European Aviation Safety Agency

Acceptable Means of Compliance (AMC) and Guidance Material (GM) to Annex V Specific approvals [Part-SPA]

of Commission Regulation (EU) 965/2012 on air operations

Consolidated version including Issue 1, Amendment 5[1]

March 2017[2]

[1] For the date of entry into force of this amendment, refer to ED Decision 2017/004/R in the Official Publication of EASA.

[2] Date of publication of the consolidated version.

Disclaimer

This consolidated document includes the initial issue of and all subsequent amendments to the AMC&GM associated with this Annex.

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Summary of amendments

Chapter	**Action**	**Issue/Amdt. no.**	**Amended by Regulation / ED Decision**
Subpart L – Single-engined turbine aeroplane operations at night or in instrument meteorological conditions (SET-IMC)	New Subpart	1/5	Reg. (EU) No 2017/363 and EDD 2017/004/R (SET-IMC)
Subpart K – Helicopter Offshore operations (HOFO)	New Subpart	1/4	Reg. (EU) No 2016/1199 and EDD 2016/022/R **Applicable from 01/07/2018**
GM1 SPA.PBN.100	New	1/3	Reg. (EU) No 2016/1199 and EDD 2016/020/R (PBN)
AMC1 SPA.PBN.105(b)	New		
AMC1 SPA.PBN.105(c)	New		
GM1 SPA.PBN.105(c)	New		
AMC1 SPA.PBN.105(d)	New		
AMC2 SPA.PBN.105(d)	New		
AMC3 SPA.PBN.105(d)	New		
AMC1 SPA.PBN.105(e)	New		
AMC1 SPA.PBN.105(f)	New		
AMC1 SPA.HEMS.135(a)	Amended	Issue 1 Amdt. 2	ED Decision 2015/022/R (CRM training)
AMC1 SPA.GEN.105(a)	Amended	Amdt. 1	ED Decision 2013/020/R; Reg. (EU) No 800/2013 on NCC and NCO
AMC1 SPA.RVSM.105	Amended		
AMC1 SPA.LVO.125	Amended		

SUBPART A:
GENERAL REQUIREMENTS

AMC1 SPA.GEN.105(a) Application for a specific approval

DOCUMENTATION

(a) Operating procedures should be documented in the operations manual.

(b) If an operations manual is not required, operating procedures may be described in a manual specifying procedures (procedures manual). If the aircraft flight manual (AFM) or the pilot operating handbook (POH) contains such procedures, they should be considered as acceptable means to document the procedures.

SUBPART B:
PERFORMANCE-BASED NAVIGATION (PBN) OPERATIONS

GM1 SPA.PBN.100 PBN operations

GENERAL

(a) PBN operations are based on performance requirements, which are expressed in navigation specifications (RNAV specification and RNP specification) in terms of accuracy, integrity, continuity, availability and functionality needed for the proposed operation in the context of a particular airspace concept.

Table 1 provides a simplified overview of:

(1) PBN specifications and their applicability for different phases of flight; and

(2) PBN specifications requiring a specific approval.

(b) More detailed guidance material for the operational use of PBN applications can be found in ICAO Doc 9613 Performance-Based Navigation (PBN) Manual.

(c) Guidance material for the design of RNP AR APCH procedures can be found in ICAO Doc 9905 RNP AR Procedure Design Manual.

(d) Guidance material for the operational approval of PBN operations can be found in ICAO Doc 9997 Performance-Based Navigation (PBN) Operational Approval Manual.

Table 1: Overview of PBN specifications

	FLIGHT PHASE							
	En-route		Arrival	Approach				Departure
	Oceanic	Continental		Initial	Intermediate	Final	Missed	
RNAV 10	10							
RNAV 5		5	5					
RNAV 2		2	2					2
RNAV 1		1	1	1	1		1	1
RNP 4	4							
RNP 2	2	2						
RNP 1			1	1	1		1	1
A-RNP	2	2 or 1	1–0.3	1–0.3	1–0.3	0.3	1–0.3	1–0.3
RNP APCH (LNAV)				1	1	0.3	1	
RNP APCH (LNAV/VNAV)				1	1	0.3	1	
RNP APCH (LP)				1	1		1	
RNP APCH (LPV)				1	1		1	
RNP AR APCH				1–0.1	1–0.1	0.3-0.1	1–0.1	
RNP 0.3 (H)		0.3	0.3	0.3	0.3		0.3	0.3

Numbers specify the accuracy level no specific approval required specific approval required

AMC1 SPA.PBN.105(b) PBN operational approval

FLIGHT CREW TRAINING AND QUALIFICATIONS — GENERAL PROVISIONS

(a) The operator should ensure that flight crew members training programmes for RNP AR APCH include structured courses of ground and FSTD training.

  (1) Flight crew members with no RNP AR APCH experience should complete the full training programme prescribed in (b), (c), and (d) below.

  (2) Flight crew members with RNP AR APCH experience with another EU operator may undertake an:

    (i) abbreviated ground training course if operating a different type or class from that on which the previous RNP AR experience was gained;

    (ii) abbreviated ground and FSTD training course if operating the same type or class and variant of the same type or class on which the previous RNP. AR experience was gained.

    (iii) the abbreviated course should include at least the provisions of (d)(1), (c)(1) and (c)(2)(x) as appropriate.

    (iv) The operator may reduce the number of approaches/landings required by (c)(2)(xii) if the type/class or the variant of the type or class has the same or similar:

      (A) level of technology (flight guidance system (FGS));

      (B) operating procedures for navigation performance monitoring; and

      (C) handling characteristics

    as the previously operated type or class.

  (3) Flight crew members with RNP AR APCH experience with the operator may undertake an abbreviated ground and FSTD training course:

    (i) when changing aircraft type or class, the abbreviated course should include at least the provisions of (d)(1), (c)(1), (c)(2);

    (ii) when changing to a different variant of aircraft within the same type or class rating that has the same or similar of all of the following:

      (A) level of technology (flight guidance system (FGS));

      (B) operating procedures for navigation performance monitoring; and

      (C) handling characteristics

    as the previously operated type or class.

    A difference course or familiarisation appropriate to the change of variant should fulfil the abbreviated course provisions.

    (iii) when changing to a different variant of aircraft within the same type or class rating that has significantly different at least one of the following:

      (A) level of technology (FGS);

      (B) operating procedures for navigation performance monitoring; and

      (C) handling characteristics,

    the provisions of (c)(1) and (c)(2) should be fulfilled.

(4) The operator should ensure when undertaking RNP AR APCH operations with different variant(s) of aircraft within the same type or class rating, that the differences and/or similarities of the aircraft concerned justify such operations, taking into account at least the following:

(i) the level of technology, including the:

(A) FGS and associated displays and controls;

(B) FMS and its integration or not with the FGS; and

(C) on-board performance monitoring and alerting (OBPMA) system;

(ii) operating procedures, including:

(A) navigation performance monitoring;

(B) approach interruption and missed approach including while in turn along an RF leg;

(C) abnormal procedures in case of loss of system redundancy affecting the guidance or the navigation; and

(D) abnormal and contingency procedures in case of total loss of RNP capability; and

(iii) handling characteristics, including:

(A) manual approach with RF leg;

(B) manual landing from automatic guided approach; and

(C) manual missed approach procedure from automatic approach.

(b) Ground training

(1) Ground training for RNP AR APCH should address the following subjects during the initial introduction of a flight crew member to RNP AR APCH systems and operations. For recurrent programmes, the curriculum need only review initial curriculum items and address new, revised, or emphasised items.

(2) General concepts of RNP AR APCH operation

(i) RNP AR APCH training should cover RNP AR APCH systems theory to the extent appropriate to ensure proper operational use. Flight crew members should understand basic concepts of RNP AR APCH systems, operation, classifications, and limitations.

(ii) The training should include general knowledge and operational application of RNP AR APCH instrument approach procedures. This training module should in particular address the following specific elements:

(A) the definitions of RNAV, RNP, RNP APCH, RNP AR APCH, RAIM, and containment areas;

(B) the differences between RNP AR APCH and RNP APCH;

(C) the types of RNP AR APCH procedures and familiarity with the charting of these procedures;

(D) the programming and display of RNP and aircraft specific displays, e.g. actual navigation performance;

(E) the methods to enable and disable the navigation updating modes related to RNP;

(F) the RNP values appropriate for different phases of flight and RNP AR APCH instrument procedures and how to select, if necessary;

(G) the use of GNSS RAIM (or equivalent) forecasts and the effects of RAIM 'holes' on RNP AR APCH procedures availability;

(H) when and how to terminate RNP navigation and transfer to conventional navigation due to loss of RNP and/or required equipment;

(I) the method to determine if the navigation database is current and contains required navigational data;

(J) the explanation of the different components that contribute to the total system error and their characteristics, e.g. drift characteristics when using IRU with no radio updating, QNH mistakes;

(K) the temperature compensation: Flight crew members operating avionics systems with compensation for altimetry errors introduced by deviations from ISA may disregard the temperature limits on RNP AR APCH procedures if flight crew training on use of the temperature compensation function is provided by the operator and the compensation function is utilised by the crew. However, the training should also recognise if the temperature compensation by the system is applicable to the VNAV guidance and is not a substitute for the flight crew compensating for the temperature effects on minimum altitudes or the DA/H;

(L) the effect of wind on aircraft performance during RNP AR APCH operations and the need to positively remain within RNP containment area, including any operational wind limitation and aircraft configuration essential to safely complete an RNP AR APCH operation;

(M) the effect of groundspeed on compliance with RNP AR APCH procedures and bank angle restrictions that may impact on the ability to remain on the course centreline. For RNP procedures, aircraft are expected to maintain the standard speeds associated with the applicable category unless more stringent constraints are published;

(N) the relationship between RNP and the appropriate approach minima line on an approved published RNP AR APCH procedure and any operational limitations if the available RNP degrades or is not available prior to an approach (this should include flight crew operating procedures outside the FAF versus inside the FAF);

(O) understanding alerts that may occur from the loading and use of improper RNP values for a desired segment of an RNP AR APCH procedure;

(P) understanding the performance requirement to couple the autopilot/flight director to the navigation system's lateral guidance on RNP AR APCH procedures requiring an RNP of less than RNP 0.3;

(Q) the events that trigger a missed approach when using the aircraft's RNP capability to complete an RNP AR APCH procedure;

(R) any bank angle restrictions or limitations on RNP AR APCH procedures;

(S) ensuring flight crew members understand the performance issues associated with reversion to radio updating, know any limitations on the use of DME and VOR updating; and

(T) the familiarisation with the terrain and obstacles representations on navigation displays and approach charts.

(3) ATC communication and coordination for use of RNP AR APCH

(i) Ground training should instruct flight crew members on proper flight plan classifications and any ATC procedures applicable to RNP AR APCH operations.

(ii) Flight crew members should receive instruction on the need to advise ATC immediately when the performance of the aircraft's navigation system is no longer adequate to support continuation of an RNP AR APCH operation.

(4) RNP AR APCH equipment components, controls, displays, and alerts

(i) Theoretical training should include discussion of RNP terminology, symbology, operation, optional controls, and display features, including any items unique to an operator's implementation or systems. The training should address applicable failure alerts and limitations.

(ii) Flight crew members should achieve a thorough understanding of the equipment used in RNP operations and any limitations on the use of the equipment during those operations.

(iii) Flight crew members should also know what navigation sensors form the basis for their RNP AR APCH compliance, and they should be able to assess the impact of failure of any avionics or a known loss of ground systems on the remainder of the flight plan.

(5) AFM information and operating procedures

(i) Based on the AFM or other aircraft eligibility evidence, the flight crew should address normal and abnormal operating procedures, responses to failure alerts, and any limitations, including related information on RNP modes of operation.

(ii) Training should also address contingency procedures for loss or degradation of the RNP AR APCH capability.

(iii) The manuals used by the flight should contain this information.

(6) MEL operating provisions

(i) Flight crew members should have a thorough understanding of the MEL entries supporting RNP AR APCH operations.

(c) Initial FSTD training

(1) In addition to ground training, flight crew members should receive appropriate practical skill training in an FSTD.

(i) Training programmes should cover the proper execution of RNP AR APCH operations in compliance with the manufacturer's documentation.

(ii) The training should include:

(A) RNP AR APCH procedures and limitations;

(B) standardisation of the set-up of the cockpit's electronic displays during an RNP AR APCH operation;

(C) recognition of the aural advisories, alerts and other annunciations that can impact on compliance with an RNP AR APCH procedure; and

(D) the timely and correct responses to loss of RNP AR APCH capability in a variety of scenarios embracing the breadth of the RNP AR APCH procedures the operator plans to complete.

(2) FSTD training should address the following specific elements:

(i) procedures for verifying that each flight crew member's altimeter has the current setting before commencing the final approach of an RNP AR APCH operation, including any operational limitations associated with the source(s) for the altimeter setting and the latency of checking and setting the altimeters for landing;

(ii) use of aircraft RADAR, TAWS or other avionics systems to support the flight crew's track monitoring and weather and obstacle avoidance;

(iii) concise and complete flight crew briefings for all RNP AR APCH procedures and the important role crew resource management (CRM) plays in successfully completing an RNP AR APCH operation;

(iv) the importance of aircraft configuration to ensure the aircraft maintains any mandated speeds during RNP AR APCH operations;

(v) the potentially detrimental effect of reducing the flap setting, reducing the bank angle or increasing airspeeds may have on the ability to comply with an RNP AR APCH operation;

(vi) flight crew members understand and are capable of programming and/or operating the FMC, autopilot, autothrottles, RADAR, GNSS, INS, EFIS (including the moving map), and TAWS in support of RNP AR APCH operations;

(vii) handling of TOGA to LNAV transition as applicable, particularly while in turn;

(viii) monitoring of flight technical error (FTE) and related go-around operation;

(ix) handling of loss of GNSS signals during a procedure;

(x) handling of engine failure during the approach operation;

(xi) applying contingency procedures for a loss of RNP capability during a missed approach. Due to the lack of navigation guidance, the training should emphasise the flight crew contingency actions that achieve separation from terrain and obstacles. The operator should tailor these contingency procedures to their specific RNP AR APCH procedures; and

(xii) as a minimum, each flight crew member should complete two RNP approach procedures for each duty position (pilot flying and pilot monitoring) that employ the unique RNP AR APCH characteristics of the operator's RNP AR APCH procedures (e.g. RF legs, missed approach). One procedure should culminate in a transition to landing and one procedure should culminate in execution of an RNP missed approach procedure.

FLIGHT CREW TRAINING AND QUALIFICATIONS — CONVERSION TRAINING

(d) Flight crew members should complete the following RNP AR APCH training if converting to a new type or class or variant of aircraft in which RNP AR operations will be conducted. For abbreviated courses, the provisions prescribed in (a)(2), (a)(3) and (a)(4) should apply.

(1) Ground training

Taking into account the flight crew member's RNP AR APCH previous training and experience, flight crew members should undertake an abbreviated ground training that should include at least the provisions of (b)(2)(D) to (I), (b)((2)(N) to (R), (b)(2)(S), and (b)(3) to (6).

(2) FSTD training

The provisions prescribed in (a) should apply, taking into account the flight crew member's RNP AR APCH training and experience.

FLIGHT CREW TRAINING AND QUALIFICATIONS — RNP AR APCH PROCEDURES REQUIRING A PROCEDURE-SPECIFIC APPROVAL

(e) Before starting an RNP AR APCH procedure for which a procedure-specific approval is required, flight crew members should undertake additional ground training and FSTD training, as appropriate.

(1) The operator should ensure that the additional training programmes for such procedures include as at least all of the following:

(i) the provisions of (c)(1), (c)(2)(x) as appropriate and customised to the intended operation;

(ii) the crew training recommendations and mitigations stated in the procedure flight operational safety assessment (FOSA); and

(iii) specific training and operational provision published in the AIP, where applicable.

(2) Flight crew members with prior experience of RNP AR APCH procedures for which a procedure-specific approval is required may receive credit for all or part of these provisions provided the current operator's RNP AR APCH procedures are similar and require no new pilot skills to be trained in an FSTD.

(3) Training and checking may be combined and conducted by the same person with regard to (f)(2).

(4) In case of a first RNP AR APCH application targeting directly RNP AR APCH procedures requiring procedure-specific approvals, a combined initial and additional training and checking, as appropriate, should be acceptable provided the training and checking includes all provisions prescribed by (a), (b), (c), (d) as appropriate, (e) and (f).

FLIGHT CREW TRAINING AND QUALIFICATIONS — CHECKING OF RNP AR APCH KNOWLEDGE

(f) Initial checking of RNP AR APCH knowledge and procedures

(1) The operator should check flight crew members' knowledge of RNP AR APCH procedures prior to employing RNP AR APCH operations. As a minimum, the check should include a thorough review of flight crew procedures and specific aircraft performance requirements for RNP AR APCH operations.

(2) The initial check should include one of the following:

(i) A check by an examiner using an FSTD.

(ii) A check by a TRE, CRE, SFE or a commander nominated by the operator during LPCs, OPCs or line flights that incorporate RNP AR APCH operations that employ the unique RNP AR APCH characteristics of the operator's RNP AR APCH procedures.

(iii) Line-oriented flight training (LOFT)/line-oriented evaluation (LOE). LOFT/LOE programmes using an FSTD that incorporates RNP AR APCH operations that employ the unique RNP AR APCH characteristics (i.e. RF legs, RNP missed approach) of the operator's RNP AR APCH procedures.

(3) Specific elements that should be addressed are:

(i) demonstration of the use of any RNP AR APCH limits/minimums that may impact various RNP AR APCH operations;

(ii) demonstration of the application of radio-updating procedures, such as enabling and disabling ground-based radio updating of the FMC (e.g. DME/DME and VOR/DME updating) and knowledge of when to use this feature;

(iii) demonstration of the ability to monitor the actual lateral and vertical flight paths relative to programmed flight path and complete the appropriate flight crew procedures when exceeding a lateral or vertical FTE limit;

(iv) demonstration of the ability to read and adapt to a RAIM (or equivalent) forecast, including forecasts predicting a lack of RAIM availability;

(v) demonstration of the proper set-up of the FMC, the weather RADAR, TAWS, and moving map for the various RNP AR APCH operations and scenarios the operator plans to implement;

(vi) demonstration of the use of flight crew briefings and checklists for RNP AR APCH operations with emphasis on CRM;

(vii) demonstration of knowledge of and ability to perform an RNP AR APCH missed approach procedure in a variety of operational scenarios (i.e. loss of navigation or failure to acquire visual conditions);

(viii) demonstration of speed control during segments requiring speed restrictions to ensure compliance with an RNP AR APCH procedure;

(ix) demonstration of competent use of RNP AR APCH plates, briefing cards, and checklists;

(x) demonstration of the ability to complete a stable RNP AR APCH operation: bank angle, speed control, and remaining on the procedure's centreline; and

(xi) knowledge of the operational limit for deviation from the desired flight path and of how to accurately monitor the aircraft's position relative to vertical flight path.

FLIGHT CREW TRAINING AND QUALIFICATIONS — RECURRENT TRAINING

(g) The operator should incorporate recurrent training that employs the unique RNP AR APCH characteristics of the operator's RNP AR APCH procedures as part of the overall training programme.

(1) A minimum of two RNP AR APCH should be flown by each flight crew member, one for each duty position (pilot flying and pilot monitoring), with one culminating in a landing and one culminating in a missed approach, and may be substituted for any required 3D approach operation.

(2) In case of several procedure-specific RNP AR APCH approvals, the recurrent training should focus on the most demanding RNP AR APCH procedures giving credit on the less demanding ones.

TRAINING FOR PERSONNEL INVOLVED IN THE FLIGHT PREPARATION

(h) The operator should ensure that training for flight operation officers/dispatchers should include:

(1) the different types of RNP AR APCH procedures;

(2) the importance of specific navigation equipment and other equipment during RNP AR APCH operations and related RNP AR APCH requirements and operating procedures;

(3) the operator's RNP AR APCH approvals;

(4) MEL requirements;

(5) aircraft performance, and navigation signal availability, e.g. GNSS RAIM/predictive RNP capability tool, for destination and alternate aerodromes.

AMC1 SPA.PBN.105(c) PBN operational approval

FLIGHT OPERATIONAL SAFETY ASSESSMENT (FOSA)

(a) For each RNP AR APCH procedure, the operator should conduct a flight operational safety assessment (FOSA) proportionate to the complexity of the procedure.

(b) The FOSA should be based on:

(1) restrictions and recommendations published in AIPs;

(2) the flyability check;

(3) an assessment of the operational environment;

(4) the demonstrated navigation performance of the aircraft; and

(5) the operational aircraft performance.

(c) The operator may take credit from key elements from the safety assessment carried out by the ANSP or the aerodrome operator.

GM1 SPA.PBN.105(c) PBN operational approval

FLIGHT OPERATIONAL SAFETY ASSESSMENT (FOSA)

(a) Traditionally, operational safety has been defined by a target level of safety (TLS) and specified as a risk of collision of 10^{-7} per approach operation. For RNP AR APCH operations, conducting the FOSA methodology contributes to achieving the TLS. The FOSA is intended to provide a level of flight safety that is equivalent to the traditional TLS, but using methodology oriented to performance-based flight operations. Using the FOSA, the operational safety objective is met by considering more than the aircraft navigation system alone. The FOSA blends quantitative and qualitative analyses and assessments by considering navigation systems, aircraft performance, operating procedures, human factor aspects and the operational environment. During these assessments conducted under normal and failure conditions, hazards, risks and the associated mitigations are identified. The FOSA relies on the detailed criteria for the aircraft capabilities and instrument procedure design to address the majority of general technical, procedure and process factors. Additionally, technical and operational expertise and prior operator experience with RNP AR APCH operations are essential elements to be considered in the conduct and conclusion of the FOSA.

(b) The following aspects need to be considered during FOSA, in order to identify hazards, risks and mitigations relevant to RNP AR APCH operations:

(1) Normal performance: lateral and vertical accuracy are addressed in the aircraft airworthiness standards, aircraft and systems operate normally in standard configurations and operating modes, and individual error components are monitored/truncated through system design or flight crew procedure.

(2) Performance under failure conditions: lateral and vertical accuracy are evaluated for aircraft failures as part of the aircraft certification. Additionally, other rare-normal and abnormal failures and conditions for ATC operations, flight crew procedures, infrastructure and operating environment are assessed. Where the failure or condition results are not acceptable for continued operation, mitigations are developed or limitations established for the aircraft, flight crew and/or operation.

(3) Aircraft failures

(i) System failure: Failure of a navigation system, flight guidance system, flight instrument system for the approach, or missed approach (e.g. loss of GNSS updating, receiver failure, autopilot disconnect, FMS failure, etc.). Depending on the aircraft, this may be addressed through aircraft design or operating procedure to cross-check guidance (e.g. dual equipage for lateral errors, use of terrain awareness and warning system).

(ii) Malfunction of air data system or altimetry: flight crew procedure cross-check between two independent systems may mitigate this risk.

(4) Aircraft performance

(i) Inadequate performance to conduct the approach operation: the aircraft capabilities and operating procedures ensure that the performance is adequate on each approach, as part of flight planning and in order to begin or continue the approach. Consideration should be given to aircraft configuration during approach and any configuration changes associated with a missed approach operation (e.g. engine failure, flap retraction, re-engagement of autopilot in LNAV mode).

(ii) Loss of engine: loss of an engine while on an RNP AR APCH operation is a rare occurrence due to high engine reliability and the short exposure time. The operator needs to take appropriate action to mitigate the effects of loss of engine, initiating a go-around and manually taking control of the aircraft if necessary.

(5) Navigation services

(i) Use of a navigation aid outside of designated coverage or in test mode: aircraft airworthiness standards and operating procedures have been developed to address this risk.

(ii) Navigation database errors: instrument approach procedures are validated through flight validation specific to the operator and aircraft, and the operator should have a process defined to maintain validated data through updates to the navigation database.

(6) ATC operations

(i) Procedure assigned to non-approved aircraft: flight crew are responsible for rejecting the clearance.

(ii) ATC provides 'direct to' clearance to or vectors aircraft onto approach such that performance cannot be achieved.

(iii) Inconsistent ATC phraseology between controller and flight crew.

(7) Flight crew operations

(i) Erroneous barometric altimeter setting: flight crew entry and cross-check procedures may mitigate this risk.

(ii) Incorrect procedure selection or loading: flight crew procedures should be available to verify that the loaded procedure matches the published procedure, line of minima and aircraft airworthiness qualification.

(iii) Incorrect flight control mode selected: training on importance of flight control mode, flight crew procedure to verify selection of correct flight control mode.

(iv) Incorrect RNP entry: flight crew procedure to verify RNP loaded in system matches the published value.

(v) Missed approach: balked landing or rejected landing at or below DA/H.

(vi) Poor meteorological conditions: loss or significant reduction of visual reference that may result in a go-around.

(8) Infrastructure

(i) GNSS satellite failure: this condition is evaluated during aircraft qualification to ensure obstacle clearance can be maintained, considering the low likelihood of this failure occurring.

(ii) Loss of GNSS signals: relevant independent equipage, e.g. IRS/INS, is mandated for RNP AR APCH procedures with RF legs and approaches where the accuracy for the missed approach is less than 1 NM. For other approaches, operating procedures are used to approximate the published track and climb above obstacles.

(iii) Testing of ground navigation aids in the vicinity of the approach: aircraft and operating procedures should detect and mitigate this event.

(9) Operating conditions

(i) Tailwind conditions: excessive speed on RF legs may result in inability to maintain track. This is addressed through aircraft airworthiness standards on the limits of command guidance, inclusion of 5 degrees of bank manoeuvrability margin, consideration of speed effect and flight crew procedure to maintain speeds below the maximum authorised for the RNP AR APCH procedure.

(ii) Wind conditions and effect on FTE: nominal FTE is evaluated under a variety of wind conditions, and flight crew procedures to monitor and limit deviations to ensure safe operation.

(iii) Extreme temperature effects of barometric altitude (e.g. extreme cold temperatures, known local atmospheric or weather phenomena, high winds, severe turbulence, etc.): the effect of this error on the vertical path is mitigated through the procedure design and flight crew procedures, with an allowance for aircraft that compensate for this effect to conduct procedures regardless of the published temperature limit. The effect of this error on minimum segment altitudes and the DA/H are addressed in an equivalent manner to all other approach operations.

AMC1 SPA.PBN.105(d) PBN operational approval

OPERATIONAL CONSIDERATIONS FOR RNP AR APCH

(a) MEL

(1) The operator's MEL should be developed/revised to address the equipment provisions for RNP AR APCH operations.

(2) An operational TAWS Class A should be available for all RNP AR APCH operations. The TAWS should use altitude values that are compensated for local pressure and temperature effects (e.g. corrected barometric and GNSS altitude), and include significant terrain and obstacle data.

(b) Autopilot and flight director

(1) For RNP AR APCH operations with RNP values less than RNP 0.3 or with RF legs, the autopilot or flight director driven by the area navigation system should be used. Thus, the flight crew should check that the autopilot/flight director is installed and operational.

(c) Preflight RNP assessment

(1) The operator should have a predictive performance capability, which can determine if the specified RNP will be available at the time and location of a desired RNP operation. This capability can be a ground service and need not be resident in the aircraft's avionics equipment. The operator should establish procedures requiring use of this capability as both a preflight preparation tool and as a flight-following tool in the event of reported failures.

(2) This predictive capability should account for known and predicted outages of GNSS satellites or other impacts on the navigation system's sensors. The prediction programme should not use a mask angle below 5 degrees, as operational experience indicates that satellite signals at low elevations are not reliable. The prediction should use the actual GNSS constellation with the RAIM (or equivalent) algorithm identical to or more conservative than that used in the actual equipment.

(3) The RNP assessment should consider the specific combination of the aircraft capability (sensors and integration), as well as their availability.

(d) NAVAID exclusion

(1) The operator should establish procedures to exclude NAVAID facilities in accordance with NOTAMs (e.g. DMEs, VORs, localisers). Internal avionics reasonableness checks may not be adequate for RNP operations.

(e) Navigation database currency

(1) During system initialisation, the flight crew should confirm that the navigation database is current. Navigation databases should be current for the duration of the flight. If the AIRAC cycle is due to change during flight, the flight crew should follow procedures established by the operator to ensure the accuracy of navigation data.

(2) The operator should not allow the flight crew to use an expired database.

AMC2 SPA.PBN.105(d) PBN operational approval

FLIGHT CONSIDERATIONS

(a) Modification of flight plan

The flight crew should not be authorised to fly a published RNP AR APCH procedure unless it is retrievable by the procedure name from the aircraft navigation database and conforms to the charted procedure. The lateral path should not be modified; with the exception of accepting a clearance to go direct to a fix in the approach procedure that is before the FAF and that does not immediately precede an RF leg. The only other acceptable modification to the loaded procedure is to change altitude and/or airspeed waypoint constraints on the initial, intermediate, or missed approach segments flight plan fixes (e.g. to apply temperature corrections or comply with an ATC clearance/instruction).

(b) Mandatory equipment

The flight crew should have either a mandatory list of equipment for conducting RNP AR APCH operations or alternate methods to address in-flight equipment failures that would prohibit RNP AR APCH operations (e.g. crew warning systems, quick reference handbook).

(c) RNP management

Operating procedures should ensure that the navigation system uses the appropriate RNP values throughout the approach operation. If the navigation system does not extract and set the navigation accuracy from the on-board navigation database for each segment of the procedure, then operating procedures should ensure that the smallest navigation accuracy required to complete the approach or the missed approach is selected before initiating the approach operation (e.g. before the IAF). Different IAFs may have different navigation accuracy, which are annotated on the approach chart.

(d) Loss of RNP

The flight crew should ensure that no loss of RNP annunciation is received prior to commencing the RNP AR APCH operation. During the approach operation, if at any time a loss of RNP annunciation is received, the flight crew should abandon the RNP AR APCH operation unless the pilot has in sight the visual references required to continue the approach operation.

(e) Radio updating

Initiation of all RNP AR APCH procedures is based on GNSS updating. The flight crew should comply with the operator's procedures for inhibiting specific facilities.

(f) Approach procedure confirmation

The flight crew should confirm that the correct procedure has been selected. This process includes confirmation of the waypoint sequence, reasonableness of track angles and distances, and any other parameters that can be altered by the flight crew, such as altitude or speed constraints. A navigation system textual display or navigation map display should be used.

(g) Track deviation monitoring

(1) The flight crew should use a lateral deviation indicator, flight director and/or autopilot in lateral navigation mode on RNP AR APCH operations. The flight crew of an aircraft with a lateral deviation indicator should ensure that lateral deviation indicator scaling (full-scale deflection) is suitable for the navigation accuracy associated with the various segments of the RNP AR APCH procedure. The flight crew is expected to maintain procedure centrelines, as depicted by on-board lateral deviation indicators and/or flight guidance during the entire RNP AR APCH operations unless authorised to deviate by ATC or demanded under

emergency conditions. For normal operations, cross-track error/deviation (the difference between the area-navigation-system-computed path and the aircraft position relative to the path) should be limited to the navigation accuracy (RNP) associated with the procedure segment.

(2) Vertical deviation should be monitored above and below the glide-path; the vertical deviation should be within ±75 ft of the glide-path during the final approach segment.

(3) Flight crew should execute a missed approach operation if:

(i) the lateral deviation exceeds one time the RNP value; or

(ii) the deviation below the vertical path exceeds 75 ft or half-scale deflection where angular deviation is indicated, at any time; or

(iii) the deviation above the vertical path exceeds 75 ft or half-scale deflection where angular deviation is indicated; at or below 1 000 ft above aerodrome level;

unless the pilot has in sight the visual references required to continue the approach operation.

(4) Where a moving map, low-resolution vertical deviation indicator (VDI), or numeric display of deviations are to be used, flight crew training and procedures should ensure the effectiveness of these displays. Typically, this involves demonstration of the procedure with a number of trained flight crew members and inclusion of this monitoring procedure in the recurrent RNP AR APCH training programme.

(5) For installations that use a CDI for lateral path tracking, the AFM should state which navigation accuracy and operations the aircraft supports and the operational effects on the CDI scale. The flight crew should know the CDI full-scale deflection value. The avionics may automatically set the CDI scale (dependent on phase of flight) or the flight crew may manually set the scale. If the flight crew manually selects the CDI scale, the operator should have procedures and training in place to assure the selected CDI scale is appropriate for the intended RNP operation. The deviation limit should be readily apparent given the scale (e.g. full-scale deflection).

(h) System cross-check

(1) The flight crew should ensure the lateral and vertical guidance provided by the navigation system is consistent.

(i) Procedures with RF legs

(1) When initiating a missed approach operation during or shortly after the RF leg, the flight crew should be aware of the importance of maintaining the published path as closely as possible. Operating procedures should be provided for aircraft that do not stay in LNAV when a missed approach is initiated to ensure the RNP AR APCH ground track is maintained.

(2) The flight crew should not exceed the maximum airspeed values shown in Table 1 throughout the RF leg. For example, a Category C A320 should slow to 160 KIAS at the FAF or may fly as fast as 185 KIAS if using Category D minima. A missed approach operation prior to DA/H may require compliance with speed limitation for that segment.

Table 1: Maximum airspeed by segment and category

Indicated airspeed (Knots)					
Segment	Indicated airspeed by aircraft category				
	Cat A	Cat B	Cat C	Cat D	Cat E
Initial & intermediate (IAF to FAF)	150	180	240	250	250
Final (FAF to DA)	100	130	160	185	as specified
Missed approach (DA/H to MAHP)	110	150	240	265	as specified
Airspeed restriction*	as specified				

*Airspeed restrictions may be used to reduce turn radius regardless of aircraft category.

(j) Temperature compensation

For aircraft with temperature compensation capabilities, the flight crew may disregard the temperature limits on RNP procedures if the operator provides pilot training on the use of the temperature compensation function. It should be noted that a temperature compensation by the system is applicable to the VNAV guidance and is not a substitute for the flight crew compensating for temperature effects on minimum altitudes or DA/H. The flight crew should be familiar with the effects of the temperature compensation on intercepting the compensated path as described in EUROCAE ED-75C/RTCA DO-236C Appendix H.

(k) Altimeter setting

Due to the performance-based obstruction clearance inherent in RNP instrument procedures, the flight crew should verify that the most current aerodrome altimeter is set prior to the FAF. The operator should take precautions to switch altimeter settings at appropriate times or locations and request a current altimeter setting if the reported setting may not be recent, particularly at times when pressure is reported or expected to be rapidly decreasing. Execution of an RNP operation necessitates the current altimeter setting for the aerodrome of intended landing. Remote altimeter settings should not be allowed.

(l) Altimeter cross-check

(1) The flight crew should complete an altimetry cross-check ensuring both pilots' altimeters agree within ±100 ft prior to the FAF but no earlier than when the altimeters are set for the aerodrome of intended landing. If the altimetry cross-check fails, then the approach operation should not be continued.

(2) This operational cross-check should not be necessary if the aircraft systems automatically compare the altitudes to within 75 ft.

(m) Missed approach operation

Where possible, the missed approach operation should necessitate RNP 1.0. The missed approach portion of these procedures should be similar to a missed approach of an RNP APCH procedure. Where necessary, navigation accuracy less than RNP 1.0 may be used in the missed approach segment.

(1) In many aircraft, executing a missed approach activating take-off/go-around (TOGA) may cause a change in lateral navigation. In many aircraft, activating TOGA disengages the autopilot and flight director from LNAV guidance, and the flight director reverts to track-

hold derived from the inertial system. LNAV guidance to the autopilot and flight director should be re-engaged as quickly as possible.

(2) Flight crew procedures and training should address the impact on navigation capability and flight guidance if the pilot initiates a missed approach while the aircraft is in a turn. When initiating an early missed approach operation, the flight crew should follow the rest of the approach track and missed approach track unless a different clearance has been issued by ATC. The flight crew should also be aware that RF legs are designed based on the maximum true airspeed at normal altitudes, and initiating an early missed approach operation will reduce the manoeuvrability margin and potentially even make holding the turn impractical at missed approach speeds.

