A NEED TO REWRITE THE TAKEOFF AND LANDING ACCEPTABLE MEANS OF COMPLIANCE (AMC/AC 27&29) FOR MULTIENGINE ROTORCRAFTS

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1 OVERVIEW

The current certification requirements for multiengine rotorcrafts (CS and FAR 27&29) for takeoff and landing performance and handling qualities do not always provide a safe approach to the applicable scenarios where the helicopters do actually operates if compliance demonstration is achieved with the current acceptable means of compliance.
Several critical aspects of the acceptable means of compliance do not produce "safe" flight envelopes and provide insufficient or inadequate operational information to allow safe operations in all typical helicopter environments.
The aim of airworthiness certification specification is to guarantee safety standards within a reasonable economic situation constrain that would justify this business.
The current acceptable means of compliance are long dated and rarely updated in order to reflect the advance in technology and the need to provide a much higher confidence to helicopter end users.
In the current regulatory structure, the accepted methods of compliance for the definition of the H-V envelope for multi-engine helicopters (CS27 and 29) do not ensure the airworthiness required for all kind of operations. In the way it is constructed and it is required to be demonstrated, it is only applicable for the type of surface where this limitation or performance has been tested. This means that the information provided in the RFM would not be applicable for all the other type of surface other than the one used to demonstrate it. For this reasons, the H-V envelope should not be considered a limitation for all the applicable CS29 multi-engine configurations and substituted by performance data that would allow defining a safe envelope rather than a No Fly zone.
Based on these considerations, a complete revisit of the compliance method for the definition of the H-V envelope for multi-engine helicopters that separates the takeoff corridor from the high hover/cruise part must be considered.
On the other end, as fa as mandatory takeoff and landing performance is concerned, particular attention should also be given to operations on elevated helidecks and oilrigs where the environment is extremely demanding and not predictable. In order to get approval for these kinds of operations, specific testing methodology should be

developed and approved including the wind effect benefits on the approved performance.
The wind effect (benefits or penalties) for all aspects of takeoff and landing must be taken into account correctly and carefully assessed since direction and intensity could substantially affect aircraft performance and controllability.
General performance should also consider correct and well addressed aircraft aerodynamic configurations that should be carefully taken into account for possible takeoff and landing performance benefit or penalties.
A detailed list of proposed changes for the AMC (or AC) contents is considered and new acceptable means of compliance for the following subjects are here discussed:

- Cat B Take Off profile definition and compliance demonstration (more than 9 passenger seats configurations)
- H-V envelope definition and demonstration based on the actual operational scenario and not just as a pure certification exercise for CS 29 multiengine helicopters (less than 10 and more than 9 passenger configurations) and for CS27 multiengine helicopters
- Cat A performance for elevated/oilrig helidecks assessment and demonstration
- Takeoff and performance influential factors that should be clearly identified and included in the RFM.

2 CAT B TAKEOFF PROFILE

Cat B helicopters (with more than 9 passenger seats configurations) takeoff must be compliant with the requirements to be clear of the H-V for the takeoff corridor and with the Cat A second segment climb performance. A “nobody’s land” exists between the 50 ft takeoff profile at which the aircraft reaches the climbout speed and maintains compliance with the safe reject and the acquisition of the V_Y.

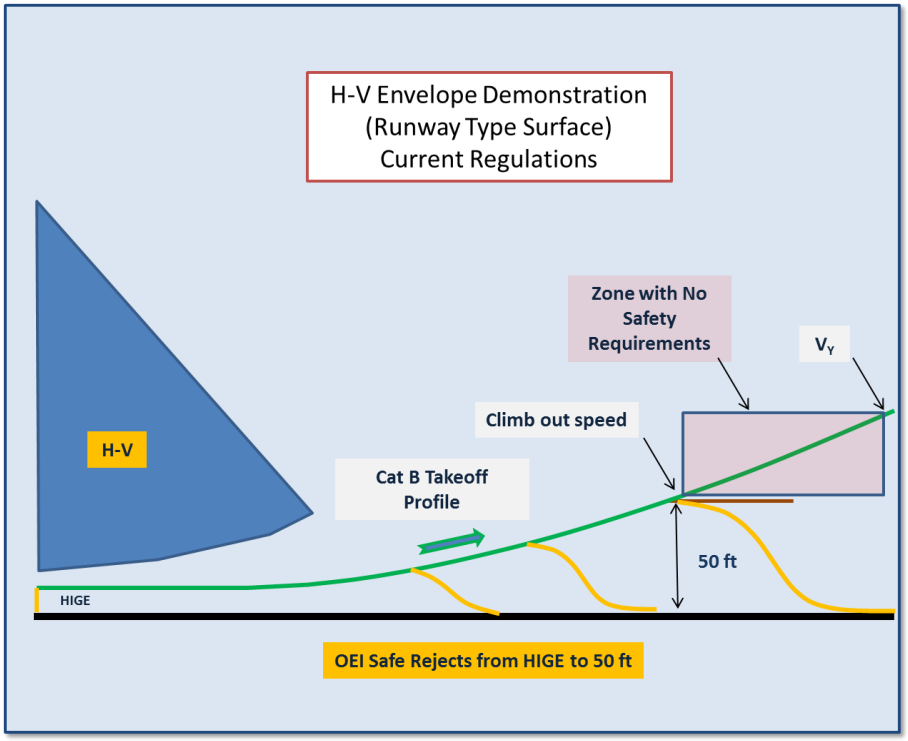

Fig. 1 - Current Cat B Takeoff Corridor Requirements (more than 9 pax seats)

Furthermore, for the H-V requirements, it must be demonstrated that a safe OEI reject can be accomplished at any point of the takeoff profile up to 50 ft.
A few safety concerns arise:

a) A safe rejected takeoff can only be carried out if the takeoff surface can allow such a maneuver
b) Any OEI event beyond the 50 ft point and before reaching V_Y could be catastrophic
c) There are no defined obstacle clearance requirements before reaching the Cat A second segment requirement

A simple conclusion for these concerns is that an adequate safety level is not ensured.

