AUTOMATIC LANDING FROM HOVER FOR CONVENTIONAL HELICOPTERS

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Abstract

The paper presents an advanced Flight Control System capability developed by Leonardo Helicopters, enabling automatic landing from hover. The novel function is designed to assist pilots in Degraded Visual Environment (DVE) conditions. Beginning with the operational requirements, the paper retraces the development and certification process. The automatic landing function is first described from an operational perspective, followed by a technical explanation of its state machine and control algorithms. Emphasis is placed on the innovative characteristics of the function. The flight testing methodology, particularly for demonstrating the wind envelope, is then described in detail, with major results summarized. Finally, the conclusions highlight the operational benefits of this new capability.

Acronyms:

AGL	Above Ground Level
CG	Center od Gravity
FCS	Flight Control System
FMS	Flight Management System
FHA	Functional Hazard Assessment
FTR	Force Trim Release
HMI	Human Machine Interface
IMC	Instrument Meteorological Conditions
LDG	Landing
MCRI	Military Certification Review Item
MPOG	Minimum Pitch On Ground
NSO	Near Surface Operations
PFD	Primary Flight Display
RoC	Rate of Climb
RoD	Rate of Descent
VSI	Vertical Speed Indicated
Vy	Speed for best RoC

1. INTRODUCTION

1.1. Background

Degraded Visual Environment (DVE) for helicopters is any condition that cases reduced visibility and compromises situational awareness. In DVE, pilot's ability to visually perceive terrain or other obstacles is reduced or obscured, creating challenges for safe flight operations. DVE has many causes including bad weather conditions (fog, rain, snow, etc.) or environmental factors, such as brownout, whiteout or night operations with insufficient lighting. Among these, brownout and whiteout typically occur in the hover flight regime, where the rotor downwash generates a cloud of particles, decreasing external visibility down to zero.

As a matter of fact, helicopters often operate close to the ground, where visibility matters most. Loss of visual references can lead to spatial disorientation, which is a major factor in helicopter accidents. Hence, rotary wing operations in DVE during near surface and landing operations pose significant risk to pilots and crew, due to the likelihood of accidents caused by partial or total visibility loss. Actually, the vast majority of events occurred during the entire cycle of helicopter operations in Afghanistan and Iraq were due to crews losing external visual references and had severe consequences, not only in financial terms but, most importantly, in lives lost.

1.2. The Flight Control System: a major player

Recent Flight Control System (FCS) equipping Leonardo Helicopters, such as the AW169, already permit automatic operations under Instrument Meteorological Conditions (IMC) throughout the predominant part of the flight envelope. The auto-hover (HOV) mode is designed to control helicopter's pitch and roll attitudes to acquire and maintain a certain ground-speed or position, according to the selected reference datum, which is easily furnished by the pilot by means of the beeper-trim installed on cyclic grip. HOV mode is usually coupled with automatic radar-height control, namely RHT mode, which controls the collective axis to acquire and maintain separation from the ground. Similarly to the HOV mode, the RHT mode is provided with a reference datum selectable by the pilot with the beeper-trim installed on collective stick. On the AW169, HOV and RHT modes are certified for single-pilot IMC operations down to the minimum safe height of 30 feet, above flat surfaces, including over sea operations up to Sea State 5.

The extension of automatic helicopter's control below the previously certified RHT minimum height, represents the natural progression of the FCS, advancing toward the execution of safer near surface and landing operations. Hence, main goal of the FCS is to restore the safety margin impaired by DVE, alleviating pilot's workload and providing a safeguarded way to approach the ground and land the helicopter.

2. AUTOMATIC LANDING REQUIREMENTS

2.1. Stakeholder needs

The presented work is rooted in stakeholder requirements. In fact, Leonardo Company was accountable of providing automatic landing capability for the skid landing gear version of the AW169 helicopter.

