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HELICOPTER NIGHT OPERATIONS WITH HIGH INTENSITY SEARCHLIGHTS

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HELICOPTER NIGHT OPERATIONS WITH HIGH INTENSITY SEARCHLIGHTS *)

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Summary

Flight test results of a BO 105 helicopter equipped with two high intensity searchlights, featuring manual control of horizontal and vertical direction, as well as of focus of the light beam, are presented. In the initial tests basic obstacle recognition in hovering flight was investigated. Minimum distances for identification were determined for different types of obstacles with weather condition and background as parameters. A special effort was made concerning the recognition of cables and wires, and the results for the least favorable conditions are compared with the minimum distances obtained under equivalent conditions during daytime and dusk.

Various procedures for selecting and scouting a suitable landing site in an unprepared terrain from a minimum safe altitude were evaluated. A brief outlook describes the possibility for applications in helicopter night rescue operations.

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1. Introduction

Extensive flight tests with a BO 105 helicopter equipped with two high intensity searchlights have been carried out.
Basic obstacle recognition limits have been investigated down to a meteorological sight of approximately 2 km, whereas approach patterns and actual landings were confined to VMC conditions.
The main purpose of these tests was an evaluation of the search light system for rescue operations into unprepared terrain during night time under VMC. The part described in this paper was intended as an initial step for the definition and development of obstacle detection and navigation systems required for such an extension of the present rescue system in the Federal Republic of Germany.

2. High intensity searchlight SX-16

After a carefull evaluation process a dual "Nightsun" •) SX-16 system was selected for the intended application. The leading particulars of this searchlight are compiled in table 1. The remotely controlled movement capabilities were somewhat restricted by the installation design on the helicopter BO 105 (fig. 1, 2), but nevertheless completely adequate for the desired application. To give an idea of the searchlight's capabilities two representative beam configurations and the corresponding illuminated ground areas are shown in figure 3.

3. Obstacle recognition distances and limits

Table 2 shows horizontal distances for clear recognition of various representative larger obstacles as determined from hovering flight in different altitudes. In most of these cases no effort was made to determine the actual limits for clear recognition, since they did not represent an actual limiting factor for flight operations at night. The limiting distances, however, were determined for small size wires. The results for two wires with a distinctively different surface are shown in table 3. As an interesting comparison table 3 contains the limiting distances for the same wires during daylight without searchlights and during dusk with searchlights. Depending on background conditions (color) and wire surface the limits were in most cases found to be considerably smaller during daytime than during nighttime with searchlights. This somewhat surprising result, however, should always be considered in context with wire detection from hovering flight only.

•) tradename by Spectrolab

4. Landing site selection and approach procedures

It was assumed that the flight to the task area is accomplished by conventional navigational aids (e.g. a Doppler System). The detection of the actual site can be facilitated by suitable light signals on the ground. Two procedures have been found to be most feasible for selection and scouting the prospective landing site under VMC. The first is a slightly modified approach pattern with a 30° tear drop turn and reduced velocity on the final descent (fig. 4), and the second a direct approach with reduced velocity ($\leqq$ 30 kts, below transition) at the Minimum Safe Altitude (MSA). The velocity reduction in this case should be carried out only after sufficient reference lines or a definite horizon for a safe evaluation of attitude have been recognized.
Both procedures are carried out starting with a medium focus angle (~ 10°) out of MSA. Reaching apx. 200' GND the focus angle is increased to maximum and horizontal and vertical searchlights motions are initiated at the pilots discretion. Approximately from this height (depending on the ground structure) attitude control with reference to the illuminated area is possible. The descent is facilitated by the adjustable searchlight angle. During the flight tests most favorable results have been obtained for inclination angles between -10° and -15°. Aiming the center of the light prints on the ground slightly in front of the prospective landing site, was found to be of great assistance in order to maintain a fairly continuous angle of descent (fig. 5). Flight path measurements have clearly demonstrated that the BO 105 remains at least within the space illuminated up to 250 m (limit for obstacle detection under poor visibility) during the rather crucial phase of descent from apx. 500' to 200' AGL.
If it is assumed that small size wires may be encountered in this height range only the second type of descent assures a detection in time for a collision avoiding manoeuvre. Below 200 ft the velocity should be already below 30 kts for both procedures and a wire detection in time can be anticipated. For landings into rather confined areas additional lights directed sidewards of the helicopter have been found very usefull for the very final part of the descent.
As take off procedure a rather steep climb was used, after the surroundings of the anticipated flight path had been searched carefully with maximum focus. Wire detection against the open sky was found considerably improved compared with the direction towards the ground.

