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ENVIRONMENTAL PROTECTION

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A. FOREWORD

In accordance with Annexes to the Chicago Convention (1944)¹ and other international obligations the Civil Aviation Affairs of the Kingdom of Bahrain (CAA) is promulgating regulations which promote safety. The ICAO Council, on 13 April 1948, adopted a resolution inviting the attention of Contracting States to the desirability of using in their own national regulations, as far as is practicable, the precise language of those ICAO Standards that are of a regulatory character and also of indicating departures from the Standards, including any additional national regulations that are important for the safety or regularity of air navigation. Wherever possible, the provisions of the Annexes to the Chicago Convention have been written in such a way as would facilitate incorporation, without major textual changes, into national legislation.²

Therefore, the Regulation at hand reproduces the provision of ICAO Annex 16 “Environmental Protection” unchanged wherever possible and adapts it to the needs of the Kingdom of Bahrain wherever necessary.

The text does not take into account any (existing or planned) difference applicable in the Kingdom of Bahrain. According to Art. 38 of the Chicago Convention, the Kingdom of Bahrain is obliged to communicate any difference between their national regulations and practices and the related ICAO Standards and Recommended Practices to ICAO and to publish in the AIP.

Any reference in the text to ICAO documents may be substituted by a reference to any existing CAA document (Manual, Instruction, Handbook) covering the same matters.

Hereinafter, wherever a reference is made to an ICAO Annex followed by a number, it shall refer to the Annex to the Chicago Convention (1944) corresponding to that number.

¹ Hereinafter: ICAO Annex (number).

² ICAO Annex 11, Foreword, p. (viii).

B. Remarks

To avoid any misunderstanding within this document:

1. The words 'shall' and 'must' indicate that compliance is compulsory.

2. The word 'should' indicates a recommendation. It does not mean that the compliance is optional but rather that, where insurmountable difficulties exist, the CAA may accept an alternative means of compliance, and provided that an acceptable safety assurance from the authority shows that the safety requirements will not be reduced below that intended by the requirement.

3. The word 'can' or 'may' is used in a permissive sense to state authority or permission to do the act prescribed.

4. The word 'will' is used to express the future.

The "Notes" contained in the ICAO Annex 16 have not been included into the regulatory part of this Regulation. They have no regulatory function and, therefore, they may form a part of the handbooks, manuals etc. and are explanatory only.

DEFINITIONS

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

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

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

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

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

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

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.

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

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.

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 certifying authority, have not changed.

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

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

Note 2.— “Adversely” refers to an increase of more than 0.30 EPNdB in any one of the noise certification levels for helicopters certificated according to Chapter 8 and 0.30 dB(A) in the certification level for helicopters certificated according to Chapter 11 ICAO Annex 16

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

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

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

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

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

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.*

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

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.*

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.*

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.*

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.*

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

Smoke Number. *The dimensionless term quantifying smoke emissions.*

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

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

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

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).*

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 nonrotating aerofoil(s) for lift during high-speed flight.*

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.*

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

Where the following symbols are used in Section II of this Regulation, 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

NO₂ Nitrogen dioxide

NO_x Oxides of nitrogen (see definition)

SN Smoke Number (see definition)

π_{oo} Reference pressure ratio (see definition)

SECTION 1 - AIRCRAFT NOISE CERTIFICATION

- 1.1 The provisions of 1.2 to 1.6 shall apply to all aircraft where such aircraft are engaged in international air navigation.
- 1.2 Noise certification shall be granted or validated by the CAA on the basis of satisfactory evidence that the aircraft complies with requirements that are at least equal to the applicable Standards specified in ICAO Annex 16.
- 1.3 If noise recertification is requested by the CAA, it shall be granted or validated by the State of Registry of an aircraft on the basis of satisfactory evidence that the aircraft complies with requirements that are at least equal to the applicable Standards specified in ICAO Annex 16. The date used by a certificating authority to determine the recertification basis shall be the date of acceptance of the first application for recertification.
- 1.4 The documents attesting noise certification shall be approved by the State of Registry and shall be carried on the aircraft.

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

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

Item 1. Name of State.

Item 2. Title of the noise document.

Item 3. Number of the document.

