ICAO

Doc 9365

Manual of All-Weather Operations

Fourth Edition, 2017

Approved by and published under the authority of the Secretary General

INTERNATIONAL CIVIL AVIATION ORGANIZATION

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Published in separate English, Arabic, Chinese, French, Russian
and Spanish editions by the
INTERNATIONAL CIVIL AVIATION ORGANIZATION
999 Robert-Bourassa Boulevard, Montréal, Quebec, Canada H3C 5H7

For ordering information and for a complete listing of sales agents
and booksellers, please go to the ICAO website at www.icao.int

Third edition, 2013
Fourth edition, 2017

Doc 9365, *Manual of All-Weather Operations*
Order Number: 9365
ISBN 978-92-9258-235-7

AMENDMENTS

Amendments are announced in the supplements to the *Products and Services Catalogue;* the Catalogue and its supplements are available on the ICAO website at www.icao.int. The space below is provided to keep a record of such amendments.

RECORD OF AMENDMENTS AND CORRIGENDA

AMENDMENTS		
No.	Date	Entered by

CORRIGENDA		
No.	Date	Entered by

FOREWORD

This fourth edition of Doc 9365 was produced by ICAO with assistance from the Operations Panel (OPSP) and the All Weather Operations Harmonization Aviation Rulemaking Committee (AWOH ARC). This version of the *Manual of All-Weather Operations* has been updated to align with Amendments 37B, 32B and 18B to Annex 6 — *Operation of Aircraft*. This edition incorporates the new approach classification terminology; more in-depth material on head-up displays, enhanced vision systems, synthetic vision systems, and combined vision systems; introduces "operational credits" and the resulting flexible aerodrome operating minima; and includes some miscellaneous updates.

Annex 6 requires the State of the Operator to ensure that the operator establishes aerodrome operating minima for each aerodrome to be used in operations and to approve the method of determination of such minima. Such minima should not be lower than any that may be established for such aerodromes by the State in which the aerodrome is located, except when specifically approved by that State. The Annex does not require the State of the Aerodrome to establish aerodrome operating minima. However, the State of the Operator needs to take responsibility for supervising the operator in the establishment of its operating minima. To assist States in fulfilling that role, the OPSP developed the guidance material contained in this manual related to surface movement, take-off, departure, approach and landing for all-weather operations. In addition, this manual provides guidance to the State of the Aerodrome concerning its obligations for providing the necessary facilities and services required to support a particular operation. The achievement of continuous improvement of operational safety and increased efficiency rests upon the willingness of States to cooperate in the sharing of experiences and the resolution of differences through harmonization.

This manual describes the technical and operational factors associated with methods of supervising the determination of aerodrome operating minima for surface movement, take-off, departure and instrument approaches, including Category I, II and III operations, to the lowest minima. Information for States, air navigation service providers and airspace users on how to implement area navigation (RNAV) and required navigation performance (RNP) applications are in the *Performance-based Navigation (PBN) Manual* (Doc 9613). The information can be applied by the State of the Operator to its operators conducting international commercial air transport operations. Some of the information in this manual describing systems and system performance is applicable to international general aviation operations and international helicopter operations, where appropriate, according to Annex 6, Part II — *International General Aviation — Aeroplanes* and Part III — *International Operations — Helicopters*.

The material in this manual is of a general nature and has been prepared in a form convenient for use as guidance material by civil aviation authorities in the development of their own requirements in their role as State of the Operator and State of the Aerodrome. The intention of ICAO is to write Standards and Recommended Practices (SARPs) and Procedures in such a manner that they are, as far as practicable, neutral as to the varying operating circumstances as well as the technologies used. These are called performance-based Standards as opposed to prescriptive Standards, which typically are very detailed. In order to assist States, air operators and other service providers to understand how to apply the Standards and resulting regulations and to appreciate the level of safety intended, guidance material is necessary. Such material can be in the form of a manual, like this one, or in the form of attachments to the respective Annexes.

In this manual numerous references are made to ICAO Annexes, Procedures for Air Navigation Services (PANS), manuals and circulars. Since these documents are frequently amended, one should ensure that the document in question is current. Nothing in this manual should be construed as contradicting or conflicting with the SARPs and Procedures contained in the Annexes and PANS.

This manual includes examples and references to detailed requirements prescribed by some States. A State may find it advantageous to adopt the detailed requirements of another State which has already established comprehensive all-weather procedures consistent with the guidance material in this manual.

Comments on this manual are appreciated, particularly with respect to its application and usefulness. These comments will be taken into consideration in the preparation of subsequent editions. Comments concerning the manual should be addressed to:

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999 Robert-Bourassa Boulevard
Montréal, Québec, Canada H3C 5H7

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GLOSSARY

ABBREVIATIONS/ACRONYMS

ACAS	Airborne collision avoidance system
AFCS	Automatic flight control system
AFM	Aeroplane flight manual
AIC	Aeronautical information circular
AIP	Aeronautical information publication
AIS	Aeronautical information service
ALS	Approach lighting system
AOC	Air operator certificate
AOM	Aerodrome operating minima
APV	Approach procedure with vertical guidance
A-SMGCS	Advanced surface movement guidance and control system
ATC	Air traffic control
ATIS	Automatic terminal information service
ATS	Air traffic services
AVG	Advisory vertical guidance
AWO	All-weather operations
BALS	Basic approach lighting system
BARO-VNAV	Barometric vertical navigation
Cat I	Category I
Cat II	Category II
Cat III	Category III
CDFA	Continuous descent final approach
CFIT	Controlled flight into terrain
CMV	Converted meteorological visibility
CRM	Collision risk model
CS	Certification specifications (EASA)
CVFP	Charted visual flight procedures
CVS	Combined vision system
DA	Decision altitude
DA/H	Decision altitude/height
DDM	Difference in depth of modulation
DH	Decision height
DME	Distance measuring equipment
EASA	European Aviation Safety Agency
EDTO	Extended diversion time operations
EFVS	Enhanced flight vision system
EVS	Enhanced vision system
FAF	Final approach fix
FALS	Full approach lighting system
FMS	Flight management system
FOR	Field of regard
FSTD	Flight simulation training device
GBAS	Ground-based augmentation system
GLS	GBAS landing system

GNSS	Global navigation satellite system
HATh	Height above threshold
HIALS	High intensity approach lighting system
HUD	Head-up display
HUDLS	Head-up display landing system
IALS	Intermediate approach lighting system
IAS	Indicated airspeed
IFR	Instrument flight rules
ILS	Instrument landing system
IMC	Instrument meteorological conditions
ISA	International standard atmosphere
JAR	Joint aviation requirements
LDA	Landing distance available
LED	Light emitting diode
LOC	Localizer
LNAV	Lateral navigation
LP	Localizer performance
LPV	Localizer performance with vertical guidance
LVO	Low-visibility operations
LVP	Low-visibility procedures
MALS	Medium intensity approach lighting system
MAPt	Missed approach point
MDA	Minimum descent altitude
MDA/H	Minimum descent altitude/height
MDH	Minimum descent height
MEL	Minimum equipment list
MET	Meteorological
METAR	Aviation routine weather report
MID	Runway mid-point
MLS	Microwave landing system
MOC	Minimum obstacle clearance
MSL	Mean sea level
MTBO	Mean time between outages
NALS	No approach lighting system
NDB	Non-directional beacon
NOTAM	Notice to airmen
NPA	Non-precision approach
OCA	Obstacle clearance altitude
OCA/H	Obstacle clearance altitude/height
OCH	Obstacle clearance height
OFZ	Obstacle-free zone
PA	Precision approach
PAR	Precision approach radar
PBN	Performance-based navigation
RCLL	Runway centre line lights
RNAV	Area navigation
RNP	Required navigation performance
RTZL	Runway touchdown zone lights
RVR	Runway visual range
SARPs	Standards and Recommended Practices
SBAS	Satellite-based augmentation system
SID	Standard instrument departure

SIGMET	Significant weather report
SMGCS	Surface movement guidance and control system
SPECI	Aerodrome special meteorological report
SRA	Surveillance radar approach
STAR	Standard instrument arrival
SVR	Slant visual range
SVS	Synthetic vision system
TDZ	Touchdown zone
THR	Threshold
VDF	Very high frequency direction-finding station
VDP	Visual descent point
VFR	Visual flight rules
VGSI	Visual glideslope indicators
VIS	Visibility
VMC	Visual meteorological conditions
VNAV	Vertical navigation
VOR	Very high frequency omnidirectional radio range

EXPLANATION OF TERMS

When the following terms are used in this manual they have the following meanings:

Advisory vertical guidance. Vertical path deviation guidance indications provided as a non-essential aid to help pilots meet barometric altitude restrictions on 2D instrument approach operations.

Aerodrome operating minima. The limits of usability of an aerodrome for:

a) take-off, expressed in terms of runway visual range and/or visibility and, if necessary, cloud conditions;

b) landing in two-dimensional (2D) instrument approach operations, expressed in terms of visibility and/or runway visual range minimum descent altitude/height (MDA/H) and, if necessary, cloud conditions; and

c) landing in three-dimensional (3D) instrument approach operations, expressed in terms of visibility and/or runway visual range and decision altitude/height (DA/H) as appropriate to the type and/or category of the operation.

Alert height. A height above the runway threshold based on the characteristics of the aeroplane and its fail operational landing system, above which a Cat III operation would be discontinued and a missed approach initiated if a failure occurred in one of the redundant parts of the landing system, or in the relevant ground equipment.

All-weather operations. Any surface movement, take-off, departure, approach or landing operations in conditions where visual reference is limited by weather conditions.

Alternate aerodrome. An aerodrome to which an aircraft may proceed when it becomes either impossible or inadvisable to proceed to or to land at the aerodrome of intended landing. Alternate aerodromes include the following:

Take-off alternate. An alternate aerodrome at which an aircraft can land should this become necessary shortly after take-off and it is not possible to use the aerodrome of departure.

En-route alternate. An aerodrome at which an aircraft would be able to land after experiencing an abnormal or emergency condition while en-route.

Destination alternate. An alternate aerodrome to which an aircraft may proceed should it become either impossible or inadvisable to land at the aerodrome of intended landing.

Note.— The aerodrome from which a flight departs may also be an en-route or a destination alternate aerodrome for that flight.

Approach ban point. The point from which an instrument approach shall not be continued below 300 m (1 000 ft) above the aerodrome elevation or into the final approach segment unless the reported visibility or controlling RVR is above the aerodrome operating minima.

Automatic flight control system (AFCS) with coupled approach mode. An airborne system which provides automatic control of the flight path of the aeroplane during approach.

Automatic landing system. The airborne system which provides automatic control of the aeroplane during the approach and landing.

Categories of aeroplanes. The following five categories of aeroplanes have been established based on 1.3 times the stall speed in the landing configuration at maximum certificated landing mass:

Category A — less than 169 km/h (91 kt) IAS

Category B — 169 km/h (91 kt) or more but less than 224 km/h (121 kt) IAS

Category C — 224 km/h (121 kt) or more but less than 261 km/h (141 kt) IAS

Category D — 261 km/h (141 kt) or more but less than 307 km/h (166 kt) IAS

Category E — 307 km/h (166 kt) or more but less than 391 km/h (211 kt) IAS.

Ceiling. The height above the ground or water of the base of the lowest layer of cloud below 6 000 m (20 000 ft) covering more than half the sky.

Note.— The definition of ceiling may differ in some States.

Circling approach. An extension of an instrument approach procedure which provides for visual circling of the aerodrome prior to landing.

Combined vision system. A system to display images from a combination of an enhanced vision system (EVS) and a synthetic vision system (SVS).

Commercial air transport operation. An aircraft operation involving the transport of passengers, cargo or mail for remuneration or hire.

Continuous descent final approach (CDFA). A technique, consistent with stabilized approach procedures, for flying the final approach segment of a non-precision instrument approach procedure as a continuous descent, without level-off, from an altitude/height at or above the final approach fix altitude/height to a point approximately 15 m (50 ft) above the landing runway threshold or the point where the flare manoeuvre should begin for the type of aircraft flown.

Converted meteorological visibility (CMV). A value (equivalent to an RVR) which is derived from the reported meteorological visibility.

Decision altitude (DA) or ***decision height (DH).*** A specified altitude or height in a 3D instrument approach operation at which a missed approach must be initiated if the required visual reference to continue the approach has not been established.

Note 1.— Decision altitude (DA) is referenced to mean sea level (MSL) and decision height (DH) is referenced to the threshold elevation or touchdown zone elevation as appropriate for the State of the Aerodrome.

Note 2.— The required visual reference means that section of the visual aids or of the approach area which should have been in view for sufficient time for the pilot to have made an assessment of the aircraft position and rate of change of position, in relation to the desired flight path. In Cat III operations with a decision height the required visual reference is that specified for the particular procedure and operation.

Note 3.— For convenience where both expressions are used they may be written in the form "decision altitude/height" and abbreviated "DA/H".

Enhanced flight vision system (EFVS). A term used by some States to identify an EVS system to display electronic real-time images of the actual external scene achieved through the use of image sensors.

Enhanced vision system (EVS). A system to display electronic real-time images of the actual external scene achieved through the use of image sensors.

Note.— EVS does not include night vision imaging system (NVIS).

Fail-operational automatic landing system. An automatic landing system is fail-operational if, in the event of a failure, the approach, flare and landing can be completed by the remaining part of the automatic system.

Fail-operational hybrid landing system. A system which consists of two or more independent landing systems and in the event of failure of one system, guidance or control is provided by the remaining system(s) to permit completion of the landing.

Note.— A fail-operational hybrid landing system may consist of a fail-passive automatic landing system with a monitored head-up display which provides guidance to enable the pilot to complete the landing manually after failure of the automatic landing system.

Fail-passive automatic landing system. An automatic landing system is fail-passive if, in the event of a failure, there is no significant deviation of aeroplane trim, flight path or attitude but the landing will not be completed automatically.

Final approach. That part of an instrument approach procedure which commences at the specified final approach fix or point, or where such a fix or point is not specified:

a) at the end of the last procedure turn, base turn or inbound turn of a racetrack procedure, if specified; or

b) at the point of interception of the last track specified in the approach procedure, and ends at a point in the vicinity of an aerodrome from which:

   1) a landing can be made; or

   2) a missed approach procedure is initiated.

Final approach segment. That segment of an instrument approach procedure in which alignment and descent for landing are accomplished.

Flight visibility. The visibility forward from the cockpit of an aircraft in flight.

GLS. An instrument approach operation that is based on GBAS.

Ground-based augmentation system (GBAS). An augmentation system in which the user receives augmentation information directly from a ground-based transmitter.

Head-up display (HUD). A display system that presents flight information into the pilot's forward external field of view.

Head-up display (HUD) approach and landing guidance system (HUDLS). An airborne instrument system which presents sufficient information and guidance in a specific area of the aircraft windshield, superimposed for a conformal view with the external visual scene, which permits the pilot to manoeuvre the aircraft manually by reference to that information and guidance alone to a level of performance and reliability that is acceptable for the category of operation concerned.

Hybrid system. Two or more systems that are combined and regarded as one system for performance purposes.

ILS critical area. An area of defined dimensions about the localizer and glide path antennas where vehicles, including aircraft, are excluded during all ILS operations.

Note.— The critical area is protected because the presence of vehicles and/or aircraft inside its boundaries will cause unacceptable disturbance to the ILS signal-in-space.

ILS sensitive area. An area extending beyond the critical area where the parking and/or movement of vehicles, including aircraft, is controlled to prevent the possibility of unacceptable interference to the ILS signal during ILS operations.

Note.— The sensitive area is protected against interference caused by large moving objects outside the critical area but still normally within the airfield boundary.

Instrument approach operations. An approach and landing using instruments for navigation guidance based on an instrument approach procedure. There are two methods for executing instrument approach operations:

a) a two-dimensional (2D) instrument approach operation, using lateral navigation guidance only; and

b) a three-dimensional (3D) instrument approach operation, using both lateral and vertical navigation guidance.

Note.— Lateral and vertical guidance refers to guidance provided either by a ground-based radio navigation aid, or by computer-generated navigation data from ground-based, space-based, self-contained navigation aids or a combination of these.

Instrument approach procedure. A series of predetermined manoeuvres by reference to flight instruments with specified protection from obstacles from the initial approach fix, or where applicable, from the beginning of a defined arrival route to a point from which a landing can be completed and thereafter, if a landing is not completed, to a position at which holding or en-route obstacle clearance criteria apply. Instrument approach procedures are classified as follows:

Non-precision approach (NPA) procedure. An *instrument* approach procedure designed for 2D instrument approach operations Type A.

Note.— Non-precision approach procedures may be flown using a continuous descent final approach (CDFA) technique. CDFAs with advisory vertical guidance calculated by on-board equipment (see PANS-OPS (Doc 8168), Volume I, Part I, Section 4, Chapter 1, 1.8.1) are considered 3D instrument approach operations. CDFAs with manual calculation guidance of the required rate of descent or with advisory vertical are considered 2D instrument approach operations. For more information on CDFA refer to PANS-OPS (Doc 8168), Volume I, Sections 1.7 and 1.8.

Approach procedure with vertical guidance (APV). A performance-based navigation (PBN) instrument approach procedure designed for 3D instrument approach operations Type A.

Precision approach (PA) procedure. An instrument approach procedure based on navigation systems (ILS, MLS, GLS and SBAS Cat I) *designed* for 3D instrument approach operations Type A or B.

Instrument flight rules (IFR). A set of rules governing the conduct of flight under instrument meteorological conditions.

Note.— IFR specifications are found in Chapter 5 of Annex 2 — Rules of the Air*. Instrument flight rules may be followed in both IMC and VMC.*

Instrument meteorological conditions (IMC). Meteorological conditions expressed in terms of visibility, distance from cloud, and ceiling, as defined in Annex 2 , less than the minima specified for visual meteorological conditions.

Note.— The specified minima for visual meteorological conditions are contained in Chapter 4 of Annex 2.

Instrument runway. One of the following types of runways intended for the operation of aircraft using instrument approach procedures:

Non-precision approach runway. A runway served by visual aids and non-visual aid(s) intended for landing operations following an instrument approach operation type A and a visibility not less than 1 000 m.

Precision approach runway, Cat I. A runway served by visual aids and non-visual aid(s) intended for landing operations following an instrument approach operation Type B with a decision height (DH) not lower than 60 m (200 ft) and either a visibility not less than 800 m or a runway visual range not less than 550 m.

Precision approach runway, Cat II. A runway served by visual aids and non-visual aid(s) intended for landing operations following an instrument approach operation Type B with a decision height (DH) lower than 60 m (200 ft) but not lower than 30 m (100 ft) and a runway visual range not less than 300 m

Precision approach runway, Cat III. A runway served by visual aids and non-visual aid(s) intended for landing operations following an instrument approach operation Type B to and along the surface of the runway and:

A — intended for operations with a decision height lower than 30 m (100 ft), or no decision height and a runway visual range not less than 175 m.

B — intended for operations with a decision height lower than 15 m (50 ft), or no decision height and a runway visual range less than 175 m but not less than 50 m.

C — intended for operations with no decision height and no runway visual range limitations.

Note 1.— Visual aids need not necessarily be matched to the scale of non-visual aids provided. The criterion for the selection of visual aids is the conditions in which operations are intended to be conducted.

Note 2.—Paragraph 2.1.16 of this manual describes the relationship between the definition of instrument runways and aerodrome operating minima.

Localizer performance (LP). A Type A instrument approach operation that utilizes SBAS lateral guidance.

Localizer performance with vertical guidance (LPV). A 3D Type A or Type B instrument approach operation that utilizes SBAS lateral and vertical guidance. SBAS Cat I is an example of a 3D Type B LPV.

Low-visibility operations (LVO). Approach operations in RVRs less than 550 m and/or with a DH less than 60 m (200 ft) or take-off operations in RVRs less than 400 m.

Low-visibility procedures (LVP). *S*pecific procedures applied by an aerodrome for the purpose of ensuring safe operations during Cat II and III approach operations and/or low-visibility take-offs.

Low-visibility take-off (LVTO). A term used by the European Regulation on air operation referring to a take-off on a runway where the RVR is less than 400 m.

Minimum descent altitude (MDA)* or *minimum descent height (MDH). A specified altitude or height in a 2D instrument approach operation or circling approach operation below which descent must not be made without the required visual reference.

Note 1.— Minimum descent altitude (MDA) is referenced to MSL and minimum descent height (MDH) is referenced to the aerodrome elevation or to the threshold elevation if that is more than 2 m (7 ft) below the aerodrome elevation. A minimum descent height for a circling approach is referenced to the aerodrome elevation.

Note 2.— The required visual reference means that section of the visual aids or of the approach area which should have been in view for sufficient time for the pilot to have made an assessment of the aircraft position and rate of change of position, in relation to the desired flight path. In the case of a circling approach the required visual reference is the runway environment.

Note 3.— For convenience when both expressions are used they may be written in the form "minimum descent altitude/height" and abbreviated "MDA/H".

Missed approach point (MAPt). That point in an instrument approach procedure at or before which the prescribed missed approach procedure must be initiated in order to ensure that the minimum obstacle clearance is not infringed.

Missed approach procedure. The procedure to be followed if the approach cannot be continued.

MLS critical area. An area of defined dimensions about the azimuth and elevation antennas where vehicles, including aircraft, are excluded during all microwave landing system (MLS) operations.

Note.— The critical area is protected because the presence of vehicles and/or aircraft inside its boundaries will cause unacceptable disturbance to the guidance signals.

MLS sensitive area. An area extending beyond the critical area where the parking and/or movement of vehicles, including aircraft, is controlled to prevent the possibility of unacceptable interference to the MLS signals during MLS operations.

Note.— The sensitive area provides protection against interference caused by large objects outside the critical area but still normally within the airfield boundary.

Non-instrument runway. A runway intended for the operation of aircraft using visual approach procedures or an instrument approach procedure to a point beyond which the approach may continue in visual meteorological conditions.

Note.— Visual meteorological conditions (VMC) are described in Chapter 3 of Annex 2.

Obstacle clearance altitude (OCA)* or *obstacle clearance height (OCH). The lowest altitude or the lowest height above the elevation of the relevant runway threshold or the aerodrome elevation as applicable, used in establishing compliance with appropriate obstacle clearance criteria.

Note 1.— Obstacle clearance altitude is referenced to MSL and obstacle clearance height is referenced to the threshold elevation or in the case of non-precision approach procedures to the aerodrome elevation or the threshold elevation if that is more than 2 m (7 ft) below the aerodrome elevation. An obstacle clearance height for a circling approach procedure is referenced to the aerodrome elevation.

Note 2.— For convenience when both expressions are used they may be written in the form "obstacle clearance altitude/height" and abbreviated "OCA/H".

Obstacle-free zone (OFZ). The airspace above the inner approach surface, inner transitional surfaces, and balked landing surface and that portion of the strip bounded by these surfaces, which is not penetrated by any fixed obstacle other than a low-mass and frangibly mounted one required for air navigation purposes.

Performance-based navigation (PBN). Area navigation based on performance requirements for aircraft operating along an ATS route, on an instrument approach procedure or in a designated airspace.

Note.— Performance requirements are expressed in navigation specifications (RNAV specification, RNP specification) in terms of accuracy, integrity, continuity and functionality needed for the proposed operation in the context of a particular airspace concept.

Procedure turn. A manoeuvre in which a turn is made away from a designated track followed by a turn in the opposite direction to permit the aircraft to intercept and proceed along the reciprocal of the designated track.

Note 1.— Procedure turns are designated "left" or "right" according to the direction of the initial turn.

Note 2.— Procedure turns may be designated as being made either in level flight or while descending, according to the circumstances of each individual instrument approach procedure.

Required navigation performance (RNP). A statement of the navigation performance necessary for operation within a defined airspace.

Note.— Navigation performance and requirements are defined for a particular RNP type and/or application.

Runway-holding position. A designated position intended to protect a runway, an obstacle limitation surface, or an ILS/MLS critical/sensitive area at which taxiing aircraft and vehicles shall stop and hold, unless otherwise authorized by the aerodrome control tower.

Note.— In radiotelephony phraseologies, the expression "holding point" is used to designate the runway-holding position.

Runway visual range (RVR). The range over which the pilot of an aircraft on the centre line of a runway can see the runway surface markings or the lights delineating the runway or identifying its centre line.

Satellite-based augmentation system (SBAS). A wide coverage augmentation system in which the user receives augmentation information from a satellite-based sensor.

Stabilized approach. An approach which is flown in a controlled and appropriate manner in terms of configuration, energy and control of the flight path from a pre-determined point or altitude/height down to a point 15 m (50 ft) above the threshold or the point where the flare manoeuvre is initiated, if higher.

State of Registry. The State on whose register the aircraft is entered.

State of the Aerodrome. The State in whose territory the aerodrome is located.

State of the Operator. The State in which the operator's principal place of business is located or, if there is no such place of business, the operator's permanent residence.

Surveillance radar. Radar equipment used to determine the position of an aircraft in range and azimuth.

Synthetic vision system (SVS). A system to display data-derived synthetic images of the external scene from the perspective of the flight deck.

Touchdown zone (TDZ). The portion of a runway, beyond the threshold, where it is intended landing aeroplanes first contact the runway.

Vertical navigation (VNAV). A method of navigation which permits aircraft operation on a vertical flight profile using altimetry sources, external flight path references, or a combination of these.

Visibility. Visibility for aeronautical purposes is the greater of:

a) the greatest distance at which a black object of suitable dimensions, situated near the ground, can be seen and recognized when observed against a bright background;

b) the greatest distance at which lights in the vicinity of 1 000 candelas can be seen and identified against an unlit background.

Note 1.— The two distances have different values in air of a given extinction coefficient, and the latter b) varies with the background illumination. The former a) is represented by the meteorological optical range (MOR).

Note. 2.— The definition applies to the observations of visibility in local routine and special reports, to the observations of prevailing and minimum visibility reported in METAR and SPECI and to the observations of ground visibility.

Visual approach. An approach by an IFR flight when either part or all of an instrument approach procedure is not completed and the approach is executed by visual reference to terrain.

Visual flight rules (VFR). A set of rules governing the conduct of flight under visual meteorological conditions.

Note.— VFR specifications are found in Chapter 4 of Annex 2.

Visual meteorological conditions (VMC). Meteorological conditions expressed in terms of visibility, distance from cloud, and ceiling, as defined in Annex 2, equal to or better than specified minima.

Note.— The specified minima for visual meteorological conditions are contained in Chapter 4 of Annex 2.

Visual segment surface (VSS). Vertically, the VSS originates at the runway threshold height and has a slope of 1.12 degrees less than the promulgated approach procedure angle. The lateral surface of the VSS is defined in PANS-OPS, Volume II.

PUBLICATIONS

(referred to in this manual)

ICAO PUBLICATIONS

Convention on International Civil Aviation, signed at Chicago on 7 December 1944 and amended by the ICAO Assembly (Doc 7300)

Annexes to the Convention on International Civil Aviation

Annex 1 — *Personnel Licensing*

Annex 2 — *Rules of the Air*

Annex 3 — *Meteorological Service for International Air Navigation*

Annex 4 — *Aeronautical Charts*

Annex 5 — *Units of Measurement to be Used in Air and Ground Operations*

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Annex 11 — *Air Traffic Services*

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- Volume I — *Aerodrome Design and Operations*

Annex 15 — *Aeronautical Information Services*

Annex 19 — *Safety Management*

Procedures for Air Navigation Services (PANS)

Procedures for Air Navigation Services — Air Traffic Management (PANS-ATM, Doc 4444)

Procedures for Air Navigation Services — Aircraft Operations (Doc 8168)
- Volume I — *Flight Procedures*
- Volume II — *Construction of Visual and Instrument Flight Procedures*

Manuals

Manual on Testing of Radio Navigation Aids (Doc 8071)
Volume I — *Testing of Ground-based Radio Navigation Systems*
Volume II — *Testing of Satellite-based Radio Navigation Systems*

Aeronautical Information Services Manual (Doc 8126)

Manual of Procedures for Operations Inspection, Certification and Continued Surveillance (Doc 8335)

Aeronautical Chart Manual (Doc 8697)

Manual of Aeronautical Meteorological Practice (Doc 8896)

Airport Services Manual (Doc 9137) Part 6 — *Control of Obstacles*
Part 9 — *Airport Maintenance Practices*

Aerodrome Design Manual (Doc 9157)
Part 2 — *Taxiways, Aprons and Holding Bays*
Part 3 — *Pavements*
Part 4 — *Visual Aids*
Part 5 — *Electrical Systems*

Manual of Runway Visual Range Observing and Reporting Practices (Doc 9328)

Air Traffic Services Planning Manual (Doc 9426)

Manual of Surface Movement Guidance and Control Systems (SMGCS) (Doc 9476)

Performance-based Navigation (PBN) Manual (Doc 9613)

Manual of Criteria for the Qualification of Flight Simulation Training Devices (Doc 9625)
Volume I — Aeroplanes

Airworthiness Manual (Doc 9760)

Advanced Surface Movement Guidance and Control Systems (A-SMGCS) Manual (Doc 9830)

Safety Management Manual (SMM) (Doc 9859)

Performance-based Navigation (PBN) Operational Approval Manual (Doc 9997)

PUBLICATIONS OF OTHER STATES OR ORGANIZATIONS

Some States and international organizations have published related documentation of an informative or regulatory nature of which the following are referred to in this manual:

Europe

European Regulations on Air Operations 965/2012

European Aviation Safety Agency (EASA) Decision 2012/18/R on Part-CAT

EASA Decision 2012/19/R on Part-SPA

European Guidance Material on All Weather Operations at Aerodromes (EUR Doc 013)

United States

Code of Federal Regulations (CFRs)

FAA Order 8260.3B, United States Standard for Terminal Instrument Procedures (TERPS)

Advisory Circular 120-29A, *Criteria for Approval of Category I and Category II Weather Minima for Approach*

Advisory Circular 120-28D, *Criteria for Approval of Category III Weather Minima for Take-off, Landing, and Rollout*

Chapter 1

INTRODUCTION

PURPOSE, SCOPE AND USE OF THE MANUAL

1.1 This document provides a total system concept from information derived from related ICAO Annexes and guidance material and from States' documents and practices. It is intended that this material will be useful to a State wishing to progress the systematic development of all-weather operations, both in regard to its role as State of the Operator/State of Registry and as State of the Aerodrome. It is also intended that this material will serve aerodrome and facility planners in fostering an understanding of the methodology used by operators in establishing their aerodrome operating minima.

Note.— The State of the Operator has an obligation under Annex 6 — Operation of Aircraft *in respect of aerodrome operating minima. States can meet this obligation by supervising the determination of operating minima by operators. The guidelines contained herein describe one option that will enable either of two possible methods to satisfy this obligation.*

1.2 Because of the complex nature of aircraft operations, there is a need to approach the subject of all-weather operations with a total-system concept. The major subsystems are the ground and airborne elements. The ground elements consist of facilities, services and obstacles: these relate, in principle, to the State of the Aerodrome. The airborne elements consist of the aircraft and its systems, flight crew capabilities and flight procedures, which fall under the jurisdiction of the State of the Operator/State of Registry.

1.3 With the previous distinction in mind, this manual provides guidance to:

a) States of the Operator in the oversight of their operators in the establishment, implementation and use of operating minima, leading to standardization of the methods used in the establishment of aerodrome operating minima;

b) States and their operators on suitable requirements for progression to the lowest possible minima;

c) States of the Aerodrome to assist in the establishment of aerodrome operating minima as well as to highlight the need for the provision of ground facilities and services when planning to implement all-weather operations; and

d) flight crew members and other personnel who need to understand these operations.