5. Application in helicopter night rescue operations

Under VMC conditions helicopter night rescue operations can be carried out using a searchlight system on a BO 105 as described in this paper. Two essential constraints are the availablility of a natural horizontal reference and the detection of a suitable landing site in the surroundings of the landing area marked by light signals. This was always the case during the flight tests under VMC conditions. Even in the most adverse case of wires in the height section between MSA and approximately 200' a direct descent at reduced velocity can be carried out within an acceptable safety margin. During this phase the pilot workload induced by the more pronounced problem of attitude control could be reduced considerably by an automatic stabilizing system. A low velocity indicator and a Doppler navigation system would be of further advantage. In addition it was found that a certain amount of operational practice with the system will improve the pilot's skill and confidence in the system considerably, in particular during the initial phase of familiarization.

TABLE I

LEADING PARTICULARS FOR NIGHTSUN SEARCHLIGHT EQUIPMENT MODEL SX-16

ILLUMINATION CHARACTERISTICS

SEARCHLIGHT UNIT	
Light Source	Xenon Arc Lamp
Beam Spread	4.0 in "Search" Mode, adjustable to 20 in "Flood" Mode. Focus continuously adjustable by remote control unit.
BEAM INTENSITY:	
"Search" Mode.	55 foot candles/20 ft. diameter at 300 foot range.
"Flood" Mode	2 foot candles/100 ft. diameter at 300 foot range
Peak Beam Candlepower	65,000,000 maximum NOTE: See Charts, Figures 1-7 and 1-8
MECHANICAL CONFIGURATION	
Overall Dimensions	Cylindrical, 11 in. OD x 18 in. Long
Weight	25 Pounds Maximum
Mounting Provisions	Axial trunnion screws, centrally located near searchlight front CG.
Cooling Provisions	Internal vane axial blower with replaceable air intake filter and exhaust at searchlight front face.
REMOTE CONTROL UNIT	
Controls	Unit includes master power on-off switch, lamp start switch, lamp focus control, and 4-way beam directional control.
Overall Dimensions	6 inches high by 4 inches wide by 2¾ inches deep.
Weight	1.75 pounds approximately.
GIMBAL MOUNTING ASSEMBLY MOTOR OPERATED, REMOTELY CONTROLLED	
*Movement Capability	350 Azimuth, 10 Elevation, 70 Down (Computed from a stationary platform) *NOTE: The full movement capability of the searchlight system cannot be utilized on all helicopters. See Installation for particulars.
Performance	When actuated by 4-way switch in remote control unit, mount shall allow searchlight to be pointed to any position from directly forward to 110 aft, and from 10 above to 70 below the aircraft horizontal centerline.
Overall Dimensions	Approximately 15 inches wide by 18 inches long.
Weight.	11.00 pounds.
COMPLETE SYSTEM: ELECTRICAL	
Input Power.	28 Volts DC, 65 Amperes
Safety Provisions.	All High voltage lamp starting circuitry enclosed in searchlight housing. Input primary power protected by circuit breakers. Searchlight automatically deactivated if malfunction occurs. Front face of searchlight covered with tempered glass plate.
TOTAL INSTALLED	
System Weight	65 pounds Maximum

