

*Extraordinary*



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**NIGERIA CIVIL AVIATION REGULATIONS**  
**PART 16—ENVIRONMENTAL PROTECTION**

**INTRODUCTION**

This Part presents standards and recommended practices as regulatory requirements for aircraft noise certification, vented fuel and aircraft engine emissions certification for aircraft engaged in international air navigation. Part 16 incorporates the ICAO Standard and Recommended Practices (SARPs) in Annex 16 Volume I and Volume II.

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**NIGERIA CIVIL AVIATION REGULATIONS**  
**PART 16—ENVIRONMENTAL PROTECTION**



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## NIGERIA CIVIL AVIATION REGULATIONS

### PART 16—ENVIRONMENTAL PROTECTION

#### 16.1. NOISE CERTIFICATION

16.1.1.1.—This part is applicable to aircraft registered and operating in Nigeria and prescribes : Applicability.

- (a) noise standards for the issue of noise certificate ;
- (b) fuel venting standards for issue of fuel venting certificate ; and
- (c) emission standards for the issue of emission certificate.

16.1.1.2.—(a) For the purpose of Part, the following definitions shall apply : Definitions.

(1) *Afterburning*. A mode of engine operation wherein a combustion system fed (in whole or part) by vitiated air is used.

(2) *Approach phase*. The operating phase defined by the time during which the engine is operated in the approach operating mode.

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

(4) *Auxiliary power-unit (APU)*. A self-contained power-unit on an aircraft providing electrical/pneumatic power to aircraft systems during ground operations.

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

(6) *Climb phase*. The operating phase defined by the time during which the engine is operated in the climb operating mode.

(7) *Date of manufacture*. The date of issue of the document attesting that the individual aircraft or engine as appropriate conforms to the requirements of the type or the date of an analogous document.

(8) *Derivative version*. An aircraft gas turbine engine of the same generic family as an originally type-certificated engine and having features which retain the basic core engine and combustor design of the original model and for which other factors, as judged by the certificating authority, have not changed.

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

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

NOTE 2.— “*Adversely*” refers to an increase of more than 0.30 EPNdB in any one of the noise certification levels for helicopters certificated according to subpart 16.8 and 0.30dB(A) in the certification level for helicopters certificated according to subpart 16.11.

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

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

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

(11) *Exhaust nozzle.* In the exhaust emissions sampling of gas turbine engines where the jet effluxes are not mixed (as in some turbofan engines for example) the nozzle considered is that for the gas generator (core) flow only. Where, however, the jet efflux is mixed the nozzle considered is the total exit nozzle.

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

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

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

(15) *Oxides of nitrogen*. The sum of the amounts of the nitric oxide and nitrogen dioxide contained in a gas sample calculated as if the nitric oxide were in the form of nitrogen dioxide.

(16) *Rated thrust*. For engine emissions purposes, the maximum take-off thrust approved by the certificating authority for use under normal operating conditions at ISA sea level static conditions, and without the use of water injection. Thrust is expressed in kilonewtons.

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

(18) *Reference pressure ratio*. The ratio of the mean total pressure at the last compressor discharge plane of the compressor to the mean total pressure at the compressor entry plane when the engine is developing take-off thrust rating in ISA sea level static conditions.

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

(20) *Smoke*. The carbonaceous materials in exhaust emissions which obscure the transmission of light.

(21) *Smoke Number*. The dimensionless term quantifying smoke emissions.

(22) *State of Design*. The State having jurisdiction over the organization responsible for the type design.

(23) *Subsonic aeroplane*. An aeroplane incapable of sustaining level flight at speeds exceeding flight Mach number of 1.

(24) *Take-off phase*. The operating phase defined by the time during which the engine is operated at the rated thrust.

(25) *Taxi/ground idle*. The operating phases involving taxi and idle between the initial starting of the propulsion engine(s) and the initiation of the take-off roll and between the time of runway turn-off and final shutdown of all propulsion engine(s).

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

(27) *Type Certificate*. A document issued by a Contracting State to define the design of an aircraft type and to certify that this design meets the appropriate airworthiness requirements of that State.

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(28) *Unburned hydrocarbons*. The total of hydrocarbon compounds of all classes and molecular weights contained in a gas sample, calculated as if they were in the form of methane.

Symbols. 16.1.1.3. Where the following symbols are used in this Part, they have the meanings ascribed to them below :

CO	-	Carbon monoxide
$D_p$	-	The mass of any gaseous pollutant emitted during the reference emissions
	-	landing and take-off cycle
$F_n$	-	Thrust in International Standard Atmosphere (ISA), sea level conditions, for the given operating mode
$F_{oo}$	-	Rated thrust
$F_{oo}^*$	-	Rated thrust with afterburning applied
HC	-	Unburned hydrocarbons (see definition)
NO	-	Nitric oxide
NO <sub>2</sub>	-	Nitrogen dioxide
NO <sub>x</sub>	-	Oxides of nitrogen (see definition)
SN	-	Smoke Number (see definition)
$\pi_{oo}$	-	Reference pressure ratio (see definition)

### 16.2. AIRCRAFT NOISE CERTIFICATION ADMINISTRATION

Applicability. 16.2.1.1.—(a) The provisions of 16.2.1.1(b) to 16.2.1.1(f) shall apply to all aircraft included in the classifications defined for noise certification purposes in 16.3, 16.4, 16.5, 16.6, 16.7, 16.8, 16.10, 16.11 and 16.12 of this part where such aircraft are engaged in international air navigation.

(b) Noise certification shall be granted or validated by the Authority for an aircraft on the basis of satisfactory evidence that the aircraft complies with requirements that are at least equal to the applicable requirements specified in this Part.

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

(d) The noise certificate granted or validated by the Authority shall be carried on board the aircraft.

(e) The noise certificate for an aircraft shall contain at least the following information :

- Item 1. Name of State.
- Item 2. Title of the noise document.
- Item 3. Number of the document.
- Item 4. Nationality or common mark and registration marks.
- Item 5. Manufacturer and manufacturer's designation of aircraft.
- Item 6. Aircraft serial number.
- Item 7. Engine manufacturer, type and model.
- Item 8. Propeller type and model for propeller-driven aeroplanes.
- Item 9. Maximum take-off mass in kilograms.
- Item 10. Maximum landing mass, in kilograms, for certificates issued under Subparts 16.2, 16.3, 16.4, 16.5 and 16.12 of this Part.
- Item 11. The subparts and section of this Part according to which the aircraft was certificated.
- Item 12. Additional modifications incorporated for the purpose of compliance with the applicable noise certification requirements.
- Item 13. The lateral/full-power noise level in the corresponding unit for documents issued under 16.2, 16.3, 16.4, 16.5 and 16.12 of this Part.
- Item 14. The approach noise level in the corresponding unit for documents issued under 16.2, 16.3, 16.4, 16.5, 16.8 and 16.12 of this Part.
- Item 15. The flyover noise level in the corresponding unit for documents issued under 16.2, 16.3, 16.4, 16.5 and 16.12 of this Part.
- Item 16. The over flight noise level in the corresponding unit for documents issued under 16.6, 16.8 and 16.11 of this Part.
- Item 17. The take-off noise level in the corresponding unit for documents issued under 16.8 and 16.10 of this Part.
- Item 18. Statement of compliance, including a reference to Annex 16, Volume I.
- Item 19. Date of issuance of the noise certification document.
- Item 20. Signature of the officer issuing it.

(f) The items on the noise certificate shall be uniformly numbered in Arabic numerals as contained in 16.1.2(e) and IS16.1.2.5.

(g) The Authority will develop the procedures for the implementation of the noise certification documents.

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(h) The Authority will recognize as valid a noise certification granted by the State of Registry provided that the requirements under which such certification was granted are at least equal to the applicable requirements specified in this Part.

(i) The Authority will suspend or revoke the noise certification of an aircraft registered in Nigeria if the aircraft ceases to comply with the applicable noise requirements. 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 the applicable noise requirements.

(j) The amendment of this Part of the subparts to be used by the Authority shall be that which is applicable on the date of submission to that Authority :

- (1) a Type Certificate in the case of a new type ; or
- (2) approval of a change in type design in the case of a derived version ; or
- (3) in either case, under an equivalent application procedure prescribed by Authority.

(k) Unless otherwise specified in this Part of the subparts, the date to be used by the Authority in determining the applicability of the requirements in this Part shall be the date the application for a Type Certificate was submitted to the State of Design, or the date of submission under an equivalent application procedure prescribed by the certifying authority of the State of Design.

(l) For derived versions where the provisions governing the applicability of the requirements of this Part 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 the requirements in this Part 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.

(m) An application shall be effective for the period specified in the designation of the airworthiness subparts appropriate to the aircraft type, except in special cases where the certifying authority accepts an extension of this period. When this period of effectivity is exceeded, the date to be used in determining the applicability of the requirements in this Part 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.

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

16.3.1.1.—(a) The requirements of this subpart shall be applicable to all subsonic jet aeroplanes for which the application for a Type Certificate was submitted before 6 October 1977, except those aeroplanes : Applicability.

(1) requiring a runway length (with no stopway or clearway) of 610 m or less at maximum certificated mass for airworthiness ; or

(2) powered by engines with a bypass ratio of 2 or more and for which a certificate of airworthiness for the individual aeroplane was first issued before 1 March 1972 ; or

(3) powered by engines with a bypass ratio of less than 2 and for which the application for a Type Certificate was submitted before 1 January 1969, and for which a certificate of airworthiness for the individual aeroplane was first issued before 1 January 1976.

(b) The maximum noise levels of 16.3.1.4(a) shall apply except for derived versions for which the application for certification of the change in type design was submitted on or after 26 November 1981, in which case the maximum noise levels of 16.3.1.4(b) shall apply.

(c) Notwithstanding 16.3.1.1(a) and 16.3.1.1(b), the Authority will recognise that the following situations for jet aeroplanes and propeller-driven heavy aeroplanes on its registry do not require demonstration of compliance with the provisions of the requirements of this Part :

(1) gear down flight with one or more retractable landing gear down during the entire flight ;

(2) spare engine and nacelle carriage external to the skin of the aeroplane (and return of the pylon or other external mount) ; and

(3) time-limited engine and/or nacelle changes, where the change in type design specifies that the aeroplane may not be operated for a period of more than 90 days unless compliance with the provisions of this Part, is shown for that change in type design. This applies only to changes resulting from a required maintenance action.

16.3.1.2.—(a) The noise evaluation measure shall be the effective perceived noise level in EPNdB as described in Appendix 1 of ICAO Annex 16. Volume I Part II. Noise evaluation measure.

16.3.1.3.—(a) An aeroplane, when tested in accordance with the flight test procedures of 16.3.1.6, shall not exceed the noise levels specified in 16.3.1.4 at the following points : Noise measurement points.

(1) *lateral noise measurement point* : the point on a line parallel to and 650 m from the runway centre line, or extended runway centre line, where the noise level is a maximum during take-off ;

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

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

Maximum  
noise levels.