2.1 **Proposal**

For configurations with more than 9 passenger seats a takeoff profile requires an adequate level of safety. This level of safety can be reached if the following requirements will be added to the existing ones:

a) The Climbout speed (AEO condition) shall be high enough to sustain a positive rate of climb and be considered a V_{TOSS} allowing an easy and safe transition to V_Y.
b) The rejected takeoff distance shall be assessed and published together with the takeoff distance (the distance required to reach 50 ft and Climbout speed).
c) Obstacle clearance information shall be provided by including gradients at V_{TOSS} and V_Y.

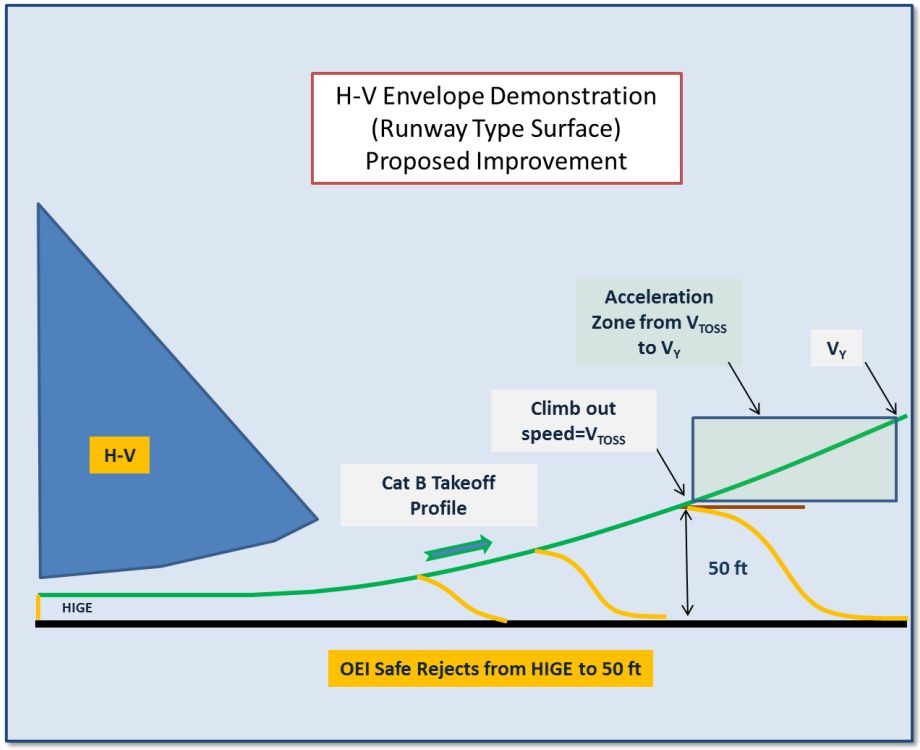

Fig. 2 - Proposed Cat B Takeoff Corridor Requirements (more than 9 pax seats)

3 H-V ENVELOPE

„***CS 29.87 Height velocity envelope***
(a) If there is any combination of height and forward velocity (including hover) under which a safe landing cannot be made after failure of the critical engine and with the remaining engines (where applicable) operating within approved limits, a height velocity envelope must be established for:
(1) All combinations of pressure altitude and ambient temperature for which takeoff and landing are approved; and
(2) Weight, from the maximum weight (at sea level) to the highest weight approved for takeoff and landing at each altitude. For helicopters, this weight need not exceed the highest weight allowing hovering out of ground effect at each altitude.“

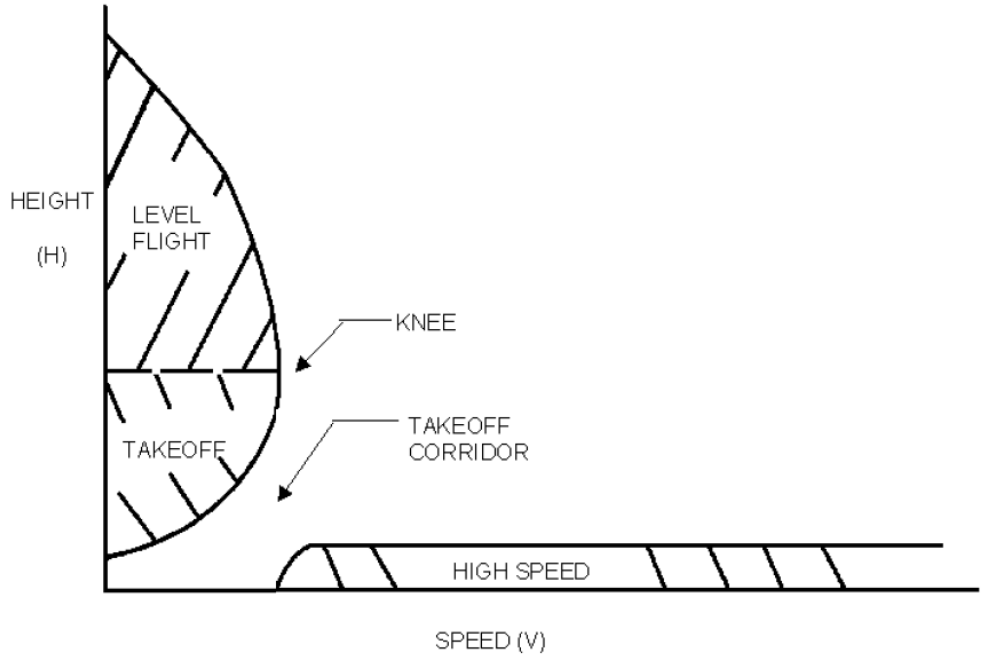

Fig. 3 – Accepted H-V Envelope Definition

The traditional way of complying with this rule is clearly stated in the Advisory Circular and widely accepted across the helicopter world. Historically created at the beginning of the helicopter era when these machines were underpowered single engine, the only and safest way to define this envelope was as shown in Fig. 3.

For single engine helicopters there are no options other than provide this kind of envelope even though not enough emphasis has ever been put on the type of surface where this envelope has been established and therefore applicable. Any landing surface different than the type where the envelope has been defined, represents a potentially catastrophic situation for a recovery from an engine failure.

The lack of a clearly defined type of surface associated to the envelope included in the RFM is a potential unsafe and unacceptable situation that should be fixed providing clear indications where the envelope applies.