Table 2: Recognition of various types of obstacles from hovering flight

Flight no.: 2 date: 8-23-75 time: 20:00 - 21:35 sun set: 19:05

meteorological conditions: VMC OAT/DP: 15°/10°C focus angle: 8°

heading	type and characteristics of obstacles	background	horizontal distance, m	hovering height ft				remarks
45	4 different cables	trees, grass, gravel	110	18	60	90	110	3 detectable
55	building crane	construction site	850	50	80	230	250	
90	wire fence, trees	forest	232	18	100	230	250	
90	edge of forest	forest	384	50	100	230	250	
98	mast of street light	parking area	350	18	100	230	250	not operating
113	edge of forest	forest	470	18	100	230	420	
113	building crane, including tension and hoisting cables	buildings, forest	270	18 18	100 100	230 230		 diam. 12 and 17mm
135	tower antennas	building, grass hills	152	18	(100)	---	---	wires detectable
139	gray cylindrical container	grass hills, forest	370	18	100	230	420	
168	wooden frame	trees, grass-land	182	18	100	260	420	model of tailfin
168	black chimney	trees, streets	330	18	100	260	420	≈ 2 m diam.
170	mast of streetlight	streets	760	--	---	---	420	not operating
176	light practice wall	trees, tennis courts	600	--	100	260	420	

Table 3: Wire recognition from hovering flight

Flight no.: 17/18 date: 11-6-75 time: 16:30 - 18:15 sun set: 16:48

meteorological conditions: sight: 4 ÷ 6 km, ceiling:4/8 st 500', OAT/DP: $6^{o}/5^{o}C$

wire no. and position		Ø mm	color	surface material	height, m
1	top	5,2	bright	aluminium	~ 8
2	bottom	7,7	black	rubber	~ 7

background mainly meadow, partially trees with automn colors, focus angle ≈ 10^{o}

	view angle [°]	horiz. distance [m]	height [ft]	detectable wires + remarks
daylight and dusk without search lights	90	20 - 25	25	1, 2 (2 worse in front of trees)
	45	20	25	1, 2
	90	15 - 20	50	(1) 2 (2 much better detectable)
	45	10 - 15	50	1, 2 (2 up to 40 m)
dusk with search lights	90	75	25	1, 2
	45	40	25	1, 2 (1 up to 90 m)
	90	60	50	1, 2 (1 up to 140 m)
	45	40	50	1, 2 (1 up to 80 m)
darkness with search-lights	90	80	25	1, 2 (1 up to 140 m)
	45	55	25	1, 2
	90	70	50	1, 2
	45	50	50	1, 2 (1 up to 120 m)

