ICAO

Doc 9365

Manual of All-Weather Operations

Fifth Edition, 2024

Approved by and published under the authority of the Secretary General

INTERNATIONAL CIVIL AVIATION ORGANIZATION

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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

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FOREWORD

The fifth edition of Doc 9365 has been updated to align with Amendments 47, 40 and 24 to Annex 6 – *Operation of* Aircraft, Part I – *International Commercial Air Transport – Aeroplanes*, Part II – *International General Aviation – Aeroplanes* and Part III – *International Operations – Helicopters*, respectively.

This edition incorporates:

a) more details on head-up displays (HUD), enhanced vision systems (EVS), synthetic vision systems (SVS), and combined vision systems (CVS);

b) updates to the instrument landing system (ILS) classification material;

c) continuous descent final approach (CDFA) technique elements including the use of minimum descent height (MDH) as decision height (DH);

d) removal of Category (CAT) III subcategories;

e) a harmonized description of Special Approval (SA) CAT I and II operations; and

f) improvements in the "operational credits" and the resulting performance-based aerodrome operating minima.

The fifth edition also includes guidance on the standards related to various forms of authorizations (approval, specific approval and acceptance), as well as additional miscellaneous updates.

Helicopter-specific all-weather operations are not included in this manual. While they will initially be available in the form of a circular, they will be incorporated in the sixth edition of this manual.

Note.— The basic concepts described in the fifth edition will continue to apply for helicopters, but special care should be exercised when adapting operational aspects for a specific use case.

All-weather operations by remotely piloted aircraft systems (RPAS) are not currently included in this manual, as the related concepts of operations are still evolving.

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 guidance material contained in this manual relates 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 CAT I, II and III operations, to the lowest minima. Information for States, air navigation service providers and airspace users on how to implement RNAV and 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, Parts II and III.

The material in this manual is of general nature and may be used as guidance material by civil aviation authorities to develop their own requirements in their role as State of the Operator, State of Registry and State of the Aerodrome, as well as operators and service providers. It complements material in Annex 6 and in the *Procedures for Air Navigation Services – Aircraft Operations* (Doc 8168). As far as practical, Standards and Recommended Practices (SARPs) and Procedures for Air Navigation Services (PANS) are written with neutral intent toward the varying operating circumstances and technologies used. These are called performance-based Standards as opposed to prescriptive Standards, which are typically very detailed. To assist States, air operators and other service providers in understanding 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 Annexes, 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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CONTENTS

GLOSSARY

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

Advanced aircraft. An aircraft with equipment in addition to that required for a basic aircraft for a given take-off, approach or landing operation.

Advisory vertical guidance. Vertical path deviation guidance indications provided as a non-essential aid to help pilots meet barometric altitude restrictions.

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

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

b) landing in two-dimensional (2D) instrument approach operations, expressed in terms of VISIBILITY and/or RVR and 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 RVR and decision altitude/height (DA/H) as appropriate to the type and/or category of the operation.

Aircraft state awareness synthetic vision system (ASA-SVS). A flight instrument display that combines the perspective view synthetic terrain depiction and overlaid primary flight display symbology.

Alert height. A height above the runway threshold (THR) based on the characteristics of the aircraft 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 at or above the AOM.

Approved vertical guidance. Vertical guidance provided on instrument procedures where VNAV is required.

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

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

Basic aircraft. An aircraft which has the minimum equipment required to perform the intended take-off, approach or landing operation.

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 (CVS). 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 (FAS) of an instrument non-precision approach (NPA) 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 begins for the type of aircraft flown; for the FAS of an NPA procedure followed by a circling approach, the CDFA technique applies until circling approach minima (circling OCA/H) or visual flight manoeuvre altitude/height are reached.

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.— DA is referenced to mean sea level (MSL) and DH is referenced to the THR elevation or touchdown zone (TDZ) 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 DH 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). An installed aircraft system using an electronic means to provide the flight crew with a real-time sensor-derived display of the external scene topography (the natural or artificial features of a place or region especially in a way to show their relative positions and elevation) through the use of imaging 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 HUD 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 aircraft 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 FAF 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 (FAS). That segment of an instrument approach procedure in which alignment and descent for landing are accomplished.

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

Flight guidance system (FGS). The means available to the flight crew to manoeuvre the aircraft in a specific manner, either manually or automatically. It may include a number of components such as the autopilot, flight directors (F/D) and relevant display and annunciation elements.

GBAS landing system (GLS). An instrument approach operation that is based on GBAS.

Ground-based augmentation system (GBAS). An augmentation system to the Global Navigation Satellite System (GNSS) in which the user receives augmentation information directly from a ground-based transmitter.

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

Head-up display 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 and approval purposes.

Note.— The component systems are normally approved as stand-alone systems.

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 (SIS).

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 (IAP). There are two methods for executing instrument approach operations:

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

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

Note.— LNAV and VNAV guidance refers to guidance provided either by:

a) a ground-based radio navigation aid; or

b) computer-generated navigation data from ground-based, space-based and self-contained navigation aids or a combination of these.

Instrument approach procedure (IAP). 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. IAPs are classified as follows:

Non-precision approach (NPA) procedure. An instrument approach procedure designed for 2D instrument approach operations with DH at or above 75 m (250 ft).

Note.— NPA procedures may be flown using a continuous descent final approach (CDFA) technique. CDFAs with advisory vertical guidance calculated by on-board equipment are considered 3D instrument approach operations. CDFAs with manual calculation of the required rate of descent are considered 2D instrument approach operations. For more information on CDFA refer to PANS-OPS (Doc 8168), Volume I, Part II, Section 5.

Approach procedure with vertical guidance (APV). A performance-based navigation (PBN) instrument approach procedure designed for 3D instrument approach operations with DH at or above 75 m (250 ft).

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.

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*. IFR may be followed in both IMC and VMC.*

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

Note.— The specified minima for VMC are contained in Chapter 4 of Annex 2.

Localizer performance (LP). The label to denote minima lines associated with the lateral element of APV-I performance on approach charts.

Localizer performance with vertical guidance (LPV). The label to denote minima lines associated with SBAS APV-I or SBAS Category I performance on approach charts.

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.

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.— MDA is referenced to MSL and MDH is referenced to the aerodrome elevation or to the THR elevation if it is more than 2 m (7 ft) below the aerodrome elevation. A MDH 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). The 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.

NOTAM. A notice distributed by means of telecommunication containing information concerning the establishment, condition or change in any aeronautical facility, service, procedure or hazard, the timely knowledge of which is essential to personnel concerned with flight operations.

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

Note 1.— OCA is referenced to MSL and OCH is referenced to the THR elevation or in the case of NPA procedures to the aerodrome elevation or the THR elevation if it is more than 2 m (7 ft) below the aerodrome elevation. An OCH 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.

Operational credit. A credit authorized for operations with an advanced aircraft enabling a lower aerodrome operating minimum than would normally be authorized for a basic aircraft, based upon the performance of advanced aircraft systems utilizing the available external infrastructure.

Performance-based aerodrome operating minimum (PBAOM). A lower aerodrome operating minimum, for a given take-off, approach or landing operation, than is available when using a basic aircraft.

Note 1.— The PBAOM is derived by considering the combined capabilities of the aircraft and available ground facilities.

Note 2.— PBAOM may be based on operational credits.

Note 3.— PBAOM are not limited to PBN operations.

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. Availability of GNSS SIS and/or some other NAVAID infrastructure is considered within the airspace concept in order to enable the navigation application.

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 and/or 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.

Special Approval Category I Operations (SA CAT I). *A* CAT I approach operation that has a DH not lower than 45 m (150 ft) and not less than RVR 400 m and which requires specific approval.

Special Approval Category II Operations (SA CAT II). *A* CAT II approach operation to a runway that does not fulfil all CAT II infrastructure requirements and which requires specific approval.

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 THR 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 guidance system (SVGS). SVGS is a type of SVS which combines flight guidance display technology and high precision position assurance monitors.

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 THR, where it is intended that landing aircraft 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. For aeronautical purposes, it 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 VIS.

Visual approach. An approach by an IFR flight when either part or all of an IAP 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 VMC.

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 equal to or better than specified minima.

Note.— The specified minima for VMC are contained in Chapter 4 of Annex 2.

Visual segment surface (VSS). Vertically, the VSS originates at the runway THR 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.

ABBREVIATIONS AND ACRONYMS

ACAS	Airborne collision avoidance system
AFCS	Automatic flight control system
AFM	Aircraft 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
ASA-SVS	Aircraft state awareness synthetic vision system
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
DH	Decision height
DME	Distance measuring equipment
EASA	European Union Aviation Safety Agency
ED	Equivalent display
EDTO	Extended diversion time operations
EFVS	Enhanced flight vision system
EVS	Enhanced vision system
FAF	Final approach fix
FALS	Full approach lighting system
FAS	Final approach segment
FGS	Flight guidance 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
HUD/ED	Head-up display/equivalent display
HUDLS	Head-up display approach and landing guidance system
HWD	Head-worn display
IALS	Intermediate approach lighting system
IAS	Indicated airspeed
IAP	Instrument approach procedure
IFR	Instrument flight rules
ILS	Instrument landing system
IMC	Instrument meteorological conditions
ISA	International standard atmosphere
JAA	Joint Aviation Authorities
JAR	Joint Aviation Requirements
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 services
METAR	Aerodrome routine meteorological 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
NPA	Non-precision approach
NVIS	Night vision imaging systems
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
PBAOM	Performance-based aerodrome operating minimum
PBN	Performance-based navigation
PFD	Primary flight display
RCLL	Runway centre line light
RDH	Reference datum height
RTZL	Runway touchdown zone light

RVR	Runway visual range
SARPs	Standards and Recommended Practices
SBAS	Satellite-based augmentation system
SDF	Stepdown fix
SID	Standard instrument departure
SIS	Signal-in-space
SIGMET	Significant weather report
SMGCS	Surface movement guidance and control system
SOP	Standard operating procedures
SPECI	Aerodrome special meteorological report
SRA	Surveillance radar approach
STAR	Standard instrument arrival
SVR	Slant visual range
SVGS	Synthetic Vision Guidance System
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
VMC	Visual meteorological conditions
VNAV	Vertical navigation
VOR	Very high frequency omnidirectional radio range
V/S	Vertical speed

REFERENCE DOCUMENTS

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*

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Procedures for Air Navigation Services

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

Procedures for Air Navigation Services – Aircraft Operations (PANS-OPS, Doc 8168)
Volume I – *Flight Procedures*
Volume II – *Construction of Visual and Instrument Flight Procedures*
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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 1 – *Runways*
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
Volume II – Helicopters

Airworthiness Manual (Doc 9760)

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

Safety Management Manual (Doc 9859)

Flight Planning and Fuel Management Manual (FPFM) (Doc 9976)

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 Regulation (EU) 965/2012 Air Operations

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)

European Guidance Material on Management of ILS Critical and Sensitive Areas (EUR Doc 040)

United States

Code of Federal Regulations (CFRs)

Federal Aviation Administration (FAA) Order 8260.3F, United States Standard for Terminal Instrument Procedures (TERPS)

Advisory Circular (AC) 120-118 *Criteria for Approval/Authorization of All Weather Operations (AWO) for Takeoff, Landing, and Rollout*

Currently:

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 Takeoff, Landing, and Rollout*

To be replaced by:

AC 20-191, *Airworthiness Approval of Airborne Systems used for Takeoff, Precision Approach, Landing and Rollout in low-visibility conditions*

AC 20-185A, *Airworthiness Approval of Synthetic Vision Systems, Synthetic Vision Guidance Systems and Aircraft State Awareness Synthetic Vision Systems*

AC 90-106B, *Enhanced Flight Vision System Operations*

Chapter 1

INTRODUCTION

1.1 PURPOSE, SCOPE AND USE OF THE MANUAL

1.1.1 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 or 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 (AOM). 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.*

1.1.2 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 or State of Registry.

1.1.3 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 AOM;

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 AOM 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.

1.1.4 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 authorization 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;

b) the provisions relevant to the State of the Aerodrome are contained in Chapter 3, Chapter 5, 5.2 to 5.4, and Chapter 7; 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, Chapter 6 and Chapter 7.

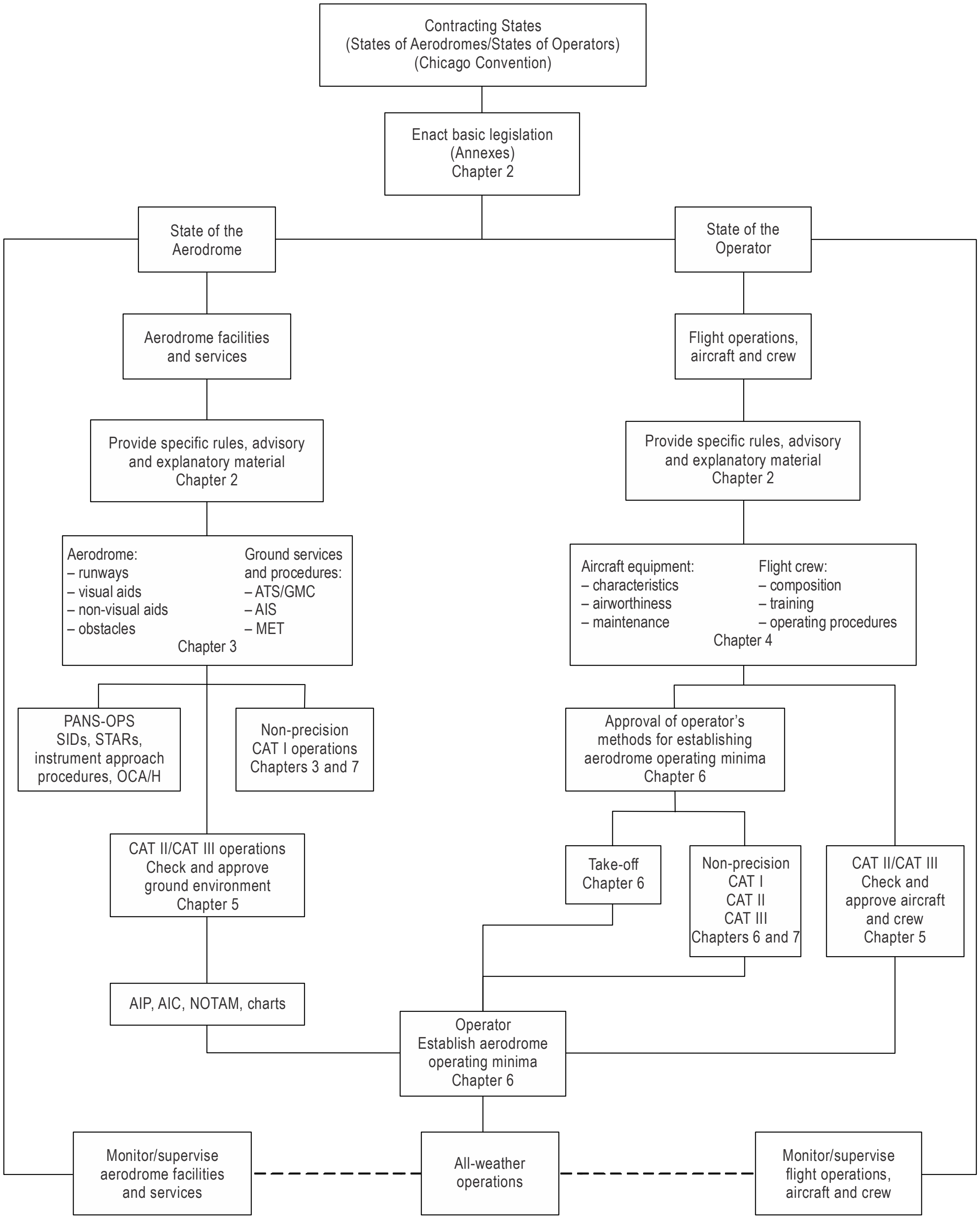


Figure 1-1. Relevant State responsibilities contained in this manual and cross-references to the relevant chapters

Chapter 2

GENERAL CONCEPTS

2.1 AERODROME OPERATING MINIMA

2.1.1 Components of aerodrome operating minima

2.1.1.1 The AOM 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 AOM 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 AOM.

2.1.1.2 Some States apply State minima in which case they publish the AOM in their AIP and/or in documents such as Operations Specifications. In such a case an operator will need to base the AOM 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 AOM 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 aircraft characteristics. Where there is a specific need to see and avoid obstacles on departure and/or for a forced landing, additional conditions (for example, ceiling) must be specified.

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

2.1.2 Traditional versus performance-based aerodrome operating minima

2.1.2.1 Traditionally, AOM have been strictly limited by the kind of instrument approach procedure (IAP) (for example, non-precision approach (NPA), approach procedure with vertical guidance (APV) or precision approach (PA)) and the type and category of operation performed. The AOM have also been closely linked to a fixed set of the external navigation means. However, Annex 6 now opens up a more flexible, performance-based approach by possibly granting operational credits for operations with advanced aircraft, as described below.

2.1.2.2 The close relationship with IAPs means that the OCA/H for a certain procedure will always be observed when establishing the relevant MDA/H and DA/H. The PBAOM, based on the combined capabilities of the external infrastructure and airborne systems, relates primarily to visibility/RVR, but also to the MDA/H and DA/H in relation to the values found in the respective definitions above OCA/H.

2.1.2.3 For the purpose of take-off and approach operations, aircraft have been designated as *basic* or *advanced* aircraft. These terms are particularly useful in relation to AOM.

2.1.2.4 Advanced aircraft are defined as those with equipment in addition to that required for a given take-off, approach or landing operation. Such additional equipment could be an AFCS capable of coupled approaches and/or an automatic landing system, head-up display (HUD) (for example, head-worn devices), enhanced flight vision systems (EFVS), combined vision systems (CVS) or synthetic vision guidance systems (SVGS). The amount of operational credit that may be granted to an operation using an advanced aircraft depends on the demonstrated capability of the airborne equipment. Training considerations are contained in Appendix I.

Note.— This definition is not identical to other definitions used for the purpose of airworthiness.

