Democratic Socialist Republic of Sri Lanka

Civil Aviation Authority of Sri Lanka

Implementing Standards

(Issued under Sec. 120, Civil Aviation Act No. 14 of 2010)

Title: Compliance to Annex-6-Part 1 – Chapter 5- Aeroplane Performance Operating Limitations

Reference No. : IS-6-(I)-5 **SLCAIS**: 014 **Date**: 15th March 2018

Pursuant to Sec. 120 of the Civil Aviation Act No.14 of 2010, Director General of Civil Aviation shall have the power to issue, whenever he considers it necessary or appropriate to do so, such Implementing Standards for the purpose of giving effect to any of the provisions of the Civil Aviation Act, any regulations or rules made thereunder including the Articles of the Convention on International Civil Aviation which are specified in the Schedule to the Act.

Accordingly, I being the Director General of Civil Aviation do hereby issue the Implementing Standards on **Annex 6- Part 1- Chapter 05- "Aeroplane Performance Operating Limitations"** as mentioned in the Attachment hereto (**Ref: IS-6-(i)-5)**, for the purpose of giving effect to the provisions in the aforementioned Act and Standards & Procedures described under Article 37 of the Convention, which are specified in the Attachment

This document supersedes the Implementing Standards 058, which shall be treated as null and void.

These Implementing Standards shall come into force with immediate effect and remain in force unless revoked.

Attention is also drawn to sec. 103 of the Act, which states inter alia that failure to comply with Implementing Standard is an offence.

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Chief Executive Officer

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Enclosure: Attachment No. **IS-6-(I)-5-Att-01**

Implementing Standards

Title: Compliance to Annex-6-Part 1-Chapter 5- Aeroplane Performance Operating Limitations

GENERAL:

i. Requirements contained in this document are based on amendments up to 42 of the 10th edition of ICAO Annex 6 Part I – "Operation of Aircraft" Chapter 5 – Aeroplane Performance Operating Limitations.

ii. The requirements contained in this document are applicable to person/organizations holding an air operator certificate issued by Director-General of Civil Aviation, Sri Lanka for commercial air transportation and prospective applicants for air operator certificate for commercial air transportation.

iii. Holders of Air Operator Certificate issued by the DGCA for commercial air transportation shall comply with the requirements published in this document and are hereby instructed to forward to the DGCA a "Declaration of Conformance" which indicates the degree of compliance with each item detailed in the document.

iv. This document supersedes the Implementing Standard 058 and ASN 044 which shall be treated as null and void.

v. This document may be amended from time to time and the amendments will be reflected with the vertical line on the right side of the text.

REQUIREMENTS FOR AEROPLANE PERFORMANCE OPERATING LIMITATIONS

1. General

1.1. Aeroplanes shall be operated in accordance with a comprehensive and detailed Code of performance established or adopted by the Director General of Civil Aviation.

1.2. Except as provided in paragraph 4, single-engine aeroplanes shall only be operated in conditions of weather and light, and over such routes and diversions therefrom, that permit a safe forced landing to be executed in the event of engine failure.

1.3. For aeroplanes for which Parts IIIA and IIIB of Annex 8 are not applicable because of the exemption provided for in Article 41 of the Convention, the DGCA should ensure that the level of performance specified in paragraph 2 should be met as far as practicable.

2. Applicable to aeroplanes certificated in accordance with Parts IIIA and IIIB of Annex 8

2.1. The requirements contained in 2.2 to 2.11 of this IS inclusive are applicable to the aeroplanes to which Parts IIIA and IIIB of Annex 8 is applicable and they do not include quantitative specifications comparable to those found in the applicable airworthiness requirements.

2.2. The level of performance defined by the appropriate parts of the requirements referred to in paragraph 1.1 for the aeroplanes designated in paragraph 2.1 shall be at least substantially equivalent to the overall level embodied in the requirements of this document.

Note.— *Appendix 3 to this IS contains guidance material which indicates the level of performance intended by the Standards and Recommended Practices of this chapter*

2.3. An aeroplane shall be operated in compliance with the terms and conditions stipulated in its certificate of airworthiness and within the approved operating limitations contained in its flight manual.

2.4. DGCA may take such precautions as are reasonably possible to ensure that the general level of safety contemplated by these provisions is maintained under all expected operating conditions, including those not covered specifically by the provisions of this document.

2.5. A flight shall not be commenced unless the performance information provided in the flight manual, supplemented as necessary with other data acceptable to the DGCA, indicates that the requirements of paragraph 2.6 to 2.11 can be complied with for the flight to be undertaken.

2.6. In applying the requirements of this document, account shall be taken of all factors that significantly affect the performance of the aeroplane, including but not limited to: the mass of the aeroplane, the operating procedures, the pressure-altitude appropriate to the elevation of the aerodrome, the ambient temperature, the wind, the runway slope, and surface conditions of the runway i.e., presence of snow, slush, water, and/or ice for landplanes, water surface condition for seaplanes. Such factors shall be taken into account directly as operational parameters or indirectly by means of allowances or margins, which may be provided in the scheduling of performance data or in the comprehensive and detailed code of performance in accordance with which the aeroplane is being operated.

Note: *Guidelines on using runway surface condition information on board Aircraft in accordance with Chapter 4.11 of IS 013. (**Applicable on 05th November 2020**.)*

2.7. **Mass limitations**

a. The mass of the aeroplane at the start of take-off shall not exceed the mass at which requirements at paragraph 2.8 is complied with, nor the mass at which requirements at paragraphs 2.9, 2.10 and 2.11 are complied with, allowing for expected reductions in mass as the flight proceeds, and for such fuel jettisoning as is envisaged in applying requirements at paragraphs 2.9 and 2.10 and, in respect of alternate aerodromes, requirements at paragraph 2.7 c) and 2.11 of this IS.

b. In no case shall the mass at the start of take-off exceed the maximum take-off mass specified in the flight manual for the pressure-altitude appropriate to the elevation of the aerodrome, and, if used as a parameter to determine the maximum take-off mass, any other local atmospheric condition.

c. In no case shall the estimated mass for the expected time of landing at the aerodrome of intended landing and at any destination alternate aerodrome, exceed the maximum landing mass specified in the flight manual for the pressure-altitude appropriate to the elevation of those aerodromes, and if used as a parameter to determine the maximum landing mass, any other local atmospheric condition.

d. In no case shall the mass at the start of take-off, or at the expected time of landing at the aerodrome of intended landing and at any destination alternate aerodrome, exceed the relevant maximum masses at which compliance has been demonstrated with the applicable noise certification Standards in Annex 16, Volume I, unless otherwise authorized in exceptional circumstances for a certain aerodrome or a runway where there is no noise disturbance problem, by the competent authority of the State in which the aerodrome is situated.

2.8. **Take-off.**

The aeroplane shall be able, in the event of a critical engine failing, or for other reasons, at any point in the take-off, either to discontinue the take-off and stop within the accelerate-stop distance available, or to continue the takeoff and clear all obstacles along the flight path by an adequate vertical or horizontal distance until the aeroplane is in a position to comply with paragraph 2.9. When determining the resulting take-off obstacle accountability area, the operating conditions, such as the crosswind component and navigation accuracy, must be taken into account.

Note.— *Appendix 3 to this IS contains guidance on the vertical and horizontal distances that are considered adequate to show compliance with this Standard*

2.8.1. In determining the length of the runway available, account shall be taken of the loss, if any, of runway length due to alignment of the aircraft prior to take-off.

2.9. **En route — one engine inoperative.** The aeroplane shall be able, in the event of the critical engine becoming inoperative at any point along the route or planned diversions therefrom, to continue the flight to an aerodrome at which the requirement of paragraph 2.11 can be met, without flying below the minimum flight altitude at any point.

2.10. **En route — two engine inoperative**. In the case of aeroplanes having three or more engines, on any part of a route where the location of en-route alternate aerodromes and the total duration of the flight are such that the probability of a second engine becoming inoperative must be allowed for if the general level of safety implied by the requirements of this document is to be maintained, the aeroplane shall be able, in the event of any two engines becoming inoperative, to continue the flight to an en-route alternate aerodrome and land.

2.11. **Landing.** The aeroplane shall, at the aerodrome of intended landing and at any alternate aerodrome, after clearing all obstacles in the approach path by a safe margin, be able to land, with assurance that it can come to a stop or, for a seaplane, to a satisfactorily low speed, within the landing distance available. Allowance shall be made for expected variations in the approach and landing techniques, if such allowance has not been made in the scheduling of performance data.

3. Obstacle data

3.1. The operator shall ensure that the pilot-in-command is provided with obstacle data in respect of each airport, which the aeroplane is intended to operate to or from complying with paragraph 2.8.

Note.— *See Annex 4 and Annex 15 for methods of presentation of certain obstacle data.*

3.2 The operator shall take account of charting accuracy when assessing compliance with paragraph 2.8.

4. Additional requirements for operations of single-engine turbine-powered aeroplanes at night and /or in Instrument Meteorological Conditions (IMC)

4.1. For grant of approval for operator of single-engine turbine-powered aeroplanes at night and/or in Instrument Meteorological Conditions (IMC) the following requirements shall be satisfied;

a. To the reliability of the turbine engine;

b. The operator's maintenance procedures, operating practices, flight dispatch procedures and crew training programmes; and

c. Equipment and other requirements provided in accordance with Appendix 1.

4.2. All single-engine turbine-powered aeroplanes operated at night and/or in IMC shall have an engine trend monitoring system, and those aeroplanes for which the individual certificate of airworthiness is first issued on or after 1 January 2005 shall have an automatic trend monitoring system.

APPENDIX 1.

ADDITIONAL GUIDANCE FOR APPROVED OPERATIONS BY SINGLE-ENGINE TURBINE-POWERED AEROPLANES AT NIGHT AND/OR IN INSTRUMENT METEOROLOGICAL CONDITIONS (IMC)

1. PURPOSE AND SCOPE

The purpose of this attachment is to give additional guidance on the airworthiness and operational requirements described in Paragraph 4 and Attachment 1 of this IS, which have been designed to meet the overall level of safety intended for approved operations by single-engine turbine-powered aeroplanes at night and/or in IMC.

2. TURBINE ENGINE RELIABILITY

2.1 The power loss rate required in Paragraph 1.1 and Appendix 1 of this IS should be established as likely to be met based on data from commercial operations supplemented by available data from private operations in similar theatres of operation. A minimum amount of service experience is needed on which to base the judgment, and this should include at least 20, 000 hours on the actual aeroplane/engine combination unless additional testing has been carried out or experience on sufficiently similar variants of the engine is available.

2.2 In assessing turbine engine reliability, evidence should be derived from a world fleet database covering as large a sample as possible of operations considered to be representative, compiled by the manufacturers and reviewed with the States of Design and of the Operator. Since flight hour reporting is not mandatory for many types of operators, appropriate statistical estimates may be used to develop the engine reliability data. Data for individual operators approved for these operations including trend monitoring and event reports should also be monitored and reviewed by the DGCA to ensure that there is no indication that the operator’s experience is unsatisfactory.

