 Hz to 10 kHz inclusive shall be determined with sinusoidal sound signals at appropriate incidence angles on the inserted microphone, for a windscreen which is undamaged and uncontaminated, the insertion effects may be taken from the manufacturer's data, In addition, the insertion effects of the windscreen may be determined within six months of each aircraft noise measurement by a method traceable to a national standards laboratory, the tolerable changes in the insertion effects from the previous calibration at each one-third octave frequency band shall be not more than 0.4 dB, the corrections for the freefield insertion effects of the windscreen shall be reported to the certificating authority and applied to the measured one-third octave sound pressure levels determined from the output of the analyser.

3.9.7 The frequency response of the entire measurement system, exclusive of the microphone and windscreen, but otherwise configured as deployed in the field during the aircraft noise measurements, shall be established. Corrections shall be determined for each one-third octave nominal midband frequency from 50 Hz to 10 kHz inclusive, the determination shall be made at a level within 5 dB of the level corresponding to the calibration sound pressure level on the reference level range and shall utilize pink random or pseudo-random noise or alternatively discrete sine or swept sine signals, the corrections for frequency response shall be reported to the certificating authority and applied to the

measured one-third octave sound pressure levels determined from the output of the analyser and if the system frequency response corrections are determined away from the field then frequency response testing shall be performed in the field to ensure the integrity of the measurement system.

3.9.8 For analogue (direct or FM) magnetic tape recorders, each volume of recording medium such as a reel, cartridge, or cassette shall carry at least 30 seconds of pink random or pseudo-random noise at its beginning and end, the aircraft noise data obtained from analogue tape-recorded signals shall be accepted as valid only if level differences in the 10 kHz one-third octave band are not more than 0.75 dB for the signals recorded at the beginning and end. For systems using analogue (direct or FM) magnetic tape recorders frequency response corrections shall be determined from pink noise recordings performed in the field during deployment for aircraft noise measurements.

3.9.9 The performance of switched attenuators in the equipment used during noise certification measurements and calibration shall be checked within six months of each aircraft noise measurement to ensure that the maximum error does not exceed 0.1 dB. The accuracy of gain-changes shall be tested or determined from manufacturers specifications to the satisfaction of the certificating authority.

(f) 3.10 Adjustments for background noise

3.10.1 Background noise shall be recorded (for at least 30 seconds) at the measurement points with the system gain set at the levels used for the aircraft noise measurements, the recorded background noise sample shall be representative of that which exists during the test run, the recorded aircraft noise data shall be accepted only if the background noise levels, when analysed in the same way and quoted in PNL (refer paragraph 4.1.3 a)), are at least 20 dB below the maximum PNL of the aircraft.

3.10.2 Aircraft sound pressure levels within the 10 dB-down points (refer paragraph 4.5.1) shall exceed mean background noise levels determined above by at least 3 dB in each one-third octave band or be adjusted using a method similar to that described in the section of the *Environmental Technical Manual* (Doc 9501), Volume I—*Procedures for the Noise Certification of Aircraft* concerning the adjustment of aircraft noise levels for the effect of background noise.

4. CALCULATION OF EFFECTIVE PERCEIVED NOISE LEVEL FROM MEASURED NOISE DATA

4.1 General

4.1.1 The metric used to quantify the certificated noise level shall be the effective perceived noise level (EPNL) expressed in units of EPNdB. EPNL is a single number evaluator taking into account the subjective effects of aircraft noise on human beings, It consists of the instantaneous perceived noise level, PNL, adjusted for spectral irregularities and for duration.

4.1.2 In order to derive the EPNL, three basic physical properties of the aircraft noise shall be measured: level, frequency distribution and variation over time. This requires

the acquisition of the instantaneous sound pressure levels in spectra composed of 24 one-third octave bands, which shall be obtained for each one-half second increment of time throughout the duration over which the aircraft noise is measured.

4.1.3 The calculation procedure which utilizes physical measurements of noise to derive the EPNL evaluation measure of subjective response shall consist of the five following steps:

- (a) each of the 24 one-third octave band sound pressure levels in each measured one-half second spectrum is converted to perceived noisiness by the method of Section 4.7, the noy values are combined and then converted to instantaneous perceived noise level, $PNL(k)$ for each spectrum, measured at the k -th instant of time, by the method of Section 4.2;
- (b) for each spectrum a tone correction factor, $C(k)$, is calculated by the method of Section 4.3 to account for the subjective response to the presence of spectral irregularities;
- (c) the tone correction factor is added to the perceived noise level to obtain the tone corrected perceived noise level, $PNLT(k)$, for each spectrum:
$$PNLT(k) = PNL(k) + C(k);$$
- (d) the history of $PNLT(k)$ noise levels is examined to identify the maximum value, $PNLTM$ as determined by the method of Section 4.4, and noise duration as determined by the method of Section 4.5; and
- (e) effective perceived noise level, EPNL, is determined by logarithmic summation of the $PNLT$ levels over the noise duration, and normalizing the duration to 10 seconds, by the method of Section 4.6.

4.2 Perceived noise level

Instantaneous perceived noise levels, $PNL(k)$, shall be calculated from instantaneous one-third octave band sound pressure levels, $SPL(i,k)$, as follows:

Step 1. Convert each one-third octave band, $SPL(i,k)$, from 50 to 10 000 Hz, to perceived noisiness, $n(i,k)$, by reference to the mathematical formulation of noy tables given in Section 4.7 or to the section in the *Environmental Technical Manual* (Doc 9501), Volume I — *Procedures for the Noise Certification of Aircraft*, concerning reference tables used in the manual calculation of effective perceived noise level.

Step 2. Combine the perceived noisiness values, $n(i,k)$, found in Step 1 by the following formula:

$$N(k) = n(k) + 0.15 \left\{ \left[\sum_{i=1}^{24} n(i, k) \right] - n(k) \right\}$$

$$= 0.85 n(k) + 0.15 \sum_{i=1}^{24} n(i, k)$$

where $n(k)$ is the largest of the 24 values of $n(i, k)$, and $N(k)$ is the total perceived noisiness.

Step 3. Convert the total perceived noisiness, $N(k)$, into perceived noise level, $PNL(k)$, by the following formula:

$$PNL(k) = 40.0 + \frac{10}{\log 2} \log N(k)$$

Note. — Perceived noise level, $PNL(k)$, as a function of total perceived noisiness is plotted in the section of the Environmental Technical Manual (Doc 9501), Volume I — Procedures for the Noise Certification of Aircraft, concerning reference tables used in the manual calculation of effective perceived noise level.

(g)4.3 Correction for spectral irregularities

4.3.1 Noise having pronounced spectral irregularities (for example, the maximum discrete frequency components or tones) shall be adjusted by the correction factor, $C(k)$, calculated as follows:

Step 1. Except for helicopters and tilt-rotors which start at 50 Hz (band number 1), start with the corrected sound pressure level in the 80 Hz one-third octave band (band number 3), calculate the changes in sound pressure level (or “slopes”) in the remainder of the one-third octave bands as follows:

$$s(3, k) = \text{no value} \quad s(4, k) = \text{SPL}(4, k) - \text{SPL}(3, k)$$

$$s(i, k) = \text{SPL}(i, k) - \text{SPL}(i-1, k)$$

$$s(24, k) = \text{SPL}(24, k) - \text{SPL}(23, k)$$

Step 2. Encircle the value of the slope, $s(i, k)$, where the absolute value of the change in slope is greater than five; that is, where:

$$| \Delta s(i, k) | = | s(i, k) - s(i-1, k) | > 5$$

Step 3.

(a) If the encircled value of the slope $s(i, k)$ is positive and algebraically greater than the slope $s(i-1, k)$, encircle $\text{SPL}(i, k)$.

(b) If the encircled value of the slope $s(i,k)$ is zero or negative and the slope $s(i-1,k)$ is positive, encircle $SPL(i-1,k)$.

(c) For all other cases, no sound pressure level value is to be encircled.

Step 4. Compute new adjusted sound pressure levels, $SPL_{\square}(i,k)$, as follows:

(a) For non-encircled sound pressure levels, let the new sound pressure levels equal the original sound pressure levels, $SPL_{\square}(i,k) = SPL(i,k)$.

(b) For encircled sound pressure levels in bands 1 to 23 inclusive, let the new sound pressure level equal the arithmetic average of the preceding and following sound pressure levels:

$$SPL_{\square}(i,k) = \frac{1}{2} [SPL(i-1,k) + SPL(i+1,k)]$$

(c) If the sound pressure level in the highest frequency band ($i = 24$) is encircled, let the new sound pressure level in that band equal:

$$SPL_{\square}(24,k) = SPL(23,k) + s(23,k)$$

Step 5. Recompute new slopes $s_{\square}(i,k)$, including one for an imaginary 25th band, as follows:

$$s_{\square}(3,k) = s_{\square}(4,k)$$

$$s_{\square}(4,k) = SPL_{\square}(4,k) - SPL_{\square}(3,k)$$

$$s_{\square}(i,k) = SPL_{\square}(i,k) - SPL_{\square}(i-1,k)$$

$$s_{\square}(24,k) = \frac{SPL_{\square}(24,k) - SPL_{\square}(23,k)}{s_{\square}(24,k)}$$

$$s_{\square}(25,k) = \frac{SPL_{\square}(25,k) - SPL_{\square}(24,k)}{s_{\square}(24,k)}$$

Step 6. For i from 3 to 23 (or 1 to 23 for helicopters), compute the arithmetic average of the three adjacent slopes as follows:

$$s^{-}(i,k) = \frac{1}{3} [s_{\square}(i,k) + s_{\square}(i+1,k) + s_{\square}(i+2,k)]$$

Step 7. Compute final one-third octave-band sound pressure levels, $SPL_{\square}(i,k)$, by beginning with band number 3 (or band number 1 for helicopters) and proceeding to band number 24 as follows:

$$SPL_{\square}(3,k) = SPL(3,k)$$

$$SPL_{\square}(4,k) = SPL_{\square}(3,k) + s^{-}(3,k)$$

$$SPL_{\square}(i,k) = SPL_{\square}(i-1,k) + s^{-}(i-1,k)$$

$$SPL_{\square}(24,k) = SPL_{\square}(23,k) + s^{-}(23,k)$$

Step 8. Calculate the differences, $F(i,k)$, between the original sound pressure level and the final broadband sound pressure level as follows:

$$F(i,k) = \text{SPL}(i,k) - \text{SPL}\square(i,k)$$

and note only values equal to or greater than one and a half.

Step 9. For each of the relevant one-third octave bands (3 to 24), determine tone correction factors from the sound pressure level differences, $F(i,k)$, and Table A2-2.

Step 10. Designate the largest of the tone correction factors, determined in Step 9, as $C(k)$. An example of the tone correction procedure is given in the section of the *Environmental Technical Manual* (Doc 9501), Volume I — *Procedures for the Noise Certification of Aircraft*, concerning reference tables used in the manual calculation of effective perceived noise level.

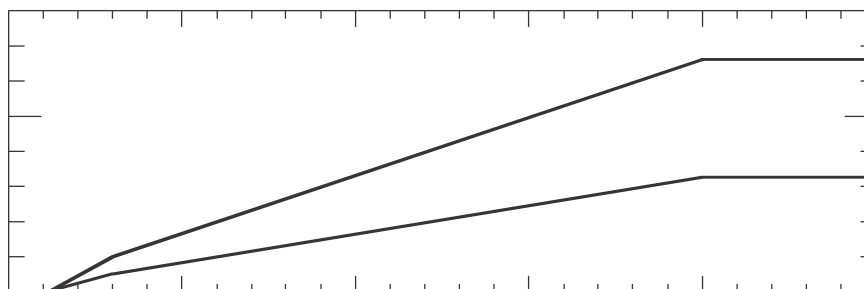
Tone corrected perceived noise levels $\text{PNLT}(k)$ shall be determined by adding the $C(k)$ values to corresponding $\text{PNL}(k)$ values, that is:

$$\text{PNLT}(k) = \text{PNL}(k) + C(k)$$

For any i -th one-third octave band, at any k -th increment of time, for which the tone correction factor is suspected to result from something other than (or in addition to) an actual tone (or any spectral irregularity other than aircraft noise), an additional analysis may be made using a filter with a bandwidth narrower than one-third of an octave, if the narrow band analysis corroborates these suspicions, then a revised value for the broadband sound pressure level, $\text{SPL}\square(i,k)$, shall be determined from the narrow band analysis and used to compute a revised tone correction factor for that particular one-third octave band.

Note. — Other methods of rejecting spurious tone corrections such as those described in Part 5 of the *Environmental Technical Manual* (Doc 9501), Volume I — *Procedures for the Noise Certification of Aircraft* may be used.

Table A2-2. Tone correction factors



Frequency difference correction f , Hz C, dB	Level Tone F , dB		
		$F/3 - \frac{1}{2}$ $F/6$	
			$20 \leq F$
			$3 \leq F < 20$
			$20 \leq F$
		$F/3 - \frac{1}{2}$ $F/6$	
			$20 \leq F$
			$20 \leq F$
			$3 \frac{1}{3}$
			$6 \frac{2}{3}$
			$3 \frac{1}{3}$

* refer Step 8 of 4.3.1.

4.3.2 This procedure will underestimate EPNL if an important tone is of a frequency such that it is recorded in two adjacent one-third octave bands, It shall be demonstrated to the satisfaction of the certificating authority:

either that this has not occurred,

or that if it has occurred that the tone correction has been adjusted to the value it would have had if the tone had been recorded fully in a single one-third octave band.

4.4 Maximum tone corrected perceived noise level

4.4.1 The tone corrected perceived noise levels, PNL $T(k)$, are calculated from measured one-half second values of SPL in accordance with the procedure of Section 4.3, the maximum tone corrected perceived noise level, PNL T_M , shall be the maximum value of PNL $T(k)$, adjusted if necessary for the presence of bandsharing by the method of Section 4.4.2, the increment associated with PNL T_M is designated as k_M .

Note.— Figure A2-2 is an example of a flyover noise time history where the maximum value is clearly indicated.

4.4.2 The tone at PNL T_M may be suppressed due to one-third octave bandsharing of that tone. To identify whether this is the case, the average of the tone correction factors of the PNL T_M spectrum and the two preceding and two succeeding spectra is calculated, if the value of the tone correction factor $C(k_M)$ for the spectrum associated with PNL T_M is less than the average value of $C(k)$ for the five consecutive spectra (k_M-2) through (k_M+2), then the average value C_{avg} shall be used to compute a bandsharing adjustment, Δ_B , and a value of PNL T_M adjusted for bandsharing.

$$C_{avg} = [C(k_M-2) + C(k_M-1) + C(k_M) + C(k_M+1) + C(k_M+2)] / 5$$

If $C_{\text{avg}} > C(k_M)$, then $\Delta_B = C_{\text{avg}} C(k_M)$ and

$$\text{PNLTM} = \text{PNLT}(k_M) + \Delta_B$$

4.4.3 The value of PNLTM adjusted for bandsharing shall be used for the calculation of EPNL.

4.5 Noise duration

4.5.1 The limits of the noise duration are bounded by the first and last 10 dB-down points. These are determined by examination of the $\text{PNLT}(k)$ time history with respect to PNLTM:

(a) the earliest value of $\text{PNLT}(k)$ which is greater than $\text{PNLTM} - 10$ dB is identified. This value and the value of PNLT for the preceding point are compared. Whichever of these two points is associated with the value closest to $\text{PNLTM} - 10$ dB is identified as the first 10 dB-down point, The associated increment is designated as k_F ; and

(b) the last value of $\text{PNLT}(k)$ which is greater than $\text{PNLTM} - 10$ dB is identified. This value and the value of PNLT for the following point are compared, whichever of these two points is associated with the value closest to $\text{PNLTM} - 10$ dB is identified as the last 10 dB-down point. The associated increment is designated as k_L .

Note. — *Figure A2-2 illustrates the selection of the first and last 10 dB-down points, k_F and k_L .*

4.5.2 The noise duration in seconds shall be equal to the number of $\text{PNLT}(k)$ values from k_F to k_L inclusive, times 0.5.

4.5.3 The value of PNLTM used for determination of the 10 dB-down points shall include the adjustment for the presence of bandsharing, Δ_B , by the method of Section 4.4.2.