2.1.2.5 The requirements for instrument and non-instrument runways are contained in Annex 14 – *Aerodromes*. Visual aids need not necessarily be matched to the scale of the non-visual aids provided. The criterion for selecting visual aids depends on the conditions in which operations are intended to be conducted. Typically, the presence of more visual and non-visual aids on a runway equates to lower operating minima. However, the use of advanced avionics in modern aircraft can mitigate the need for some visual and non-visual aids and/or allow for lower operating minima on a runway. Annex 14 also allows for instrument approach operations on a non-instrument runway under certain conditions. Some States prescribe circling minima to be applied to such operations.

2.1.3 Operational credit

2.1.3.1 Operational credit is defined as:

A credit authorized for operations with an advanced aircraft enabling a lower aerodrome operating minimum than would normally be authorized for a basic aircraft, based on the performance of advanced aircraft systems utilizing the available external infrastructure.

2.1.3.2 This means that an advanced aircraft can operate in poorer weather conditions than a basic aircraft. This can be expressed as reduction of the required visibility/RVR and/or DA/H, satisfying the flight visibility requirements or requiring fewer ground facilities when adequately compensated by airborne capabilities. For example, an operational credit is where the required flight visibility for an IAP is achieved through a certified enhanced vision system (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.

2.1.4 Determining factors for surface movement

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 (LVO), aerodromes are commonly required to have low-visibility procedures (LVP) 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.

2.1.5 Determining factors for take-off and initial climb minima

2.1.5.1 For take-off, the visual reference available should be sufficient to enable the pilot to keep the aircraft 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.

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

2.1.5.3 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 aircraft systems such as an engine failure. It also should be ensured that once the aircraft is airborne, sufficient instrument guidance is available to enable a flight path to remain clear of obstacles.

2.1.5.4 At some locations, the onboard 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.

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

2.1.6 Determining factors for instrument approach operations

2.1.6.1 For approach and landing the specific considerations involved in the determination of AOM are:

a) the accuracy with which the aircraft 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 aircraft (for example, size, speed, missed approach performance) and equipment provided on-board (for example, HUD, automatic landing systems, vision systems) and of the ground environment (for example, 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 aircraft;

d) the flight technique applied: whether the final approach is flown applying a 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.

2.1.6.2 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 or 175 m (depending on State regulations) 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 aerodrome infrastructure to support operations at visibilities below about 150 m, as discussed in Chapter 5, 5.3.2.3.

2.1.7 Effect of navigation performance on landing minima

2.1.7.1 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 OCH and lower landing minima (that is, lower DA/H or MDA/H and visibility/RVR).

2.1.7.2 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. 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 legacy systems, such as non-directional beacon (NDB), VHF omnidirectional radio range (VOR) and instrument landing systems (ILS), are still in use, newer systems such as satellite-based augmentation system (SBAS) and ground-based augmentation system (GBAS) have emerged. 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.

2.1.7.3 The path of an aircraft on a PA or APV procedure is defined in the vertical dimension by procedure design. Precision and APV IAPs 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 an NPA procedure. As a result, in most cases minima will be lower.

2.1.7.4 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.

2.1.8 Visibility/runway visual range requirement

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 (TDZ). 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.

2.1.9 Continuous descent final approach

Utilizing a CDFA flight technique is recommended to reduce the risk of controlled flight into terrain (CFIT). Where a CDFA technique is not applied, for example, if a stepdown 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. In certain States, executing an NPA procedure without using a CDFA technique requires an operational approval which may increase the required visibility or RVR to aid in the visual transition to landing and to establish the aircraft’s final descent to land.

2.1.10 Approach ban policy

2.1.10.1 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.

2.1.10.2 The approach ban limits aircraft from proceeding beyond a point on an IAP, 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.

2.1.11 Relationship to runway definitions in Annex 14

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 AOM, which may be lower than the values in the definitions, in particular in cases granting operational credits.

2.2 PERFORMANCE-BASED APPROACH CLASSIFICATION

2.2.1 General

Performance-based navigation represents a shift from sensor-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, requirements are identified through the use of navigation specifications detailing the system functionality, training and procedures needed for the intended operation. This transition and the evolution of new navigation systems such as SBAS and GBAS require abandoning the old, sensor-based terms *precision* and *NPA* in favour of a new approach classification system related to performance-based specifications. This new system also better facilitates future development of navigation applications associated with approach and landing operations such as those based on advanced aircraft systems.

2.2.2 Procedures versus operations

2.2.2.1 Performance-based approach classification makes a clear distinction between IAPs and instrument approach operations.

2.2.2.1.1 An IAP is the instrument flight procedure allowing an aircraft to navigate on the final approach down to a given OCH, relying on a given type of navigational infrastructure. IAPs are classified as either:

a) an NPA procedure;

b) an APV; or

c) a PA procedure.

2.2.2.1.2 An instrument approach operation (two-dimensional (2D) or three-dimensional (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 operating minima and operating technique (type of vertical guidance).

2.2.2.2 Instrument approach operations are classified according to the operating minima specified for an approach and the operating technique 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 IAP may be designed to support a certain category of operation (for example CAT I) but the aircraft capabilities may allow for lower minima. The operating minima are categorized as:

a) Category I (CAT I): a DH 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;

b) Category II (CAT II): a DH lower than 60 m (200 ft) but not lower than 30 m (100 ft) and an RVR not less than 300 m;

c) Category III (CAT III): a DH lower than 30 m (100 ft) or no DH and an RVR less than 300 m or no RVR limitation;

Note.— Appendix J summarizes approach classification.

2.2.2.3 The operating techniques for executing an instrument approach are 2D or 3D. A 2D instrument approach operation uses LNAV guidance only, and a 3D instrument approach operation uses both LNAV and VNAV guidance. LNAV and/or VNAV 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. All 2D approach operations are flown to an MDA/H.

2.2.2.4 Examples of the navigation sensors used in 2D instrument approach operations include VOR, NDB, localizer (LOC), localizer performance (LP) and localizer type directional aid. Examples of navigation sensors used in 3D instrument approach operations include ILS, microwave landing system (MLS), GBAS and SBAS.

2.2.2.5 PBN IAPs are based on either the RNP APCH or RNP AR APCH navigation specification. For basic aircraft, procedures with minima lines labelled LNAV or LP are examples of procedures used in 2D approach operations. Advanced aircraft may be able to conduct 3D approaches using either Baro-VNAV or SBAS to provide vertical guidance. An APV is an example of a procedure designed for 3D instrument approach operations. Such procedures will have lines of minima labelled LNAV/VNAV and LPV. See Chapter 7 for additional information.

Note.— SBAS CAT I is classified as a PA and also uses minima lines labelled as LPV.

2.2.2.6 Benefits of performance-based approach classification include better alignment of 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 IAP. Under performance-based approach classification, the runway facilities needed are derived by the AOM applied regardless of the type of system used to fly the procedure.

2.2.2.7 For example, an ILS approach was classified as a PA procedure under the old system and would always require a precision approach runway regardless of the DA of the approach. With performance-based approach classification, an ILS approach operation with a DH or minimum descent height (MDH) of 75 m (250 ft) or higher can be performed on an NPA runway.

2.3 THE NEED FOR BASIC LEGISLATION

2.3.1 The State is responsible for ensuring the safe conduct of operations, including the development of legislation to implement 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 AOM, 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 aircraft 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 Aerodrome and the State of the Operator.

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 the *Safety Oversight Manual* (Doc 9734)). 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* (Doc 7300);

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 AOM 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 (ATS), 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) AOM;

   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) ATS, 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 aircraft 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 the *Procedures for Air Navigation Services – Aircraft Operations* (PANS-OPS, 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, ATS, navigation facilities and rescue and firefighting services available at the aerodrome; and

   2) NOTAM are used, among other things, to promulgate changes in the status of the aerodrome 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 of the 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 aircraft and equipment, for example, automatic landing 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, 6 and 7 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, aircraft 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 IAPs.

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 IAPs 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 (ATC) service should be required in order to provide safe separation between aircraft in the air and to avoid collisions on the ground between aircraft, vehicles and objects.

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 ATS and/or aeronautical information service (AIS). Their details should be included in a publication issued by the AIS described in 3.3.4.

3.1.5 Some aircraft carry additional equipment such as EVS, HUD or automatic landing system. Aircraft with such systems will be able to operate in conditions of lower visibility/RVR for any given set of aerodrome facilities or conversely operate at aerodromes with fewer facilities.

3.2 AERODROME FACILITIES AND REQUIREMENTS

3.2.1 General

3.2.1.1 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.

3.2.1.2 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.

3.2.2 Physical characteristics

3.2.2.1 Specifications for runways, taxiways and holding bays at an aerodrome are given in Annex 14, Volume I, and guidance on design is contained in 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.

3.2.2.2 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.

3.2.2.3 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 automatic landing, 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 aircraft 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).

3.2.3 Obstacle limitation surfaces

3.2.3.1 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 zone (OFZ) around the aerodrome.

3.2.3.2 At aerodromes, various visual and non-visual aids, for example: 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 (for example, 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.

3.2.3.3 Annex 14 recommends that 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 OCA/H for an IAP or have other operational impact on flight procedure design.

3.2.3.4 For this purpose, PANS-OPS (Doc 8168), Volume II – *Construction of Visual and Instrument Flight Procedures*, specifies the dimensions and requirements related to the protection for obstacles in the visual segment surface (VSS) to safeguard the visual phase of all IAPs where navigation is based on visual cues. According to PANS-OPS, 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 PANS-OPS, Volume II, Part I, Section 4, Chapter 5, 5.4.6.4.

3.2.3.5 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 PANS-OPS, Volume II, should be taken into account. Guidance on the control of obstacles is contained in the *Airport Services Manual* (Doc 9137), Part 6 – *Control of Obstacles*.

3.2.4 Visual aids

3.2.4.1 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 ALSs. The length and shape of the ALS play an essential role in the determination of landing minima.

3.2.4.2 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, RCLL, 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 (THR) lighting and markings provide a roll reference. Runway touchdown zone lights (RTZL) and markings indicate the plane of the runway surface and show the touchdown area providing vertical and longitudinal references.

3.2.4.3 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 (for example, fail-operational automatic landing system or HUD guidance through roll-out).

3.2.4.4 Visual aids are also important for the safe and expeditious guidance and control of taxiing aircraft. 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. RCLL and stop bars may be selectively operated to indicate the assigned routing as well as for the control of aircraft. Doc 9476 contains guidance on the selection of surface movement guidance and control system (SMGCS) aids and procedures.

3.2.4.5 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.

3.2.4.6 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.

3.2.4.7 Visual cues can also be obtained through approved EVS (see Chapter 6, 6.9).

3.2.5 Non-visual aids

3.2.5.1 The term "non-visual aids" refers to the navigation aids or position-fixing systems (for example, 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 IAPs are given in PANS-OPS (Doc 8168), Volume II.

3.2.5.2 Some approach aids provide azimuth and/or distance information only. Other approach aids provide vertical (that is, a glide path) information in addition to azimuth guidance and distance information.

3.2.5.3 Regardless of 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), LVP at the aerodrome need to be in force. Some States require LVPs for any automatic landing system operation. More information on automatic landing system operations is provided in Chapter 6, 6.10.

3.2.5.4 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).

3.2.5.5 To ensure that the integrity of the guidance signal radiated by the ground facility (that is, 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.

3.2.5.6 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.

3.2.5.7 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 3.2.5.5 applies.

3.2.5.8 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 automatic terminal information service (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.

3.2.5.9 It is possible for signals-in-space (SIS) 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.

3.2.5.10 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.

3.2.6 Secondary power supplies

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 – *Electrical Systems*, 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.

3.2.7 Movement area safety

For LVO, 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

3.3.1 General

3.3.1.1 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 ATS, a meteorological service and an aeronautical information service.

3.3.1.2 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 Doc 9137, Part 9 – *Airport Maintenance Practices.*

3.3.1.3 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.

3.3.2 Air traffic services

3.3.2.1 The criteria for the establishment of ATS are given in Annex 11 – *Air Traffic Services* and the *Procedures for Air Navigation Services – Air Traffic Management* (PANS-ATM, Doc 4444). For all-weather operations, additional guidance is also available in the *European Guidance Material on All Weather Operations at Aerodromes* (EUR Doc 013) and the *European Guidance Material on Management of ILS Critical and Sensitive Areas* (EUR Doc 040). The objectives of ATS 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.

3.3.2.2 When establishing ATS, 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 (for more details see EUR Doc 040);

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 IAPs 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.

3.3.2.3 ATC 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.

3.3.2.4 The provision of information to the aircraft flight crew by ATS 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 aircraft. 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.

3.3.2.5 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.

3.3.2.6 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.

3.3.3 Meteorological service

3.3.3.1 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).

3.3.3.2 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.

3.3.3.3 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.

3.3.4 Aeronautical information services

3.3.4.1 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).

3.3.4.2 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.

3.3.4.3 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.

3.3.4.4 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 IAPs, 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 IAP is to provide for the orderly progress of an aircraft operated under instrument flight rules (IFR), 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 IAP 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 IAP. 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 and for NPA operations, at or before the missed approach point (MAPt) and not lower than the MDA/H. The 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 unless otherwise authorized by the State of the Operator (see Chapter 4, 4.6.4). Where there is a need for specific missed approach procedures for each approach procedure (for example, 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 FAF 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 aircraft 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 IAP, SID and STAR should be established and published as an integral procedure designed to permit aircraft to navigate without radar vectoring. When radar vectoring is an essential part of the IAP, 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 aircraft types may also be a limiting factor (refer to PANS-OPS (Doc 8168), Volumes I and III, for details). Therefore, when IAPs, SIDs and STARs are established, they should be flight-checked for validity.

3.4.9 PANS-OPS, Volume I contains information concerning IAPs 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 IAPs 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 aircraft 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 IAPs, obstacle clearance has been closely related to the effective performance of the approach facilities in use and the operational performance and size of modern aircraft. 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 AIRCRAFT AND FLIGHT CREW

4.1 INTRODUCTION

When an aircraft is to be operated under 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 aircraft under IFR and trained in the use of the flight deck procedures required. This chapter describes a means of compliance with these requirements and 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 particular navigation specification are identified in Doc 9613, Volume II – Implementing RNAV and RNP Operations.

4.2 THE AIRCRAFT AND ITS EQUIPMENT

4.2.1 The provisions of Annex 6, Part I require that the aircraft 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 aircraft flight instruments and radio communication and navigation equipment should exist in addition to the basic requirements of Annex 6, Parts I, II and III, to support relevant instrument departure, arrival and approach operations. As a consequence, some States supplement Annex 6 by specifying the minimum aircraft equipment requirements for particular flight operations. The equipment listed in 4.2.3 is an example of such minimum requirements for the equipment that should be functioning in the aircraft for operations down to CAT I. This is a minimum requirement, and experience 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 Category I operations by aircraft 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) a 75 MHz marker beacon receiver and indicator (or equivalent); and

d) flight director – single with single display (prescribed by some States for turbine-engine aircraft); or

e) AFCS with ILS/MLS/GBAS/SBAS coupled approach mode; or

f) head-up, head-down or ED, and where appropriate, EFVS, SVGS, or CVS presentation with ILS/MLS/GBAS/SBAS guidance; or

g) RNAV/RNP system with a minimum of LNAV and VNAV guidance or control with an appropriate DA/H.

Note.— Aircraft with equipment such as HUD, EFVS, CVS or SVGS could be granted operational credit.

4.3 ADVISORY VERTICAL GUIDANCE

4.3.1 Positioning and navigation equipment may provide vertical path deviation guidance indications on a non-essential 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 procedures with LNAV/VNAV or localizer performance with vertical guidance (LPV) minima lines 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 4.3.1 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.

4.3.1.1 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.

4.3.1.2 When used in conjunction with NPA procedures:

a) the aircraft should not descend below the MDA unless visual references for the intended runway are distinctly visible and identifiable by the pilot;

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

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

d) the minimum crossing altitudes of stepdown fixes along the approach path must be complied with.

4.4 THE FLIGHT CREW

4.4.1 General

4.4.1.1 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 aircraft, 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).*

4.4.1.2 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 AOM 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.

4.4.2 Crew composition and training

4.4.2.1 Requirements for the minimum composition of the flight crew are contained in Annex 6, Parts I and III, 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 aircraft and monitoring of flight progress;

b) operation and monitoring of aircraft systems; and

c) decision-making.

4.4.2.2 For a period after initial qualification, and until sufficient experience is gained on a particular aircraft 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 pilots-in-command. The required margin and the required experience should be determined by the operator and approved by the State of the Operator.

4.4.2.3 An all-weather operations ground training programme should provide for all flight crew members instructions 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) aircraft-specific flight systems, instrumentation and display systems and the associated limitations;

c) changes, if any, to AOM 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 flight deck 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 aircraft 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 and where applicable, alert height;

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

k) the effect of system malfunction on auto-throttle or autopilot performance (for example: 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.

4.4.2.4 The all-weather operations programme for initial and recurrent training should provide FSTD and/or in-flight training on the particular aircraft 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, may not, or should be performed in an FSTD; and

b) which elements must be performed in the aircraft.

4.4.2.5 All-weather operations flight 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 aircraft, 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 aircraft, down to the specified operating minima, followed by a missed approach, all without external visual reference;

e) instrument approaches using the aircraft'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.

4.4.2.6 The frequency of system malfunctions introduced in the all-weather operations flight 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.

4.4.2.7 The recurrent training required by Annex 6, Parts I and III, to maintain pilot proficiency on an aircraft 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 recent experience requirement, that is, 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 recent experience requirement is in no way a substitute for recurrent training.

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

4.5 OPERATING PROCEDURES

4.5.1 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, Parts I and III, 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.

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

a) standardized flight crew procedures for instrument approaches applicable to the aircraft in question, including the allocation of flight crew duties in the operation of aircraft 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 CDFA technique for NPAs with emphasis on the importance of being stabilized at the required height above the runway THR;

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

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

4.5.3 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 aircraft 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 aircraft 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 MDA/H. The visual scene would normally be expected to expand as the aircraft descends. To assist the transition into visual conditions, the pilot's scan pattern should still include reference to the aircraft instruments below DA/H or MDA/H.