1.4 A State may play a dual role. As a State of the Operator (and State of Registry for general aviation operators), it is responsible for the approval and monitoring of operations conducted by operators subject to its oversight. As a State of the Aerodrome, it is responsible for the oversight of the aerodrome, including associated facilities and services, located in its territory. Separate departments within the administration may be assigned the discharge of these two areas of responsibility. To facilitate use of this document:

a) the general concepts of legislation, application and promulgation of information on all-weather operations are contained in Chapter 2;

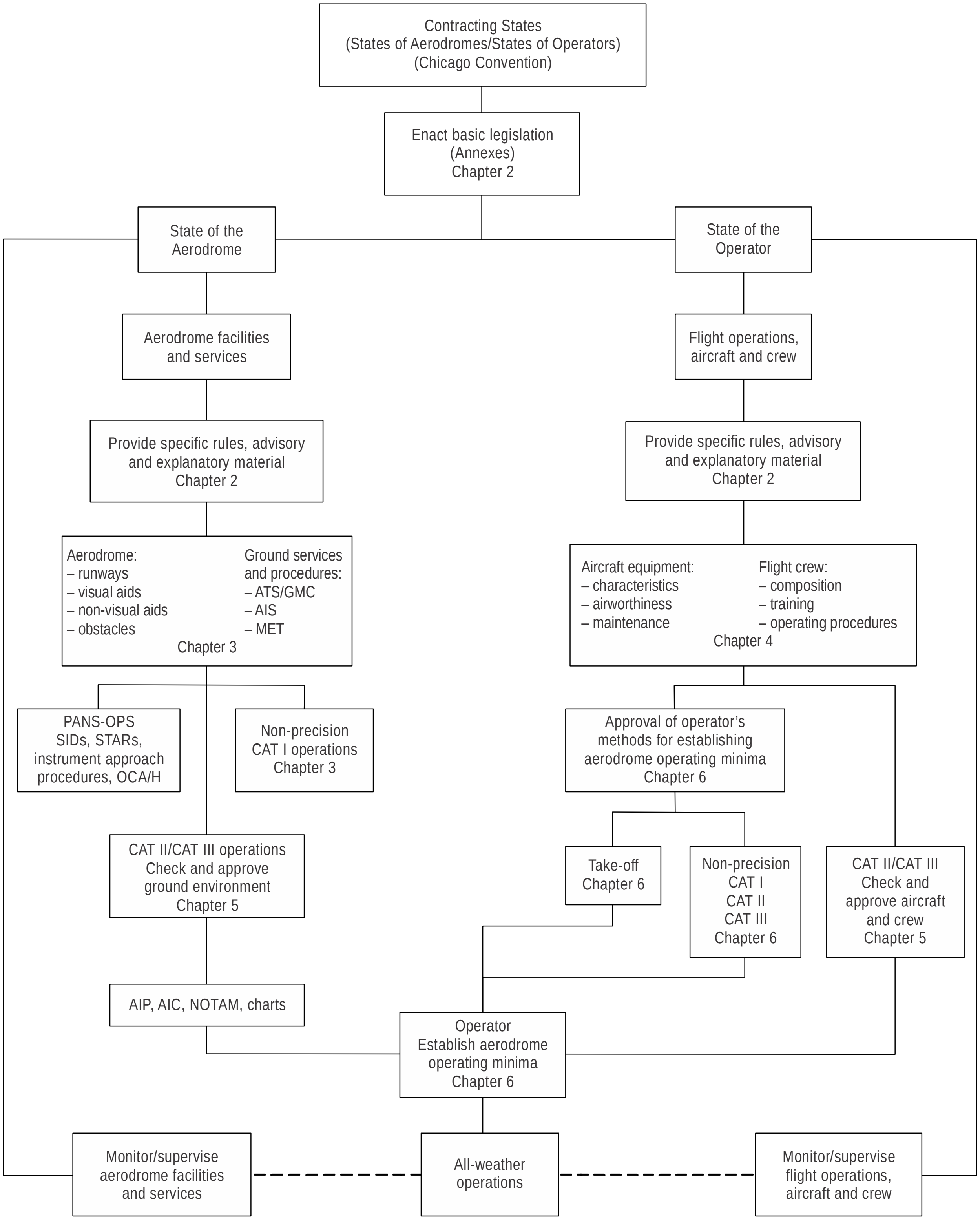

Figure 1-1. Relevant State responsibilities contained in this manual and cross-references to the relevant chapters

b) the provisions relevant to the State of the Aerodrome are contained in Chapter 3 and Chapter 5, 5.2 to 5.4; and

c) the provisions relevant to the State of the Operator (State of Registry for general aviation operators) are contained in Chapter 4, Chapter 5, 5.5 to 5.7 and Chapter 6.

Chapter 2

GENERAL CONCEPTS

2.1 AERODROME OPERATING MINIMA

General

Components of aerodrome operating minima

2.1.1 The aerodrome operating minima for approach operations comprise a horizontal and a vertical component and are expressed in terms of minimum visibility/runway visual range (RVR) and minimum descent altitude/height (MDA/H) or decision altitude/height (DA/H). An operator needs to establish aerodrome operating minima in accordance with an approved method for each aerodrome to be used. In many States the designed approach procedure is published in the Aeronautical Information Publication (AIP) and includes the obstacle clearance altitude/height (OCA/H) only and gives no information on what the minimum visibility/RVR must be. Based on this information the operator will develop aerodrome operating minima.

2.1.2 Some States apply State minima in which case they publish the aerodrome operating minima in their AIP and/or in documents such as Operations Specifications. In such a case an operator will need to base the aerodrome operating minima on the published State minima if they are higher than the minima determined by the operator. The State minima typically include both the horizontal and vertical components of aerodrome operating minima for approach operations. Take-off minima are normally expressed as visibility or RVR limits, taking into account all relevant factors for each aerodrome planned to be used and the aeroplane characteristics. Where there is a specific need to see and avoid obstacles on departure and/or for a forced landing, additional conditions (e.g. ceiling) must be specified.

2.1.3 States which apply State minima for approach operations typically apply State minima for take-off operations as well.

Traditional versus flexible aerodrome operating minima for approach operations

2.1.4 Traditionally aerodrome operating minima have been strictly limited by the type of instrument approach procedure (non-precision approach (NPA), approach procedure with vertical guidance (APV) or precision approach (PA)) and the category of operation performed. For example, Cat I operations are limited to 550 m as the lowest RVR value and below this value the operation would be Cat II. These minima and the requirements for aerodrome facilities are designed to support operations with those aircraft carrying only the minimum equipment requirement for the particular operation. However, Annex 6 — *Operation of Aircraft* now opens up a more flexible approach by adding the possibility of granting operational credits for operations with aeroplanes carrying suitable additional equipment.

2.1.5 The following are not intended to be formal definitions but rather descriptions intended to enhance the understanding of flexible aerodrome operating minima:

a) "Basic" aircraft — an aircraft which has the minimum equipment required for the type and/or category of approach and landing operation intended.

b) "Advanced" aircraft — an aircraft with equipment additional to that required for the basic aircraft. Such equipment could be auto-flight systems capable of coupled approaches and/or autoland, head-up display (HUD), enhanced vision system (EVS), combined vision system (CVS) or synthetic vision system (SVS). There are no specific classes of advanced aircraft. Instead consideration is given to what, if any, operational credit may be granted for each additional piece of equipment.

2.1.6 The requirements for instrument and non-instrument runways are contained in Annex 14 — *Aerodromes*. Typically, the presence of more visual and non-visual aids on a runway equates to lower operating minima. However, advanced avionics in modern aircraft can mitigate the need for some visual and non-visual aids and allow for lower operating minima on a runway. Annex 14 also allows for instrument approach operations on a non-instrument runway provided the instrument approach procedure may continue in visual meteorological conditions as described in Chapter 3 of Annex 2 — *Rules of the Air* .

Operational credit

2.1.7 Operational credit means lowering of the aerodrome operating minima or satisfying the flight visibility requirements or requiring fewer ground facilities when compensated by airborne capabilities. An example of operational credit is satisfying the flight visibility requirement for an instrument approach procedure through the use of a certified EVS. The reported natural vision might be less than prescribed for the procedure but the enhanced flight visibility as determined by the pilot is sufficient to land.

Determining factors for surface movement

2.1.8 The minimum visibility required for take-off and landing is, in most cases, greater than that necessary for surface movement. The pilot-in-command is ultimately responsible for ensuring clearance from other aircraft, vehicles, and obstacles. For low-visibility operations, aerodromes are commonly required to have low-visibility procedures in place to enhance safety during low-visibility ground operations. Such systems need to be proportional to the traffic volume and the complexity of the aerodrome. Air operators should have a policy and procedures for low-visibility taxi operations.

Determining factors for take-off and initial climb minima

2.1.9 For take-off, the visual reference available should be sufficient to enable the pilot to keep the aeroplane within acceptable limits relative to the runway centre line throughout the take-off roll until it is either airborne or has been brought to a stop following discontinuation of the take-off.

2.1.10 The guidance available should enable the pilot to judge the aeroplane lateral position and rate of change of position. This is normally provided by external visual cues, such as runway edge lighting, runway centre line lighting and runway marking but these may be supplemented by instrument-derived guidance (e.g. HUD guidance).

2.1.11 In establishing take-off minima, due consideration should be given to the need for the pilot to continue to have adequate guidance in the event of abnormal situations or malfunctions of the aeroplane systems such as an engine failure. It also should be ensured that once the aeroplane is airborne, sufficient instrument guidance is available to enable a flight path to remain clear of obstacles.

2.1.12 At some locations, the on-board navigation systems and ground-based navigation aids may not provide sufficient guidance and, in cases such as mountainous terrain, special procedures and/or requirements may be necessary. Visual guidance may be required under such specific conditions. Minimum visibility or RVR for take-off depends on the visual cues provided for along the runway.

2.1.13 In cases where the take-off phase is guided or supplemented by instrumental means, the required visibility/RVR may be reduced.

Determining factors for instrument approach operations

2.1.14 For approach and landing the specific considerations involved in the determination of aerodrome operating minima are:

a) the accuracy with which the aeroplane can be controlled along its desired approach path by reference to the instrumentation and use of the equipment provided on board and by utilization of the guidance provided by navigation aids;

b) the characteristics of the aeroplane (e.g. size, speed, missed approach performance) and equipment provided on-board (e.g. HUD, autoland systems, vision systems) and of the ground environment (e.g. obstacles in the approach or missed approach areas, availability of non-visual and visual aids);

c) the proficiency of the flight crew in the operation of the aeroplane;

d) the flight technique applied: whether the final approach is flown applying a continuous descent final approach (CDFA) technique or whether a stepdown technique is used;

e) the extent to which external visual information is required for use by the pilot in controlling the aircraft; and

f) the interaction of all these factors in demonstrating satisfactory total system performance.

2.1.15 For the roll-out, the determining factor is the availability of a roll-out guidance system. Without a roll-out guidance system, a minimum RVR of 125 m has been seen as sufficient to control the aircraft during the deceleration phase of landing. Where a roll-out guidance system meeting the required accuracy and integrity is used, a minimum of 75 m RVR should be applied. This minimum value is based on the minimum visual requirements for taxiing the aircraft on the runway. Surface movements from the runway to the terminal require suitable airport infrastructure to support operations at visibilities below about 150 m, as discussed in Chapter 5, 5.3.6.

Effect of navigation performance on landing minima

2.1.16 The accuracy, integrity and continuity of the airborne and ground-based guidance and control systems generally determine the size of the area in which obstacles need to be considered. A system with better navigation performance will require a smaller area. As a general rule, a smaller area means fewer obstacles need to be considered, which generally results in lower obstacle clearance height and lower landing minima (i.e. lower DA/H or MDA/H and visibility/RVR).

2.1.17 Where obstacles are not limiting, the minimum height to which an approach may be continued without external visual reference will be determined by the performance of the total system, and the general rule is that better performance will allow lower minima. The area width required for obstacle evaluation is determined by the navigation capability of the aircraft and the ground and/or space element. While ground-based systems, such as NDB, VOR and ILS, are still in use, newer systems such as SBAS and GLS have emerged. In the United States there are now twice as many SBAS instrument approach procedures as ILS instrument approach procedures. The continual development of diverging systems, together with the increase in airborne capabilities, has led to a fundamental change in thinking. To prevent further proliferation of systems, the performance-based navigation (PBN) concept was developed based on performance-based requirements. The PBN concept characterizes lateral and potentially vertical performance for airspace use and system performance. Use of this concept will simplify assignment of operating minima.

2.1.18 The path of an aircraft on a precision approach or APV procedure is defined in the vertical dimension by procedure design. Precision and APV instrument approach procedures optimize required protection in the vertical dimension. With vertical guidance, the protected airspace more closely follows the vertical flight path, eliminating potential obstacles. The required area needed for obstacle clearance is considerably less than for a non-precision approach procedure. As a result, in most cases minima will be lower.

2.1.19 The final approach track may not be aligned with the runway. In such cases, additional visibility/RVR should be required in order to allow the pilot sufficient time to assess the position of the aircraft relative to the runway. In the case of a side-step manoeuvre, where the aircraft will manoeuvre at a relatively late stage toward a parallel runway, additional visibility/RVR should also be required.

Visibility/RVR requirement

2.1.20 The visibility/RVR requirement should be such that there is a high degree of probability that sufficient visual references will be acquired from a position where the DA/H or MDA/H intersects a normal descent path down to the touchdown zone. The visibility element for landing minima is determined by the task, based on visual references, that the pilot is required to carry out below DA/H or MDA/H in order to complete the landing safely. It will depend on the extent of the visual reference requirements of the pilot. The availability of an approach lighting system (ALS) and its length will also affect the visibility/RVR required. As a general rule, a higher DA/H or MDA/H or visual reference requirement results in larger visibility/RVR minima.

Continuous descent final approach (CDFA)

2.1.21 Use of a CDFA flight technique is recommended to reduce the risk of controlled flight into terrain (CFIT). Where a CDFA technique is not applied, e.g. if a step-down approach technique has been used, there may be a need for additional visibility/RVR. If the approach is not stable at a critical point, the pilot may need additional reaction time for the vertical manoeuvre. When executing an NPA procedure without using a CDFA technique, some States recommend the visibility/RVR minima be increased by 200 m for Cat A and B aircraft and by 400 m in the case of Cat C and D aircraft to aid the visual transition to landing and to establish the aircraft's final descent to land.

Approach ban policy

2.1.22 Annex 6, Part I, Chapter 4, 4.4.1, specifies what has come to be known as an "approach ban policy" (commencement or continuation of the approach) to arriving aircraft when weather conditions are reported to be below landing minima. This policy is intended to facilitate the regularity of instrument approach operations, to prevent a landing/go-around decision at a low altitude and in a vulnerable condition, and to minimize unnecessary instrument approach operations where a successful landing would be highly unlikely. This approach ban limits aircraft from proceeding beyond a point, on an instrument approach procedure, which is 300 m (1 000 ft) above the aerodrome elevation or the beginning of the final approach segment unless weather conditions are reported at or above a specified minima. If weather deteriorates after an aircraft has passed the approach ban point, the policy may permit aircraft to continue, established on the approach, to DA/H or MDA/H. For some States, avionics and vision systems may provide additional capabilities that reduce the approach ban or permit the aircraft to initiate the approach using EVS.

2.1.23 In relation to the definitions of various instrument runways, it is important to keep in mind the introductory note in Chapter 1 of Annex 14, Volume I, which states: "It is not intended that these specifications limit or regulate the operation of an aircraft". The consequence of this statement is that there is no conflict between the runway definitions and the actual aerodrome operating minima, which may be lower than the values in the definitions, in particular in cases granting operational credits.

2.2 PERFORMANCE-BASED APPROACH CLASSIFICATION

General

2.2.1 ICAO PBN represents a shift from sensor-based to performance-based navigation. Historically, aircraft navigation specifications were defined in terms of navigation sensors which classified an approach as either precision or non-precision. Under PBN, navigation requirements are identified through the use of performance specifications referred to as required navigation performance (RNP) rather than through the use of navigation sensors. This transition and the evolution of new navigation systems such as satellite-based augmentation systems (SBAS) and ground-based augmentation systems (GBAS) require abandoning the old, sensor-based terms "precision" and "non-precision" approach in favour of a new approach classification system related to performance-based specifications. This new system will also better facilitate future development of navigation applications associated with approach and landing operations such as those based on HUD, EVS and SVS.

Procedures versus operations

2.2.2 Performance-based approach classification makes a clear distinction between instrument approach procedures and instrument approach operations.

2.2.2.1 An instrument approach procedure is the instrument flight procedure allowing an aircraft to navigate on the final approach down to a given obstacle clearance height (OCH), relying on a given type of navigational infrastructure. Instrument approach procedures are classified as either:

a) non-precision approach (NPA) procedure;

b) approach procedure with vertical guidance (APV); or

c) precision approach (PA) procedure.

2.2.2.2 An instrument approach operation method (2D or 3D) is the manner in which an aircraft is operated on a procedure. Performance-based approach classification focuses on the operation and is based on minima and flight method.

2.2.3 Instrument approach operations are classified according to the operating minima specified for an approach and the flight method applied for this type of approach operation. It is possible that an operational credit may be gained by an advanced aircraft which results in lower minima but does not change the category of operation. For example, the instrument approach procedure is designed to support a category of operation (e.g. Type B Cat I) but the aircraft capabilities may allow for lower minima. The operating minima are classified as follows:

a) Type A: a minimum descent height or decision height at or above 75 m (250 ft); and

b) Type B: a decision height below 75 m (250 ft). Type B instrument approach operations are categorized as:

1) Category I (Cat I): a decision height not lower than 60 m (200 ft) and with either a visibility not less than 800 m or an RVR not less than 550 m;

2) Category II (Cat II): a decision height lower than 60 m (200 ft) but not lower than 30 m (100 ft) and an RVR not less than 300 m;

3) Category IIIA (Cat IIIA): a decision height lower than 30 m (100 ft) or no decision height and an RVR not less than 175 m;

4) Category IIIB (Cat IIIB): a decision height lower than 15 m (50 ft) or no decision height and an RVR less than 175 m but not less than 50 m; and

5) Category IIIC (Cat IIIC): no decision height and no RVR limitations.

Note.— Appendix J summarizes performance-based approach classification.

2.2.4 The flight methods for executing an instrument approach are two-dimensional (2D) or three-dimensional (3D). A 2D instrument approach operation uses lateral navigation only, and a 3D instrument approach operation uses both lateral and vertical navigation guidance. Lateral and/or vertical guidance can be provided either by a ground-based radio navigation aid or computer-generated navigation data from ground-based, spaced-based, self-contained navigation aids or a combination of these. Examples of the navigation sensors used in 2D instrument approach operations include VOR, NDB, LOC, LP and LDA. PBN instrument approach procedures with only LNAV or LP minima are also examples of NAVSPECS used in 2D approach operations. All 2D approach operations are flown to an MDA/H and are classified as Type A. 3D instrument approach operations can be classified as Type A or B depending on the designed lowest operating minima. Examples of navigation sensors used in 3D Type B instrument approach operations include ILS, MLS, GBAS and SBAS. An approach procedure with vertical guidance (APV) is an example of a 3D Type A instrument approach operation. LNAV/VNAV and some SBAS LPV procedures are 3D Type A instrument approach operations. See Table 2-1.

Table 2-1. Instrument approach operations

	2D (flown to MDA/H)		*3D (flown to DA/H)*	
Approach Type	*Conventional*	*PBN*	*Conventional*	*PBN*
Type A (MDH or DH at/above 75 m (250 ft))	VOR, NDB, LOC	APCH (LNAV, LP)	ILS, MLS, GLS Cat I	APCH (LNAV/VNAV,LPV) AR (RNP 0.x)
Type B (DH below 75 m (250 ft))			ILS, MLS, GLS Cat I, II or III	APCH (LPV)

Note.— For RNP AR APCH, the minima will be represented as RNP 0.x, where 0.x refers to the RNP value specified in the final approach segment (0.3 NM, 0.2 NM, 0.1 NM).

2.2.5 One of the benefits of performance-based approach classification is that it aligns better the runway facilities provided with the instrument approach operations. Previously, the type of runway and required visual markings were aligned to the type of navigational aid or sensor required to fly the instrument approach. Under performance-based approach classification, the runway facilities needed are derived by the aerodrome operating minima applied regardless of the type of system used to fly the procedure. For example, an ILS approach was classified as a precision approach procedure under the old system and would always require a precision runway regardless of the decision altitude of the approach. With performance-based approach classification, an ILS approach operation with a DA/H or MDA/H of 75 m (250 ft) or higher will be a Type A operation and can be performed on a non-precision approach runway.

2.3 THE NEED FOR BASIC LEGISLATION

2.3.1 The responsibility of the State for ensuring the safe conduct of operations is implicit in its acceptance of the International Standards and Recommended Practices (SARPs) for the safety of air navigation required by Article 37 of the *Convention on International Civil Aviation*. These SARPs appear in Annex 6 for air operations and in Annex 14 for the design and certification of aerodromes. Although the methods for discharging its responsibility may vary from State to State, no particular method can, in any way, relieve the State of the responsibility to enact basic legislation which will provide for the development and promulgation of a code of operational regulations and practices consistent with its obligations under the Convention.

2.3.2 For the safety of all-weather operations, States should fulfil the dual roles of State of the Operator and State of the Aerodrome as follows:

a) regulate all-weather operations by national operators (State of the Operator); and

b) regulate and ensure the provision of aerodrome facilities and services appropriate for such types of operation (State of the Aerodrome).

2.3.2.1 The State of the Operator should ensure that it has the basic legislation to provide for certification of operators, approval of the operator's methods for establishing aerodrome operating minima, and inspection and revision as needed. For the oversight of all-weather operations, there should be clear and specific references in law to provide for the establishment of the necessary rules to ensure safe conduct of the intended operations, such as those for establishing take-off and landing minima, flight crew qualifications and aeroplane airworthiness.

2.3.2.2 Likewise, the State of the Aerodrome should have regulations concerning the installation and maintenance of the necessary aerodrome facilities and equipment, the development of appropriate procedures and the timely dissemination of information, as well as the certification of the aerodrome infrastructure and the aerodrome operator.

2.3.2.3 The State of the Aerodrome should also have regulations and procedures for the certification and oversight of its aerodromes. Appendix A describes the division of responsibilities and tasks between the State of the Operator and the State of the Aerodrome.

2.4 THE NEED FOR SPECIFIC RULES

2.4.1 Annex 19 — *Safety Management* contains provisions related to the need to establish specific operating regulations (see also Doc 9734 — *Safety Oversight Manual*). The basic aviation law of the State should:

a) require commercial air transport operations to be conducted in accordance with conditions the State may consider applicable in the interests of safety;

b) make provision for the adoption of operating regulations compatible with the provisions of the Annexes to the *Convention on International Civil Aviation*;

c) make provision for the delegation to a designated official of the authority to develop and amend operating rules consistent with the operating regulations; and

d) make provision for the enforcement of operating regulations and rules.

2.4.2 In establishing regulations governing aerodrome operating minima as part of a State's regulatory system, two basic prerequisites should be understood and accepted. These are:

a) provision, in the basic aviation law of the State, for a code of operating regulations and the promulgation thereof; and

b) establishment by the State of an appropriate entity with the necessary powers to ensure compliance with the regulations.

2.4.3 In accordance with the concepts of basic aviation law, States are empowered to formulate specific rules for the implementation of all-weather operations within their area of jurisdiction. These rules should apply to the States' operators and applicable aerodromes. While such requirements may also apply to foreign operators to the extent necessary to fulfil the obligations of States under the *Convention on International Civil Aviation*, the primary responsibility for the safety of take-off and landing operations resides with the State of the Operator. The primary responsibility of the State in which the operation takes place is the certification and oversight of aerodromes, navigation facilities, air traffic services, and promulgation, through the AIPs of information necessary to support all-weather operations. The principal aim of these rules is to ensure an adequate level of safety but they should also establish legal requirements and provide specific guidance to operators and aerodrome authorities involved in all-weather operations. The specific rules relating to such operations form part of those which generally relate to the authorization and control of flight operations. The rules should cover:

a) the operations, taking into account:

   1) aerodrome operating minima;

   2) airworthiness requirements;

   3) flight crew qualification and training; and

   4) operating procedures and their validation;

b) the aerodrome, taking into account:

   1) aerodrome operating procedures and approval;

   2) adequacy of runways and taxiways;

   3) availability of visual and non-visual aids;

   4) control of obstacles;

   5) meteorological service and assessment and dissemination of RVR; and

   6) air traffic services, including surface movement control if required;

c) certification and/or authorization in relation to:

1) the aircraft;

2) the aerodrome; and

3) the operator; and

d) requirements for compliance with operating minima.

2.5 THE NEED FOR DIRECTIVE, EXPLANATORY, ADVISORY AND INFORMATIVE MATERIAL

2.5.1 Although authority to regulate may be granted by the State's basic legislation and specific rules may provide the necessary legal mechanism to promulgate the requirements considered necessary for safe operations, a certain amount of directive, explanatory and advisory material should be provided to sufficiently detail performance standards, facilitate compliance with specific rules and regularly update operational information. This material may directly specify a means to satisfy the criteria for aeroplane or aerodrome operations, or it may describe the end result to be achieved and provide broad guidelines to be followed. Of the two methods, the latter is preferred. Material issued initially for informative or explanatory purposes may be upgraded subsequently to regulatory status if operational considerations warrant such action.

2.5.2 Directive material may be needed to set policy or detail criteria particularly in States where there are many operators or aerodromes or where there are State aviation organizations that implement national policies. The directive material in the form of "orders", "notices", "policy letters", "manuals", etc., serve to ensure that all elements of the authority are properly fulfilling the necessary functions related to all-weather operations. While directive material is primarily intended for use within the State aviation authority, it may also have value as explanatory material to those outside the authority or in the international community for purposes of coordinating activities or as guidance in training. Information primarily intended for use outside of the aviation authority normally would be issued through advisory circulars or similar methods.

2.5.3 The application of advisory and explanatory material in the area of all-weather operations should be clearly understood by the user community. The industry users are expected to carry out their professional responsibilities, and such material should not attempt to produce a description of every single facet of aviation. However, a State should be expected to publish sufficient information in order to establish and maintain an overall acceptable level of expertise and to:

a) enable a common basis of understanding to be achieved among all parties;

b) assist in the achievement of sound operational practices; and

c) disseminate knowledge gained from experience.

2.5.4 The degree to which a State may need to use directives or advisory material to implement an all-weather operations programme should relate to the size and complexity of the State's civil aviation system, including its civil aviation authority, the number of aerodromes and/or operators, its internal organization and other such factors.

2.5.5 Directive, explanatory, advisory and informative material used wholly or in part in the implementation of all-weather operations takes various forms. Apart from this manual, other ICAO documents such as PANS–OPS — *Aircraft Operations* (Doc 8168), the *Performance-based Navigation (PBN) Manual* (Doc 9613) and the *Aerodrome*

Design Manual (Doc 9157) are available and should be used to provide the details necessary to carry out a specific function in specialized fields. These may be used directly or put into equivalent forms of directives, orders or notices. Some examples are given below:

a) material that is required to be published in accordance with ICAO SARPs:

1) a State's AIP provides details of services provided at aerodromes. It includes, for example, a description of the aerodrome, communications, air traffic services, navigation facilities and rescue and firefighting services available at the aerodrome; and

2) notices to airmen (NOTAM) are used, among other things, to promulgate changes in the status of the airport facility. They may also be used to give details about an item such as a trial period for the introduction of a new air traffic procedure;

b) other material that is published at the discretion of the State or operator:

1) circulars, which may be designated advisory circulars or aeronautical information circulars, may be used by States to define in detail the criteria for particular operations or to give advice on a particular aspect such as hazards associated with limited visual cues;

2) booklet formats may be used to describe, for example, the requirements to be satisfied for the issue of flight crew licenses or for the introduction and authorization of various types of all-weather operations;

3) operations bulletins may provide specific guidance to field offices or operators to highlight safety problems or to specify necessary remedial actions. Safety bulletins may be used by operators to impart this type of information to flight crew members; and

4) civil airworthiness requirements provide a means for airworthiness authorities to notify manufacturers and operators of the characteristics and performance Standards required for aeroplanes and equipment, e.g., autoland systems.

2.5.6 A State should ensure that it has provided appropriate means to implement ICAO SARPs in terms of the material to be published. The State's system of directive and advisory material should be able to cover any specific areas identified in Chapters 3, 4, 5 and 6 of this manual. The material so produced should provide adequate coverage of the subject matter, be amended and updated when necessary, and be appropriate in terms of format and content for the personnel to which it applies. These personnel may include pilots, air traffic controllers, aerodrome personnel and management, meteorological observers, aeroplane maintenance staff, flight operations dispatchers and regulatory inspectors.

Chapter 3

PROVISION OF FACILITIES AND SERVICES AT AERODROMES

3.1 INTRODUCTION

3.1.1 This chapter describes the aerodrome facilities, visual aids, non-visual aids, aerodrome services, operating procedures, surface movement (guidance and control) and departure, arrival and instrument approach procedures.

3.1.2 Operations conducted under limited visual reference should have additional facilities and equipment, services and procedures available at aerodromes beyond those required for operations in good weather. The runways and taxiways should meet more stringent criteria, an instrument approach aid with associated instrument approach procedures should be required, and visual aids should be provided to assist the flight crew in transitioning from instrument to visual reference. Meteorological and aeronautical information should provide details of the weather conditions and the availability of the aerodrome facilities and equipment, and an air traffic control service should be required in order to provide safe separation between aircraft in the air and to avoid collisions on the ground and collisions between aircraft and/or vehicles/objects on the ground.

3.1.3 Facilities, equipment, services and procedures that are provided at an aerodrome should be operated under the oversight of the competent authority in the State. This authority should ensure that the appropriate requirements in national regulations, ICAO Annexes and other relevant documents are met and that details are properly promulgated.

3.1.4 Where such facilities, equipment, services and procedures are provided, up-to-date information on any unserviceability or change of status should be immediately made available to pilots through air traffic services (ATS) and/or aeronautical information service (AIS). Their details should be included in a publication issued by the AIS described in 3.3.13 to 3.3.16.

3.1.5 Some aircraft carry additional equipment such as EVS, HUD, or autoland system. Aircraft with such systems will be able to operate in conditions of lower RVR/visibility for any given set of aerodrome facilities or conversely operate at aerodromes with fewer facilities. Examples of such classification of operations are “lower than Standard Cat I operations” and “other than Standard Cat II operations.”

3.2 AERODROME FACILITIES AND REQUIREMENTS

General

3.2.1 The following guidance assumes that basic facilities, equipment, services and procedures are provided and describes the extension of basic facilities to provide for all-weather operations at aerodromes. Aerodrome facilities and requirements to be considered fall under the following headings:

a) physical characteristics of the runway environment, including approach and departure areas;

b) obstacle limitation surfaces;

c) visual aids;

d) non-visual aids

e) secondary power supplies; and

f) movement area safety.

3.2.2 The physical characteristics include the disposition of the manoeuvring area and the terrain in the approach and departure areas. The obstacle limitation surfaces assess geographic, artificial and mobile obstacles. The visual aids comprise lighting and markings in the approach area and on runways, taxiways and aprons. Non-visual aids are those aids used as guidance systems. The secondary power supply includes a reserve source and changeover time specifications.