2.2.1 **Engine trend monitoring should include the following:**

a) An oil consumption monitoring programme based on manufacturers’ recommendations; and

b) an engine condition monitoring programme describing the parameters to be monitored, the method of data collection and the corrective action process; this should be based on the manufacturer’s recommendations. The monitoring is intended to detect turbine engine deterioration at an early stage to allow for corrective action before safe operation is affected.

2.2.2 A reliability programme should be established covering the engine and associated systems.

The engine programme should include engine hours flown in the period and the in-flight shutdown rate for all causes and the unscheduled engine removal rate, both on a 12-month moving average basis. The event reporting process should cover all items relevant to the ability to operate safely at night and/or in IMC.

The data should be available for use by the operator, the Type Certificate Holder and the DGCA so as to establish that the intended reliability levels are being achieved. Any sustained adverse trend should result in an immediate evaluation by the operator in consultation with the DGCA and manufacturer with a view to determining actions to restore the intended safety level. The operator should develop a parts control programme with support from the manufacturer that ensures that the proper parts and configuration are maintained for single-engine turbine- powered aeroplanes approved to conduct these operations. The programme includes verification that parts placed on an approved single-engine turbine-powered aeroplane during parts borrowing or pooling arrangements, as well as those parts used after repair or overhaul, maintain the necessary configuration of that aeroplane for operations approved in accordance with paragraph 4 of this IS.

2.3 Power loss rate should be determined as a moving average over a specified period (e.g. a 12-month moving average if the sample is large). Power loss rate, rather than in-flight shut-down rate, has been used as it is considered to be more appropriate for a single-engine aeroplane. If a failure occurs on a multi-engine aeroplane that causes a major, but not total, loss of power on one engine, it is likely that the engine will be shut down as positive engine-out performance is still available, whereas on a single-engine aeroplane it may well be decided to make use of the residual power to stretch the glide distance.

2.4 The actual period selected should reflect the global utilization and the relevance of the experience included (e.g. early data may not be relevant due to subsequent mandatory modifications which affected the power loss rate). After the introduction of a new engine variant and whilst global utilization is relatively low, the total available experience may have to be used to try to achieve a statistically meaningful average.

3. OPERATIONS MANUAL

The operations manual should include all necessary information relevant to operations by single-engine turbine-powered aeroplanes at night and/or in IMC. This should include all of the additional equipment, procedures and training required for such operations, route and/or area of operation and aerodrome information (including planning and operating minima).

4. OPERATOR CERTIFICATION OR VALIDATION

The certification or validation process specified by the DGCA should ensure the adequacy of the operator’s procedures for normal, abnormal and emergency operations, including actions following engine, systems or equipment failures.

In addition to the normal requirements for operator certification or validation, the following items should be addressed in relation to operations by single-engine turbine-powered aeroplanes:

a) Proof of the achieved engine reliability of the aeroplane engine combination (see Appendix 1, paragraph 1 of this IS);

b) Specific and appropriate training and checking procedures including those to cover engine failure/malfunction on the ground, after take-off and en-route and descend to a forced landing from the normal cruising altitude;

c) A maintenance programme which is extended to address the equipment and systems referred to in Appendix 1, paragraph 2 of this IS;

d) An MEL modified to address the equipment and systems necessary for operations at night and/or in IMC;

e) Planning and operating minima appropriate to the operations at night and/or in IMC;

f) Departure and arrival procedures and any route limitations;

g) Pilot qualifications and experience; and

h) The operations manual, including limitations, emergency procedures, approved routes or areas of operation, the MEL and normal procedures related to the equipment referred to in Appendix 1, paragraph 2 of this IS.

5. OPERATIONAL AND MAINTENANCE PROGRAMME REQUIREMENTS

5.1 Approval to undertake operations by single-engine turbine-powered aeroplanes at night and/or in IMC specified in an air operator certificate or equivalent document should include the particular airframe/engine combinations, including the current type design standard for such operations, the specific aeroplanes approved, and the areas or routes of such operations.

5.2 The operator's maintenance control manual should include a statement of certification of the additional equipment required, and of the maintenance and reliability programme for such equipment, including the engine.

6. ROUTE LIMITATIONS OVER WATER

6.1 Operators of single-engine turbine-powered aeroplanes carrying out operations at night and/or in IMC should make an assessment of route limitations over water. The distance that the aeroplane may be operated from a land mass suitable for a safe forced landing should be determined.

This equates to the glide distance from the cruise altitude to the safe forced landing area following engine failure, assuming still air conditions. DGCA may add to this an additional distance taking into account the likely prevailing conditions and type of operation. This should take into account the likely sea conditions, the survival equipment carried, the achieved engine reliability and the search and rescue services available.

6.2 Any additional distance allowed beyond the glide distance should not exceed a distance equivalent to 15 minutes at the aeroplane's normal cruise speed.

APPENDIX 2

ADDITIONAL REQUIREMENTS FOR APPROVED OPERATIONS BY SINGLE-ENGINE TURBINE-POWERED AEROPLANES AT NIGHT AND /OR IN INSTRUMENT METEOROLOGICAL CONDITIONS (IMC)

1. TURBINE ENGINE RELIABILITY

1.1. Turbine engine reliability shall be shown to have a power loss rate of less than 1 per 100 000 engine hours.

Note.— *Power loss in this context is defined as any loss of power, the cause of which may be traced to faulty engine or engine component design or installation, including design or installation of the fuel ancillary or engine control systems. (See Appendix 4)*

1.2. The operator shall be responsible for engine trend monitoring.

1.3. To minimize the probability of in-flight engine failure, the engine shall be equipped with:

a. an ignition system that activates automatically, or is capable of being operated manually, for take-off and landing and during flight, in visible moisture;

b. a magnetic particle detection, or equivalent, system that monitors the engine, accessories gearbox, and reduction gearbox, and which includes a flight deck caution indication; and

c. an emergency engine power control device that permits continuing operation of the engine through a sufficient power range to safely complete the flight in the event of any reasonably probable failure of the fuel control unit.

2. SYSTEMS AND EQUIPMENT

Single-engine turbine powered aeroplane approved to operate at night and /or in IMC shall be equipped with the following systems and equipment intended to ensure continued safe flight and to assist in achieving a safe forced landing after an engine failure, under all allowable operating conditions:

a. Two separate electrical generating systems, each one capable of supplying all probable combinations of continuous in-flight electrical loads for instruments, equipment and systems required at night and /or in IMC;

b. A radio altimeter;

c. An emergency electrical supply system of sufficient capacity and endurance, following loss of all generated power to as a minimum:

i. maintain the operation of all essential flight instruments, communication and navigation systems during a descent from the maximum certificated altitude in a glide configuration to the completion of a landing;
ii. lower the flaps and landing gear, if applicable;
iii. provide power to one pilot heater, which must serve an air speed indicator clearly visible to the pilot;
iv. provide for operation of the landing light specified in paragraph 2 j. below;

v. provide for one engine restart, if applicable; and

vi. provide for the operation of the radio altimeter;

d. Two attitude indicators, powered from independent sources;

e. A means to provide for at least one attempt at engine re-start;

f. Airborne weather radar;

g. A certified area navigation system capable of being programmed with the positions of aerodromes and safe forced landing areas, and providing instantly available track and distance information to those location;

h. For passenger operations, passenger seats and mounts which meet dynamically-tested performance standards and which are fitted with a shoulder harness or a safety belt with a diagonal shoulder strap for each passenger seat;

i. In pressurized aeroplanes, sufficient supplemental oxygen for all occupants for descent following engine failure at the maximum glide performance from the maximum certificated altitude to an altitude at which supplemental oxygen is no longer required;

j. A landing light that is independent of the landing gear and is capable of adequately illuminating the touchdown area in a night forced landing; and

k. An engine fire warning system.

3. MINIMUM EQUIPMENT LIST

The Director General of Civil Aviation shall require the minimum equipment list of an operator to be approved in accordance with paragraph 4 of the attachment to specify the operating equipment required for night and /or IMC operations, and for day/VMC operations.

4. FLIGHT MANUAL INFORMATION

The flight manual shall include limitations, procedures, approval status and other information relevant to operations by single-engine turbine-powered aeroplanes at night and /or in IMC.

5. EVENT REPORTING

5.1. An operator approved for operations by single-engine turbine-powered aeroplane at night and /or in IMC shall report all significant failure, malfunctions or defects to the Director General of Civil Aviation who in turn will notify the State of Design.

5.2. The Director General of Civil Aviation shall review the safety data and monitor the reliability information so as to be able to take any actions necessary to ensure that the intended safety level is achieved. The Director General of Civil Aviation will notify major events or trends of particular concern to the appropriate Type Certificate Holder and the State of Design.

6. OPERATOR PLANNING

6.1. Operator route planning shall take account of all relevant information in the assessment of intended routes or areas of operations, including the following:

a. The nature of the terrain to be overflown, including the potential for carrying out a safe forced landing in the event of an engine failure or major malfunction;

b. Weather information, including seasonal and other adverse meteorological influences that may affect the flight; and

c. Other criteria and limitations as specified by the Director General of Civil Aviation.

6.2. An operator shall identify aerodromes or safe forced landing areas available for use in the event of engine failure, and the position of these shall be programmed into the area navigation system.

Note 1. *−A 'safe' forced landing in this context means a landing in an area at which it can reasonably be expected that it will not lead to serious injury or loss of life, even though the aeroplane may incur extensive damage.*

Note 2.— *Operation over routes and in weather conditions that permit a safe forced landing in the event of an engine failure, as specified in 1.2,of this IS is not required by 6.1 and 6.2 for aeroplanes approved in accordance with Paragraph 4 of this IS. The availability of forced landing areas at all points along a route is not specified for these aeroplanes because of the very high engine reliability, additional systems and operational equipment, procedures and training requirements specified in this Appendix.*

7. FLIGHT CREW EXPERIENCE, TRAINING, CHECKING AND FLIGHT OPERATIONS OFFICER/DISPATCHER CHECKING

7.1. The minimum flight crew experience required for night/ IMC operations by single-engine turbine-powered aeroplane shall be approved by the Director General of Civil Aviation.

7.2. An operator's flight crew training and checking shall be appropriate to night and /or IMC operations by single-engine turbine-powered aeroplanes, covering normal, abnormal and emergency procedures and, in particular, engine failure, including descent to a forced landing in night and /or in IMC conditions.

7.3. An operator's Flight Operations Officer/Dispatcher checking shall be appropriate to night and /or IMC operations by single-engine turbine-powered aeroplanes, covering normal, abnormal and emergency procedures.

8. ROUTE LIMITATIONS OVER WATER

The Director General of Civil Aviation shall apply route limitation criteria for single engine turbine-powered aeroplanes at night and /or in IMC on over water operations if beyond gliding distance from an area suitable for a safe forced landing /ditching having regard to the characteristics of the aeroplane, seasonal weather influences, including likely sea state and temperature, and the availability of search and rescue services.

9. OPERATOR CERTIFICATION OR VALIDATION

The operator shall demonstrate the ability to conduct operations by single-engine turbine-powered aeroplanes at night and /or in IMC through a certification and approval process as specified by the Director General of Civil Aviation.