Customer requirements have been developed into the capability of steering the helicopter from an initial hovering down to ground contact, along a vertical trajectory, while mastering a certain precision in terms of position control. Once on ground, helicopter attitude and flight controls should be automatically managed to complete the maneuver, reaching the Minimum Pitch On Ground (MPOG) condition and centering cyclic and pedals.

Nominal maneuver should require the lowest interaction between the pilot and the flight controls, while providing resilience to external disturbances in term of wind and gusts. On the other hand, the automatic landing maneuver should be tolerant of pilot's temporary override on flight controls, permitting manual helicopter repositioning and heading adjustments.

Furthermore, the helicopter should be provided with an automatic mean to safely abort the landing maneuver.

As regards design constrains introduced within the Company, the most notable was the impossibility to update the avionic suite in term of sensor's kind. Hence, FCS was to provide automatic landing capability relying only on the already available sensors data, consisting in redundant attitude and heading inertial data, GPS-derived data and radar-altimeter sensors.

2.2. Certification framework

The AW169 provided a robust baseline in term of already certified configuration under the EASA CS 29 (ref. [3]) large rotorcraft Certification Specifications. To face certification of the new automatic landing function, the Company and the Italian Military Authority agreed the definition of a Military Certification Review Item (MCRI), to supplement the Civilian Certification Basis with an appropriate set of requirements dedicated to the FCS functions, based on Leonardo experience and available standards.

The MCRI was deemed sufficient to define a comprehensive set of performance and safety requirements, along with acceptable Means of Compliance.

2.3. Control, system and safety requirements

FCS requirements have been flown-down from the Military Certification Review Item mentioned in paragraph 2.2. Concerning the dynamic stability during automatic near surface and landing operations, the FCS was required to maintain and regain the aircraft trimmed condition and damp-out any oscillation when flying in the environmental conditions limited to the operational wind envelope defined and demonstrated by the Company. More in detail, control laws implemented into the FCS were required to grant position accuracy better than +/- 2 meters. Accuracy is intended as the deviation from pilot's selected reference position, considered from landing activation down to touchdown.

Moreover, automatic landing had to grant a smooth and safe ground contact, in compliance with CS 29.75 (a)(2) and (3). Accordingly, control laws were required to properly optimize the helicopter rate of descent (RoD) and to manage the touch-down phase, minimizing loads and accelerations on the helicopter and its occupants.

Deserving of attention is that the MCRI required a safety level of the rotorcraft, when flown using the automatic landing mode, not to be less than the average safety level achieved in the already approved IMC envelope.

To this end, the FCS must incorporate continuous monitoring for deviations and failures, providing clear alerts to the crew unless such faults are proven harmless. During descent to ground the collective control should prevent exceeding a safe maximum RoD.

According to Military Certification Review Item mentioned in paragraph 2.2, failure modes with probability of occurrence greater than 10E-7 are subject to in-flight demonstration to verify they do not induce hazardous loads or unsafe deviations in the flight path. Pilot response times comply with AC 29 Chg. 7 standard (ref. [4]), requiring recognition and reaction within 0.5 seconds during landing operations to ensure timely intervention. Safety assessments also incorporate failure probabilities weighted by the exposure duration during landing, reflecting realistic operational scenarios.

Together, these requirements ensure that the automatic landing function provides precise, stable control with robust safety features suitable for critical near-ground operations.

3. AUTOMATIC LANDING DESCRIPTION

3.1. At a glance

First and foremost, with the above mentioned sensor suite, automatic landing function is not capable of obstacle recognition. Because of this, the selection and suitability of the landing area remain the crew's responsibility. The automatic landing sequence initiates with the helicopter in stationary hover above the selected landing spot, at zero-groundspeed, with HOV and RHT modes active. The FCS is in charge of controlling helicopter zero-groundspeed and constant separation from the terrain, based on the reference selected by the pilot, which is "*fly-attentive*", "*hands-off*" and "*feet-off*" from flight controls.