4.6 CONTINUOUS DESCENT FINAL APPROACH

4.6.1 Introduction

4.6.1.1 Controlled flight into terrain (CFIT) is a significant cause of worldwide commercial aviation fatal accidents. Unstabilized approaches are a key contributor to CFIT events.

4.6.1.2 Precision IAPs and APV have a continuous descent approach profile in their design. NPAs were not originally designed with this vertical path. Present NPAs are designed with and without stepdown fixes in the final approach segment. Stepdowns flown without a constant descent will require multiple thrust, pitch and altitude adjustments inside the FAF. These adjustments increase pilot workload and potential errors during a critical phase of flight.

4.6.1.3 Non-precision approaches designed without stepdown fixes in the final segment allow pilots to immediately descend to the MDA after crossing the FAF. The aircraft remains at the MDA until descending for the runway or reaching the missed approach point (MAPt). This practice, commonly referred to as “dive and drive”, can result in extended level flight as low as 70 m (250 ft) above the ground in instrument meteorological conditions (IMC) and shallow or steep final approaches. However, NPAs may easily be flown using the CDFA technique.

4.6.1.4 The goal of implementing CDFA is to incorporate the safety benefits derived from flying a continuous descent in a stabilized manner as a standard practice on an NPA. A stabilized approach is a key feature to a safe approach and landing. The stabilized approach concept is characterized by maintaining a stable approach speed, descent rate, vertical flightpath and configuration to the landing touchdown point.

4.6.1.5 A CDFA is a specific technique for flying the final approach segment of an NPA procedure as a continuous descent, without level-off, from an altitude/height at or above the FAF altitude/height to a point approximately 15 m (50 ft) above the landing runway THR or the point where the flare manoeuvre should begin for the type of aircraft flown. For the FAS of an NPA procedure followed by a circling, the CDFA technique applies until circling minima (circling MDA/H) or visual flight manoeuvre altitude/height are reached.

4.6.1.5.1 The CDFA is achieved by using a descent profile calculated by the on-board equipment such as Baro-VNAV or SBAS or using a manually calculated descent profile such as rate of descent or angle of descent. Some on-board equipment may calculate a descent profile as advisory guidance which may not be suitable for auto-coupling but may still provide a means to track this descent profile on the primary flight instruments. This provides an optimum descent path to supplement the LNAV guidance.

4.6.1.5.2 Continuous descent final approach with VNAV guidance calculated by on-board equipment such as Baro-VNAV or SBAS (see PANS-OPS (Doc 8168), Volume I, Part II, Section 5, Chapter 1, 1.8.2) are considered 3D instrument approach operations. PANS-OPS, Volume I, Part II, Section 5, Chapter 2, 2.5 addresses the use of Baro-VNAV on CDFAs and states that the Baro-VNAV system can only be used with a current local altimeter setting source. This restriction assumes that the Baro-VNAV is flown to a LNAV/VNAV line of minima on an APV. When the Baro-VNAV function is used to perform the CDFA on an NPA, it is not mandatory to have a current local altimeter setting source (see PANS-OPS, Volume II, Part III, Section 3, Chapter 4, 4.1). However, the OCH/A of the non-precision procedure would have to take into account the remote altimeter setting in accordance with PANS-OPS, Volume II, Part I, Section 4, Chapter 5, 5.4.5.3.

4.6.1.5.3 Continuous descent final approach with manual calculation guidance (such as time-to-height crosschecks of the required rate of descent or with vertical guidance not calculated using Baro-VNAV or SBAS) are considered 2D instrument approach operations. At a predetermined point, prior to reaching the MDA/H on the NPA procedure, a decision is to be made to either go-around or to continue the descent and make a landing within the TDZ. This is similar to the pilot’s action at DA/H on a precision or APV IAP. It is important to note that any descent below the MDA/H invalidates the obstacle protection provided by the MDA/H.

4.6.1.5.4 With some specific approach procedures or with specific aircraft types, in particular certain aeroplane types or classes in Categories A and B, there will be a need to change configuration when visual references are obtained. This chapter 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.

4.6.1.5.5 In all cases, regardless of the flight technique used, a cold temperature correction must be applied to all minimum altitudes (see PANS-OPS, Volume III, Section 2, Chapter 4, 4.3).

4.6.2 When to use the continuous descent final approach technique

4.6.2.1 For most IAPs 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 Annex 6 utilizing stabilized approach criteria. It is especially advantageous on NPA procedures with final approach course closely aligned to the runway, that is, runway heading is within 15 degrees of approach course for Category A or B aircraft or within 5 degrees for Category C and D aircraft.

4.6.2.1.1 While the CDFA technique is the preferred technique, there are cases where a typical CDFA technique may require adjustment. For example, on a straight-in approach offset from the runway centre line or, when a circling manoeuvre is anticipated, flying the CDFA to arrive at the MDA/H at a specific point that gives the pilot sufficient time and distance to line up with the landing runway. 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.

4.6.2.1.2 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 operator. If the approach is not stable at a critical moment, the pilot may need additional reaction time for the vertical manoeuvre.

4.6.3 Advantages of continuous descent final approach

4.6.3.1 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 THR and extends to an altitude which ensures that the vertical path will remain above all minimum crossing altitudes in the final approach segment. Ideally a 3 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 degrees, this may increase minima for aircraft in faster approach categories.

4.6.3.1.1 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.

4.6.3.1.2 There are many different methods to fly a CDFA technique; some are more accurate, more stable and safer than others. For example, it is more difficult and less accurate for a pilot to manually calculate the descent rate and meet all altitude restrictions than it is to fly a published vertical descent angle or an angle generated by the flight management system. The pilot-calculated rate of descent is still considered to be safer and more stable than the low-altitude level flight and multiple thrust changes required to fly a traditional 2D operation.

4.6.4 Continuous descent final approach and minimum descent altitude/decision altitude

4.6.4.1 Instrument approach procedures designed without vertical guidance are protected against obstacle until an MDA/H. The MDA/H is therefore the minimum descent altitude/height that must not be crossed if visual references are not acquired. It is determined from an OCA/H that does not take into account the aircraft's altitude loss during the go-around.

4.6.4.2 The CDFA technique requires a go-around if visual references are not acquired at a DA/H. The *D* no longer means *descent,* but instead *decision*. Approach procedures are designed to include safety buffers. A delay in the initiation of the missed approach manoeuvre at the MDA/DA may result in infringement of these buffers, particularly if the MAPt is located before the runway THR. Flight crews should always be prepared to initiate a missed approach procedure in advance.

4.6.4.3 When using the CDFA technique, operators have to convert the MDA into a DA. An operator may decide, as part of its management system, to add an increment to the MDA/OCH to convert it to DA.

4.6.4.3.1 An increment to the MDA, for conversion to a DA may be considered in the following cases:

a) at runways with obstacles that penetrate the VSS or have no obstacle assessment of the VSS, the operator may require flight crews to add an altitude increment to the MDA (for example, 9 m (30 ft), 15 m (50 ft), see 4.6.4.5) to determine the altitude at which the vertical transition to the missed approach should be initiated. This additional increment is to prevent descent below the MDA or transgression below the OCH and/or beyond the MAPt; and

b) operators should also consider adding an altitude increment when operating at new or unfamiliar aerodromes, or at aerodromes where there is low confidence in the reliability of obstacle or procedure data.

Note.— Such an increment does not warrant any increase to the RVR or visibility requirements for the approach.

4.6.4.3.2 The addition of a margin is less important when NPAs are operated in 3D. In this case, the management of the vertical plane is as precise as during the realization of APV (Baro-VNAV) approaches and the crews now practicing almost exclusively 3D operations have more experience of this type of operations and of the way to manage the decision-making at the DA.

4.6.4.3.3 Using MDA as a DA should be permitted in the following cases:

a) at runways with existing IAPs with vertical guidance, where vertical obstacle clearance has already been verified to the DH of these procedures. At these runways, it is reasonable to assume safe vertical obstacle clearance using a CDFA technique to fly an NPA procedure using DA in lieu of MDA if the final approach course is aligned with the APV or ILS final approach course, the DA is not lower than the DA of the APV and the vertical descent angle is the same angle as the APV or ILS glide slope or vertical descent angle. If the vertical descent angle of the CDFA is greater, additional height loss at go-around must be accounted for; and

b) at runways with an IAP without vertical guidance (an NPA), if the approach is flown using a CDFA technique. Operators should evaluate the obstacle environment in the visual segment surface (VSS) to determine if it is safe for pilots using a CDFA technique to descend briefly below the MDA/H when executing a missed approach.

4.6.4.4 Any turning manoeuvre associated with the missed approach should be initiated no earlier than the MAPt.

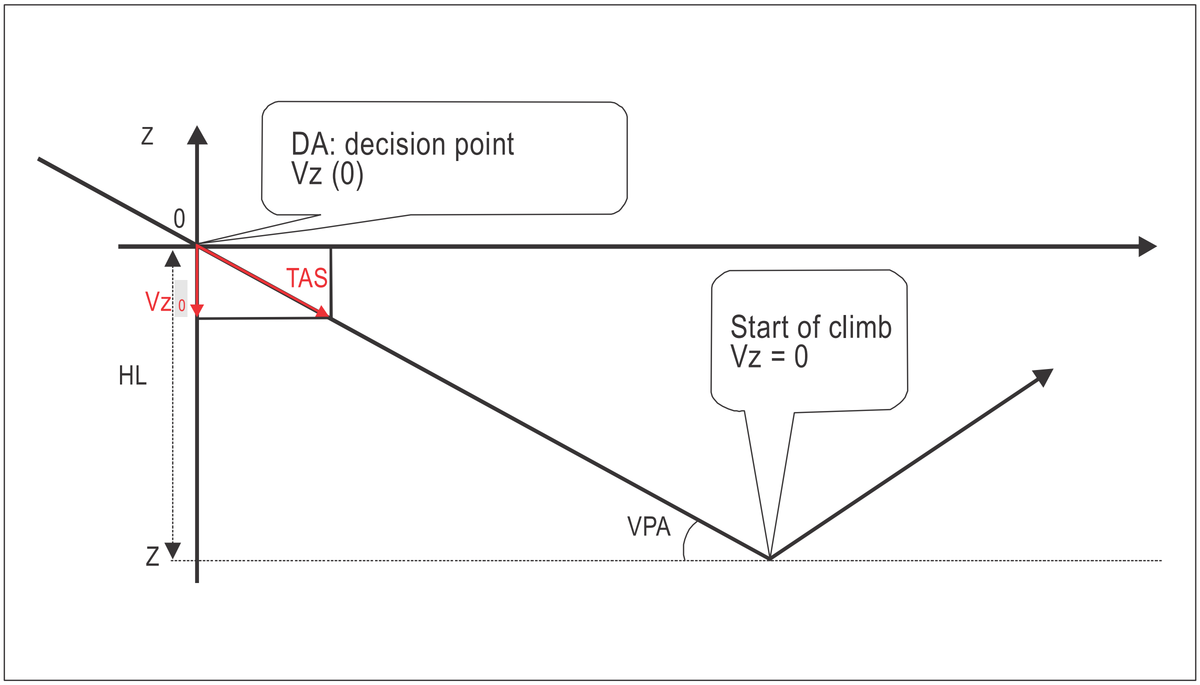
Note.— Some States consider the operational use of CDFA techniques when developing and promulgating non-precision IAPs and promulgate a vertical descent angle (when suitable) as part of the procedure. This angle should be equal to or higher than that providing compliance with all minimum altitudes in the final approach segment (MDA, stepdown, FAF altitudes). Some States utilize other ground based or procedural vertical guidance to ensure obstacle clearance along the vertical flight path, such as a runway visual glideslope indicator (VGSI), provided the VGSI characteristics are suitable (angle, THR crossing height, etc.).

4.6.4.5 For operators deciding to add a margin, recommended margins according to the aircraft category are provided in Table 4-1. This table is provided as a guide to assist operators who may have determined, based on their management system, the need to add a margin to the MDA or OCH of an NPA in order to convert it to DA. The value of the margin depends on the category of aircraft.

Table 4-1. Example of margins to convert an MDA/OCH into DA

Aircraft category	*Add-on*
A	6 m (20 ft)
B	9 m (30 ft)
C	12 m (40 ft)
D	18 m (60 ft)

4.6.4.6 Figure 4-1 illustrates the method to calculate height loss as a function of true airspeed. The samples in Table 4-2 show how this can be applied.



Legend:

Vz: aircraft vertical speed
Vz_0: aircraft vertical speed at decision point
γ: aircraft vertical deceleration at TOGA action

Z: aircraft height
VPA: vertical path angle
TAS: true airspeed

HL: Height Loss
t: time

$Vz_0 = -$ TAS sin (VPA) (negative, as z- axis is considered positive upwards)

$Vz = \gamma\, t + Vz_0$

$Z = \frac{1}{2}\gamma\, t^2 + Vz_0\, t$ (considering Z = 0 at DA)

$Vz = 0$ for $t = -Vz_0 / \gamma$

at Vz = 0 , $Z = \frac{1}{2}\, 1/\gamma\, (Vz_0)^2 - 1/\gamma\, (Vz_0)^2 = -\frac{1}{2}\, (Vz_0)^2 / \gamma = -\frac{1}{2}\, [TAS \sin (VPA)]^2 / \gamma$

therefore $HL = \frac{1}{2}\, [TAS \sin (VPA)]^2 / \gamma$

Figure 4-1. Determination of height loss (without ground effect) as a function of true airspeed

Table 4-2. Sample calculations for height loss

IAS = 100 kt (Category A aeroplane) and VPA = 3°	$TAS_{(2000\ ft,\ ISA+15°)}$ = 105.7 kt = 54.4 m/s with γ = 0.08g = 0.08 x 9.81 = 0.785 m/s^2 HL = 5.16 m (16.94 ft)
IAS = 130 kt (Category B aeroplane) and VPA = 3°	$TAS_{(2000\ ft,\ ISA+15°)}$ = 137.4 kt = 70.7 m/s with γ = 0.08g = 0.08 x 9.81 = 0.785 m/s^2 HL = 8.72 m (28.61 ft)
IAS = 160 kt (Category C aeroplane) and VPA = 3°	$TAS_{(2000\ ft,\ ISA+15°)}$ = 169.1 kt = 87.0 m/s with γ = 0.08g = 0.08 x 9.81 = 0.785 m/s^2 HL = 13.20 m (43.32 ft)
IAS = 185 kt (Category D aeroplane) and VPA = 3°	$TAS_{(2000\ ft,\ ISA+15°)}$ = 195.5 kt = 100.6 m/s with γ = 0.08g = 0.08 x 9.81 = 0.785 m/s^2 HL = 17.65 m (57.92 ft)

4.6.5 Training

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 IAPs to be flown.

4.6.6 Visual descent point – non-continuous descent final approach technique

4.6.6.1 If the CDFA technique is not used, 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 = HATh (in feet)/300

For example, the height above touchdown for a localizer only IAP is 600 ft.

VDP = 600/300 = 2

4.6.6.2 The pilot should begin the descent from MDA when the aircraft is two miles from the THR of the runway. If distance measuring equipment (DME) is available, the pilot can convert the VDP to DME. If the DME is located 2.4 km (1.5 miles) behind the THR, the VDP will be 3.5 DME.

4.6.6.3 Some States 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 runway at the normally expected descent angle. However, this could be true of any NPA even if it is flown with the CDFA technique. Therefore, pilots must be especially vigilant any time 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.

4.7 VISUAL APPROACHES

4.7.1 Introduction

A visual approach is conducted under IFR, on an IFR flight plan, using visual references and allows 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 ATC facility, and ATC may authorize this approach when it becomes operationally beneficial. Visual approaches are used to reduce pilot and 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.

4.7.2 Visual approach techniques

4.7.2.1 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 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.

4.7.2.2 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 90 m (300 ft) of altitude for everyone 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.

4.7.2.3 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 aircraft 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.

4.7.2.4 Some States publish charted visual flight procedures (CVFP). CVFPs are normally established for environmental or 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.

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Chapter 5

ADDITIONAL REQUIREMENTS FOR CATEGORY II AND III OPERATIONS

5.1 GENERAL

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 aircraft 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 recent experience;

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 (for example, 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

5.2.1 Initial planning considerations

5.2.1.1 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 PA 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.

5.2.1.2 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 IAPs are promulgated.

5.2.2 Runways and taxiways

Specifications and guidance on the physical characteristics of runways and taxiways are contained in Annex 14, Volume I, and Doc 9157, Parts 1 – *Runways* and 2 – *Taxiways, Aprons and Holding Bays*. 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.

5.2.3 Obstacle limitation criteria

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 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.

5.2.4 Pre-threshold terrain

5.2.4.1 Annex 4 requires that a PA 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 THR can be affected by the profile of the terrain immediately prior to the THR. The terrain which is most critical lies in an area 60 m (200 ft) either side of the runway centre line extending into the approach area to a distance of at least 300 m (1 000 ft) before the THR (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 aircraft 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 autoflight behaviour may result as follows:

a) where the terrain under the approach is markedly lower than the THR, 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 THR, 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.

5.2.4.2 Where the characteristics of the terrain are considered marginal for a particular aircraft 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.

5.2.4.3 In accordance with Annex 4, Chapter 6, the PA terrain chart depicts a profile of the terrain to a distance of 900 m (3 000 ft) from the THR 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 THR.

5.2.5 Visual aids

Note.— This section applies to standard CAT II operations. Operational credit, as for Special Approval Category II Operations (SA CAT II), is treated separately.

5.2.5.1 Approach, THR, TDZ, 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.

5.2.5.2 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.

5.2.5.3 Stop bars are valuable aids to safety and ground traffic flow control in LVO. 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 aircraft, 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.

5.2.5.4 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 – *Visual Aids*.