Note. *− Guidance on the airworthiness and operational requirements is contained in Appendix 1 of this IS.*

APPENDIX 3

AEROPLANE PERFORMANCE OPERATING LIMITATIONS

1. PURPOSE AND SCOPE

The purpose of this Attachment is to provide guidance as to the level of performance intended by the provisions of Chapter 5 as applicable to turbine-powered subsonic transport type aeroplanes over 5 700 kg maximum certificated take-off mass having two or more engines. However, where relevant, it can be applied to all subsonic turbine-powered or piston-engine aeroplanes having two, three or four engines. Piston-engine aeroplanes having two, three or four engines which cannot comply with this Attachment may continue to be operated in accordance with Examples 1 or 2 of this Attachment.

Note.*— This Attachment is not intended for application to aeroplanes having short take-off and landing (STOL) or vertical take-off and landing (VTOL) capabilities.*

2. DEFINITIONS

Accelerate-stop distance available (ASDA). The length of the take-off run available plus the length of the stop way, if provided.

CAS (calibrated airspeed). The calibrated airspeed is equal to the airspeed indicator reading corrected for position and instrument error. (As a result of the sea level adiabatic compressible flow correction to the airspeed instrument dial, CAS is equal to the true airspeed (TAS) in Standard Atmosphere at sea level.)

Declared temperature. A temperature selected in such a way that when used for performance purposes, over a series of operations, the average level of safety is not less than would be obtained by using official forecast temperatures.

Expected. Used in relation to various aspects of performance (e.g. rate or gradient of climb), this term means the standard performance for the type, in the relevant conditions (e.g. mass, altitude and temperature).

Grooved or porous friction course runway. A paved runway that has been prepared with lateral grooving or a porous friction course (PFC) surface to improve braking characteristics when wet.

Height. The vertical distance of a level, a point, or an object considered as a point, measured from a specified datum.

***Note. —** For the purposes of this example, the point referred to above is the lowest part of the aeroplane and the specified datum is the take-off or landing surface, whichever is applicable.*

Landing distance available (LDA). The length of runway which is declared available and suitable for the ground run of an aeroplane landing.

Landing surface. That part of the surface of an aerodrome which the aerodrome authority has declared available for the normal ground or water run of aircraft landing in a particular direction.

Net gradient. The net gradient of climb throughout these requirements is the expected gradient of climb diminished by the maneuver performance (i.e. that gradient of climb necessary to provide power to maneuver) and by the margin (i.e. that gradient of climb necessary to provide for those variations in performance which are not expected to be taken explicit account of operationally).

Reference humidity. The relationship between temperature and reference humidity is defined as follows:

— At temperatures at and below ISA, 80 per cent relative humidity,
— At temperatures at and above ISA + 28° C, 34 per cent relative humidity,
— At temperatures between ISA and ISA + 28° C, the relative humidity varies linearly between the humidity specified for those temperatures.

Runway surface condition. The state of the surface of the runway: either dry, wet, or contaminated:

a) **Contaminated runway**. A runway is contaminated when more than 25 per cent of the runway surface area (whether in isolated areas or not) within the required length and width being used is covered by:

  — Water, or slush more than 3 mm (0.125 in) deep;
  — Loose snow more than 20 mm (0.75 in) deep; or
  — Compacted snow or ice, including wet ice.

b) **Dry runway**. A dry runway is one which is clear of contaminants and visible moisture within the required length and the width being used.

c) **Wet runway**. A runway that is neither dry nor contaminated.

***Note 1. —** In certain situations, it may be appropriate to consider the runway contaminated even when it does not meet the above definition. For example, if less than 25 per cent of the runway surface area is covered with water, slush, snow or ice, but it is located where rotation or lift-off will occur, or during the high speed part of the take-off roll, the effect will be far more significant than if it were encountered early in take-off while at low speed. In this situation, the runway should be considered to be contaminated.*

***Note 2.—** Similarly, a runway that is dry in the area where braking would occur during a high speed rejected take-off, but damp or wet (without measurable water depth) in the area where acceleration would occur, may be considered to be dry for computing take-off performance. For example, if the first 25 per cent of the runway was damp, but the remaining runway length was dry, the runway would be wet using the definitions above. However, since a wet runway does not affect acceleration, and the braking portion of a* *rejected take-off would take place on a dry surface, it would be appropriate to use dry runway take-off performance.*

Take-off distance available (TODA). The length of the take-off run available plus the length of the clearway, if provided.

Take-off run available (TORA). The length of runway declared available and suitable for the ground run of an aeroplane taking off.

Take-off surface. That part of the surface of an aerodrome which the aerodrome authority has declared available for the normal ground or water run of aircraft taking off in a particular direction.

TAS (True airspeed). The speed of the aeroplane relative to undisturbed air.

Vso. A stalling speed or minimum steady flight speed in the landing configuration.

***Note.** — See Example 1, 2.4.*

V_{S_1}. A stalling speed or minimum steady flight speed. (Note. — See Example 1, 2.5.)

***Note 1.** — See Chapter 1 and ICAO Annexes 8 and 14, Volume I, for other definitions.*

***Note 2.**— The terms "accelerate-stop distance", "take-off distance", "V1", "take-off run", "net take-off flight path", "one engine inoperative en-route net flight path", and "two engines inoperative en-route net flight path", as relating to the aeroplane, have their meanings defined in the airworthiness requirements under which the aeroplane was certificated. If any of these definitions are found inadequate, then a definition specified by the DGCA should be used.*

3. GENERAL

3.1 The provisions of 4 to 7 should be complied with, unless deviations therefrom are specifically authorized by the DGCA on the grounds that the special circumstances of a particular case make a literal observance of these provisions unnecessary for safety.

3.2 Compliance with 4 to 7 should be established using performance data in the flight manual and in accordance with other applicable operating requirements. In no case should the limitations in the flight manual be exceeded.

However, additional limitations may be applied when operational conditions not included in the flight manual are encountered. The performance data contained in the flight manual may be supplemented with other data acceptable to the DGCA if necessary to show compliance with 4 to 7. When applying the factors prescribed in this Attachment, account may be taken of any operational factors already incorporated in the flight manual data to avoid double application of factors.

3.3 The procedures scheduled in the flight manual should be followed except where operational circumstances require the use of modified procedures in order to maintain the intended level of safety.

***Note.** — See the Airworthiness Manual (Doc 9760) for the related airworthiness performance guidance material.*

4. AEROPLANE TAKE-OFF PERFORMANCE LIMITATIONS

4.1 No aeroplane should commence a take-off at a mass which exceeds the take-off mass specified in the flight manual for the altitude of the aerodrome and for the ambient temperature existing at the time of the take-off.

4.2 No aeroplane should commence a take-off at a mass such that, allowing for normal consumption of fuel and oil in flight to the aerodrome of destination and to the destination alternate aerodromes, the mass on arrival will exceed the landing mass specified in the flight manual for the altitude of each of the aerodromes involved and for the ambient temperatures anticipated at the time of landing.

4.3 No aeroplane should commence a take-off at a mass which exceeds the mass at which, in accordance with the minimum distances for take-off scheduled in the flight manual, compliance with 4.3.1 to 4.3.3 inclusive is shown.

4.3.1 The take-off run required should not exceed the take-off run available.

4.3.2 The accelerate-stop distance required should not exceed the accelerate-stop distance available.

4.3.3 The take-off distance required should not exceed the take-off distance available.

4.3.4 When showing compliance with 4.3 the same value of V1 for the continued and discontinued take-off phases should be used.

4.4 When showing compliance with 4.3 the following parameters should be taken into account:

a) The pressure altitude at the aerodrome;
b) The ambient temperature at the aerodrome;
c) The runway surface condition and the type of the runway surface;
d) The runway slope in the direction of the take-off;
e) The runway slope;
f) Not more than 50 per cent of the reported headwind component or not less than 150 per cent of the reported tailwind component; and
g) The loss, if any, of runway length due to alignment of the aeroplane prior to take-off.

4.5 Credit is not taken for the length of the stop way or the length of the clearway unless they comply with the relevant specifications in ICAO Annex 14, Volume I.

5. TAKE-OFF OBSTACLE CLEARANCE LIMITATIONS

5.1 No aeroplane should commence a take-off at a mass in excess of that shown in the flight manual to correspond with a net take-off flight path which clears all obstacles either by at least a height of 10.7 m (35 ft) vertically or at least 90 m (300 ft) plus 0.125D laterally, where D is the horizontal distance the aeroplane has travelled from the end of take-off distance available, except as provided in 5.1.1 to 5.1.3 inclusive.

For aeroplanes with a wingspan of less than 60 m (200 ft) a horizontal obstacle clearance of half the aeroplane wingspan plus 60 m (200 ft), plus 0.125D may be used.

In determining the allowable deviation of the net take-off flight path in order to avoid obstacles by at least the distances specified, it is assumed that the aeroplane is not banked before the clearance of the net take-off flight path above obstacles is at least one half of the wingspan but not less than 15.2 m (50 ft) height and that the bank thereafter does not exceed 15°, except as provided in 5.1.4.

The net take-off flight path considered is for the altitude of the aerodrome and for the ambient temperature and not more than 50 per cent of the reported headwind component or not less than 150 per cent of the reported tailwind component existing at the time of take-off. The take-off obstacle accountability area defined above is considered to include the effect of crosswinds.

5.1.1 Where the intended track does not include any change of heading greater than 15°,

a) For operations conducted in VMC by day, or
b) For operations conducted with navigation aids such that the pilot can maintain the aeroplane on the intended track with the same precision as for operations specified in 5.1.1 a),

Obstacles at a distance greater than 300 m (1 000 ft) on either side of the intended track need not be cleared.

5.1.2 Where the intended track does not include any change of heading greater than 15° for operations conducted in IMC, or in VMC by night, except as provided in 5.1.1 b); and where the intended track includes changes of heading greater than 15° for operations conducted in VMC by day, obstacles at a distance greater than 600 m (2 000 ft) on either side of the intended track need not be cleared.

5.1.3 Where the intended track includes changes of heading greater than 15° for operations conducted in IMC, or in VMC by night, obstacles at a distance greater than 900 m (3 000 ft) on either side of the intended track need not be cleared.

5.1.4 An aeroplane may be operated with bank angles of more than 15° below 120 m (400 ft) above the elevation of the end of the take-off run available, provided special procedures are used that allow the pilot to fly the desired bank angles safely under all circumstances. Bank angles should be limited to not more than 20° between 30 m (100 ft) and 120 m (400 ft), and not more than 25° above 120 m (400 ft). Methods approved by the DGCA should be used to account for the effect of bank angle on operating speeds and flight path including the distance increments resulting from increased operating speeds. The net take-off flight path in which the aeroplane is banked by more than 15° should clear all obstacles by a vertical distance of at least 10.7 m (35 ft) relative to the lowest part of the banked aeroplane within the horizontal distance specified in 5.1. The use of bank angles greater than those mentioned above should be subject to the approval from the DGCA.

6. EN-ROUTE LIMITATIONS

6.1 General

At no point along the intended track is an aeroplane having three or more engines to be more than 90 minutes at normal cruising speed away from an aerodrome at which the distance specifications for alternate aerodromes (see 7.3) are complied with and where it is expected that a safe landing can be made, unless it complies with 6.3.1.1.