Entry condition for near surface and landing operations require the helicopter to be at any height between 200 feet and 30 feet AGL. The pilot's first action is to press the dedicated NSO/LDG pushbutton on collective grip, enabling near surface operations. At the pilot's discretion, the height reference datum can be lowered down to 10 feet AGL, or adjusted as necessary to ensure visual references, especially in areas prone to brownout or whiteout conditions.

The pilot's second press of the NSO/LDG pushbutton activates the automatic landing mode (LDG). An appropriate Human Machine Interface (HMI) is provided: LDG mode is annunciated on Primary Flight Display (PFD), with a coherent modification of height reference datum to 0 feet. The helicopter begins descending while maintaining position. At any time during the descent, the flight crew can monitor position deviation from the intended landing spot via appropriate indication on the instrumentation of PFD.

The rate of descent is optimized by the FCS, allowing a faster descent when farther from the ground and gradually reducing vertical speed as the helicopter approaches the surface. Touchdown is achieved smoothly, with rate of descent not greater than 100 feet per minute.

The FCS incorporates synthetic ground contact recognition and, from that point, FCS begin to control helicopter's attitude. Pitch and roll are gently adjusted to accommodate the ground slope. Finally, collective lever is lowered to achieve MPOG condition, while cyclic and pedals are centered. When the helicopter is safely on ground the LDG mode deactivates.

At any moment during automatic landing sequence, pilot can overrides the FCS by maneuvering the flight controls.

Furthermore, LDG mode can be aborted by activating go-around (GA) mode. The pilot initiates GA mode by pressing the dedicated pushbutton on the collective grip.

3.2. A dive into

The LDG mode (ref. [1]) operates through a structured sequence of phases designed to ensure a safe and controlled descent and landing, governing the helicopter's flight control inputs across the Collective, Pitch, Roll, and Yaw axes. Each axis manages a specific control variable based on the operational objective of the current phase.

These phases are as follows:

- **Descent Phase** – This is the initial and default state activated upon engagement of the LDG mode. During this phase, the system autonomously manages the helicopter's vertical trajectory, gradually reducing altitude to approach the ground in a controlled manner, while maintaining stable horizontal positioning and minimizing pilot workload. The Pitch and Roll axes are tasked with maintaining the longitudinal and lateral positions, respectively, as captured at the moment of mode activation. The Yaw axis regulates the aircraft's heading to ensure directional stability, while the Collective axis commands a predefined vertical speed reference aimed at smoothly guiding the helicopter to a radar altitude of 0 feet. In the event that the descent is suspended, such as during repositioning maneuvers initiated by pilot input, the system continues to hold the longitudinal and lateral positions via the Pitch and Roll axes. Simultaneously, the Yaw axis continues to manage heading control, and the Collective axis adjusts to maintain a vertical speed reference of 0 feet per minute, effectively holding the aircraft at a constant height until descent is resumed.

- **Touchdown Phase** – This phase is triggered automatically when the ground contact recognition algorithm detects landing. Ground contact is identified through a combination of sensor inputs, including the verification of height convergence to zero and the cessation of vertical speed. Upon successful recognition, the system transitions to stabilize the aircraft on the ground. In this phase Pitch, Roll, and Yaw axes shift to managing aircraft attitude, ensuring that the helicopter maintains a stable and controlled posture upon ground interaction. Concurrently, the Collective control is driven to its fully down position, enabling a complete reduction in lift and facilitating a secure and stable touchdown.
- **Centering Phase** – Once ground contact is confirmed and the collective pitch is reduced to a low value, the system enters the centering phase. In this phase, the system automatically drives the flight controls to a centered and safe position, ensuring the helicopter remains stable on the ground. During this final stage, the cyclic stick and pedals are automatically commanded to their neutral (centered) positions, while the Collective remains in a lowered position corresponding to the MPOG (Minimum Pitch On Ground) condition. This configuration ensures the helicopter is safely stabilized on the ground and all active flight control inputs are neutralized.