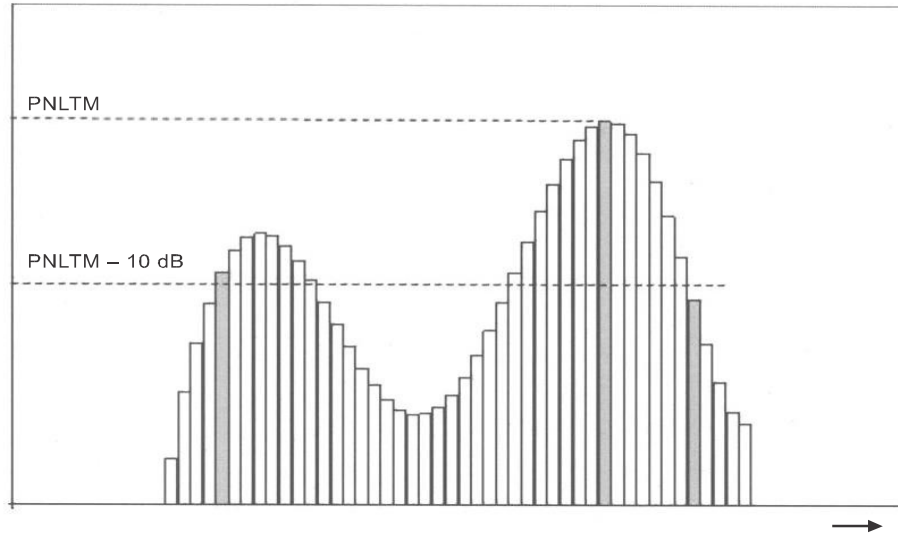


Figure A2-2. Example of a flyover noise time history

4.6 Effective perceived noise level

4.6.1 If the instantaneous tone corrected perceived noise level is expressed in terms of a continuous function with time, $PNLT(t)$, then the effective perceived noise level, EPNL, would be defined as the level, in EPNdB, of the time integral of $PNLT(t)$ over the noise event duration, normalized to a reference duration, t_0 , of 10 seconds. The noise event duration is bounded by t_1 , the time when $PNLT(t)$ is first equal to $PNLTM - 10$, and t_2 , the time when $PNLT(t)$ is last equal to $PNLTM - 10$.

$$EPNL = 10 \log \frac{1}{t_0} \int_{t_1}^{t_2} 10^{0.1 PNL T(t)} dt$$

4.6.2 In practice $PNLT$ is not expressed as a continuous function with time since it is computed from discrete values of $PNLT(k)$ every half second. In this case the basic working definition for EPNL is obtained by replacing the integral in Section 4.6.1 with the following summation expression:

$$EPNL = 10 \log \frac{1}{t_0} \sum_{k_F}^{k_L} 10^{0.1 PNL T(k)} \Delta t$$

For $t_0 = 10$ and $\Delta t = 0.5$, this expression can be simplified as follows:

$$EPNL = 10 \log \sum_{k_F}^{k_L} 100.1 PNL T(k) - 13$$

Note. — 13 dB is a constant relating the one-half second values of PNL $T(k)$ to the 10-second reference duration to: $10 \log (0.5/10) = -13$.

4.6.3 The value of PNL T_M used for determination of EPNL shall include the adjustment for the presence of bandsharing, Δ_B , by the method of Section 4.4.2.

4.7 Mathematical formulation of noy tables

4.7.1 The relationship between sound pressure level (SPL) and the logarithm of perceived noisiness is illustrated in Table A2-3 and Figure A2-3.

4.7.2 The important aspects of the mathematical formulation are:

- (a) the slopes ($M(b)$, $M(c)$, $M(d)$ and $M(e)$) of the straight lines;
- (b) the intercepts ($SPL(b)$ and $SPL(c)$) of the lines on the SPL axis; and
- (c) the coordinates of the discontinuities, $SPL(a)$ and $\log n(a)$; $SPL(d)$ and $\log n = -1.0$; and $SPL(e)$ and $\log n = \log (0.3)$.

4.7.3 The equations are as follows:

(d) $SPL \geq SPL(a)$ $n = \text{antilog} \{M(c) [SPL - SPL(c)]\}$

(e) $SPL(b) \leq SPL < SPL(a)$ $n = \text{antilog} \{M(b) [SPL - SPL(b)]\}$

(f) $SPL(e) \leq SPL < SPL(b)$
 $n = 0.3 \text{ antilog} \{M(e) [SPL - SPL(e)]\}$

(g) $SPL(d) \leq SPL < SPL(e)$
 $o = 0.1 \text{ antilog} \{M(d) [SPL - SPL(d)]\}$

4.7.4 Table A2-3 lists the values of the constants necessary to calculate perceived noisiness as a function of sound pressure level.

5. REPORTING OF DATA TO THE CERTIFICATING AUTHORITY

5.1 General

5.1.1 Data representing physical measurements or corrections to measured data shall be recorded in permanent form and appended to the record.

5.1.2 All corrections shall be approved by the certificating authority, in particular the corrections to measurements for equipment response deviations shall be reported.

5.1.3 Estimates of the individual errors inherent in each of the operations employed in obtaining the final data shall be reported, if required.

Table A2-3. Constants for mathematically formulated noy values

BAND ISO <i>f</i>										
(i) BAND	Hz	SPL(a)	SPL(b)	SPL(c)	SPL(d)	SPL(e)	M(b)	M(c)	M(d)	M(e)
17	50	91.0	64	52	49	55	0.043478			
		0.030103	0.079520		0.058098					
1	18	63	85.9	60	51	44	51	0.040570		
		0.030103		0.068160		0.058098				
2	19	80	87.3	56	49	39	46	0.036831		
		0.030103		0.068160		0.052288				
3	20	100	79.9	53	47	34	42	0.036831		
		0.030103		0.059640		0.047534				
4	21	125	79.8	51	46	30	39	0.035336		
		0.030103		0.053013		0.043573				
5	22	160	76.0	48	45	27	36	0.033333		
		0.030103		0.053013		0.043573				
6	23	200	74.0	46	43	24	33	0.033333		
		0.030103		0.053013		0.040221				
7	24	250	74.9	44	42	21	30	0.032051		
		0.030103		0.053013		0.037349				
8	25	315	94.6	42	41	18	27	0.030675		
		0.030103		0.053013		0.034859				
9	26	400	∞	40	40	16	25	0.030103		
		0.053013		0.034859						
10	27	500	∞	40	40	16	25	0.030103		
		0.053013		0.034859						
11	28	630	∞	40	40	16	25	0.030103		
		0.053013		0.034859						
12	29	800	∞	40	40	16	25	0.030103		
		0.053013		0.034859						
13	30	1 000	∞	40	40	16	25	0.030103		
		0.053013		0.034859						
14	31	1 250	∞	38	38	15	23	0.030103		
		0.059640		0.034859						
15	32	1 600	∞	34	34	12	21	0.029960		
		0.053013		0.040221						
16	33	2 000	∞	32	32	9	18	0.029960		
		0.053013		0.037349						
17	34	2 500	∞	30	30	5	15	0.029960		
		0.047712		0.034859						
18	35	3 150	∞	29	29	4	14	0.029960		
		0.047712		0.034859						
19	36	4 000	∞	29	29	5	14	0.029960		
		0.053013		0.034859						
20	37	5 000	∞	30	30	6	15	0.029960		
		0.053013		0.034859						

21	38	6 300	∞	31	31	10	17	0.029960
		0.029960		0.068160		0.037349		
22	39	8 000	44.3	37	34	17	23	0.042285
		0.029960		0.079520		0.037349		
23	40	10 000	50.7	41	37	21	29	0.042285
		0.029960		0.059640		0.043573		

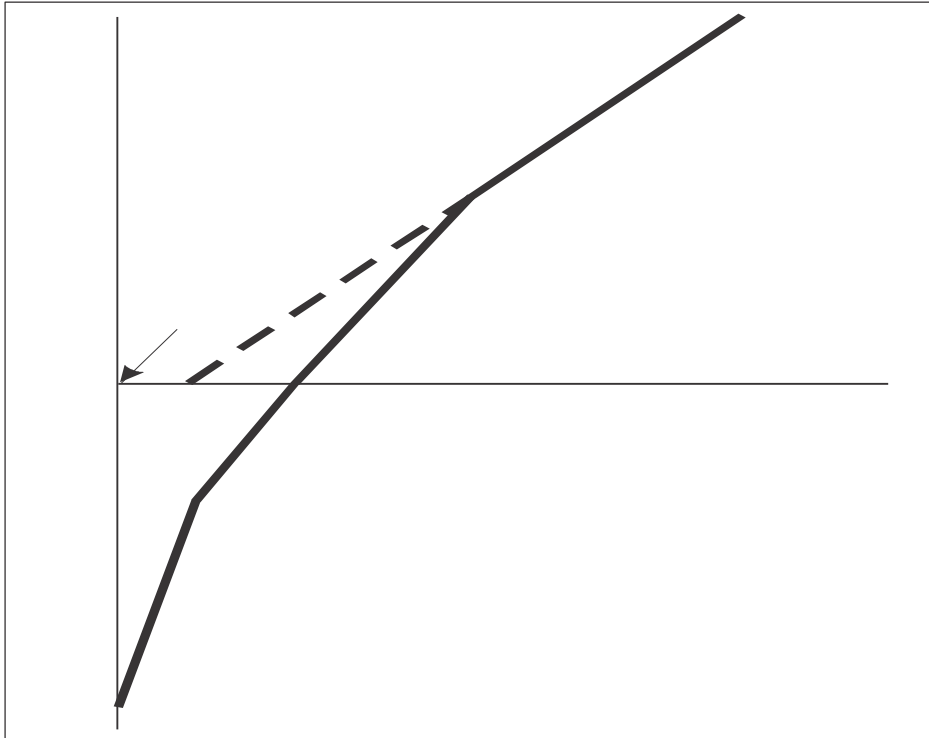


Figure A2-3. Perceived noisiness as a function of sound pressure level

5.2 Data reporting

5.2.1 Measured and corrected sound pressure levels shall be presented in one-third octave band levels obtained with equipment conforming to the Standards described in Section 3 of this appendix.

5.2.2 The type of equipment used for measurement and analysis of all acoustic performance and meteorological data shall be reported.

5.2.3 The following atmospheric environmental data, measured immediately before, after, or during each test at the observation points prescribed in Section 2 of this appendix shall be reported:

- (a) air temperature and relative humidity;
- (b) wind speeds and wind directions; and
- (c) atmospheric pressure.

5.2.4 Comments on local topography, ground cover, and events that might interfere with sound recordings shall be reported. **1/1/18**

5.2.5 The following information shall be reported:

- (a) type, model and serial numbers (if any) of aircraft, engines, propellers or rotors (as applicable);
- (b) gross dimensions of aircraft and location of engines and rotors (if applicable);
- (c) aircraft gross mass for each test run and centre of gravity range for each series of test runs;
- (d) aircraft configuration such as flap, air brakes and landing gear positions and propeller pitch angles (if applicable);
- (e) whether auxiliary power units, when fitted, are operating;
- (f) conditions of pneumatic engine bleeds and engine power take-offs;
- (g) indicated airspeed in kilometres per hour (knots);
 - (i) for jet aeroplanes: engine performance in terms of net thrust, engine pressure ratios, jet exhaust temperatures and fan or compressor shaft rotational speeds as determined from aeroplane instruments and manufacturer's data;
 - (ii) *for propeller-driven aeroplanes*: engine performance in terms of brake horsepower and residual thrust or equivalent shaft horsepower or engine torque and propeller rotational speed as determined from aeroplane instruments and manufacturer's data;
 - (iii) *for helicopters*: engine performance and rotor speed in rpm during each demonstration;
- (a) aircraft flight path and ground speed during each demonstration; and
- (b) any aircraft modifications or non-standard equipment likely to affect the noise characteristics of the aircraft and approved by the certificating authority.

5.3 Reporting of noise certification reference conditions

Aircraft position and performance data and the noise measurements shall be corrected to the noise certification reference conditions as specified in the relevant Parts,

and these conditions, including reference parameters, procedures and configurations shall be reported.

5.4 Validity of results

5.4.1 Three average reference EPNL values and their 90 per cent confidence limits shall be produced from the test results and reported, each such value being the arithmetical average of the adjusted acoustical measurements for all valid test runs at the appropriate measurement point (take-off, approach, or lateral or overflight, in the case of helicopters), if more than one acoustic measurement system is used at any single measurement location, the resulting data for each test run shall be averaged as a single measurement. For helicopters, the three microphone test results for each flight should be averaged as a single measurement. The calculation shall be performed by:

- (a) computing the arithmetic average for each flight phase using the values from each reference microphone point;
- (b) computing the overall arithmetic average for each appropriate reference condition (take-off, overflight or approach) using the values in a) and the related 90 per cent confidence limits.

Note.— For helicopters a flight shall only be considered valid if simultaneous measurements are made at all three noise measurement locations.

5.4.2 The minimum sample size acceptable for each of the three certification measuring points for aeroplanes and for each set of three microphones for helicopters is six, the samples shall be large enough to establish statistically for each of the three average noise certification levels a 90 per cent confidence limit not exceeding ± 1.5 EPNdB, no test result shall be omitted from the averaging process unless otherwise specified by the certifying authority.

Note.— Methods for calculating the 90 per cent confidence interval are given in the section of the Environmental Technical Manual (Doc 9501), Volume I — Procedures for the Noise Certification of Aircraft, concerning the calculation of confidence intervals.

5.4.3 The average EPNL figures obtained by the foregoing process shall be those by which the noise performance of the aircraft is assessed against the noise certification criteria.

6. RESERVED

7. SOUND ATTENUATION IN AIR

7.1 The atmospheric attenuation of sound shall be determined in accordance with the procedure presented below.

7.2 The relationship between sound attenuation, frequency, temperature and humidity is expressed by the following equations:

$$\alpha(i) = 10[2.05 \log (f_0/1\ 000) + 1.1394 \times 10^{-30} - 1.916984] + \eta(\delta) \times 10[\log (f_0) + 8.42994 \times 10^{-30} - 2.755624]$$

$$\delta = \sqrt{\frac{1010}{f_0}} 10^{(\log RH - 1.328924 + 3.179768 \times 10^{-2} \times T)} \times 10(-2.173716 \times 10^{-4} \times T2 + 1.7496 \times 10^{-6} \times T3)$$

where:

$\eta(\delta)$ is given by Table A2-4 and f_0 by Table A2-5;

$\alpha(i)$ being the attenuation coefficient in dB/100 m;

T being the temperature in °C; and

RH being the relative humidity expressed as a percentage.

7.3 The equations given in 7.2 are convenient for calculation by means of a computer.

Table A2-4. Values of $\eta(\delta)$

Table A2-5. Value of f_0

δ	$\eta(\delta)$	Centre frequency of the 1/3 octave band (Hz)	f_0 (Hz)	Centre frequency of the 1/3 octave band (Hz)	f_0 (Hz)
0.00	0.000				
0.25	0.315				
0.50	0.700				
0.60	0.840	50	50	800	800
0.70	0.930	63	63	1 000	1 000
0.80	0.975	80	80	1 250	1 250
0.90	0.996	100	100	1 600	1 600
1.00	1.000	125	125	2 000	2 000
1.10	0.970	160	160	2 500	2 500
1.20	0.900	200	200	3 150	3 150
1.30	0.840	250	250	4 000	4 000
1.50	0.750	315	315	5 000	4 500
1.70	0.670	400	400	6 300	5 600
2.00	0.570				

2.30	0.495	500	500	8 000	7 100
A term of quadratic interpolation shall		be used where necessary.			
		630	630	10 000	9 000

8. ADJUSTMENT OF AIRCRAFT FLIGHT TEST RESULTS

8.1 Flight profiles and noise geometry

Flight profiles for both test and reference conditions are described by their geometry relative to the ground, the associated aircraft ground speed, and, in the case of aeroplanes, the associated engine noise performance parameter(s) used for determining the acoustic emission of the aeroplane, the idealized aircraft flight profiles are described in 8.1.1 for aeroplanes and 8.1.2 for helicopters.

Note. — The “noise flight path” referred to in 8.1.1 and 8.1.2 is defined in accordance with the requirements of 2.3.2.

