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IMPLEMENTATION OF ALL WEATHER OPERATIONS

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FOREWORD

At an early stage in its work, the All Weather Operations Panel (AWOP) recognized the potential usefulness of a document consolidating States' and operator's experience in the preparation for, approval and implementation of All Weather Operations. At its Fourth Meeting in Montreal in early 1971, the Panel considered that the time had arrived for the preparation of such a document based on the considerable experience which had then accumulated regarding operations in Category II conditions, and an appropriate recommendation was made to the Air Navigation Commission. That recommendation was approved by the Commission, and the Panel undertook the preparation of the document as part of its ongoing Work Programme.

A Working Group of the AWOP, through the co-operation of States and operators, had available to it a great deal of related information. It prepared a comprehensive working paper for consideration by the Fifth Meeting of the AWOP, held in Montreal, Canada. 22 October to 2 November 1973. The Panel further refined the material and recommended to the Air Navigation Commission its publication as an ICAO Circular.

The Air Navigation Commission, on 12 February 1974, approved the related recommendation of the Panel, and requested the Secretary General to publish this Document.

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CHAPTER 1. - INTRODUCTION

1. Purpose

1.1 This document describes and discusses significant operational and technical factors associated with the achievement of all weather landing operations. It is intended to provide guidelines to assist States in their development of improved all weather landing capabilities by presenting the collective experience of those actively engaged in such programmes. It should contribute to the development of uniform practices among States.

1.2 General

1.2.1 During the early years of effort toward developing an all weather landing system, most attention was given to obtaining a suitable non-visual precision guidance system. The ICAO ILS has been refined until, at present, it represents a well-documented standard guidance system. The role of other elements, such as aerodrome environment and the aircraft flight control system, is equally important but less well-documented. The work of the ICAO All Weather Operations Panel has served to inter-relate these various elements.

1.2.2 This document indicates the need to approach the achievement of all weather operations from a total system concept. Ground guidance, the airport environment, meteorological measurements, airborne equipment, flight procedures and the capabilities of the flight crew are all discussed. The material in the text has been compiled from States' documents and practices and from related ICAO Annexes and documents, appropriately referenced. Suitable examples and reference to detailed requirements for all weather operations prescribed by some States are provided.

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CHAPTER 2. - GENERAL CONCEPTS

2.1 General

2.1.1 All weather operations aim at improving traffic regularity in limiting visibility conditions without reducing the currently accepted safety levels.

2.2 Benefits

2.2.1 The provision of all weather landing facilities involves considerable expenditure on both ground and airborne facilities. The cost varies on a scale with the operational objective, increasing rapidly as zero visibility capability is approached, but will lead to benefits resulting from improved regularity and safety.

2.3 System concept

2.3.1 All weather operations Categories II and III are based on a total system concept; the system encompasses the complex of air and ground equipment (including both electronic guidance and visual aids), and their use with defined flight deck operating techniques. The pilot is part of the system and takes an active role in the landing operation. To this effect he has to be furnished with the necessary information to supervise all phases of automatic approach and landing and, if necessary, to assume manual control of the aircraft in order to complete the landing if adequate visual reference is established or to carry out a missed approach procedure.

2.3.2 System reliability and integrity is achieved through design for low failure rates, redundancy, system monitoring and procedures to allow for operational alternatives.

2.4 Equipment design concepts

2.4.1 As landing visibility is reduced, more use is made of electronic guidance and automatic control. Proximity of the aircraft to the ground and obstacles at this stage of flight demands a high level of equipment reliability, system integrity and improved flight-path accuracy.

2.4.2 Mathematical assessments of system reliability are used in system design and manufacture; however other factors, together with unforeseen occurrences, need to be considered in order to provide the confidence necessary for the operations. This suggests a conservative approach to the implementation of all weather operations, through a gradual reduction in weather criteria commensurate with the confidence gained by experience.

2.4.3 Monitoring of all elements of the system, including both ground and airborne equipment, is essential. The pilot must be informed of any failure affecting the status of the system.

2.4.4 Redundancy is an important concept in providing operational reliability; standby facilities are used with both ground and airborne equipment. The redundant facility may also operate in a monitoring mode by comparison of its performance with that of the operating equipment; an alert may be provided if differences exceed established values.

2.4.5 Autopilot design has advanced from simple installations to duplicated installations providing "fail passive" capability, and triplicated and other installations providing "fail operational" capability.

2.4.6 A fail-passive autopilot provides that, in the event of failure, the aircraft reverts to manual operation but is left in a stable flight condition, while a fail-operational system provides that automatic control is retained following a failure. Fail-operational capability may also be provided by a fail-passive autopilot with a suitable flight data display as a back-up.

2.5 Operations

2.5.1 The visual phase

The capability of the all weather operations system and the degree of confidence established in its operation will determine how much of the approach must be conducted in visibility conditions which permit the pilot to visually assess the system's operation and, if required, to fly the aircraft manually.

2.5.2 Associated with the visual phase is a decision height, at which point the pilot, having visually assessed the approach, makes a final decision to either continue with the approach, or to make a missed approach. The factors to be considered in determination of decision heights in conjunction with limiting visibility conditions, are discussed in Chapter 7.

2.5.3 The landing

Some automated systems provide for touchdown and even roll-out. Such systems may overcome many of the limitations inherent in rapid transition from instrument flight to visual flight, increase the probability of approach success and improve runway utilization in low visibility conditions. The degree of confidence in such automated systems is a decisive factor in the acceptance of low visibility minima. To achieve the required degree of confidence, reliability and integrity must be adequately demonstrated.

2.5.4 Operational objectives

2.5.4.1 To enable the specification of equipment and performance requirements a series of operational objectives is described in Annex 10, Volume I, Attachment C to Part I.

Note: It is important to note the difference between operational categories and facility performance categories, the latter are determined by quite separate technical specification. For example, an ILS can have a facility performance category different from the operational category promulgated for the particular runway.

2.5.4.2 Category I. The objective: Operation down to 60 metres (200 feet) decision height and with a runway visual range not less than a value of the order of 800 metres (2600 feet) with a high probability of approach success.

Comment This can be regarded as a precision approach operation achieved without the need for facilities additional to those which have been in use for several years for the classic ILS approach.

2.5.4.3 Category II. The objective: Operation down to 30 metres (100 feet) decision height and with a runway visual range not less than a value of the order of 400 metres (1200 feet) with a high probability of approach success.

Comment In this category the time available in the visual phase limits the corrections which can be made to the aircraft's flight path. Consequently improved quality of non-visual guidance and aircraft equipment from that required for Category I is necessary. Improved approach and runway lighting systems are necessary to provide adequate visual cues. Carefully considered flight deck procedures and flight crew training are called for.

2.5.4.4 Category IIIA. The objective: Operation, with no decision height limitation, to and along the surface of the runway with external visual reference during the final phase of the landing and with a runway visual range not less than a value of the order of 200 metres (700 feet).

Comments In practice, Category IIIA operations may include a decision height below 30 m (100 feet) to permit pilot confirmation that a safe automatic landing can be effected.

In this operation the guidance and control systems must have the capability to permit the aircraft to land safely on the runway without visual reference but thereafter, during the landing roll the pilot will normally control the aircraft by external visual references.

2.5.4.5 Category IIIB. The objective: Operation, with no decision height limitation, to and along the surface of the runway without reliance on external visual reference, and subsequently, taxiing with external visual reference in a visibility corresponding to a runway visual range not less than a value of the order of 50 metres (150 feet).

Comment This operation introduces a requirement to provide non-visual guidance for roll-out. Depending on the taxiway configuration, extensive improvements to taxiway lighting, marking and traffic control may be required if the attainment of the lowest limits of Category IIIB are intended.

2.5.4.6 Category IIIC. The objective: Operation, with no decision height limitation, to and along the surface of the runway and taxiways without reliance on external visual reference.

Comment This ultimate objective creates the need for non-visual guidance to guide the aircraft on the taxiways and on the apron. The system will have to be applicable to emergency services and other essential vehicles unless alternative means can be applied to provide them with facilities for rapid and safe movement while performing their tasks.

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CHAPTER 3. - GROUND ENVIRONMENT

3.1 Electronic guidance system

3.1.1 ILS ground equipment consists of a localizer, glide path and two marker beacons, or a suitably sited DME where the siting of marker beacons is impractical.

3.1.1.1 The localizer, glide path, marker beacons and/or DME must meet the facility performance requirements for the appropriate category of operation specified in Annex 10, Volume I, Part I, Chapter 3. The guidance material in Attachment C to Part I of that document also provides useful information for the planning and implementation of the system. The Manual on Testing of Radio Navigation Aids, Doc 8071, provides detailed guidance information on ground and flight testing of radio navigation aids. Volume II of Doc 8071 is concerned with ILS facilities exclusively, while Volume I is devoted to other ICAO-Standard radio navigation aids. It will be noted that the quality of the ILS signals in space is not determined solely by the quality of the ground equipment. The suitability of the site for ILS operations, including the influence of reflection from obstacles illuminated by the ILS signals imposes a significant influence on the ultimate quality of the signal received at the aircraft. In some instances the cost of site preparation may exceed the cost of the best quality ILS equipment, however, modern antenna design may, in some instances reduce the need for expensive site preparation.

3.1.2 The weather conditions experienced at some international airports may be such that operating minima for low visibility conditions may not be required. In some cases relatively high OCLs may preclude low decision heights. Notwithstanding these considerations it is desirable to provide for coupled approaches to low altitudes with future provision for automatic landings and roll-outs, irrespective of the weather conditions. It follows then that it may require careful site preparation to ensure that the ILS installation meets the applicable ICAO standards, referred to above.

3.1.3 The quality of both the localizer and glide path signals and the operation of the monitor may be adversely affected by flooding, or by an accumulation of snow in the area surrounding the antennas. Adequate drainage will assist in alleviating flooding in this area. Guidance material on the removal of snow as practised by two States is attached as Appendix 2.

3.1.4 All facilities associated with the ILS ground equipment must be monitored in accordance with the requirements of Annex 10, Volume 1, Part I, Chapter 3. Some guidance material on monitoring is contained in Attachment C to Part I of the same Annex. The provision of integral monitors and far field monitors offer advantages for operations in Category II minima and below.

3.1.5 Annex 10, Volume I, Part I, Chapter 3 recommends a glide path angle between 2 and 4 degrees and continues further to recommend the operationally desirable angle of 2.5 degrees. Notwithstanding the latter recommendation, factors such as glide path quality, obstacle clearance requirements and aircraft noise nuisance must be considered, keeping in mind that safety and the operational requirement are of prime importance.

3.1.6 To ensure that the integrity of the guidance signal radiated by the ILS is maintained during aircraft approaches, all vehicles, including aircraft on the ground, must remain outside the ILS critical areas, as described in Annex 10, Volume I, Attachment C to Part 1. It may also be necessary to supervise carefully the parking and movement of some types of aircraft and large vehicles in a much larger "sensitive area". If a vehicle is within the critical area, it will cause reflection or diffraction of the ILS signals which will result in significant disturbances to the guidance signals on the approach path. This problem is aggravated by the ground movement of large aircraft if they are parked or taxied in the vicinity of the runway within several thousand feet of ILS antennas, and certain combinations of distance and aspect can cause serious disturbances to both the glide path and the localizer signals. Minimum sizes of critical areas are contained in Annex 10, Volume I, Attachment C to Part I. In addition interference experienced in the sensitive areas may disturb the ILS guidance signals. It is therefore essential to determine the level of interference caused by aircraft and vehicles at various positions in the sensitive area and where this interference takes the ILS signal outside the performance limits, this area is also critical and therefore it becomes part of the designated "critical area". The size of this final critical area will depend on the type of ILS, i.e. the radiated signal pattern, its achieved performance in the absence of interference and the size of the aircraft and vehicles being considered. Thus for a particular ILS installation, the ATS unit and the operators will be concerned with only one area - the critical area - where all types of aircraft and other ground vehicles can cause an unacceptable disturbance to the ILS performance. It is obviously not practicable to develop precise criteria covering all such cases hence the size and shape of the critical area for a particular ILS/taxiing aircraft combination must be determined by the State concerned.

