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FOREWORD

The research reported in this paper was instigated and funded by the UK Civil Aviation Authority in response to the conclusions of the study of off-shore platform identification signs, reported in CAA Paper 92006. Following the completion of this earlier research, the Authority determined that the provision of a helideck status signalling system represented the most effective means of minimising the exposure of the helicopter to the potential hazards of 'wrong-rig' landings.

The practical difficulties of providing a system capable of annunciating three discrete helideck status conditions (deck unsafe = do not land, deck safe but unmanned, deck safe = OK to land) outlined in this report are recognised and accepted. Consequently, it has been determined that a signalling system which annunciates only the deck unsafe condition offers the greatest potential for providing a satisfactory solution. Further investigation and in-service trials, aimed at developing appropriate requirements for such a system, are therefore planned.

CONTENTS

1 INTRODUCTION

The safety of off-shore helicopter operations is of primary concern to the CAA, the HSE, the helicopter companies and the rig owners. The maintenance of high levels of safety is promoted by a constant review of procedures and standards.

Following a review of the various aspects of the problem of 'wrong-rig' landings, a paperwork study was initiated to determine a minimum acceptable standard for off-shore platform identification markings. The report, CAA Paper No. 92006, concluded that existing identification signs are not adequate to meet the stated operational requirement and recommended the specification of a new visual aid.

The provision of a helideck status signalling system is an alternative approach to countering the safety hazards that could be associated with a 'wrong-rig' landing. Although helideck status lights cannot prevent an aircraft landing on the wrong platform they could help prevent it landing on a platform which is in an unsafe condition.

The Paper reviews the operational parameters, evaluates technologies and techniques that could provide a signalling system and proposes trials of candidate systems.

2 THE PROBLEM

Helidecks at off-shore facilities are not always available for use. Visual inspection by a pilot during the final approach to landing may not provide adequate monitoring of the deck status. For example, if explosives are in use at the rig this may not be obvious from the air. Similarly, if the deck surface is itself in a dangerous condition this may not be identified by visual inspection. For these and other operational reasons the need for some form of helideck status signalling system is clearly identified. The CAA has proposed that any system that is developed should, as a minimum, meet several criteria. It should:

(a) Comply with all relevant aviation and maritime standards, including the obstacle environment criteria if equipment is required to be sited in the vicinity of the helideck.

(b) Be compatible with all existing and specified off-shore aids and systems.

(c) Be effective at ranges up to that commensurate with the distance at which helicopter operations may be hazardous, irrespective of approach or landing heading, and under all environmental conditions in which helicopter operations could take place.

(d) Be capable of providing commensurate reliability, and integrity.

(e) Be capable of unambiguously indicating the three discrete helideck status conditions of:

- helideck unsafe (do not land)
- helideck safe, but not manned
- helideck safe and manned (OK to land).

3 OPERATIONAL PARAMETERS

3.1 Visual range of lights

From discussions with experienced off-shore helicopter pilots it is clear that any system that is developed must be capable of providing status information by day and at night at ranges out to at least 600 m, and preferably 1200 m.

For any system based on lights, it is necessary to specify the lowest visibility conditions in which the system is to be used. A meteorological visibility equal to a safety range of 1200 m could be chosen as the design parameter. Alternatively some lesser visibility, perhaps corresponding to the lowest in which approaches can be made, can be chosen. For this latter case a meteorological visibility of 600 m has been adopted for the purposes of this study.

Figure 1 shows the relationships between meteorological visibility and required light intensities for a light to be seen at these ranges of 600 m and 1200 m for day and night operations.

3.2 Signal Characteristics

If a lighting system is to be adopted to indicate deck status, it must not only be bright enough to be seen at a safe range but it must also be conspicuous in an environment where at night many other light sources are present. Furthermore, if the information being conveyed by the visual signal is to be acted upon it must be unambiguous and readily interpreted. Absolute and relative brightness and signal coding are therefore of paramount importance.

