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Aircraft Performance Code

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Aircraft Performance Code

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Appendix 1

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FOREWORD

This Aeroplane Performance Code (APC) is primarily intended for application to large turbine-powered subsonic transport type aeroplanes having two or more engines. However, where relevant, it can be applied to all turbine or piston-powered subsonic aeroplanes having two or more engines. It is not intended for application to STOL or VTOL aeroplanes.

This manual is subject to regular review and improvement as approved by the Director General. The CAASL has authority to amend the manual, as necessary, to conform to the Sri Lanka Safety Oversight Program.

This manual will be treated as a dynamic document. As a result of amendments to the Sri Lanka Civil Aviation legislation and the progress of aviation safety practices, there will be the need for amendments.

Contribution of meaningful ideas for the improvement of the content of this manual is therefore encouraged and requested from all users.

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October 2010

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Abbreviations

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Definitions

CAS: (Calibrated Airspeed). The calibrated airspeed is equal to the airspeed indicator reading corrected for position and instrument error.

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

IMC: The symbol used to designate instrument meteorological conditions.

V_{MC}: The symbol used to designate visual meteorological conditions.

V_{LOF}: The lift-off speed

V_{MCA}: The minimum control speed

V_{MCG}: The minimum control speed on the ground

V_{MCLD}: The minimum control speed in approach and landing for discontinued approach

V_{MCLC}: The minimum control speed in approach and landing for continued approach

V_{MU}: The minimum unstick speed

V_R: The rotation speed

V_S: The stalling speed

V_1: The decision speed

V_2: The initial climb-out speed

V_{2min}: The minimum take-off safety speed

V_{TMD}: The minimum demonstrated threshold speed

V_{Tmin}: The minimum threshold speed

V_{Tmax}: The maximum threshold speed

Chapter 1

Airworthiness Specification

1. General

1.1 The performance of the aeroplane should be determined in such a manner that it is representative of the performance that reasonably can be assured to exist in service.

1.2 The performance of the aeroplane should be determined and scheduled in accordance with, and should meet the minima prescribed by, the specifications contained in this APC.

1.3 These APC specifications should be complied with at all combinations of weights, altitudes, ambient temperatures and throughout the allowable range of centre of gravity for which the applicant is presenting the aeroplane for certification.

1.4 Unless otherwise specifically prescribed, the performance should correspond with ambient atmospheric conditions and still air.

1.5 The performance as affected by engine power and/or thrust should be based on a relative humidity of 80 per cent at and below standard temperatures and of 34 per cent at and above standard temperatures plus 28ºC (5OºF); between these two temperatures the relative humidity should vary linearly. If engines particularly sensitive to variations in humidity are employed, a more precise method of accounting for humidity should be used.

1.6 The performance should correspond with the propulsive thrust available under particular ambient atmospheric conditions, the particular flight condition, and the relative humidity specified in 1.5. The available propulsive thrust should correspond with engine power and/or thrust not exceeding the approved power and/or thrust, less the installational losses and less the power and/or equivalent thrust absorbed by the accessories and services appropriate to the particular ambient atmospheric conditions and the particular flight condition.

Note: “Approved” is used here to mean the engine manufacture’s approved power or the fleet mean power.

1.7 The airspeed indicator and any supplementary cockpit instrumentation used in demonstrating the performance associated with an airspeed to be used in operation should be of the same accuracy as those approved for use in service.

2. Aeroplane Configuration and Procedures

2.1 The aeroplane configuration (setting of wing and cowl flaps, air brakes, landing gear, propeller, etc.), denoted respectively as the take-off, en-route, approach and landing configurations, should be selected by the applicant except as otherwise specified.

2.2 It should be acceptable to make the aeroplane configurations variable with weight, altitude, and temperature, to an extent considered compatible with operating procedures specified in 2.3.

2.3 In determining the accelerate-stop distances, take-off flight paths, takeoff distances and landing distances, changes in the aeroplane configuration and speed, and in the power and/or thrust should be in accordance with procedures established by the applicant for the operation of the aeroplane in service, except as otherwise specified. In addition, procedures should be established for the execution of balked landings and missed approaches associated with the conditions specified in 6.2 and 6.3.4 respectively. All procedures should comply with 2.3.1 to 2.3.3 inclusive.

2.3.1 The procedures should be such that they can be consistently executed in service by crews of average skill.

2.3.2 The procedures should not involve methods or the use of devices which have not been proven to be safe and reliable.

2.3.3 Allowance should be made for such time delays in the execution of the procedures as may be reasonably expected to occur during service.

3. Stalling Speed

3.1 The speed VS should denote the calibrated stalling speed, or the minimum: steady flight speed at which the aeroplane is controllable, in knots, with:

a. Zero thrust at the stalling speed, or engines idling and throttles closed if it is shown that the resultant thrust does not lower the stalling speed appreciably;

b. If applicable, propeller pitch controls in the position necessary for compliance with (a) , the aeroplane in all other respects (flaps ,landing gear, etc.) in the particular configuration corresponding with that in connection with which V_S is being used;

c. The weight of the aeroplane equal to the weight in connection with which VS is being used to determine compliance with a particular specification;

d. The centre of gravity in the most unfavorable position within the allowable range appropriate to the weight being considered.

3.2 The stalling speed should be the minimum speed in flight at which the aeroplane can develop a lift equal to the weight of the aeroplane, the lift being the aerodynamic force perpendicular to the flight path. The flight test should be conducted in accordance with 3.2.1 and 3.2.2.

Note 1: The stalling speed used in this specification is commonly known as the 1g stalling speed. However, stalling speeds can be determined by several acceptable methods. When these other acceptable alternatives are used, the factors to be applied to stalling speed in the determination of operational speeds will need to be adjusted in order to achieve the intended level of safety.

Note 2: In flight tests to determine V_S, it is not possible to achieve a load factor of unity and it is necessary to utilize the data obtained during the stalling demonstration to establish the speed corresponding with a load factor (n) of unity normal to the flight path, the stalling speed V_S defined in 3.2 being the minimum value of $V/\sqrt{n}$ obtained.

3.2.1 With the aeroplane trimmed for straight flight at a speed not less than 1.2 V_S nor greater than 1.4 V_S, and from a speed sufficiently above the stalling speed to ensure steady conditions, the elevator control should be applied at a rate such that the aeroplane speed reduction does not exceed one knot per second.

3.2.2 During the test prescribed in 3.2.1, the appropriate flight handling characteristics provisions of the national code ensuring compliance with paragraph 2.3 of Part III of Annex 8 should be complied with.

4. Minimum Control Speed

4.1 The minimum control speed V_{MCA}, in terms of calibrated airspeed. should be the speed at which, when the critical engine is suddenly made inoperative at that speed, it is possible to recover control of the aeroplane with the engine still inoperative and to maintain it in straight flight at that speed, either with zero yaw or, at the option of the applicant, with an angle of bank not in excess of 5º.

4.2 In demonstrating the minimum control speed specified in 4.1, it should not be necessary to reduce power on the remaining engines , and the rudder force required to maintain flight control should not be greater than 68 kg (150 lb).