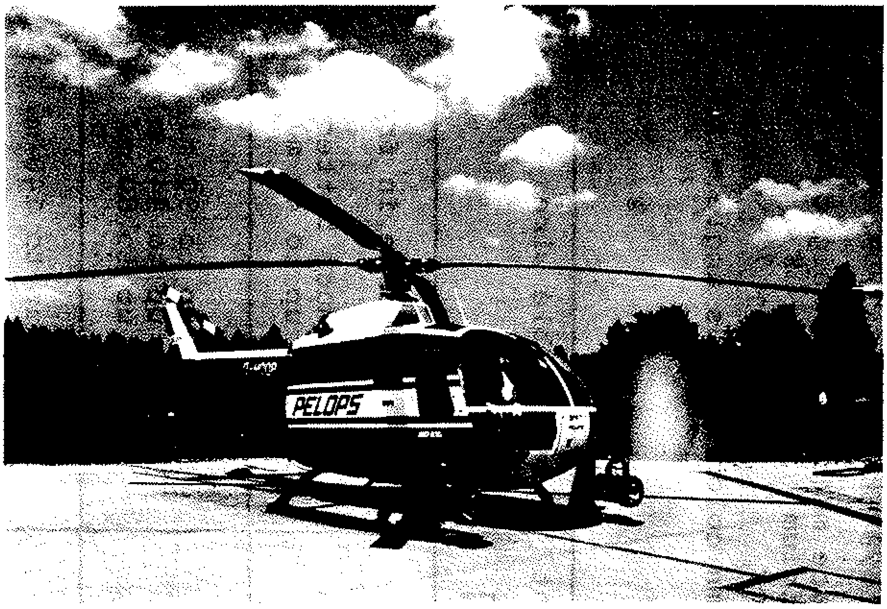

Fig.1: Installation of a dual search light system on a BO 105

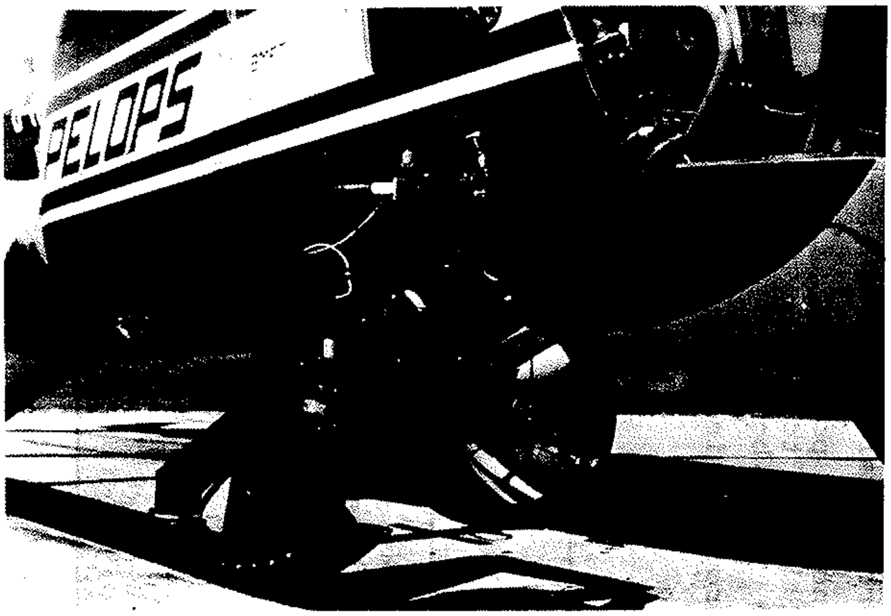

Fig.2: Close up of a search light unit