A considerable number of lighting systems already exist on rigs. The main types of lighting generally found are:

(a) Steady lights

Domestic lighting	–	white (50–100 cd)
Floodlighting	–	white/orange (100–20,000 cd)
Obstacle lighting	–	red (200–2000 cd)
Helideck perimeter lights	–	yellow (25 cd)
Helicopter Approach Path Indicator	–	red (9000 cd)
Helicopter Approach Path Indicator	–	green (9000 cd)

(b) Flashing lights

Helicopter Approach Path Indicator	–	red (2 Hz) (9000 cd)
Helicopter Approach Path Indicator	–	green (2 Hz) (9000 cd)
Alarm lights	–	white/red (1 Hz) (10,000–50,000 cd)

The requirement for the signal system to be designed to ensure that it is conspicuous and legible in this visually cluttered environment is therefore very demanding, particularly at night.

3.3 Angular Coverage and Siting

The criteria set out in para 2c indicate that the helideck status signalling system must be usable over all angles of azimuth. In elevation the system must be usable from deck level (0° elevation) to the angle defined by the greatest height at which the helicopter is likely to be the shortest usable range of the system. The maximum aircraft heights associated with ranges of 600 m and 1200 m are 350 ft and 600 ft respectively. The corresponding elevation coverage angles are 10.2° and 8.8° for the helideck at sea level.

Since the aid is to be used to safeguard helideck operations it is important that it and the deck can both be seen simultaneously. To ensure that both the deck and the aid can be seen their angular separation should preferably not exceed 1°. For a range of 1200 m this implies a siting for the aid at a position within a distance of approximately 20 m from the helideck. The separation would be less pro rata for shorter ranges. In addition, if the proposed status lighting system is to consist of several lights viewed simultaneously then the individual lights must be separated by an angle of at least 3 min arc as seen by the pilot. In practice this means the lights must be 1 m apart for every 1000 m of viewing range. For a 1200 m range this implies a light separation of at least 1.2 m. For a range of 600 m the separation must be at least 0.6 m.

4 PERFORMANCE SPECIFICATION

Most of the operational parameters discussed in para 3 can be readily translated into a performance specification. However, the light intensity to be specified must result from an informed judgement of conflicting considerations. Since the aid is to be used by day, it is the poor visibility daytime conditions that govern the intensity specification. If the lowest meteorological visibility in which the aid is to be used is 600 m when the range is 600 m, then from Figure 1 it can be seen that a light intensity of 3200 cd should be specified. If the requirement is that the light is to be visible at a range of 1200 m when the visibility is 1200 m then an intensity of 16,000 cd must be specified. An intensity of 16,000 cd is feasible from an omni-directional steady light. If an omni-directional steady light is to be used the practical limits are 2000–10,000 cd depending on the colour of the light. It should be noted that the intensities given above are the values for the light to be just above the threshold of detection. Greater values are needed to ensure that the lights are are obvious to pilots at the specified ranges.

For the purposes of this study a practical intensity of at least 10,000 cd will be assumed, with a design goal of 20,000 cd. As can be seen from Figure 2, lights of these intensities will give a range by day of approximately 1 km when the meteorological visibility is 600 m and 2.9 km when the visibility is 3 km. At night these lights will have a range of 1.7 km in a visibility of 600 m and 5.7 km in a visibility of 3 km.

The system coverage should be omni-directional but this can, if necessary, be achieved by multiple light units. In these circumstances higher intensities can be provided, but at a higher overall cost due to the number of lights used.

The recommended performance specification is therefore.

Intensity	–	20,000 cd (design)
	–	10,000 cd (minimum)
Beam dimensions	–	omni-directional, azimuth
	–	0–10° elevation
System location	–	within 20 m of the helipad
Simultaneous lights location	–	at least 1m apart
Signal format	–	conspicuous, legible and credible in a background of steady and flashing lights of various intensity and colour.

5 FORMAT OPTIONS

In paragraph 3.2 it was pointed out that any status light system that is proposed must be conspicuous, legible and credible. Because light signals are already used extensively on off-shore facilities to provide various information to pilots several signal formats cannot be used.

Any system such as a 'traffic light' system that at any instant shows a single light to the pilot cannot be used because steady red, green and yellow/white lights are variously used for obstacle lighting, glidescope indication (HAPI), helideck perimeter lighting and floodlighting. Thus the three effective long range, high intensity signalling colours are already in use in single steady light configurations. Similarly, for occulting signals red is already in use for both obstacle lighting and HAPI and green is in use for HAPI. To use single light signals that are used for another purpose is to risk mis-identification of the meaning of the signal.

