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Reports Question Engine Failure Safety Margins at U.S. Heliports

A survey of helicopter operational data and interviews with pilots suggest that protected airspace at heliports should be modified to better accommodate multi-engine helicopter performance.

Editorial Staff Report

Current U.S. federal regulations defining protected airspace around heliports are inadequate and do not address emergency situations involving engine failures, according to a government-sponsored report.

The report, *Helicopter Rejected Takeoff Airspace Requirements*, focused on performance data for helicopters certified to have one engine inoperative (OEI) performance capability, known in the industry as Category A. The performance data were compared with data from heliports where Category A operations were of concern.

Commissioned by the Federal Aviation Administration (FAA), the report examined heliport airspace requirements in relation to helicopter performance. It concluded that current air and ground space regulations "do not take into consideration emergency situations involving engine failures during takeoff and landing operations" and provide "no margin of safety for acceleration or stopping distance for a rejected takeoff."

In addition, the regulations define departure paths (climbout angles) "that are too steep for many helicopters' climbout capabilities (with one engine inoperative)."

The performance data used in the report were developed using assumptions and guidelines specifically aimed at investigating the design of heliports in confined areas. "Therefore, these data do not necessary reflect the performance capabilities of these helicopters in a broader operational or economic context," the report said.

Helicopters selected for study included the Aérospatiale 355F, Sikorsky S76A, Aérospatiale 332C, Boeing Vertol 234LR and the MBB BO 105CBS. Selection of the helicopter types was based on a combination of factors including availability of data, mix of weights, mix of IFR (instrument flight rules) and VFR (visual flight rules) capabilities and a mix of normal and transport category rotorcraft. (Table 1, page 2)

Table 1
Helicopters Selected for Detailed Analysis

Helicopter	Gross Wt. (lbs)	No. of Engines	Percent of Twin-Turbine Fleet	IFR/VFR	Performance Category
Aérospatiale 355F	5,071	2	12.4	VFR/IFR	NCR
MBB BO 105CBS	5,291	2	12.6	VFR	NCR
Sikorsky S76A	10,500	2	16.5	VFR/IFR	TCR/A/B
Aérospatiale 332C	18,959	2	0.2	VFR/IFR	TCR/A/B
Boeing Vertol 234LR	48,500	2	0.5	VFR/IFR	TCR/A

VFR — Certified for Visual Flight Rules Operations
IFR — Certified for Instrument Flight Rules Operations
NCR — Normal Category Rotorcraft
TCR/A/B — Transport Category Rotorcraft, Categories A and B
TCR/A — Transport Category Rotorcraft, Category A
Source: U.S. Federal Aviation Administration (FAA)

Helicopter flight manuals were used as the primary source of takeoff performance data. To create a meaningful operational context, weight, temperature and field elevation were calculated in the following ways:

- Aircraft weight: 70 percent, 85 percent and 100 percent of maximum gross weight;

- Field elevation: sea level, 2,000 feet and 4,000 feet; and,

- Temperatures: international standard atmosphere (ISA) and ISA plus 20 degrees centigrade.

In addition, profiles were evaluated for Category A takeoff procedures, vertical takeoff procedures and, where applicable, OEI climbout procedures.

"The study of airspace requirements for failed engine situations naturally limits the scope of the effort to multi-engine rotorcraft," the report said. "The single-engine aircraft with a failed engine is obviously going to be forced to land. Pilots of multi-engine rotorcraft, however, are faced with a choice in a failed engine situation — reject the takeoff and land or continue the takeoff with one engine inoperative."

Although only a small part of the U.S. civil helicopter fleet is certified for Category A (and an even smaller number actually operate Category A), the report noted that increases in U.S. Federal Aviation Regulations (FAR) Part 29 operations forecast in the coming years and "their impact on the industry must be considered in the development of heliport design standards."

The report also included operational data collected from a survey of 88 operators engaged in various missions throughout the United States.

"An overwhelming majority of the pilots [surveyed] expressed concerns about vertical and/or steep approaches and departures," the report said. "Almost half ... indicated that the use of these procedures is appropriate only when needed or required by the mission."

Pilots also described preferred takeoff procedures for unrestricted and confined areas:

Unrestricted Area (Two Takeoff Variations)

1. This takeoff technique began with lift off to a normal hover (three to five feet), followed by an acceleration to forward flight.