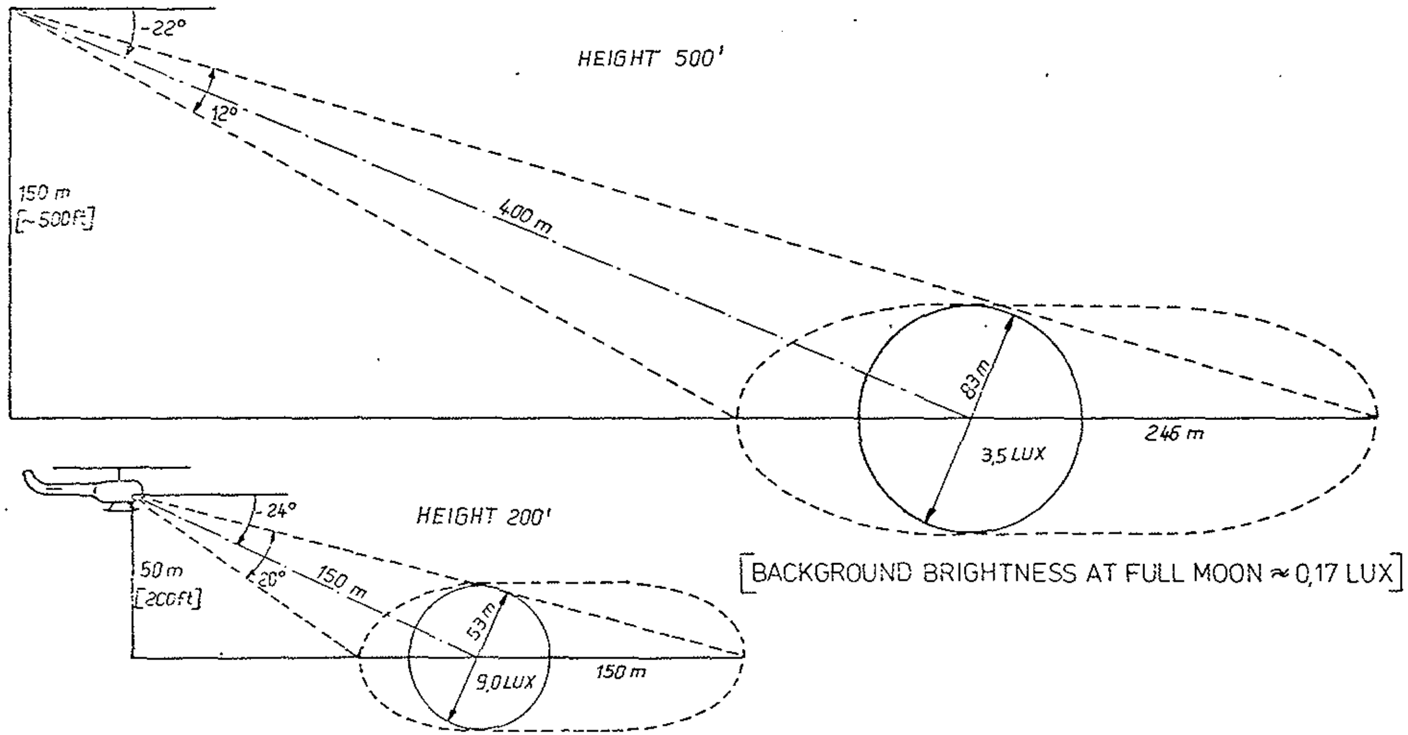

Fig.3: Examples of illuminated ground areas

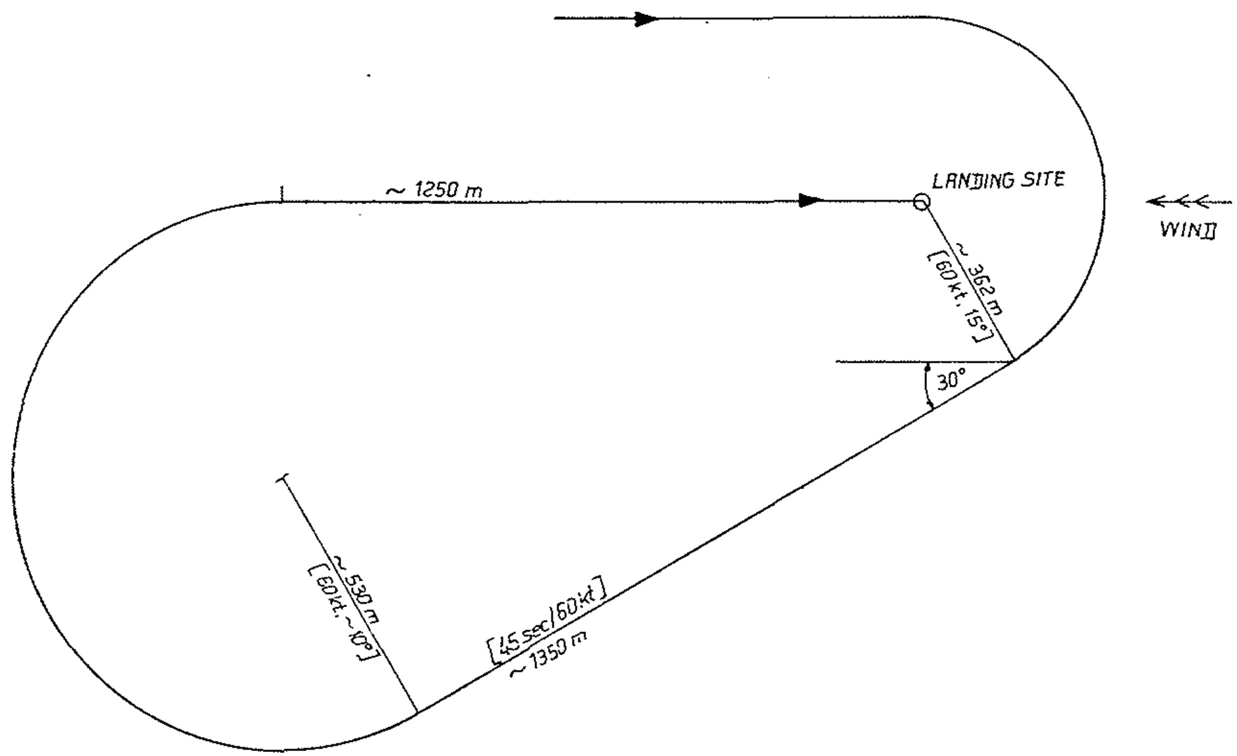

Fig.4: Approach pattern with 30° teardrop turn