5.2.6 Non-visual aids

The ILS/MLS/GBAS 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 such as GBAS. The quality of the ILS/MLS/GBAS SIS 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/MLS/GBAS 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 aircraft. The ILS/MLS/GBAS SIS should be flight-checked in order to confirm that it meets in all aspects the appropriate Standards of Annex 10, Volume I.

5.2.6.1 Instrument landing system

Note.— Guidance on the ILS facility classification and downgrading can be found in Chapter 6, 6.6.5 and Appendix C.

5.2.6.1.1 All facilities associated with the ILS ground equipment should be monitored in accordance with the requirements of Annex 10, Volume I. Guidance material on ILS 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.

5.2.6.1.2 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 5.2.6.1.2.

5.2.6.1.3 To ensure that the integrity of the guidance signal radiated by the ILS is maintained during aircraft 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 aircraft contributes to the integrity of ILS guidance signals.

Note 1.— Additional information on the operational management of ILS critical and sensitive areas can also be found in EUR Doc 040.

Note 2.— Aircraft can be expected to be using the ILS signal or GLS operations enabled by GBAS as the primary means of navigation when the weather conditions are IMC and the aircraft is in the final approach segment of the IAP.

5.2.6.1.4 The reliability (that is, 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.

5.2.6.2 Microwave landing system

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 MLS critical area, is called the MLS sensitive area. The extent of MLS sensitive areas will vary with the characteristics of the MLS 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 MLS sensitive areas may be determined. Since it is not practicable to develop precise criteria covering all cases, the size and shape of MLS sensitive areas for a particular category of operation should be determined by the State concerned.

Note.— Some States do not distinguish between MLS critical and MLS sensitive areas as defined in Annex 10. These States define an area larger than that defined in Annex 10 but still called the MLS 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.

5.2.6.3 Ground-based augmentation system

All facilities associated with the GBAS ground equipment should be monitored in accordance with the requirements of Annex 10, Volume I. Guidance material for GBAS is contained in Annex 10, Volume I, Attachment D, Section 7.

5.2.7 Secondary power supplies

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

5.3.1 Aerodrome safety assessment

5.3.1.1 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 aircraft from aircraft or from vehicles. Guidance on such systems is given in Docs 9476 and 9830.

5.3.1.2 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 aircraft operators and other organizations with movement-area access of the commencement of the more restrictive measures; and

h) developing appropriate emergency procedures.

5.3.1.3 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 LVO and examples of LVP are given in Doc 9476.

5.3.2 Surface movement control of aircraft and vehicles

5.3.2.1 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 advanced surface movement guidance and control system (A-SMGCS) operational requirements in order to facilitate implementation of various functions in modular form depending on specific local aerodrome circumstances.

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

5.3.2.3 Flight crews can be expected to see and avoid other ground traffic down to visibilities in the order of 400 m (1 300 ft). 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.

5.3.3 Security and surveillance

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 (that is, security fences around the aerodrome, 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.

5.3.4 Air traffic services

5.3.4.1 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.

5.3.4.2 Information on the status of relevant supporting systems (for example: 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 (for example automatic landing system or HUD guidance) and relevant low-visibility weather-reporting capability may need to be conveyed with more detail, suited to the operations being conducted (for example, particular RVR reporting equipment is inoperative). Although the general guidance in Chapter 3, 3.3.2.6, 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 (or when specifically requested by the pilots):

a) as a minimum, information should be provided in accordance with 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 take-off in low-visibility, 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.

5.3.4.3 Because ILS signals can be disturbed by reflections caused by aircraft overflying the localizer or azimuth antenna, ATC follows appropriate procedures so that, during ILS operations, a departing aircraft will fly past the ILS localizer antenna before the arriving aircraft 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 aircraft is critically dependent on the quality of the SIS. For the same reason, additional longitudinal separation may be required between successive landing aircraft which may affect the capacity of the aerodrome. GLS does not have these restrictions. Appropriate ATC procedures should be developed at those locations where CAT II or III operations are planned, based on experience gained during CAT I operations.

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

5.3.4.5 ATC should recognize the need for aircraft 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.

5.3.5 Meteorological services

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.

5.3.6 Aeronautical information services

The requirements for AIS, given in Chapter 3, 3.3.4, apply to CAT II and III operations.

5.3.7 Minimum ground system requirements for Category II and III operations

The minimum requirements for ground system facilities are in Annex 14, Volume I. It may be expected that all the facilities detailed in 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 IAPs. 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 OFZs are met (see 5.2.3).

5.5 THE AIRCRAFT AND ITS EQUIPMENT

5.5.1 General

5.5.1.1 The physical characteristics of the aircraft should be considered in the determination of AOM. Most relevant for the determination of AOM 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.

5.5.1.2 The instruments and equipment for CAT II and III operations should comply with the airworthiness requirements of the State of Registry of the aircraft. In addition, aircraft 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 DH 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.

5.5.1.3 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.

5.5.2 Reporting system

5.5.2.1 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.

5.5.2.2 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 aircraft's position relative to the centre line and glide path when descending through 30 m (100 ft).

5.5.2.3 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.

5.5.2.4 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.

5.5.3 Aircraft equipment requirements

Developments in aircraft 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.

5.5.4 Performance requirements for initial approval of airborne systems

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 aircraft flight manual (AFM). 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 aircraft as a whole for approach and landing in restricted visibility (that is, for CAT II and III operations).

5.5.5 Airborne system approval

5.5.5.1 Category II

ILS/MLS/GLS 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.

5.5.5.2 Category III

In addition to the requirements for CAT II operations, acceptable touchdown performance requirements for CAT III operations should be demonstrated during the certification or operational evaluation programme by successfully completing a sufficient number of landings, supported by an FSTD 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.

5.5.5.3 Maintenance

5.5.5.3.1 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 5.5.2. 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.

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

5.5.5.4 Magnetic variation data and on-board database

5.5.5.4.1 Discrepancies 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 automatic landings 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 display a flag or disengage the autopilot.

5.5.5.4.2 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 automatic landing capability.

5.5.5.4.3 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 automatic landing at aerodromes where they intend to operate. Some manufacturers will list in bulletins the aerodromes where autoflight and automatic landing 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. Flight crews should use caution when conducting autoflight and automatic landing 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 AOM 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 aircraft 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/MLS/GLS 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 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 AOM 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

5.7.1 General

5.7.1.1 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.

5.7.1.2 Before conducting CAT II or III operations, the flight crew should complete a suitable programme of training and qualification. The particular programme of training will be related to the aircraft 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.

5.7.1.3 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 aircraft and monitoring of the AFCS performance throughout all phases of the approach, flare, touchdown and roll-out.

5.7.1.4 Flight crews should be required to demonstrate their competency to the appropriate authorities. They should have gained sufficient flight experience on the aircraft 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.

5.7.2 Ground training

5.7.2.1 Flight crews and flight operations officers/flight dispatchers (where relevant) 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 (for example, ILS, MLS, GLS), including the effect on aircraft system performance of interference to the ILS signal caused by other landing, departing or overflying aircraft, and the effect of the infringement of ILS critical and sensitive areas by aircraft or vehicles in the manoeuvring area;

b) the characteristics of the visual aids (for example, approach lighting, RTZL, RCLL) and the limitations on their use as visual cues in reduced visibility with various glide path angles and flight deck 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 (for example, the AFCSs; monitoring and warning devices; flight instruments, including altimetry systems; and the means the pilot has to assess the position of the aircraft 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 aircraft 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 DH, 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 (RDH);

i) action to be taken if the visual reference becomes inadequate when the aircraft is below DH 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 DH;

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

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

n) effect of specific aircraft malfunctions (for example, 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.

5.7.2.2 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 Doc 9625.

5.7.2.3 In actual operations some approaches may result in the aircraft being off centre line or glide path at, before or after DH. 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 aircraft 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.

5.7.3 Flight training and proficiency programme

5.7.3.1 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.

5.7.3.2 Initial flight 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 aircraft 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 aircraft down to the appropriate minimum height, followed by missed approaches, all without external visual reference;

c) approaches utilizing the AFCS and automatic 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 AFCS and automatic 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 DH which may result in a touchdown on the runway in cases of a go-around initiated from a very low altitude, for example, such as to simulate failures or loss of visual reference prior to touchdown.

Note.— Guidance on FSTD qualification is contained in Doc 9625.

5.7.3.3 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 as to undermine the confidence of flight crews in the overall integrity and reliability of the systems used in low minima operations.

5.7.4 Simulation techniques

5.7.4.1 Simulation techniques are a valuable training aid for limited visibility operations. FSTDs should be used for general training in the aircraft 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 aircraft 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 Doc 9625.

5.7.4.2 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 RCLL or runway edge lights which are visible with the FSTD aligned for take-off, to the selected RVR. It is preferred, however, that checks also be made of the visual references with the FSTD in the flying mode because the static and dynamic visual scenes may differ in some visual systems.

5.7.5 Recurrent proficiency checks

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.

5.7.6 Recent experience requirements

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 recent experience requirement, that is, 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 recent experience requirement is in no way a substitute for recurrent training.

5.7.7 Training and qualification for Category II or III operations

5.7.7.1 Commercial air transport operations

5.7.7.1.1 The training and qualification of flight crew members should be initially accomplished and maintained in accordance with 5.7.2, 5.7.3, 5.7.5 and 5.7.6. 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.

5.7.7.1.2 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 proficiency checks of 5.7.5, so that 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.

5.7.7.2 General aviation operations

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. Recurrent proficiency checks and recent experience should be conducted in accordance with 5.7.5 and 5.7.6. 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 General

6.1.1.1 In accordance with Annex 6, Part I, Chapter 4, 4.2.8.1, the State of the Operator must require that an operator establish AOM. 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 its obligations, the State of the Aerodrome is required to publish data (for example, OCA/H, precise details of visual and electronic aids, pre-threshold terrain, obstacles) necessary for the operator to determine the appropriate AOM. 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.

6.1.1.2 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 2D and 3D instrument approach operations and CAT II and III LVO, 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 AOM 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.

6.1.1.3 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 aircraft 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.

6.1.2 Authorization of the aircraft and its equipment

Authorization of the aircraft 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 AOM 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 AFCS 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 aircraft in limited visibility conditions, such as the procedures to be followed if the aircraft's climb performance after take-off or during a missed approach is seriously reduced with an engine inoperative.

6.1.3 Authorization of the use of the aerodrome

6.1.3.1 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 AOM 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 IAPs are constructed, for example, by consulting the PANS-OPS (Doc 8168), Volume II or the United States Standard for Terminal Instrument Procedures (TERPS). In all cases, the operator should ensure that the IAP is compatible with the type of aircraft being flown.

6.1.3.2 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.

6.1.4 Authorization of the flight crew

6.1.4.1 In fulfilling the requirements of Annex 6, 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 AOM.

6.1.4.2 Annex 1 and Annex 6, Part I, requires 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, 4.4, and, where required for take-off in low-visibility 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 aircraft type with restricted (higher) minima before being authorized to use the lowest approved minima.

6.1.4.3 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.

6.1.5 Authorization of the operation

6.1.5.1 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.

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

a) sufficient AOM 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.

6.1.5.3 The operator may be authorized to carry out operations in limited visibility by the issue of a specific approval indicating the AOM which may be applied.

6.2 AERODROME OPERATING MINIMA

6.2.1 Introduction

6.2.1.1 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 aircraft may be expected to have available the external visual reference required for the control of the aircraft 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 aircraft during the visual phase of the approach, landing and roll-out.

6.2.1.2 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.

6.2.1.3 The combination of instrument information and visual references required for making the land or 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 aircraft'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, for example, the pilot should have a lateral reference such as a crossbar on the approach lights or the landing THR. 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 ALS;*

2) *THR;*

3) *THR markings;*

4) *THR lights;*

5) *THR identification lights;*

6) *visual glideslope indicator (VGSI);*

7) *TDZ or TDZ markings;*

8) RTZL;

9) runway edge lights; or

10) other visual references accepted by the authority.

b) For CAT III operations with DA/H (for example, fail-passive operations), the requirement is for a view of RTZL or TDZ markings which will give visual confirmation of the on-board system indications that the aircraft 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 approach and landing guidance system (HUDLS) not having roll-out guidance capability, a DH is required.

d) For fail-operational CAT III operations, without DH, 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 DH is not required.

6.2.1.4 There is considerable agreement on the principles involved in the determination of AOM by those States having experience in LVO. In current operations, the AOM 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 AOM. 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 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.

6.2.2 States' harmonization efforts

6.2.2.1 In the mid-1990s, several European States and the FAA formed working groups for the development and implementation of harmonized AOM. The aim was to establish a set of minima covering those approach procedures, which today are called non-precision, APV and precision IAPs, 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 visibility/RVR 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.

6.2.2.2 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 IAPs designed with vertical guidance where the descent angle typically ranges from 2.75 to 3.5 degrees.

6.2.3 Tables of aerodrome operating minima

6.2.3.1 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.

6.2.3.2 The tables of operating minima in this section 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. These tables of operating minima 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 flight deck instrumentation typical of multi-engine turbine aircraft;

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

c) comprehensive programmes for airworthiness, with any necessary equipment operational (such as 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 aerodrome configurations, obstruction clearance, surrounding terrain, and other characteristics typical of major facilities serving scheduled international operations;

g) routine low-visibility weather conditions (for example, 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 air transport aeroplanes)

Facilities	*Visibility/RVR*[1]
Adequate visual reference[2] (day only)	500 m/1 600 ft
Runway edge lights or runway centre line markings[3]	400 m/1 300 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/650 ft
Runway edge lights and runway centre line lights and relevant RVR information[4]	TDZ 150 m MID 150 m Stop-end 150 m
High intensity runway edge lights and runway centre line lights (spacing 15 m or less) and relevant RVR information[4]	TDZ 125 m MID 125 m Stop-end 125 m
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 MID 75 m Stop-end 75 m

1. The TDZ visibility/RVR 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 aircraft in normal and non-normal configurations pertinent to the operation. In addition, in the non-normal configuration, the aircraft 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 AFM, 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 AFM, 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 authorized for EDTO operations and the aircraft has been dispatched in accordance with applicable EDTO requirements. Refer to Appendix D for additional information.

6.4 NON-PRECISION APPROACH MINIMA

6.4.1 Introduction

6.4.1.1 In VOR, LOC or NDB approach procedures, or for RNP approach procedures without approved vertical guidance, 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 VNAV 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/RNP system provides VNAV guidance that can be used as advisory VNAV information on a traditionally designed "non-precision" approach.

6.4.1.2 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 IAP designed with VNAV guidance, 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 NPA procedures than for precision/APV approach procedures. The criteria for obstacle clearance for approach procedures are contained in PANS-OPS (Doc 8168), Volume II.

6.4.2 The height element of approach minima for non-precision approach procedures

6.4.2.1 The height element in the minima of a VOR, LOC or NDB approach procedure, or an RNP approach procedure designed without VNAV guidance, is the MDA/H. It is the altitude/height below which the aircraft should not descend unless the runway environment, that is, the runway THR, touchdown area, elements of the approach lighting or markings identifiable with the runway, is in sight and the aircraft is in a position for a normal visual descent to land.

6.4.2.2 The MDA/H is based upon the OCA/H. The MDA/H may be higher than, but never lower than, the OCA/H. The method of determining the OCA/H is given in PANS-OPS, Volume II, and the relationship between MDA/H and OCA/H is illustrated in PANS-OPS, Volume I. This covers VOR, LOC or NDB approach procedures, or RNP IAPs that were not designed with VNAV 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.

6.4.3 The visibility element of approach minima for non-precision approach procedures

6.4.3.1 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) aircraft having slow approach speeds;

b) lower MDA/H; and

c) better visual aids.

6.4.3.2 The DH is based on the MDH if the procedure is flown utilizing a CDFA technique instead of a level flight segment at MDA (see Chapter 4, 4.6.4.3.3).

6.4.3.3 The application of these criteria by States results in visibility minima for NPA 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.

6.4.4 Circling approach minima

6.4.4.1 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 aeroplane 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.

6.4.4.2 The circling areas are based on arcs measured from runway THRs and connected by tangents. The radii of the arcs are calculated based on aerodrome elevation and maximum indicated airspeed (IAS) values for aeroplane categories A, B, C and D. Previously, significant differences existed in the applied criteria between procedures designed in accordance with PANS-OPS and the United States TERPS. This resulted in markedly larger circling areas for PANS-OPS-designed procedures than for procedures designed in accordance with the United States TERPS criteria. A change to the United States 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 United States TERPS circling criteria, the radii of the circling areas used in PANS-OPS are still larger than those used in United States TERPS due to the different methods applied for TAS calculation and different bank angles used in PANS-OPS and United States 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 (Doc 8168), Volume I.
2. These circling approach visibility values differ from those in PANS-OPS (Doc 8168), Volume I since the visual manoeuvring (circling) approach values in Table I-4-7-3 of Doc 8168, Volume II are not intended for the establishment of operating minima.

Notes.—

1. 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 IAP.

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 IAP.

6.5 APPROACH PROCEDURE WITH VERTICAL GUIDANCE AND PRECISION APPROACH MINIMA

6.5.1 General

The AOM for APV and PA procedures are expressed in terms of visibility and/or RVR and DA/H. APV are PBN approach procedures designed for 3D instrument approach operations (DH at or above 75 m (250 ft)). PA procedures are IAPs based on navigation systems (ILS, MLS, GLS, SBAS CAT I).

6.5.2 Approach procedure with vertical guidance

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

a) those based on barometric altitude, that is, LNAV/VNAV; and

b) those based on SBAS (LPV).

6.5.2.2 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 RDH.

6.5.2.3 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.

6.5.2.4 APV/Baro-VNAV approach procedures are promulgated with a DA/H. They should not be confused with classical NPA procedures that have an MDA/H below which the aircraft must not descend.

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

Note 1.— A complete description of APV/Baro-VNAV approach procedures may be found in PANS-OPS (Doc 8168), Volume II.

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

6.5.3 Standard Category I operations

A standard CAT I operation is a 3D instrument approach operation to a DH not lower than 60 m (200 ft) and with either a visibility not less than 800 m (2 600 ft) or an RVR not less than 550 m. CAT I operations are flown only on precision IAPs (ILS, MLS, GLS and SBAS CAT I).