2. This takeoff method used the same hover distance as a starting point. However, accelerating to V_{TOSS} (takeoff safety speed) was the predominant consideration during the maneuver. [This was the procedure most often selected by the twin-engine operators.]

"The breakdown of responses to takeoff procedures in an unrestricted area correlated with whether pilots were operating single or twin-engine helicopters," the report said. "Of the 42 single-engine helicopter pilots surveyed, 41 indicated they were using the type [see 1 above] takeoff."

Confined Area (Two Takeoff Variations)

1. This takeoff technique was described as lift off to a normal hover (three to five feet) and, after ensuring that there was sufficient reserve power to achieve the necessary climb angle, a departure was initiated at a constant

climb angle needed to clear the obstruction. Obstacle clearance was the major objective. Once the obstacle was cleared, a normal departure climb was initiated. The application of takeoff power vs. using only the power needed to perform the climb was a major difference between operators.

2. This takeoff technique also started from the same hover height. However, acceleration to V_{TOSS} was secondary only to clearing the obstacle. This was most often mentioned by twin-engine operators. The use of the most shallow departure angle and the full area was also advocated.

In all types of operations, the pilots advised making maximum use of available area.

The report said that twin-engine operators, concerned with continuing after an engine failure, valued the safety margin that airspeed above V_{TOSS} provided. It said that the majority of twin-engine operators also believed that engine power above published limits could be used if absolutely necessary after the first engine failed.

Pilots said there were instances when there must be a willingness to risk potential aircraft or engine damage in order to preserve passenger and crew safety.

However, the report added: "Most pilots [surveyed] did not feel extraordinary precautionary measures were justified in dealing with the possibility of a potential engine failure. A reason that is often mentioned for this lack of concern is that turbine engines are very reliable and pilots have confidence that an engine loss on takeoff is a rare event."

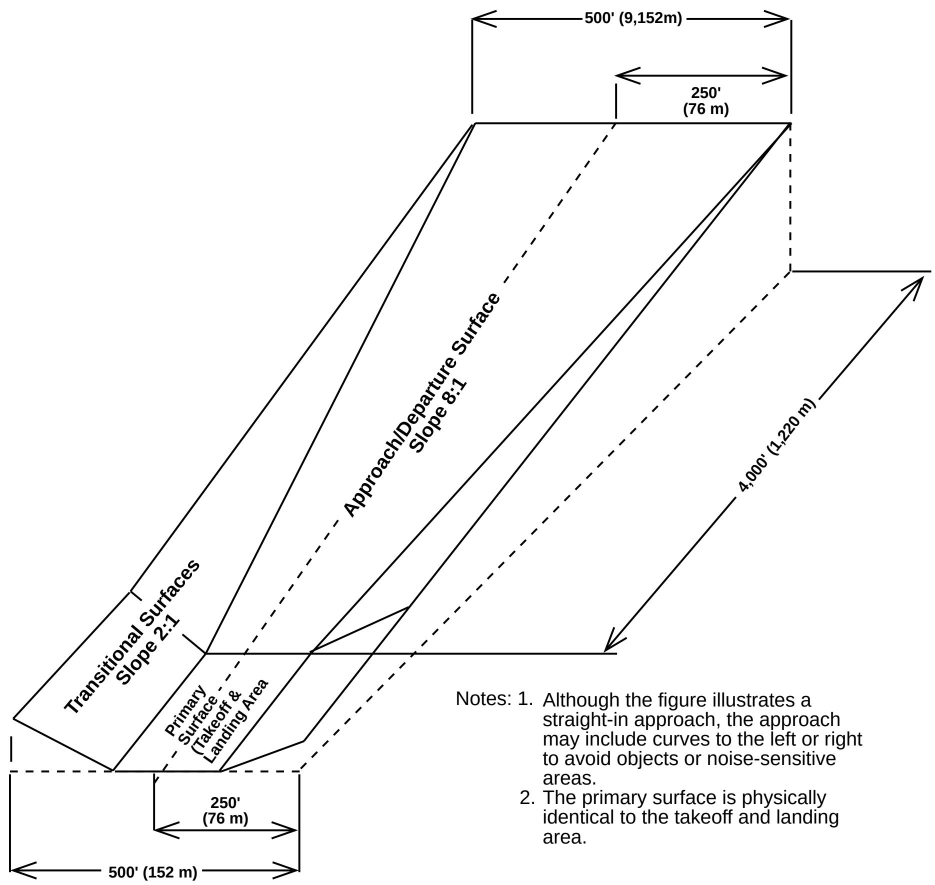
Nevertheless, operators responded that they wanted "sufficient acceleration distance to reach effective translational lift so that performance increases could be realized."