3.1.7 The reliability of the system is related to the number of unscheduled outages which may be experienced. These outages can be reduced by a number of techniques, such as duplicating or triplicating equipment, control accessories, cabling, etc. The extent to which equipment should be duplicated or triplicated will depend on the number and the extent of the outages which can be operationally tolerated and on an assessment of the reliability and availability of individual components making up the system. Power supplies designed to provide the appropriate degree of availability, or continuity of service must be provided for Category II and III operations. Adequate monitoring of all facilities associated with precision approaches is essential to achieve the high degree of integrity demanded by lower operating minima. It is necessary that the pilot be made immediately aware of any operationally significant failure or degradation of service observed at a ground monitoring station. The system must ensure minimum delay in relaying this essential information to the pilot hence system status information, as derived from the monitor, must be available with a minimum of delay to the ATS unit providing approach control service. With regard to monitoring in general, it will be appreciated that secondary equipment is needed to increase reliability and monitoring facilities are needed to maintain integrity. However, since the monitor is, in itself, subject to failure its design should not degrade the ILS reliability to an unacceptable degree.

3.1.8 It is essential that all ILS installations be ground and flight checked at the time of commissioning and at regular intervals in accordance with the requirements of Annex 10, Volume I, Part I, Chapter 2 to ensure an adequate and uniform standard of non-visual guidance anywhere in the world. The Manual of Testing of Radio Navigation Aids (Doc 8071) provides guidance on the frequency of testing, and on techniques and procedures for conducting ground and flight tests. In the event that a facility fails to meet the requirements for the category for which it was commissioned, it must be downgraded to the category which can be met and users advised through the AIS. If flight testing of the ILS cannot be arranged within the required time period, plus the specified margin, the installation should be downgraded to an appropriate lower category.

3.2 Visual aids

3.2.1 Lighting: - Approach, threshold, touchdown zone, runway edge and centre line and other aerodrome lights are required in compliance with Annex 14, Part V, Chapter 2, appropriate to the category of operation for which the runway(s) is intended. Wherever feasible, and particularly in instances where the runway may in future be up-graded to Category II status, it is advantageous to provide improved lighting (i.e. Category II) during the initial construction or resurfacing of Precision approach runways Category I. This would eliminate the need for extensive modifications to the lighting system in future up-grading of the runway to a full Category II status. Furthermore, operational benefits would result at some locations, and advantages would accrue for training and crew exposure.

3.2.2 Monitoring and lighting circuitry: - All lighting should be monitored in downgrading must be available to the pilot in compliance with Annex 15. It will be appreciated that some lights may fail, but provided these failed lights do not exceed a predetermined maximum and are distributed in a manner which does not confuse the lighting pattern, the system may be regarded as satisfactory. It is both difficult and expensive to provide monitoring of individual lights, except by regular visual inspection in all sections of the lighting system and consideration may therefore be given to monitoring only lighting circuits. To help safeguard recognizable patterns in the event of failure of a single circuit, circuits should be interlaced so that the failure of adjacent lights or clusters of lights, will be avoided. Further information on lighting circuity is contained in Annex 14, Part VII, 3.3.

Note 1: The effectiveness of the lighting is directly related to the maintenance of the fixtures e.g. cleanliness of the lenses. Where transmissometers are installed to provide RVR measurements a small deterioration factor is usually included in the final readout to compensate for differences between the theoretical light intensity and that observed in practice.

Note 2: In the event that any part of the approach or runway lighting differs from the Standards or Recommended Practices in Annex 14, the difference, such as variations in light spacing or pattern, should be clearly stated in the State AIPs so that the expected visual segment at particular decision heights can be established by aircraft operators. However, in the interests of international standardization it is important that only ICAO standard lighting systems should be installed at airports where low visibility operations are to be carried out.

3.2.3 Runway and taxiway marking - the importance of clear and conspicuous runway and taxiway markings increases as the visibility decreases. Runways and taxi-holding positions should be marked to conform with the requirements of Annex 14, Part V, Chapter 2. The conspicuity of runway markings and taxiway markings deteriorates rapidly, particularly at aerodromes having high movement rates, therefore, the need to frequently inspect and maintain these markings cannot be over-emphasized, especially for Category II and III operations.

Note: In addition to material available in ICAO Annexes and Manuals, considerable guidance material on design criteria for non-visual and visual facilities in the terminal area is provided in State documents.

3.3 Runways and taxiways

3.3.1 Runways should be at least 45 m (150 feet) wide for Categories II and III operations and they should be provided with adequate load bearing shoulders. When considering the design aspects for a new runway, or major changes to an existing one, due consideration should be given to the need to provide for the ultimate category of operations intended at each such runway. Although present requirements may not require this degree of development for several years, limitations may need to be placed on the erection of obstructions in the vicinity of the airport and/or the taxi pattern to ensure that critical areas are avoided. Adequate provisions should also be made for holding bays in which aircraft can await clearance to enter the runway. Annex 14, Parts III and IV, provide material which will assist in many respects.

3.4 Pre-threshold terrain

3.4.1 The operation of some automatic landing systems are dependent on the radio altimeter. The flare profile, the rate of descent at touchdown and the distance of the touchdown point from the runway threshold can be affected by the profile of the terrain immediately prior to the threshold. Terrain considered most critical lies in an area 60 m (200 feet) either side of the runway centre line extending into the approach area to a distance of at least 300 m (1 000 feet) before the threshold. Annex 4, Chapter 15, requires that a terrain profile chart be published by States providing facilities for operations below Category I and the Aeronautical Chart Manual, Doc 8697-AN/889, provides guidance on the production of suitable charts. Due to the difference between sizes of the areas illuminated by different types of radio altimeters, flight tests should be conducted to ensure repetitive profile heights. The guidance material in Annex 14, Attachment B makes reference to the maximum slopes of pre-threshold terrain which are normally acceptable when planning a new runway for low visibility operations. Notwithstanding this guidance, where terrain is considered marginal, practical flight tests conducted with equipment representative of that used by aircraft operators, are considered to be the only means of determining final acceptance. Before an operator conducts an approach in instrument meteorological conditions (IMC) down to Category II minima at any airport, an approach in visual weather conditions should first be made to ensure that the aircraft with its associated Category II equipment will perform satisfactorily. Any additions or alterations to existing structures in the pre-threshold terrain area must be closely examined to determine any effect on published information. In the event that an alteration in this area has a significant effect on radio altimeters then the amended data relating to the terrain profile chart must be disseminated by NOTAM.

3.5 Secondary power supplies

3.5.1 Requirements for the provision of secondary power supplies for visual and non-visual aids are specified in Annex 14, Part VI, and Annex 10, Volume I, Part I, Chapter 2, respectively. Guidance material in the Aerodrome Manual, Part IV, Chapter 1 and in Annex 10, Volume I, Attachment C to Part I, will also assist in achieving the changeover times specified. Standby power is also required for essential communications and for other associated facilities, such as visibility measuring systems, etc. Changeover times for these latter facilities will be commensurate with those applying to visual and non-visual aids.

3.6 Air traffic service (ATS)

3.6.1 The provision of aerodrome control service is considered essential at aerodromes planned for Categories II and III operations. The ATS unit must ensure that pilots are kept informed during flight of any change in the status of airport facilities at the destination and/or alternate aerodrome. The ATS unit concerned may, in some locations, require a discrete frequency for communicating essential information to aircraft at the commencement of an approach and during the final approach, landing and roll-out phases.

An Automatic Terminal Information Service (ATIS), where provided, will assist operations prior to the commencement of final approach, but this service would not normally be updated with sufficient frequency to eliminate the need for essential information to the pilots being passed on a discrete pilot-controller channel for operations below Category I The essential information to be provided to pilots is specified in Annex 11 and in Part IV of PANS-RAC (Doc 4444-RAC/501).

3.6.2 Because ILS signals can be disturbed by reflections, ATS units must exercise the necessary control to ensure that in Categories II and III conditions, aircraft do not take off from the landing runway while an aircraft is on final approach. This is necessary to preserve the integrity of the precision guidance system during the time when the landing aircraft is critically dependent on the quality of the signal in space. For the same reason, additional longitudinal separation is required between successive landing aircraft in Categories II and III conditions.

3.6.3 When designing approach procedures for use in conjunction with Categories II and III ILS facilities, it is desirable to make provisions whereby aircraft equipped for low visibility operations will not be unnecessarily delayed by aircraft not so equipped. This may require special holding procedures, or special radar vectoring procedures. However, when Categories II or III conditions do not prevail, all aircraft should be afforded normal priorities by ATS units.

3.6.4 Air traffic service units should recognize the need for aircraft to simulate low minima approaches in good weather conditions so that both crew and equipment can gain practical exposure. Approval to conduct such an exercise should be requested by the pilot-in-command and ATS units should agree to such a request whenever traffic will permit. While this exercise is being conducted, ATS units should, where feasible, restrict take-offs and ground manoeuvring to the same extent as if actual low minima conditions exist. When this is not feasible ATS should advise the pilot accordingly.

3.7 Aeronautical information service (AIS)

3.7.1 The efficient operation of this service is essential to Categories II and III operations so that pilots are kept informed of the status of all airport facilities, appropriate to the flight, at the flight planning stage. Any change in, or degradation of, any operationally significant airport facility must be immediately advised to the appropriate AIS Units. Annex 15, Chapter 7 outlines some of the requirements which must be met in this respect.

3.8 Meteorology

3.8.1 PANS-MET (Doc 7605) specifies the type of meteorological service which is necessary to meet the requirements for take-offs and landings in low visibility conditions. This document also recommends the location of ground measuring instruments and their tolerances.

3.8.2 Ideally, slant visual range (SVR) will enable a pilot to assess, before commencing final approach, the length of the visual segment he can expect to have available from his decision height to touchdown. Unfortunately, a practical method of measuring SVR in the approach area has not yet been perfected and runway visual range (RVR) has to be used. The importance of runway visual range information calls for systems for the assessment of this element with a high degree of reliability and integrity to meet the stated accuracy requirements (Doc 7605, PANS-MET - Attachment G). There is also a requirement for the RVR system to be such as to allow for any significant change in RVR values to be available in ATS for transmission to the pilot within 15 seconds, and with less delay if this can be achieved (PANS-MET 2.2.4.2). In order to meet these requirements, States are installing equipment for RVR assessment at suitable locations with automated display and back-up as considered necessary. Detailed guidance material on RVR observing and reporting practices is given in ICAO Circular 113-AN/85 - "Runway Visual Range Observing and Reporting Practices."