16.3.1.4.—(a) The maximum noise levels of those aeroplanes covered by 16.3.1.1(a) when determined in accordance with the noise evaluation method of Appendix 1 of ICAO Annex 16 Volume I Part II, shall not exceed the following :

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

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

(b) The maximum noise levels of those aeroplanes covered by 16.3.1.1(b), when determined in accordance with the noise evaluation method of Appendix 1 of ICAO Annex 16 Volume I Part II, shall not exceed the following :

(1) *At lateral noise measurement point* :

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

(2) *At flyover noise measurement point*

(i) *Aeroplanes with two engines or less*

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

(ii) *Aeroplanes with three engines*

As (i) but with 107 EPNdB for aeroplanes with maximum certificated take-off mass of 325 000 kg or over or as defined by 16.3.1.4(a)(2), whichever is the lower.

(iii) *Aeroplanes with four engines or more*

As (i) but with 108 EPNdB for aeroplanes with maximum certificated



take-off mass of 325,000kg or over or as defined by 16.3.1.4(a)(2), whichever is the lower.

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

16.3.1.5.—(a) If the maximum noise levels are exceeded at one or two measurement points : Trade-offs.

(1) 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 ;

(2) any excess at any single point shall not be greater than 3 EPNdB ; and

(3) any excesses shall be offset by corresponding reductions at the other point or points.

16.3.1.6.—(a) Take-off test procedure :

Test procedures.

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

(2) 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.

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

(b) Approach test procedure :

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

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

(3) The configuration of the aeroplane shall be with maximum allowable landing flap setting.

16.4.—(a) SUBSONIC JET AEROPLANES—

Application for Type Certificate submitted on or after 6 October 1977 and before 1 January 2006.

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(b) PROPELLER-DRIVEN AEROPLANES OVER 8618kg—

Application for Type Certificate submitted on or after 1 January 1985 and before 1 January 2006.

Applicability.

16.4.1.1.—(a) The requirements of this subpart shall, with the exception of those propeller-driven aeroplanes specifically designed and used for agricultural or fire-fighting purposes, be applicable to :

(1) all subsonic jet aeroplanes, including their derived versions, other than aeroplanes which require a runway (with no stopway or clearway) length of 610 m or less at maximum certificated mass for airworthiness, for which the application for a Type Certificate was submitted on or after 6 October 1977 and before 1 January 2006 ; and

(2) all propeller-driven aeroplanes, including their derived versions, of over 8618 kg maximum certificated take-off mass, for which the application for a Type Certificate was submitted on or after 1 January 1985 and before 1 January 2006.

(b) Notwithstanding 16.4.1.1(a), it may be recognized by the Authority that the following situations for jet aeroplanes and propeller-driven heavy aeroplanes on its registry do not require demonstration of compliance with the provisions of the requirements of this Part :

(1) gear down flight with one or more retractable landing gear down during the entire flight ;

(2) spare engine and nacelle carriage external to the skin of the aeroplane (and return of the pylon or other external mount) ; and

(3) time-limited engine and/or nacelle changes, where the change in type design specifies that the aeroplane may not be operated for a period of more than 90 days unless compliance with the provisions of Part, is shown for that change in type design. This applies only to changes resulting from a required maintenance action.

Noise  
measure-  
ments.

16.4.1.2.—(a) Noise evaluation measure :

The noise evaluation measure shall be the effective perceived noise level in EPNdB as described in Appendix 2 of ICAO Annex 16 Volume 1 Part II.

Noise  
measurement  
points.

16.4.1.3.—(a) Reference noise measurement points :

An aeroplane, when tested in accordance with these requirements, shall not exceed the noise levels specified in 16.4.1.4 at the following points :

(1) *lateral full-power reference noise measurement point*

(i) for jet-powered aeroplanes : the point on a line parallel to and 450 m from the runway centre line, where the noise level is a maximum during take-off ;

(ii) for propeller-driven aeroplanes : the point on the extended centre line of the runway 650 m vertically below the climb-out flight path at full take-off power, as defined in 16.4.1.6(b). Until 19 March 2002, the requirement for lateral noise in 16.4.1.3.(a) (1)(i) shall alternatively be permitted ;

NOTE.—For aeroplanes specified in 16.4.1.1(b) for which the application for a Type Certificate was submitted before 19 March 2002, the lateral noise requirement specified in 16.4.1.3(a) (1) is permitted as an alternative.

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

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

(b) Test noise measurement points

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

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

16.4.1.4.—(a) The maximum noise levels, when determined in accordance with the noise evaluation method of Appendix 2 of ICAO Annex 16 Volume I Part II, shall not exceed the following :

Maximum  
noise levels.

(1) *At the lateral full-power reference noise measurement point*

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

(2) *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 385,000 kg and over and

decreasing linearly with the logarithm of the aeroplane mass at the rate of 4 EPNdB per halving of mass down to 89 EPNdB, after which the limit is constant.

*(ii) Aeroplanes with three engines*

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

*(iii) Aeroplanes with four engines or more*

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

*(3) At approach reference noise measurement point*

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

Trade-offs.

16.4.1.5.—(a) If the maximum noise levels are exceeded at one or two measurement points :

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

Noise certification reference procedures.

16.4.1.6.—(a) General conditions

- (1) The reference procedures shall comply with the appropriate airworthiness requirements
- (2) The calculations of reference procedures and flight paths shall be approved by the certifying authority.
- (3) Except in conditions specified in 16.4.1.6(a)(4), the take-off and approach reference procedures shall be those defined in 16.4.1.6(b) and 16.4.1.6(c), respectively.
- (4) When it is shown by the applicant that the design characteristics of the aeroplane would prevent flight being conducted in accordance with 16.4.1.6(b) and 16.4.1.6(c), the reference procedures shall :
  - (i) depart from the reference procedures defined in 16.4.1.6(b) and 16.4.1.6(c) only to the extent demanded by those design characteristics which make compliance with the procedures impossible ; and
- (5) be approved by the certifying authority.
- (6) The reference procedures shall be calculated under the following reference atmospheric conditions :
  - (i) sea level atmospheric pressure of 1013.25 hPa ;

(ii) ambient air temperature of 25°C, i.e. ISA + 10°C ;

(iii) relative humidity of 70 per cent ;

(iv) zero wind ; and

(v) for the purpose of defining the reference take-off profiles for both take-off and lateral noise measurements, the runway gradient is zero.

(b) Take-off reference procedure

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

(1) 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 :

(i) aeroplanes with two engines or less - 300m (984 ft) ;

(ii) aeroplanes with three engines - 260m (853 ft) ;

(iii) aeroplanes with four engines or more - 210m (689 ft) ;

(2) upon reaching the height specified in (a) above, 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-engined aeroplanes, level flight with one engine inoperative ; whichever thrust or power is greater ;

(3) 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 ;

(4) 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. 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.

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

(5) a constant take-off configuration selected by the applicant shall be maintained throughout the take-off reference procedure except that the

landing gear may be retracted. Configuration shall be interpreted as meaning the conditions of the systems and centre of gravity position and shall include the position of lift augmentation devices used, whether the APU is operating, and whether air bleeds and power off-takes are operating ;

(6) the mass of the aeroplane at the brake release shall be the maximum take-off mass at which the noise certification is requested ; and

(7) the average engine shall be defined by the average of all the certification compliant engines used during the aeroplane flight tests up to and during certification when operated to the limitations and procedures given in the flight manual. This will establish a technical standard including the relationship of thrust/power to control parameters (e.g. N1 or EPR). Noise measurements made during certification tests shall be corrected to this standard.

(c) Approach reference procedure

The approach reference flight path shall be calculated as follows :

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

(2) 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 ;

(3) 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 ;

(4) the mass of the aeroplane at the touchdown shall be the maximum landing mass permitted in the approach configuration defined in 16.4.1.6(c)(3) at which noise certification is requested ; and

(5) the most critical (that which produces the highest noise level) configuration with normal deployment of aerodynamic control surfaces including lift and drag producing devices, at the mass at which certification is requested shall be used. This configuration includes all those items listed in 5.2.5 of Appendix 2, ICAO Annex 16 Volume I Part II that will contribute to the noisiest continuous state at the maximum landing mass in normal operation.

Test  
procedures.

16.4.1.7.—(a) The test procedures shall be acceptable to the Authority.

(b) The test procedures and noise measurements shall be conducted and processed in an approved manner to yield the noise evaluation measure designated as effective perceived noise level, EPNL, in units of EPNdB, as described in Appendix 2 of ICAO Annex 16 Volume I Part II.

(c) Acoustic data shall be adjusted by the methods outlined in Appendix 2 of ICAO Annex 16 Volume I Part II to the reference conditions specified in this Part. Adjustments for speed and thrust shall be made as described in Section 8 of Appendix 2 of ICAO Annex 16 Volume I Part II.

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

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

(f) If equivalent test procedures different from the reference procedures are used, the test procedures and all methods for adjusting the results to the reference procedures shall be approved by the certificating authority. The amounts of the adjustments shall not exceed 16 EPNdB on take-off and 8 EPNdB on approach, and if the adjustments are more than 8 EPNdB and 4 EPNdB, respectively, the resulting numbers shall be more than 2 EPNdB below the noise limits specified in 16.4.1.4.

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

16.5.—(a) SUBSONIC JET AEROPLANES AND PROPELLER-DRIVEN AEROPLANES WITH MAXIMUM CERTIFICATED TAKE-OFF MASS 55,000KG 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 55,000KG — Application for Type Certificate submitted on or after 1 January 2006 and before 31 December 2020.

(c) PROPELLER-DRIVEN AEROPLANES WITH MAXIMUM CERTIFICATED TAKE-OFF MASS OVER 8,618KG AND LESS THAN 55,000KG — Application for Type Certificate submitted or after 1 January 2006 and before 31 December 2020.

16.5.1.1.—(a) The requirements of this subpart shall, with the exception of those aeroplanes which require a runway (with no stopway or clearway length) of 610 m or less at maximum certificated mass for airworthiness or propeller-driven aeroplanes specifically designed and used for agricultural or firefighting purposes, be applicable to :

Applicability.

(1) all subsonic jet aeroplanes and propeller-driven aeroplanes, including their derived versions, with a maximum certificated take-off mass of 55,000 kg and over for which the application for a Type Certificate was submitted on or after 1 January 2006 and before 31 December 2017;

(2) all subsonic jet aeroplanes, including their derived versions, with a maximum certificated take-off mass of less than 55,000 kg for which the application for a Type Certificate was submitted on or after 1 January 2006 and before 31 December 2020 ;

(3) all propeller-driven aeroplanes, including their derived versions, with a maximum certificated take-off mass of over 8,618 kg and less than 55,000 kg, for which the application for a Type Certificate was submitted on or after 1 January 2006 and before 31 December 2020 ; and

(4) all subsonic jet aeroplanes and all propeller-driven aeroplanes certificated originally as satisfying subpart 16.4 or subpart 16.6, for which recertification to subpart 16.5 is requested.