6.2 One engine inoperative

6.2.1 No aeroplane should commence a take-off at a mass in excess of that which, in accordance with the one-engine- inoperative en-route net flight path data shown in the flight manual, permits compliance either with 6.2.1.1 or 6.2.1.2 at all points along the route.

The net flight path has a positive slope at 450 m (1 500 ft.) above the aerodrome where the landing is assumed to be made after engine failure. The net flight path used is for the ambient temperatures anticipated along the route.

In meteorological conditions where icing protection systems are to be operable, the effect of their use on the net flight path data is taken into account.

6.2.1.1 The slope of the net flight path is positive at an altitude of at least 300 m (1 000 ft) above all terrain and obstructions along the route within 9.3 km (5 NM) on either side of the intended track.

6..2.1.2 The net flight path is such as to permit the aeroplane to continue flight from the cruising altitude to an aerodrome where a landing can be made in accordance with 7.3, the net flight path clearing vertically, by at least 600 m (2 000 ft.), all terrain and obstructions along the route within 9.3 km (5 NM) on either side of the intended track. The provisions of 6.2.1.2.1 to 6.2.1.2.5 inclusive are applied.

6.2.1.2.1 The engine is assumed to fail at the most critical point along the route, allowance being made for indecision and navigational error.

6.2.1.2.2 Account is taken of the effects of winds on the flight path.

6.2.1.2.3 Fuel jettisoning is permitted to an extent consistent with reaching the aerodrome with satisfactory fuel reserves, if a safe procedure is used.

6.2.1.2.4 The aerodrome, where the aeroplane is assumed to land after engine failure, is specified in the operational flight plan, and it meets the appropriate aerodrome operating minima at the expected time of use.

6.2.1.2.5 The consumption of fuel and oil after the engine becomes inoperative is that which is accounted for in the net flight path data shown in the flight manual.

6.3 Two engines inoperative — aeroplanes with three or more engines

6.3.1 Aeroplanes which do not comply with 6.1 should comply with 6.3.1.1.

6.3.1.1 No aeroplane should commence a take-off at a mass in excess of that which, according to the two-engine inoperative en-route net flight path data shown in the flight manual, permits the aeroplane to continue the flight from the point where two engines are assumed to fail simultaneously, to an aerodrome at which the landing distance specification for alternate aerodromes (see 7.3) is complied with and where it is expected that a safe landing can be made.

The net flight path clears vertically, by at least 600 m (2 000 ft) all terrain and obstructions along the route within 9.3 km (5 NM) on either side of the intended track. The net flight path considered is for the ambient temperatures anticipated along the route. In altitudes and meteorological conditions where icing protection systems are to be operable, the effect of their use on the net flight path data is taken into account. The provisions of 6.3.1.1.1 to 6.3.1.1.5 inclusive apply.

6.3.1.1.1 The two engines are assumed to fail at the most critical point of that portion of the route where the aeroplane is at more than 90 minutes at normal cruising speed away from an aerodrome at which the landing distance specification for alternate aerodromes (see 7.3) is complied with and where it is expected that a safe landing can be made.

6.3.1.1.2 The net flight path has a positive slope at 450 m (1 500 ft) above the aerodrome where the landing is assumed to be made after the failure of two engines.

6.3.1.1.3 Fuel jettisoning is permitted to an extent consistent with 6.3.1.1.4, if a safe procedure is used.

6.3.1.1.4 The aeroplane mass at the point where the two engines are assumed to fail is considered to be not less than that which would include sufficient fuel to proceed to the aerodrome and to arrive there at an altitude of at least 450 m (1 500 ft) directly over the landing area and thereafter to fly for 15 minutes at cruise power and/or thrust.

6.3.1.1.5 The consumption of fuel and oil after the engines become inoperative is that which is accounted for in the net flight path data shown in the flight manual.

7. LANDING LIMITATIONS

7.1 Aerodrome of destination — dry runways

7.1.1 No aeroplane should commence a take-off at a mass in excess of that which permits the aeroplane to be brought to a full stop landing at the aerodrome of intended destination from 15.2 m (50 ft) above the threshold:

a) For turbo jet powered aeroplanes, within 60 per cent of the landing distance available; and

b) For turbo-propeller aeroplanes, within 70 per cent of the landing distance available.

The mass of the aeroplane is assumed to be reduced by the mass of the fuel and oil expected to be consumed in flight to the aerodrome of intended destination. Compliance is shown with 7.1.1.1 and with either 7.1.1.2 or 7.1.1.3.

7.1.1.1 It is assumed that the aeroplane is landed on the most favorable runway and in the most favorable direction in still air.

7.1.1.2 It is assumed that the aeroplane is landed on the runway which is the most suitable for the wind conditions anticipated at the aerodrome at the time of landing, taking due account of the probable wind speed and direction, of the ground handling characteristics of the aeroplane, and of other conditions (i.e. landing aids, terrain).

7.1.1.3 If full compliance with 7.1.1.2 is not shown, the aeroplane may be taken off if a destination alternate aerodrome is designated which permits compliance with 7.3.

7.1.1.4 When showing compliance with 7.1.1 at least the following factors should be taken into account:

a) The pressure altitude of the aerodrome;
b) The runway slope in the direction of the landing if greater than ±2.0 per cent; and
c) Not more than 50 per cent of the headwind component or not less than 150 per cent of the tailwind component.

7.2 Aerodrome of destination — wet or contaminated runways

7.2.1 When the appropriate weather reports or forecasts or a combination thereof indicate that the runway at the estimated time of arrival may be wet, the landing distance available should be at least 115 per cent of the required landing distance determined in accordance with 7.1.

7.2.2 A landing distance on a wet runway shorter than that required by 7.2.1 but not less than that required by 7.1 may be used if the flight manual includes specific additional information about landing distance on wet runways.

7.2.3 When the appropriate weather reports or forecasts or a combination thereof indicate that the runway at the estimated time of arrival may be contaminated, the landing distance available should be the greater of:

a) The landing distance determined in accordance with 7.2.1; or

b) The landing distance determined in accordance with contaminated landing distance data with a safety margin acceptable to the DGCA.

7.2.4 If compliance with 7.2.3 is not shown, the aeroplane may take off if a destination alternate aerodrome is designated for which compliance is shown with 7.2.3 and 7.3.

7.2.5 When showing compliance with 7.2.2 and 7.2.3, the criteria of 7.1 should be applied accordingly. However, 7.1.1 a) and b) need not be applied to the wet and contaminated runway landing distance determination required by 7.2.2 and 7.2.3.

7.3 Destination alternate aerodrome

No aerodrome should be designated as a destination alternate aerodrome unless the aeroplane, at the mass anticipated at the time of arrival at such aerodrome, can comply with 7.1 and either 7.2.1 or 7.2.2, in accordance with the landing distance required for the altitude of the alternate aerodrome and in accordance with other applicable operating requirements for the alternate aerodrome.

7.4 Performance considerations before landing

The operator should provide the flight crew with a method to ensure that a full stop landing, with a safety margin acceptable to the DGCA, that is at least the minimum specified in the Type Certificate holder's aircraft flight manual (AFM), or equivalent, can be made on the runway to be used in the conditions existing at the time of landing and with the deceleration means that will be used.

EXAMPLE 1

1. PURPOSE AND SCOPE

The purpose of the following example is to illustrate the level of performance intended by the provisions of Chapter 5 as applicable to the types of aeroplanes described below.

The Standards and Recommended Practices in ICAO Annex 6 effective on 14 July 1949 contained specifications similar to those adopted by some Contracting States for inclusion in their national performance codes. A very substantial number of civil transport aeroplanes have been manufactured and are being operated in accordance with these codes. Those aeroplanes are powered with reciprocating engines including turbo-compound design. They embrace twin-engine and four-engine aeroplanes over a mass range from approximately 4 200 kg to 70 000 kg over a stalling speed range, Vso from approximately

100 to 175 km/h (55 to 95 Kts) and over a wing loading range from approximately 120 to 360 kg/m2. Cruising speeds range over 555 km/h (300 Kts). Those aeroplanes have been used in a very wide range of altitude, air temperature and humidity conditions. At a later date, the code was applied with respect to the evaluation of certification of the so-called "first generation" of turboprop and turbo-jet aeroplanes.

Although only past experience can warrant the fact that this example illustrates the level of performance intended by the Standards and Recommended Practices of Chapter 5, it is considered to be applicable over a wide range of aeroplane characteristics and atmospheric conditions. Reservation should however be made concerning the application of this example with respect to conditions of high air temperatures. In certain extreme cases, it has been found desirable to apply additional temperature and/or humidity accountability, particularly for the obstacle limited take-off flight path.

This example is not intended for application to aeroplanes having short take-off and landing (STOL) or vertical take-off and landing (VTOL) capabilities.

No detailed study has been made of the applicability of this example to operations in all-weather conditions. The validity of this example has not therefore been established for operations which may involve low decision heights and be associated with low minima operating techniques and procedures.

2. STALLING SPEED — MINIMUM STEADY FLIGHT SPEED

2.1 For the purpose of this example, the stalling speed is the speed at which an angle of attack greater than that of maximum lift is reached, or, if greater, the speed at which a large amplitude pitching or rolling motion, not immediately controllable, is encountered, when the maneuver described in 2.3 is executed.

Note. *— It should be noted that an uncontrollable pitching motion of small amplitude associated with pre-stall buffeting does not necessarily indicate that the stalling speed has been reached.*

2.2 The minimum steady flight speed is that obtained while maintaining the elevator control in the most rearward possible position when the manoeuvre described in 2.3 is executed. This speed would not apply when the stalling speed defined in 2.1 occurs before the elevator control reaches its stops.

2.3 Determination of stalling speed — minimum steady flight speed

2.3.1 The aeroplane is trimmed for a speed of approximately 1.4VS1. From a value sufficiently above the stalling speed to ensure that a steady rate of decrease is obtainable, the speed is reduced in straight flight at a rate not exceeding 0.5 m/s2 (1 Kt/s) until the stalling speed or the minimum steady flight speed, defined in 2.1 and 2.2, is reached.

2.3.2 For the purpose of measuring stalling speed and minimum steady flight speed, the instrumentation is such that the probable error of measurement is known.

2.4 Vso denotes the stalling speed if obtained in flight tests conducted in accordance with 2.3, or the minimum steady flight speed, CAS, as defined in 2.2, with:

a) Engines at not more than sufficient power for zero thrust at a speed not greater than 110 per cent of the stalling speed;

b) Propeller pitch controls in the position recommended for normal use during take-off;

c) Landing gear extended;

d) Wing flaps in the landing position;

e) Cowl flaps and radiator shutters closed or nearly closed;

f) Centre of gravity in that position within the permissible landing range which gives the maximum value of stalling speed or of minimum steady flight speed;

g) Aeroplane mass equal to the mass involved in the specification under consideration.

2.5 Vs1 denotes the stalling speed if obtained in flight tests conducted in accordance with 2.3, or the minimum steady flight speed, CAS, as defined in 2.2, with:

a) Engines at not more than sufficient power for zero thrust at a speed not greater than 110 per cent of the stalling speed;

b) Propeller pitch controls in the position recommended for normal use during take-off;

c) Aeroplane in the configuration in all other respects and at the mass prescribed in the specification under consideration.