"Many pilots [surveyed] responded that given the availability of additional space at a heliport, the takeoff would start at the furthest point from the departure end of the heliport. This technique maximizes the acceleration distance and minimizes the required obstacle plane slope."

Airspace around airports and heliports is regulated in part by assessments of how objects and terrain affect navigable airspace. A series of "imaginary" surfaces in the vicinity of heliports and airports were created to assess the impact of new construction or obstacles on air navigation. The FAA-designated "surfaces" include (Figure 1):

- *Heliport primary surface*. The area that coincides in size and shape with the designated takeoff and landing area of the heliport.

Heliport Imaginary Surfaces



Notes: 1. Although the figure illustrates a straight-in approach, the approach may include curves to the left or right to avoid objects or noise-sensitive areas.
2. The primary surface is physically identical to the takeoff and landing area.

Source: U.S. Federal Aviation Administration

Figure 1

- *Heliport approach surface*. The approach surface begins at the end of the heliport primary surface (with the same width) and extends outward and upward for a horizontal distance of 4,000 feet and a width of 500 feet. The slope of the approach surface is 8:1 for civil airports and 10:1 for military heliports.

- *Heliport transitional surfaces*. These surfaces extend outward and upward from the lateral boundaries of the heliport primary surface and from the approach surfaces at a slope of 2:1 for a distance of 250 feet measured horizontally from the centerline of the primary and approach surfaces.

The report said the slope of the heliport approach surface was of particular interest in the examination. It said the 8:1 slope corresponds to an angle of 7.125 degrees above the horizon and begins at the edge of the takeoff and landing area.

A comparison of helicopter performance data and heliport airspace parameters found that the aircraft studied

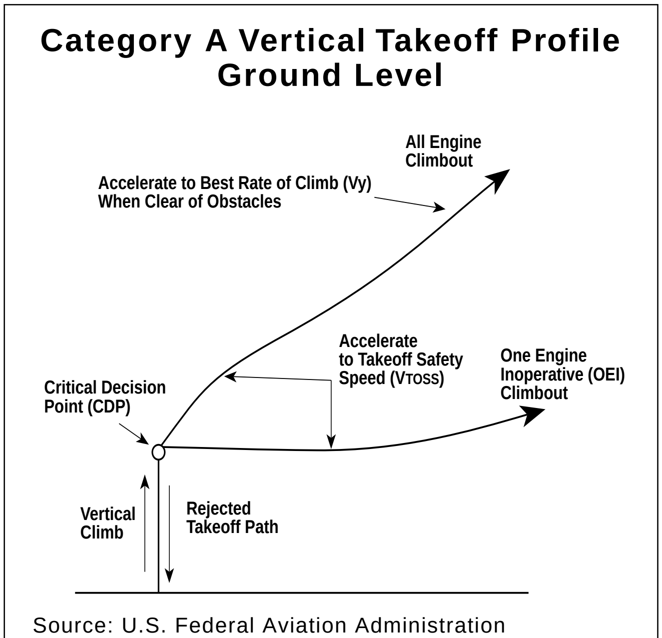


Figure 2

needed (at a minimum) "400 feet to reject a takeoff and 800 feet to achieve an acceleration to V_{TOSS} if an engine failed at the critical decision point (CDP)." It said that in some cases helicopters needed more than 1,300 feet to meet these requirements.

"It is apparent that the current Part 77 airspace rules are inadequate as a means of protecting airspace around heliports for helicopters needing to use Category A takeoff procedures," the report said.

"Helicopters that are required to perform Category A type takeoffs require between 400 feet and 1,600 feet of area to either reject a takeoff or to accelerate to V_{TOSS} and perform an OEI climbout. The current airspace protection surface begins at the edge of the helipad which provides no room for acceleration or rejected takeoff."

In addition, the report said current regulations are "inadequate to cover the range of helicopters and conditions that are encountered during rejected takeoff and climbout with one engine inoperative."

Current climbout angle requirements, the report said, are too steep for many OEI climbout conditions encountered.

[Helicopter performance calculations are based on meeting an 8:1 climb gradient. Man-made or natural obstacles are allowed to grow up to that same 8:1 slope.]

