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CAA PAPER 98003

SPECIFICATION FOR AN OFFSHORE HELIDECK STATUS LIGHT SYSTEM

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Foreword

The research reported in this paper follows on from the study of helideck status signalling systems reported in CAA Paper 93020. The project was funded by the UK Civil Aviation Authority and the UK Health and Safety Executive, and was supported by Shell UK Exploration and Production.

The Authority concurs with the results of this work, and has adopted the helideck status light system specification recommended in section 6.1 of this paper by incorporation of a reference in CAP 437 (Offshore Helicopter Landing Areas: A Guide to Criteria, Recommended Minimum Standards and Best Practice).

The desire within the Industry for a 'helideck safe' light signal is recognised and understood by the Authority, and an indication of how this might sensibly be provided is described in section 4.5 of this paper. It is stressed, however, that it is the view of the Authority that the primary potential hazards to the helicopter of 'wrong rig' landings are adequately addressed by the provision of a helideck status light system which meets the specification contained in this paper.

Executive summary

This paper reports the results of research to develop and validate a specification for a light signalling system for off-shore platforms. The purpose of the system is to warn pilots of approaching helicopters if the helideck is in an unsafe condition (e.g. due to moving machinery or a gas cloud in the vicinity of the helideck).

The original operational requirement for the lighting system was to provide a signal that is visible and conspicuous at any range within 600m, at all azimuths and in visibilities down to 600m (day and night).

An 'off the shelf' high intensity red rotating beacon system was procured and installed on a 'complex' North Sea offshore platform. Flight trials demonstrated the vertical beamspread and intensity of the light to be insufficient at night; with the high levels of stray platform cultural lighting at night, the signal was lost in the visually cluttered environment.

An in-service trial showed that for high brightness conditions the only practicable means of achieving a conspicuous signal with an acquisition range of 600m in visibilities down to 600m was using white light. However, from a human factors point of view, a red light system is more suitable than white light for indicating a warning. A trial on a less visually cluttered platform demonstrated that a high intensity red light system would suit most platforms at night, and that acquisition ranges of 400m can be expected in visibilities down to 600m. The operational requirement for the acquisition range would therefore have to be reduced.

A specification has been developed and validated using 'off the shelf' technology. The requirements for flash rate, intensity and coverage could be met by installing three high intensity red strobe lights. The light system should be integrated with the platform safety system such that under unsafe conditions the lights would be automatically activated wherever possible.

Although not a part of the work reported in this paper, a recommended specification for a flashing green 'helideck safe' light has been outlined.

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1 INTRODUCTION

DERA Bedford were tasked under Contract Number 7D/S/980 by the Safety Regulation Group of the UK Civil Aviation Authority to carry out studies, flight trials and reporting on a Helideck Status Signalling System.

The project was jointly funded by HSE and CAA and was managed by the CAA. Shell Expro UK and NAM made suitable helidecks available for the trials and supported them with their personnel. They also provided transport and offshore accommodation for trials personnel.

This report details the objectives of the project and provides a record of the flight trials and laboratory testing carried out on 'off the shelf' candidate light systems. The results of this series of trials are discussed and a procurement specification for the production light system is recommended.

2 BACKGROUND AND OBJECTIVES

The original intention was to have a lighting system that would indicate the three discrete helideck conditions of:

- the deck is safe and fit to land on,
- the deck is safe but not manned,
- the deck is unsafe to land on.

A study performed by DERA Bedford in 1993 (Ref. 1) identified the practical difficulties of providing such a system. The solution would be complex and expensive. The study recommended implementing a system using two lights for indicating the 'helideck unsafe' condition only.

As a result of this study a modified objective for the project was agreed. This was 'to develop and validate a specification for a light signalling system for offshore platforms capable of warning pilots of approaching helicopters if the helideck is in an unsafe condition'. Examples of an unsafe helideck are when there is a gas cloud present or moving machinery in the area of the helideck. DERA was tasked with producing the photometric specification for the light system, procuring and installing equipment and validating it using available 'off the shelf' lighting equipment.

The operational requirement for the system was to provide a light signal that the pilot will recognise as a warning whilst the helicopter is on the deck and at any range within at least 600m from the installation, at all azimuths in visibilities down to 600m (day and night).

3 SUMMARY OF TRIALS AND TESTING PROGRAMME

An overview of the trials and testing conducted is provided in Table 1 below. Detailed reports on the content, conduct, results and conclusions for each of the trials are contained in Appendices A-F.

Table 1

Date of trial	*Location of trial*	*Type of lighting evaluated*	*Conclusions/ comments*
December 1994	Shell – Safe Gothia flotel moored alongside Brent Charlie platform.	1. Red high intensity rotating beacons arranged in various configurations on platform.	• Vertical beamspread not sufficient. • Intensity not high enough. • Power up time too long. • At least two high intensity lights required for this complex platform.
May 1995	Shell – Safe Gothia flotel moored alongside Brent Charlie platform	1. White high intensity rotating beacons	• Vertical beamspread not sufficient. • Intensity okay. • Power up time too long. • At least two high intensity lights required for this complex platform.
		2. Flashing perimeter lights (for short range)	• Flashing perimeter lights ineffective. • Supplementary (flashing) strobe lights or rotating beacons required for short-range signals.
January 1996	Shell – Safe Gothia flotel moored alongside Brent Delta platform	1. White high intensity rotating beacons	• Vertical beamspread not sufficient. • Intensity okay. • Power up time too long. • At least two high intensity lights required for this complex platform.
		2. Supplementary red flashing lights on deck (using flasher circuit)	• Minimum effective intensity required for supplementary lights is 60Cd between 3 to 15° to the horizontal and flash rate should be around 2 flashes per second.
March – July 1996	Shell – Safe Gothia flotel moored alongside Brent Delta platform	1. White high intensity rotating beacons	• Lighting system suitable at range of 600m. • Within 400m and on deck the signal was too weak. • Power up time too long.
February 1997	NAM – K14	1. Red high intensity rotating beacon	• Vertical beamspread of high intensity beacon not sufficient.
		2. Red high intensity strobe	• Red high intensity strobe suitable for this platform if flash rate increased.
		3. Red battery operated low intensity flashing light (rotating beacon)	• Battery operated light suitable for short-range (200m) signal. (Effective intensity 65Cd, flash rate 2 flashes per second)
July 1997	DERA laboratories	1. Red/ white high intensity strobe	• For flash rate of 40fpm effective intensity of white light is 21,900 Cd • Red filter allows only 15% of light to be transmitted.

