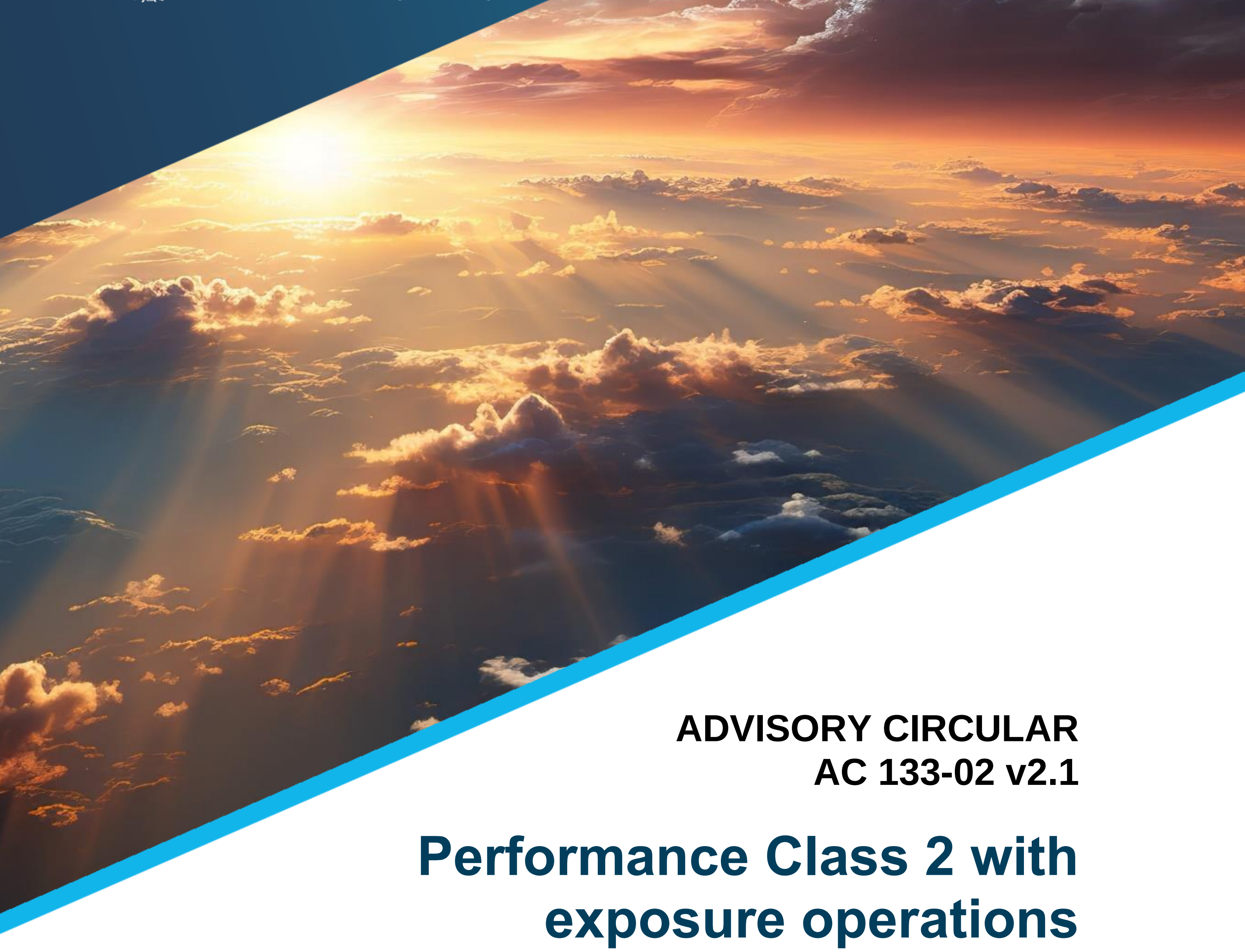
Australian Government
Civil Aviation Safety Authority



ADVISORY CIRCULAR
AC 133-02 v2.1

Performance Class 2 with exposure operations

File ref: D25/47979

February 2025

Audience

This advisory circular (AC) applies to:

- commercial and air transport helicopter Pilots
- current and future Air Operator's Certificate (AOC) holders who are, or wish to be authorised to conduct PC2 with exposure helicopter operations
- current and future aerodrome, heliport, and helideck operators
- aerodrome, heliport, and helideck designers.

Purpose

This AC provides advice in the form of Guidance Material (GM) and, where relevant, suggests an Acceptable Means of Compliance (AMC) with the Part 133 of the CASR regulations and Part 133 Manual of Standards (MOS) requirements pertaining to the Helicopter Performance Class 2 with exposure (PC2WE).

The CASR Subpart 133.F regulations and Part 133 MOS Chapter 10 standards on helicopter PC2WE are a new concept within Australian aviation and require significant guidance and educational material to ensure full understanding is achieved.

The intention of this AC is to translate the regulatory requirements and MOS content into language that is easily understood and, where necessary, provide expanded explanations to ensure the intent of the legislation is clear.

It is recommended that this AC be read in conjunction with the relevant CASR Part 133 requirements and that AC 133-01 *Performance Class Operations* be read prior to this AC to ensure maximum understanding.

The AC has three components:

- AC 133-02 itself which performs the function outlined above
- Annexures A and B:
- Annex A provides further guidance and specific AMC material for operators of the rotorcraft types and models covered by the Annex
- Annex B provides information on how to submit PC2WE applications to CASA.

If you are an operator of one or more of the rotorcraft types and models in Annex A, then after reading the main AC 133-02, you may refer to the Annex for PC2WE AMC material specific to the rotorcraft you are operating.

Any AMC outlined will allow an AOC holder to satisfy CASA of the regulatory requirement if they choose to use and follow the AMC material however, they may also propose alternative means of compliance to the AMC if they so desire. This alternative means will need to be assessed and found acceptable for the purpose by CASA.

Unless specified otherwise, all subregulations, regulations, Divisions, Subparts and Parts referenced in this AC are references to the *Civil Aviation Safety Regulations 1998 (CASR)*.

Advisory circulars are intended to provide advice and guidance to illustrate a means, but not necessarily the only means, of complying with the Regulations, or to explain certain regulatory requirements by providing informative, interpretative and explanatory material.

Advisory circulars should always be read in conjunction with the relevant regulations.

For further information

For further information or to provide feedback on this AC, visit CASA's contact us page.

Status

This version of the AC is approved by the National Manager, Flight Standards Branch.

Note: Changes made in the current version are annotated with change bars.

Table 1: Status

Version	Date	Details
v2.1	February 2025	• Additional contact PERR information added to section 3.3 • Additional note added to subsection 4.1.1.
v2.0	September 2024	The following changes have been made: • acronym (WAT) added to section 1.1 acronyms • more detail added to section 2.6 and subsection 6.1.4 • new subparagraph 2.5.3 added providing information advising location of PC2WE application process in new Annex B • new Annex B added to provide guidance on PC2WE application and document submission process.
v1.4	March 2024	The following updates have been made in this version: • Updated content sections 6, 7 and 8. • Additional material in risk considerations section 6.3 on the consequence of the impact of rotor downwash and outwash during PC2WE on persons and things during approach and landing and take-off and climb from PC2WE operating sites. • New content added to paragraphs 7.2.5, 7.2.6 and 7.2.7 and previous Figure 5 deleted. • Section 7.3 deleted and old figures 6, 7 and 15 removed. • Updated content in section 8.4 regarding double angle PC2WE operations. • Section 10 tables 1 and 2 amended to align with new section 7 content. Additional rotor downwash/outwash content added to risk assessment considerations in Annex A.

Unless specified otherwise, all subregulations, regulations, Divisions, Subparts and Parts referenced in this AC are references to the *Civil Aviation Safety Regulations 1998 (CASR)*.

Version	Date	Details
v1.3	August 2023	Additional content added to section 5.3 regarding operators needing to be aware of the limitations contained in *Part IIIB- Protection of CVR (Cockpit Voice Recording) Information* of the *Civil Aviation Act*.
v1.2	July 2023	Additional content added to section 5.3 regarding the use of airborne image recording systems. Some information replaced in paragraph 8.2.3 of Annex A.
v1.1	September 2021	Minor rewording to Annex A, Section 8.2.3 and the addition of the definition of “target torque”.
v1.0	December 2020	Initial AC.

Unless specified otherwise, all subregulations, regulations, Divisions, Subparts and Parts referenced in this AC are references to the *Civil Aviation Safety Regulations 1998 (CASR)*.

Contents

Acknowledgement of Country

The Civil Aviation Safety Authority (CASA) respectfully acknowledges the Traditional Custodians of the lands on which our offices are located and their continuing connection to land, water and community, and pays respect to Elders past, present and emerging.

Artwork: James Baban.

1 Reference material

1.1 Acronyms

The acronyms and abbreviations used in this AC are listed in the table below.

Table 2: Acronyms

Acronym	Description
AC	Advisory Circular
AEO	All Engines Operating
AGL	Above Ground Level
AIRS	Airborne image recording system
AMC	Acceptable Means of Compliance
CAAP	Civil Aviation Advisory Publication
CAR 1988	*Civil Aviation Regulations 1988*
CASA	Civil Aviation Safety Authority
CASR 1998	*Civil Aviation Safety Regulations 1998*
CAT A	*Category A*
CAT B	*Category B*
DPATO	*Defined Point After Take-Off*
DPBL	*Defined Point Before Landing*
EASA	European Aviation Safety Authority
FATO	*Final Approach and Take-off Area*
fpm	*Feet Per Minute*
ft	*Feet*
GM	*Guidance Material*
HIGE	*Hover In Ground Effect*
HLS	*Helicopter Landing Site*
HOGE	*Hover Outside Ground Effect*
HV	*Height-Velocity*
ICAO	*International Civil Aviation Organisation*
IFR	Instrument flight rules
IFSD	in-flight shutdown
LDP	Landing Decision Point

Acronym	Description
MOPSC	Maximum Operational Passenger Seat Configuration
NAA	National Aviation Authority
NVD	Night Vision Devices
NVIS	Night Vision Imaging System
OEI	One Engine Inoperative
OEM	Original Equipment Manufacturer
PC1	Performance Class 1
PC2	Performance Class 2
PC2WE	Performance Class 2 with exposure
PC3	Performance Class 3
PERR	Powerloss Exposure Risk Report
RFM	Rotorcraft Flight Manual
RP	Rotation Point
TCH	Type Certificate Holder
TDP	Take-off Decision Point
TLS	Target Level of Safety
UMS	Usage Monitoring System
WAT	Weight/altitude/temperature

1.2 Definitions

Terms that have specific meaning within this AC are defined in the table below. Where definitions from the civil aviation legislation have been reproduced for ease of reference, these are identified by 'grey shading'. Should there be a discrepancy between a definition given in this AC and the civil aviation legislation, the definition in the legislation prevails.

Table 3: Definitions

Term	Definition
Adequate vertical margin	for a rotorcraft, is the minimum vertical distance the rotorcraft must be from an object during a stage of a flight mentioned in: 1. the rotorcraft's flight manual, or 2. if paragraph (a) does not apply, the rotorcraft operator's exposition.
Avoid area of the HV envelope	for a rotorcraft, means the combinations of altitude and airspeed displayed on the height-velocity diagram in the aircraft flight manual, which have been determined by the original equipment manufacturer not to offer safe autorotational landing capability, or OEI capability, in the event of engine failure.
Category A	in relation to a rotorcraft, means a multi engine rotorcraft that is:

Term	Definition
	1. designed with engine and system isolation features stated for Category A requirements in any of the following: a. Part 27 of the FARs b. Part 29 of the FARs c. EASA CS—27 d. EASA CS—29 e. an equivalent airworthiness code of a Contracting State, and 2. capable of operation using take-off and landing data scheduled under a critical engine failure concept, which assures adequate designated ground or water area and adequate performance capability for continued safe flight or safe rejected take off in the event of engine failure, as mentioned in the rotorcraft's flight manual. **Note:** This definition is based on the ICAO, FAA and EASA definitions of the term Category A in relation to rotorcraft.
Category A procedure	means a procedure presented in the normal procedures, performance sections or performance supplement sections of the RFM referenced as being mandatory requirements in the limitations section (unless a HV diagram valid for category A operations is presented), which assures adequate designated ground or water area and adequate performance capability for continued safe flight or safe rejected take off in the event of engine failure.
Category A rotorcraft	means a rotorcraft that: 1. meets the requirements of the definition Category A, and 2. is type-certificated in accordance with any of the following: a. Part 27 of the FARs b. Part 29 of the FARs c. EASA CS—27 d. EASA CS—29 e. an equivalent airworthiness code of a Contacting State.
Contracting State	means a foreign country that is a party to the Chicago Convention.
Drop-down	The available height below a helipad or helideck that a rotorcraft may use as part of an OEI take-off or baulked landing procedure, or the height loss of the rotorcraft following an engine failure.
Exposure time	for a rotorcraft that is flying in still air, means the period during which the rotorcraft, with one engine inoperative, may not be able to achieve a safe forced landing or continue the flight safely.
Field of View	is the extent of the observable world that is seen at any given moment, normally from the aircraft's design eye position as defined by the manufacturer, or if undefined, the appropriate seated position of the pilot.
Flight manual	Refer to section 37, Part 2 of the CASR Dictionary.
Heliport	means an area: 1. intended for use wholly or partly for the arrival or departure of rotorcraft, on: a. land, or b. a building or other structure on land, and 2. that meets the standards for a heliport set out in the Part 139 Manual of Standards.

Term	Definition
Maximum Operational Passenger Seat Configuration	Refer to section 19, Part 1 of the CASR Dictionary.
Medical transport operation	Refer to clause [70] of Part 2 of the CASR Dictionary
Populous Area	For the purposes of this AC, is an area that is substantially used for, or is in use or available for use for, residential, commercial, industrial or recreational purposes. CASR definition – populous area includes a city and a town. **Note:** This definition is not the same as the definitions of this term in CASR Parts 101 and 137.
Suitable forced landing area	Refer to regulation 133.010 of the CASR.
Target level of safety	The level of risk which is considered acceptable in particular circumstances.