Physical characteristics

3.2.3 Specifications for runways, taxiways and holding bays at an aerodrome are given in Annex 14 — *Aerodromes*, Volume I — *Aerodrome Design and Operations,* and guidance on design is contained in the *Aerodrome Design Manual (*Doc 9157). Explanations of the visibility conditions and levels of traffic density to be considered when developing systems for use in conditions of low visibility are given in the *Manual of Surface Movement Guidance and Control Systems (SMGCS) (*Doc 9476) and the *Advanced Surface Movement Guidance and Control Systems (A-SMGCS) Manual (*Doc 9830), together with a comprehensive listing of appropriate aids and references to Annex 14, Volume I, and other relevant ICAO documents.

3.2.4 Sufficient taxiways should be provided to minimize the occupancy of an active runway and for taxiing in limited visibility. Appropriate facilities and procedures should be provided to protect an active runway against intrusion during take-off and landing operations. The layout and usage of the taxiway system should be determined so as to simplify the flow of traffic in limited visibility operations in order to minimize the possibility of loss of orientation and to avoid surface movement conflicts.

3.2.5 The topography of the terrain under the approach path can be important in all-weather operations because it can affect radio altimeter operation. Radio altimeters are useful for any operation and are typically required for autoland, HUD guidance to landing, and for Cat II and Cat III operations. The ground under the last part of the final approach should be regular and preferably level. This is important to ensure correct radio altimeter operation for pilot use, as well as for the terrain awareness and warning system and automatic landing system operation. At runways with significant irregularity of the terrain under the approach path, it may be necessary for an operator to conduct aeroplane model-specific assessments of the effect of the irregular terrain on approach and landing operations. Isolated buildings or projections that do not materially disturb radio altimeter indications are usually acceptable (see also 5.2.5).

Obstacle limitation surfaces

3.2.6 A method to control obstacles should be established and maintained by the State of the Aerodrome. In accordance with Annex 14, Volume I, the airspace around aerodromes must be maintained free from obstacles so as to permit operations to be conducted safely and efficiently and to prevent the aerodromes from becoming unusable due to the growth of obstacles in the area where flight operations take place. This is achieved by establishing a series of obstacle limitation surfaces (OLS) that define the limits to which objects may penetrate into the associated obstacle-free airspace around the aerodrome. At airports, various visual and non-visual aids, e.g. approach lighting, meteorological equipment, and radio navigational aids, are located near runways, taxiways and aprons, where they may present a hazard to aircraft in the event of accidental impact during landing, take-off or ground manoeuvring. Only essential equipment and installations that cannot be located elsewhere because of their function should be placed on the runway strip (e.g. an ILS glide path transmitter antenna) or in the runway end safety area. However, all such equipment and installations as well as their supports should be frangible and of minimum mass in order to ensure that impact does not result in loss of control of the aircraft. Annex 14 recommends that obstacle-free zones (OFZs) be established for ILS Cat I runways and states as well that the OFZ must be established in the case of ILS Cat II and III approach procedures. Obstacles penetrating the obstacle limitation surfaces may in certain circumstances cause an increase in the obstacle clearance altitude/height for an instrument approach procedure or have other operational impact on flight procedure design. For this purpose PANS-OPS, Doc 8168, Volume II, specifies the dimensions and requirements related to the protection for obstacles in the visual segment surface (VSS) to safeguard the visual phase of all instrument approach procedures where navigation is based on visual cues. According to Doc 8168, Volume II, no obstacles should penetrate a VSS associated to a straight-in or offset approach procedure. However, if the VSS is penetrated, the respective approach procedure should not be promulgated without conducting an aeronautical study. As a consequence, the study may result in mitigating actions to achieve an acceptable level of safety in operations such as listed in Doc 8168, Volume II, Part I, Section 4, Chapter 5, 5.4.6.4.

3.2.7 The appropriate authority should be consulted before any new construction is started in the vicinity of an aerodrome. The authority should have the power to restrict any new construction that might have an adverse effect on operations. In assessing the effect of obstacle penetration of the Annex 14 obstacle limitation surfaces, the guidelines in respect of protection for the visual segment of the approach procedures as described in Doc 8168, Volume II, should be taken into account. Guidance on the control of obstacles is contained in Doc 9137, Part 6.

Visual aids

3.2.8 The criteria for approach lighting, runway lighting and runway markings are contained in Annex 14, Volume I. Refer to Appendix B of this manual for detailed information related to approach lighting systems. The length and shape of the approach lighting systems play an essential role in the determination of landing minima.

3.2.9 Visual aids are designed to increase the conspicuousness of the runway, provide visual references in the final stages of the approach and landing and expedite surface movement. The importance of visual aids increases as visibility becomes limited. Approach lighting, runway centre line lighting, runway edge lighting and runway markings provide a reference for the pilot to assess lateral position and cross-track velocity. The approach lighting and threshold lighting and markings provide a roll reference. Touchdown zone (TDZ) lighting and markings indicate the plane of the runway surface and show the touchdown area providing vertical and longitudinal references.

3.2.10 The visual guidance derived from runway lights and/or markings should be sufficient to ensure adequate take-off alignment and directional control for take-off and stopping after landing or in an emergency. Although additional instruments or new technology displays may enhance the safety of the operation, reference to visual aids is a primary requirement unless operations can be shown to be safe, based on the use of non-visual guidance (e.g. fail-operational autoland or HUD guidance through roll-out).

3.2.11 Visual aids are also important for the safe and expeditious guidance and control of taxiing aeroplanes. Annex 14, Volume I, contains specifications for markings, lights, signs and markers. Requirements may vary but they may consist of markings and signs supplemented by taxi-holding position lights to denote holding positions, taxiing guidance signs and markings on the centre line and edges of taxiways. Centre line lights and stop bars may be selectively operated to indicate the assigned routing as well as for the control of aeroplanes. Doc 9476 contains guidance on the selection of surface movement guidance and control system (SMGCS) aids and procedures.

3.2.12 The visual aids required for runways can be found in Annex 14, Volume I. These requirements can be mitigated by specifying conditions under which the operation can be conducted and by requiring additional capabilities of the airborne systems.

3.2.13 Alternate visual aid requirements for PBN procedures and for GBAS landing system (GLS) may be applicable. This is because both PBN and GLS procedures may be established to runways where it is impractical to install or maintain traditional visual aids in the approach zone, or where the approach paths may not necessarily follow a long straight-in final segment.

3.2.14 Visual cues can also be obtained through approved EVS (see Section 6.9).

Non-visual aids

3.2.15 The term “non-visual aids” refers to the navigation aids or position-fixing systems (e.g. GNSS) used to assist the pilot in executing an approach and landing in clouds or in limited visibility which prevents visual acquisition of the runway throughout much of the approach phase. In conditions of moderate cloud base and visibility, the purpose of the aid is to establish the aircraft in a position from which the pilot can safely complete the approach and landing by visual references. In such conditions, a relatively simple aid may suffice. In very low cloud base and/or low-visibility conditions, visual acquisition references may not be available before landing, and a much more accurate and reliable system will be required to locate the aircraft precisely in a vertical and lateral sense on the nominal approach path. Specifications for radio and radar aids are given in Annex 10 — *Aeronautical Telecommunications*, Volume I — *Radio Navigation Aids*. The criteria for terminal area fixes and information on the construction of instrument approach procedures are given in PANS-OPS, Volume II (Doc 8168).

3.2.16 Some approach aids provide azimuth and/or distance information only. Other approach aids provide vertical (i.e. glide path) information in addition to azimuth guidance and distance information.

3.2.17 Regardless whether the DA/H or MDA/H are high or low, the use of HUD or auto-flight system to heights below the DA/H or MDA/H is preferable from a safety point of view especially when the RVR is low or when facing other challenging conditions. When possible, these systems should be used all the way through landing and roll-out. When RVR is low (less than 550 m), low-visibility procedures (LVPs) at the aerodrome need to be in force. Some States require LVPs for any autoland operation.

3.2.18 All facilities should be ground- and flight-checked at the time of commissioning and at regular intervals in accordance with the requirements of Annex 10, Volume I, to ensure an adequate and uniform standard of non-visual guidance. In the event that a facility fails to meet the requirements for which it was commissioned, or if a periodic flight test cannot be completed within the appropriate time interval, its status should be reviewed and the facility downgraded as necessary. Users should be advised of changes in facility status through the AIS or NOTAM process. Guidance material on flight testing is contained in the *Manual on Testing of Radio Navigation Aids (*Doc 8071).

3.2.19 To ensure that the integrity of the guidance signal radiated by the ground facility (i.e. ILS, MLS) is maintained during aircraft approaches, all vehicles and aircraft on the ground must remain outside the facility’s critical areas as described in Annex 10, Volume I, Attachment C, if the guidance signal is being used as the primary means of navigation. When a vehicle or aircraft is within the critical area it may cause reflection and/or diffraction of the facility’s signals that may result in significant disturbances to the guidance signals on the approach path.

3.2.20 Diffraction and/or reflection may also be caused by one or more large aircraft or vehicles in the vicinity of the runway, which may affect both the glide path and localizer signals. This additional area, outside the critical area, is called the sensitive area. The extent of the sensitive area will vary with the characteristics of the facility and the category of operations. The level of interference caused by aircraft and vehicles at various positions on the aerodrome should be established so that the boundaries of the sensitive area may be determined.

3.2.21 In addition to critical areas, sensitive areas associated with a facility must be protected if the weather conditions are lower than 60 m (200 ft) cloud base or 550 m RVR when instrument approach operations are being carried out. In the latter case, aircraft which will overfly the localizer transmitter antenna after take-off should be past the antenna before an aircraft making an approach has descended to a height of 60 m (200 ft) above the runway; similarly an aircraft manoeuvring on the ground, for example when clearing the runway after landing, should be clear of the critical and sensitive areas before an aircraft approaching to land has descended to a height of 60 m (200 ft) above the runway. The protection of these areas when the weather conditions are better than the minimum specified above will facilitate the use of automatic approach and landing systems and will provide a safeguard in deteriorating weather conditions and when actual weather conditions are lower than reported.

Note.— Some States do not distinguish between ILS critical and ILS sensitive areas as defined in Annex 10. These States define an area larger than that defined in Annex 10 but it is still called the "ILS critical area". The protection to the ILS guidance signal as described in 3.2.19 applies.

3.2.22 Various facilities of suitable quality are routinely used to provide automatic approach and landing experience in visibility conditions permitting visual monitoring of the operation by the pilot. They should therefore be protected, by interlocks, from interference due to the simultaneous radiation of opposite-direction localizer beams (Annex 10, Volume I). Where this is impracticable for technical or operational reasons and both localizers radiate simultaneously, pilots should be notified by the appropriate ATS unit, by ATIS broadcast, by NOTAM or in the relevant part of the AIP. Similar harmful interference can occur if aircraft in the final phase of approach or roll-out pass closely in front of the ILS localizer antenna serving another runway. The provisions listed above should therefore be applied to any such facilities where experience shows this to be necessary.

3.2.23 It is possible for signals-in-space to be affected by the presence of signals from radio and television transmitters, citizen band radios, industrial plastic welders, intentional jammers, etc. Periodic measurements should be made, and the level of any signals detected should then be compared with an accepted maximum. Such measurements can be made by positioning a wide frequency band receiver in the vicinity of the middle marker. Complaints by flight crews of signal disturbances should be investigated, and special flight checks should be made when there is reason to believe that serious interference is occurring. Every effort should be made to identify and eliminate the cause of the interference.

3.2.24 Terminology used and protection criteria for critical and sensitive areas may vary among States. For example, some States use the term "critical area" to refer to both ICAO critical and sensitive areas as specified in Annex 10. Thus, when terms used or protection provided requires clarification or explanation, such clarifying information should be made available to relevant operators or States.

Secondary power supplies

3.2.25 Requirements for the provision of secondary power supplies for visual and non-visual aids are specified in Annex 14, Volume I, and Annex 10, Volume I, respectively. Guidance material in Doc 9157, Part 5, and Annex 10, Volume I, Attachment C, describes how to achieve the changeover times specified. Secondary power should also be required for essential communications and for other associated facilities, such as visibility measuring systems. Changeover times for the latter facilities should be commensurate with the operations conducted.

Movement area safety

3.2.26 For low-visibility operations, additional precautions should be in place to ensure the safety of aircraft operations, vehicle movement and personnel. The aerodrome authority should complete a comprehensive safety assessment of the aerodrome movement area and its operations to facilitate the development of procedures to exclude unwanted vehicles and personnel from the movement area. Guidance material is contained in Doc 9476 and Doc 9830.

3.3 SERVICES AT AERODROMES

General

3.3.1 Aerodrome services provide the essential ground support elements required for all-weather operations. Lower aerodrome minima and greater traffic volume in bad weather require more complex and extensive aerodrome services to support the operation. However, regardless of traffic volume and the frequency of operations, there are basic services which should be provided for aerodromes where operations in limited visibility are permitted, including an air traffic service, a meteorological service and an aeronautical information service.

3.3.2 Certain aerodrome management functions relate to the safety of conducting limited visibility operations. Of particular importance is inspection and maintenance of the visual and non-visual aids provided. Maintenance practices for visual aids are contained in Annex 14, Volume I, and Doc 9476. Guidance material on establishing a preventive maintenance programme for aerodrome lighting is contained in the *Airport Services Manual (*Doc 9137), Part 9 — *Airport Maintenance Practices.*

3.3.3 Aerodrome operators should also be responsible for making available to AIS or ATS, as appropriate, information on the status of the aerodrome facilities. These requirements are detailed in Annex 14, Volume I. Aerodrome operators should have procedures that provide for timely availability of such information.

Air traffic services

3.3.4 The criteria for the establishment of air traffic services are given in Annex 11 — *Air Traffic Services* and PANS-ATM (Doc 4444). The objectives of air traffic services are to:

a) prevent collisions between aircraft;

b) prevent collisions between aircraft and obstructions on the manoeuvring area;

c) expedite and maintain an orderly flow of air traffic; and

d) provide advice and information for the safe and efficient conduct of flights.

3.3.5 When establishing air traffic services, account should be taken of the need to provide:

a) reports of meteorological information, including altimeter settings, visibility/RVR and winds;

b) the status of operational facilities, including navigation aids, aerodrome lighting, signs and markings;

c) protection of ILS/MLS critical and sensitive areas, if applicable;

d) surface movement control and surveillance;

e) NOTAMs:

   1) navigation facility status;

   2) snow removal, etc.;

   3) lighting system status; and

   4) closed runways, construction, etc.;

f) monitoring of instrument approach procedures in use;

g) approach and departure obstacle clearance;

h) runway selection criteria including, where applicable, noise abatement procedures;

i) alerting of emergency services — liaison with rescue and firefighting services; and

j) service to aircraft in an emergency.

3.3.6 Air traffic control service is provided at most aerodromes used for international aircraft operations and equipped with navigation aids for instrument approach and landing, except where the type and density of traffic do not justify the provision of such a service. Airspace designation, in the form of terminal control areas, control zones, etc., is recommended in regional planning criteria to encompass at least the climb to cruising level of departing aircraft and the descent from cruising level of arriving aircraft.

3.3.7 The provision of information to the aircraft flight crew by air traffic services becomes increasingly important as weather conditions deteriorate. The provisions of Annex 11 and PANS-ATM (Doc 4444) define the stages at which the relevant information on weather conditions should be passed to the aeroplane. During adverse weather conditions, this information, particularly the visibility conditions, should be up to date. When an RVR assessment system is available, RVR should be reported to the flight crew whenever either the horizontal visibility or the RVR is observed to be less than 1 500 m.

3.3.8 Doc 9476 provides information on appropriate combinations of visual aids, non-visual aids, radiotelephony communications, procedures, and control and information facilities. The system to be adopted at a particular aerodrome should be designed to meet the operational requirements for guidance and control of all relevant surface traffic in reduced visibility conditions.

3.3.9 As a general rule, extraneous communications from ATC to arriving and departing aircraft should be avoided during critical phases of flight. This period extends from shortly before MDA/H, DA/H or alert height to the later stages of landing roll. For aircraft on visual approaches, this period typically starts at least 30 m (100 ft) above ground level. For departing aircraft, this period extends from the beginning of the take-off roll at least through the initial stage of departure. In cases where an aircraft emergency exists, this period may be considerably greater. Examples of extraneous communications include such items as requests by ATC for taxiway exit intentions, requests for pilot reports or information on equipment failures not operationally relevant, and facility status changes such as taxiway closures not immediately affecting the operation.

Meteorological service

3.3.10 Meteorological service required to support all-weather operations is specified in Annex 3 — *Meteorological Service for International Air Navigation* and in the *Manual of Aeronautical Meteorological Practice (*Doc 8896). Guidance material on RVR is contained in the *Manual of Runway Visual Range Observing and Reporting Practices* (Doc 9328).

3.3.11 Accurate and timely reporting of meteorological conditions should be considered essential. Current meteorological information should be available to the flight crew prior to dispatch, en-route, and in sufficient time for adequate planning of the approach and landing. During the approach, significant changes in weather and relevant significant weather reports (SIGMETs) should be transmitted to the flight crew immediately. The primary elements of meteorological reports affecting flight crew decisions on approach include RVR, visibility, cloud conditions, obscuration, surface wind, runway condition, thunderstorm and wind shear reports.

3.3.12 Slant visual range (SVR) addresses the measurement of the visibility available to the flight crew along the final approach path. However, a practical method of measuring SVR has not been developed. Thus, it is important that RVR assessment systems which have a high degree of reliability and integrity be installed.

Aeronautical information services

3.3.13 The SARPs for aeronautical information services are contained in Annex 15 — *Aeronautical Information Services*, and further guidance is given in the *Aeronautical Information Services Manual* (Doc 8126).

3.3.14 One of the principal functions of the AIS is to ensure the timely dissemination of information on the availability and serviceability of aerodrome facilities, services and procedures. This information should be available to the flight crew during pre-flight planning and in flight.

3.3.15 Depending upon the nature of the information and the period of notice available, dissemination may be made by:

a) AIP for relatively static basic information;

b) AIP supplements, aeronautical information circulars (AICs) or amendment to the AIP when adequate notice is available;

c) NOTAM when notice is short; and

d) ATS transmission when changes occur too late for the NOTAM to be received by the flight crew or are of short duration.

3.3.16 At an aerodrome with relatively few movements it may be possible for those persons in charge of particular equipment or functions to arrange for the relevant information to be published and disseminated. For a busy aerodrome, an AIS staffed with specialists may be required both to receive information from those in charge of facilities and to arrange for its dissemination to users.

3.4 INSTRUMENT DEPARTURE, ARRIVAL AND APPROACH PROCEDURES

3.4.1 Material relating to the establishment of standard instrument departure and arrival routes and associated procedures is contained in Annex 11 and Doc 9426. Criteria for the design of standard instrument departures (SID), standard instrument arrivals (STAR) and instrument approach procedures, with the means of determining obstacle clearance, are given in PANS-OPS (Doc 8168), Volume II. Adequate information on obstacles should be promulgated to permit operators to develop departure contingency procedures. Guidance on the control and survey of obstacles is given in Doc 9137, Part 6. Specifications for the production of instrument procedure charts and obstacle charts are given in Annex 4 — *Aeronautical Charts* and Annex 15. Further guidance is contained in the *Aeronautical Chart Manual (*Doc 8697).

3.4.2 The purpose of an instrument approach procedure is to provide for the orderly progress of an aeroplane operated under instrument flight rules, from the beginning of the initial approach to a point from which a landing may be made visually or to the completion of the missed approach segment of the procedure. Whenever an instrument approach aid is provided to serve a runway, an instrument approach procedure should be required. This procedure should define the tracks to be flown, along with the associated altitudes/heights, and should include the minimum altitudes/heights to be flown in order to ensure that the required obstacle clearance is maintained.

3.4.3 A missed approach procedure, designed to provide protection from obstacles throughout the manoeuvre, is established for each instrument approach procedure. It specifies a point where the missed approach begins and a point or an altitude/height where it ends. The missed approach is assumed to be initiated not lower than the DA/H in precision approach operations or at or before a specified point and not lower than the MDA/H in non-precision approach operations. The missed approach point (MAPt) in a procedure may be:

a) the point of intersection of a vertical path with the applicable OCA/H;

b) a navigation facility;

c) a fix; or

d) a specified distance from the final approach fix (FAF) or navigation facility.

3.4.4 The missed approach following a CDFA operation must be initiated so that the aircraft does not descend below the MDA/H or OCH. Where there is a need for specific missed approach procedures for each approach procedure (e.g. in the case of operations to converging runways) the specific missed approaches should be identified. In such cases, the missed approach procedure is clearly identified in the approach designation. The flight crew should fly the missed approach procedure as published. In the event a missed approach is initiated prior to arriving at the MAPt, the flight crew should normally proceed to the MAPt and then follow the missed approach procedure. The lateral part of the missed approach procedure should be flown via the MAPt to ensure obstacle clearance is maintained. Vertical limits of the missed approach procedure should be observed. This does not preclude flying over the MAPt at an altitude/height greater than that required by the procedure. However, when executing an early missed approach, the flight crew should not climb higher than the final approach fix altitude until reaching the MAPt, to avoid conflict with other air traffic.

3.4.5 Standard departure and arrival procedures are used to facilitate air traffic flow and management and simplify clearance delivery procedures. This is particularly beneficial at aerodromes with large numbers of movements. A further benefit may be the avoidance of restricted or populated areas. However, prior to the implementation of such routes, terrain and obstacle clearance, as well as navigation and communication requirements should be attainable by aeroplanes likely to use the standard routes.

3.4.6 The obstacle environment should be monitored to ensure that new obstacles such as building construction and growing trees do not affect the obstacle limitation surfaces. States should ensure that proposals for construction in the vicinity of the approach and departure paths are brought to the attention of the aerodrome authority.

3.4.7 Each instrument approach procedure, SID and STAR should be established and published as an integral procedure designed to permit aeroplanes to navigate without radar vectoring. When radar vectoring is an essential part of the instrument approach procedure, SID or STAR, this requirement should be clearly stated in the procedure.

3.4.8 Instrument approach procedures, SIDs and STARs should be based on the availability and the characteristics of the facilities used. The manoeuvrability of certain aeroplane types may also be a limiting factor (refer to PANS-OPS, Doc 8168, Volumes I and II, for details). Therefore, when instrument approach procedures, SIDs and STARs are established, they should be flight-checked for validity.

3.4.9 PANS-OPS, Volume I (Doc 8168), contains information concerning instrument approach procedures that should be brought to the attention of flight operations personnel, including flight crews. This may be summarized as:

a) the parameters on which the instrument approach procedures are based;

b) the flight manoeuvres which the protected areas of the procedure are designed to contain;

c) the procedures that have been developed;

d) the need for strict adherence to the procedures in order for aeroplanes to remain within the designated areas and thereby achieve and maintain safety in operation; and

e) the fact that the procedures have been developed for normal operating conditions.

3.4.10 In developing the instrument approach procedures, obstacle clearance has been closely related to the effective performance of the approach facilities in use and the operational performance and size of modern aeroplanes. However, flight crews should be trained to make allowance for abnormal operating conditions, such as low-level wind shear or severe turbulence, and to recognize when they are likely to be encountered.

Chapter 4

BASIC REQUIREMENTS FOR THE AEROPLANE AND FLIGHT CREW

4.1 INTRODUCTION

When an aeroplane is to be operated under instrument flight rules (IFR), it should be equipped with the flight instruments and the communication and navigation equipment which will enable the flight crew to carry out the required procedures for instrument departure, arrival and approach appropriate to the operation. For PBN terminal operations, the most stringent navigation specification and any additional navigation performance requirements needed to conduct the PBN operation need to be included in the PBN box depicted on the appropriate chart(s) for the operation. The flight crew should be licensed in accordance with Annex 1 — *Personnel Licensing*, qualified to operate the aeroplane under IFR and trained in the use of the flight deck procedures required. This chapter describes a means of compliance with these requirements and also shows where the criteria can be found.

Note 1.— Requirements for flight instruments equipage for IFR operations may be found in Annex 6, Part I, Chapter 6.

Note 2.— Equipment requirements to conduct PBN operations are dependent upon the most stringent navigation specification applicable to the operation. Equipment requirements for a specific navigation specification are identified in the Performance-based Navigation (PBN) Manual, *Doc 9613, Volume II, Part C.*

4.2 THE AEROPLANE AND ITS EQUIPMENT

4.2.1 The provisions of Annex 6, Part I, require that the aeroplane be operated under a current certificate of airworthiness and be maintained in a serviceable condition in accordance with an approved maintenance programme. It should also be able to achieve the level of performance necessary to make all the manoeuvres required to safely complete take-off, approach and landing at all aerodromes of intended operations. Any adverse conditions that are likely to be encountered during such operations should be considered in making the performance assessment.

4.2.2 Specific requirements for aeroplane flight instruments and radio communication and navigation equipment should exist in addition to the basic requirements of Annex 6, Part I, to support relevant instrument departure, arrival and approach operations. As a consequence, some States supplement Annex 6 by specifying the minimum aeroplane equipment requirements for particular flight operations. The equipment listed in 4.2.3 is an example of the minimum requirements of some States for the equipment that should be functioning in the aeroplane for operations down to Cat I. This is a minimum requirement, and experience in these States has shown that some duplication of equipment is necessary to ensure that this minimum will be available when it is needed.

4.2.3 The following are examples of minimum equipment combinations acceptable for Cat I operations by commercial air transport aeroplanes using ILS, MLS, SBAS or GBAS for either manual or automatic approaches:

a) ILS, MLS or GNSS receiver with GBAS and/or SBAS receiver capability;

b) display of deviation information based on the ILS, MLS, GBAS or SBAS information;

c) 75 MHz marker beacon receiver and indicator (or equivalent); and

1) flight director — single with single display (prescribed by some States for turbine-engine aeroplanes); or

2) automatic flight control system (AFCS) with ILS/MLS/GBAS/SBAS coupled approach mode; or

3) HUD or equivalent display, and where appropriate, EVS, SVS or CVS presentation with ILS/MLS/GBAS/SBAS guidance; or

4) RNAV/RNP system with a minimum of lateral and vertical guidance or control with an appropriate DA/H.

4.2.4 Advanced aeroplanes with equipment such as HUD, EVS, CVS or SVS could be granted additional operational credit.

Advisory vertical guidance (AVG)

4.2.5 Positioning and navigation equipment may provide vertical path deviation guidance indications on a non-essential, not-required basis as an aid to help pilots meet barometric altitude restrictions and provide for a stabilized final approach. Equipment that has this capability typically uses SBAS or barometric vertical navigation (BARO-VNAV), but may use any method to generate the vertical path information. AVG does not provide approved vertical guidance deviation indications for operational credit. Only vertical guidance deviation indications for LNAV/VNAV or localizer performance with vertical guidance (LPV) designed instrument approach procedures are approved for operational credit.

Note 1.— AVG is an optional capability implemented at the equipment manufacturer's discretion for en-route, terminal, and/or approach operations and is not a requirement for positioning and navigation equipment.

Note 2.— Paragraph 4.2.5 does not apply to ILS.

Note 3.— AVG deviation information is only an aid to help pilots comply with altitude restrictions. When using AVG, the pilot must use the primary barometric altimeter to ensure compliance with all altitude restrictions, particularly during instrument approach operations.

4.2.5.1 Positioning and navigation equipment manufacturers should consider providing a method to differentiate AVG indications from those used for approved vertical guidance to reduce potential crew confusion. If practical, the vertical deviation indications for each mode of vertical guidance should be unique and distinct. It is acceptable to provide AVG as a descent aid during oceanic/remote, en-route, and terminal operations.

4.2.5.2 When used in conjunction with non-precision approach procedures:

a) the aircraft should not descend below the minimum descent altitude (MDA) unless visual references for the intended runway are distinctly visible and identified to the pilot;

b) the procedure design does not provide protection for continued use of advisory guidance below the MDA; and

c) the missed approach should be initiated prior to arriving at the MDA so that the aircraft does not descend below the MDA.

4.3 THE FLIGHT CREW

General

4.3.1 It is essential that flight crews be trained and qualified in aspects of all-weather operations appropriate to the intended instrument operations. This process is divided into two parts:

a) ground instruction in the background and philosophy of all-weather operations including a description of the characteristics, limitations and use of instrument approach and departure procedures and those of the airborne equipment and ground facilities; and

b) flight training in procedures and techniques specific to the aeroplane, which may be carried out in an approved flight simulation training device (FSTD) and/or during airborne training.

Note.— Guidance on FSTD qualification is contained in the Manual of Criteria for the Qualification of Flight Simulation Training Devices *(Doc 9625).*

4.3.2 Before flight crews are authorized to carry out take-offs in limited visibility conditions or instrument approaches, a number of factors must be taken into account. As specific approval for progressively lower aerodrome operating minima is sought, increasing emphasis on these factors will be required:

a) composition of the flight crew;

b) qualifications and experience;

c) initial and recurrent training;

d) special procedures; and

e) operating limitations.

Crew composition and training

4.3.3 Requirements for the minimum composition of the flight crew are contained in Annex 6, Part I, and associated documents. Information on the allocation of crew duties and responsibilities should be fully described in the operations manual. The composition of the flight crew and the distribution of duties should be such that each crew member is able to devote the necessary time to the following assigned tasks:

a) operation of the aeroplane and monitoring of flight progress;

b) operation and monitoring of aeroplane systems; and

c) decision-making.

4.3.4 For a period after initial qualification, and until sufficient experience is gained on a particular aeroplane type, a margin should be added to the minima approved for suitably experienced flight crews. The addition of a margin should also apply to pilots newly appointed as pilot-in-command. The required margin and the required experience should be determined by the operator and approved by the State of the Operator.

4.3.5 An all-weather operations ground training programme should provide for all flight crew members instruction appropriate to their designated duties. The specific format of any training programme should be designed to fit the particular operation. It should cover the following items, where applicable:

a) characteristics of visual and non-visual approach aids;

b) aeroplane-specific flight systems, and instrumentation and display systems and the associated limitations;

c) changes, if any, to aerodrome operating minima necessitated by inoperable or unserviceable instruments or systems;

d) approach and missed approach procedures and techniques;

e) use of visibility and RVR reports, including the various methods of assessing RVR, and the limitations associated with each method, the characteristics of fog and its effect on the relationship of RVR to the pilot's visual segment and the problem of visual illusions;

f) influence of wind shear, turbulence, precipitation and day or night conditions;

g) the pilot's tasks at DA/H, MDA/H or MAPt; the use of visual cues, their availability and limitations in reduced RVR and various glide path angles, pitch attitudes and cockpit cut-off angles; the heights at which various cues may be expected to become visible in actual operations; procedures and techniques for transition from instrument to visual reference, including the geometry of eye-height, wheel height, antenna position and pitch attitude with reference to various pitch attitudes;

h) action to be taken if the visibility deteriorates when the aeroplane is below DA/H or MDA/H, and the techniques to be adopted for transition from visual to instrument flight;

i) action in the event of ground or airborne equipment failure, both above and below DA/H or MDA/H;

j) significant factors in the calculation or determination of aerodrome operating minima, including height loss during the missed approach manoeuvre and obstacle clearance;

k) the effect of system malfunction on auto-throttle or autopilot performance (e.g. engine failure, pitch trim failure);

l) procedures and techniques for reduced visibility take-offs including rejected take-off and action to be taken if the visibility or aerodrome facilities deteriorate during the take-off run; and

m) such other factors considered to be necessary by the State of the Operator.

4.3.6 The all-weather operations programme for initial and recurrent training should provide simulator and/or in-flight training on the particular aeroplane type for all flight crew members. The State of the Operator, in consultation with the operator, should decide which elements of a training programme:

a) may or may not or should be performed in an FSTD; and

b) which elements must be performed in the aeroplane.