Item 4. Nationality or common mark and registration marks.

Item 5. Manufacturer and manufacturer's designation of aircraft.

Item 6. Aircraft serial number.

Item 7. Engine manufacturer, type and model.

Item 8. Propeller type and model for propeller-driven aeroplanes.

Item 9. Maximum take-off mass in kilograms.

Item 10. Maximum landing mass, in kilograms, for certificates issued under Chapters 2, 3, 4, 5, 12 and 14 of ICAO Annex 16.

Item 11. The chapter and section of ICAO Annex 16 according to which the aircraft was certificated.

Item 12. Additional modifications incorporated for the purpose of compliance with the applicable noise certification Standards.

Item 13. The lateral/full-power noise level in the corresponding unit for documents issued under Chapters 2, 3, 4, 5, 12 and 14 of ICAO Annex 16.

Item 14. The approach noise level in the corresponding unit for documents issued under Chapters 2, 3, 4, 5, 8, 12, 13 and 14 of ICAO Annex 16.

Item 15. The flyover noise level in the corresponding unit for documents issued under Chapters 2, 3, 4, 5, 12 and 14 of ICAO Annex 16.

Item 16. The overflight noise level in the corresponding unit for documents issued under Chapters 6, 8, 11 and 13 of ICAO Annex 16.

Item 17. The take-off noise level in the corresponding unit for documents issued under Chapters 8, 10 and 13 of ICAO Annex 16.

Item 18. Statement of compliance, including a reference to Annex 16, Volume I.

Item 19. Date of issuance of the noise certification document.

Item 20. Signature of the officer issuing it.

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

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

1.8 The CAA shall recognize as valid a noise certification granted by another Contracting State provided that the requirements under which such certification was granted are at least equal to the applicable Standards specified in ICAO Annex 16.

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

1.10 The amendment of the volume of the ICAO Annex 16 to be used by the CAA shall be that which is applicable on the date of submission to the CAA for:

a) a Type Certificate in the case of a new type; or

b) approval of a change in type design in the case of a derived version; or

c) in either case, under an equivalent application procedure prescribed by the certifying authority of that Contracting State.

1.11 Unless otherwise specified in this Regulation, the date to be used by the CAA in determining the applicability of the Standards in ICAO Annex 16 shall be the date the application for a Type

Certificate was submitted to the State of Design, or the date of submission under an equivalent application procedure prescribed by the certifying authority of the State of Design.

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

Note 1.— Unless otherwise specified in a volume of the Annex 16, the edition of the Environmental Technical Manual (Doc 9501), Volume I — Procedures for the Noise Certification of Aircraft, to be used as guidance on the use of acceptable means of compliance and equivalent procedures by a Contracting State should be that which is in effect on the date the application for a Type Certificate or the change in type design is submitted to that Contracting State.

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

- 1.13 An application shall be effective for the period specified in the designation of the airworthiness regulations appropriate to the aircraft type, except in special cases where the certifying authority accepts an extension of this period. When this period of effectivity is exceeded, the date to be used in determining the applicability of the Standards in ICAO Annex 16 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.

- 1.14 Propeller-driven STOL aeroplanes shall be certified as per ICAO Annex 16 Attachment B.

CHAPTER 2 - INSTALLED AUXILIARY POWER UNITS (APU) AND ASSOCIATED AIRCRAFT SYSTEMS DURING GROUND OPERATIONS.

2.1 Standards used for noise certification, when required by the CAA, of installed auxiliary power units (APU) and associated aircraft systems shall be as per ICAO Annex 16 Attachment C.

CHAPTER 3 - NOISE MEASUREMENT FOR MONITORING PURPOSES

3.1 Where the measurement of aircraft noise is made for monitoring purposes, the method of ICAO Annex 16 Appendix 5 shall be used.

CHAPTER 4 - ASSESSMENT OF AIRPORT NOISE

4.1 Where required by the CAA, international comparison of noise assessment around airports shall be undertaken. The methodology described in “Recommended Method for Computing Noise Contours around Airports (ICAO Doc 9911)” shall be used.

CHAPTER 5 - BALANCED APPROACH TO NOISE MANAGEMENT

5.1 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.