6.5.4 Decision altitude/height

6.5.4.1 The DA/H should not be lower than:

a) the minimum height stated in the aircraft airworthiness certification or operating requirements to which the aircraft 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.

6.5.4.2 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 aircraft geometry, aircraft performance, offset final approach course and atmospheric turbulence.

6.5.4.3 In some cases there are runways where the ILS/MLS/GLS/LPV RDH 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 THR. Where there is a displaced THR or there is adequate underrun of sufficient strength available, there is no need for additional visibility/RVR. This situation should be clearly depicted on the approach chart.

6.5.4.4 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 AFM or equivalent document which indicates the minimum height for committal to a landing following an approach with an engine inoperative.

6.5.4.5 When using an offset final approach course, the aircraft 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 THR. Additional altitude will need to be added to the approach minima to allow for this manoeuvre.

6.5.4.6 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 minimum obstacle clearance (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.

6.5.5 Visibility/runway visual range

6.5.5.1 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.

6.5.5.2 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.

6.5.5.3 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)".*

6.5.5.4 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.

6.5.5.5 The difference between the distance that a pilot can see from a position on the approach and the measurements made on the ground is therefore a variable that can only be expressed in statistical terms, and no specific relationship for a particular approach can 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.

6.5.5.6 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 aircraft structure, and the type of visual aids. With a higher DA/H and larger aircraft, 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 ALS will require less visibility.

6.5.5.7 Some visual factors tend to cancel each other out. For example, in large aircraft the pilot eye height above the main landing gear wheels is generally great; this undesirable feature is generally compensated for by equipping the aircraft 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 aircraft 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 aircraft using automatic equipment will be the same as for small to medium-sized aircraft that are flown manually. A greater RVR may be required for manual operation of large aircraft with high approach speeds.

6.5.5.8 Although the ICAO standard ALS for a runway using ILS or MLS is 900 m (3 000 ft) 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 TDZ is about 1 100 m (3 600 ft) ahead of the aircraft. 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 TDZ. Conversely, with full approach, TDZ, runway THR, 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.

6.5.5.9 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 III. It must be emphasized that these are nonmandatory examples that some States use but operators must adhere to the minima promulgated by the State of the Aerodrome.

6.5.5.10 In order to qualify for the lowest allowable values of RVR detailed in Table 6-3 (applicable to each approach grouping), the IAPs 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 IAPs 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 IAPs 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 Category A and B aeroplanes or by not more than 5 degrees for Category 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 would be 4.5 degrees for Category A and B aeroplanes and 3.77 degrees for Cat C and D aeroplanes (see 6.2.2.2).

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

a) CAT I operations to runways with full approach lighting system (FALS) (see Appendix B), RTZL and 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.

Note.— Publishing the ILS facility classification, as described in Annex 10, Volume I, is not a requirement. If the facility classification has not been published by a State, it must then be assumed that the facility is only meeting the minimum requirements for the intended operation. See Appendix C for more information about ILS facility classification and Table C-1 for details on the relationship between ILS facility classification and operational minima.

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

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

b) if the approach operation is based on NDB, NDB/DME, VOR, VOR/DME, LOC, LOC/DME, VDF, SRA and RNAV without approved vertical guidance but fulfilling the criteria in 6.5.5.10.

6.5.5.13 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 6.5.5.10 are not fulfilled; or

b) the DH or MDH is 400 m (1 300 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 III

DH or MDH (ft)			*Class of lighting facility*					DH or MDH (ft)			*Class of lighting facility*			
			FALS	*IALS*	*BALS*	*NALS*					*FALS*	*IALS*	*BALS*	*NALS*
			RVR (metres)								*RVR (metres)*			
			See 6.5.5.11 for RVR < 750 m								*See 6.5.5.11 for RVR < 750 m*			
200	–	210	550	750	1 000	1 200		541	–	560	1 800	2 100	2 300	2 500
211	–	220	550	800	1 000	1 200		561	–	580	1 900	2 200	2 400	2 600
221	–	230	550	800	1 000	1 200		581	–	600	2 000	2 300	2 500	2 700
231	–	240	550	800	1 000	1 200		601	–	620	2 100	2 400	2 600	2 800
241	–	250	550	800	1 000	1 300		621	–	640	2 200	2 500	2 700	2 900
251	–	260	600	800	1 100	1 300		641	–	660	2 300	2 600	2 800	3 000
261	–	280	600	900	1 100	1 300		661	–	680	2 400	2 700	2 900	3 100
281	–	300	650	900	1 200	1 400		681	–	700	2 500	2 800	3 000	3 200
301	–	320	700	1 000	1 200	1 400		701	–	720	2 600	2 900	3 100	3 300
321	–	340	800	1 100	1 300	1 500		721	–	740	2 700	3 000	3 200	3 400
341	–	360	900	1 200	1 400	1 600		741	–	760	2 700	3 000	3 300	3 500
361	–	380	1 000	1 300	1 500	1 700		761	–	800	2 900	3 200	3 400	3 600
381	–	400	1 100	1 400	1 600	1 800		801	–	850	3 100	3 400	3 600	3 800
401	–	420	1 200	1 500	1 700	1 900		851	–	900	3 300	3 600	3 800	4 000
421	–	440	1 300	1 600	1 800	2 000		901	–	950	3 600	3 900	4 100	4 300
441	–	460	1 400	1 700	1 900	2 100		951	–	1 000	3 800	4 100	4 300	4 500
461	–	480	1 500	1 800	2 000	2 200		1 001	–	1 100	4 100	4 400	4 600	4 900
481	–	500	1 500	1 800	2 100	2 300		1 101	–	1 200	4 600	4 900	5 000	5 000
501	–	520	1 600	1 900	2 100	2 400		1 201 and above			5000	5 000	5 000	5 000
521	–	540	1 700	2 000	2 200	2 400								

6.5.6 Special approval Category I operations

6.5.6.1 In order to benefit from today's in-service aircraft and create incentives for improved system equipage, some States have implemented the concept of Special Approval Category I Operations (SA CAT I), making better use of approved onboard systems and highly accurate and reliable external infrastructure. These operations are built on the concept of operational credits as described in Annex 6.

6.5.6.2 By definition, Category I operations have been limited to 200 ft DH and 550 m RVR. However, PANS-OPS (Doc 8168), Volume II provides for OCH values below 550 m using the CAT I procedure design, in particular, where the OCH is based on the height loss values for radio altimeters, and depending on the obstacle situation.

6.5.6.3 The use of approved automatic landing systems, HUD or SVGS reduces the flight technical error and pilot workload and eases the transition from the instrument approach phase to visual manoeuvring. A requirement for increased ground equipment accuracy and integrity, as well as protection of the critical and sensitive areas, is necessary to support automatic landing system operations. Special approval CAT I operations are allowed in order to make maximum use of technological advances in airborne equipment and external infrastructure. Strict conditions should be adhered to for both equipment and operations.

6.5.6.4 The SA CAT I concept was introduced in 2001. Several States have since implemented an SA CAT I approach operation that has a DH not lower than 45 m (150 ft) and not less than RVR 400 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 operation, since it is flown on a CAT I ILS (or equivalent system SIS). Some States require ground infrastructure with some additions to the basic CAT I precision approach runway defined in Annex 14, but lower than those of a CAT II PA runway.

6.5.6.5 The lower DH and RVR is achieved by requiring the use of a suitably equipped and authorized aircraft for this operation, the use of radio altimeter minima, runway infrastructure suitable to the operation and special flight crew and aircraft authorization and training. Details can be found in the examples of implementing practices contained in Appendix K.

6.6 STANDARD CATEGORY II OPERATIONS

6.6.1 Introduction

Standard CAT II operations are made to a DH 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 aircraft, a suitable HUD, etc.) The factors considered in 6.5.3 to 6.5.5 for CAT I operations are generally applicable to CAT II operations.

6.6.2 Decision height

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.

6.6.3 Visibility/runway visual range

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

6.6.3.2 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.

6.6.3.3 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 RTZL or RCLL 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, that is, an approach lighting crossbar or the landing THR or a barrette of the RTZL, unless the operation is conducted utilizing an approved HUDLS to touchdown.

6.6.4 Approach minima

The DH for a CAT II operation should be the OCH or the DH 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, THR, centre line and TDZ lights as well as runway markings. The RVR minimum of 300 m is applicable to CAT II operations. However, larger aircraft may necessitate a greater RVR, unless use is made of an automatic landing system, thus making use of aircraft capabilities to increase safety. Similarly, if it is necessary to increase DH 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*
30 m–35 m (100 ft–120 ft)	300 m	300[2] m/350 m
36 m–42 m (121 ft–140 ft)	400 m	400 m
43 m–60 m (141 ft–199 ft)	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 Category D aeroplane conducting an automatic landing, 300 m may be used.

6.6.5 Instrument landing system facility classification

Annex 10, Volume I describes the ILS facility classification, which defines the coverage area (facility performance CAT I, II, or III course and glide path structure tolerances referenced to specific positions along the approach course and runway (A, B, C, T, D or E), and integrity and continuity of service levels (1, 2, 3 or 4) of the ILS ground equipment. CAT II operations typically require a minimum II/T/2 classification for both the localizer and the glide path. This states that: the ILS ground facility has the integrity to support CAT II operations; it meets CAT II/III course structure tolerances to at least point *T* (900 m (3 000 ft) beyond the landing THR); and meets a Level 2 integrity and continuity of service requirements. See Appendix C for more information about ILS facility classification.

6.6.6 Special approval Category II operations

To create further incentives for improved on-board systems equipage, some States have implemented SA 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 an automatic landing system or HUDLS, increasing the emphasis on highly accurate and reliable airborne and ground equipment. States may allow the use of special approval CAT II minima under specific conditions.

6.7 CATEGORY III OPERATIONS

6.7.1 Introduction

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 of 175 m to less than 50 m, although in actual practice 75 m RVR is used as a practicable minimum value for ground manoeuvring purposes.

6.7.2 Decision height

6.7.2.1 The obstacle environment in the final segment of the approach should permit an aircraft, 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 aircraft 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 (for example, 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.

6.7.2.2 In those CAT III operations where DHs are used, 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 aircraft is being satisfactorily delivered to the runway and that adequate visual reference is available for control of the initial part of the landing roll.

6.7.2.3 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.

6.7.3 Alert height

Alert height is a height specified for operational use by pilots (typically 30 m (100 ft) or less above the THR), 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 aircraft 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.

6.7.4 Runway visual range

6.7.4.1 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 operations, RVR is used to establish that the visual reference will be adequate for initial roll-out. For fail-passive operations, RVR provides for the necessary visual reference to enable the pilot to verify that the aircraft 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.

6.7.4.2 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 aircraft 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.

6.7.4.3 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.

6.7.4.4 For CAT III 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 RTZL or RCLL or runway edge lights or a combination of these is attained and can be maintained.

6.7.4.5 For CAT III operations conducted either with fail-operational flight control systems or with a fail-operational hybrid landing system (comprising, for example, a HUDLS), a pilot using a DH 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.

6.7.4.6 For a CAT III operation without a DH, there are no requirements for a visual verification prior to landing.

6.7.5 Operating minima

6.7.5.1 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, THR, centre line and TDZ 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

DH (ft)	*Roll-out control/guidance system*	*RVR (m)**
15 m < DH < 30 m (50 ft < DH < 100 ft)	Not required	175
0 m < DH < 15 m (0 ft < DH < 50 ft)	Fail-passive	125
No DH	Fail-operational	75

* If a roll-out control system is demonstrated to be suitable for use to a lower RVR as part of the certification process, then operations may be conducted to that lower RVR provided the operator has implemented appropriate operating procedures and training.

6.7.5.2 While the distinction of CAT III operations by operating minima was prompted by the evolution of aircraft performance characteristic, some States have not removed the regulatory definitions of CAT IIIA and CAT IIIB, which may define the lowest operational minima for those categories. In addition, aircraft certificated using previous CAT III criteria may have statements in their AFM or other documentation referencing CAT IIIA and CAT IIIB. These aircraft have traditionally been limited to minima no lower than the previous definitions of CAT IIIA or CAT IIIB (as applicable) unless they have been demonstrated to meet the requirements of more recent criteria, such as fail-passive or fail-operational with no reference to CAT IIIA or CAT III B. Previous definitions subdivided 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.

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

a) the minimum DH specified in the AFM, if stated;

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

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

6.7.5.4 *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.

6.7.5.5 Some States publish CAT III minima for their IAPs 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 flight 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.

6.7.6 Instrument landing system facility classification

Annex 10, Volume I describes the ILS facility classification, which defines the coverage area (facility performance CAT I, II or III), course and glide path structure tolerances referenced to specific positions along the approach course and runway (A, B, C, T, D or E), and integrity and continuity of service levels (1, 2, 3 or 4) of the ILS ground equipment. CAT III operations typically require a minimum III/E/3 classification for the localizer and III/T/3 for the glide path, which states that: the ILS ground facility has the coverage to support CAT III operations; it meets CAT III course structure tolerances to at least point *E* (600 m (2 000 ft) from the end of the landing runway); and meets a Level 3 integrity and continuity of service and reliability requirements. An ILS facility should be classified III/E/4 for the localizer and III/T/4 for the glide path, with the highest level of continuity of service and reliability, to support the lowest CAT III landing minima (RVR 75 m). Additionally, CAT III operations with a lower ILS facility classification (III/D/3) may also be appropriate if the required RVR is increased and operators are required to complete a manual roll-out after touchdown. See Appendix C for more information about ILS facility classification.

6.8 HEAD-UP DISPLAY AND EQUIVALENT DISPLAYS

6.8.1 General

6.8.1.1 A HUD presents flight information into the pilot's forward external field of view without significantly restricting that external view.

6.8.1.2 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). The information presented on 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 (for example: navigation sensor, autopilot, flight director); and

j) alerts and warning displays (for example: ACAS, wind shear, ground proximity warning).

6.8.1.3 Equivalent display (ED) refers to a display system (for example, a head worn display (HWD)) that is certified to have performance characteristics equal to or better than a conventional HUD for specific intended functions. These include the following characteristics:

a) provides a head-up presentation not requiring transition of visual attention from head-down to head-up, and is certified for the intended function;

b) displays information necessary for the intended use as outlined for HUD in paragraph 6.8.2;

c) presents required aircraft flight symbology and sensor imagery where required, superimposed for a conformal view with the external visual scene; and

d) has display characteristics and dynamics that are suitable for manual control of the aircraft.

Note.— Night vision imaging systems (NVIS) have not traditionally been included as EDs.

6.8.1.4 An HUD/ED may also permit the simultaneous view of the EVS sensor imagery and/or computer-generated imagery. The appropriate airworthiness approvals and, with some exceptions, operational authorizations must be obtained before such systems can be used.

6.8.2 Operational aspects

6.8.2.1 Flight operations with a HUD/ED can improve situational awareness and aircraft state awareness by combining flight information otherwise 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 awareness can also reduce errors in flight operations and improve the pilot's ability to transition between instrument and external references. 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 and warning, and rapid recognition of and recovery from unusual attitudes.

6.8.2.2 An approved HUD/ED 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 flight deck instruments remain the primary means for manually controlling or manoeuvring the aircraft; and

b) as a primary flight display (PFD);

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

2) information presented by the HUD/ED 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/ED. Operational credit, in the form of lower minima, for a head-up display used for this purpose may be approved for a particular aircraft or AFCS.

6.8.2.3 A qualified HUD/ED 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 RTZL and/or RCLL.

6.8.3 Head-up display training

6.8.3.1 Training programmes should be established, monitored and authorized 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.

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

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

b) head-up display 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 head-up display operating modes;

c) head-up display use during LVO, 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 head-up display and the impact of the failure modes or limitations on crew workload and performance;

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

f) crew coordination, monitoring and verbal call-out procedures for dual head-up display installations with use of a head-up display 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 head-up display; and

i) head-up display airworthiness requirements.

6.9 VISION SYSTEMS

6.9.1 General

6.9.1.1 “Vision systems” is used as a generic term to refer to the existing systems designed to provide images, that is, EVSs, EFVSs, SVSs, SVGSs and 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. Examples of image sensors are passive or active forward-looking infrared sensors, passive millimetre wave radiometer or active millimetre wave radar or low-light level image intensification. An EFVS includes the display element, sensors, computers and power supplies, indications and controls. A sensor may be used as a stand-alone sensor or be combined with other types of sensors into a multi-sensor system. As discussed in 6.9.1.4 regarding the effects of light emitting diode (LED) lights, there may be a need for modified sensors or multi-sensor systems.

6.9.1.2 The information from vision systems may be displayed on a head-up or head-down display. When EVS, EFVS or SVS imagery is displayed on the HUD, it should be a conformal image presented to the pilot’s forward external field of view without significantly restricting that external view.

6.9.1.3 The increased situational and aircraft state awareness provided by SVS may provide additional safety for all phases of flight.

6.9.1.4 Light emitting diode (LED) lights may not be visible to infrared (IR)-based vision systems, including most EVS in use when this manual was published, due to the fact that LED lights are limited to specific visible 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. Some States may allow these vision systems to provide guidance all through the landing.

6.9.1.5 Another significant characteristic of LED lights is the perceived brightness. 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.

6.9.1.6 Work is being done by some States to explore possible mitigations that will improve the performance of EVS and EFVS 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 includes melting freezing precipitation that may accumulate around the light. Implementing LED lights at aerodromes may be performed in steps, typically starting with the runway lights while keeping incandescent lights in the approach lights systems. This could create a black hole effect on the EVS and EFVS. Operators of EVS and EFVS will therefore need to acquire information about the LED implementation programmes at aerodromes where they operate and include this in the operators' safety risk assessment. Aerodrome operators should be encouraged to publish the details of the status of LED light implementation.

6.9.2 Operational aspects

6.9.2.1 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 (see Figure 6-1).