4.3.7 All-weather operations training should cover the following items, as appropriate:

a) take-offs in reduced visibility, including system failures, engine failures and rejected take-off;

b) system failures during approach, landing and missed approach;

c) instrument approaches with all engines operating and with the critical engine inoperative, using the various flight guidance and control systems installed in the aeroplane, down to the specified operating minima and transition to visual reference and landing;

d) instrument approach with all engines operating and with the critical engine inoperative, using the various flight guidance and control systems installed in the aeroplane, down to the specified operating minima, followed by a missed approach, all without external visual reference;

e) instrument approaches using the aeroplane's AFCS, followed by reversion to manual control for flare and landing; and

f) procedures and techniques for reversion to instrument flight and the execution of a balked landing and subsequent recovery resulting from loss of visual reference below DA/H or MDA/H.

4.3.8 The frequency of system malfunctions introduced in the all-weather operations training programme should not be such so as to undermine the confidence of flight crews in the overall integrity and reliability of the systems used.

4.3.9 The recurrent training required by Annex 6, Part I, to maintain pilot proficiency on an aeroplane type, together with that required to maintain and renew the instrument rating, will normally be sufficient to ensure continued qualification to conduct instrument approaches. However, as a minimum, the recurrent training should include take-offs in reduced visibility and all types of instrument approaches which the pilot is authorized to carry out. These approaches should be flown to the specified operating minima, and the pilot should demonstrate the level of proficiency required by the State of the Operator. Consideration should be given to a recency requirement, i.e., that pilots should carry out a minimum number of practice or actual instrument approaches each month (or other suitable period) to maintain their instrument flying qualification. This recency requirement is in no way a substitute for recurrent training.

Note.— Examples of training, checking and recency requirements for HUD and EVS can be found in Appendix I.

4.4 OPERATING PROCEDURES

4.4.1 All-weather operations call for special procedures and instructions which should be included in the operations manual. Guidance as to the form and content of an operations manual is given in Annex 6, Part I, and in the *Manual of Procedures for Operations Inspection, Certification and Continued Surveillance* (Doc 8335). Further guidance relative to Cat II and III operations is given in Chapter 5 of this manual.

4.4.2 The precise nature and scope of the operations manual with respect to all-weather operations will vary from operator to operator and among different aeroplanes with different equipment. The following items should always be included:

a) standardized flight crew procedures for instrument approaches applicable to the aeroplane in question, including the allocation of flight crew duties in the operation of aeroplane equipment, and allocation of responsibility for cross-monitoring during approach and landing. These procedures should ensure that:

1) standardized callouts include verbal recognition of critical altitudes or fixes, including an approaching minima call at a height of, for example, 30 m (100 ft) above the MDA/H or DA/H in order to prevent inadvertent descent below the applicable descent limit;

2) the need is emphasized for strict adherence to the minimum crossing altitudes of stepdown fixes along the final approach path for approach procedures other than ILS/MLS/GLS/LPV;

3) it is preferable to use a continuous descent final approach technique for non-precision approaches with emphasis on the importance of being stabilized at the required height above the runway threshold;

b) minima for take-off;

c) minima for each type of approach;

d) any increments to be added to the minima in the event of airborne or ground system deficiencies or failures;

e) any increments to be added to the minima for use by the pilot-in-command recently converted to type or operating to an aerodrome for the first time, together with the period during which the increased minima should apply;

f) authority for the pilot-in-command to apply higher values of minima as when judged to be required by circumstances;

g) action to be taken when weather conditions deteriorate below minima;

h) guidance on the visual references required for continuation of the approach below DA/H or MDA/H;

i) requirements for a take-off alternate when conditions at the departure aerodrome are below landing minima;

j) checks for satisfactory functioning of equipment both on the ground and in the air;

k) a list of aeroplane equipment allowable deficiencies, including related considerations of the minimum equipment list (MEL); and

l) identification of aeroplane system or equipment failures requiring abnormal or emergency actions.

4.4.3 The transition from instrument flight to flight using visual references is not an instantaneous occurrence. Assuming a stable approach path in limited visibility conditions, the first visual contact with the visual aids or identifiable features in the approach area for approaches other than those using ILS/MLS/GLS may do no more than indicate to the pilot that the aeroplane is in the final approach area; a pilot will generally need to keep visual contact for a period of several seconds in order to assess the aeroplane position relative to the approach centre line as well as any cross-track velocity. Of more importance is the assessment of the expansion of the visual scene that occurs during this period. Since this assessment should occur before the pilot makes a decision to continue the approach, it follows that visual contact normally should occur above either the DA/H or the MDA/H. The visual scene would normally be expected to expand as the aeroplane descends. To assist the transition into visual conditions, the pilot's scan pattern should still include reference to the aeroplane instruments below DA/H or MDA/H.

4.5 CONTINUOUS DESCENT FINAL APPROACH (CDFA)

Introduction

4.5.1 A CDFA is a specific technique for flying the final approach segment of a non-precision approach procedure as a continuous descent, without level-off, from an altitude/height at or above the final approach fix altitude/height to a point approximately 15 m (50 ft) above the landing runway threshold or the point where the flare manoeuvre should begin for the type of aeroplane flown.

4.5.1.1 The CDFA is achieved by means of time-to-height cross-checks, the use of a flight path angle, or a pre-stored flight path based on the flight management system (FMS) capability in order to follow the optimum descent path to supplement the lateral guidance. CDFA with advisory VNAV guidance calculated by on-board equipment (see PANS-OPS (Doc 8168), Volume I, Part I, Section 4, Chapter 1, 1.8.1) are considered 3D instrument approach operations.

4.5.1.2 The CDFA with manual calculation guidance like time-to-height cross-checks of the required rate of descent or with AVG are considered 2D instrument approach operations. At a predetermined point, prior to reaching the MDA/H on the non-precision approach procedure, a decision is to be made to either go around or to continue the descent and make a landing within the touchdown zone. This is similar to the pilot's action at DA/H on a precision or APV instrument approach procedure. It is important to note that any descent below the MDA/H invalidates the obstacle protection provided by the MDA/H. It is recognized that with some specific approach procedures or with specific aeroplane types, in particular certain aeroplane types/classes in Cat A and B, there will be a need to change configuration when visual references are obtained. This section highlights some of the advantages of the use of a CDFA technique for existing approaches that do not otherwise use a VNAV or ILS/MLS/GLS/LPV glide path.

When to use the CDFA technique

4.5.2 For most instrument approach procedures that were not designed with vertical guidance (glide slope or glide path) a CDFA technique is recommended, where possible, to reduce the risk of CFIT as prescribed by ICAO Annex 6 utilizing stabilized approach criteria. It is especially advantageous on non-precision approach procedures with final approach course closely aligned to the runway, i.e. runway heading is within 15 degrees of approach course for Cat A or B or within 5 degrees for Cat C and D.

4.5.2.1 While the CDFA technique is the preferred technique, there are cases where it may not be the best option, for example, on straight-in approaches when the angle of offset from the runway exceeds 15 degrees. Flying CDFA on these types of approaches at or near weather minima could force the pilot to do an excessive amount of manoeuvring at low altitude very close to the runway. If the weather permits, it could be advantageous to have the aircraft reach the MDA/H as soon as safely practicable so that the pilot can line up with the landing runway sooner. If obstacles penetrate the visual segment surface, the operator must evaluate the associated risks and determine if the approach profile must be changed to clear these obstacles. In extreme cases a CDFA may not be a suitable method for the approach. Instead, level flight to a defined point at a defined altitude may be preferable. In such a case, the additional visibility/RVR requirements will apply and, in some States, a specific approval is required. It should be noted that the CDFA technique does not require a constant descent angle, only a continuous descent where the gradient may vary as required to clear the obstacles. In case of general aviation, this evaluation must be done by the pilot-in-command or the responsible operator. For those cases where the CDFA technique is not applied, e.g. if a stepdown approach technique has been used, some States require additional visibility/RVR. If the approach is not stable at a critical moment, the pilot may need additional reaction time for the vertical manoeuvre. When executing an approach without using a CDFA technique, some States increase the visibility/RVR minima by 200 m for Cat A and B aircraft, and by 400 m in the case of Cat C and D aircraft to aid the visual transition to landing.

Advantages of CDFA

4.5.3 Applying the CDFA technique reduces the need to guard against late, steep descents that are characteristic of a flight technique where the aircraft maintains level flight at the MDA until the MAPt. A typical vertical descent path when utilizing a CDFA technique consists of a linear path which begins 15 m (50 ft) above the runway threshold and extends to an altitude which ensures that the vertical path will remain above all altitudes in the final approach segment. Ideally a 3.00 degree vertical path angle, similar to Cat I approaches is desirable, however CDFA angles will vary based on local conditions (terrain, obstacles, wind, etc.). The CDFA profile should be flown at or above any stepdown fix altitudes. Altering a CDFA to accommodate a stepdown fix may require the flight crew to begin the descent at a later point on the approach, resulting in a steeper descent angle. It is important to emphasize that as approach angles increase beyond a standard 3.00 degrees, this may increase minima for aircraft in faster approach categories.

4.5.3.1 Compared to the traditional descent approach technique, where the aircraft descends step-by-step prior to the next minimum altitude, the CDFA technique has safety and operational advantages, such as standardization of procedures, simplification of the decision process (one technique, one decision at one point), increased height above obstacles, use of a stable flight path, reduced noise and reduced fuel burn. The CDFA technique can be flown on almost any published approach when VNAV or ILS/MLS/GLS/LPV is not available.

Use of minimum descent altitude (MDA)

4.5.4 Instrument approach procedures which are designed without vertical guidance assume that the aeroplane descends to the MDA/H prior to reaching the missed approach point thus reaching it in a level-flight attitude. The transition from a level-flight to a climb attitude will normally not have the aeroplane descend below the MDA/H. On approach procedures designed with vertical guidance, aeroplanes normally initiate the missed approach at the DA/H, if the runway environment is not visible, transitioning from a descent to a climb attitude. Procedures designed with vertical guidance take into consideration the height loss associated with that attitude transition. In the case of application of the CDFA technique, a State or operator may require flight crews to add an altitude increment to the MDA (e.g. 15 m, 50 ft) to determine the altitude at which the vertical transition to the missed approach should be initiated in order to prevent descent below the MDA or transgression below the OCH, past the MAPt. Such an add-on will not warrant any increase to the RVR or visibility requirements for the approach. Any turning manoeuvre associated with the missed approach should be initiated no earlier than the MAPt. Approach procedures are designed to include additional safety buffers. Delay in the initiation of the missed approach manoeuvre may result in infringement of these buffers. Flight crews should always be prepared to initiate a missed approach procedure in advance if necessary.

4.5.4.1 If it is not appropriate or desired to use the CDFA technique, calculating and using a visual descent point (VDP) is another way to guard against late, steep descents. VDPs provide pilots with a reference for the optimal location to begin descent from the MDA based on the designed visual descent angle for the approach procedure. Some approaches will publish a VDP on the chart but the pilot can calculate a VDP if one is not published. The formula for calculating a VDP for a three-degree glide path is:

$$VDP = HAT/300$$

For example, the height above touchdown for a localizer only instrument approach procedure is 600 ft.

$$VDP = 600/300 = 2$$

The pilot should begin the descent from MDA when the aircraft is two miles from the threshold of the runway. If distance measuring equipment (DME) is available, the pilot can convert the VDP to DME. If the DME is located 1.5 miles behind the threshold, the VDP will be 3.5 DME.

4.5.4.2 Some States will publish a VDP on the chart. Additional protection for the visual segment below the MDA is provided if the descent below the MDA is started at or after the published VDP. Approaches without published VDPs may not provide a clear vertical path to the runway at the normally expected descent angle. This could be true, however, of any non-precision approach even if it is flown with the CDFA technique. Therefore, pilots must be especially vigilant when descending below the MDA. This does not necessarily prevent flying the normal angle; it only means that obstacle clearance in the visual segment could be less, and pilots should exercise greater care in looking for and avoiding obstacles in the visual segment.

Training

4.5.5 The operator should ensure that, prior to conducting CDFA, each flight crew member intending to fly CDFA profiles undertakes training appropriate to the aircraft, equipment and instrument approach procedures to be flown.

4.6 VISUAL APPROACHES

Introduction

4.6.1 A visual approach is conducted under IFR using visual references. A visual approach is conducted on an IFR flight plan and authorizes a pilot to proceed visually and clear of clouds to the aerodrome. The pilot normally must have the aerodrome in sight prior to accepting clearance for a visual approach. This approach must be authorized and controlled by the appropriate air traffic control facility, and ATC may authorize this approach when it becomes operationally beneficial. Visual approaches are used to reduce pilot/controller workload and expedite traffic by shortening flight paths to the aerodrome. It is the pilot's responsibility to advise ATC as soon as possible if a visual approach is not desired.

Visual approach techniques

4.6.2 Pilots should use available and appropriate electronic and visual aids when conducting visual approaches. It can be advantageous for a pilot to fly the ground track on a suitable instrument approach to the runway when conducting a visual approach. This includes tuning all applicable electronic navigational aids and setting the appropriate course select windows. This technique is helpful when the pilot is unfamiliar with the aerodrome or when visibility conditions are at or near the limit for a visual approach. Pilots should also use available visual glideslope indicators (VGSI) to assist with vertical path control on a visual approach. Caution should be exercised when conducting visual approaches to areas where there are multiple aerodromes, especially those that have similar runway alignment configurations. Configuring the aircraft for an instrument approach at the destination aerodrome can help eliminate some of the confusion of multiple, similarly aligned runways.

4.6.3 Occasionally, electronic or visual glide path indicators are not available to assist the pilot. Reduced visibility and/or night-time conditions can make it difficult for the pilot to achieve and maintain a proper glide path. One technique that can assist the pilot is the 3:1 technique. Most aeroplanes are designed for a three-degree glide path and pilots can verify their glide path by comparing their altitude above the ground to their distance from the runway. According to the 3:1 technique, an aeroplane on a three-degree glide path will lose approximately 75 m (300 ft) of altitude for every one nautical mile it travels across the ground. Pilots can use this technique to determine when to begin descent on the glide path and to verify that a proper glide path is being maintained. For example, an aeroplane that is on a three-degree glide path at 450 m (1 500 ft) above the ground should be approximately five miles from the runway. Pilots should also be aware if the published electronic glide path or VGSI is something other than three degrees and adjust this technique accordingly.

4.6.4 Another technique to assist in vertical path control is utilizing known power settings at typical landing weights for an instrument approach. These power settings should provide an excellent approximation for maintaining a proper glide path. If the power setting is significantly lower than normal but the aeroplane is maintaining the proper airspeed, it might indicate that the glide path is too steep. A higher than normal power setting might indicate a shallower glide path. A good technique can be to add “power setting” to a pilot’s cross-check of “aim point” and “airspeed” on a visual approach.

4.6.5 Some States publish charted visual flight procedures (CVFP). CVFPs normally are established for environmental/noise considerations and/or when necessary for the safety and efficiency of air traffic operations. The approach charts depict prominent landmarks, courses, and recommended altitudes to specific runways. Unless specifically noted on the chart, all altitudes are recommended altitudes only. Some CVFPs have published weather minima on the charts, and pilots should not expect to be cleared to CVFP if weather is less than published.

Chapter 5

ADDITIONAL REQUIREMENTS FOR TYPE B CATEGORY II AND III ILS OPERATIONS

5.1 GENERAL

5.1.1 There is a need to consider factors additional to those described in Chapters 3 and 4. This chapter provides detailed guidance on these factors for Category II and III operations, including:

a) the need for additional, more reliable ground equipment and airborne systems capable of guiding the aeroplane with greater accuracy to the DA/H and, when appropriate, to a landing and subsequent roll-out;

b) special requirements for flight crew qualification, training and demonstration of proficiency and currency;

c) more stringent criteria for obstacle limitation surfaces;

d) the nature of the pre-threshold terrain;

e) more stringent criteria for the protection of the landing aid signal as appropriate (e.g. ILS sensitive and critical areas) as well as prevention of runway incursion;

f) the adequacy of runways and taxiways, including approach, runway and taxiway lighting and marking for such operations;

g) the need for more comprehensive surface movement guidance and control in limited visibility conditions; and

h) the deployment of rescue and firefighting equipment.

5.2 AERODROME FACILITIES

Initial planning considerations

5.2.1 Category II and III operations involve the routine planning, management, administration and control typically associated with modern civil aviation operations. For these operations, the equipment standards required and the associated features are typically addressed as a by-product of modern aircraft design and certification. Most operators now routinely apply Cat II and III minima in recognition of the incidence of low-visibility conditions, traffic volumes, the proximity of alternate aerodromes and their facilities and the potential enhancement of regularity of service and safety. Where a case can be made for the initial introduction of precision approach and landing operations, consideration should be given to the installation of equipment of the highest standards. Guidance material is also contained in Docs 9476 and 9830.

5.2.2 It should be recognized that there are national differences in methods of certifying aerodromes and authorizing operations. Cat II or III operations should not be authorized until the facilities and services meet ICAO criteria, meet equivalent or stricter criteria or are appropriately mitigated. If the State of the Aerodrome has additional requirements, these should be provided to operators before instrument approach procedures are promulgated.

Runways and taxiways

5.2.3 Specifications and guidance on the physical characteristics of runways and taxiways are contained in Annex 14, Volume I, and Doc 9157, Parts 2 and 3. When considering the design aspects of a new runway, or major changes to an existing one, due consideration should be given to the need to provide adequate facilities and services for the category of operations intended at each such runway. For example, limitations may need to be placed on the surface movement of vehicles and aircraft to ensure that ILS critical and sensitive areas are avoided. However, the separation distance between a holding bay or taxi-holding position and the centre line of the runway may be different for Cat II and III operations. Also, the dimensions of the critical and sensitive areas may be different for Cat II and III operations.

Obstacle limitation criteria

5.2.4 Criteria for obstacle limitation surfaces are specified in Annex 14, Volume I. Guidance on obstacle limitation surfaces for runways using ILS, MLS or GLS is given in Doc 9137, Part 6. The limitation of obstacles in, and the dimensions of, an obstacle-free zone (OFZ) are prescribed in Annex 14, Volume I. For Cat II and III operations, the OFZ, extended to the appropriate Cat II OCH, should not be penetrated by any obstacle except those specifically permitted in Annex 14, Volume I.

Pre-threshold terrain

5.2.5 Annex 4 requires that a precision approach terrain chart be published by States providing facilities for Cat II and III operations, and Doc 8697 provides guidance on the production of suitable charts. The operation of some automatic landing systems is dependent on the radio altimeters. The flare profile, 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. The terrain which is most critical lies in an area 60 m either side of the runway centre line extending into the approach area to a distance of at least 300 m before the threshold (radio altimeter operating area). The guidance material in Annex 14, Volume I, makes reference to the maximum slopes of pre-threshold terrain which are normally acceptable when planning a new runway on which operations are to include coupled approaches and automatic landing. However, radio altimeter inputs may also be required when the aeroplane is on final approach as much as 8 km (5 NM) from touchdown. At aerodromes where the terrain beneath the approach flight path is not level, abnormal autopilot behaviour may result as follows:

a) where the terrain under the approach is markedly lower than the threshold, the radio altimeter input for a particular stage of the approach may be signalled later than required;

b) where the terrain under the approach is markedly higher than the threshold, the radio altimeter input for a particular stage of the approach may be signalled sooner than required; and

c) where the terrain consists of a series of ridges and valleys, an input of incorrect altitude information to the AFCS may take place. This may result in unacceptable autopilot and flight-path behaviour.

5.2.6 Where the characteristics of the terrain are considered marginal for a particular aeroplane type, a demonstration should be made to determine that the performance or function of the AFCS is not adversely affected. The demonstration may take the form of flight trials or a suitable analysis. Any additions or alterations to existing structures or terrain in the pre-threshold area should be considered for their effect on published information. In the event that an alteration has a significant effect on radio altimeters, the amended data relating to the terrain profile should be rapidly disseminated.

5.2.7 In accordance with Annex 4, Chapter 6, the precision approach terrain chart depicts a profile of the terrain to a distance of 900 m (3 000 ft) from the threshold along the extended centre line of the runway. Therefore, determination of DA/H by means of the radio altimeter should consider the approach terrain out to 900 m from the threshold.

Visual aids

5.2.8 Approach, threshold, touchdown zone, runway edge, centre line, runway end and other aerodrome lights are specified in accordance with Annex 14, Volume I, appropriate to the category of operation for which a runway is intended. In instances where consideration is given to upgrading a runway for Cat II and III operations, it is advantageous to provide the necessary improvements to lighting during the initial construction or resurfacing of the runway.

5.2.9 For most daylight operations, surface markings are an effective means of indicating the centre line of taxiways and holding positions but may not be adequate in limited visibility conditions. Annex 14 requires a holding position sign at all Cat II and III holding positions. Similarly, taxiway centre line lights or taxiway edge lights and centre line markings which provide adequate guidance are required for Cat II and III operations. The conspicuousness of runway markings and taxiway markings may deteriorate rapidly, particularly at aerodromes having high movement rates. Frequent inspection and maintenance of the markings should be emphasized for Cat II and III operations.

5.2.10 Stop bars are valuable aids to safety and ground traffic flow control in low-visibility operations. The primary safety function of the stop bar is the prevention of inadvertent penetrations of active runways and of the OFZ by aircraft and vehicles in low-visibility conditions. Stop bars should be provided at all taxiways which provide access to active runways during limited visibility conditions unless, at the discretion of the responsible authority, the aerodrome layout, traffic density and applied procedures enable protection by other means. Stop bars, when provided, should be used in visibility conditions corresponding to RVRs of less than 550 m. Exceptions are allowed (refer to Annex 14, Volume I, Chapter 5, 5.3.20.1 and 5.3.20.2). They also may contribute, in conjunction with other elements of the SMGCS, to effective traffic flow when low visibility prevents ATC from effecting optimum flow and ground separation by visual reference. It may also be advantageous to partly automate the operation of selected stop bars so that ATC will not be required to operate them manually, thus avoiding potential human error. For example, a manual switch-off of a stop bar after issue of a movement clearance would be followed by an automatic re-illumination triggered by the crossing aeroplane, or a “limited visibility” setting on the control panel would automatically illuminate stop bars across taxiways which are not to be used in limited visibility.

5.2.11 Some lights in a particular system may fail but if such failures are distributed in a manner which does not confuse the lighting pattern, the system may be regarded as serviceable. Monitoring of individual lights should be performed either by regular visual inspection of all sections of the lighting system or by use of automated systems. To help safeguard recognizable patterns in the event of failure of a single circuit, circuits should be integrated so that the failure of adjacent lights or clusters of lights will be avoided. Requirements and guidance on the design, maintenance and monitoring of lighting circuits are contained in Annex 14, Volume I, and in Doc 9157, Part 4.

Non-visual aids

5.2.12 The ILS ground equipment should meet the facility performance requirements specified in Annex 10, Volume I, or equivalent. The guidance material in Attachment C to that document also provides information for the planning and implementation of the ILS. Doc 8071, Volume I, provides guidance on ground and flight testing and inspection of the radio navigation aids of ILS facilities. Volume II provides guidance on testing satellite-based radio navigation systems. The quality of the ILS signals-in-space is not determined solely by the quality of the ground equipment. The suitability of the site, including the influence of reflection from objects illuminated by the ILS signals and the manner in which the ground equipment is adjusted and maintained, has a significant effect on the quality of the signal received at the aeroplane. The ILS signal-in-space should be flight-checked in order to confirm that it meets in all aspects the appropriate Standards of Annex 10, Volume I.

ILS

Note.— Guidance on the ILS facility classification and downgrading can be found in Appendix C.

5.2.13 All facilities associated with the ILS ground equipment should be monitored in accordance with the requirements of Annex 10, Volume I. Guidance material on monitoring is contained in Attachment C to Annex 10, Volume I. The specifications in Annex 10, Volume I, indicate the total maximum periods of time allowed outside the specified performance limits for each ILS facility performance requirement.

5.2.14 Diffraction and/or reflection may also be caused by large aircraft or vehicles in the vicinity of the runway, which may affect both the glide path and the localizer signals. This additional area, outside the ILS critical area, is called the ILS sensitive area. The extent of ILS sensitive areas will vary with the characteristics of the ILS and the category of operations. It is essential to establish the level of interference caused by aircraft and vehicles at various positions on the aerodrome so that the boundaries of the ILS sensitive areas may be determined. Since it is not practicable to develop precise criteria covering all cases, the size and shape of ILS sensitive areas for a particular category of operation should be determined by the State concerned.

Note.— Some States do not distinguish between ILS critical and ILS sensitive areas as defined in Annex 10. These States define an area larger than that defined in Annex 10 but still called the ILS critical area. In addition, this area is protected when an arriving aircraft is within the middle marker when cloud and visibility conditions are below specified values. This affords protection equivalent to that described in 5.2.14.

5.2.15 To ensure that the integrity of the guidance signal radiated by the ILS is maintained during aeroplane approaches that are using the ILS as the primary means of navigation, all vehicles and aircraft on the ground must remain outside the ILS critical area as described in Annex 10, Volume I, Attachment C. If a vehicle or aircraft is within the ILS critical area it could cause reflection and/or diffraction of the ILS signals which may result in significant disturbances to the guidance signals on the approach path. Additional longitudinal separation between successive landing aeroplanes contributes to the integrity of ILS guidance signals.

Note.— Aircraft can be expected to be using the ILS signal as the primary means of navigation when the weather conditions are instrument meteorological conditions (IMC) and the aeroplane is in the final approach segment of the instrument approach procedure.

5.2.16 The reliability (i.e. mean time between outages (MTBO)) of the ILS ground equipment is a measure of the frequency of unscheduled outages which may be experienced. Reliability will be increased by providing online standby equipment and by duplication or triplication of key functions, including power supplies.

Secondary power supplies

5.2.17 Requirements for the provision of secondary power supplies for visual and non-visual aids are specified in Annex 14, Volume I, and Annex 10, Volume I, respectively. Guidance material in Doc 9157, Part 4, and in Annex 10, Volume I, Attachment C, describes how to achieve the specified changeover times. Secondary power is also required for essential communications and for other associated facilities, such as visibility measuring systems. Changeover times for these latter facilities should be commensurate with the operations conducted.

5.3 AERODROME SERVICES

Aerodrome safety assessment

5.3.1 In conditions of limited visibility, air traffic controllers may no longer be able to see the entire movement area of the aerodrome, but flight crews will still have the capability to see and avoid other traffic in their vicinity. In worse conditions, neither the controller nor the flight crews may be able to see other proximate traffic, and it may then become essential to have a system which effectively ensures the separation of the aeroplane from aircraft or from vehicles. Guidance on such systems is given in Docs 9476 and 9830.

5.3.2 In creating procedures for surface movements in limited visibility a comprehensive safety assessment of the aerodrome should be undertaken. Such an assessment requires examination of all the relevant factors such as layout of the movement area and aircraft and vehicle routings, relevant existing instructions and rules, meteorological records, movement statistics, records of runway intrusions and existing security procedures. The required actions identified by an assessment will be influenced by the characteristics of the movement area and the type(s) of operation and should include the following:

a) training of ground personnel;

b) ATS surveillance, control, and communication of the movement of persons and vehicles on the manoeuvring area;

c) withdrawing non-essential personnel and vehicles from manoeuvring areas when limited visibility weather conditions prevail or are impending;

d) permitting essential vehicles with radiotelephony communication with ATS to enter the movement area in limited visibility conditions;

e) patrolling in areas of intensive vehicle movement where there is no traffic control point between those areas and the runway;

f) locking and inspecting unguarded aerodrome entrances at frequent intervals;

g) having procedures to warn airline operators and other organizations with movement-area access of the commencement of the more restrictive measures; and

h) developing appropriate emergency procedures.

5.3.3 In some States, these actions are a by-product of normal security procedures, but in others they may be part of special procedures which are implemented in worsening weather situations when the RVR falls below a predetermined value, typically 800 m. Guidance on low-visibility operations and examples of low-visibility procedures are given in Doc 9476.

Surface movement control of aircraft and vehicles

5.3.4 Doc 9476 provides information on appropriate combinations of visual aids, non-visual aids, radiotelephony communications, procedures, control and information facilities for guidance and control of aerodrome surface traffic. The system to be adopted at an aerodrome should be designed to meet the operational requirements for guidance and control of all relevant traffic in low-visibility conditions. In addition, Doc 9830 provides an overview of the A-SMGCS operational requirements in order to facilitate implementation of various functions in modular form depending on specific local aerodrome circumstances.

5.3.5 Surface movement control procedures should ensure that runway incursions are prevented when the runway is required for take-off and landing operations.

5.3.6 Flight crews can be expected to see and avoid other ground traffic down to visibilities in the order of 400 m. During ground operations in lower visibilities, the flight crews' ability to maintain separation from other aircraft, vehicles and obstacles, solely based on visual reference, is limited. Control, surveillance and safety will be enhanced by the use of supplementary facilities such as aerodrome surface movement radar, controllable taxiway lights, stop bars, signs and local detectors such as induction loops and intrusion alarm devices. Essential vehicles should be able to manoeuvre in limited visibility conditions, and they should be strategically located during these operations so that their services will be available in a timely manner.

Security and surveillance

5.3.7 When no special surveillance equipment is employed and control of traffic on the movement area is maintained by procedures and visual aids, unauthorized traffic should be restricted by local security measures. Routine measures for restricting unauthorized traffic on an aerodrome may be adequate for limited 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 and sensitive areas and active runways. For example, when construction or maintenance vehicles are engaged in mobile activities on the aerodrome at the onset of Cat II or III operations, it may be necessary to terminate their activities and remove them from the manoeuvring area until visibility improves.

Air traffic services

5.3.8 The provision of ATC services is essential at aerodromes planned for Cat II and III operations. The essential information to be provided to pilots is specified in Annex 11 and in PANS-ATM (Doc 4444). Guidance on the responsibilities of the ATS is given in Doc 9476.

5.3.9 Information on the status of relevant supporting systems (e.g. navaids, lighting, weather, obstacle protection areas) should be promptly passed to flight crews conducting instrument approaches. For Cat II and III operations, information related to navaids used for flight guidance systems (e.g. autoland or HUD guidance) and relevant low-visibility-weather-reporting capability may need to be conveyed with more detail, suited to the operations being conducted (e.g. particular RVR reporting equipment is inoperative). Although the general recommendation found in Chapter 3, 3.3.9, encourages ATC to minimize transmission of extraneous communications to flight crews during critical phases of flight, care should be taken not to filter information which may be operationally relevant but may seem unimportant to ATC. Accordingly, the following principles should be applied to radio communications between ATC and Cat II and III arrivals or aircraft departing in low visibility:

a) as a minimum, information should be provided in accordance with the PANS-ATM (Doc 4444), Chapter 4;

b) ATC, operators and authorities should reach prior agreement on deficiencies, failures or anomalies that may occur which could affect Cat II and III operations or low-visibility take-offs, particularly if they are site-specific or unique;

c) common phraseology and terminology should be agreed upon for communicating the information in b) above to flight crews;

d) flight crew members should be informed of any situations which may occur for which ATC does not, or will not, advise landing aircraft; and

e) as a general rule, if doubt exists regarding the operational relevance of information, ATC will pass that information to flight crews so they may evaluate its operational application and significance.

5.3.10 Because ILS signals can be disturbed by reflections caused by aeroplanes overflying the localizer/azimuth antenna, ATC follows appropriate procedures so that, during ILS operations, a departing aeroplane will fly past the ILS localizer antenna before the arriving aeroplane descends to 60 m (200 ft). This is necessary to preserve the integrity of an ILS/MLS guidance system during the time when the landing aeroplane is critically dependent on the quality of the signal-in-space. For the same reason, additional longitudinal separation may be required between successive landing aeroplanes which may affect the capacity of the aerodrome. Appropriate air traffic control procedures should be developed at those locations where Cat II or III operations are planned, based on experience gained during Cat I operations.