3.9 Obstacle clearance limits and obstacle limitation surfaces

3.9.1 Obstacle clearance limits are specified in detail in PANS-OPS (Doc 8168-OPS/611/3) although a limited number of options are available in respect to some parameters. It is essential, therefore, that where alternative parameters are available the State should clearly identify the criteria used to determine operating limits. The Obstacle Clearance Panel is currently studying the subject of obstacle limitation surfaces, and it is expected that related amendments will be made to the appropriate ICAO documents, including Annex 14, through the usual ICAO consultative process. Such amendments could become applicable about 1975.

3.10 Essential vehicle manoeuvring

3.10.1 Essential vehicles must be able to manoeuvre in low visibility conditions and they should be strategically located during these operations so that their services will be available at the site of any mishap in a minimum of time. Helpful guidance on this facility is provided in the ICAO Aerodrome Manual, Part 5, Volume 1.

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CHAPTER 4. - THE AIRCRAFT SYSTEM

4.1 General requirements

4.1.1 The requirements for airborne equipment should be related to the expected level of operating minima to be established for the aircraft concerned. In addition to the requirements for airborne equipment contained in national airworthiness requirements, account must be taken of the requirements for airborne equipment in the approach or landing phase stemming from consideration of the following aspects for each category of operation:

a) safety target;

b) acceptable frequency of missed approaches.

4.1.2 The safety target and the acceptable frequency of missed approaches, in conjunction with the intended level of operating minima, determines the airborne equipment requirements with regard to:

a) system accuracy;

b) reliability;

c) characteristics in case of failures;

d) monitoring procedures and equipment;

e) degree of redundancy;

f) method of demonstrating the attainment of the safety target.

4.2 Minimum equipment requirements

4.2.1 At the present time the equipment required for Categories II and III operations and the performance demanded of it differs from one State to another. In view of these differences Tables 1 and 2 have been compiled to give the equipment acceptable to several States* who have published all weather operating requirements.

4.2.2 The method of operation must also be considered, for example an automatic landing will require more failure protection than a manual operation from decision height.

* France, Federal Republic of Germany, United Kingdom, and United States.

4.3 Airborne system approval

System approval requirements for each Category are summarized below.

4.3.1 Category I

ILS glide path and localizer tracking performance for individual equipments is not usually specified. It is often preferred to demonstrate by means of a number of approaches that the system is capable of adequate performance. Consideration of failures should cover runaway to the limit of control of an autopilot, together with an examination of failure warnings and crew operating procedures.

4.3.2 Category II

ILS glide path and localizer tracking performance standards should be laid down in the form of a required standard deviation of guidance signal error. The accuracy of the airborne system should be shown to be met by sufficient numbers of approaches during certification or operational evaluation. More detailed consideration of failure cases is required than for Category I conditions, a statistical failure analysis being preferred by some States. Sufficient experience and use of the system should be gained before use in Category II conditions.

4.3.3 Category III

During the certification programme it should be shown by a considerable number of landings supported by a simulator test programme that the touchdown performance requirements have been satisfied. This may also include a detailed statistical failure analysis with demonstration of selected failures in flight. Sufficient operational experience and use of the system should be gained before approval for operational use in Category III conditions.

4.4 Maintenance

4.4.1 The operator should establish a maintenance programme to assure that the airborne equipment continues to operate in service to the required performance level; any deterioration in performance should be readily detectable. During the period of evaluation and acceptance the operator should provide a periodic summary of operational performance. Included in the summary should be details of unsatisfactory aircraft operational performance attributed to airborne equipment, from which an analysis is made to determine system and equipment deficiencies.

4.4.2 For Categories II and III operations the importance of maintenance in the following areas should be emphasized:

a) maintenance procedures;

b) maintenance and calibration of test equipment;

c) initial and re-current training of maintenance staff;

d) recording and analysis of airborne equipment failures.

4.5 Summary of some States' equipment requirements

4.5.1 Tables 1 and 2 show some States' equipment requirements. Both Tables show the operational function, and the equipment used to carry out that function, together with possible aircraft system that would be accepted. Differences between States' requirements are referred to in the remarks column together with any necessary amplifying remarks.

NOTE: The tables do not include specific reference to monitoring, comparison and associated warning systems associated with the airborne equipment.

4.6 Summary of some States' aircraft performance requirements

4.6.1 Tables 3 and 4 contain a summary of some States' aircraft performance standards for certification to Categories II and IIIA operations respectively.

4.6.2 It must be stressed that the figures given should not be regarded as firm requirements. The US figures, for example, are given in Advisory Circulars while the UK figures are given as typical of the system performance which, provided that the failure analysis is satisfactory, might be expected to be adequate.

4.6.3 For Category II operations, standards are given for glide path and localizer error (deviation of the aircraft from the indicated ILS centre line) and, in the case of the UK requirements, for the error in rate of descent at the decision height. Landing distance is also considered.

4.6.4 For Category III operations, standards are given for longitudinal and lateral touchdown position, vertical velocity, bank and pitch angle and heading error at touchdown.

4.6.5 For more detailed information the reader is referred to the following documents:

1. Category II

   US Advisory Circulars AC 120-29, AC 20-57A;
   UK BCAR Paper No. 423;

   Federal Republic of Germany - Rules for Category II all weather operations;

   France - Réglementation concernant l'execution des approches de précision de Catégorie II.

2. Category III

   US Advisory Circulars AC 20-57A, AC 120-28A;

   UK BCAR Paper No. 367;

   France - Réglementation concernant l'execution des approches de precision de Categorie III A.

4.6.6 The following abbreviations are used in these tables:

SD : standard deviation;

DH : decision height;

MH : minimum height to which the system may be used;

FRG : Federal Republic of Germany;

UK : United Kingdom;

US : United States.

4.6.7 Explanation of Tables 1 and 2

Column 1 : Identifies a function to be performed by airborne equipment during the approach and landing phase.

Column 2 : Indicates the equipment which could fulfil the function and which would be required by a majority of States having published requirements.

Column 3 : Indicates any significant differences in States' requirements and, where appropriate, amplifying remarks.

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Table 1. - Equipment Requirements

Automatic approach and landing - Category II

Function 1	Equipment 2	Remarks 3
1. Steering	Autopilot system and/or flight director display to both pilots	US requires a single flight director system and an autopilot or two independent flight director systems. For twin engine propeller aircraft a single flight director or an autopilot is acceptable. FRG requires a single monitored flight director system. UK requires a fail passive autopilot with audible warning of autopilot disengagement, or a single fully monitored or two cross monitored flight director systems.
2. Approach guidance	ILS receivers: Two glide path and localizer receivers	UK will accept a single adequately self monitored receiver but two are normally fitted.
3. Flight path deviation warning	Excess ILS deviation warning	Not required by US and FRG.
4. Decision height determination	Radio altimeter	Radio altimeter not required by US where use of inner marker is acceptable
5. Missed approach	Missed approach guidance or control: Attitude displays with calibrated pitch markings	
6. Speed control	Automatic throttle	Most States require auto-throttle if workload is unacceptable without it.
7. Rain removal	Essential	

Table 2. - Equipment requirements

Automatic approach and landing - Categories IIIA and IIIB

Function 1	Equipment 2	Remarks 3
1. Steering	Automatic landing system	US and France will conditionally accept a fail passive autopilot and a manual back-up capability for landing by reference to instruments as a fail operational system. UK requires a fail operational autopilot and audible warning of autopilot disengagement.
2. Ground steering		UK require a single channel reversionary ground roll out guidance or control system to provide for loss of external visual reference in the lower half of Category IIIA. Fail operational system required by the UK for Cat. IIIB.
3. Approach guidance	ILS receivers	As required by flight control system but a minimum of two.
4. Flight path deviation warning	Excess deviation warnings	Required by UK and France
5. Decision height determination	Radio altimeters	Minimum of two normally required but number may be determined by flight control system.

Table 2. (Cont'd)

6. Missed approach		Missed approach guidance required by the U.K.
7. Speed control	Autothrottle	Required by all States.
8. Rain removal	Essential	

Note

The above apply to all State requirements so far published.

An equipment used during determination of performance will normally become mandatory when operations are established.

TABLE 3

Performance requirements - Cat. II

Item	United Kingdom	United States	France
1. Glide Path	Average: a) SD of glide path error from 152 metres (500 feet) to DH: the greater of 25 uA or 24 metres (8 feet). b) SD of rate of descent error at MH: 0.76 metres/sec (2.5 feet/sec). Critical parameter on limit: a) SD of glide path error from 152 metres (500 feet) to DH: 30 uA or 3 metres (10 feet). b) SD of rate of descent error at MH: 1 metre/sec (3.0 feet/sec).	From 215 metres (700 feet) altitude to DH the autopilot/coupler should cause the airplane to track the center of the indicated glide path to within ± 35 uA or ± 3.6 metres (12 feet), whichever is larger, without sustained oscillations. Airplane speed: maximum and minimum design approach speeds Wind conditions (the effects may be shown analytically): Surface downwind component of 10 kt. Windshear of 4 kt per 30 metres (100 feet) altitude applied along or across the runway individually, commencing at an altitude of 152 metres (500 feet).	SD of vertical error relative to glide path centre line at DH: 1.8 metres (6 feet). Conditions: Performance to be met or exceeded under following conditions: Tailwind (surface): 10 kt Tailwind shear /below 152 metres (500 feet)/: 3 kt/30 metres (100 feet) Cross wind: 15 kt Cross wind shear /below 152 metres (500 feet)/: 3 kt/30 metres (100 feet)
2. Localiser	Average: SD of localiser error from 152 metres (500 feet) to DH: 8.5 uA. Critical parameter on limit: SD of localiser error from 152 metres (500 feet) to DH: 12.5 uA.	From the outer marker to an altitude of 90 metres (300 feet) above the runway elevation on approach path, the autopilot/coupler should cause the airplane to track automatically to within ± 35 uA (95% probability) of the indicated course. The performance should be free of sustained oscillations. From an altitude of 90 metres (300 feet) above runway elevation to the DH 30 metres (100 feet) the autopilot/coupler should cause the airplane to track automatically to within ± 25 uA (95% probability) of indicated course. The performance should be free of sustained oscillations. Wind conditions: as for glide path above.	SD of lateral error relative to localiser centre line at DH: 8.5 metres (28 feet). Conditions: As for glide path above.
3. Landing Distance	Must be recomputed and, if necessary, rescheduled.	Not considered appropriate for aircraft requirements for Category III operations.	Runway length available 15% greater than that scheduled in operations manual.