An important conclusion is therefore reached that the helideck status signalling system must consist of a pattern of lights if it is to be unambiguous and credible under all circumstances. The pattern, of at least two lights, must be clearly differentiated from all other signals. Layout, colour and occulting format can be used to achieve the necessary performance.

The provision of a pattern that presents the same picture to pilots, no matter what the approach direction, is most easily achieved by a vertical array. However, a vertically deployed system may itself be a significant obstacle on some helidecks and may therefore not be an acceptable format.

6 CANDIDATE SYSTEMS

The systems shown in the Appendix are suggested as being technically feasible and operationally effective. Their principal characteristics and estimated costs are also summarised.

It can be seen from the Appendix that the proposed systems are made by the use of zenon discharge sources or tungsten halogen filaments. In the former case the output from each unit is omni-directional and of very short duration, whereas the output from the tungsten halogen lamps is limited in azimuth to not greater than 90°. However, the on/off ratio, repetition rate and intensity are more readily adjustable with the latter technology, which therefore offers a greater possibility of devising a signal characteristic that differs from any other system on the helideck. For example, it would be possible to transmit a Morse letter rather than a steady rhythm.

Generally, systems based on zenon flash technology consume less electrical power, a significant consideration at some locations.

It is important that a balance is struck between the high intensity required for long range viewing and the low intensities essential at short ranges at night if glare is to be avoided. In this context lights using reflectors rather than lenses offer better beam control, enabling light to be directed where it is required.

The systems suggested in the Appendix can, in most cases, be realised by the use of equipment already available from commercial sources, much of it certified to CENELEC standards. Where equipment does not exist it is feasible to devise prototype test lighting which could subsequently be developed to meet CENELEC standards. One of the proposed systems (G) does not fully comply with requirement 2(e) since only the helideck unsafe signal meets the 3 km range requirement. However, it is for further consideration whether the other two states need to be legible from long range, or indeed need to be displayed at all, bearing in mind the costs and complexity of most systems shown in the Appendix.

7 DISCUSSION

An inspection of the Appendix clearly shows that the various candidate lighting systems are all complex, physically extensive and costly. Meeting the full specification with a conspicuous, legible and credible signal is a difficult practical task. If the requirement at 2(e) could be limited to the 'deck unsafe' signal, then the provision of a system becomes more feasible. For example, a variation of System A, using 2 red lights, flashing at 0.5 Hz and vertically separated by 1m could be an acceptable solution. The estimated installed cost would be approximately £6K.

8 FUTURE WORK

It is recommended that the systems shown in the Appendix should be evaluated in three stages:

(i) Comments should be sought and collated from a wide range of helicopter operators, helideck operators, regulatory authorities and equipment manufacturers, on the operational acceptability and engineering feasibility of the proposed systems, bearing in mind the cost of any such installation.

(ii) Based on the results of the consultative stage a modified Appendix should be drawn up. The signal formats should then be implemented on a work station or simple simulation facility for pilot evaluation.

(iii) On completion of stage (ii) equipment should be procured for flight trials. These trials would be in two phases, an off-shore initial evaluation, followed by an in-service trial at an off-shore helideck.