1.3 References

Legislation

Legislation is available on the Federal Register of Legislation website https://www.legislation.gov.au/

Table 4: Legislation references

Document	Title
The Act	*Civil Aviation Act 1988*
Part 91 of CASR	General operating and flight rules
Part 91 MOS	Part 91 (General Operating and Flight Rules) Manual of Standards 2020
Part 133 of CASR	Australian air transport operations - rotorcraft
Part 133 MOS	Part 133 (Australian Air Transport Operations—Rotorcraft) Manual of Standards 2020
Part 138 of CASR	Aerial work operations
Part 138 MOS	Part 138 (Aerial Work Operations) Manual of Standards 2020
Part 139 of CASR	Aerodromes
Part 139 MOS	Part 139 (Aerodromes) Manual of Standards 2019

International Civil Aviation Organization documents

International Civil Aviation Organization (ICAO) documents are available for purchase from http://store1.icao.int/

Many ICAO documents are also available for reading, but not purchase or downloading, from the ICAO eLibrary (https://elibrary.icao.int/home).

Table 5: ICAO references

Document	Title
ICAO Annex 6 Part III	International Standards and Recommended Practices for Operation of Aircraft – International Operations - Helicopters
ICAO Annex 14 Volume 2	International Standards and Recommended Practices for Aerodromes - Heliports
ICAO Doc 10110	ICAO Helicopter Code of Performance Development Manual
ICAO Doc 9261	ICAO Heliport Manual Parts 1 and 2

Advisory material

CASA's advisory materials are available at https://www.casa.gov.au/publications-and-resources/guidance-materials

Table 6: Advisory material references

Document	Title
AC 11-04	Approvals under CASR Parts 91, 103, 119, 121, 129, 131, 132, 133, 135, 138 and 149 (incl MOS)
AC 133-01	Performance class operations
AC 133-02	Performance Class 2 with exposure operations
AC 139.R-01	Guidelines for Heliports - design and operation

1.4 Forms

CASA's forms are available at http://www.casa.gov.au/forms

Table 7: Forms

Form number	Title
	Air operator's certificate and associated approvals **Note:** This form is used to apply for PC2WE approvals.
	Air Operator's Certificate/Associated Approvals
	Transitional Operator - Rotorcraft performance class self-assessment worksheet

2 Introduction to Performance Class 2 with exposure

2.1 Introduction

2.1.1 ICAO Annex 6, Part III, Section II, Chapter 3, section 3.1.2 states *"in conditions where the safe continuation of flight is not ensured in the event of a critical engine failure, helicopter operations shall be conducted in conditions of weather and light, and over such routes and diversions, that permit a safe forced landing to be executed*".

2.1.2 Despite section 3.1.2, section 3.1.3 provides the State (in our case Australia) with the capacity to include operations without a safe forced landing (exposure) in their Code of Performance.

2.1.3 The process used to establish such operations should, however, indicate how the safety risk of operating with exposure in the take-off, landing, or en-route phase of a flight will be managed (refer to ICAO Doc 10110 Helicopter Code of Performance Development Manual (HCPDM)).

2.2 What is exposure

2.2.1 The term 'exposure' is used within a Code of Performance to describe any part of a flight during which the failure of an engine or system could result in a forced landing with an outcome of 'hazardous' or 'catastrophic' (refer to ICAO Doc 10110 HCPDM).

2.3 Operations with exposure

2.3.1 Following on from above, within performance class operations, a flight where failure of an engine or system does not permit continued safe flight and does not ensure a forced landing into a suitable forced landing area, and subsequent survival of the occupants of the rotorcraft or any potentially impacted third parties, is considered as being conducted with exposure.

2.3.2 The consequence of this event will likely result in a safety risk severity category of either 'Hazardous' or 'Catastrophic':

- HAZARDOUS - failure that would result in serious or fatal injury to an occupant.
- CATASTROPHIC - failure that would result in multiple fatalities, or loss of rotorcraft.

2.3.3 Despite the above, it is also recognised a failure leading to a forced landing in an unsuitable forced landing area (for example, one that does not support the survival of the occupants of the rotorcraft), if handled with exceptional skill or with sufficient luck, could result in an outcome better than hazardous or catastrophic, and occupants have been known to survive and be rescued from the most extreme conditions. However, such an outcome is not assured and, as such, this concept cannot be reasonably utilised within a Code of Performance risk assessment due to the inherent unpredictability of safety risk severity category outcome.

2.3.4 With this in mind, within performance class operations, the use of the defined place known as a 'suitable forced landing area' is intended to facilitate management of safety and not to engender unrealistic expectations or constrain normal operations. However, when continued safe flight is not possible, or alternatively suitable forced landing areas are not available, the operation is assumed as being conducted **with exposure**.

2.4 Performance Class 2 (PC2)

2.4.1 ICAO Annex 6; Part III, PC2 definition: "*A helicopter with performance such that, in the case of critical power-unit failure, it is able to safely continue the flight, except when the failure occurs* *prior to a defined point after take-off (DPATO) or after a defined point before landing (DPBL), in which case a forced landing may be required*".

2.4.2 During the take-off and landing phases of flight, operations within PC2 need not provide an absolute assurance of safety, provided a forced landing into suitable forced landing area (refer to definition in regulation 133.010) can be achieved, or a safe climb-out conducted. The use of a suitable forced landing area is on the assumption that normal aircraft limits may be exceeded, but there remains a 'reasonable expectation that there would be no injuries to persons in the rotorcraft or on the ground'.

2.5 Flight in performance class 2 with exposure (PC2WE)

2.5.1 PC2WE permits operations without the safety assurance of a suitable forced landing area. However, suitable forced landing areas are just one means of protecting persons and property against the engine failure risk. PC2WE offers operators alternative mitigation strategies based on:

- a defined exposure time limit
- demonstrated engine reliability
- engine maintenance standards
- pilot procedures and training, and
- operator risk assessments.

2.5.2 Due to complexities around the risk mitigation strategies for PC2WE, CASA can only permit this by the issue of specific instruments of approval under regulation 133.015. The approval to operate in PC2WE is specific to the operator and the type and model of rotorcraft and not specific to location. Despite this, operators should not assume that PC2WE will be acceptable for every departure or landing site due to significant variations in the consequence of engine failures across different sites, particularly for third parties exposed to the operation. For example, PC2WE may not be operationally acceptable to the operator to/from a heliport within a densely populated urban area, but it may meet the operator's risk criteria to/from a rural heliport with few people routinely in the vicinity. Thus, most operators will use a combination of the available performance classes across their operations dependant on location and circumstance, with each situation supported by the results of a risk assessment using their SMS processes.

2.5.3 To determine that individual operator PC2WE risk mitigation strategies are suitable, the application for approval under regulation 133.015 must contain information prescribed in Subdivision 3 of the Part 133 MOS. Annex B of this AC contains guidance on how to submit your PC2WE application.

2.6 Examples of 'exposure' to engine failure risk

2.6.1 If what would normally be a PC2 take-off, due to a lack of available rejected take-off distance for PC1 operations, is flown outside of the avoid area of the HV envelope, or within the weights and profile of a Category A procedure, but the forced landing area does not allow for 'a reasonable expectancy of no injuries to persons in the aircraft or on the surface', (i.e. there is no suitable forced landing area available) this is PC2WE (e.g. over bush, swamp, rocky ground, houses, public roads etc.).

2.6.2 If a PC2 take-off is flown over a suitable forced landing area, but the take-off is flown inside the avoid area of the HV envelope, when not using an appropriate category A procedure and when not within category A weight/altitude/temperature (WAT) limits, this is PC2WE (e.g. vertical OGE take-off from a football field). As operations within the avoid area of the HV envelope outside of flight manual limitations and procedures, will very likely result in an unsatisfactory forced landing if an engine fails prior to DPATO.

2.6.3 If the take-off is flown over a suitable forced landing area via a published Category A flight path, but the aircraft mass is beyond the Category A WAT mass limits, this is PC2WE (e.g. using a back-up Category A technique to a large hospital helipad when above Category A weight limits).

2.6.4 Where the landing area can provide for a suitable forced landing, but the approach path is not flown via a normal, constant angle approach profile to a zero speed landing, with AEO power less than OEI take-off power, this is PC2WE.

2.7 Rotorcraft permitted to fly in PC2WE

2.7.1 The performance classes exist to provide a measure of safety assurance following an engine failure. A key component of this assurance is the knowledge that the rotorcraft being used is meeting a specified certification standard that represents redundancy of systems, quality of manufacture, and availability of performance data for pilots. For these reasons, only rotorcraft which fall within the definition of a Category A rotorcraft, or others prescribed by a specific instrument issued under regulation 133.015, may be permitted to fly in PC2WE.

2.8 Limitations of exposure

2.8.1 The maximum permitted exposure time must be limited to a period in seconds, as approved by CASA, in accordance with the requirements of meeting a defined target level of safety as described within Section 3 of this document (refer to section 10.11 of the Part 133 MOS).

2.8.2 Part 133 of the CASR details the types of operations where PC2WE, or a higher performance class, is required. This includes:

- reg 133.335 - any operation with maximum operational passenger seat configuration of 10-19 inclusive
- reg 133.335 - any rotorcraft medical transport operation (MTO)
- reg 133.335(1)(c)(ii) and (iii) – any night or IFR operation with passengers.

2.8.3 All obstacles encountered while All Engines Operating (AEO) during the exposure time must be avoided by an adequate vertical margin as defined by the operator (refer to section 10.02 of the Part 133 MOS).

2.8.4 Exposure operations are only permitted before *Defined Point After Take-Off* (DPATO) or after *Defined Point Before Landing* (DPBL). This equates to a maximum height of 300 ft above the *Helicopter Landing Site* (HLS). While above this height, rotorcraft must be flown in accordance with the standard PC2 and PC1 requirements as explained in AC 133-01.

2.8.5 Take-off and landing mass limits are as for PC2, either the more limiting of a mass which will permit OEI, a 150 fpm rate of climb at 1,000 ft above the HLS, or the mass determined by the OEI power required for the procedure. It is recommended for added safety these mass limits should be reduced for operations over populous areas as detailed in the next section below.

2.9 Limitations over populous areas

2.9.1 Operations over populous areas do not change the likelihood of the engine failure risk being realised, but they increase the consequences compared with being outside populous areas. These increased consequences may be realised due to the presence of third parties on the ground or critical public infrastructure (hospitals). For this reason, any operator approved for PC2WE should when operating over populous areas consider further limitations aimed at maximising a pilot’s ability to avoid third parties or property.

2.9.2 For PC2WE operations over populous areas, it is recommended the rotorcraft mass, with the critical power unit inoperative and the remaining power unit at the maximum for the OEI procedure, avoid exceeding the maximum mass specified in the RFM for a climb gradient of 8.0% in still air.

Note: 8.0% climb gradient at a V_{TOSS} of 40 kts equates to 324 fpm rate of climb and will ensure pilots have sufficient power margins to allow increased flexibility in their actions during the exposure time.

2.9.3 If the PC2WE requirements over populous areas mentioned above are not possible, some rotorcraft with a Maximum Operational Passenger Seat Configuration (MOPSC) of nine or fewer, provided the operation permits, may be operated by day under the VFR in accordance with the requirements of PC3. However, although PC3 operations over populous areas are available without a suitable forced landing area, the requirements of section 10.26 of the Part 133 MOS must be met, and it is strongly recommended such operations still identify emergency landing areas for the critical stages of the flight.

2.9.4 Degraded vision at night reduces a pilot's ability to avoid obstacles (while exposed) and select options to minimise the risk to third parties or property. Because of this, PC2WE will not be approved for night Air Transport operations over populous areas unless being conducted by operators who are authorised to use Night Vision Imaging System (NVIS).

2.9.5 In these cases, risk assessment processes are required, and operations must be conducted in accordance with the NVIS requirements in Parts 61, 91 and 133 of the CASR.

3 The application of risk assessment to PC2

3.1 The principle of risk assessment

3.1.1 CASA acceptance of the risk of failure of the critical engine without having a suitable forced landing area is based on the principles of risk management as described in AS/NZS ISO 31000:2018 Risk Management – Principles and guidelines.

3.1.2 Under circumstances where such engine failure risk would be present, operations must be conducted under a specific approval, for example:

- operations to an elevated *Final Approach and Take-off Area* (FATO) – exposure to deck edge strike
- when permitted, operations from a site where a suitable forced landing area is not available because the surface is inadequate
- operations where there is penetration into the avoid area if the HV envelope for a short period during take-off or landing.

3.1.3 Provided these operations listed above are conducted in accordance with this AC and can be conducted to an established safety target, they may be approved via an instrument issued under regulation 133.015 (refer to regulation 133.325).

3.1.4 Approval is based on a risk assessment that includes the mandatory application of five key risk control measures for operations with exposure, all of which are discussed in detail in the following sections:

- A stated target level of safety that represents the likelihood of the engine failure risk being realised during a stage of flight where suitable forced landing areas are not available, or a safe fly-away is not possible.
- A rotorcraft reliability assessment that is used to derive maximum approved exposure times from the safety target.
- Continuing reliability assurance processes to ensure the rotorcraft reliability assessment remains valid.
- Mitigating airworthiness procedures used as an additional control measure aimed at further reducing the likelihood below the safety target.
- Mitigating operational procedures aimed at further reducing the likelihood below the safety target, and also for reducing the consequences of any realised risk.