Throughout the Descent Phase, continuous monitoring ensures safe operation. If the pilot intervenes by applying hands-on or feet-on controls, or if the helicopter deviates from its station-keeping position, the automatic descent is immediately suspended. In such cases, the pilot can re-establish a new reference position by pressing the cyclic Force Trim Release (FTR) button. This action synchronizes the position reference, allowing for repositioning of the aircraft. Once the new desired position is acquired and the pilot resumes a hands-off and feet-off posture, the system detects the stabilization and automatically resumes the descent sequence.

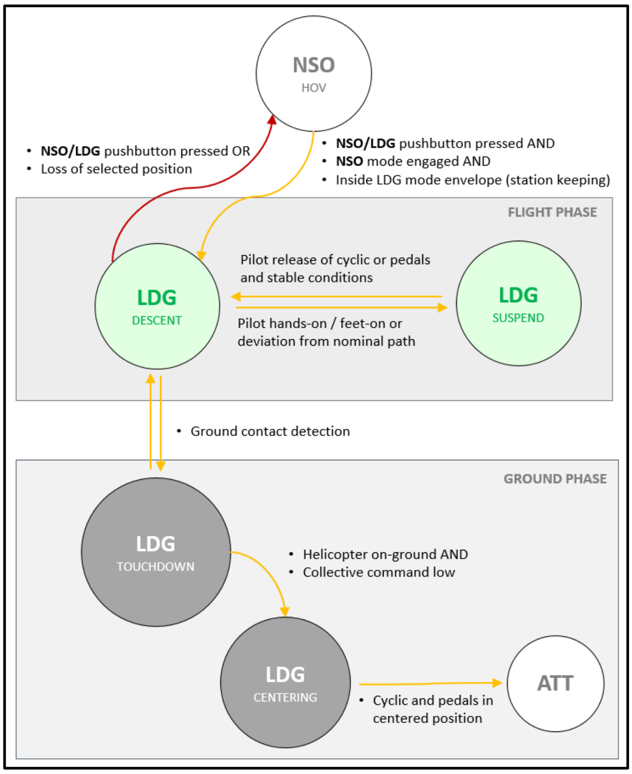

Figure 1: automatic landing mode state machine.

LDG mode is considered complete once the centering phase is successfully executed and all control axes are in their designated final positions. This structured, axis-specific control logic enhances safety, repeatability, and pilot confidence during automated or assisted landing operations.

The LDG mode can be aborted in any moment with GA mode. Upon GA engagement, the helicopter is automatically guided to 200 feet AGL and zero-groundspeed, ensuring a safe extraction from landing zone. Once at 200 feet, or at pilot’s request, GA transitions to the fly-away phase, targeting Vy and +1000 feet per minute climb rate. Power is continuously and automatically protected to avoid over-torque or turbine temperature exceedance. Whenever engine limits are approached, rate of climb is reduced to the maximum permissible based on available power. Similar to the LDG mode, the GA is provided with a dedicated and unambiguous HMI.

The automatic landing function is supported by a comprehensive suite of safety mechanisms specifically designed to assist the pilot in continuously monitoring the proper execution of the maneuver. These mechanisms provide real-time feedback and generate alerts, enabling timely corrective actions when deviations from the nominal descent profile are detected. Their primary objective is to prevent the aircraft from making ground contact under inappropriate flight conditions, such as excessive vertical or horizontal speed or unsafe attitudes, thereby enhancing operational safety and minimizing the risk of hard landings or loss of control during touchdown.

The first safety mechanism involves the display of a deviation alert when the aircraft departs from the nominal descent path. This includes both a collective deviation alert, based on divergence from the vertical descent profile, and lateral and longitudinal deviation alerts, which are evaluated based on the aircraft's displacement from the target landing position.

The second safety mechanism is designed to prevent excessive descent rates that could potentially damage the landing gear. The system continuously monitors a non-controlled variable associated with vertical speed, and if the descent rate exceeds a predefined safety threshold, the automatic landing mode is immediately disengaged and the descent is halted.