6.9.2.2 The enhanced imagery displayed by the EVS and EFVS 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. EFVS are designed to provide visual cues at published minima in fog and other visual obscurants. Some systems are approved for operations to touchdown and roll-out.

6.9.2.3 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.

6.9.2.4 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 instrument displays supplemented with a computer-generated image, such as SVGS, may facilitate the transition from the instrument segment to the visual segment, for example by directing the visual search for the required visual references.

6.9.2.5 SVGS provides the pilot with a geospatially accurate computer-generated image of the external scene and the runway of intended landing. These elements provide the pilot with enhanced position and path awareness as well as flight path trajectory information. Flight operations with SVGS improve situational awareness by combining PFD information with a computer-generated image of the external view. This provides pilots with an immediate awareness of relevant flight parameters and situation information. This improved situational awareness can also reduce errors in flight operations and improve the pilot's ability to transition between instrument and visual references during instrument approaches. SVGS must be certified for its intended use.

6.9.2.6 The CVS concept involves a combination of SVS and EVS. Examples of a CVS include database-driven computer-generated synthetic vision images combined with real-time sensor enhanced vision images superimposed and correlated on the same integrated display. The angular extent of the external scene presented on the display is called field of regard (FOR). The FOR of a typical EVS is approximately 40 degrees by 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.

6.9.2.7 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 and the image would gradually and smoothly transition from synthetic to enhanced vision. 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 contained in Chapter 2, 2.1 and Chapter 6, 6.10.

6.9.3 Vision system training

6.9.3.1 Training programmes should be established, monitored and authorized by the State of the Operator. These training requirements should include recent experience requirements if the State of the Operator determines that those requirements are significantly different from current requirements for the use of HUD without enhanced vision imagery or for conventional head-down instrumentation.

6.9.3.2 Training should address all flight operations for which the vision system is used. 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 (for example, sensor theory including radiant versus 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 LVO, including taxi, take-off, instrument approach and landing. System use for IAPs 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, TDZ or roll-out area;

j) any effects that weather, such as obscurants, 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 recent experience requirements for HUD and EVS can be found in Appendix I.

6.9.4 Operational concepts

6.9.4.1 Instrument approach operations that use vision systems include, in principle, two phases: the instrument phase and the visual phase, respectively. The instrument phase ends at the published MDA/H or DA/H unless a missed approach is initiated. The continued approach to landing from MDA/H or DA/H will be conducted using visual references. The visual references will be acquired by:

a) EVS imagery presented on the HUD;

b) natural vision; or

c) a combination of these.

6.9.4.2 An EFVS operation allows for the descent below the instrument approach minimum using a real-time imaging sensor in lieu of natural visibility to identify required visual references. Some EFVS operations require visual references to be acquired using natural vision at a defined height above the ground (typically 30 m (100 ft)). EFVS operations can be authorized to touchdown and roll-out using only the EFVS imaging sensor for the acquisition of visual references.

6.9.4.3 It should be noted that an EFVS operation does not change the category of the operation; the DA/H or MDA/H remains unchanged and the manoeuvring below DA/H or MDA/H is conducted using visual references provided by the EFVS (see Figure 6-2). Initial aircraft certifications may include statements regarding EFVS sensor performance. States may use EFVS sensor performance to determine the operational credit granted for EFVS operations.

6.9.4.4 In addition to the operational credit that EFVS/CVS/SVGS is able to provide, these systems also provide an operational and safety advantage through improved aircraft state awareness, earlier acquisition of visual references and smoother transition to references by natural vision.

6.9.4.5 The use of a vision system for operational credit requires the appropriate airworthiness certification and appropriate operational authorisations.

6.9.5 Visual references

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

6.9.5.2 Some States have developed requirements for operations with an EVS; the visual references are as indicated in Appendix G. The EFVS provides an advantage to the visual segment, the amount of which depends on the performance of the sensor in the prevailing meteorological conditions and kind of obscurant, such as fog, mist, haze, snow, etc.

6.9.6 Synthetic vision guidance systems

An SVGS is a type of SVS which combines flight guidance display technology and high precision position assurance monitors. This enables the monitoring of guidance, navigation and other aircraft parameters to improve position assurance and reduce flight technical error. It includes a flight instrument display which provides a continuous, geo-spatially correct depiction of the external scene topography, including obstacles, augmented by the display of the runway of intended landing. SVGS requires specific symbology elements, integrity and performance monitors and annunciations that support and enable low visibility operations. Using SVGS may enable the pilot to meet and exceed performance typical of instrument approach performance requirements.

6.9.7 Aircraft state awareness synthetic vision system

An aircraft state awareness synthetic vision system (ASA-SVS) is a combination of perspective view synthetic terrain depiction and overlaid PFD symbology. The ASA-SVS flight instrument provides a continuous, geospatially correct depiction of the external scene topography, including obstacles, augmented by the display of the runway of intended landing. The ASA-SVS provides the pilot with a virtual day visual meteorological conditions (VMC) display irrespective of the outside conditions. It is intended to support the pilots' early recognition of non-navigation related divergence from the intended path and thereby reduce the risk of loss of control inflight. The ASA-SVS is intended for display full-time on the pilots' full colour head-down PFDs. ASA-SVS may be displayed on a HUD or HUD/ED, to supplement the head-down PFD ASA-SVS presentation. If an operator intends to use a HUD ASA-SVS without a corresponding PFD ASA-SVS, they should provide analysis showing the HUD or HUD/ED implementation meets the ASA-SVS function.

6.9.8 Combined vision systems

A CVS is the integration of EVS sensors to provide real-time sensor enhanced visual references and the use of database-driven computer-generated synthetic vision images superimposed and correlated on the same integrated display to improve the instrument approach and navigation functions. With the addition of SVS/SVGS elements and features to an EFVS flight display, the EFVS visual references are presented more clearly to the flight crew. The elements also enable additional position awareness and position assurance to the instrument procedure.

6.9.9 Hybrid systems

6.9.9.1 A hybrid system is the combination of two or more systems. The component systems are normally approved as stand-alone systems. A hybrid system typically has improved performance compared to each of the component systems. Normally, the more components that are included in a hybrid system, the better it performs. A hybrid system may offer the benefits of dissimilar redundancy and may also qualify for operational credit, the amount of which depends on the demonstrated performance of the system.

6.9.9.2 The following paragraphs contain examples of hybrid systems to raise awareness of the possibilities they can bring. This is not an exhaustive list.

Example 1: Fail-operational hybrid landing system.
This is a combined HUD and an automatic landing system. While the component systems were certified as fail-passive CAT III systems, the hybrid system was certified as a fail-operational CAT III system and qualified for lower DH and RVR than the component systems.

Example 2: Combined vision system and FMS.
Generically speaking, a vision system may be combined with an FMS into a hybrid system. One such system is SVGS where flight guidance display technology is combined with high precision position assurance monitors into a system capable of qualifying for SA CAT I.

Example 3: CVS.
This is defined as a combination of synthetic and EVS. CVS, when paired with a sensor qualified to meet the enhanced flight visibility requirement, may be used to meet the intended function of an EFVS. CVS are intended to increase the pilot's (or crew's) situational awareness during the EVS or EFVS operation. To receive operational credit, the CVS used to provide the enhanced vision image must be certified for that specific operation.

6.9.9.3 Certain systems, despite taking on the hybrid format by definition, are seen as separate, stand-alone systems, such as the EFVS. While it is a hybrid system combining EVS, HUD and FGS, EFVS is now treated as a separate system. In a performance-based setting, the labels are not important, what matters is the performance and resulting AOM.

6.9.9.4 It is also possible that two (or more) systems are combined to fulfil a function otherwise fulfilled by one system. For example, the use of a DA and a virtual inner marker. This may be an alternative to a DH measured by a radio altimeter and is consistent with the concept of onboard avionics in lieu of ground infrastructure. This solution may extend the number of runways for operations where a DH by radio altimeter is required, but where its function may be impaired by the pre-threshold terrain or to provide an alternative to radio altimeters, which is foreseen in some national regulations. This solution may also be possible for qualified LPV approaches in addition to today's SA CAT I ILS.

Figure 6-1. Difference with and without EFVS

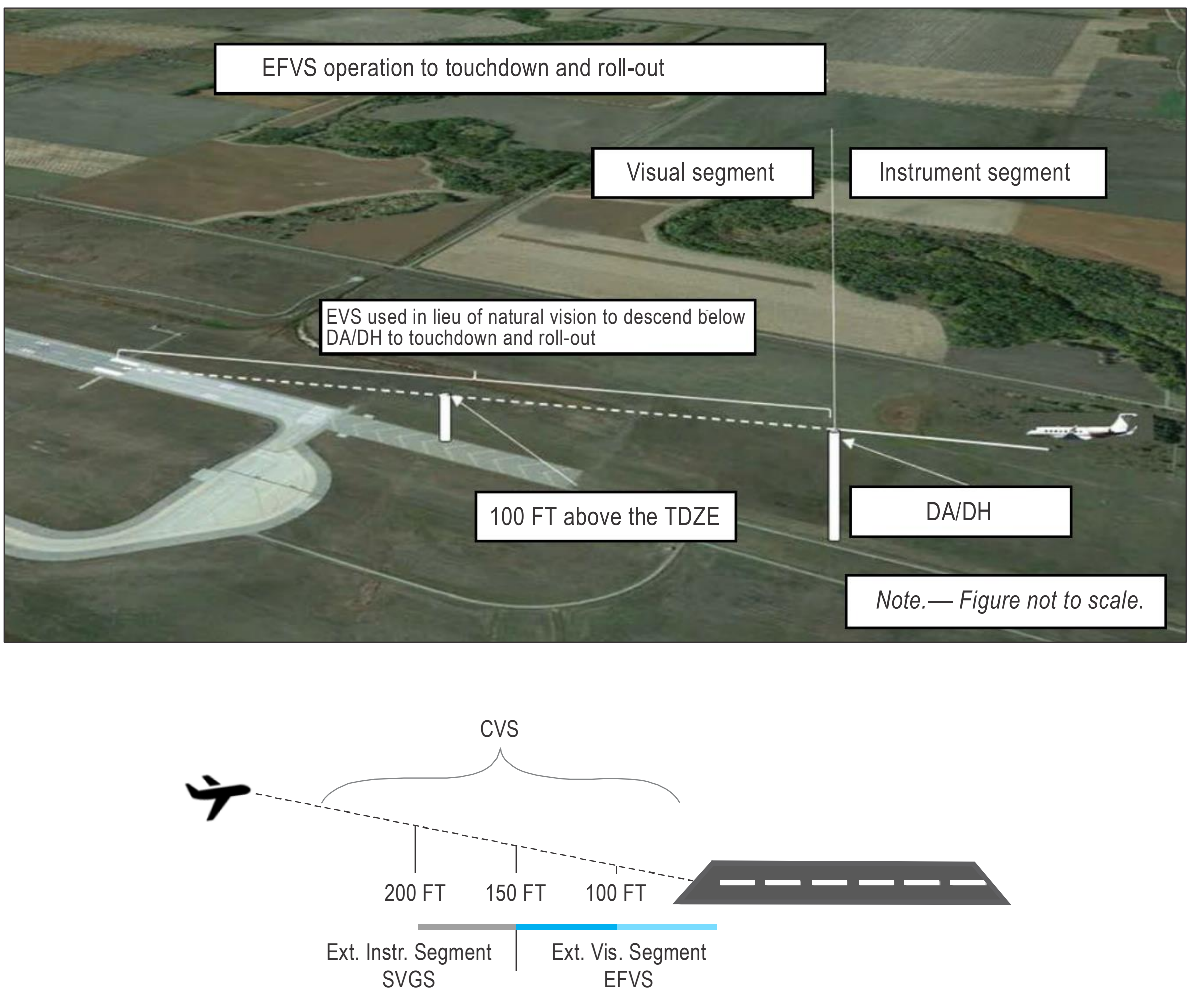

Figure 6-2. Vision systems operations

6.9.10 Operational procedures

6.9.10.1 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 operational approvals;

b) how any operational credit affects:

1) flight planning with respect to destination and alternate aerodromes;

2) ground operations;

3) flight execution, for example, approach ban and minimum flight visibility;

4) CRM that takes into account that the pilots may have different presentation equipment;

5) standard operating procedures (SOPs), for example, 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.

6.9.10.2 It is not prohibited to use vision systems in connection with circling. However, due to the 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.

6.10 OPERATIONAL CREDIT AND AUTHORIZATIONS FOR AUTOMATIC LANDING SYSTEMS, HEAD-UP DISPLAY AND VISION SYSTEMS

6.10.1 General

6.10.1.1 Aerodrome operating minima are expressed in terms of minimum visibility/RVR and MDA/H or DA/H. The degree of operational credit that may be given to a system depends on its performance (accuracy, integrity and availability) as assessed and determined by the certification and operational authorization processes. Operational credit means that the MDH/DH and/or visibility/RVR may be reduced for operation of an aircraft equipped with appropriately certified HUD or vision systems such as EFVS. Operational credit for EFVS or CVS can only be authorized if the imagery is combined with flight guidance and presented on a HUD.

6.10.1.2 An automatic landing system or a HUD not combined with a vision system may also be granted operational credit. See 6.11.2 for more details.

6.10.1.3 Credit related to visibility/RVR can be applied using at least three concepts:

a) applying 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;

b) authorizing 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; and

c) providing operational credit by allowing operations in visibilities/RVRs which are not lower than normal, but the approach operation is conducted with less than the otherwise required aerodrome facilities, for example CAT II operations without RTZL and/or RCLL, compensated by additional on-board equipment, such as a HUD.

6.10.1.4 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.

6.10.1.5 The authorization of operational credits does not affect the classification of an IAP 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.

6.10.1.6 As stated in Annex 14, the aerodrome requirements are not intended to regulate or limit the operation of aircraft. In practice, this means that the aerodrome will state which facilities, standards and services (including LVP) it will offer, and the air operator will assess which AOM should be applied. This will be done in accordance with the method approved for establishment of AOM including the authorized operational credits. Where the State of the Aerodrome has established AOM, these will have to be observed. The application of operational credit and the resulting performance-based AOM do not change any of the above conditions.

6.10.1.7 In order to provide optimum service, the ATS should be informed about the capabilities of the better equipped aircraft, for example the minimum RVR capability for the filed destination.

6.10.2 Authorizations

6.10.2.1 Authorization is the term used to cover approvals, specific approvals and acceptances. More details are contained in Annex 6.

6.10.2.2 An operator that wishes to conduct operations with an advanced aircraft, for example using a HUD or ED, a vision system or a hybrid system, will need to obtain certain authorizations except as specified in 6.10.2.3. The extent of the authorizations will depend on the nature of the intended operation and the complexity of the equipment.

6.10.2.3 When the enhanced vision imagery is used solely to improve situational awareness, authorizations are not required. An example of this type of operation may include an EVS or an SVS 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 must 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.

6.10.2.4 When a vision system or hybrid system with vision systems imagery is intended to provide operational credit, the EFVS sensor images must be combined with flight guidance and presented on a HUD. Operational credit for SVGS may be granted for systems presented on a head-up or head-down display. Where two pilots are required (by airworthiness or operational requirements), information presented on the HUD to the pilot flying should also be presented to the pilot monitoring in a form that allows the monitoring function to be performed.

6.10.2.5 Where operational credit is used for LVO, a specific approval is required. This approval will be contained in the Operations Specification (see Annex 6, Part I, Appendix 6) or, for non-commercial operations, in the specific approvals document, as specified in Annex 6, Part II, Appendix 2.4. The specific approval will specify the AOM and the equipment used to qualify for those minima (see also Appendix H).

6.10.2.6 Where operational credit is only used for other than LVO, a specific approval is not required. However, the operator is expected to specify the equipment used and include the procedures for using the equipment, including MEL and training programmes in the Operations Manual or, in case of non-commercial operations, in another suitable document (see Annex 6, Part I, Chapter 4, 4.2.8.1.3 and Annex 6, Part II, Chapter 2, 2.2.2.2.1.3, respectively). Appendices H and I may be used as applicable.

6.10.2.7 When the application for specific approval relates to operational credits for systems not including a vision system, for example a HUD, the guidance in this chapter may be used to the extent applicable as determined by the State of the Operator or, in case of General Aviation, the State of Registry (see Appendix H).

6.10.2.8 Operators should be aware that some States may require information about the specific operational credits which have been authorized by the State of the Operator or State of Registry. Typically, the approval from the State of the Operator may have to be presented. In some cases, the State of the Aerodrome may wish to issue an approval or to validate the original authorization.

6.10.2.9 To obtain a specific approval based on 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:

- *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 and fax numbers of the applicant.

- *Aircraft details*. Aircraft make(s), model(s) and registration mark(s).

- *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 or fleet is included in a single application, a completed compliance list should be included for each aircraft or fleet.

- *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 or pages should be required.

- *Name, title and signature*.

6.10.2.10 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 is provided in the Airworthiness Manual *(Doc 9760).*

6.11 CRITERIA FOR USING AUTOMATIC LANDING SYSTEM, HEAD-UP DISPLAY, ENHANCED VISION SYSTEM, SYNTHETIC VISION SYSTEM, COMBINED VISION SYSTEM OR ANY COMBINATION THEREOF FOR THE SAFE OPERATION OF AN AIRCRAFT

6.11.1 The Standards in Annex 6 require action by the State of the Operator or State of Registry to establish criteria for the safe operation of aircraft when automatic landing systems, HUD or ED, EVS, SVS, CVS or any combination of these systems are used "for the safe operation" of the aircraft. Such criteria may include requirements related to:

a) normal and abnormal procedures for the use of the equipment;

b) training programmes for flight crew and other personnel involved in the operation (refer to Appendix I); and

c) MEL.

6.11.2 Automatic landing system operations may be conducted:

a) when required to support an LVO (usually CAT II or CAT III). In this case, the pilot should be satisfied that appropriate facility-protections are in force, such as LVP or protection of critical and sensitive areas. This is verified via information provided by ATC or by automated means, such as ATIS;

b) for practice (for example, for training or recent experience) or to reduce workload during the visual segment of a landing operation. Such operations may be conducted in good weather, without facility protections being in force; and

c) in case of airborne emergency or failure requiring the use of an automatic landing system, even though the weather conditions would not make the operation obligatory.