8.1.1 Aeroplane flight profiles

8.1.1.1 Reference lateral full-power profile characteristics

Figure A2-4 illustrates the profile characteristics for the aeroplane take-off procedure for noise measurements made at the lateral full-power noise measurement points:

- (a) the aeroplane begins the take-off roll at point A and lifts off at point B at full take-off power. The climb angle increases between points B and C. From point C the climb angle is constant up to point F, the end of the noise flight path; and
- (b) positions K_{2L} and K_{2R} are the left and right lateral noise measurement points for jet aeroplanes, located on a line parallel to and at the specified distance from the runway centre line, where the noise level during take-off is greatest. Position K_4 is the “lateral” full-power noise measurement point for propeller-driven aeroplanes located on the extended centre line of the runway vertically below the point on the climb-out flight path where the aeroplane is at the specified height.

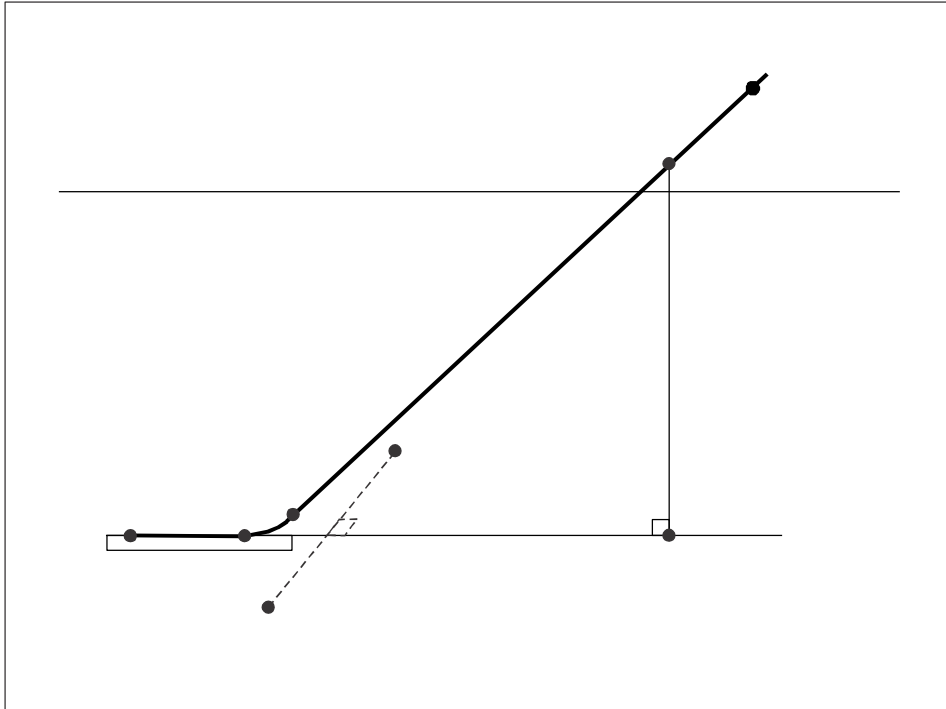


Figure A2-4. Reference aeroplane lateral full-power profile characteristics

8.1.1.2 *Reference flyover profile characteristics*

Figure A2-5 illustrates the profile characteristics for the aeroplane take-off procedure for noise measurements made at the flyover noise measurement point:

- (a) the aeroplane begins the take-off roll at point A and lifts off at point B at full take-off power. The climb angle increases between points B and C, From point C the climb angle is constant up to point D where thrust (or power) reduction is initiated, at point E the thrust (or power) and climb angle are once more stabilized and the aeroplane continues to climb at a constant angle up to point F, the end of the noise flight path; and

Note. — The flyover profile may be flown without thrust (power) reduction in which case point C will extend through point D at a constant climb angle.

- (b) position K_1 is the flyover noise measurement point and AK_1 is the specified distance from start of roll to the flyover noise measuring point.

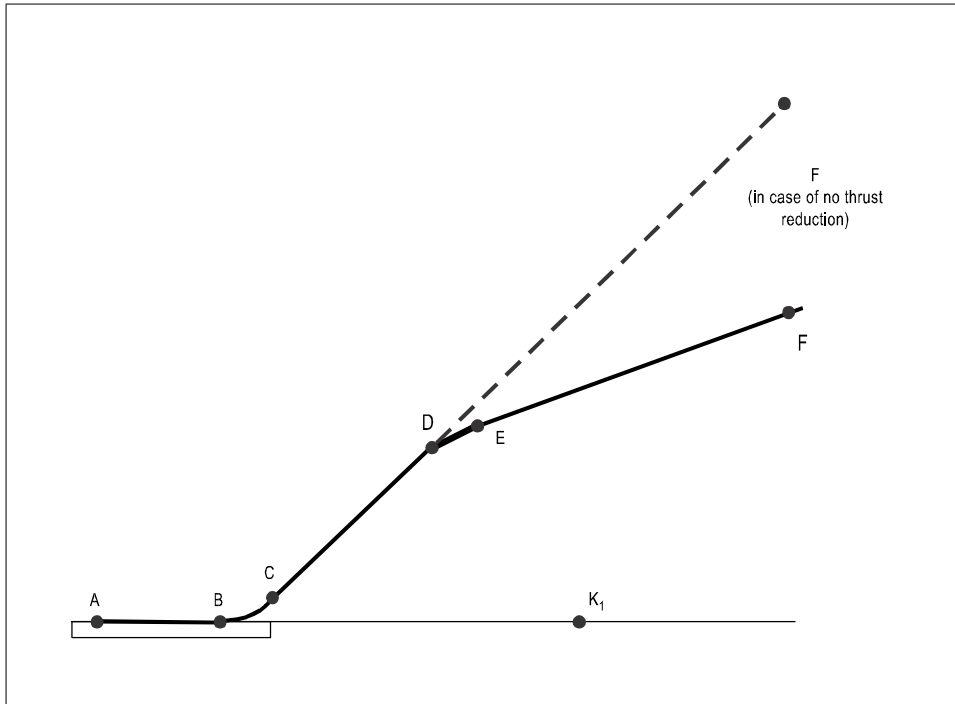


Figure A2-5. Reference aeroplane flyover profile characteristics

8.1.1.3 *Reference approach profile characteristics*

Figure A2-6 illustrates the profile characteristics for the aeroplane approach procedure for noise measurements made at the approach noise measurement point:

- (a) the aeroplane is initially stabilized on the specified glideslope at point G and continues through point H and point I, touching down on the runway at point J; and
- (b) position K_3 is the approach noise measurement point and K_3O is the specified distance from the approach noise measurement point to the runway threshold.

Note. — The aeroplane reference point during approach measurements shall be the ILS antenna.

8.1.2 Helicopter flight profiles

8.1.2.1 *Reference take-off profile characteristics*

Figure A2-7 illustrates the profile characteristics for the helicopter take-off procedure for noise measurements made at the take-off noise measurement point:

- (a) the helicopter is initially stabilized in level flight at point A at the best rate of climb speed V_Y . The helicopter continues to point B where take-off power is applied, and a steady climb is initiated. A steady climb is maintained through point X and beyond to point F, the end of the noise flight path; and
- (b) position K_1 is the take-off noise measurement point, and NK_1 is the specified distance from the initiation of the steady climb to the take-off reference noise measurement point. Positions K_1' and K_1'' are associated noise measurement points located on a line $K_1'K_1''$ through K_1 at right angles to the take-off flight track TM and at the specified distance either side of K_1 .

Note. — *In practice the point at which take-off power is applied will be some distance before point B.*

8.1.2.2 *Reference overflight profile characteristics*

Figure A2-8 illustrates the profile characteristics for the helicopter overflight procedure for noise measurements made at the overflight noise measurement points:

- (a) the helicopter is stabilized in level flight at point D and flies through point W, overhead the overflight noise measurement point K_2 , to point E, the end of the noise flight path; and
- (b) position K_2 is the overflight noise measurement point, and K_2W is the specified height of the helicopter overhead the overflight noise measurement point. Positions K_2' and K_2'' are associated noise measurement points located on a line $K_2'K_2''$ through K_2 at right angles to the overflight flight track RS and at the specified distance either side of K_2 .

8.1.2.3 *Reference approach profile characteristics*

Figure A2-9 illustrates the profile characteristics for the helicopter approach procedure for noise measurements made at the approach noise measurement points:

- (a) the helicopter is initially stabilized on the specified glideslope at point G and continues through point H and point I, touching down at point J; and

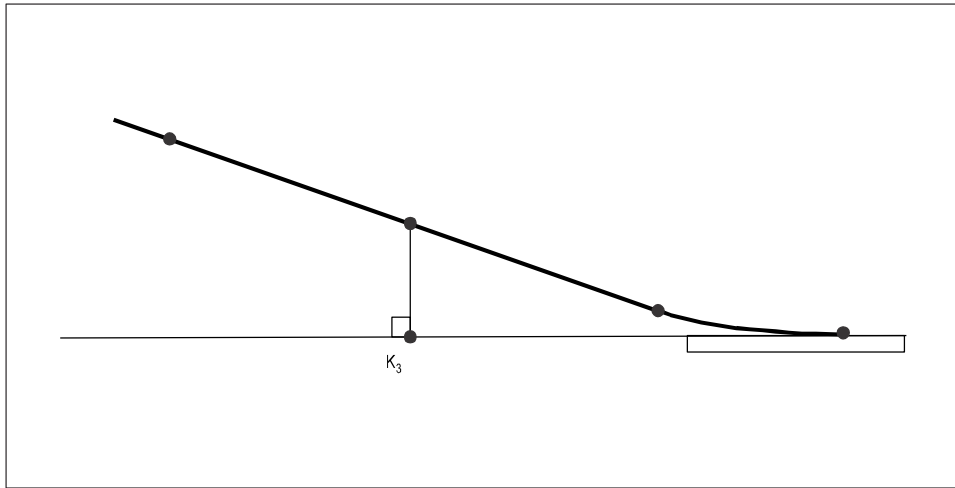


Figure A2-6. Reference aeroplane approach profile characteristics

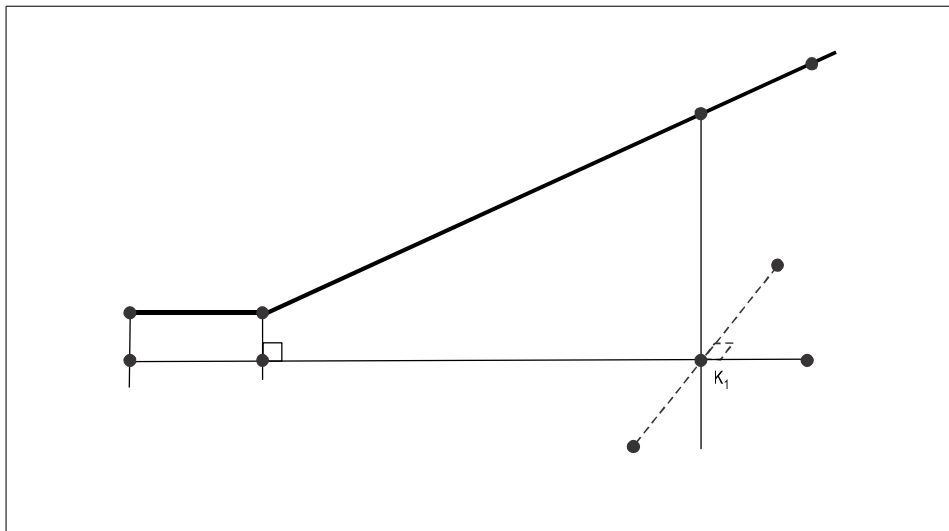


Figure A2-7. Reference helicopter take-off profile characteristics

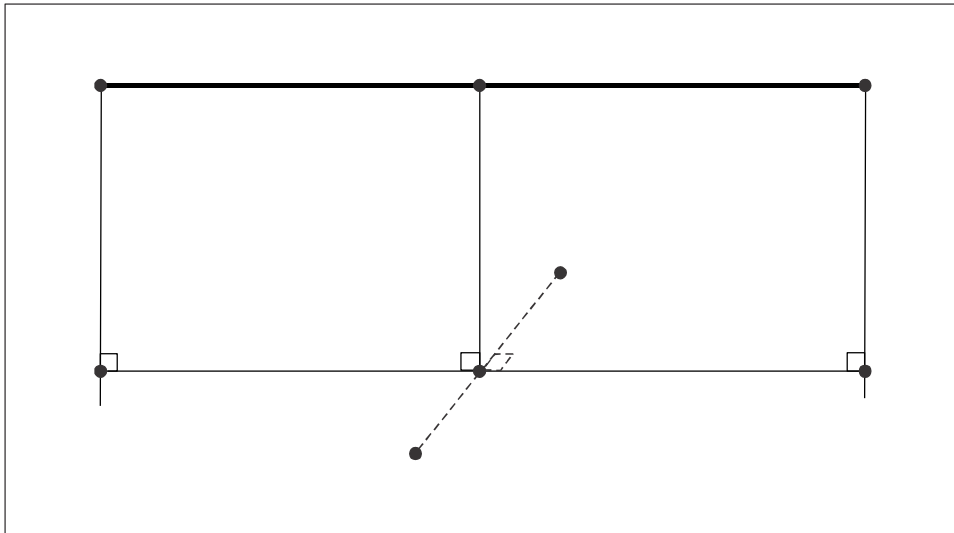


Figure A2-8. Reference helicopter overflight profile characteristics

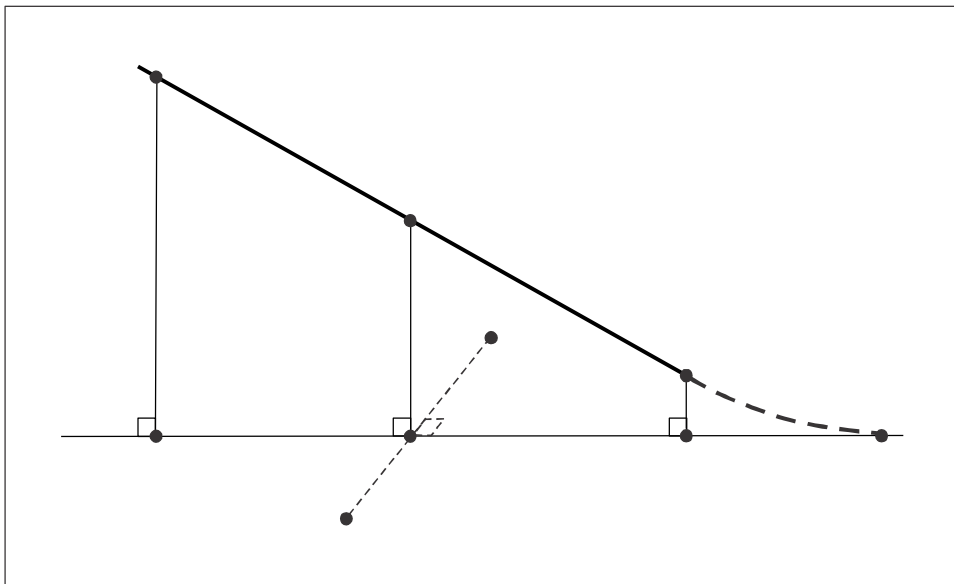


Figure A2-9. Reference helicopter approach profile characteristics

- (b) position K_3 is the approach noise measurement point, and K_3H is the specified height of the helicopter overhead the approach noise measurement point, Positions K_3' and K_3'' are associated noise measurement points located on a line $K_3'K_3''$ at right angles to the approach flight track PU and at the specified distance either side of K_3 .

8.1.3 Adjustment of measured noise levels from measured to reference profile in the calculation of EPNL

Note. — The “useful portion of the measured flight path” referred to in this section is defined in accordance with the requirements of 2.3.2.

8.1.3.1 For the case of a microphone located beneath the flight path, the portions of the test flight path and the reference flight path which are significant for the adjustment of the measured noise levels from the measured profile to the reference profile in the EPNL calculation are illustrated in Figure A2-10, where:

- (a) XY represents the useful portion of the measured flight path (Figure A2-10 a)), and $X_r Y_r$ that of the corresponding reference flight path (Figure A2-10 b)); and
- (b) K is the actual noise measurement point and K_r the reference noise measurement point. Q represents the aircraft position on the measured flight path at which the noise was emitted and observed as PNLTM at point K, the angle between QK and the direction of flight along the measured flight path is θ , the sound emission angle, Q_r is the corresponding position on the reference flight path where the angle between $Q_r K_r$ is also θ . QK and $Q_r K_r$ are, respectively, the measured and reference sound propagation paths.