"The climbout angles identified in the study range from a high of 20 degrees to a low of 1 degree for helicopters operating with Category A restrictions. The standard 8:1 slope (7.125 degrees) is too steep for most OEI climbout cases observed in this study."

According to the FAA report, heliport imaginary surfaces should take into account operational performances detailed in another FAA report, *Heliport VFR Airspace Design Based on Helicopter Performance*.

"This system of classification uses acceleration distance and climb angle parameters to define performance-related airspace protection requirements at heliports. It allows certain trade-offs to be made between available airspace, helicopter performance and protection of the airspace from man-made or natural objects," the report focusing on rejected takeoffs said. (Figure 4)

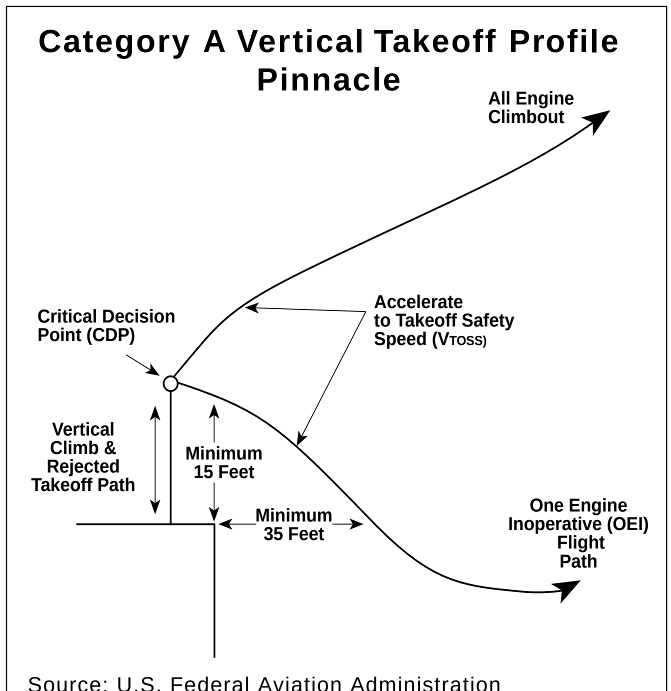


Figure 3

The FAA heliport design study recommended that:

- Airspace parameters be modified to allow departing helicopters to accelerate to the speed of translational lift with a 50-foot safety margin added to the achieved acceleration distance to establish the point where the obstruction clearance plane slope begins;

- The approach/departure slope be decreased to 9:1 at heliports with field elevations exceeding 3,000 feet. It said that heliports with 3,000 feet or less elevation could retain the current 8:1 slope;

- Airspace parameters (imaginary surfaces) be required to provide a safety margin factor of 1:2 between allowable obstructions and aircraft climb capability; and,

- Helicopter manufacturers be required to include performance data in flight manuals to inform pilots of aircraft capabilities for operations at confined area heliports along with takeoff and landing procedures.

[The report noted that one of the two normal category rotorcraft flight manuals reviewed provided the pilot with sufficient performance data for failed engine operations during takeoff. The other manual was lacking in distance and some climb related data. Neither the rejected takeoff data nor the distance to achieve V_{TOSS} were provided, the report said.