(n) Contingency procedures

(1) Failure while en route

The flight crew should be able to assess the impact of GNSS equipment failure on the anticipated RNP AR APCH operation and take appropriate action.

(2) Failure on approach

The operator's contingency procedures should address at least the following conditions:

(i) failure of the area navigation system components, including those affecting lateral and vertical deviation performance (e.g. failures of a GPS sensor, the flight director or autopilot);

(ii) loss of navigation signal-in-space (loss or degradation of external signal).

AMC3 SPA.PBN.105(d) PBN operational approval

NAVIGATION DATABASE MANAGEMENT

(a) The operator should validate every RNP AR APCH procedure before using the procedure in instrument meteorological conditions (IMC) to ensure compatibility with their aircraft and to ensure the resulting path matches the published procedure. As a minimum, the operator should:

(1) compare the navigation data for the procedure(s) to be loaded into the FMS with the published procedure.

(2) validate the loaded navigation data for the procedure, either in an FSTD or in the actual aircraft in VMC. The depicted procedure on the map display should be compared to the published procedure. The entire procedure should be flown to ensure the path is flyable, does not have any apparent lateral or vertical path disconnects and is consistent with the published procedure.

(3) Once the procedure is validated, a copy of the validated navigation data should be retained for comparison with subsequent data updates.

(4) For published procedures, where FOSA demonstrated that the procedure is not in a challenging operational environment, the flight or FSTD validation may be credited from already validated equivalent RNP AR APCH procedures.

(b) If an aircraft system required for RNP AR APCH operations is modified, the operator should assess the need for a validation of the RNP AR APCH procedures with the navigation database and the modified system. This may be accomplished without any direct evaluation if the manufacturer verifies that the modification has no effect on the navigation database or path computation. If no such assurance from the manufacturer is available, the operator should conduct initial data validation with the modified system.

(c) The operator should implement procedures that ensure timely distribution and insertion of current and unaltered electronic navigation data to all aircraft that require it.

AMC1 SPA.PBN.105(e) PBN operational approval

REPORTABLE EVENTS

The operator should report events which are listed in AMC2 ORO.GEN.160.

AMC1 SPA.PBN.105(f) PBN operational approval

RNP MONITORING PROGRAMME

(a) The operator approved to conduct RNP AR APCH operations, should have an RNP monitoring programme to ensure continued compliance with applicable rules and to identify any negative trends in performance.

(b) During an interim approval period, which should be at least 90 days, the operator should at least submit the following information every 30 days to the competent authority.

  (1) Total number of RNP AR APCH operations conducted;

  (2) Number of approach operations by aircraft/system which were completed as planned without any navigation or guidance system anomalies;

  (3) Reasons for unsatisfactory approaches, such as:

    (i) UNABLE REQ NAV PERF, NAV ACCUR DOWNGRAD, or other RNP messages during approaches;

    (ii) excessive lateral or vertical deviation;

    (iii) TAWS warning;

    (iv) autopilot system disconnect;

    (v) navigation data errors; or

    (vi) flight crew reports of any anomaly;

  (4) Flight crew comments.

(c) Thereafter, the operator should continue to collect and periodically review this data to identify potential safety concerns, and maintain summaries of this data.

SUBPART C: OPERATIONS WITH SPECIFIED MINIMUM NAVIGATION PERFORMANCE (MNPS)

GM1 SPA.MNPS.100 MNPS operations

DOCUMENTATION

MNPS and the procedures governing their application are published in the Regional Supplementary Procedures, ICAO Doc 7030, as well as in national AIPs.

AMC1 SPA.MNPS.105 MNPS operational approval

LONG RANGE NAVIGATION SYSTEM (LRNS)

(a) For unrestricted operation in MNPS airspace an aircraft should be equipped with two independent LRNSs.

(b) An LRNS may be one of the following:

  (1) one inertial navigation system (INS);

  (2) one global navigation satellite system (GNSS); or

  (3) one navigation system using the inputs from one or more inertial reference system (IRS) or any other sensor system complying with the MNPS requirement.

(c) In case of the GNSS is used as a stand-alone system for LRNS, an integrity check should be carried out.

(d) For operation in MNPS airspace along notified special routes the aeroplane should be equipped with one LRNS.

SUBPART D:
OPERATIONS IN AIRSPACE WITH REDUCED VERTICAL SEPARATION MINIMA (RVSM)

AMC1 SPA.RVSM.105 RVSM operational approval

CONTENT OF OPERATOR RVSM APPLICATION

The following material should be made available to the competent authority, in sufficient time to permit evaluation, before the intended start of RVSM operations:

(a) Airworthiness documents

Documentation that shows that the aircraft has RVSM airworthiness approval. This should include an aircraft flight manual (AFM) amendment or supplement.

(b) Description of aircraft equipment

A description of the aircraft appropriate to operations in an RVSM environment.

(c) Training programmes, operating practices and procedures

The operator should submit training syllabi for initial and recurrent training programmes together with other relevant material. The material should show that the operating practices, procedures and training items, related to RVSM operations in airspace that requires State operational approval, are incorporated.

(d) Manuals and checklists

The appropriate manuals and checklists should be revised to include information/guidance on standard operating procedures. Manuals should contain a statement of the airspeeds, altitudes and weights considered in RVSM aircraft approval, including identification of any operating limitations or conditions established for that aircraft type. Manuals and checklists may need to be submitted for review by the competent authority as part of the application process.

(e) Past performance

Relevant operating history, where available, should be included in the application. The applicant should show that any required changes have been made in training, operating or maintenance practices to improve poor height-keeping performance.

(f) Minimum equipment list

Where applicable, a minimum equipment list (MEL), adapted from the master minimum equipment list (MMEL), should include items pertinent to operating in RVSM airspace.

(g) Plan for participation in verification/monitoring programmes

The operator should establish a plan for participation in any applicable verification/monitoring programme acceptable to the competent authority. This plan should include, as a minimum, a check on a sample of the operator's fleet by an regional monitoring agency (RMA)’s independent height-monitoring system.

AMC2 SPA.RVSM.105 RVSM operational approval

OPERATING PROCEDURES

(a) Flight planning

(1) During flight planning the flight crew should pay particular attention to conditions that may affect operation in RVSM airspace. These include, but may not be limited to:

(i) verifying that the airframe is approved for RVSM operations;

(ii) reported and forecast weather on the route of flight;

(iii) minimum equipment requirements pertaining to height-keeping and alerting systems; and

(iv) any airframe or operating restriction related to RVSM operations.

(b) Pre-flight procedures

(1) The following actions should be accomplished during the pre-flight procedure:

(i) Review technical logs and forms to determine the condition of equipment required for flight in the RVSM airspace. Ensure that maintenance action has been taken to correct defects to required equipment.

(ii) During the external inspection of aircraft, particular attention should be paid to the condition of static sources and the condition of the fuselage skin near each static source and any other component that affects altimetry system accuracy. This check may be accomplished by a qualified and authorised person other than the pilot (e.g. a flight engineer or ground engineer).

(iii) Before take-off, the aircraft altimeters should be set to the QNH (atmospheric pressure at nautical height) of the airfield and should display a known altitude, within the limits specified in the aircraft operating manuals. The two primary altimeters should also agree within limits specified by the aircraft operating manual. An alternative procedure using QFE (atmospheric pressure at aerodrome elevation/runway threshold) may also be used. The maximum value of acceptable altimeter differences for these checks should not exceed 23 m (75 ft). Any required functioning checks of altitude indicating systems should be performed.

(iv) Before take-off, equipment required for flight in RVSM airspace should be operative and any indications of malfunction should be resolved.

(c) Prior to RVSM airspace entry

(1) The following equipment should be operating normally at entry into RVSM airspace:

(i) two primary altitude measurement systems. A cross-check between the primary altimeters should be made. A minimum of two will need to agree within ±60 m (±200 ft). Failure to meet this condition will require that the altimetry system be reported as defective and air traffic control (ATC) notified;

(ii) one automatic altitude-control system;

(iii) one altitude-alerting device; and

(iv) operating transponder.

(2) Should any of the required equipment fail prior to the aircraft entering RVSM airspace, the pilot should request a new clearance to avoid entering this airspace.

(d) In-flight procedures

(1) The following practices should be incorporated into flight crew training and procedures:

(i) Flight crew should comply with any aircraft operating restrictions, if required for the specific aircraft type, e.g. limits on indicated Mach number, given in the RVSM airworthiness approval.

(ii) Emphasis should be placed on promptly setting the sub-scale on all primary and standby altimeters to 1013.2 hPa / 29.92 in Hg when passing the transition altitude, and rechecking for proper altimeter setting when reaching the initial cleared flight level.

(iii) In level cruise it is essential that the aircraft is flown at the cleared flight level. This requires that particular care is taken to ensure that ATC clearances are fully understood and followed. The aircraft should not intentionally depart from cleared flight level without a positive clearance from ATC unless the crew are conducting contingency or emergency manoeuvres.

(iv) When changing levels, the aircraft should not be allowed to overshoot or undershoot the cleared flight level by more than 45 m (150 ft). If installed, the level off should be accomplished using the altitude capture feature of the automatic altitude-control system.

(v) An automatic altitude-control system should be operative and engaged during level cruise, except when circumstances such as the need to re-trim the aircraft or turbulence require disengagement. In any event, adherence to cruise altitude should be done by reference to one of the two primary altimeters. Following loss of the automatic height-keeping function, any consequential restrictions will need to be observed.

(vi) Ensure that the altitude-alerting system is operative.

(vii) At intervals of approximately 1 hour, cross-checks between the primary altimeters should be made. A minimum of two will need to agree within ±60 m (±200 ft). Failure to meet this condition will require that the altimetry system be reported as defective and ATC notified or contingency procedures applied:

(A) the usual scan of flight deck instruments should suffice for altimeter cross-checking on most flights; and

(B) before entering RVSM airspace, the initial altimeter cross-check of primary and standby altimeters should be recorded.

(viii) In normal operations, the altimetry system being used to control the aircraft should be selected for the input to the altitude reporting transponder transmitting information to ATC.

(ix) If the pilot is notified by ATC of a deviation from an assigned altitude exceeding ±90 m (±300 ft) then the pilot should take action to return to cleared flight level as quickly as possible.

(2) Contingency procedures after entering RVSM airspace are as follows:

(i) The pilot should notify ATC of contingencies (equipment failures, weather) that affect the ability to maintain the cleared flight level and coordinate a plan of action appropriate to the airspace concerned. The pilot should obtain to the guidance on contingency procedures is contained in the relevant publications dealing with the airspace.

(ii) Examples of equipment failures that should be notified to ATC are:

(A) failure of all automatic altitude-control systems aboard the aircraft;

(B) loss of redundancy of altimetry systems;

(C) loss of thrust on an engine necessitating descent; or

(D) any other equipment failure affecting the ability to maintain cleared flight level.

(iii) The pilot should notify ATC when encountering greater than moderate turbulence.

(iv) If unable to notify ATC and obtain an ATC clearance prior to deviating from the cleared flight level, the pilot should follow any established contingency procedures for the region of operation and obtain ATC clearance as soon as possible.

(e) Post-flight procedures

(1) In making technical log entries against malfunctions in height-keeping systems, the pilot should provide sufficient detail to enable maintenance to effectively troubleshoot and repair the system. The pilot should detail the actual defect and the crew action taken to try to isolate and rectify the fault.

(2) The following information should be recorded when appropriate:

(i) primary and standby altimeter readings;

(ii) altitude selector setting;

(iii) subscale setting on altimeter;

(iv) autopilot used to control the aircraft and any differences when an alternative autopilot system was selected;

(v) differences in altimeter readings, if alternate static ports selected;

(vi) use of air data computer selector for fault diagnosis procedure; and

(vii) the transponder selected to provide altitude information to ATC and any difference noted when an alternative transponder was selected.

(f) Crew training

(1) The following items should also be included in flight crew training programmes:

(i) knowledge and understanding of standard ATC phraseology used in each area of operations;

(ii) importance of crew members cross-checking to ensure that ATC clearances are promptly and correctly complied with;

(iii) use and limitations in terms of accuracy of standby altimeters in contingencies. Where applicable, the pilot should review the application of static source error correction/position error correction through the use of correction cards; such correction data should be available on the flight deck;

(iv) problems of visual perception of other aircraft at 300 m (1 000 ft) planned separation during darkness, when encountering local phenomena such as northern lights, for opposite and same direction traffic, and during turns;

(v) characteristics of aircraft altitude capture systems that may lead to overshoots;

(vi) relationship between the aircraft's altimetry, automatic altitude control and transponder systems in normal and abnormal conditions; and

(vii) any airframe operating restrictions, if required for the specific aircraft group, related to RVSM airworthiness approval.

GM1 SPA.RVSM.105(d)(9) RVSM operational approval

SPECIFIC REGIONAL PROCEDURES

(a) The areas of applicability (by Flight Information Region) of RVSM airspace in identified ICAO regions is contained in the relevant sections of ICAO Document 7030/4. In addition, these sections contain operating and contingency procedures unique to the regional airspace concerned, specific flight planning requirements and the approval requirements for aircraft in the designated region.

(b) Comprehensive guidance on operational matters for European RVSM airspace is contained in EUROCONTROL Document ASM ET1.ST.5000 entitled “The ATC Manual for a Reduced Vertical Separation (RVSM) in Europe” with further material included in the relevant State aeronautical publications.

AMC1 SPA.RVSM.110(a) RVSM equipment requirements

TWO INDEPENDENT ALTITUDE MEASUREMENT SYSTEMS

Each system should be composed of the following components:

(a) cross-coupled static source/system, with ice protection if located in areas subject to ice accretion;

(b) equipment for measuring static pressure sensed by the static source, converting it to pressure altitude and displaying the pressure altitude to the flight crew:

(c) equipment for providing a digitally encoded signal corresponding to the displayed pressure altitude, for automatic altitude reporting purposes;

(d) static source error correction (SSEC), if needed to meet the performance criteria for RVSM flight envelopes; and

(e) signals referenced to a flight crew selected altitude for automatic control and alerting. These signals will need to be derived from an altitude measurement system meeting the performance criteria for RVSM flight envelopes.

SUBPART E:
LOW VISIBILITY OPERATIONS (LVO)

AMC1 SPA.LVO.100 Low visibility operations

LVTO OPERATIONS – AEROPLANES

For a low visibility take-off (LVTO) with an aeroplane the following provisions should apply:

(a) for an LVTO with a runway visual range (RVR) below 400 m the criteria specified in Table 1.A;

(b) for an LVTO with an RVR below 150 m but not less than 125 m:

(1) high intensity runway centre line lights spaced 15 m or less apart and high intensity edge lights spaced 60 m or less apart that are in operation;

(2) a 90 m visual segment that is available from the flight crew compartment at the start of the take-off run; and

(3) the required RVR value is achieved for all of the relevant RVR reporting points;

(c) for an LVTO with an RVR below 125 m but not less than 75 m:

(1) runway protection and facilities equivalent to CAT III landing operations are available; and

(2) the aircraft is equipped with an approved lateral guidance system.

Table 1.A: LVTO – aeroplanes
RVR vs. facilities

Facilities	RVR (m) *, **
Day: runway edge lights and runway centre line markings Night: runway edge lights and runway end lights or runway centre line lights and runway end lights	300
Runway edge lights and runway centre line lights	200
Runway edge lights and runway centre line lights	TDZ, MID, rollout 150***
High intensity runway centre line lights spaced 15 m or less and high intensity edge lights spaced 60 m or less are in operation	TDZ, MID, rollout 125***
Runway protection and facilities equivalent to CAT III landing operations are available and the aircraft is equipped either with an approved lateral guidance system or an approved HUD / HUDLS for take-off.	TDZ, MID, rollout 75

*: The reported RVR value representative of the initial part of the take-off run can be replaced by pilot assessment.

**: Multi-engined aeroplanes that in the event of an engine failure at any point during take-off can either stop or continue the take-off to a height of 1 500 ft above the aerodrome while clearing obstacles by the required margins.

***: The required RVR value to be achieved for all relevant RVRs

TDZ: touchdown zone, equivalent to the initial part of the take-off run

MID: midpoint

AMC2 SPA.LVO.100 Low visibility operations

LVTO OPERATIONS – HELICOPTERS

For LVTOs with helicopters the provisions specified in Table 1.H should apply.

Table 1.H: LVTO – helicopters
RVR vs. facilities

Facilities	RVR (m)
Onshore aerodromes with IFR departure procedures	
No light and no markings (day only)	250 or the rejected take-off distance, whichever is the greater
No markings (night)	800
Runway edge/FATO light and centre line marking	200
Runway edge/FATO light, centre line marking and relevant RVR information	150
Offshore helideck *	
Two-pilot operations	250
Single-pilot operations	500

*: The take-off flight path to be free of obstacles

FATO: final approach and take-off area

AMC3 SPA.LVO.100 Low visibility operations

LTS CAT I OPERATIONS

(a) For lower than Standard Category I (LTS CAT I) operations the following provisions should apply:

(1) The decision height (DH) of an LTS CAT I operation should not be lower than the highest of:

(i) the minimum DH specified in the AFM, if stated;

(ii) the minimum height to which the precision approach aid can be used without the specified visual reference;

(iii) the applicable obstacle clearance height (OCH) for the category of aeroplane;

(iv) the DH to which the flight crew is qualified to operate; or

(v) 200 ft.

(2) An instrument landing system / microwave landing system (ILS/MLS) that supports an LTS CAT I operation should be an unrestricted facility with a straight-in course, ≤ 3º offset, and the ILS should be certified to:

(i) class I/T/1 for operations to a minimum of 450 m RVR; or

(ii) class II/D/2 for operations to less than 450 m RVR.

Single ILS facilities are only acceptable if level 2 performance is provided.

(3) The following visual aids should be available:

(i) standard runway day markings, approach lights, runway edge lights, threshold lights and runway end lights;

(ii) for operations with an RVR below 450 m, additionally touch-down zone and/or runway centre line lights.

(4) The lowest RVR / converted meteorological visibility (CMV) minima to be used are specified in Table 2.

Table 2: LTS CAT I operation minima
RVR/CMV vs. approach lighting system

DH (ft)	Class of light facility *			
	FALS	IALS	BALS	NALS
	RVR/CMV (m)			
200 – 210	400	500	600	750
211 – 220	450	550	650	800
221 – 230	500	600	700	900
231 – 240	500	650	750	1 000
241 – 249	550	700	800	1 100

*: FALS: full approach lighting system

IALS: intermediate approach lighting system

BALS: basic approach lighting system

NALS: no approach lighting system

AMC4 SPA.LVO.100 Low visibility operations

CAT II AND OTS CAT II OPERATIONS

(a) For CAT II and other than Standard Category II (OTS CAT II) operations the following provisions should apply:

(1) The ILS / MLS that supports OTS CAT II operation should be an unrestricted facility with a straight in course (≤ 3º offset) and the ILS should be certified to class II/D/2.

Single ILS facilities are only acceptable if level 2 performance is provided.

(2) The DH for CAT II and OTS CAT II operation should not be lower than the highest of:

(i) the minimum DH specified in the AFM, if stated;

(ii) the minimum height to which the precision approach aid can be used without the specified visual reference;

(iii) the applicable OCH for the category of aeroplane;

(iv) the DH to which the flight crew is qualified to operate; or

(v) 100 ft.

(3) The following visual aids should be available:

(i) standard runway day markings and approach and the following runway lights: runway edge lights, threshold lights and runway end lights;

(ii) for operations in RVR below 450 m, additionally touch-down zone and/or runway centre line lights;

(iii) for operations with an RVR of 400 m or less, additionally centre line lights.

(4) The lowest RVR minima to be used are specified:

(i) for CAT II operations in Table 3; and

(ii) for OTS CAT II operations in Table 4.

(b) For OTS CAT II operations, the terrain ahead of the runway threshold should have been surveyed.

Table 3: CAT II operation minima
RVR vs. DH

DH (ft)	**Auto-coupled or approved HUDLS to below DH ***	
	Aircraft categories A, B, C RVR (m)	**Aircraft category D RVR (m)**
100 – 120	300	300/350**
121 – 140	400	400
141 – 199	450	450

*: This means continued use of the automatic flight control system or the HUDLS down to a height of 80 % of the DH.

**: An RVR of 300 m may be used for a category D aircraft conducting an auto-land.

Table 4: OTS CAT II operation minima
RVR vs. approach lighting system

	Auto-land or approved HUDLS utilised to touchdown				
	Class of light facility				
	FALS		IALS	BALS	NALS
	Aircraft categories A – C	Aircraft category D	Aircraft categories A – D	Aircraft categories A – D	Aircraft categories A - D
DH (ft)	RVR (m)				
100 - 120	350	400	450	600	700
121 - 140	400	450	500	600	700
141 - 160	400	500	500	600	750
161 - 199	400	500	550	650	750

AMC5 SPA.LVO.100 Low visibility operations

CAT III OPERATIONS

The following provisions should apply to CAT III operations:

(a) Where the DH and RVR do not fall within the same category, the RVR should determine in which category the operation is to be considered.

(b) For operations in which a DH is used, the DH should not be lower than:

(1) the minimum DH specified in the AFM, if stated;

(2) the minimum height to which the precision approach aid can be used without the specified visual reference; or

(3) the DH to which the flight crew is qualified to operate.

(c) Operations with no DH should only be conducted if:

(1) the operation with no DH is specified in the AFM;

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

(3) the flight crew is qualified to operate with no DH.

(d) The lowest RVR minima to be used are specified in Table 5.

Table 5: CAT III operations minima
RVR vs. DH and rollout control/guidance system

CAT	DH (ft) *	Rollout control/guidance system	RVR (m)
IIIA	Less than 100	Not required	200
IIIB	Less than 100	Fail-passive	150**
IIIB	Less than 50	Fail-passive	125
IIIB	Less than 50 or no DH	Fail-operational ***	75

*: Flight control system redundancy is determined under CS-AWO by the minimum certified DH.

**: For aeroplanes certified in accordance with CS-AWO 321(b)(3) or equivalent.

***: The fail-operational system referred to may consist of a fail-operational hybrid system.

AMC6 SPA.LVO.100 Low visibility operations

OPERATIONS UTILISING EVS

The pilot using a certified enhanced vision system (EVS) in accordance with the procedures and limitations of the AFM:

(a) may reduce the RVR/CMV value in column 1 to the value in column 2 of Table 6 for CAT I operations, APV operations and NPA operations flown with the CDFA technique;

(b) for CAT I operations:

(1) may continue an approach below DH to 100 ft above the runway threshold elevation provided that a visual reference is displayed and identifiable on the EVS image; and

(2) should only continue an approach below 100 ft above the runway threshold elevation provided that a visual reference is distinctly visible and identifiable to the pilot without reliance on the EVS;

(c) for APV operations and NPA operations flown with the CDFA technique:

(1) may continue an approach below DH/MDH to 200 ft above the runway threshold elevation provided that a visual reference is displayed and identifiable on the EVS image; and

(2) should only continue an approach below 200 ft above the runway threshold elevation provided that a visual reference is distinctly visible and identifiable to the pilot without reliance on the EVS.

Table 6: Operations utilising EVS
RVR/CMV reduction vs. normal RVR/CMV

RVR/CMV (m) normally required	RVR/CMV (m) utilising EVS
550	350
600	400
650	450
700	450
750	500
800	550
900	600
1 000	650
1 100	750
1 200	800
1 300	900
1 400	900
1 500	1 000
1 600	1 100
1 700	1 100
1 800	1 200
1 900	1 300
2 000	1 300
2 100	1 400
2 200	1 500
2 300	1 500
2 400	1 600
2 500	1 700
2 600	1 700
2 700	1 800
2 800	1 900
2 900	1 900
3 000	2 000
3 100	2 000
3 200	2 100
3 300	2 200
3 400	2 200

RVR/CMV (m) normally required	RVR/CMV (m) utilising EVS
3 500	2 300
3 600	2 400
3 700	2 400
3 800	2 500
3 900	2 600
4 000	2 600
4 100	2 700
4 200	2 800
4 300	2 800
4 400	2 900
4 500	3 000
4 600	3 000
4 700	3 100
4 800	3 200
4 900	3 200
5 000	3 300

AMC7 SPA.LVO.100 Low visibility operations

EFFECT ON LANDING MINIMA OF TEMPORARILY FAILED OR DOWNGRADED EQUIPMENT

(a) General

These instructions are intended for use both pre-flight and in-flight. It is however not expected that the pilot-in-command/commander would consult such instructions after passing 1 000 ft above the aerodrome. If failures of ground aids are announced at such a late stage, the approach could be continued at the pilot-in-command/commander's discretion. If failures are announced before such a late stage in the approach, their effect on the approach should be considered as described in Table 7, and the approach may have to be abandoned.

(b) The following conditions should be applicable to the tables below:

(1) multiple failures of runway/FATO lights other than indicated in Table 7 are not acceptable;

(2) deficiencies of approach and runway/FATO lights are treated separately;

(3) for CAT II and CAT III operations, a combination of deficiencies in runway/FATO lights and RVR assessment equipment are not permitted; and

(4) failures other than ILS and MLS affect RVR only and not DH.

Table 7: Failed or downgraded equipment – affect on landing minima
Operations with an LVO approval

<table>
<tr><th rowspan="2">Failed or downgraded equipment</th><th colspan="4">Effect on landing minima</th></tr>
<tr><th>CAT IIIB (no DH)</th><th>CAT IIIB</th><th>CAT IIIA</th><th>CAT II</th></tr>
<tr><td>ILS/MLS stand-by transmitter</td><td>Not allowed</td><td>RVR 200 m</td><td colspan="2">No effect</td></tr>
<tr><td>Outer marker</td><td colspan="4">No effect if replaced by height check at 1 000 ft</td></tr>
<tr><td>Middle marker</td><td colspan="4">No effect</td></tr>
<tr><td>RVR assessment systems</td><td>At least one RVR value to be available on the aerodrome</td><td colspan="3">On runways equipped with two or more RVR assessment units, one may be inoperative</td></tr>
<tr><td>Approach lights</td><td>No effect</td><td colspan="2">Not allowed for operations with DH >50 ft</td><td>Not allowed</td></tr>
<tr><td>Approach lights except the last 210 m</td><td colspan="3">No effect</td><td>Not allowed</td></tr>
<tr><td>Approach lights except the last 420 m</td><td colspan="4">No effect</td></tr>
<tr><td>Standby power for approach lights</td><td colspan="4">No effect</td></tr>
<tr><td rowspan="2">Edge lights, threshold lights and runway end lights</td><td rowspan="2" colspan="2">No effect</td><td>Day: no effect</td><td>Day: no effect</td></tr>
<tr><td>Night: RVR 550 m</td><td>Night: not allowed</td></tr>
<tr><td rowspan="2">Centre line lights</td><td>Day: RVR 200 m</td><td rowspan="2">Not allowed</td><td>Day: RVR 300 m</td><td>Day: RVR 350 m</td></tr>
<tr><td>Night: not allowed</td><td>Night: RVR 400 m</td><td>Night: RVR 550 m (400 m with HUDLS or auto-land)</td></tr>
<tr><td>Centre line lights spacing increased to 30 m</td><td colspan="2">RVR 150 m</td><td colspan="2">No effect</td></tr>
<tr><td>Touchdown zone lights</td><td>No effect</td><td>Day: RVR 200 m</td><td colspan="2">Day: RVR 300 m</td></tr>
</table>

Failed or downgraded equipment	Effect on landing minima			
	CAT IIIB (no DH)	CAT IIIB	CAT IIIA	CAT II
		Night: RVR 300 m	Night: RVR 550 m, 350 m with HUDLS or auto-land	
Taxiway light system	No effect			

GM1 SPA.LVO.100 Low visibility operations

DOCUMENTS CONTAINING INFORMATION RELATED TO LOW VISIBILITY OPERATIONS

The following documents provide further information to low visibility operations (LVO):

(a) ICAO Annex 2 Rules of the Air;

(b) ICAO Annex 6 Operation of Aircraft;

(c) ICAO Annex 10 Telecommunications Vol. 1;

(d) ICAO Annex 14 Aerodromes Vol. 1;

(e) ICAO Doc 8168 PANS - OPS Aircraft Operations;

(f) ICAO Doc 9365 AWO Manual;

(g) ICAO Doc 9476 Manual of surface movement guidance and control systems (SMGCS);

(h) ICAO Doc 9157 Aerodrome Design Manual;

(i) ICAO Doc 9328 Manual of RVR Observing and Reporting Practices;

(j) ICAO EUR Doc 013: European Guidance Material on Aerodrome Operations under Limited Visibility Conditions;

(k) ECAC Doc 17, Issue 3; and

(l) CS-AWO All weather operations.

GM2 SPA.LVO.100 Low visibility operations

ILS CLASSIFICATION

The ILS classification system is specified in ICAO Annex 10.

GM1 SPA.LVO.100(c),(e) Low visibility operations

ESTABLISHMENT OF MINIMUM RVR FOR CAT II AND CAT III OPERATIONS

(a) General

(1) When establishing minimum RVR for CAT II and CAT III operations, operators should pay attention to the following information that originates in ECAC Doc 17 3rd Edition, Subpart A.

It is retained as background information and, to some extent, for historical purposes although there may be some conflict with current practices.

(2) Since the inception of precision approach and landing operations various methods have been devised for the calculation of aerodrome operating minima in terms of DH and RVR. It is a comparatively straightforward matter to establish the DH for an operation but establishing the minimum RVR to be associated with that DH so as to provide a high probability that the required visual reference will be available at that DH has been more of a problem.

(3) The methods adopted by various States to resolve the DH/RVR relationship in respect of CAT II and CAT III operations have varied considerably. In one instance there has been a simple approach that entailed the application of empirical data based on actual operating experience in a particular environment. This has given satisfactory results for application within the environment for which it was developed. In another instance a more sophisticated method was employed which utilised a fairly complex computer programme to take account of a wide range of variables. However, in the latter case, it has been found that with the improvement in the performance of visual aids, and the increased use of automatic equipment in the many different types of new aircraft, most of the variables cancel each other out and a simple tabulation can be constructed that is applicable to a wide range of aircraft. The basic principles that are observed in establishing the values in such a table are that the scale of visual reference required by a pilot at and below DH depends on the task that he/she has to carry out, and that the degree to which his/her vision is obscured depends on the obscuring medium, the general rule in fog being that it becomes more dense with increase in height. Research using flight simulation training devices (FSTDs) coupled with flight trials has shown the following:

(i) most pilots require visual contact to be established about 3 seconds above DH though it has been observed that this reduces to about 1 second when a fail-operational automatic landing system is being used;

(ii) to establish lateral position and cross-track velocity most pilots need to see not less than a three light segment of the centre line of the approach lights, or runway centre line, or runway edge lights;

(iii) for roll guidance most pilots need to see a lateral element of the ground pattern, i.e. an approach light cross bar, the landing threshold, or a barrette of the touchdown zone light; and

(iv) to make an accurate adjustment to the flight path in the vertical plane, such as a flare, using purely visual cues, most pilots need to see a point on the ground which has a low or zero rate of apparent movement relative to the aircraft.

(v) With regard to fog structure, data gathered in the United Kingdom over a 20 year period have shown that in deep stable fog there is a 90 % probability that the slant visual range from eye heights higher than 15 ft above the ground will be less than the horizontal visibility at ground level, i.e. RVR. There are at present no data available to show what the relationship is between the slant visual range and RVR in other low visibility conditions such as blowing snow, dust or heavy rain, but there is some evidence in pilot reports that the lack of contrast between visual aids and the background in such conditions can produce a relationship similar to that observed in fog.

(b) CAT II operations

The selection of the dimensions of the required visual segments that are used for CAT II operations is based on the following visual provisions:

(1) a visual segment of not less than 90 m will need to be in view at and below DH for pilot to be able to monitor an automatic system;

(2) a visual segment of not less than 120 m will need to be in view for a pilot to be able to maintain the roll attitude manually at and below DH; and

(3) for a manual landing using only external visual cues, a visual segment of 225 m will be required at the height at which flare initiation starts in order to provide the pilot with sight of a point of low relative movement on the ground.

Before using a CAT II ILS for landing, the quality of the localiser between 50 ft and touchdown should be verified.

(c) CAT III fail-passive operations

(1) CAT III operations utilising fail-passive automatic landing equipment were introduced in the late 1960s and it is desirable that the principles governing the establishment of the minimum RVR for such operations be dealt with in some detail.

(2) During an automatic landing the pilot needs to monitor the performance of the aircraft system, not in order to detect a failure that is better done by the monitoring devices built into the system, but so as to know precisely the flight situation. In the final stages the pilot should establish visual contact and, by the time the pilot reaches DH, the pilot should have checked the aircraft position relative to the approach or runway centre line lights. For this the pilot will need sight of horizontal elements (for roll reference) and part of the touchdown area. The pilot should check for lateral position and cross-track velocity and, if not within the pre-stated lateral limits, the pilot should carry out a missed approach procedure. The pilot should also check longitudinal progress and sight of the landing threshold is useful for this purpose, as is sight of the touchdown zone lights.

(3) In the event of a failure of the automatic flight guidance system below DH, there are two possible courses of action; the first is a procedure that allows the pilot to complete the landing manually if there is adequate visual reference for him/her to do so, or to initiate a missed approach procedure if there is not; the second is to make a missed approach procedure mandatory if there is a system disconnect regardless of the pilot's assessment of the visual reference available:

(i) If the first option is selected then the overriding rule in the determination of a minimum RVR is for sufficient visual cues to be available at and below DH for the pilot to be able to carry out a manual landing. Data presented in ECAC Doc 17 showed that a minimum value of 300 m would give a high probability that the cues needed by the pilot to assess the aircraft in pitch and roll will be available and this should be the minimum RVR for this procedure.

(ii) The second option, to require a missed approach procedure to be carried out should the automatic flight-guidance system fail below DH, will permit a lower minimum RVR because the visual reference provision will be less if there is no need to provide for the possibility of a manual landing. However, this option is only acceptable if it can be shown that the probability of a system failure below DH is acceptably low. It should be recognised that the inclination of a pilot who experiences such a failure would be to continue the landing manually but the results of flight trials in actual conditions and of simulator experiments show that pilots do not always recognise that the visual cues are inadequate in such situations and present recorded data reveal that pilots' landing performance reduces progressively as the RVR is reduced below 300 m. It should further be recognised that there is some risk in carrying out a manual missed approach procedure from below 50 ft in very low visibility and it should therefore be accepted that if an RVR lower than 300 m is to be approved, the flight deck procedure should not normally allow the pilot to continue the landing manually in such conditions and the aircraft system should be sufficiently reliable for the missed approach procedure rate to be low.

(4) These criteria may be relaxed in the case of an aircraft with a fail-passive automatic landing system that is supplemented by a head-up display that does not qualify as a fail-operational system but that gives guidance that will enable the pilot to complete a landing in the event of a failure of the automatic landing system. In this case it is not necessary to make a missed approach procedure mandatory in the event of a failure of the automatic landing system when the RVR is less than 300 m.

(d) CAT III fail-operational operations - with a DH

(1) For CAT III operations utilising a fail-operational landing system with a DH, a pilot should be able to see at least one centre line light.

(2) For CAT III operations utilising a fail-operational hybrid landing system with a DH, a pilot should have a visual reference containing a segment of at least three consecutive lights of the runway centre line lights.

(e) CAT III fail operational operations - with no DH

(1) For CAT III operations with no DH the pilot is not required to see the runway prior to touchdown. The permitted RVR is dependent on the level of aircraft equipment.

(2) A CAT III runway may be assumed to support operations with no DH unless specifically restricted as published in the AIP or NOTAM.

GM1 SPA.LVO.100(e) Low visibility operations

CREW ACTIONS IN CASE OF AUTOPILOT FAILURE AT OR BELOW DH IN FAIL-PASSIVE CAT III OPERATIONS

For operations to actual RVR values less than 300 m, a missed approach procedure is assumed in the event of an autopilot failure at or below DH. This means that a missed approach procedure is the normal action. However, the wording recognises that there may be circumstances where the safest action is to continue the landing. Such circumstances include the height at which the failure occurs, the actual visual references, and other malfunctions. This would typically apply to the late stages of the flare. In conclusion, it is not forbidden to continue the approach and complete the landing when the pilot-in-command/commander determines that this is the safest course of action. The operator's policy and the operational instructions should reflect this information.