3.1 H-V Envelope for Multi Engine Helicopters

The same type of envelope has always been produced for multi engine helicopters where a single engine failure is not always a „must go down“ situation but, specifically for modern helicopters, it can always be survived when conditions and procedures are respected.

Standard certification demonstrations for H-V envelope is carried out over well prepared open surfaces (runway types) where a rejected takeoff after an engine failure can be safely carried out during the takeoff profile or in the OGE low speed regime. Likewise any point just outside of the H-V no fly zone can be safely demonstrated with controlled OEI landing (Fig. 4).

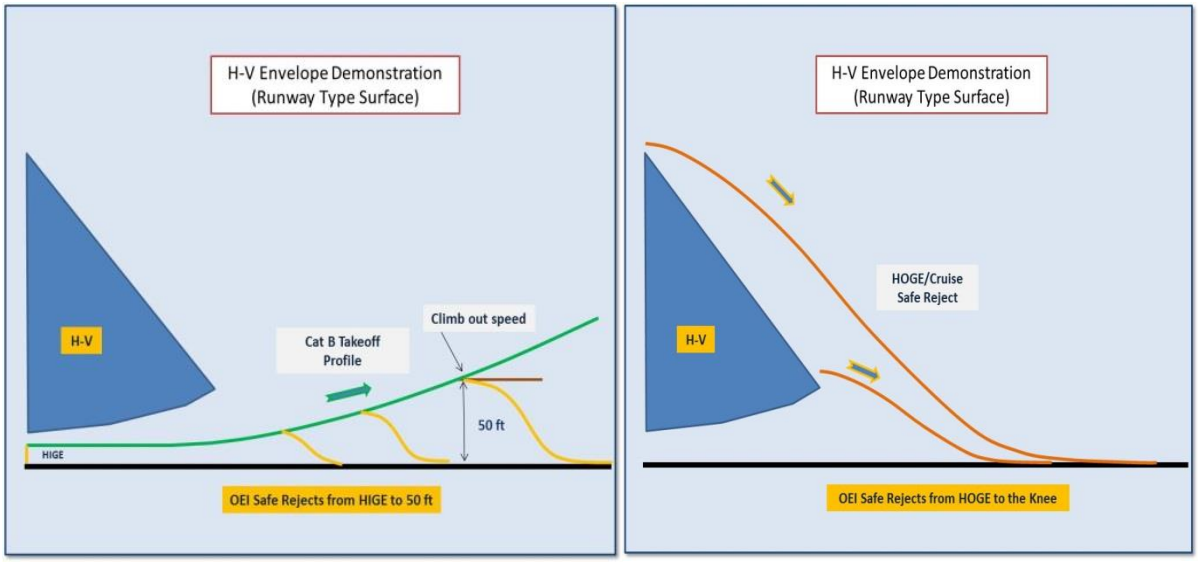

Fig. 4 – H-V Envelope Certification Demonstration

For CS 29 multiengine helicopters (less than 10 and more than 9 passengers configurations) and for CS27 multiengine helicopters, the fundamental condition of the type of surface applies but never included in the H-V envelope definition as the key factor for the applicability of the envelope giving the wrong belief that any engine failure that occurs outside of the NO FLY ZONE is always a recoverable and safe condition.
This is not the case, practically all the operations Out of Ground effect in all possible operational scenarios are carried out over unfriendly environments where the H-V limitation does not have any meaning at all (Fig. 5).

The H-V is one of the four limitations that apply to all CS 29 Cat B envelopes for configurations with more than 9 passenger seats (the others are the HIGE performance, IGE controllability and Cat A second segment climb performance). Foe the reasons stated before this limitation is never respected but, most of all, provides an unacceptable level of unsafety.

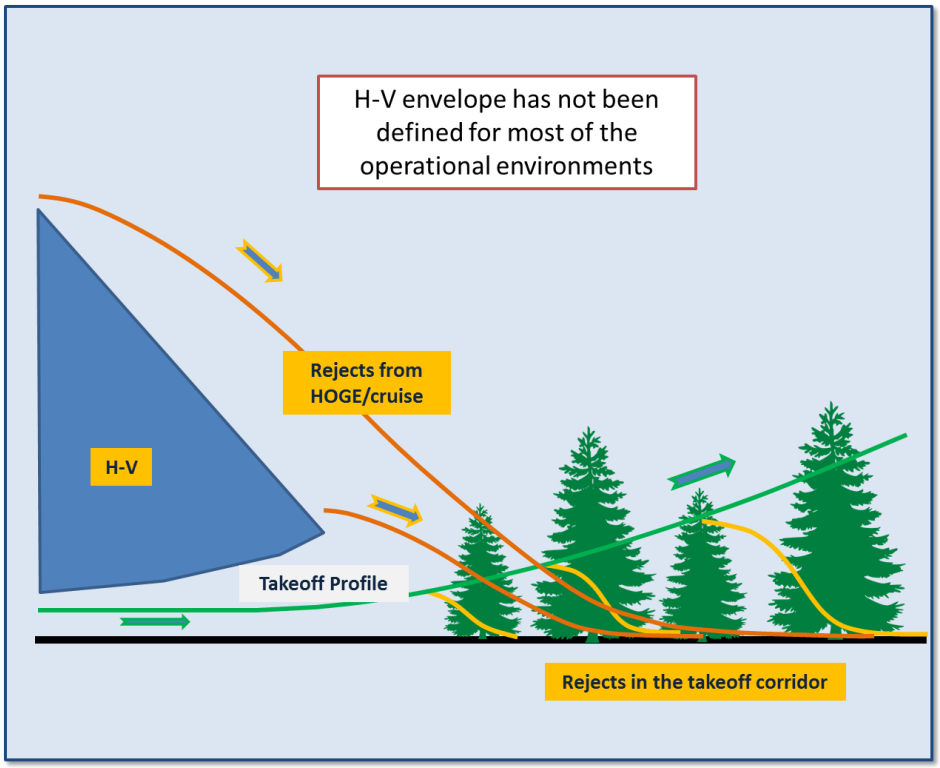

Fig. 5 – Unsafe H-V Envelope for Different Types of Surface

This incorrect definition of the applicability of the H-V envelope has created an unsafe regulatory case also in the operational rules (AIR-OPS) for Operations in performance class 2 with exposure, including operations from helidecks with the alleviation to be clear of the H-V, while operations without exposure are restricted by the H-V limitation from helidecks when the H-V requirements applied to this kind of environment would actually prevent takeoffs and landings in all possible ambient conditions! (See Fig. 6 and Fig. 7).