Note: It is recommended that, where possible, the rudder control force - required to maintain control at the initial climb-out speed V_2 (See 5.2.3) should not exceed 41 kg (90 lb) during take-off demonstrations specified in 5.4.

4.3 During recovery from the manoeuvre, the aeroplane should not assume any dangerous attitude, nor should it require exceptional skill, strength or alertness on the part of the pilot to prevent a change of heading in excess of 200 and an angle of bank in excess of 300 before recovery is complete.

Note: Allowance should be made for the time which will elapse between engine failure and recognition of the failure by the pilot .

4.4 The value of V_{MCA} determined in accordance with 4.1 to 4.3, should not exceed 1.15VS associated with the maximum take-off weight, with:

a. The remaining engine(s) operating at the available take-off power and/or thrust ;

b. The weight of the aeroplane corresponding with the minimum control speed being demonstrated, except that V_{MCA} need not be demonstrated below V_S relative to the condition;

c. The aeroplane in the take-off configuration existing at the point of the flight path under consideration, except that the landing gear is retracted;

d. The aeroplane trimmed for take-off ;

e. The aeroplane airborne and the ground effect negligible;

f. The centre of gravity in the most unfavourable position within the allowable range.

4.5 **<u>The Minimum Control Speed on the Ground V_{MCG}</u>**, in terms of calibrated airspeed, should be the minimum speed at which, the critical engine having been made suddenly inoperative at that speed and having been recognized by the pilot, it is possible to maintain control of the aeroplane with the engine still inoperative, using primary aerodynamic controls alone, and thereafter maintain a straight path parallel to that originally intended. In demonstrating the minimum control speed on the ground V_{MCG}, the rudder force required to maintain control should not exceed 68 kg (150 lb) and it should not be necessary to reduce power on the remaining engines. During the manoeuvre, the aeroplane should not assume any dangerous attitude, nor should it require exceptional skill, strength, or alertness on the part of the pilot to prevent excessive yaw and lateral displacement before recovery is complete.

Note1: In requiring demonstration of the controllability by primary aerodynamic controls alone, this specification provides for adequate control on a reasonably critical runway surface condition, and for moderate crosswind. It is acceptable to demonstrate controllability on a wet, well-soaked runway with no major areas of measurable depth of water covering the runway, and by using all available directional control means with which the aeroplane is equipped. Wet controllability demonstration will be accepted as being applicable to both wet and dry runway surfaces.

Note 2: It is acceptable that the information on the effect of crosswind be established by means of computations based on data from a limited amount of flight testing supplemented by data obtained by wind tunnel experimentation.

Note 3: When applying the specification relating to the minimum value of V1, it is usual to consider a maximum lateral deviation consistent with the width of the runways from which the aeroplane is likely to be operated. A value of 9 meters (30 feet) for this maximum deviation has been used by some airworthiness authorities.

4.6 The minimum control speed in approach and landing for discontinued approach V_{MCLD}, in terms of calibrated airspeed, should be determined with one engine inoperative, and in addition, for aeroplanes with three or more engines, with two engines inoperative, for the prescribed conditions.

a. At V_{MCLD} it should be possible, without re-trimming, to: close the throttles of the operating engine(s) fully,

b. Increase the power of the operating engine(s) until maximum take-off power conditions are reached, without encountering dangerous flight characteristics.

4.7 The minimum control speed in approach and landing for continued approach , V_{MCLC} in terms of calibrated airspeed, should be determined, with one engine inoperative, at which it is possible to fail the critical operating engine and to increase power on the remaining operating engine(s) to that required to continue at an angle of descent of 30 without encountering dangerous flight characteristics.

5. Take –off

5.1 General

5.1.1 The take-off data in 5.2 to 5.5 inclusive should be determined:

a. At all weights, altitudes, and ambient temperatures within the operational limits established by the applicant for the aeroplane;

b. In the configuration for takeoff (see 2).

5.1.2 Take-off data should be based on a smooth, dry, hard-surfaced runway, and should be determined in such a manner that reproduction of the performance does not require exceptional skill or alertness on the part of the pilot. In addition, the take-off data should include corrections for wind and for runway gradients within the operational limits established by the applicant for the aeroplane.

a. The take-off distance should be corrected for wind. The wind correction should be not more than 50 per cent of nominal wind components along the take-off path opposite to the direction of take-off, and not less than 150 per cent of nominal wind components along the take-off path in the direction of take-off.

b. Operational correction factors should be established to indicate the effect of crosswinds on the take-off performance.

5.2 <u>Take-off speeds</u>

5.2.1 The decision speed V_1, in terms of calibrated airspeed, should not be less than V_{MCG} defined by para. 4.5.

5.2.2 The minimum take-off safety speed V_{2min}, in terms of calibrated airspeed, should be the greater of (a) or (b),

a. As applicable, a speed equal to

i) 1.15 V_S for two-engine and three-engine propeller driven aeroplanes, and for aeroplanes without propellers on which the application of power does not result in a significant reduction in the one-engine-inoperative power-on stalling speed;

ii) 1.10 V_S for propeller-driven aeroplanes having four engines, and for aeroplanes without propellers on which the application of pawer results in a significant reduction in the one-engine-inoperative power-on stalling speed;

b. A speed equal to 1.10 V_{MCA}

5.2.3 The initial climb-out speed V_2, in terms of calibrated airspeed, should be selected by the applicant so as to permit the gradient of climb specified in 6.3.2, but it should not be less than:

a. The speed V_{2min};

b. The rotation speed V_R plus the increment in speed attained in compliance with 5.4.1.(f)

5.2.4 The minimum unstick speed V_{MU}, in terms of calibrated airspeed, should be the speed selected by the applicant at and above which the aeroplane can be made to lift off the ground and continue the take-off without displaying any hazardous characteristics. V_{MU} speed should be established by means of ground take-offs at that speed.

5.2.5 The rotation speed V_R, in terms of calibrated airspeed, should be selected by the applicant in accordance with 5.2.5.(a) to 5.2.5.(d) inclusive.

a. The rotation speed V_R should not be less than

i) The speed V_1;

ii) A speed equal to 1.05 V_{MCA};

iii) A speed which permits the attainment of the speed V_2 prior to reaching a height of 10.7 metres (35 feet) above the runway as determined accordance with 5.4.1.(f);

iv) A speed which, if the aeroplane is rotated at its maximum practicable rate, will result in a lift-off speed V_{LOF} (see 5.2.6) not less than 1.10 V_{MU} in the all-engines-operating condition.

Note 1: Where, in the demonstration of V_{MU}, the geometry of the -aeroplane prevents a pitch attitude that would result in further deterioration of aeroplane performance beyond that at the selected V_{MU} speed and attitude it is acceptable to reduce the margin between V_{LOF} and V_{MU} to as low as 5 per cent.