GM1 SPA.LVO.100(f) Low visibility operations

OPERATIONS UTILISING EVS

(a) Introduction

(1) Enhanced vision systems use sensing technology to improve a pilot's ability to detect objects, such as runway lights or terrain, which may otherwise not be visible. The image produced from the sensor and/or image processor can be displayed to the pilot in a number of ways including use of a HUD. The systems can be used in all phases of flight and can improve situational awareness. In particular, infra-red systems can display terrain during

operations at night, improve situational awareness during night and low-visibility taxiing, and may allow earlier acquisition of visual references during instrument approaches.

(b) Background to EVS provisions

(1) The provisions for EVS were developed after an operational evaluation of two different EVS systems, along with data and support provided by the FAA. Approaches using EVS were flown in a variety of conditions including fog, rain and snow showers, as well as at night to aerodromes located in mountainous terrain. The infra-red EVS performance can vary depending on the weather conditions encountered. Therefore, the provisions take a conservative approach to cater for the wide variety of conditions which may be encountered. It may be necessary to amend the provisions in the future to take account of greater operational experience.

(2) Provisions for the use of EVS during take-off have not been developed. The systems evaluated did not perform well when the RVR was below 300 m. There may be some benefit for use of EVS during take-off with greater visibility and reduced light; however, such operations would need to be evaluated.

(3) Provisions have been developed to cover use of infra-red systems only. Other sensing technologies are not intended to be excluded; however, their use will need to be evaluated to determine the appropriateness of this, or any other provision. During the development, it was envisaged what minimum equipment should be fitted to the aircraft. Given the present state of technological development, it is considered that a HUD is an essential element of the EVS equipment.

(4) In order to avoid the need for tailored charts for approaches utilising EVS, it is envisaged that the operator will use AMC6 SPA.LVO.110 Table 6 Operations utilising EVS RVR/CMV reduction vs. normal RVR/CMV to determine the applicable RVR at the commencement of the approach.

(c) Additional operational considerations

(1) EVS equipment should have:

(i) a head-up display system (capable of displaying, airspeed, vertical speed, aircraft attitude, heading, altitude, command guidance as appropriate for the approach to be flown, path deviation indications, flight path vector and flight path angle reference cue and the EVS imagery);

(ii) a head-down view of the EVS image, or other means of displaying the EVS-derived information easily to the pilot monitoring the progress of the approach; and

(iii) means to ensure that the pilot monitoring is kept in the 'loop' and crew resource management (CRM) does not break down.

AMC1 SPA.LVO.105 LVO approval

OPERATIONAL DEMONSTRATION – AEROPLANES

(a) General

(1) The purpose of the operational demonstration should be to determine or validate the use and effectiveness of the applicable aircraft flight guidance systems, including HUDLS if appropriate, training, flight crew procedures, maintenance programme, and manuals applicable to the CAT II/III programme being approved.

(i) At least 30 approaches and landings should be accomplished in operations using the CAT II/III systems installed in each aircraft type if the requested DH is 50 ft or higher. If the DH is less than 50 ft, at least 100 approaches and landings should be accomplished.

(ii) If the operator has different variants of the same type of aircraft utilising the same basic flight control and display systems, or different basic flight control and display systems on the same type of aircraft, the operator should show that the various variants have satisfactory performance, but need not conduct a full operational demonstration for each variant. The number of approaches and landings may be based on credit given for the experience gained by another operator, using the same aeroplane type or variant and procedures.

(iii) If the number of unsuccessful approaches exceeds 5 % of the total, e.g. unsatisfactory landings, system disconnects, the evaluation programme should be extended in steps of at least 10 approaches and landings until the overall failure rate does not exceed 5 %.

(2) The operator should establish a data collection method to record approach and landing performance. The resulting data and a summary of the demonstration data should be made available to the competent authority for evaluation.

(3) Unsatisfactory approaches and/or automatic landings should be documented and analysed.

(b) Demonstrations

(1) Demonstrations may be conducted in line operations or any other flight where the operator's procedures are being used.

(2) In unique situations where the completion of 100 successful landings could take an unreasonably long period of time and equivalent reliability assurance can be achieved, a reduction in the required number of landings may be considered on a case-by-case basis. Reduction of the number of landings to be demonstrated requires a justification for the reduction. This justification should take into account factors such as a small number of aircraft in the fleet, limited opportunity to use runways having CAT II/III procedures or the inability to obtain ATS sensitive area protection during good weather conditions. However, at the operator's option, demonstrations may be made on other runways and facilities. Sufficient information should be collected to determine the cause of any unsatisfactory performance (e.g. sensitive area was not protected).

(3) If the operator has different variants of the same type of aircraft utilising the same basic flight control and display systems, or different basic flight control and display systems on the same type or class of aircraft, the operator should show that the various variants have satisfactory performance, but need not conduct a full operational demonstration for each variant.

(4) Not more than 30 % of the demonstration flights should be made on the same runway.

(c) Data collection for operational demonstrations

(1) Data should be collected whenever an approach and landing is attempted utilising the CAT II/III system, regardless of whether the approach is abandoned, unsatisfactory, or is concluded successfully.

(2) The data should, as a minimum, include the following information:

(i) Inability to initiate an approach. Identify deficiencies related to airborne equipment that preclude initiation of a CAT II/III approach.

(ii) Abandoned approaches. Give the reasons and altitude above the runway at which approach was discontinued or the automatic landing system was disengaged.

(iii) Touchdown or touchdown and rollout performance. Describe whether or not the aircraft landed satisfactorily within the desired touchdown area with lateral velocity or cross track error that could be corrected by the pilot or automatic system so as to remain within the lateral confines of the runway without unusual pilot skill or technique. The approximate lateral and longitudinal position of the actual touchdown point in relation to the runway centre line and the runway threshold, respectively, should be indicated in the report. This report should also include any CAT II/III system abnormalities that required manual intervention by the pilot to ensure a safe touchdown or touchdown and rollout, as appropriate.

(d) Data analysis

Unsuccessful approaches due to the following factors may be excluded from the analysis:

(1) ATS factors. Examples include situations in which a flight is vectored too close to the final approach fix/point for adequate localiser and glide slope capture, lack of protection of ILS sensitive areas, or ATS requests the flight to discontinue the approach.

(2) Faulty navaid signals. Navaid (e.g. ILS localiser) irregularities, such as those caused by other aircraft taxiing, over-flying the navaid (antenna).

(3) Other factors. Any other specific factors that could affect the success of CAT II/ III operations that are clearly discernible to the flight crew should be reported.

AMC2 SPA.LVO.105 LVO approval

OPERATIONAL DEMONSTRATION – HELICOPTERS

(a) The operator should comply with the provisions prescribed below when introducing into CAT II or III service a helicopter type that is new to the EU.

(1) Operational reliability

The CAT II and III success rate should not be less than that required by CS-AWO or equivalent.

(2) Criteria for a successful approach

An approach is regarded as successful if:

(i) the criteria are as specified in CS-AWO or equivalent are met; and

(ii) no relevant helicopter system failure occurs.

For helicopter types already used for CAT II or III operations in another Member State, the in-service proving programme in (e) should be used instead.

(b) Data collection during airborne system demonstration - general

(1) The operator should establish a reporting system to enable checks and periodic reviews to be made during the operational evaluation period before the operator is approved to conduct CAT II or III operations. The reporting system should cover all successful and unsuccessful approaches, with reasons for the latter, and include a record of system component failures. This reporting system should be based upon flight crew reports and automatic recordings as prescribed in (c) and (d) below.

(2) The recordings of approaches may be made during normal line flights or during other flights performed by the operator.

(c) Data collection during airborne system demonstration – operations with DH not less than 50 ft

(1) For operations with DH not less than 50 ft, data should be recorded and evaluated by the operator and evaluated by the competent authority when necessary.

(2) It is sufficient for the following data to be recorded by the flight crew:

(i) FATO and runway used;

(ii) weather conditions;

(iii) time;

(iv) reason for failure leading to an aborted approach;

(v) adequacy of speed control;

(vi) trim at time of automatic flight control system disengagement;

(vii) compatibility of automatic flight control system, flight director and raw data;

(viii) an indication of the position of the helicopter relative to the ILS, MLS centre line when descending through 30 m (100 ft); and

(ix) touchdown position.

(3) The number of approaches made during the initial evaluation should be sufficient to demonstrate that the performance of the system in actual airline service is such that a 90 % confidence and a 95 % approach success will result.

(d) Data collection during airborne system demonstration – operations with DH less than 50 ft or no DH

(1) For operations with DH less than 50 ft or no DH, a flight data recorder (FDR), or other equipment giving the appropriate information, should be used in addition to the flight crew reports to confirm that the system performs as designed in actual airline service. The following data should be recorded:

(i) distribution of ILS, MLS deviations at 30 m (100 ft), at touchdown and, if appropriate, at disconnection of the rollout control system and the maximum values of the deviations between those points; and

(ii) sink rate at touchdown.

(2) Any landing irregularity should be fully investigated using all available data to determine its cause.

(e) In-service proving

The operator fulfilling the provisions of (f) above should be deemed to have met the in-service proving contained in this subparagraph.

(1) The system should demonstrate reliability and performance in line operations consistent with the operational concepts. A sufficient number of successful landings should be accomplished in line operations, including training flights, using the auto-land and rollout system installed in each helicopter type.

(2) The demonstration should be accomplished using a CAT II or CAT III ILS. Demonstrations may be made on other ILS or MLS facilities if sufficient data are recorded to determine the cause of unsatisfactory performance.

(3) If the operator has different variants of the same type of helicopter utilising the same basic flight control and display systems, or different basic flight control and display systems on the same type of helicopter, the operator should show that the variants comply with the basic system performance criteria, but the operator need not conduct a full operational demonstration for each variant.

(4) Where the operator introduces a helicopter type that has already been approved by the competent authority of any Member State for CAT II and/or CAT III operations, a reduced proving programme may be acceptable.

AMC3 SPA.LVO.105 LVO approval

CONTINUOUS MONITORING – ALL AIRCRAFT

(a) After obtaining the initial approval, the operations should be continuously monitored by the operator to detect any undesirable trends before they become hazardous. Flight crew reports may be used to achieve this.

(b) The following information should be retained for a period of 12 months:

(1) the total number of approaches, by aircraft type, where the airborne CAT II or III equipment was utilised to make satisfactory, actual or practice, approaches to the applicable CAT II or III minima; and

(2) reports of unsatisfactory approaches and/or automatic landings, by aerodrome and aircraft registration, in the following categories:

(i) airborne equipment faults;

(ii) ground facility difficulties;

(iii) missed approaches because of ATC instructions; or

(iv) other reasons.

(c) The operator should establish a procedure to monitor the performance of the automatic landing system or HUDLS to touchdown performance, as appropriate, of each aircraft.

AMC4 SPA.LVO.105 LVO approval

TRANSITIONAL PERIODS FOR CAT II AND CAT III OPERATIONS

(a) Operators with no previous CAT II or CAT III experience

(1) The operator without previous CAT II or III operational experience, applying for a CAT II or CAT IIIA operational approval, should demonstrate to the competent authority that it has gained a minimum experience of 6 months of CAT I operations on the aircraft type.

(2) The operator applying for a CAT IIIB operational approval should demonstrate to the competent authority that it has already completed 6 months of CAT II or IIIA operations on the aircraft type.

(b) Operators with previous CAT II or III experience

(1) The operator with previous CAT II or CAT III experience, applying for a CAT II or CAT III operational approval with reduced transition periods as set out in (a), should demonstrate to the competent authority that it has maintained the experience previously gained on the aircraft type.

(2) The operator approved for CAT II or III operations using auto-coupled approach procedures, with or without auto-land, and subsequently introducing manually flown CAT II or III operations using a HUDLS should provide the operational demonstrations set out in AMC1 SPA.LVO.105 and AMC2 SPA.LVO.105 as if it would be a new applicant for a CAT II or CAT III approval.

AMC5 SPA.LVO.105 LVO approval

MAINTENANCE OF CAT II, CAT III AND LVTO EQUIPMENT

Maintenance instructions for the on-board guidance systems should be established by the operator, in liaison with the manufacturer, and included in the operator's aircraft maintenance programme in accordance with Annex I to Regulation (EC) No 2042/2003[3] (Part-M).

AMC6 SPA.LVO.105 LVO approval

ELIGIBLE AERODROMES AND RUNWAYS

(a) Each aircraft type/runway combination should be verified by the successful completion of at least one approach and landing in CAT II or better conditions, prior to commencing CAT III operations.

(b) For runways with irregular pre-threshold terrain or other foreseeable or known deficiencies, each aircraft type/runway combination should be verified by operations in CAT I or better conditions, prior to commencing LTS CAT I, OTS CAT II or CAT III operations.

(c) If the operator has different variants of the same type of aircraft in accordance with (d), utilising the same basic flight control and display systems, or different basic flight control and display systems on the same type of aircraft in accordance with (d), the operator should show that the variants have satisfactory operational performance, but need not conduct a full operational demonstration for each variant/runway combination.

(d) For the purpose of this AMC, an aircraft type or variant of an aircraft type should be deemed to be the same type/variant of aircraft if that type/variant has the same or similar:

(1) level of technology, including the following:

(i) flight control/guidance system (FGS) and associated displays and controls;

(ii) FMS and level of integration with the FGS; and

(iii) use of HUDLS;

(2) operational procedures, including:

(i) alert height;

(ii) manual landing /automatic landing;

(iii) no DH operations; and

(iv) use of HUD/HUDLS in hybrid operations;

(3) handling characteristics, including:

(i) manual landing from automatic or HUDLS guided approach;

(ii) manual missed approach procedure from automatic approach; and

3 OJ L 315, 28.11.2003, p. 1.

(iii) automatic/manual rollout.

(e) Operators using the same aircraft type/class or variant of a type in accordance with (d) above may take credit from each other's experience and records in complying with this subparagraph.

(f) Where an approval is sought for OTS CAT II, the same provisions as set out for CAT II should be applied.

GM1 SPA.LVO.105 LVO approval

CRITERIA FOR A SUCCESSFUL CAT II, OTS CAT II, CAT III APPROACH AND AUTOMATIC LANDING

(a) The purpose of this GM is to provide operators with supplemental information regarding the criteria for a successful approach and landing to facilitate fulfilling the requirements prescribed in SPA.LVO.105.

(b) An approach may be considered to be successful if:

(1) from 500 ft to start of flare:

(i) speed is maintained as specified in AMC-AWO 231, paragraph 2 'Speed Control'; and

(ii) no relevant system failure occurs;

and

(2) from 300 ft to DH:

(i) no excess deviation occurs; and

(ii) no centralised warning gives a missed approach procedure command (if installed).

(c) An automatic landing may be considered to be successful if:

(1) no relevant system failure occurs;

(2) no flare failure occurs;

(3) no de-crab failure occurs (if installed);

(4) longitudinal touchdown is beyond a point on the runway 60 m after the threshold and before the end of the touchdown zone light (900 m from the threshold);

(5) lateral touchdown with the outboard landing gear is not outside the touchdown zone light edge;

(6) sink rate is not excessive;

(7) bank angle does not exceed a bank angle limit; and

(8) no rollout failure or deviation (if installed) occurs.

(d) More details can be found in CS-AWO 131, CS-AWO 231 and AMC-AWO 231.

GM1 SPA.LVO.110(c)(4)(i) General operating requirements

APPROVED VERTICAL FLIGHT PATH GUIDANCE MODE

The term 'approved' means that the vertical flight path guidance mode has been certified by the Agency as part of the avionics product.

AMC1 SPA.LVO.120 Flight crew training and qualifications

GENERAL PROVISIONS

(a) The operator should ensure that flight crew member training programmes for LVO include structured courses of ground, FSTD and/or flight training.

(1) Flight crew members with no CAT II or CAT III experience should complete the full training programme prescribed in (b), (c), and (d) below.

(2) Flight crew members with CAT II or CAT III experience with a similar type of operation (auto-coupled/auto-land, HUDLS/hybrid HUDLS or EVS) or CAT II with manual land, if appropriate, with another EU operator may undertake an:

(i) abbreviated ground training course if operating a different type or class from that on which the previous CAT II or CAT III experience was gained;

(ii) abbreviated ground, FSTD and/or flight training course if operating the same type or class and variant of the same type or class on which the previous CAT II or CAT III experience was gained. The abbreviated course should include at least the provisions of (d)(1), (d)(2)(i) or (d)(2)(ii) as appropriate and (d)(3)(i). The operator may reduce the number of approaches/landings required by (d)(2)(i) if the type/class or the variant of the type or class has the same or similar:

(A) level of technology - flight control/guidance system (FGS);

(B) operating procedures;

(C) handling characteristics;

(D) use of HUDLS/hybrid HUDLS; and

(E) use of EVS,

as the previously operated type or class, otherwise the provisions of (d)(2)(i) should be met.

(3) Flight crew members with CAT II or CAT III experience with the operator may undertake an abbreviated ground, FSTD and/or flight training course.

(i) When changing aircraft type or class, the abbreviated course should include at least the provisions of (d)(1), (d)(2)(i) or (d)(2)(ii) as appropriate and (d)(3)(i).

(ii) When changing to a different variant of aircraft within the same type or class rating that has the same or similar:

(A) level of technology - FGS;

(B) operating procedures - integrity;

(C) handling characteristics;

(D) use of HUDLS/Hybrid HUDLS; and

(E) use of EVS,

as the previously operated type or class, a difference course or familiarisation appropriate to the change of variant should fulfil the abbreviated course provisions.

(iii) When changing to a different variant of aircraft within the same type or class rating that has a significantly different:

(A) level of technology - FGS;

(B) operating procedures - integrity;

(C) handling characteristics;

(D) use of HUDLS/Hybrid HUDLS; or

(E) use of EVS,

the provisions of (d)(1), (d)(2)(i) or (d)(2)(ii) as appropriate and (d)(3)(i) should be fulfilled.

(4) The operator should ensure when undertaking CAT II or CAT III operations with different variant(s) of aircraft within the same type or class rating that the differences and/or similarities of the aircraft concerned justify such operations, taking into account at least the following:

(i) the level of technology, including the:

(A) FGS and associated displays and controls;

(B) FMS and its integration or not with the FGS; and

(C) use of HUD/HUDLS with hybrid systems and/or EVS;

(ii) operating procedures, including:

(A) fail-passive / fail-operational, alert height;

(B) manual landing / automatic landing;

(C) no DH operations; and

(D) use of HUD/HUDLS with hybrid systems;

(iii) handling characteristics, including:

(A) manual landing from automatic HUDLS and/or EVS guided approach;

(B) manual missed approach procedure from automatic approach; and

(C) automatic/manual rollout.

GROUND TRAINING

(b) The initial ground training course for LVO should include at least the following:

(1) characteristics and limitations of the ILS and/or MLS;

(2) characteristics of the visual aids;

(3) characteristics of fog;

(4) operational capabilities and limitations of the particular airborne system to include HUD symbology and EVS characteristics, if appropriate;

(5) effects of precipitation, ice accretion, low level wind shear and turbulence;

(6) effect of specific aircraft/system malfunctions;

(7) use and limitations of RVR assessment systems;

(8) principles of obstacle clearance requirements;

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

(10) procedures and precautions to be followed with regard to surface movement during operations when the RVR is 400 m or less and any additional procedures required for take-off in conditions below 150 m (200 m for category D aeroplanes);

(11) significance of DHs based upon radio altimeters and the effect of terrain profile in the approach area on radio altimeter readings and on the automatic approach/landing systems;

(12) importance and significance of alert height, if applicable, and the action in the event of any failure above and below the alert height;

(13) qualification requirements for pilots to obtain and retain approval to conduct LVOs; and

(14) importance of correct seating and eye position.

FSTD TRAINING AND/OR FLIGHT TRAINING

(c) FSTD training and/or flight training

(1) FSTD and/or flight training for LVO should include at least:

(i) checks of satisfactory functioning of equipment, both on the ground and in flight;

(ii) effect on minima caused by changes in the status of ground installations;

(iii) monitoring of:

(A) automatic flight control systems and auto-land status annunciators with emphasis on the action to be taken in the event of failures of such systems; and

(B) HUD/HUDLS/EVS guidance status and annunciators as appropriate, to include head-down displays;

(iv) actions to be taken in the event of failures such as engines, electrical systems, hydraulics or flight control systems;

(v) the effect of known unserviceabilities and use of MELs;

(vi) operating limitations resulting from airworthiness certification;

(vii) guidance on the visual cues required at DH together with information on maximum deviation allowed from glide path or localiser; and

(viii) the importance and significance of alert height if applicable and the action in the event of any failure above and below the alert height.

(2) Flight crew members should be trained to carry out their duties and instructed on the coordination required with other crew members. Maximum use should be made of suitably equipped FSTDs for this purpose.

(3) Training should be divided into phases covering normal operation with no aircraft or equipment failures but including all weather conditions that may be encountered and detailed scenarios of aircraft and equipment failure that could affect CAT II or III operations. If the aircraft system involves the use of hybrid or other special systems, such as HUD/HUDLS or enhanced vision equipment, then flight crew members should practise the use of these systems in normal and abnormal modes during the FSTD phase of training.

(4) Incapacitation procedures appropriate to LVTO, CAT II and CAT III operations should be practised.

(5) For aircraft with no FSTD available to represent that specific aircraft, operators should ensure that the flight training phase specific to the visual scenarios of CAT II operations is

conducted in a specifically approved FSTD. Such training should include a minimum of four approaches. Thereafter, the training and procedures that are type specific should be practised in the aircraft.

(6) Initial CAT II and III training should include at least the following exercises:

(i) approach using the appropriate flight guidance, autopilots and control systems installed in the aircraft, to the appropriate DH and to include transition to visual flight and landing;

(ii) approach with all engines operating using the appropriate flight guidance systems, autopilots, HUDLS and/or EVS and control systems installed in the aircraft down to the appropriate DH followed by missed approach - all without external visual reference;

(iii) where appropriate, approaches utilising automatic flight systems to provide automatic flare, hover, landing and rollout; and

(iv) normal operation of the applicable system both with and without acquisition of visual cues at DH.

(7) Subsequent phases of training should include at least:

(i) approaches with engine failure at various stages on the approach;

(ii) approaches with critical equipment failures, such as electrical systems, auto flight systems, ground and/or airborne ILS, MLS systems and status monitors;

(iii) approaches where failures of auto flight equipment and/or HUD/HUDLS/EVS at low level require either:

(A) reversion to manual flight to control flare, hover, landing and rollout or missed approach; or

(B) reversion to manual flight or a downgraded automatic mode to control missed approaches from, at or below DH including those which may result in a touchdown on the runway;

(iv) failures of the systems that will result in excessive localiser and/or glideslope deviation, both above and below DH, in the minimum visual conditions specified for the operation. In addition, a continuation to a manual landing should be practised if a head-up display forms a downgraded mode of the automatic system or the head-up display forms the only flare mode; and

(v) failures and procedures specific to aircraft type or variant.

(8) The training programme should provide practice in handling faults which require a reversion to higher minima.

(9) The training programme should include the handling of the aircraft when, during a fail-passive CAT III approach, the fault causes the autopilot to disconnect at or below DH when the last reported RVR is 300 m or less.

(10) Where take-offs are conducted in RVRs of 400 m and below, training should be established to cover systems failures and engine failure resulting in continued as well as rejected take-offs.

(11) The training programme should include, where appropriate, approaches where failures of the HUDLS and/or EVS equipment at low level require either:

(i) reversion to head down displays to control missed approach; or

(ii) reversion to flight with no, or downgraded, HUDLS guidance to control missed approaches from DH or below, including those which may result in a touchdown on the runway.

(12) When undertaking LVTO, LTS CAT I, OTS CAT II, CAT II and CAT III operations utilising a HUD/HUDLS, hybrid HUD/HUDLS or an EVS, the training and checking programme should include, where appropriate, the use of the HUD/HUDLS in normal operations during all phases of flight.

CONVERSION TRAINING

(d) Flight crew members should complete the following low visibility procedures (LVPs) training if converting to a new type or class or variant of aircraft in which LVTO, LTS CAT I, OTS CAT II, approach operations utilising EVS with an RVR of 800 m or less and CAT II and CAT III operations will be conducted. Conditions for abbreviated courses are prescribed in (a)(2), (a)(3) and (a)(4).

(1) Ground training

The appropriate provisions are as prescribed in (b), taking into account the flight crew member's CAT II and CAT III training and experience.

(2) FSTD training and/or flight training

(i) A minimum of six, respectively eight for HUDLS with or without EVS, approaches and/or landings in an FSTD. The provisions for eight HUDLS approaches may be reduced to six when conducting hybrid HUDLS operations.

(ii) Where no FSTD is available to represent that specific aircraft, a minimum of three, respectively five for HUDLS and/or EVS, approaches including at least one missed approach procedure is required on the aircraft. For hybrid HUDLS operations a minimum of three approaches is required, including at least one missed approach procedure.

(iii) Appropriate additional training if any special equipment is required such as head-up displays or enhanced vision equipment. When approach operations utilising EVS are conducted with an RVR of less than 800 m, a minimum of five approaches, including at least one missed approach procedure are required on the aircraft.

(3) Flight crew qualification

The flight crew qualification provisions are specific to the operator and the type of aircraft operated.

(i) The operator should ensure that each flight crew member completes a check before conducting CAT II or III operations.

(ii) The check specified in (d)(3)(i) may be replaced by successful completion of the FSTD and/or flight training specified in (d)(2).

(4) Line flying under supervision

Flight crew member should undergo the following line flying under supervision (LIFUS):

(i) For CAT II when a manual landing or a HUDLS approach to touchdown is required, a minimum of:

(A) three landings from autopilot disconnect; and

(B) four landings with HUDLS used to touchdown, except that only one manual landing, respectively two using HUDLS, to touchdown is required when the training required in (d)(2) has been carried out in an FSTD qualified for zero flight time conversion.

(ii) For CAT III, a minimum of two auto-lands, except that:

(A) only one auto-land is required when the training required in (d)(2) has been carried out in an FSTD qualified for zero flight time conversion;

(B) no auto-land is required during LIFUS when the training required in (d)(2) has been carried out in an FSTD qualified for zero flight time (ZFT) conversion and the flight crew member successfully completed the ZFT type rating conversion course; and

(C) the flight crew member, trained and qualified in accordance with (B), is qualified to operate during the conduct of LIFUS to the lowest approved DA/H and RVR as stipulated in the operations manual.

(iii) For CAT III approaches using HUDLS to touchdown, a minimum of four approaches.

TYPE AND COMMAND EXPERIENCE

(e) Type and command experience

(1) Before commencing CAT II operations, the following additional provisions should be applicable to pilots-in-command/commanders, or pilots to whom conduct of the flight may be delegated, who are new to the aircraft type or class:

(i) 50 hours or 20 sectors on the type, including LIFUS; and

(ii) 100 m should be added to the applicable CAT II RVR minima when the operation requires a CAT II manual landing or use of HUDLS to touchdown until:

(A) a total of 100 hours or 40 sectors, including LIFUS, has been achieved on the type; or

(B) a total of 50 hours or 20 sectors, including LIFUS, has been achieved on the type where the flight crew member has been previously qualified for CAT II manual landing operations with an EU operator;

(C) for HUDLS operations the sector provisions in (e)(1) and (e)(2)(i) should always be applicable; the hours on type or class do not fulfil the provisions.

(2) Before commencing CAT III operations, the following additional provisions should be applicable to pilots-in-command/commanders, or pilots to whom conduct of the flight may be delegated, who are new to the aircraft type:

(i) 50 hours or 20 sectors on the type, including LIFUS; and

(ii) 100 m should be added to the applicable CAT II or CAT III RVR minima unless he/she has previously qualified for CAT II or III operations with an EU operator, until a total of 100 hours or 40 sectors, including LIFUS, has been achieved on the type.

RECURRENT TRAINING AND CHECKING

(f) Recurrent training and checking – LVO

(1) The operator should ensure that, in conjunction with the normal recurrent training and operator's proficiency checks, the pilot's knowledge and ability to perform the tasks associated with the particular category of operation, for which the pilot is authorised by the operator, are checked. The required number of approaches to be undertaken in the FSTD

within the validity period of the operator's proficiency check should be a minimum of two, respectively four when HUDLS and/or EVS is utilised to touchdown, one of which should be a landing at the lowest approved RVR. In addition one, respectively two for HUDLS and/or operations utilising EVS, of these approaches may be substituted by an approach and landing in the aircraft using approved CAT II and CAT III procedures. One missed approach should be flown during the conduct of an operator proficiency check. If the operator is approved to conduct take-off with RVR less than 150 m, at least one LVTO to the lowest applicable minima should be flown during the conduct of the operator's proficiency check.

(2) For CAT III operations the operator should use an FSTD approved for this purpose.

(3) For CAT III operations on aircraft with a fail-passive flight control system, including HUDLS, a missed approach should be completed by each flight crew member at least once over the period of three consecutive operator proficiency checks as the result of an autopilot failure at or below DH when the last reported RVR was 300 m or less.

LVTO OPERATIONS

(g) LVTO with RVR less than 400 m

(1) Prior to conducting take-offs in RVRs below 400 m, the flight crew should undergo the following training:

(i) normal take-off in minimum approved RVR conditions;

(ii) take-off in minimum approved RVR conditions with an engine failure:

(A) for aeroplanes between V_1 and V_2 (take-off safety speed), or as soon as safety considerations permit;

(B) for helicopters at or after take-off decision point (TDP); and

(iii) take-off in minimum approved RVR conditions with an engine failure:

(A) for aeroplanes before V_1 resulting in a rejected take-off; and

(B) for helicopters before the TDP.

(2) The operator approved for LVTOs with an RVR below 150 m should ensure that the training specified by (g)(1) is carried out in an FSTD. This training should include the use of any special procedures and equipment.

(3) The operator should ensure that a flight crew member has completed a check before conducting LVTO in RVRs of less than 150 m. The check may be replaced by successful completion of the FSTD and/or flight training prescribed in (g)(1) on conversion to an aircraft type.

LTS CAT I, OTS CAT II, OPERATIONS UTILISING EVS

(h) Additional training provisions

(1) General

Operators conducting LTS CAT I operations, OTS CAT II operations and operations utilising EVS with RVR of 800 m or less should comply with the provisions applicable to CAT II operations and include the provisions applicable to HUDLS, if appropriate. The operator may combine these additional provisions where appropriate provided that the operational procedures are compatible.

(2) LTS CAT I

During conversion training the total number of approaches should not be additional to the requirements of Subpart FC of Annex III (ORO.FC) provided the training is conducted utilising the lowest applicable RVR. During recurrent training and checking the operator may also combine the separate requirements provided the above operational procedure provision is met and at least one approach using LTS CAT I minima is conducted at least once every 18 months.

(3) OTS CAT II

During conversion training the total number of approaches should not be less than those to complete CAT II training utilising a HUD/HUDLS. During recurrent training and checking the operator may also combine the separate provisions provided the above operational procedure provision is met and at least one approach using OTS CAT II minima is conducted at least once every 18 months.

(4) Operations utilising EVS with RVR of 800 m or less

During conversion training the total number of approaches required should not be less than that required to complete CAT II training utilising a HUD. During recurrent training and checking the operator may also combine the separate provisions provided the above operational procedure provision is met and at least one approach utilising EVS is conducted at least once every 12 months.

GM1 SPA.LVO.120 Flight crew training and qualifications

FLIGHT CREW TRAINING

The number of approaches referred to in AMC1 SPA.LVO.120 (g)(1) includes one approach and landing that may be conducted in the aircraft using approved CAT II/III procedures. This approach and landing may be conducted in normal line operation or as a training flight.

AMC1 SPA.LVO.125 Operating procedures

GENERAL

(a) LVOs should include the following:

(1) manual take-off, with or without electronic guidance systems or HUDLS/hybrid HUD/HUDLS;

(2) approach flown with the use of a HUDLS/hybrid HUD/HUDLS and/or EVS;

(3) auto-coupled approach to below DH, with manual flare, hover, landing and rollout;

(4) auto-coupled approach followed by auto-flare, hover, auto-landing and manual rollout; and

(5) auto-coupled approach followed by auto-flare, hover, auto-landing and auto-rollout, when the applicable RVR is less than 400 m.

PROCEDURES AND INSTRUCTIONS

(b) The operator should specify detailed operating procedures and instructions in the operations manual or procedures manual.

(1) The precise nature and scope of procedures and instructions given should depend upon the airborne equipment used and the flight deck procedures followed. The operator should clearly define flight crew member duties during take-off, approach, flare, hover, rollout and missed approach in the operations manual or procedures manual. Particular emphasis

should be placed on flight crew responsibilities during transition from non-visual conditions to visual conditions, and on the procedures to be used in deteriorating visibility or when failures occur. Special attention should be paid to the distribution of flight deck duties so as to ensure that the workload of the pilot making the decision to land or execute a missed approach enables him/her to devote himself/herself to supervision and the decision making process.

(2) The instructions should be compatible with the limitations and mandatory procedures contained in the AFM and cover the following items in particular:

(i) checks for the satisfactory functioning of the aircraft equipment, both before departure and in flight;

(ii) effect on minima caused by changes in the status of the ground installations and airborne equipment;

(iii) procedures for the take-off, approach, flare, hover, landing, rollout and missed approach;

(iv) procedures to be followed in the event of failures, warnings to include HUD/HUDLS/EVS and other non-normal situations;

(v) the minimum visual reference required;

(vi) the importance of correct seating and eye position;

(vii) action that may be necessary arising from a deterioration of the visual reference;

(viii) allocation of crew duties in the carrying out of the procedures according to (b)(2)(i) to (iv) and (vi), to allow the pilot-in-command/commander to devote himself/herself mainly to supervision and decision making;

(ix) the rule for all height calls below 200 ft to be based on the radio altimeter and for one pilot to continue to monitor the aircraft instruments until the landing is completed;

(x) the rule for the localiser sensitive area to be protected;

(xi) the use of information relating to wind velocity, wind shear, turbulence, runway contamination and use of multiple RVR assessments;

(xii) procedures to be used for:

(A) LTS CAT I;

(B) OTS CAT II;

(C) approach operations utilising EVS; and

(D) practice approaches and landing on runways at which the full CAT II or CAT III aerodrome procedures are not in force;

(xiii) operating limitations resulting from airworthiness certification; and

(xiv) information on the maximum deviation allowed from the ILS glide path and/or localiser.

SUBPART F:
EXTENDED RANGE OPERATIONS WITH TWO-ENGINED AEROPLANES (ETOPS)

GM1 SPA.ETOPS.105 ETOPS operational approval

AMC 20-6

AMC 20-6 provides further criteria for the operational approval of ETOPS.

SUBPART G:
TRANSPORT OF DANGEROUS GOODS

AMC1 SPA.DG.105(a) Approval to transport dangerous goods

TRAINING PROGRAMME

(a) The operator should indicate for the approval of the training programme how the training will be carried out. For formal training courses, the course objectives, the training programme syllabus/curricula and examples of the written examination to be undertaken should be included.

(b) Instructors should have knowledge of training techniques as well as in the field of transport of dangerous goods by air so that the subject is covered fully and questions can be adequately answered.

(c) Training intended to give general information and guidance may be by any means including handouts, leaflets, circulars, slide presentations, videos, computer-based training, etc., and may take place on-the-job or off-the-job. The person being trained should receive an overall awareness of the subject. This training should include a written, oral or computer-based examination covering all areas of the training programme, showing that a required minimum level of knowledge has been acquired.

(d) Training intended to give an in-depth and detailed appreciation of the whole subject or particular aspects of it should be by formal training courses, which should include a written examination, the successful passing of which will result in the issue of the proof of qualification. The course may be by means of tuition, as a self-study programme, or a mixture of both. The person being trained should gain sufficient knowledge so as to be able to apply the detailed rules of the Technical Instructions.