AIR-OPS extract

(i) Operations to elevated FATOs or helidecks

PC2 operations to elevated FATOs and helidecks are a specific case of operations with exposure. In these operations, the alleviation covers the possibility of:

(A) a deck-edge strike if the engine fails early in the take-off or late in the landing;

(B) penetration into the HV Curve during take-off and landing; and

(C) forced landing with obstacles on the surface (hostile water conditions) below the elevated FATO (helideck). The take-of mass is as stated above and relevant techniques are as described in GM1 CAT.POL.H.310(c) & CAT.POL.H.325(c).

It is unlikely that the DPATO will have to be calculated with operations to helidecks (due to the absence of obstacles in the take-off path).

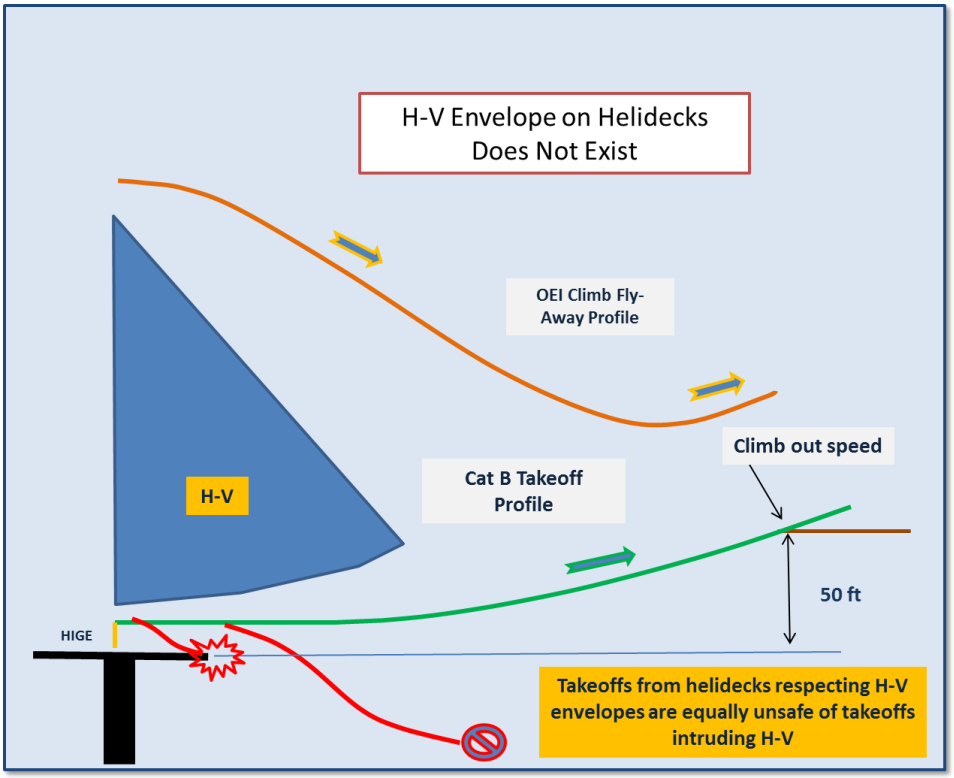

Fig. 6 – Inapplicability of the H-V requirements for Helideck Operations

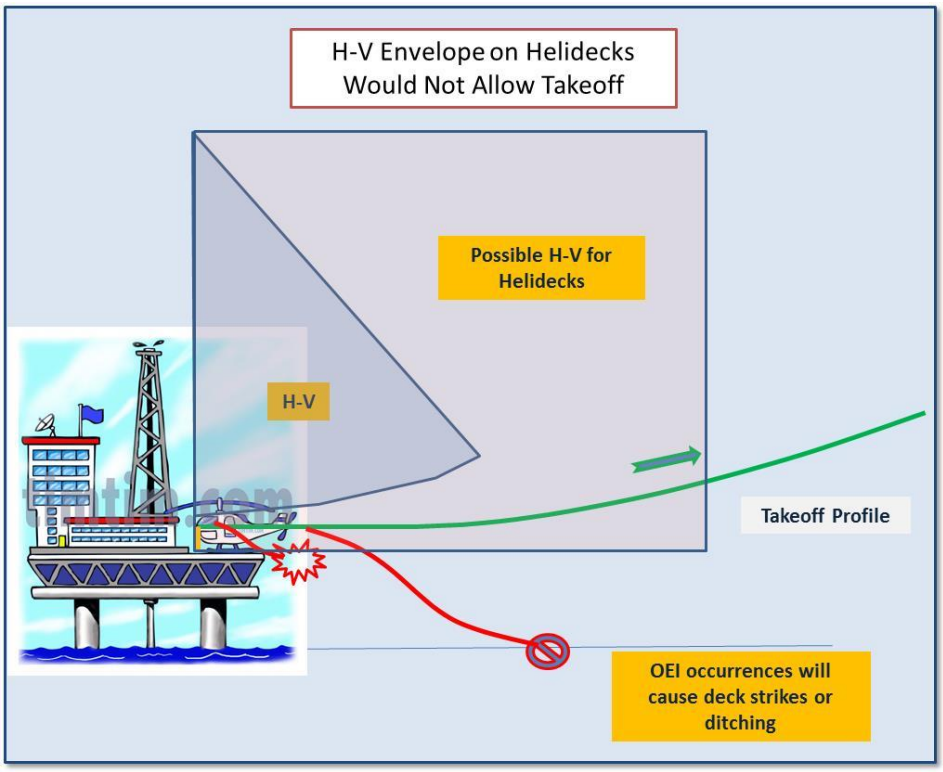

Fig. 7 – H-V Envelope is Limited to One Type of Surface

3.2 **Proposal**

The common H-V envelope as currently accepted in AC27 and 29 should now be urgently reassessed and moved from the Limitations to the approved Performance set of data (this is a limitation only for CS29 helicopters with more than 9 passenger seats configurations).