(b) Notwithstanding 16.5.1.1(a), it may be recognized by the Authority that the following situations for jet aeroplanes and propeller-driven aeroplanes over 8 618 kg maximum certificated take-off mass on its registry do not require demonstration of compliance with the provisions of the requirements of ICAO Annex 16, Volume I :

(1) gear down flight with one or more retractable landing gear down during the entire flight ;

(2) spare engine and nacelle carriage external to the skin of the aeroplane (and return of the pylon or other external mount) ; and

(3) time-limited engine and/or nacelle changes, where the change in type design specifies that the aeroplane may not be operated for a period of more than 90 days unless compliance with the provisions of ICAO Annex 16, Volume I, is shown for that change in type design. This applies only to changes resulting from a required maintenance action.

Noise  
measure-  
ments.

16.5.1.2.—(a) Noise evaluation measure

(1) The noise evaluation measure shall be the effective perceived noise level in EPNdB as described in Appendix 2 of ICAO Annex 16 Volume I Part II.

Reference  
noise  
measure-  
ment points.

16.5.1.3.—(a) An aeroplane, when tested in accordance with these requirements, shall not exceed the maximum noise level specified in 16.5.1.4 of the noise measured at the points specified in subpart 16.4, 16.4.1.3(a) (1)(2)(3).

(b) Test noise measurement points

(1) The provisions of subpart 16.4, 16.4.1.2, relating to test noise measurement points shall apply.



16.5.1.4.—(a) The maximum permitted noise levels are defined in subpart 16.4, 16.4.1.4(a), 16.4.1.4(b) and 16.4.1.4(c), and shall not be exceeded at any of the measurement points. Maximum noise levels.

(b) The sum of the differences at all three measurement points between the maximum noise levels and the maximum permitted noise levels.

(c) The sum of the differences at any two measurement points between the maximum noise levels and the corresponding maximum permitted noise levels specified in subpart 16.4, 16.4.1.4(a), 16.4.1.4(b) and 16.4.1.4(c), shall not be less than 2 EPNdB.

16.5.1.5.—(a) The noise certification reference procedures shall be as specified in subpart 16.4, 16.4.1.6. Noise certification reference procedures.

16.5.1.6.—(a) The test procedures shall be as specified in subpart 16.4, 16.4.1.7. Test procedures.

16.5.1.7.—(a) For aeroplanes specified in 16.5.1.1(a)(3), recertification shall be granted on the basis that the evidence used to determine compliance with subpart 16.5 is as satisfactory as the evidence associated with aeroplanes specified in 16.5.1.1(a)(1) and 16.5.1.1(a)(2). Recertification.

16.6. PROPELLER-DRIVEN AEROPLANES OVER 8618KG — Application for Type Certificate submitted before 1 January 1985.

16.6.1.1.—(a) The requirements defined hereunder are not applicable to : Applicability.

(1) aeroplanes requiring a runway length (with no stopway or clearway) of 610m or less at maximum certificated mass for airworthiness ;

(2) aeroplanes specifically designed and used for firefighting purposes ;  
and

(3) aeroplanes specifically designed and used for agricultural purposes.

(b) The requirements of this subpart shall be applicable to all propeller-driven aeroplanes, including their derived versions, of over 8618 kg maximum certificated take-off mass for which either the application for a Type Certificate was submitted on or after 6 October 1977 and before 1 January 1985.

(c) The requirements of subpart 16.3, with the exception of Sections 16.3.1.1 and 16.3.1.4(b), shall be applicable to propeller-driven aeroplanes of over 8618 kg for which the application for a Type Certificate was submitted before 6 October 1977 and which are either :

(1) derived versions for which the application for certification of the change in type design was submitted on or after 6 October 1977; or

(2) individual aeroplanes for which a certificate of airworthiness was first issued on or after 26 November 1981.

(d) Notwithstanding 16.6.1.1(b) and 16.6.1.1(c), it may be recognized by the Authority that the following situations for jet aeroplanes and propeller-driven aeroplanes over 8,618 kg maximum certificated take-off mass on its registry do not require demonstration of compliance with the provisions of this Part.

(1) gear down flight with one or more retractable landing gear down during the entire flight ;

(2) spare engine and nacelle carriage external to the skin of the aeroplane (and return of the pylon or other external mount) ; and

(3) time-limited engine and/or nacelle changes, where the change in type design specifies that the aeroplane may not be operated for a period of more than 90 days unless compliance with the provisions of Annex 16, Volume I, is shown for that change in type design. This applies only to changes resulting from a required maintenance action.

Noise  
measure-  
ments.

16.6.1.2.—(a) Noise evaluation measure :

(1) The noise evaluation measure shall be the effective perceived noise level in EPNdB as described in Appendix 2 of ICAO Annex 16 Volume I Part II.

Noise  
measurement  
points.

16.6.1.3.—(a) Reference noise measurement points :

An aeroplane, when tested in accordance with these requirements, shall not exceed the noise levels specified in 16.6.1.4 at the following points :

(1) *lateral reference noise measurement point* : the point on a line parallel to and 450 m from the runway centre line, or extended runway centre line, where the noise level is a maximum during take-off ;

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

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

(b) Test noise measurement points

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

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

be made at one test noise measurement point at a symmetrical position on the other side of the runway.

16.6.1.4. The maximum noise levels, when determined in accordance with the noise evaluation method of Appendix 2 of ICAO Annex 16 Volume I Part II, shall not exceed the following :

Maximum noise levels.

(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 34 000 kg 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 34 000 kg 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 34 000 kg 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.

16.6.1.5.—(a) If the maximum noise levels are exceeded at one or two measurement points :

Trade-offs.

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

16.6.1.6.—(a) General conditions—

(1) The reference procedures shall comply with the appropriate airworthiness requirements.

Noise certification reference procedures.

(2) The calculations of reference procedures and flight paths shall be approved by the certificating authority.

(3) Except in conditions specified in 16.6.1.6(a)(4), the take-off and approach reference procedures shall be those defined in 16.6.1.6(b) and 16.6.1.6(c), respectively.

(4) When it is shown by the applicant that the design characteristics of the aeroplane would prevent flight being conducted in accordance with 16.6.1.6(b) and 16.6.1.6(c), the reference procedures shall :

(i) depart from the reference procedures defined in 16.6.1.6(b) and 16.6.1.6(c), only to the extent demanded by those design characteristics which make compliance with the procedures impossible ; and

(ii) be approved by the certificating authority.

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

(i) sea level atmospheric pressure of 1013.25 hPa ;

(ii) ambient air temperature of 25°C, i.e. ISA + 10°C except that at the discretion of the Authority, an alternative reference ambient air temperature of 15°C, i.e. ISA may be used ;

(iii) relative humidity of 70 per cent ; and

(iv) zero wind.

(b) Take-off reference procedure :

The take-off flight path shall be calculated as follows :

(1) 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. 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 16.6.1.6(a)(5) ;

(i) aeroplanes with two engines or less - 300 m (984 ft) ;

(ii) aeroplanes with three engines - 260 m (853 ft) ;

(iii) aeroplanes with four engines or more - 210 m (689 ft) ;

(2) upon reaching the height specified in a) 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 ;

(3) 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 ;

(4) 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

(5) the mass of the aeroplane at the brake release shall be the maximum take-off mass at which the noise certification is requested.

(c) Approach reference procedure :

The approach reference flight path shall be calculated as follows :

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

(2) the approach shall be made at a stabilized airspeed of not less than 1.3 VS + 19 km/h (1.3 VS + 10 kt) with power stabilized during approach and over the measuring point and continued to a normal touchdown ;

(3) the constant approach configuration used in the airworthiness certification test, but with the landing gear down, shall be maintained throughout the approach reference procedure ;

(4) the mass of the aeroplane at the touchdown shall be the maximum landing mass permitted in the approach configuration defined in 16.6.1.6(c)(3) at which noise certification is requested ; and

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

16.6.1.7.—(a) The test procedures shall be acceptable to the Authority.

Test  
procedures.

(b) The test procedures and noise measurements shall be conducted and processed in an approved manner to yield the noise evaluation measure designated as effective perceived noise level, EPNL, in units of EPNdB, as described in Appendix 2 of ICAO Annex 16 Volume I Part II.

(c) Acoustic data shall be adjusted by the methods outlined in Appendix 2 of ICAO Annex 16 Volume I Part II to the reference conditions specified in this chapter. Adjustments for speed and thrust shall be made as described in Section 8 of Appendix 2 of ICAO Annex 16 Volume I Part II.

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

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

(f) If equivalent test procedures different from the reference procedures are used, the test procedures and all methods for adjusting the results to the reference procedures shall be approved by the certificating authority. The amounts of the adjustments shall not exceed 16 EPNdB on take-off and 8

EPNdB on a pproach, 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 16.6.1.4.

16.7. PROPELLER-DRIVEN AEROPLANES NOT EXCEEDING 8618KG — Application for Type Certificate submitted before 17 November 1988.

Applicability. 16.7.1.1.—(a) The requirements of this subpart shall be applicable to all propeller-driven aeroplanes, except those aeroplanes specifically designed and used for aerobatic, agricultural or fire fighting purposes, having a maximum certificated take-off mass not exceeding 8618 kg for which either :

(1) the application for the Type Certificate was submitted on or after 1 January 1975 and before 17 November 1988, except for derived versions for which the application for certification of the change in type design was submitted on or after 17 November 1988, in which case the requirements of subpart 16.10 10 apply ; or

(2) a certificate of airworthiness for the individual aeroplane was first issued on or after 1 January 1980.

Noise evaluation measure. 16.7.1.2.—(a) The noise evaluation measure shall be a weighted overall sound pressure level as defined in International Electro technical Commission (IEC) Publication No. 179. 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”.

Maximum noise levels. 16.7.1.3.—(a) For aeroplanes specified in 16.7.1.1(a)(1) and (2), the maximum noise levels, when determined in accordance with the noise evaluation method of Appendix 3 of ICAO Annex 16 Volume I Part II, shall not exceed the following :

(1) a 68 dB(A) constant limit up to an aeroplane mass of 600 kg, varying linearly with mass from that point to 1 500 kg, after which the limit is constant at 80 dB(A) up to 8 618 kg.

Noise certification reference procedures. 16.7.1.4. The reference procedure shall be calculated under the following reference atmospheric conditions :

- (a) sea level atmospheric pressure of 1013.25 hPa ;
- (b) ambient air temperature of 25°C, i.e. ISA + 10°C.

Test procedures. 16.7.1.5.—(a) Either the test procedures described in 16.7.1.5(b) and 16.7.1.5(c) or equivalent test procedures approved by the Authority shall be used.