(e) Training in emergency procedures should include as a minimum:

  (1) for personnel other than crew members:

    (i) dealing with damaged or leaking packages; and

    (ii) other actions in the event of ground emergencies arising from dangerous goods;

  (2) for flight crew members:

    (i) actions in the event of emergencies in flight occurring in the passenger compartment or in the cargo compartments; and

    (ii) the notification to ATS should an in-flight emergency occur;

  (3) for crew members other than flight crew members:

    (i) dealing with incidents arising from dangerous goods carried by passengers; or

    (ii) dealing with damaged or leaking packages in flight.

(f) Training should be conducted at intervals of no longer than 2 years.

AMC1 SPA.DG.105(b) Approval to transport dangerous goods

PROVISION OF INFORMATION IN THE EVENT OF AN IN-FLIGHT EMERGENCY

If an in-flight emergency occurs the pilot-in-command/commander should, as soon as the situation permits, inform the appropriate ATS unit of any dangerous goods carried as cargo on board the aircraft, as specified in the Technical Instructions.

GM1 SPA.DG.105(b)(6) Approval to transport dangerous goods

PERSONNEL

Personnel include all persons involved in the transport of dangerous goods, whether they are employees of the operator or not.

AMC1 SPA.DG.110(a) Dangerous goods information and documentation

INFORMATION TO THE PILOT-IN-COMMAND/COMMANDER

If the volume of information provided to the pilot-in-command/commander by the operator is such that it would be impracticable to transmit it in the event of an in-flight emergency, an additional summary of the information should also be provided, containing at least the quantities and class or division of the dangerous goods in each cargo compartment.

AMC1 SPA.DG.110(b) Dangerous goods information and documentation

ACCEPTANCE OF DANGEROUS GOODS

(a) The operator should not accept dangerous goods unless:

  (1) the package, overpack or freight container has been inspected in accordance with the acceptance procedures in the Technical Instructions;

  (2) they are accompanied by two copies of a dangerous goods transport document or the information applicable to the consignment is provided in electronic form, except when otherwise specified in the Technical Instructions; and

  (3) the English language is used for:

    (i) package marking and labelling; and

    (ii) the dangerous goods transport document,

  in addition to any other language provision.

(b) The operator or his/her handling agent should use an acceptance checklist which allows for:

  (1) all relevant details to be checked; and

  (2) the recording of the results of the acceptance check by manual, mechanical or computerised means.

SUBPART H:
HELICOPTER OPERATIONS WITH NIGHT VISION IMAGING SYSTEMS

AMC1 SPA.NVIS.110(b) Equipment requirements for NVIS operations

RADIO ALTIMETER

(a) The radio altimeter should:

(1) be of an analogue type display presentation that requires minimal interpretation for both an instantaneous impression of absolute height and rate of change of height;

(2) be positioned to be instantly visible and discernable from each cockpit crew station;

(3) have an integral audio and visual low height warning that operates at a height selectable by the pilot; and

(4) provide unambiguous warning to the crew of radio altimeter failure.

(b) The visual warning should provide:

(1) clear visual warning at each cockpit crew station of height below the pilot-selectable height; and

(2) adequate attention-getting-capability for typical NVIS operations.

(c) The audio warning should:

(1) be unambiguous and readily cancellable;

(2) not extinguish any visual low height warnings when cancelled; and

(3) operate at the same pilot-selectable height as the visual warning.

GM1 SPA.NVIS.110(b) Equipment requirements for NVIS operations

RADIO ALTIMETER

An analogue type display presentation may be, for example, a representation of a dial, ribbon or bar, but not a display that provides numbers only. An analogue type display may be embedded into an electronic flight instrumentation system (EFIS).

GM1 SPA.NVIS.110(f) Equipment requirements for NVIS operations

MODIFICATION OR MAINTENANCE TO THE HELICOPTER

It is important that the operator reviews and considers all modifications or maintenance to the helicopter with regard to the NVIS airworthiness approval. Special emphasis needs to be paid to modification and maintenance of equipment such as light emitting or reflecting devices, transparencies and avionics equipment, as the function of this equipment may interfere with the NVGs.

GM1 SPA.NVIS.130(e) Crew requirements for NVIS operations

UNDERLYING ACTIVITY

Examples of an underlying activity are:

(a) commercial air transport (CAT);

(b) helicopter emergency medical service (HEMS); and

(c) helicopter hoist operation (HHO).

GM2 SPA.NVIS.130(e) Crew requirements for NVIS operations

OPERATIONAL APPROVAL

(a) When determining the composition of the minimum crew, the competent authority should take account of the type of operation that is to be conducted. The minimum crew should be part of the operational approval.

(b) If the operational use of NVIS is limited to the en-route phase of a CAT flight, a single-pilot operation may be approved.

(c) Where operations to/from a HEMS operating site are to be conducted, a crew of at least one pilot and one NVIS technical crew member would be necessary (this may be the suitably qualified HEMS technical crew member).

(d) A similar assessment may be made for night HHO, when operating to unprepared sites.

AMC1 SPA.NVIS.130(f)(1) Crew requirements for NVIS operations

TRAINING AND CHECKING SYLLABUS

(a) The flight crew training syllabus should include the following items:

  (1) NVIS working principles, eye physiology, vision at night, limitations and techniques to overcome these limitations;

  (2) preparation and testing of NVIS equipment;

  (3) preparation of the helicopter for NVIS operations;

  (4) normal and emergency procedures including all NVIS failure modes;

  (5) maintenance of unaided night flying;

  (6) crew coordination concept specific to NVIS operations;

  (7) practice of the transition to and from NVG procedures;

  (8) awareness of specific dangers relating to the operating environment; and

  (9) risk analysis, mitigation and management.

(b) The flight crew checking syllabus should include:

  (1) night proficiency checks, including emergency procedures to be used on NVIS operations; and

  (2) line checks with special emphasis on the following:

    (i) local area meteorology;

    (ii) NVIS flight planning;

    (iii) NVIS in-flight procedures;

    (iv) transitions to and from night vision goggles (NVG);

    (v) normal NVIS procedures; and

(vi) crew coordination specific to NVIS operations.

(c) Whenever the crew is required to also consist of an NVIS technical crew member, he/she should be trained and checked in the following items:

(1) NVIS working principles, eye physiology, vision at night, limitations, and techniques to overcome these limitations;

(2) duties in the NVIS role, with and without NVGs;

(3) the NVIS installation;

(4) operation and use of the NVIS equipment;

(5) preparing the helicopter and specialist equipment for NVIS operations;

(6) normal and emergency procedures;

(7) crew coordination concepts specific to NVIS operations;

(8) awareness of specific dangers relating to the operating environment; and

(9) risk analysis, mitigation and management.

AMC1 SPA.NVIS.130(f) Crew requirements

CHECKING OF NVIS CREW MEMBERS

The checks required in SPA.NVIS.130 (f) may be combined with those checks required for the underlying activity.

GM1 SPA.NVIS.130(f) Crew requirements

TRAINING GUIDELINES AND CONSIDERATIONS

(a) Purpose

The purpose of this GM is to recommend the minimum training guidelines and any associated considerations necessary for the safe operation of a helicopter while operating with night vision imaging systems (NVISs).

To provide an appropriate level of safety, training procedures should accommodate the capabilities and limitations of the NVIS and associated systems as well as the restraints of the operational environment.

(b) Assumptions

The following assumptions were used in the creation of this material:

(1) Most civilian operators may not have the benefit of formal NVIS training, similar to that offered by the military. Therefore, the stated considerations are predicated on that individual who has no prior knowledge of NVIS or how to use them in flight. The degree to which other applicants who have had previous formal training should be exempted from this training will be dependent on their prior NVIS experience.

(2) While NVIS are principally an aid to flying under VFR at night, the two- dimensional nature of the NVG image necessitates frequent reference to the flight instruments for spatial and situational awareness information. The reduction of peripheral vision and increased reliance on focal vision exacerbates this requirement to monitor flight instruments. Therefore, any basic NVIS training syllabus should include some instruction on basic instrument flight.

(c) Two-tiered approach: basic and advance training

To be effective, the NVIS training philosophy would be based on a two-tiered approach: basic and advanced NVIS training. The basic NVIS training would serve as the baseline standard for all individuals seeking an NVIS endorsement. The content of this initial training would not be dependent on any operational requirements. The training required for any individual pilot should take into account the previous NVIS flight experience. The advanced training would build on the basic training by focusing on developing specialised skills required to operate a helicopter during NVIS operations in a particular operational environment. Furthermore, while there is a need to stipulate minimum flight hour requirements for an NVIS endorsement, the training should also be event-based. This necessitates that operators be exposed to all of the relevant aspects, or events, of NVIS flight in addition to acquiring a minimum number of flight hours. NVIS training should include flight in a variety of actual ambient light and weather conditions.

(d) Training requirements

(1) Flight crew ground training

The ground training necessary to initially qualify a pilot to act as the pilot of a helicopter using NVGs should include at least the following subjects:

(i) applicable aviation regulations that relate to NVIS limitations and flight operations;

(ii) aero-medical factors relating to the use of NVGs to include how to protect night vision, how the eyes adapt to operate at night, self-imposed stresses that affect night vision, effects of lighting (internal and external) on night vision, cues utilized to estimate distance and depth perception at night, and visual illusions;

(iii) NVG performance and scene interpretation;

(iv) normal, abnormal, and emergency operations of NVGs; and

(v) NVIS operations flight planning to include night terrain interpretation and factors affecting terrain interpretation.

The ground training should be the same for flight crew and crew members other than flight crew. An example of a ground training syllabus is presented in Table 1 of GM2 SPA.NVIS.130(f).

(2) Flight crew flight training

The flight training necessary to initially qualify a pilot to act as the pilot of a helicopter using NVGs may be performed in a helicopter or FSTD approved for the purpose, and should include at least the following subjects:

(i) preparation and use of internal and external helicopter lighting systems for NVIS operations;

(ii) pre-flight preparation of NVGs for NVIS operations;

(iii) proper piloting techniques (during normal, abnormal, and emergency helicopter operations) when using NVGs during the take-off, climb, en-route, descent, and landing phases of flight that includes unaided flight and aided flight; and

(iv) normal, abnormal, and emergency operations of the NVIS during flight.

Crew members other than flight crew should be involved in relevant parts of the flight training. An example of a flight training syllabus is presented in Table 1 of GM3 SPA.NVIS.130(f).

(3) Training crew members other than flight crew

Crew members other than flight crew (including the technical crew member) should be trained to operate around helicopters employing NVIS. These individuals should complete all phases of NVIS ground training that is given to flight crew. Due to the importance of crew coordination, it is imperative that all crew members are familiar with all aspects of NVIS flight. Furthermore, these crew members may have task qualifications specific to their position in the helicopter or areas of responsibility. To this end, they should demonstrate competency in those areas, both on the ground and in flight.

(4) Ground personnel training

Non-flying personnel who support NVIS operations should also receive adequate training in their areas of expertise. The purpose is to ensure, for example, that correct light discipline is used when helicopters are landing in a remote area.

(5) Instructor qualifications

An NVIS flight instructor should at least have the following licences and qualifications:

(i) at least flight instructor (FI(H)) or type rating instructor (TRI(H)) with the applicable type rating on which NVIS training will be given; and

(ii) logged at least 100 NVIS flights or 30 hours' flight time under NVIS as pilot-in-command/commander.

(6) NVIS equipment minimum requirements (training)

While minimum equipment lists and standard NVIS equipment requirements may be stipulated elsewhere, the following procedures and minimum equipment requirements should also be considered:

(i) NVIS: the following is recommended for minimum NVIS equipment and procedural requirements:

(A) back-up power supply;

(B) NVIS adjustment kit or eye lane;

(C) use of helmet with the appropriate NVG attachment; and

(D) both the instructor and student should wear the same NVG type, generation and model.

(ii) Helicopter NVIS compatible lighting, flight instruments and equipment: given the limited peripheral vision cues and the need to enhance situational awareness, the following is recommended for minimum compatible lighting requirements:

(A) NVIS compatible instrument panel flood lighting that can illuminate all essential flight instruments;

(B) NVIS compatible hand-held utility lights;

(C) portable NVIS compatible flashlight;

(D) a means for removing or extinguishing internal NVIS non-compatible lights;

(E) NVIS pre-flight briefing/checklist (an example of an NVIS pre-flight briefing/checklist is in Table 1 of GM4-SPA.NVIS.130(f));

(F) training references:

a number of training references are available, some of which are listed below:

- DO 295 US CONOPS civil operator training guidelines for integrated NVIS equipment
- United States Marine Corp MAWTS-1 Night Vision Device (NVD) Manual;
- U.S. Army Night Flight (TC 1-204);
- U.S. Army NVIS Operations, Exportable Training Package;
- U.S. Army TM 11-5855-263-10;
- Air Force TO 12S10-2AVS6-1;
- Navy NAVAIR 16-35AVS-7; and
- U.S. Border Patrol, Helicopter NVIS Ground and Flight Training Syllabus.

There may also be further documents available from European civil or military sources.

GM2 SPA.NVIS.130(f) Crew requirements

INSTRUCTION – GROUND TRAINING AREAS OF INSTRUCTION

A detailed example of possible subjects to be instructed in an NVIS ground instruction is included below. (The exact details may not always be applicable, e.g. due to goggle configuration differences.)

Table 1
Ground training areas of instruction

Item	Subject Area	Subject Details	Recommended Time
1	General anatomy and characteristics of the eye	Anatomy: • Overall structure of the eye • Cones • Rods Visual deficiencies: • myopia • hyperopia • astigmatism • presbyopia Effects of light on night vision & NV protection physiology: • Light levels - illumination - luminance - reflectance - contrast • Types of vision: - photopic - mesopic - scotopic	1 hour

Item	Subject Area	Subject Details	Recommended Time
		• Day versus night vision • Dark adaptation process: - dark adaptation - pre-adaptive state • Purkinje shift • Ocular chromatic aberration • Photochromatic interval	
2	Night vision human factors	• Night blind spot (as compared to day blind spot) • Field of view and peripheral vision • Distance estimation and depth perception: - monocular cues - motion parallax - geometric perspective - size constancy - overlapping contours or interposition of objects • Aerial perspective: - variations in colour or shade - loss of detail or texture - position of light source - direction of shadows • Binocular cues • Night vision techniques: - off-centre vision - scanning - shapes and silhouettes	1 hour
		• Vestibular illusions • Somatogyral illusions: - leans - graveyard spin - coriolis illusion • Somatogravic illusions: - oculographic illusions - elevator illusion - oculoagravic illusions • Proprioceptive illusions • Dealing with spatial disorientation • Visual illusions: - auto kinetic illusion - confusion with ground lights - relative motion	

Item	Subject Area	Subject Details	Recommended Time
		- reversible perspective illusion - false vertical and horizontal cues - altered planes of reference - height /depth perception illusion - flicker vertigo - fascination (fixation) - structural illusions - size-distance illusion • Helicopter design limitations: - windscreen condition - helicopter instrument design - helicopter structural obstruction - interior lights - exterior lights • Self-imposed stresses: - drugs - exhaustion - alcohol - tobacco - hypoglycaemia - injuries - physical fitness • Stress & fatigue: - acute vs. chronic - prevention • Hypoxia issues and night vision • Weather/environmental conditions: - snow (white-out) - dust (brown-out) - haze - fog - rain - light level • Astronomical lights (moon, star, northern lights) • Effects of cloud cover	
3	NVIS general characteristics	• Definitions and types of NVIS: - light spectrum - types of NVIS • Thermal-imaging devices • Image-intensifier devices • Image-intensifier operational theory	1 hour

Item	Subject Area	Subject Details	Recommended Time
		• Types of image intensifier systems: - generation 1 - generation 2 - generation 3 - generation 4 - type I / II - class A & B minus blue filter • NVIS equipment - shipping and storage case - carrying case - binocular assembly - lens caps - lens paper - operators manual - power pack (dual battery) - batteries • Characteristics of NVIS: - light amplification - light intensification - frequency sensitivity - visual range acuity - unaided peripheral vision - weight - flip-up device - break-away feature - neck cord - maintenance issues - human factor issues • Description and functions of NVIS components: - helmet visor cover and extension strap - helmet NVIS mount and attachment points - different mount options for various helmets - lock release button - vertical adjustment knob - low battery indicator - binocular assembly - monocular tubes - fore and aft adjustment knob - eye span knob - tilt adjustment lever - objective focus rings	

Item	Subject Area	Subject Details	Recommended Time
		- eyepiece focus rings - battery pack	
4	NVIS care & cleaning	• Handling procedures • NVIS operating instructions: - pre-mounting inspection - mounting procedures - focusing procedures - faults • Post-flight procedures; • Deficiencies: type and recognition of faults: - acceptable faults - black spots - chicken wire - fixed pattern noise (honeycomb effect) - output brightness variation - bright spots - image disparity - image distortion - emission points - unacceptable faults: - shading - edge glow - fashing, flickering or intermittent operation • Cleaning procedures • Care of batteries • Hazardous material considerations;	1 hour
5	Pre- & post-flight procedures	• Inspect NVIS • Carrying case condition • Nitrogen purge due date • Collimation test due date • Screens diagram(s) of any faults • NVIS kit: complete • NVIS binocular assembly condition • Battery pack and quick disconnect condition • Batteries life expended so far • Mount battery pack onto helmet: - verify no LED showing (good battery) - fail battery by opening cap and LED illuminates (both compartments) • Mount NVIS onto helmet • Adjust and focus NVIS	1 hour

Item	Subject Area	Subject Details	Recommended Time
		• Eye-span to known inter-pupillary distance • Eye piece focus ring to zero • Adjustments: - vertical - fore and aft - tilt - eye-span (fine-tuning) • Focus (one eye at a time at 20 ft, then at 30 ft from an eye chart) - objective focus ring - eye piece focus ring - verify both images are harmonised - read eye-chart 20/40 line from 20 ft • NVIS mission planning • NVIS light level planning • NVIS risk assessment	
6	NVIS terrain interpretation and environmental factors	• Night terrain interpretation • Light sources: - natural - lunar - solar - starlight - northern lights - artificial - cultural - infra-red • Meteorological conditions: - clouds/fog - indications of restriction to visibility: - loss of celestial lights - loss of ground lights - reduced ambient light levels - reduced visual acuity - increase in video noise - increase in halo effect • Cues for visual recognition: - object size - object shape - contrast - ambient light - colour	1 hour

Item	Subject Area	Subject Details	Recommended Time
		- texture - background - reflectivity • Factors affecting terrain interpretation: - ambient light - flight altitudes - terrain type • Seasons • Night navigation cues: - terrain relief - vegetation - hydrographical features - cultural features	
7	NVIS training & equipment requirements	Cover the relevant regulations and guidelines that pertain to night and NVIS flight to include as a minimum: • Crew experience requirements; • Crew training requirements; • Airspace requirements; • Night / NVIS MEL; • NVIS / night weather limits; • NVIS equipment minimum standard requirements.	1 hour
8	NVIS emergency procedures	Cover relevant emergency procedures: • Inadvertent IMC procedures • NVIS goggle failure • Helicopter emergencies: - with goggles - transition from goggles	1 hour
9	NVIS flight techniques	Respective flight techniques for each phase of flight for the type and class of helicopter used for NVIS training	1 hour
10	Basic instrument techniques	Present and confirm understanding of basic instrument flight techniques: • Instrument scan • Role of instruments in NVIS flight • Unusual attitude recovery procedures	1 hour
11	Blind cockpit drills	Perform blind cockpit drills: • Switches • Circuit breakers • Exit mechanisms • External / internal lighting • Avionics	1 hour

GM3 SPA.NVIS.130(f) Crew requirements

FLIGHT TRAINING – AREAS OF INSTRUCTION

A detailed example of possible subjects to be instructed in a NVIS flight instruction is included below.

Table 1

Flight training areas of instruction

Item	Subject Area	Subject Details	Recommended Time
1	Ground operations	• NVIS equipment assembly • Pre-flight inspection of NVISs • Helicopter pre-flight • NVIS flight planning: - light level planning - meteorology - obstacles and known hazards - risk analysis matrix - CRM concerns - NVIS emergency procedures review • Start-up/shut down • Goggling and degoggling	1 hour
2	General handling	• Level turns, climbs, and descents • For helicopters, confined areas and sloped landings • Operation specific flight tasks • Transition from aided to unaided flight • Demonstration of NVIS related ambient and cultural effects	1 hour
3	Take-offs & landings	• At both improved illuminated areas such as airports/airfields and unimproved unlit areas such as open fields • Traffic pattern • Low speed manoeuvres for helicopters	1 hour
4	Navigation	• Navigation over variety of terrain and under different cultural lighting conditions	1 hour
5	Emergency procedures	• Goggle failure • Helicopter emergencies • Inadvertent IMC • Unusual attitude recovery	1 hour

GM4 SPA.NVIS.130(f) Crew requirements

NVIS PRE-FLIGHT BRIEFING/CHECKLIST

A detailed example of a pre-flight briefing/checklist is included below.

Table 1

NVIS pre-flight briefing/checklist

Item	Subject
1	Weather: • METAR/forecast • Cloud cover/dew point spread/precipitation
2	OPS items: • NOTAMs • IFR publications backup/maps • Goggles adjusted using test set (RTCA Document DO-275 [NVIS MOPS], Appendices G & H give suggested NVG pre-flight and adjustment procedures and a ground test checklist)
3	Ambient light: • Moon rise/set/phase/position/elevation • % illumination and millilux (MLX) for duration of flight • Recommended minimum MLX: 1.5
4	Mission: • Mission outline • Terrain appreciation • Detailed manoeuvres • Flight timings • Start/airborne/debrief • Airspace coordination for NVIS • Obstacles/minimum safe altitude • NVIS goggle up/degoggle location/procedure • Instrument IFR checks
5	Crew: • Crew day/experience • Crew position • Equipment: NVIS, case, video, flashlights • Lookout duties: left hand seat (LHS) – from 90° left to 45° right, RHS – from 90° right to 45° left; • Calling of hazards/movements landing light • Transfer of control terminology • Below 100 ft AGL – pilot monitoring (PM) ready to assume control
6	Helicopter: • Helicopter configuration • Fuel and CG

Item	Subject
7	Emergencies: • NVIS failure: cruise and low level flight • Inadvertent IMC/IFR recovery • Helicopter emergency: critical & non-critical

AMC1 SPA.NVIS.140 Information and documentation

OPERATIONS MANUAL

The operations manual should include:

(a) equipment to be carried and its limitations;

(b) the minimum equipment list (MEL) entry covering the equipment specified;

(c) risk analysis, mitigation and management;

(d) pre- and post-flight procedures and documentation;

(e) selection and composition of crew;

(f) crew coordination procedures, including:

(1) flight briefing;

(2) procedures when one crew member is wearing NVG and/or procedures when two or more crew members are wearing NVGs;

(3) procedures for the transition to and from NVIS flight;

(4) use of the radio altimeter on an NVIS flight; and

(5) inadvertent instrument meteorological conditions (IMC) and helicopter recovery procedures, including unusual attitude recovery procedures;

(g) the NVIS training syllabus;

(h) in-flight procedures for assessing visibility, to ensure that operations are not conducted below the minima stipulated for non-assisted night VFR operations;

(i) weather minima, taking the underlying activity into account; and

(j) the minimum transition heights to/from an NVIS flight.

GM1 SPA.NVIS.140 Information and documentation

CONCEPT OF OPERATIONS

Night Vision Imaging System for Civil Operators

Foreword

This document, initially incorporated in JAA TGL-34, prepared by a Sub-Group of EUROCAE Working Group 57 “Night Vision Imaging System (NVIS) Standardisation” is an abbreviated and modified version of the RTCA Report DO-268 “Concept Of Operations – Night Vision Imaging Systems For Civil Operators” which was prepared in the USA by RTCA Special Committee 196 (SC-196) and approved by the RTCA Technical Management Committee in March 2001.

The EUROCAE Working Group 57 (WG-57) Terms of Reference included a task to prepare a Concept of Operations (CONOPS) document describing the use of NVIS in Europe. To complete this task, a Sub-Group of WG-57 reviewed the RTCA SC-196 CONOPS (DO-268) to assess its applicability for use in Europe. Whilst the RTCA document was considered generally applicable, some of its content, such as crew eligibility and qualifications and the detail of the training requirements, was considered to be material more appropriately addressed in Europe by at that time other Joint Aviation Requirements (JAR) documents such as JAR-OPS and JAR-FCL. Consequently, WG-57 condensed the RTCA CONOPS document by removing this material which is either already addressed by other JAR documents or will be covered by the Agency's documents in the future.

In addition, many of the technical standards already covered in the Minimum Operational Performance Standards (MOPS) for Integrated Night Vision Imaging System Equipment (DO-275) have been deleted in this European CONOPS.

Executive summary

The hours of darkness add to a pilot's workload by decreasing those visual cues commonly used during daylight operations. The decreased ability of a pilot to see and avoid obstructions at night has been a subject of discussion since aviators first attempted to operate at night. Technology advancements in the late 1960s and early 1970s provided military aviators some limited ability to see at night and therein changed the scope of military night operations. Continuing technological improvements have advanced the capability and reliability of night vision imaging systems to the point that they are receiving increasing scrutiny are generally accepted by the public and are viewed by many as a tool for night flight.

Simply stated, night vision imaging systems are an aid to night VFR flight. Currently, such systems consist of a set of night vision goggles and normally a complimentary array of cockpit lighting modifications. The specifications of these two sub-system elements are interdependent and, as technology advances, the characteristics associated with each element are expected to evolve. The complete description and performance standards of the night vision goggles and cockpit lighting modifications appropriate to civil aviation are contained in the Minimum Operational Performance Standards for Integrated Night Vision Imaging System Equipment.

An increasing interest on the part of civil operators to conduct night operations has brought a corresponding increased level of interest in employing night vision imaging systems. However, the night vision imaging systems do have performance limitations. Therefore, it is incumbent on the operator to employ proper training methods and operating procedures to minimise these limitations to ensure safe operations. In turn, operators employing night vision imaging systems must have the guidance and support of their regulatory agency in order to safely train and operate with these systems.

The role of the regulatory agencies in this matter is to develop the technical standard orders for the hardware as well as the advisory material and inspector handbook materials for the operations and training aspect. In addition, those agencies charged with providing flight weather information should modify their products to include the night vision imaging systems flight data elements not currently provided.

An FAA study (DOT/FAA/RD-94/21, 1994) best summarised the need for night vision imaging systems by stating, "When properly used, NVGs can increase safety, enhance situational awareness, and reduce pilot workload and stress that are typically associated with night operations."

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2. TERMINOLOGY

2.1 Night vision goggles

An NVG is a binocular appliance that amplifies ambient light and is worn by a pilot. The NVG enhances the wearer's ability to maintain visual surface reference at night.

2.1.1 Type

Type refers to the design of the NVG with regards to the manner in which the image is relayed to the pilot. A Type 1 NVG is one in which the image is viewed directly in-line with the image intensification process. A Type 1 NVG is also referred to as "direct view" goggle. A Type 2 NVG is one in which the image intensifier is not in-line with the image viewed by the pilot. In this design, the image may be reflected several times before being projected onto a combiner in front of the pilot's eyes. A Type 2 NVG is also referred to as an "indirect view" goggle.

2.1.2 Class

Class is a terminology used to describe the filter present on the NVG objective lens. The filter restricts the transmission of light below a determined frequency. This allows the cockpit lighting to be designed and installed in a manner that does not adversely affect NVG performance.

2.1.2.1 Class A

Class A or "minus blue" NVGs incorporate a filter, which generally imposes a 625 nanometercutoff. Thus, the use of colours in the cockpit (e.g., colour displays, colour warning lights, etc.) may be limited. The blue green region of the light spectrum is allowed through the filter.

2.1.2.2 Class B

Class B NVGs incorporate a filter that generally imposes a 665 nanometercutoff. Thus, the cockpit lighting design may incorporate more colours since the filter eliminates some yellows and oranges from entering the intensification process.

2.1.2.3 Modified class B

Modified Class B NVGs incorporate a variation of a Class B filter but also incorporates a notch filter in the green spectrum that allows a small percentage of light into the image intensification process. Therefore, a Modified Class B NVG allows pilots to view fixed head-up display (HUD) symbology through the NVG without the HUD energy adversely affecting NVG performance.

2.1.3 Generation

Generation refers to the technological design of an image intensifier. Systems incorporating these light-amplifying image intensifiers were first used during WWII and were operationally fielded by the US military during the Vietnam era. These systems were large, heavy and poorly performing devices that were unsuitable for aviation use, and were termed Generation I (Gen I). Gen II devices represented a significant technological advancement and provided a system that could be head-mounted for use in ground vehicles. Gen III devices represented another significant technological advancement in image intensification, and provided a system that was designed for aviation use. Although not yet fielded, there are prototype NVGs that include technological advances that may necessitate a Gen IV designation if placed into production. Because of the variations in interpretations as to generation, NVGs will not be referred to by the generation designation.

2.1.4 OMNIBUS

The term OMNIBUS refers to a US Army contract vehicle that has been used over the years to procure NVGs. Each successive OMNIBUS contract included NVGs that demonstrated improved performance. There have been five contracts since the mid 1980s, the most current being OMNIBUS V. There may be several variations of NVGs within a single OMNIBUS purchase, and some NVGs from previous OMNIBUS contracts have been upgraded in performance to match the performance of goggles from later contracts. Because of these variations, NVGs will not be referred to by the OMNIBUS designation.

2.1.5 Resolution and visual acuity

Resolution refers to the capability of the NVG to present an image that makes clear and distinguishable the separate components of a scene or object.

Visual acuity is the relative ability of the human eye to resolve detail and interpret an image.

2.2 Aviation night vision imaging system (NVIS)

The Night Vision Imaging System is the integration of all elements required to successfully and safely operate an aircraft with night vision goggles. The system includes at a minimum NVGs, NVIS lighting, other aircraft components, training, and continuing airworthiness.

2.2.1 Look under (under view)

Look under is the ability of pilots to look under or around the NVG to view inside and outside the aircraft.

2.3 NVIS lighting

An aircraft lighting system that has been modified or designed for use with NVGs and which does not degrade the performance of the NVG beyond acceptable standards, is designated as NVIS lighting. This can apply to both interior and exterior lighting.

2.3.1 Design considerations

As the choice of NVG filter drives the cockpit lighting design, it is important to know which goggle will be used in which cockpit. Since the filter in a Class A NVG allows wavelengths above 625 nanometers into the intensification process, it should not be used in a cockpit designed for Class B or Modified Class B NVGs. However, since the filter in a Class B and Modified Class B NVGs is more restrictive than that in a Class ANVG, the Class B or Modified Class B NVG can be used with either Class A or Class B cockpit lighting designs.

2.3.2 Compatible

Compatibility, with respect to an NVIS system, includes a number of different factors: compatibility of internal and external lighting with the NVG, compatibility of the NVG with the crew station design (e.g., proximity of the canopy or windows, proximity of overhead panels, operability of controls, etc.), compatibility of crew equipment with the NVG and compatibility with respect to colour discrimination and identification (e.g., caution and warning lights still maintain amber and red colours). The purpose of this paragraph is to discuss compatibility with respect to aircraft lighting. An NVIS lighting system, internal and external, is considered compatible if it adheres to the following requirements:

1. the internal and external lighting does not adversely affect the operation of the NVG during any phase of the NVIS operation;
2. the internal lighting provides adequate illumination of aircraft cockpit instruments, displays and controls for unaided operations and for “look-under” viewing during aided operations; and
3. The external lighting aids in the detection and separation by other aircraft.

NVIS lighting compatibility can be achieved in a variety of ways that can include, but is not limited to, modification of light sources, light filters or by virtue of location. Once aircraft lighting is modified for using NVGs, it is important to keep in mind that changes in the crew station (e.g., addition of new display) must be assessed relative to the effect on NVIS compatibility.

2.4. NVIS operation

A night flight wherein the pilot maintains visual surface reference using NVGs in an aircraft that is NVIS approved

2.4.1 Aided

Aided flight is flight with NVGs in an operational position.

2.4.2 Unaided

Unaided flight is a flight without NVGs or a flight with NVGs in a non-operational position.

3. SYSTEM DESCRIPTION

3.1 NVIS capabilities

NVIS generally provides the pilot an image of the outside scene that is enhanced compared to that provided by the unaided, dark-adapted eye. However, NVIS may not provide the user an image equal to that observed during daylight. Since the user has an enhanced visual capability, situational awareness is generally improved.

3.1.1 Critical elements

The following critical elements are the underlying assumptions in the system description for NVIS:

1. aircraft internal lighting has been modified or initially designed to be compatible;
2. environmental conditions are adequate for the use of NVIS (e.g. enough illumination is present, weather conditions are favourable, etc.);
3. the NVIS has been properly maintained in accordance with the minimum operational performance standards;
4. a proper pre-flight has been performed on the NVIS confirming operation in accordance with the continued airworthiness standards and training guidelines; and
5. the pilot(s) has been properly trained and meets recency of experience requirements.

Even when insuring that these conditions are met, there still are many variables that can adversely affect the safe and effective use of NVIS (e.g., flying towards a low angle moon, flying in a shadowed area, flying near extensive cultural lighting, flying over low contrast terrain, etc.). It is important to understand these assumptions and limitations when discussing the capabilities provided by the use of NVIS.

3.1.2 Situation awareness

Situation awareness, being defined as the degree of perceptual accuracy achieved in the comprehension of all factors affecting an aircraft and crew at a given time, is improved at night when using NVG during NVIS operations. This is achieved by providing the pilot with more visual cues than is normally available under most conditions when operating an aircraft unaided at night. However, it is but one source of the factors necessary for maintaining an acceptable level of situational awareness.

3.1.2.1 Environment detection and identification

An advantage of using NVIS is the enhanced ability to detect, identify, and avoid terrain and/or obstacles that present a hazard to night operations. Correspondingly, NVIS aid in night navigation by allowing the aircrew to view waypoints and features.

Being able to visually locate and then (in some cases) identify objects or areas critical to operational success will also enhance operational effectiveness. Finally, use of NVIS may allow pilots to detect other aircraft more easily.

3.1.3 Emergency situations

NVIS generally improve situational awareness, facilitating the pilot’s workload during emergencies. Should an emergency arise that requires an immediate landing, NVIS may provide the pilot with a means of locating a suitable landing area and conducting a landing. The pilot must determine if the use of NVIS during emergencies is appropriate. In certain instances, it may be more advantageous for the pilot to remove the NVG during the performance of an emergency procedure.

3.2.1 NVG design characteristics

There are limitations inherent in the current NVG design.

3.2.1.1 Visual acuity

The pilot’s visual acuity with NVGs is less than normal daytime visual acuity.

3.2.1.2 Field of view

Unaided field of view (FOV) covers an elliptical area that is approximately 120° lateral by 80° vertical, whereas the field of view of current Type I NVG systems is nominally 40° and is circular. Both the reduced field of view of the image and the resultant decrease in peripheral vision can increase the pilot's susceptibility to misperceptions and illusions. Proper scanning techniques must be employed to reduce the susceptibility to misperception and illusions.

3.2.1.3 Field of regard

The NVG has a limited FOV but, because it is head-mounted, that FOV can be scanned when viewing the outside scene. The total area that the FOV can be scanned is called the field of regard (FOR). The FOR will vary depending on several factors: physiological limit of head movement, NVG design (e.g., protrusion of the binocular assembly, etc.) and cockpit design issues (e.g., proximity of canopy or window, seat location, canopy bow, etc.).

3.2.1.4 NVG weight & centre of gravity

The increased weight and forward CG projection of head supported devices may have detrimental effects on pilot performance due to neck muscle strain and fatigue. There also maybe an increased risk of neck injury in crashes.

3.2.1.5 Monochromatic image

The NVG image currently appears in shades of green. Since there is only one colour, the image is said to be "monochromatic". This colour was chosen mostly because the human eye can see more detail at lower brightness levels when viewing shades of green. Colour differences between components in a scene helps one discriminate between objects and aids in object recognition, depth perception and distance estimation. The lack of colour variation in the NVG image will degrade these capabilities to varying degrees.

