



**CIVIL AVIATION AUTHORITY OF SRI LANKA
AVIATION SAFETY NOTICE**

ASN No 079	Ref No: AWS/2010/01	File Ref: AW/20/2/2
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- Recipients : 1) Holders of Air Operator Certificates issued by DGCA
2) Prospective applicants for Air Operator Certificates
3) All Scheduled Airlines operating to BIA
4) Head of Air Navigation Services – to publish the contents of the attachment to this ASN as an AIC
- 01.Subject : **Aircraft Engine Emissions.**
- 02.Nature : Compulsory
- 03.Issue no : 02
- 04.Status : Replacement of ASN 079 first issue on 16th September 2005
05. Effective date : With immediate effect
06. Validity : Until further notice
- 07.Contact persons : Inquiries may be directed, preferably by letter to, Deputy Director (Airworthiness), Civil Aviation Authority of Sri Lanka, No 64, Galle Road Colombo 3. Telephone:94 11 2391305.
- 08.Availability : A copy of this document is available on web site www.caa.lk and the Technical library of Civil Aviation Authority. Copies can be collected at reproduction cost from the library.
- 09.Applicability : All Aircraft engaged in commercial air transport operations in Sri Lanka Airspace.
- 10.Comments : Comments (if any) on the contents of this Aviation Safety Notice may be forwarded to the Contact Persons. However the Aviation Safety Notice will come into effect on the date shown therein notwithstanding any objection or comment made by any person or party unless and until an amendment to the Aviation Safety Notice is issued afresh by the Director General of Civil Aviation

11. Notice : Any Aircraft to be operated into and out of Sri Lanka including foreign registered aircraft shall conform to the requirements specified in the attachment hereto.
- Amendments to the attachment are indicated by a vertical line on the left hand side of relevant paragraphs.
12. History of Revision : ASN No 079 (Issue No 01) issued on 16th September 2005 is revised for the inclusion of third edition 2008 to the Annex 16 Volume II – Aircraft Engine Emission.
13. Related ASNs : None
14. Action Required : For strict compliance of the contents in the attachment by all aircraft in the Sri Lanka airspace.
15. Check list : List of current ASN nos. are as follows

ASN No	Issue No	Date of Applicability	Remarks
ASN002	01	10.03.2000	nil
ASN003	01	18.08.2000	nil
ASN004	01	13.02.2001	nil
ASN005	01	26.03.2001	nil
ASN007	01	15.09.2001	nil
ASN008	02	16.11.2006	Replaced ASN 008 issue no 01
ASN009	01	18.02.2002	nil
ASN010	01	18.02.2002	nil
ASN011	01	18.02.2002	nil
ASN012	01	18.02.2002	nil
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ASN014	01	01.03.2002	nil
ASN015	01	01.03.2002	nil
ASN016	01	01.03.2002	nil
ASN017	02	10.03.2005	Replaced ASN 017 issue no 01
ASN018	01	20.03.2002	nil
ASN019	01	01.04.2002	nil
ASN021	01	01.04.2002	nil
ASN022	01	08.04.2002	nil
ASN023	01	01.06.2002	Replaced ASN no 003
ASN024	01	02.09.2002	nil
ASN025	02	15.10.2002	Replaced ASN no 001
ASN026	01	15.10.2002	nil
ASN027	01	12.12.2002	nil
ASN028	01	12.03.2003	nil
ASN029	01	21.03.2002	nil
ASN030	01	10.07.2002	nil
ASN031	01	15.07.2003	Replaced ASN no 006
ASN032	01	25.07.2003	nil
ASN033	02	25.08.2005	Replaced ASN no 033 issue no 01
ASN034	01	11.09.2003	nil
ASN035	01	12.09.2003	nil
ASN036	01	12.09.2003	nil
ASN037	01	13.10.2003	nil
ASN038	01	07.06.2004	nil
ASN039	03	05.01.2007	Replaced ASN no 039 issue no 02
ASN040	01	07.07.2004	nil