Note 2: If forms of guidance for use during rotation and initial climb which reduce substantially the magnitude of likely errors of rotation are utilized, it may be possible to reduce the value of the speed at which rotation is initiated below that given in paragraph 5.2.5.(a)(iv) provided that the lift margins at normal lift-off speeds are not reduced.

b. For any given set of conditions (weight, configuration, temperature, etc.) a single value of V_R obtained in accordance with 5.2.5 should be used in showing compliance with both the one-engine-inoperative and the all-engines-operating take-off specifications.

c. It should be shown that the one-engine-inoperative take-off distance determined, the aeroplane being rotated at its maximum practicable rate, with a rotation speed 5 knots less than the V_R established in accordance with 5.2.5.(a) and 5.2.5.(b), does not exceed the corresponding one-engine-inoperative take-off distance determined with the established V_R speed. The determination of the take-off distances should be in accordance with 5.5.1 (a) except that the speed at the 10.7 metre (35-foot) height point map be as low as:

- V_{2min} for aeroplanes without propellers and for aeroplanes on which the application of power does not result in a significant reduction in the one-engine-inoperative power-on stalling speed;

- V_{2min} 5 knots for propeller-driven aeroplanes and for aeroplanes without propellers on which the application of power results in a significant reduction in the one-engine-inoperative power-on stalling speed.

d. It should be demonstrated that the take-off distance to the 10.7-metre (35-foot) height point with:

i) All engines operating;

ii) The aeroplane rotated so that it lifts off at a speed not more than 93 per cent of the established V_{LOF} speed:

iii) The aeroplane achieving a speed not less than 0.93 of the corresponding V2 speed prior to reaching a height of 10.7 metres (35 feet)does not exceed the distance specified in 5.5.1.

e. It should be demonstrated that reasonably expected variations of trim conditions in service do not result in unsafe flights characteristics nor in a take-off distance to the 10.7-metre (35-foot) height point longer than the distance specified in 5.5.1.

5.2.6 The lift- off speed V_{LOF}, in terms of calibrated airspeed, should be the speed at which the aeroplane first becomes airborne.

5.3 Accelerate-stop distance

5.3.1 The accelerate-stop distance should be the sum of the following:

a. The distance required to accelerate the aeroplane from a standing start to a speed at which the critical engine is assumed to be made suddenly inoperative.

b. The distance traversed between the point at which the critical engine is assumed to fail , and the point at which the decision speed V_1 is reached;

c. The distance required to bring the aeroplane to a full stop, from the point at which the decision speed V_1 is reached.

5.3.2 In determining the accelerate-stop distance, the decision speed should not be less than the speed V_1 assumed in determining the take-off distance.

5.3.3 In determining the accelerate-stop distance it should be acceptable to use all means of retardation, provided that such means have been proven to be safe and reliable, that the manner of their employment is such that consistent results can be expected in service, and that exceptional skills not required to control the aeroplane.

5.3.4 The landing gear should remain extended throughout the accelerate-stop distance.

5.3.5 If the accelerate-stop distance is intended to include a stopway with surface characteristics substantially different from those of the runway, the take-off data should include operational correction factors the accelerate-stop distance to account for the particular surface characteristics of the stopway and for the variations in such characteristics with seasonal weather conditions (i.e. temperature, rain, ice ,etc.), within the operational limits established by the applicant.

5.4 Take-off path

5.4.1 The take-off path should be considered to extend from the standing start to a point in the take-off where a height of 450 metres (1500 feet) above the runway is reached or to a point in the take-off where the transition from the take-off to the enroute configuration is completed and a speed is reached at which compliance with 6.3.3 is shown, whichever point is at a higher altitude . In determining the take-off path, the conditions of 6.4.1.(a) to 6.4.1.(j) apply.

a. The take-off path should be based upon procedures prescribed in 2.3.

b. The aeroplane should be accelerated to the speed V_2 during which time it should be permissible to initiate raising the nose gear off the ground at a speed not less than the rotation speed V_R

c. In determining the take-off path the critical engine should be made incorporative at the point such that failure of the engine would be recognized by the pilot at the decision speed V_1

d. Landing gear retraction should not be initiated until the aeroplane becomes airborne.

e. The slope of the airborne portion of the take-off path should be positive at all points.

f. The aeroplane should attain the speed V_2 prior to reaching a height of 10.7 metres (35 feet) above the runway and should continue at a speed as close as practical to ,but not less than, V2 until a height of 120 metres (400 feet) above the runway is reached. Changes in configuration made after reaching 120 metres (400 feet) above the runway should not result in a speed less than V_{2min} established in accordance with 5.2.2 for the new configuration.

g. Except for gear retraction and propeller feathering, the aeroplane configuration should not be changed before reaching a height of 120 metres (400 feet) above the runway.

h. At all points along the take-off path starting at the point where the aeroplane fist reaches a height of 120 metres (400 ft) above the runway, the available gradient of climb should not be less than:

- 1.2 per cent for two-engine aeroplanes,
- 1.4 per cent for three-engine aeroplanes, and

- 1.5 per cent for four-engine aeroplanes.

i. The take-off path should be determined either by a continuous demonstrated take-off, or alternatively, by synthesizing from segments the complete take-off path.

j. If the take-off path is determined by the segmental method,

i) The segments of the segmental take-off path should be clearly defined and should be related to the distinct changes in the configuration of the aeroplane, in power and/or trust , and in speed;

ii) The weight of the aeroplane, the configuration, and the power and/or thrust should be constant throughout each segment and should correspond with the most critical condition prevailing in the particular segment;

iii) The segmental flight path should be based on the aeroplane performance without ground effect;

iv) Segmental take-off path data should be checked by continuous demonstrated take-offs to the point where the aeroplane performance is out of ground effect and the aeroplane speed is stabilized, to ensure that the segmental path is conservative relative to the continuous path. Take-off distance and take-off run Take-off distance. The take-off distance should be the greater of:

5.5 Take –off distance and take-off run

5.5.1 Take-off distance. The take off distance should be the grater of

a. The horizontal distance from the start of the take-off to the point where the aeroplane attains a height of 10.7 metres (35 feet) above the runway. as determined in accordance with 5.4;

b. The distance equal to 1.15 times the horizontal distance, with all engines operating, from the start of the take-off to the point where the aeroplane attains a height of 10.7 metres (35 feet) above the runway, as determined by a procedure consistent with that established in accordance with 5.4.

5.5.2 Take-off run. If the take-off distance is intended to apply when a stopway and/or a clearway is used, the take-off run should be determined and should be the greater of:

a. The horizontal distance from the start of the take-off to a point equidistant between the point where the speed V_{LOF} is reached and the point where the aeroplane attains a height of 10; 7 metres (35 feet) above the runway, as determined in accordance with 5.4;

b. A distance equal t o 1.15 times the horizontal distance with all engines operating, from the start of the take-off to a point equidistant between the point where the speed $_{VLOF}$ is reached and the point where the aeroplane attains a height of 10.7 metres (35 feet) above the runway, as determined by a procedure consistent with that established in accordance with 5.4.

5.6 **Take-off flight path**

5.6.1 The take-off flight path should be that portion of the take-off path which begins at a height of 10.7 metres (35 feet) above the runway. It should be assumed that this height is reached a t the end of the take-off distance as determined in accordance with 5.5.1.

Note: No specifications for the climb path with all engines operating have been included. It is necessary that operating procedures with all engines operating ensure that the climb path under all operating conditions will lie above the take-off path established in accordance with 5.4 .