Note.— In some States, the hours during which practice automatic landings are permitted are published in the AIP.

6.11.3 In the case of the operations referred to in 6.11.2.b), it is not necessary for the pilot to inform ATC that an automatic landing system operation is being conducted, unless information to the contrary is published in the AIP. This is because visual verification of aircraft position and trajectory and, if necessary, manual intervention by the pilot-flying either to go-around or to accomplish the landing or roll-out manually, will compensate for any short-term inaccuracy in guidance. However, if the pilot deems it necessary to conduct an automatic landing to ensure the safety of the operation, they should inform ATC and request appropriate facility protections be put into effect. It should be noted that such protection may have an impact on aerodrome operations and capacity and may disturb the approach flow.

6.11.4 If the pilot wishes to conduct an automatic landing system operation when ILS facility-protections are not in force, they must be aware that ILS installations may be subject to signal interference by aircraft and other objects. To protect the ILS signal during LVO, the sensitive or critical area is protected to ensure that the accuracy of the ILS signal is maintained. However, when LVO are not in force at an aerodrome, aircraft and vehicles may cause disturbance to the ILS signal. This may result in sudden and unexpected flight control movements at a very low altitude or during the landing and roll-out, when the autopilot attempts to follow the disturbed signal. As a result, pilots are advised to exercise caution during these operations in accordance with instructions provided in their Operations Manual. Mitigation against the effects of interference is provided by stipulating visual-reference requirements which allow the pilot flying to ascertain that the aircraft is in the correct position during landing and roll-out.

6.11.5 In the case of automatic landing system operations on a runway equipped with an ILS-classification II/T/2, 3 or 4, the operation will initially be limited to CAT I only. After an assessment of the effect of the LOC deviation on the FGS, a subsequent upgrading to CAT II may be authorized by the operator and published in the route documentation, or information may be given that the use of the flight guidance (for example, automatic landing system operations) is not approved. A higher than standard CAT II RVR or specific flight crew training, or information, may be applied when deemed necessary.

6.11.6 Operators should include information or instructions in the Operations Manual that automatic landing system operations, on a runway equipped with an ILS-classification II/T/2, 3 or 4, may still be subject to signal interference, even when facility protections are in force, due to the design of the ground installation.

6.11.7 If conducting an automatic landing system operation using ILS guidance when low-visibility facility protections are not in force:

a) the pilot flying should actively monitor the AFCS and be prepared to intervene if the aircraft starts to deviate from the intended flight path; and

b) the required visual references must be in view by the DA/DH for a CAT I approach, otherwise a go-around must be carried out.

Chapter 7

2D AND 3D INSTRUMENT APPROACH OPERATIONS

7.1 INTRODUCTION

The terms 2D and 3D instrument approach operations were introduced in Annex 6. This chapter explains these terminologies to correctly interpret the regulatory texts prescribing these operations.

7.2 APPROACH OPERATIONS VERSUS APPROACH PROCEDURES

7.2.1 Approach operations

7.2.1.1 2D and 3D terminologies are associated with instrument approach operations and not with IAPs.

- *3D instrument approach operation*. This is an approach operation during which the pilot uses LNAV and VNAV guidance information.

- *2D instrument approach operation.* This is an approach operation during which the pilot only uses LNAV guidance information.

7.2.1.2 The LNAV and/or VNAV guidance information consists of deviations (angular or linear) displayed continuously in the pilot's primary field of view during the final approach. This guidance information can be coupled to the flight director and/or autopilot.

7.2.2 Instrument approach procedures

7.2.2.1 There are three types of IAPs:

- *Non-precision approach (NPA) procedures.* When designing these approach procedures, only LNAV guidance is considered. The vertical plane is protected by minimum altitudes in successive steps. These procedures can be operated in 2D or 3D.

- *Approach procedures with vertical guidance (APV).* The design of these approach procedures considers both LNAV and VNAV guidance. They are protected from obstacles by a surface that considers the performance of the VNAV guidance. These approach procedures cannot be called PAs because their guidance performance does not allow them to consider DHs below 75 m (250 ft). These procedures are operated in 3D.

- *Precision approach (PA) procedures.* These approach procedures are based on ILS, MLS, GLS or SBAS CAT I navigation systems that integrate both LNAV and VNAV guidance and whose guidance performance allows DHs below 75 m (250 ft), depending on the presence of obstacles. These procedures are operated in 3D.

7.2.2.2 Figure 7-1 illustrates the categorization of different IAPs into these three types.

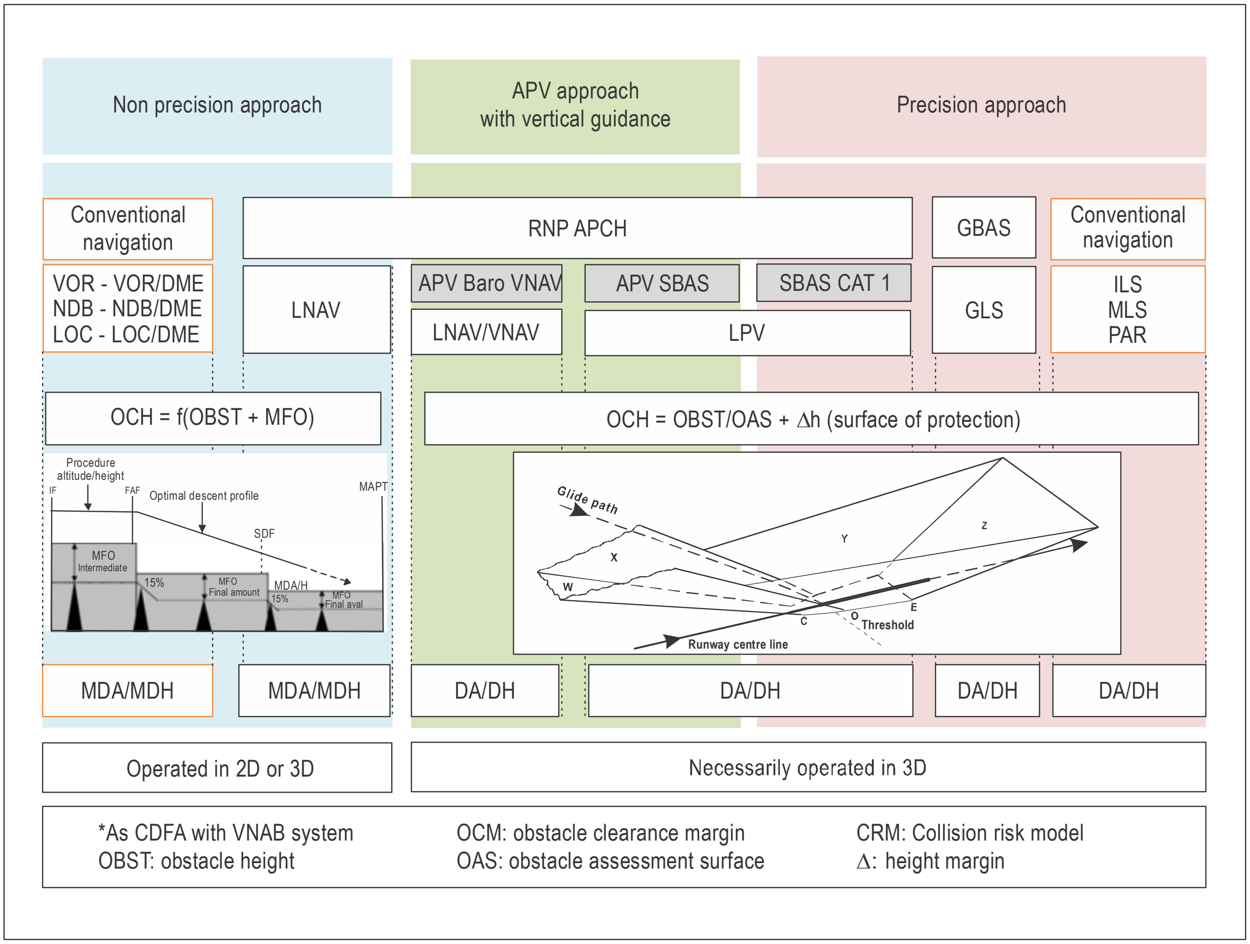

Figure 7-1. Categorization of instrument approach procedures.

7.3 CONTINUOUS DESCENT FINAL APPROACH, 2D AND 3D OPERATIONS

7.3.1 Principle

The CDFA is a flight technique that consists of performing a continuous descent without level-off on the final approach segment of an NPA procedure. The instrument approach is flown to a DA at which the pilot will decide either to land or go-around if visual references are not acquired. This flying technique does not require any particular systems. It can be performed using vertical speed, descent angle or VNAV guidance provided by the aircraft's on-board systems (VNAV function).

7.3.2 Continuous descent final approach, 2D and 3D operations

If the approach operation is performed as a CDFA without the help of VNAV guidance information, the approach operation is considered a 2D operation. If the approach operation is performed in CDFA using VNAV, then the operation is considered a 3D operation. This is why an NPA can be operated in 3D.

7.3.3 Continuous descent final approach, 3D operations and vertical navigation guidance performance

A VNAV function certified for LNAV/VNAV approaches (Baro-VNAV) or certified for LPV approaches (SBAS VNAV) should allow 3D operations on NPA procedures. Vertical deviations from a vertical plane coded in the navigation database are then displayed in the pilot's primary field of view. The VNAV function, depending on the aircraft, can be coupled to the autopilot and the flight director. The operational limitations associated with the VNAV function must be respected (for example, verification of the navigation database, consistency between the mapped and FMS-coded information, verification of the local pressure, temperature management, etc., as reported in the manufacturer's AFM or SOP limitations).

7.3.4 3D operations, minimum descent altitude/decision altitude and stepdown fix

Some States consider the operational use of CDFA techniques when developing and promulgating non-precision IAPs and promulgate a vertical descent angle as part of the procedure. This descent angle should allow for the aircraft to be higher than or equal to all minimum altitudes in the final approach segment (MDA, step-down, FAF altitudes). When the NPA procedure is operated in 3D (see 7.3.3), the MDA could be used as a DA and it would not be necessary to check the stepdown fix altitudes (if any) since the promulgated vertical descent angle would consider them. As not all required data are available to the operator, the State should publish the appropriate DA/H in this case. Figure 7-2 shows the promulgated descent angle in a specimen chart.

7.3.5 2D operations and stepdown fix

When the VNAV function is not certified to operate to LNAV/VNAV or LPV minima, so that the vertical deviations displayed to the pilot can only be used for advisory purposes, the vertical descent is managed by adjusting vertical speed or flight path angle in accordance with the barometric altitude and distance to the THR. In that case, the stepdown fix (SDF) altitude has to be carefully checked not to inadvertently descend below it. If a table of distance and altitude is promulgated to support CDFA, meeting the table altitudes is appropriate for considering the SDF (if any). In Figure 7-2, a table of distance and altitudes are included in a specimen chart.

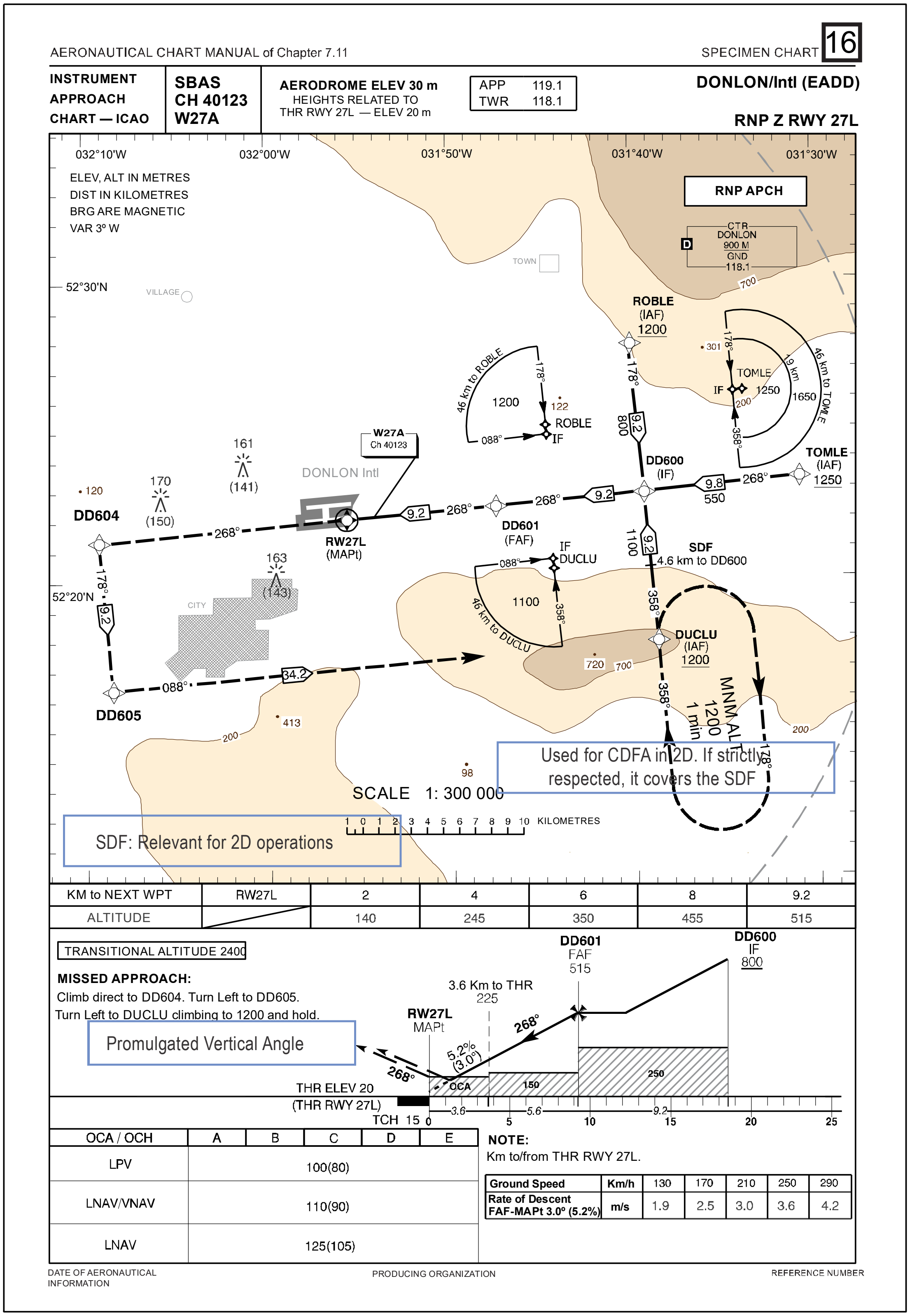

Figure 7-2. Specimen chart showing additional information to support the CDFA

Appendix A

DIVISION OF RESPONSIBILITIES BETWEEN THE STATE OF THE AERODROME AND THE STATE OF THE OPERATOR

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, such as 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 the aerodrome 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 IAPs designed for its aerodromes.	
Some States may also issue the visibility/RVR for all IAPs designed for their aerodromes.	
Establishing the conditions for operations (by any operator) to its non-standard aerodromes. This may include issuing authorizations for operations to those aerodromes.	When applicable, establishing the conditions for authorizing 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 air operator

Aerodrome	*Air operator*
Gathering and disseminating information about the obstacle situation, facilities and equipment at the aerodrome.	Establishing the AOM for the use of authorized 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 authorized by regulation.
Surveying and maintaining the obstacle situation and performance of the facilities.	Ensuring proper training and certification of flight crew members for all-weather operations.
Establishing LVP, disseminating the related information and ensuring their application.	Ensuring that all authorized 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 ALS 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 ALS configurations are described in Table B-1.

Table B-1. Approach lighting systems

Class of facility	*Example national regulations for length, configuration and intensity of approach lights*
Full approach lighting system (FALS) (see Annex 14)	Precision approach CAT I lighting system (HIALS ≥ 720 m) Distance coded centre line, barrette centre line
Intermediate approach lighting system (IALS) (see Annex 14)	Simple ALS (HIALS 420 m to 719 m) single source, barrette
Basic approach lighting system (BALS)	Any other ALS (HIALS, MIALS or ALS 210 m to 419 m)
No approach lighting system (NALS)	Any other approach lighting system (HIALS, MIALS or ALS < 210 m) or no approach lights

Appendix C

INSTRUMENT LANDING SYSTEM FACILITY CLASSIFICATION AND DOWNGRADING

1. 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 localizer facility classification is "III/E/4", and an example of ILS glide path facility classification is "II/T/3". 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, 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 THR;

   2) B: 1 050 m (3 500 ft) before the THR (CAT I decision point);

   3) C: Glide path altitude of 30 m (100 ft) HATh (CAT II decision point);

   4) T: Threshold (glide path classification is limited to point T);

   5) D: 900 m (3 000 ft) beyond the THR (facility performance CAT III requirement only); and

   6) E: 600 m (2 000 ft) before the runway end (facility performance CAT III requirement only); and

c) the third group, comprised of a single character, indicates the level of integrity and continuity of service. Level 4 is the highest level, while Level 1 means that the facility integrity and/or continuity level is not known. 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 1×10^{-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.

2. The ILS facility classification scheme may be used to describe how ILS localizer and glide path facilities may exceed the minimum performance requirements of a given facility classification. For example, a facility performance CAT I system may still provide suitable course and glide path structure all the way down to points E or T. However, this additional guidance can only be relied on if corresponding critical and sensitive area safeguarding procedures have been defined and are in force. If not, guidance may be subject to transient erratic effects due to multipath disturbances. The classification scheme can also be used to enable some operations in case the facility had to be downgraded temporarily.