3.2 The target level of safety (TLS)

3.2.1 The TLS establishes the probability of an engine failure occurring within the period of time where a safe continuation of flight, or a safe forced landing to a suitable forced landing area is not possible. This is known as the exposure time (refer to section 10.11 of the Part 133 MOS). In keeping with a number of international National Aviation Authorities, CASA considers a TLS of 5×10^{-8} (1:20 million) as an acceptable residual risk of engine failure within the defined stages of flight which allow PC2WE, for a well-maintained turbine powered rotorcraft operated in accordance with this AC.

3.2.2 Most modern rotorcraft, with well-maintained turbine engines, are assumed to be able to achieve an engine failure rate of less than 1:100,000 flight hours. On this assumption, a calculation can be made to determine that a nine-second exposure time for a multi-engine helicopter results in a 1:20 million probability of an engine failure occurring during that nine seconds (derivation as follows):

$$T_{max} = (100{,}000 \times 3{,}600 \times k \times RA) / (n \times PR \times F)$$

$$= (360{,}000{,}000 \times 1 \times 1/20{,}000{,}000) / (2 \times 1 \times 1) = 9 \text{ seconds}$$

Where:

T_{max} = maximum permitted exposure time

k = Confidence factor (between 0 and 1) – taken as being 1

R_A = probability of power unit failure during the exposure time (safety target)

n = number of engines

P_R = power unit failure rate per 100,000 hours

F = High power correction factor – taken as being 1

3.2.3 In line with the calculations above, if the demonstrable engine failure rate is 0.25 per 100,000 flight hours, the acceptable exposure time to achieve a 1:20 million TLS would be 36 seconds. Based on an Australian fleet-wide assessment, operators are permitted to increase their exposure time beyond nine seconds to maximum of 36 seconds using known engine failure data, provided the TLS is still met. As PC2WE operations mature over time this figure may be further reviewed based on available data indicating additional variations can be supported.

3.3 Reliability assessment

3.3.1 The TLS can only be validated by assessing the reliability of specific models of rotorcraft and their engines. For this reason, operators wishing to conduct PC2WE operations are required to access manufacturer's power loss data to accurately establish the engine failure rates as being not greater than 1:100,000. This data which is known as a Power-loss Exposure Risk Report (PERR) is available on request from the rotorcraft *Original Equipment Manufacturer* (OEM).

3.3.2 If the PERR only indicates the rotorcraft engine/airframe combination is compliant with the requirements of Appendix 1 to JAR-OPS 3.517(a) or with the requirements of CAT.POL.H.305 of the EU-OPS and not the actual failure rate per 100,000 hours, this would limit the rotorcraft to the generic nine-second exposure period which is the basis of this legislation.

3.3.3 Therefore, for operations as described in 3.2.3 above with extended exposure periods, the actual engine failure rate per 100,000 flight hours will be required to demonstrate the continuity of the TLS for the operation and the rotorcraft type and model.

3.3.4 When requesting this data from OEM's, operators are recommended to ask for the following information:

- By type and model of rotorcraft (and engine type if variable): the latest version of the EASA CAT.POL.H – Powerplant sudden in-service power loss calculation.
- If this specific data is not available: a letter with information confirming that the type and model of rotorcraft meets the requirements of EASA-OPS Part CAT (EU Regulation n° 965/2012) CAT.POL.H.305(b).

> **Note:** EASA AMC1 CAT.POL.H.305 (b) paragraph (e) outlines that the OEM and/or the type certificate holder (TCH) has a shared role with the operator in providing this information and to calculate the in-service sudden power loss rate for certain engine/helicopter families.

3.4 Continuing reliability assurance

3.4.1 It is not sufficient to rely on a snapshot of rotorcraft reliability in terms of power loss and a rolling five-year average reliability assessment must be obtained each year. This will identify upwards or downwards trends in reliability and allow operators to adequately adjust their procedures where necessary.

3.4.2 For new types and new engine airframe combinations that are yet to establish and five-year reliability history, CASA will assess these on a case-by-case basis in conjunction with the certifying National Aviation Authority (NAA).

3.5 Mitigating procedures (airworthiness)

3.5.1 Mitigating airworthiness procedures are required and consist of a number of elements:

- the fulfilment of all manufacturer's safety modifications
- a comprehensive reporting system for failures and usage data, and
- the implementation of an engine usage monitoring system (UMS).

3.5.2 Each of these elements is to ensure that engines, once shown to be sufficiently reliable to meet the safety target, will sustain such reliability (or improve on it). The monitoring system is felt to be particularly important, as it has already been demonstrated that, when such systems are in place, it encourages a more considered approach to operations.

3.6 Mitigating procedures (operations)

3.6.1 Operational and training procedures to mitigate the risk – or minimise the consequences – are required of the operator. Such procedures are intended to minimise risk by ensuring that:

- the rotorcraft is operated within the exposed region for the minimum time, and
- simple but effective procedures are followed to minimise the consequence should an engine failure occur.

4 Engine reliability statistics

4.1 Operator requirements

4.1.1 As part of the risk assessment when applying for an approval for PC2WE, the operator should provide CASA with appropriate engine reliability statistics for the rotorcraft type and the engine type. This data is available from the rotorcraft OEM or TCH and is in line with the requirements of EASA AMC/GM to Annex IV (Part-CAT), AMC1 CAT.POL.H.305(b) and previous JAR-OPS 3 Subpart H, ACJ-1 to Appendix 1 to JAR-OPS 3.517(a).

> **Note:** Subsection 3.3.4 has further details on how to make this request to OEM's and TCH's.

4.1.2 In situations where the operator cannot gain access to the actual failure rate per 100,000 flight hours, CASA may be able to access this information directly from the OEM.

4.1.3 Except in the case of new engines, the PERR data should show sudden power loss from the set of in-flight shutdown (IFSD) events not exceeding one per 100,000 engine hours in a five-year moving window. However, a rate slightly in excess of this value may be accepted by CASA after an assessment showing an improving trend. While acceptance of such variations in the IFSD is possible, CASA will consider the potential for heightened exposure of third-party persons and facilities a priority in such assessment and may need to impose safety conditions to manage the level of exposure of the operation.

4.1.4 New engines should be assessed on a case-by-case basis.

4.1.5 After the initial assessment, updated statistics should be periodically reassessed. Any adverse sustained trend will require an immediate evaluation to be accomplished by the operator in consultation with CASA and the manufacturers concerned. The evaluation may result in corrective action or operational restrictions being applied.

4.1.6 Where data for the rotorcraft and engine type can demonstrate sudden power loss rates of less than one per 100,000 engine hours, this lesser figure may be used in determining the exposure time for the specified safety target. Power loss rates of less than 0.25 per 100,000 engine hours must not be used in determining exposure time.

4.2 Requirements on rotorcraft Type Certificate Holders (TCH)

4.2.1 The purpose of this section is to provide guidance for TCH on how the in-service power plant sudden power loss rate is determined. In this determination, there should be shared roles between the rotorcraft and engine type certificate holders. This information may also be of interest to operators using PC2WE.

4.2.2 Documents should be provided to CASA establishing the in-service sudden power loss rate for the rotorcraft/engine installation. Such documents should be provided by the engine TCH or the rotorcraft TCH, depending on the way they share the corresponding analysis work. For reasons of maintaining commercial confidentiality, these documents are not required to be presented to rotorcraft operators, unless OEMs allow such data sharing. PC2WE will not be approved for a rotorcraft unless the TCH provides the data described in this section.

4.2.3 The engine TCH should provide the rotorcraft TCH with a document including:

- the list of in-service power loss events
- the applicability factor for each event (if used), and
- the assumptions made on the efficiency of any corrective actions implemented (if used).

4.2.4 The engine or rotorcraft TCH should provide CASA with a document that details the calculation results taking into account:

- events caused by the engine and the events caused by the engine installation
- applicability factor for each event (if used), the assumptions made on the efficiency of any corrective actions implemented on the engine and on the rotorcraft (if used), and
- calculation of the power plant power loss rate.

4.2.5 The following documentation should be updated every year:

- the document with detailed methodology and calculation as distributed to the authority of the State of design
- a summary document with results of computation, and
- a service letter establishing the eligibility for PC2WE and defining the corresponding required configuration as provided to the operators.

4.2.6 Sudden in-service power loss is an engine power loss:

- larger than 30 % of the take-off power
- occurring during operation, and
- without the occurrence of an early intelligible warning to inform and give sufficient time for the pilot to take any appropriate action.

4.2.7 Each power loss event should be documented, by the engine and/or rotorcraft TCHs, as follows:

- incident report number
- engine type
- engine serial number
- rotorcraft serial number
- date
- event type
- presumed cause
- applicability factor when used, and
- reference and assumed efficiency of the corrective actions that will have to be applied (if any).

4.2.8 Various methodologies for counting engine power loss rates have been accepted by authorities. The following is an example of one of these methodologies:

- The events resulting from:
  - unknown causes (wreckage not found or totally destroyed, undocumented or unproven statements), or
  - where the engine or the elements of the engine installation have not been investigated (e.g. when the engine has not been returned by the customer), or
  - an unsuitable or non-representative use (operation or maintenance) of the rotorcraft or the engine

  are not counted as engine in-service sudden power loss and the applicability factor is 0%.
- The events caused by:
  - the engine or the engine installation, or

  - the engine or rotorcraft maintenance, when the applied maintenance was compliant with the maintenance manuals,

are counted as engine in-service sudden power loss and the applicability factor is 100%.

- For the events where the engine or an element of the engine installation has been submitted for investigation, but where this investigation subsequently failed to define a presumed cause, the applicability factor is 50%.

4.2.9 The corrective actions made by the engine and helicopter manufacturers on the definition or maintenance of the engine, or its installation, may be defined as mandatory for specific operations. In this case, the associated reliability improvement may be considered a mitigating factor for the event. A factor defining the efficiency of the corrective action may be applied to the applicability factor of the concerned event.

4.2.10 The detailed method of calculation of the power plant power loss rate should be documented by engine or helicopter TCH and accepted by CASA.

5 Ongoing engine airworthiness requirements

5.1 Airworthiness conditions of approval for PC2WE

5.1.1 The rotorcraft operator must attain and then maintain the helicopter/engine modification standard defined by the manufacturer, including where that standard has been specifically designated to enhance reliability during the take-off and landing phases.

5.2 Preventative maintenance

5.2.1 Operators must conduct the preventive maintenance actions recommended by the helicopter or engine manufacturer as follows:

- engine oil spectrometric and debris analysis, where the OEM specifies a system or process for collection, analysis and interpretation of such data
- engine trend monitoring, based on available power assurance checks
- engine vibration analysis (plus any other vibration monitoring systems where fitted), and
- oil consumption monitoring.

5.3 Usage monitoring system (UMS)

5.3.1 The UMS should fulfil at least the requirements of this subsection.

5.3.2 The following data should be recorded:

- date and time of recording, or a reliable means of establishing these parameters
- amount of flight hours recorded during the day plus total flight time
- N1 (gas producer RPM) cycle count
- N2 (power turbine RPM) cycle count (if the engine features a free turbine)
- turbine temperature exceedance: value, duration
- power-shaft torque exceedance: value, duration (if a torque sensor is fitted)
- engine shafts speed exceedance: value, duration.

5.3.3 Data storage of the above parameters, if applicable, should cover the maximum flight time in a day, and not less than five flight hours, with an appropriate sampling interval for each parameter.

5.3.4 The system should include a comprehensive self-test function with a malfunction indicator and a detection of power-off or sensor input disconnection.

5.3.5 A means should be available for the download and analysis of the recorded parameters. Download frequency should be sufficient to ensure data are not lost through overwriting.

5.3.6 The analysis of parameters gathered by the UMS, the analysis methodology and the frequency of such analysis should be described in the operator's exposition UMS management procedures, and any subsequent maintenance actions generated by that analysis must be described in the aircraft's maintenance documentation.

5.3.7 The data should be stored in an acceptable form and accessible to CASA for at least 24 months.

5.3.8 Where a Full Authority Digital Engine Control (FADEC) system is already being used to record some of the parameters described in this subsection, it is not intended that recording of those parameters are duplicated with an alternative device.

5.3.9 For rotorcraft which do not have installed UMS, off the shelf products such as an airborne image recording system (AIRS) with the capability to record and store images, and which permit the download and analysis of the parameters outlined above (as applicable to the rotorcraft) may be suitable for this task.

5.3.10 Where an AIRS is used to meet the UMS requirements, operators need to be aware of the limitations relating to such devices that are contained in Part IIIB *Protection of CVR (Cockpit Voice Recording) Information* of the *Civil Aviation Act 1988* (the Act). In order to be able to use an AIRS to satisfy the UMS requirements without contravening this Part of the Act, the images recorded of the flight deck would need to be limited to images of the instrument panel only. Any images of persons on the flight deck would need to be limited to transient images only, for example a hand adjusting the QNH on an altimeter. If the AIRS has the function, any recording of ambient flight deck sounds would need to be disabled so that the information recorded does not constitute *CVR information*[1].

5.3.11 Any UMS to be utilised in PC2WE operations must remain, a reliable, accurate, comprehensive and continuously operating system. Paragraph 10.22(b) of the Part 133 MOS requires the operator to supply information in their PC2WE application to CASA demonstrating that this is the case.

5.4 Power loss reporting

5.4.1 Operators must report to the manufacturer on any loss of power control, engine shutdown (precautionary or otherwise), or engine failure for any cause (excluding simulation of engine failure during training). The content of each report should provide:

- date and time
- operator (and maintenance organisations where relevant)
- type of rotorcraft and description of operations
- registration and serial number of the airframe
- engine type and serial number
- power unit modification standard where relevant to failure
- engine position
- symptoms leading up to the event
- circumstances of engine failure including phase of flight or ground operation
- consequences of the event
- weather/environmental conditions
- reason for engine failure (if known)
- in case of an in-flight shutdown (IFSD), nature of the IFSD (demanded/un- demanded)
- procedure applied and any comment regarding engine restart potential
- engine hours and cycles (from new and last overhaul)

1 The phrase *CVR information* is defined in section 32AN of the Act, and that the term *CVR* or *cockpit voice recording* is also defined in section 32AO of the Act. The definition of *CVR* is used solely within Part IIIB of the Act and this definition does not legally apply to the mentions of CVR in the regulations and manuals of standards.