H-V should only be considered as performance information regardless of the type or Category of rotorcraft since if maintained as a limitation would prevent any takeoff and landing from/to all sites that do not match the one where this envelope applies.

The traditional shape should be replaced by a set of improved performance information (see §2.1) regarding the takeoff/landing corridor (Fig. 8) and a set safe vertical rejects/safe fly away performance for the near to the ground low speed envelope (Fig. 9).

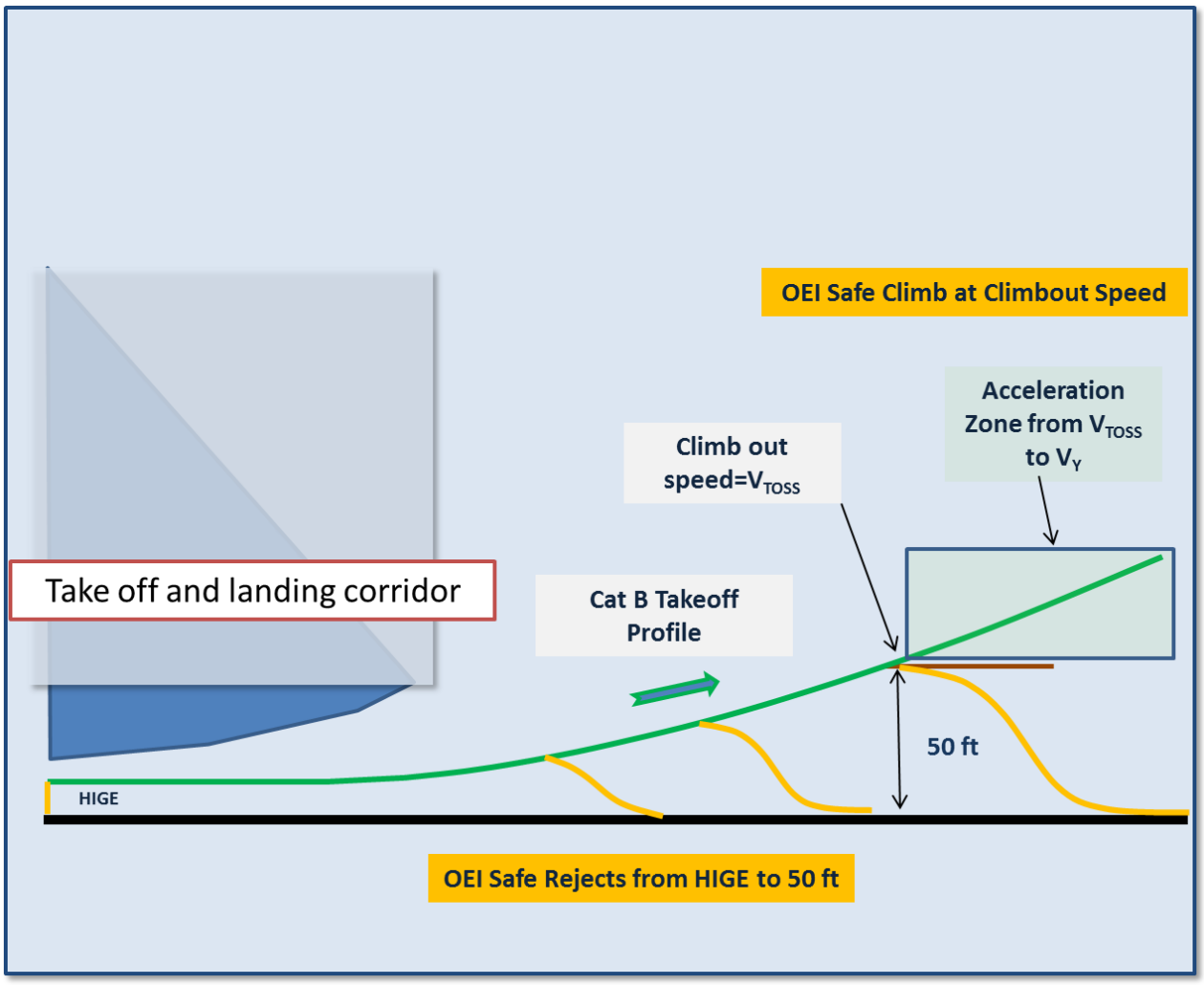

Fig. 8 – Proposed Cat B Takeoff and Landing H-V Envelope

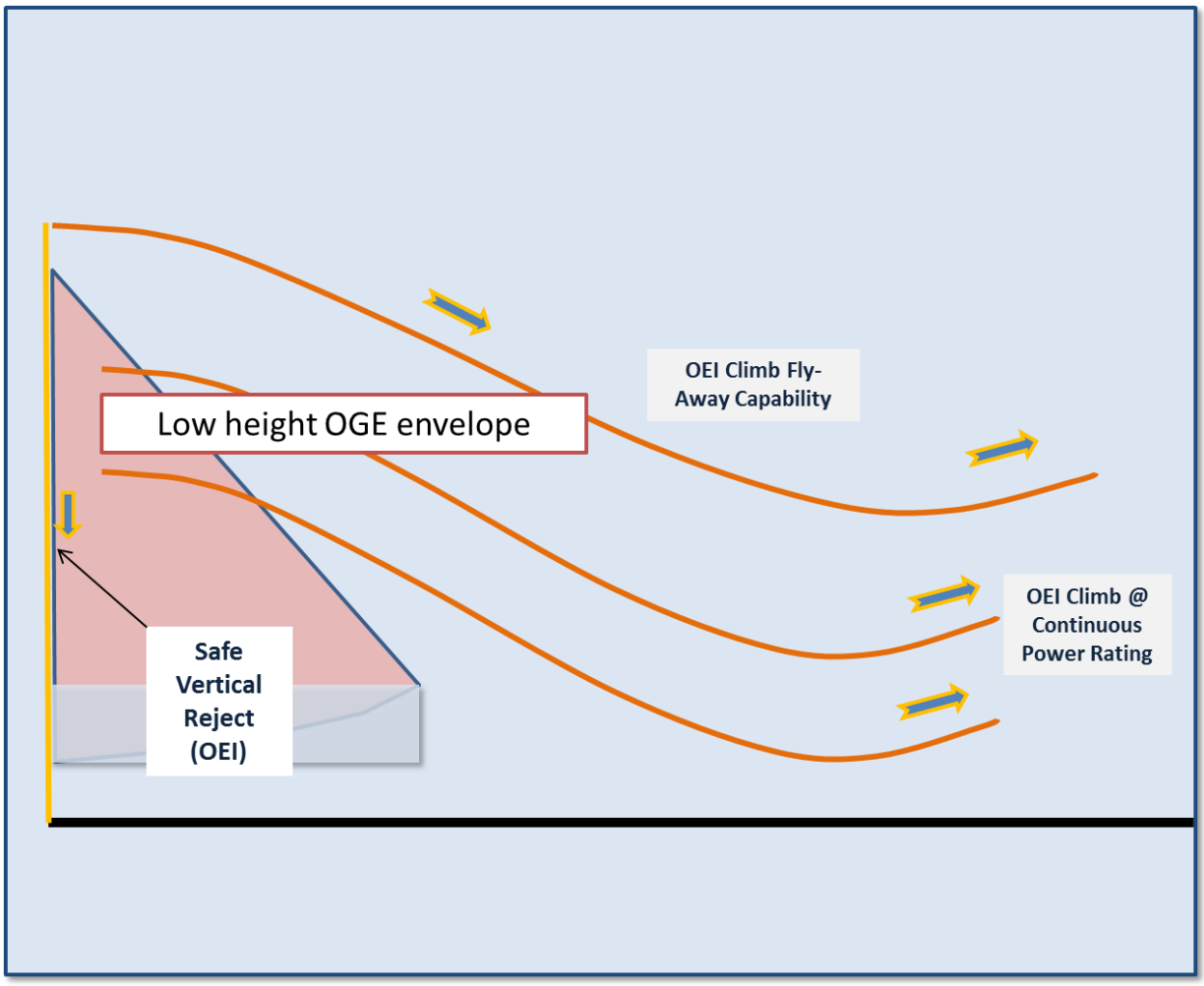

Fig. 9 - Proposed Cat B High Hover H-V Envelope

The proposed change will delete an unrealistic limitation and will provide a safer takeoff performance without the uncertainty included in the current regulation from the climbout speed to the reach of the V_Y.

It will also provide a full set of performance data for the accountability of an engine failure necessary to allow safe HOGE vertical rejects where a fly away could not be possible and a safe fly away escape taking into account all kind of obstacles for all other conditions (Fig. 11).