Note. — This situation will apply in the case of aeroplanes for the flyover, approach, and for propeller-driven aeroplanes only, the lateral full-power noise measurements, and in the case of helicopters for the take-off, overflight, and approach noise measurements for the centre microphone only.

8.1.3.2 For the case of a microphone laterally displaced to the side of the flight path, the portions of the test flight path and the reference flight path which are significant for the adjustment of the measured noise levels from the measured profile to the reference profile in the EPNL calculation are illustrated in Figure A2-11, where:

- (a) XY represents the useful portion of the measured flight path (Figure A2-11 a)), and $X_r Y_r$ that of the corresponding reference flight path (Figure A2-11 b)); and
- (b) K is the actual noise measurement point and K_r the reference noise measurement point. Q represents the aircraft position on the measured flight path at which the noise was emitted and observed as PNLTM at point K, The angle between QK and the direction of flight along the measured flight path is θ , the sound emission angle, The angle between QK and the ground is ψ , the elevation angle. Q_r is the corresponding position on the reference flight path where the angle between $Q_r K_r$ and the direction of flight along the reference flight path is also θ , and the angle between $Q_r K_r$ and the ground is ψ_R , where in the case of aeroplanes, the difference between ψ and ψ_R is minimized.

Note. — This situation will apply in the case of jet aeroplanes for the lateral full-power noise measurements, and in the case of helicopters for the take-off, overflight and approach noise measurements for the two laterally displaced microphones only.

8.1.3.3 In both situations the sound emission angle θ shall be established using three-dimensional geometry.

8.1.3.4 In the case of lateral full-power noise measurements of jet aeroplanes the extent to which differences between ψ and ψ_R can be minimized is dependent on the geometrical restrictions imposed by the need to maintain the reference microphone on a line parallel to the extended runway centre line.

Note. — In the case of helicopter measurements, there is no requirement to minimize the difference between ψ and ψ_R .

8.1.3.5 The reference ground track is defined as the vertical projection of the reference flight path onto the ground.

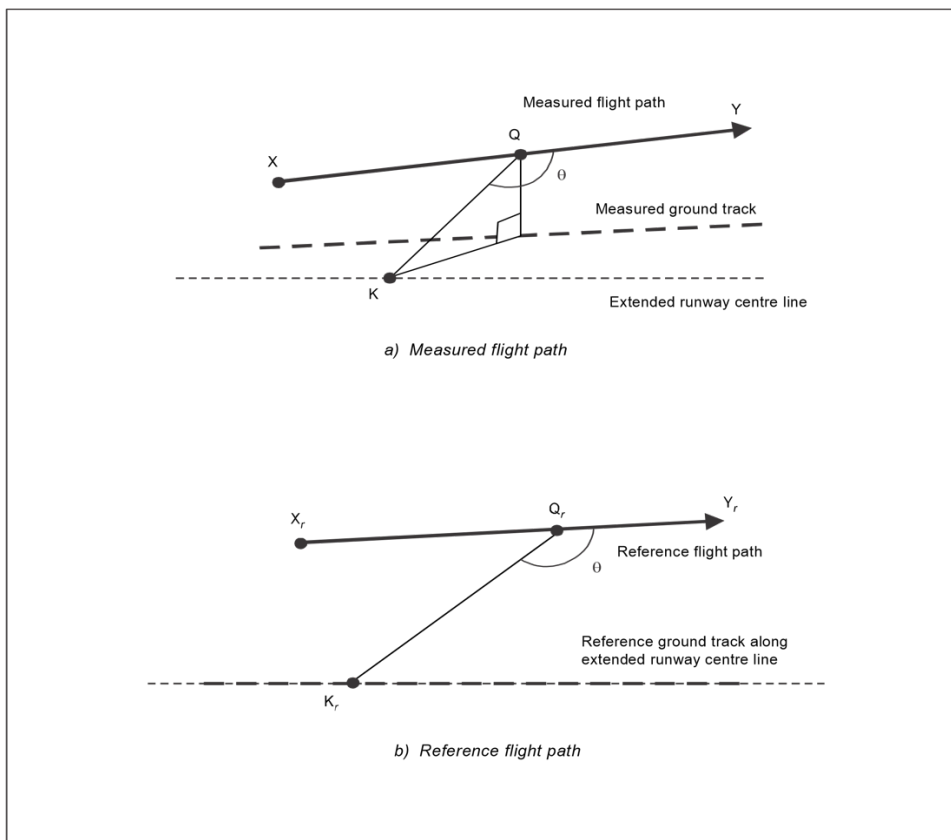


Figure A2-10. Profile characteristics influencing noise level for microphone located beneath the flight path

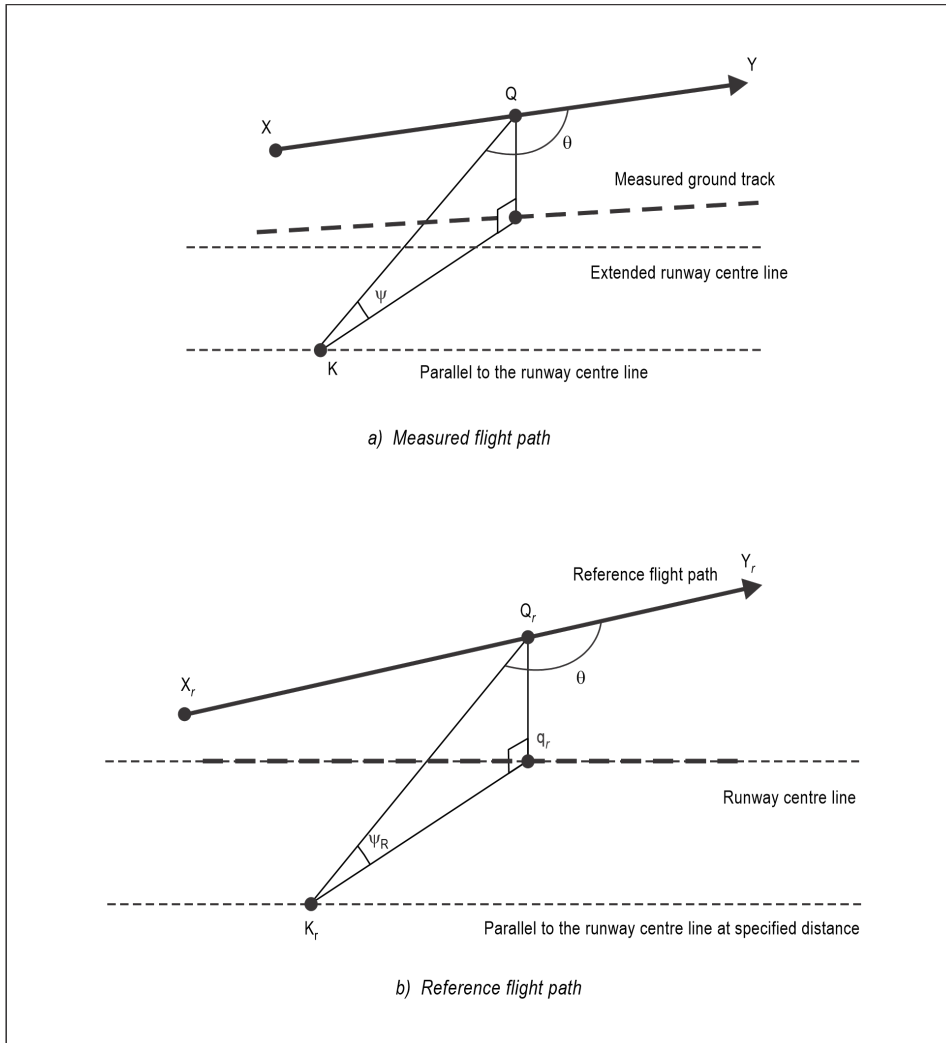


Figure A2-11. Profile characteristics influencing noise level for laterally displaced microphone

8.2 Selection of adjustment method

8.2.1 Adjustments to the measured noise values shall be made for the following:

- (a) aircraft flight path and velocity relative to the microphone;
- (b) sound attenuation in air; and

(c) source noise.

8.2.2 For helicopters, the simplified method described in 8.3 shall be used.

Note. — *The integrated method may be approved by the certifying authority as being equivalent to the simplified method.*

8.2.3 For aeroplanes, either the simplified method, described in 8.3, or the integrated method, described in 8.4, shall be used for the lateral, flyover or approach conditions. The integrated method shall be used when:

(a) for flyover, the absolute value of the difference between the value of $EPNLR$, when calculated according to the simplified method described in 8.3, and the measured value of EPNL calculated according to the procedure described in 4.1.3 is greater than 8 EPNdB;

(b) for approach, the absolute value of the difference between the value of $EPNLR$, when calculated according to the simplified method described in 8.3, and the measured value of EPNL calculated according to the procedure described in 4.1.3 is greater than 4 EPNdB; or

(c) for flyover or approach, the value of $EPNLR$, when calculated according to the simplified method described in 8.3, is greater than the maximum noise levels prescribed in Regulation 13 of Part 4, less 1 EPNdB.

Note. — *Part 4, 3.7.6, specifies limitations regarding the validity of test data based upon both the extent to which $EPNLR$ differs from EPNL, and also the proximity of the final $EPNLR$ values to the maximum permitted noise levels, regardless of the method used for adjustment.*

8.3 Simplified method of adjustment

8.3.1 General

8.3.1.1 The simplified adjustment method consists of the determination and application of adjustments to the EPNL calculated from the measured data for the differences between measured and reference conditions at the moment of PNLTM. The adjustment terms are:

Δ_1 — adjustment for differences in the PNLTM spectrum under test and reference conditions (refer paragraph 8.3.2);

(a) Δ_{peak} — adjustment 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 (refer paragraph 8.3.3);

- (b) Δ_2 — adjustment for the difference in noise duration, taking into account the differences between test and reference aircraft speed and position relative to the microphone (refer paragraph 8.3.4); and
- (c) Δ_3 — adjustment for differences in source noise generating mechanisms (refer paragraph 8.3.5).

8.3.1.2 The coordinates (time, X, Y and Z) of the reference data point associated with the emission of PNL_{TM} shall be determined such that the sound emission angle θ on the reference flight path, relative to the reference microphone, is the same value as the sound emission angle of the as-measured data point associated with PNL_{TM}.

8.3.1.3 The adjustment terms described in 8.3.2 to 8.3.5 are applied to the EPNL calculated from measured data to obtain the simplified reference condition effective perceived noise level, EPNL_R as described in 8.3.6.

8.3.1.4 Any asymmetry in the lateral noise shall be accounted for in the determination of EPNL as described in 8.3.7.

8.3.2 Adjustments to spectrum at PNL_{TM}

8.3.2.1 The one-third octave band levels SPL(*i*) used to construct PNL(*k_M*) (the PNL at the moment of PNL_{TM} observed at measurement point K) shall be adjusted to reference levels SPL_R(*i*) as follows:

$$\begin{aligned} \text{SPL}_R(i) = \text{SPL}(i) + 0.01 [\alpha(i) - \alpha_R(i)] \text{QK} \\ + 0.01 \alpha_R(i) (\text{QK} - \text{Q}_r\text{K}_r) \\ + 20 \log (\text{QK}/\text{Q}_r\text{K}_r) \end{aligned}$$

In this expression:

— the term $0.01 [\alpha(i) - \alpha_R(i)] \text{QK}$ accounts for the effect of the change in sound attenuation due to atmospheric absorption, and $\alpha(i)$ and $\alpha_R(i)$ are the coefficients for the test and reference atmospheric conditions, respectively, obtained from Section 7;

— the term $0.01 \alpha_R(i) (\text{QK} - \text{Q}_r\text{K}_r)$ accounts for the effect of the change in the sound propagation path length on the sound attenuation due to atmospheric absorption;

— the term $20 \log (\text{QK}/\text{Q}_r\text{K}_r)$ accounts for the effect of the change in the sound propagation path length due to spherical spreading (also known as the “inverse square” law);

— QK and Q_rK_r are measured in metres, and $\alpha(i)$ and $\alpha_R(i)$ are obtained in the form of dB/100 m.

Note.— Refer to Figures A2-10 and A2-11 for identification of positions and distances referred to in this paragraph.

8.3.2.2 The adjusted values of SPL_R(*i*) obtained in 8.3.2.1 shall be used to calculate a reference condition PNL_T value, PNL_{TR}(*k_M*), as described in 4.2 and 4.3 of this

appendix. The value of the bandsharing adjustment, Δ_B , calculated for the testday PNLTM by the method of 4.4.2, shall be added to this $\text{PNLT}_{R(k_M)}$ value to obtain the reference condition PNLTM_R :

$$\text{PNLTM}_R = \text{PNLT}_{R(k_M)} + \Delta_B$$

An adjustment term, Δ_1 , is then calculated as follows:

$$\Delta_1 = \text{PNLTM}_R - \text{PNLTM}$$

8.3.2.3 Δ_1 shall be added algebraically to the EPNL calculated from measured data as described in 8.3.6.

8.3.3 Adjustment for secondary peaks

8.3.3.1 During a test flight any values of PNLTM that are within 2 dB of $\text{PNLT}_{R(k_M)}$ are defined as “secondary peaks”, the one-third octave band levels for each “secondary peak” shall be adjusted to reference conditions according to the procedure defined in paragraph 8.3.2.1. Adjusted values of PNLT_R shall be calculated for each “secondary peak” as described in paragraph 4.2 and paragraph 4.3 of this appendix. If any adjusted peak value of PNLT_R exceeds the value of PNLTM_R , a Δ_{peak} adjustment shall be applied.

8.3.3.2 Δ_{peak} shall be calculated as follows:

$$\Delta_{\text{peak}} = \text{PNLT}_{R(k_{M2})} - \text{PNLTM}_R$$

Where $\text{PNLT}_{R(k_{M2})}$ is the reference condition PNLTM value of the largest of the secondary peaks; and PNLTM_R is the reference condition PNLTM value at the moment of PNLTM.

8.3.3.3 Δ_{peak} shall be added algebraically to the EPNL calculated from measured data as described in 8.3.6.

8.3.4 Adjustment for effects on noise duration

8.3.4.1 Whenever the measured flight paths and/or the ground velocities of the test conditions differ from the reference flight paths and/or the reference ground velocities, adjustments to noise duration shall be determined as follows.

8.3.4.2 Referring to the flight paths shown in Figures A2-10 and A2-11, the adjustment term Δ_2 shall be calculated from the measured data as follows:

$$\Delta_2 = -7.5 \log (QK/Q_r K_r) + 10 \log (V_G/V_{GR})$$

where:

V_G is the test ground speed (horizontal component of the test airspeed); and

V_{GR} is the reference ground speed (horizontal component of the reference airspeed).

Note.— The factors, -7.5 and 10, have been determined empirically from a representative sample population of certificated aeroplanes and helicopters. The factors account for the effects of changes in noise duration on EPNL due to distance and speed, respectively.

8.3.4.3 Δ_2 shall be added algebraically to the EPNL calculated from measured data as described in 8.3.6.

8.3.5 Source noise adjustments

8.3.5.1 The source noise adjustment shall be applied to take account of differences in test and reference source noise generating mechanisms, for this purpose, the effect on aircraft propulsion source noise of differences between the acoustically significant propulsion operating parameters actually realized in the certification flight tests and those calculated or specified for the reference conditions of Part 4, is determined. Such operating parameters may include for jet aeroplanes, the engine noise performance parameter μ (typically normalized low pressure fan speed, normalized engine thrust or engine pressure ratio), for propeller-driven aeroplanes both shaft horsepower and propeller helical tip Mach number and for helicopters, during overflight only, advancing rotor blade tip Mach number. The adjustment shall be determined from manufacturer's data approved by the certificating authority.

8.3.5.2 For aeroplanes, the adjustment term Δ_3 shall normally be determined from sensitivity curve(s) of EPNL versus the propulsion operating parameter(s) referred to in paragraph 8.3.5.1, it is obtained by subtracting the EPNL value corresponding to the measured value of the correlating parameter from the EPNL value corresponding to the reference value of the correlating parameter, the adjustment term Δ_3 shall be added algebraically to the EPNL value calculated from the measured data (refer paragraph 8.3.6).