- airframe flight hours
- actions applied including, if any, component changes with part number and serial number of the removed equipment, and
- any other relevant information.

6 Requirements for operational mitigation

6.1 Development of operational procedures

6.1.1 Rotorcraft operators must carefully consider their rotorcraft type and operating environments before developing procedures for PC2WE and seeking approvals. The aim is to adopt take-off and landing flight profiles that minimise the exposure time wherever possible. It should be possible to demonstrate to CASA how these flight profiles, across a range of operating conditions, keep the exposure time low enough to ensure the 1:20 million TLS is being met.

6.1.2 Some rotorcraft may only have a nine-second exposure time available to work within. In these cases, flight profiles must be selected to ensure either a suitable forced landing area can be utilised, or a safe *One Engine Inoperative* (OEI) climb is achievable, before the nine seconds has expired. This may only be feasible with a normal angle IGE-type take-off where rapid acceleration to V_{TOSS} is possible. Vertical take-offs from confined areas often take much more than nine seconds before V_{TOSS} is achieved, so may not be a viable option.

6.1.3 Some rotorcraft manufacturers of modern rotorcraft will provide specific procedures designed to meet exposure requirements. These should be used wherever practical. These procedures may be called 'PC2 Defined Limit of Exposure (DLE)'.

6.1.4 Rotorcraft with demonstrable engine failure rates of much less than 1:100,000 may have the ability to utilise exposure times up to 36 seconds. In these cases, there is much more flexibility with the procedures adopted and vertical take-offs from enclosed confined areas may become practical alternatives. In all cases, from 300 ft above the HLS, the rotorcraft must be capable of continuing a safe OEI climb in accordance with PC2 climb requirements of section 10.38 of the Part 133 MOS. In these more flexible situations, the decision about what profile and operational procedure is the most appropriate for each specific location, on any given day, can only be made by the operator developing appropriate operational planning and decision-making processes within their PC2WE exposition procedures for the use of their flight crew.

6.1.5 During an approach to land, if RFM Category A weights and procedures are being met (this may not mean PC1), it is always possible to reach the FATO no matter where the engine fails on approach. In these cases, there is zero exposure time, provided the FATO is a suitable forced landing area. For some hot/high/heavy non-Category A approaches, there may be periods where there is insufficient height or speed energy to allow a safe baulked landing or to allow the rotorcraft to reach the FATO. Profiles should be adopted that aid in minimising this time.

6.1.6 There are two key questions for exposure following an engine failure during landing where there are no suitable forced landing areas surrounding the FATO:

- Does the rotorcraft have the speed and/or height energy available to allow a safe OEI fly-away?

  and

- Does the approach profile and power requirements allow the pilot to achieve a safe zero speed OEI landing?

Exposure will be present if the answer to both questions is NO.

6.1.7 Guidance for the speed and/or height energy requirements can come from RFM landing procedures and with knowledge of OEI climb performance. For example, provided the speed is not below V_{TOSS}, and 35 ft obstacle clearance is maintained, there is no exposure. Maintaining V_{TOSS} until as late as possible will delay the commencement of exposure but may introduce other hazards associated with losing sight of the HLS and potential obstacle strikes.

6.1.8 Reaching the HLS following an engine failure is more difficult in the hot, high and heavy environment. Shallow, faster approaches provide a measure of assurance due to lower power demands but require a largely obstacle free surrounding area. Steeper approaches may more easily reach the helipad, but there remains a risk of excessive rate of descent with a resulting excessively hard landing. Procedures should be chosen that best suit the AEO and OEI performance of the relevant rotorcraft for the operating environment. As a guide, if an approach technique is flown where the total AEO power required is no more than the OEI take-off power available, until over the helipad, then the helipad can at least be reached albeit with a possible hard, but safe, landing.

6.2 Training in operational procedures

6.2.1 Development of operational procedures for PC2WE will be driven by:

- the rotorcraft type
- the operating environment, and
- the requirements of the task.

These issues all require specific pilot training processes to be put in place.

6.2.2 Operators must detail within their exposition, pilot induction and recurrent training to cover at least the following elements of PC2WE:

- differences between PC2 and PC2WE
- understanding of when a rotorcraft is exposed to the risk of engine failure
- knowledge of the limitations for approval of PC2WE
- take-off and landing techniques to be applied for the range of expected heliports
- understanding of the PC2 climb performance requirements prior to exposure commencing on approach, or after exposure finishes on take-off, and
- detailed discussion around PC2WE from different types of heliports.

6.3 Requirement for risk assessments

6.3.1 Any operator conducting PC2WE operations will require a formalised risk assessment process within their exposition for the application of PC2WE to their particular operational situations. This risk assessment may form part of the operator’s overall risk management processes contained within their SMS, but should include identification of the hazards particular to their operations with exposure plus outline control measures put in place to mitigate the risk.

6.3.2 Operators wishing to conduct PC2WE operations should consider the following points when developing their risk assessment:

- the consequence of the engine failure risk being realised over critical public infrastructure
- the consequence of the impact of rotor downwash and outwash during PC2WE on persons and things during approach and landing and take-off and climb from PC2WE operating sites
- identifying possible heliports where PC2WE will not be used due to excessive risk
- for night operations consideration of the benefits of the use of NVIS to aid with obstacle avoidance and flight path management
- development and publication of OEI escape manoeuvre flight paths for specific heliports
- the potential benefits of the use of full-motion Level-D flight simulator modelling of critical heliports and regular pilot training in low speed OEI handling and escape manoeuvres in these devices

- methods of minimising or removing exposure by operating within Category A helipad weight limits and procedures, and
- regular pilot competency checks to confirm adherence to company procedures to/from critical heliports.

7 PC2WE operations to/from non-confined area ground level helipads

7.1 Open areas unsuitable for forced landings

7.1.1 PC2WE may be relevant for non-confined area ground level helipads over areas of flat ground or water where the potential reject area does not constitute a suitable forced landing area. This may be due to excessive vegetation, rocky/uneven conditions, rough seas, or water areas where flotation systems are not available. However, the low height of obstacles might allow Clear Area Category A flight paths, or normal IGE take-offs or landings to be performed (these may also be known as oblique or Cat B take-offs and landings).

7.2 Operations within Clear Area Category A weight limits

7.2.1 Assuming the rotorcraft is operating within the RFM Clear Area Category A weights, and following the published Category A flight paths, the exposure time will commence once there is insufficient FATO or clearway remaining to allow for a rejected take-off. This could be as early as the rotate point (Figure 1 below), or after some greater distance (Figure 2 below), depending on the particular heliport.

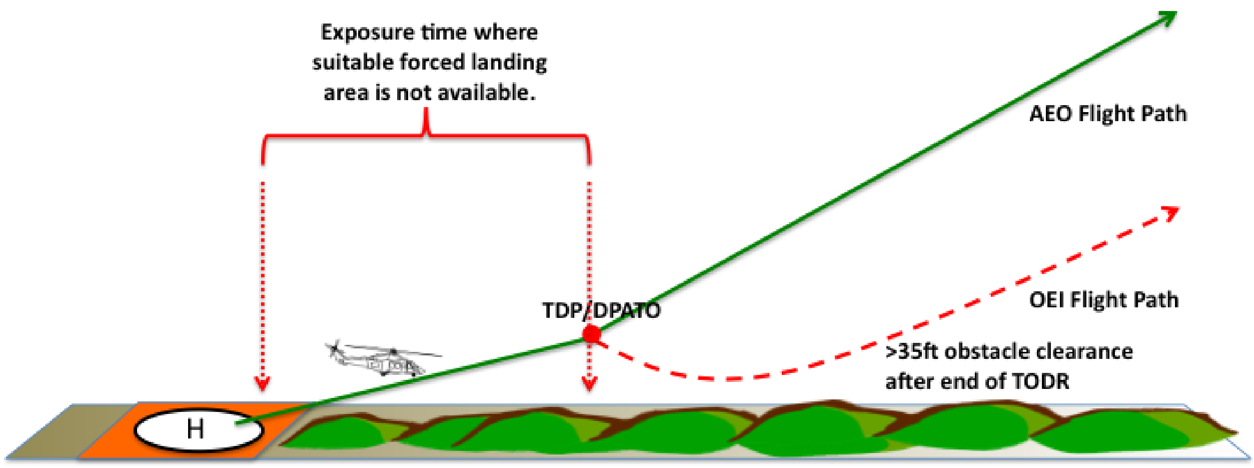


Figure 1: Exposure within Category A weight limits

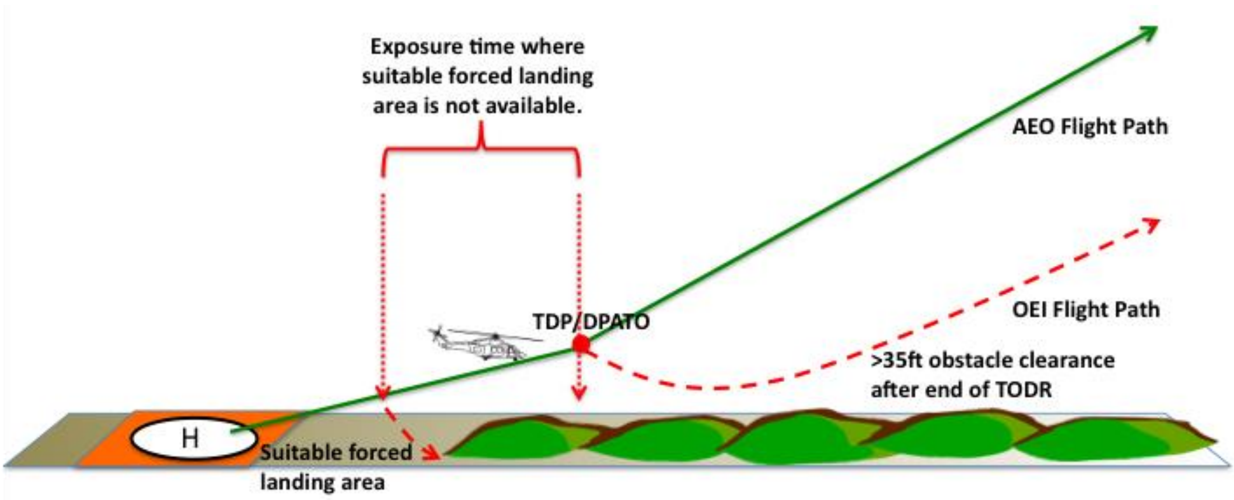


Figure 2: Partial exposure on take-off

7.2.2 The exposure time can finish once the rotorcraft is at *Take-off Decision Point* (TDP) for the procedure, from which point a safe OEI climb will be achievable, and supportable with RFM Category A data. In some cases, obstacles in the take-off path may require more height to be gained, beyond the TDP, before the exposure time can be finished and a safe OEI climb conducted (Figure 3 below). In this case, the DPATO is the point where V_{TOSS} is achieved and 35 ft clearance from obstacles can be continuously maintained.

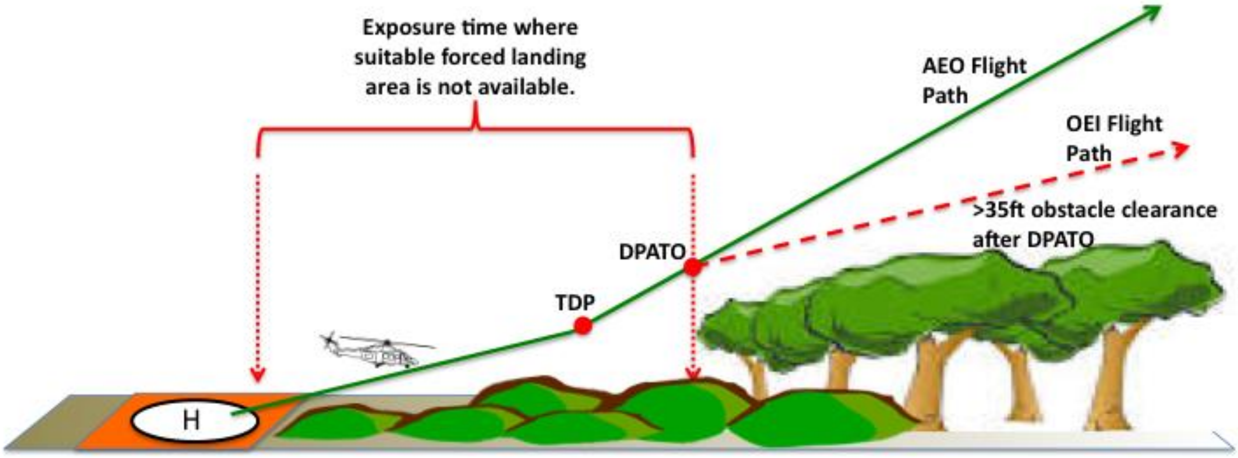


Figure 3: Increased exposure time due to obstacles

7.2.3 The point from which the rotorcraft can comply with all the obstacle clearance requirements of a PC2 climb usually marks the end of the exposure time, and it is also the DPATO. However, in some cases, where suitable forced landing areas become available after clearing unsuitable areas (e.g. across rough terrain or rivers), the exposure time could finish before DPATO (Figure 4 below).