(b) Tests to demonstrate compliance with the maximum noise levels of 16.6.3 shall consist of a series of level flights overhead the measuring station at a height of  $\frac{300 \begin{smallmatrix} +10 \\ -30 \end{smallmatrix}}{\text{m}} \left( 985 \begin{smallmatrix} +30 \\ -100 \end{smallmatrix} \text{ft} \right)$  The aeroplane shall pass over the measuring point within  $\pm 10^\circ$  from the vertical.

(c) Overflight shall be performed at the highest power in the normal operating range, stabilized airspeed and with the aeroplane in the cruise configuration.

#### 16.8. HELICOPTERS

16.8.1.1.—(a) The requirements of this subpart shall be applicable to all helicopters for which 16.8.1.1(b), 16.8.1.1(c) and 16.8.1.1(d) apply, except those specifically designed and used for agricultural, fire fighting or external load carrying purposes. Applicability.

(b) For a helicopter for which the application for the Type Certificate was submitted on or after 1 January 1985, except for those helicopters specified in 16.8.1.1(d), the maximum noise levels of 16.8.1.4 shall apply.

(c) For a derived version of a helicopter for which the application for certification of the change in type design was submitted on or after 17 November 1988, except for those helicopters specified in 16.8.1.1(d), the maximum noise levels of 16.8.1.4 shall apply.

(d) For all helicopters, including their derived versions, for which the application for the Type Certificate was submitted on or after 21 March 2002, the maximum noise levels of 16.8.1.4 shall apply.

(e) Certification of helicopters which are capable of carrying external loads or external equipment shall be made without such loads or equipment fitted.

(f) An applicant under 8.1.1 may alternatively elect to show compliance with 16.11 instead of 16.8 if the helicopter has a maximum certificated take-off mass of 3,175 kg or less.

16.8.1.2.—(a) The noise evaluation measure shall be the effective perceived noise level in EPNdB as described in Appendix 2 of ICAO Annex 16 Volume I Part II. Noise evaluation measure.

16.8.1.3.—(a) A helicopter, when tested in accordance with these requirements, shall not exceed the noise levels specified in 16.8.1.4 at the following points : Reference noise measurement points.

(1) *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 m horizontally in the direction of flight from the point at which transition to climbing flight is initiated in the reference procedure (see 16.8.1.6(b)) ;

(ii) two other points on the ground symmetrically disposed at 150 m 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.

(2) *Overflight reference noise measurement points* :

(i) a flight path reference point located on the ground 150 m (492 ft) vertically below the flight path defined in the overflight reference procedure (see 16.8.1.6(c)) ;

(ii) two other points on the ground symmetrically disposed at 150 m on both sides of the flight path defined in the overflight reference procedure and lying on a line through the flight path reference point.

(3) *Approach reference noise measurement points* :

(1) a flight path reference point located on the ground 120 m (394 ft) vertically below the flight path defined in the approach reference procedure (see 16.8.1.6(d)). On level ground, this corresponds to a position 1,140 m from the intersection of the 6.0° approach path with the ground plane ;

(2) two other points on the ground symmetrically disposed at 150 m 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.

16.8.1.4.—(a) For helicopters specified in 16.8.1.1(a) and (b), the maximum noise levels, when determined in accordance with the noise evaluation method of Appendix 2 of ICAO Annex 16 Volume I Part II, shall not exceed the following :

(1) *For take-off*: 109 EPNdB for helicopters with maximum certificated take-off mass, at which the noise certification is requested, of 80,000 kg 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.

(2) *For overflight*: 108 EPNdB for helicopters with maximum certificated take-off mass, at which the noise certification is requested, of 80,000 kg 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.

(3) *For approach*: 110 EPNdB for helicopters with maximum certificated take-off mass, at which the noise certification is requested, of 80,000 kg 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.

(b) For helicopters specified in 16.8.1.4(a), the maximum noise levels, when determined in accordance with the noise evaluation method of Appendix 2 of ICAO Annex 16 Volume I Part II, shall not exceed the following :

(1) *For take-off*: 106 EPNdB for helicopters with maximum certificated take-off mass, at which the noise certification is requested, of 80,000 kg



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.

(2) *For overflight*: 104 EPNdB for helicopters with maximum certificated take-off mass, at which the noise certification is requested, of 80,000 kg 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.

(3) *For approach*: 109 EPNdB for helicopters with maximum certificated take-off mass, at which the noise certification is requested, of 80 000 kg 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.

16.8.1.5.—(a) If the noise level limits are exceeded at one or two measurement points : Trade-offs.

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

16.8.1.6.—(a) General conditions

(1) The reference procedures shall comply with the appropriate airworthiness requirements.

(2) The reference procedures and flight paths shall be approved by the certifying authority.

(3) Except in conditions specified in 16.8.1.6(a)(4), the take-off, overflight and approach reference procedures shall be those defined in 16.8.1.6(b), 16.8.1.6(c) and 16.8.1.6(d), respectively.

(4) When it is shown by the applicant that the design characteristics of the helicopter would prevent flight being conducted in accordance with 16.8.1.6(b), 16.8.1.6(c) and 16.8.1.6(d), the reference procedures shall :

(i) depart from the reference procedures defined in 16.8.1.6(b), 16.8.1.6(c) or 16.8.1.6(d) 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.

(5) The reference procedures shall be established for the following reference atmospheric conditions :

(i) sea level atmospheric pressure of 1,013.25 hPa ;

Noise  
certification  
reference  
procedures.

- (ii) ambient air temperature of 25°C, i.e. ISA + 10°C ;
- (iii) relative humidity of 70 per cent ; and
- (iv) zero wind.

(6) In 16.8.1.6(b)(3), 16.8.1.6(c)(3) and 16.8.1.6(d)(3), 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. 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. If 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. If 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.

(b) Take-off reference procedure

The take-off reference flight procedure shall be established as follows :

(1) the helicopter shall be stabilized at the maximum take-off power corresponding to minimum installed engine(s) 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 m prior to the flight path reference point, at 20 m (65 ft) above the ground ;

(2) 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 ;

(3) the steady climb shall be made with the rotor speed stabilized at the maximum normal operating rpm certificated for take-off ;

(4) 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,  $V_y$  ;

(5) the mass of the helicopter shall be the maximum take-off mass at which noise certification is requested ; and

(6) the reference take-off path is defined as a straight line segment inclined from the starting point (500 m prior to the centre microphone location and 20 m (65ft) above ground level) at an angle defined by best rate of climb (BRC) and  $V_y$  for minimum specification engine performance.

## (c) Overflight reference procedure

(1) The overflight 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 m (492 ft) ;

(ii) a speed of  $0.9 V_H$  or  $0.9 V_{NE}$  or  $0.45 V_H + 120 \text{ km/h}$  ( $0.45 V_H + 65 \text{ kt}$ ) or  $0.45 V_{NE} + 120 \text{ km/h}$  ( $0.45 V_{NE} + 65 \text{ kt}$ ), whichever is the least, shall be maintained throughout the overflight reference procedure ;

NOTE.— *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.  $V_{NE}$  is defined as the not-to-exceed airworthiness airspeed imposed by the manufacturer and approved by the certificating authority.*

(iii) the overflight shall be made with the rotor speed stabilized at the maximum normal operating rpm certificated for level flight ;

(iv) the helicopter shall be in the cruise configuration ; and

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

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

## (d) Approach reference procedure

(1) The approach reference procedure shall be established as follows :

(i) the helicopter shall be stabilized and following a  $6.0^\circ$  approach path ;

(ii) 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 touchdown ;

(iii) the approach shall be made with the rotor speed stabilized at the maximum normal operating rpm certificated for approach ;

(iv) the constant approach configuration used in airworthiness certification tests, with the landing gear extended, shall be maintained throughout the approach reference procedure ; and

(v) the mass of the helicopter at touchdown shall be the maximum landing mass at which noise certification is requested.

16.8.1.7.—(a) The test procedures shall be acceptable to the Authority.

Test  
procedures.

(b) The test procedures and noise measurements shall be conducted and processed in an approved manner to yield the noise evaluation measure designated as effective perceived noise level, EPNL, in units of EPNdB, as described in Appendix 2 of ICAO Annex 16 Volume I Part II.

(c) 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 Appendix 2 of ICAO Annex 16 Volume I Part II, to the reference conditions and procedures specified in this subpart.

(d) Adjustments for differences between test and reference flight procedures shall not exceed :

- (1) *for take-off* : 4.0 EPNdB, of which the arithmetic sum of  $\triangle 1$  and the term  $-7.5 \log (QK/QrKr)$  from 2 shall not in total exceed 2.0 EPNdB ;
- (2) *for overflight or approach* : 2.0 EPNdB.

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

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

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

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

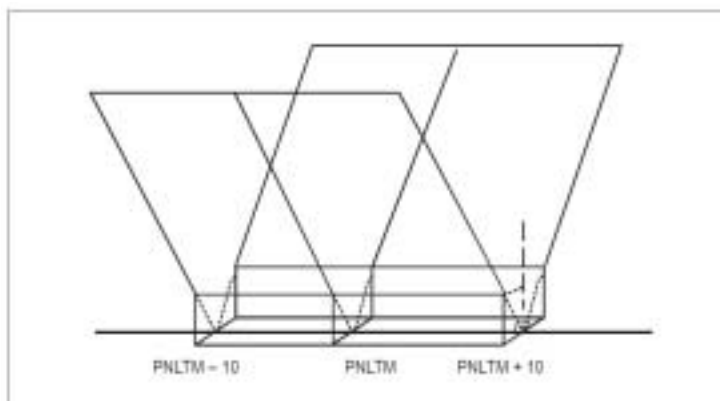


FIGURE 8-1. Helicopter lateral deviation tolerances

(l) The helicopter height shall not vary during overflight from the reference height at the overhead point by more than  $\pm 9$  m (30 ft).

(m) 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°.

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

16.9. INSTALLED AUXILIARY POWER UNITS (APU) AND ASSOCIATED AIRCRAFT SYSTEMS DURING GROUND OPERATIONS — *Reserved*

16.10. PROPELLER-DRIVEN AEROPLANES NOT EXCEEDING 8618KG — Application for Type Certificate or Certification of Derived Version submitted on or after 17 November 1988.

16.10.1.1.—(a) The requirements of this subpart shall be applicable to all propeller-driven aeroplanes with a certificated take-off mass not exceeding 8,618 kg, except those aeroplanes specifically designed and used for aerobatic, agricultural or fire fighting purposes and self-sustaining powered sailplanes

Applicability.

(b) For aeroplanes for which the application for the Type Certificate was submitted on or after 17 November 1988, except for those aeroplanes specified in 16.10.1.6, the maximum noise levels of 16.10.4(a)(1) shall apply.

(c) For aeroplanes specified in 16.10.1.1(b) where the application for the Type Certificate was submitted before 17 November 1993 and which fail to comply with the requirements of this subpart, the requirements of Part 16.6 shall apply.

(d) For derived versions for which the application for certification of the change in type design was submitted on or after 17 November 1988, except for those derived versions specified in 16.10.1.1(f), the maximum noise levels of 16.10.4 shall apply.