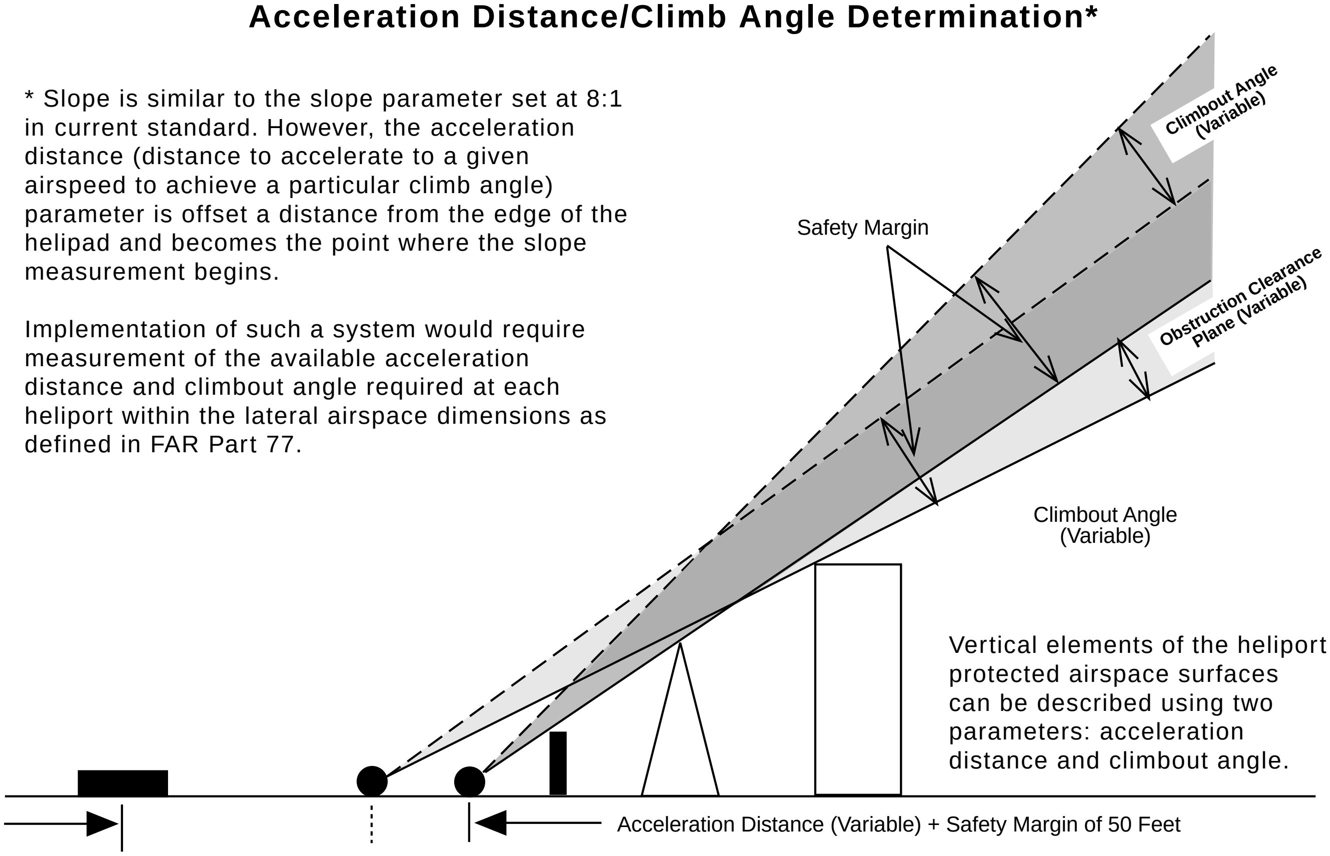
The three transport category rotorcraft manuals provided adequate information regarding Category A departure performance of the helicopters. However, one manual provided rejected takeoff distance and distance to achieve V_{TOSS} only at the maximum allowable weight.

These manuals contain data supporting the requirements in FAR Parts 27 and 29. The report said adding new requirements to the regulations can be equated to increasing cost to the manufacturers, a cost ultimately passed to the customer in the price of the helicopter. However, as a result of (this and companion) studies additional flight manual information on takeoff performance may be recommended.]

The heliport design report noted that helicopter performance varies with a number of operational and environmental factors including gross weight, takeoff procedures, air temperature and elevation.

"Because performance depends on several variables, the development of a general classification system for helicopter performance is not feasible."

Acceleration Distance/Climb Angle Determination*



Source: U.S. Federal Aviation Administration

Figure 4

Heliports located in rural areas with few obstructions require few if any operational constraints, the reports said. Other heliports are located in suburban or low density areas where future development could threaten heliport airspace.

"Defensible standards are needed to protect this airspace," the heliport design study said. It added, however, that airspace requirements need not necessarily preclude development of heliports in confined areas. "This should indicate to operators and heliport developers that helicopters with extra margins of performance will be required to operate at these locations."

The FAA report focusing on rejected takeoff requirements said the FAA and industry need to work together to resolve safety and economic issues associated with commercial operations at heliports. It said that while aircraft certification requirements for takeoffs and landings are quite clear, operational applications of these requirements "are considerably less clear."

"If rotorcraft ... are to be seriously considered for enhancing the capacity of the airspace system, as is being widely discussed, takeoff and landing requirements at heliports must reflect safe and economically effective operations.

"This effort should be part of an overall effort to better define takeoff and landing requirements at heliports for commercial rotorcraft and powered-lift vehicles." ♦

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