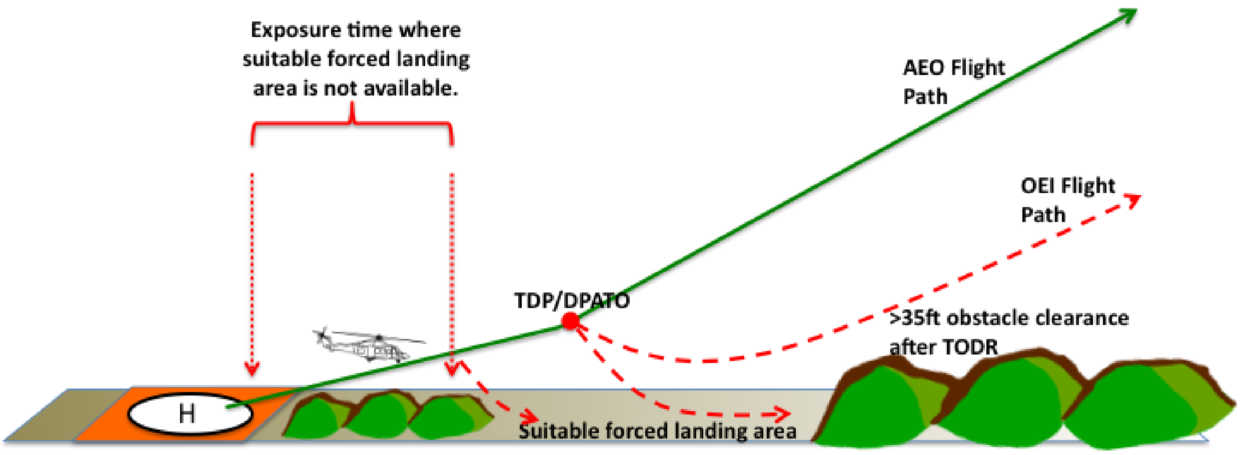


Figure 4: Exposure Finishing before DPATO

7.2.4 Unless the end point of the exposure time coincides with the TDP, the position of the DPATO must be based on achievement of a valid V_{TOSS} and a positive climb 35 ft clear of obstacles. However, it must be no higher than 300 ft above the heliport. In all cases, the pilot should consider the rotorcraft performance and topography to keep the exposure time less than the approved maximum.

7.2.5 When within the Clear Area (Runway) Category A weights, but without sufficient flight manual required landing distance available, it is considered acceptable to have no exposure (therefore PC2) provided a normal, constant angle flight path is flown. Below the LDP, it may not be possible to conduct a safe baulked landing, therefore the LDP will become a 'committal point' after which a landing must occur. Beyond this committal point, it is accepted that any engine power loss can still be carried safely through to a safe touchdown. Despite the insufficient Category A landing distance available, the FATO may still be considered a suitable forced landing area provided the pilot uses correct power management and a 'zero speed' touchdown technique.

7.2.6 In cases with high obstacles beyond the FATO, the committal point might be prior to the LDP. However, electing to continue an OEI landing from higher than the Category A LDP remains without exposure, as discussed in 7.2.5 above.

8 PC2WE to/from confined area ground level helipads

8.1 Introduction

8.1.1 PC1 may not be possible from confined ground level helipads due to excessive rotorcraft weight, lack of a formal survey or the complexity of obstacles surrounding the helipad. PC2 is only possible if an operator survey or pilot assessment has been conducted, and helipad Category A weights and procedures can be complied with.

8.1.2 Therefore, PC2WE will primarily be required from confined area ground level helipads when Category A weights and procedures cannot be complied with.

8.1.3 Rotorcraft manufacturers often provide Category A data for ground level helipads. Generally, there are two different types of take-offs that could be described: vertical (short field) take-off, and the back-up take-off. Vertical take-offs usually require a lower TDP (due to less height loss), but the TDP height may be limited by the dimensions of the FATO, and the ability to maintain visual cues. The back-up take-off requires a higher TDP (due to more height loss), but because vision of the helipad is maintained, the TDP height may be raised to allow for obstacles in the take-off path. A back-up take-off will also need consideration of obstacles within the back-up zone.

8.2 Exposure during take-offs from ground level helipads within Category A weights

8.2.1 If Category A weight and available space limits and procedures are complied with for vertical or back-up take-offs, and sufficient height loss is available from TDP for a safe OEI fly-away, this could be PC1 or PC2 (depending on the obstacle survey) but it is not PC2WE.

8.2.2 If obstacles ahead require the TDP to be raised to achieve 35 ft obstacle clearance, but the RFM does not allow this, exposure will commence from the TDP. A pilot may elect to continue the vertical/back-up climb (above TDP) to a height where the known RFM height loss (if available) could ensure 35 ft obstacle clearance (Figure 5 below), in which case the exposure is from TDP up to the pre-determined Rotate Point (RP). If a rejected take-off is conducted from above TDP, without the support of the RFM, the potential rate of descent build-up may result in a hard landing beyond the ultimate load limits (Figure 5 below).

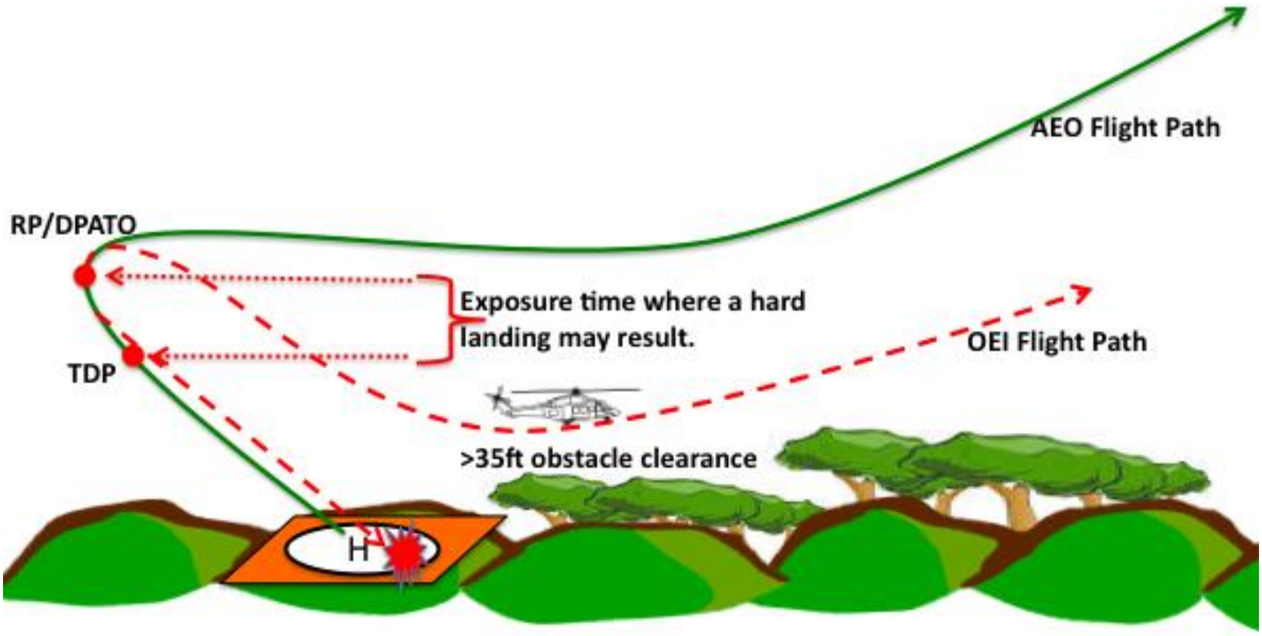


Figure 5: Exposure to hard landing above TDP

8.2.3 Alternatively, the pilot could elect to rotate from TDP and, due to insufficient drop-down height available, the exposure will be present from rotate until a V_{TOSS} climb 35 ft clear of obstacles is achieved (Figure 6 below). In these two cases, the choice of which exposure to accept may be driven by the anticipated consequences to any persons on the ground or in the rotorcraft, and also by the time period required to climb above TDP compared with accelerating to V_{TOSS}.

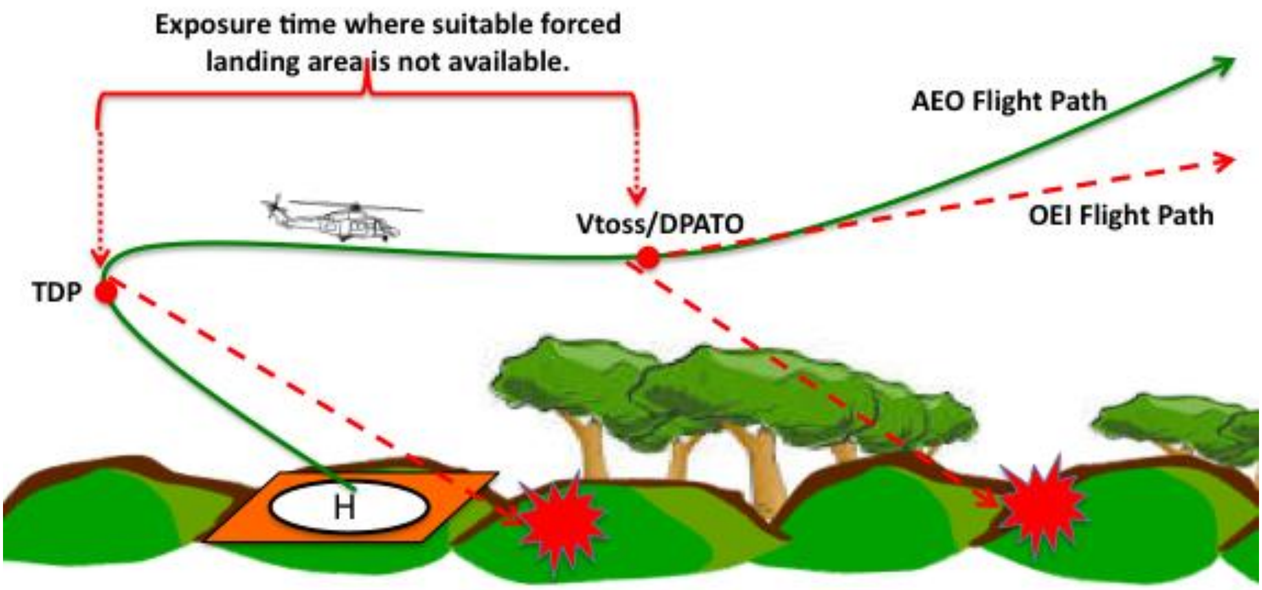


Figure 6: Exposure after the Rotate Point (RP) with insufficient drop-down

8.3 Exposure during take-offs from ground level helipads above Category A weights

8.3.1 For many rotorcraft types, operations from confined area ground level helipads are conducted above helipad Category A weight limits. If Category A helipad weight limits and procedures cannot be complied with, and suitable forced landing areas are not available, this becomes PC2WE. In these operations, the exposure is present for the possibility of:

- penetration into the avoid area of the HV envelope during take-off and landing, and/or
- a forced landing to an unsuitable forced landing area.

8.3.2 If a vertical or back-up take-off procedure is used, exposure will be from the point of entry into the avoid area of the HV envelope (often 15-20 ft) until established in a V_{TOSS}/V_Y climb 35 ft clear of obstacles (a clear area CAT A V_{TOSS} could be a valid speed to use and keeps the exposure time lower). For take-offs from confined areas with high obstacles, long exposure times may result, so determinations may be needed regarding maximum rotate heights to ensure exposure limits are not exceeded. For example, if the operator knows that V_{TOSS} can be achieved from an OGE rotate point with a level acceleration in about five seconds, and the exposure time limit is 18 seconds, then a 13-second vertical component would be the limit. In 13 seconds, only 65 ft of vertical component is achievable with a 300 fpm rate of climb.

8.3.3 In circumstances where there is a rich variety of lateral cues, vertical, instead of back-up take-offs may be preferable from ground level helipads. Vertical take-offs require fewer control inputs, allow faster accelerations, and are at less risk of obstacle strikes to the rear. To minimise exposure time, the rotate point should be at the point where all obstacles can be avoided AEO by an adequate vertical margin and a near-level acceleration can be achieved (Figure 7 below).

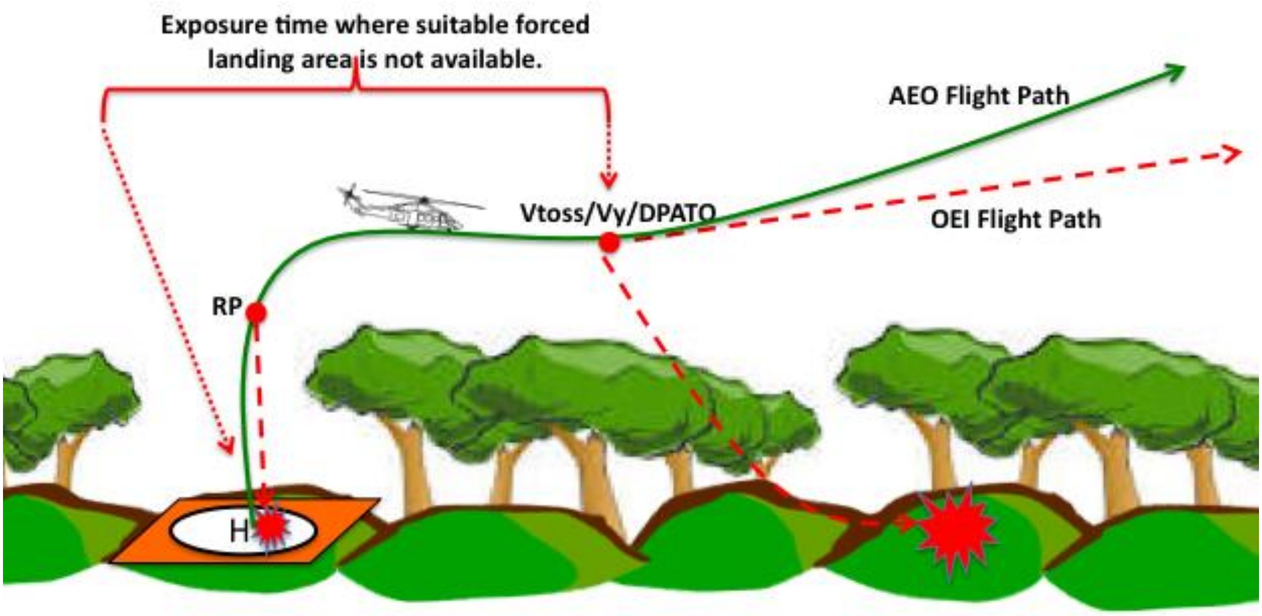


Figure 7: Non-Category A helipad vertical take-off

8.3.4 In some circumstances, a confined area ground level helipad may allow scope for an angled departure, as shown in Figure 8 below. This will reduce overall exposure time by allowing a faster acceleration to V_{TOSS}/V_Y. However, careful consideration should be given to the consequences of a rejected landing to an area off the FATO. In some circumstances, where those consequences may be fatal to rotorcraft occupants or persons on the ground, it would be prudent to accept the longer exposure time (within limits) provided by the pure vertical take-off.