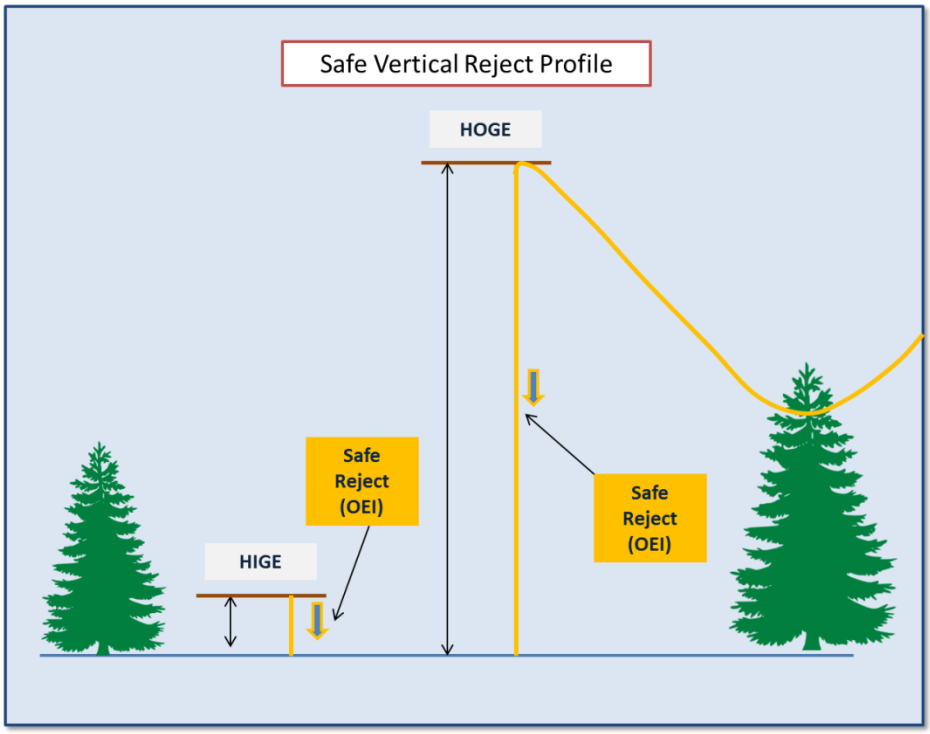

Fig. 10 – Safe Vertical Reject from OGE Condition

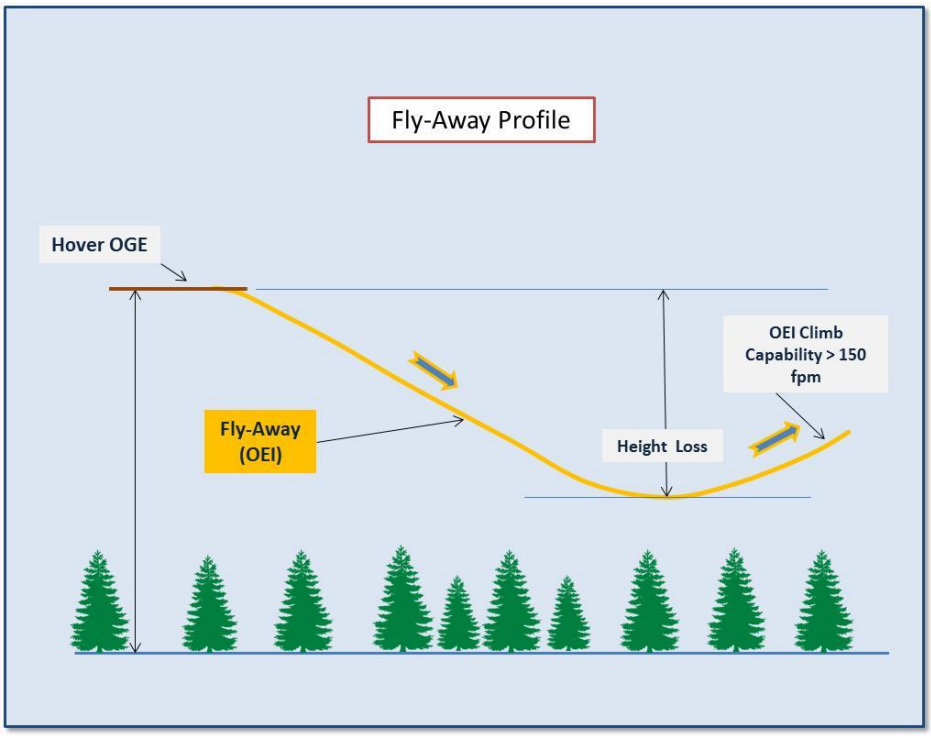

Fig. 11 – Safe Fly Away Profile for Obstacle Clearance

4 PERFORMANCE ASSESSMENT AND DEMONSTRATION

On the other end, as fa as mandatory takeoff and landing performance is concerned, particular attention should also be given to operations on elevated helidecks and oilrigs where the environment is extremely demanding and not predictable. In order to get approval for these kinds of operations, specific testing methodology should be developed and approved including the wind effect benefits on the approved performance.
The wind effect (benefits or penalties) for all aspects of takeoff and landing must be taken into account correctly and carefully assessed since direction and intensity could substantially affect aircraft performance and controllability.

Current AC material states the following:

(iii) Wind Accountability. Wind accountability may be utilized for determining takeoff and landing field lengths. This accountability may be up to 100 percent of the minimum wind component along the takeoff or landing path opposite to the direction of takeoff. Wind accountability data presented in the RFM should be labeled "UNFACTORED" (if 100 percent accountability is taken) and should be accompanied by the following note: "Unless otherwise authorized by operating regulations, the pilot is not authorized to credit more than 50 percent of the performance increase resulting from the actual headwind component and must reduce performance by 150 percent of the performance decrement resulting from the actual tail wind component." In some rotorcraft, it may be necessary to discount the beneficial aid to takeoff performance for winds from zero to 10 