The third safety mechanism is aimed at preventing excessive deviations from the designated landing point and ensuring the aircraft does not reach the ground with a non-zero velocity. This mechanism relies on a comparative check between a hybrid groundspeed variable, obtained by fusing GPS and inertial sensor data, and a purely inertial-based velocity measurement derived from integrating inertial sensors alone. By comparing these two independent velocity estimates, the system can detect discrepancies that may arise from erroneous GPS data or signal degradation. If the difference between the hybrid and inertial groundspeed exceeds a predetermined threshold, indicating a potential navigation error, the automatic landing mode is immediately disengaged and the descent is aborted to maintain safety.

Finally, the interruption of the descent profile is not only triggered by manual repositioning actions (i.e. "*hands-on*" and "*feet-on*" by the pilot), but also functions as a protective measure. In cases where the aircraft approaches the ground with excessive planar or directional velocity, the system automatically suspends the descent to prevent unsafe ground contact conditions.

4. FLIGHT TESTING AND CERTIFICATION

4.1. Flight testing methodology

During piloted landing maneuvers conducted in respect of helicopter's limitations, normal variations of external conditions, such as wind intensity and direction, landing surface characteristics and slope, are generally managed through piloting technique and experience. In fact, well trained pilots with sufficient visual cues exemplify adaptive control systems, capable of adjusting flight control inputs to successfully complete the landing task even under challenging circumstances, including adverse wind conditions and unprepared or sloped surfaces.

Conversely, the automatic landing algorithm addressed in this work operates entirely independently of external visual references and is fundamentally deterministic. Therefore, the primary objective of flight testing the automatic landing system is to demonstrate its intended function with a high degree of repeatability, ensuring appropriate accuracy and smoothness within a defined envelope of external conditions. For the purposes of this study, particular focus is placed on wind conditions and terrain characteristics.

The flight test methodology for defining the relative wind envelope is a revised version of the testing technique originally adopted to ensure helicopter operations on moving vessels (ref. [2]). The key factors considered are terrain characteristics, wind direction (measured relative to the helicopter's heading), and wind magnitude. Throughout the progression of the flight tests, these three factors are never changed simultaneously, allowing the effect of each variable to be assessed independently.

The flight test campaign was planned and conducted under progressively increasing wind conditions, starting from calm air (below 5 knots) and gradually stepping up to maximum reachable wind speed. During the tests, prevailing (average) wind speed and gust intensities were recorded during the test with a LIDAR sensor configured to measure wind at 30 ft above ground level.

For each wind magnitude condition, the wind envelope was expanded starting from a headwind condition, then shifting the wind relative direction incrementally to the left (or to the right) in approximately 15 degrees steps. At each step, automatic landing was performed, followed by a second attempt that was voluntary aborted with the automatic go-around, initiated just prior to touchdown. Whenever the first landing attempt was deemed insufficient to evaluate FCS performance and robustness, the test point was repeated three times to confirm test results.

The test evaluation was conducted in a comprehensive and structured manner, combining the flight crew's (subjective) assessments with the engineers' (objective) post-flight data analysis.

More specifically, the test rating was managed using a dedicated three-level scale, purposefully designed for this evaluation. Ratings were assigned based on a checklist consisting of ten items, following a pass/fail logic. The checklist (see Table 1) is divided into four sections:

- **the first section** verifies that the automatic landing completes according to its intended function and with appropriate safety margins (robustness). This aims to prevent unsafe dynamics, such as dynamic rollover, which could potentially occur due to adverse interactions between the skid landing gear and ground irregularities or small, undetected obstacles;

- **the second section** addresses the accuracy of control in the horizontal plane (helicopter positioning) and vertical plane (rate of descent management);

- **the third section** focuses on smoothness, subjectively evaluated by onboard comfort during descent, at touchdown, and after touchdown, and objectively measured through variations in the helicopter's attitude during descent, as well as residual ground speed and vertical speed at touchdown;

- **the fourth and final section** evaluates the automatic recovery capability by assessing the effectiveness of the go-around mode.

Level 1 was considered achieved if all checklist items were passed.