Note.— Representative data for jet aeroplanes are illustrated in Figure A2-12 which shows a curve of EPNL versus the engine noise performance parameter μ . The EPNL data is adjusted to all other relevant reference conditions (aeroplane mass, speed, height and air temperature) and, at each value of μ , for the difference in noise between the installed engine and the flight manual standard of engine.

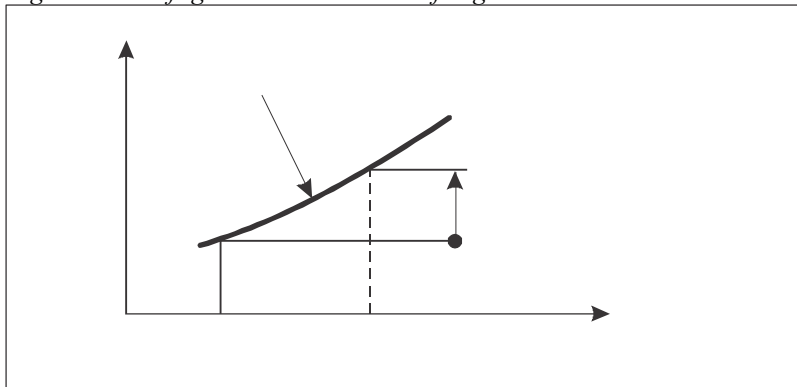


Figure A2-12. Source noise adjustment

8.3.5.3 For jet aeroplanes, noise data acquired from measurements conducted at test site locations at or above 366 m (1 200 ft) above mean sea level (MSL) shall, in addition, be adjusted for the effects on jet source noise.

Note.— A procedure for determining and applying the adjustment for the effects on jet source noise is given in the section of the Environmental Technical Manual (Doc 9501), Volume I — Procedures for the Noise Certification of Aircraft, concerning noise data adjustments for tests at high altitude sites.

8.3.5.4 For jet aeroplanes, when the test and reference true airspeeds differ by more than 28 km/h (15 kt), the effect of the difference in airspeed on engine component noise sources and the consequential effect on the certification noise levels shall be taken into account, the test data and/or analysis procedures used to quantify this effect shall be approved by the certifying authority.

8.3.5.5 For helicopter overflight, if any combination of the following three factors results in the measured value of an agreed noise correlating parameter deviating from the reference value of this parameter, then source noise adjustments shall be determined from manufacturer's data approved by the certifying authority:

- a) airspeed deviations from reference;
- b) rotor speed deviations from reference; and/or
- c) temperature deviations from reference.

This adjustment should normally be made using a sensitivity curve of $PNLTM_R$ versus advancing blade tip Mach number. The adjustment may be made using an alternative parameter, or parameters, approved by the certifying authority.

Note 1.— If it is not possible during noise measurement tests to attain the reference value of advancing blade tip Mach number or the agreed reference noise correlating parameter, then an extrapolation of the sensitivity curve is permitted, provided the data cover an adequate range of values, agreed by the certifying authority, of the noise correlating parameter. The advancing blade tip Mach number, or agreed noise correlating parameter, shall be computed from as measured data. Separate curves of $PNLTM_R$ versus advancing blade tip Mach number, or another agreed noise correlating parameter, shall be derived for each of the three certification microphone locations, centre line, left sideline and right sideline, defined relative to the direction of flight of each test run.

Note 2.— When using advancing blade tip Mach number it should be computed using true airspeed, on-board outside air temperature (OAT), and rotor speed.

8.3.5.6 For helicopters, the adjustment term Δ_3 , obtained according to paragraph 8.3.5.5, shall be added algebraically to the EPNL value calculated from the measured data as described in 8.3.6.

8.3.6 Application of adjustment terms for simplified method

Determine EPNL for reference conditions, $EPNL_R$, using the simplified method, by adding the adjustment terms identified in paragraph 8.3.2 through paragraph 8.3.5 to the EPNL calculated for measurement conditions as follows:

$$EPNL_R = EPNL + \Delta_1 + \Delta_{\text{peak}} + \Delta_2 + \Delta_3$$

8.3.7 Lateral noise asymmetry

For the determination of the lateral noise level for jet aeroplanes, asymmetry (refer Part 4) shall be accounted for as follows:

- a) if a symmetrical measurement point is opposite the point where the highest noise level is obtained, the certification noise level shall be the (arithmetical) mean of the noise levels measured at these two points (refer Figure A2-13 a);
- b) if not, it shall be assumed that the variation of noise with the height of the aeroplane is the same on both sides (i.e. there is a constant difference of noise versus height on the two sides (refer Figure A2-13 b)). The certification noise level shall then be the maximum value of the mean between these lines.

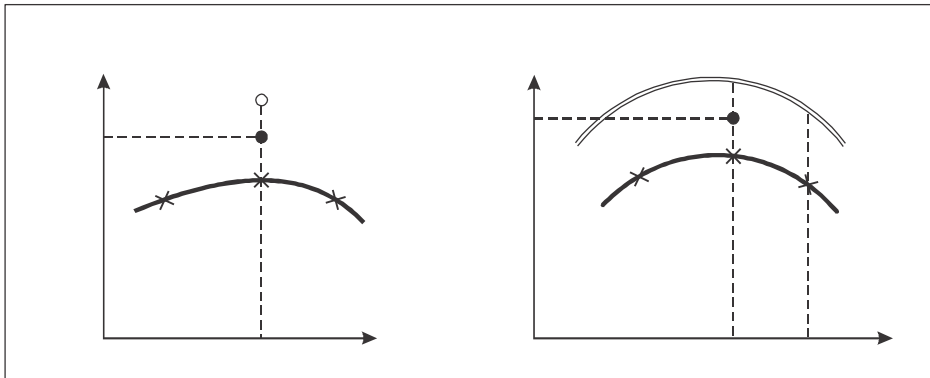


Figure A2-13. Lateral asymmetry adjustments

8.4 Integrated method of adjustment

8.4.1 General

8.4.1.1 The integrated method consists of recomputing, under reference conditions, points in the PNL_T time history corresponding to measured points obtained during the tests, and then computing EPNL directly for the new time history.

8.4.1.2 The emission coordinates (time, X, Y, and Z) of the reference data point associated with each $PNL_{TR}(k)$ shall be determined such that the sound emission angle θ on the

reference flight path, relative to the reference microphone, is the same value as the sound emission angle of the as-measured data point associated with $PNLT(k)$.

Note.— As a consequence, and unless the test and reference conditions are identical, the reception time intervals between the reference data points will typically neither be equally-spaced nor equal to one-half second.

8.4.1.3 The steps in the integrated procedure are as follows:

- a) The spectrum associated with each test-day data point, $PNLT(k)$, is adjusted for spherical spreading and attenuation due to atmospheric absorption, to reference conditions (refer 8.4.2.1);
- b) A reference tone-corrected perceived noise level, $PNLT_R(k)$, is calculated for each one-third octave band spectrum (refer 8.4.2.2);
- c) The maximum value, $PNLTM_R$ and first and last 10 dB-down points are determined from the $PNLT_R$ series (refer 8.4.2.3 and 8.4.3.1);
- d) The effective duration, $\delta_{TR}(k)$, is calculated for each $PNLT_R(k)$ point, and the reference noise duration is then determined (refer paragraph 8.4.3.2 and 8.4.3.3);
- e) The integrated reference condition effective perceived noise level, $EPNL_R$, is determined by the logarithmic summation of $PNLT_R(k)$ levels within the noise duration normalized to a duration of 10 seconds (refer paragraph 8.4.4); and
- f) A source noise adjustment is determined and applied (refer paragraph 8.4.5).

8.4.2 PNL T computations

8.4.2.1 The measured values of $SPL(i,k)$ shall be adjusted to the reference values $SPL_R(i,k)$ for the differences between measured and reference sound propagation path lengths and between measured and reference atmospheric conditions, by the methods of 8.3.2.1. Corresponding values of $PNL_R(k)$ shall be computed as described in 4.2.

8.4.2.2 For each value of $PNL_R(k)$, a tone correction factor C shall be determined by analysing each reference value $SPL_R(i,k)$ by the methods of 4.3, and added to $PNL_R(k)$ to obtain $PNLT_R(k)$.

8.4.2.3 The maximum reference condition tone corrected perceived noise level, $PNLTM_R$, shall be identified, and a new reference condition bandsharing adjustment, Δ_{BR} , shall be determined and applied as described in paragraph 4.4.2.

Note.— Due to differences between test and reference conditions, it is possible that the maximum $PNLT_R$ value will not occur at the data point associated with $PNLTM$. The determination of $PNLTM_R$ is independent of $PNLTM$.

8.4.3 Noise duration

8.4.3.1 The limits of the noise duration shall be defined as the 10 dB-down points obtained from the series of reference condition $PNLT_R(k)$ values. Identification of the 10 dB-down points shall be performed in accordance with paragraph 4.5.1, in the case of the integrated method, the first and last 10 dB-down points shall be designated as k_{FR} and k_{LR} .

8.4.3.2 The noise duration for the integrated reference condition shall be equal to the sum of the effective durations, $\delta_{tR}(k)$, associated with each of the $PNLT_R(k)$ data points within the 10 dB-down period, inclusive.

8.4.3.3 The effective duration, $\delta_{tR}(k)$, shall be determined for each $PNLT_R(k)$ reference condition data point as follows:

$$\delta_{tR}(k) = [(t_R(k) - t_R(k-1)) + (t_R(k+1) - t_R(k))] / 2$$

where:

$t_R(k)$ is the time associated with $PNLT_R(k)$;

$t_R(k-1)$ is the time associated with $PNLT_R(k-1)$, the data point preceding $PNLT_R(k)$; and

$t_R(k+1)$ is the time associated with $PNLT_R(k+1)$, the data point following $PNLT_R(k)$.

Note 1.— Due to differences in flight path geometry, airspeed and sound speed between test and reference conditions, the times, $t_R(k)$, associated with the $PNLT_R(k)$ points projected to the reference flight path are likely to occur at varying, nonuniform time intervals.

Note 2.— Relative values of time $t_R(k)$ for the reference data points can be determined by using the distance between such points on the reference flight path, and the reference aircraft airspeed V_R .

Note 3.— The Environmental Technical Manual (Doc 9501), Volume I — Procedures for the Noise Certification of Aircraft, provides additional guidance for one method for performing the integrated procedure, including the determination of effective durations, $\delta_{tR}(k)$, for the individual data points of the reference time history.

8.4.4 Calculation of integrated reference condition EPNL

8.4.4.1 The equation for calculating reference condition EPNL using the integrated method, $EPNL_R$, is similar to the equation for test-day EPNL given in 4.6. However, the numerical constant related to one-half second intervals is eliminated, and a multiplier is introduced within the logarithm to account for the effective duration of each $PNLT_R(k)$ value, $\delta_{tR}(k)$:

$$EPNL_R = 10 \log \frac{1}{t_0} \sum_{k_{FR}}^{k_{LR}} 10^{0.1PNL_{TR}(k)} \delta t_R(k)$$

Where-

the reference time, t_0 , is 10 seconds;

k_{FR} and k_{LR} are the first and last 10 dB-down points as defined in 8.4.3.1; and

$\delta t_R(k)$ is the effective duration as defined in 8.4.3.3 of each reference condition $PNL_{TR}(k)$ value.

8.4.5 Source noise adjustment

8.4.5.1 Finally, a source noise adjustment shall be determined by the methods of 8.3.5, and added to the $EPNL_R$ determined in 8.4.4.1.

8.4.5.2 For jet aeroplanes, noise data acquired from measurements conducted at test site locations at or above 366 m (1 200 ft) above mean sea level (MSL) shall, in addition, be adjusted for the effects on jet source noise.

Note. — A procedure for determining the adjustment for the effects on jet source noise is given in the section of the Environmental Technical Manual (Doc 9501), Volume I — Procedures for the Noise Certification of Aircraft, concerning noise data adjustments for test at high altitude sites.

THIRD SCHEDULE

(Made under regulation 12 and 69)

MONITORING AIRCRAFT NOISE ON AND IN THE VICINITY OF AERODROMES

Note— Refer Part 4.

1. INTRODUCTION

Note 1. — The introduction of jet aircraft operations, as well as the general increase in air traffic, has resulted in international concern over aircraft noise. To facilitate international collaboration on the solution of aircraft noise problems, it is desirable to recommend a procedure for monitoring aircraft noise on and in the vicinity of aerodromes.

Note 2. — In this appendix monitoring is understood to be the routine measurement of noise levels created by aircraft in the operation of an aerodrome. Monitoring usually involves a large number of measurements per day, from which an immediate indication of the noise level may be required.

Note 3. — This appendix specifies the measuring equipment to be used in order to measure noise levels created by aircraft in the operation of an aerodrome. The noise levels measured according to this appendix are approximations to perceived noise levels, PNL, in PNdB, as calculated by the method described in Appendix 1, 4.2.

Monitoring of aircraft noise should be carried out either with mobile equipment, often using only a sound level meter, or with permanently installed equipment incorporating one or more microphones with amplifiers located at different positions in the field with a data transmission system linking the microphones to a central recording installation. This appendix describes primarily the latter method, but specifications given in this appendix should also be followed, to the extent the specifications are relevant, when using mobile equipment.

2. DEFINITION

Monitoring of aircraft noise is defined as the routine measurement of noise levels created by aircraft on and in the vicinity of aerodromes for the purpose of monitoring compliance with and checking the effectiveness of noise abatement requirements.

3. MEASUREMENT EQUIPMENT

3.1 The measurement equipment should consist of either portable recording apparatus capable of direct reading, or apparatus located at one or more fixed positions in the field linked through a radio transmission or cable system (e.g. telephone line) to a centrally located recording device.

The characteristics of the field equipment, including the transmission system, should comply with IEC Publication No. 179,⁷ "Precision Sound Level Meters", except that frequency weighting equal to the inverse of the 40 noy contour (see Figure A5-1) should 3.2 An approximation, to the nearest decibel, of the inverse of the 40 noy contour relative to the value at 1 000 Hz is given in Table A5-1. The relative frequency response of the weighting element of the equipment should be maintained within a tolerance of ± 0.5 dB. When such a weighting network is incorporated in a direct-reading instrument, the relation between the acoustical input to the microphone and the meter reading should follow the inverse of the 40 noy contour with the same tolerances as those specified for weighting

⁷ . This publication was first issued in 1965 by the Central Office of the International Electrotechnical Commission, 3 rue de Varembe, Geneva, Switzerland.

curve C in IEC Publication No. 179.⁸ Measurements obtained by means of the instrumentation described above provide, after adding 7 dB, values which are approximations to the perceived noise levels in PNdB.

3.3 An alternative method of determining approximations to the perceived noise levels can be obtained from measuring the noise using a sound-level meter incorporating the A-weighting network⁹ and adding a correction K normally between 9 and 14 dB dependent on the frequency spectrum of the noise. The value of K and the method used by the measuring authorities for determination of that value should be specified when reporting results.

3.4 The field installation of microphones for aircraft noise monitoring purposes should provide for suitable protection of the microphones from rain, snow and other adverse weather conditions. Adequate correction for any insertion loss, as a function of frequency and weather conditions, produced by windscreens or other protective enclosures should be applied to the measured data.

Note.— Where a record of the noise as a function of time is required this can be obtained by recording the noise signal on a magnetic tape, a graphic level recorder or other suitable equipment.

3.5 The recording and indicating equipment should comply with IEC Publication No. 179² regarding the dynamic characteristics of the indicating instrument designated as “slow”.

Note. — If the anticipated duration of the noise signal is less than 5 s, the dynamic characteristics designated as “fast” may be used. For the purpose of this note, the duration is described as the length of the significant time history during which the recorded signal, passed through a weighting network having an amplitude characteristic equal to the inverse 40 noy contour, remains within 10 dB of its maximum value.

3.6 The microphone system should have been originally calibrated at a laboratory equipped for free-field calibration and its calibration should be rechecked at least every six months.

Table A5-1. Approximation to the nearest decibel of the inverse of the 40 noy contour relative to the value at 1 000 Hz

⁸ . This publication was first issued in 1965 by the Central Office of the International Electrotechnical Commission, 3 rue de Varembe, Geneva, Switzerland.

⁹ . The A-weighting network is described in IEC Publication No. 179.

Figure A5-1. Contours of perceived noisiness

3.7 The complete measurement system prior to field installation and at periodic intervals thereafter should be calibrated in a laboratory to ensure that the frequency response and dynamic range requirements of the system comply with the specifications described in this document.