5.3.11 Traffic flow should be coordinated so that aeroplanes equipped for limited visibility operations will not be unnecessarily delayed by aeroplanes not so equipped. This may require discrete flow control, flow management procedures or special radar procedures.

5.3.12 ATC should recognize the need for aeroplanes to simulate low minima approaches in good weather conditions so that flight crews can gain practical experience in the proper operation of the equipment. If a flight crew requests to conduct a simulated approach, the ATC unit should make every effort to grant such a request when traffic permits and protect ILS critical and sensitive areas, when possible. While a simulated approach is being conducted, ATC should, if possible, apply restrictions to take-off, landing and taxiing aircraft as if low minima conditions actually existed in order to derive maximum benefit from the exercise. When this is not feasible, ATC should advise the flight crew accordingly.

Meteorological services

5.3.13 Meteorological information required to support Cat II and III operations is specified in Annex 3 and amplified in the guidance in Doc 8896. Further guidance on RVR assessment and reporting, particularly on the increase in the number of reporting positions from one (Cat I operations), to two or three (Cat II operations) and to three (Cat III operations) is given in Doc 9328.

Aeronautical information services

5.3.14 The requirements for AIS, given in Chapter 3, 3.3.13 to 3.3.16, apply to Cat II and III operations.

Minimum ground system requirements for Category II and III operations

5.3.15 The minimum requirements for ground system facilities are set forth in Annex 14, Volume I. It may be expected that all the facilities detailed in ICAO SARPs and described in this manual will be available for operations on a particular runway. Operations to aerodromes with temporarily reduced facilities require reassessment and approval of revised minima. It is the responsibility of the operator to develop adequate operating instructions to counter the effects of deficient ground equipment and to disseminate this information to flight crews.

5.4 INSTRUMENT APPROACH PROCEDURES

Instrument approach procedure design criteria are contained in PANS-OPS (Doc 8168), Volume II, which also requires States to publish OCA/Hs for instrument approach procedures. PANS-OPS also includes a methodology for OCA/H determination. An OCA/H is required for Cat II operations, but not for Cat III operations. Cat III operations are permitted provided the obstacle limitation criteria within the obstacle-free zones are met (see 5.2.4).

5.5 THE AEROPLANE AND ITS EQUIPMENT

General

5.5.1 The physical characteristics of the aeroplane should be considered in the determination of aerodrome operating minima. Most relevant for the determination of aerodrome operating minima is the navigation performance, but the aircraft category also plays a role. In case of an approach procedure, the climb performance may be an element for the missed approach phase. For the take-off phase of flight, aircraft size and handling comprise one of the elements to be taken into account. Further information is provided in Chapter 6.

5.5.2 The instruments and equipment for Cat II and III operations should comply with the airworthiness requirements of the State of Registry of the aeroplane. In addition, aeroplane performance should enable a missed approach to be carried out with an engine inoperative and without outside visual reference, from any height down to the decision height in Cat II operations and down to touchdown in Cat III operations, while remaining clear of obstacles. The instruments and equipment appropriate to various ILS/MLS/GLS approach operations, as required by some States, are given in this chapter. The degree of redundancy required and the methods employed for monitoring and warning may vary according to the category and type of operation.

5.5..3 The target level of safety and the acceptable frequency of missed approaches due to airborne equipment performance, in conjunction with the intended operating minima, determine the airborne equipment design requirements with regard to:

a) system accuracy;

b) reliability;

c) characteristics in case of failures;

d) monitoring procedures and equipment; and

e) degree of redundancy.

Reporting system

5.5.4 A reporting system should be implemented to enable continual checks and periodic reviews during the operational evaluation period before the operator is authorized to conduct Cat II and III operations. Furthermore, it is particularly important that the reporting system be used for a specified period to ensure that the required standards of performance are maintained. The reporting system should cover all successful and unsuccessful approaches, with reasons for the latter, and include a record of system component failures.

5.5.5 For Cat II operations, it may be sufficient to differentiate between successful and unsuccessful approaches and to provide a questionnaire to be completed by the flight crew to obtain data on actual or practice approaches which were not successful. For example, the following data may be useful to a State or operator in evaluating a Cat II operation:

a) the aerodrome and runway used;

b) weather conditions;

c) time;

d) reason for failure leading to an aborted approach;

e) adequacy of speed control;

f) trim at time of AFCS disengagement;

g) compatibility of AFCS;

h) flight director and raw data; and

i) an indication of the aeroplane's position relative to the ILS centre line and glide path when descending through 30 m (100 ft).

The number of approaches made during initial operational evaluation will vary depending on the capabilities of the system and the operator's experience. It should be sufficient to demonstrate that the performance of the system in commercial service is such that an adequate approach success rate will result. When determining the success rate, failures due to external factors, such as ATC instructions or ground equipment faults, should be taken into account.

5.5.6 For Cat III operations, a similar but more stringent procedure should be followed. Use may be made of recording equipment such as a sophisticated flight data recorder to obtain the necessary data. Any landing irregularity should be fully investigated using all available data to determine its cause. Failure to positively identify and correct the cause of any landing reported to be unsatisfactory may jeopardize the future of the particular operation.

Aeroplane equipment requirements

5.5.7 Developments in aeroplane flight control and guidance systems make it possible to conduct operations using various combinations of equipment. Aircraft meeting appropriate airworthiness requirements are eligible for operational approval.

Performance requirements for initial approval of airborne systems

5.5.8 Criteria for AFCSs and automatic landing systems, as identified by States of the Operator, are used by aircraft manufacturers in the design and certification of aircraft having Cat I, II and III operational capability. The automatic systems concept is described in type-certification requirements, including requirements for minimum system performance and failure conditions, flight demonstration during certification and information to be included in the aeroplane flight manual. The material provides guidance for the airworthiness certification of the systems, but in the case of AFCSs, it does not include any special requirements for certification of the system in restricted visibility conditions. In the case of the certification of automatic landing systems, the acceptability of the system may be dependent on weather conditions, of which visibility is only one factor. There are additional considerations for the certification of the aeroplane as a whole for approach and landing in restricted visibility (i.e. for Cat II and III operations).

Airborne system approval

Category II

5.5.9 ILS glide path and localizer tracking performance standards should be based on a required standard deviation of guidance signal error. The airborne system should demonstrate accuracy by successfully completing a sufficient number of approaches during certification or operational evaluation. More detailed consideration of failure cases is required than for Cat I operations, and a statistical failure analysis is preferred by some States. Sufficient experience and use of the system should be gained before specific approval of Cat II operations.

Category III

5.5.10 In addition to the requirements for Cat II operations, for Cat III operations acceptable touchdown performance requirements should be demonstrated during the certification or operational evaluation programme by successfully completing a sufficient number of landings, supported by a simulator test programme. An acceptable probability of system failures and their consequences should be based on an appropriate failure analysis and demonstration of selected failures by simulation or in flight. Before specific approval of Cat III operations, sufficient operational experience and use of the system should be gained to verify system reliability and performance in day-to-day operations.

Maintenance

5.5.11 The operator should establish a maintenance programme to ensure that the airborne equipment continues to operate in service to the required performance level. This programme should be capable of detecting any deterioration in the overall level of performance as described in 5.5.4 to 5.5.6. The importance of the following areas should be emphasized:

a) maintenance procedures;

b) maintenance and calibration of test equipment;

c) initial and recurrent training of maintenance staff; and

d) recording and analysis of airborne equipment failures.

5.5.12 Maintenance programmes should be established consistent with the aeroplane manufacturer's recommendations. Aeroplane system design and architecture and the manufacturer's maintenance philosophy can introduce significant variation between aeroplane types for failure detection, annunciation and return-to-service methods.

Magnetic variation (MagVar) data and on-board database

5.5.13 Discrepanices in magnetic variation occur primarily when the magnetic variation data being used internally by the aircraft does not align with the current magnetic variation at a location, or when it is not sufficiently similar to the procedure in use. This is generally only critical for Cat II/III operations and for coupled approach and practice autoland on Cat I ILS. When flying these procedures, the aircraft systems construct a True track in, used for guidance during roll-out and as a cross-check on final approach, apply magnetic variation from the on-board source(s), and compare the resulting magnetic course to the published final approach course. If the difference is greater than 3 to 4 degrees, the system may flag or disengage the autopilot. The difference between the on-board source and the published procedure may be in the opposite direction from the current magnetic variation at the location, one leading and one lagging. Therefore, the total amount of difference must be considered, not just the difference from the current local magnetic variation. Avionics may use values other than the localizer magnetic variation, such as the aerodrome magnetic variation, or the on-aerodrome navaid, or in some cases a calculated value, as the on-board source. Also, some aircraft have more than one on-board source of magnetic variation data, used by different systems, which in some cases may cause an internal magnetic variation disagreement when one database is updated and the other is not. This internal disagreement may cause flags and disconnects. Some aircraft seem to experience problems only when there is a strong cross-wind, which affects the calculated difference. The magnetic variation on the aerodrome diagram is not related to instrument procedures and is updated on a different schedule. Therefore it should not be used in any determination of coupled approach and autoland capability.

5.5.14 Magnetic variation discrepancies have occurred mostly at aerodromes with a high rate of change, most of which are located at higher latitudes. However, they can occur at any location where the on-board magnetic variation data and the published procedures differ beyond the avionics tolerance. Operators should consult manufacturer guidance concerning the on-board magnetic variation database and its suitability for autoflight and autoland at aerodromes where they intend to operate. Some manufacturers will list in bulletins the aerodromes where autoflight and autoland are supported by the on-board magnetic database. NOTAMs may contain magnetic variation restrictions. A change in the ILS procedure or aerodrome magnetic variation should be evaluated to determine whether autoflight is still supported with the current on-board magnetic variation data. Also, updating the on-board data may cause discrepancies at an aerodrome where the procedure magnetic variation has not been updated. Aircrews should use caution when conducting autoflight and autoland at any new aerodrome.

5.6 OPERATING PROCEDURES

5.6.1 Operating procedures follow the basic format described in Chapter 4. Guidance on aspects of particular importance when operating to low aerodrome operating minima is given below.

5.6.2 Low weather minima operations call for special procedures and instructions to be included in the operations manual, but it is desirable that any such procedures should also be used as the basis for all operations in order to provide the same operating philosophy for all categories of operations. These procedures cover all foreseeable circumstances so that flight crews are fully informed as to the correct course of action which should be followed. This is particularly true for the last part of the approach and landing where limited time is available for decision-making. Possible modes of operation include:

a) manual take-off;

b) manual approach and landing;

c) coupled approach down to DA/H, manual landing thereafter;

d) coupled approach to below DA/H, but manual flare and landing;

e) coupled approach followed by auto-flare and auto-landing; and

f) coupled approach followed by auto-flare, auto-landing and auto-roll-out.

Note.— Any of the modes of operation described above may be combined with the use of HUD, EVS, SVS or CVS.

5.6.3 The precise nature and scope of procedures and instructions should be a function of the airborne equipment used and the flight deck procedure applied. The duties of flight crew members during take-off, approach, flare, roll-out and missed approach are to be clearly delineated in the operations manual. Particular emphasis should be placed on flight crew responsibilities when transitioning from non-visual conditions to visual conditions, and on procedures to be used in deteriorating visibility or when failures occur. Special attention should be paid to the distribution of flight deck duties to ensure that the workload of the pilot making the decision to land or to execute a missed approach is such that it enables the pilot to concentrate on oversight and decision-making.

5.6.4 The following areas are emphasized:

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

b) effects on minima caused by changes in the status of the ground installations;

c) use and application of RVR reports from multiple runway positions and sensors;

d) pilot assessment of aircraft position and monitoring of the performance of the AFCS, the effects of the failure of any required portion of the AFCS or instruments used with the system and action to be taken in the event of inadequate performance or failure of any portion of either the system or the associated instruments;

e) actions to be taken in the case of failures, such as engines, electrical systems, hydraulics and flight control systems;

f) allowable aeroplane equipment deficiencies;

g) precautions necessary when making practice approaches where full ATC procedures to support Cat III operations are not in force or when ILS ground equipment of a lower standard is used for Cat II or III practice operations;

h) operating limitations resulting from airworthiness certification; and

i) information on the maximum deviation allowed from the ILS glide path and/or localizer from the region of the DA/H down to touchdown, as well as guidance regarding the visual reference required.

5.6.5 Experience has demonstrated that it is useful for operators to establish procedures for the gradual introduction of low weather minima operations. This suggests a conservative approach to the implementation of all-weather operations through a gradual reduction in meteorological criteria commensurate with experience. In some States, this is a firm requirement associated with authorization of the operations. 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 by another State of Manufacture;

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

c) accumulation of actual operating experience with aerodrome operating minima within the authorized category of operation, but not as low as the lowest limit of the category;

d) accumulation of operating experience using Cat II operations minima before proceeding to Cat III operations minima;

e) providing, for analysis purposes, a means of pilot reporting on ground and airborne system performance;

f) accumulation of flight crew experience; and

g) accumulation of experience in the maintenance of particular equipment.

5.7 FLIGHT CREW QUALIFICATION AND TRAINING

General

5.7.1 The basic requirements for flight crew qualification and training that cover instrument approach operations down to Cat I minima are set out in Chapter 4. Additional factors pertinent to Cat II and III operations are discussed below.

5.7.2 Before conducting Cat II or III operations, the flight crew should complete a suitable programme of training and education. The particular programme of training will be related to the aeroplane type and the operating procedures adopted, which are discussed under 5.6. For modern transport aircraft and operators, this is typically incorporated as part of the operator's type qualification programme for flight crews.

5.7.3 The increased dependence on the use of automatic systems highlights the role of the flight crew in safely and effectively operating these systems and the need for this role to be addressed in training and qualification processes. This emphasis should include pilot assessment of the position of the aeroplane and monitoring of the AFCS performance throughout all phases of the approach, flare, touchdown and roll-out.

5.7.4 Flight crews should be required to demonstrate their competency to the appropriate authorities. They should have gained sufficient flight experience on the aeroplane type before being authorized to apply Cat II or III operations minima under actual conditions. The operator should demonstrate that the training programme, operating procedures and instructions result in a standard of operation that is acceptable to the State of the Operator and should produce evidence that the operational techniques proposed have been satisfactorily used in weather conditions above the proposed minima.

Ground training

5.7.5 Flight crews should make full use of ground and airborne equipment intended for use during Cat II and III operations. They should therefore be instructed in how to obtain maximum benefit from redundancy provided in the airborne equipment and to fully understand the limitations of the total system, including both ground and airborne elements. The ground instruction should cover at least:

a) the characteristics, capabilities and limitations of the navaids involved (e.g. ILS, MLS, GLS), including the effect on aeroplane system performance of interference to the ILS signal caused by other landing, departing or overflying aeroplanes, and the effect of the infringement of ILS critical and sensitive areas by aeroplanes or vehicles in the manoeuvring area;

b) the characteristics of the visual aids (e.g. approach lighting, touchdown zone lighting, centre line lighting) and the limitations on their use as visual cues in reduced visibility 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;

c) the operation, capabilities and limitations of the airborne systems (e.g. the AFCSs; monitoring and warning devices; flight instruments, including altimetry systems; and the means the pilot has to assess the position of the aeroplane during the approach, touchdown and roll-out);

d) approach, including missed approach procedures and techniques, along with descriptions of the factors affecting height loss during missed approach in normal and abnormal aeroplane configurations;

e) the use and limitations of RVR, including the applicability of RVR readings from different positions on the runway, the different methods of assessing RVR, the conversion method of visibility into an RVR in some States, and the limitations associated with each method;

f) the basic understanding of obstacle limitation and the OFZ, including missed approach design criteria and obstacle clearance for Cat II and III operations (refer to PANS-OPS, Volume I);

g) the effects of low-level wind shear, turbulence and precipitation;

h) pilot tasks at decision height, and procedures and techniques for transition from instrument to visual flight in low-visibility conditions, including the geometry of eye, wheel and antenna positions with reference to ILS reference datum height;

i) action to be taken if the visual reference becomes inadequate when the aeroplane is below decision height and the technique to be adopted for transition from visual to instrument flight should a go-around become necessary at these low heights;

j) use of alert height and appropriate actions;

k) action to be taken in the event of failure of approach and landing equipment above and below decision height;

l) recognition of and action to be taken in the event of failure of ground equipment;

m) significant factors in the determination of decision height (Annex 6);

n) effect of specific aeroplane malfunctions (e.g. engine failure) on auto-throttle, auto-pilot performance, etc.;

o) procedures and precautions to be followed while taxiing during limited visibility conditions; and

p) the existence and effects of visual illusions.

5.7.6 Training aids may include videos of approaches in actual conditions or the use of an approved FSTD with a suitable visual system. The training should ensure that all flight crew members understand their duties and responsibilities, those of the other flight crew members and the need for close crew coordination.

Note.— Guidance on FSTD qualification is contained in the Manual of Criteria for the Qualification of Flight Simulation Training Devices *(Doc 9625).*

5.7.7 In actual operations some approaches may result in the aeroplane being off centre line or glide path at, before or after decision height. Therefore, pilots should be given instruction on decision-making in such circumstances, which will illustrate the limitations of visual cues in reduced visibility. Pilots should also be made aware that they can be led into a premature transition to outside references for aeroplane control when available visual cues are not adequate for control of pitch attitude and/or vertical flight path. They should therefore be cautioned against premature disengagement of the auto-pilot and should continue monitoring flight instrumentation, even when adequate visual contact with the runway and its environment can be maintained, until the safe completion of the approach and landing.

Flight training and proficiency programme

5.7.8 Each member of the flight crew should be trained to carry out the duties appropriate to the particular airborne system and subsequently demonstrate the ability to carry out the duties, as a member of the flight crew, to an acceptable level of competency as determined by the State of the Operator before being authorized to engage in the particular category of operations. Additionally, before a pilot is authorized to operate to Cat II or III minima, the pilot should have gained experience in using the appropriate procedures in meteorological conditions above the relevant minima. Flight crews should be given practical training and tests in the use of applicable systems and associated procedures in conditions of the lowest minima to be authorized.

5.7.9 Initial training can most effectively be carried out in an approved FSTD with a suitable visual system. The specific type of training will depend upon the particular airborne system and on the operating procedures adopted. The initial training should at least include:

a) approaches with all engines operating, and with an engine inoperative, using the appropriate flight guidance and control systems installed in the aeroplane down to the appropriate minimum height, without external visual reference, followed by transition to visual reference and landings;

b) approaches with all engines operating, and with an engine inoperative, using the appropriate flight guidance and control systems installed in the aeroplane down to the appropriate minimum height, followed by missed approaches, all without external visual reference;

c) approaches utilizing the automatic flight control and landing system, followed by reversion to manual control for flare and landing after disconnecting the automatic system at low level, if appropriate;

d) approaches utilizing the automatic flight control and landing system with automatic flare, automatic landing and, where appropriate, automatic roll-out;

e) procedures and techniques for reversion to instrument flight and the execution of a missed approach from DA/H, including obstacle clearance aspects; and

f) go-around from a height below decision height which may result in a touchdown on the runway in cases of a go-around initiated from a very low altitude, e.g. such as to simulate failures or loss of visual reference prior to touchdown.

Note.— Guidance on FSTD qualification is contained in the Manual of Criteria for the Qualification of Flight Simulation Training Devices *(Doc 9625).*

5.7.10 The flight training programme should provide practice in handling system faults, particularly those which have an effect on the operating minima and/or subsequent conduct of the operation. However, the frequency of system malfunctions introduced should not be such so as to undermine the confidence of flight crews in the overall integrity and reliability of the systems used in low minima operations.

Simulation techniques

5.7.11 Simulation techniques are a valuable training aid for limited visibility operations. FSTDs should be used for general training in the aeroplane system and the operating procedures to be used. However, their real value in training is that different RVR values can be simulated so that pilots, who may rarely encounter limited 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. To provide for missed approach training, it should be possible to simulate visibilities lower than the lowest authorized for the operator. An approved FSTD with a suitable visual system can be used during initial and recurrent training, with various RVR values simulated, for:

a) approaches;

b) missed approaches;

c) landings;

d) relevant drills and procedures after experiencing malfunction of:

   1) the aeroplane system; and

   2) the ground system;

e) transition from instrument to visual flight; and

f) transition from visual to instrument flight at low level.

Note.— Guidance on FSTD qualification is contained in the Manual of Criteria for the Qualification of Flight Simulation Training Devices *(Doc 9625).*

5.7.12 It is most important that the visibility simulated is a correct reflection of the RVR intended. A simple calibration check of the visual system can be made by relating the number of runway centre line lights or runway edge lights which are visible with the simulator aligned for take-off, to the selected RVR. It is preferred, however, that checks also be made of the visual references with the simulator in the flying mode because the static and dynamic visual scenes may differ in some visual systems.

Recurrent proficiency checks

5.7.13 In conjunction with normal pilot proficiency checks at regular intervals, a pilot should demonstrate the knowledge and ability necessary to perform the tasks associated with the authorized category of operation. Due to the low probability of encountering limited visibility conditions during actual operations, the use of an approved FSTD for recurrent training, proficiency checking and renewal of authorizations assumes increased importance.

Recency requirements

5.7.14 Some States actively encourage or require operators and pilots to use procedures developed for Cat II or III operations during normal service, regardless of the weather conditions, and whenever the necessary ground facilities are available and traffic conditions permit. This practice ensures flight crew familiarity with the procedures, builds confidence with the equipment and ensures appropriate maintenance of the Cat II and III related systems. However, it is important to ensure that pilots maintain proficiency in manual flying skills. Experience has shown that this is particularly important where crews are flying a route structure with long stage lengths. Consideration should be given to a recency requirement, i.e. that crews should achieve a minimum number of automatic approaches, or approaches and landing as applicable, each month (or other suitable period) to maintain their Cat II or III qualifications. This recency requirement is in no way a substitute for recurrent training.

Training and qualification for Category II or III operations

Commercial air transportation operations

5.7.15 The training and qualification of flight crew members should be initially accomplished and maintained in accordance with 5.7.5 to 5.7.7, 5.7.8 to 5.7.10, 5.7.13 and 5.7.14. Cat II or III operations by qualified flight crew members can be conducted once the operator has received specific approval as reflected in the appropriate operations specifications as per Annex 6, Part I, Appendix 6.

5.7.16 When a flight crew member becomes fully qualified for Cat II or III operations, the operator should document these qualifications in a manner acceptable to the State of the Operator. The qualifications may be documented by one of several means. For example, the operator could issue a qualification card, which should contain evidence of the recurrent checks of 5.7.13, so that the currency of the flight crew member's qualifications can be easily verified. The qualification card should be carried by the flight crew member when conducting Cat II or III operations. Alternatively, other means of documenting qualifications are acceptable, such as an endorsed pilot logbook, which for verification purposes should be available on board the aircraft either in original form or via copies of the relevant endorsements if the pilot logbook is not carried on board.

General aviation operations

5.7.17 The civil aviation authority should issue a qualification record when satisfied that the general aviation flight crew member is properly trained and has demonstrated the ability to conduct Cat II or III operations to an acceptable level of competency. To maintain currency, recurrent proficiency checks and recency requirements should be conducted in accordance with 5.7.13 and 5.7.14. The qualification record may take the form of a letter of authorization, a logbook endorsement (via copies of relevant endorsements if the pilot logbook is not carried on board), or any other equivalent type of record, and should be available on board the aircraft.

Chapter 6

IMPLEMENTATION OF AERODROME OPERATING MINIMA

6.1 APPROVAL OF METHODS AND COMPLIANCE

6.1.1 In accordance with Annex 6, Part I, 4.2.8.1, the State of the Operator must require that an operator establish aerodrome operating minima. In meeting this Standard, an operator is responsible to the State of the Operator. The State is responsible for the approval of the method used to establish such minima and for supervising compliance with such rules as it may prescribe for the operation as a whole. For the operator to meet the foregoing obligations, the State of the Aerodrome is required to publish data (e.g. OCA/H, precise details of visual and electronic aids, pre-threshold terrain, obstacles) necessary for the operator to determine the appropriate aerodrome operating minima. Recognizing the need for an operator to conform with the rules laid down by its own State, the operator should also account for any restrictions which might be applied by the State of the Aerodrome. The State of the Aerodrome is responsible for the safety of air navigation within its own borders and retains the authority to accept the minima approved by other States for use at its aerodromes. However, this authority should not necessarily be exercised by the determination and imposition of common minima for all operators. The general applicability of such minima would inevitably cause the minima to be unnecessarily restrictive in some conditions and inappropriately permissive in others. The acceptance or rejection by the State of the Aerodrome of minima approved by other States should consider the means by which the minima are derived and should be resolved between the State of the Aerodrome and the State of the Operator.

6.1.2 This chapter considers the documentation which may be used to establish the requirements of the State of the Operator relating to take-off minima, alternate minima and approach/landing minima for all-weather operations, including non-precision approach and landing operations, precision approach and landing operations, Cat II and Cat III, to indicate that those requirements have been met by its operators and to ensure continuing compliance with those requirements. It reflects the practices of States already engaged in all aspects of all-weather operations and contains tables of aerodrome operating minima based on harmonized operating minima used in some States. The need for States to establish basic legislation; specific rules; directives; and explanatory, advisory and informative material is discussed in Chapter 2. Guidance material on the development of a State regulatory system is contained in Doc 8335.

6.1.3 The nature of all-weather operations necessitates a clear presentation of the requirements of the State of the Operator and an agreed-upon means of indicating authorization and approval to achieve full utilization of facilities in international operations. There are five elements involved in the approval of an operation by the State of the Operator:

a) authorization of the aeroplane and its equipment;

b) authorization of the use of the aerodrome;

c) authorization of the flight crew;

d) authorization of the operation; and

e) authorization of minima.

Authorization of the aeroplane and its equipment

6.1.4 Authorization of the aeroplane and its equipment should be indicated by appropriate entries in the flight manual and the operations manual. Any limitations or procedures necessary for the safe use of the system should be identified, including but not limited to:

a) the DA/H or MDA/H limitations and any other relevant aerodrome operating minima with which the authorization is associated;

b) the minimum airborne equipment required before an approach in limited visibility conditions may be planned and carried out;

c) the equipment operating procedures such as use of the automatic flight control and automatic landing systems, if installed, and use of the flight instrument systems, system operating sequences, etc.;

d) detailed performance data relevant to the approach procedure which may differ from or be additional to normal aircraft certification data, such as loss of height during the missed approach procedure; and

e) any other factors affecting the use of the aeroplane in limited visibility conditions, such as the procedures to be followed if the aeroplane's climb performance after take-off or during a missed approach is seriously reduced with an engine inoperative.

Authorization of the use of the aerodrome

6.1.5 There are national differences in the manner in which States ensure that their operators make proper allowance for the facilities available at an aerodrome when establishing operating minima. Some States carry out an inspection of the aerodromes used by their operators and give explicit approval for the appropriate minima, and some States delegate this responsibility to their operators by requiring them to fully account for the facilities available at the aerodrome they intend to use. In either case, it should be expected that:

a) the State of the Aerodrome authorizes use of the facilities and services only if they meet the relevant ICAO specifications;

b) the appropriate OCA/H is published by the State of the Aerodrome; and

c) where the State of the Aerodrome has established an aerodrome operating minima policy and published landing and take-off minima in the AIP, the minima authorized for the use of an operator by the State of the Operator are not lower than the former, except where specifically authorized by the State of the Aerodrome. The operator should review the AIP to determine how instrument approach procedures are constructed, e.g. PANS-OPS (Doc 8168), Volume II or US TERPS. In all cases, the operator should ensure that the instrument approach procedure is compatible with the type of aircraft being flown.

6.1.6 To facilitate these procedures, it is essential that up-to-date information be available on the facilities and procedures in use at each aerodrome. The State of the Aerodrome should promulgate this information through its aeronautical information service.

Authorization of the flight crew

6.1.7 In fulfilling the requirements of Annex 6, Parts I and II, the State of the Operator should ensure, either directly or by delegated authority, that flight crews and individual flight crew members are qualified to operate to the applicable aerodrome operating minima.

6.1.8 Annex 1 and Annex 6, Part I, require that:

a) the pilot-in-command and co-pilot each hold an instrument rating as prescribed in Annex 1 and meet the requirements for recent experience established by the State issuing the rating;

b) flight crew members are qualified and trained for take-off, instrument approaches and operations to the lowest Cat I operations minima, as described in Chapter 4, 4.3, and, where required for low-visibility take-off and Cat II or III operations, as described in Chapter 5, 5.7;

c) flight crew members have completed all required proficiency checks, including demonstration of proficiency using the relevant types of instrument approaches; and

d) the pilot-in-command has the necessary experience in the aeroplane type with restricted (higher) minima before being authorized to use the lowest approved minima.

6.1.9 The operator should maintain a system of records to ensure that the necessary qualifications of the flight crew members are being met on a continuing basis.

Authorization of the operation

6.1.10 The precise method by which specific approvals are granted by the State of the Operator for operations in limited visibility conditions and the method by which compliance with established rules is monitored may vary from State to State but should follow a basic sequence. The authorization procedure will normally follow this sequence:

a) application by the operator;

b) examination of the application by the appropriate authority of the State of the Operator;

c) issuance of a specific approval by the State of the Operator; and

d) continuing supervision of the operator to ensure compliance.

Note.— Doc 8335 describes the above procedure in detail and should be consulted for guidance.

6.1.11 As a minimum, the State of the Operator should ensure that the operator has established:

a) sufficient aerodrome operating minima for the use of flight crews for all types of approaches to all aerodromes to be used in the operations;

b) the proficiency of flight crews;

c) operating procedures;

d) operations manual instructions appropriate to the operation and that reflect the mandatory procedures and/or limitations contained in the flight manual; and

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

6.1.12 The operator may be authorized to carry out operations in limited visibility by the issue of a specific approval indicating the aerodrome operating minima which may be applied.

6.2 AERODROME OPERATING MINIMA

Introduction

6.2.1 Aerodrome operating minima are usually expressed as a minimum altitude or height and a minimum visibility or RVR. For take-off, they are an indication of the minimum visibility or RVR conditions in which the pilot of an aeroplane may be expected to have available the external visual reference required for the control of the aeroplane along the surface of the runway until it is airborne or until the end of a rejected take-off. For approach and landing, they are an expression of the minimum altitude or height by which the specified visual reference should be available and at which the decision to continue for landing or to execute a missed approach should be made. They are also an indication of the minimum visibility in which the pilot may have the visual information necessary for continued control of the flight path of the aeroplane during the visual phase of the approach, landing and roll-out.

6.2.2 Minimum visibility values are primarily used in association with regulations that address the commencement and continuation of an approach. The minimum visibility specified by a State of the Operator, the operator or in some instances a State of the Aerodrome may be used to prohibit commencement or continuation of an instrument approach or prohibit take-off if visibility is less than a specified value.

6.2.3 The combination of instrument information and visual references required for making the land/missed approach decision varies with the type of operation and can be classified as follows:

a) For other than Cat III operations, a view of the visual aids or of the runway or of a combination of the two, which, when combined with the speed, height and, where appropriate, glide path information provided by the flight instruments, will enable the pilot to assess the aeroplane's position and its progress relative to the desired flight path during the transition from the instrument phase to the visual phase of the approach and during the subsequent descent to a landing. The pilot should be able to identify the centre line of the approach, e.g. should have a lateral reference such as a crossbar on the approach lights or the landing threshold. In order to control the descent path, the pilot should be able to see the touchdown area on the runway. In general where the certified capability of the airborne and ground systems is greater, there is less need for visual references.