5.2 A “balanced approach” to noise management shall be taken. The balanced approach to noise management consists of identifying the noise problem at an airport and then analysing the various measures available to reduce noise through the exploration of four principal elements, namely reduction at source (addressed in Part II of ICAO Annex 16), 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).

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

5.4 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.

Note 1.— See ICAO Annex 6, Part I, Chapter 4, for aeroplane noise abatement operating procedures.

Note 2.— Guidance material on human performance can be found in the Human Factors Training Manual (ICAO Doc 9683).

SECTION II - VENTED FUEL

CHAPTER 1 - ADMINISTRATION

1.1 The provision of this Part shall apply to all turbine engine powered aircraft intended for operation in international air navigation manufactured after 18 February 1982.

1.2 Certification related to the prevention of intentional fuel venting shall be granted by the certificating authority on the basis of satisfactory evidence that either the aircraft or the aircraft engines comply with requirements of Chapter 2.

Note.— The document attesting certification relating to fuel venting may take the form of a separate fuel venting certificate or a suitable statement contained in another document approved by the certificating authority.

1.3 The CAA 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 Section II of this Regulation.

CHAPTER 2 - PREVENTION OF INTENTIONAL FUEL VENTING

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.

SECTION III - EMISSIONS CERTIFICATION

CHAPTER 1 - ADMINISTRATION

1.1 The provisions of 1.2 to 1.4 shall apply to all engines included in the classifications defined for emission certification purposes in Chapters 2 and 3 where such engines are fitted to aircraft engaged in international air navigation.

1.2 Emissions certification shall be granted by the certificating 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 Section III of this Regulation.

Compliance with the emissions levels of Chapters 2 and 3 shall be demonstrated using the procedure described in Appendix 6.

Note.— The document attesting emissions certification may take the form of a separate emissions certificate or a suitable statement contained in another document approved by the certificating authority.

1.3 The document attesting emissions certification for each individual engine shall include at least the following information which is applicable to the engine type:

- a) name of certifying authority;
- b) manufacturer=s type and model designation;
- c) statement of any additional modifications incorporated for the purpose of compliance with the applicable emissions certification requirements;
- d) rated thrust;
- e) reference pressure ratio;
- f) a statement indicating compliance with Smoke Number requirements;
- g) a statement indicating compliance with gaseous pollutant requirements.

1.4 The CAA shall recognize as valid emissions certification 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 Section III of this Regulation.

CHAPTER 2. TURBOJET AND TURBOFAN ENGINES INTENDED FOR PROPULSION ONLY AT SUBSONIC SPEEDS

2.1 General

2.1.1 Applicability

2.1.1.1 The provisions of this chapter shall apply to all turbojet and turbofan engines intended for propulsion only at subsonic speeds, except when certifying authorities make exemptions for:

- a) 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
- b) a limited number of engines beyond the dates of applicability for the manufacture of the individual engine.

2.1.1.2 In such cases, an exemption document shall be issued by the certifying authority, the identification plates on the engines shall be marked "EXEMPT," and the grant of exemption shall be noted in the permanent engine record.

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

Note.— In considering exemptions, certifying authorities should take into account the probable numbers of such engines that will be produced and their impact on the environment. When such an exemption is granted, the certifying authority should consider imposing a time limit on the production of such engines for installation on new aircraft or on existing aircraft as spares.

2.1.2 Emissions involved

The following emissions shall be controlled for certification of aircraft engines:

Smoke
Gaseous emissions
Unburned hydrocarbons (HC);
Carbon monoxide (CO); and
Oxides of nitrogen (NOx).

2.1.3 Units of measurement

2.1.3.1 The smoke emission shall be measured and reported in terms of Smoke Number (SN).

2.1.3.2 The mass (Dp) of the gaseous pollutant HC, CO, or NOx emitted during the reference emissions landing and take-off (LTO) cycle, defined in 2.1.4.2 and 2.1.4.3, shall be measured and reported in grams.

2.1.4 Reference conditions

2.1.4.1 *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.

2.1.4.2 *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 certifying 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}

2.1.4.3 *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	0.7
Climb	2.2
Approach	4.0
Taxi/ground idle	26.0

2.1.4.4 Fuel specifications

The fuel used during tests shall meet the specifications of ICAO Annex 16 Volume II Appendix 4, 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.