Note. — Direct-reading measuring systems that yield approximate values of perceived noise levels other than those defined above are not meant to be excluded from use in monitoring.

4. FIELD EQUIPMENT INSTALLATION

4.1 Microphones used for monitoring noise levels from aircraft operations should be installed at appropriate locations with the axis of maximum sensitivity of each microphone oriented in a direction such that the highest sensitivity to sound waves is achieved, the microphone position should be selected so that no obstruction which influences the sound field produced by an aircraft exists above a horizontal plane passing through the active centre of the microphone.

Note 1. — Monitoring microphones may need to be placed in locations having substantial background noise levels caused by motor vehicle traffic, children playing, etc. In these instances it is often expedient to locate the microphone on a rooftop, telephone pole or other structure rising above the ground. Consequently, it is necessary to determine the background noise level and to carry out a field check, at one or more frequencies, of the overall sensitivity of the measuring system after or before the measurement of the noise level for a sequence of aircraft operations.

Note 2. — If, due to the microphone being placed in a structure above the ground, it is impracticable for operating personnel to calibrate it directly because of its inaccessibility, it can be useful to provide a calibrated sound source at the microphone location. This sound source can be a small loudspeaker, an electrostatic actuator, or similar device.

4.2 Monitoring concerns the noise produced by a single aircraft flight, by a series of flights or by a specified type of aircraft, or by a large number of operations of different aircraft. Such noise levels vary, for a specific monitoring location, with variations in flight procedures or meteorological conditions;

In interpretation of the results of a monitoring procedure, consideration should therefore be given to the statistical distribution of the measured noise levels. In describing the results of a monitoring procedure an appropriate description of the distribution of the observed noise levels should be provided.

FOURTH SCHEDULE

(Made under regulation 34)

EVALUATION METHOD FOR NOISE CERTIFICATION OF PROPELLER-DRIVEN AEROPLANES NOT EXCEEDING 8 618 KILOGRAMS FOR TYPE CERTIFICATE SUBMITTED BEFORE 17 NOVEMBER 1988

Note. — Refer Part 7

1. INTRODUCTION

Note 1.— This noise evaluation method includes:

- (a) noise certification test and measurement conditions;*
- (b) measurement of aeroplane noise received on the ground; and*
- (c) reporting of data to the certifying authority and correction of measured data.*

Note 2. — The instructions and procedures given in the method are clearly delineated to ensure uniformity during compliance tests, and to permit comparison between tests of various types of aeroplanes, conducted in various geographical locations, The method applies only to aeroplanes within the applicability clauses of Part 7.

2. NOISE CERTIFICATION TEST AND MEASUREMENT CONDITIONS

2.1 General

This section prescribes the conditions under which noise certification tests shall be conducted and the measurement procedures that shall be used to measure the noise made by the aeroplane for which the test is conducted.

2.2 General test conditions

2.2.1 Locations for measuring noise from an aeroplane in flight shall be surrounded by relatively flat terrain having no excessive sound absorption characteristics such as might be caused by thick, matted or tall grass, shrubs or wooded areas, no obstructions which significantly influence the sound field from the aeroplane shall exist within a conical space above the measurement position, the cone being defined by an axis normal to the ground and by a half-angle 75° from this axis.

2.2.2 The tests shall be carried out under the following atmospheric conditions:

- (a) no precipitation;

(b) relative humidity not higher than 95 per cent and not lower than 20 per cent and ambient temperature not above 35°C and not below 2°C at 1.2 m (4 ft) above ground except that on a diagram of temperature plotted against relative humidity combinations of temperature and relative humidity which fall below a straight line between 2°C and 60 per cent and 35°C and 20 per cent shall be avoided;

(c) at 1.2 m (4 ft) above ground, instantaneous wind speed shall not exceed 5.1 m/s (10 kt) and instantaneous crosswind speed shall not exceed 2.6 m/s (5 kt). Flights shall be made in equal numbers with tailwind and headwind components; and

Note.— The noise certification test windows for wind speed expressed in m/s are the result of converting historically used values expressed in knots using a conversion factor consistent with Model EAC, Civil Aviation (Units of Measurements to be used in air and ground operations) Regulations, Table 3-3, and rounded to 0.1 m/s. The values as given here, expressed in either unit, are considered equivalent for establishing adherence to the wind speed test windows for noise certification purposes.

(d) no temperature inversions or anomalous wind conditions that would significantly affect the noise level of the aeroplane when the noise is recorded at the measuring points specified by the certifying authority.

2.3 Aeroplane testing procedures

2.3.1 The test procedures and noise measurement procedure shall be acceptable to the airworthiness and noise certifying authorities of the State issuing the certification.

2.3.2 The aeroplane height and lateral position relative to the microphone shall be determined by a method independent of normal flight instrumentation, such as radar tracking, theodolite triangulation, photographic scaling techniques, or other methods to be approved by the certifying authority.

3. MEASUREMENT OF AEROPLANE NOISE RECEIVED ON THE GROUND

3.1 General

3.1.1 All measuring equipment shall be approved by the certifying authority.

3.1.2 Sound pressure level data for noise evaluation purposes shall be obtained with acoustical equipment and measurement practices that conform to the specifications given hereunder in 3.2.

3.2 Measurement system

The acoustical measurement system shall consist of approved equipment equivalent to the following:

- (a) a microphone system with frequency response compatible with measurement and analysis system accuracy as stated in 3.3;
- (b) tripods or similar microphone mountings that minimize interference with the sound being measured;
- (c) recording and reproducing equipment characteristics, frequency response, and dynamic range compatible with the response and accuracy requirements of 3.3; and
- (d) acoustic calibrators using sine wave or broadband noise of known sound pressure level. If broadband noise is used, the signal shall be described in terms of its average and maximum root-mean-square (rms) value of non-overload signal level.

3.3 Sensing, recording and reproducing equipment

3.3.1 When so specified by the certificating authority, the sound produced by the aeroplane shall be recorded in such a way that the complete information, including time history, is retained, a magnetic tape recorder is acceptable.

3.3.2 The characteristics of the complete system shall comply with the recommendations given in International Electrotechnical Commission (IEC) Publication No. 179¹¹ with regard to the sections concerning microphone, amplifier and indicating instrument characteristics, the text and specifications of IEC Publication No. 179¹ entitled "Precision Sound Level Meters" are incorporated by reference into this section and are made a part hereof.

Note. — When a tape recorder is used, it forms part of the complete system complying with IEC Recommendation 561.¹

3.3.3 The response of the complete system to a sensibly plane progressive sinusoidal wave of constant amplitude shall lie within the tolerance limits specified in Table IV and Table V for Type I instruments in IEC Publication No. 179,¹ for weighting curve "A" over the frequency range 45 to 11 200 Hz.

3.3.4 The recorded noise signal shall be read through an "A" filter as defined in IEC Publication No. 179,¹ and with dynamic characteristics designated "slow".

Note. — During tests with high flight speeds, the "fast" dynamic characteristics may be necessary to obtain the true level.

3.3.5 The equipment shall be acoustically calibrated using facilities for acoustic free-field calibration, the overall sensitivity of the measuring system shall be checked before and after the measurement of the noise level for a sequence of aeroplane operations, using an acoustic calibrator generating a known sound pressure level at a known frequency.

¹¹. As amended. Available from the Central Office of the International Electrotechnical Commission, 3 rue de Varembé, Geneva, Switzerland.

Note. — *A pistonphone operating at a nominal 124 dB and 250 Hz is generally used for this purpose.*

3.3.6 A windscreen shall be employed with the microphone during all measurements of aeroplane noise when the wind speed is in excess of 3 m/s (6 kt), its characteristics shall be such that when it is used, the complete system including the windscreen will meet the specifications above and its insertion loss at the frequency of the acoustic calibrator shall also be known and included in the provision of an acoustic reference level for the analysis of the measurements.

3.4 Noise measurement procedures

3.4.1 The microphones shall be oriented in a known direction so that the maximum sound received arrives as nearly as possible in the direction for which the microphones are calibrated, the microphones shall be placed so that their sensing elements are approximately 1.2 meters (4 ft) above ground.

3.4.2 Immediately prior to and after each test, a recorded acoustic calibration of the system shall be made in the field with an acoustic calibrator for the two purposes of checking system sensitivity and providing an acoustic reference level for the analysis of the sound level data.

3.4.3 Background noise, including ambient noise and electrical noise of the measurement systems, shall be recorded and determined in the test area with the system gain set at levels which will be used for aeroplane noise measurements and if aeroplane sound pressure levels do not exceed background sound pressure levels by at least 10 dB(A), approved corrections for the contribution of background sound pressure level to the observed sound pressure level shall be applied.

4. REPORTING OF DATA TO THE CERTIFICATING AUTHORITY AND CORRECTION OF MEASURED DATA

4.1 Data reporting

4.1.1 Measured and corrected sound pressure levels obtained with equipment conforming to the specifications described in Section 3 of this appendix shall be reported.

4.1.2 The type of equipment used for measurement and analysis of all acoustic aeroplane performance and meteorological data shall be reported.

4.1.3 The following atmospheric environmental data, measured immediately before, after, or during each test at the observation points prescribed in Section 2 of this appendix shall be reported:

- (a) air temperature and relative humidity; and
- (b) maximum, minimum and average wind velocities.

4.1.4 Comments on local topography, ground cover, and events that might interfere with sound recordings shall be reported.

4.1.5 The following aeroplane information shall be reported:

- (a) type, model and serial numbers of aeroplane, engine(s) and propeller(s);
- (b) any modifications or non-standard equipment likely to affect the noise characteristics of the aeroplane;
- (c) maximum certificated take-off mass;
- (d) for each overflight, airspeed and air temperature at the flyover altitude determined by properly calibrated instruments;
- (e) for each overflight, engine performance as manifold pressure or power, propeller speed in revolutions per minute and other relevant parameters determined by properly calibrated instruments;
- (f) aeroplane height above ground (refer paragraph 2.3.2);
- (g) corresponding manufacturer's data for the reference conditions relevant to 4.1.5 d) and e).

4.2 Data correction

4.2.1 Correction of noise at source

4.2.1.1 When so specified by the certifying authority, corrections for differences between engine power achieved during the tests and the power that would be achieved at settings corresponding to the highest power in the normal operating range by an average engine of the type under reference conditions shall be applied using approved methods.

4.2.1.2 At a propeller helical tip Mach number at or below 0.70 no correction is required if the test helical tip Mach number is within 0.014 of the reference helical tip Mach number, at a propeller helical tip Mach number above 0.70 and at or below 0.80 no correction is required if the test helical tip Mach number is within 0.007 of the reference helical tip Mach number. Above a helical tip Mach number of 0.80 no correction is required if the helical tip Mach number is within 0.005 of the reference helical tip Mach number. If the test power at any helical tip Mach number is within 10 per cent of the reference power, no correction for source noise variation with power is required. No corrections are to be made for power changes for fixed pitch propeller-driven aeroplanes. If test propeller helical tip Mach number and power variations from reference conditions are outside these constraints, corrections based on data developed using the actual test aeroplane or a similar configured aeroplane with the same engine and propeller operating as the aeroplane being certificated shall be used as described in the section of the *Environmental Technical Manual* (Doc 9501), Volume I — *Procedures for the Noise Certification of Aircraft*, concerning source noise adjustments for aeroplanes evaluated under this appendix.

4.2.2 Correction of noise received on the ground

The noise measurements made at heights different from 300 m (984 ft) shall be adjusted to 300 m (984 ft) by the inverse square law.

4.2.3 Performance correction

Note. — The performance correction is intended to credit higher performance aeroplanes based on their ability to climb at a steeper angle and to fly the traffic pattern at a lower power setting. Also, this correction penalizes aeroplanes with limited performance capability which results in lower rates of climb and higher power settings in the traffic pattern.

4.2.3.1 A performance correction determined for sea level, 15°C conditions and limited to a maximum of 5 dB(A) shall be applied using the method described in paragraph 4.2.3.2 and added algebraically to the measured value.

4.2.3.2 The performance correction shall be calculated by using the following formula:

$$\Delta\text{dB} = 49.6 - 20 \log \left[(3\,500 - D_{15}) \frac{\text{Best R/C}}{V_Y} + 15 \right]$$

where D_{15} = Take-off distance to 15 m at maximum certificated take-off mass and maximum take-off power (paved runway)

Best R/C = Best rate of climb at maximum certificated take-off mass and maximum take-off power

V_Y = Climb speed corresponding to Best R/C at maximum take-off power and expressed in the same units.

Note.— When take-off distance is not certificated, the figure of 610 m for single-engined aeroplanes and 825 m for multiengined aeroplanes is used.

4.3 Validity of results

4.3.1 The measuring point shall be overflown at least four times. The test results shall produce an average dB(A) value and its 90 per cent confidence limits, the noise level being the arithmetic average of the corrected acoustical measurements for all valid test runs over the measuring point.

4.3.2 The samples shall be large enough to establish statistically a 90 per cent confidence limit not exceeding ± 1.5 dB(A). No test result shall be omitted from the averaging process, unless otherwise specified by the certificating authority.

Note. — *Methods for calculating the 90 per cent confidence interval are given in the section of the Environmental Technical Manual (Doc 9501), Volume I— Procedures for the Noise Certification of Aircraft, concerning calculation of confidence intervals.*

FIFTH SCHEDULE

(Made under regulation 44, 46 and 48(2))

EVALUATION METHOD FOR NOISE CERTIFICATION OF PROPELLER-DRIVEN AEROPLANES NOT EXCEEDING 8618 KILOGRAMS FOR TYPE CERTIFICATE OR CERTIFICATION OF DERIVED VERSION SUBMITTED ON OR AFTER 17 NOVEMBER 1988

Note.— Refer Part 11.

1. INTRODUCTION

Note 1.— *This noise evaluation method includes:*

- (a) *noise certification test and measurement conditions;*
- (b) *noise unit;*
- (c) *measurement of aeroplane noise received on the ground;*
- (d) *adjustments to test data; and*
- (e) *reporting of data to the certifying authority and validity of results.*

Note 2. — *The instructions and procedures given in the method are clearly delineated to ensure uniformity during compliance tests and to permit comparison between tests of various types of aeroplanes, conducted in various geographical locations. The method applies only to aeroplanes within the applicability clauses of Part 11.*

2. NOISE CERTIFICATION TEST AND MEASUREMENT CONDITIONS

2.1 General

This section prescribes the conditions under which noise certification tests shall be conducted and the measurement procedures that shall be used to measure the noise made by the aeroplane for which the test is conducted.

2.2 General test conditions

2.2.1 Locations for measuring noise from an aeroplane in flight shall be surrounded by relatively flat terrain having no excessive sound absorption characteristics such as might be caused by thick, matted or tall grass, shrubs or wooded areas. No obstructions which significantly influence the sound field from the aeroplane shall exist within a conical space above the measurement position, the cone being defined by an axis normal to the ground and by a half-angle 75° from this axis.

2.2.2 The tests shall be carried out under the following atmospheric conditions:

- (a) no precipitation;
- (b) relative humidity not higher than 95 per cent and not lower than 20 per cent and ambient temperature not above

35°C and not below 2°C;

- (a) average wind speed shall not exceed 5.1 m/s (10 kt) and crosswind average wind speed shall not exceed 2.6 m/s (5 kt);

Note 1.— Meteorological specifications are defined in Section 2.2.2.1 of Appendix 2.

Note 2.— The noise certification test windows for wind speed expressed in m/s are the result of converting historically used values expressed in knots using a conversion factor consistent with the, Civil Aviation (Units of Measurements to be used in air and ground operations) Regulations, and rounded to 0.1 m/s. The values as given here, expressed in either unit are considered equivalent for establishing adherence to the wind speed test windows for noise certification purposes.

- (b) no other anomalous meteorological conditions that would significantly affect the noise level of the aeroplane when the noise is recorded at the measuring points specified by the certificating authority; and

- (c) the meteorological measurements shall be made between 1.2 m and 10 m above ground level. If the measurement site is within 2 000 m of an airport meteorological station, measurements from this station may be used.

2.2.3 The atmospheric conditions shall be measured within 2 000 m (6 562 ft) from the microphone locations and shall be representative of the conditions existing over the geographical area in which noise measurements are made.