5.6.2 The net take-off flight path data should be determined in such a manner that they represent the actual take-off flight paths of the aeroplane, determined in accordance with 5.5.1 reduced at each point by a gradient of climb equal to:

- 0.8 per cent for two-engine aeroplane
- 0.9 per cent for three-engine aeroplanes, and
- 1.0 per cent for four-engine aeroplanes.
- It should be acceptable to apply the specified reduction in climb gradient as an equivalent reduction in the acceleration of the aeroplane along the portion of the

actual take-off flight path where the aeroplane is accelerated in level flight.

6. Climb

6.1 General

6.1.1 Compliance should be shown with the climb specifications of 6.2 and 6.3 at all weights, altitudes, and ambient temperatures, within the operational limits established by the applicant for the aeroplane. The centre of gravity of the aeroplane should be in the most unfavourable position corresponding with the applicable configuration.

6.2 All-engines-operating landing climb

6.2.1 In the landing configuration, or in the configuration that the aeroplane may automatically assume 5 seconds after and as the result of the initiation of the movement of the controls specified in(a), the steady gradient of climb should not be less than 3.2 per cent, with:

a. All engines operating at the power and/or thrust which is available 8 seconds after initiation of movement of the power and/or thrust controls from the minimum flight idle to the take-off position;

b. A climb speed not in excess of the minimum approach speed prescribed for landing.

6.3 One engine-inoperative climb

6.3.1 Take-off: landing gear extended

a. In the critical take-off configuration existing at the point of the flight path where the aeroplane reaches V_{LOF} in accordance with 5.4 but without ground effect, the steady gradient of climb should be

i) positive for two-engine aeroplanes,

ii) not less than 0.3 per cent for three-engine aeroplanes, and

iii) not less than 0.5 per cent for four-engine aeroplanes, with:

- The critical engine assumed to be made inoperative on attaining a speed such that the failure of the critical engine would be recognized by the pilot at V_1, except that for propeller-driven aeroplanes the critical engine should be assumed to be made inoperative on attaining a speed equal to the speed such that failure of the critical engine would be recognized at the highest value of V_1 corresponding with the maximum weight appropriate to the altitude and temperature;

- The remaining engine(s) operating at the available take-off power and/or thrust existing in accordance with 5.4 at the time retraction of the landing gear is initiated, unless subsequently a more critical power operating condition exists along the flight path prior to the point where the landing gear is fully retracted;

Note: A power operating condition more critical than that existing - at the time retraction of the landing gear is initiated would exist, for example, if water methanol injection were discontinued prior to the point where the landing gear is fully retracted.

- The weight equal to the aeroplane weight existing in accordance with 5.4 at the time retraction of the landing gear is initiated;

- The speed equal to the speed. V_{LOF}

6.3.2 Take-off: landing gear retracted

a. In the take-off configuration existing at the point! of the flight path where the landing gear is fully retracted, in accordance with 5.4, but without ground effect, the steady gradient of climb should not be less than

i) 2.4 per cent for two-engine aeroplanes,

ii) 2.7 per cent for three-engine aeroplanes, and

iii) 3.0 per cent for four-engine aeroplanes,

with:

- The critical engine assumed to be made inoperative on attaining a speed such that the failure of the critical engine would be recognized by the pilot at V_1, except that for propeller-driven aeroplanes the critical engine should be assumed to be made inoperative on attaining a speed equal to the speed such that failure of the critical engine would be recognized at the highest value of V_1 corresponding with the maximum weight appropriate to the altitude and to temperature;

- The remaining engine(s) operating at the available take-off power and/or thrust existing in accordance with 5.4 at the time the landing gear is fully retracted, unless subsequently a more critical power operating condition exists along the flight path prior to the point where a height of 120 metres (400 feet) above the runway is reached;

Note:A power operating condition more critical than that existing at the time the landing gear is fully retracted would exist, for example, if water methanol injection were discontinued prior to the point where the 120-metre(400-foot) height is reached.

- The weight equal to the aeroplane weight existing in accordance with 5.4 at the time the landing gear is fully retracted;

- The speed equal to the speed V_2

6.3.3 **Final take-off**

a. In the en-route configuration, the steady gradient of climb should not be less than

i) 1.2 per cent for two-engine aeroplanes,

ii) 1.4 per cent for three-engine aeroplanes, and

iii) 1.5 per cent for four-engine aeroplanes,

iv) at the end of the take-off path as determined, in accordance with 5.4, with:

- The critical engine inoperative, the remaining engine(s) operating at the available maximum continuous power and/or thrust;

- The weight equal to the aeroplane weight existing in accordance with 5.4 at the end of the take-off path;

- The speed equal to not less than 1.2 V

6.3.4 Discontinued approach

a. In the final approach configuration corresponding with the one-engine-inoperative procedure, except that the configuration may be changed to a configuration that can be achieved in 15 seconds, such that VS in the new configuration does not exceed 1.05 VS related to the final approach configuration, the steady gradient of climb should not be lees than

i) 2.1 per cent for two -engine aeroplanes,

ii) 2.3 per cent for three-engine aeroplanes, and

iii) 2.4 per cent for four-engine aeroplanes,

with:

- The critical engine inoperative, the remaining engine(s) operating at the available takeoff power and/or thrust;
- The weight equal to the maximum landing weight;
- A climb speed established in connection with the discontinued approach procedures, except that it should not exceed VTmax or 1.45 VS

Note: By the final approach configuration is meant the -stabilized configuration which would be used during approach down to the point where a decision to land would be made when operating in limiting visibility conditions. It is intended that the missed approach procedure given in the Aeroplane Flight Manual should be used in showing compliance with this requirement.

7. En-route

7.1 En-route flight paths

7.1.1 With the aeroplane in the en-route configuration, the flight paths specified in 7.2 and 7.3 should be determined a tall weights, altitudes, and ambient temperatures , within the operational limits established by the applicant for the aeroplane. For altitudes and temperatures at which icing protection systems are to be operable, the effect of their use on the net flight path should be determined.

7.2 **One engine inoperative**

7.2.1 The one-engine-inoperative net flight path data should be determined in such a manner that they represent the actual climb performance diminished by a gradient of climb equal to

a. per cent for two-engine aeroplanes,

b. per cent for three-engine aeroplanes, and

c. per cent for four-engine aeroplanes.

It should be acceptable to include in these data the variation of the weight along the flight path to take into account the progressive consumption of fuel and oil by the operating engine(s).

7.3 **Two engines inoperative**

7.3.1 For aeroplanes with three or four engines, the two-engines-inoperative net flight path data should be determined in such a manner that they represent the actual climb performance of the aeroplane diminished by a gradient of climb equal to

a. 0.3 per cent for three-engine aeroplanes, and

b. 0.5 per cent for four-engine aeroplanes.

It should be acceptable to include in these data the variation of the weight along the flight path to take into account the progressive consumption of fuel and oil by the operating engine(s).

7.4 **Conditions**

7.4.1 In determining the flight paths specified in 7.2 and 7.3:

a. The centre of gravity should be in the most unfavourable position;

b. The critical engine(s) should be inoperative, the remaining engine(s) operating at the available maximum continuous power and/or thrust;

c. Means for controlling the engine cooling air supply should be in the position which provides adequate cooling for the conditions under consideration;

d. the speed should be selected by the applicant.