knots. This should be done if it is evident that the winds from zero to 10 knots have resulted in a significant degradation to the takeoff performance due to flight through the main rotor vortex. Degradation may be determined by determining the power required to fly, by reference to a pace vehicle, at speeds of 10 knots or less.

We have proven that the statement of considering the wind component along the takeoff and landing path opposite to the direction of takeoff is generally incorrect when claiming wind benefits for performance credits.
A careful investigation on the drop down heights consequence of an engine failure at TDP during a takeoff profile from an oilrig deck has proven that any wind coming from the right front sector up to 15 kt could provide either minimal benefits, even considering only the headwind component, or no benefits at all. Meanwhile the same amount of wind, either full headwind or winds from any direction in the front left sector (up to 90°) provide always the same amount of benefit. Every type of helicopter must be carefully assessed and the final benefits envelope correctly defined.

This investigation must also be extended to all aspects of the takeoff and landing profile and performance with the aim to provide a safer and more realistic performance data package.

The envelopes shown in Fig. 12 and Fig. 13 provide a good example of how the wind benefit envelope for the critical phases of flight such takeoff and landing should be carefully assessed for two different types of helicopters.

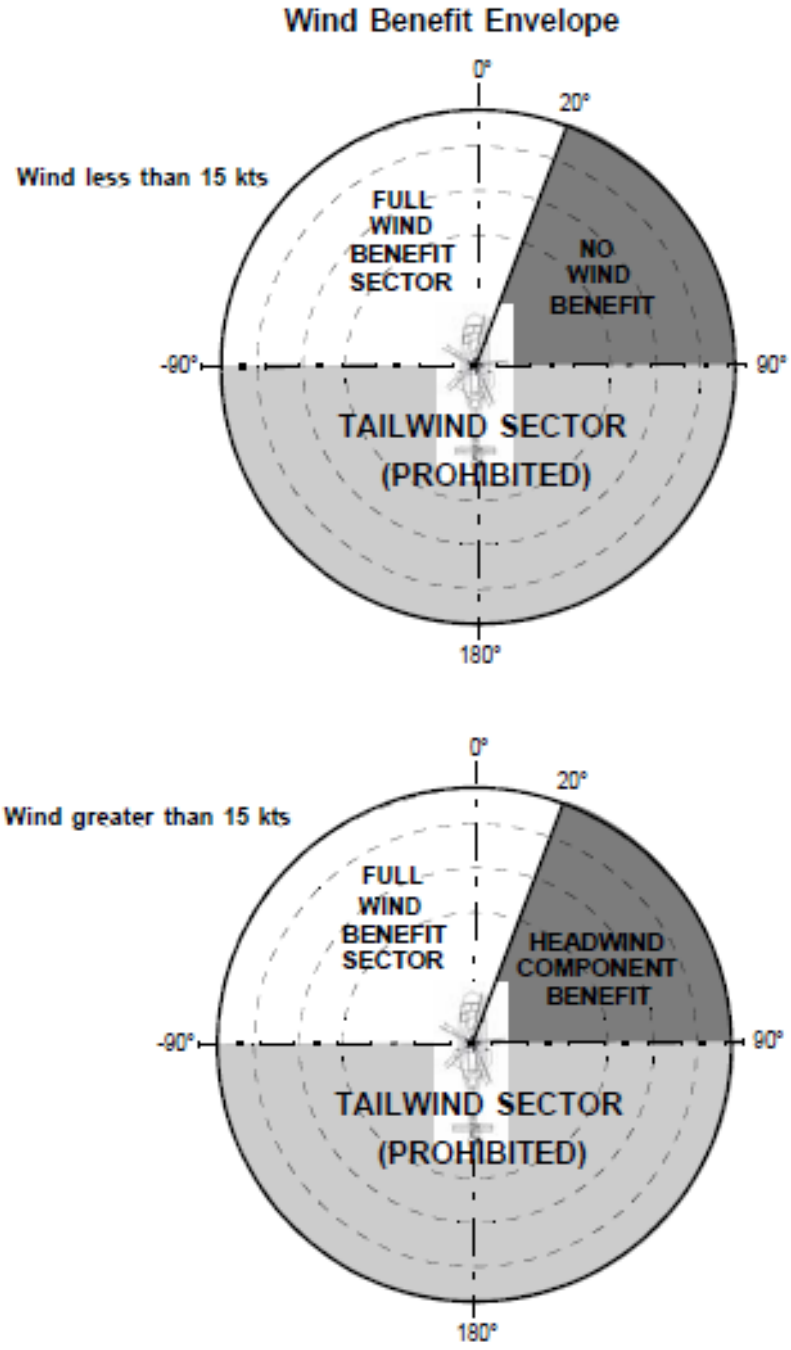

Fig. 12 – Wind Benefit Envelope A

The AC29 clearly states that the wind benefits must be stated as UNFACTORED or FACTORED if only 50% of the performance benefit is taken for both Cat B and Cat A envelopes.