TABLE 4

Performance requirements - Category III

Item	United Kingdom	United States	France
1. Lateral dispersion at touchdown	Average: SD of displacement: 3.8 metres (12.5 feet) SD of cross track vel.: 0.6 metres/sec (2 feet/sec) Mean values to be zero. Limit: (Note 1) SD of displacement: 4.6 metres (15.0 feet) SD of cross track vel.: 0.8 metres/sec (2.7 feet/sec) with means zero, or the equivalent if the means are not zero.	(1) Distribution of touchdowns about a nominal point on a two-sigma basis should be established with reference to desired airplane/system characteristics, as follows: (also applies to longitudinal dispersions below) lateral dispersions of aircraft centre line at the main landing gear should not exceed 8.2 metres (27 feet) either side of the centre line of the runway. (2) A suitable computer analysis should show that under realistic environmental conditions including the wind model described in Appendix 1 of AC 20-57A, the touchdown performance will be such that landing outside of the prescribed dispersion area will be improbable. (Also applies to longitudinal dispersions below). Lateral touchdown with the outboard landing gear no closer than 1.5 metres (5 feet) from the lateral limits of a 45.6 metres (150 feet) wide runway.	Average: SD of displacement::5 metres (16.4 feet) SD of cross track vel.: 1 metre (3.1 feet)/sec SD of u/c lat. vel.: 2.5 metres (8.2 feet)/sec. Limit: Displacement: 10 metres (32.8 feet) Cross track vel.: - u/c lateral vel.: 6 metres (19.7 feet)/sec.
2. Longitudinal dispersion at touchdown	Average: SD: 88 metres (290 feet) Mean (Note 2): 460 metres (1500 feet) from threshold. Limit: SD: 102 metres (335 feet) Mean: 460 metres (1500 feet) from threshold	(1) above applicable. longitudinal dispersion about the nominal point of the main landing gear touchdown should not exceed 460 metres (1500 feet) total, but need not be symmetrical about the nominal point. (2) above applicable. longitudinal touchdowns between a point at least 61 metres (200 feet) beyond the threshold and that point down the runway at which the pilot is in a position to see at least 4 bars /on 30 metres (100 feet) centres/ of the 1020 metres (300 feet) touch-down zone lights.	Average: 300 - 800 metres (985 - 2,630 feet) from threshold (95%)
3. Vertical velocity at touchdown	No values given because distribution is thought to be probably not Gaussian.	No values given but must be shown to be acceptable during the certification process.	Average: 0 - 1 metres/sec (0 - 3.3 feet/sec) Limit: 1.8 metres/sec (5.9 feet/sec).

Table 4. (Cont'd)

Item	United Kingdom	United States	France
4. Bank angle at touchdown	No values given but must be shown to be acceptable in relation to overall safety levels.	No values given but must be shown to be acceptable during the certification process.	**Average:** ± 3° (95%) **Limit:** ± 6°
5. Pitch attitude at touchdown	No values given but must be shown to be acceptable in relation to overall safety levels.	No values given but must be shown to be acceptable during the certification process.	**Average:** ± 2° (95%) relative to the mean value **Limit:** 0 - 8°
6. Heading error at touchdown	No values given but must be shown to be acceptable in relation to overall safety levels.	No values given but must be shown to be acceptable during the certification process.	**Average:** ± 4° (95%)
7. Landing distance	Any increase in landing distance over that required for a manual landing must be scheduled in the Flight Manual.	Not considered appropriate for aircraft requirements. for Category III operations.	If landing after the pilot has been warned of a failure it must be demonstrated that in the most adverse case with the aircraft at max. landing weight, the aircraft can be stopped in normal operating conditions in bad visibility within 2500 metres (8,200 feet) of the landing threshold.
8. Approach performance			Must comply with Category II requirements.

Table 4. (Cont'd)

Item	United Kingdom	United States	France
9. Wind speed and turbulence	Wind speed limits chosen by applicant. Turbulence spectrum specified.	Dispersion limits in (1) and (2) should consider headwinds up to 25 kt; tailwinds up to 10 kt; crosswinds up to 15 kt; moderate turbulence; wind shear of 8 kt/30 metres (100 feet) from 60 metres (200 feet) to touchdown.	

Note 1 - With any one parameter on its permitted limit (e.g. visibility, wind speed).

Note 2 - If the mean touchdown position is not 460 metres (1,500 ft.) from the threshold SD will be different.

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CHAPTER 5. - OPERATIONAL PROCEDURES

5.1 General

5.1.1 This material is offered for consideration by both the operator and the State of Registry when Categories II and III operations are to be introduced. The subjects are complementary to the requirements mentioned in Chapter 9 - Authorization.

5.2 The operations manual

5.2.1 Low weather minima operations call for special procedures and instructions to be included in the operations manual. These should cover all foreseeable circumstances so that flight crew are fully informed as to the correct course of action which must be followed. This is particularly true for the last part of the approach and landing where only a limited time is available for decision making and execution of the prescribed action.

5.2.2 The precise nature and scope of operations manual material will vary for each operator in accordance with the airborne equipment used and the flight deck procedure applied. The contents of the operations manual are specified in Annex 6, Part I, Chapter 11. However the following are particularly important with respect to Categories II and III operations:

a) a standard procedure applicable to the aircraft in question including call-outs, the use of radio and flight guidance equipment and allocation of crew duties with reference to equipment operating sequences and monitoring during all stages of the approach and landing;

b) checks for satisfactory functioning of equipment, both on the ground and in-flight;

c) effect on minima caused by changes in the status of ground installations including meteorological measuring devices;

d) use and application of multiple position RVR reports;

e) identification of the failure of any portion of the system or instruments used with the system and action to be taken. With respect to the above, an alert height is often used to denote different actions as a function of height;

f) a list of aircraft equipment allowable deficiencies, as necessary taking account of Category III and/or Category II operations separately;

g) action to be taken in case of aircraft system failures such as engines, electrical system, hydraulics and flight controls;

h) operating limitations resulting from low weather minima certification such as maximum cross and tail wind, minimal braking action, extra runway length required, minimum height to which autopilot operation is authorized, etc;

i) information on the maximum deviation allowed from the ILS glide path and/or localizer in the region of the decision height as well as guidance regarding the visual reference required for assessment of aircraft position, and rate of change of position in relation to the nominal flight path;

j) action to be taken when weather deteriorates below limits;

k) a standard missed approach procedure including allocation of crew duties and, if applicable, monitoring of automatic missed approach performance;

l) a take-off procedure when, depending on aircraft type, special techniques or operating procedures are needed to ensure runway alignment for take-off in RVR conditions well into the Category III operations region.

5.3 Procedures for the introduction of low weather minima operations

5.3.1 It has been found useful to establish procedures for the gradual introduction of low weather minima operations by individual operators. This suggests a conservative approach to the implementation of all weather operations through a gradual reduction in meteorological criteria commensurate with the confidence gained by experience. In some States this is a requirement associated with authorization of the operation (see 9.3.3). Such procedures are normally aimed at:

a) the practical evaluation of airborne equipment before commencing actual operations. This may be of particular interest to States relying on the certification of the State of manufacture;

b) accumulation of experience with the procedures discussed in 5.2 before commencing actual operations and, if necessary, the adjustment of those procedures;

c) accumulation of actual operating experience with weather minima within the Category of operation in question but not as low as the lower limit of this category;

d) accumulation of operating experience under Category II conditions before proceeding to Category III conditions;

e) providing for maintenance purposes a means of feed-back on system performance, mainly of the airborne equipment but, in some cases, also of the ground installations;

f) maintaining crew proficiency.

5.3.2 For Category II operations it would be sufficient to accept as a minimum a definition of a successful approach and to prepare a questionnaire for the flight crew to obtain data on simulated or actual approaches. The following information is normally requested as applicable: the airport/runway in question, weather conditions, time, reason or failure leading to an aborted approach, adequacy of speed control, trim state at autopilot disengage, compatibility of autopilot, flight director and raw data, an indication of the aircraft's position relative to the ILS beam centre lines at 30 metres (100 feet) as well as the aircraft's position relative to the runway at this height. The number of approaches made during this phase of operational evaluation will vary widely depending on the background of the system and the operators experience. It should be sufficient to demonstrate that the performance of the system in airline service is such that an adequate approach success rate will result. When calculating the success rate, factors such as ground facility beam quality, ATC reasons, etc., may be taken into account.

5.3.3 For Category III operations a similar procedure could be followed but due to the narrow tolerances of Category III equipment and the crew workload below 30 metres (100 feet), use is often made of recording equipment such as a sophisticated flight data recorder. Any landing irregularity should be fully investigated using all available data to determine its cause.

Note: The following parameters are worthwhile considering for inclusion in the recording programme: radio altitude, localizer and glide slope deviation on approach, localizer deviation at touchdown, sink rate and/or vertical acceleration at touchdown, airspeed, heading, pitch and roll angle and rates, automatic switching in the airborne equipment e.g. capture, glide path extension, flare capture and automatic disengage functions.

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CHAPTER 6. - FLIGHT CREW TRAINING

6.1 General

6.1.1 Before operations in Categories II and III conditions, it will be necessary for the flight crew to undergo a comprehensive programme of training and education. The particular programme of training will, of necessity, be fitted to the aircraft type and the operating procedures adopted, which procedures are discussed under Section 5.

6.1.2 In Categories II and III operations there will be increased emphasis on the role of the pilot as a supervisor of automatic systems. This may require an adjustment in attitudes and the topic is discussed further below.

6.1.3 Following completion of training, applicants must demonstrate their skill to the appropriate authorities.

6.2 Education and ground training

6.2.1 Flight crew must make full use of ground and airborne equipment intended for use during Categories II and III operations. They must therefore be instructed in how to obtain maximum benefit from the redundancy provided in the airborne equipment while understanding fully the limitations of the total system, including both ground and airborne elements.

6.2.2 It is suggested that the ground instruction should cover at least:

a) the characteristics, capabilities and limitations of the ILS as applied to Categories II and III operations;

b) the characteristics of the visual aids, i.e, approach lighting, touchdown zone lighting, centre line lighting etc. and the limitations to their use in reduced and varying visibilities;

c) the operation of and the capabilities and limitations of the airborne systems (e.g. the automatic flight control systems, flight instruments - including altimetry systems, etc.);

d) approach and missed approach procedures and techniques;

e) the use and limitations of RVR, including the different ways of measuring RVR and the limitations associated with each method;

f) the influence of windshear, turbulence and precipitation;

g) the use of visual cues, their availability and limitations in reduced RVR with various glide path angles and cockpit cut-off angles and the heights at which various cues may be expected to become visible in actual operations;

h) procedures and techniques for transition from instrument to visual flight in low RVR conditions, including the geometry of eye height, wheel height and antenna position with reference to various glide path angles;

i) action to be taken if the visibility deteriorates when the aircraft is below decision height and the technique to be adopted for transition from visual to instrument flight should a missed approach become necessary at these low heights;

j) action in the event of equipment failure above and below decision height;

k) use of operational data connected with the approval of the operation;

l) significant factors in the calculation and determination of decision height;

m) effect of engine loss on autothrottle, autopilot performance etc;

n) procedures and precautions to be followed while taxiing during low visibility conditions.

To help in this training use can be made of films of actual approaches in Categories II and III conditions, of an approved simulator having a visual attachment, and of other training material.

6.2.3 The duties and responsibilities of each member of the operating crew during an approach and landing must be clearly understood as must the changed role of the pilot as supervisor where automatic approach is to be the method of operation. The techniques employed for this supervision will depend on the particular airborne system, but flight crew should be instructed in the means of detecting at an early stage, any deviation from path and the trend in that deviation. This will, of course, be backed up later by flight training.

6.2.4 Some approaches will result in the aircraft being off centre line or glide path at decision height. Flight crew should be given guidelines to help with decision making on such occasions.

6.2.5 Where the approach and landing is to be completed by reference to visual cues as in Category II conditions, flight crew must be educated to the limitations of these visual cues in reduced visibility. During an approach to landing under conditions of low visibility, pilots can be led into a premature transition to outside references for aircraft control when available visual cues are not adequate for control of pitch attitude and/or vertical flight path. Flight crews must therefore be cautioned to continue monitoring flight instrumentation until adequate visual contact with the runway and its environment can be maintained to complete safely an approach and landing. Furthermore, during an automatic approach, pilots must be warned against disengaging the autopilot prematurely.