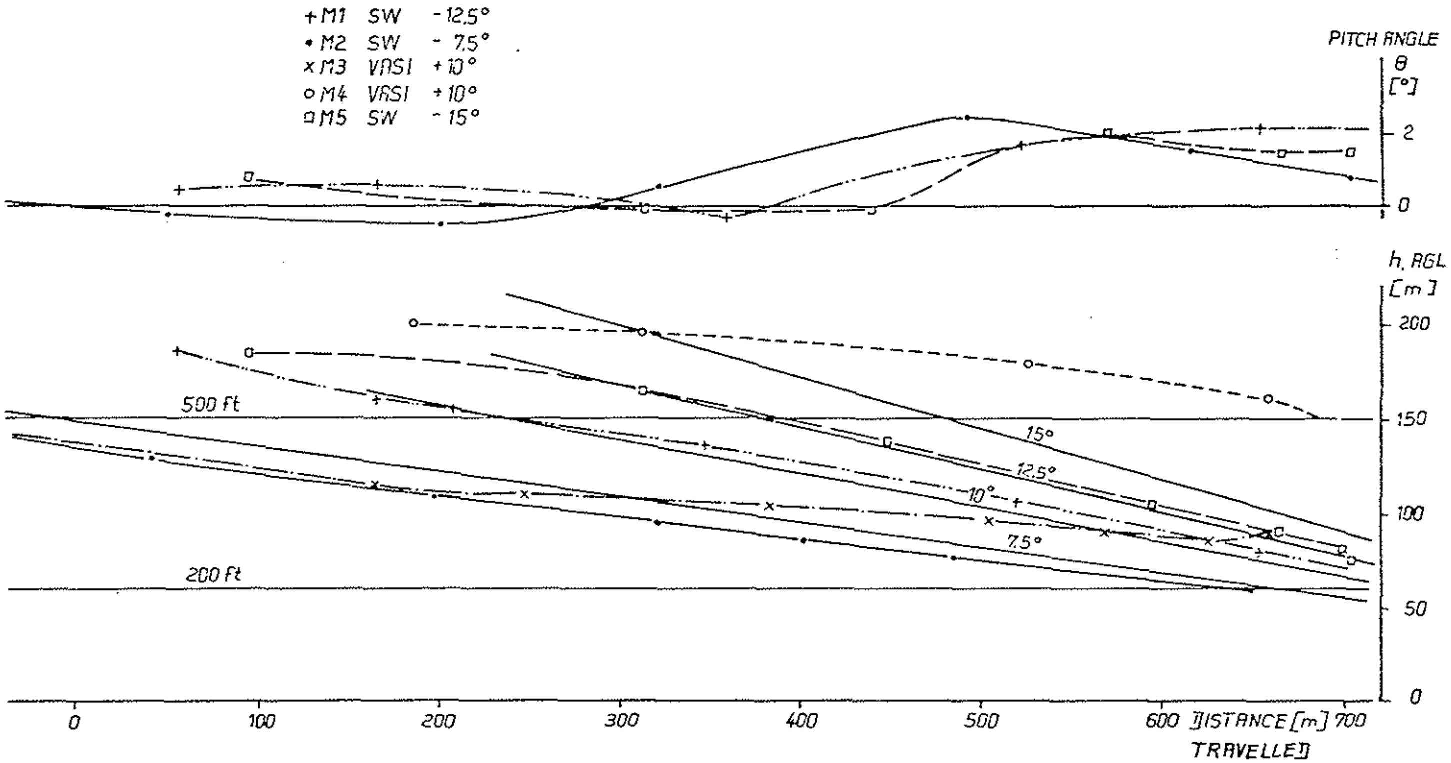

Fig.5: Glide paths and pitch angles for different searchlight angles and a visual approach slope indicator (VASI) of 10°