8. Landing

Note: Two alternative methods of determining landing distances for – certification presented below. Both are considered worthy of trial application in accordance with the concept of this class of specification. These specifications appear as 8.1 and 8.2 respectively.

8.1 Landing specification- Method A

8.1.1 **Landing Speeds.** The landing speeds specified in 8.1.1.(a) to 8.1.1.(c) should be determined at all weights and altitudes within the operational limits established by the applicant for the aeroplane.

a. **The minimum demonstrated threshold speed V_{TMD}**, In terms of calibrated airspeed, should be the speed obtained at a height of 10.7 metres (35 feet) above the landing surface at and above which it has been demonstrated that the aeroplane can be made consistently to complete an approach, touchdown, and landing without displaying any hazardous characteristics when flown in no appreciable atmospheric turbulence in the following manner:

i) a steady approach from a height of 60 metres (200 feet) above the landing surface to the 10.7-metre (35-foot) height point, at a substantially stabilized angle of descent of not less than 3^o;

ii) a rate of descent equal to zero before touchdown;

iii) only those changes of configuration and/or- power which would be made in a normal landing should be made. No increase in power should be made after passing the threshold.

b. The minimum threshold speed V_{Tmin} , in terms of calibrated airspeed, should be selected by the applicant but should not be less than (a) and (b):

i) a speed equal to V_{TMD} + 5 knots;

ii) a speed equal to 1.2 V_S.

c. The maximum threshold speed VTmax , in terms of calibrated airspeed, should be selected by the applicant but should not be less than a speed equal to V_{Tmin} plus the

i) lesser of 0.2 V_S or 20 knots.

Note: The values of V_{Tmin} and V_{Tmax} specified in 8.1.1.(b) and 8.1.1.(c) respectively, define the range within which the operator selects one or several values of a target threshold speed, in application of Chapter 2, paragraph 1.4. V_{Tmin} is intended for use in service as a target threshold speed only in relatively favourable operating conditions.

8.1.2 **Landing distances**

The landing distances should be determined in accordance with 8.1.2.(a) to 8.1.2.(i) inclusive, at all weights, altitudes, runway gradients and winds within the operational limits established by the applicant for the aeroplane, and should be the greater of the folowing

- *1.15 times the horizontal distance to land with all engines operating and to come to a complete stop from a point at a height of 10.7 metres (35 feet) above the landing surface;*
- *1.10 times the horizontal distance to land with the critical engine inoperative and to come to a complete stop from a point at a height of 10.7 metres (35 feet) above the landing surface.*

a. The aeroplane should be in the landing configuration. During the landing, changes in configuration and in power and/or thrust should be in accordance with procedures established by the applicant for the operation of the aeroplane in service. The procedure should comply with 2.3, except that the time delays between successive control actions should be representative of those which would be expected in a landing which is associated with the use of V_{Tmax} in service.

Note: Examples of sequences of control actions and approximate time delays - that are considered reasonably representative of those intended by 8.1.2.(a) are:

i) Control actions before touchdown. Air brake, spoiler, or reverse trust selection at the threshold where approved for use when airborne (where these are not used normally during the approach to the threshold).

ii) Control actions after touchdown but before nose down. Air brake, spoiler, or reverse trust selections: two seconds after touchdown where approved for use before nose down.

iii) Nosedown

- two seconds after touchdown where spoiler, air brake, or reverse trust selection is not made before nosedown;

- four seconds after touchdown where spoiler, air brake, or reverse trust selection is not made before nosedown.

iv) Control actions after nosedown

- wheel brake application: one second after nosedown;

- other control actions (spoilers, air brakes, reverse thrust) ,first action one second after nosedown, successive actions one second after completion of the previous action.

b. A steady approach should be started at a height of at least 90 metres (300 feet) above the landing surface, and continued down to the height at which the throttles may be closed. The speed during the steady approach should be such that it enables the aeroplane to reach the 10.7-metre (35-foot) point at a speed not less than VTmax determined in accordance with 8.1.1.(c) The descent to the 10.7-metre (35-foot) point should be at a substantially stabilized angle of descent of 3^{o}.

c. The elapsed time between the 10.7-metre (35-foot) height point and the touchdown of the main landing gears should be representative of that which would be expected in a landing from V_{Tmx} in service.

Note: An elapsed time of (13- .045 VTmax) seconds, where V_{Tmax} is in knots, - has been found to be typical for transport aeroplanes having V_{Tmax} values in the range of 100 knots to 165 knots.

d. The landing distances should be based on a wet runway condition which can reasonably be expected to be encountered in service. The landing distances may, additionally, at the discretion of the applicant, be determined for a dry runway condition.

Note: Amplification of this specification and one method-of describing a standard wet runway are presented in the Appendix.

e. During the stopping portion of the landing, the brakes should be applied in a manner consistent with operational procedures. The wheel brakes should not be used in such a manner as to produce excessive wear of brakes and tyres.

f. The adjustment of the braking systems should be that which is intended for use in service. The landing gear wheels should be fitted with tyres of a tread design representative of that intended for use in service. The state of wear of the tyres should correspond with that permitted in service.

g. In determining the landing distance, it should be acceptable to use all those means of retardation with which the aeroplane is fitted for use during landing, provided that such means have been proved to be safe and reliable, that the manner of their employment is such that consistent results can be expected in service, and that exceptional skills is not required to control the aeroplane.

Note: The braking means which cannot be conveniently used at every landing (such as tail parachutes), may be used to determine the landing distance, provided that the landing distance is also determined without those braking means.

h. The landing distance data should include corrections for wind; the corrections should be not more than 50 per cent of nominal wind components along the landing path opposite to the direction of landing and not less than 150 per cent of nominal wind components along the landing path in the direction of landing.

i. Where operational factors, such as crosswind, have a significant effect on landing distances, these effects should be determined and scheduled.

8.2 Landing specification - Method B

8.2.1 **Landing distance (Dry runway)** The horizontal distance, necessary to land and to come to a complete stop from a point 15 metres (50 feet) above the landing surface should be determined, for each weight, altitude , and wind component within the operational limits established by the applicant for the aeroplane and in accordance with subparagraphs 2.3.1, 2.3.2 and 2.3.3 as follows:

a. The aeroplane should be in the landing configuration.

b. A steady approach, with a calibrated airspeed of not less than 1.25 VS, must be maintained down to a 15-metre (50-foot) height.

c. Any changes in configuration, power and/or thrust, and speed, should be made in accordance with established procedures for service operation.

d. The landing should be made without excessive vertical acceleration, tendency to bounce, porpoise, nose over or ground loop.

e. The landings should not require exceptional pilot skill or alertness.

f. The landing distance should be determined on a level, smooth, hard-surfaced runway.

g. The pressures on the wheel braking systems may not exceed those specified by the manufacturer.

h. The brakes may not be used so as to cause excessive wear of brakes or tyres.

i. Means other than wheel brakes may be used if that means:

- is safe and reliable ;
- is used so that consistent results can be expected in service; and
- is such that exceptional skill is not required to control the aeroplane.

j. The landing distance data should also include correction factors for not more than 50 per cent of the nominal wind components along the landing path opposite to the direction of landing, and not less than 150 per cent of the nominal wind components along the landing path in the direction of landing.

k. If any device is used that depends on the operation of any engine, and if the landing distance would be noticeably increased when a landing is made with that engine inoperative, the landing distance must be determined with that engine inoperative.

l. The scheduled landing distance will be the measured distance as in accordance with 8.2.1 increased by a factor of 1.67.