2.3 Aeroplane testing procedures

2.3.1 The test procedures and noise measurement procedure shall be approved by the certificating authority.

2.3.2 The flight test programme shall be initiated at the maximum take-off mass for the aeroplane, and the mass shall be adjusted to maximum take-off mass after each hour of flight time.

2.3.3 The flight test shall be conducted at $V_Y \pm 9$ km/h ($V_Y \pm 5$ kt) indicated airspeed.

2.3.4 The aeroplane spatial position relative to the measurement microphone shall be determined by a method approved by the certifying authority and is independent of cockpit flight instrumentation.

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

2.3.5 The aeroplane height when over the microphone shall be measured by an approved technique. The aeroplane shall pass over the microphone within $\pm 10^\circ$ from the vertical and within ± 20 per cent of the reference height (s Figure A6-1).

2.3.6 Aeroplane speed, position and performance data required to make the adjustments referred to in Section 5 of this appendix shall be recorded when the aeroplane is directly over the measurement site. Measuring equipment shall be approved by the certifying authority.

2.3.7 An independent device accurate to within ± 1 per cent shall be used for the measurement of propeller rotational speed to avoid orientation and installation errors when the test aeroplane is equipped with mechanical tachometers.

3. NOISE UNIT DEFINITION

The L_{ASmax} is defined as the maximum level, in decibels, of the A-weighted sound pressure (slow response) with reference to the square of the standard reference sound pressure (p_0) of 20 micropascals (μPa).

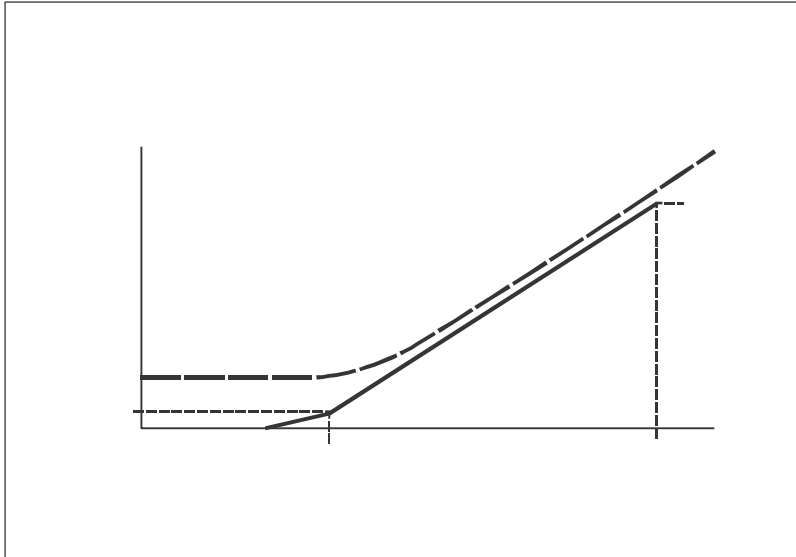


Figure A6-1. Typical test and reference profiles

4. MEASUREMENT OF AEROPLANE NOISE RECEIVED ON THE GROUND

4.1 General

4.1.1 All measuring equipment shall be approved by the certifying authority.

4.1.2 Sound pressure level data for noise evaluation purposes shall be obtained with acoustical equipment and measurement practices that conform to the specifications given hereunder in paragraph 4.2.

4.2 Measurement system

The acoustical measurement system shall consist of approved equipment equivalent to the following:

- (a) a microphone system designed to have mostly-uniform frequency response for sound incident on the diaphragm from random directions, or in the pressure field of a closed cavity, with performance characteristics meeting the requirements of 4.3;
- (b) microphone installation and mounting hardware that minimizes interference with the sound being measured, in the configuration specified in 4.4;

- (c) recording and reproducing equipment performance characteristics meeting the requirements of 4.3; and
- (d) sound calibrators using sine wave signals of known sound pressure level meeting the requirements of 4.3.

4.3 Sensing, recording and reproducing equipment

4.3.1 The sound level produced by the aeroplane shall be recorded. A magnetic tape recorder, graphic level recorder or sound level meter is acceptable at the option of the certifying authority.

4.3.2 The characteristics of the complete system with regard to directional response, frequency weighting A, time weighting S (slow), level linearity, and response to short-duration signals shall comply with the class 1 specifications given in the IEC Publication 61672-1.¹² The complete system may include tape recorders according to IEC 61672-1.¹

Note. — The certifying authority may approve the use of equipment compliant with class 2 of the current IEC standard, or the use of equipment compliant with class 1 or Type 1 specifications of earlier standards, as an alternative to equipment compliant with class 1 of the current IEC standard, if the applicant can show that the equipment had previously been approved for noise certification use by a certifying authority. The certifying authority may also approve the use of magnetic tape recorders that comply with the specifications of the older IEC 561 standard if the applicant can show that such use had previously been approved for noise certification use by a certifying authority.

4.3.3 The overall sensitivity of the measurement system shall be checked before the start of testing, after testing has ended, and at intervals during testing using a sound calibrator generating a known sound pressure level at a known frequency. The sound calibrator shall conform to the class 1 requirements of IEC 60942.¹³ The output of the sound calibrator shall have been checked by a standardizing laboratory within 6 months of each aircraft noise measurement;

Tolerable changes in output shall be not more than 0.2 dB. Measured aircraft noise data shall not be considered valid for certification purposes unless preceded and succeeded by valid sound pressure level calibrations and the measurement system shall be considered satisfactory if the difference between the acoustical sensitivity levels recorded immediately before and immediately after each group of aircraft noise measurements on a given day is not greater than 0.5 dB.

¹² . IEC 61672-1: 2002 entitled "Electroacoustics — Sound level meters — Part I: Specifications". This IEC publication may be obtained from the Bureau central de la Commission électrotechnique internationale, 3 rue de Varembé, Geneva, Switzerland.

¹³ . IEC 60942: 2003 entitled "Electroacoustics — Sound calibrators". This IEC publication may be obtained from the Bureau central de la Commission électrotechnique internationale, 3 rue de Varembé, Geneva, Switzerland.

Note. — *The certifying authority may approve the use of calibrators compliant with class 2 of the current IEC standard, or the use of calibrators compliant with class 1 of an earlier standard, if the applicant can show that the calibrator had previously been approved for noise certification use by a certifying authority.*

4.3.4 When the sound from the aeroplane is tape recorded, the maximum A-frequency-weighted and S-time-weighted sound level may be determined by playback of the recorded signals into the electrical input facility of an approved sound level meter that conforms to the class 1 performance requirements of IEC 61672-1.¹⁴ The acoustical sensitivity of the sound level meter shall be established from playback of the associated recording of the signal from the sound calibrator and knowledge of the sound pressure level produced in the coupler of the sound calibrator under the environmental conditions prevailing at the time of the recording of the sound from the aeroplane.

4.4 Noise measurement procedures

4.4.1 The microphone shall be a 12.7 mm diameter pressure type, with its protective grid, mounted in an inverted position such that the microphone diaphragm is 7 mm above and parallel to a circular metal plate. This white-painted metal plate shall be 40 cm in diameter and at least 2.5 mm thick, and shall be placed horizontally and flush with the surrounding ground surface with no cavities below the plate. The microphone shall be located three-quarters of the distance from the centre to the edge along a radius normal to the line of flight of the test aeroplane.

4.4.2 If the noise signal is tape-recorded, the frequency response of the electrical system shall be determined, during each test series, at a level within 10 dB of the full-scale reading used during the tests, utilizing random or pseudorandom pink noise, the output of the noise generator shall have been checked by an approved standards laboratory within six months of the test series, and tolerable changes in the relative output at each one-third octave band shall be not more than 0.2 dB and Sufficient determinations shall be made to ensure that the overall calibration of the system is known for each test.

4.4.3 Where a magnetic tape recorder forms part of the measuring chain, each reel of magnetic tape shall carry 30 s of this electrical calibration signal at its beginning and end for this purpose. In addition, data obtained from tape-recorded signals shall be accepted as reliable only if the level difference in the 10 kHz one-third octave band filtered levels of the two signals is not more than 0.75 dB.

Note. — *Digital audio recorders typically do not exhibit substantial variation in frequency response or level sensitivity, therefore the pink noise testing described in 4.4.3 is not necessary for digital audio recorders. Design characteristics for digital audio recorders should be compliant with class 1 performance specifications of IEC 61672-1.³*

4.4.4 The A-frequency-weighted sound level of the background noise, including ambient noise and electrical noise of the measurement systems, shall be determined in the test area with the system gain set at levels which will be used for

aeroplane noise measurements. If the maximum A-frequency-weighted and S-time-weighted sound level of the aeroplane does not exceed the A-frequency-weighted sound level of the background noise by at least 10 dB, a take-off measurement point nearer to the start of roll shall be used and the results adjusted to the reference measurement point by an approved method.

5. ADJUSTMENT TO TEST RESULTS

5.1 When certification test conditions differ from the reference conditions, appropriate adjustments shall be made to the measured noise data by the methods of this section.

5.2 Corrections and adjustments

5.2.1 The adjustments take account of the effects of:

- (a) differences in atmospheric absorption between meteorological test conditions and reference conditions;
- (b) differences in the sound propagation path length between the actual aeroplane flight path and the reference flight path;
- (c) the change in the helical tip Mach number between test and reference conditions; and
- (d) the change in engine power between test and reference conditions.

5.2.2 The noise level under reference conditions, L_{ASmaxR} shall be obtained by adding increments for each of the above effects to the test day noise level, L_{ASmax} .

$$L_{ASmaxR} = L_{ASmax} + \Delta 1 + \Delta 2 + \Delta 3 + \Delta 4$$

where

- Δ_1 is the adjustment for sound propagation path lengths;
 Δ_2 is the adjustment for helical tip Mach number;
 Δ_3 is the adjustment for engine power; and
 Δ_4 is the adjustment for the change in atmospheric absorption between test and reference conditions.

3. IEC 61672-1: 2002 entitled "Electroacoustics — Sound level meters — Part I: Specifications". This IEC publication may be obtained from the Bureau central de la Commission électrotechnique internationale, 3 rue de Varembé, Geneva, Switzerland.

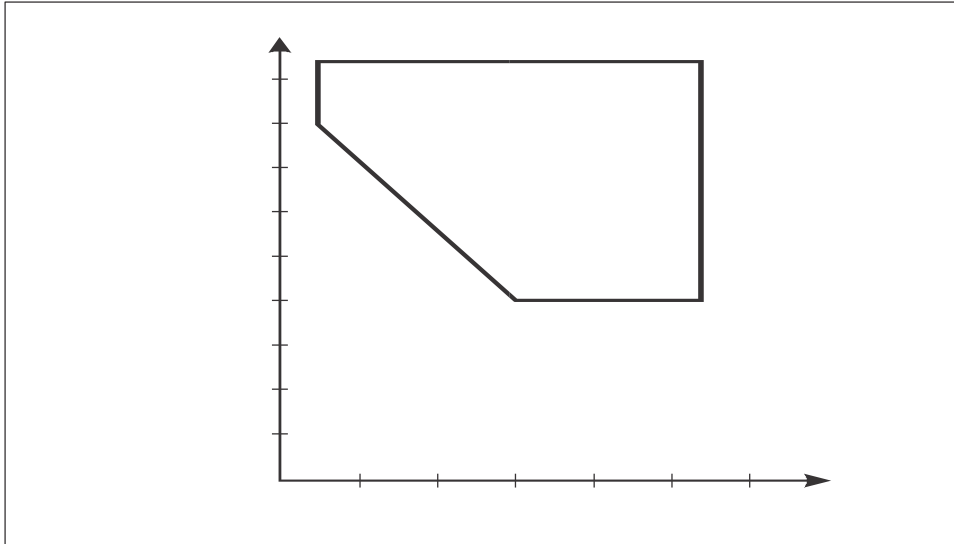


Figure A6-2. Measurement window for no absorption correction

(a) When the test conditions are within those specified in Figure A6-2, no adjustments for differences in atmospheric absorption need be applied, i.e. $\Delta_4 = 0$, if conditions are outside those specified in Figure A6-2 then adjustments must be applied by an approved procedure or by adding an increment Δ_4 to the test day noise levels where:

$$\Delta_4 = 0.01 (H \times \alpha_{500} - 0.2 H_R)$$

and where H is the height in metres of the test aeroplane when directly over the noise measurement point, H_R is the reference height of the aeroplane above the noise measurement point, and α_{500} is the rate of absorption at 500 Hz specified in Tables A1-5 to A1-16 of second schedule.

(b) Measured noise levels should be adjusted to the height of the aeroplane over the noise measuring point on a reference day by algebraically adding an increment equal to Δ_1 . When test day conditions are within those specified in Figure A6-2:

$$\Delta_1 = 22 \log (H/H_R)$$

When test day conditions are outside those specified in Figure A6-2:

$$\Delta_1 = 20 \log (H/H_R)$$

where H is the height of the aeroplane when directly over the noise measurement point, and H_R is the reference height of the aeroplane over the measurement point.

(c) No adjustments for helical tip Mach number variations need be made if the propeller helical tip Mach number is:

1) at or below 0.70 and the test helical tip Mach number is within 0.014 of the reference helical tip Mach number; 2) above 0.70 and at or below 0.80 and the test helical tip Mach number is within 0.007 of the reference helical tip Mach number;

3) above 0.80 and the test helical tip Mach number is within 0.005 of the reference helical tip Mach number. For mechanical tachometers, if the helical tip Mach number is above 0.8 and the test helical tip Mach number is within 0.008 of the reference helical tip Mach number.

Outside these limits measured noise levels shall be adjusted for helical tip Mach number by an increment equal to:

$$\Delta_2 = k_2 \log (M_{HR}/M_H)$$

which shall be added algebraically to the measured noise level, where M_H and M_{HR} are the test and reference helical tip Mach numbers respectively, The value of k_2 shall be determined from approved data from the test aeroplane and in the absence of flight test data and at the discretion of the certificating authority, a value of $k_2 = 150$ may be used for M_H less than M_{HR} ; however, for M_H greater than or equal to M_{HR} , no correction is applied.

Note. — The reference helical tip Mach number M_{HR} is the one corresponding to the reference conditions above the measurement point:

where

$$M^{HR} = \frac{\left[\left(\frac{D\pi N}{60} \right)^2 + V_R^2 \right]^{1/2}}{C_{HR}}$$

where D is the propeller diameter in metres.

V_R is the true airspeed of the aeroplane in reference conditions in metres per second.

N is the propeller speed in reference conditions in rpm. If N is not available, its value can be taken as the average of the propeller speeds over nominally identical power conditions during the flight tests.

C_{HR} is the reference day speed of sound at the altitude of the aeroplane in metres per second corresponding to the ambient temperature – assuming a lapse rate of 0.65°C per 100 m – for a standard day at the aeroplane reference height above mean sea level.

(d) Measured sound levels shall be adjusted for engine power by algebraically adding an increment equal to:

$$\Delta_3 = k_3 \log (P_R/P)$$

where P_R and P are the test and reference engine powers respectively obtained from the manifold pressure/torque gauges and engine rpm. The value of k_3 shall be determined from approved data from the test aeroplane. In the absence of flight test data and at the discretion of the certifying authority a value of $k_3 = 17$ may be used;

The reference power P_R shall be that obtained at the reference height temperature and pressure assuming temperature and pressure lapse rates with height defined by the ICAO Standard Atmosphere.

Note 1.— Details for calculating the variation of reference atmospheric temperature and 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).

6. REPORTING OF DATA TO THE CERTIFICATING AUTHORITY AND VALIDITY OF RESULTS

6.1 Data reporting

6.1.1 Measured and corrected sound pressure levels obtained with equipment conforming to the specifications described in Section 4 of this appendix shall be reported.

6.1.2 The type of equipment used for measurement and analysis of all acoustic aeroplane performance and meteorological data shall be reported.

6.1.3 The following atmospheric environmental data, measured immediately before, after, or during each test at the observation points prescribed in Section 2 of this appendix shall be reported:

- a) air temperature and relative humidity;
- b) wind speeds and wind directions; and
- c) atmospheric pressure.

6.1.4 Comments on local topography, ground cover and events that might interfere with sound recordings shall be reported.