Note.— For operations where "see to land" is applicable, the position of the aircraft relative to the runway should be verified by one or more of the following visual references:

1) elements of the approach lighting system;

2) threshold;

3) threshold markings;

4) threshold lights;

5) threshold identification lights;

6) visual glide slope indicator;

7) touchdown zone or touchdown zone markings;

8) touchdown zone lights;

9) runway edge lights; or

10) other visual references accepted by the authority.

b) For Cat III operations with DA/H (e.g. fail-passive operations), the requirement is for a view of runway touchdown zone lighting or markings which will give visual confirmation of the on-board system indications that the aeroplane has been delivered accurately to the touchdown area of the runway and that a landing may safely be carried out.

c) For Cat III operations conducted either with fail-passive flight control systems or with the use of an approved head-up display landing system (HUDLS) not having roll-out guidance capability, a decision height is required.

d) For fail-operational Cat III operations, without decision height, there is generally no requirement for visual references for touchdown. There are, however, RVR requirements established to ensure safety during landing roll-out and surface movement.

e) For Cat III operations with fail-operational flight control systems or fail-operational capability using HUDLS with roll-out capability, a decision height is not required.

6.2.4 There is considerable agreement on the principles involved in the determination of aerodrome operating minima by those States having experience in low-visibility operations. In current operations, the aerodrome operating minima in use among States are remarkably similar for a particular aircraft and level of airborne equipment. The principles applied by States have enabled the development of the tables of applied minima contained in this chapter. They are based on a thorough international harmonization process between European States, represented in the European Aviation Safety Agency (EASA), and the United States and are published in EASA Certification Specifications and Federal Aviation Administration (FAA) Regulations. These tables are intended for use as guidance to States of the Operator in the supervision of their operators in the determination of aerodrome operating minima. They are not intended to be taken as absolute values, and the determination of lower values by a State is not precluded if such values result in an acceptable level of safety. Additionally, it is not intended that these values will be approved for an operator’s use at DA/H below the relevant OCH value published by the State of the Aerodrome or below any other restricting minimum values that States may apply.

States’ harmonization efforts

6.2.5 In the mid-1990s, several European States and the FAA formed working groups for the development and implementation of harmonized aerodrome operating minima. The aim was to establish a set of minima covering those approach procedures, which today are called non-precision, APV, and precision instrument approach procedures, with minima down to as low as 60 m (200 ft). The harmonization work was based upon the nominal relationship between the height above threshold (HATh) and the required RVR/visibility to specify necessary visual reference, taking account of the length of the approach lights provided. The minima should ideally be predicated upon the geometric relationship between HATh for the particular approach aid or system and the horizontal distance to the first element of the facility (in the direction of the approach) that forms part of the specified visual reference.

6.2.5.1 The default vertical path angle for the calculation is increased in increments of 0.10 degrees with each “height band” shown in Table 6-3 until reaching the upper default value of 3.77 degrees (400 ft/NM). This reflects the probability of having higher approach angles with higher MDH/DH. It is important to emphasize that this does not have a direct operational connection to instrument approach procedures designed with vertical guidance where the descent angle typically ranges from 2.75 to 3.5 degrees.

Tables of aerodrome operating minima

6.2.6 Operating minima cannot be derived without considering:

a) aircraft equipage;

b) navigation aid capability;

c) the sophistication of the aerodrome infrastructure such as lights and markings;

d) the role of ATS and/or the facility's maintenance personnel in monitoring the navaid and protecting critical and sensitive areas, etc.; and

e) the operating policies, procedures and instructions imposed by the State of the Operator.

The tables of operating minima below have significance only in conjunction with a set of operating policies, procedures and instructions. Since all of these factors are essential in determining operating minima, such policies are specified by the State of the Operator and vary widely. It should be emphasized that determination of operating minima solely by the State of the Operator or by the State of the Aerodrome could lead to confusion and inconsistencies. The tables of operating minima in this manual are intended to provide for standardized application and contain values of minima which are commonly acceptable to several States. They are not necessarily absolute values but have been shown to maintain safety without adversely affecting operations. The values of minima are given in units prescribed by Annex 5 — *Units of Measurement to be Used in Air and Ground Operations*. It is recognized that reduced visibility may be caused by different factors (fog, blowing snow, dust, heavy rain, etc.) and that the values in these tables may not be universally appropriate. States may accept values of operating minima which are lower than those in the tables if they are satisfied that the safety of operation can be maintained. Conversely, it is not intended that these values will be approved for an operator's use in those cases where the State of the Aerodrome has established higher values, unless specifically authorized by that State.

6.3 TAKE-OFF MINIMA

6.3.1 Take-off minima are usually stated as visibility or RVR limits. Where there is a specific need to see and avoid obstacles on departure, take-off minima may include cloud base limits. Where avoidance of such obstacles may be accomplished by alternate procedural means, such as use of climb gradients or specified departure paths, cloud base restrictions need not be applied. Take-off minima typically account for factors such as terrain and obstacle avoidance, aircraft controllability and performance, visual aids available, runway characteristics, navigation and guidance available, non-normal conditions such as engine failure, and adverse weather including runway contamination or winds.

6.3.2 The take-off minima shown in Table 6-1 are appropriate for most international operations. Use of these minima is based on the following factors:

a) flight characteristics and cockpit instrumentation typical of multi-engine turbine aircraft;

b) comprehensive programmes for crew qualification which address use of the specified minima;

c) comprehensive programmes for airworthiness, with any necessary equipment operational (MEL);

d) availability of specified facilities for the respective minima, including programmes for assurance of the necessary reliability and integrity;

e) availability of ATS to ensure separation of aircraft and timely and accurate provision of weather, NOTAM and other safety information;

f) standard runway and airport configurations, obstruction clearance, surrounding terrain, and other characteristics typical of major facilities serving scheduled international operations;

g) routine low-visibility weather conditions (e.g. fog, precipitation, haze, wind components) which do not require special consideration; and

h) availability of alternate courses of action in the event of emergency situations.

Table 6-1. Examples of approved take-off minima
(Commercial transport aeroplanes)

Facilities	*RVR/VIS[1]*
Adequate visual reference[2] (day only)	500 m/1 600 ft
Runway edge lights or runway centre line markings[3]	400 m/1 200 ft
Runway edge lights and runway centre line markings[3]	300 m/1 000 ft
Runway edge lights and runway centre line lights	200 m/600 ft
Runway edge lights and runway centre line lights and relevant RVR information[4]	TDZ 150 m/500 ft MID 150 m/500 ft Stop-end 150 m/500 ft
High intensity runway edge lights and runway centre line lights (spacing 15 m or less) and relevant RVR information[4]	TDZ 125 m/400 ft MID 125 m/400 ft Stop-end 125 m/400 ft
High intensity runway edge lights and runway centre line lights (spacing 15 m or less), approved lateral guidance system and relevant RVR information[4]	TDZ 75 m/300 ft MID 75 m/300 ft Stop-end 75 m/300 ft

1. The TDZ RVR/VIS may be assessed by the pilot.
2. Adequate visual reference means that a pilot is able to continuously identify the take-off surface and maintain directional control.
3. For night operations, at least runway edge lights or centre line lights and runway end lights are available.
4 The required RVR is achieved for all relevant RVRs.

6.3.3 Take-off minima, which are relevant to the take-off manoeuvre itself, should not be confused with weather minima required for flight initiation. For flight initiation, departure weather minima at an aerodrome should not be less than the applicable minima for landing at that aerodrome unless a suitable take-off alternate aerodrome is available. The take-off alternate aerodrome should have weather conditions and facilities suitable for landing the aeroplane in normal and non-normal configurations pertinent to the operation. In addition, in the non-normal configuration the aeroplane should be capable of climbing to, and maintaining, altitudes which provide suitable obstacle clearance and navigation signals en route to a take-off alternate aerodrome. The take-off alternate aerodrome should be located within the following distances of the aerodrome of departure:

a) aeroplanes with two engines: one hour of flight time at a one-engine-inoperative cruising speed, determined from the aircraft operating manual, calculated in international standard atmosphere (ISA) and still-air conditions using the actual take-off mass; or

b) aeroplanes with three or more engines: two hours of flight time at an all-engine operating cruising speed, determined from the aircraft operating manual, calculated in ISA and still-air conditions using the actual take-off mass; or

c) aeroplanes engaged in extended diversion time operations (EDTO): where an alternate aerodrome meeting the distance criteria of a) or b) is not available, the first available alternate aerodrome located within the distance of the operator’s approved maximum diversion time considering the actual take-off mass.

Note.— To be “engaged in EDTO operations” means that the aircraft and operator have been approved for EDTO operations and the aircraft has been dispatched in accordance with applicable EDTO requirements. Refer to Appendix D for a table of alternate minima values.

6.4 2D INSTRUMENT APPROACH OPERATIONS

Introduction

6.4.1 In VOR, LOC, NDB or RNAV without approved vertical guidance[1] approach procedures, track guidance is provided, but vertical path information is not typically available unless the VNAV function of the FMS is used as advisory information. The term “non-precision” was originally used to describe the relative imprecision and lack of vertical guidance available as compared with ILS approaches. However, these terms are becoming less appropriate since it is considered that all instrument approaches need to be flown precisely, and in many cases, the on-board RNAV system provides vertical guidance that can be used as advisory vertical navigation information on a traditionally designed “non-precision” approach.

6.4.2 The errors in position that may occur at MDA/H may be larger than those that would occur in an ILS/MLS/GLS/SBAS approach procedure due to the characteristics of the track guidance and the selected rate of descent. If not using an RNAV instrument approach procedure designed with vertical guidance[2], a larger visual manoeuvre may be necessary in order to successfully complete the approach and landing. These considerations and the need to satisfy associated obstacle clearance requirements result in generally higher operating minima for non-precision approach procedures and 2D instrument approach operations than for precision/APV approach procedures and 3D instrument approach operations. The criteria for obstacle clearance for approach procedures are contained in PANS-OPS (Doc 8168), Volume II.

The height element of approach minima for 2D instrument approach operations

6.4.3 The height element in the minima of a VOR, LOC, NDB or an RNAV approach procedure designed without vertical guidance is the MDA/H. It is the altitude/height below which the aeroplane should not descend unless the runway environment, i.e. the runway threshold, touchdown area, elements of the approach lighting or markings identifiable with the runway, is in sight and the aeroplane is in a position for a normal visual descent to land.

1. RNAV with LNAV or LP.
2. RNAV with LNAV/VNAV or LPV.

6.4.4 The MDA/H is based upon the OCA/H. It may be higher than, but never lower than, the OCA/H. The method of determining the OCA/H is given in PANS-OPS (Doc 8168), Volume II, and the relationship between MDA/H and OCA/H is illustrated in PANS-OPS, Volume I, for VOR, LOC, NDB or RNAV instrument approach procedures that were not designed with vertical guidance having a straight-in final approach segment, and for approaches leading to visual circling of the aerodrome prior to landing. Circling minima are normally higher than those for straight-in approaches.

The visibility element of approach minima for 2D instrument approach operations

6.4.5 The minimum visibility required for the pilot to establish visual reference in time to descend safely from the MDA/H and continue to land will vary with the aeroplane category, the MDA/H, the facilities available, and whether a straight-in or circling approach is used. In general, the minimum visibility required will be less for:

a) aeroplanes having slow approach speeds;

b) lower MDA/H; and

c) better visual aids.

Some States will authorize lower visibility minima if the procedure is flown utilizing a CDFA technique instead of a level flight segment at MDA.

6.4.6 The application of these criteria by States results in visibility minima for non-precision approach and landing operations varying from 5 km to 750 m. The wide range of these minima is a consequence of the large number of factors and situations that affect the visibility requirement.

Circling approach minima

6.4.7 The MDA/H for a visual circling approach is based on the highest OCH for a specified category of aeroplane promulgated for the final and missed approach used to enter into the circling area and the OCH of the circling area itself. The minimum visibility for a circling approach should be that associated with the applicable category of aircraft as shown in Table 6-2. The visibility values for circling minima given in this table are examples of commonly accepted operating minima and should not be confused with the visibility values given in PANS-OPS (Doc 8168) design criteria for visual manoeuvring (circling). Some States impose a minimum RVR of not less than 800 m for landing from a visual approach even if the pilot expects that the visual reference will be maintained. This may prevent visual approaches from being carried out with subsequent loss of visual reference in the flare.

6.4.8 The circling areas are based on arcs measured from runway thresholds and connected by tangents. The radii of the arcs are calculated based on airport elevation and maximum IAS values for aircraft categories A, B, C and D. Previously, significant differences existed in the applied criteria between procedures designed in accordance with ICAO PANS-OPS (Doc 8168) and US TERPS (FAA Directive No 8260.3B) which resulted in markedly larger circling areas for PANS-OPS-designed procedures than for procedures designed in accordance with US TERPS criteria. A change to US TERPS circling criteria gives directives to increase circling radii dimensions as the circling MDA increases. This increase in radii size with higher MDAs accounts for greater true airspeeds and adverse wind gradients encountered at higher mean sea level (MSL) altitudes. Despite the changes of the US TERPS circling criteria, the radii of the circling areas used in PANS-OPS are still larger than those used in US TERPS due to the different methods applied for TAS calculation and different bank angles used in PANS-OPS and US TERPS.

Table 6-2. Example of minimum visibility, max IAS and lowest MDH for circling versus aeroplane category

	Aeroplane Category			
	A	*B*	*C*	*D*
Max IAS (kt)[1]	100	135	185	205
MDH (ft)	400	500	600	700
Minimum meteorological visibility (m)[2]	1 500	1 600	2 400	3 600

1. As per PANS-OPS, Volume I (Doc 8168).
2. These circling approach visibility values differ from those in PANS-OPS, Volume I (Doc 8168) since the visual manoeuvring (circling) approach values in Table I-4-7-3 of Doc 8168 are not intended for establishment of operating minima.

Notes.—

1. Minimum descent height (MDH). The MDH for circling should be the higher of:

   a) the published circling OCH for the aeroplane category; or
   b) the minimum circling height derived from Table 6-2; or
   c) the DH/MDH of the preceding instrument approach procedure.

2. The MDA for circling must be calculated by adding the published aerodrome elevation to the MDH, as determined by 1. above.

3. Visibility. The minimum visibility for circling should be the higher of:

   a) the circling visibility for the aeroplane category, if published; or
   b) the minimum visibility derived from Table 6-2; or
   c) the RVR minima for the preceding instrument approach procedure.

6.5 3D INSTRUMENT APPROACH OPERATIONS

General

6.5.1 Three-dimensional (3D) instrument approach operations are executed using both lateral and vertical navigation guidance. The lateral and vertical guidance can be provided by ground-based radio navigation aid or computer-generated navigation data from ground-based, space-based, self-contained navigation aids or a combination of these. The two types of instrument approach procedures that are flown with a 3D operation are precision approach procedure (PA) and approach procedure with vertical guidance (APV). The aerodrome operating minima for 3D instrument approach operations are expressed in terms of visibility and/or RVR and DA/H. APV are PBN approach procedures designed for 3D instrument approach operations Type A (DH at or above 75m (250 ft)). Precision approach procedures are instrument approach procedures based on navigation systems (ILS, MLS, GLS, SBAS Cat I) and can be either Type A or Type B (DH below 75 m (250 ft)).

APV

6.5.2 The emergence of APV, based on the use of the on-board FMS navigation computer and stand-alone SBAS, is one of the reasons for the change to performance-based approach classification. As the on-board area navigation system is the primary navigation system, the title of the approach chart is RNP approach. There are two variants of vertical navigation:

a) those based on barometric altitude, i.e. LNAV/VNAV; and

b) those based on SBAS (LPV).

6.5.3 Barometric vertical navigation (BARO-VNAV) is a navigation system that presents to the pilot computed vertical guidance referenced to a specified vertical path angle (VPA), nominally 3 degrees. The computer-resolved vertical guidance is based on barometric altitude and is specified as a VPA from reference datum height (RDH).

6.5.4 By enabling a guided, stabilized descent to landing, APV/BARO-VNAV approach procedures provide a greater margin of safety than do 2D approach operations. They are particularly relevant to the operation of large commercial jet transport aircraft for which they are considered safer than the basic technique of an early descent to, and level-off at, minimum altitudes.

6.5.5 APV/BARO-VNAV approach procedures are classified as 3D instrument approach operations (see Annex 6). Such procedures are promulgated with a DA/H. They should not be confused with classical NPA procedures or 2D instrument approach operations that have an MDA/H below which the aircraft must not descend.

6.5.6 The APV minimum DH is 75 m (250 ft) plus a height loss margin.

Note 1.— Equipment specifications and a complete description of APV/BARO-VNAV approach procedures may be found in Doc 8168, Volume II.

Note 2.— The equipment requirements for specific navigation specifications are identified in Doc 9613, Volume II, Part C.

Standard Category I operations

6.5.7 A standard Cat I operation is a 3D Type B instrument approach operation to a decision height not lower than 60 m (200 ft) and with either a visibility not less than 800 m or an RVR not less than 550 m. Cat I operations are flown only on precision instrument approach procedures (ILS, MLS, GLS and SBAS Cat I).

Decision altitude/height

6.5.8 The DA/H for a 3D instrument approach operation should not be lower than:

a) the minimum height stated in the aeroplane airworthiness certification or operating requirements to which the aeroplane can be flown solely by reference to instruments;

b) the minimum height to which the approach aid or position-fixing system may be used solely by reference to instruments (refer to Appendix F for minimum heights for different systems);

c) the OCH; or

d) the DA/H to which the flight crew is permitted to operate.

A DA/H higher than the minimum stated above may be established where abnormal conditions prevail or are likely to be encountered. The following paragraphs discuss some of the effects on DA/H of aeroplane geometry, aeroplane performance, offset final approach course and atmospheric turbulence.

6.5.9 In some cases there are runways where the ILS/MLS/GLS/LPV reference datum height is less than the recommended 15 m (50 ft). In such cases it may be necessary to adjust visibility/RVR minima and ensure that flight crews are trained to provide adequate wheel clearance over the threshold. Where there is a displaced threshold or there is adequate under-run of sufficient strength available, there is no need for additional visibility/RVR. This situation should be clearly depicted on the approach chart.

6.5.10 An increase in DA/H may be required when an approach is carried out with an engine inoperative. A greater than normal height loss is likely to occur at the initiation of a go-around as the landing gear and flaps are retracted. DA/H in this case should not be lower than any height contained in the aeroplane flight manual or equivalent document which indicates the minimum height for committal to a landing following an approach with an engine inoperative.

6.5.11 When using an offset final approach course, the aeroplane will be displaced laterally from the extended runway centre line. Therefore, the DA/H is set high enough to permit a visual lateral alignment manoeuvre to be completed before reaching the landing threshold. Additional altitude will need to be added to the approach minima to allow for this manoeuvre.

6.5.12 A DA/H higher than the minimum may also be established where it is known that abnormal flight conditions are likely to be met. For example, if it is known that topographical features in a particular runway environment frequently produce downdraughts in the approach area, then the DA/H may be increased by 15 m (50 ft) or more for propeller-driven aeroplanes and by 30 m (100 ft) or more for turbo-jet aeroplanes; a larger increment may be used if the downdraught is likely to be severe. PANS-OPS, Volume II, advises to increase the MOC by as much as 100 per cent in areas of mountainous terrain where adverse meteorological effects may exist. The increase of the MOC will also result in an increase of the OCH, which is the basis for the calculation of the DA/H and the visibility/RVR minima.

Runway visual range (RVR)/visibility

6.5.13 The minimum weather conditions in which the pilot may be considered to have the visual references required at and below DA/H may be specified either as an RVR or as a visibility. An additional parameter used by some States is the lowest cloud base. However, these are values measured on the ground and not one or a combination of them can indicate with accuracy whether or not the pilot will have the required visual reference when reaching DA/H, due to a number of factors. For example, RVR is measured horizontally at the runway but the pilot will normally be looking along a slant path at approach lights from a position some distance from the runway. If the visibility is reduced by fog, it is likely that it will be less dense at ground level than above ground level and slant visibility will probably be less than the horizontal visibility at ground level. When visibility is reduced by snow or blowing dust, the slant visibility may be less than horizontal visibility due to the lack of contrast between the approach lighting and the snow-covered ground or the lack of contrast in ground texture seen through dust. Conversely, there may be cases, such as in shallow fog, where the slant visual range is greater than horizontal visibility during the earlier phases of an approach. Visibility is less likely than RVR to be representative of the slant visibility seen by a pilot, since it is often measured at some distance from the runway and possibly in a direction different from the orientation of the runway. In general, there is a difference between a measured visibility and the RVR. Part of the transmissometer's measurement is the effect of the lighting setting and the background luminance, which is not the case when a visibility is reported. The effect of these differences is tabulated and explained in Appendix E. Annex 3 requires that instrumented systems based on transmissometers or forward-scatter meters be used to assess RVR on runways intended for Cat II and III instrument approach and landing operations.

Note.— Annex 3 further provides the following information concerning the use of transmissometers and forward-scatter meters. "Since accuracy can vary from one instrument design to another, performance characteristics are to be checked before selecting an instrument for assessing runway visual range. The calibration of a forward-scatter meter has to be traceable and verifiable to a transmissometer standard, the accuracy of which has been verified over the intended operational range. Guidance on the use of transmissometers and forward-scatter meters in instrumented runway visual range systems is given in the Manual of Runway Visual Range Observing and Reporting Practices *(Doc 9328)."*

6.5.14 A measurement of cloud base may not provide an accurate indication of the height at which a pilot will acquire visual contact with the ground for a number of reasons:

a) the measurement is unlikely to be taken underneath the position of the glide path where the pilot establishes visual contact;

b) the cloud base may be uneven;

c) the position on the glide path may coincide with a break in the clouds; and

d) the distance that a pilot can see while still in cloud will vary with the thickness of the cloud and the visibility below the cloud.

6.5.15 To sum up, the difference between the distance that a pilot can see from a position on the approach and the measurements made on the ground is a variable that can only be expressed in statistical terms, and no specific relationship for a particular approach can therefore be established. Nevertheless, there is still a need to determine minima that produce values that give a high probability that the pilot will see enough, at and below DA/H, to carry out the task. There is also a need to specify the minimum visual reference required for descent below DA/H.

6.5.16 The distance that a pilot needs to be able to see in order to have an adequate visual reference in sight at and below DA/H depends on the eye position in space relative to the visual aids on the ground, the extent to which the view forward and downward is restricted by the aeroplane structure, and the type of visual aids. With a higher DA/H and larger aeroplane, the pilot's eyes will be higher above the ground and greater visibility will be required to achieve an acceptable visual segment; conversely a better downward view over the nose and longer approach lighting system (ALS) will require less visibility.

6.5.17 Some visual factors tend to cancel each other out. For example, in large aeroplanes the pilot eye height above the main landing gear wheels is generally great; this undesirable feature is generally compensated for by equipping the aeroplane with accurate automatic approach equipment, which makes the pilot's task easier in poor visibility and by designing the flight deck to provide the pilots with a good forward and downward view. In small aeroplanes the pilot eye height above the wheels is generally small. This desirable feature may be offset by a relatively poor forward and downward view provided to the pilots and/or the lack of accurate automatic approach equipment. As a rule, the minimum RVR for a Cat I operation by large aeroplanes using automatic equipment will be the same as for small to medium-sized aeroplanes that are flown manually. A greater RVR may be required for manual operation of large aeroplanes with high approach speeds.

6.5.18 Although the ICAO standard ALS for a runway using ILS or MLS is 900 m long, there are some runways where there are lighting systems less than 900 m in length or no ALSs because it is physically impossible to install them. The length and character of the approach lighting will have a significant effect on the visibility minima. For example, at a height of 60 m (200 ft) on a three-degree glide slope, the touchdown zone is about 1 100 m ahead of the aeroplane. If there is no approach lighting, the required RVR would need to be greater than 1 200 m to give the pilot an adequate view of the touchdown zone. Conversely, with full approach, touchdown zone, runway threshold, edge, and centre line lighting, sufficient visual information may be available at and below DA/H with RVRs as low as 550 m to enable the pilot to continue the approach using a combination of instrument and visual information. Therefore, the RVR values as given in Table 6-3 take the length of the ALS into account as part of the formula for the derivation of the RVR.

6.5.19 Table 6-3 contains an example of the lowest straight-in approach minima which can be used for any instrument approach and landing operation other than Cat II or Cat III. It must be emphasized that these are non-mandatory examples that some States use but operators must adhere to the minima promulgated by the State of the aerodrome.

6.5.20 In order to qualify for the lowest allowable values of RVR detailed in Table 6-3 (applicable to each approach grouping), the instrument approach procedures should be flown as a 3D approach and landing operation and need to meet at least the following facility requirements and associated conditions:

a) precision or APV instrument approach procedures with a designated vertical profile which do not require a rate of descent greater than 5 m/s (1 000 ft per minute), unless other approach angles are approved by the authority;

b) non-precision instrument approach procedures flown using the CDFA technique with a nominal vertical profile which do not require a rate of descent greater than 5 m/s (1 000 ft per minute), unless other approach angles are approved by the authority, where the facilities are NDB, NDB/DME, VOR, VOR/DME, LOC, LOC/DME, VDF, SRA or RNAV/LNAV, with a final approach segment of at least 3 NM, which also fulfil the following criteria:

   1) the final approach track is offset by not more than 15 degrees for Cat A and B aeroplanes or by not more than 5 degrees for Cat C and D aeroplanes; and

   2) the FAF or another appropriate fix where descent is initiated is available, or distance to THR is available by FMS/RNAV or DME; and

   3) if the MAPt is determined by timing, the distance from FAF to THR is less than 8 NM.

Note.— The limiting approach path angle for Cat A and B aeroplanes would be 4.5 degrees and 3.77 degrees for Cat C and D aeroplanes (see 6.2.5.1).

6.5.21 An RVR as low as 550 m as indicated in Table 6-3 may be used for:

a) Cat I operations to runways with FALS (see Appendix B), runway touchdown zone lights (RTZL) and runway centre line lights (RCLL); or

b) Cat I operations to runways without RTZL and RCLL when using an approved HUDLS, or equivalent approved system, or when conducting a coupled approach or flight-director-flown approach to the DH.

6.5.22 Values in Table 6-3 exceeding 1 500 m (Cat A and B aircraft) or 2 400 m (Cat C and D aircraft) do not have to be applied if:

a) the instrument approach operation is based on precision or APV instrument approach procedure; or

b) if the approach operation is based on NDB, NDB/DME, VOR, VOR/DME, LOC, LOC/DME, VDR, SRA and RNAV without approved vertical guidance but fulfilling the criteria in 6.5.20.

6.5.23 Values in Table 6-3 which are less than 1 000 m may not be applied if the approach operation is based on NDB, NDB/DME, VOR, VOR/DME, LOC, LOC/DME, VDF, SRA and RNAV without approved vertical guidance if:

a) the criteria in 6.5.20 are not fulfilled; or

b) the DH or MDH is 400 m (1 200 ft) or higher.

Table 6-3. Example of the lowest approved straight-in approach minima for instrument approach and landing operations other than Cat II or Cat III

			Class of lighting facility			
			FALS	*IALS*	*BALS*	*NALS*
			RVR (metres)			
DH or MDH (ft)			*See 6.5.2.1 for RVR < 750 m*			
200	–	210	550	750	1 000	1 200
211	–	220	550	800	1 000	1 200
221	–	230	550	800	1 000	1 200
231	–	240	550	800	1 000	1 200
241	–	250	550	800	1 000	1 300
251	–	260	600	800	1 100	1 300
261	–	280	600	900	1 100	1 300
281	–	300	650	900	1 200	1 400
301	–	320	700	1 000	1 200	1 400
321	–	340	800	1 100	1 300	1 500
341	–	360	900	1 200	1 400	1 600
361	–	380	1 000	1 300	1 500	1 700
381	–	400	1 100	1 400	1 600	1 800
401	–	420	1 200	1 500	1 700	1 900
421	–	440	1 300	1 600	1 800	2 000
441	–	460	1 400	1 700	1 900	2 100
461	–	480	1 500	1 800	2 000	2 200
481	–	500	1 500	1 800	2 100	2 300
501	–	520	1 600	1 900	2 100	2 400
521	–	540	1 700	2 000	2 200	2 400
541	–	560	1 800	2 100	2 300	2 500
561	–	580	1 900	2 200	2 400	2 600
581	–	600	2 000	2 300	2 500	2 700
601	–	620	2 100	2 400	2 600	2 800
621	–	640	2 200	2 500	2 700	2 900
641	–	660	2 300	2 600	2 800	3 000
661	–	680	2 400	2 700	2 900	3 100
681	–	700	2 500	2 800	3 000	3 200
701	–	720	2 600	2 900	3 100	3 300
721	–	740	2 700	3 000	3 200	3 400
741	–	760	2 700	3 000	3 300	3 500
761	–	800	2 900	3 200	3 400	3 600
801	–	850	3 100	3 400	3 600	3 800
851	–	900	3 300	3 600	3 800	4 000
901	–	950	3 600	3 900	4 100	4 300
951	–	1 000	3 800	4 100	4 300	4 500
1 001	–	1 100	4 100	4 400	4 600	4 900
1 101	–	1 200	4 600	4 900	5 000	5 000
1 201 and above			–	5 000	5 000	5 000

Lower than the standard Category I operations

6.5.24 In order to provide benefits and create incentives for improved system equipage, some States have implemented procedures which emphasize the use of in-flight automation systems and highly accurate and reliable ground equipment to allow all-weather operations with reduced approach and/or runway lighting as an alternative to the standard lighting systems described in Annex 14, Volume I. Operations which require the use of approved autoland, HUD or coupled autopilot to a specific altitude help to reduce pilot workload and ease the transition from instrument to visual cues at runways with reduced approach and/or runway lighting systems. A requirement for increased ground equipment accuracy and integrity, as well as protection of the critical and sensitive areas, is necessary to support autoland operations. Lower than the standard Cat I operations are allowed in order to make maximum use of technological advances in airborne and ground equipment. Strict conditions should be adhered to in the field of equipment and operations. Historically, Cat I rated ILS equipment only supported low-visibility operations with positioning guidance to approximately 60 m (200 ft) above the threshold. Some States are supplementing Cat I rated ILS equipment with advanced aircraft avionics to go below 60 m (200 ft) above the threshold. An example is provided in 6.5.25.

6.5.25 Some States have implemented a special authorization Cat I ILS approach that has a decision height of 50 m (150 ft) and RVR 450 m. Even though it is below the ICAO-defined DH for Cat I (60 m or 200 ft), these States consider it a Cat I approach since it is flown on a Cat I ILS and associated ground infrastructure. The lower DH is mitigated by requiring the use of a Cat II approved HUD to DH, radio altimeter minima, and special aircrew and aircraft authorization and training. Since autoland is not allowed for this operation, protection of the critical and sensitive areas is only required to Cat I Standards.

6.6 STANDARD CATEGORY II OPERATIONS

Introduction

6.6.1 Standard Cat II operations are made to a DA/H below 60 m (200 ft), but not lower than 30 m (100 ft), with associated RVRs ranging from 550 m to 300 m. In order to obtain the maximum benefit from improvements in ground facilities, it is important to take into account all of the factors that might enable a safe reduction in minima (the use of automatic approach equipment in the aeroplane, a suitable HUD, etc.) The factors considered in 6.6 for Cat I operations are generally applicable to Cat II operations.