3. TAKE-OFF

3.1 Mass

The mass of the aeroplane at take-off is not to exceed the maximum take-off mass specified in the flight manual for the altitude at which the take-off is to be made.

3.2 Performance

The performance of the aeroplane as determined from the information contained in the flight manual is such that:

a) The accelerate-stop distance required does not exceed the accelerate-stop distance available;

b) The take-off distance required does not exceed the take- off distance available;

c) The take-off path provides a vertical clearance of not less than 15.2 m up to D = 500 m (50 ft up to D = 1 500 ft) and 15.2 + 0.01 [D – 500] m (50 + 0.01 [D – 1 500] ft) thereafter, above all obstacles lying within 60 m plus half the wing span of the aeroplane plus 0.125D on either side of the flight path, except that obstacles lying beyond 1 500 m on either side of the flight path need not be cleared.

The distance D is the horizontal distance that the aeroplane has travelled from the end of the take-off distance available.

Note.*— This need not be carried beyond the point at which the aeroplane would be able, without further gaining in height, to commence a landing procedure at the aerodrome of take-off or, alternatively, has attained the minimum safe altitude for commencing flight to another aerodrome.*

However, the lateral obstacle clearance is liable to be reduced (below the values stated above) when, and to the extent that, this is warranted by special provisions or conditions which assist the pilot to avoid inadvertent lateral deviations from the intended flight path. For example, particularly in poor weather conditions, a precise radio aid may assist the pilot to maintain the intended flight path. Also, when the take-off is made in sufficiently good visibility conditions, it may, in some cases, be possible to avoid obstacles which are clearly visible but may be within the lateral limits noted in 3.2 c).

Note 1. *— The procedures used in defining the accelerate-stop distance required, the take-off distance required and the take-off flight path are described in the Appendix to this example.*

Note 2. *— In some national codes similar to this example, the specification for "performance" at take-off is such that no credit can be taken for any increase in length of accelerate-stop distance available and take-off distance available beyond the length specified in Section 1 for take-off run available. Those codes specify a vertical clearance of not less than 15.2 m (50 ft) above all obstacles lying within 60 m on either side of the flight path while still within the confines of the aerodrome, and 90 m on either side of the flight path when outside those confines.*

It is to be observed that those codes are such that they do not provide for an alternative to the method of elements (see the Appendix to this example) in the determination of the take-off path. It is considered that those codes are compatible with the general intent of this example.

3.3 **Conditions**

For the purpose of 3.1 and 3.2, the performance is that corresponding to:

a) The mass of the aeroplane at the start of take-off;
b) An altitude equal to the elevation of the aerodrome; and for the purpose of 3.2:
c) The ambient temperature at the time of take-off for 3.2 a) and b) only;
d) The runway slope in the direction of take-off (landplanes);
e) Not more than 50 per cent of the reported wind component opposite to the direction of take-off, and not less than 150 per cent of the reported wind component in the direction of take-off. In certain cases of operation of seaplanes, it has been found necessary to take account of the reported wind component normal to the direction of take-off.

3.4 **Critical point**

In applying 3.2 the critical point chosen for establishing compliance with 3.2 a) is not nearer to the starting point than that used for establishing compliance with 3.2 b) and 3.2 c).

3.5 **Turns**

In case the flight path includes a turn with bank greater than 15 degrees, the clearances specified in 3.2 c) are increased by an adequate amount during the turn, and the distance D is measured along the intended track.

4. EN ROUTE

4.1 One engine inoperative

4.1.1 At all points along the route or planned diversion therefrom, the aeroplane is capable, at the minimum flight altitudes en route, of a steady rate of climb with one engine inoperative, as determined from the flight manual, of at least

1) $K\left(\frac{V_{s_o}}{185.2}\right)^2$ m/s, V_{s_o} being expressed in km/h;

2) $K\left(\frac{V_{s_o}}{100}\right)^2$ m/s, V_{s_o} being expressed in kt;

3) $K\left(\frac{V_{s_o}}{100}\right)^2$ ft/min, V_{s_o} being expressed in kt;

and K having the following value:

$K = 4.04 - \frac{5.40}{N}$ in the case of 1) and 2); and

$K = 797 - \frac{1\,060}{N}$ in the case of 3)

where N is the number of engines installed.

It should be noted that minimum flight altitudes are usually considered to be not less than 300 m (1 000 ft) above terrain along and adjacent to the flight path.

4.1.2 As an alternative to 4.1.1 the aeroplane is operated at an all engines operating altitude such that, in the event of an engine failure, it is possible to continue the flight to an aerodrome where a landing can be made in accordance with 5.3, the flight path clearing all terrain and obstructions along the route within 8 km (4.3 NM) on either side of the intended track by at least 600 m (2 000 ft). In addition, if such a procedure is utilized, the following provisions are complied with:

a) The rate of climb, as determined from the flight manual for the appropriate mass and altitude, used in calculating the flight path is diminished by an amount equal to

1) $K\left(\frac{V_{s_o}}{185.2}\right)^2$ m/s, V_{s_o} being expressed in km/h;

2) $K\left(\frac{V_{s_o}}{100}\right)^2$ m/s, V_{s_o} being expressed in kt;

3) $K\left(\frac{V_{s_o}}{100}\right)^2$ ft/min, V_{s_o} being expressed in kt;

and K having the following value:

$K = 4.04 - \frac{5.40}{N}$ in the case of 1) and 2); and

$K = 797 - \frac{1\,060}{N}$ in the case of 3)

where N is the number of engines installed.

b) The aeroplane complies with 4.1.1 at 300 m (1 000 ft) above the aerodrome used as an alternate in this procedure;

c) After the engine failure considered, account is taken of the effect of winds and temperatures on the flight path;
d) It is assumed that the mass of the aeroplane as it proceeds along its intended track is progressively reduced by normal consumption of fuel and oil;
e) It is customary to assume such fuel jettisoning as is consistent with reaching the aerodrome in question.

4.2 **Two engines inoperative**
(Applicable only to aeroplanes with four engines)

The possibility of two engines becoming inoperative when the aeroplane is more than 90 minutes at all engines operating cruising speed from an en-route alternate aerodrome is catered for. This is done by verifying that at whatever such point such a double failure may occur, the aeroplane in the configuration and with the engine power specified in the flight manual can thereafter reach the alternate aerodrome without coming below the minimum flight altitude. It is customary to assume such fuel jettisoning as is consistent with reaching the aerodrome in question.

5. LANDING

5.1 Mass

The calculated mass for the expected time of landing at the aerodrome of intended landing or any destination alternate aerodrome is not to exceed the maximum specified in the flight manual for the elevation of that aerodrome.

5.2 Landing distance

5.2.1 Aerodrome of intended landing

The landing distance at the aerodrome of the intended landing, as determined from the flight manual, is not to exceed 60 per cent of the landing distance available on:

a) The most suitable landing surface for a landing in still air; and, if more severe,

b) Any other landing surface that may be required for landing because of expected wind conditions at the time of arrival.

5.2.2 **Alternate aerodromes**

The landing distance at any alternate aerodrome, as determined from the flight manual, is not to exceed 70 per cent of the landing distance available on:

a) The most suitable landing surface for a landing in still air; and, if more severe,

b) Any other landing surface that may be required for landing because of expected wind conditions at the time of arrival.

Note. *— The procedure used in determining the landing distance is described in the Appendix to this example.*

5.3 **Conditions**

For the purpose of 5.2, the landing distances are not to exceed those corresponding to:

a) The calculated mass of the aeroplane for the expected time of landing;

b) An altitude equal to the elevation of the aerodrome;

c) For the purpose of 5.2.1 a) and 5.2.2 a), still air;

a) For the purpose of 5.2.1 b) and 5.2.2 b), not more than 50 per cent of the expected wind component along the landing path and opposite to the direction of landing and not less than 150 per cent of the expected wind component in the direction of landing.

APPENDIX TO EXAMPLE 1 ON AEROPLANE PERFORMANCE OPERATING LIMITATIONS — PROCEDURES USED IN DETERMINING TAKE-OFF AND LANDING PERFORMANCE

1. GENERAL

1.1 Unless otherwise specified, Standard Atmosphere and still air conditions are applied.

1.2 Engine powers are based on a water vapor pressure corresponding to 80 per cent relative humidity in standard conditions. When performance is established for temperature above standard, the water vapor pressure for a given altitude is assumed to remain at the value stated above for standard atmospheric conditions.

1.3 Each set of performance data required for a particular flight condition is determined with the engine accessories absorbing the normal amount of power appropriate to that flight condition.

1.4 Various wing flap positions are selected. These positions are permitted to be made variable with mass, altitude and temperature in so far as this is considered consistent with acceptable operating practices.

1.5 The position of the centre of gravity is selected within the permissible range so that the performance achieved in the configuration and power indicated in the specification under consideration is a minimum.

1.6 The performance of the aeroplane is determined in such a manner that under all conditions the approved limitations for the engine are not exceeded.

1.7 The determined performance is so scheduled that it can serve directly in showing compliance with the aeroplane performance operating limitations.

2. TAKE-OFF

2.1 **General**

2.1.1 The take-off performance data are determined:

a) For the following conditions:

1) Sea level;

2) Aeroplane mass equal to the maximum take-off mass at sea level;

3) Level, smooth, dry and hard take-off surfaces (landplanes);

4) Smooth water of declared density (seaplanes);

b) Over selected ranges of the following variables:

1) Atmospheric conditions, namely: altitude and also pressure-altitude and temperature;

2) Aeroplane mass;

3) steady wind velocity parallel to the direction of take-off;

4) steady wind velocity normal to the direction of take-off (seaplanes);

5) Uniform take-off surface slope (landplanes);

6) Type of take-off surface (landplanes);

7) Water surface condition (seaplanes);

8) Density of water (seaplanes);

9) Strength of current (seaplanes).

2.1.2 The methods of correcting the performance data to obtain data for adverse atmospheric conditions include appropriate allowance for any increased airspeeds and cowl flap or radiator shutter openings necessary under such conditions to maintain engine temperatures within appropriate limits.

2.1.3 For seaplanes appropriate interpretations of the term landing gear, etc., are made to provide for the operation of retractable floats, if employed.

2.2 **Take-off safety speed**

2.2.1 The take-off safety speed is an airspeed (CAS) so selected that it is not less than:

a) 1.20 V_{S1}, for aeroplanes with two engines;
b) 1.15 V_{S1}, for aeroplanes having more than two engines;
c) 1.10 times the minimum control speed, VMC, established as prescribed in 2.3;

Where V_{S1} is appropriate to the configuration, as described in 2.3.1 b), c) and d).

2.3 **Minimum control speed**

2.3.1 The minimum control speed, VMC, is determined not to exceed a speed equal to 1.2 V_{S1} where V_{S1} corresponds with the maximum certificated take-off mass with:

a) Maximum take-off power on all engines;
b) Landing gear retracted;
c) Wing flaps in take-off position;
d) Cowl flaps and radiator shutters in the position recommended for normal use during take-off;

e) Aeroplane trimmed for take-off;

f) Aeroplane airborne and ground effect negligible.

2.3.2 The minimum control speed is such that, when any one engine is made inoperative at that speed, it is possible to recover control of the aeroplane with the one engine still inoperative and to maintain the aeroplane in straight flight at that speed either with zero yaw or with a bank not in excess of 5 degrees.