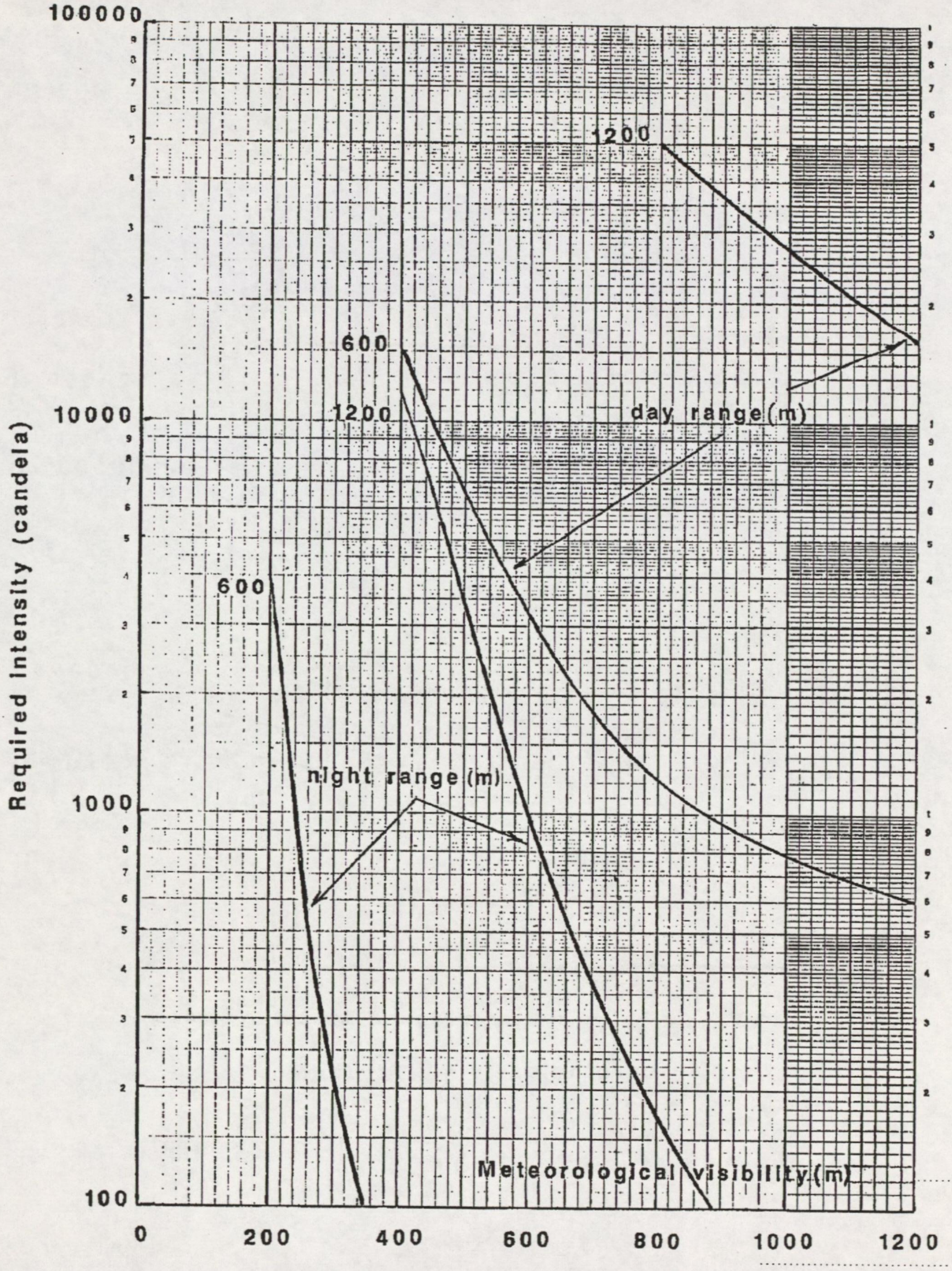


Fig. 1 Required Intensity

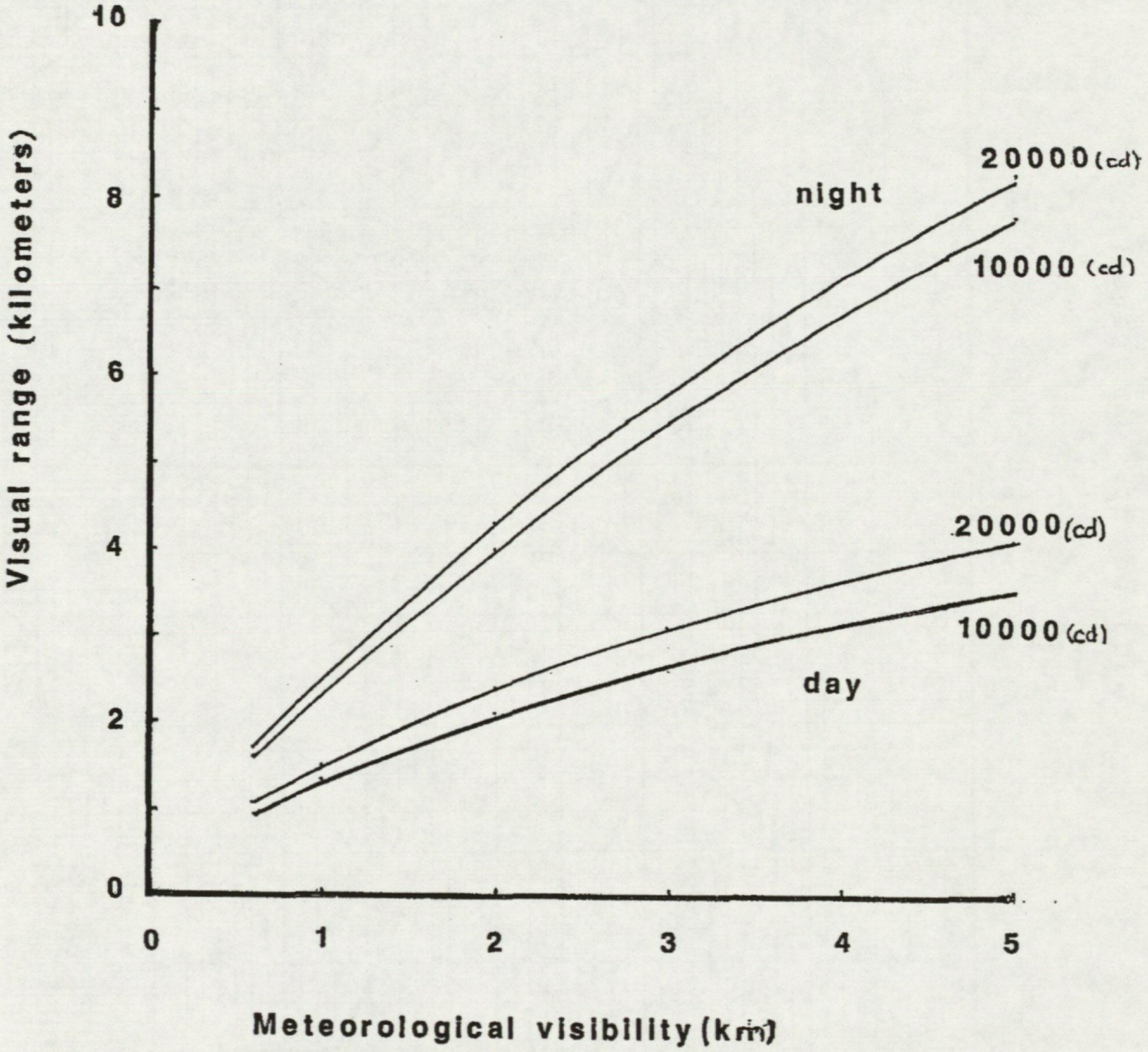


Fig. 2 Visual Range of Lights

APPENDIX HELIDECK STATUS LIGHT SYSTEMS

SYSTEM A

Colour	Lamp Type	Intensity (KCd)	Rate (Hz)	Duration (m sec)	Unit Cost (£)	No Units
Red	Z	10	1	2	1200	2
Yellow	Z	10	1	2	1200	2
Green	Z	10	1	2	1200	2

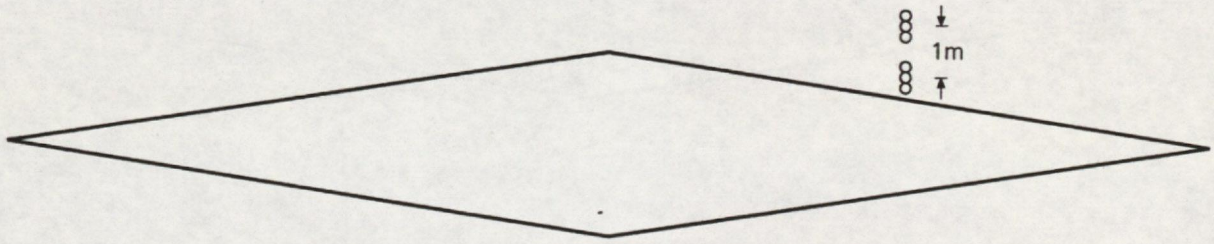
(Z = Zenon)

The system consists of 2 omni-directional flashing red lights vertically separated by 1 m, 2 similar yellow lights and 2 similar green lights.

When the helideck is unsafe the red lights are selected. When the helideck is safe but unmanned the yellow lights are selected and when the helideck is safe and manned, the green lights are selected. The lights flash at 1 Hz, but the 2 units are timed such that the lights are in anti-phase, so that alternate lights flash every 0.5 sec.