Level 2 was assigned if at least one of the accuracy and/or smoothness criteria was not fully met, while the intended function remained preserved with appropriate safety margins and go-around capability.

Level 3 was assigned whenever pilot intervention on the flight controls, either before or after touchdown, was necessary to prevent potentially unsafe dynamics. Pilot intervention was evaluated in light of the specific conditions under which the automatic landing is designed to operate (e.g., DVE conditions, unprepared surfaces, etc.).

		Pass / Fail / not applicable		
1	**Function**			
1.1	LDG mode performed as expected from activation to MPOG condition and cyclic/pedal flight controls re-centering.	P	F	n/a
1.2	LDG provides adequate safety margins, in term of aircraft attitude variations and groundspeed, to grant a successful landing without risk of dynamic rollover after ground contact.	P	F	n/a
2	**Accuracy**			
2.1	Horizontal plane: confirm position figure of merit respected and "deviation alert" symbology not displayed on longitudinal and lateral axis.	P	F	n/a
2.2	Vertical axis: confirm "excessive deviation" symbology not displayed on collective axis.	P	F	n/a
3	**Smoothness**			
3.1	Groundspeed is below 1 kts just prior to ground contact.	P	F	n/a
3.2	Aircraft pitch attitude variations/corrections are limited (+/- 2 deg) around trim condition during descent.	P	F	n/a
3.3	Aircraft roll attitude variations/corrections are limited (+/- 5 deg) around trim condition during descent.	P	F	n/a
3.4	Aircraft is promptly (no delay) and smoothly (without bounces and/or prolonged ground slides) accompanied to full helicopter ground contact after first ground contact.	P	F	n/a
3.5	Rate of descent is below 100 fpm just prior to ground contact.	P	F	n/a
4	**Automatic recovery**			
4.1	GA engagement permits a prompt and safe abort of the condition when activated just prior to touchdown.	P	F	n/a

Table 1: automatic landing checklist.

Test point progression is depicted in Figure 2. X_1 to X_6 represent increasing wind speed from all azimuths.

It shall be noted that, when constructing the wind envelope, only ratings of 1 were included, while ratings 2 and 3 were excluded, as shown in Figure 3. This conservative approach provided a confidence margin for automatic landing operations in areas where precise wind measurements are not available to the flight crew, relying instead on estimations provided by the Flight Management System (FMS), often measured far above ground level.

A similar approach was used to extend automatic landing testing to unprepared smooth terrain and slope surface. Once the resilience of the function was assessed within the defined wind envelope, tests were conducted on smooth unprepared terrains, such as grassy terrain, hard-packed, dusty ground and fresh snow, under available wind conditions.

Finally, inclined surfaces were addressed, considering two factors: slope magnitude and slope direction. The terrain gradient was increased up to 8 degrees, while four prevalent directions (nose uphill/downhill, right wing uphill/downhill) were tested.

Another key factor during flight testing is the helicopter's weight and center of gravity (CG) position. It should be noted that the CG position is the predominant factor when assessing automatic landing characteristics. Extensive development activities have shown that an aft CG represents the most demanding configuration due to the pitched-up attitude that defines the helicopter's trim during hovering, both in and out of ground effect. Conversely, lateral CG, when within the already certified envelope, is less critical, as the roll attitude is primarily influenced by the crosswind component. Accordingly, automatic landing testing has been mainly conducted with the maximum aft CG position. Boundaries of the defined wind and slope envelopes have been then tested with the maximum forward CG position, to confirm performances. As regards helicopter's weight, maximum take-off weight was mainly targeted for flight testing. Again, boundaries of the defined wind and slope envelopes have been confirmed with the minimum operative helicopter's weight.