8.2.2 **Landing Distance (Wet Runway)**

a. Wet runway distance should be the scheduled landing distance of 8.2.1.(*l*) increased by a factor of 1.15.

b. The conditions of 8.2.2 may be met by acceptable tests as in accordance with 2.3.1, 2.3.2 and 2.3.3 conducted on a wet runway, when a wet runway is defined as a runway that is thoroughly soaked with no major areas of measurable depth of water covering the runway.

Note: One method of describing a standard wet runway is presented in the Appendix.

9. Limitations and Information

9.1 **Limitations**

9.1.1 The performance limitations on the operation of the aeroplane should be established in accordance with 9.1.1.(a) to 9.1.1.(d) inclusive. (see also 10).

a. **Take-off Weights** – The maximum take-off weights should be established at which compliance is shown with the generally applicable provisions of this APC and with the take-off climb provisions specified in 6.3.1, 6.3.2 and 6.3.3 for altitudes and ambient temperatures within the operational limits of the aeroplane. (see 9.1.1.d).

b. **Landing weights –** The maximum landing weights should be establiehed at which compliance is shown with the generally applicable provisions of this APC and with the landing and takeoff climb provisions specified in 6.2 and 6.3, for altitudes and ambient temperatures within the operational limits of the aeroplane. (see 9.1.1.d)

c. **Accelerate-stop distance. take-off distance and take-off run –** The minimum distances required for take-off should be established at which compliance is shown with the generally applicable provisions of this APC and with 5.3 and 5.5.1 and with 5.5.2 if the take-off distance is intended to apply when a stopway and/ or a clearway is used, for weights, altitudes, ambient temperatures, wind components, and runway gradients, within the operational limits of the aeroplane. (see 9.1.1.d)

d. **Operational limits –** The operational limits of the aeroplane should be established by the applicant for all variable factors required in showing compliance with this APC (weight, altitude, ambient temperature, etc.). (see 5.1.1 (a), 5.1.2, 6.1, 7.1 and 8).

9.2 **Information**

9.2.1 The performance information on the operation of the aeroplane should be scheduled in compliance with the generally applicable provisions of this APC and with 5.6.2, 7.1 and 8, for weights, altitudes, ambient temperatures, wind components and runway gradients, as these may be applicable, within the operational limits of the aeroplane (see 9.1.1.(d). In addition, the performance information specified in (a), (b) and (c) should be determined by extrapolation and scheduled for the ranges of weights between the maximum landing and maximum take-off weights established in accordance with 9.1.1.(a) and 9.1.1(b) (see also 10) :

a. Climb in the landing configuration (see 6.2).

b. Climb in the approach configuration (see 6.3.4);

c. Landing distance (see 8).

10. Aeroplane Flight Manual

10.1 **Limitations**

10.1.1 The aeroplane performance limitations should be given in accordance with 9.1.

10.2 **Information**

10.2.1 The performance information specified in 9.2 for the application of the operating rules of this APC should be given together with the descriptions of the conditions, airspeeds, etc., under which the data was determined.

10.2.2 Additional data should be presented so that information can be obtained to enable a V_1 suitable for a wet runway to be selected. One method of presenting this information is to provide the following in respect of wet runway operations:

a. The lowest value of V_1 at which there is adequate controllability (V_{MCG}) ;

b. The lowest value of V_1 that will enable the attainment of a height of at least 4.6 metres (15 feet) at the end of the take-off distance specified in 5.5.1;

c. The lowest value of V_1 which will enable the aeroplane to lift off within the take-off run specified in 5.5.2;

d. The highest value of V_1 which will enable the aeroplane to be stopped on a wet runway within the accelerate-stop distance available.

10.2.3 **Landing Distance**

a. Information should be included giving the landing distances to be reasonably expected during a moderate to heavy rain, on runways covered with slush, and on runways covered with ice and snow.

b. Information should be included with respect to the effects of crosswind where these effects are regarded as significant to the landing distance.

c. Information should be included with respect to the effects on landing distance of ambient temperatures other than standard.

d. Information should be included giving the **1g** stalling speeds as a function of weight and flap setting.

10.3 Procedures

10.3.1 Procedures established in accordance with 2.3 should be given to the extent such procedures are related to the limitations and information set forth in accordance with 10.1 and 10.2. Such procedures, in the form of guidance material, should be included with the relevant limitations or information, as applicable.

10.4 Miscellaneous

10.4.1 An explanation should be given of significant or unusual flight or ground handling characteristics of the aeroplane.

Chapter 2

Performance Operating Limitations

1. Aeroplane Operating Limitations

1.1 The provisions of 1 to 6 inclusive should be complied with, unless deviations there from are specifically authorized by the State of Registry on the ground that the special circumstances of a particular case make a literal observance of these provisions unnecessary for safety.

1.2 The performance data in the Aeroplane Flight Manual should be applied in determining compliance with 2 to 6 inclusive. Where conditions differ from those for which specific tests were made, compliance should be determined by approved interpolation or extrapolation of the effects of changes in the specific variables if such interpolations or extrapolations give results substantially equalling in accuracy the results of a direct test.

1.3 There should be selected one value or a range of values for the landing target threshold speed for the all-engines-operating and the one-engine inoperative cases within the speed range V_{Tmin} and V_{Tmax}. These should be scheduled in the Aeroplane Flight Manual to cover specific operating conditions.

1.4 The procedures scheduled in the Aeroplane Flight Manual (see Chapter I, Para 10 and Chapter 2, 1.3) established in accordance with Chapter 1, Para 2.3 should be followed except where operational circumstances require the use of modified procedures in order to maintain the intended level of safety.

2. Aeroplane Certificate Limitations

2.1 No aeroplane should be taken off at a weight which exceeds the take-off weight specified in the Aeroplane Flight Manual for the altitude of the aerodrome and for the ambient temperature existing at the time of the take-off. (see Chapter 1, Para 9.1.1.(a) and 10.1).

2.2 No aeroplane should be taken off at a weight such that, allowing for normal consumption of fuel and oil in flight to the aerodrome of destination and to the alternate aerodromes, the weight on arrival will exceed the landing weight specified in the Aeroplane Flight Manual for the altitude of each of the aerodromes involved and for the ambient temperatures anticipated at the time of landing. (see Chapter 1,Para 9.1.1.(b) and 10.1).

2.3 No aeroplane should be taken off at a weight which exceeds the weight at which, in accordance with the minimum distances for take-off scheduled in the Aeroplane Flight Manual, compliance with 2.3.1 to 2.3.3 Inclusive is shown.