Advantages – modest power consumption
– available technology

Disadvantages – size of units and vertical extent (3 m) of system
– difficult to dim
– poor control of vertical beam spread



SYSTEM B

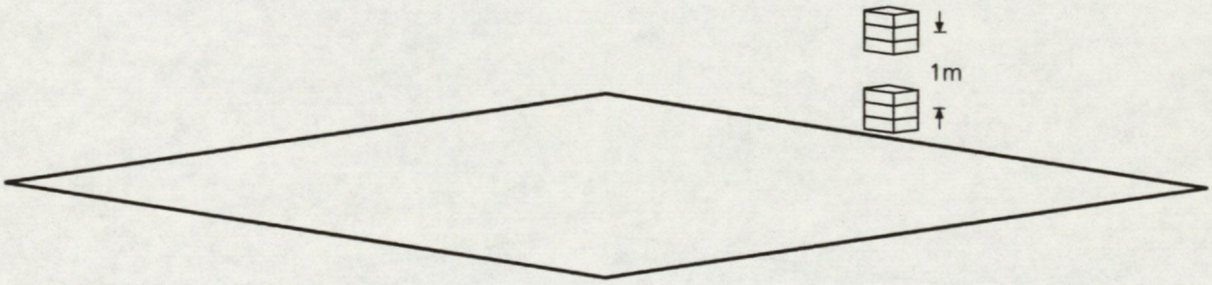
Colour	Lamp Type	Intensity (KCd)	Rate (Hz)	Duration (m sec)	Unit Cost (£)	No Units
Red	TH	20	1	100	6000	8
Yellow	TH	40	1	100	6000	8
Green	TH	20	1	100	6000	8

(TH = tungsten halogen)

The system is similar to System A. There are two differences; the first is that 4 lights are needed at each height (total 8) to provide the omni-directional coverage. The second is that the flash duration is much larger.

Advantages – easy to dim
– good vertical beam control
– larger flash, more legible

Disadvantages – cost and number of units
– large power consumption (3 kw per lamp)
– size of installation
– may need some equipment modification



SYSTEM C

Colour	Lamp Type	Intensity (KCd)	Rate (Hz)	Duration (m sec)	Unit Cost (£)	No Units
Red	TH	20	1	100	6000	8
Green	TH and	20 10	1 –	100 steady	6000	8

The system is a variant of B. When the helideck is unsafe the red flashing lights are selected. When the helideck is safe but unmanned the flashing green lights are selected and when the helideck is safe and manned the steady green lights are selected.

The dimensions and flash characteristics are as for B.

Advantages
- easy to dim
- good vertical beam control
- larger flash, more legible
- steady signal during most landing operations

Disadvantages
- cost and number of units
- large power consumption
- size of installation
- may require equipment modification

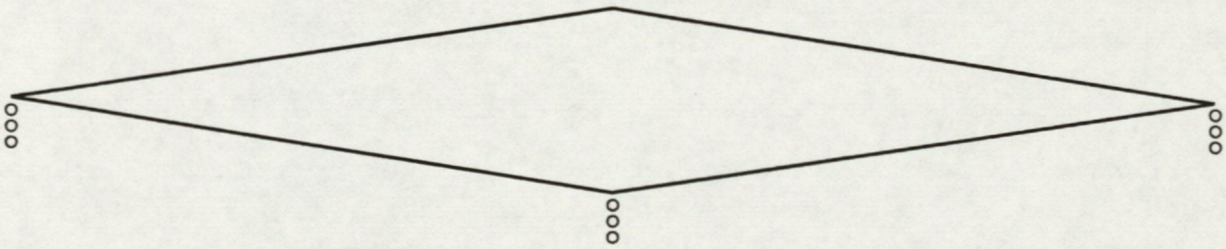
SYSTEM D

Colour	Lamp Type	Intensity (KCd)	Rate (Hz)	Duration (m sec)	Unit Cost (£)	No Units
Red	Z	10	1	2	1200	4
Yellow	Z	10	1	2	1200	4
Green	Z	10	1	2	1200	4

The system consists of a set of 3 lights (red, yellow, green) at each corner of a square helipad. Multi-sided helipads would have correspondingly more lights. All red lights flash simultaneously when the helideck is unsafe. When the deck is safe but unmanned the yellow lights flash and when the helideck is safe and manned the green lights flash.