ASN041	01	16.07.2004	nil
ASN042	03	05.01.2007	Replaced ASN no 042 issue no 02
ASN043	02	12.08.2004	Amendment to ASN no 013
ASN044	02	13.03.2006	Replaced ASN no 044 issue no 01
ASN045	02	05.01.2007	Replaced ASN no 045 issue no 01
ASN046	01	14.09.2006	nil
ASN047	03	05.01.2007	Replaced ASN no 047 issue no 02
ASN048	02	05.01.2007	Replaced ASN no 048 issue no 01
ASN049	01	20.09.2004	nil
ASN051	01	20.09.2004	nil
ASN052	01	20.09.2004	nil
ASN053	03	15.11.2006	Replaced ASN 053 issue no 02
ASN054	02	16.01.2008	Replaced ASN 054 issue no 01
ASN055	03	13.03.2009	Replaced ASN055 issue no 02
ASN056	01	01.12.2005	nil
ASN057	01	01.12.2005	nil
ASN058	01	01.12.2005	nil
ASN059	-	-	Not issued yet
ASN060	02	05.08.2005	Replaced Page no 01 of the attachment to the ASN no 060 issue no 01
ASN061	02	05.08.2005	Replaced Page no 01 of the attachment to the ASN no 061 issue no 01
ASN062	01	01.04.2005	nil
ASN063	01	20.12.2004	nil
ASN065	01	06.04.2005	nil
ASN066	01	16.05.2005	nil
ASN067	01	16.05.2005	nil
ASN068	01	18.05.2005	nil
ASN069	01	18.05.2005	nil
ASN070	01	18.05.2005	nil
ASN071	01	18.05.2005	nil
ASN072	01	18.05.2005	nil
ASN073	01	19.05.2005	nil
ASN074	01	19.05.2005	nil
ASN075	01	19.05.2005	nil
ASN076	01	16.06.2005	nil
ASN077	01	08.08.2005	nil
ASN078	01	21.12.2005	nil
ASN079	02	15.06.2010	Replaced ASN 079 issue no 01
ASN080	01	07.11.2005	nil
ASN081	02	25.06.2006	Replaced ASN no 081 issue No. 01
ASN082	01	23.11.2005	nil
ASN083	01	01.12.2005	nil
ASN084	01	16.12.2005	nil
ASN085	01	05.01.2006	nil
ASN086	02	05.05.2008	Replaced ASN No 086, 087 and 088 issued on 2006 April 2006.
ASN089	01	10.05.2006	nil
ASN090	01	03.06.2006	nil
ASN091	01	15.06.2006	nil
ASN092	01	09.11.2007-	nil
ASN093	01	26.05.2008	nil
ASN094	01	02.06.2006	nil
ASN095	01	25.09.2006	nil
ASN096	01	11.09.2007	nil
ASN097	01	22.09.2006	nil
ASN098	01	04.04.2007	nil
ASN099	01	09.10.2007	nil

ASN100	02	08.05.2008	Replaced ASN no 100 Issue no 01.
ASN101	01	28.01.2008	nil
ASN102	01	04.03.2008	nil
ASN103	01	01.08.2008	nil
ASN104	01	28.08.2008	nil
ASN105	01	07.08.2008	nil
ASN106	01	03.12.2008	nil
ASN107	01	12.01.2009	nil
ASN108	01	20.05.2009	nil
ASN109	01	07.09.2009	nil
ASN110	01	08.09.2009	nil
ASN111	01	25.09.2009	nil
ASN112	01	22.02.2010	nil
ASN113	01	03.03.2010	nil
ASN114	01	04.03.2010	nil
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ASN116	01	06.04.2010	nil
ASN117	01	21.05.2010	nil
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AIRCRAFT ENGINE EMISSIONS

APPLICABILITY

Requirements contained in this document are based on the ICAO Annex – 16 “Environmental Protection” Aircraft Engine Emissions or validation procedures apply to all such aircraft are specified in Annex 16 Volume II and registered in Sri Lanka. These procedures are also applicable to foreign registered aircraft operated under AOC issued by the Director General of Civil Aviation. In respect of foreign aircraft conducting flight operations into and out of Sri Lanka, the requirement for Aircraft Engine Emissions shall be as approved by the state of the Operator. Nevertheless such requirements shall not be less than that are specified in the Annex-16 part II to the Convention on International Civil Aviation in writing.

STANDARDS

PART I DEFINITIONS AND SYMBOLS

CHAPTER 1. DEFINITIONS

Where the following expressions are used in this ASN, they have the meanings ascribed to them below:

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

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

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 or for which other factors, as judge by the Director General of Civil Aviation, have not change.

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.

Rated thrust. For engine emissions purposes, the maximum take-off thrust approved by the certifying 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.

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.

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

Smoke Number. The dimensionless term quantifying smoke emissions (see 3 of Appendix 2 of Annex 16 Part II)



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 phase 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).

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

CHAPTER 2. SYMBOLS.