These distances should correspond with the altitude of the aerodrome, the runway, stopway and clearway to be used, the runway gradient, the stopway gradient, the clearway plane gradient, and the ambient temperature and wind existing at the time of take-off. (see Chapter 1,Para 9.1.1.(c) and 11.1). For nominal wind components up to a magnitude of 4 knots, the wind correction for the all-engines-operating condition should be not more than the nominal wind components along the take-off path opposite to the direction of take-off less 2 knots, and not less than the nominal wind components along the take-off path in the direction of take-off plus 2 knots.

Note1: The specification for wind accountability in light winds is based on the availability of well-sited anemometers capable of giving accurate information on wind speed and direction at wind speeds down to 1 knot. At many aerodromes, however, wind measurements at present do not reach these standards, and in such cases a more conservative approach may have to be taken for the operation of jet aeroplanes in lights winds of a nominal value of 5 knots or less .

Note 2: In certain meteorological conditions, where the air is absolutely still, (e.g. still air conditions encountered during the Arctic winter), it may not be necessary to apply the wind correction of 2.3 to the take-off data.

2.3.1 The take-off run required should not exceed the length of the runway.

2.3.2 The accelerate-stop distance required should not exceed the length of the runway plus the length of the stopway, where present.

2.3.3 The take-off distance required should not exceed the length of the runway, plus the length of the stopway, where present, and/or the length of the clearway, where present, except that the sum of the lengths of the runway, the stopway, and the clearway should in no case be considered as being greater than 1.5 times the length of the runway.

2.4 No aeroplane should be operated outside the operational limits specified in the Aeroplane Flight Manual. (see Chapter 1, Para 9.1.1.(d) and 10.1).

3. Take-off Obstacle Clearance Limitations

3.1 No aeroplane should be taken off at a weight in excess of that shown in the Aeroplane Flight Manual to correspond with a net take-off flight path which clears all obstacles either by at least a height of 10.7 metres (35 feet) vertically or at least 90 metres (300 feet) plus 0.125 D laterally , where D is the horizontal distance the aeroplane has travelled from the boundary of the aerodrome, except as provided in 3.1.1 to inclusive. In determining the allowable deviation of the take-off flight path in order to avoid obstacles by at least the distances specified, it should be assumed that the aeroplane is not banked before the clearance of the net take-off flight path above obstacles is at least 15 metres (50 feet) and that the bank thereafter does not exceed 15 degrees. The net take-off flight path considered should be for the altitude of the aerodrome, for the runway gradient, and for the ambient temperature and wind component existing at the time of take-off. (see Chapter 1, Para 9.2 and 10.2).

3.1.1 Where the intended track does not include any change of heading greater than 15 degrees,

a. for operations conducted in VMC by day, or

b. for operations conducted with navigational aids such that the pilot can maintain the aeroplane on the intended track with the same precision as for operations specified in (a)

Note: Obstacles at a distance greater than 300 metres (1 000 feet) on either side of the intended track need not be cleared.

3.1.2 Where the intended track does not include any change of heading greater than 15 degrees for operations conducted in IMC, or in VMC by night, except as provided in 3.1.1 (b); and where the intended track includes changes of heading greater than 15 degrees for operations conducted in VMC by day, obstacles at a distance greater than 600 metres (2 000 feet) on either side of the intended track need not be cleared.

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

4. Specifications for Stopways and Clearways

4.1 Stopway

4.1.1 Credit should not be taken for the length of the stopway unless it complies with 4.1.2.

4.1.2 A stopway should not be less in width than the width of the runway; it should be centrally located about the extended centre line of the runway, and it should be designated by the aerodrome authorities for use in decelerating the aeroplane during an interrupted take-off. To be designated as such, a stopway should be capable of supporting the aeroplane during an interrupted take-off without inducing structural damage to the aeroplane.

Note: It is highly desirable the characteristics of the surface of the stopway be not worse than those of the runway. Para. 5.3.5 of Chapter 1 provides for the scheduling of operational correction factors in order to account for surface characteristics substantially different from those of the runway.

4.2 Clearway

4.2.1 Credit should not be taken for the length of a clearway unless it complies with 4.2.1.(a) to 4.2.1 (c).

a. A clearway should be centrally located about the extended centre line of the runway. It should be under the control of the aerodrome authorities. The width of the clearway should not be less than 150 metres (500 feet). The clearway is expressed in terms of a clearway plane, extending from the end of the runway with an upward slope not exceeding 1.25 per cent above which no object or portion of the terrain should protrude, except for frangibly mounted lightweight aerodrome lights not more than approximately 0.90 metres (36 inches) above ground level.

b. If the clearway plane is above the horizontal, there should be no obstructions above ground other than the aerodrome lights specified in 4.2.1.(a), and the average and local slopes of the surface of the ground should not generally exceed those permitted for the runway, except for isolated depressions such as ditches running across the clearway. Where the clearway plane has a positive gradient, the rate of change of the longitudinal elope between the runway and the surface of the ground in the clearway should not exceed that specified for the runway.

c. The slope of the obstacle free plane beyond the end of the clearway should not exceed that required by the aerodrome authorities for the associated runway.

Note: It is intended that 2.3 be applied so that aeroplane achieves - the height of 10.7 metres (35 feet) above the clearway plane a t the end of the take-off distance.

5. En-route Limitations

5.1 General

5.1.1 No place along the intended track should be more than 90 minutes at normal cruising speed away from an aerodrome at which the distance specifications for alternate aerodrome (see 6.2) can be complied with and where it can be reasonably expected that a safe landing can be made, unless the aeroplane complies with 5.3.1 (a).

5.2 One engine inoperative

5.2.1 No aeroplane should be taken off at a weight in excess of that which, in accordance with the one-engine-inoperative en-route net flight path data shown in the Aeroplane Flight Manual, will permit compliance either with 5.2.1(a) or 5.2.1(b) at all points along the route. The net flight path should have a positive slope at 450 metres (1,500 feet) above the aerodrome where the landing is assumed to be made after engine failure. The net flight path used should be 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 should be taken into account. (see Chapter 1, Para9.2 and 10.2).

a. The slope of the net flight path should be positive at an altitude of at least 300 metres (1000 feet) above all terrain and obstructions along the route within 5 nautical miles on either side of the intended track.

b. The net flight path should be 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 6.2, the net flight path clearing vertically, by at least 600 metres (2 000 feet) , all terrain and obstructions along the route within 5 nautical miles on either side of the intended track. The provisions of 5.2.1(a) (i) to 5.2.1.(a)(v) inclusive should apply.

i) The engine should be assumed to fail at the most critical point along the route, allowance being made for indecision and navigational error.

ii) Account should be taken of the effects of winds on the flight path.

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

iv) The aerodrome where the aeroplane is assumed to land after engine failure should be specified in the operational flight plan and should meet the appropriate weather minima.

v) The consumption of fuel and oil after the engine becomes inoperative should be that which is accounted for in the net flight path data shown in the Aeroplane Flight Manual.