6.3 <u>Training and proficiency programme</u>

6.3.1 Each member of the operating crew must be trained to carry out the duties that are set out for him appropriate to the particular airborne system. He must subsequently demonstrate his ability to carry out these duties, to an acceptable level of performance, before he is authorized to engage in the particular category of operations for which he has been trained.

6.3.2 **Initial training for operating crews**

6.3.2.1 Initial training will depend on the particular airborne system and on the operating procedures adopted but it is suggested that this initial training should include at least the following:

a) ILS approaches by use of the system down to decision height without external visibility, followed by landing using the system;

b) ILS approaches by use of the system down to decision height without external visibility, followed by missed approach on instruments;

c) ILS approaches by use of the system followed by manual flare and landing when these are included as part of the normal operation or following take over from disconnection of the autopilot at low level;

d) ILS approaches by use of the system down to decision height followed by missed approach on instruments with simulated failure of the critical engine, at a flap setting appropriate to the exercise. Note: It is better to confine this particular exercise to the simulator;

e) missed approaches from just before flare height, on instruments, to train the pilot for the eventuality of loss of external visibility at low height;

f) take off and abandoned take off procedures in low visibility

6.3.3 Recurrent proficiency checks

6.3.3.1 In conjunction with the normal checking of pilot proficiency at fixed intervals, a pilot's ability to perform the tasks associated with the particular category of operation for which he is trained must be demonstrated to the licencing Authority. Due to the low probability of an individual pilot encountering Category II or III conditions during actual operations, recurrent training, proficiency checking and renewal of rating assumes increased importance with the advent of all weather operations.

6.3.3.2 Part of the recurrent training can be carried out by such means as questionnaires, oral tests and discussion of equipment and procedures.

6.3.3.3 It may be possible to perform recurrent checking on an approved simulator.

6.3.4 Some States actively encourage pilots to use Category II or III systems and procedures during normal service, regardless of the weather conditions, whenever the necessary ground facilities are available and traffic conditions permit. There is merit in this pratice. There is also conflict in that the pilot will want to maintain his proficiency in normal manual flying of the aircraft. Experience has shown that this conflict is most acute where crews are engaged on a route structure having long stage lengths.

6.3.5 Consideration should be given to a recency requirement, i.e. that crews should achieve a minimum number of automatic approaches, or approaches and landings as applicable, each month (or other suitable period) to maintain their Category II or III qualification. **This recency requirement is in no way a substitute for recurrent training.**

6.4 Simulation techniques

6.4.1 Simulation techniques are a valuable training aid in low visibility operations. Use should be made of them for general training in the aircraft system and the operating procedures to be used. However, their real value in training for Categories II and III operations is that different RVR values can be simulated so that flight crew, who may but rarely meet low visibility conditions in practice, can be given a realistic idea of what to expect in these conditions and can maintain their proficiency during recurrent training. Since it will happen that the visibility as observed from the cockpit will, at times, be less than that observed on the runway, it is important that visibility values lower than the lowest authorized for the operator can be simulated. This will help with subsequent decision making.

6.4.2 A simulator with a visual attachment can be used during initial and recurrent training, with various RVR values simulated, for:

a) ILS approaches;

b) missed approaches;

c) landings;

d) relevant drills and procedures after experiencing malfunction of:

   i) the aircraft system;

   ii) the ground system.

e) transition from non-visual to visual flight;

f) transition from visual to non-visual flight at low level.

6.4.3 A simulator without a visual attachment can be used during initial and recurrent training for:

a) ILS approaches;

b) missed approaches;

c) relevant drills and procedures after experiencing malfunctions of:

   i) the aircraft system;

   ii) the ground system.

6.4.4 Simulation techniques employed may cover the use of flight simulators and devices fitted to aircraft for simulating low weather minima conditions in flight.

6.4.5 Approved simulators may be used for recurrent proficiency checks.

6.4.6 Consideration should be given, during simulator training, to the introduction of vertical as well as horizontal offsets at decision height. These offsets will occur at times in actual operation and simulator training will be an aid to decision making. Offsets in roll and pitch and the effects of wind-shear could also be introduced at decision height.

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CHAPTER 7. - AERODROME OPERATING MINIMA

7.1 General

7.1.1 Aerodrome Operating Minima are established in accordance with Annex 6, Part I, Section 4.2.6.

7.1.2 For the most part a good measure of uniformity has been reached in establishing limits within the Category I range of visibility conditions. This desirable level of uniformity should be maintained or bettered for the lower minima in Categories II and III conditions, even though additional factors have to be taken into account. These additional considerations, and how they can affect Aerodrome Operating Minima, are discussed below. It should be emphasized that there are several aspects to the establishment of low minima which have not yet received universal acceptance. For the sake of illustration, examples are sometimes given of current practices in States with a well-advanced Category II or III programme, but while these practices are obviously acceptable to the State concerned, they are not necessarily covered in ICAO documents.

7.2 Special considerations

7.2.1 Factors to be considered in the determination of aerodrome operating minima are specified in Annex 6, Part I, 4.2.6. However, in determining acceptable decision height and runway visual range limits, special consideration should be given to the following:

a) aircraft performance;

b) obstacle clearance;

c) ground environment;

d) mode of operation;

e) DH/RVR relationship.

The above factors are discussed in some detail in the following paragraphs.

7.3 Aircraft performance

7.3.1 The following have been identified as some of the factors and variables of aircraft characteristics which could be taken into account in arriving at proper values of DH and RVR:

a) approach speed;

b) approach angle;

c) cockpit cut-off angle;

d) manoeuverability;

e) response to wind shear and turbulence;

f) capability of equipment;

g) height resolution accuracy;

h) missed approach performance, taking into account pilot reaction time.

7.3.2 Most of these characteristics will have been taken into account during the airworthiness certification of the aircraft and its system, and this analysis should have indicated the lowest decision height to which the aircraft can be operated from a technical viewpoint. This can be regarded as the height to which the aircraft can safely make a non-visual approach and from which it can make a safe non-visual missed approach. This calculated height must then be adjusted to take account of the additional factors that apply; obstacle clearance, ground environment and mode of operation.

7.3.3 In one State, a simple system is used to arrive at a minimum DH in which aircraft are grouped according to approach speeds, and a minimum attainable DH assigned to each group. In another, a similar system is used but based on approach speed at maximum certificated landing weight. It can be appreciated that various methods of increasing complexity could be applied, and that the method applied by each State should be clearly defined.

7.4 Obstacle clearance

7.4.1 As mentioned in Chapter 4, Ground Environment, criteria for obstacle clearance are contained in the PANS-OPS, and this document is generally accepted as guidance for Categories I and II runways.

7.4.2 Obstacle clearance has been the subject of much study within ICAO, and it is expected that there will be significant amendments to Annex 14 and other relevant documents in the near future. The following is therefore tentative, and subject to early amendment.

7.4.3 Although a common practice is desirable, as long as there are differing practices, it is important that States publish the method they follow for establishing obstacle clearance surfaces.

7.4.4 There is a view that an area overlying the strip should be kept free of obstacles to afford protection to aircraft which, having descended below decision height, subsequently needs to carry out a missed approach. A full description of such an "Obstruction Free Zone" adopted by one State is contained in Appendix 1.

7.5 Ground environment

7.5.1 Chapter 3 of this document lists the airport requirements for establishing Categories II and III minima.

7.5.2 In the case where limited deficiencies in certain airport elements are acceptable, the element should be identified and the consequences of the deficiency clearly defined. That is, States should publish the degree of degradation that is acceptable for a given Category, or when appropriate, stipulate the higher limits which would apply for a given level of performance.

7.5.3 While it is not deemed practical to list all the possible deficiencies which could be accepted for low minima operations, the following is a representative list of airport elements which, if degraded below acceptable limits, could require a temporary increase in aerodrome operating minima:

a) ground conditions at ILS antenna sites;

b) runway surface conditions;

c) runway markings;

d) approach, threshold, touchdown, edge, centre line and runway end lights;

e) secondary power supply;

f) RVR system;

g) ground guidance system.

7.6 Mode of operation

7.6.1 DH/RVR limits can be lowered commensurate with the degree of system capability and performance providing that crew training, proficiency and procedures are adequate for the type of operation. Possible modes of operation include:

a) manual approach and landing;

b) coupled to DH, manual thereafter;

c) coupled below DH, but manual flare and landing;

d) coupled followed by auto-flare and auto-landing.

7.7 DH/RVR relationship

7.7.1 The operational objectives for ILS Performance Categories I, II and III are stated in Attachment C to Annex 10, Volume 1, and are listed in full in paragraph 3.5.4 of this document.

7.7.2 The DH/RVR values given in these operational objectives are used by some States in establishing aerodrome operating minima. In other cases variations from the objectives in Annex 10 have been used.

7.7.3 Studies have been made and other studies are in progress seeking to develop uniformly acceptable methods for establishing DH's and RVR's.

CHAPTER 8. - GROUND MOVEMENT CONTROL OF AIRCRAFT AND VEHICLES

8.1 General

8.1.1 The main purpose of ground movement control in low visibility operations is:

a) to avoid traffic conflicts between taxiing aircraft or between an aircraft and a ground vehicle ;

b) to assure that aircraft or ground vehicles do not enter the ILS critical or sensitive areas at an improper time;

c) to assure clearance of the runway in use when an aircraft is landing or taking off ;

d) to facilitate the taxiing to and from the runway ;

e) to maintain the maximum safe capacity of the airport.

8.1.2 In low visibility conditions all aircraft and other vehicles operated on the manoeuvring area of the aerodrome must be subject to the control of an aerodrome controller in the tower, and controlled by radio communications, light signals or as otherwise authorized by prior arrangement. Control may include accompaniment by an appropriate escort who is in direct radio communications with the aerodrome controller.

8.1.3 Plans for ground movement of aircraft and vehicles during periods of low visibility (Category II or IIIA conditions) should be based on maximum use of procedures and aids which are common for operations in good visibility. It has been found that, to a certain extent, procedures and aids which facilitate movement on a busy aerodrome will also satisfy the requirements for low visibility operations, and vice versa.

8.1.4 In order for ground movement of aircraft and vehicles to operate with efficiency and safety in low visibility, an effective means must be provided to substitute for the long range visual information normally used by pilots and controllers for surveillance and guidance information.

8.1.5 The primary means of control and surveillance over ground traffic in low visibility (Categories II and IIIA conditions) can be procedural, using radio voice communications between the aerodrome controller and the pilot (or vehicle operator), supplemented by visual information for the pilot in the form of lights, surface marking, and signs.

8.1.6 Experience in actual low visibility operations has shown that the concept of using standard visual aids and traffic control procedures is suitable in RVRs above about 150 metres. In visibilities below this range, aids specifically designed for very low visibility movement of aerodrome traffic may be necessary.

8.1.7 Control, surveillance, and safety will be enhanced by the use of supplementary facilities, such as an aerodrome surveillance radar (ASDE or ASME), controllable taxiway lights, stop bars, signs, and local detectors such as induction loops intrusion alarm devices, etc.

8.1.8 Although existing visual aids and procedures can be employed for ground movement in low visibility, such operations must be conducted with extra caution and procedures must be imposed which may limit traffic. In recognition of the limitations of currently available procedures and visual aids, operational requirements are being defined for development of a taxiing guidance and control system appropriate for use in Category III operations and high traffic situations , by the Eighth Air Navigation Conference. Several States are engaged in developments and investigations leading to the design of a system which will satisfy the requirements.