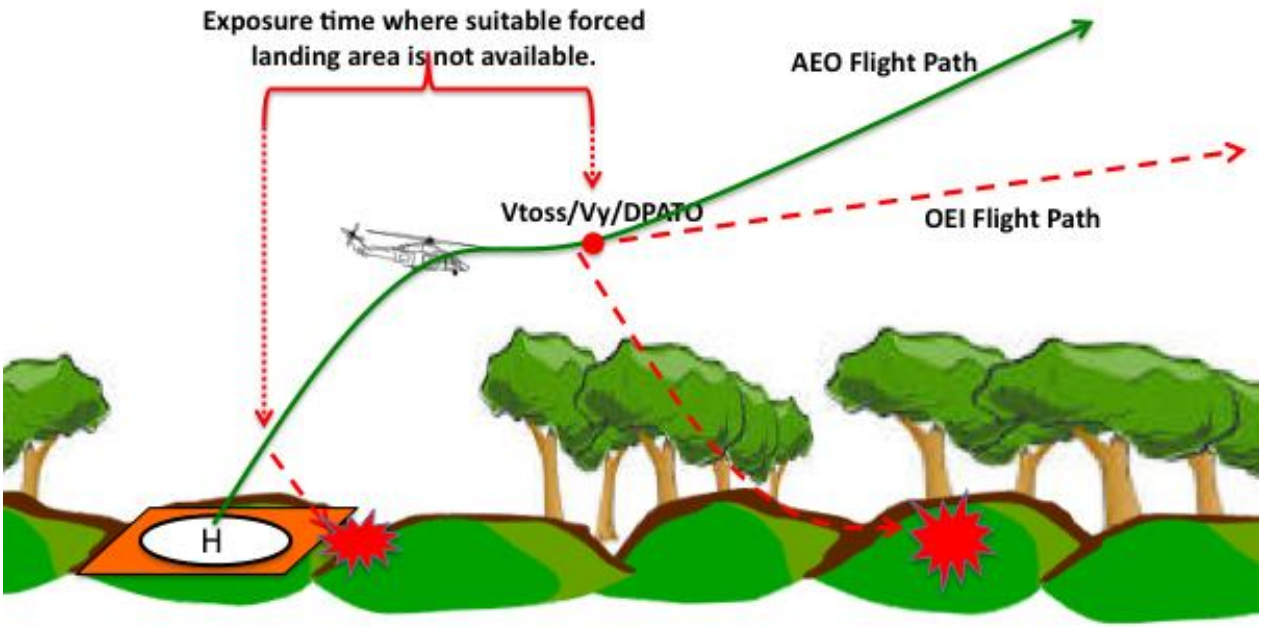


Figure 8: Non-Category A helipad angled take-off

8.3.5 Figure 9 below shows another example from a football field where the initial take-off can remain outside the avoid area of the HV envelope, and suitable forced landing areas can be used. This could allow a more rapid early acceleration before commencing a steeper climb to clear obstacles then acceleration to V_{TOSS}/V_Y. In this case, exposure commences at the last point the pilot assesses that a reject is possible. Once again, the consequences of a reject from this type of take-off should be carefully considered.

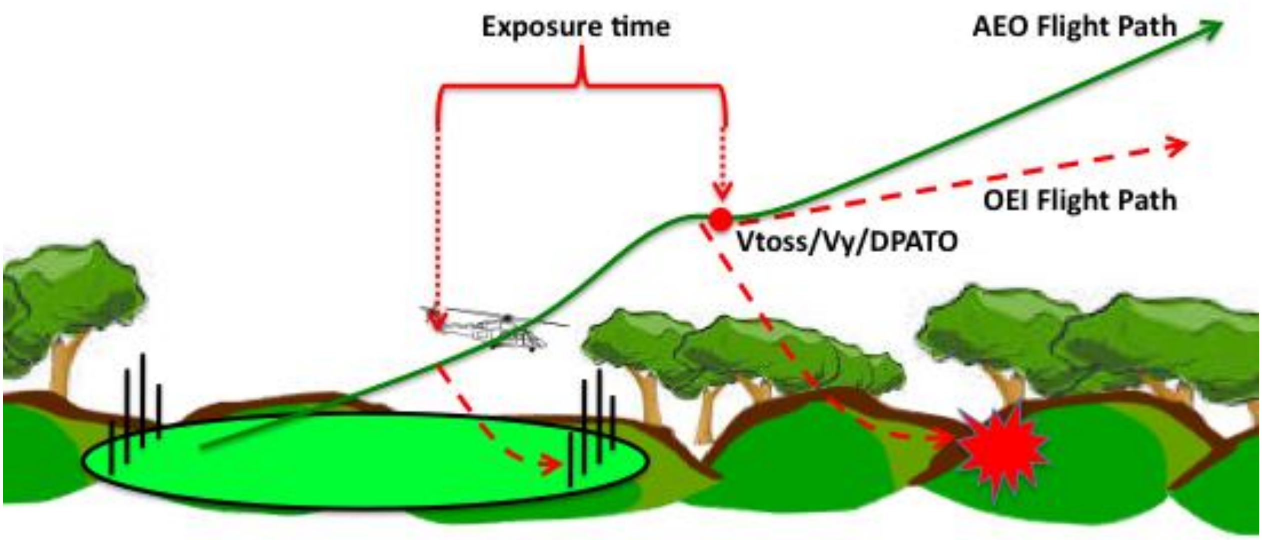


Figure 9: Delayed commencement of exposure

8.4 Exposure during approach and landing to confined area ground level helipads

8.4.1 Where RFM Category A weights and procedures can be followed, PC1 or PC2 operations without exposure may be possible depending on the formality of the surveys. Where they are not possible, there are two main scenarios of exposure:

- within helipad Category A weights but with insufficient height from LDP to achieve a baulked landing, and
- above helipad Category A weights.

8.4.2 When within Helipad Category A weights, there is no exposure provided that the correct flight path is flown (PC2). However, where there are obstacles beyond the FATO, and where the RFM procedure does not allow the LDP to be elevated, it may not be possible to conduct a safe baulked landing from LDP. In these cases, there will be a committal point at the LDP equivalent speed/height above the obstacles, after which a baulked landing is not possible. Beyond this committal point, it is accepted that any engine power loss can still be carried safely through to touchdown, provided the category A speed, height and rate of descent parameters are maintained (Figure 10 below).

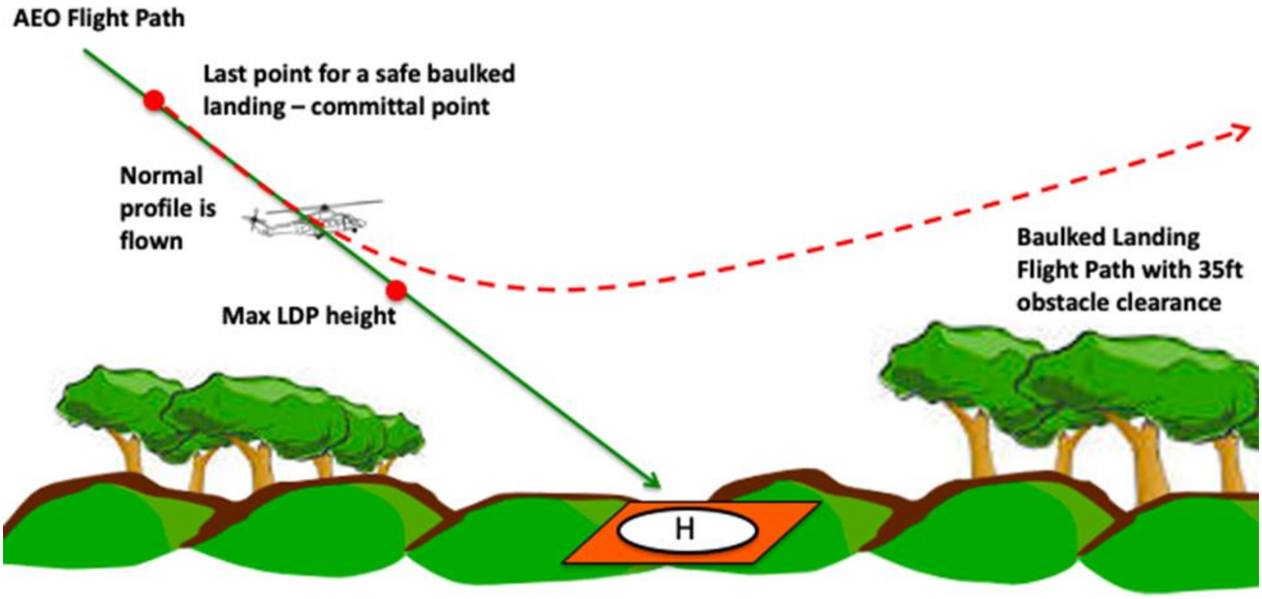


Figure 10: Nil exposure with height limited LDP

8.4.3 If the Figure 10 profile above is being flown, when above Helipad Category A weights, it may be advantageous to use Clear Area (Runway) Category A V_{TOSS} speeds for guidance on the committal point. Below this point, a baulked landing is not safe. At the expected HOGE weight limits for PC2WE, even if above helipad category A weights, it is considered acceptable to carry an engine power loss through to an OEI landing without having any exposure. Though this approach profile may penetrate the avoid area of the HV envelope, the combination of a HOGE power margin, low power and a normal, constant angle descent profile all contribute to an expectation that the helipad could be reached.

8.4.4 If the obstacle and visual cue environment permits the conduct of a double-angle approach into a confined area, with the first stage being a normal angle approach, exposure will be from the point of deceleration through V_{TOSS}, with 35 ft obstacle clearance, until touchdown (Figure 11 below). Category A height loss data can also be derived from the relevant LDP, and this can aid in providing guidance for the last safe point where a baulked landing could be conducted.

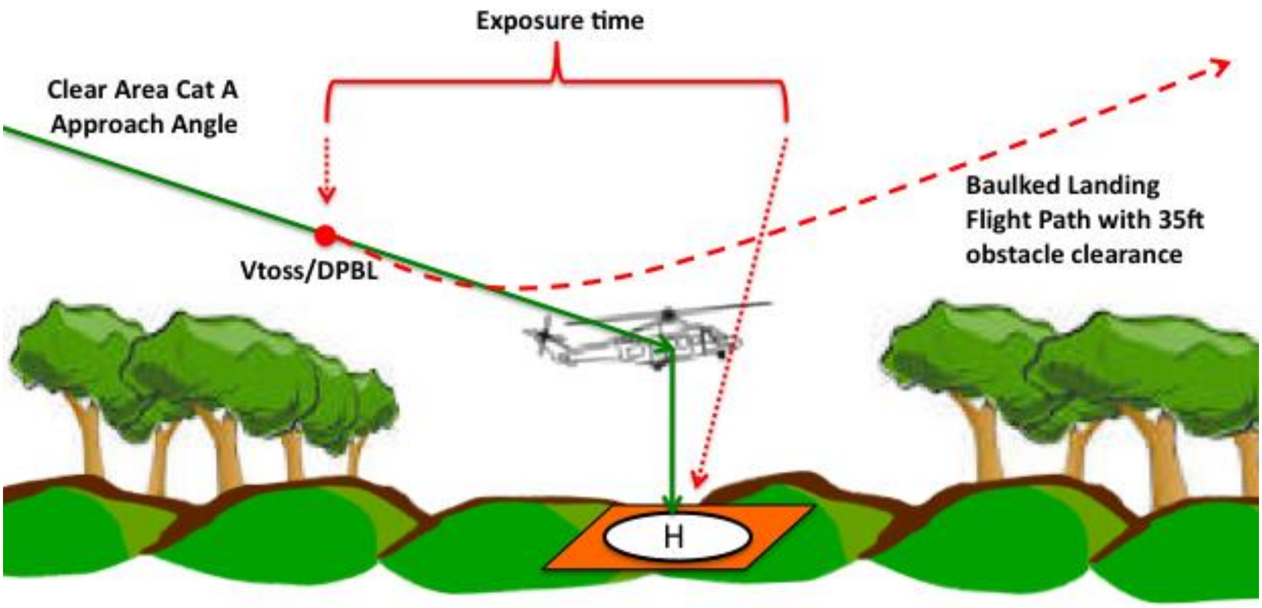


Figure 11: Exposure during helipad approach using Clear Area V_{TOSS}

8.4.5 Double angle approaches above helipad Category A weights may prevent PC2WE operations to such sites. To safely conduct a dynamic approach to HOGE, establish suitable hover markers and then conduct a vertical descent to landing within the exposure window may not be possible to achieve. Operators must carefully consider the performance parameters they permit for double angle PC2WE, if they choose to use this option in their operations.

8.4.6 Adoption of 'quick-stop' or autorotation profiles (to maintain speed for as long as possible) **should not be conducted** due to the high potential for pilot mishandling, hard landings, overshooting the helipad and/or tail strikes.