Decision height

6.6.2 The DH specified for a Cat II operation will normally be the OCH promulgated for the procedure but will not be less than 30 m (100 ft). Three methods for calculating the OCH are given in PANS-OPS (Doc 8168), Volume II. In general, a more comprehensive assessment will allow a lower OCH for a given obstacle environment. If an aerodrome is located in an area with a large number of obstacles, the use of the ICAO collision risk model (CRM) will facilitate obstacle assessment. If an aerodrome is located in an area where relatively few obstacles dictate that the DH should be in excess of 30 m (100 ft), removal of the obstacles to permit the lowering of the DH to 30 m (100 ft) should be considered. Except in unusual circumstances, such as with irregular underlying terrain, DHs are based on radio altimeter information.

Runway visual range (RVR)/visibility

6.6.3 The RVRs specified for Cat II operations consider that the first visual contact typically is made with the approach lighting system and that by the time the aeroplane has descended to 15 m (50 ft) the TDZ should clearly be in view. Although manual Cat II operations may be authorized, Cat II operations are normally carried out coupled. In addition, some large aeroplanes may use automatic landing equipment. Where use is made of other than standard Cat II RVR values, the use of an autoland system or approved HUDLS to touchdown is required.

6.6.4 Visibility minima for Cat II operations are normally specified in terms of RVR rather than visibility. Thus, an RVR assessment system is a requirement for a runway used for Cat II operations.

6.6.5 In the case of a Cat II operation a pilot may not continue an approach below the Cat II DH unless visual reference containing a segment of at least three consecutive lights that depict the centre line of the approach lights or touchdown zone lights or runway centre line lights or runway edge lights or a combination of these is attained and can be maintained. This visual reference should include a lateral element of the ground pattern, i.e., an approach lighting crossbar or the landing threshold or a barrette of the touchdown zone lighting, unless the operation is conducted utilizing an approved HUDLS to touchdown.

Approach minima

6.6.6 The DA/H for a Cat II operation should be the OCH or the DA/H authorized for the aircraft or the crew and should not be less than 30 m (100 ft). The visual aids available should be those currently described in Annex 14, Volume I, as a lighting system supporting Cat II operations, including runway edge, threshold, centre line and touchdown zone lights plus runway markings. The RVR minimum of 300 m is applicable to Cat II operations. However, larger aeroplanes may necessitate a greater RVR, unless use is made of an autoland system, thus making use of aircraft capabilities to increase safety. Similarly, if it is necessary to increase DA/H due to, for example, facility limitations or an increased OCH, then a corresponding increase in minimum RVR will be required as shown in Table 6-4. Standard visual aids appropriate to the category of operation should be provided.

Table 6-4. Example of Category II operations minima

	Category II operations minima coupled to below DH[1]	
Decision height	*RVR/aeroplane Category A, B and C*	*RVR/aeroplane Category D*
100 ft–120 ft (30 m–35 m)	300 m	300[2] m/350 m
121 ft–140 ft (36 m–42 m)	400 m	400 m
141 ft–199 ft (43 m–60 m)	450 m	450 m

1. The reference to “Coupled to below DH” in this table means continued use of the AFCS down to a height which is not greater than 80 per cent of the applicable DH. Thus airworthiness requirements may, through minimum engagement height for the AFCS, affect the DH to be applied.

2. For a Cat D aeroplane conducting an autoland, 300 m may be used.

Other than standard Category II operations

6.6.7 To create further incentives for improved on-board systems equipage, some States have implemented other than standard Cat II operations (OTS Cat II) with increased RVR minima at runways with reduced approach and/or runway lighting systems, as an alternative to the standard lighting systems described in Annex 14, Volume I. Decreased emphasis on approach and runway lighting systems in the visual segment is offset by the required use of autoland or HUDLS, increasing the emphasis on highly accurate and reliable airborne and ground equipment. States may allow the use of other than standard Cat II minima under specific conditions.

6.7 CATEGORY III OPERATIONS

Introduction

6.7.1 Although the original ICAO operational objective for fail-operational Cat III operations did not include or require the use of a DH, current States' practices require the use of a DH for all fail-passive operations and for some fail-operational operations. Certain operations require the specification of a DH at or below 15 m (50 ft). Most Cat III fail-operational operations specify an alert height at which the satisfactory operation of a fail-operational automatic landing system and relevant ground systems is confirmed. Visibilities range from a TDZ RVR not less than 175 m for Cat IIIA operations to less than 50 m (150 ft) for Cat IIIC operations, although in actual practice 75 m RVR is used as a practicable minimum value for ground manoeuvring purposes.

Decision height

6.7.2 The obstacle environment in the final segment of the approach should permit an aeroplane, coupled to the ILS by an AFCS, to fly safely without visual reference to the ground, down to the TDZ and carry out a missed approach. In Cat III operations, as in other operations, the aeroplane should be capable of executing a missed approach from any height prior to touchdown. The height loss allowance used in the determination of the DH for a Cat II operation is not applicable to a Cat III operation using a fail-operational automatic or hybrid system because the fail-operational characteristics assure that the landing flare will occur. Moreover the missed approach height loss will become less as the height of missed approach initiation decreases. For Cat III operations with landing systems which are not fail operational (e.g. a fail-passive system), roll-out may need to be accomplished manually. Consequently, a DH is used with the intent to have adequate visual reference to support a possible manual roll-out during the period following touchdown.

6.7.3 In those Cat III operations where DHs are used, specific DHs are associated with RVRs. They are generally specified at or below 15 m (50 ft). Their purpose is to specify the lowest height at which a pilot should be assured that an aeroplane is being satisfactorily delivered to the runway and that adequate visual reference is available for control of the initial part of the landing roll.

6.7.4 For Cat III fail-passive operations a DH is used. For Cat III fail-operational operations either a DH or an alert height may be used. If a DH is used, any necessary visual reference is specified.

Alert height

6.7.5 Alert height is a height specified for operational use by pilots (typically 30 m (100 ft) or less above the threshold), above which a Cat III operation would be discontinued and a missed approach initiated if a failure occurred in one of the required redundant operational systems in the aeroplane or in the relevant ground equipment. Below this height, the approach, flare, touchdown and, if applicable, roll-out may be safely accomplished following any failure in the aircraft or associated Cat III systems not shown to be extremely improbable. This height is based on characteristics of an aircraft and its particular fail-operational airborne Cat III system.

Runway visual range (RVR)

6.7.6 In Cat III operations, the entire approach down to the touchdown should be flown automatically except for those systems approved for manual control based on the use of HUDs. For fail-operational Cat IIIA operations, RVR is used to establish that the visual reference will be adequate for initial roll-out. For fail-passive Cat IIIA operations, RVR provides for the necessary visual reference to enable the pilot to verify that the aeroplane is in a position which will permit a successful landing in the TDZ. If the ground roll is to be manually controlled using visual reference, then a minimum RVR of 175 m will be required.

6.7.7 For Cat III minima discussed above, a fail-operational flight control system ensures that the pilot is extremely unlikely to have to revert to manual control of the aeroplane because of a system failure in the Cat III regime. If the flight control system is fail-passive in operation, then consideration should be given to the ability of the pilot to continue safely with the landing or to carry out a missed approach manually, and unless a mandatory missed approach is required following equipment failure, consideration should be given to establishing the RVR at a value which will enable the pilot to assess that sufficient visual reference exists for manual control of the flare.

6.7.8 In Cat III operations, the need for specific minima in the form of visual reference or DH requirements is determined by the reliability of the automatic systems. Where such minima are necessary, they will depend on the visual segment required, the pilot's field of view and the probability of the automatic system failing.

6.7.9 For Cat IIIA operations, and for Cat IIIB operations conducted either with fail-passive flight control systems or with the use of an approved HUDLS, a pilot may not continue an approach below the DH unless a visual reference containing a segment of at least three consecutive lights that depict the centre line of the approach lights or touchdown zone lights or runway centre line lights or runway edge lights or a combination of these is attained and can be maintained.

6.7.10 For Cat IIIB operations conducted either with fail-operational flight control systems or with a fail-operational hybrid landing system (comprising, for example, a HUDLS), using a DH a pilot must not continue an approach below the DH unless a visual reference containing at least one centre line light is attained and can be maintained.

6.7.11 For a Cat IIIB operation without a DH, there are no requirements for a visual verification prior to landing.

Operating minima

6.7.12 The facilities required for operations with the RVR values shown in Table 6-5 are those currently described in Annex 14, Volume I, as a lighting system supporting Cat III operations, including runway edge, threshold, centre line and touchdown zone lighting, except that the absence of approach lights may, in some circumstances, be acceptable for Cat III operations. The minimum RVR for Cat III operations is the minimum TDZ and midpoint value which is acceptable for runways greater than 2 500 m (8 000 ft). In some cases, a minimum value may be specified for the stop end of the runway. For Cat III operations to runways less than 2 500 m (8 000 ft), the minimum RVR applies to all parts of the runway.

Table 6-5. Example of RVR for Category III operations

Category III minima			
Category	*Decision height*	*Roll-out control/guidance system*	*RVR*
IIIA	Less than 30 m (100 ft)	Not required	175 m
IIIB	Less than 30 m (100ft)	Fail-passive	150 m
IIIB	Less than 15 m (50 ft)	Fail-passive	125 m
IIIB	Less than 15 m (50 ft) or no DH	Fail-operational[1]	75 m

[1]. The fail-operational system referred to may consist of a fail-operational hybrid system.

6.7.13 Cat III operations are subdivided as follows:

a) *Cat IIIA operations.* A precision instrument approach and landing operation with:

1) a DH lower than 30 m (100 ft) or no DH; and

2) an RVR not less than 175 m.

b) *Cat IIIB operations.* A precision instrument approach and landing operation with:

1) a DH lower than 15 m (50 ft) or no DH; and

2) an RVR lower than 175 m but not less than 50 m.

Note.— Where the DH and RVR do not fall within the same category, the RVR will determine in which category the operation is to be considered.

6.7.14 *Decision height*. For operations in which a DH is used, an operator should ensure that the decision height is not lower than:

a) the minimum DH specified in the aeroplane flight manual (AFM), if stated;

b) the minimum height to which the precision approach aid can be used without the required visual reference; and

c) the DH to which the flight crew is authorized to operate.

6.7.15 *No decision height.* For operations with no DH, an operator should ensure that the operation is conducted only if:

a) the operation with no DH is authorized in the AFM;

b) the approach aid and the aerodrome facilities can support operations with no DH; and

c) the operator has a specific approval for Cat III operations with no DH.

Note.— In the case of a Cat III runway, it may be assumed that operations with no DH can be supported unless specifically restricted as published in the AIP or NOTAM.

6.7.16 Some States have published rules removing the definitions of Cat IIIA and Cat IIIB. These States publish Cat III minima for their instrument approach procedures determined by the lowest RVR value that the ILS can support. Operators in these States, however, can be issued operations specifications that authorize the lowest Cat III RVR minima for the crew and type of aircraft. The operating minimum is determined by the higher of the two values. Operators with fail-passive flight control systems use a DH in accordance with their AFM and operations specifications. Operators with fail-operational flight control systems are authorized for operations with no DH in accordance with their AFM and operations specifications.

6.8 HUD AND EQUIVALENT DISPLAYS

General

6.8.1 A head-up display (HUD) presents flight information into the pilot's forward external field of view without significantly restricting that external view.

6.8.2 A variety of flight information may be presented on a HUD depending on the intended flight operation, flight conditions, systems capabilities and specific approval (including any operational credit). A HUD may include, but is not limited to, the following:

a) airspeed;

b) altitude;

c) heading;

d) vertical speed;

e) angle of attack;

f) flight path or velocity vector;

g) attitude with bank and pitch references;

h) course and glide path with deviation indications;

i) status indications (e.g. navigation sensor, autopilot, flight director); and

j) alerts and warning displays (e.g. ACAS, wind shear, ground proximity warning).

6.8.3 Equivalent head-up display refers to a display system that is certified to be equivalent to a HUD. A HUD equivalent display is one that has at least the following characteristics:

- is a head-up presentation not requiring transition of visual attention from head down to head up;
- displays sensor-derived imagery that conforms with the pilot's external view;
- presents required aircraft flight symbology, and the external view; and
- has display characteristics and dynamics that are suitable for manual control of the aircraft.

A HUD equivalent may also permit the simultaneous view of the EVS sensor imagery and/or computer-generated imagery. The appropriate airworthiness and specific approvals must be obtained before such systems can be used.

6.8.4 Equivalent performing display refers to a display system that is certified to provide performance levels equivalent with a HUD. An equivalent performing display conforms with the pilot's external view and presents required aircraft symbology, display characteristics, and dynamics suitable for manual control of the aircraft. The appropriate airworthiness and specific approvals must be obtained before such systems can be used.

Operational applications

6.8.5 Flight operations with a HUD can improve situational awareness by combining flight information located on head-down displays with the external view to provide pilots with more immediate awareness of relevant flight parameters and situation information while they continuously view the external scene. This improved situational awareness can also reduce errors in flight operations and improve the pilot's ability to transition between instrument and visual references as meteorological conditions change. Flight operations applications may include the following:

a) enhanced situational awareness during all flight operations but especially during taxi, take-off, approach and landing;

b) reduced flight technical error during take-off, approach and landing; and

c) improvements in performance due to precise prediction of touchdown area, tail strike awareness/ warning and rapid recognition of and recovery from unusual attitudes.

6.8.6 An approved HUD may be used for the following purposes:

a) to supplement conventional flight deck instrumentation in the performance of a particular task or operation. The primary cockpit instruments remain the primary means for manually controlling or manoeuvring the aircraft; and

b) as a primary flight display;

1) information presented by the HUD may be used by the pilot in lieu of scanning head-down displays. Specifically, approval of a HUD for such use allows the pilot to control the aircraft by reference to the HUD for approved ground or flight operations; and

2) information presented by the HUD may be used as a means to achieve additional navigation or control performance in combination with another system. The required information is displayed on the HUD. Operational credit, in the form of lower minima, for a HUD used for this purpose may be approved for a particular aircraft or AFCS.

6.8.7 A qualified HUD when used as the primary flight reference may qualify for operations in reduced visibility or RVR or replace some parts of the ground facilities such as touchdown zone and/or centre line lights.

HUD training

6.8.8 Training requirements should be established, monitored and approved by the State of the Operator or the State of Registry, as appropriate. Training requirements should include requirements for recent experience if the State determines that these requirements are significantly different from the current requirements for the use of conventional head-down instrumentation.

6.8.9 HUD training should address all flight operations for which the HUD is designed and operationally approved. Some training elements may require adjustments based on whether the aircraft has a single or dual HUD installation. Training should include contingency procedures required in the event of head-up display degradation or failure. HUD training should include the following elements as applicable to the intended use:

a) an understanding of the HUD, its flight path, energy management concepts and symbology. This should include operations during critical flight events (e.g. ACAS Traffic Advisory/Resolution Advisory, upset and wind shear recovery, engine or system failure);

b) HUD limitations and normal procedures, including maintenance and operational checks performed to ensure normal system function prior to use. These checks include pilot seat adjustment to attain and maintain appropriate viewing angles and verification of HUD operating modes;

c) HUD use during low-visibility operations, including taxi, take-off, instrument approach and landing in both day and night conditions. This training should include the transition from head-down to head-up and head-up to head-down operations;

d) failure modes of the HUD and the impact of the failure modes or limitations on crew performance;

e) crew coordination, monitoring and verbal call-out procedures for single HUD installations with head-down monitoring for the pilot not equipped with a HUD and head-up monitoring for the pilot equipped with a HUD;

f) crew coordination, monitoring and verbal call-out procedures for dual HUD installations with use of a HUD by the pilot flying the aircraft and either head-up or head-down monitoring by the other pilot;

g) consideration of the potential for loss of situational awareness due to “tunnel vision” (also known as cognitive tunnelling or attention tunnelling);

h) any effects that weather, such as low ceilings and visibilities, may have on the performance of a HUD; and

i) HUD airworthiness requirements.

6.9 VISION SYSTEMS

General

6.9.1 “Vision systems” is used as a generic term to refer to the existing systems designed to provide images, i.e. enhanced vision systems (EVSs), synthetic vision systems (SVSs) and combined vision systems (CVSs). EVS can display electronic real-time images of the actual external scene achieved through the use of image sensors while SVS display computer-generated images, which are derived from aircraft attitude, high-precision navigation solution, and/or an independent database of terrain, obstacles and relevant cultural features. CVS consist of a combination of the two aforementioned systems. Such a system displays electronic real-time images of the external scene using the EVS component of the system.

6.9.2 The information from vision systems may be presented on a head-up or head-down display. When EVS imagery is displayed on the HUD, it should present an image which conforms with the pilot’s forward external field of view without significantly restricting that external view.

6.9.3 The increased situational awareness provided by SVS may provide additional safety for all phases of flight.

6.9.4 Light emitting diode (LED) lights may not be visible to infrared (IR)-based vision systems, e.g. current EVS, due to the fact that LED lights are limited to specific light spectrums, whereas incandescent lights operate over a broad spectrum that includes near infrared range. The current EVS is highly dependent on the heat signature of the aerodrome lighting systems. The EVS uses the light patterns to provide guidance, typically from about 60 m (200 ft) down to 30 m (100 ft). In the near future some States may allow these vision systems to provide guidance all through the landing. The main aspect of the proposed change to the ICAO Standard for white light is the expansion to the colour blue. Another significant element is the brightness. Recent flight-testing by several original equipment manufacturers and one cargo airline has resulted in adverse comments on the characteristics of some LED lights. These comments relate both to the colours and the intensity of the LED lights resulting in significant glare and concerns about operational suitability. These concerns are applicable to various conditions of light and weather phenomena. LED lights operate in a narrower wavelength band than incandescent lights, even when being within the colour definitions in Annex 14. This may create problems with colour perception for some pilots even when they are considered to have a normal colour perception based on today's medical requirements, which in turn are based on the existing colour definitions for incandescent lights. Work is being done by some States to explore possible mitigations that will improve the performance of EVS with respect to LED lights. An example of a possible mitigation is the addition of a heating element to the LED light which will increase its IR signature. An additional benefit of the heating element will be to help melt freezing precipitation that may accumulate around the light. Operators of EVS will therefore need to acquire information about the LED implementation programmes at aerodromes where they operate and plan accordingly.

Operational applications

6.9.5 Flight operations with enhanced vision image sensors allow the pilot to view an image of the external scene obscured by darkness or other visibility restrictions. When the external scene is obscured, enhanced vision imaging may allow the pilot to acquire an image of the external scene earlier than with natural vision. The improved acquisition of an image of the external scene may improve situational awareness or allow operational credit.

6.9.6 The enhanced imagery displayed by the EVS may also allow pilots to detect terrain or aircraft on the runway or taxiways. An enhanced image can also provide visual cues to enable earlier runway alignment and a more stabilized approach.

6.9.7 The combined display of aircraft performance, guidance and imagery may allow the pilot to maintain a more stabilized approach and smoothly transition from enhanced visual references to natural visual references.

6.9.8 An SVS provides the pilot with improved situational awareness. The computer-generated imagery provides the pilot with a visual presentation of terrain, obstacles, and the runway in all weather conditions. Advanced guidance displays supplemented with a computer-generated image may facilitate the transition from the instrument segment to the visual segment and direct the visual search for the runway.

6.9.9 The CVS concept involves a combination of an SVS and an EVS. Some examples of a CVS include database-driven synthetic vision images combined with real-time sensor images superimposed and correlated on the same display. The angular extent of the external scene presented on the display is called field of regard (FOR). The FOR of a typical enhanced vision system is approximately 40 degrees x 25 degrees but may vary slightly by manufacturer. Due to the limited FOR of most EVSs, the addition of a synthetic database-driven image may increase the pilot's situational awareness and aid in acquiring the runway environment. An example of how a combined system might be used during an approach would be to rely on the synthetic database-generated image until the aircraft approaches the point where the EVS becomes effective. The image would then gradually and smoothly transition from synthetic to enhanced vision. A CVS can provide increased situational awareness, but may not necessarily be used for operational credit. In order to receive operational credit, the system used to provide the enhanced vision image must be certified for that specific operation. More information on operational credit is in Section 6.10.

Training

6.9.10 Training requirements should be established and monitored, and where appropriate, approved by the State of the Operator. These training requirements should include recency of experience requirements if the State of the Operator determines those requirements are significantly different from current requirements for the use of HUD without enhanced vision imagery or conventional head-down instrumentation.

6.9.11 Training should address all flight operations for which the vision system is approved. This training should include contingency procedures required in the event of system degradation or failure. Training for situational awareness should not interfere with other required operations. Training for operational credit should also require training for the applicable HUD used to present the enhanced visual imagery. Training should include the following elements as applicable:

a) an understanding of the system characteristics and operational constraints. Normal procedures, controls, modes, and system adjustments (e.g. sensor theory including radiant vs thermal energy and resulting images);

b) operational constraints, normal procedures, controls, modes, and system adjustments;

c) limitations;

d) airworthiness requirements;

e) vision system display during low-visibility operations, including taxi, take-off, instrument approach and landing. System use for instrument approach procedures in both day and night conditions;

f) failure modes and the impact of the failure modes or limitations upon crew performance, in particular, for two-pilot operations;

g) crew coordination and monitoring procedures and pilot call-out responsibilities;

h) transition from enhanced imagery to visual conditions during the runway visual acquisition;

i) rejected landing: loss of visual cues of the landing area, touchdown zone, or rollout area;

j) any effects that weather, such as low ceilings and visibilities, may have on the performance of the vision system ; and

k) effects of aerodrome lighting using LED lights.

Note.— Examples of training, checking and recency requirements for HUD and EVS can be found in Appendix I.

Operational concepts

6.9.12 Instrument approach operations that involve the use of vision systems include in principle two phases, the instrument and visual phases, respectively. The instrument phase ends at the published MDA/H or DA/H unless a missed approach is initiated. SVS is used during the instrument phase of the approach operation. The continued approach to landing from MDA/H or DA/H will be conducted using visual references. The visual references will be acquired by use of the EVS on the HUD or equivalent display, natural vision or a combination of these.

6.9.13 Current operations allow operations down to a defined height, typically 30 m (100 ft); the visual references will be acquired by means of EVS (or the EVS subsystem of a CVS) presented on the HUD. See Figure 6-1. Below this height the visual references required for landing must be visible utilizing natural vision. In the most advanced applications, the enhanced vision system is expected to be able to be used down to touchdown without the requirement for natural vision acquisition of visual references. It should be noted that using the EVS or CVS to touchdown and roll-out does not change the category of the operation, since the DA/H remains unchanged and the manoeuvring below DA/H is conducted by visual references acquired by means of the EVS. At least one State is preparing operational regulations to allow operations to touchdown without natural vision. The initial aircraft certification implementation may include a natural vision minimum. The progress of operations to touchdown will depend on technical developments and the gathering of additional operational experience.

6.9.14 In addition to the operational credit that EVS/CVS is able to provide, these systems also provide an operational and safety advantage through improved situational awareness, earlier acquisition of visual references and smoother transition to references by natural vision. These advantages are equally if not more pronounced for Type A approach operations than for Type B approach operations.

6.9.15 The use of a vision system for operational credit requires the appropriate airworthiness and specific operational approvals.

Visual references

6.9.16 The required visual references do not change due to the use of an EVS, but those references are allowed to be acquired by means of the EVS until a certain height during the approach.

6.9.17 In two regions that have developed requirements for operations with an EVS, the visual references are as indicated in Table 6-6.

Note.— Appendix G presents an example of visibility credit for EVS.

Hybrid systems

6.9.18 A hybrid system generically means that two or more systems are combined. The hybrid system typically has improved performance compared to each of the component systems, which in turn may qualify for operational credit. The more components included in a hybrid system, normally the better the performance of the hybrid system.

6.9.19 Table 6-7 gives some examples of hybrid system components. Any combination of the listed systems may constitute a hybrid system. The degree of operational credit that may be given to a hybrid system depends on its performance (accuracy, integrity and availability) as assessed and determined by the certification and specific operational approval processes.

Operational credit

6.9.20 Aerodrome operating minima are expressed in terms of minimum visibility/RVR and MDA/H or DA/H. With respect to operational credit, for aircraft equipped with appropriately approved vision systems such as EVS, this means that the visibility/RVR requirements may be lower than those established for the instrument approach procedure or fulfilled by means of the extra equipment. Operational credit can only be obtained if EVS or CVS imagery is combined with flight guidance and presented on a HUD or equivalent display. Lower minima may be granted to an operator’s aircraft that is better equipped than what was originally considered when designing the instrument approach procedure or when runway visual aids, considered in the design of the instrument approach procedure, are not available and compensated by the aircraft’s on-board equipment.

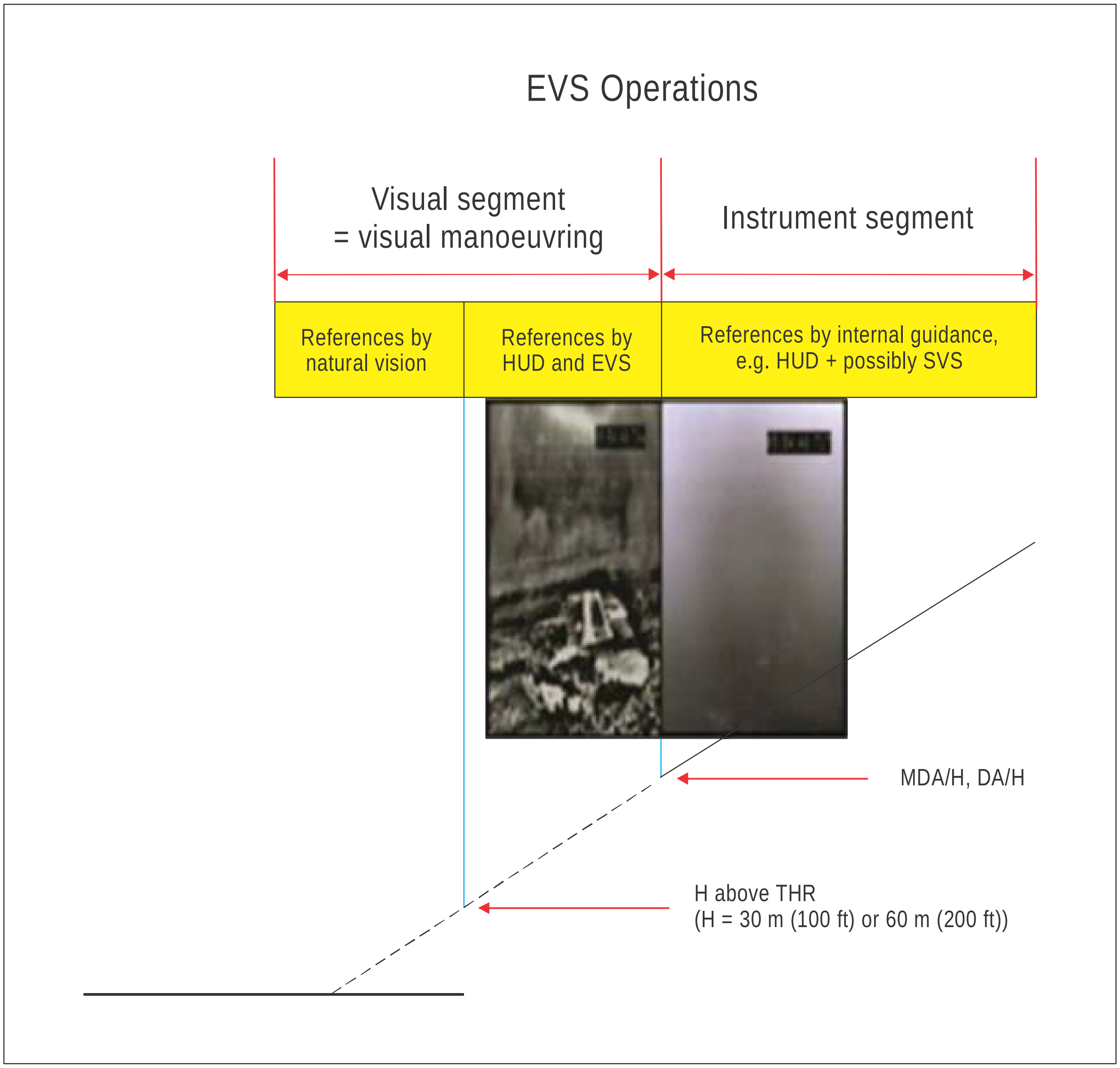

Figure 6-1. EVS operations

Table 6-6. Sample requirements for operations with EVS

OPERATIONS BELOW DA/H OR MDA/H	
Example 1	*Example 2*

For operations designed to support Type A operations, the following visual references for the intended runway must be distinctly visible and identifiable:
 	
• approach lighting system, or
 	
• the runway threshold identified by at least one of the following:
  • the beginning of the runway landing surface;
  • the threshold lights; or
  • runway end identifier lights;
 	
and
 	
• the touchdown zone, identified by at least one of the following:
  • the runway touchdown zone landing surface;
  • the touchdown zone lights;
  • the touchdown zone markings; or
  • the runway lights.
	For operations designed to support 3D Type A and Type B Cat I operations, the following visual references should be displayed and identifiable to the pilot on the EVS image:
	
	• elements of the approach light; or
	
	• the runway threshold, identified by at least one of the following:
	  • the beginning of the runway landing surface;
	  • the threshold lights, the threshold identification lights;
	or
	
	• the touchdown zone, identified by at least one of the following:
	  • the runway touchdown zone landing surface;
	  • the touchdown zone lights;
	  • the touchdown zone markings; or
	  • the runway lights.

Operations below 60 m (200 ft) above touchdown zone elevation — Example 1	*Operations below 60 m (200 ft) above threshold elevation — Example 2*
No additional requirements apply at 60 m (200 ft).	For procedures designed to support 3 D Type A operations, the visual references are the same as those specified below for Type B Cat I operations.
Operations below 30 m (100 ft) above touchdown zone elevation — Example 1	*Operations below 30 m (100 ft) above threshold elevation — Example 2*
The flight visibility must be sufficient for the following to be distinctly visible and identifiable to the pilot without reliance on the EVS: • the lights or markings of the threshold; or • the lights or markings of the touchdown zone.	For procedures designed to support Type B Cat I operations, at least one of the visual references specified below should be distinctly visible and identifiable to the pilot without reliance on the EVS: • the lights or markings of the threshold; or • the lights or markings of the touchdown zone.

Table 6-7. Examples of hybrid system components

Systems based on image sensors	*Systems not based on image sensors*
EVS	SVS
• Passive infrared sensors • Active infrared sensors • Passive millimetre wave radiometer • Active millimetre wave radar	Auto-flight systems, flight control computers, autoland system
	Systems for position fixing
CVS (the EVS component as above and is the component currently qualifying for operational credit)	CVS (the SVS component)
	HUD, Equivalent display
	ILS, GNSS

6.9.21 Credit related to RVR/visibility can be applied using at least three concepts.

1) Apply a reduced RVR as opposed to the normally required RVR. This will allow the aircraft to continue the approach beyond the approach ban point in an RVR that is lower than what normally would be required.

2) Grant operational credit where a flight visibility is prescribed. In this case, the required flight visibility is kept unchanged but the visual references are initially acquired by means of the on-board equipment, typically an EVS.

3) Provide operational credit by allowing operations in RVR/visibilities which are not lower than normal, but the approach operation is conducted with less than the required aerodrome facilities, e.g. Cat II operations without touchdown lights and/or centre line lights, compensated by additional on-board equipment, such as a HUD.