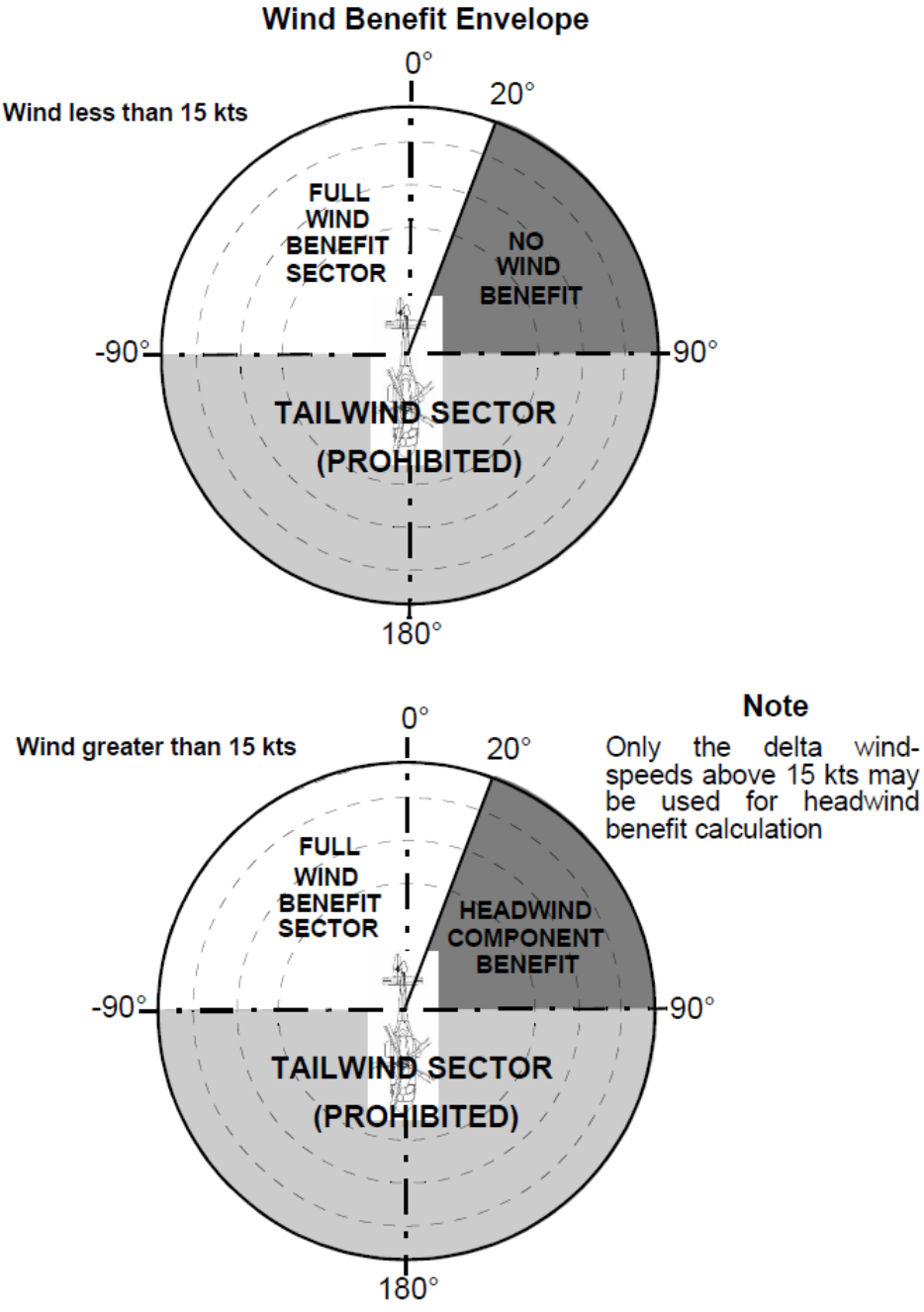

Fig. 13 – Wind Benefit Envelope B

In some cases the head wind benefit in the right sector must be carefully measured. This could reveal that the real benefit is only available for winds higher than 10-15 kt.

5 CONCLUSIONS AND RECCOMENDATIONS

Current AC27 and AC29 incorporate out of date and unsafe means of compliance specifically when applied to multiengine helicopters H-V envelopes and performance wind benefits.

The current definition of the H-V envelope limitation that does not restrict its applicability to the only surface type where it has been demonstrated, allows unsafe operations practically in all daily activities. This unacceptable approach is also perpetuated in the operational regulations that reflect the certification rules allowing extremely dangerous operations since the limitation is incorrectly applied.

Particular attention should be given to CS29 multiengine helicopters configurations with more than 9 passenger seats in order to provide a more realistic and operational Cat B takeoff requirement, removing the H-V envelope from the limitations but providing better H-V envelope performance information.
Current accepted means of compliance for the H-V takeoff and landing corridor define operations limitations from/to sites that do not allow compliance with the regulation.

Performance wind benefits as accepted by the current AC27 and AC29 are too generics without requiring a more detailed and comprehensive investigation in order to clearly identify the actual envelope where the benefit applies and assessing the correct amount of the benefit.

A more pragmatic and safer approach must be implemented as soon as possible. A base for discussion amongst the all players (EASA, FAA and OEMs) is here presented. EASA and FAA should act urgently, safety must be protected.