8.2 Visual aids

8.2.1 The standard visual aids which are required or recommended for ground movement on an aerodrome in low visibility include runway and taxiway lighting, surface marking, and signs. They are specified in Annex 14, Part V (Visual Ground Aids) and are described in Doc 7920-AN/855, Part 4 (Aerodrome Manual, Visual Ground Aids).

8.2.2 Taxiway centre line lights are considered to be the preferred visual guidanc system for use in Category IIIA conditions, and they are advantageous in Category II conditions. A praticular configuration of these lights may be used on the runway for exit taxiway turn-off lighting to aid the pilot in locating runway exits and minimizing runway occupancy time in low visibility. When combined with controlled stop bars, and when lighted only for the route to be followed, taxiway centre line lights provide an efficient system for ground movement. Details on taxiway centre line lighting configuration may be found in Annex 14, Part V.

8.2.3 As a guide for maintenance, it is considered that not more than 20 percent of taxiway centre line lights should be inoperative, and two consecutive lights should not be inoperative. Because of the normally high reliability of aerodrome lighting systems, a monitoring system may not be required, but visual inspection should be accomplished with sufficient frequency to assure adequacy of the taxiway lighting system.

8.2.4 Stop bars are useful in low visibility when traffic signals and signs on the sides of the taxiways may not be visible. They are particularly effective as an added measure for preventing ground traffic from entering an active runway or an ILS critical area at an improper time or when verbal instructions may be misunderstood. When the nature of the use of stop bars has an important impact on safety, consideration should be given in their design to the provision of adequate redundancy to enable them to survive a single failure in their control mechanism without loss of service. It is also considered advantageous to automate the operation of stop bars so that the aerodrome controller will not be required to operate them manually, thus avoiding possible human error.

8.2.5 A system of guidance signs is a flexible and suitable method of providing guidance in moderately poor visibility (Category II conditions). Holding position markings are required on the taxiway surface to designate positions where aircraft must hold to assure that obstacle free zones and ILS critical areas are clear while aircraft are on an approach in Category II visibility. Holding position signs are required as a supplement to Category II holding position markings. Experience has shown that surface marking, when it is clean and contrasts with the background, provides very effective guidance information for daylight operations when taxiway lighting may be less conspicuous; however, where the taxiway surface is not clean or is wet, taxiway marking may have to be augmented with lights or signs.

8.3 Procedures

8.3.1 To simplify procedures and minimize the potential for conflict in low visibility, it is advantageous to minimize the number of options for taxi routes between parking areas and runways. For example, where feasible, the clearance to taxi may include a standard, common route for all departing aircraft; and landing aircraft may be directed over a standard, common route to the parking area.

8.3.2 To assure that aircraft with authority to take-off in low visibility are not blocked on taxiways by others who must wait for improved visibility, it is advantageous to grant taxi clearance only to those aircraft authorized to take-off. Alternatively, a holding area away from the terminal would be required which permits safe passage of those taxiing aircraft which are authorized to take-off as well as those inbound to the terminal.

8.3.3 When stop bars are not used on taxiways, and there may be a potential traffic conflict along taxi routes, it is preferable to grant clearance to taxi only to an intermediate holding point where the potential conflict may be assessed and avoided by subsequent direction. Upon reporting arrival at the holding point, the aircraft may be cleared to continue if the controller is then assured that no conflicting traffic exists.

8.3.4 Clearance to taxi, acknowledgements of the clearance, and position reports on the taxi route should be as clear as possible, as in flight, in order to avoid misunderstanding between the aerodrome controller and pilot. This is particularly important with respect to control of ground movements near an active runway. Controlling authorities must bear in mind that they have the responsibility to assure that active runways, and ILS critical areas are clear, when required, and that pilots are totally dependent on the controllers for such assurance during operations in low visibility.

8.3.5 In Categories II and III conditions it is highly desirable for ground movement control to be effected through the use of a discrete radio frequency, separate from the local control frequency used for aircraft in flight. Radio communication on the frequency used by pilots making a final approach in low visibility should be limited to that which is essential to the pilot making the approach.

Experience has indicated that when aircraft land sequentially at minimum time intervals in low visibility, it is desirable for pilots to report on the local control frequency when they are clear of the runway. Subsequent communications should be on the ground control frequency.

8.4 Security and surveillance

8.4.1 When no special surveillance equipment is employed and control over traffic on the manoeuvring area of the aerodrome is maintained by procedures and visual aids, unauthorized traffic must be restricted by local security. Normally, it may be expected that routine measures for restricting unauthorized traffic on an aerodrome will be adequate for low visibility operations (i.e., security fences around the airport, signs restricting unauthorized access, and limiting access only to those vehicle operators who are familiar with essential precautions and procedures). When the local situation is such that routine measures may not be adequate, special measures should be taken to provide surveillance and control, particularly for the ILS critical areas and active runways. For example, when construction or maintenance vehicles are engaged in mobile activities on the aerodrome at the onset of Category II or III visibility conditions, it may be necessary to terminate their activity and remove them from the aerodrome until the visibility improves. Alternatively, it may be appropriate to accompany such vehicles with a radio controlled escort while the low visibility condition prevails.

8.4.2 Aerodrome surveillance radars have been found useful as an aid for ground controllers to monitor and assist traffic on an aerodrome; however, a basic radar display may be difficult to interpret because of the effects of precipitation, daytime brightness in the control tower, and lack of adequate resolution. Other systems using such devices as improved radar displays, Doppler radar, induction loop detectors, and intrusion alarm devices are being used or tested at some major airports to suit a local situation.

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CHAPTER 9. - AUTHORIZATION AND APPROVAL

9.1 General

9.1.1 This Chapter considers the documentation which can be used to indicate that a State's requirements have been met by its aircraft and aerodrome operators. It reflects the practices of States already engaged in all weather operations, Categories II and III operations. An understanding of the nature of States' requirements and the documentation in which they appear will be helpful in achieving agreement between States.

9.1.2 The international nature of all weather operations raises the need for agreed means of indicating authorization and approval. There are three elements involved which should be considered on a total system basis:

a) certification of the aircraft;

b) authorization of the operation;

c) the aerodrome.

9.2 Certification of the aircraft

Certification of the aircraft and its equipment as having conformed to the airworthiness requirements of the State of Registry for Category II or III operations can best be indicated by appropriate entries in the flight manual. Any limitation necessary for the safe use of the system must be identified. Some States include the following:

a) the decision height limitation and any other relevant aerodrome operating minima with which the certification is associated;

b) the minimum airborne equipment which must be serviceable before an approach in Category II or III conditions may be commenced;

c) the mandatory flight deck procedures which may be involved such as minimum autopilot disengage height, system operating sequences etc;

d) detailed aircraft performance data, including such information as loss of height during missed approach procedure, etc;

e) any other factors affecting the use of the aircraft in low minima conditions.

9.2.2 Where the airworthiness certification is effected by rendering valid the certification of another State, such as the State of manufacture of the aircraft, as allowed for in Art. 33 of the Convention and Annex 8, Part II, 5, this may be taken as acceptance of the original certification criteria as conforming to the requirements of the new State of Registry for elements or parts not the subject of Standards.

9.3 Authorization of the operation

9.3.1 An operator utilizing aircraft having a low minima capability will be required to satisfy the State of Registry on at least the following:

a) proficiency of flight crew;

b) operating procedures;

c) that the operations manual instructions are appropriate to the operation and reflect the mandatory procedures and limitations contained in the flight manual;

d) that sufficient experience has been gained with the system in operational service in weather minima higher than those proposed.

9.3.2 The Authorization practice in one State is to have its operators proposing minima in and below Category II to follow a procedure in two parts:

a) a submission in principle for the relevant minima in which the crew training and ratings obtained and the proposed operating procedures are given in detail. In particular the operator is required to establish that the proposed method of operation does not in any way lower the level of safety established for the aircraft and its equipment during the course of airworthiness certification;

b) specification of precise minima for each individual runway. In the case of minima specifications for aerodromes in other States, the operator is required to satisfy its own State that the facilities and procedures at the aerodrome are the equivalent of his own State's requirements and, together with the aircraft and its equipment and the proposed method of operation, comprise a total system with a safety level in accord with that postulated in the main submission.

9.3.5 As a pre-requisite for authorization of Category II or III operations, some States require operators to make use of equipment and procedures in aerodrome operating conditions better than the minima which they eventually intend to apply and to maintain records of the results obtained. Not only does this enable an assessment of the success rate to be calculated but it also serves to accustom flight crews to the procedures as a matter of routine. Further, because actual minima for which an operator is authorized will rarely be encountered, some States require operators to continue this practice after authorization and to provide, for a specified period, a record of success rates covering both the approaches made in the better conditions and those made in Category II or III conditions.

9.4 The aerodrome

9.4.1 There are National differences in the methods of licensing or authorizing aerodromes. However, it is desirable that there be an inter-State understanding that:

a) no State will promulgate a runway as available for Category II or III operations until the facilities and services meet ICAO requirements. Where the State in which the aerodrome is situated has additional requirements, it is implicit that these are provided before promulgation;

b) the basic facilities, services and procedures are:-

   (i) ILS;

   (ii) visual aids (lighting and marking);

   (iii) RVR reporting;

   (iv) obstacle clearance criteria;

   (v) ATC and ground movement control procedures, including the holding procedures.

9.4.2 Provided the above criteria are applied, authorization of an aerodrome can be by promulgation through the Aeronautical Information Services and relevant AIPs.

9.5 Summary

9.5.1 The suitability of the aircraft and its equipment for low minima operations should be included in the approved flight manual for the aircraft.

9.5.2 The aircraft operator can be authorized by its National Authority by issue of a suitable document indicating the limits of aerodrome operating minima to which it has satisfied its National requirements. Such authorization does not automatically allow an operator to use the approach operating minima in States other than the State of Registry.

9.5.3 The promulgation of the aerodrome and facilities through the Aeronautical Information Service and recognized air publications will indicate conformity with ICAO and national requirements. National requirements may vary from one State to another.

9.5.4 A common method of indicating conformity with declared requirements will facilitate the international application of all weather operations.

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CHAPTER 10. - BIBLIOGRAPHY

10.1 ICAO (latest editions, where applicable)

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Doc 4444, RAC/501/10 (PANS-RAC).

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Doc 7605-MET/526/5 (PANS-MET).

Doc 8168-OPS/611/3 (PANS-OPS).

Circular 113-AN/85 "Runway visual range observing and reporting practices".

10.2 Canada

Manual of all weather operations (Category II)

10.3 Federal Republic of Germany (BFS)

Rules for Category II all weather operations.

10.4 United Kingdom

Civil Aviation Authority Publications

CAP 168 Aerodrome requirements.

CAP 321 Provisional operating requirements for all weather operations - Category II.

BCAR Paper No. 432 Airworthiness requirements for landing in restricted visibility - Category 2 operations.

BCAR Paper No. 367 Airworthiness requirements for automatic landing including automatic landing in restricted visibility down to Category 3.

UK Aeronatical Information Circulars

106/1968 Introduction of Category II and III ILS Facilities in the United Kingdom

28/1969 ILS interference during Category II Operations

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28/1969 ILS interference during Category II Operations

10.4 United Kingdom (cont'd)

29/1971 ILS introduction of a Category III facility at runway 28L Heathrow Airport, London.

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15/1972 Introduction of instrumented runway visual range system at United Kingdom airports.