2.3.3 From the time at which the engine is made inoperative to the time at which recovery is complete, exceptional skill, alertness, or strength on the part of the pilot is not required to prevent any loss of altitude other than that implicit in the loss of performance or any change of heading in excess of 20 degrees, nor does the aeroplane assume any dangerous attitude.

2.3.4 It is demonstrated that to maintain the aeroplane in steady straight flight at this speed after recovery and before retiming does not require a rudder control force exceeding 800 N and does not make it necessary for the flight crew to reduce the power of the remaining engines.

2.4 **Critical point**

2.4.1 The critical point is a selected point at which, for the purpose of determining the accelerate-stop distance and the take-off path, failure of the critical engine is assumed to occur. The pilot is provided with a ready and reliable means of determining when the critical point has been reached.

2.4.2 If the critical point is located so that the airspeed at that point is less than the take-off safety speed, it is demonstrated that, in the event of sudden failure of the critical engine at all speeds down to the lowest speed corresponding with the critical point, the aeroplane is controllable satisfactorily and that the take-off can be continued safely, using normal piloting skill, without reducing the thrust of the remaining engines.

2.5 **Accelerate-stop distance required**

2.5.1 The accelerate-stop distance required is the distance required to reach the critical point from a standing start and, assuming the critical engine to fail suddenly at this point, to stop if a landplane, or to bring the aeroplane to a speed of approximately 6 km/h (3 kt) if a seaplane.

2.5.2 Use of braking means in addition to, or in lieu of, wheel brakes is permitted in determining this distance, provided that they are reliable and that the manner of their employment is such that consistent results can be expected under normal conditions of operation, and provided that exceptional skill is not required to control the aeroplane.

2.5.3 The landing gear remains extended throughout this distance.

2.6 **Take-off path**

2.6.1 **General**

2.6.1.1 The take-off path is determined either by the method of elements, 2.6.2, or by the continuous method, 2.6.3, or by any acceptable combination of the two.

2.6.1.2 Adjustment of the provisions of 2.6.2.1 c) 1) and 2.6.3.1 c) is permitted when the take-off path would be affected by the use of an automatic pitch changing device, provided that a level of performance safety exemplified by 2.6 is demonstrated.

2.6.2 **Method of elements**

2.6.2.1 In order to define the take-off path, the following elements are determined:

a) The distance required to accelerate the aeroplane from a standing start to the point at which the take-off safety speed is first attained, subject to the following provisions:

1) The critical engine is made inoperative at the critical point;

2) The aeroplane remains on or close to the ground;

3) The landing gear remains extended.

b) The horizontal distance traversed and the height attained by the aeroplane operating at the take-off safety speed during the time required to retract the landing gear, retraction being initiated at the end of 2.6.2.1 a) with:

1) The critical engine inoperative, its propeller wind milling, and the propeller pitch control in the position recommended for normal use during take-off, except that, if the completion of the retraction of the landing gear occurs later than the completion of the stopping of the propeller initiated in accordance with 2.6.2.1 c) 1), the propeller may be assumed to be stopped throughout the remainder of the time required to retract the landing gear;

2) The landing gear extended.

c) When the completion of the retraction of the landing gear occurs earlier than the completion of the stopping of the propeller, the horizontal distance traversed and the height attained by the aeroplane in the time elapsed from the end of 2.6.2.1 b) until the rotation of the inoperative propeller has been stopped, when:

1) The operation of stopping the propeller is initiated not earlier than the instant the aeroplane has attained a total height of 15.2 m (50 ft) above the take-off surface;

2) The aeroplane speed is equal to the take-off safety speed;

3) The landing gear is retracted;

4) The inoperative propeller is wind milling with the propeller pitch control in the position recommended for normal use during take-off.

d) The horizontal distance traversed and the height attained by the aeroplane in the time elapsed from the end of 2.6.2.1

e) Until the time limit on the use of take-off power is reached, while operating at the take-off safety speed, with:

1) The inoperative propeller stopped;

2) The landing gear retracted.

The elapsed time from the start of the take-off need not extend beyond a total of 5 minutes.

f) The slope of the flight path with the aeroplane in the configuration prescribed in 2.6.2.1 d) and with the remaining engine(s) operating within the maximum continuous power limitations, where the time limit on the use of take-off power is less than 5 minutes.

2.6.2.2 If satisfactory data are available, the variations in drag of the propeller during feathering and of the landing gear throughout the period of retraction are permitted to be taken into account in determining the appropriate portions of the elements.

2.6.2.3 During the take-off and subsequent climb represented by the elements, the wing flap control setting is not changed, except that changes made before the critical point has been reached, and not earlier than 1 minute after the critical point has been passed, are permitted; in this case, it is demonstrated that such changes can be accomplished without undue skill, concentration, or effort on the part of the pilot.

2.6.3 **Continuous method**

2.6.3.1 The take-off path is determined from an actual take-off during which:

a) The critical engine is made inoperative at the critical point;

b) The climb-away is not initiated until the take-off safety speed has been reached and the airspeed does not fall below this value in the subsequent climb;

c) Retraction of the landing gear is not initiated before the aeroplane reaches the take-off safety speed;

d) The wing flap control setting is not changed, except that changes made before the critical point has been reached, and not earlier than 1 minute after the critical point has been passed, are permitted; in this case, it is demonstrated that such changes can be accomplished without undue skill, concentration, or effort on the part of the pilot;

e) The operation of stopping the propeller is not initiated until the aeroplane has cleared a point 15.2 m (50 ft) above the take-off surface.

2.6.3.2 Suitable methods are provided and employed to take into account, and to correct for, any vertical gradient of wind velocity which may exist during the take-off.

2.7 **Take-off distance required**

The take-off distance required is the horizontal distance along the take-off flight path from the start of the take-off to a point where the aeroplane attains a height of 15.2 m (50 ft) above the take-off surface.

2.8 **Temperature accountability**

Operating correction factors for take-off mass and take-off distance are determined to account for temperature above and below those of the Standard Atmosphere. These factors are obtained as follows:

a) For any specific aeroplane type the average full temperature accountability is computed for the range of mass and altitudes above sea level, and for ambient temperatures expected in operation. Account is taken of the temperature effect both on the aerodynamic characteristics of the aeroplane and on the engine power. The full temperature accountability is expressed per degree of temperature in terms of a mass correction, a take-off distance correction and a change, if any, in the position of the critical point.

b) Where 2.6.2 is used to determine the take-off path, the operating correction factors for the aeroplane mass and take- off distance are at least one half of the full accountability values. Where 2.6.3 is used to determine the take-off path, the operating correction factors for the aeroplane mass and take-off distance are equal to the full accountability values. With both methods, the position of the critical point is further corrected by the average amount necessary to assure that the aeroplane can stop within the runway length at the ambient temperature, except that the speed at the critical point is not less than a minimum at which the aeroplane can be controlled with the critical engine inoperative.

3. LANDING

3.1 General

The landing performance is determined:

a) For the following conditions:

1) Sea level;

2) Aeroplane mass equal to the maximum landing mass at sea level;

3) Level, smooth, dry and hard landing surfaces (landplanes);

4) Smooth water of declared density (seaplanes);

b) Over selected ranges of the following variables:

1) Atmospheric conditions, namely: altitude and also pressure-altitude and temperature;

2) Aeroplane mass;

3) steady wind velocity parallel to the direction of landing;

4) Uniform landing-surface slope (landplanes);
5) Type of landing surface (landplanes);

6) Water surface condition (seaplanes);

7) Density of water (seaplanes);

8) Strength of current (seaplanes).

3.2 **Landing distance**

The landing distance is the horizontal distance between that point on the landing surface at which the aeroplane is brought to a complete stop or, for seaplanes, to a speed of approximately 6 km/h (3 Kts) and that point on the landing surface which the aeroplane cleared by 15.2 m (50 ft).

3.3 **Landing technique**

3.3.1 In determining the landing distance:

a) Immediately before reaching the 15.2 m (50 ft) height, a steady approach is maintained, landing gear fully extended, with an airspeed of not less than 1.3 Vso;

b) The nose of the aeroplane is not depressed in flight nor the forward thrust increased by application of engine power after reaching the 15.2 m (50 ft) height;

c) The wing flap control is set in the landing position, and remains constant during the final approach, flare out and touch down, and on the landing surface at air speeds above 0.9 Vso

When the aeroplane is on the landing surface and the airspeed has fallen to less than 0.9 Vs0, change of the wing-flap-control setting is permitted;

d) The landing is made in a manner such that there is no excessive vertical acceleration, no excessive tendency to bounce, and no display of any uncontrollable or otherwise undesirable ground (water) handling characteristics, and such that its repetition does not require either an exceptional degree of skill on the part of the pilot, or exceptionally favorable conditions;

e) Wheel brakes are not used in a manner such as to produce excessive wear of brakes or tires, and the operating pressures on the braking system are not in excess of those approved.

3.3.2 In addition to, or in lieu of, wheel brakes, other reliable braking means are permitted to be used in determining the landing distance, provided that the manner of their employment is such that consistent results can be expected under normal conditions of operation and that exceptional skill is not required to control the aeroplane.

3.3.3 The gradient of the steady approach and the details of the technique used in determining the landing distance, together with such variations in the technique as are recommended for landing with the critical engines inoperative, and any appreciable variation in landing distance resulting therefrom, are entered in the flight manual.

EXAMPLE 2

1. PURPOSE AND SCOPE

The purpose of the following example is to illustrate the level of performance intended by the provisions of Chapter 5 as applicable to the types of aeroplanes described below.

This material was contained in substance in Attachment C to the now superseded edition of ICAO Annex 6 which became effective on 1 May 1953. It is based on the type of requirements developed by the Standing Committee on Performance* with such detailed changes as are necessary to make it reflect as closely as possible a performance code that has been used nationally.

A substantial number of civil transport aeroplanes have been manufactured and are being operated in accordance with these codes. Those aeroplanes are powered with reciprocating engines, turbo-propellers and turbo-jets. They embrace twin- engine and four-engine aeroplanes over a mass range from approximately 5 500 kg to 70 000 kg over a stalling speed range, Vso, from approximately 110 to 170 km/h (60 to 90 Kts) and over a wing loading range from approximately 120 to 325 Kgs/M2 cruise speed range up to 740 Km/h (400Kts). Those aeroplanes have been used a very wide range of altitude, air temperature and humidity conditions.

Although only past experience can warrant the fact that this example illustrates the level of performance intended by the Standards and Recommended Practices of Chapter 5, it is considered to be applicable, except for some variations in detail as necessary to fit particular cases, over a much wider range of aeroplane characteristics. Reservation should, however, be made concerning one point. The landing distance specification of this example, not being derived from the same method as other specifications, is valid only for the range of conditions stated for Example 1 in this Attachment.

This example is not intended for application to aeroplanes having short take-off and landing (STOL) or vertical take-off and landing (VTOL) capabilities.

No detailed study has been made of the applicability of this example to operations in all-weather conditions. The validity of this example has not therefore been established for operations which may involve low decision heights and be associated with low weather minima operating techniques and procedures.