3. Some States publish CAT III minima for their IAPs determined by the lowest RVR value that the ILS can support. Operators in these States are issued operations specifications that authorize the lowest Cat III RVR minima for the crew and type of aircraft. Some States authorize take-off minima that require the use of the ILS localizer to provide LNAV during take-off, and require similar localizer classification for take-off based on the RVR minimum. For example, an RVR 75 m take-off minimum may require a localizer classification III/E/4 to provide LNAV guidance during take-off. The following are examples of the ILS facility classification required to support specific RVR minima, either when published as State's minima or when derived by the operator (see also Table C-1):

a) I/B/1 as a minimum for CAT I operations. Manual landing required;

b) II/D/2 for operations not less than RVR 300 m;

c) III/D/3 for operations not less than RVR 200 m;

d) III/E/3 for operations not less than RVR 175 m; and

e) III/E/4 for operations not less than RVR 75 m.

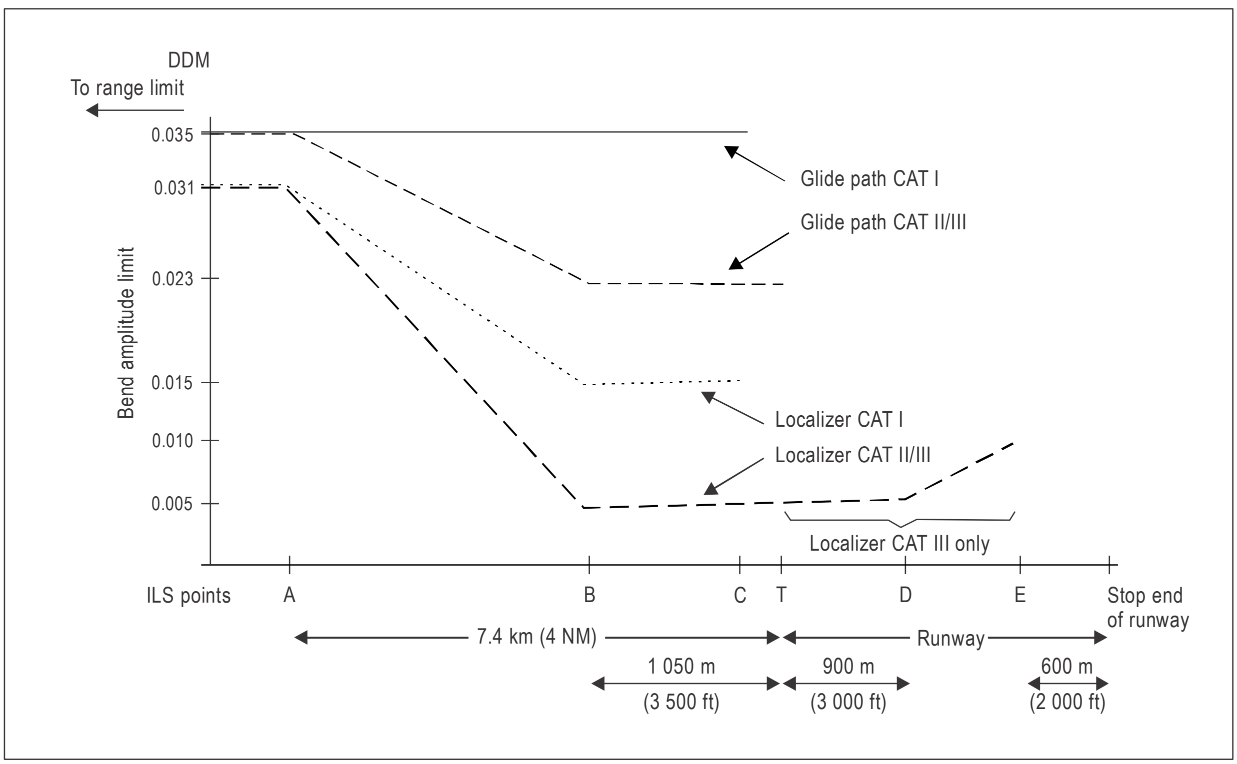

Figure C-1. Localizer course and glide path bend amplitude limits

Table C-1. Example of ILS classification and supported operations for aeroplanes

ILS classification			*Correlation between ILS classification and system minima*	
Facility performance category	*Limit of course structure*	*Minimum level of integrity and continuity of service*	*Lowest operational Cat*	*ILS ground equipment system minimum RVR (m)* *(authorized minima depend on aircraft approach category, installed airborne equipment, procedure and training and may be higher, operational credits in the visual segment not considered)*
I	C, T, D or E	1	I	TDZ: 550 (CAT I), 400 (SA CAT I); Midpoint: advisory; Roll-out advisory
II	T	2	II (some States I)	TDZ: 350 (some States 300); Midpoint: 175*; Roll-out: 75*
	D or E	2	II	TDZ: 300; Midpoint: 175*; Roll-out: 75*
III	D	2	II	TDZ: 300; Midpoint: 175*; Roll-out: 75*
		3	III	TDZ: 200 (some States 175); Midpoint: 175*; Roll-out: 75*
		4	III	TDZ: 175; Midpoint: 175*; Roll-out: 75*
	E	3	III	TDZ: 175; Midpoint: 175*; Roll-out: 75*
		4	III	TDZ: 75; Midpoint: 75*; Roll-out: 75*

* some States advisory only

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Appendix D

PLANNING MINIMA FOR ALTERNATE AERODROMES

1. Operators are required to specify incremental values for cloud base height and visibility/RVR to be added to the operators' AOM for the selection of alternate aerodromes. The purpose of the higher minima is to provide a safety margin, for example, to cover changing weather conditions.

2. Several States have promulgated minimum criteria for departure, destination and en-route alternates as applicable. Typically, these criteria are expressed as flexible ceiling and visibility requirements based on the navigation facilities for one or more runways, which can be reasonably expected to be available.

3. The criteria may also be expressed as fixed minimum ceiling and visibility/RVR requirements. The type of operation, for example EDTO, may also affect the alternate minima. The *Flight Planning and Fuel Management Manual (FPFM)* (Doc 9976) provides guidance and contains examples of alternate minima used in some States.

4. Higher minima for alternate aerodromes apply only during the planning stage. Once airborne, the regular AOM apply for the continuous evaluation of whether the selected aerodromes are usable. The exception to this principle is in-flight re-planning, where alternate aerodrome planning minima apply.

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Appendix E

CONVERSION OF REPORTED METEOROLOGICAL VISIBILITY (RUNWAY VISUAL RANGE/CONVERTED METEOROLOGICAL VISIBILITY) 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. 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 meteorological visibility to RVR/CMV

	RVR/CMV = reported meteorological visibility multiplied by:	
Lighting elements in operation	*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

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 4, 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, for example, "RVR more than 1 500 metres", it is not considered to be a reported value for the purpose of this paragraph.

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Appendix F

EXAMPLE OF MINIMA FOR APPROACH AND LANDING OPERATIONS

In EASA Air Operations (AIR-OPS), the DH or MDH for a particular operation should be the OCH (for the IAP), the minimum height authorized for the aircraft and the crew, or the system minima of Table F-1, whichever is the highest. The minimum RVR to be associated with this DH or MDH can be determined from Table 6-3 of Chapter 6. These values are without consideration of operational credit.

Table F-1. System minima versus instrument approach procedures

Instrument approach procedure	*Lowest DH/MDH*
ILS/MLS/GLS	60 m (200 ft)
GNSS (LPV)	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)

Appendix G

EXAMPLE OF OPERATIONAL CREDIT FOR ENHANCED FLIGHT VISION SYSTEMS

1. Operational credit for EFVS is based on the actual performance of the EFVS sensor in adverse weather conditions. The MDA/H or DA/H remains unchanged and the remainder of the approach below MDA/H or DA/H is conducted in the visual segment with the required visual references being partly or wholly provided by the EFVS. Visual references by means of natural vision are typically required from 30 m (100 ft) above the TDZ elevation or the THR. However, more advanced EFVS may be capable of displaying the required references all the way to touchdown and roll-out. For touchdown and roll-out, a minimum RVR of 300 m is required to ensure visual references by natural vision for the roll-out to mitigate against HUD and/or EFVS sensor failures. Conversely, EFVS 200 (see paragraph 7 below), requires visual references by means of natural vision below 60 m (200 ft) above the TDZ elevation or the THR.

2. The visual references mentioned include:

a) elements of the approach lighting; or

b) the runway THR, identified by at least one of the following: the beginning of the runway landing surface, the THR lights, the THR identification lights; and the TDZ, identified by at least one of the following: the runway TDZ landing surface, the RTZL, the TDZ markings or the runway lights.

3. The minimum RVR for the approach is derived by reducing the value in the first column of Table G-1 to the value in the second column, unless a different visual advantage has received airworthiness and operational approval.

4. The use of EFVS for approach operations with RVR values less than 550 m requires a specific approval in some States.

5. The use of EFVS for operational credit for take-off in low visibility requires a specific approval.

6. Navigation facilities to be used for the operations described in paragraph 1 are, for example, 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).

7. In some States, EFVS certificated for use during the landing is labelled EFVS-L and an EFVS which requires natural vision below 30 m (100 ft) is labelled EFVS-A. An EFVS, which is not intended to be used for LVO, is labelled EFVS 200 in some States. Other States label EFVS approved for use during the landing EFVS-A and those which require natural vision below 30 m (100 ft) EFVS-B.

Table G-1. Approach utilizing EVS RVR reduction versus normal RVR

RVR normally required	*RVR for approach utilizing EFVS for approach or touchdown operation*	*RVR for approach utilizing EFVS 200*
550	350	550
600	400	550
650	450	550
700	450	550
750	500	550
800	550	550
900	600	600
1 000	650	650
1 100	750	750
1 200	800	800
1 300	900	900
1 400	900	900
1 500	1 000	1 000
1 600	1 100	1 100
1 700	1 100	1 100
1 800	1 200	1 200
1 900	1 300	1 300
2 000	1 300	1 300
2 100	1 400	1 400
2 200	1 500	1 500
2 300	1 500	1 500
2 400	1 600	1 600

Appendix H

EXAMPLE OF VISION SYSTEMS COMPLIANCE LIST

(Applies to Annex 6, Parts I and II)

Table H-1. Example of vision systems compliance list

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, reporting significant problems with the vision system or HUD, including circumstances and 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 AOM 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 SOPs.		

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* (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.		
9. Data collection and trend monitoring	Description of the system for data collection, evaluation and trend monitoring for LVO for which there is an operational credit.		

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Appendix I

EXAMPLES OF TRAINING, CHECKING AND RECENT EXPERIENCE REQUIREMENTS FOR HEAD-UP DISPLAYS AND VISION SYSTEMS

Initial ground training should consist of the following subjects:

1. Applicable regulatory guidelines that relate to HUD or ED, vision systems (for example, EVS) flight operations and limitations, including AFM limitations;

2. HUD, controls, modes, features, symbology, annunciations and associated systems and components;

3. Vision system sensor performance, sensor limitations, scene interpretation, visual anomalies and other visual effects;

4. Pre-flight planning and operational considerations associated with using HUD and vision systems during taxi, take-off, climb, cruise, descent and landing phases of flight, including the use of HUDs, vision systems for instrument approaches, operating below DA/DH or MDA, executing missed approaches, landing, roll-out and balked landings;

5. Weather conditions associated with low-visibility conditions and its effect on EVS vision system performance;

6. Normal and abnormal procedures, and crew coordination when using a HUD or vision systems; and

7. Approach and runway lighting systems and their characteristics (for example, patterns, colours, LED vs incandescent lights) related to operations using HUDs and vision systems (for example, EVS).

Initial flight training should consist of the following subjects:

1. Pre-flight and inflight preparation of HUD and vision system 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 HUDs and vision systems 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 HUDs and vision systems 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 vision system operations;

6. Transitioning from vision system sensor imagery to natural vision acquisition of required visual references and the runway environment;

7. Using vision system sensor imagery to touchdown and roll-out, if applicable; and

8. Normal and abnormal procedures, and crew coordination when using a HUD and vision system, including crew procedures for using the pilot monitoring display.

Recurrent or differences training

Recurrent and differences training for vision system operations should consist of the same subject areas covered by initial training. Differences training for a new vision system should also include special conditions or considerations associated with conducting vision system operations using the new system.

Recent flight experience

Head-up display and vision system 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 vision system flight experience and training is necessary to prevent the loss of skill.

The purpose of requiring recent HUD and vision system flight experience is to ensure that a pilot remains proficient in the use of all HUD and vision system components and operating procedures and to ensure that the pilot conducts EVS operations safely. As vision systems evolve to permit operations in lower VIS conditions than are currently permitted, and as the scope and number of such operations increases over time, the need for pilots to maintain recent flight experience becomes even more critical. Operators whose policy is to use HUD and vision system equipment on nearly all operations can build experience and proficiency quicker than if they used it only during LVO.

A HUD is an excellent safety enhancement in all-weather operations, and vision systems can provide benefit in other than just LVO. For example, vision systems 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 aircraft during a vision system operation or who acts as pilot-in-command of an aircraft during a vision system 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 a vision system. States allow for recent flight experience to be met in an aircraft or in an FSTD equipped with a representative vision system.

Proficiency check requirements

Some States will require that a person acting as pilot-in-command or a person who is manipulating the controls of a vision system-equipped aircraft passes a HUD and vision system proficiency check. A typical HUD and vision system proficiency check should include a representative sample of the subjects that were covered during the initial ground and flight training for HUD and vision system.

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Appendix J

APPROACH CLASSIFICATION SUMMARY

For definitions not used in this manual, please refer to the referenced documents.

<table>
<tr><th>Domain</th><th>Document</th><th colspan="4">Operations</th></tr>
<tr><td rowspan="3">Approach Operations</td><td rowspan="3">Annex 6</td><td rowspan="3">Classification</td><td>(>=250 ft)</td><td>(200 ft<= DA/H <250 ft)</td><td>(<200 ft)</td></tr>
<tr><td>2D or 3D</td><td>3D</td><td>3D</td></tr>
<tr><td>MDA/H or DA/H</td><td>DA/H</td><td>DA/H</td></tr>
<tr><td rowspan="4">Approach Minima Runway Requirements</td><td rowspan="4">Annex 14</td><td>M(DA/H) >=250 ft
VIS >= 1000 m</td><td>Non-precision RWY</td><td></td><td rowspan="2"></td></tr>
<tr><td>DA/H >= 200 ft
RVR >= 550 m</td><td colspan="2">Precision RWY, CAT I</td></tr>
<tr><td>DA/H >= 100 ft
RVR >= 300 m</td><td colspan="3">Precision RWY, CAT II</td></tr>
<tr><td>DA/H >= 0 ft
RVR >= 0 m</td><td colspan="3">Precision RWY, CAT III</td></tr>
<tr><td rowspan="2">System Performance Procedures</td><td rowspan="2">Annex 10, PANS-OPS, Volume II, PBN Manual (Doc 9613)</td><td rowspan="2"></td><td>VOR, NDB, LOC and LOC type directional aid w/ GS</td><td></td><td rowspan="2">ILS, MLS, GBAS</td></tr>
<tr><td colspan="2">PBN (including SBAS), ILS, MLS, GBAS</td></tr>
</table>

Appendix K

EXAMPLE OF IMPLEMENTATION OF SPECIAL APPROVAL CAT I OPERATIONS

1. Several of the following conditions are common for SA CAT I authorizations:

   a) a specific approval is required and is documented either in the Operations Specifications or in the list of Specific Approvals (General Aviation);

   b) the lowest DH authorized is 45 m (150 ft) above THR or touch-down zone elevation;

   c) DH is based on radio altimeter or another approved system providing height over the terrain with equivalent performance;

   d) the lowest RVR authorized is 400 m;

   e) CAT I IAP design where the OCH is based on radio altimeter height loss is the basis for SA CAT I, with some additional requirements applied in some States as indicated below;

   f) a regular CAT I precision approach runway is sufficient but the OFZ should be available for runways to be eligible;

   g) standard CAT I approach lights (distance coded or barrette centre line type) are required for SA CAT I, with some additional requirements applied in some States as indicated below;

   h) the pre-threshold terrain should be verified by the operator as suitable for radio altimeter operations especially before the DH location and, where applicable, landing systems operations. This applies in particular in case of irregular terrain; and

   i) current authorizations are based on ILS as the navigation facility. The ILS must meet regular CAT I criteria without deficiencies. Some specifics are listed below:

      1) a HUD is a qualifying system in all States concerned;

      2) the flight crew must be trained to the minima they are authorized to fly to; and

      3) the approach should not have an offset from the runway centre line.

2. Additional or differing requirements:

   a) some States allow SVGS as a qualifying system;

   b) some States that use HUD as the basic qualifying system may accept an automatic landing system as a qualifying system on a case-by-case basis and with additional requirements;

c) one State requires a minimum runway length of 1 500 m (5 000 ft);

d) some States require the aerodrome or runway to be certified for SA CAT I;

e) some States allow single pilot operations to the same minima as for multi-crew operations if RCLL and RTZL are installed otherwise the RVR must at least be 600 m;

f) some States have requirements for a one second switch-over time for the electrical power for certain parts of the lighting system;

g) some States require the aircraft to be certified for SA CAT I (also for CAT II certified aircraft to consider that the ILS minimum requirements are less than for CAT II);

h) some States require the ILS glide path to be 3.0° whereas other States allows the glide path to be up to 3.5° subject to assessment; and

i) a PA terrain chart is required in some States.

3. Due to the complexity of the regulations governing SA CAT I, it is recommended to study the respective national regulations and guidance material. This applies both to States considering implementation of SA CAT I and to operators intending to conduct operations in other States. In order to assist such studies, a list of documents is given below.

a) CASA Civil Aviation Advisory Publication (CAAP) 257-EX-01, Approval to conduct low visibility operations;

b) FAA AC 120-118, *Criteria for Approval/Authorization of All Weather Operations for Takeoff, Landing, and Rollout*;

c) FAA Order 8400.13F, *Procedures for the Evaluation and Approval of Facilities for Special Authorization Category I Operations and All Category II and III Operations with Change 1*;

d) Commission Regulation (EU) 965/2012, *Easy Access Rules for Air Operations* (as amended by subsequent EASA Opinions) and related EASA acceptable means of compliance and guidance material.

— END —

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