3.2.1.6 Ambient or artificial light

The NVG requires some degree of light (energy) in order to function. Low light levels, non-compatible aircraft lighting and poor windshield/window light transmissibility, diminish the performance capability of the NVG. It is the pilot's responsibility to determine when to transition from aided to unaided due to unacceptable NVG performance.

3.2.2 Physiological and other conditions

3.2.2.1 Cockpit resource management

Due to the inherent limitations of NVIS operations, there is a requirement to place emphasis on NVIS related cockpit resource management (CRM). This applies to both single and multi-pilot cockpit environments. Consequently, NVIS flight requires effective CRM between the pilot(s), controlling agencies and other supporting personnel. An appropriate venue for addressing this issue is the pre-flight NVIS mission brief.

3.2.2.2 Fatigue

Physiological limitations that are prevalent during the hours of darkness along with the limitations associated with NVGs, may have a significant impact on NVIS operations. Some of these limitations are the effects of fatigue (both acute and chronic), stress, eyestrain, working outside the pilot's normal circadian rhythm envelope, increased helmet weight, aggressive scanning techniques associated with NVIS, and various human factors engineering concerns that may have a direct influence on how the pilot works in the aircraft while wearing NVGs. These limitations may be mitigated through proper training and recognition, experience, adaptation, rest, risk management, and proper crew rest/duty cycles.

3.2.2.3 Over-confidence

Compared to other types of flight operations, there may be an increased tendency by the pilot to over-estimate the capabilities of the NVIS.

3.2.2.4 Spatial orientation

There are two types of vision used in maintaining spatial orientation: central (focal) vision and peripheral (ambient) vision. Focal vision requires conscious processing and is slow, whereas peripheral information is processed subconsciously at a very fast rate. During daytime, spatial orientation is maintained by inputs from both focal vision and peripheral vision, with peripheral vision providing the great majority of the information. When using NVGs, peripheral vision can be significantly degraded if not completely absent. In this case, the pilot must rely on focal vision to interpret the NVG image as well as the information from flight instruments in order to maintain spatial orientation and situation awareness. Even though maintaining spatial orientation requires more effort when using NVGs than during daytime, it is much improved over night unaided operations where the only information is obtained through flight instruments. However, anything that degrades the NVG image to a point where the horizon is not visualised and/or ground reference is lost or significantly degraded will necessitate a reversion to flight on instruments until adequate external visual references can be established. Making this transition quickly and effectively is vital in order to avoid spatial disorientation. Additionally, added focal task loading during the operation (e.g., communications, looking at displays, processing navigational information, etc.) will compete with the focal requirement for interpreting the NVG image and flight instruments. Spatial disorientation can result when the task loading increases to a point where the outside scene and/or the flight instruments are not properly scanned. This potential can be mitigated to some extent through effective training and experience.

3.2.2.5 Depth perception & distance estimation

When flying, it is important for pilots to be able to accurately employ depth perception and distance estimation techniques. To accomplish this, pilots use both binocular and monocular vision. Binocular vision requires the use of both eyes working together, and, practically speaking, is useful only out to approximately 100 ft.

Binocular vision is particularly useful when flying close to the ground and/or near objects (e.g. landing a helicopter in a small landing zone). Monocular vision can be accomplished with either eye alone, and is the type of vision used for depth perception and distance estimation when viewing beyond approximately 100 ft. Monocular vision is the predominant type of vision used when flying fixed wing aircraft, and also when flying helicopters and using cues beyond 100 ft. When viewing an NVG image, the two eyes can no longer provide accurate binocular information, even though the NVG used when flying is a binocular system. This has to do with the way the eyes function physiologically (e.g. accommodation, stereopsis, etc.) and the design of the NVG (i.e. a binocular system with a fixed channel for each eye). Therefore, binocular depth perception and distance estimation tasking when viewing terrain or objects with an NVG within 100 ft is significantly degraded. Since monocular vision does not require both eyes working together, the adverse impact on depth perception and distance estimation is much less, and is mostly dependent on the quality of the NVG image. If the image is very good and there are objects in the scene to use for monocular cueing (especially objects with which the pilot is familiar), then distance estimation and depth perception tasking will remain accurate. However, if the image is degraded (e.g., low illumination, airborne obscurants, etc.) and/or there are few or unfamiliar objects in the scene, depth perception and distance estimation will be degraded to some extent. In summary, pilots using NVG will maintain the ability to accurately perceive depth and estimate distances, but it will depend on the distances used and the quality of the NVG image.

Pilots maintain some ability to perceive depth and distance when using NVGs by employing monocular cues. However, these capabilities may be degraded to varying degrees.

3.2.2.6 Instrument lighting brightness considerations

When viewing the NVG image, the brightness of the image will affect the amount of time it takes to adapt to the brightness level of the instrument lighting, thereby affecting the time it takes to interpret information provided by the instruments. For example, if the instrument lighting is fairly bright, the time it takes to interpret information provided by the instruments may be instantaneous. However, if the brightness of the lighting is set to a very low level, it may take several seconds to interpret the information, thus increasing the heads-down time and increasing the risk of spatial disorientation. It is important to ensure that instrument lighting is kept at a brightness level that makes it easy to rapidly interpret the information. This will likely be brighter than one is used to during unaided operations.

3.2.2.7 Dark adaptation time from NVG to unaided operations

When viewing an NVG image, both rods and cones are being stimulated (i.e., mesopic vision), but the brightness of the image is reducing the effectiveness of rod cells. If the outside scene is bright enough (e.g., urban area, bright landing pad, etc.), both rods and cones will continue to be stimulated. In this case there will be no improvement in acuity over time and the best acuity is essentially instantaneous. In some cases (e.g., rural area with scattered cultural lights), the outside scene will not be bright enough to stimulate the cones and some amount of time will be required for the rods to fully adapt. In this case it may take the rods one to two minutes to fully adapt for the best acuity to be realised. If the outside scene is very dark (e.g., no cultural lights and no moon), it may take up to five minutes to fully adapt to the outside scene after removing the NVGs. The preceding are general guidelines and the time required to fully adapt to the outside scene once removing the NVG depends on many variables: the length of time the NVG has been used, whether or not the pilot was dark adapted prior to flight, the brightness of the outside scene, the brightness of cockpit lighting, and variability in visual function among the population. It is important to understand the concept and to note the time requirements for the given operation.

3.2.2.8 Complacency

Pilots must understand the importance of avoiding complacency during NVG flights. Similar to other specialised flight operations, complacency may lead to an acceptance of situations that would normally not be permitted. Attention span and vigilance are reduced, important elements in a task series are overlooked, and scanning patterns, which are essential for situational awareness, break down (usually due to fixation on a single instrument, object or task). Critical but routine tasks are often skipped.

3.2.2.9 Experience

High levels of NVIS proficiency, along with a well-balanced NVIS experience base, will help to offset many of the visual performance degradations associated with night operations. NVIS experience is a result of proper training coupled with numerous NVIS operations. An experienced NVIS pilot is acutely aware of the NVIS operational envelope and its correlation to various operational effects, visual illusions and performance limitations. This experience base is gained (and maintained) over time through a continual, holistic NVIS training programme that exposes the pilot to NVIS operations conducted under various moon angles, percentage of available illumination, contrast levels, visibility levels, and varying degrees of cloud coverage. A pilot should be exposed to as many of these variations as practicable during the initial NVIS qualification programme. Continued exposure during the NVIS recurrent training will help strengthen and solidify this experience base.

4. OPERATIONS

Operations procedures should accommodate the capabilities and limitations of the systems described in Section 3 of this GM as well as the restraints of the operational environment.

All NVG operations should fulfil all applicable requirements in accordance with Regulation (EC) No 216/2008.

4.1 Pilot eligibility

About 54% of the civil pilot population wears some sort of ophthalmic device to correct vision necessary to safely operate an aircraft. The use of inappropriate ophthalmic devices with NVGs may result in vision performance decrement, fatigue, and other human factor problems, which could result in increased risk for aviation accidents and incidents.

4.2 Operating environment considerations

4.2.1 Weather and atmospheric obscurants

Any atmospheric condition, which absorbs, scatters, or refracts illumination, either before or after it strikes terrain, may reduce the usable energy available to the NVG.

4.2.1.1 Weather

During NVIS operations, pilots can see areas of moisture that are dense (e.g., clouds, thick fog, etc.) but may not see areas that are less dense (e.g., thin fog, light rain showers, etc.). The inability to see some areas of moisture may lead to hazardous flight conditions during NVIS operations and will be discussed separately in the next section.

The different types of moisture will have varying effects and it is important to understand these effects and how they apply to NVIS operations. For example:

1. It is important to know when and where fog may form in the flying area. Typically, coastal, low-lying river, and mountainous areas are most susceptible.
2. Light rain or mist may not be observed with NVIS but will affect contrast, distance estimation, and depth perception. Heavy rain is more easily perceived due to large droplet size and energy attenuation.
3. Snow occurs in a wide range of particle sizes, shapes, and densities. As with clouds, rain, and fog, the denser the airborne snow, the greater the effect on NVG performance. On the ground, snow has mixed effect depending on terrain type and the illumination level. In mountainous terrain, snow may add contrast, especially if trees and rocks protrude through the snow. In flatter terrain, snow may cover high contrast areas, reducing them to areas of low contrast. On low illumination nights, snow may reflect the available energy better than the terrain it covers and thus increase the level of illumination.

All atmospheric conditions reduce the illumination level to some degree and recognition of this reduction with NVGs can be difficult. Thus, a good weather briefing, familiarity with the local weather patterns and understanding the effects on NVG performance are important for a successful NVIS flight.

4.2.1.2 Deteriorating weather

It is important to remain cognizant of changes in the weather when using NVGs. It is possible to “see through” areas of light moisture when using NVGs, thus increasing the risk of inadvertently entering IMC. Some ways to help reduce this possibility include the following:

1. Be attentive to changes in the NVG image. Halos may become larger and more diffuse due to diffraction of light in moisture. Scintillation in the image may increase due to a lowering of the illumination level caused by the increased atmospheric moisture. Loss of scene detail may be secondary to the lowering illumination caused by the changing moisture conditions.
2. Obtain a thorough weather brief with emphasis on NVG effects prior to flight.
3. Be familiar with weather patterns in the flying area.
4. Occasionally scan the outside scene. The unaided eye may detect weather conditions that are not detectable to the NVG.

Despite the many methods of inadvertent instrument meteorological conditions (IMC) prevention, one should have established IMC recovery procedures and be familiar with them.

4.2.1.3 Airborne obscurants

In addition to weather, there may be other obscurants in the atmosphere that could block energy from reaching the NVG, such as haze, dust, sand, or smoke. As with moisture, the size and concentration of the particles will determine the degree of impact. Examples of these effects include the following:

1. high winds during the day can place a lot of dust in the air that will still be present at night when the wind may have reduced in intensity;
2. forest fires produce heavy volumes of smoke that may cover areas well away from the fire itself;
3. the effects of rotor wash may be more pronounced when using NVGs depending on the material (e.g. sand, snow, dust, etc.); and
4. pollution in and around major cultural areas may have an adverse effect on NVG performance.

4.2.1.4 Winter operations

Using NVGs during winter conditions provide unique issues and challenges to pilots.

4.2.1.4.1 Snow

Due to the reflective nature of snow, it presents pilots with significant visual challenges both en-route and in the terminal area. During the en-route phase of a flight the snow may cause distractions to the flying pilot if any aircraft external lights (e.g., anti-collision beacons/strobes, position lights, landing lights, etc.) are not compatible with NVGs. In the terminal area, whiteout landings can create the greatest hazard to unaided night operations. With NVGs the hazard is not lessened, and can be more disorienting due to lights reflecting from the snow that is swirling around the aircraft during the landing phase. Any emergency vehicle lighting or other airport lighting in the terminal area may exaggerate the effects.

4.2.1.4.2 Ice fog

Ice fog presents the pilot with hazards normally associated with IMC in addition to problems associated with snow operations. The highly reflective nature of ice fog will further aggravate any lighting problems. Ice fog conditions can be generated by aircraft operations under extremely cold temperatures and the right environmental conditions.

4.2.1.4.3 Icing

Airframe ice is difficult to detect while looking through NVGs. The pilot will need to develop a proper crosscheck to ensure airframe icing does not exceed operating limits for that aircraft. Pilots should already be aware of icing indicator points on their aircraft. These areas require consistent oversight to properly determine environmental conditions.

4.2.1.4.4 Low ambient temperatures

Depending on the cockpit heating system, fogging of the NVGs can be a problem and this will significantly reduce the goggle effectiveness. Another issue with cockpit temperatures is the reduced battery duration. Operations in a cold environment may require additional battery resources.

4.2.2 Illumination

NVGs require illumination, either natural or artificial, to produce an image. Although current NVG technology has significantly improved low light level performance, some illumination, whether natural or artificial, is still required to provide the best possible image.

4.2.2.1 Natural illumination

The main sources of natural illumination include the moon and stars. Other sources can include sky glow, the aurora borealis, and ionisation processes that take place in the upper atmosphere.

4.2.2.1.1 Moon phase

The moon provides the greatest source of natural illumination during night time. Moon phase and elevation determines how much moonlight will be available, while moonrise and moonset times determine when it will be available. Lunar illumination is reported in terms of percent illumination, 100% illumination being full moon. It should be noted that this is different from the moon phase (e.g., 25% illumination does not mean the same thing as a quarter moon). Currently, percent lunar illumination can only be obtained from sources on the Internet, military weather facilities and some publications (e.g. Farmers Almanac).

4.2.2.1.2 Lunar azimuth and elevation

The moon can have a detrimental effect on night operations depending on its relationship to the flight path. When the moon is on the same azimuth as the flight path, and low enough to be within or near the NVG field of view, the effect on NVG performance will be similar to that caused by the sun on the unaided eye during daytime. The brightness of the moon drives the NVG gain down, thus reducing image detail. This can also occur with the moon at relatively high elevations. For example, it is possible to bring the moon near the NVG field of view when climbing to cross a ridgeline or other obstacle, even when the moon is at a relatively high elevation. It is important to consider lunar azimuth and elevation during pre-flight planning. Shadowing, another effect of lunar azimuth and elevation, will be discussed separately.

4.2.2.1.3 Shadowing

Moonlight creates shadows during night time just as sunlight creates shadows during daytime. However, night time shadows contain very little energy for the NVG to use in forming an image. Consequently, image quality within a shadow will be degraded relative to that obtained outside the shadowed area. Shadows can be beneficial or can be a disadvantage to operations depending on the situation.

4.2.2.1.3.1 Benefits of shadows

Shadows alert aircrew to subtle terrain features that may not otherwise be noted due to the reduced resolution in the NVG image. This may be particularly important in areas where there is little contrast differentiation; such as flat featureless deserts, where large dry washes and high sand dunes may go unnoticed if there is no contrast to note their presence. The contrast provided by shadows helps make the NVG scene appear more natural.

4.2.2.1.3.2 Disadvantages due to shadows

When within a shadow, terrain detail can be significantly degraded, and objects can be regarding flight in or around shadowed areas is the pilot’s response to loss of terrain detail. During flight under good illumination conditions, a pilot expects to see a certain level of detail. If flight into a shadow occurs while the pilot is preoccupied with other matters (e.g., communication, radar, etc.), it is possible that the loss in terrain detail may not have been immediately noted. Once looking outside again, the pilot may think the reduced detail is due to an increase in flight altitude and thus begin a descent - even though already at a low altitude. Consideration should be given during mission planning to such factors as lunar azimuth and elevation, terrain type (e.g., mountainous, flat, etc.), and the location of items significant to operation success (e.g., ridgelines, pylons, targets, waypoints, etc.). Consideration of these factors will help predict the location of shadows and the potential adverse effects.

4.2.2.1.4 Sky glow

Sky glow is an effect caused by solar light and continues until the sun is approximately 18 degrees below the horizon. When viewing in the direction of sky glow there may be enough energy present to adversely affect the NVG image (i.e., reduce image quality). For the middle latitudes the effect on NVG performance may last up to an hour after official sunset. For more northern and southern latitudes the effect may last for extended periods of times (e.g., days to weeks) during seasons when the sun does not travel far below the horizon. This is an important point to remember if planning NVG operations in those areas. Unlike sky glow after sunset, the sky glow associated with sunrise does not have an obvious effect on NVG performance until fairly close to official sunrise. The difference has to do with the length of time the atmosphere is exposed to the sun's irradiation, which causes ionisation processes that release near-IR energy. It is important to know the difference in these effects for planning purposes.

4.2.2.2 Artificial illumination

Since the NVGs are sensitive to any source of energy in the visible and near infrared spectrums, there are also many types of artificial illumination sources (e.g., flares, IR searchlights, cultural lighting, etc). As with any illumination source, these can have both positive and detrimental effects on NVG utilisation. For example, viewing a scene indirectly illuminated by a searchlight can enable the pilot to more clearly view the scene; conversely, viewing the same scene with the searchlight near or within the NVG field of view will reduce the available visual cues. It is important to be familiar with the effects of cultural lighting in the flying area in order to be able to avoid the associated problems and to be able to use the advantages provided. Also, it is important to know how to properly use artificial light sources (e.g., aircraft IR spotlight). It should be noted that artificial light sources may not always be available or dependable, and this should be taken into consideration during flight planning.

4.2.3 Terrain contrast

Contrast is one of the more important influences on the ability to correctly interpret the NVG image, particularly in areas where there are few cultural features. Any terrain that contains varying albedos (e.g., forests, cultivated fields, etc.) will likely increase the level of contrast in a NVG image, thus enhancing detail. The more detail in the image, the more visual information aircrews have for manoeuvring and navigating. Low contrast terrain (e.g., flat featureless desert, snow-covered fields, water, etc.) contains few albedo variations, thus the NVG image will contain fewer levels of contrast and less detail.

4.3 Aircraft considerations

4.3.1 Lighting

Factors such as aircraft internal and external lighting have the potential to adversely impact NVG gain and thus image quality. How well the windshield, canopy, or window panels transmit near infrared energy can also affect the image. Cleanliness of the windshield directly impacts this issue.

4.3.2 Cockpit ergonomics

While wearing NVGs, the pilot may have limited range of head movement in the aircraft. For example, switches on the overhead console may be difficult to read while wearing NVGs. Instruments, controls, and switches that are ordinarily accessible, may now be more difficult to access due to the extended mass (fore/aft) associated with NVGs.

In addition, scanning may require a more concentrated effort due to limited field of view. Lateral viewing motion can be hindered by cockpit obstructions (i.e. door post or seat back design).

4.3.3 Windshield reflectivity

Consideration within the cockpit and cabin should be given to the reflectivity of materials and equipment upon the windshield. Light that is reflected may interfere with a clear and unobstructed view. Items such as flight suits, helmets, and charts, if of a light colour such as white, yellow, and orange, can produce significant reflections. Colours that impart the least reflection are black, purple, and blue. This phenomenon is not limited to windshields but may include side windows, chin bubbles, canopies, etc.

4.4 Generic operating considerations

This section lists operating topics and procedures, which should be considered when employing NVIS. The list and associated comments are not to be considered all inclusive. NVIS operations vary in scope widely and this section is not intended to instruct a prospective operator on how to implement an NVIS programme.

4.4.1 Normal procedures

4.4.1.1 Scanning

When using NVGs there are three different scan patterns to consider and each is used for different reasons: instrument scan, aided scan outside, and unaided scan outside. Normally, all three are integrated and there is a continuous transition from one to the other depending on the mission, environmental conditions, immediate tasking, flight altitude and many other variables. For example, scanning with the NVG will allow early detection of external lights. However, the bloom caused by the lights will mask the aircraft until fairly close or until the lighting scheme is changed. Once close to the aircraft (e.g., approximately one-half mile for smaller aircraft), visual acquisition can possibly be made unaided or with the NVG. Whether to use the NVG or unaided vision depends on many variables (e.g., external lighting configuration, distance to aircraft, size of aircraft, environmental conditions, etc.). The points to be made are that a proper scan depends on the situation and variables present, and that scanning outside is critical when close to another aircraft. Additionally, for a multi-crew environment, coordination of scan responsibilities is vital.

4.4.1.1.1 Instrument crosscheck scan

In order to effect a proper and effective instrument scan, it is important to predict when it will be important. A start can be made during pre-flight planning when critical phases of flight can be identified and prepared for. For example, it may be possible when flying over water or featureless terrain to employ a good instrument crosscheck. However, the most important task is to make the appropriate decision during flight as conditions and events change. In this case, experience, training and constant attention to the situation are vital contributors to the pilot's assessment of the situation.

4.4.1.1.2 NVG scan

To counteract the limited field of view, pilots should continually scan throughout the field of regard. This allows aircrew to build a mental image of the surrounding environment. How quickly the outside scene is scanned to update the mental image is determined by many variables. For example, when flying over flat terrain where the highest obstacle is below the flight path, the scan may be fairly slow. However, if flying low altitude in mountainous terrain, the scan will be more aggressive and rapid due to the presence of more information and the increased risk. How much of the field of regard to scan is also determined by many variables. For example, if a pilot is anticipating a turn, more attention may be placed in the area around the turn point, or in the direction of the new heading. In this situation, the scan will be limited briefly to only a portion of the field of regard.

As with the instrument scan, it is very important to plan ahead. It may, for example, be possible to determine when the scan may be interrupted due to other tasks, when it may be possible to become fixated on a specific task, or when it is important to maximise the outside scan. An important lesson to learn regarding the NVG scan is when not to rely on visual information. It is easy to overestimate how well one can see with NVGs, especially on high illumination nights, and it is vital to maintain a constant awareness regarding their limitations. This should be pointed out often during training and, as a reminder, should be included as a briefing item for NVG flights.

4.4.1.1.3 Unaided scan

Under certain conditions, this scan can be as important as the others can. For example, it may be possible to detect distance and/or closure to another aircraft more easily using unaided vision, especially if the halo caused by the external lights is masking aircraft detail on the NVG image. Additionally, there are other times when unaided information can be used in lieu of or can augment NVG and instrument information.

4.4.1.1.4 Scan patterns

Environmental factors will influence scan by limiting what may be seen in specific directions or by degrading the overall image. If the image is degraded, aircrew may scan more aggressively in a subconscious attempt to obtain more information, or to avoid the chance of missing information that suddenly appears and/or disappears. The operation itself may influence the scan pattern. For example, looking for another aircraft, landing zone, or airport may require focusing the scan in a particular direction. In some cases, the operation may require aircrew in a multi place aircraft to assign particular pilots responsibility for scanning specific sectors.

The restrictions to scan and the variables affecting the scan patter are not specific to night operations or the use of NVGs, but, due to the NVG's limited field of view, the degree of impact is magnified.

4.4.1.2 Pre-flight planning

4.4.1.2.1 Illumination criteria

The pilot should provide a means for forecasting the illumination levels in the operational area. The pilot should make the effort to request at least the following information in addition to that normally requested for night VFR: cloud cover and visibility during all phases of flight, sunset, civil and nautical twilight, moon phase, moonrise and moonset, and moon and/or lux illumination levels, and unlit tower NOTAMS.

4.4.1.2.2 NVIS operations

An inspection of the power pack, visor, mount, power cable and the binocular assembly should be performed in accordance with the operations manual.

To ensure maximum performance of the NVGs, proper alignment and focus must be accomplished following the equipment inspection. Improper alignment and focus may degrade NVIS performance.

4.4.1.2.3 Aircraft pre-flight

A normal pre-flight inspection should be conducted prior to an NVIS flight with emphasis on proper operation of the NVIS lighting. The aircraft windshield must also be clean and free of major defects, which might degrade NVIS performance.

4.4.1.2.4 Equipment

The basic equipment required for NVIS operations should be those instruments and equipment specified within the current applicable regulations for VFR night operations. Additional equipment required for NVIS operations, e.g. NVIS lighting system and a radio altimeter must be installed and operational. All NVIS equipment, including any subsequent modifications, shall be approved.

4.4.1.2.5 Risk assessment

A risk assessment is suggested prior to any NVIS operation. The risk assessment should include as a minimum:

1. illumination level
2. weather
3. pilot recency of experience
4. pilot experience with NVG operations
5. pilot vision
6. pilot rest condition and health

7. windshield/window condition
8. NVG tube performance
9. NVG battery condition
10. types of operations allowed
11. external lighting environment.

4.4.1.3 Flight operations

4.4.1.3.1 Elevated terrain

Safety may be enhanced by NVGs during operations near elevated terrain at night. The obscuration of elevated terrain is more easily detected with NVGs thereby allowing the pilot to make alternate flight path decisions.

4.4.1.3.2 Over-water

Flying over large bodies of water with NVGs is difficult because of the lack of contrast in terrain features. Reflections of the moon or starlight may cause disorientation with the natural horizon. The radio altimeter must be used as a reference to maintain altitude.

4.4.1.4 Remote area considerations

A remote area is a site that does not qualify as an aerodrome as defined by the applicable regulations. Remote area landing sites do not have the same features as an aerodrome, so extra care must be given to locating any obstacles that may be in the approach/departure path.

A reconnaissance must be made prior to descending at an unlighted remote site. Some features or objects may be easy to detect and interpret with the unaided eye. Other objects will be invisible to the unaided eye, yet easily detected and evaluated with NVGs.

4.4.1.5 Reconnaissance

The reconnaissance phase should involve the coordinated use of NVGs and white lights. The aircraft's external white lights such as landing lights, searchlights, and floodlights, should be used during this phase of flight. The pilot should select and evaluate approach and departure paths to the site considering wind speed and direction, and obstacles or signs of obstacles.

4.4.1.6 Sources of high illumination

Sources of direct high illumination may have the potential to reduce the effectiveness of the NVGs. In addition, certain colour lights, such as red, will appear brighter, closer and may display large halos.

4.4.2 Emergency procedures

No modification for NVG operations is necessary to the aircraft emergency procedures as approved in the operations manual or approved checklist. Special training may be required to accomplish the appropriate procedures.

4.4.3 Inadvertent IMC

Some ways to help reduce the potential for inadvertent flight into IMC conditions are:

1. obtaining a thorough weather brief (including pilot reports);
2. being familiar with weather patterns in the local flying area; and
3. by looking beneath the NVG at the outside scene.

However, even with thorough planning a risk still exists. To help mitigate this risk it is important to know how to recognise subtle changes to the NVG image that occur during entry into IMC conditions. Some of these include the onset of scintillation, loss of scene detail, and changes in the appearance of halos.

5. TRAINING

To provide an appropriate level of safety, training procedures must accommodate the capabilities and limitations of the systems described in Section 3 of this GM as well as the restraints of the operational environment.

To be effective, the NVIS training philosophy would be based on a two-tiered approach: basic and advanced NVIS training. The basic NVIS training would serve as the baseline standard for all individuals seeking an NVIS endorsement. The content of this initial training would not be dependent on any operational requirements. The advanced training would build on the basic training by focusing on developing specialised skills required to operate an aircraft during NVIS operations in a particular operational environment. Furthermore, while there is a need to stipulate minimum flight hour requirements for an NVIS endorsement, the training must also be event based. This necessitates that pilots be exposed to all of the relevant aspects, or events, of NVIS flight in addition to acquiring a minimum number of flight hours.

6. CONTINUING AIRWORTHINESS

The reliability of the NVIS and safety of operations are dependent on the pilots adhering to the instructions for continuing airworthiness. Personnel who conduct the maintenance and inspection on the NVIS must be qualified and possess the appropriate tools and facilities to perform the maintenance.

Acronyms used in this GM

AC	Advisory Circular
AGL	above ground level
ATC	air traffic control
CONOPs	concept of operations
CG	centre of gravity
CRM	cockpit resource management
DOD	Department of Defence
DOT	Department of Transportation
EFIS	electronic flight instrumentation systems
EMS	emergency medical service
FAA	Federal Aviation Administration
FLIR	forward looking infrared radar
FOR	field of regard
FOV	field of view
GEN	generation
HUD	head-up display

IFR	instrument flight rules
IMC	instrument meteorological conditions
IR	infrared
JAA	Joint Aviation Authorities
MOPS	Minimum Operational Performance Standard
NAS	national airspace system
NOTAMS	Notices to Airmen
NVD	night vision device
NVED	night vision enhancement device
NVG	night vision goggles
NVIS	night vision imaging system
SC	special committee
TFR	temporary flight restrictions
VA	visual acuity
VFR	visual flight rules
VMC	visual meteorological conditions

Glossary of terms used in this GM

1. ‘Absorptance’: the ratio of the radiant energy absorbed by a body to that incident upon it.
2. ‘Albedo’: the ratio of the amount of light reflected from a surface to the amount of incident light.
3. ‘Automatic brightness control (ABC)’: one of the automatic gain control circuits found in second and third generation NVG devices. It attempts to provide consistent image output brightness by automatic control of the micro channel plate voltage.
4. ‘Automatic gain control (AGC)’: comprised of the automatic brightness control and bright source protection circuits. Is designed to maintain image brightness and protect the user and the image tube from excessive light levels. This is accomplished by controlling the gain of the intensifier tube.
5. ‘Blackbody’: an ideal body of surface that completely absorbs all radiant energy falling upon with no reflection.
6. ‘Blooming’: common term used to denote the “washing out” of all or part of the NVG image due to de-gaining of the image intensifier tube when a bright light source is in or near the NVG field of view.
7. ‘Bright source protection (BSP)’: protective feature associated with second and third generation NVGs that protects the intensifier tube and the user by controlling the voltage at the photo cathode.
8. ‘Brownout’: condition created by blowing sand, dust, etc., which can cause the pilots to lose sight of the ground. This is most commonly associated with landings in the desert or in dusty LZs.
9. ‘Civil nautical twilight’: the time when the true altitude of the centre of the sun is six degrees below the horizon. Illuminance level is approximately 3.40 lux and is above the usable level for NVG operations.

10. ‘Diopter’: a measure of the refractive (light bending) power of a lens.
11. ‘Electro-optics (EO)’: the term used to describe the interaction between optics and electronics, leading to transformation of electrical energy into light or vice versa.
12. ‘Electroluminescent (EL)’: referring to light emission that occurs from application of an alternating current to a layer of phosphor.
13. ‘Foot-candle’: a measure of illuminance; specifically, the illuminance of a surface upon which one lumen is falling per square foot.
14. ‘Foot-Lambert’: a measure of luminance; specifically the luminance of a surface that is receiving an illuminance of one foot-candle.
15. ‘Gain’: when referring to an image intensification tube, the ratio of the brightness of the output in units of foot-lambert, compared to the illumination of the input in foot-candles. A typical value for a GEN III tube is 25,000 to 30,000 Fl/fc. A “tube gain” of 30,000 Fl/fc provides an approximate “system gain” of 3,000. This means that the intensified NVG image is 3,000 times brighter to the aided eye than that of the unaided eye.
16. ‘Illuminance’: also referred to as illumination. The amount, ratio or density of light that strikes a surface at any given point.
17. ‘Image intensifier’: an electro-optic device used to detect and intensify optical images in the visible and near infrared region of the electromagnetic spectrum for the purpose of providing visible images. The component that actually performs the intensification process in a NVG. This component is composed of the photo cathode, MCP, screen optic, and power supply. It does not include the objective and eyepiece lenses.
18. ‘Incandescent’: refers to a source that emits light based on thermal excitation, i.e., heating by an electrical current, resulting in a very broad spectrum of energy that is dependent primarily on the temperature of the filament.
19. ‘Infrared’: that portion of the electromagnetic spectrum in which wavelengths range from 0.7 microns to 1 mm. This segment is further divided into near infrared (0.7-3.0 microns), mid infrared (3.0-6.0 microns), far infrared (6.0-15 microns), and extreme infrared (15 microns-1 mm). A NVG is sensitive to near infrared wavelengths approaching 0.9 microns.
20. ‘Irradiance’: the radiant flux density incident on a surface. For the purpose of this document the terms irradiance and illuminance shall be interchangeable.
21. ’Lumen’: a measurement of luminous flux equal to the light emitted in a unit solid angle by a uniform point source of one candle intensity.
22. ’Luminance’: the luminous intensity (reflected light) of a surface in a given direction per unit of projected area. This is the energy used by NVGs.
23. ’Lux’: a unit measurement of illumination. The illuminance produced on a surface that is one-meter square, from a uniform point source of one candle intensity, or one lumen per square meter.
24. ‘Microchannel plate’: a wafer containing between 3 and 6 million specially treated microscopic glass tubes designed to multiply electrons passing from the photo cathode to the phosphor screen in second and third generation intensifier tubes.
25. ‘Micron’: a unit of measure commonly used to express wavelength in the infrared region; equal to one millionth of a meter.
26. ‘Nanometer (nm)’: a unit of measure commonly used to express wavelength in the visible and near infrared region; equal to one billionth of a meter.

27. ‘Night vision device (NVD)’: an electro-optical device used to provide a visible image using the electromagnetic energy available at night.
28. ‘Photon’: a quantum (basic unit) of radiant energy (light).
29. ‘Photopic vision’: vision produced as a result of the response of the cones in the retina as the eye achieves a light adapted state (commonly referred to as day vision).
30. ‘Radiance’: the flux density of radiant energy reflected from a surface. For the purposes of this manual the terms radiance and luminance shall be interchangeable.
31. ‘Reflectivity’: the fraction of energy reflected from a surface.
32. ‘Scotopic vision’: that vision produced as a result of the response of the rods in the retina as the eye achieves a dark-adapted state (commonly referred to as night vision).
33. ‘Situational awareness (SA)’: degree of perceptual accuracy achieved in the comprehension of all factors affecting an aircraft and crew at a given time.
34. ‘Starlight’: the illuminance provided by the available (observable) stars in a subject hemisphere. The stars provide approximately 0.00022 lux ground illuminance on a clear night. This illuminance is equivalent to about one-quarter of the actual light from the night sky with no moon.
35. ‘Stereopsis’: visual system binocular cues that are used for distance estimation and depth perception. Three dimensional visual perception of objects. The use of NVGs seriously degrades this aspect of near-depth perception.
36. ‘Transmittance’: the fraction of radiant energy that is transmitted through a layer of absorbing material placed in its path.
37. ‘Ultraviolet’: that portion of the electromagnetic spectrum in which wavelengths range between 0.1 and 0.4 microns.
38. ‘Wavelength’: the distance in the line of advance of a wave from any one point to the next point of corresponding phase; is used to express electromagnetic energy including IR and visible light.
39. ‘Whiteout’: a condition similar to brownout but caused by blowing snow.

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SUBPART I:
HELICOPTER HOIST OPERATIONS

AMC1 SPA.HHO.110(a) Equipment requirements for HHO

AIRWORTHINESS APPROVAL FOR HUMAN EXTERNAL CARGO

(a) Hoist installations that have been certificated according to any of the following standards should be considered to satisfy the airworthiness criteria for human external cargo (HEC) operations:

(1) CS 27.865 or CS 29.865;

(2) JAR 27 Amendment 2 (27.865) or JAR 29 Amendment 2 (29.865) or later;

(3) FAR 27 Amendment 36 (27.865) or later - including compliance with CS 27.865(c)(6); or

(4) FAR 29 Amendment 43 (29.865) or later.

(b) Hoist installations that have been certified prior to the issuance of the airworthiness criteria for HEC as defined in (a) may be considered as eligible for HHO provided that following a risk assessment either:

(1) the service history of the hoist installation is found satisfactory to the competent authority; or

(2) for hoist installations with an unsatisfactory service history, additional substantiation to allow acceptance by the competent authority should be provided by the hoist installation certificate holder (type certificate (TC) or supplemental type certificate (STC)) on the basis of the following requirements:

(i) The hoist installation should withstand a force equal to a limit static load factor of 3.5, or some lower load factor, not less than 2.5, demonstrated to be the maximum load factor expected during hoist operations, multiplied by the maximum authorised external load.

(ii) The reliability of the primary and back-up quick release systems at helicopter level should be established and failure mode and effect analysis at equipment level should be available. The assessment of the design of the primary and back-up quick release systems should consider any failure that could be induced by a failure mode of any other electrical or mechanical rotorcraft system.