(e) For derived versions specified in 16.10.1.4 where the application for certification of the change in type design was submitted before 17 November 1993 and which fail to comply with the requirements of this Part, the requirements of Part 16.6 shall apply.

(f) For single-engined aeroplanes, except float planes and amphibians :

(1) the maximum noise levels of 16.10.1.4 (a)(2) shall apply to those aeroplanes, including their derived versions, for which the application for the Type Certificate was submitted on or after 4 November 1999 ;

(2) the maximum noise levels of 16.10.1.4(b) shall apply to those derived versions of aeroplanes for which the application for the Type Certificate was submitted before 4 November 1999 and for which the application for

certification of the change in type design was submitted on or after 4 November 1999 ; except

(3) for those derived versions described in 16.10.1.1(f)(2) where the application for certification of the change in type design was submitted before 4 November 2004 and which exceed the maximum noise levels of 16.10.4(b), in which case the maximum noise levels of 16.10.4(a) shall apply.

Noise  
evaluation  
measure.

16.10.1.2.—(a) The noise evaluation measure shall be the maximum A-weighted noise level (L<sub>Amax</sub>) as defined in Appendix 6 of ICAO Annex 16 Volume I Part II.

Reference  
noise  
measurement  
points.

16.10.1.3.—(a) An aeroplane, when tested in accordance with these requirements, shall not exceed the noise level specified in 16.10.1.4 at the take-off reference noise measurement point.

(b) The take-off reference noise measurement point is the point on the extended centre line of the runway at a distance of 2,500 m from the start of take-off roll.

Maximum  
noise levels.

16.10.1.4.—(a) The maximum noise levels determined in accordance with the noise evaluation method of Appendix 6 of ICAO Annex Volume I Part II shall not exceed the following :

(1) for aeroplanes specified in 16.10.1.1(b) and 16.10.1.1(d), a 76 dB(A) constant limit up to an aeroplane mass of 600 kg varying linearly from that point with the logarithm of aeroplane mass until at 1,400 kg the limit of 88 dB(A) is reached after which the limit is constant up to 8,618 kg ; and

(2) for aeroplanes specified in 16.10.1.1(d), a 70 dB(A) constant limit up to an aeroplane mass of 570 kg increasing linearly from that point with the logarithm of aeroplane mass until at 1,500 kg the limit of 85 dB(A) is reached after which the limit is constant up to 8,618 kg.

Noise  
certification  
reference  
procedures.

16.10.1.5.—(a) General conditions

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

(2) Except in conditions specified in 16.10.1.5(a)(3), the take-off reference procedure shall be that defined in 16.10.1.5(b).

(3) When it is shown by the applicant that the design characteristics of the aeroplane would prevent flights being conducted in accordance with 16.10.1.5(b), 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 authority.

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

- (i) sea level atmospheric pressure of 1,013.25 hPa ;
- (ii) ambient air temperature of 15°C, i.e. ISA ;
- (iii) relative humidity of 70 per cent ; and
- (iv) zero wind.

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

(b) Take-off reference procedure

The take-off flight path shall be calculated taking into account the following two phases.

(1) First phase

(i) take-off power shall be used from the brake release point to the point at which the height of 15 m (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.

(2) 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,  $V_y$  ; and

(iv) take-off power and, for aeroplanes equipped with variable pitch or constant speed propellers, rpm shall be maintained throughout the second phase. If 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. Limiting of time for which take-off power and rpm shall be used in order to comply with this chapter shall not be permitted. The reference height shall be calculated assuming climb gradients appropriate to each power setting used.

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Test procedures.

16.10.1.6.—(a) The test procedures shall be acceptable to the Authority

(b) 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<sub>Amax</sub> as described in Appendix 6 of ICAO Annex 16 Volume I Part II.

(c) Acoustic data shall be adjusted by the methods outlined in Appendix 6 of ICAO Annex 16 Volume I Part II to the reference conditions specified in this subpart.

(d) If 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

**16.11. HELICOPTERS NOT EXCEEDING 3175 KG MAXIMUM CERTIFICATED TAKE-OFF MASS**

Applicability.

16.11.1.1.—(a) The requirements of this subpart shall be applicable to all helicopters having a maximum certificated take-off mass not exceeding 3175 kg for which 16.11.1.1(b), (c) and (d) apply, except those specifically designed and used for agricultural, fire fighting or external load carrying purposes.

(b) For a helicopter for which the application for the Type Certificate was submitted on or after 11 November 1993, except for those helicopters specified in 16.11.1.1(d), the maximum noise levels of 16.11.1.4 shall apply.

(c) For a derived version of a helicopter for which the application for certification of the change in type design was submitted on or after 11 November 1993, except for those helicopters specified in 16.11.1.4, the maximum noise levels of 16.11.4.1 shall apply.

(d) For all helicopters, including their derived versions, for which the application for the Type Certificate was submitted on or after 21 March 2002, the maximum noise levels of 16.11.4.2 shall apply.

(e) Certification of helicopters which are capable of carrying external loads or external equipment shall be made without such loads or equipment fitted.

(f) An applicant under 16.11.1.1(a), (b), (c) and (d) may alternatively elect to show compliance with subpart 16.8 instead of complying with this Part.

Noise evaluation measure.

16.11.1.2.—(a) The noise evaluation measure shall be the sound exposure level (SEL) as described in Appendix 4 of ICAO Annex 16 Volume I Part II.



16.11.1.3. A helicopter, when tested in accordance with these requirements, shall not exceed the noise levels specified in 16.11.1.4 at a flight path reference point located on the ground 150 m (492 ft) vertically below the flight path defined in the overflight reference procedure (see 16.11.1.5(b)).

Reference noise measurement point.

16.11.1.4.—(a) For helicopters specified in 16.11.1.1(a) and (b), the maximum noise levels, when determined in accordance with the noise evaluation method of Appendix 4, shall not exceed 82 decibels SEL for helicopters with maximum certificated take-off mass, at which the noise certification is requested, of up to 788 kg and increasing linearly with the logarithm of the helicopter mass at a rate of 3 decibels per doubling of mass thereafter.

Maximum noise level.

(b) For helicopters specified in 16.11.1.1(d), the maximum noise levels, when determined in accordance with the noise evaluation method of Appendix 4 of ICAO Annex 16 Volume I Part II, shall not exceed 82 decibels SEL for helicopters with maximum certificated take-off mass, at which the noise certification is requested, of up to 1,417 kg and increasing linearly with the logarithm of the helicopter mass at a rate of 3 decibels per doubling of mass

16.11.1.5.—(a) General conditions

Noise certification reference procedure.

(1) The reference procedure shall comply with the appropriate airworthiness requirements and shall be approved by the certifying authority.

(2) Except as otherwise approved, the overflight reference procedure shall be as defined in 16.11.1.5(b).

(3) When it is shown by the applicant that the design characteristics of the helicopter would prevent flight being conducted in accordance with 16.11.1.5(b) the reference procedure shall be permitted to depart from the standard reference procedure, with the approval of the authority, but only to the extent demanded by those design characteristics which make compliance with the reference procedures impossible.

(4) The reference procedure shall be established for the following reference atmospheric conditions :

- (i) sea level atmospheric pressure of 1013.25 hPa ;
- (ii) ambient air temperature of 25°C ;
- (iii) relative humidity of 70 per cent ; and
- (iv) zero wind.

(5) 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 authority for overflight. 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. If 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. If 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.

(b) Reference procedure

(i) 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 m (492 ft)  $\pm$  15 m (50 ft) ;

(ii) a speed of  $0.9 V_H$  or  $0.9 V_{NE}$  or  $0.45 V_H + 120\text{km/h}$  (65 kt) or  $0.45 V_{NE} + 120\text{ km/h}$  (65 kt), whichever is the least, shall be maintained throughout the overflight procedure. 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 (1 013.25 hPa), 25°C ambient conditions at the relevant maximum certificated mass.  $V_{NE}$  is defined as the not-to-exceed airworthiness airspeed imposed by the manufacturer and approved by the certificating authority ;

(iii) the overflight shall be made with the rotor speed stabilized at the maximum normal operating rpm certificated for level flight ;

(iv) the helicopter shall be in the cruise configuration ; and

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

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

Test  
procedures.

16.11.1.6.—(a) The test procedures shall be acceptable to the Authority.

(b) 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 (SEL), in A-weighted decibels, as described in Appendix 4 of ICAO Annex 16 Volume I Part II.

(c) 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 Appendix 4 of ICAO Annex 16 Volume I Part II, to the reference conditions and procedures specified in this Subpart.

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

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

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

(g) The helicopter airspeed shall not vary from the reference airspeed appropriate to the flight demonstration as described in Appendix 4 of ICAO Annex 16 Volume I Part II by more than  $\pm 5$  km/h ( $\pm 3$  kt) throughout the 10 dB-down time period.

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

(i) 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.

#### 16.12. SUPERSONIC AEROPLANES

16.12.1.1.—(a) The requirements of 16.3 of this Part, with the exception of the maximum noise levels specified in 16.3.1.4, 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.

Supersonic aeroplanes - Application for Type Certificate submitted before 1 January 1975.

(b) The maximum noise levels of those aeroplanes covered by 16.12.1.1(a), when determined in accordance with the noise evaluation method of Appendix 1 of ICAO Annex Volume I Part II, shall not exceed the measured noise levels of the first certificated aeroplane of the type.

16.12.1.2. Supersonic aeroplanes - Application for Type Certificate submitted on or after 1 January 1975—*Reserved*.

#### 16.13. TILT-ROTOR AIRCRAFT

16.13.1.1.—(a) The requirements of this Subpart shall be applicable to all tilt-rotors, including their derived versions, for which the application for a Type Certificate was submitted on or after 1 January 2018.

Applicability.

(b) Noise certification of tilt-rotors which are capable of carrying external loads or external equipment shall be made without such loads or equipment fitted.

16.13.1.2.—(a) The noise evaluation measure shall be the effective perceived noise level in EPNdB as described in Appendix 2 of ICAO Annex Volume I Part II. The correction for spectral irregularities shall start at 50 Hz.

Noise Evaluation Measure.

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Noise measurement reference points.

16.13.1.3.—(a) A tilt-rotor, when tested in accordance with the reference procedures of 16.13.1.6 and the test procedures of 16.13.1.7, shall not exceed the noise levels specified in 16.13.1.4 at the following reference points :

(1) *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 (see 16.13.1.6(b)) and 500 m (1,640 ft) horizontally in the direction of flight from the point at which transition to climbing flight is initiated in the reference procedure ;

(ii) two other points on the ground symmetrically disposed at 150 m (492 ft) 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.

(2) *Overflight reference noise measurement points :*

(i) a flight path reference point located on the ground 150 m (492 ft) vertically below the flight path defined in the overflight reference procedure (see 16.13.1.6(c)) ;

(ii) two other points on the ground symmetrically disposed at 150 m (492 ft) on both sides of the flight path defined in the overflight reference procedure and lying on a line through the flight path reference point.