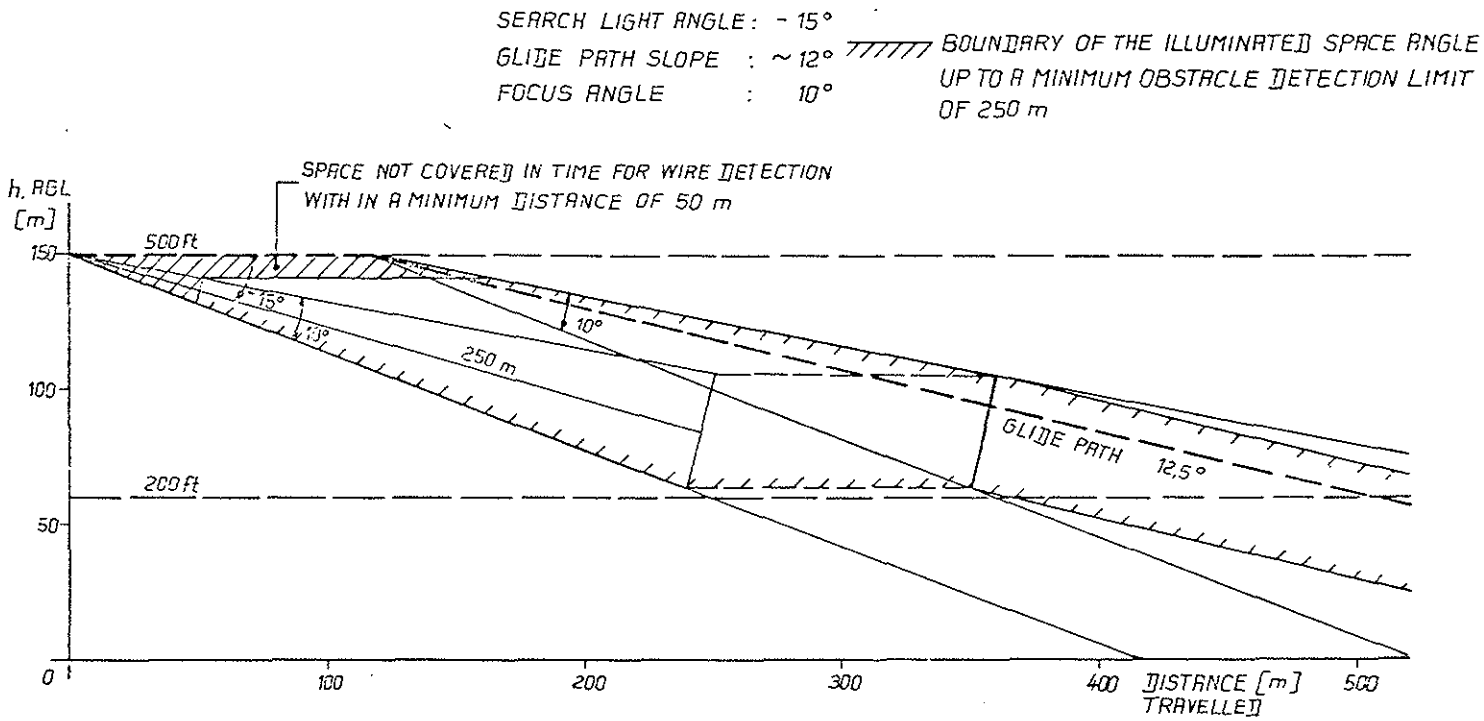

Fig.6: Ideal glide path and illuminated space angle, descent from 500' AGL