* The ICAO Standing Committee on Performance, established as a result of recommendations of the Airworthiness and Operations Divisions at their Fourth Sessions, in 1951, met four times between 1951 and 1953.

2. TAKE-OFF

2.1 Mass

The mass of the aeroplane at take-off is not to exceed the maximum take-off mass specified in the flight manual for the altitude and temperature at which the take-off is to be made.

2.2 Performance

The performance of the aeroplane, as determined from the information contained in the flight manual, is such that:

a) The accelerate-stop distance required does not exceed the accelerate-stop distance available;

b) The take-off run required does not exceed the take-off run available;

c) The take-off distance required does not exceed the take-off distance available;

d) The net take-off flight path starting at a point 10.7 m (35 ft) above the ground at the end of the take-off distance required provides a vertical clearance of not less than 6 m (20 ft) plus 0.005D above all obstacles lying within 60 m plus half the wing span of the aeroplane plus 0.125D on either side of the intended track until the relevant altitude laid down in the operations manual for an en-route flight has been attained; except that obstacles lying beyond 1 500 m on either side of the flight path need not be cleared.

The distance D is the horizontal distance that the aeroplane has travelled from the end of the take-off distance available.

Note.*— This need not be carried beyond the point at which the aeroplane would be able, without further gaining in height, to commence a landing procedure at the aerodrome of take-off or, alternatively, has attained the minimum safe altitude for commencing flight to another aerodrome.*

However, the lateral obstacle clearance is liable to be reduced (below the values stated above) when, and to the extent that, this is warranted by special provisions or conditions which assist the pilot to avoid inadvertent lateral deviations from the intended flight path.

For example, particularly in poor weather conditions, a precise radio aid may assist the pilot to maintain the intended flight path. Also, when the take-off is made in sufficiently good visibility conditions, it may, in some cases, be possible to avoid obstacles which are clearly visible but may be within the lateral limits noted in 2.2 d).

Note. *— The procedures used in determining the accelerate-stop distance required, the take-off run required, the take-off distance required and the net take-off flight path are described in the Appendix to this example.*

2.3 **Conditions**

For the purpose of 2.1 and 2.2, the performance is that corresponding to:

a) The mass of the aeroplane at the start of take-off;

b) An altitude equal to the elevation of the aerodrome;

c) Either the ambient temperature at the time of take-off, or a declared temperature giving an equivalent average level of performance; and for the purpose of 2.2:

d) The surface slope in the direction of take-off (landplanes);

e) Not more than 50 per cent of the reported wind component opposite to the direction of take-off, and not less than 150 per cent of the reported wind component in the direction of take-off. In certain cases of operation of seaplanes, it has been found necessary to take account of the reported wind component normal to the direction of take-off.

2.4 **Power failure point**

In applying 2.2 the power failure point chosen for establishing compliance with 2.2 a) is not nearer to the starting point than that used for establishing compliance with 2.2 b) and 2.2 c).

2.5 **Turns**

The net take-off flight path may include turns, provided that:

a) The radius of steady turn assumed is not less than that scheduled for this purpose in the flight manual;

b) If the planned change of direction of the take-off flight path exceeds 15 degrees, the clearance of the net take-off flight path above obstacles is at least 30 m (100 ft) during and after the turn, and the appropriate allowance, as prescribed in the flight manual, is made for the reduction in assumed gradient of climb during the turn;

c) The distance D is measured along the intended track.

3. EN ROUTE

3.1 **All engines operating**

At each point along the route and planned diversion therefrom, the all engines operating performance ceiling appropriate to the aeroplane mass at that point, taking into account the amount of fuel and oil expected to be consumed, is not less than the minimum altitude (see Chapter 4, 4.2.6) or, if greater, the planned altitude which it is intended to maintain with all engines operating, in order to ensure compliance with 3.2 and 3.3.

3.2 **One engine inoperative**

From each point along the route and planned diversions therefrom, it is possible in the event of one engine becoming inoperative to continue the flight to an en-route alternate aerodrome where a landing can be made in accordance with 4.2 and, on arrival at the aerodrome, the net gradient of climb is not less than zero at a height of 450 m (1 500 ft) above the elevation of the aerodrome.

3.3 **Two engines inoperative**
(Applicable only to aeroplanes with four engines)

For each point along the route or planned diversions therefrom, at which the aeroplane is more than 90 minutes’ flying time at all engines operating cruising speed from an en-route alternate aerodrome, the two engines inoperative net flight path is such that a height of at least 300 m (1 000 ft.) above terrain can be maintained until arrival at such an aerodrome.

***Note.** — The net flight path is that attainable from the expected gradient of climb or descent diminished by 0.2 per cent.*

3.4 **Conditions**

The ability to comply with 3.1, 3.2 and 3.3 is assessed:

a) Either on the basis of forecast temperatures, or on the basis of declared temperatures giving an equivalent average level of performance;

b) On the forecast data on wind velocity versus altitude and locality assumed for the flight plan as a whole;

c) In the case of 3.2 and 3.3, on the scheduled gradient of climb or gradient of descent after power failure appropriate to the mass and altitude at each point considered;

d) On the basis that, if the aeroplane is expected to gain altitude at some point in the flight after power failure has occurred, a satisfactory positive net gradient of climb is available;

e) In the case of 3.2 on the basis that the minimum altitude (see Chapter 4, 4.2.6), appropriate to each point between the place at which power failure is assumed to occur and the aerodrome at which it is intended to alight, is exceeded;

f) In the case of 3.2, making reasonable allowance for indecision and navigational error in the event of engine failure at any point.

4. LANDING

4.1 Mass

The calculated mass for the expected time of landing at the aerodrome of intended landing or any destination alternate aerodrome is not to exceed the maximum specified in the flight manual for the altitude and temperature at which the landing is to be made.

4.2 Landing distance required

The landing distance required at the aerodrome of the intended landing or at any alternate aerodrome, as determined from the flight manual, is not to exceed the landing distance available on:

a) The most suitable landing surface for a landing in still air; and, if more severe,

b) Any other landing surface that may be required for landing because of expected wind conditions at the time of arrival.

4.3 Conditions

For the purpose of 4.2, the landing distance required is that corresponding to:

a) The calculated mass of the aeroplane for the expected time of landing;
b) An altitude equal to the elevation of the aerodrome;

c) The expected temperature at which landing is to be made or a declared temperature giving an equivalent average level of performance;

d) The surface slope in the direction of landing;

e) For the purpose of 4.2 a), still air;

f) For the purpose of 4.2 b), not more than 50 per cent of the expected wind component along the landing path and opposite to the direction of landing and not less than 150 per cent of the expected wind component in the direction of landing.

APPENDIX TO EXAMPLE 2 ON AEROPLANE PERFORMANCE OPERATING LIMITATIONS — PROCEDURES USED IN DETERMINING TAKE-OFF AND LANDING PERFORMANCE

1. GENERAL

1.1 Unless otherwise stated, reference humidity and still air conditions are applied.

1.2 The performance of the aeroplane is determined in such a manner that the approved airworthiness limitations for the aeroplane and its systems are not exceeded.

1.3 The wing flap positions for showing compliance with the performance specifications are selected.

***Note.** — Alternative wing flap positions are made available, if so desired, in such a manner as to be consistent with acceptably simple operating techniques.*

1.4 The position of the centre of gravity is selected within the permissible range so that the performance achieved in the configuration and power indicated in the specification under consideration is a minimum.

1.5 The performance of the aeroplane is determined in such a manner that under all conditions the approved limitations for the engine are not exceeded.

1.6 While certain configurations of cooling gills have been specified based upon maximum anticipated temperature, the use of other positions is acceptable provided that an equivalent level of safety is maintained.

1.7 The determined performance is so scheduled that it can serve directly in showing compliance with the aeroplane performance operating limitations.

2. TAKE-OFF

2.1 General

2.1.1 The following take-off data are determined for sea level pressure and temperature in the Standard Atmosphere, and reference humidity conditions, with the aeroplane at the corresponding maximum take-off mass for a level, smooth, dry and hard take-off surface (landplanes) and for smooth water of declared density (seaplanes):

a) Take-off safety speed and any other relevant speed;

b) Power failure point;

c) Power failure point criterion, e.g. airspeed indicator reading; associated with items d), e), f)

d) Accelerate-stop distance required;

e) Take-off run required;

f) Take-off distance required;

g) Net take-off flight path;

h) Radius of a steady Rate 1 (180 degrees per minute) turn made at the airspeed used in establishing the net take-off flight path, and the corresponding reduction in gradient of climb in accordance with the conditions of 2.9.

2.1.2 The determination is also made over selected ranges of the following variables:

a) Aeroplane mass;

b) Pressure-altitude at the take-off surface;

c) Outside air temperature;

d) Steady wind velocity parallel to the direction of take-off;

e) Steady wind velocity normal to the direction of take-off (seaplanes);

f) Take-off surface slope over the take-off distance required (landplanes);

g) Water surface condition (seaplanes);

h) Density of water (seaplanes);

i) Strength of current (seaplanes);

j) Power failure point (subject to provisions of 2.4.3).

2.1.3 For seaplanes appropriate interpretations of the term landing gear, etc., are made to provide for the operation of retractable floats, if employed.

2.2 Take-off safety speed

2.2.1 The take-off safety speed is an airspeed (CAS) so selected that it is not less than:

a) 1.20 V_{S1}, for aeroplanes with two engines;

b) 1.15 V_{S1}, for aeroplanes having more than two engines;

c) 1.10 times the minimum control speed, VMC, established as prescribed in 2.3;

d) The minimum speed prescribed in 2.9.7.6; where is V_{S1} appropriate to the take-off configuration.

Note. *— See Example 1 for definition of V1.*

2.3 Minimum control speed

2.3.1 The minimum control speed is such that, when any one engine is made inoperative at that speed, it is possible to recover control of the aeroplane with the one engine still inoperative and to maintain the aeroplane in straight flight at that speed either with zero yaw or with a bank not in excess of 5 degrees.

2.3.2 From the time at which the engine is made inoperative to the time at which recovery is complete, exceptional skill, alertness, or strength, on the part of the pilot is not required to prevent any loss of altitude other than that implicit in the loss of performance or any change of heading in excess of 20 degrees, nor does the aeroplane assume any dangerous attitude.

2.3.3 It is demonstrated that to maintain the aeroplane in steady straight flight at this speed after recovery and before retiming does not require a rudder control force exceeding 800 N and does not make it necessary for the flight crew to reduce the power of the remaining engines.

2.4 **Power failure point**

2.4.1 The power failure point is the point at which sudden complete loss of power from the engine, critical from the performance aspect in the case considered, is assumed to occur. If the airspeed corresponding to this point is less than the take-off safety speed, it is demonstrated that, in the event of sudden failure of the critical engine at all speeds down to the lowest speed corresponding with the power failure point, the aeroplane is controllable satisfactorily and that the take-off can be continued safely, using normal piloting skill, without:

a) Reducing the thrust of the remaining engines; and

b) Encountering characteristics which would result in unsatisfactory controllability on wet runways.

2.4.2 If the critical engine varies with the configuration, and this variation has a substantial effect on performance, either the critical engine is considered separately for each element concerned, or it is shown that the established performance provides for each possibility of single engine failure.