(3) *Approach reference noise measurement points :*

(i) a flight path reference point located on the ground 120 m (394 ft) vertically below the flight path defined in the approach reference procedure (see 16.13.1.6 (d)). On level ground, this corresponds to a position 1,140 m (3,740 ft) from the intersection of the 6.0° approach path with the ground plane ;

(ii) two other points on the ground symmetrically disposed at 150 m (492 ft) on both sides of the flight.

Maximum noise levels.

16.13.1.4.—(a) For tilt-rotors specified in 16.13.1.1, the maximum noise levels, when determined in accordance with the noise evaluation method of Appendix 2 of ICAO Annex Volume I Part II for helicopters, shall not exceed the following :

(1) *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 80,000 kg and over and decreasing linearly with the logarithm of the tilt-rotormass at a rate of 3 EPNdB per halving of mass down to 89 EPNdB after which the limit is constant.

(2) *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 80,000 kg 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.

NOTE 1.— For the tilt-rotor in aeroplane mode, there is no maximum noise level.

NOTE 2.— VTOL/conversion mode is all approved configurations and flight modes where the design operating rotor speed is that used for hover operations.

(3) *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 80,000 kg 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.

16.13.1.5.—(a) If the maximum noise levels are exceeded at one or two measurement points : Trade-Offs.

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

16.13.1.6.—(a) General conditions

(1) The reference procedures shall comply with the appropriate airworthiness requirements.

(2) The reference procedures and flight paths shall be approved by the certifying authority.

(3) Except in conditions specified in 16.13.1.6(a)(4), the take-off, overflight and approach reference procedures shall be those defined in 16.13.1.6(b), 16.13.1.6(c) and 16.13.1.6(d), respectively.

(4) When it is shown by the applicant that the design characteristics of the tilt-rotor would prevent a flight from being conducted in accordance with 13.6.2, 13.6.3 or 13.6.4, the reference procedures shall :

(i) depart from the reference procedures defined in 13.6.2, 13.6.3 or 13.6.4 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.

(5) The reference procedures shall be established for the following reference atmospheric conditions :

- (i) sea level atmospheric pressure of 1,013.25 hPa ;
- (ii) ambient air temperature of 25°C, i.e. ISA + 10°C ;

Noise certification reference procedures.

(iii) relative humidity of 70 per cent ; and

(iv) zero wind.

(6) In 16.13.1.6(b)(4), 16.13.1.6(c)(4), and 16.13.1.6(d)(3), 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 Authority. 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. If 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. If 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.

(b) Take-off reference procedure

The take-off reference flight procedure shall be established as follows :

(1) a constant take-off configuration, including nacelle angle, selected by the applicant shall be maintained throughout the take-off reference procedure ;

(2) the tilt-rotor shall be stabilized at the maximum take-off power corresponding to minimum installed engine(s) 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 m (1,640 ft) prior to the flight path reference point, at 20 m (65 ft) above the ground ;

(3) 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 ;

(4) the steady climb shall be made with the rotor speed stabilized at the maximum normal operating rpm certificated for take-off ;

(5) the mass of the tilt-rotor shall be the maximum take-off mass at which noise certification is requested ; and

(6) the reference take-off path is defined as a straight line segment inclined from the starting point (500 m (1,640 ft) prior to the centre noise measurement point and 20 m (65 ft) above ground level) at an angle defined by best rate of climb (BRC) and the best rate of climb speed corresponding to the selected nacelle angle and for minimum specification engine performance.

(c) Overflight reference procedure

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

(i) the tilt-rotor shall be stabilized in level flight overhead the flight path reference point at a height of 150 m (492 ft) ;

(ii) a constant configuration selected by the applicant shall be maintained throughout the overflight reference procedures ;

(iii) the mass of the tilt-rotor shall be the maximum take-off mass at which noise certification is requested ;

(iv) 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  $0.9V_{CON}$  and a rotor speed stabilized at the maximum normal operating rpm certificated for level flight shall be maintained throughout the overflight reference procedure ;

NOTE.— *For noise certification purposes,  $V_{CON}$  is defined as the maximum authorized speed for VTOL/conversion mode at a specific nacelle angle.*

(v) in the aeroplane mode, the nacelles shall be maintained on the down-stop throughout the overflight reference procedure, with :

(A) rotor speed stabilized at the rpm associated with the VTOL/conversion mode and a speed of  $0.9V_{CON}$  ; and

(B) rotor speed stabilized at the normal cruise rpm associated with the aeroplane mode and at the corresponding  $0.9V_{MCP}$  or  $0.9V_{MO}$ , whichever is lesser, certificated for level flight.

NOTE.— *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 (MCP) 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 (MO) limit airspeed that may not be deliberately exceeded.*

(2) The values of  $V_{CON}$  and  $V_{MCP}$  or  $V_{MO}$  used for noise certification shall be quoted in the approved flight manual.

(d) Approach reference procedure

The approach reference procedure shall be established as follows :

(1) the tilt-rotor shall be stabilized and follow a  $6.0^\circ$  approach path ;

(2) 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 ;

(3) the approach shall be made with the rotor speed stabilized at the maximum normal operating rpm certificated for approach ;

Test  
procedures.

(4) the constant approach configuration used in airworthiness certification tests, with the landing gear extended, shall be maintained throughout the approach reference procedure ; and

(5) the mass of the tilt-rotor at touchdown shall be the maximum landing mass at which noise certification is requested.

16.13.1.7.—(a) The test procedures shall be acceptable to the Authority.

(b) The test procedures and noise measurements shall be conducted and processed in an approved manner to yield the noise evaluation measure designated in 16.13.1.2.

(c) Test conditions and procedures shall be similar to reference conditions and procedures or the acoustic data shall be adjusted, by the methods outlined in Appendix 2 of ICAO Annex Volume I Part II for helicopters, to the reference conditions and procedures specified in this Part.

(d) Adjustments for differences between test and reference flight procedures shall not exceed :

(1) *for take-off*: 4.0 EPNdB, of which the arithmetic sum of  $\Delta_1$  and the term  $-7.5 \log QK/QrKr$  from  $\Delta_2$  shall not in total exceed 2.0 EPNdB ; and

(2) for overflight or approach: 2.0 EPNdB.

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

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

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

(h) The tilt-rotor shall fly within  $\pm 10^\circ$  or  $\pm 20$  m ( $\pm 65$  ft), whichever is greater, from the vertical above the reference track throughout the 10 dB-down period (see Figure 8-1).

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

(j) 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  $5.5^\circ$  and  $6.5^\circ$  throughout the 10 dB-down period

(k) 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. For



each of the flight conditions, at least one test must be completed at or above this maximum certificated mass.

16.14. SUBSONIC JET AEROPLANES AND PROPELLER-DRIVEN AEROPLANES WITH MAXIMUM CERTIFICATED TAKE-OFF MASS 55,000KG AND OVER—Application for Type Certificate submitted on or after 31 December 2017.

2.— SUBSONIC JET AEROPLANES WITH MAXIMUM CERTIFICATED TAKE-OFF MASS LESS THAN 55,000KG—Application for Type Certificate submitted on or after 31 December 2020.

3.— PROPELLER-DRIVEN AEROPLANES WITH MAXIMUM CERTIFICATED TAKE-OFF MASS OVER 8,618KG AND LESS THAN 55,000KG—Application for Type Certificate submitted on or after 31 December 2020.

16.14.1.1.—(a) The requirements of this Subpart shall, with the exception of those aeroplanes which require a runway length (with no stopway or clearway) of 610 m or less at maximum certificated mass for airworthiness or propeller-driven aeroplanes specifically designed and used for agricultural or firefighting purposes, be applicable to :

Applicability.

(1) all subsonic jet aeroplanes and propeller-driven aeroplanes, including their derived versions, with a maximum certificated take-off mass of 55,000 kg and over for which the application for a Type Certificate was submitted on or after 31 December 2017 ;

(2) all subsonic jet aeroplanes, including their derived versions, with a maximum certificated take-off mass of less than 55,000 kg for which the application for a Type Certificate was submitted on or after 31 December 2020 ;

(3) all propeller-driven aeroplanes, including their derived versions, with a maximum certificated take-off mass of over 8,618 kg and less than 55,000 kg for which the application for a Type Certificate was submitted on or after 31 December 2020 ; and

(4) all subsonic jet aeroplanes and all propeller-driven aeroplanes certificated originally as satisfying Annex 16, Volume I, 16.3, 16.4 or 16.5, for which recertification to 16.14 is requested.

(b) Notwithstanding 16.14.1.1, it may be recognized by a Contracting State that the following situations for jet aeroplanes and propeller-driven aeroplanes over 8 618 kg maximum certificated take-off mass on its registry do not require demonstration of compliance with the provisions of the Standards of ICAO Annex 16, Volume I :

(1) gear down flight with one or more retractable landing gear down during the entire flight ;

(2) spare engine and nacelle carriage external to the skin of the aeroplane (and return of the pylon or other external mount) ; and

(3) time-limited engine and/or nacelle changes, where the change in type design specifies that the aeroplane may not be operated for a period of more than 90 days unless compliance with the provisions of Annex 16, Volume I, is shown for that change in type design. This applies only to changes resulting from a required maintenance action.

Noise  
Measure-  
ments.

16.14.1.2. The noise evaluation measure shall be the effective perceived noise level in EPNdB as described in Appendix 2 of ICAO Annex Volume I Part II.

Reference  
Noise  
Measurement  
Points.

16.14.1.3.—(a) An aeroplane, when tested in accordance with these Standards, shall not exceed the maximum noise level specified in 14.4 of the noise measured at the points specified in Chapter 3, 3.3.1(a), (b) and (c).

(b) Test noise measurement points

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

Maximum  
Noise  
Levels.

16.14.1.4.—(a) The maximum noise levels, when determined in accordance with the noise evaluation method of Appendix 2 of ICAO Annex Volume I Part II, shall not exceed the following :

(1) *At the lateral full-power reference noise measurement point*

103 EPNdB for aeroplanes with maximum certificated take-off mass, at which the noise certification is requested, of 400,000 kg and over, decreasing linearly with the logarithm of the mass down to 94 EPNdB at 35,000 kg, after which the limit is constant to 8,618 kg, where it decreases linearly with the logarithm of the mass down to 88.6 EPNdB at 2 000 kg, after which the limit is constant.

(2) *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 385,000 kg 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 8,618 kg, where it decreases linearly with the logarithm of the mass at a rate of 4 EPNdB per halving of mass down to 2,000 kg, after which the limit is constant.

(ii) *Aeroplanes with three engines*

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

(iii) *Aeroplanes with four engines or more*

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

(3) *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 280,000 kg and over, decreasing linearly with the logarithm of the mass down to 98 EPNdB at 35,000 kg, after which the limit is constant to 8,618 kg, where it decreases linearly with the logarithm of the mass down to 93.1 EPNdB at 2 000 kg, after which the limit is constant.