Where the following symbols are used in this ASN, they have the meanings ascribed to them below:

CO	carbon monoxide
Dp	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_2	Nitrogen dioxide
NO_x	Oxides of nitrogen (see definition)
SN	Smoke Number (see definition)
π_{00}	Reference pressure ratio (see definition)

PART 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 certifying authority on the basis of satisfactory evidence that either the aircraft or the aircraft engines comply with requirements of Chapter 2.
- 1.3 Director General of Civil Aviation shall recognize as valid a certification relating to fuel venting granted by the certifying authority of another Contracting State provided the requirements under which such certification was granted are not less stringent than provision of this ASN.



CHAPTER 2 PREVENTION OF INTENTIONAL FUEL VENTING

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.

PART III EMISSION CERTIFICATION

CHAPTER 1 ADMINISTRATION

1.1 The provisions of paragraph 1.2 to 1.4 below 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 Emission certification shall be granted by the certifying 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 ASN. Compliance with the emissions levels of Chapter 2 and 3 shall be demonstrated using the procedure described in Appendix 6 of Annex 16 part II.

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 certifying 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 the 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 Director General of Civil Aviation 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 this ASN.

CHAPTER 2 TURBOJET AND TURBO FAN ENGINES INTENDED FOR PROPULSION ONLY AT SUBSONIC SPEED.

2.1 GENERAL



2.1.1 APPLICABILITY

2.1.1.1 The provisions of this chapter shall apply to all turbojet and turbofan engines, as further specified in paragraph 2.2 and 2.3 below, intended for propulsion only at subsonic speeds, except when certifying Authority 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 01 January 1965: and
- b) a limited number of engines beyond the dates of applicability specified in 2.2 and 2.3 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 and their impact on the environment. When such an exemption is granted, the certifying authority should consider importing a time limit on the production of such engines for installation on new aircraft or 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 (NO_x).

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 (D_p) of the gaseous pollutant HC, CO, or NO_x emitted during the reference emissions landing and take-off (LTO) cycle, defined in paragraph 2.1.4.2 and 2.1.4.3 below, 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 exempt 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;

LTO operating mode	Thrust setting
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;

Phase	Time in operating mode, minutes
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 Appendix 4 of Annex 16 part II, unless a deviation and any necessary corrections have been agreed by the certifying 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 test shall be made with the engine on its test bed.

2.1.5.2 The engine shall be representative of certificated configuration (see Appendix 6 of Annex 16 part II) 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 Appendix 3 of Annex 16 part II.



2.2 SMOKE

2.2.1. APPLICABILITY

The provisions of paragraph 2.2.2. shall apply to engines whose date of manufacture is on or after 01 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 in Appendix 2 of Annex 16 part II and converted to a characteristic level by the procedures in Appendix 6 Annex 16 part II shall not exceed the level determined from the following formula:

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

or a value of 50, whichever is lower.

2.3 GASEOUS EMISSIONS

2.3.1 APPLICABILITY

The provisions of paragraph 2.3.2. below shall apply to engines whose rated thrust is greater than 26.7 kN and whose date of manufacture is on or after 01 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 in Appendix 03 of Annex 16 part II and converted to characteristic levels by the procedures in Appendix 6 of Annex 16 part II shall not exceed the regulatory levels determined from the following formulas:

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

$$\text{Carbon monoxide (CO): } D_p / F_{oo} = 118.0$$

Oxides of nitrogen (NO_x):

- 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.

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

- 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.

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

- 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
$$D_p / F_{oo} = 19 + 1.6\pi_{oo}$$
 - ii) For engines with a maximum rated thrust of more than 26.7 kN but not more than 89.0 kN:
$$D_p / F_{oo} = 37.572 + 1.6\pi_{oo} - 0.2087F_{oo}$$
- 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
$$D_p / F_{oo} = 7 + 2.0\pi_{oo}$$
 - ii) For engines with a maximum rated thrust of more than 26.7 kN but not more than 89.0 kN
$$D_p / F_{oo} = 42.71 + 1.4286\pi_{oo} - 0.4013F_{oo} + 0.00642\pi_{oo} \times F_{oo}$$
- 3) For engines with a pressure ratio of 62.5 or more:
$$D_p / F_{oo} = 32 + 1.6\pi_{oo}$$
- d) For engines of a type or model for which the date of manufacture of the 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
$$D_p / F_{oo} = 16.72 + (1.4080 * \pi_{oo})$$
 - ii) For engines with a maximum rated thrust of more than 26.7 kN but not more than 89.0 kN
$$D_p / F_{oo} = 38.5486 + (1.6823 * \pi_{oo}) - (0.2453 * F_{oo}) - (0.00308 * \pi_{oo} * F_{oo})$$
 - 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
$$D_p / F_{oo} = -1.04 + (2.0 * \pi_{oo})$$
 - iii) For engines with a maximum rated thrust of more than 26.7 kN but not more than 89.0 kN
$$D_p / F_{oo} = 46.1600 + (1.4286 * \pi_{oo}) - (0.5303 * F_{oo}) + (0.00642 * \pi_{oo} * F_{oo})$$
 - 3) For engines with a pressure ratio of 82.6 or more:
$$D_p / F_{oo} = 32 + (1.6 * \pi_{oo})$$