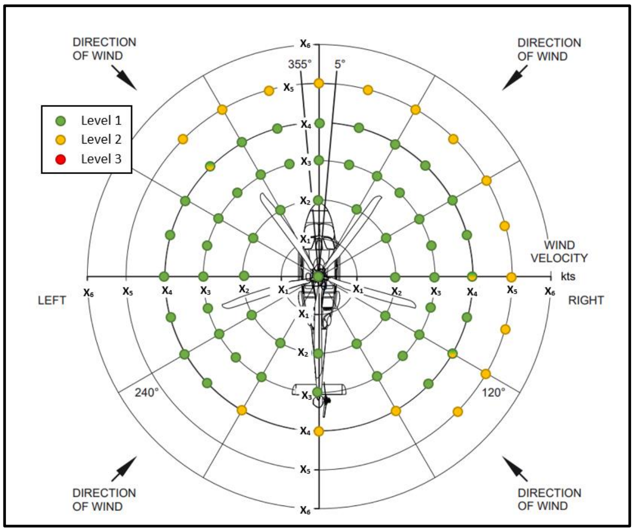

Figure 2: automatic landing test points progression.

For the verification of safety and malfunction conditions, a set of dedicated Functional Failures (FFs) were identified and analyzed within the Flight Control System (FCS) Functional Hazard Assessment (FHA) framework. This assessment was guided by two fundamental operational assumptions that define the conditions under which the automatic landing function operates. First, landing mode (LDG) engagement is strictly conditional upon prior confirmation that the designated landing area is clear of any obstacles or hazards, ensuring a safe touchdown environment. Second, before initiating LDG mode, the pilot is required to conduct a visual inspection of the landing site and achieve a stable hover condition with zero groundspeed, precisely positioned above the intended touchdown point. This stabilization is critical to guarantee that the subsequent descent phase begins without any unintentional drift or bias in longitudinal or lateral groundspeed components induced by sensor errors.

Within this context, the FHA considered multiple potential Functional Failures, including erroneous guidance commands, single or multi-axis slowover, and erroneous attitude control during the automatic landing sequence. The probability of these failures occurring in proximity to the ground was determined to be on the order of 1E-07, factoring in mitigation through limited exposure time during this flight phase. Consequently, severity validation through flight testing close to the ground was deemed unnecessary, in alignment with the established Military Type Certification Basis requirements. However, flight tests were conducted above 30 feet for these specific malfunctions to substantiate their severity. This approach is also justified by the ground effect near the surface, which tends to mitigate helicopter dynamics and reduce failure impacts, making flight testing at higher altitudes more representative of worst-case scenarios.

4.2. Major results

Demonstration of compliance to the requirements listed in section 2.3 is fulfilled within the wind envelope depicted in Figure 3: appropriate damping of external disturbances is provided showing gust rejection capability with gust intensity commensurate with prevailing wind condition. Position accuracy is as well demonstrated as constitutive part of the evaluation checklist. Figure 4 shows the helicopter's path, expressed in term of position error, from 10 ft down to ground contact, for 40 automatic landings. These tests represent a subset (for matter of clarity) of the broader set conducted in windy conditions, with wind direction included between azimuth -135 deg and + 135 deg, and wind intensity corresponding to the X_4 value reported in Figure 2. The 2-meters cylinder depicted in Figure 4 encompasses all landing profiles, confirming required performance in term of position accuracy. Note that the total number of automatic landings performed for development and certification purpose was about 300.

As regards surfaces characteristics, automatic landing has proven affective on smooth unprepared terrains, typical of operative scenario, while the slope envelope was limited to the one successfully demonstrated.

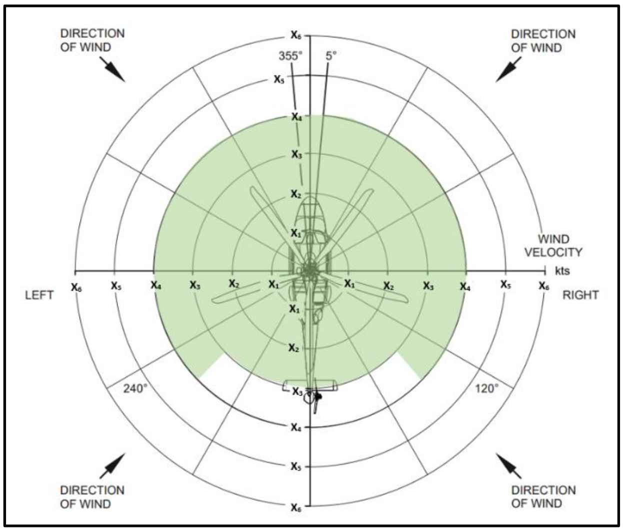

Figure 3: automatic landing wind envelope.