(4) The sum of the differences at all three measurement points between the maximum noise levels and the maximum permitted noise levels specified in 16.14.1.4 (a)(1)(2) and (3), shall not be less than 17 EPNdB.

(5) 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 16.14.1.4 (a)(1)(2) and (3).

16.14.1.5. NOISE CERTIFICATION REFERENCE PROCEDURES

The noise certification reference procedures shall be as specified in 16.3, 16.3.1.6.

16.14.1.6. TEST PROCEDURES

The test procedures shall be as specified in 16.3, 16.3.1.7.

16.14.1.7. RECERTIFICATION

For aeroplanes specified in 16.14.1.1 (a)(4), recertification shall be granted on the basis that the evidence used to determine compliance with 16.14 is as satisfactory as the evidence associated with aeroplanes specified in 16.14.1.1 (a)(1)(2) and (3).

16.15. NOISE MEASUREMENT FOR MONITORING PURPOSES

16.15.1.1. Where the measurement of aircraft noise is made for monitoring purposes, the method of Appendix 5 of ICAO Annex 16 Volume I Part II shall be used.

16.16. ASSESSMENT OF AIRPORT NOISE

16.16.1.1. Where international comparison of noise assessment around airports is undertaken, the methodology described in Recommended Method for Computing Noise Contours around Airports (Doc 9911) shall be used.

16.17. BALANCED APPROACH TO NOISE MANAGEMENT

16.17.1.1. The balanced approach to noise management consists of identifying the noise problem at an airport and then analyzing the various measures available to reduce noise through the exploration of four principal elements, namely reduction at source (addressed in subpart of this subparts), land-use planning and management, noise abatement operational procedures

and operating restrictions, with the goal of addressing the noise problem in the most cost-effective manner. All the elements of the balanced approach are addressed in the Guidance on the Balanced Approach to Aircraft Noise Management (Doc 9829).

16.17.1.2. Aircraft operating procedures for noise abatement shall not be introduced unless the regulatory authority, based on appropriate studies and consultation, determines that a noise problem exists.

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

16.17.1.4. 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 :
  - (1) the location of noise-sensitive areas ; and
  - (2) 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 (PANS-OPS (Doc 8168), Volumes I and II) ; and
- (e) human performance in the application of the operating procedures.

16.17.1.5. Although in most countries, land-use planning and management are the responsibility of national and/or local planning authorities rather than aviation authorities, ICAO has developed guidance material which shall be used to assist planning authorities in taking appropriate measures to ensure compatible land-use management around airports to the benefit of both the airport and the surrounding communities (Airport Planning Manual, Part 2, (Doc 9184)).

#### 16.18. VENTED FUEL ADMINISTRATION

Applicability.

16.18.1.1.—(a) The provision of this subpart shall apply to all turbine engine powered aircraft intended for operation in international air navigation manufactured after 18 February 1982.

Administration.

16.18.1.2.—(a) Certification related to the prevention of intentional fuel venting shall be granted by the Authority on the basis of satisfactory evidence that either the aircraft or the aircraft engines comply with requirements of 16.18.1.3.

(b) The Authority shall recognize as valid a certification relating to fuel venting granted by the certificating authority of another Contracting State

provided the requirements under which such certification was granted are not less stringent than the provision of ICAO Annex 16 Volume II.

#### 16.18.2. PREVENTION OF INTENTIONAL FUEL VENTING

16.18.2.1. Aircraft shall be so designed and constructed as to prevent the intentional discharge into the atmosphere of liquid fuel from the fuel nozzle manifolds resulting from the process of engine shutdown following normal flight or ground operations.

#### 16.19. EMISSIONS CERTIFICATION

##### 16.19.1. EMISSION CERTIFICATE AND ADMINISTRATION

16.19.1.1.—(a) The provisions of 16.19.1.2 to 16.19.1.4 shall apply to all engines included in the classifications defined for emission certification purposes in subparts 16.18.2 and 16.18.3 where such engines are fitted to aircraft engaged in international air navigation.

Applicability.

16.19.1.2.—(a) Emissions certification shall be granted by the authority on the basis of satisfactory evidence that the engine complies with requirements which are at least equal to the stringency of the provisions of this subpart. Compliance with the emissions levels of subpart 16.18.2 and 16.18.3 shall be demonstrated using the procedure described in Appendix 6 of ICAO Annex 16 Volume II.

Emission  
Administra-  
tion.

(b) The emissions certificate for each individual engine shall include at least the following information which is applicable to the engine type :

- (1) name of Authority ;
- (2) manufacturers type and model designation ;
- (3) statement of any additional modifications incorporated for the purpose of compliance with the applicable emissions certification requirements ;
- (4) rated thrust ;
- (5) reference pressure ratio ;
- (6) a statement indicating compliance with Smoke Number requirements ;
- (7) a statement indicating compliance with gaseous pollutant requirements.

(a) The items on the emissions certificate shall be uniformly numbered in Arabic/Roman numerals as contained in IS 16.19.1.2(b).

(c) The Authority shall recognize as valid emissions certificate granted by the certifying authority of another Contracting State provided that the requirements under which such certification was granted are not less stringent than the provisions of this subpart.

16.19.2. TURBOJET AND TURBOFAN ENGINES INTENDED FOR PROPULSION ONLY AT SUBSONIC SPEEDS

Applicability. 16.19.2.1.—(a) The provisions of this chapter shall apply to all turbojet and turbofan engines, as further specified in 16.18.3 and 16.18.4, intended for propulsion only at subsonic speeds, except when certificating authorities make exemptions for :

- (1) specific engine types and derivative versions of such engines for which the type certificate of the first basic type was issued or other equivalent prescribed procedure was carried out before 1 January 1965 ; and
- (2) a limited number of engines beyond the dates of applicability specified in 16.19.3 and 16.18.4 for the manufacture of the individual engine.

(b) In such cases, an exemption document shall be issued by the authority, the identification plates on the engines shall be marked “EXEMPT”, and the grant of exemption shall be noted in the permanent engine record.

(c) The provisions of this chapter shall also apply to engines designed for applications that otherwise would have been fulfilled by turbojet and turbofan engines.

Emissions involved. 16.19.2.2.—(a) The following emissions shall be controlled for certification of aircraft engines :

Smoke

Gaseous emissions

Unburned hydrocarbons (HC) ;

Carbon monoxide (CO) ; and

Oxides of nitrogen (NO<sub>x</sub>).

Units of measurement. 16.19.2.3.—(a) The smoke emission shall be measured and reported in terms of Smoke Number (SN).

(b) The mass ( $D_p$ ) of the gaseous pollutant HC, CO, or NO<sub>x</sub> emitted during the reference emissions landing and take-off (LTO) cycle, defined in 16.19.2.1.4(b) and 16.19. 2.4(c), shall be measured and reported in grams.

Reference conditions. 16.19.2.4.—(a) *Atmospheric conditions*

(1) The reference atmospheric conditions shall be ISA at sea level except that the reference absolute humidity shall be 0.00634kg water/kg dry air.

(b) *Thrust settings*

The engine shall be tested at sufficient thrust settings to define the gaseous and smoke emissions of the engine so that mass emission rates and Smoke Numbers can be determined at the following specific percentages of rated thrust as agreed by the certificating authority :

<i>LTO operating mode</i>	<i>Thrust setting</i>
Take-off	100 per cent $F_{oo}$
Climb	85 per cent $F_{oo}$
Approach	30 per cent $F_{oo}$
Taxi/ground idle	7 per cent $F_{oo}$

(c) *Reference emissions landing and take-off (LTO) cycle*

(1) The reference emissions LTO cycle for the calculation and reporting of gaseous emissions shall be represented by the following time in each operating mode.

<i>Phase</i>	<i>Time in operating mode, minutes</i>
Take-off	0.7
Climb	2.2
Approach	4.0
Taxi/ground idle	26.0

(d) *Fuel specifications*

The fuel used during tests shall meet the specifications of Appendix 4 of ICAO Annex 16 Volume II, unless a deviation and any necessary corrections have been agreed by the certificating authority. Additives used for the purpose of smoke suppression (such as organo-metallic compounds) shall not be present.

16.19.2.5.—(a) The tests shall be made with the engine on its test bed.

Test conditions.

(b) The engine shall be representative of the certificated configuration (see Appendix 6 of ICAO Annex 16 Volume II); off-take bleeds and accessory loads other than those necessary for the engine's basic operation shall not be simulated.

(c) When test conditions differ from the reference atmospheric conditions in 16.19.2.4, the gaseous emissions test results shall be corrected to the reference atmospheric conditions by the methods given in Appendix 3 of ICAO Annex 16 Volume II.

16.19.2.6.—(a) *Applicability*

Smoke.

The provisions of 16.19.3.2 shall apply to engines whose date of manufacture is on or after 1 January 1983.

(b) *Regulatory Smoke Number*

The Smoke Number at any of the four LTO operating mode thrust settings when measured and computed in accordance with the procedures of Appendix 2 of ICAO Annex 16 Volume II and converted to a characteristic level by the

procedures of Appendix 6 of ICAO Annex 16 Volume II shall not exceed the level determined from the following formula :

Regulatory Smoke Number =  $83.6 (F_{oo})^{-0.274}$   
or a value of 50, whichever is lower

Gaseous  
emissions.

16.19.2.7.—(a) Applicability

The provisions of 16.19.2.3.2 shall apply to engines whose rated thrust is greater than 26.7 kN and whose date of manufacture is on or after 1 January 1986 and as further specified for oxides of nitrogen.

(b) Regulatory levels

Gaseous emission levels when measured and computed in accordance with the procedures of Appendix 3 of ICAO Annex 16 Volume II and converted to characteristic levels by the procedures of Appendix 6 shall not exceed the regulatory levels determined from the following formulas :

Hydrocarbons (HC) :  $D_p / F_{oo} = 19.6$

Carbon monoxide (CO) :  $D_p / F_{oo} = 118$

Oxides of nitrogen ( $\text{NO}_x$ ) :

(1) for engines of a type or model for which the date of manufacture of the first individual production model was on or before 31 December 1995 and for which the date of manufacture of the individual engine was on or before 31 December 1999.

$$D_p / F_{oo} = 40 + 2\pi_{oo}$$

(2) for engines of a type or model for which the date of manufacture of the first individual production model was after 31 December 1995 or for which the date of manufacture of the individual engine was after 31 December 1999.

$$D_p / F_{oo} = 32 + 1.6\pi_{oo}$$

(3) for engines of a type or model for which the date of manufacture of the first individual production model was after 31 December 2003 :

(i) for engines with a pressure ratio of 30 or less :

(a) for engines with a maximum rated thrust of more than 89.0 kN:

$$D_p / F_{oo} = 19 + 1.6\pi_{oo}$$

(b) for engines with a maximum rated thrust of more than 26.7 kN but not more than 89.0 kN :

$$D_p / F_{oo} = 37.572 + 1.6\pi_{oo} - 0.2087F_{oo}$$

(ii) for engines with a pressure ratio of more than 30 but less than 62.5 :



(a) for engines with a maximum rated thrust of more than 89.0 kN :

$$D_p / F_{oo} = 7 + 2.0 \tau_{\tau_{oo}}$$

(b) for engines with a maximum rated thrust of more than 26.7 kN but not more than 89.0 kN :

$$D_p / F_{oo} = 46.1600 + (1.4286 * \tau_{\tau_{oo}}) - (0.5303 * F_{oo}) + (0.00642 * \tau_{\tau_{oo}} * F_{oo})$$

(c) for engines with a pressure ratio of 82.6 or more :

$$D_p / F_{oo} = 32 + (1.6 * \tau_{\tau_{oo}})$$

16.19.2.8.—(a) General information

Information  
Required.