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 methods 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 purpose:

- a) emission rate, i.e. emission index \times 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 D_p / F_{oo} for each gaseous pollutant (grams/ kilonewtons); 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 GENERAL

3.1.1 APPLICABILITY

The provisions of this ASN 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.

3.1.2 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 (NO_x).

3.1.3 UNITS OF MEASUREMENT

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

3.1.3.2 The mass (D_p) of the gaseous pollutants HC, CO or NO_x emitted during the reference emissions landing and take-off (LTO) cycle, defined in paragraph 3.1.5.2 and 3.1.5.3 below shall be measured and reported in grams.

3.1.4 NOMENCLATURE

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.

3.1.5 REFERENCE CONDITIONS

3.1.5.1 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.

3.1.5.2 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 certifying 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}

3.1.5.3 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	1.2
Climb	2.0
Descent	1.2
Approach	2.3
Taxi/ ground idle	26.0

3.1.5.4 FUEL SPECIFICATIONS

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

3.1.6 TEST CONDITIONS

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

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

3.1.6.3 Measurements made for determination of emission levels at the thrusts specified in 3.1.5.2 shall be made with the afterburner operating at the level normally used, as applicable.

3.1.7 When test conditions differ from the reference conditions in paragraph 3.1.5, the test results shall be corrected to the reference conditions by the methods given in Appendix 5 of Annex 16 part II.

3.2 SMOKE



3.2.1 REGULATORY SMOKE NUMBER

The Smoke Number at any thrust setting when measured and computed in accordance with the procedures in Appendix 2 of Annex 16 part II and converted to a characteristic level by the procedures in Appendix 6 of Annex 16 part 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

3.3 GASEOUS EMISSIONS

3.3.1 REGULATORY LEVELS

Gaseous emission levels when measured and computed in accordance with the procedures in Appendix 3 or Appendix 5 as applicable of Annex 16 part II, and converted to characteristic levels by the procedures in Appendix 6 of Annex 16 part II shall not exceed the regulatory levels determined from the following formulas:

$$\text{Hydrocarbons (HC): } D_p / F^*_{oo} = 140(0.92)^{\pi_{oo}}$$

$$\text{Carbon monoxide (CO): } D_p / F^*_{oo} = 4550(\pi_{oo})^{-1.03}$$

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

Note:- The characteristic level of the Smoke Number or gaseous pollutant emissions is the mean of the values of all the engines tested, measured and corrected to the reference standard engine and reference ambient conditions, divided by the coefficient corresponding to the number of engines tested, as shown in Appendix 6 of Annex 16 part II.

3.4 INFORMATION REQUIRED

Note:- The information required is divided into three groups: 1) general information to identify the engine characteristic, 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.

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

- a) engine identification;
- b) rated output (in kilonewtons);
- c) rated output with afterburning applied, if applicable (in kilonewtons)
- d) reference pressure ratio;
- e) fuel specification reference;
- f) fuel hydrogen/ carbon ratio;
- g) the methods of data acquisition;



- h) the methods of making corrections for ambient conditions; and
- i) the method of data analysis.

3.4.2 TEST INFORMATION

The following information shall be provided for each engine tested for certification purposes at each of the thrust settings specified in paragraph 3.1.5.2. 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;
- c) percentage of thrust contributed by afterburning; and
- d) measured Smoke Number.

3.4.3 DERIVED INFORMATION

3.4.3.1 the following derived information shall be provided for each engine tested for certification purposes:

- a) emission rate, i.e. emission index \times 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 D_p/F^*_{oo} for each gaseous pollutant (grams/ kilonewton); and
- d) maximum Smoke Number.

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

Note:- The characteristic level of the Smoke Number or gaseous is the mean of the values of all the engines tested, measured and corrected to the reference standard engine and reference ambient conditions, divided by the coefficient corresponding to the number of engines tested, as shown in Appendix 6 of Annex 16 part II.