(iii) The operations or flight manual contains one-engine-inoperative (OEI) hover performance data and procedures for the weights, altitudes, and temperatures throughout the flight envelope for which hoist operations are accepted.

(iv) Information concerning the inspection intervals and retirement life of the hoist cable should be provided in the instructions for continued airworthiness.

(v) Any airworthiness issue reported from incidents or accidents and not addressed by (i), (ii), (iii) and (iv) should be addressed.

AMC1 SPA.HHO.130(b)(2)(ii) Crew requirements for HHO

RELEVANT EXPERIENCE

The experience considered should take into account the geographical characteristics (sea, mountain, big cities with heavy traffic, etc.).

AMC1 SPA.HHO.130(e) Crew requirements for HHO

CRITERIA FOR TWO PILOT HHO

A crew of two pilots should be used when:

(a) the weather conditions are below VFR minima at the offshore vessel or structure;

(b) there are adverse weather conditions at the HHO site (i.e. turbulence, vessel movement, visibility); and

(c) the type of helicopter requires a second pilot to be carried because of:

 (1) cockpit visibility;

 (2) handling characteristics; or

 (3) lack of automatic flight control systems.

AMC1 SPA.HHO.130(f)(1) Crew requirements for HHO

TRAINING AND CHECKING SYLLABUS

(a) The flight crew training syllabus should include the following items:

 (1) fitting and use of the hoist;

 (2) preparing the helicopter and hoist equipment for HHO;

 (3) normal and emergency hoist procedures by day and, when required, by night;

 (4) crew coordination concepts specific to HHO;

 (5) practice of HHO procedures; and

 (6) the dangers of static electricity discharge.

(b) The flight crew checking syllabus should include:

 (1) proficiency checks, which should include procedures likely to be used at HHO sites with special emphasis on:

  (i) local area meteorology;

  (ii) HHO flight planning;

  (iii) HHO departures;

  (iv) a transition to and from the hover at the HHO site;

  (v) normal and simulated emergency HHO procedures; and

  (vi) crew coordination.

(c) HHO technical crew members should be trained and checked in the following items:

 (1) duties in the HHO role;

 (2) fitting and use of the hoist;

(3) operation of hoist equipment;

(4) preparing the helicopter and specialist equipment for HHO;

(5) normal and emergency procedures;

(6) crew coordination concepts specific to HHO;

(7) operation of inter-communication and radio equipment;

(8) knowledge of emergency hoist equipment;

(9) techniques for handling HHO passengers;

(10) effect of the movement of personnel on the centre of gravity and mass during HHO;

(11) effect of the movement of personnel on performance during normal and emergency flight conditions;

(12) techniques for guiding pilots over HHO sites;

(13) awareness of specific dangers relating to the operating environment; and

(14) the dangers of static electricity discharge.

AMC1 SPA.HHO.140 Information and documentation

OPERATIONS MANUAL

The operations manual should include:

(a) performance criteria;

(b) if applicable, the conditions under which offshore HHO transfer may be conducted including the relevant limitations on vessel movement and wind speed;

(c) the weather limitations for HHO;

(d) the criteria for determining the minimum size of the HHO site, appropriate to the task;

(e) the procedures for determining minimum crew; and

(f) the method by which crew members record hoist cycles.

SUBPART J: HELICOPTER EMERGENCY MEDICAL SERVICE OPERATIONS

GM1 SPA.HEMS.100(a) Helicopter emergency medical service (HEMS) operations

THE HEMS PHILOSOPHY

(a) Introduction

This GM outlines the HEMS philosophy. Starting with a description of acceptable risk and introducing a taxonomy used in other industries, it describes how risk has been addressed in this Subpart to provide a system of safety to the appropriate standard. It discusses the difference between HEMS and air ambulance - in regulatory terms. It also discusses the application of operations to public interest sites in the HEMS context.

(b) Acceptable risk

The broad aim of any aviation legislation is to permit the widest spectrum of operations with the minimum risk. In fact it may be worth considering who/what is at risk and who/what is being protected. In this view three groups are being protected:

(1) third parties (including property) - highest protection;

(2) passengers (including patients); and

(3) crew members (including technical crew members) – lowest.

It is for the Legislator to facilitate a method for the assessment of risk - or as it is more commonly known, safety management (refer to Part-ORO).

(c) Risk management

Safety management textbooks[4] describe four different approaches to the management of risk. All but the first have been used in the production of this section and, if it is considered that the engine failure accountability of performance class 1 equates to zero risk, then all four are used (this of course is not strictly true as there are a number of helicopter parts - such as the tail rotor which, due to a lack of redundancy, cannot satisfy the criteria):

(1) Applying the taxonomy to HEMS gives:

(i) zero risk; no risk of accident with a harmful consequence – performance class 1 (within the qualification stated above) - the HEMS operating base;

(ii) de minimis; minimised to an acceptable safety target - for example the exposure time concept where the target is less than 5 x 10^{-8} (in the case of elevated final approach and take-off areas (elevated FATOs) at hospitals in a congested hostile environment the risk is contained to the deck edge strike case - and so in effect minimised to an exposure of seconds);

(iii) comparative risk; comparison to other exposure - the carriage of a patient with a spinal injury in an ambulance that is subject to ground effect compared to the risk of a HEMS flight (consequential and comparative risk);

[4] Reason, J., 1997. Managing the Risks of Organizational Accidents. Ashgate, Farnham.

(iv) as low as reasonably practicable; where additional controls are not economically or reasonably practicable - operations at the HEMS operating site (the accident site).

(2) HEMS operations are conducted in accordance with the requirements contained in Annex IV (Part-CAT) and Annex III (Part-ORO), except for the variations contained in SPA.HEMS, for which a specific approval is required. In simple terms there are three areas in HEMS operations where risk, beyond that allowed in Part-CAT and Part-ORO, are identified and related risks accepted:

(i) in the en-route phase, where alleviation is given from height and visibility rules;

(ii) at the accident site, where alleviation is given from the performance and size requirement; and

(iii) at an elevated hospital site in a congested hostile environment, where alleviation is given from the deck edge strike - providing elements of the CAT.POL.H.305 are satisfied.

In mitigation against these additional and considered risks, experience levels are set, specialist training is required (such as instrument training to compensate for the increased risk of inadvertent entry into cloud) and operation with two crew (two pilots, or one pilot and a HEMS technical crew member) is mandated. (HEMS crews and medical passengers are also expected to operate in accordance with good crew resource management (CRM) principles.)

(d) Air ambulance

In regulatory terms, air ambulance is considered to be a normal transport task where the risk is no higher than for operations to the full OPS.CAT and Part-ORO compliance. This is not intended to contradict/complement medical terminology but is simply a statement of policy; none of the risk elements of HEMS should be extant and therefore none of the additional requirements of HEMS need be applied.

To provide a road ambulance analogy:

(1) if called to an emergency: an ambulance would proceed at great speed, sounding its siren and proceeding against traffic lights - thus matching the risk of operation to the risk of a potential death (= HEMS operations);

(2) for a transfer of a patient (or equipment) where life and death (or consequential injury of ground transport) is not an issue: the journey would be conducted without sirens and within normal rules of motoring - once again matching the risk to the task (= air ambulance operations).

The underlying principle is that the aviation risk should be proportionate to the task.

It is for the medical professional to decide between HEMS or air ambulance - not the pilot. For that reason, medical staff who undertake to task medical sorties should be fully aware of the additional risks that are (potentially) present under HEMS operations (and the pre-requisite for the operator to hold a HEMS approval). (For example in some countries, hospitals have principal and alternative sites. The patient may be landed at the safer alternative site (usually in the grounds of the hospital) thus eliminating risk - against the small inconvenience of a short ambulance transfer from the site to the hospital.)

Once the decision between HEMS or air ambulance has been taken by the medical professional, the commander makes an operational judgement over the conduct of the flight.

Simplistically, the above type of air ambulance operations could be conducted by any operator holding an Air Operator Certificate (AOC) (HEMS operators hold an AOC) - and usually are when the carriage of medical supplies (equipment, blood, organs, drugs etc.) is undertaken and when urgency is not an issue.

(e) Operating under a HEMS approval

There are only two possibilities: transportation as passengers or cargo under the full auspices of OPS.CAT and Part-ORO (this does not permit any of the alleviations of SPA.HEMS - landing and take-off performance should be in compliance with the performance Subparts of Part-CAT), or operations under a HEMS approval as contained in this Subpart.

(f) HEMS operational sites

The HEMS philosophy attributes the appropriate levels of risk for each operational site; this is derived from practical considerations and in consideration of the probability of use. The risk is expected to be inversely proportional to the amount of use of the site. The types of site are as follows:

(1) HEMS operating base: from which all operations will start and finish. There is a high probability of a large number of take-offs and landings at this HEMS operating base and for that reason no alleviation from operating procedures or performance rules are contained in this Subpart.

(2) HEMS operating site: because this is the primary pick-up site related to an incident or accident, its use can never be pre-planned and therefore attracts alleviations from operating procedures and performance rules, when appropriate.

(3) The hospital site: is usually at ground level in hospital grounds or, if elevated, on a hospital building. It may have been established during a period when performance criteria were not a consideration. The amount of use of such sites depends on their location and their facilities; normally, it will be greater than that of the HEMS operating site but less than for a HEMS operating base. Such sites attract some alleviation under this Subpart.

(g) Problems with hospital sites

During implementation of the original HEMS rules contained in JAR-OPS 3, it was established that a number of States had encountered problems with the impact of performance rules where helicopters were operated for HEMS. Although States accept that progress should be made towards operations where risks associated with a critical engine failure are eliminated, or limited by the exposure time concept, a number of landing sites exist that do not (or never can) allow operations to performance class 1 or 2 requirements.

These sites are generally found in a congested hostile environment:

(1) in the grounds of hospitals; or

(2) on hospital buildings.

The problem of hospital sites is mainly historical and, whilst the authority could insist that such sites are not used – or used at such a low weight that critical engine failure performance is assured – it would seriously curtail a number of existing operations.

Even though the rule for the use of such sites in hospital grounds for HEMS operations attracts alleviation, it is only partial and will still impact upon present operations.

Because such operations are performed in the public interest, it was felt that the authority should be able to exercise its discretion so as to allow continued use of such sites provided that it is satisfied that an adequate level of safety can be maintained - notwithstanding that the site does not allow operations to performance class 1 or 2 standards. However, it is in the interest of continuing improvements in safety that the alleviation of such operations be constrained to existing sites, and for a limited period.

It is felt that the use of public interest sites should be controlled. This will require that a State directory of sites be kept and approval given only when the operator has an entry in the route manual section of the operations manual.

The directory (and the entry in the operations manual) should contain for each approved site:

(i) the dimensions;

(ii) any non-conformance with ICAO Annex 14;

(iii) the main risks; and

(iv) the contingency plan should an incident occur.

Each entry should also contain a diagram (or annotated photograph) showing the main aspects of the site.

(h) Summary

In summary, the following points are considered to be pertinent to the HEMS philosophy and HEMS regulations:

(1) absolute levels of safety are conditioned by society;

(2) potential risk must only be to a level proportionate to the task;

(3) protection is afforded at levels appropriate to the occupants;

(4) this Subpart addresses a number of risk areas and mitigation is built in;

(5) only HEMS operations are dealt with by this Subpart;

(6) there are three main categories of HEMS sites and each is addressed appropriately; and

(7) State alleviation from the requirement at a hospital site is available but such alleviations should be strictly controlled by a system of registration.

GM1 SPA.HEMS.120 HEMS operating minima

REDUCED VISIBILITY

(a) In the rule the ability to reduce the visibility for short periods has been included. This will allow the commander to assess the risk of flying temporarily into reduced visibility against the need to provide emergency medical service, taking into account the advisory speeds included in Table 1. Since every situation is different it was not felt appropriate to define the short period in terms of absolute figures. It is for the commander to assess the aviation risk to third parties, the crew and the aircraft such that it is proportionate to the task, using the principles of GM1 SPA.HEMS.100(a).

(b) When flight with a visibility of less than 5 km is permitted, the forward visibility should not be less than the distance travelled by the helicopter in 30 seconds so as to allow adequate opportunity to see and avoid obstacles (see table below).

Table 1

Operating minima – reduced visibility

Visibility (m)	Advisory speed (kt)

800	50
1 500	100
2 000	120

GM1 SPA.HEMS.125(b)(3) Performance requirements for HEMS operations

PERFORMANCE CLASS 2 OPERATIONS AT A HEMS OPERATING SITE

As the risk profile at a HEMS operating site is already well known, operations without an assured safe forced landing capability do not need a separate approval and the requirements does not call for the additional risk assessment that is specified in CAT.POL.H.305 (b)(1).

AMC1 SPA.HEMS.125(b)(4) Performance requirements for HEMS operations

HEMS OPERATING SITE DIMENSIONS

(a) When selecting a HEMS operating site it should have a minimum dimension of at least 2 x D (the largest dimensions of the helicopter when the rotors are turning). For night operations, unsurveyed HEMS operating sites should have dimensions of at least 4 x D in length and 2 x D in width.

(b) For night operations, the illumination may be either from the ground or from the helicopter.

AMC1 SPA.HEMS.130(b)(2) Crew requirements

EXPERIENCE

The minimum experience level for a commander conducting HEMS flights should take into account the geographical characteristics of the operation (sea, mountain, big cities with heavy traffic, etc.).

AMC1 SPA.HEMS.130(d) Crew requirements

RECENCY

This recency may be obtained in a visual flight rules (VFR) helicopter using vision limiting devices such as goggles or screens, or in an FSTD.

AMC1 SPA.HEMS.130(e) Crew requirements

HEMS TECHNICAL CREW MEMBER

(a) When the crew is composed of one pilot and one HEMS technical crew member, the latter should be seated in the front seat (co-pilot seat) during the flight, so as to be able to carry out his/her primary task of assisting the commander in:

    (1) collision avoidance;

    (2) the selection of the landing site; and

    (3) the detection of obstacles during approach and take-off phases.

(b) The commander may delegate other aviation tasks to the HEMS technical crew member, as necessary:

(1) assistance in navigation;

(2) assistance in radio communication/radio navigation means selection;

(3) reading of checklists; and

(4) monitoring of parameters.

(c) The commander may also delegate to the HEMS technical crew member tasks on the ground:

(1) assistance in preparing the helicopter and dedicated medical specialist equipment for subsequent HEMS departure; or

(2) assistance in the application of safety measures during ground operations with rotors turning (including: crowd control, embarking and disembarking of passengers, refuelling etc.).

(d) There may be exceptional circumstances when it is not possible for the HEMS technical crew member to carry out his/her primary task as defined under (a).

This is to be regarded as exceptional and is only to be conducted at the discretion of the commander, taking into account the dimensions and environment of the HEMS operating site.)

(e) When two pilots are carried, there is no requirement for a HEMS technical crew member, provided that the pilot monitoring performs the aviation tasks of a technical crew member.

GM1 SPA.HEMS.130(e)(2)(ii) Crew requirements

SPECIFIC GEOGRAPHICAL AREAS

In defining those specific geographical areas, the operator should take account of the cultural lighting and topography. In those areas where the cultural lighting an topography make it unlikely that the visual cues would degrade sufficiently to make flying of the aircraft problematical, the HEMS technical crew member is assumed to be able to sufficiently assist the pilot, since under such circumstances instrument and control monitoring would not be required. In those cases where instrument and control monitoring would be required the operations should be conducted with two pilots.

AMC1 SPA.HEMS.130(e)(2)(ii)(B) Crew requirements

FLIGHT FOLLOWING SYSTEM

A flight following system is a system providing contact with the helicopter throughout its operational area.

AMC1 SPA.HEMS.130(f)(1) Crew requirements

TRAINING AND CHECKING SYLLABUS

(a) The flight crew training syllabus should include the following items:

(1) meteorological training concentrating on the understanding and interpretation of available weather information;

(2) preparing the helicopter and specialist medical equipment for subsequent HEMS departure;

(3) practice of HEMS departures;

(4) the assessment from the air of the suitability of HEMS operating sites; and

(5) the medical effects air transport may have on the patient.

(b) The flight crew checking syllabus should include:

(1) proficiency checks, which should include landing and take-off profiles likely to be used at HEMS operating sites; and

(2) line checks, with special emphasis on the following:

(i) local area meteorology;

(ii) HEMS flight planning;

(iii) HEMS departures;

(iv) the selection from the air of HEMS operating sites;

(v) low level flight in poor weather; and

(vi) familiarity with established HEMS operating sites in the operator's local area register.

(c) HEMS technical crew members should be trained and checked in the following items:

(1) duties in the HEMS role;

(2) map reading, navigation aid principles and use;

(3) operation of radio equipment;

(4) use of on-board medical equipment;

(5) preparing the helicopter and specialist medical equipment for subsequent HEMS departure;

(6) instrument reading, warnings, use of normal and emergency checklists in assistance of the pilot as required;

(7) basic understanding of the helicopter type in terms of location and design of normal and emergency systems and equipment;

(8) crew coordination;

(9) practice of response to HEMS call out;

(10) conducting refuelling and rotors running refuelling;

(11) HEMS operating site selection and use;

(12) techniques for handling patients, the medical consequences of air transport and some knowledge of hospital casualty reception;

(13) marshalling signals;

(14) underslung load operations as appropriate;

(15) winch operations as appropriate;

(16) the dangers to self and others of rotor running helicopters including loading of patients; and

(17) the use of the helicopter inter-communications system.

AMC1 SPA.HEMS.130(f)(2)(ii)(B) Crew requirements

LINE CHECKS

Where due to the size, the configuration, or the performance of the helicopter, the line check cannot be conducted on an operational flight, it may be conducted on a specially arranged representative flight. This flight may be immediately adjacent to, but not simultaneous with, one of the biannual proficiency checks.

AMC1 SPA.HEMS.135(a) HEMS medical passenger and other personnel briefing

HEMS MEDICAL PASSENGER BRIEFING

The briefing should ensure that the medical passenger understands his/her role in the operation, which includes:

(a) familiarisation with the helicopter type(s) operated;

(b) entry and exit under normal and emergency conditions both for self and patients;

(c) use of the relevant on-board specialist medical equipment;

(d) the need for the commander’s approval prior to use of specialised equipment;

(e) method of supervision of other medical staff;

(f) the use of helicopter inter-communication systems;

(g) location and use of on board fire extinguishers; and

(h) the operator’s crew coordination concept including relevant elements of crew resource management.

AMC1.1 SPA.HEMS.135(a) HEMS medical passenger and other personnel briefing

HEMS MEDICAL PASSENGER BRIEFING

Another means of complying with the rule as compared to that contained in AMC1-SPA.HEMS.135(a) is to make use of a training programme as mentioned in AMC1.1 CAT.OP.MPA.170.

AMC1 SPA.HEMS.135(b) HEMS medical passenger and other personnel briefing

GROUND EMERGENCY SERVICE PERSONNEL

(a) The task of training large numbers of emergency service personnel is formidable. Wherever possible, helicopter operators should afford every assistance to those persons responsible for training emergency service personnel in HEMS support. This can be achieved by various means, such as, but not limited to, the production of flyers, publication of relevant information on the operator’s web site and provision of extracts from the operations manual.

(b) The elements that should be covered include:

(1) two-way radio communication procedures with helicopters;

(2) the selection of suitable HEMS operating sites for HEMS flights;

(3) the physical danger areas of helicopters;

(4) crowd control in respect of helicopter operations; and

(5) the evacuation of helicopter occupants following an on-site helicopter accident.

AMC1 SPA.HEMS.140 Information and documentation

OPERATIONS MANUAL

The operations manual should include:

(a) the use of portable equipment on board;

(b) guidance on take-off and landing procedures at previously unsurveyed HEMS operating sites;

(c) the final reserve fuel, in accordance with SPA.HEMS.150;

(d) operating minima;

(e) recommended routes for regular flights to surveyed sites, including the minimum flight altitude;

(f) guidance for the selection of the HEMS operating site in case of a flight to an unsurveyed site;

(g) the safety altitude for the area overflown; and

(h) procedures to be followed in case of inadvertent entry into cloud.

SUBPART K: HELICOPTER OFFSHORE OPERATIONS

GM1 SPA.HOFO.105(c) Approval for offshore operations

The requirement to inform both Member States (MSs) allows the MSs to mutually decide on how best to exercise their obligations in accordance with ARO.GEN.300(d) and (e) when operations are intended to be performed in a MS other than the MS issuing the approval for offshore operations.

AMC1 SPA.HOFO.110(a) Operating procedures

RISK ASSESSMENT

The operator’s risk assessment should include, but not be limited to, the following hazards:

(a) collision with offshore installations, vessels and floating structures;

(b) collision with wind turbines;

(c) collision with skysails;

(d) collision during low-level instrument meteorological conditions (IMC) operations;

(e) collision with obstacles adjacent to helidecks;

(f) collision with surface/water;

(g) IMC or night offshore approaches;

(h) loss of control during operations to small or moving offshore locations;

(i) operations to unattended helidecks; and

(j) weather and/or sea conditions that could either cause an accident or exacerbate its consequences.

AMC1 SPA.HOFO.110(b)(1) Operating procedures

OPERATIONAL FLIGHT PLAN

The operational flight plan should contain at least the items listed in AMC1 CAT.OP.MPA.175(a) Flight preparation.

AMC1 SPA.HOFO.110(b)(2) Operating procedures

PASSENGER BRIEFING

The following aspects applicable to the helicopter used should be presented and demonstrated to the passengers by audio-visual electronic means (video, DVD or similar), or the passengers should be informed about them by a crew member prior to boarding the aircraft:

(a) the use of the life jackets and where they are stowed if not in use;

(b) the proper use of survival suits, including briefing on the need to have suits fully zipped with, if applicable, hoods and gloves on, during take-off and landing or when otherwise advised by the pilot-in-command/commander;

(c) the proper use of emergency breathing equipment;

(d) the location and operation of the emergency exits;

(e) life raft deployment and boarding;

(f) deployment of all survival equipment; and

(g) boarding and disembarkation instructions.

When operating in a non-hostile environment, the operator may omit items related to equipment that is not required.

AMC1.1 SPA.HOFO.110(b)(2) Operating procedures

PASSENGER BRIEFING

This AMC is applicable to passengers who require more knowledge of the operational concept, such as sea pilots and support personnel for offshore wind turbines.

The operator may replace the passenger briefing as set out in AMC1 SPA.HOFO.110(b)(2) with a passenger training and checking programme provided that:

— the operator ensures that the passenger is appropriately trained and qualified on the helicopter types on which they are to be carried;

— the operator defines the training and checking programme for each helicopter type, covering all safety and emergency procedures for a given helicopter type, and including practical training;

— the passenger has received the above training within the last 12 calendar months; and

— the passenger has flown on the helicopter type within the last 90 days.

AMC1 SPA.HOFO.110(b)(5) Operating procedures

AUTOMATIC FLIGHT CONTROL SYSTEM (AFCS)

To ensure competence in manual handling of the helicopter, the operator should provide instructions to the flight crew in the operations manual (OM) under which circumstances the helicopter may be operated in lower modes of automation. Particular emphasis should be given to flight in instrument meteorological conditions (IMC) and instrument approaches.

GM1 SPA.HOFO.110(b)(9) Operating Procedures

Emergency flotation systems (EFSs) cannot always be armed safely before the approach when a speed limitation needs to be complied with. In such case, the EFS should be armed as soon as safe to do so.

AMC1 SPA.HOFO.115 Use of offshore locations

GENERAL

(a) The operations manual (OM) relating to the specific usage of offshore helicopter landing areas (Part C for CAT operators) should contain, or make reference to, a directory of helidecks (helideck directory (HD)) intended to be used by the operator. The directory should provide details of helideck limitations and a pictorial representation of each offshore location and its helicopter landing area, recording all necessary information of a permanent nature and using a standardised template. The HD entries should show, and be amended as necessary, the most recent status of each helideck concerning non-compliance with applicable national standards, limitations, warnings, cautions or other comments of operational importance. An example of a typical template is shown in Figure 1 of GM1 SPA.HOFO.115 below.

(b) In order to ensure that the safety of flights is not compromised, the operator should obtain relevant information and details in order to compile the HD, as well as the pictorial representation from the owner/operator of the offshore helicopter landing area.

(c) If more than one name for the offshore location exists, the common name painted on the surface of the landing area should be listed, but other names should also be included in the HD (e.g. radio call sign, if different). After renaming an offshore location, the old name should also be included in the HD for the following 6 months.

(d) Any limitations associated with an offshore location should be included in the HD. With complex installation arrangements, including combinations of installations/vessels (e.g. combined operations), a separate listing in the HD, accompanied by diagrams/pictures, where necessary, may be required.

(e) Each offshore helicopter landing area should be inspected and assessed based on limitations, warnings, instructions and restrictions, in order to determine its acceptability with respect to the following as a minimum:

(1) The physical characteristics of the landing area, including size, load-bearing capability and the appropriate ‘D’ and ‘t’ values.

Note 1: ‘D’ is the overall length of the helicopter from the most forward position of the main rotor tip to the most rearward position of the tail rotor tip plane path, or rearmost extension of the fuselage in the case of ‘Fenestron’ or ‘NOTAR’ tails.

Note 2: ‘t’ is the maximum allowable mass in tonnes.

(2) The preservation of obstacle-protected surfaces (an essential safeguard for all flights). These surfaces are:

(i) the minimum 210° obstacle-free surface (OFS) above helideck level;

(ii) the 150° limited-obstacle surface (LOS) above helideck level; and

(iii) the minimum 180° falling ‘5:1’ gradient with respect to significant obstacles below helideck level.

If these sectors/surfaces are infringed, even on a temporary basis, and/or if an adjacent installation or vessel infringes the obstacle-protected surfaces related to the landing area, an assessment should be made to determine whether it is necessary to impose operating limitations and/or restrictions to mitigate any non-compliance with the criteria.

(3) Marking and lighting:

(i) for operations at night, adequate illumination of the perimeter of the landing area, using perimeter lighting that meets national requirements;

(ii) for operations at night, adequate illumination of the location of the touchdown marking by use of a lit touchdown/positioning marking and lit helideck identification marking that meet national requirements;

(iii) status lights (for night and day operations, indicating the status of the helicopter landing area, e.g. a red flashing light indicates ‘landing area unsafe: do not land’) meeting national requirements;

(iv) dominant-obstacle paint schemes and lighting;

(v) condition of helideck markings; and

(vi) adequacy of general installation and structure lighting.

Any limitations with respect to non-compliance of lighting arrangements may require the HD to be annotated 'daylight only operations'.

(4) Deck surface:

(i) assessment of surface friction;

(ii) adequacy and condition of helideck net (where provided);

(iii) 'fit for purpose' drainage system;

(iv) deck edge safety netting or shelving;

(v) a system of tie-down points that is adequate for the range of helicopters in use; and

(vi) procedures to ensure that the surface is kept clean of all contaminants, e.g. bird guano, sea spray, snow and ice.

(5) Environment:

(i) foreign-object damage;

(ii) an assessment of physical turbulence generators, e.g. structure-induced turbulence due to clad derrick;

(iii) bird control measures;

(iv) air flow degradation due to gas turbine exhaust emissions (turbulence and thermal effects), flares (thermal effects) or cold gas vents (unburned flammable gas); and

(v) adjacent offshore installations may need to be included in the environmental assessment.

To assess for potential adverse environmental effects, as described in (ii), (iv) and (v) above, an offshore location should be subject to appropriate studies, e.g. wind tunnel testing and/or computational fluid dynamics (CFD) analysis.

(6) Rescue and firefighting:

(i) systems for delivery of firefighting media to the landing area, e.g. deck integrated firefighting system (DIFFS);

(ii) delivery of primary media types, assumed critical area, application rate and duration;

(iii) deliveries of complementary agent(s) and media types, capacity and discharge;

(iv) personal protective equipment (PPE); and

(v) rescue equipment and crash box/cabinet.

(7) Communication and navigation (Com/Nav):

(i) aeronautical radio(s);

(ii) radio-telephone (R/T) call sign to match the offshore location name with the side identification that should be simple and unique; and

(iii) radio log.

(8) Fuelling facilities:

in accordance with the relevant national guidance and legislation.

(9) Additional operational and handling equipment:

(i) windsock;

(ii) meteorological information, including wind, pressure, air temperature, and dew point temperature, and equipment recording and displaying mean wind (10-min wind) and gusts;

(iii) helideck motion recording and reporting system, where applicable;

(iv) passenger briefing system;

(v) chocks;

(vi) tie-down strops/ropes;

(vii) weighing scales;

(viii) a suitable power source for starting helicopters (e.g. ground power unit (GPU)), where applicable; and

(ix) equipment for clearing the landing area of snow, ice and other contaminants.

(10) Personnel:

trained helicopter-landing-area staff (e.g. helicopter landing officer/helicopter deck assistant and firefighters, etc.); persons required to assess local weather conditions or communicate with the helicopter by radio-telephony should be appropriately qualified.

(f) The HD entry for each offshore location should be completed and kept up to date, using the template and reflecting the information and details described in (e) above. The template should contain at least the following (GM1 SPA.HOFO.115 below is provided as an example):

(1) details:

(i) name of offshore location;

(ii) R/T call sign;

(iii) helicopter landing area identification marking;

(iv) side panel identification marking;

(v) landing area elevation;

(vi) maximum installation/vessel height;

(vii) helideck size and/or ‘D’ value;

(viii) type of offshore location:

(A) fixed, permanently manned installation;

(B) fixed, normally unattended installation;

(C) vessel type (e.g. diving support vessel, tanker, etc.);

(D) semi-submersible, mobile, offshore drilling unit:

(E) jack-up, mobile, offshore drilling unit:

(F) floating production, storage and offloading (FPSO);

(ix) name of owner/operator;

(x) geographical position, where appropriate;

(xi) Com/Nav frequencies and identification;

(xii) general drawing of the offshore location that shows the helicopter landing area with annotations indicating location of derrick, masts, cranes, flare stack, turbine and gas exhausts, side identification panels, windsock, etc.;

(xiii) plan view drawing, and chart orientation from the general drawing to show the above; the plan view should also show the 210-degree sector orientation in degrees true;

(xiv) type of fuelling:

(A) pressure and gravity;

(B) pressure only;

(C) gravity only; and

(D) none;

(xv) type and nature of firefighting equipment;

(xvi) availability of GPU;

(xvii) deck heading;

(xviii) 't' value ;

(xix) status light system (Yes/No); and

(xx) revision publication date or number; and

(2) one or more diagrams/photographs, and any other suitable guidance to assist pilots.

(g) For offshore locations for which there is incomplete information, 'restricted' usage based on the information available may be considered by the operator, subject to risk assessment prior to the first helicopter visit. During subsequent operations, and before any restriction on usage is lifted, information should be gathered and the following should apply:

(1) pictorial (static) representation:

(i) template blanks (GM1 SPA.HOFO.115 is provided as an example) should be available to be filled in during flight preparation on the basis of the information given by the offshore location owner/operator and of flight crew observations;

(ii) where possible, suitably annotated photographs may be used until the HD entry and template have been completed;

(iii) until the HD entry and template have been completed, conservative operational restrictions (e.g. performance, routing, etc.) may be applied;

(iv) any previous inspection reports should be obtained and reviewed by the operator; and

(v) an inspection of the offshore helicopter landing area should be carried out to verify the content of the completed HD entry and template; once found suitable, the landing area may be considered authorised for use by the operator; and

(2) with reference to the above, the HD entry should contain at least the following:

(i) HD revision date or number;

(ii) generic list of helideck motion limitations;

(iii) name of offshore location;

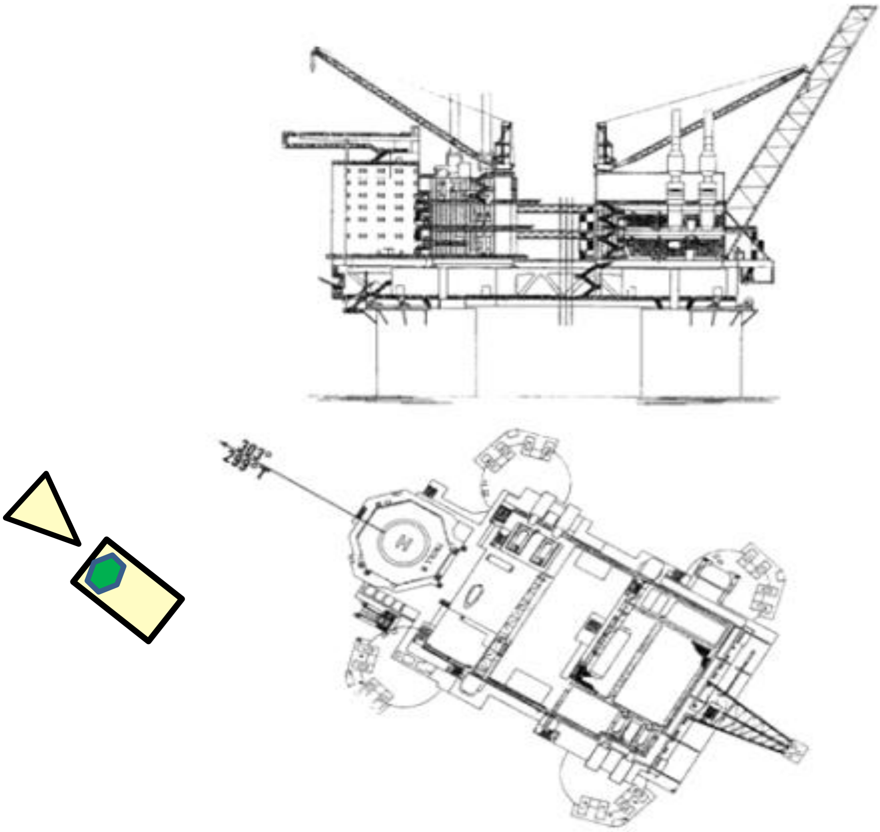
(iv) helideck size and/or 'D' value and 't' value; and

(v) limitations, warnings, instructions and restrictions.