2.4.3 The power failure point is selected for each take-off distance required and take-off run required, and for each accelerate-stop distance required. The pilot is provided with a ready and reliable means of determining when the applicable power failure point has been reached.

2.5 **Accelerate-stop distance required**

2.5.1 The accelerate-stop distance required is the distance required to reach the power failure point from a standing start and, assuming the critical engine to fail suddenly at this point, to stop if a landplane, or to bring the aeroplane to a speed of approximately 9 km/h (5 kt) if a seaplane.

2.5.2 Use of braking means in addition to, or in lieu of, wheel brakes is permitted in determining this distance, provided that they are reliable and that the manner of their employment is such that consistent results can be expected under normal conditions of operation, and provided that exceptional skill is not required to control the aeroplane.

2.6 Take-off run required

The take-off run required is the greater of the following:

a. 1.15 times the distance required with all engines operating to accelerate from a standing start to take-off safety speed;

b. 1.0 times the distance required to accelerate from a standing start to take-off safety speed assuming the critical engine to fail at the power failure point.

2.7 Take-off distance required

2.7.1 The take-off distance required is the distance required to reach a height of:

a. 10.7 m (35 ft.), for aeroplanes with two engines,

b. 15.2 m (50 ft.), for aeroplanes with four engines,

Above the take-off surface, with the critical engine failing at the power failure point.

2.7.2 The heights mentioned above are those which can be just cleared by the aeroplane when following the relevant flight path in an unbanked attitude with the landing gear extended.

Note.— *Paragraph 2.8 and the corresponding operating requirements, by defining the point at which the net take-off flight path starts as the 10.7 m (35 ft) height point, ensure that the appropriate net clearances are achieved.*

2.8 Net take-off flight path

2.8.1 The net take-off flight path is the one-engine-inoperative flight path which starts at a height of 10.7 m (35 ft) at the end of the take-off distance required and extends to a height of at least 450 m (1 500 ft) calculated in accordance with the conditions of 2.9, the expected gradient of climb being diminished at each point by a gradient equal to:

a. 0.5 per cent, for aeroplanes with two engines,

b. 0.8 per cent, for aeroplanes with four engines.

2.8.2 The expected performance with which the aeroplane is credited in the take-off wing flap, take-off power condition, is available at the selected take-off safety speed and is substantially available at 9 km/h (5 kts) below this speed.

2.8.3 In addition the effect of significant turns is scheduled as follows:

Radius. The radius of a steady Rate 1 (180 degrees per minute) turn in still air at the various true airspeeds corresponding to the take-off safety speeds for each wing-flap setting used in establishing the net take-off flight path below the 450 m (1 500 ft) height point, is scheduled.

Performance change. The approximate reduction in performance due to the above turns is scheduled and corresponds to a change in gradient of

$$\left[0.5\left(\frac{V}{185.2}\right)^2\right] \text{ \% where V is the true airspeed in km/h; and}$$

$$\left[0.5\left(\frac{V}{100}\right)^2\right] \text{ \% where V is the true airspeed in knots.}$$

2.9 **Conditions**

2.9.1 **Air speed**

2.9.1.1 In determining the take-off distance required, the selected take-off safety speed is attained before the end of the take-off distance required is reached.

2.9.1.2 In determining the net take-off flight path below a height of 120 m (400 ft), the selected take-off safety speed is maintained, i.e. no credit is taken for acceleration before this height is reached.

2.9.1.3 In determining the net take-off flight path above a height of 120 m (400 ft), the airspeed is not less than the selected take-off safety speed. If the aeroplane is accelerated after reaching a height of 120 m (400 ft) and before reaching a height of 450 m (1 500 ft), the acceleration is assumed to take place in level flight and to have a value equal to the true acceleration available diminished by an acceleration equivalent to a climb gradient equal to that specified in 2.8.1.

2.9.1.4 The net take-off flight path includes transition to the initial en-route configuration and airspeed. During all transition stages, the above provisions regarding acceleration are complied with.

2.9.2 **Wing flaps**

The wing flaps are in the same position (take-off position) throughout, except:

a) That the flaps may be moved at heights above 120 m (400 ft), provided that the airspeed specifications of 2.9.1 are met and that the take-off safety speed applicable to subsequent elements is appropriate to the new flap position;

b) The wing flaps may be moved before the earliest power failure point is reached, if this is established as a satisfactory normal procedure.

2.9.3 **Landing gear**

2.9.3.1 In establishing the accelerate-stop distance required and the take-off run required, the landing gear are extended throughout.

2.9.3.2 In establishing the take-off distance required, retraction of the landing gear is not initiated until the selected take-off safety speed has been reached, except that, when the selected take-off safety speed exceeds the minimum value prescribed in 2.2, retraction of the landing gear may be initiated when a speed greater than the minimum value prescribed in 2.2 has been reached.

2.9.3.3 In establishing the net take-off flight path, the retraction of the landing gear is assumed to have been initiated not earlier than the point prescribed in 2.9.3.2.

2.9.4 **Cooling**

For that part of the net take-off flight path before the 120 m (400 ft) height point, plus any transition element which starts at the 120 m (400 ft) height point, the cowl flap position is such that, starting the take-off at the maximum temperatures permitted for the start of take-off, the relevant maximum temperature limitations are not exceeded in the maximum anticipated air temperature conditions. For any subsequent part of the net take-off flight path, the cowl flap position and airspeed are such that the appropriate temperature limitations would not be exceeded in steady flight in the maximum anticipated air temperatures.

The cowl flaps of all engines at the start of the take-off are as above, and the cowl flaps of the inoperative engine may be assumed to be closed upon reaching the end of the take-off distance required.

2.9.5 **Engine conditions**

2.9.5.1 From the starting point to the power failure point, all engines may operate at maximum take-off power conditions. The operative engines do not operate at maximum take-off power limitations for a period greater than that for which the use of maximum take-off power is permitted.

2.9.5.2 After the period for which the take-off power may be used, maximum continuous power limitations are not exceeded. The period for which maximum take-off power is used is assumed to begin at the start of the take-off run.

2.9.6 **Propeller conditions**

At the starting point, all propellers are set in the condition recommended for take-off. Propeller feathering or pitch coarsening is not initiated (unless it is by automatic or auto-selective means) before the end of the take-off distance required.

2.9.7 **Technique**

2.9.7.1 In that part of the net take-off flight path prior to the 120 m (400 ft) height point, no changes of configuration or power are made which have the effect of reducing the gradient of climb.

2.9.7.2 The aeroplane is not flown or assumed to be flown in a manner which would make the gradient of any part of the net take-off flight path negative.

2.9.7.3 The technique chosen for those elements of the flight path conducted in steady flight, which are not the subject of numerical climb specifications, are such that the net gradient of climb is not less than 0.5 per cent.

2.9.7.4 All information which it may be necessary to furnish to the pilot, if the aeroplane is to be flown in a manner consistent with the scheduled performance, is obtained and recorded.

2.9.7.5 The aeroplane is held on, or close to the ground until the point at which it is permissible to initiate landing gear retraction has been reached.

2.9.7.6 No attempt is made to leave the ground until a speed has been reached which is at least:

a. 15 per cent above the minimum possible unstick speed with all engines operating;

b. 17 per cent above the minimum possible unstick speed with the critical engine inoperative;

Except that these unstick speed margins may be reduced to 10 per cent and 5 per cent, respectively, when the limitation is due to landing gear geometry and not to ground stalling characteristics.

Note. *— Compliance with this specification is determined by attempting to leave the ground at progressively lower speeds (by normal use of the controls except that up-elevator is applied earlier and more coarsely than is normal) until it has been shown to be possible to leave the ground at a speed which complies with these specifications, and to complete the take- off. It is recognized that during the test maneuver, the usual margin of control associated with normal operating techniques and scheduled performance information will not be available.*

2.10 **Methods of derivation**

2.10.1 **General**

The take-off field lengths required are determined from measurements of actual take-offs and ground runs. The net take-off flight path is determined by calculating each section separately on the basis of performance data obtained in steady flight.

2.10.2 **Net take-off flight path**

Credit is not taken for any change in configuration until that change is complete, unless more accurate data are available to substantiate a less conservative assumption; ground effect is ignored.

2.10.3 **Take-off distance required**

Satisfactory corrections for the vertical gradient of wind velocity are made.

3. LANDING

3.1 General

The landing distance required is determined:

a) For the following conditions:

1) Sea level;

2) Aeroplane mass equal to the maximum landing mass at sea level;

3) Level, smooth, dry and hard landing surfaces (landplanes);

4) Smooth water of declared density (seaplanes);

b) Over selected ranges of the following variables:

1) Atmospheric conditions, namely: altitude, or pressure-altitude and temperature;

2) Aeroplane mass;

3) Steady wind velocity parallel to the direction of landing;

4) Uniform landing surface slope (landplanes);

5) Nature of landing surface (landplanes);

6) Water surface condition (seaplanes);

7) Density of water (seaplanes);

8) Strength of current (seaplanes).

3.2 **Landing distance required**

The landing distance required is the measured horizontal distance between that point on the landing surface at which the aeroplane is brought to a complete stop or, for seaplanes,

to a speed of approximately 9 km/h (5 kts) and that point on the landing surface which the aeroplane cleared by 15.2 m (50 ft.) multiplied by a factor of 1/0.7.

Note. — Some States have found it necessary to use a factor of 1/0.6 instead of 1/0.7.

3.3 **Landing technique**

3.3.1 In determining the measured landing distance:

a) Immediately before reaching the 15.2 m (50 ft.) height, a steady approach is maintained, landing gear fully extended, with an airspeed of at least 1.3 Vs0;

Note. *— See Example 1 for definition of Vs0.*

b) the nose of the aeroplane is not depressed in flight nor the forward thrust increased by application of engine power after reaching the 15.2 m (50 ft.) height;

c) the power is not reduced in such a way that the power used for establishing compliance with the balked landing climb requirement would not be obtained within 5 seconds if selected at any point down to touch down;

d) Reverse pitch or reverse thrust are not used when establishing the landing distance using this method and field length factor. Ground fine pitch is used if the effective drag/weight ratio in the airborne part of the landing distance is not less satisfactory than that of conventional piston-engine aeroplane;

Note. *— This does not mean that reverse pitch or reverse thrust, or use of ground fine pitch, are to be discouraged.*

e) The wing flap control is set in the landing position, and remains constant during the final approach, flare out and touch down, and on the landing surface at airspeeds above 0.9Vs0.

When the aeroplane is on the landing surface and the airspeed has fallen to less than 0.9 Vs0, change of the wing-flap-control setting is acceptable;

f) The landing is made in a manner such that there is no excessive vertical acceleration, no excessive tendency to bounce, and no display of any other undesirable handling characteristics, and such that its repetition does not require either an exceptional degree of skill on the part of the pilot, or exceptionally favorable conditions;

g) Wheel brakes are not used in a manner such as to produce excessive wear of brakes or tires, and the operating pressures on the braking system are not in excess of those approved.

3.3.2 The gradient of the steady approach and the details of the technique used in determining the landing distance, together with such variations in the technique as are recommended for landing with the critical engine inoperative, and any appreciable variation in landing distance resulting therefrom, are entered in the flight manual.