5.3 **Two engines inoperative**

5.3.1 Aeroplanes which do not comply with 5.1 should comply with 5.3.1(a).

a. No aeroplane should be taken off at a weight in excess of that which according to the two-engines-inoperative en-route net flight path data shown in the Aeroplane Flight Manual, will permit the aeroplane to continue 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 6.2) can be complied with and where it can be reasonably expected that a safe landing can be made, the net flight path clearing vertically, by at least 600 metres (2 000 feet), all terrain and obstructions along the route within 5 nautical miles on either side of the intended track. The net flight path considered should be 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 should be taken into account. The provisions of 5.3.1(a)(i) to 5.3.1(a)(v) inclusive should apply. (see Chapter 1, Para 9.2 and 10.2).

i) The two engines should be assumed to fail at the moat 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 6.2) can be complied with and where it can be reasonably expected that a safe landing can be made.

ii) The net flight path should have a positive slope at 450 metres (1 500 feet) above the aerodrome where the landing is assumed to be made after the failure of two engines.

iii) Fuel jettisoning should be permitted to an extent consistent with 5.3.1. (a) (iv), if a safe procedure is used.

iv) The aeroplane weight at the point where the two engines are assumed to fail should be 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 metres (1 500 feet) directly over the landing area and thereafter to fly for 15 minutes at cruise parser and/or thrust.

v) The consumption of fuel and oil after the engines become inoperative should be that which is accounted for in the net flight path data shown in the Aeroplane Flight Manual.

6. Landing Limitations

6.1 Aerodrome of destination

6.1.1 No aeroplane should be taken off at a weight in excess of that which, in accordance with the landing distances required as shown in the Aeroplane Flight Manual for the altitude of the aerodrome of intended destination, would permit the aeroplane to be brought to rest at the aerodrome of intended destination within the effective length of the runway, this length being as declared by the aerodrome authorities with regard to the obstructions in the approach. The weight of the aeroplane should be assumed to be reduced by the weight of the fuel and oil expected to be consumed in flight to the aerodrome of intended destination. Compliance should be shown with 6.1.1(c) and with either 6.1.1(d) or 6.1.1(e) (see Chapter 1, Para 9.2 and 10.2).

a. For aeroplanes operating according to landing specification Chapter 1, Para 8.1 the runway gradient should be assumed to be zero, unless the runway is usable in only one direction.

b. The expected runway condition (wet or dry)should be taken into account for operations according to landing specification Chapter 1, Para 8.1, and for turbo-jet aeroplanes operating according to landing specification Chapter 1, Para 8.2

Note: National authorities will need to develop suitable methods for - dealing with accountability for wet and dry runways.

c. It should be assumed that the aeroplane is landed on the most favourable runway and in the most favourable direction in still air.

d. It should be assumed that the aeroplane is landed on the runway which is the most suitable for the wind conditions anticipated a t the aerodrome a t 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 etc.).

e. If full compliance with 6.1.1(d) is not show, the aeroplane may be taken off if an alternate aerodrome is designated which permits compliance with 6.2.

6.2 **Alternate aerodrome**

6.2.1 No aerodrome should be designated as an alternate aerodrome in an operational flight plan unless the aeroplane, at the weight anticipated at the time of arrival at such aerodrome, can comply with 6.1, except as specified in 6.2.1(a) and 6.2.1(b).

a. For aeroplanes operating according to the landing specification Chapter 1, Para 8.1 the Landing distance required (see Chapter 1, Para 8.1.2) may be multiplied by a factor 0.95.

b. For aeroplanes operating according to the landing specification Chapter 1, Para 8.2 the landing distance required may be based on a dry runway (see Chapter 1, Para 8.2.1(*l*)) and for turbo- jet aeroplanes should be equal to the landing distance specified for a destination aerodrome in 6.1.1, and for other aeroplanes should be equal to the landing distance specified for a destination aerodrome in 6.1.1 multiplied by 0.86.

Appendix

Wet Runway Testing

1. In order to ensure that the final scheduled distances correspond to conditions representative of an average wet, well soaked runway, it would be necessary to verify during the certification tests , the level of friction existing. An acceptable means of checking this would be by the use of a testing apparatus which has shown reasonable correlation over a range of runway surfaces between the results it has produced and those likely to apply to aeroplane braking. Where the runway friction calibrations are not made during the aeroplane test, the friction level corresponding to that obtained from calibration before each test shall be determined.

2. Where the runway friction level during the tests differs significantly from that of an average wet, well soaked runway, the measured distances have, in practice, been corrected for this difference.

3. A method, implementing the principles of (1) and (2) above, used in the United Kingdom is to make measurements with the Road Research Laboratories Skidding Trailer of the locked wheel braking force coefficient of the runway surface on which the aeroplane braking performance is measured. The aeroplane wheel braking drag is separated by analysis of braked and unbraked performance measurements. This braking drag is then corrected to a "Reference Friction Condition" by multiplying the drag at each speed by the ratio (for the same speed) of

$$\frac{\textit{Reference wet surface braking force coefficient}}{\textit{Trailer braking force coefficient for the test runway}}$$

4. The wet braking distance is then recomputed using the corrected wheel braking drag.

5. The Reference friction condition used is the ICAO Reference Wet Surface, shown in Figure 1, developed by the Standing Committee on Performance and which is the mean measurement made on a range of runway surfaces using the RRL, trailer.

7. The Road Research Laboratories Friction Trailer is an apparatus which measures the skidding drag of a specially manufactured tyre supporting a 143 kg (315 lb) load.

APPENDIX (Contd)

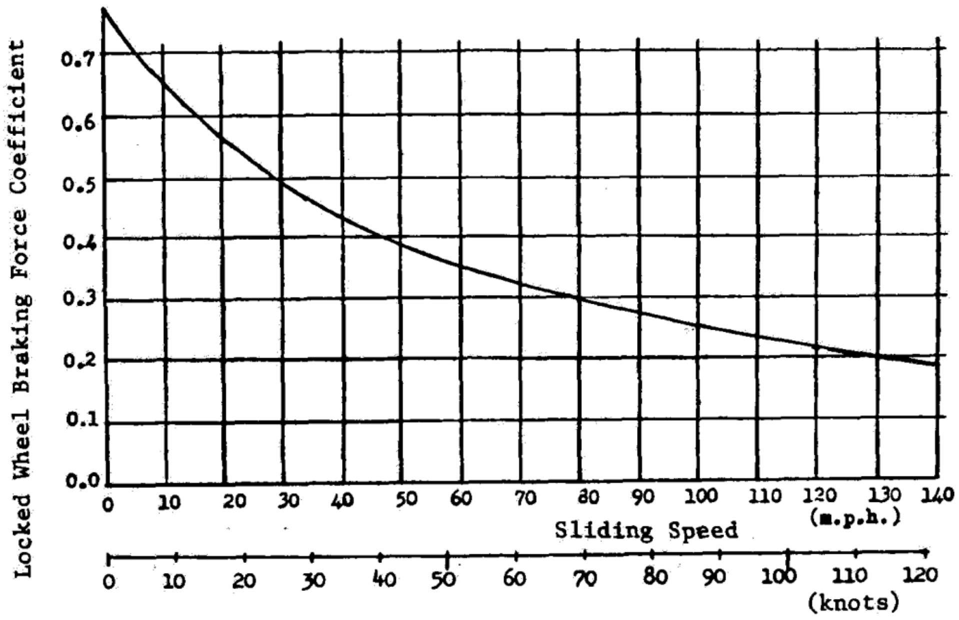

FIG. 1. - REFERENCE WET SURFACE