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10.5 United States

- FAA - Order 6950.16 - Siting criteria for ILS
- FAA - Order 6990.3 - RVR siting
- FAA - AC 120-29 - Criteria for approving Category I and Category II landing minima for FAR 121 operators
- FAA - Order 6560.10 - Runway visual range (RVR)
- FAA - Handbook 7110.8C - Terminal ATC (Category II Excerpts)
- FAA - Handbook 7210.3A - Facility management (Category II excerpts)
- FAA - FAR 121 - Certification and operation; domestic, flag and supplemental air carrier and commercial operators of large aircraft
- FAA - AC 150/5300-2B - Airport design standards
- FAA - Order 8400.3A - Minimum operating standards for touchdown zone and centerline lighting
- FAA - AC 150/5340-22 - Maintenance guide for determining degradation and cleaning of centerline and touchdown zone lights
  Order 6850.2 - Visual guidance lighting systems
- FAA - Minimum operating standards for lighting systems supporting Category II operations

  AC 20-57A - Automatic landing performance

  AC-90-44 Airport ground operations during low visibility conditions

10.5 United States (cont'd)

AC 120-28A Criteria for approving Category III Landing weather minima

AC 150/5340-18 Taxiway guidance sign system

- FAA - RD-70-15 Evaluation of taxiway centerline lighting for runway exits and taxiway intersections, May 1970

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APPENDIX 1

UNITED KINGDOM REQUIREMENTS FOR OBSTRUCTION FREE ZONES

The requirements which have been incorporated into the U.K. Licensing of Aerodromes document CAP 168 are given below, together with explanatory notes on the specifications selected.

1. Definition

1.1 Obstruction free zone. A volume of airspace extending upwards and outwards from an inner portion of the strip to specified upper limits which is kept clear of all obstructions except for minor specified items.

2. Description

2.1 An Obstruction Free Zone (OFZ) is to be established for each precision approach Category II and III runway. The OFZ is intended to afford aircraft protection from obstructions when approaches are continued below decision height and during subsequent missed approach with all engines operating normally. It is not intended to supplant the application of other requirements on the removal and restriction of obstructions.

2.2 The limits of the OFZ required for use by aircraft with a wing span of up to 61m (200 feet) are shown in Figure I and comprise:

a) that portion of the instrument approach surface commencing at its inner edge at a width of 61m (200 feet) on each side of its centre line and extending at the same width for a distance of 1524m (5000 feet) away from the direction of landing and with an outer edge parallel to the inner edge;

/Explanatory Note: The ILS equipment for Cat. II and III is designed to deliver the aircraft in a narrow window approx. 43m (140 feet) wide (i.e. 21.5m (70 feet) from centre line), about 700m (2,300 feet) from touchdown at 30m (100feet) above threshold. The pilot should only continue below decision height if he can be certain by visual means that the aircraft is in a position to carry on and land. This is taken to mean that the aircraft is within the width of the supplementary barrettes or the second cross-bar of the Calvert system i.e. plus or minus 15m (50 feet) from centre line. An allowance is added for the largest aircraft likely to carry out the operation e.g. the Boeing 747 wingspan of 60m (196 feet) and a buffer area for wingtip/obstacle clearance of 15m (50 feet) either side, making a total width of 121m (400 feet) at origin 30m + 60m + 30m = 120m

(100' + 196' + 100' = 396'), i.e. 61m (200 feet) either side of centre line. The origin of this surface coincides with the AGA approach surface and extends at 1:50 to a height of 30m (100 feet) above datum, that is 1524m (5000 feet) from origin7.

b) that portion of the strip commencing 61m (200 feet) measured horizontally from the threshold away from the direction of landing and extending for a distance of 1890m (6200 feet) in the direction of landing, at a width of 61m (200 feet) on each side of the centre line of the runway;

/Explanatory Note: The width of the portion of the strip is similar to that of the portion of the Instrument Approach Surface specified at Para. 2.2.a) above for the same reason. The length is derived as follows. The latest point at which a decision to overshoot will be taken is assumed to be where the pilot loses sight of the touchdown zone lighting, about 762m (2,500 ft.) upwind from threshold. To this are added two seconds initiation time and eight seconds (assuming a maximum speed of 76 metres/sec (250 feet/sec) to establish a climb gradient, plus an allowance for adverse conditions, total 1829m (6000 feet) upwind of threshold7.

c) a missed approach area commencing at the upwind end of the area at (a) and comprising:-

i) an inner edge extending to a distance of 61m (200 feet) on each side of the centre line of the runway and perpendicular to it;

ii) two sides originating at the ends of the inner edge diverging uniformly at 10 per cent (1:10) from the centre line of the runway;

iii) an outer edge 1372m (4500 feet) from and parallel to the inner edge;

d) a missed approach surface measured above the horizontal in the vertical plane containing the centre line of the runway and having a slope of 3.3 per cent (1:30). The lower limit shall be a horizontal line in the vertical plane containing the inner edge and at the elevation of the runway centre line at that point;

/Explanatory Note: The gradient of 1:30 is taken because it is the lowest gradient permitted for an all engines operating balked landing. The all engines operating assumption is considered to be justified because the probability of having to overshoot below the decision height combined with the probability of an engine failure at the start of overshoot is too low a value to be considered.

The divergence of 10% takes account of the splay recorded during the FAA Look-Out Project and, with the side surfaces specified at sub-para. e) below, provides protection up to a height of 45m (150 feet). The length of 1372m (4,500 feet) is derived from the gradient of 1:30 extending up to 45m (150 feet)/.

e) <u>side surfaces</u> which slope upwards and outwards from the sides of the portion of the strip, of the portion of the approach surface and of the missed approach surface and with the following limits:-

i) at any point along the sides of the portion of the strip the side surfaces shall originate at the same elevation as that of the centre line of the runway opposite that point;

ii) the slope of the side surfaces measured in a vertical plane perpendicular to the extended centre line of the runway shall be 33 per cent (1:3);

iii) the outer limit of the side surfaces shall be - in the case of those adjacent to the approach surface 45m (150 feet) above threshold elevation; in the case of those adjacent to the strip, 45m (150 feet) above the elevation of the centre line of the runway opposite the point being considered; in the case of those adjacent to the missed approach surface, 45m (150 feet) above the elevation of the missed approach surface inner edge.

2.3 Where the physical characteristics of a runway and its approach do not permit an OFZ to be established with the dimensions given at paragraph 2.2, it may be possible to permit the implementation of an OFZ of reduced width depending on the wing span of the aircraft intended for operation.

3. Restriction and removal of obstructions

3.1 Categories II and III Operations

3.1.1 No object is permitted to penetrate the obstruction free zone other than essential frangibly mounted items such as visual aids.

3.1.2 No object is permitted to penetrate the OFZ missed approach surface extended beyond the limits defined at paragraph 2.2c) and d) to intersect the lowest height at which protection is provided by other missed approach obstacle clearance criteria i.e. a calculation involving two clearance planes and related to the particular value for the Obstacle Clearance Limit (OCL). The height (h) at which the 1:30 extended missed approach surface of the OFZ intercepts the 1:40 missed approach surface of the ILS Category I Obstacle Clearance Limit (OCL) criteria is given by the formula:

h = 4(OCL in m.)-122m [4 (OCL in feet) - 400 feet]

e.g. when OCL = 52m (170 feet)
then, h = 4(52)-122 = 86m [4(170)-400 = 280 feet]

To ensure that the requirements at paragraphs 3.1.1 and 3.1.2 are met a survey to provide information at a scale of 1:2500 or larger has to be made before a runway is cleared for Category II and Category III operations. Subsequently the normal safeguarding procedures should ensure that proposed new construction which might infringe the OFZ or the extended missed approach surface will be referred for consideration by the U.K. Civil Aviation Authority.

4. New construction

4.1 No new construction shall penetrate an obstruction free zone.

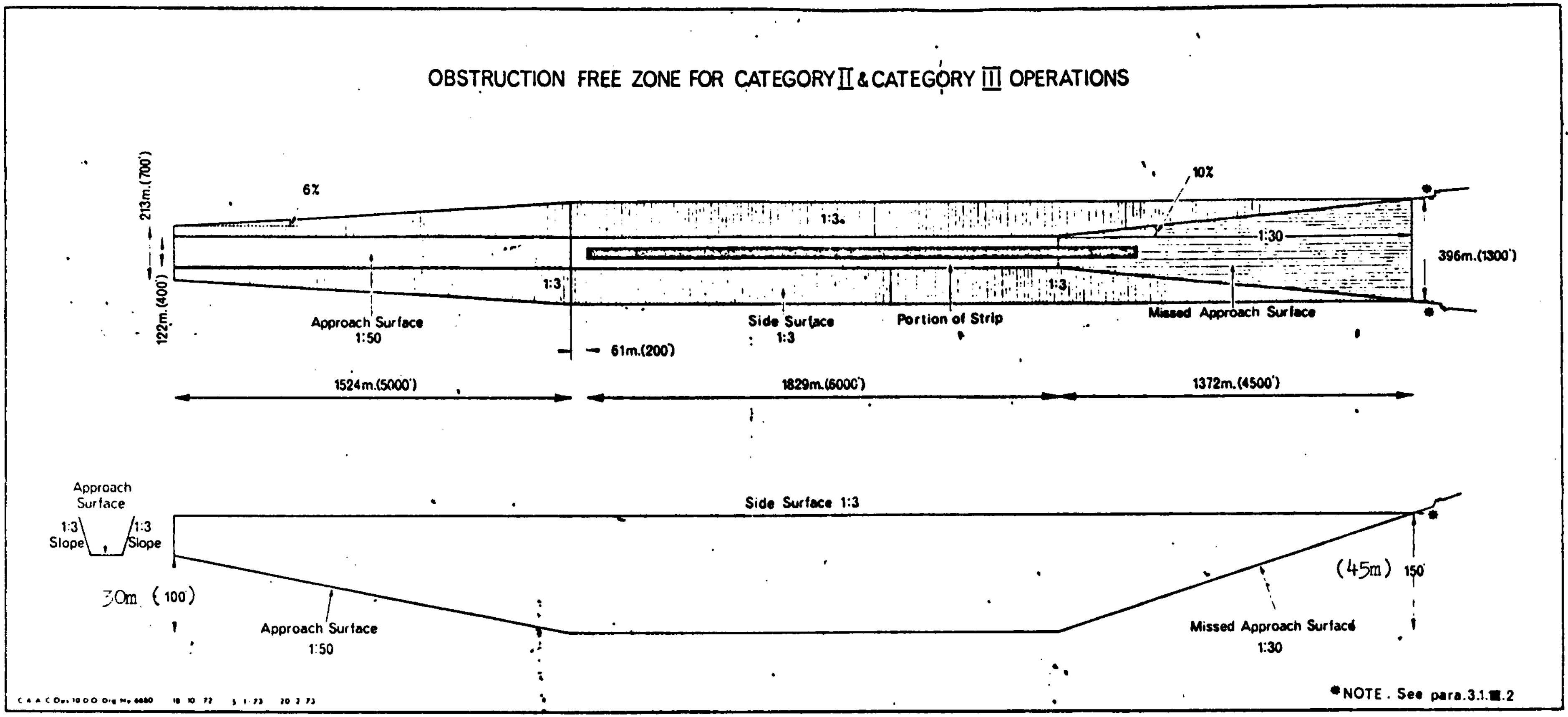
OBSTRUCTION FREE ZONE FOR CATEGORY II & CATEGORY III OPERATIONS
213m.(700')
122m.(400')
6%
10%
1:3
1:30
1:3
1:3
396m.(1300')
Approach Surface
1:50
Side Surface
1:3
Portion of Strip
Missed Approach Surface
61m.(200')
1524m.(5000')
1829m.(6000')
1372m.(4500')
Approach
Surface
1:3
Slope
1:3
Slope
Side Surface 1:3
30m (100')
Approach Surface
1:50
(45m) 150'
Missed Approach Surface
1:30
*NOTE. See para.3.1.■.2

FIGURE I

APPENDIX 2

SNOW REMOVAL PRACTICES IN CANADA AND THE UNITED STATES

General

1. This material is offered by Canada and the U.S. as tentative procedures for handling the effects of snow on Categories II and III ILS facilities.