2.1.5 Test conditions

2.1.5.1 The tests shall be made with the engine on its test bed.

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

2.1.5.3 When test conditions differ from the reference atmospheric conditions in 2.1.4.1, the gaseous emissions test results shall be corrected to the reference atmospheric conditions by the methods given in ICAO Annex 16 Volume II Appendix 3.

2.2 Smoke

2.2.1 Applicability

The provisions of 2.2.2 shall apply to engines whose date of manufacture is on or after 1 January 1983.

2.2.2 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 ICAO Annex 16 Part II Appendix 2 and converted to a characteristic level by the procedures of ICAO Annex 16 Part II Appendix 6 shall not exceed the level determined from the following formula:

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

2.3 Gaseous emissions

2.3.1 Applicability

The provisions of 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.

2.3.2 Regulatory levels

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

Hydrocarbons (HC): $Dp / Foo = 19.6$

Carbon monoxide (CO): $Dp / Foo = 118$

Oxides of nitrogen (NOx):

a) 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.

$$Dp / Foo = 40 + 2\pi\omega$$

b) 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.

$$Dp / Foo = 32 + 1.6\pi\omega$$

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

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

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

$$Dp / Foo = 19 + 1.6\pi\omega$$

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

$$Dp / Foo = 37.572 + 1.6\pi\omega - 0.2087 Foo$$

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

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

$$Dp / Foo = 7 + 2.0\pi\omega$$

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

$$Dp / Foo = 42.71 + 1.4286\pi\omega - 0.4013 Foo + 0.00642\pi\omega \times Foo$$

3) for engines with a pressure ratio of 62.5 or more:

$$Dp / Foo = 32 + 1.6\pi\omega$$

d) for engines of a type or model for which the date of manufacture of the first individual production model was after 31 December 2007:

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

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

$$Dp / Foo = 16.72 + (1.4080 * \pi\omega)$$

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

$$Dp / Foo = 38.5486 + (1.6823 * \pi\omega) - (0.2453 * Foo) - (0.00308 * \pi\omega * Foo)$$

2) for engines with a pressure ratio of more than 30 but less than 82.6:

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

$$Dp / Foo = -1.04 + (2.0 * \pi\omega)$$

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

$$Dp / Foo = 46.1600 + (1.4286 * \pi\omega) - (0.5303 * Foo) + (0.00642 * \pi\omega * Foo)$$

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

$$Dp / Foo = 32 + (1.6 * \pi\omega)$$

2.4 Information required

Note.— The information required is divided into three groups: 1) general information to identify the engine characteristics, the fuel used and the method of data analysis; 2) the data obtained from the engine test(s); and 3) the results derived from the test data.

2.4.1 General information

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

- a) engine identification;
- b) rated thrust (in kilonewtons);
- c) reference pressure ratio;
- d) fuel specification reference;
- e) fuel hydrogen/carbon ratio;
- f) the methods of data acquisition;
- g) the method of making corrections for ambient conditions; and
- h) the method of data analysis.

2.4.2 Test information

The following information shall be provided for each engine tested for certification purposes at each of the thrust settings specified in 2.1.4.2. The information shall be provided after correction to the reference ambient conditions where applicable:

- a) fuel flow (kilograms/second);
- b) emission index (grams/kilogram) for each gaseous pollutant; and
- c) measured Smoke Number.

2.4.3 Derived information

2.4.3.1 The following derived information shall be provided for each engine tested for certification purposes:

- a) emission rate, i.e. emission index × fuel flow, (grams/second) for each gaseous pollutant;
- b) total gross emission of each gaseous pollutant measured over the LTO cycle (grams);

- c) values of Dp / Foo for each gaseous pollutant (grams/kilonewton); and
- d) maximum Smoke Number.

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

CHAPTER 3. TURBOJET AND TURBOFAN ENGINES INTENDED FOR PROPULSION AT SUPERSONIC SPEEDS

3.1 The emission levels, reference conditions, and test conditions for smoke and gaseous emissions shall be as specified in ICAO Annex 16 Volume II Chapter 3.