6.9.21.1 The result of the first two concepts is that operations are allowed in poorer meteorological conditions than would otherwise be possible. All concepts can be combined to achieve successful instrument approaches into aerodromes with reduced facilities, with appropriately equipped aircraft, in meteorological conditions that would otherwise preclude an instrument approach operation.

6.9.22 The granting of operational credits does not affect the classification of an instrument approach procedure since they are designed to support instrument approach operations conducted with aircraft with the minimum equipment prescribed. Nor is the type or category of operation affected.

6.9.23 As is stated in Annex 14, the aerodrome requirements will not regulate or limit the operation of aircraft. The application of the operational credits and flexible aerodrome operating minima are practical examples of this principle. In practice this will mean that the aerodrome will state which facilities, standards and services (including low-visibility procedures) it will offer, and the air operator will assess which aerodrome operating minima should be applied. This will be done in accordance with the method approved for establishment of aerodrome operating minima and the operational credits approved. Where the State of the Aerodrome has established aerodrome operating minima, these will have to be observed.

6.9.24 In order to provide optimum service, the ATS may have to be informed about the capabilities of the better equipped aircraft, e.g., which RVR is required.

6.9.25 In addition to the operational credit that HUD, vision systems and hybrid systems are able to provide, these systems will also provide an operational and safety advantage. These advantages are described in 6.9.14.

Operational procedures

6.9.26 The operational procedures associated with the use of HUD, vision systems and any hybrid system should be included in the *Operations Manual*. The instructions in the *Operations Manual* should include:

a) any limitation that is imposed by the airworthiness or specific operational approvals;

b) how any operational credit affects:

1) flight planning with respect to destination and alternate aerodromes;

2) ground operations;

3) flight execution, e.g. approach ban and minimum flight visibility;

4) CRM that takes into account that the pilots may have different presentation equipment;

5) standard operating procedures, e.g. use of auto-flight systems, call-outs that may be particular to the vision system or hybrid system, criteria for stabilized approach; and

6) ATS flight plans and radio communication.

6.9.27 It is not prohibited to use vision systems in connection with circling. However, due to the system lay-out of a vision system and the nature of a circling procedure, key visual references can only be obtained by natural vision, and operational credit is not feasible for existing vision systems. The visions system can only provide additional situational awareness.

Approvals

6.9.28 An operator that wishes to conduct operations with a HUD or equivalent display, vision system or hybrid system will need to obtain certain approvals (see Annex 6, Part I, 4.2.8.1 and 6.23 and the corresponding requirements in Parts II or III). The extent of the approvals will depend on the intended operation and the complexity of the equipment.

6.9.29 When enhanced vision imagery is used to improve situational awareness, operational approval requirements may be limited. An example of this type of operation may include an EVS or an SVS on a head-down display that is only used for situational awareness of the surrounding area of the aircraft during ground operations where the display is not in the pilot's primary field of view. For situational awareness, the installation and operational procedures need to ensure that the operation of the vision system does not interfere with normal procedures or the operation or use of other aircraft systems. In some cases, modifications to these normal procedures, other systems or equipment may be necessary to ensure compatibility.

6.9.30 When a vision system or a hybrid system with vision systems imagery is used for operational credit, specific approvals will typically require that the imagery be combined with flight guidance and presented on a HUD. Specific approvals may require that this information be also presented on a head-down display, in particular in a single HUD installation for the pilot monitoring. Operational credit may be applied for any flight operation, but credit for instrument approach operations is most common.

6.9.31 When the application for specific approval relates to operational credits for systems not including a vision system, the guidance in this chapter may be used to the extent applicable as determined by the State of the Operator (see Appendix H).

6.9.32 Operators should be aware that some States may require information about the specific credits which have been granted by the State of the Operator. Typically the approval from the State of the Operator will have to be presented and, in some cases, the State of the Aerodrome may wish to issue an approval or to validate the original approval.

6.9.33 To obtain a specific approval for operational credit, the operator will need to specify the desired operational credit and submit a suitable application in accordance with the appropriate provisions of Annex 6. The content of a suitable application should include:

a) Applicant details — For air operator certificate (AOC) holders, the company name, AOC number and e-mail address. For other operators, the official name and business or trading name(s), address, mailing address, e-mail address and contact telephone/fax numbers of the applicant.

b) Aircraft details — Aircraft make(s), model(s) and registration mark(s).

c) Operator's vision system compliance list — The contents of the compliance list are included in Appendix H. The compliance list should include the information that is relevant to the specific approval requested and the registration marks of the aircraft involved. If more than one type of aircraft/fleet is included in a single application a completed compliance list should be included for each aircraft/fleet.

d) Documents to be included with the application — Copies of all documents referred to in the fourth column (Operator's Operations Manual Reference or Document Reference) of the operator's vision systems compliance list (Appendix H) should be included when returning the completed application form to the civil aviation authority. There should be no need to send complete manuals; only the relevant sections/pages should be required.

e) Name, title and signature.

6.10 CONDITIONS FOR THE USE OF AUTOLAND SYSTEMS, HUD, EQUIVALENT DISPLAY, EVS, SVS OR CVS OR ANY COMBINATION OF THESE SYSTEMS FOR THE SAFE OPERATION OF AN AIRCRAFT

6.10.1 The Standards in Annex 6 require action by the State of the Operator or State of Registry, when autoland systems, HUD or equivalent display, EVS, SVS, CVS, or any combination of these systems are used "for the safe operation" of the aircraft. In the case of:

a) commercial air transport: they require an operator to be approved under the normal process a State of the Operator would carry out to authorize an application to undertake or modify a flight operation that has been submitted by an operator; and

b) general aviation: the State of Registry must establish criteria which must be met for the use of these systems.

Note.— Information about specific approvals for operational credits and approvals of the use of these systems or criteria for the use of these systems is contained in Annex 6, Part I, Attachment I; Annex 6, Part II, Attachment IIB; and Annex 6, Part III, Attachment I.

6.10.2 The use of vision systems solely for enhanced situational awareness, improved navigational accuracy and/or reduced workload is an important safety feature, but the system does not require a specific operational approval if it is not necessary for the kind of operation, i.e., an operational credit.

6.10.3 Operational credits based on the use of autoland systems, HUD or equivalent display, EVS, SVS, CVS, or any combination of these systems into a hybrid system, will require a specific approval. This applies to commercial air transport operations as well as general aviation and is established in the related Standards in Annex 6, Parts I and II.

6.10.4 When considering an application for operational credits, in addition to the requirements described in 6.10,1, the use of the qualifying system must be assessed and becomes an integral part of the specific approval. In the case of:

a) commercial air transport: the specific approval for the operational credit is issued by the State of the Operator, and it is reflected in the Operator's Operations Specifications (See Annex 6 Part I, Appendix 6); and

b) general aviation: the specific approval for the operational credit is issued by the State of Registry, and it is reflected in the "Specific Approval" document in accordance with the specific approvals template, contained in Annex 6, Part II, Appendix 2.4.

6.10.5 Any system installed on an aircraft must have an airworthiness approval. The airworthiness aspects are handled through the type certificate or supplementary type certificate.

Note.— Information on the appropriate airworthiness requirements are provided in the Airworthiness Manual *(Doc 9760).*

APPENDIX A

DIVISION OF RESPONSIBILITIES BETWEEN THE STATE OF THE OPERATOR AND THE STATE OF THE AERODROME

Table A-1. Responsibilities of the State of the Aerodrome and the State of the Operator

State of the Aerodrome	*State of the Operator*
Establishing requirements for aerodromes in accordance with Annex 14.	Establishing regulations for operators in accordance with Annex 6, i.e., for AWO and AOM.
	Establishing certification and training requirements for flight crew members performing all-weather take-off and/or landing operations.
Certification of aerodromes and their operators in accordance with the requirements of the regulations.	Issuing AOC in accordance with the regulations.
Ensuring that information on the conditions and services at its aerodromes is made available to the operators (Annexes 4 and 15).	Surveying its operators.
Issuing OCA/H for all instrument approach procedures designed for its aerodromes.	
Some States may also issue the RVR/visibility for all instrument approach procedures designed for their aerodromes.	
Establishing the conditions for operations (by any operator) to its non-standard aerodromes. This may include issuing approvals for operations to those aerodromes.	When applicable, establishing the conditions for approving operators to conduct operations to non-Standard aerodromes.
Checking foreign operators operating in the State by means of ramp inspections or by requiring assurances that the AOM applied are in accordance with or equivalent to the applicable minima.	

Table A-2. Responsibilities of the aerodrome and the operator

Aerodrome	*Operator*
Gathering and disseminating information about the obstacle situation, facilities and equipment at the aerodrome.	Establishing the AOM for the use of approved runways, including classification of aerodromes and the related qualification requirements. This should be done within the regulatory framework.
Implementing more restrictive procedures when failures or degradations in facilities and/or equipment no longer support optimal operational capabilities.	Monitoring aerodrome changes, via NOTAM, which affect operations that have been approved by regulation.
Surveying and maintaining the obstacle situation and performance of the facilities.	Ensuring proper training and certification of airmen for all-weather operations.
Establishing LVP, disseminating the related information and ensuring their application.	Ensuring that all approved operators have proper methods or systems to disseminate updated LVP information from either the operator or the State of the Operator.

APPENDIX B

APPROACH LIGHTING SYSTEMS

The length and shape of the approach lights play an essential role in the determination of the landing minima. Shorter approach lighting systems require greater RVR. Therefore, the length of the approach lights is directly correlated with the RVR. Approach lighting systems are described in Annex 14, Volume I. Examples of approach lighting system configurations are described in Table B-1. The visibility values in the table are based on the availability of the indicated facilities.

Table B-1. Approach lighting systems

Class of Facility	*Length, Configuration and Intensity of Approach Lights*
FALS (full approach lighting system) (see Annex 14)	Precision approach Cat I lighting system (HIALS ≥ 720 m) Distance coded centre line, barrette centre line
IALS (intermediate approach lighting system) (see Annex 14)	Simple approach lighting system (HIALS 420 m to 719 m) single source, barrette
BALS (basic approach lighting system)	Any other approach lighting system (HIALS, MIALS or ALS 210 m to 419 m)
NALS (no approach lighting system)	Any other approach lighting system (HIALS, MIALS or ALS < 210 m) or no approach lights

APPENDIX C

ILS FACILITY CLASSIFICATION AND DOWNGRADING

The ILS facility classification system provides a more comprehensive method of describing ILS performance than the simple Cat I/II/III classification. An example of an ILS facility classification is "III/E/4". ILS facility classification is described in Annex 10, Volume I. A facility's "class" of performance is defined by using three characters as follows:

a) The first group of characters (I or II or III) indicates conformance to the facility performance category Standards contained in Annex 10, Volume I. This character indicates if the ground equipment meets a facility performance Cat I, II or III.

b) The second group, comprised of a single character, defines the ILS point (Figure C-1) to which the localizer conforms to the facility performance Cat II/III course structure tolerances. These classifications indicate ILS conformance to a physical location on the approach or runway as follows:

   1) A: 7.4 km (4 NM) before the threshold;

   2) B: 1 050 m (3 500 ft) before the threshold (Cat I decision point);

   3) C: Glide path altitude of 30 m (100 ft) HATh (Cat II decision point);

   4) T: Threshold;

   5) D: 900 m (3 000 ft) beyond the threshold (facility performance Cat III requirement only);

   6) E: 600 m (2 000 ft) before the runway end (facility performance Cat III requirement only).

c) The third group, comprised of a single character, indicates the level of integrity and continuity of service. It is generally accepted, irrespective of the operational objective, that the average rate of a fatal accident during landing due to failures or shortcomings in the whole system, comprising the ground equipment, the aircraft and the pilot, should not exceed $1x10^{-7}$. This criterion is frequently referred to as the global risk factor. In Cat III operations, this objective should be inherent in the whole system. In this context it is of the utmost importance to endeavour to achieve the highest level of integrity and continuity of service of the ground equipment. Integrity is needed to ensure that an aircraft on approach will have a low probability of receiving false guidance. Continuity of service is needed to ensure that an aircraft in the final stages of approach will have a low probability of being deprived of a guidance signal. Integrity and continuity of service requirements are defined in Annex 10, Volume I, Chapter 3, 3.1.3.12, for the localizer and 3.1.5.8, for the glide path.

Table C-1. Minimum localizer (LOC) and glide slope (GS) integrity and continuity levels

Level	*Localizer or glide path*		
	Integrity	*Continuity of service*	*MTBO (hours)*
1		Not demonstrated, or less than required for Level 2	
2	$1 - 10^{-7}$ in any one landing	$1 - 4 \times 10^{-6}$ in any period of 15 seconds	1 000
3	$1 - 0.5 \times 10^{-9}$ in any one landing	$1 - 2 \times 10^{-6}$ in any period of 15 seconds	2 000
4	$1 - 0.5 \times 10^{-9}$ in any one landing	$1 - 2 \times 10^{-6}$ in any period of 30 seconds (localizer) 15 seconds (glide path)	4 000 (localizer) 2 000 (glide path)

Note.— For currently installed systems, in the event that the Level 2 integrity value is not available or cannot be readily calculated, it is necessary to at least perform a detailed analysis of the integrity to assure proper monitor fail-safe operation.

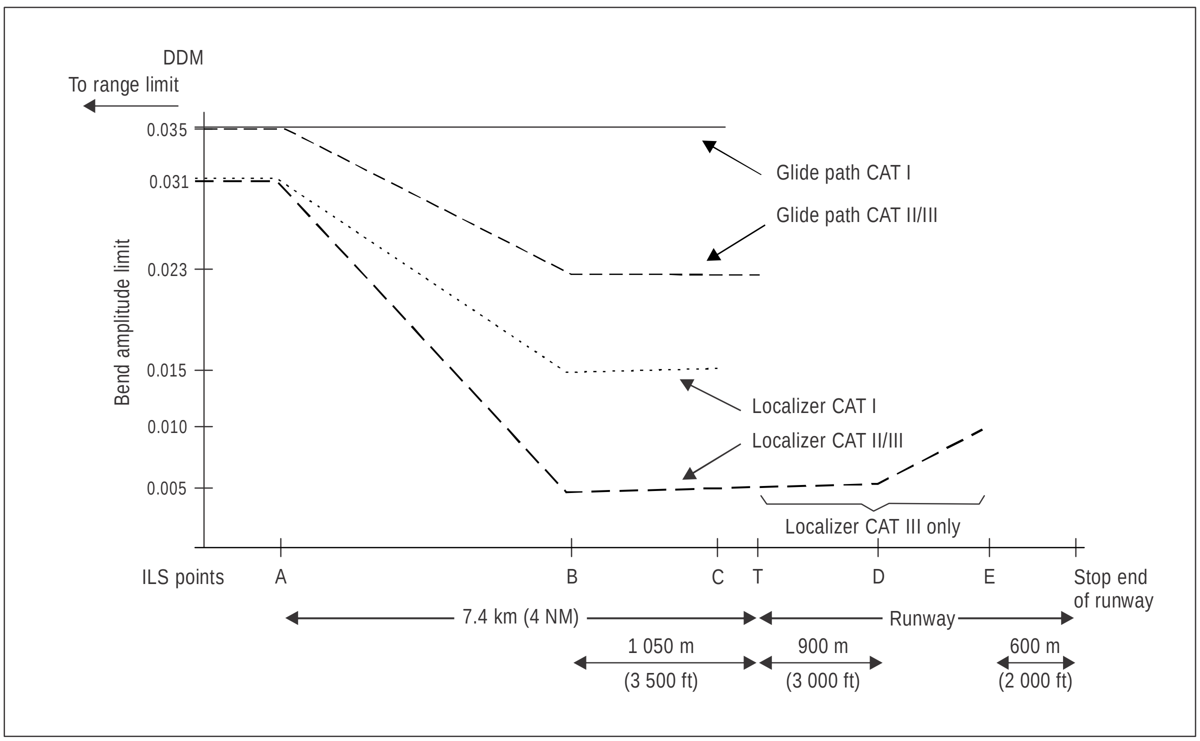

Figure C-1. Localizer course and glide path bend amplitude limits

Table C-2. Example of ILS classification and supported operations

Temporary changes of ILS classification			*Correlation between ILS classification and procedure or published minima*	
Facility performance category	*Limit of course structure*	*Minimum level of integrity and continuity of service*	*Lowest operational Cat*	*Minimum RVR values unless approved otherwise (m) (when applicable)*
I	A, B, C, T, D or E	1	I	TDZ: 550; Midpoint: 125; Stop-end: 75
II	T, D or E	1	I	TDZ: 550; Midpoint: 125; Stop-end 75
	T	2	I[1]	TDZ: 550; Midpoint: 125; Stop-end 75
	D or E	2	II	TDZ: 300; Midpoint: 125; Stop-end 75
III	D	1	I	TDZ: 550; Midpoint: 125; Stop-end 75
		2	II	TDZ: 300; Midpoint: 125; Stop-end 75
		3	IIIB + DH	TDZ: 75; Midpoint: 125; Stop-end 75
		4	IIIB no DH	
	E	1	I	TDZ: 550; Midpoint: 125; Stop-end 75
		2	II	TDZ: 300; Midpoint: 125; Stop-end 75
		3	IIIB + DH	TDZ: 75; Midpoint: 75; Stop-end 75
		4	IIIB no DH	TDZ: 75; Midpoint: 75; Stop-end 75

1. In the case of a downgrading to classification II/T/2 to 4, the operation will be initially limited to Cat I only. After an assessment of the effect of the LOC deviation on the autoland systems, a subsequent upgrading to Cat II may be authorized and published in the route documentation, or information may be given that autoland approaches are not approved. A higher than standard Cat II RVR may be applied when deemed necessary.

APPENDIX D

ALTERNATE MINIMA

States may promulgate minimum criteria for departure, destination and en-route alternates when applicable. Typically, alternate minima are either a fixed minimum ceiling and visibility requirement, or a flexible ceiling and visibility requirement which are based on navigation and other facilities for one or more runways which can reasonably be expected to be available at arrival time based on forecast weather conditions and AIS. Table D-1 provides an example of alternate minima.

Table D-1. Example destination alternate aerodrome operating minima

Approach facility configuration	*Ceiling DA/H or MDA/H*	*RVR*
For airports supporting one approach and landing operation.	Authorized DA/H or MDA/H plus an increment of 125 m (400 ft).	Authorized visibility plus an increment of 1 500 m.
For airports supporting at least two approach and landing operations, each providing a straight-in approach and landing operation to different, suitable runways.	Authorized DA/H or MDA/H plus an increment of 60 m (200 ft).	Authorized visibility plus an increment of 800 m.
For airports with a published Cat II or Cat III approach and landing operation, and at least two approach and landing operations, each providing a straight-in approach and landing operation to different, suitable runways.	For Cat II procedures, a ceiling of at least 90 m (300 ft), or for Cat III procedures, a ceiling of at least 60 m (200 ft).	For Cat II, a visibility of at least RVR 1 200 m or, for Cat III, a visibility of at least RVR 550 m.

APPENDIX E

CONVERSION OF REPORTED METEOROLOGICAL VISIBILITY (RVR/CMV) PRACTICES FOR THE APPLICATION OF AN APPROACH BAN

1. The principle of converting reported meteorological visibilities into corresponding RVR values and the exclusive use of either reported or converted RVR values for the determination of straight-in approach minima were introduced in 1995 by Europe's Joint Aviation Authorities (JAA) and defined in JAR-OPS 1, subpart E. In the years following the first publication of JAR-OPS 1, the JAA AOM concept was not only adopted by all European States but also by a large number of States outside Europe. As a result, the concept of converting reported meteorological visibilities into RVR values used for the establishment of an approach ban with straight-in approach minima has found widespread acceptance by many airline operators worldwide.

2. The evolution of the JAA AOM concept into a new AOM concept, based on CDFA and largely harmonized between Europe and the United States, made it necessary to develop a new term for reported meteorological visibilities converted into RVRs when these values exceed 2 000 m because, other than in the original JAA AOM concept, upper RVR values defined for straight-in approaches in the new AOM concept do not end at 2 000 m but at 5 000 m. The new term adopted was "converted meteorological visibility (CMV)". CMV values are derived by applying the same methodology as applied for the conversion of reported meteorological visibilities into RVR values in those cases where the resulting values exceed 2 000 m. Since its first introduction in EU-OPS in 2008, the CMV concept has been in use by all European operators and States and by many operators and States outside Europe.

3. Because RVR and meteorological visibility are established differently, a ratio can be established between the two. The effect of lighting intensities and background luminance play a role when establishing an RVR. Table E-1 indicates the relation between light intensity and day or night condition.

Table E-1. Conversion of MET visibility to RVR/CMV

Lighting elements in operation	*RVR/CMV = reported meteorological visibility multiplied by:*	
	Day	*Night*
High intensity approach and runway lighting	1.5	2.0*
Any type of lighting installation other than above	1.0	1.5*
No lighting	1.0	Not applicable

* The relationship between reported visibility and RVR/CMV at night is under review by ICAO.

4. An operator must ensure that a meteorological visibility to RVR/CMV conversion is not used for take-off, for calculating any other required RVR minimum less than 800 m, or when reported RVR is available.

5. When converting meteorological visibility to RVR in all other circumstances than those in the paragraphs above, an operator must ensure that Table E-1 is used.

Note.— If the RVR is reported as being above the maximum value assessed by the aerodrome operator, e.g. "RVR more than 1 500 metres", it is not considered to be a reported value for the purpose of this paragraph.

APPENDIX F

EXAMPLE OF MINIMA FOR APPROACH AND LANDING OPERATIONS

In EU-OPS the DA/H or MDA/H for a particular operation should be the OCH (for the non-precision approach procedure) or the minimum height authorized for the aeroplane and the crew or the system minima of Table F-1, whichever is the highest. The minimum RVR to be associated with this DA/H or MDA/H can be determined from Table 6-3 of Chapter 6.

Table F-1. System minima versus instrument approach procedures

Instrument approach procedure	*Lowest DH/MDH*
ILS/MLS/GLS/SBAS Cat I	60 m (200 ft)[1]
GNSS (SBAS)	60 m (200 ft)
GNSS (LNAV/VNAV)	75 m (250 ft)
Localizer with or without DME	75 m (250 ft)
SRA (terminating at 1/2 NM)	75 m (250 ft)
SRA (terminating at 1 NM)	90 m (300 ft)
SRA (terminating at 2 NM or more)	105 m (350 ft)
GNSS (LNAV)	75 m (250 ft)
VOR	90 m (300 ft)
VOR/DME	75 m (250 ft)
NDB	105 m (350 ft)
NDB/DME	90 m (300 ft)
VDF	105 m (350 ft)

1. The lowest authorized DH for Cat I operations is 60 m (200 ft) unless an equivalent level of safety can be achieved through use of additional procedural or operational requirements.

APPENDIX G

EXAMPLE OF VISIBILITY CREDIT FOR ENHANCED VISION SYSTEMS

1. A pilot using an appropriately certificated EVS in accordance with the procedures and limitations of the approved flight manual may:

a) continue an approach below DH or MDH to 30 m (100 ft) above the threshold elevation of the runway provided that at least one of the following visual references is displayed and identifiable on the EVS:

1) elements of the approach lighting; or

2) the runway threshold, identified by at least one of the following: the beginning of the runway landing surface, the threshold lights, the threshold identification lights; and the touchdown zone, identified by at least one of the following: the runway touchdown zone landing surface, the touchdown zone lights, the touchdown zone markings or the runway lights.

b) reduce the calculated RVR for the approach from the value in column 1 of Table G-1 to the value in column 2.

2. Paragraph 1 may, for example, be used for ILS, MLS, PAR, GLS and SBAS Cat I with a DH no lower than 60 m (200 ft) or an approach flown using approved vertical flight path guidance to an MDH or DH no lower than 75 m (250 ft).

3. A pilot may not continue an approach below 30 m (100 ft) above runway threshold elevation for the intended runway unless at least one of the visual references specified below is distinctly visible and identifiable to the pilot without reliance on the EVS:

a) the lights or markings of the threshold; or

b) the lights or markings of the touchdown zone.

Table G-1. Approach utilizing EVS RVR reduction versus normal RVR

RVR normally required	*RVR for approach utilizing EVS*		*RVR normally required*	*RVR for approach utilizing EVS*
550	350		2 700	1 800
600	400		2 800	1 900
650	450		2 900	1 900
700	450		3 000	2 000
750	500		3 100	2 000
800	550		3 200	2 100
900	600		3 300	2 200
1 000	650		3 400	2 200
1 100	750		3 500	2 300
1 200	800		3 600	2 400
1 300	900		3 700	2 400
1 400	900		3 800	2 500
1 500	1 000		3 900	2 600
1 600	1 100		4 000	2 600
1 700	1 100		4 100	2 700
1 800	1 200		4 200	2 800
1 900	1 300		4 300	2 800
2 000	1 300		4 400	2 900
2 100	1 400		4 500	3 000
2 200	1 500		4 600	3 000
2 300	1 500		4 700	3 100
2 400	1 600		4 800	3 200
2 500	1 700		4 900	3 200
2 600	1 700		5 000	3 300

APPENDIX H

EXAMPLE OF VISION SYSTEMS COMPLIANCE LIST

(Applies to all parts of Annex 6)

Table H-1. Example of vision systems compliance list (applies to all parts of Annex 6)

Main Heading	*Expanded areas to be addressed by application*	*Sub-requirement*	*Operator's Operations Manual Reference or Document Reference*
1. Reference documents used in compiling submission	The submission should be based on current up-to-date regulatory material. A compliance statement showing how the criteria of the applicable regulations and requirements have been satisfied.		
2. Flight Manual (FM)	A copy of the relevant FM (or equivalent document) entry showing the aircraft certification basis for the vision system and any operational conditions.		
3. Feedback and reporting of significant problems	Outline of the process for reporting of failures in the operational use of procedures. *Note.— In particular, significant problems with the vision system/HUD systems, reporting on circumstances/locations where the vision system was unsatisfactory.*		
4. Requested operational credit and resulting operating minima	The requested operational credit in accordance with the applicable national regulations. Confirmation that all aerodrome operating minima are established in accordance with the method approved by the relevant authority or, in case of general aviation, in accordance with criteria established by the relevant authority.		
5. Operations Manual (or an equivalent document)	The relevant entries including MEL (where applicable) and standard operating procedures.		

Main Heading	*Expanded areas to be addressed by application*	*Sub-requirement*	*Operator's Operations Manual Reference or Document Reference*
6. Safety risk assessment	A safety risk assessment of the operations supported by the system contained in the application. Guidance on safety risk assessments is contained in the *Safety Management Manual (SMM)* (Doc 9859).		
7. Training programmes	Training programmes including the training syllabi for the system contained in the application.		
8. Continuing airworthiness	Continuing airworthiness programme for the system contained in the application.		

APPENDIX I

EXAMPLES OF TRAINING, CHECKING AND RECENCY REQUIREMENTS FOR HUD AND EVS

Initial ground training should consist of the following subjects:

1. Applicable regulatory guidelines that relate to HUD and EVS flight operations and limitations, including aircraft flight manual limitations;

2. HUD display, controls, modes, features, symbology, annunciations, and associated systems and components;

3. EVS sensor performance, sensor limitations, scene interpretation, visual anomalies, and other visual effects;

4. Pre-flight planning and operational considerations associated with using HUD and EVS during taxi, take-off, climb, cruise, descent, and landing phases of flight, including the use of HUD and EVS for instrument approaches, operating below DA/DH or MDA, executing missed approaches, landing, roll-out, and balked landings;

5. Weather associated with low-visibility conditions and its effect on EVS performance;

6. Normal, abnormal, emergency, and crew coordination procedures when using EVS; and

7. Interpretation of approach and runway lighting systems and their display characteristics when using a HUD and EVS.

Initial flight training should consist of the following subjects:

1. Pre-flight and inflight preparation of HUD and EVS equipment for operations, including set up and use of display, controls, modes, and associated systems, including adjustments for brightness and contrast under day and night conditions;

2. Proper piloting techniques associated with use of HUD and EVS during taxi, take-off, climb, cruise, descent, landing, and roll-out, to include missed approaches and balked landings;

3. Proper piloting techniques for the use of HUD and EVS during instrument approaches, to include operations below DA/DH or MDA in accordance with applicable State regulations, under both day and night conditions;

4. Determining enhanced flight visibility;

5. Identifying required visual references appropriate to EVS operations;

6. Transitioning from EVS sensor imagery to natural vision acquisition of required visual references and the runway environment;

7. Using EVS sensor imagery to touchdown and roll-out, if applicable; and

8. Normal, abnormal, emergency, and crew coordination procedures when using a HUD and EVS, including crew procedures for using the pilot monitoring (PM) display.

Recurrent or differences training

Recurrent and differences training for EVS operations should consist of the same subject areas covered by initial training. Differences training for a new EVS system should also include special conditions or considerations associated with conducting EVS operations using the new system.

Recent flight experience

HUD and EVS operations are complex operations involving the use of a HUD with a sensor image that a pilot typically conducts in low-visibility conditions. Because the occurrence of low-visibility conditions is infrequent and because the skills necessary to operate this equipment under these conditions depreciate, recent HUD and EVS flight experience and training is necessary to prevent the loss of skill. The purpose of requiring recent HUD and EVS flight experience is to ensure that a pilot remains proficient in the use of all HUD and EVS components and operating procedures and to ensure that the pilot conducts EVS operations safely. As EVS equipment evolves to permit operations in lower visibility environments than are currently permitted, and as the scope and number of EVS operations increases over time, the need for pilots to maintain recent flight experience becomes even more critical. HUD and EVS operators whose policy is to use this equipment on nearly all operations can build experience and proficiency quicker than if they used it only during lower visibility operations. The HUD is an excellent safety enhancement in all-weather operations, and EVS systems can provide benefit in other than just low-visibility operations. For example, EVS can enhance safety in night operations especially in mountainous terrain in almost all weather conditions. Some States require that a person who manipulates the controls of an aeroplane during an EVS operation or who acts as pilot-in-command of an aeroplane during an EVS operation, can do so only if, within six calendar months preceding the month of the flight, that person performed and logged six instrument approach operations as the sole manipulator of the controls using an EVS. States do allow for recent flight experience to be met in an aircraft or in a simulator equipped with an EVS.

Proficiency check requirements

Some States will require a person acting as pilot-in-command or a person who is manipulating the controls of an EVS-equipped aeroplane to pass a HUD and EVS proficiency check. A typical HUD and EVS proficiency check should include a representative sample of the items that were covered during the initial ground and flight training for HUD and EVS.

APPENDIX J

PERFORMANCE-BASED APPROACH CLASSIFICATION SUMMARY

Domain	*Document*	*ICAO Panel*	*Operations*			
Approach Operations	Annex 6	FLTOPSP	Classification	Type A	Type B	
				(>=250 ft)	(200 ft<= DA/H <250 ft)	(<200 ft)
				2D or 3D	3D	3D
				MDA/H or DA/H	DA/H	DA/H
Approach Minima Runway Requirements	Annex 14	ADOP	MDA/H or DA/H >= VCM	Non Instrument RWY		
			M(DA/H) >=250 ft Visibility >= 1000 m	Non Precision RWY		
			DA/H >= 200 ft RVR >= 550 m	Precision RWY, Cat I		
			DA/H >= 100 ft RVR >= 300 m	Precision RWY, Cat II		
			DA/H >= 0 ft RVR >= 0 m	Precision RWY, Cat III (A,B,C)		
System Performance Procedures	Annex 10, PANS-OPS, Volume II, PBN Manual	NSP IFPP PBNSG		VOR, NDB, LOC and LDA w/ GS		ILS, MLS, GBAS
				PBN (including SBAS), ILS, MLS, GBAS		

— END —

ISBN 978-92-9258-235-7

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