2. It has been established that a significant accumulation of snow on the ground surrounding most types of ILS glide path antennas can affect the signal at the far-field monitor site and the signal in space. (No measurable effect from snow has been noted on wave guide glide path antennas, or any type of localizer antenna). The form of interference can vary with snow depth, type of snow and its water content, but both the glide path angle and course structure can be affected.

3. Ideally, therefore, snow should be kept to an acceptable minimum in the area that could affect the glide path. This area is taken to be 15m (50 ft.) wide at the antenna array and 60m (200 ft.) wide at a distance of 300m (1000 ft.) in front of the antenna, plus that area formed by drawing a line from the antenna array to a point at threshold on the opposite side of the runway from the glide path site. These areas, labelled "B" and "A", are depicted in Figure 1.

4. As a general guide, a snow accumulation of 0.3m (1 ft.) is deemed significant for Categories II/III systems, therefore Areas "A" and "B" should be maintained so that this amount is not exceeded. If snow clearing is not feasible, for example when the ground is too soft to support heavy equipment, action should be taken either to downgrade the ILS to Facility Category I, validate its performance by a check flight, or, if information is unavailable, alert incoming pilots of a possible out-of-tolerance condition.

5. At some airports, it may be appropriate to maintain Area "C" at a level comparable to Areas "A" and "B". On the other hand, if Area "C" has to be used as a snow dump area, the depth of snow should not exceed 2m (6 ft.). In addition, sharp snow banks more than 0.6m (2 ft.) high along the line between Areas "A" and "C" and along the outside edge of Area "B" should be tapered to prevent reflections.

6. If the glide path becomes unusable because of high accumulation of snow, landing limits should be raised to those applicable for "localizer only". If, however, parts of Areas "A" and "B" can be cleared, it is probable that Category I limits can be maintained if the following areas are cleared:

a) For a glide path operating in a null reference mode, Areas "A" and "B" to a distance of 105m (350 ft.) ahead of the antenna;

b) For a glide path operating in an Equisignal mode, areas "A" and "B" to a distance of 90m (300 ft.) ahead of the antenna. (Extra care should be taken in authorizing limits for an equisignal glide path, since the signal can be affected by as little as six inches of snow when it is very wet or in the form of slush).

7. When feasible, snow removal should be started before critical levels have been reached. This action should be timed, whenever possible, to take advantage of off-peak traffic hours.

8. Snow depth as recorded at the meteorological observation point may not always be representative of the actual depth in the critical ILS areas. Additionally, as indicated previously, the extent to which the signal is affected is a direct function of the snow's water content. Accordingly, when there is doubt on the necessity to clear snow, an ILS technician should be consulted.

Categories II and III Runways

9. In most States, runway centre line, touchdown zone and taxiway exit lights are raised fixtures, protruding above the surface of the runway. These fixtures can be extensively damaged by snow removal equipment.

10. Steel blades, steel shoes or steel castors used as supporting surfaces for plow frames, blades or bankhead assemblies should therefore not be used. Equipment requiring supporting attachments should be fitted with pneumatic or semi-pneumatic rubber tire castors.

11. Steel blades should be replaced by a rubber blade, attached to the front of the moldboard between a steel plate (such as an old cutting blade) and the moldboard so that approximately 8cm (3 inches) of rubber extends below the bottom of the moldboard. Snow removal plowing will then force the rubber blade to fold under this edge and allow a smooth scraping action. The angle of the plow and the pavement surface should be a negative one of approximately 5°.

12. The metal underbody of snow plows or blowers should have a minimum clearance of 4cm (1 1/2 inches) from the pavement surface. The use of vehicles with tire chains, high speed snow drags and underbody metal scrapers should be forbidden.

13. Snow removal operations should commence as soon as snow begins to accumulate. Runway sweepers should be utilized first, and during as much of the snow removal activity as possible. Snow plows and blowers should supplement the sweeper operation only when the sweeper cannot efficiently remove the accumulation.

14. Ice control should be carried out by the application of urea (an anti-icing chemical) or sand. It may be necessary to apply additional quantities of urea around each light fixture during severe icing conditions.

15. If the runway lights are on during conditions of drifting or blowing snow, snow will melt in the area immediately downwind of the hot light fixture. If the pavement surface is at or below a freezing temperature, this water will form an ice ring adjacent to each light, to the point of becoming a hazard to landing aircraft. This problem can be minimized by keeping the lights off as much as traffic will permit. Continual sweeping and the liberal use of urea, however, will normally prevent this accumulation.

16. In States where snow is a minor problem, and where specialized equipment cannot be economically justified, airport maintenance personnel should be cautioned about the damage to light fixtures that can be caused by standard, steel-bladed plows, or equipment fitted with chains or metal castors. Under these circumstances, the following precautions should be taken:

a) Leave in-pavement lights off as long as possible;

b) Use rotary brooms to remove snow from light fixtures, and repeat the process as often as necessary. This will define the area of in-pavement lights so that plows and blowers can take extra precautions;

c) Snow displaced from light fixtures should then be removed by snow blowers or plows. (Rounding off of sharp corners of the plow blade will help minimize light damage). When plows traverse light fixtures, speed should be reduced to 8km/p/h (5 m.p.h.) or less, or the blade should be lifted clear of the fixtures.

SNOW REMOVAL AREAS - GLIDE PATH SITES

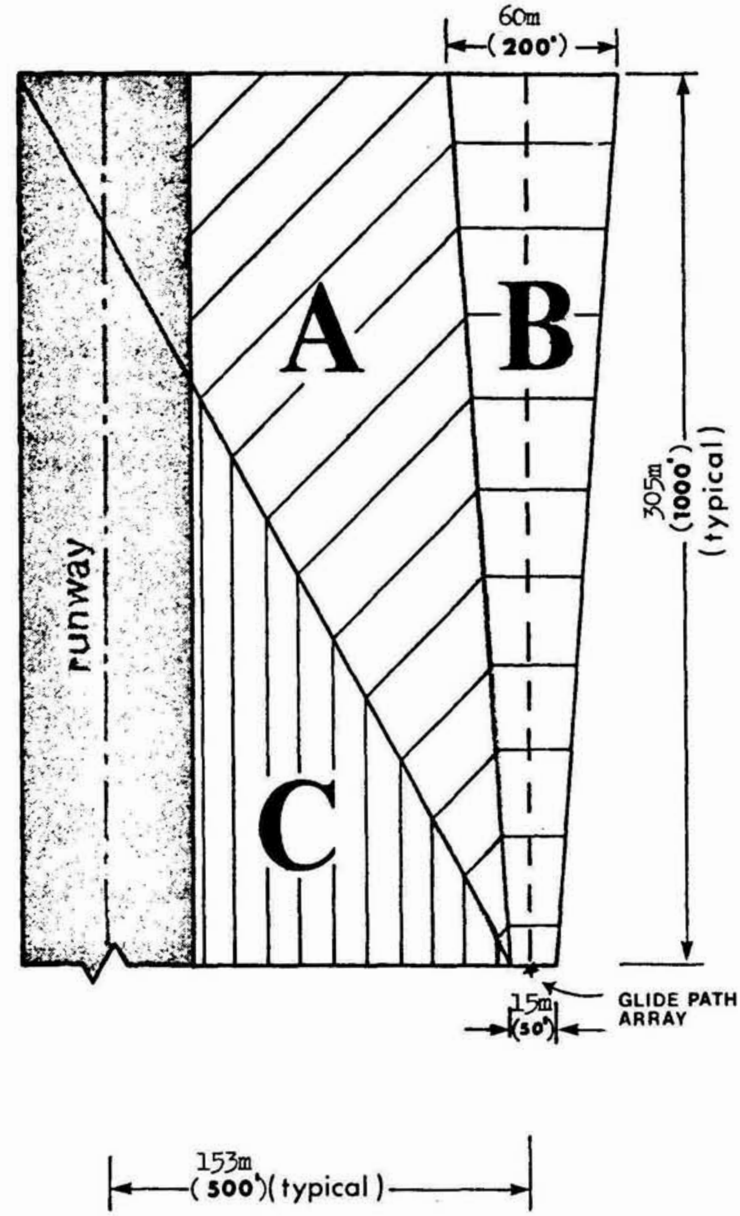

FIGURE 1

ICAO TECHNICAL PUBLICATIONS

The following summary gives the status, and also describes in general terms the contents of the various series of technical publications issued by the International Civil Aviation Organization. It does not include specialized publications that do not fall specifically within one of the series, such as the Aeronautical Chart Catalogue *or the* Meteorological Tables for International Air Navigation.

International Standards and Recommended Practices are adopted by the Council in accordance with Articles 54, 37 and 90 of the Convention on International Civil Aviation and are designated, for convenience, as Annexes to the Convention. The uniform application by Contracting States of the specifications contained in the International Standards is recognized as necessary for the safety or regularity of international air navigation while the uniform application of the specifications in the Recommended Practices is regarded as desirable in the interest of safety, regularity or efficiency of international air navigation. Knowledge of any differences between the national regulations or practices of a State and those established by an International Standard is essential to the safety or regularity of international air navigation. In the event of non-compliance with an International Standard, a State has, in fact, an obligation, under Article 38 of the Convention, to notify the Council of any differences. Knowledge of differences from Recommended Practices may also be important for the safety of air navigation and, although the Convention does not impose any obligation with regard thereto, the Council has invited Contracting States to notify such differences in addition to those relating to International Standards.

Procedures for Air Navigation Services (PANS) are approved by the Council for world-wide application. They contain, for the most part, operating procedures regarded as not yet having attained a sufficient degree of maturity for adoption as International Standards and Recommended Practices, as well as material of a more permanent character which is considered too detailed for incorporation in an Annex, or is susceptible to frequent amendment, for which the processes of the Convention would be too cumbersome.

Regional Supplementary Procedures (SUPPS) have a status similar to that of PANS in that they are approved by the Council, but only for application in the respective regions. They are prepared in consolidated form, since certain of the procedures apply to overlapping regions or are common to two or more regions.

The following publications are prepared by authority of the Secretary General in accordance with the principles and policies approved by the Council.

Technical Manuals provide guidance and information in amplification of the International Standards, Recommended Practices and PANS, the implementation of which they are designed to facilitate.

Air Navigation Plans detail requirements for facilities and services for international air navigation in the respective ICAO Air Navigation Regions. They are prepared on the authority of the Secretary General on the basis of recommendations of regional air navigation meetings and of the Council action thereon. The plans are amended periodically to reflect changes in requirements and in the status of implementation of the recommended facilities and services.

ICAO Circulars make available specialized information of interest to Contracting States. This includes studies on technical subjects.

PRICE: U.S. $1.50
(or equivalent in other currencies)