9 Operations from elevated heliports, helipads or helidecks

9.1 Introduction

9.1.1 PC1 is not traditionally a standard that is applied to offshore helidecks or vessels due to the complexities around obstacles and their likely infringement on the Category A flight paths. However, some newer types with improved performance and procedures make this more feasible in the future. Many types will therefore require PC2 or PC2WE. PC2 without exposure requires an RFM Category A (or alternative) procedure that avoids backing up toward obstacles, avoids deck-edge strike, and either achieves a safe OEI fly away or has the ability to take advantage of a suitable forced landing area (water surface within ditching limits for the rotorcraft). If the RFM has no such procedures, PC2WE may be the only remaining option.

9.1.2 RFM Category A procedures should be carefully studied and applied to the elevated FATO or helideck scenarios. RFM data that allows for deck-edge strike, drop-down heights, and possible ditching needs to be carefully considered before any exposure time can be defined. Some manufacturers are now offering PC2 Defined Limit of Exposure (DLE) RFM procedures to assist operators in PC2WE operations.

9.2 Procedures to minimise exposure from helidecks

9.2.1 Rotorcraft manufacturers often provide Category A data for elevated heliports, helipads or helidecks. Generally, there are three different types of take-offs that could be described:

- vertical-dynamic take-off
- lateral take-off, and
- back-up take-off.

The first two usually involve the use of a low TDP, with a drop-down height below the level of the helideck to allow V_{TOSS} to be gained.

9.2.2 The back-up take-off assumes a higher TDP, with no descent below the level of the helideck, but may require a larger size FATO for maintenance of adequate visual cues. The back-up take-off also requires a less complex obstacle environment surrounding elevated heliports, helipads or helidecks, but is not always available. Guidance on PC2WE during back-up take-offs is similar to that for ground level helipads and is provided in Section 8 of this document.

9.2.3 If Category A weight limits and procedures are complied with for vertical dynamic and lateral take-offs, and sufficient drop-down is available for a safe OEI fly-away, PC1 could be achieved with appropriate surveys. Alternatively, if a forced landing to a suitable forced landing area was available below the heliport or helideck, this could be PC2.

9.2.4 If Category A weight limits and procedures cannot be complied with, or there is insufficient drop-down available, this becomes a specific case of PC2WE. In these operations, the exposure is relevant for the possibility of:

- a deck-edge strike if the engine fails early in the take-off or late in the landing
- penetration into the avoid area of the HV envelope during take-off and landing, and
- forced landing with obstacles on the surface (hostile water conditions or structures) below the elevated helipad (helideck).

9.2.5 Where the RFM elevated heliport, helipad or helideck take-off procedure cannot be applied, it is necessary to adopt a procedure that minimises the risk of a deck-edge strike and minimises the time to V_{TOSS}. A recommended helideck procedure (described below) has been modelled across various European rotorcraft types to achieve mean exposure times of less than nine seconds and is shown in Figure 12 below.

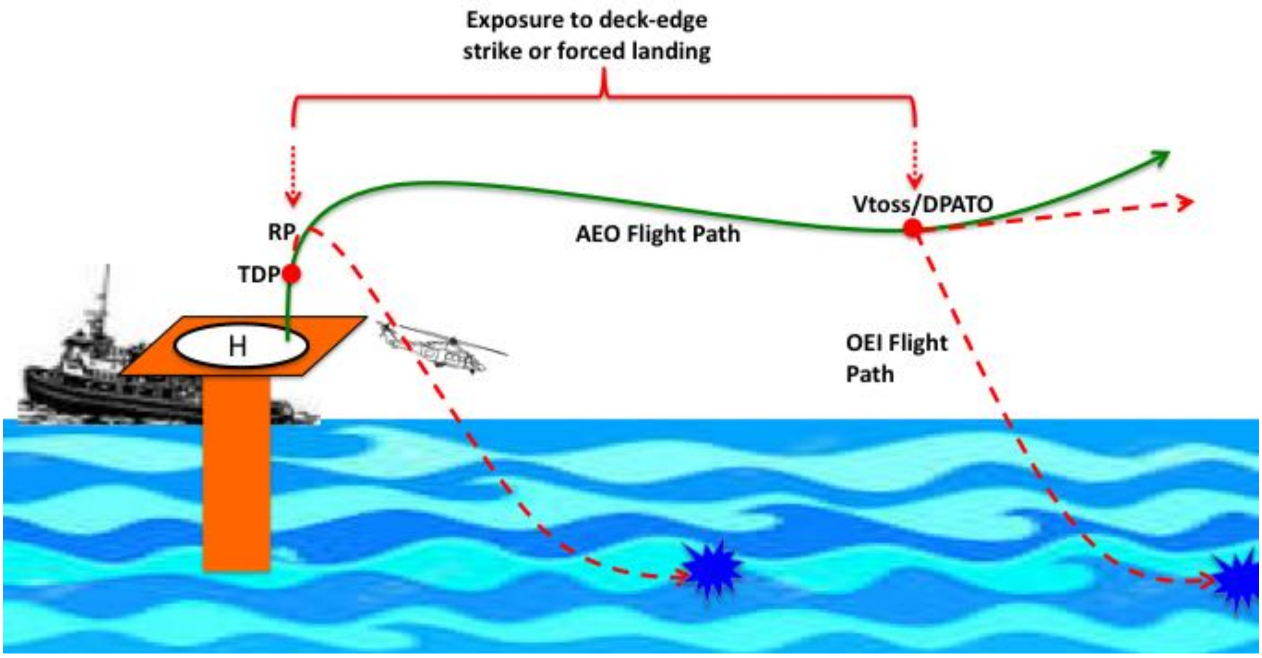


Figure 12: PC2 Vertical-dynamic take-off technique for minimising exposure

9.2.6 The take-off should be performed in a dynamic manner ensuring that the rotorcraft continuously moves vertically from the hover to the rotation point (RP) and then into forward flight. If the manoeuvre is too dynamic, there is an increased risk of losing spatial awareness (through loss of visual cues) in the event of a rejected take-off, particularly at night.

9.2.7 If the transition to forward flight is too slow, the rotorcraft is exposed to an increased risk of contacting the deck edge in the event of an engine failure at or just after the point of cyclic input (RP).

9.2.8 It has been found that the climb to RP is best made between 110% and 120% of the power required in the hover. This power offers a rate of climb that assists with deck-edge clearance following engine failure at RP, while minimising ballooning following a failure before RP. Individual types will require selection of different values within this range.

Note: Ref. EASA Annex to ED Decision 2012/018/R - GM1 CAT.POL.H.310(c)&CAT.POL.H.325(c)

9.3 Avoidance of deck-edge strikes

9.3.1 Where Category A weights and procedures are followed, a 4.5 m (15 ft) deck-edge clearance will be assured. In these cases, exposure to the deck-edge strike is removed. Where Category A weights and procedures are not possible, there remains a risk of deck-edge strike, but this risk can be reduced by use of the procedure described above and consideration of the factors in this section. Many of these considerations can also be relevant to ground level helipad operations.

9.3.2 **Positioning on the helideck -** It is important to position the rotorcraft as close to the deck edge (including safety nets) as possible while maintaining sufficient visual cues, particularly a lateral marker. The ideal position is normally achieved when the rotor tips are positioned at the forward deck edge. This position minimises the risk of striking the deck edge following recognition of an engine failure at or just after RP.

9.3.3 **Lateral visual cues -** To obtain the maximum performance in the event of an engine failure being recognised at or just after RP, the RP should be at its optimum value, consistent with maintaining the necessary visual cues. If an engine failure is recognised just before RP, the rotorcraft, if operating at a low mass, may 'balloon' a significant height before the reject action has any effect. It is, therefore, important that the pilot flying selects a lateral visual marker and maintains it until the RP is achieved, particularly on decks with few visual cues. In the event of a rejected take-off, the lateral marker will be a vital visual cue in assisting the pilot to carry out a successful landing.

9.3.4 **Rotation point -** The optimum RP should be selected to ensure that the take-off path continues upwards and away from the deck with AEO, but minimising the possibility of hitting the deck edge due to the height loss in the event of an engine failure at or just after RP. The optimum RP may vary from type to type. Lowering the RP will result in a reduced deck edge clearance in the event of an engine failure being recognised at or just after RP. Raising the RP will result in possible loss of visual cues, or a hard landing in the event of an engine failure just prior to RP.

9.3.5 **Pilot reaction times -** Pilot reaction time is an important factor affecting deck edge clearance in the event of an engine failure prior to or at RP. Simulation has shown that a delay of one second can result in a loss of up to 15 ft in deck edge clearance.

9.3.6 **Acceleration -** Elevated helipads and helidecks provide the opportunity to quickly and safely gain airspeed using a level or slightly descending acceleration to V_{TOSS}/V_{Y}. This technique can reduce potential exposure time compared with the climbing acceleration that would be used from ground level helipads. Only slight descents should be tolerated during the acceleration due to the possibility that OEI power available (if required) is unable to overcome the descent rate prior to obstacle impact.

9.3.7 **Variation of wind speed -** Relative wind is an important parameter in the achieved take-off path following an engine failure. Wherever practicable, the take-off should be made into wind. Simulation has shown that a 10 kt wind can give an extra five feet of deck edge clearance compared to a zero-wind condition.

9.4 Adequacy of drop-down height

9.4.1 Category A procedures may provide data for drop-down heights at specified weights for vertical-dynamic or lateral take-offs. If this data can be used, determinations can be made regarding the adequacy of the drop-down height available, with an assurance of 35 ft obstacle clearance. In these cases, there may be zero exposure (Figure 13 below). Operators should allow for the inaccuracies in available drop-down due to possible tidal influences, variable buoyancy of vessels, sea state, or uncertain construction activities over land.

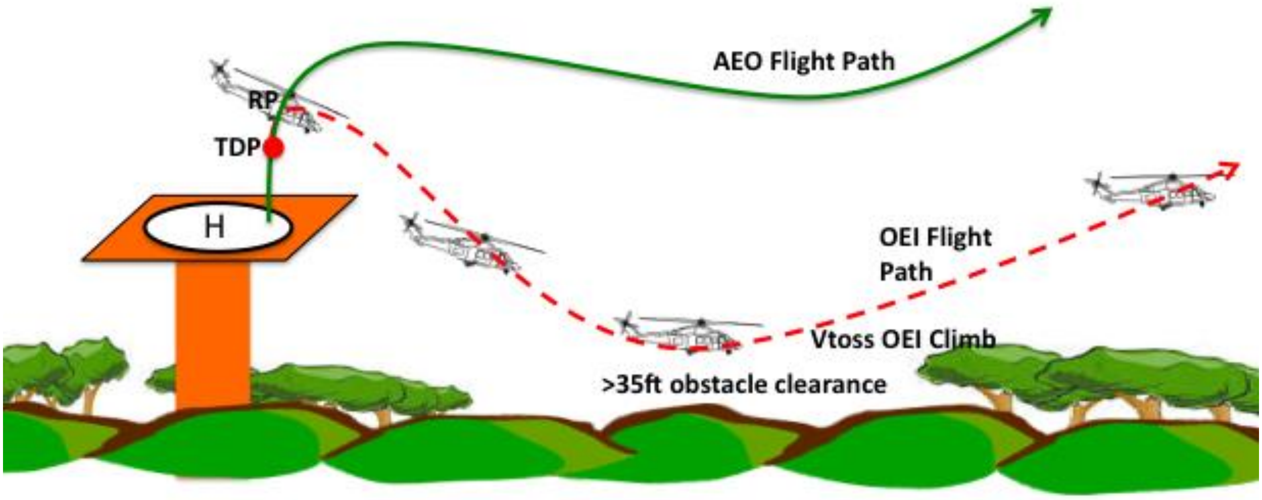


Figure 13: Vertical-Dynamic Category A take-off (zero exposure)

9.4.2 A helideck take-off outside of Category A limits places many rotorcraft inside the avoid area of the HV envelope, from where a safe forced landing cannot be assured. In some circumstances, the rotorcraft OEM may provide non-Category A procedures that allow for a forced landing to a suitable forced landing area (sea surface) below the helideck. Where these procedures are present, this operation may be classified as PC2. However, if there is no suitable forced landing area and/or the drop-down height is insufficient, exposure will be present.

9.4.3 If there is no achievable suitable forced landing area, or the drop-down height is insufficient for a safe OEI fly-away, the exposure time will be from the decision point (equivalent TDP) until the earliest point where a safe OEI climb speed is achieved, and obstacles can be cleared by 35 ft. During the exposure time prior to DPATO, an OEI fly-away may still be possible, but unless RFM data supports a procedure, exposure will still be present (Figure 14 below).