GM1 SPA.HOFO.115 Use of offshore locations

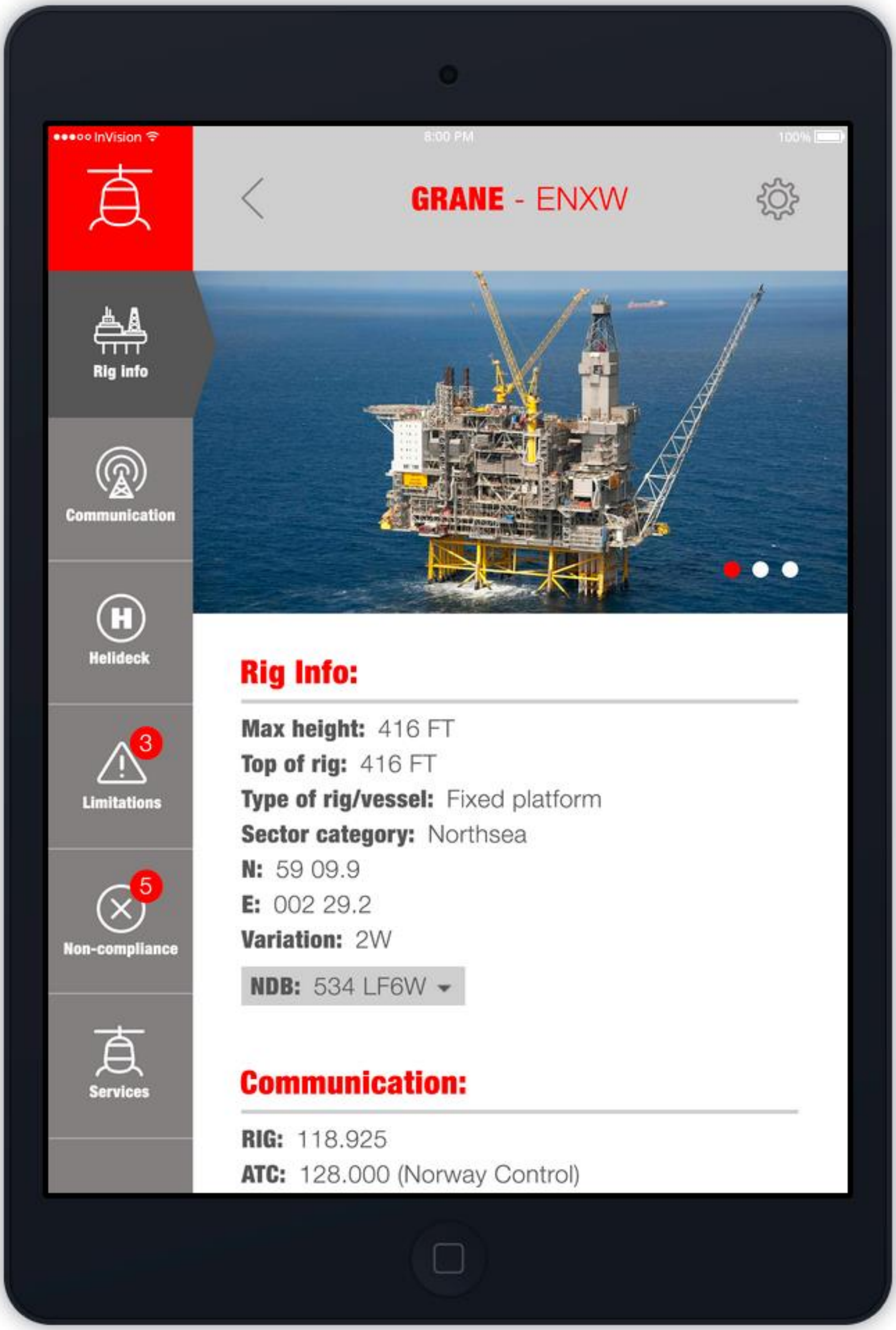
Figure 1 — Example of a helicopter landing area template

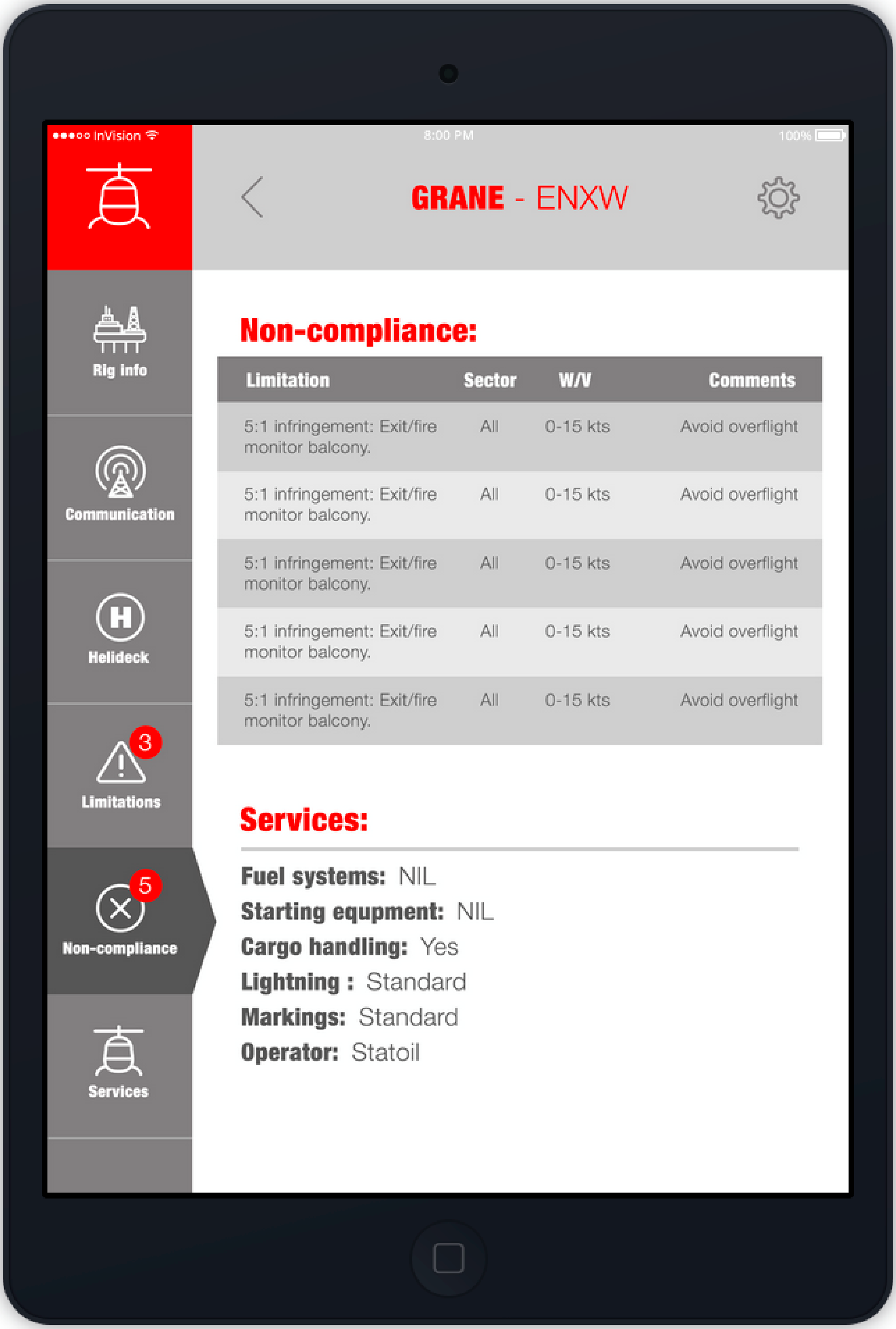
Operator		10-1	Revision date	
Installation/vessel name		Position	(N/S XXX)	(E/W XXX)
Deck height	Installation height	Highest obstacle within 5 nm	Deck heading	Deck ident
(XXX ft)	(XXX ft)			
AIMS/ICAO code	Radio	Radio	Deck category	Side ident
			(1/2/3)	
Deck size (m)	T value (XXX kg)	Cleared for (above D or t values)	Installation type	Operator
		(Helicopter type xxx)	(Fixed/semi/etc.)	
Fuel	Ground power	Inspection date	Inspected by	Next due
(Press/gravity/no)	(AC/DC/no)			



Wind direction	Wind speed	Limitations
(All) (000–050)	(All) (> 30)	(Performance requirements) (Table 2 etc.)
5:1 non-compliant obstacles		
Additional information		

Figure 2 — Example of a helicopter landing area template





GM2 SPA.HOFO.115 Use of offshore locations

Operators should use available standards and regulations provided for operations to offshore locations such as those contained in United Kingdom Civil Aviation Authority (UK CAA) CAP 437 'Standards for Offshore Helicopter Landing Areas', Norwegian Civil Aviation Regulation BSL D 5-1 or similar national documentation, or ICAO Annex 14, Vol II 'Heliports'.

AMC1 SPA.HOFO.120 Selection of aerodromes and operating sites

COASTAL AERODROME

(a) Any alleviation from the requirement to select an alternate aerodrome for a flight to a coastal aerodrome under instrument flight rules (IFR) routing from offshore should be based on an individual safety risk assessment.

(b) The following should be taken into account:

(1) suitability of the weather based on the landing forecast for the destination;

(2) the fuel required to meet the IFR requirements of CAT.OP.MPA.150, NCC.OP.131 or SPO.OP.131 except for the alternate fuel;

(3) where the destination coastal aerodrome is not directly on the coast, it should be:

(i) within a distance that with the fuel specified in (b)(2), the helicopter is able, at any time after crossing the coastline, to return to the coast, descend safely, carry out an approach under visual flight rules (VFR) and land, with the VFR fuel reserves intact;

(ii) within 5 nm of the coastline; and

(iii) geographically sited so that the helicopter is able, within the rules of the air and within the landing forecast:

(A) to proceed inbound from the coast at 500-ft above ground level (AGL), and carry out an approach and landing under VFR; or

(B) to proceed inbound from the coast on an agreed route, and carry out an approach and landing under VFR;

(4) procedures for coastal aerodromes should be based on a landing forecast no worse than:

(i) by day, a cloud base of ≥ 400 ft above descent height (DH)/minimum descent height (MDH), and a visibility of 4 km, or, if descent over the sea is intended, a cloud base of 600 ft and a visibility of 4 km; or

(ii) by night, a cloud base of 1 000 ft and a visibility of 5 km;

(5) the descent to establish visual contact with the surface should take place over the sea or as part of the instrument approach;

(6) routings and procedures for coastal aerodromes nominated as such should be included in the operations manual (OM) (Part C for CAT operators);

(7) the minimum equipment list (MEL) should reflect the requirement for airborne radar and radio altimeter for this type of operation; and

(8) operational limitations for each coastal aerodrome should be specified in the OM.

AMC2 SPA.HOFO.120 Selection of aerodromes and operating sites

OFFSHORE DESTINATION ALTERNATE AERODROME

'Aerodrome' is referred to as 'helideck' in this AMC.

(a) Offshore destination alternate helideck landing environment

The landing environment at an offshore location proposed for use as an offshore destination alternate helideck should be pre-surveyed, together with the physical characteristics, such as the effect of wind direction and strength, as well as of turbulence established. This information, which should be available to the pilot-in-command/commander both at the planning stage and in-flight, should be published in an appropriate form in the operations manual (OM) (including the orientation of the helideck) so that the suitability of the alternate helideck can be assessed. This helideck should meet the criteria for size and obstacle clearance appropriate to the performance requirements of the type of helicopter concerned.

(b) Performance considerations

The use of an offshore destination alternate helideck should be restricted to helicopters that can achieve one engine inoperative (OEI) in ground effect (IGE) hover at an appropriate power rating above the helideck at the offshore location. Where the surface of the helideck or prevailing conditions (especially wind velocity) precludes an OEI IGE, OEI out-of-ground effect (OGE) hover performance at an appropriate power rating should be used to compute the landing mass. The landing mass should be calculated based on graphs provided in the operations manual (OM) (Part B for CAT operators). When this landing mass is computed, due account should be taken of helicopter configuration, environmental conditions and the operation of systems that have an adverse effect on performance. The planned landing mass of the helicopter, including crew, passengers, baggage, cargo plus 30-min final reserve fuel (FRF), should not exceed the OEI landing mass of the helicopter at the time of approach to the offshore destination alternate.

(c) Weather considerations

(1) Meteorological observations

When the use of an offshore destination alternate helideck is planned, the meteorological observations, both at the offshore destination and the alternate helideck, should be made by an observer acceptable to the authority responsible for the provision of meteorological services. Automatic meteorological-observation stations may be used.

(2) Weather minima

When the use of an offshore destination alternate helideck is planned, the operator should neither select an offshore location as destination nor as alternate helideck unless the weather forecasts for the two offshore locations indicate that during a period commencing 1 h before and ending 1 h after the expected time of arrival at the destination and the alternate helideck, the weather conditions will be at or above the planning minima shown in the following table:

Table 1 — Planning minima

Planning minima		
	Day	Night
Cloud base	600 ft	800 ft
Visibility	4 km	5 km

(3) Conditions of fog

To use an offshore destination alternate helideck, it should be ensured that fog is not forecast or present within 60 nm of the destination helideck and alternate helideck during the period commencing 1 h before and ending 1 h after the expected time of arrival at the offshore destination or alternate helideck.

(d) Actions at point of no return

Before passing the point of no return, which should not be more than 30 min from the destination, the following actions should have been completed:

(1) confirmation that navigation to the offshore destination and offshore destination alternate helideck can be assured;

(2) radio contact with the offshore destination and offshore destination alternate helideck (or master station) has been established;

(3) the landing forecast at the offshore destination and offshore destination alternate helideck have been obtained and confirmed to be at or above the required minima;

(4) the requirements for OEI landing (see (b) above) have been checked in the light of the latest reported weather conditions to ensure that they can be met; and

(5) to the extent possible, having regard to information on the current and forecast use of the offshore alternate helideck and on prevailing conditions, the availability of the helideck on the offshore location intended as destination alternate helideck should be guaranteed by the duty holder (the rig operator in the case of fixed installations, and the owner in the case of mobile ones) until the landing at the destination, or the offshore destination alternate helideck, has been achieved or until offshore shuttling has been completed.

AMC1 SPA.HOFO.125 Airborne radar approach (ARA) to offshore locations

Note: alternative approach procedures using original equipment manufacturer (OEM)-certified approach systems are not covered by this AMC.

GENERAL

(a) Before commencing the final approach, the pilot-in-command/commander should ensure that a clear path exists on the radar screen for the final and missed approach segments. If lateral clearance from any obstacle will be less than 1 nm, the pilot-in-command/commander should:

(1) approach to a nearby target structure and thereafter proceed visually to the destination structure; or

(2) make the approach from another direction leading to a circling manoeuvre.

(b) The cloud ceiling should be sufficiently clear above the helideck to permit a safe landing.

(c) Minimum descent height (MDH) should not be less than 50 ft above the elevation of the helideck:

(1) the MDH for an airborne radar approach should not be lower than:

(i) 200 ft by day; or

(ii) 300 ft by night; and

(2) the MDH for an approach leading to a circling manoeuvre should not be lower than:

(i) 300 ft by day; or

(ii) 500 ft by night.

(d) Minimum descent altitude (MDA) may only be used if the radio altimeter is unserviceable. The MDA should be a minimum of the MDH + 200 ft, and be based on a calibrated barometer at the destination or on the lowest forecast barometric pressure adjusted to sea level (QNH) for the region.

(e) The decision range should not be less than 0.75 nm.

(f) The MDA/MDH for a single-pilot ARA should be 100 ft higher than that calculated in accordance with (c) and (d) above. The decision range should not be less than 1 nm.

(g) For approaches to non-moving offshore locations, the maximum range discrepancy between the global navigation satellite system (GNSS) and the weather radar display should not be greater than 0.3 nm at any point between the final approach fix (FAF) at 4 nm from the offshore location and the offset initiation point (OIP) at 1.5 nm from the offshore location.

(h) For approaches to non-moving offshore locations, the maximum bearing discrepancy between the GNSS and the weather radar display should not be greater than 10° at the FAF at 4 nm from the offshore location.

GM1 SPA.HOFO.125 Airborne radar approach (ARA) to offshore locations

GENERAL

(a) General

(1) The helicopter ARA procedure may have as many as five separate segments: the arrival, initial, intermediate, final approach, and missed approach segment. In addition, the specifications of the circling manoeuvre to a landing under visual conditions should be considered. The individual approach segments can begin and end at designated fixes. However, the segments of an ARA may often begin at specified points where no fixes are available.

(2) The fixes, or points, are named to coincide with the beginning of the associated segment. For example, the intermediate segment begins at the intermediate fix (IF) and ends at the final approach fix (FAF). Where no fix is available or appropriate, the segments begin and end at specified points; for example, at the intermediate point (IP) and final approach point (FAP). The order in which the segments are discussed in this GM is the order in which the pilot would fly them in a complete procedure: that is, from the arrival through the initial and intermediate to the final approach and, if necessary, to the missed approach.

(3) Only those segments that are required by local conditions applying at the time of the approach need to be included in a procedure. In constructing the procedure, the final approach track, which should be orientated so as to be substantially into the wind, should be identified first as it is the least flexible and most critical of all the segments. When the origin and the orientation of the final approach have been determined, the other necessary segments should be integrated with it to produce an orderly manoeuvring pattern that does not generate an unacceptably high workload for the flight crew.

(4) Where an ARA is conducted to a non-moving offshore location (i.e. fixed installation or moored vessel), and a reliable global navigation satellite system (GNSS) position for the location is available, the GNSS/area navigation system should be used to enhance the safety of the ARA. This is achieved by using the GNSS/area navigation system to navigate the helicopter onto, and maintain, the final approach track, and by using the GNSS range and bearing information to cross-check the position of the offshore location on the weather radar display.

(5) Examples of ARA procedures, as well as vertical profile and missed approach procedures, are contained in Figures 1 and 2 below.

(b) Obstacle environment

(1) Each segment of the ARA is located in an overwater area that has a flat surface at sea level. However, due to the passage of large vessels which are not required to notify their presence, the exact obstacle environment cannot be determined. As the largest vessels and structures are known to reach elevations exceeding 500 ft above mean sea level (AMSL), the uncontrolled offshore obstacle environment applying to the arrival, initial and

intermediate approach segments can reasonably be assumed to be capable of reaching to at least 500 ft AMSL. Nevertheless, in the case of the final approach and missed approach segments, specific areas are involved within which no radar returns are allowed. In these areas, the height of wave crests, and the possibility that small obstacles may be present that are not visible on radar, results in an uncontrolled surface environment that extends to an elevation of 50 ft AMSL.

(2) Information about movable obstacles should be requested from the arrival destination or adjacent installations.

Under normal circumstances, the relationship between the approach procedure and the obstacle environment is governed by the concept that vertical separation is very easy to apply during the arrival, initial and intermediate segments, while horizontal separation, which is much more difficult to guarantee in an uncontrolled environment, is applied only in the final and missed approach segments.

(c) Arrival segment

The arrival segment commences at the last en-route navigation fix, where the aircraft leaves the helicopter route, and it ends either at the initial approach fix (IAF) or, if no course reversal or similar manoeuvre is required, it ends at the IF. Standard en-route obstacle clearance criteria should be applied to the arrival segment.

(d) Initial approach segment

The initial approach segment is only required if the intermediate approach track cannot be joined directly. Most approaches will be flown direct to a point close to the IF, and then on to the final approach track, using GNSS/area navigation guidance. The segment commences at the IAF, and on completion of the manoeuvre, it ends at the IP. The minimum obstacle clearance (MOC) assigned to the initial approach segment is 1 000 ft.

(e) Intermediate approach segment

The intermediate approach segment commences at the IP, or in the case of straight-in approaches, where there is no initial approach segment, it commences at the IF. The segment ends at the FAP and should not be less than 2 nm in length. The purpose of the intermediate segment is to align the helicopter with the final approach track and prepare it for the final approach. During the intermediate segment, the helicopter should be lined up with the final approach track, the speed should be stabilised, the destination should be identified on the radar, and the final approach and missed approach areas should be identified and verified to be clear of radar returns. The MOC assigned to the intermediate segment is 500 ft.

(f) Final approach segment

(1) The final approach segment commences at the FAP and ends at the missed approach point (MAPt). The final approach area, which should be identified on radar, takes the form of a corridor between the FAP and the radar return of the destination. This corridor should not be less than 2 nm wide so that the projected track of the helicopter does not pass closer than 1 nm to the obstacles lying outside the area.

(2) On passing the FAP, the helicopter will descend below the intermediate approach altitude and follow a descent gradient which should not be steeper than 6.5 %. At this stage, vertical separation from the offshore obstacle environment will be lost. However, within the final approach area, the MDA/MDH will provide separation from the surface environment. Descent from 1 000 ft AMSL to 200 ft AMSL at a constant 6.5 % gradient will involve a horizontal distance of 2 nm. In order to follow the guideline that the procedure should not generate an unacceptably high workload for the flight crew, the required actions of levelling

off at MDH, changing heading at the offset initiation point (OIP), and turning away at the MAPt, should not be planned to occur at the same time from the destination.

(3) During the final approach, compensation for drift should be applied, and the heading which, if maintained, would take the helicopter directly to the destination should be identified. It follows that at an OIP located at a range of 1.5 nm, a heading change of 10° is likely to result in a track offset of 15° at 1 nm, and the extended centre line of the new track can be expected to have a mean position approximately 300–400 m to one side of the destination structure. The safety margin built into the 0.75-nm decision range (DR) is dependent upon the rate of closure with the destination. Although the airspeed should be in the range of 60–90 KIAS during the final approach, the ground speed, after due allowance for wind velocity, should not be greater than 70 kt.

(g) Missed approach segment

(1) The missed approach segment commences at the MAPt and ends when the helicopter reaches the minimum en route altitude. The missed approach manoeuvre is a 'turning missed approach' which should be of not less than 30° and should not, normally, be greater than 45°. A turn away of more than 45° does not reduce the collision risk factor any further nor does it permit a closer DR. However, turns of more than 45° may increase the risk of pilot disorientation, and by inhibiting the rate of climb (especially in the case of an OEI missed approach procedure), may keep the helicopter at an extremely low level for longer than it is desirable.

(2) The missed approach area to be used should be identified and verified as a clear area on the radar screen during the intermediate approach segment. The base of the missed approach area is a sloping surface at 2.5 % gradient starting from MDH at the MAPt. The concept is that a helicopter executing a turning missed approach will be protected by the horizontal boundaries of the missed approach area until vertical separation of more than 130 ft is achieved between the base of the area and the offshore obstacle environment of 500 ft AMSL that prevails outside the area.

(3) A missed approach area, taking the form of a 45° sector orientated left or right of the final approach track, originating from a point 5 nm short of the destination, and terminating on an arc 3 nm beyond the destination, should normally satisfy the specifications of a 30° turning missed approach.

(h) Required visual reference

The visual reference required is that the destination should be in view in order to be able to carry out a safe landing.

(i) Radar equipment

During the ARA procedure, colour mapping radar equipment with a 120° sector scan and a 2.5-nm range scale selected may result in dynamic errors of the following order:

(1) bearing/tracking error of ± 4.5° with 95 % accuracy;

(2) mean ranging error of 250 m; or

(3) random ranging error of ± 250 m with 95 % accuracy.

Figure 1 — Horizontal profile

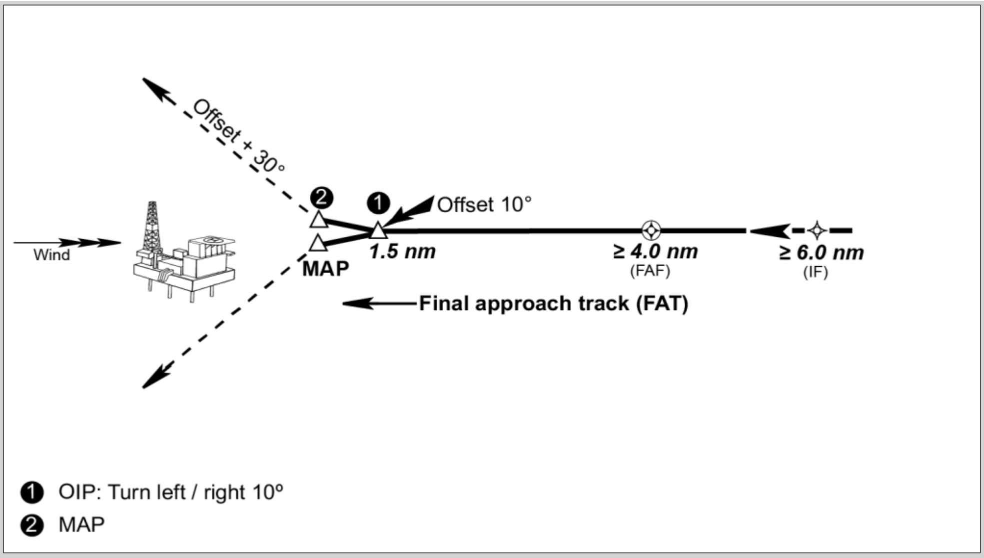
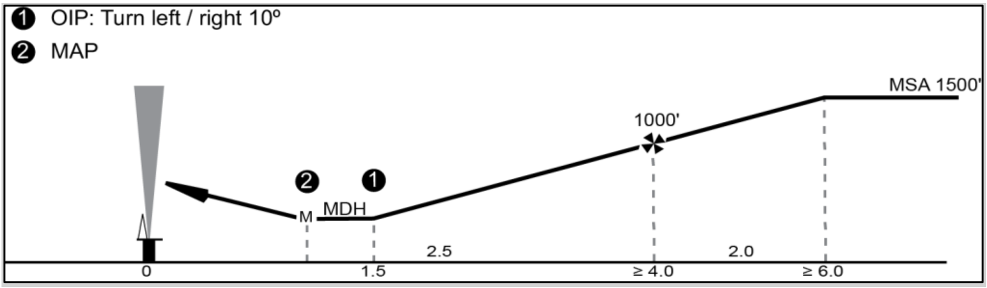


Figure 2 — Vertical profile



GM2 SPA.HOFO.125 Airborne radar approach (ARA) to offshore locations

GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS)/AREA NAVIGATION SYSTEM

Where an ARA is conducted to a non-moving offshore location (i.e. fixed installation or moored vessel), and the GNSS/area navigation system is used to enhance the safety of the ARA, the following procedure or equivalent should be applied:

(a) selection from the area navigation system database or manual entry of the offshore location;

(b) manual entry of the final approach fix (FAF) or intermediate fix (IF), as a range of and bearing from the offshore location;

(c) operation of the GNSS equipment in terminal mode;

(d) comparison of weather radar and GNSS range and bearing data to cross-check the position of the offshore location;

(e) use of GNSS guidance to guide the aircraft onto the final approach track during the initial or intermediate approach segments;

(f) use of GNSS guidance from the FAF towards the offset initiation point (OIP) during the final approach segment to establish the helicopter on the correct approach track and, hence, heading;

(g) transition from GNSS guidance to navigation based on headings once the track is stabilised and before reaching OIP;

(h) use of GNSS range of and bearing to the offshore location during the intermediate and final approach segments to cross-check weather radar information (for correct 'painting' of the destination and, hence, of other obstacles);

(i) use of GNSS range of the offshore location to enhance confidence in the weather radar determination of arrival at the OIP and MAPt; and

(j) use of GNSS range of and bearing to the destination to monitor separation from the offshore location.

AMC1 SPA.HOFO.140 Performance requirements — take-off and landing at offshore locations

FACTORS

To ensure that the necessary factors are taken into account, operators not conducting CAT operations should use take-off and landing procedures that are appropriate to the circumstances and have been developed in accordance with ORO.MLR.100 in order to minimise the risks of collision with obstacles at the individual offshore location under the prevailing conditions.

AMC1 SPA.HOFO.145 Flight data monitoring (FDM) programme

FDM PROGRAMME

Refer to AMC1 ORO.AOC.130.

Note: Appendix 1 to AMC1 ORO.AOC.130 is not valid for helicopters.

GM1 SPA.HOFO.145 Flight data monitoring (FDM) programme

DEFINITION OF AN FDM PROGRAMME

Refer to GM1 ORO.AOC.130, except for the examples that are specific to aeroplane operation.

GM2 SPA.HOFO.145 Flight data monitoring (FDM) programme

FDM

Additional guidance material for the establishment of a FDM programme is found in:

(a) International Civil Aviation Organization (ICAO) Doc 10000 — Manual on Flight Data Analysis Programmes (FDAP); and

(b) United Kingdom Civil Aviation Authority (UK CAA) CAP 739 — Flight Data Monitoring.

The following table provides examples of FDM events that may be further developed using operator- and helicopter-specific limits. The table is considered illustrative and non-exhaustive.

Table 1 — Examples of FDM events

Event title/description	**Parameters required**	**Comments**
Ground		
Outside air temperature (OAT) high — Operating limits	OAT	To identify when the helicopter is operated at the limits of OAT.

Sloping-ground high-pitch attitude	Pitch attitude, ground switch (similar)	To identify when the helicopter is operated at the slope limits.
Sloping-ground high-roll attitude	Roll attitude, ground switch (similar)	To identify when the helicopter is operated at the slope limits.
Rotor brake on at an excessive number of rotations (main rotor speed) (NR)	Rotor brake discreet, NR	To identify when the rotor brake is applied at too high NR.
Ground taxiing speed — max	Ground speed (GS), ground switch (similar)	To identify when the helicopter is ground taxied at high speed (wheeled helicopters only).
Air taxiing speed — max	GS, ground switch (similar), radio altitude (Rad Alt)	To identify when the helicopter is air taxied at high speed.
Excessive power during ground taxiing	Total torque (Tq), ground switch (similar), GS	To identify when excessive power is used during ground taxiing.
Pedal — max left-hand (LH) and right-hand (RH) taxiing	Pedal position, ground switch (similar), GS or NR	To identify when the helicopter flight controls (pedals) are used to excess on the ground. GS or NR to exclude control test prior to rotor start.
Excessive yaw rate on ground during taxiing	Yaw rate, ground switch (similar), or Rad Alt	To identify when the helicopter yaws at a high rate when on the ground.
Yaw rate in hover or on ground	Yaw rate, GS, ground switch (similar)	To identify when the helicopter yaws at a high rate when in a hover.
High lateral acceleration (rapid cornering)	Lateral acceleration, ground switch (similar)	To identify high levels of lateral acceleration, when ground taxiing, that indicate high cornering speed.
High longitudinal acceleration (rapid braking)	Longitudinal acceleration, ground switch (similar)	To identify high levels of longitudinal acceleration, when ground taxiing, that indicate excessive braking.
Cyclic-movement limits during taxiing (pitch or roll)	Cyclic stick position, ground switch (similar), Rad Alt, NR or GS	To identify excessive movement of the rotor disc when running on ground. GS or NR to exclude control test prior to rotor start.
Excessive longitudinal and lateral cyclic rate of movement on ground	Longitudinal cyclic pitch rate, lateral cyclic pitch rate, NR	To detect an excessive rate of movement of cyclic control when on the ground with rotors running.

Lateral cyclic movement — closest to LH and RH rollover	Lateral cyclic position, pedal position, roll attitude, elapsed time, ground switch (similar)	To detect the risk of a helicopter rollover due to an incorrect combination of tail rotor pedal position and lateral cyclic control position when on ground.
Excessive cyclic control with insufficient collective pitch on ground	Collective pitch, longitudinal cyclic pitch, lateral cyclic pitch	To detect an incorrect taxiing technique likely to cause rotor head damage.
Inadvertent lift-off	Ground switch (similar), autopilot discreet	To detect inadvertent lifting into hover.
Flight — Take-off and landing		
Day or night landing or take-off	Latitude and Longitude (Lat & Long), local time or UTC	To provide day/night relevance to detected events.
Specific location of landing or take-off	Lat & Long, ground switch (similar), Rad Alt, total Tq	To give contextual information concerning departures and destinations.
Gear extension and retraction — airspeed limit	Indicated airspeed (IAS), gear position	To identify when undercarriage airspeed limitations are breached.
Gear extension & retraction — height limit	Gear position, Rad Alt	To identify when undercarriage altitude limitations are breached.
Heavy landing	Normal/vertical acceleration, ground switch (similar)	To identify when hard/heavy landings take place.
Cabin heater on (take-off and landing)	Cabin heater discreet, ground switch (similar)	To identify use of engine bleed air during periods of high power demand.
High GS prior to touchdown (TD)	GS, Rad Alt, ground switch (similar), elapsed time, latitude, longitude	To assist in the identification of ‘quick stop’ approaches.
Flight — Speed		
High airspeed — with power	IAS, Tq 1, Tq 2, pressure altitude (Palt), OAT	To identify excessive airspeed in flight.
High airspeed — low altitude	IAS, Rad Alt	To identify excessive airspeed in low-level flight.
Low airspeed at altitude	IAS, Rad Alt	To identify a ‘hover out of ground’ effect.
Airspeed on departure (< 300 ft)	IAS, ground switch (similar), Rad Alt	To identify shallow departure.
High airspeed — power off	IAS, Tq 1, Tq 2 or one engine inoperative (OEI) discreet, Palt, OAT	To identify limitation exceedance of power-off airspeed.
Downwind flight within 60 sec of	IAS, GS, elapsed time	To detect early downwind turn

take-off		after take-off.
Downwind flight within 60 sec of landing	IAS, GS, elapsed time	To detect late turn to final shortly before landing.
Flight — Height		
Altitude — max	Palt	To detect flight outside of the published flight envelope.
Climb rate — max	Vertical speed (V/S), or Palt, or Rad Alt, Elapsed time	Identification of excessive rates of climb (RoC) can be determined from an indication/rate of change of Palt or Rad Alt.
High rate of descent	V/S	To identify excessive rates of descent (RoD).
High rate of descent (speed or height limit)	V/S, IAS or Rad Alt or elevation	To identify RoD at low level or low speed.
Settling with power (vortex ring)	V/S, IAS, GS, Tq	To detect high-power settling with low speed and with excessive rate of descent.
Minimum altitude in autorotation	NR, total Tq, Rad Alt	To detect late recovery from autorotation.
Low cruising (inertial systems)	GS, V/S, elevation, Lat & Long	To detect an extended low-level flight. Ground speed is less accurate with more false alarms. Lat & Long used for geographical boundaries.
Low cruising (integrated systems)	Rad Alt, elapsed time, Lat & Long, ground switch (similar)	To detect an extended low-level flight.
Flight — Attitude and controls		
Excessive pitch (height related — turnover (T/O), cruising or landing)	Pitch attitude, Rad Alt elevation, Lat & Long	To identify inappropriate use of excessive pitch attitude during flight. Height limits may be used (i.e. on take-off and landing or < 500 ft) — Lat & Long required for specific-location-related limits. Elevation less accurate than Rad Alt. Elevation can be used to identify the landing phase in a specific location.
Excessive pitch (speed related — T/O, cruising or landing)	Pitch attitude, IAS, GS, Lat & Long	To identify inappropriate use of excessive pitch attitude during flight. Speed limits may be used

		(i.e. on take-off and landing or in cruising) — Lat & Long required for specific-location-related limits. GS less accurate than IAS.
Excessive pitch rate	Pitch rate, Rad Alt, IAS, ground switch (similar), Lat & Long	To identify inappropriate use of excessive rate of pitch change during flight. Height limits may be used (i.e. on take-off and landing). IAS only for IAS limit, ground switch (similar) and Lat & Long required for specific-location-related limits.
Excessive roll/bank attitude (speed or height related)	Roll attitude, Rad Alt, IAS/GS	To identify excessive use of roll attitude. Rad Alt may be used for height limits, IAS/GS may be used for speed limits.
Excessive roll rate	Roll rate, Rad Alt, Lat & Long, Ground switch (similar)	Rad Alt may be used for height limits, Lat & Long and ground switch (similar) required for specific-location-related and air/ground limits.
Excessive yaw rate	Yaw rate	To detect excessive yaw rates in flight.
Excessive lateral cyclic control	Lateral cyclic position, ground switch (similar)	To detect movement of the lateral cyclic control to extreme left or right positions. Ground switch (similar) required for pre or post T/O.
Excessive longitudinal cyclic control	Longitudinal cyclic position, ground switch (similar)	To detect movement of the longitudinal cyclic control to extreme forward or aft positions. Ground switch (similar) required for pre or post T/O.
Excessive collective pitch control	Collective position, ground switch (similar)	To detect exceedances of the aircraft flight manual (AFM) collective pitch limit. Ground switch (similar) required for pre or post T/O.
Excessive tail rotor control	Pedal position, ground switch (similar)	To detect movement of the tail rotor pedals to extreme left and right positions. Ground switch (similar) required for pre or post T/O.

Manoeuvre G loading or turbulence	Lat & Long, normal accelerations, ground switch (similar) or Rad Alt	To identify excessive G loading of the rotor disc, both positive and negative. Ground switch (similar) required to determine air/ground. Rad Alt required if height limit required.
Pilot workload/turbulence	Collective and/or cyclic and/or tail rotor pedal position and change rate (Lat & Long)	To detect high workload and/or turbulence encountered during take-off and landing phases. Lat & Long required for specific landing sites. A specific and complicated algorithm for this event is required. See United Kingdom Civil Aviation Authority (UK CAA) Paper 2002/02.
Cross controlling	Roll rate, yaw rate, pitch rate, GS, accelerations	To detect an 'out of balance' flight. Airspeed could be used instead of GS.
Quick stop	GS (min and max), V/S, pitch	To identify inappropriate flight characteristics. Airspeed could be used instead of GS.
Flight — General		
OEI — Air	OEI discreet, ground switch (similar)	To detect OEI conditions in flight.
Single engine flight	No 1 engine Tq, No 2 engine Tq	To detect single-engine flight.
Torque split	No 1 engine Tq, No 2 engine Tq	To identify engine-related issues.
Pilot event	Pilot event discreet	To identify when flight crews have depressed the pilot event button.
Traffic collision avoidance system (TCAS) traffic advisory (TA)	TCAS TA discreet	To identify TCAS alerts.
Training computer active	Training computer mode active or discreet	To identify when helicopter have been on training flights.
High/low rotor speed — power on	NR, Tq (ground switch (similar), IAS, GS)	To identify mishandling of NR. Ground switch (similar), IAS or ground speed required to determine whether helicopter is airborne.
High/low rotor speed — power off	NR, Tq (ground switch (similar), IAS, GS)	To identify mishandling of NR. Ground switch (similar), IAS or ground speed to determine whether helicopter is airborne.