Advantages – modest power consumption
– available technology
– minor obstacle

Disadvantages – difficult to dim
– poor control of vertical beam spread



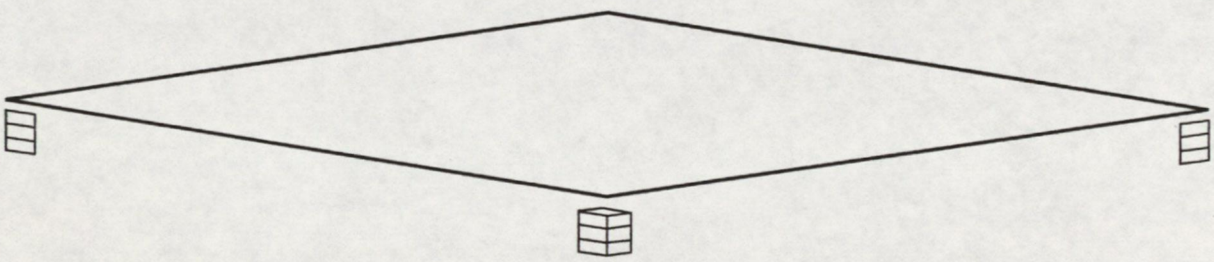
SYSTEM E

Colour	Lamp Type	Intensity (KCd)	Rate (Hz)	Duration (m sec)	Unit Cost (£)	No Units
Red	TH	20	1	100	6000	8
Yellow	TH	40	1	100	6000	8
Green	TH	20	1	100	6000	8

The system is a variant of D, but uses 2 lights of each colour at each corner to ensure adequate beam coverage so that the pilot sees at least 2 lights flashing coincidentally.

Advantages – easy to dim
– good control of vertical beam spread
– long duration flash

Disadvantages – high power consumption
– high cost



SYSTEM F

Colour	Lamp Type	Intensity (KCd)	Rate (Hz)	Duration (m sec)	Unit Cost (£)	No Units
Red	TH	20	1	100	6000	8
Green	TH	40	1	100	6000	8
	and	10	–	steady		

The system uses the same layout and equipment as System E. However, a flashing green signal denotes the helideck is safe but unmanned, and steady green lights denote the helideck is safe and manned.

Advantages – as for E
– fewer units than E

Disadvantages – as for E

SYSTEM G

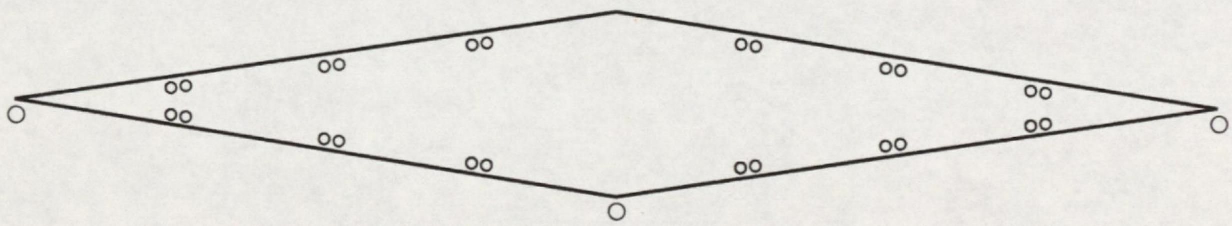
Colour	Lamp Type	Intensity (KCd)	Rate (Hz)	Duration (m sec)	Unit Cost (£)	No Units
Red	Z	10	1	2	1200	4
Yellow	TH	0.4	–	steady	1000	12
Green	TH	0.2	–	steady	1000	12

The system uses a flashing red light at each corner of the helideck to denote an unsafe condition. Steady yellow and green lights are used to denote a safe but unmanned and a safe and manned condition respectively.

The yellow lights could replace perimeter lights on unmanned helidecks and the green lights could replace the perimeter lights on manned decks.

Advantages – only uses flashing lights for the unsafe condition
– yellow and green lights can be dual-purpose

Disadvantages – similar to E



SYSTEM H

Colour	Lamp Type	Intensity (KCd)	Rate (Hz)	Duration (m sec)	Unit Cost (£)	No Units
Red	Z	10	1	2	1200	2

The system uses two flashing red lights at the edges of the helideck and on a line normal to the bi-sector of the obstacle free sector. The lights flash in anti-phase.

Advantages – modest power consumption
– available technology

Disadvantages – only provides helideck unsafe signal