The following information shall be provided for each engine type for which emissions certification is sought :

- (1) engine identification ;
- (2) rated thrust (in kilonewtons) ;
- (3) reference pressure ratio ;
- (4) fuel specification reference ;
- (5) fuel hydrogen/carbon ratio ;
- (6) the methods of data acquisition ;
- (7) the method of making corrections for ambient conditions ; and
- (8) the method of data analysis.

(b) Test information

The following information shall be provided for each engine tested for certification purposes at each of the thrust settings specified in 16.19.2.4.(b). The information shall be provided after correction to the reference ambient conditions where applicable :

- (1) fuel flow (kilograms/second) ;
- (2) emission index (grams/kilogram) for each gaseous pollutant ; and
- (3) measured Smoke Number.

(c) Derived information

(1) The following derived information shall be provided for each engine tested for certification purposes :

- (i) emission rate, i.e. emission index  $\times$  fuel flow, (grams/second) for each gaseous pollutant ;
- (ii) total gross emission of each gaseous pollutant measured over the LTO cycle (grams) ;
- (iii) values of  $D_p / F_{oo}$  for each gaseous pollutant (grams/kilonewton) ; and

(iv) maximum Smoke Number.

(2) The characteristic Smoke Number and gaseous pollutant emission levels shall be provided for each engine type for which emissions certification is sought.

16.19.3. TURBOJET AND TURBOFAN ENGINES INTENDED FOR PROPULSION AT SUPERSONIC SPEEDS

Applicability. 16.19.3.1. The provisions of this subpart shall apply to all turbojet and turbofan engines intended for propulsion at supersonic speeds whose date of manufacture is on or after 18 February 1982.

Emissions involved. 16.19.3.2. The following emissions shall be controlled for certification of aircraft engines :

- Smoke
- Gaseous emissions
- Unburned hydrocarbons (HC)

Units of measurement. 16.19.3.3.—(a) The smoke emission shall be measured and reported in terms of Smoke Number (SN).

(b) The mass ( $D_p$ ) of the gaseous pollutants HC, CO, or  $\text{NO}_x$  emitted during the reference emissions landing and take-off (LTO) cycle, defined in 16.19.3.1.5.(a) and 16.19.3.1.5.(b) shall be measured and reported in grams.

Nomenclature. 16.19.3.4. Throughout this chapter, where the expression  $F_{oo}^*$  is used, it shall be replaced by  $F_{oo}$  for engines which do not employ afterburning. For taxi/ground idle thrust setting,  $F_{oo}$  shall be used in all cases.

Reference conditions. 16.19.3.5.—(a) Atmospheric conditions  
The reference atmospheric conditions shall be ISA at sea level except that the reference absolute humidity shall be 0.00634 kg water/kg dry air.

(b) Thrust settings

The engine shall be tested at sufficient power settings to define the gaseous and smoke emissions of the engine so that mass emission rates and Smoke Numbers corrected to the reference ambient conditions can be determined at the following specific percentages of rated output as agreed by the Authority.

<i>Operating mode</i>	<i>Thrust setting</i>
Take-off	100 per cent $F_{oo}^*$
Climb	65 per cent $F_{oo}^*$
Descent	15 per cent $F_{oo}^*$
Approach	34 per cent $F_{oo}^*$
Taxi/ground idle	5.8 per cent $F_{oo}^*$

(c) *Reference emissions landing and take-off (LTO) cycle*

The reference emissions LTO cycle for the calculation and reporting of gaseous emissions shall be represented by the following time in each operating mode.

<i>Phase</i>	<i>Time in operating mode, minutes</i>
Take-off	1.2
Climb	2.0
Descent	1.2
Approach	2.3
Taxi/ground idle	26.0

(d) *Fuel specifications*

The fuel used during tests shall meet the specifications of Appendix 4 of ICAO Annex 16 Volume II. Additives used for the purpose of smoke suppression (such as organo-metallic compounds) shall not be present.

16.19.3.6.—(a) The tests shall be made with the engine on its test bed.

Test conditions.

(b) The engine shall be representative of the certificated configuration (see Appendix 6 of ICAO Annex 16 Volume II) ; off-take bleeds and accessory loads other than those necessary for the engine's basic operation shall not be simulated.

(c) Measurements made for determination of emission levels at the thrusts specified in 16.19.3.5(b) shall be made with the afterburner operating at the level normally used, as applicable.

(d) When test conditions differ from the reference conditions in 16.19.3.5, the test results shall be corrected to the reference conditions by the methods.

16.19.3.7.—(a) *Regulatory Smoke Number*

Smoke.

The Smoke Number at any thrust setting when measured and computed in accordance with the procedures of Appendix 2 of ICAO Annex 16 Volume II and converted to a characteristic level by the procedures of Appendix 6 of ICAO Annex 16 Volume II shall not exceed the regulatory level determined from the following formula :

$$\text{Regulatory Smoke Number} = 83.6 (F_{oo}^*)^{-0.274}$$

or a value of 50, whichever is lower

16.19.3.8.—(a) *Regulatory levels*

Gaseous emissions.

Gaseous emission levels when measured and computed in accordance with the procedures of Appendix 3 of ICAO Annex 16 Volume II or Appendix 5, of ICAO Annex 16 Volume II as applicable, and converted to characteristic

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levels by the procedures of Appendix 6 of ICAO Annex 16 Volume II shall not exceed the regulatory levels determined from the following formulas :

$$\text{Hydrocarbons (HC)} : D_p / F_{oo}^* = 140(0.92)^{\tau_{\tau_{oo}}}$$

$$\text{Carbon monoxide (CO)} : D_p / F_{oo}^* = 4,500(\tau_{\tau_{oo}})^{-1.03}$$

$$\text{Oxides of nitrogen (NO}_x\text{)} : D_p / F_{oo}^* = 36 + 2.42\tau_{\tau_{oo}}$$

Information  
required.

### 16.19.3.9.—(a) General Information

The following information shall be provided for each engine type for which emissions certification is sought :

- (1) engine identification ;
- (2) rated output (in kilonewtons) ;
- (3) rated output with afterburning applied, if applicable (in kilonewtons) ;
- (4) reference pressure ratio ;
- (5) fuel specification reference ;
- (6) fuel hydrogen/carbon ratio ;
- (7) the methods of data acquisition ;

### (b) Test information

The following information shall be provided for each engine tested for certification purposes at each of the thrust settings specified in 16.18.3.5(b). The information shall be provided after correction to the reference ambient conditions where applicable :

- (1) fuel flow (kilograms/second) ;
- (2) emission index (grams/kilogram) for each gaseous pollutant ;
- (3) percentage of thrust contributed by afterburning ; and
- (4) measured Smoke Number.

### (c) Derived information

(1) The following derived information shall be provided for each engine tested for certification purposes :

(i) emission rate, i.e. emission index  $\times$  fuel flow, (grams/second), for each gaseous pollutant ;

(ii) total gross emission of each gaseous pollutant measured over the LTO cycle (grams) ;

(iii) values of  $D_p / F_{oo}^*$  for each gaseous pollutant (grams/kilonewton) ;  
and

(iv) maximum Smoke Number.

(2) The characteristic Smoke Number and gaseous pollutant emission levels shall be provided for each engine type for which emissions certification is sought.

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**NIGERIA CIVIL AVIATION REGULATIONS**

PART 16—IMPLEMENTING STANDARDS				
<b>IS : 16.1.2.5</b>				
<b>1. FEDERAL REPUBLIC OF NIGERIA</b>				
<b>2. NOISE CERTIFICATE</b>				
3. CERT NO.				
4. NATIONALITY AND REGISTRATION MARKS		5. MANUFACTURER AND MANUFACTURER'S DESIGNATION OF AIRCRAFT		6. AIRCRAFT SERIAL NUMBER
7. ENGINE MANUFACTURER, TYPE AND MODEL		8. PROPELLER MANUFACTURER, TYPE AND MODEL		
9. MAXIMUM TAKEOFF MASS (KG)	10. MAXIMUM LANDING MASS (KG)			
11. NOISE CERTIFICATION STANDARD.				
12. ADDITIONAL MODIFICATIONS INCORPORATED FOR THE PURPOSE OF COMPLIANCE WITH THE APPLICABLE NOISE CERTIFICATION STANDARDS:				
13. LATERAL/FULL POWER NOISE LEVEL	14. APPROACH NOISE LEVEL	15. FLYOVER NOISE LEVEL	16. OVERFLIGHT NOISE LEVEL	17. TAKEOFF NOISE LEVEL
18. THIS NOISE CERTIFICATE IS ISSUED PURSUANT TO VOLUME I OF ANNEX 16 TO THE CONVENTION ON INTERNATIONAL CIVIL AVIATION AND PART 16 OF THE NIGERIA CIVIL AVIATION SUBPARTS, IN RESPECT OF THE ABOVE-MENTIONED AIRCRAFT, WHICH IS CONSIDERED TO COMPLY WITH THE INDICATED NOISE STANDARD WHEN MAINTAINED AND OPERATED IN ACCORDANCE WITH THE RELEVANT REQUIREMENTS AND OPERATING LIMITATIONS.				

REMARKS

19. DATE OF ISSUE      20. SIGNATURE:

1. This Certificate must be carried on board the aircraft	
<del>2. This Certificate is not transferable</del>	
<b>IS 16.19.1.2(b)</b>	
<b>1. FEDERAL REPUBLIC OF NIGERIA</b>	
<b>2. EMISSION CERTIFICATE</b>	
3. CERT NO.	
4. ENGINE MANUFACTURER, TYPE AND MODEL	5. ENGINE SERIAL NUMBER
6. Rated thrust:	7. Reference pressure ratio:
8. A statement of any additional modifications incorporated for the purpose of compliance with the applicable emissions certification requirements:	
9. A statement indicating compliance with Smoke Number requirements:	
10. A statement indicating compliance with gaseous pollutant requirements:	

11. REMARKS

12. DATE OF ISSUE

13. SIGNATURE:

1. This Certificate must be carried on board the aircraft

2. This Certificate is not transferable