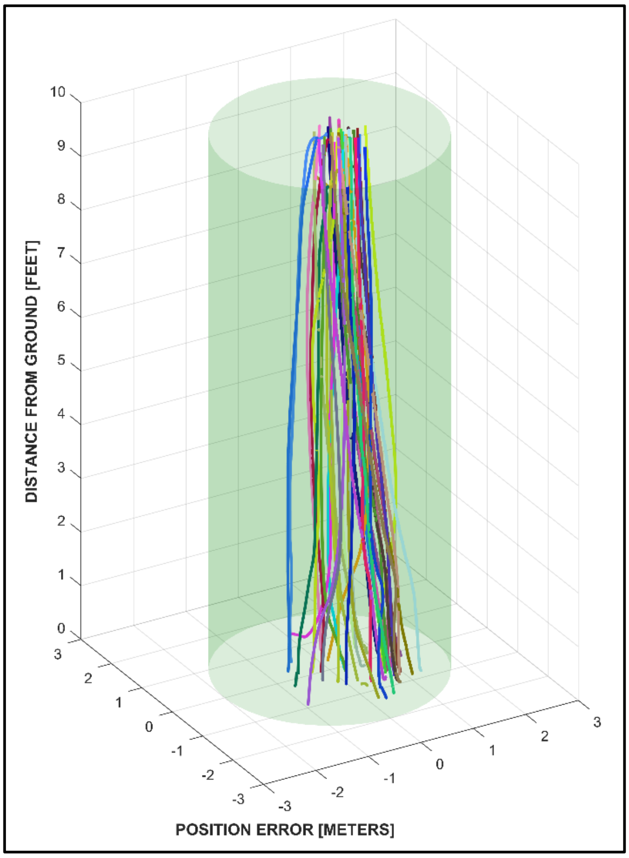

Figure 4: automatic landing profiles from 10 feet AGL down to ground contact.

In addition to performance validation, the flight test activity, together with the Functional Hazard Assessment (FHA) and the Safety Assessment, demonstrated compliance with the MCRI requirements. The Functional Failures identified for validation were tested in accordance with the Flight Test Plan. Specifically, the following conditions were evaluated: erroneous guidance during LDG mode and single- or multi-axis slowover in the same operational context. When required, a build-up approach was applied, progressively increasing the failure amplitude and/or duration to safely explore system behavior and assess the impact on flight dynamics. All tests were conducted in alignment with the defined procedures and acceptance criteria. The outcomes confirmed that the observed system behavior remained within the expected boundaries and supported the criticality classifications assigned in the FCS FHA. Furthermore, the test results validated the operational limitations and design protections implemented for the automatic landing function.

5. CONCLUSIONS

Automatic landing function was certified in accordance to Military Certification Review Item referred in sect. 2.2, as a major item included into the Military Type Certification of the AW169 helicopter, achieved at the beginning of 2025. Consequently, the presented function has been delivered to the customer for training purposes and is currently transitioning into full operational use.

Flight testing demonstrated the benefits of the automatic landing, highlighting its robustness under various operational conditions such as windy environments and diverse surface types. Most importantly, the safety level achieved is nearly compliant with civilian certification standards, paving the way for its extension to the civilian market.

In conclusion, the authors believe this novel function will significantly enhance safety margins during helicopters landings in DVE, opening the door to the introduction of new FCS capabilities that will follow in the near future, both for the military and for the civilian helicopter market.

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8. CLASSIFICATION & COPYRIGHT[1]