6.1.5 The following aeroplane information shall be reported:

- a) type, model and serial numbers of aeroplane, engine(s) and propeller(s);
- b) any modifications or non-standard equipment likely to affect the noise characteristics of the aeroplane;

- c) maximum certificated take-off mass;
- d) for each overflight, airspeed and air temperature at the flyover altitude determined by properly calibrated instruments;
- e) for each overflight, engine performance as manifold pressure or power, propeller speed in revolutions per minute and other relevant parameters determined by properly calibrated instruments;
- f) aeroplane height above the measurement point; and
- g) corresponding manufacturer's data for the reference conditions relevant to 6.1.5 d), e) and f).

6.2 Validity of results

6.2.1 The measuring point shall be overflown at least six times. The test results shall produce an average noise level value, L_{ASmax} , and its 90 per cent confidence limits, the noise level being the arithmetic average of the corrected acoustical measurements for all valid test runs over the measuring point.

6.2.2 The samples shall be large enough to establish statistically a 90 per cent confidence limit not exceeding ± 1.5 dB(A), no test results shall be omitted from the averaging process, unless otherwise specified by the certifying authority.

SIXTH SCHEDULE

(Made under regulation 49, 51(1) and (2), 53(2) and (3))

EVALUATION METHOD FOR NOISE CERTIFICATION OF HELICOPTERS NOT EXCEEDING 3 175 KILOGRAMS MAXIMUM CERTIFICATED TAKE- OFF MASS

Note.— Refer Part 12.

1. INTRODUCTION

Note 1.— This noise evaluation method includes:

- (a) noise certification test and measurement conditions;*
- (b) definition of sound exposure level using measured noise data;*
- (c) measurement of helicopter noise received on the ground;*

- (d) *adjustment of flight test results; and*
- (e) *reporting of data to the certifying authority.*

Note 2.— The instructions and procedures given in the method are intended to ensure uniformity during compliance tests of various types of helicopters conducted in various geographical locations. The method applies only to helicopters meeting the applicability clauses of Part 12 these Regulations.

2. NOISE CERTIFICATION TEST AND MEASUREMENT CONDITIONS

2.1 General

This section prescribes the conditions under which noise certification shall be conducted and the meteorological and flight path measurement procedures that shall be used.

2.2 Test environment

2.2.1 The location for measuring noise from the helicopter in flight shall be surrounded by relatively flat terrain having no excessive ground absorption characteristics such as might be caused by thick, matted or tall grass, shrubs or wooded areas, no obstructions which significantly influence the sound field from the helicopter shall exist within a conical space above the test noise measurement position, the cone being defined by an axis normal to the ground and by a half-angle of 80° from this axis.

Note. — Those people carrying out the measurements could themselves constitute such obstructions.

2.2.2 The tests shall be carried out under the following atmospheric conditions:

- (a) no precipitation;
- (b) relative humidity not higher than 95 per cent or lower than 20 per cent and ambient temperature not above 35°C and not below 2°C at a height between 1.2 m (4 ft) and 10 m (33 ft) above ground; combinations of temperature and humidity which lead to an absorption coefficient in the 8 KHz one-third octave band of greater than 10 dB/100 m shall be avoided;

Note. — Absorption coefficients as a function of temperature and relative humidity are given in Section 7 of Appendix 2 or SAE ARP 866A.

- (a) at a height between 1.2 m (4 ft) and 10 m (33 ft) above ground, average wind speed shall not exceed 5.1 m/s (10 kt) and the average crosswind component shall not exceed 2.6 m/s (5 kt); and

Note.— The noise certification test windows for wind speed expressed in m/s are the result of converting historically used values expressed in knots using a conversion factor consistent with the Civil Aviation (Units of Measurements to be used in air and ground operations) Regulations, and rounded to 0.1 m/s. The values as given here, expressed in either unit are considered equivalent for establishing adherence to the wind speed test windows for noise certification purposes.

- (b) no other anomalous meteorological conditions that would significantly affect the noise level when recorded at the measuring points specified by the certifying authority.

Note. — Meteorological specifications are given in Section 2.2.2.1 of Second Schedule.

2.2.3 The atmospheric conditions shall be measured within 2000 meters (6 562 ft) from the microphone locations and shall be representative of the conditions existing over the geographical area in which noise measurements are made.

2.3 Flight path measurement

2.3.1 The helicopter spatial position relative to the measurement microphone shall be determined by a method which is approved by the certifying authority and is independent of cockpit flight instrumentation.

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

2.3.2 Position and performance data required to make the adjustments referred to in Section 5 of this appendix shall be recorded at an approved sampling rate. Measuring equipment shall be approved by the certifying authority.

2.4 Flight test conditions

2.4.1 The helicopter shall be flown in a stabilized flight condition over a distance sufficient to ensure that the timevarying sound level is measured during the entire time period that the sound level is within 10 dB(A) of L_{ASmax} .

Note.— L_{ASmax} is defined as the maximum of the A-frequency-weighted S-time-weighted sound level measured during the test run.

2.4.2 The helicopter flyover noise test shall be conducted at the airspeed referred to in Part 12, with such airspeed adjusted as necessary to produce the same advancing blade tip Mach number as associated with the reference conditions.

1/1/1/2118

2.4.3 The reference advancing blade tip Mach number, M_{ATR} , is defined as the ratio of the arithmetic sum of the reference blade tip rotational speed, V_{tipR} , and the reference helicopter true airspeed, V_R , divided by the reference speed of sound, c_R at 25°C such that:

$$\text{MATR} = \frac{(\text{VtipR+VR})}{c_R}$$

3. NOISE UNIT DEFINITION

3.1 The sound exposure level, L_{AE} , is defined as the level, in decibels, of the time integral of squared A-weighted sound pressure, p_A , over a given time period or event, with reference to the square of the standard reference sound pressure, p_0 , of 20 μPa and a reference duration of one second.

3.2 This unit is defined by the expression:

$$L_{AE} = 10 \log \frac{1}{t_0} \int_{t_1}^{t_2} \left(\frac{p_A(t)}{p_0} \right)^2 dt$$

where t_0 is the reference integration time of one second and $(t_2 - t_1)$ is the integration time interval.

3.3 The above integral can be approximated from periodically sampled measurement as:

$$L_{AE} = 10 \log \frac{1}{t_0} \sum_{k_F}^{k_L} 10^{0.1 L_{AS}(k)} \Delta t$$

where $L_{AS}(k)$ is the time varying A-frequency-weighted S-time-weighted sound level measured at the k -th instant of time, k_F and k_L are the first and last increment of k , and Δt is the time increment between samples.

3.4 The integration time $(t_2 - t_1)$ in practice shall not be less than the 10 dB-down period during which $L_{AS}(t)$ first rises to 10 dB(A) below its maximum value and last falls below 10 dB(A) of its maximum value.

4. MEASUREMENT OF HELICOPTER NOISE RECEIVED ON THE GROUND

4.1 General

4.1.1 All measuring equipment shall be approved by the certifying authority.

4.1.2 Sound pressure level data for noise evaluation purposes shall be obtained with acoustical equipment and measurement practices that conform to the specifications given in 4.2.

4.2 Measurement system

The acoustical measurement system shall consist of approved equipment equivalent to the following:

- (a) a microphone system with performance characteristics meeting the requirements of 4.3;
- (b) tripods or similar microphone mountings that minimize interference with the sound being measured;
- (c) recording and reproducing equipment with performance characteristics meeting the requirements of 4.3; and
- (d) sound calibrators using sine wave signals of known sound pressure level meeting the requirements of 4.3.

4.3 Sensing, recording and reproducing equipment

4.3.1 The microphone shall be of the type that has a pressure or a diffuse-field sensitivity whose frequency response is nearly flat at grazing incidence.

4.3.2 The L_{AE} may be directly determined from an integrating sound level meter. Alternatively, with the approval of the certificating authority the sound pressure signal produced by the helicopter may be stored on an analogue magnetic tape recorder or a digital audio recorder for later evaluation using an integrating sound level meter, the L_{AE} may also be calculated from one-third octave band data obtained from measurements made in conformity with Section 3 of second schedule and using the equation given in paragraph 3.3 and in this case each one-third octave band sound pressure level shall be weighted in accordance with the A-weighting values given in IEC Publication 61672-1.¹⁵

4.3.3 The characteristics of the complete system with regard to directional response, frequency weighting A, time weighting S (slow), level linearity, and response to short-duration signals shall comply with the class 1 specifications given in IEC 61672-1.¹ The complete system may include tape recorders or digital audio recorders according to IEC 61672-1.¹

Note. — The certificating authority may approve the use of equipment compliant with class 2 of the current IEC standard, or the use of equipment compliant with class 1 or Type 1 specifications of an earlier standard, if the applicant can show that the equipment had previously been approved for noise certification use by a certificating authority. This includes the use of a sound level meter and graphic level recorder to approximate L_{AE} using the equation given in 3.3. The certificating authority may also approve the use of magnetic

¹⁵ . IEC 61672-1: 2002 entitled "Electroacoustics — Sound level meters — Part I: Specifications". This IEC publication may be obtained from the Bureau central de la Commission électrotechnique internationale, 3 rue de Varembe, Geneva, Switzerland.

tape recorders that comply with the specifications of the older IEC 561 standard if the applicant can show that such use had previously been approved for noise certification use by a certifying authority.

4.3.4 The overall sensitivity of the measurement system shall be checked before the start of testing, after testing has ended and at intervals during testing using a sound calibrator generating a known sound pressure level at a known frequency, the sound calibrator shall conform to the class 1 requirements of IEC 60942.¹⁶¹⁷ The output of the sound calibrator shall have been checked by a standardizing laboratory within 6 months of each aircraft noise measurement, tolerable changes in output shall be not more than 0.2 dB, Measured aircraft noise data shall not be considered valid for certification purposes unless preceded and succeeded by valid sound pressure level calibrations and the measurement system shall be considered satisfactory if the difference between the acoustical sensitivity levels recorded immediately before and immediately after each group of aircraft noise measurements on a given day is not greater than 0.5 dB.

Note.— The certifying authority may approve the use of calibrators compliant with class 2 of the current IEC standard, or the use of calibrators compliant with class 1 of an earlier standard, if the applicant can show that the calibrator had previously been approved for noise certification use by a certifying authority.

4.3.5 When the sound pressure signals from the helicopter are recorded, the L_{AE} may be determined by playback of the recorded signals into the electrical input facility of an approved sound level meter that conforms to the class 1 performance requirements of IEC 61672-1.¹⁸ The acoustical sensitivity of the sound level meter shall be established from playback of the associated recording of the signal from the sound calibrator and knowledge of the sound pressure level produced in the coupler of the sound calibrator under the environmental conditions prevailing at the time of the recording of the sound from the helicopter.

4.3.6 A windscreen should be employed with the microphone during all measurements of helicopter sound levels. Its characteristics should be such that when it is used, the complete system including the windscreen will meet the specifications in 4.3.3.

(h) 4.4 Noise measurement procedures

4.4.1 The microphone shall be mounted with the centre of the sensing element 1.2 m (4 ft) above the local ground surface and shall be oriented for grazing incidence, i.e. with the sensing element substantially in the plane defined by the nominal flight path of the

¹⁶ . IEC 60942: 2003 entitled “Electroacoustics — Sound calibrators”. This IEC publication may be obtained from the Bureau central de la Commission électrotechnique internationale, 3 rue de Varembe, Geneva, Switzerland.

¹⁸ . IEC 61672-1: 2002 entitled “Electroacoustics — Sound level meters — Part I: Specifications”. This IEC publication may be obtained from the Bureau central de la Commission électrotechnique internationale, 3 rue de Varembe, Geneva, Switzerland.

helicopter and the measuring station, the microphone mounting arrangement shall minimize the interference of the supports with the sound to be measured.

4.4.2 If the helicopter sound pressure signal is recorded, the frequency response of the electrical system shall be determined, during each test series, at a level within 10 dB of the full-scale reading used during the tests, utilizing random or pseudo-random pink noise;

The output of the noise generator shall have been checked by an approved standards laboratory within six months of the test series, and tolerable changes in the relative output at each one-third octave band shall be not more than 0.2 dB. Sufficient determinations shall be made to ensure that the overall calibration of the system is known for each test.

4.4.3 Where an analogue magnetic tape recorder forms part of the measuring chain, each reel of magnetic tape shall carry 30 s of this electrical calibration signal at its beginning and end for this purpose. In addition, data obtained from taperecorded signals shall be accepted as reliable only if the level difference in the 10 kHz one-third octave band filtered levels of the two signals is not more than 0.75 dB.

Note.— Digital audio recorders typically do not exhibit substantial variation in frequency response or level sensitivity; therefore the pink noise testing described in 4.4.2 is not necessary for digital audio recorders.

4.4.4 The A-frequency-weighted sound level of the background noise, including ambient noise and electrical noise of the measurement systems, shall be determined in the test area with the system gain set at levels which will be used for helicopter noise measurements, if the L_{ASmax} of each test run does not exceed the A-frequency-weighted sound level of the background noise by at least 15 dB(A), flyovers at an approved lower height may be used and the results adjusted to the reference measurement height by an approved method.

5. ADJUSTMENT TO TEST RESULTS

5.1 When certification test conditions differ from the reference conditions, appropriate adjustments shall be made to the measured noise data by the methods of this section.

5.2 Corrections and adjustments

5.2.1 The adjustments may be limited to the effects of differences in spherical spreading between the helicopter test flight path and the reference flight path (and between reference and adjusted reference airspeed). No adjustment for the differences in atmospheric attenuation between the test and reference meteorological conditions and between the helicopter test and reference ground speeds need be applied.

5.2.2 The adjustments for spherical spreading and duration may be approximated from:

$$\Delta_1 = 12.5 \log (H/150)$$

where H is the height, in metres, of the test helicopter when directly over the noise measurement point.

5.2.3 The adjustment for the difference between reference airspeed and adjusted reference airspeed is calculated from:

$$\Delta_2 = 10 \log \left(\frac{V_{AR}}{V_R} \right)$$

where Δ_2 is the quantity in decibels that shall be algebraically added to the measured L_{AE} noise level to correct for the influence of the adjustment of the reference airspeed on the duration of the measured flyover event as perceived at the noise measurement station, V_R is the reference airspeed as prescribed under Part 12, and V_{AR} is the adjusted reference airspeed as prescribed in 2.4.2 of this Schedules.

6. REPORTING OF DATA TO THE CERTIFICATING AUTHORITY AND VALIDITY OF RESULTS

6.1 Data reporting

6.1.1 Measured and corrected sound pressure levels obtained with equipment conforming to the specifications described in Section 4 of this appendix shall be reported.

6.1.2 The type of equipment used for measurement and analysis of all acoustic helicopter performance and meteorological data shall be reported.

6.1.3 The following atmospheric environmental data, measured immediately before, after, or during each test at the observation point prescribed in Section 2 of this appendix shall be reported:

- (a) air temperature and relative humidity;
- (b) wind speeds and wind directions; and
- (c) atmospheric pressure.

6.1.4 Comments on local topography, ground cover and events that might interfere with sound recording shall be reported.

6.1.5 The following helicopter information shall be reported:

- (a) type, model and serial numbers of helicopter, engine(s) and rotor(s);
- 1/1/181/21**
- (b) any modifications or nonstandard equipment likely to affect the noise characteristics of the helicopter;
 - (c) maximum certificated take-off and landing mass;
 - (d) indicated airspeed in kilometres per hour (knots) and rotor speed in rpm during each demonstration;
 - (e) engine performance parameters during each demonstration; and
 - (f) helicopter height above the ground during each demonstration.

6.2 Reporting of noise certification reference conditions

Helicopter position and performance data and noise measurements shall be corrected to the noise certification reference conditions specified in Part 12. These conditions, including reference parameters, procedures and configurations shall be reported.

6.3 Validity of results

6.3.1 The measuring point shall be overflown at least six times. The test results shall produce an average L_{AE} and its 90 per cent confidence limits, the noise level being the arithmetic average of the corrected acoustical measurements for all valid test runs over the measuring point for the reference procedure.

6.3.2 The sample shall be large enough to establish statistically a 90 per cent confidence limit not exceeding ± 1.5 dB(A). No test results shall be omitted from the averaging process unless approved by the certificating authority.

Note.— Methods for calculating the 90 per cent confidence interval are given in the section of the Environmental Technical Manual (Doc 9501), Volume I — Procedures for the Noise Certification of Aircraft concerning the calculation of confidence intervals.

Dodoma,
22nd December, 2025,

MAKAME M. MBARAWA
Minister for Transport