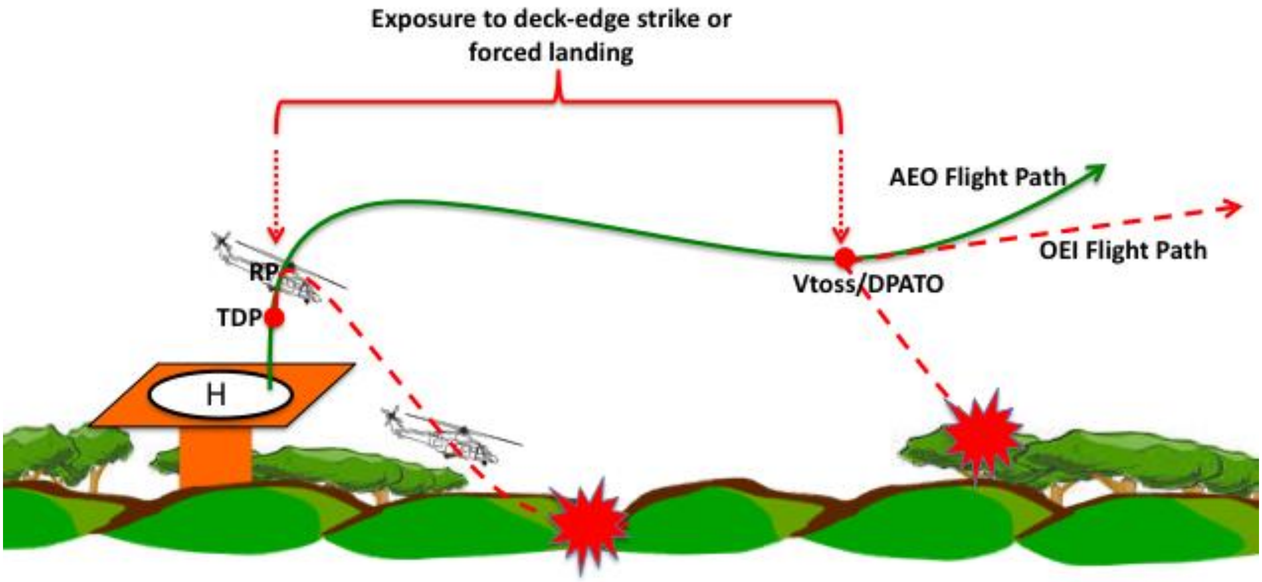


Figure 14: Vertical-dynamic take-off with insufficient drop-down

9.5 Exposure during approach and landing to elevated heliports, helipads or helidecks

9.5.1 There are two common Category A approach techniques usually described within the RFM for elevated helipads or helidecks: offset procedure or straight-on procedure. Either of these procedures may be flown as part of a PC2WE operation. The offset procedure is based on the concept of an approach to an LDP that is laterally displaced from the helipad, and where baulked landings require a drop-down below the level of the helipad. This procedure may not be feasible depending on the nature of surrounding obstacles, wind direction, and pilot seating arrangements.

9.5.2 The straight-on procedure has a higher LDP, and the baulked landing flight path overflies the FATO. This procedure requires a FATO of sufficient size, appropriate visual cues, and minimal obstacles in the approach or baulked landing flight paths. Guidance on exposure for this type of procedure is provided in Section 8 of this document.

9.5.3 The offset procedure should be considered in the context of two exposure scenarios:

- within Category A weights, but with insufficient drop-down for the procedure, and
- above Category A weights.

9.5.4 Within Category A weights, but with insufficient drop-down height available, the offset procedure can provide varying exposure times depending on the degree of drop-down available. The landing exposure time will commence at the closest point to the helideck from which the OEI baulked landing height loss retains 35 ft obstacle clearance (Figure 15 below). Exposure will finish at the standard LDP for the procedure, after which a safe landing to the helideck will be possible.

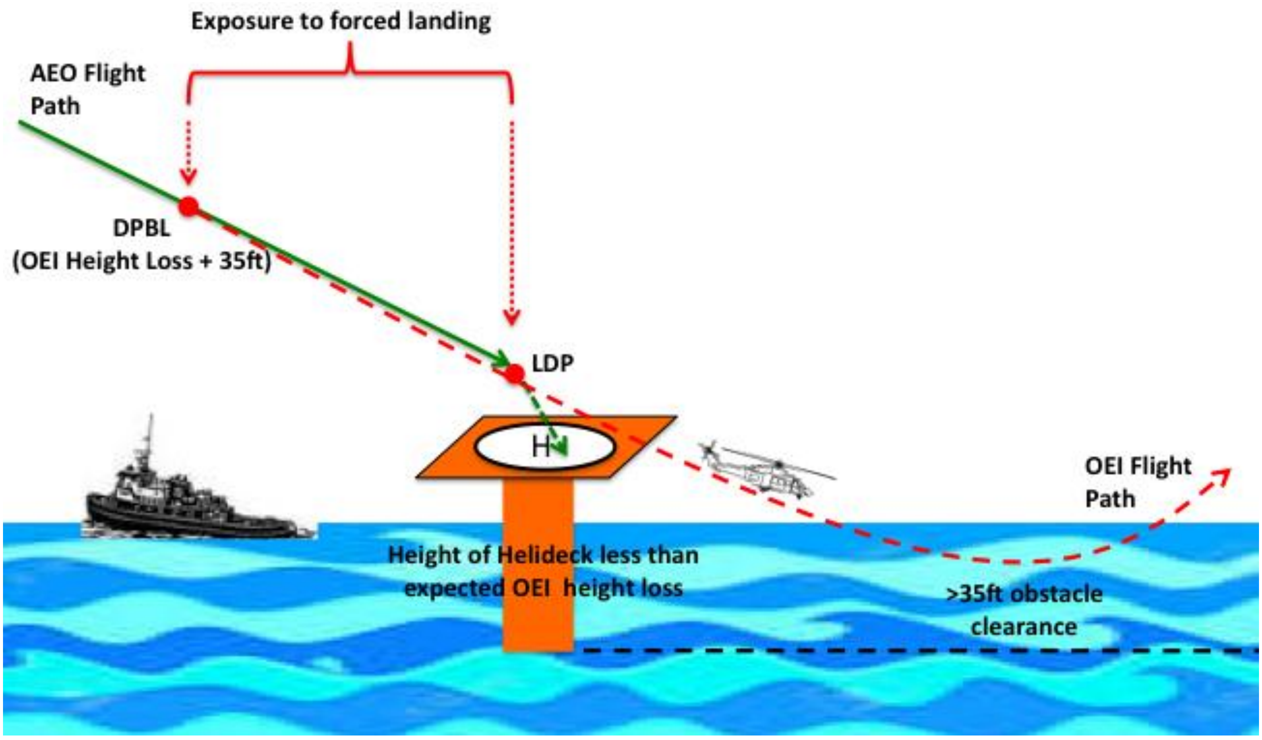


Figure 15: Landing exposure with insufficient drop-down (offset procedure)

9.5.5 RFM Category A data can provide height loss information for the pilot to apply. For example, an RFM-defined height loss of 85 ft plus 35 ft obstacle clearance will place the DPBL at 120 ft above the surface obstacles at the applicable LDP speed. However, speeds faster than the LDP speed will achieve a baulked landing with much less height loss, but this figure is not determinable from the RFM. Therefore, depending on the circumstances, the DPBL could be based on height loss data, or on the point of deceleration through V_{TOSS}, which, as discussed earlier, is a speed from which a climb will be certain.

9.5.6 For offset approaches above Category A weight limits, the principle is the same as described above, but the lack of RFM height loss data place the DPBL at the point of deceleration through V_{TOSS}/V_Y (Figure 16 below). Exposure will only finish once positively over the helideck because the use of an LDP is not supported by the RFM at these weights. Depending on the helideck obstacle complexity, safe deceleration times from V_{TOSS} to the helideck may be beyond the exposure time limits for the rotorcraft and, therefore make this, not a viable option.

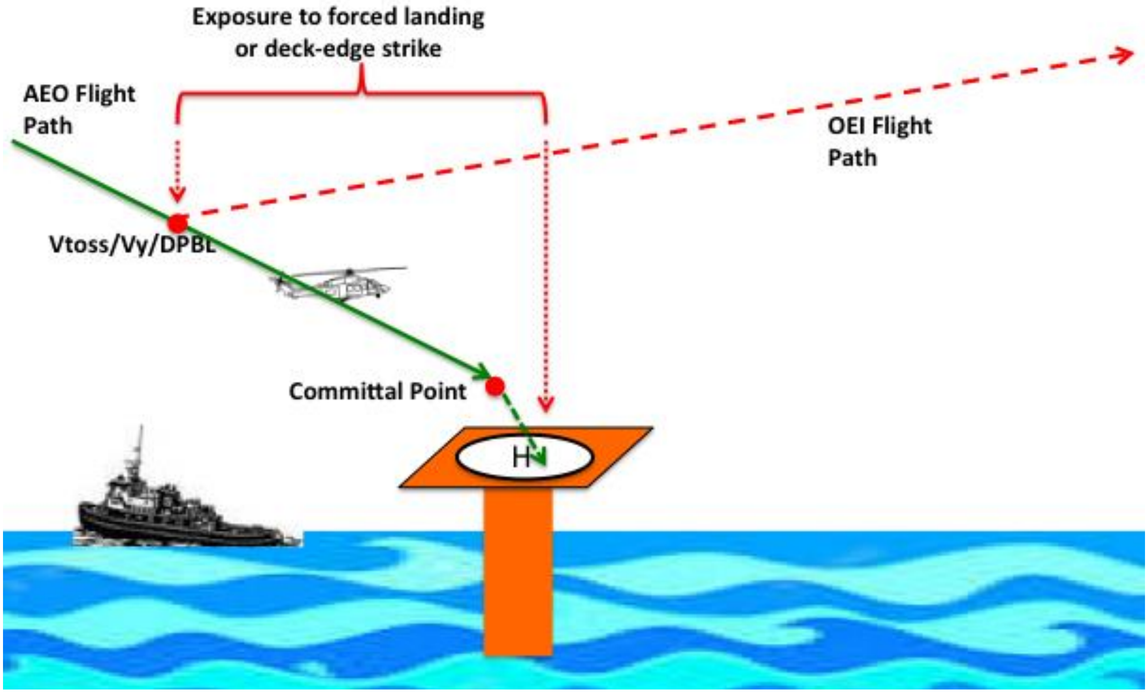


Figure 16: Landing exposure above Category A weights (offset procedure)

9.5.7 In spite of the best planning by the operator and/or pilot, there may be occasions where the circumstances of operating at a particular helideck require an extra level of care to be taken in the approach and/or take-off. Pilots should not allow their perceived need to keep exposure times within limits for the rotorcraft to overcome the requirement to exercise an appropriate level of caution during helideck operations. Examples of this lack of caution might include approaches that are too fast for the power available, obstacles, and wind conditions. This can be particularly relevant to moving helidecks/vessels close to surface obstacles or the sea.

10 Summary tables of exposure

10.1 Summary of exposure during take-off

10.1.1 Table 1 below summarises the points where exposure commences and finishes for a take-off and climb. Of benefit is retaining the ability to use a shallow, or even level acceleration profile to aid in minimising the time to V_{TOSS}. Some operators may find they are unable to operate within the limits of exposure unless this is possible.

Table 8: Exposure during take-off

Characteristic	Type of HLS	Exposure starts	Exposure finishes
Within the applicable RFM Category A Weights & Procedures	Open Area clear of obstacles, but not suitable for a forced landing	When there is no more reject area available	The later of: TDP, OR V_{TOSS} and able to maintain 35 ft clear of obstacles throughout the climb.
	Confined Area with fixed Helipad TDP	Passing the TDP while continuing upwards climb	Rotate Point (RP) - being Height Loss + 35 ft + Obstacles
		OR At the TDP which is also the RP	V_{TOSS} and able to maintain 35 ft clear of obstacles throughout the climb.
	Confined Area with a TDP that can be raised	Should be zero exposure provided the TDP can be raised to a point equalling Height Loss + 35 ft + Obstacles	
	Elevated Heliport, Helipad or Helideck with insufficient drop-down available	At the TDP	V_{TOSS} and able to maintain 35 ft clear of obstacles throughout the climb.
	Elevated Heliport, Helipad or Helideck with sufficient drop-down available	Should be zero exposure provided the procedure removes the risk of deck-edge strike	
Outside the applicable Category A Weights & Procedures	Open Area clear of obstacles, but not suitable for a forced landing	This should not occur as being above clear area Category A weight limits is unlikely to meet PC1, PC2 or PC2WE limiting requirement of 150fpm OEI rate of climb at 1000' above the take-off surface.	
	Confined Area vertical or angled take-off	Upon entry into the HV envelope	V_{TOSS} or V_Y and able to maintain 35 ft clear of obstacles throughout the climb

Characteristic	Type of HLS	Exposure starts	Exposure finishes
	Elevated / Helideck	Upon entry into the HV envelope	V_{TOSS} or V_Y and able to maintain 35 ft clear of obstacles throughout the climb

10.2 Summary of exposure during landing

10.2.1 Table 2 below summarises the points where exposure commences and finishes for an approach and landing. Of benefit is retaining the ability to fly a normal, constant angle profile to ensure aircraft performance is sufficient to carry any engine power loss to the landing site.

Table 9: Exposure during landing

Characteristic	Type of HLS	Exposure starts	Exposure finishes
Within the applicable RFM Category A Weights & Procedures	Open Area clear of obstacles, but not suitable for a running landing.	Should be zero exposure provided committal point allows 35 ft clear of obstacles throughout a baulked landing, or on the assumption of near zero-speed touchdown.	
	Confined Area with fixed Helipad LDP.	Should be zero exposure if the committal point is raised to a point equalling LDP Height Loss + 35 ft + Obstacles.	
	Confined Area with an LDP that can be raised.	Should be zero exposure provided the LDP can be raised to a point equalling LDP Height Loss + 35 ft + Obstacles.	
	Elevated Helipad or Helideck with insufficient drop-down available.	V_{TOSS} and able to maintain 35 ft clear of obstacles throughout the baulked landing.	At LDP
	Elevated Helipad or Helideck with sufficient drop-down available.	Should be zero exposure.	
Outside the applicable Category A Weights & Procedures	Open Area clear of obstacles, but not suitable for a running landing.	This should not occur as being above clear area Category A weight limits is unlikely to meet PC1, PC2 or PC2WE limiting requirement of 150fpm OEI rate of climb at 1000' above the take-off surface.	

Characteristic	Type of HLS	Exposure starts	Exposure finishes
	Confined Area steep or double-angle approach	V_{TOSS} and able to maintain 35 ft clear of obstacles throughout the baulked landing	At the helipad
	Normal, constant angle approach to a ground-level helipad.	Should be zero exposure.	
	Elevated / Helideck with straight on approach.	Committed from V_{TOSS} and able to maintain 35 ft clear of obstacles throughout the baulked landing, but no exposure for a normal profile.	
	Elevated helideck using offset procedure requiring a drop-down.	VTOSS and able to maintain 35 ft clearance of obstacles the baulked landing.	At the helipad.