Fuel content low	Fuel contents	To identify low-fuel alerts.
Helicopter terrain awareness and warning system (HTAWS) alert	HTAWS alerts discreet	To identify when HTAWS alerts have been activated.
Automatic voice alert device (AVAD) alert	AVAD discreet	To identify when AVAD alerts have been activated.
Bleed air system use during take-off (e.g. heating)	Bleed air system discreet, ground switch (similar), IAS	To identify use of engine bleed air during periods of high power demand.
Rotors' running duration	NR, elapsed time	To identify rotors' running time for billing purposes.
Flight — Approach		
Stable approach heading change	Magnetic heading, Rad Alt, ground switch (similar), gear position, elapsed time	To identify unstable approaches.
Stable approach pitch attitude	Pitch attitude, Rad Alt, ground switch (similar), gear position	To identify unstable approaches.
Stable approach rod GS	Altitude rate, Rad Alt, ground switch (similar), gear position	To identify unstable approaches.
Stable approach track change	Track, Rad Alt, ground switch (similar), gear position	To identify unstable approaches.
Stable approach angle of bank	Roll attitude, Rad Alt, ground switch (similar), gear position	To identify unstable approaches.
Stable approach — rod at specified height	Altitude rate, Rad Alt, ground switch (similar), gear position	To identify unstable approaches.
Stable approach — IAS at specified height	IAS, Rad Alt, ground switch (similar), gear position	To identify unstable approaches.
Glideslope deviation above or below	Glideslope deviation	To identify inaccurately flown instrument landing system (ILS) approaches.
Localiser deviation left and right	Localiser deviation	To identify inaccurately flown ILS approaches.
Low turn to final	Elevation, GS, V/S, heading change	Airspeed could be used instead of GS.
Premature turn to final	Elevation, GS, V/S, heading change	Airspeed could be used instead of GS.
Stable approach — climb	IAS (min & max), V/S (min & max), elevation	To identify unstable approaches.
Stable approach — descent	IAS (min & max), V/S, elevation	To identify unstable approaches.

Stable approach — bank	IAS (min & max), V/S, elevation, roll	To identify unstable approaches.
Stable approach — late turn	Heading change, elevation, GS	To identify unstable approaches.
Go-around	Gear select (Rad Alt)	To identify missed approaches. Rad Alt for height limit.
Rate of descent on approach	Altitude rate, Rad Alt, Lat & Long, ground switch (similar)	To identify high rates of descent when at low level on approach. Rad Alt if below specified height, Lat & Long for specified location required.
Flight — Autopilot		
Condition of autopilot in flight	Autopilot discreet	To detect flight without autopilot engaged; per channel for multichannel autopilots.
Autopilot engaged within 10 sec after take-off	Autopilot engaged discreet, elapsed time, ground switch (similar), total Tq, Rad Alt	To identify inadvertent lift-off without autopilot engaged.
Autopilot engaged on ground (postflight or preflight)	Autopilot engaged discreet, elapsed time, ground switch (similar), total Tq, Rad Alt	To identify inappropriate use of autopilot when on ground. Elapsed time required to allow for permissible short periods.
Excessive pitch attitude with autopilot engaged on ground (offshore)	Pitch attitude, autopilot discreet, ground switch (similar), Lat & Long	To identify potential for low NR when helicopter pitches on floating helideck.
Airspeed hold engaged — airspeed (departure or non-departure)	Autopilot modes discreet, IAS, (ground switch (similar), total Tq, Rad Alt)	To detect early engagement of autopilot higher modes. Ground switch (similar), total Tq and Rad Alt to determine if the flight profile is 'departure'.
Airspeed hold engaged — altitude (departure or non-departure)	Autopilot modes discreet, Rad Alt, (IAS, ground switch (similar), total Tq)	To detect early engagement of autopilot higher modes. IAS, ground switch (similar), total Tq to determine if the flight profile is 'departure'.
Alt mode engaged — altitude (departure or non-departure)	Autopilot modes discreet, Rad Alt, (ground switch (similar), total Tq, IAS)	To detect early engagement of autopilot higher modes. Ground switch (similar), total Tq and Rad Alt to determine if the flight profile is 'departure'.
Alt mode engaged — airspeed (departure or non-departure)	Autopilot modes discreet, IAS, (ground switch (similar), total Tq,	To detect early engagement of autopilot higher modes. IAS,

	Rad Alt)	ground switch (similar), total Tq to determine if the flight profile is 'departure'.
Heading mode engaged — speed	Autopilot modes discreet, IAS	To detect engagement of autopilot higher modes below minimum speed limitations. Ground switch (similar), total Tq and Rad Alt to determine if the flight profile is 'departure'.
V/S mode active — below specified speed	Autopilot modes discreet, IAS	To detect engagement of autopilot higher modes below minimum speed limitations.
VS mode engaged — altitude (departure or non-departure)	Autopilot modes discreet, IAS, (WOW, total Tq, Rad Alt)	To detect early engagement of autopilot higher modes. Ground switch (similar), total Tq and Rad Alt to determine if the flight profile is 'departure'.
Flight director (FD) engaged — speed	FD discreet, IAS	To detect engagement of autopilot higher modes below minimum speed limitations.
FD-coupled approach or take off — airspeed	FD discreet, IAS, ground switch (similar)	To detect engagement of autopilot higher modes below minimum speed limitations.
Go-around mode engaged — airspeed	Autopilot modes discreet, IAS, ground switch (similar), total Tq, Rad Alt	To detect engagement of autopilot higher modes below minimum speed limitations.
Flight without autopilot channels engaged	Autopilot channels	To detect flight without autopilot engaged; per channel for multichannel autopilots.

AMC1 SPA.HOFO.150 Aircraft tracking system

GENERAL

Flights should be tracked and monitored from take-off to landing. This function may be achieved by the air traffic services (ATS) when the planned route and the planned diversion routes are fully included in airspace blocks where:

(a) ATS surveillance service is normally provided and supported by ATC surveillance systems locating the aircraft at time intervals with adequate duration; and

(b) the operator has given to competent air navigation services (ANS) providers the necessary contact information.

In all other cases, the operator should establish a detailed procedure describing how the aircraft tracking system is to be monitored, and what actions and when are to be taken if a deviation or anomaly has been detected.

GM1 SPA.HOFO.150 Aircraft tracking system

OPERATIONAL PROCEDURE

The procedure should take into account the following aspects:

(a) the outcome of the risk assessment made when the update frequency of the information was defined;

(b) the local environment of the intended operations; and

(c) the relationship with the operator's emergency response plan.

Aircraft tracking data should be recorded on the ground and retained for at least 48 h. Following an accident or a serious incident subject to investigation, the data should be retained for at least 30 days, and the operator should be capable of providing a copy of this data without delay.

AMC1 SPA.HOFO.155 Vibration health monitoring (VHM) system

GENERAL

Any VHM system should meet all of the following criteria:

(a) VHM system capability

The VHM system should measure vibration characteristics of rotating critical components during flight, using suitable vibration sensors, techniques, and recording equipment. The frequency and flight phases of data measurement should be established together with the type certificate holder (TCH) during the initial entry into service. In order to appropriately manage the generated data and focus upon significant issues, an alerting system should be established; this is normally automatic. Accordingly, alert generation processes should be developed to reliably advise maintenance personnel of the need to intervene and help determine what type of intervention is required.

(b) Approval of VHM installation

The VHM system, which typically comprises vibration sensors and associated wiring, data acquisition and processing hardware, the means of downloading data from the helicopter, the ground-based system and all associated instructions for operation of the system, should be certified in accordance with CS-29 or equivalent, established by the Agency.

Note: for applications that may also provide maintenance credit (see Federal Aviation Administration (FAA) Advisory Circular (AC) 29-2C Miscellaneous Guidance (MG) 15), the level of system integrity required may be higher.

(c) Operational procedures

The operator should establish procedures to address all necessary VHM subjects.

(d) Training

The operator should determine which staff will require VHM training, determine appropriate syllabi, and incorporate them into the operator's initial and recurrent training programmes.

GM1 SPA.HOFO.155 Vibration health monitoring (VHM) system

GENERAL

Operators should utilise available international guidance material provided for the specification and design of VHM systems.

Further guidance can be found in:

(a) CS 29.1465 Vibration health monitoring and associated AMC;

(b) Federal Aviation Administration (FAA) Advisory Circular (AC) 29-2C Miscellaneous Guidance (MG) 15 — Airworthiness Approval of Rotorcraft Health Usage Monitoring Systems (HUMSs); and

(c) United Kingdom Civil Aviation Authority (UK CAA) CAP 753 — Helicopter Vibration Health Monitoring.

GM1 SPA.HOFO.160(a)(1) Additional equipment requirements

PUBLIC ADDRESS (PA) SYSTEM

When demonstrating the performance of the PA system or that the pilot's voice is understandable at all passengers' seats during flight, the operator should ensure compatibility with the passengers' use of ear defenders/ear plugs (hearing protection). The operator should only provide hearing protection that is compatible with the intelligibility of the PA system or pilot's voice, as appropriate.

GM1 SPA.HOFO.160(a)(2) Additional equipment requirements

RADIO ALTIMETER

For additional information, please refer to AMC1 CAT.IDE.H.145 Radio altimeters and AMC2 CAT.IDE.H.145 Radio altimeters, as well as to GM1 CAT.IDE.H.145 Radio altimeters.

AMC1 SPA.HOFO.165(c) Additional procedures and equipment for operations in hostile environment

EMERGENCY BREATHING SYSTEM (EBS)

The EBS of SPA.HOFO.165(c) should be an EBS system capable of rapid underwater deployment.

AMC1 SPA.HOFO.165(d) Additional procedures and equipment for operations in hostile environment

INSTALLATION OF THE LIFE RAFT

(a) Projections on the exterior surface of the helicopter that are located in a zone delineated by boundaries that are 1.22 m (4 ft) above and 0.61 m (2 ft) below the established static waterline could cause damage to a deployed life raft. Examples of projections that need to be considered are aerials, overboard vents, unprotected split-pin tails, guttering, and any projection sharper than a three-dimensional right-angled corner.

(b) While the boundaries specified in (a) above are intended as a guide, the total area that should be considered should also take into account the likely behaviour of the life raft after deployment in all sea states up to the maximum in which the helicopter is capable of remaining upright.

(c) Wherever a modification or alteration is made to a helicopter within the boundaries specified, the need to prevent the modification or alteration from causing damage to a deployed life raft should be taken into account in the design.

(d) Particular care should also be taken during routine maintenance to ensure that additional hazards are not introduced by, for example, leaving inspection panels with sharp corners proud of the surrounding fuselage surface, or by allowing door sills to deteriorate to a point where their sharp edges may become a hazard.

AMC1 SPA.HOFO.165(h) Additional procedures and equipment for operations in a hostile environment

EMERGENCY EXITS AND ESCAPE HATCHES

In order for all passengers to escape from the helicopter within an expected underwater survival time of 60 sec in the event of capsize, the following provisions should be made:

(a) there should be an easily accessible emergency exit or suitable opening for each passenger;

(b) an opening in the passenger compartment should be considered suitable as an underwater escape facility if the following criteria are met:

(1) the means of opening should be rapid and obvious;

(2) passenger safety briefing material should include instructions on the use of such escape facilities;

(3) for the egress of passengers with shoulder width of 559 mm (22 in.) or smaller, a rectangular opening should be no smaller than 356 mm (14 in.) wide, with a diagonal between corner radii no smaller than 559 mm (22 in.), when operated in accordance with the instructions;

(4) non-rectangular or partially obstructed openings (e.g. by a seat back) should be capable of admitting an ellipse of 559 mm x 356 mm (22 in. x 14 in.); and

(5) for the egress of passengers with shoulder width greater than 559 mm (22 in.), openings should be no smaller than 480 mm x 660 mm (19 in. x 26 in.) or be capable of admitting an ellipse of 480 mm x 660 mm (19 in. x 26 in.);

(c) suitable openings and emergency exits should be used for the underwater escape of no more than two passengers, unless large enough to permit the simultaneous egress of two passengers side by side:

(1) if the exit size provides an unobstructed area that encompasses two ellipses of size 480 mm x 660 m (19 in. x 26 in.) side by side, then it may be used for four passengers; and

(2) if the exit size provides an unobstructed area that encompasses two ellipses of size 356 mm x 559 mm (14 in. x 22 in.) side by side, then it may be used for four passengers with shoulder width no greater than 559 mm (22 in.) each; and

(d) passengers with shoulder width greater than 559 mm (22 in.) should be identified and allocated to seats with easy access to an emergency exit or opening that is suitable for them.

GM1 SPA.HOFO.165(h) Additional procedures and equipment for operations in a hostile environment

SEAT ALLOCATION

The identification and seating of the larger passengers might be achieved through the use of patterned and/or colour-coded armbands and matching seat headrests.

AMC1 SPA.HOFO.165(i) Additional procedures and equipment for operations in a hostile environment

MEDICALLY INCAPACITATED PASSENGER

(a) A 'Medically incapacitated passenger' means a person who is unable to wear the required survival equipment, including life jackets, survival suits and emergency breathing systems (EBSs), as determined by a medical professional. The medical professional's determination should be made available to the pilot-in-command/commander prior to arrival at the offshore installation.

(b) The operator should establish procedures for the cases where the pilot-in-command/commander may accept a medically incapacitated passenger not wearing or partially wearing survival equipment. To ensure proportionate mitigation of the risks associated with an evacuation, the procedures should be based on, but not be limited to, the severity of the incapacitation, sea and air temperature, sea state, and number of passengers on board.

In addition, the operator should establish the following procedures:

(1) under which circumstances one or more dedicated persons are required to assist a medically incapacitated passenger during a possible emergency evacuation, and the skills and qualifications required;

(2) seat allocation for the medically incapacitated passenger and possible assistants in the helicopter types used to ensure optimum use of the emergency exits; and

(3) evacuation procedures related to whether or not the dedicated persons as described in (1) above are present.

AMC1 SPA.HOFO.170(a) Crew requirements

FLIGHT CREW TRAINING AND CHECKING

(a) Flight crew training programmes should:

(1) improve knowledge of the offshore operations environment with particular consideration of visual illusions during approach, introduced by lighting, motion and weather factors;

(2) improve crew cooperation specifically for offshore operations;

(3) provide flight crew members with the necessary skills to appropriately manage the risks associated with normal, abnormal and emergency procedures during flights by day and night;

(4) if night operations are conducted, give particular consideration to approach, go-around, landing, and take-off phases;

(5) include instructions on the optimum use of the helicopter's automatic flight control system (AFCS);

(6) for multi-pilot operation, emphasise the importance of multi-crew procedures, as well as the role of the pilot monitoring during all phases of the flight; and

(7) include standard operating procedures.

(b) Emergency and safety equipment training should focus on the equipment fitted/carried. Water entry and sea survival training, including operation of all associated safety equipment, should be an element of the recurrent training, as described in AMC1 ORO.FC.230(a)(2)(iii)(F).

(c) The training elements referred to above should be assessed during: operator proficiency checks, line checks, or, as applicable, emergency and safety equipment checks.

(d) Training and checking should make full use of full flight simulators (FFSs) for normal, abnormal, and emergency procedures related to all aspects of helicopter offshore operations (HOFO).

SUBPART L:
SINGLE-ENGINED TURBINE AEROPLANE OPERATIONS AT NIGHT OR IN INSTRUMENT METEOROLOGICAL CONDITIONS (SET-IMC)

AMC1 SPA.SET-IMC.105 SET-IMC operations approval

ANNUAL REPORT

After obtaining the initial approval, the operator should make available to its competent authority on an annual basis a report related to its SET-IMC operations containing at least the following information:

(a) the number of flights operated;

(b) the number of hours flown; and

(c) the number of occurrences sorted by type.

AMC1 SPA.SET-IMC.105(a) SET-IMC operations approval

TURBINE ENGINE RELIABILITY

(a) The operator should obtain the power plant reliability data from the type certificate (TC) holder and/or supplemental type certificate (STC) holder.

(b) The data for the engine-airframe combination should have demonstrated, or be likely to demonstrate, a power loss rate of less than 10 per million flight hours. Power loss in this context is defined as any loss of power, including in-flight shutdown, the cause of which may be traced to faulty engine or engine component design or installation, including design or installation of the fuel ancillary or engine control systems.

(c) The in-service experience with the intended engine-airframe combination should be at least 100 000 h, demonstrating the required level of reliability. If this experience has not been accumulated, then, based on analysis or test, in-service experience with a similar or related type of airframe and turbine engine might be considered by the TC/STC holder to develop an equivalent safety argument in order to demonstrate that the reliability criteria are achievable.

AMC1 SPA.SET-IMC.105(b) SET-IMC operations approval

MAINTENANCE PROGRAMME

The following maintenance aspects should be addressed by the operator:

(a) Engine monitoring programme

The operator's maintenance programme should include an oil-consumption-monitoring programme that should be based on engine manufacturer's recommendations, if available, and track oil consumption trends. The monitoring should be continuous and take account of the oil added. An engine oil analysis programme may also be required if recommended by the engine manufacturer. The possibility to perform frequent (recorded) power checks on a calendar basis should be considered.

The engine monitoring programme should also provide for engine condition monitoring describing the parameters to be monitored, the method of data collection and a corrective action process, and should be based on the engine manufacturer's instructions. This monitoring will be used to detect propulsion system deterioration at an early stage allowing corrective action to be taken before safe operation is affected.

(b) Propulsion and associated systems’ reliability programme

A propulsion and associated systems’ reliability programme should be established or the existing reliability programme supplemented for the particular engine-airframe combination. This programme should be designed to early identify and prevent problems, which otherwise would affect the ability of the aeroplane to safely perform its intended flight.

Where the fleet of SET-IMC aeroplanes is part of a larger fleet of the same engine-airframe combination, data from the operator’s total fleet should be acceptable.

For engines, the programme should incorporate reporting procedures for all significant events. This information should be readily available (with the supporting data) for use by the operator, type certificate (TC) holders, and the competent authority to help establish that the reliability level set out in AMC1 SPA.SET-IMC.105(a) is achieved. Any adverse trend would require an immediate evaluation to be conducted by the operator in consultation with its competent authority. The evaluation may result in taking corrective measures or imposing operational restrictions.

The engine reliability programme should include, as a minimum, the engine hours flown in the period, the power loss rate for all causes, and the engine removal rate, both rates on an annual basis, as well as reports with the operational context focusing on critical events. These reports should be communicated to the TC holder and the competent authority.

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

AMC1 SPA.SET-IMC.105(c) SET-IMC operations approval

TRAINING PROGRAMME

The operator’s flight crew training and checking, established in accordance with ORO.FC, should incorporate the following elements:

(a) Conversion training

Conversion training should be conducted in accordance with a syllabus devised for SET-IMC operations and include at least the following:

(1) normal procedures:

(i) anti-icing and de-icing systems operation;

(ii) navigation system procedures;

(iii) radar positioning and vectoring, when available;

(iv) use of radio altimeter; and

(v) use of fuel control, displays interpretation;

(2) abnormal procedures:

(i) anti-icing and de-icing systems failures;

(ii) navigation system failures;

(iii) pressurisation system failures;

(iv) electrical system failures; and

(v) engine-out descent in simulated IMC; and

(3) emergency procedures:

(i) engine failure shortly after take-off;

(ii) fuel system failures (e.g. fuel starvation);

(iii) engine failure other than the above: recognition of failure, symptoms, type of failure, measures to be taken, and consequences;

(iv) depressurisation; and

(v) engine restart procedures:

(A) choice of an aerodrome or landing site; and

(B) use of an area navigation system;

(vi) air traffic controller (ATCO) communications;

(vii) use of radar positioning and vectoring (when available);

(viii) use of radio altimeter; and

(ix) practice of the forced landing procedure until touchdown in simulated IMC, with zero thrust set, and operating with simulated emergency electrical power.

(b) Conversion checking

The following items should be checked following completion of the SET-IMC operations conversion training as part of the operator's proficiency check (OPC):

(1) conduct of the forced landing procedure until touchdown in simulated IMC, with zero thrust set, and operating with simulated emergency electrical power;

(2) engine restart procedures;

(3) depressurisation following engine failure; and

(4) engine-out descent in simulated IMC.

(c) Use of simulator (conversion training and checking)

Where a suitable full flight simulator (FFS) or a suitable flight simulation training device (FSTD) is available, it should be used to carry out training on the items under (a) and checking of the items under (b) above for SET-IMC operations conversion training and checking.

(d) Recurrent training

Recurrent training for SET-IMC operations should be included in the recurrent training required by Subpart FC (FLIGHT CREW) of Annex III (Part-ORO) to Regulation (EU) No 965/2012 for pilots carrying out SET-IMC operations. This training should include all items under (a) above.

(e) Recurrent checking

The following items should be included into the list of required items to be checked following completion of SET-IMC operations recurrent training as part of the OPC:

(1) conduct of the forced landing procedure until touchdown in simulated IMC, with zero thrust set, and operating with simulated emergency electrical power;

(2) engine restart procedures;

(3) depressurisation following engine failure; and

(4) emergency descent in simulated IMC.

(f) Use of simulator (recurrent training and checking)

Following conversion training and checking, the next recurrent training session and the next OPCs including SET-IMC operations items should be conducted in a suitable FFS or FSTD, where available.

AMC2 SPA.SET-IMC.105(c) SET-IMC operations approval

CREW COMPOSITION

(a) Unless the pilot-in-command has a minimum experience of 100 flight hours under instrument flight rules (IFR) with the relevant type or class of aeroplane including line flying under supervision (LIFUS), the minimum crew should be composed of two pilots.

(b) A lesser number of flight hours under IFR on the relevant type or class of aeroplane may be acceptable to the competent authority when the flight crew member has significant previous IFR experience.

AMC1 SPA.SET-IMC.105(d)(2) SET-IMC operations approval

FLIGHT PLANNING

(a) The operator should establish flight planning procedures to ensure that the routes and cruising altitudes are selected so as to have a landing site within gliding range.

(b) Notwithstanding (a) above, whenever a landing site is not within gliding range, one or more risk periods may be used for the following operations:

(1) over water;

(2) over hostile environment; or

(3) over congested areas.

Except for the take-off and landing phase, the operator should ensure that when a risk period is planned, there is a possibility to glide to a non-congested area.

The total duration of the risk period per flight should not exceed 15 min unless the operator has established, based on a risk assessment carried out for the route concerned, that the cumulative risk of fatal accident due to an engine failure for this flight remains at an acceptable level (see GM2 SPA.SET-IMC.105(d)(2)).

(c) The operator should establish criteria for the assessment of each new route. These criteria should address the following:

(1) the selection of aerodromes along the route;

(2) the identification and assessment, at least on an annual basis, of the continued suitability of landing sites (obstacles, dimensions of the landing area, type of the surface, slope, etc.) along the route when no aerodrome is available; the assessment may be performed using publicly available information or by conducting on-site surveys;

(3) assessment of en route specific weather conditions that could affect the capability of the aeroplane to reach the selected forced landing area following loss of power (icing conditions including gliding descent through clouds in freezing conditions, headwinds, etc.);

(4) consideration of landing sites' prevailing weather conditions to the extent that such information is available from local or other sources; expected weather conditions at landing sites for which no weather information is available should be assessed and evaluated taking into account a combination of the following information:

(i) local observations;

(ii) regional weather information (e.g. significant weather charts); and

(iii) terminal area forecast (TAF)/meteorological aerodrome report (METAR) of the nearest aerodromes; and

(5) protection of the aeroplane occupants after landing in case of adverse weather.

(d) At the flight planning phase, any selected landing site should have been assessed by the operator as acceptable for carrying out a safe forced landing with a reasonable expectation of no injuries to persons in the aeroplane or on the ground. All information reasonably practical to acquire should be used by the operator to establish the characteristics of landing sites.

(e) Landing sites suitable for a diversion or forced landing should be programmed into the navigation system so that track and distance to the landing sites are immediately and continuously available. None of these preprogrammed positions should be altered in-flight.

AMC2 SPA.SET-IMC.105(d)(2) SET-IMC operations approval

ROUTE AND INSTRUMENT PROCEDURE SELECTION

The following should be considered by the operator, as appropriate, depending on the use of a risk period:

(a) Departure

The operator should ensure, to the extent possible, that the instrument departure procedures to be followed are those guaranteeing that the flight path allows, in the event of power loss, the aeroplane to land on a landing site.

(b) Arrival

The operator should ensure, to the extent possible, that the arrival procedures to be followed are those guaranteeing that the flight path allows, in the event of power loss, the aeroplane to land on a landing site.

(c) En route

The operator should ensure that any planned or diversionary route should be selected and be flown at an altitude such that, in the event of power loss, the pilot is able to make a safe landing on a landing site.

AMC3 SPA.SET-IMC.105(d)(2) SET-IMC operations approval

LANDING SITE

A landing site is an aerodrome or an area where a safe forced landing can be performed by day or by night, taking into account the expected weather conditions at the time of the foreseen landing.

(a) The landing site should allow the aeroplane to completely stop within the available area, taking into account the slope and the type of the surface.

(b) The slope of the landing site should be assessed by the operator in order to determine its acceptability and possible landing directions.

(c) Both ends of the landing area, or only the zone in front of the landing area for one-way landing areas, should be clear of any obstacle which may be a hazard during the landing phase.

GM1 SPA.SET-IMC.105(d)(2) SET-IMC operations approval

LANDING SITE

(a) When selecting landing sites along a route to be operated, it is recommended to prioritise the different types of landing sites as follows:

(1) aerodromes with available runway lighting;

(2) aerodromes without available runway lighting;

(3) non-populated fields with short grass/vegetation or sandy areas.

(b) When assessing the suitability of a landing site which is not an aerodrome, it is recommended to consider the following landing site criteria:

(1) size and shape of the landing area:

(i) landing sites with a circular shape providing multiple approach paths depending on the wind; and

(ii) for other cases, landing sites with a minimum width of 45 m; and

(2) type of surface:

the surface of the landing area should allow a safe forced landing to be conducted.

GM2 SPA.SET-IMC.105(d)(2) SET-IMC operations approval

SAFETY RISK ASSESSMENT FOR A SPECIFIC ROUTE

(a) Introduction

The risk assessment methodology should aim at estimating for a specific route the likelihood of having fatalities due to emergency landing caused by engine failure. Based on the outcome of this risk assessment, the operator may extend the duration of the risk period beyond the maximum allowed duration if no landing site is available within gliding range.

(b) The safety target

The overall concept of SET-IMC operations is based on an engine reliability rate for all causes of 10 per million flight hours, which permits in compliance with SET-IMC requirements an overall fatal accident rate for all causes of 4 per million flight hours.

Based on accident databases, it is considered that the engine failure event does not contribute by more than 33 % to the overall fatal accident rate. Therefore, the purpose of the risk assessment is to ensure that the probability of a fatal accident for a specific flight following engine failure remains below the target fatal accident rate of 1.3×10^{-6}.

(c) Methodology

The methodology aims at estimating the likelihood of failing to achieve a safe forced landing in case of engine failure, a safe forced landing being defined as a landing on an area for which it is reasonably expected that no serious injury or fatalities will occur due to the landing even though the aeroplane may suffer extensive damage.

This methodology consists of creating a risk profile for a specific route, including departure, en route and arrival airfield and runway, by splitting the proposed flight into appropriate segments (based on the flight phase or the landing site selected), and by estimating the risk for each segment should the engine fail in one of these segments. This risk profile is considered to be an estimation of the probability of an unsuccessful forced landing if the engine fails during one of the identified segments.

When assessing the risk for each segment, the height of the aeroplane at which the engine failure occurs, the position relative to the departure or destination airfield or to an emergency landing site en route, and the likely ambient conditions (ceiling, visibility, wind and light) should be taken into account, as well as the standard procedures of the operator (e.g. U-turn procedures after take-off, use of synthetic vision, descent path angle for standard descent from cruising altitude, etc.).

The duration of each segment determines the exposure time to the estimated risk. The risk is estimated based on the following calculation:

Segment risk factor = segment exposure time (in s)/3 600 × probability of unsuccessful forced landing in this segment x assumed engine failure rate per flight hour (FH).

By summing up the risks for all individual segments, the cumulative risk for the flight due to engine failure is calculated and converted to risk on a 'per flight hour' basis.

This total risk must remain below the target fatal accident rate of 1.3×10^{-6} as under (b) above.

(d) Example of a risk assessment

An example of such a risk assessment is provided below. In any case, this risk assessment is an example designed for a specific flight with specific departure and arrival aerodrome characteristics. It is an example of how to implement this methodology, and all the estimated probabilities used in the table below may not directly apply to any other flight.

The meaning of the different parameters used is further detailed below:

<u>AD/Other</u>: 'AD' is ticked whenever only aerodromes are selected as landing sites in the segment concerned. 'Other' is ticked if the selected landing sites in the segment concerned are not aerodromes. When a risk period is used by the operator, none of the two boxes (neither 'AD' nor 'Other') are ticked.

<u>Segment exposure time</u>: this parameter represents the duration of each segment in seconds (s).

<u>Estimated probability of an unsuccessful forced landing if engine fails in the segment</u>: probability of performing in the segment a safe forced landing following engine power loss.

<u>Segment risk factor</u>: risk of an unsuccessful forced landing (because of power loss) per segment (see formula above).

		LANDING SITE				Assumed engine failure rate per FH			$1{,}00 \times 10^{-5}$
Segments of flight	**Assumed height or height band above ground level (AGL) in ft**	**AD**	**Other**	**Segment exposure time (in s)**	**Cumulative flight time from start of take-off to end of segment (in s)**	**Estimated probability of unsuccessful forced landing if engine fails in this segment**	**Segment risk factor**	**Cumulative risk per flight**	**Comment on estimation of unsuccessful outcome**
Take-off (T-O) ground roll	0 ft	X		20	20	0.01 %	5.56×10^{-12}	5.56×10^{-12}	T-O aborted before being airborne. Runway long enough to stop the aircraft.
Climb-out	0-50 ft	X		8	28	0.10 %	2.22×10^{-11}	2.78×10^{-11}	Aircraft aborts T-O and lands ahead within runway length available.
	50-200 ft	X		10	38	1.00 %	2.78×10^{-10}	3.06×10^{-10}	
	200-1 100 ft			36	74	100.00 %	1.00×10^{-7}	1.00×10^{-7}	Aircraft has to land ahead outside airfield with little height for manoeuvring
	1 100-2 000 ft	X		36	110	50.00 %	5.00×10^{-8}	1.50×10^{-7}	U-turn and landing at opposite q-code for magnetic heading of a runway (QFU) possible.
	2 000-4 000 ft	X		80	190	25.00 %	5.56×10^{-8}	2.06×10^{-7}	
Climbing to en route height	4 000-10 000ft	X	X	240	430	5.00 %	3.33×10^{-8}	2.39×10^{-7}	Aircraft able to operate a glide-in approach.
Cruising: emergency area available	≤ 10 000 ft	X		5 400	5 830	5.00 %	7.50×10^{-7}	9.89×10^{-7}	En route cruising time with available landing sites along the route within gliding range.
Cruising: emergency area NOT available	≤ 10 000 ft			300	6 130	100.00 %	8.33×10^{-7}	1.82×10^{-6}	En route cruising time without available landing sites within gliding range.

Descent to initial approach fix for instrument flight rules (IFR) approach	10 000-4 000 ft on a 4° slope (1 200 ft/min)	X		300	6 430	5.00 %	4.17×10^{-8}	1.86×10^{-6}	Descent with available landing sites within gliding range, and destination not reachable.
Aircraft has to descend below the glide approach capability to set up for a normal powered landing from 1 000 ft on a 3° approach path	4 000-1 000 ft on the approach		X	150	6 580	50.00 %	2.08×10^{-7}	2.07×10^{-6}	Aircraft descends below the height needed to maintain a glide approach for reaching the airfield. Therefore, it may land short of airfield if engine fails.
Aircraft descends on a 3° approach path	1 000 -50 ft on approach at 120 kt (600 ft/min)			95	6 675	100.00 %	2.64×10^{-7}	2.34×10^{-6}	Aircraft assumes 3° glideslope, regained to ensure normal landing. Therefore, it may undershoot the landing field if engine fails at this late stage.
Landing	50 ft above threshold until touchdown	X		10	6 685	5.00 %	1.39×10^{-9}	2.34×10^{-6}	Aircraft over runway. Engine is to be idled anyway, but failure, while airborne, may surprise pilot and result in hard landing.
Landing ground run	Touchdown to stop	X		15	6 700	0.01 %	4.17×10^{-12}	2.34×10^{-6}	Aircraft on ground. Risk negligible, if engine stops on the example runway (very long) providing that all services are retained.
								1.26×10^{-6}	Risk per flight

The following likelihood scale may be used to determine the estimated probability of an unsuccessful forced landing:

Probability in %	Description
0	Impossible
0-1	Negligible likelihood/remote possibility
1-10	Possible but not likely
10-35	Moderately likely
35-65	Possible
65-90	Likely
90-99	Almost certain
99-100	Certain

AMC1 SPA.SET-IMC.105(d)(4) SET-IMC operations approval

CONTINGENCY PROCEDURES

When a risk period is used during the take-off or landing phase, the contingency procedures should include appropriate information for the crew on the path to be followed after an engine failure in order to minimise to the greatest extent possible the risk to people on the ground.

AMC1 SPA.SET-IMC.110(b) Equipment requirements for SET-IMC operations

ATTITUDE INDICATORS

A backup or standby attitude indicator built in the glass cockpit installations is an acceptable means of compliance for the second attitude indicator.

AMC1 SPA.SET-IMC.110(d) Equipment requirements for SET-IMC operations

AIRBORNE WEATHER-DETECTING EQUIPMENT

The airborne weather-detecting equipment should be an airborne weather radar, as defined in the applicable Certification Specification — European Technical Standard Order (CS-ETSO) issued by the Agency, or equivalent.

AMC1 SPA.SET-IMC.110(f) Equipment requirements for SET-IMC operations

AREA NAVIGATION SYSTEM

The area navigation system should be based on a global navigation satellite system (GNSS) stand-alone receiver or multi-sensor system, including at least one GNSS sensor, to enable at least required navigation performance approach (RNP APCH) operations without vertical guidance.

GM1 SPA.SET-IMC.110(f) Equipment requirements for SET-IMC operations

AREA NAVIGATION SYSTEM

Acceptable standards for the area navigation system are ETSO-145/146c, ETSO-C129a, ETSO-C196a or ETSO-C115 issued by the Agency, or equivalent.

GM1 SPA.SET-IMC.110(h) Equipment requirements for SET-IMC operations

LANDING LIGHTS

In order to demonstrate the compliance of its aeroplane's landing lights with the 200-ft illumination capability requirement, and in the absence of relevant data available in the aircraft flight manual (AFM), the operator should liaise with the type certificate (TC) holder or supplemental type certificate (STC) holder, as applicable, to obtain a statement of compliance.

GM1 SPA.SET-IMC.110(i)(7) Equipment requirements for SET-IMC operations

ELEMENTS AFFECTING PILOT'S VISION FOR LANDING

Examples of elements affecting pilot's vision for landing are rain, ice and window fogging.

AMC1 SPA.SET-IMC.110(l) Equipment requirements for SET-IMC operations

EMERGENCY ENGINE POWER CONTROL DEVICE

The means that allows continuing operation of the engine within a sufficient power range for the flight to be safely completed in the event of any reasonably probable failure/malfunction of the fuel control unit should enable the fuel flow modulation.