4 DISCUSSION

4.1 Intensity, colour and beamspread requirements of status light system

The series of trials conducted for this research programme has shown that the provision of visual landing cues at offshore platforms can be seriously impeded by extraneous light at night. For a warning light to be conspicuous and 'attention getting' in this visually cluttered environment, the DERA tests have shown that it must be much more intense than would be the case for a similar light in normal environments.

Table 2 summarises the characteristics of the light units tested in the series of trials.

Table 2

Light Unit	*Effective Intensity of main beam*	*Beamspread (vertical)*	*Flash rate*	*Colour*
High intensity rotating beacon	30,000Cd	0 to 10° from horizontal	2 per second	white
	11,000Cd	0 to 10° from horizontal	2 per second	red
High intensity strobe	3,860Cd	0 to 90°	1 every 3 seconds	red
Low intensity flashing light (using flasher circuit)	60Cd 10Cd	3 to 15° from horizontal up to 45° from horizontal	1 per second	red
Low intensity battery operated flashing light (rotating beacon)	65Cd	5 to 15 ° from horizontal	2 per second	red

The operational requirement for the status light system was to provide a signal that the pilot will recognise as a warning whilst the helicopter is on the deck and at any range within 600m from the installation, at all azimuths and in visibilities down to 600m (day and night).

The trials data and Allard's Law (Appendix G) show that for a light to be visible and conspicuous as a warning signal from this range on a bright and sunny day, it should have an intensity of around 21,750Cd. (For some platforms that have a very high level of cultural lighting, the intensity requirements for the light to make it conspicuous at night would be equivalent to that required for a bright and sunny day).

The vertical beamspread requirements for the status light system can be established from the typical helicopter final approach angle of between 5 and 10° and knowing that when the aircraft is on or above the helideck the required viewing angle between the pilot and the light can be up to 45°. Additionally if the light system is required to be visible to helicopters flying over the installation the (vertical) beamspread should be increased to 90°. The trials' data has shown that the vertical beamspread of the light should conform to that shown in Figure 1 in order to meet the range requirement originally specified.

A key factor in the recognition of a signal as a warning signal is the use of the colour red. Red also has the benefit of being detected in the offshore environment because of the colour contrast it provides against the sea, sky or platform superstructure background. It is, therefore, very desirable to achieve a practicable helideck status light system in red. However, a comprehensive review of commercially available light units has shown that it is a very demanding requirement to make a red light unit that has a large vertical beamspread and 360 degree coverage in azimuth with intensities in the order of 21,750Cd. No such unit was available at the time of these trials.

The high intensity red strobe light that was used on the NAM K14 trials was deemed to have a suitable vertical beamspread and had an effective intensity of 3860Cd at 20 flashes per minute and 3250Cd at 40 flashes per minute. The calculation in Appendix G using Allard's law shows that, on a bright and sunny day in a visibility of 600m, the light should be conspicuous from a range of 420m if flashed at 40 flashes per minute.

From the foregoing considerations it follows that it is only practicable to fully meet the original specification of 600m acquisition range in visibilities down to 600m by day and at night using white light. It was also very apparent that, from a human factors point of view, a red signal is preferable. These two conflicting criteria of range and colour can be reconciled in a practical manner if the warning range requirement is reduced from 600m to 400m. It is believed that such a modification to the operational requirement is acceptable.

Figure 2 shows the vertical beamspread of the Pulsolux XI-100 high intensity strobe light. Also shown in this figure is the minimum required intensity of the status light at angles between 0 and 90° from the horizontal. It can be seen that the Pulsolux XI-100 unit satisfies the minimum requirements.

4.2 Flash rate, number of units, location and flash sequencing of units

The recommended flash rate of the status light system should be approximately 120 flashes per minute. This was the flash rate of the high intensity rotating beacon which was deemed acceptable by a number of pilots during in-service and dedicated flight trials. The high intensity strobe unit, which was tested on the K14A platform, can only achieve a maximum flash rate of 90 flashes per minute. One of these units set at the maximum flash rate can only achieve an effective intensity of 1500Cd in red. However three such strobe lights, each flashing at 40 flashes per minute, can be arranged to flash in sequence to produce a system which, viewed from a distance, would have the required effective intensity of 3250Cd and flash rate of 120 flashes per minute. If the three strobe lights were positioned approximately equally spaced around the perimeter of the helideck with one light on the origin of the 210° obstacle free sector, another requirement of the system would be met, i.e. locating the lights in such a way that, irrespective of the direction the helicopter is facing on the deck, at least one status light would always be visible to the pilot.

The sequencing of the flashes from each of the three units in turn should be arranged to ensure that there is an equal gap of 0.5 seconds between each flash.

For some large platforms there may be occasions when the helideck cannot be seen until the helicopter range has reduced to a few hundred metres because of the approach track being flown. The Brent Delta/ Safe Gothia was an example of such a situation. In these circumstances, another light unit should be located at the opposite end of the platform to the helideck.

4.3 Switch on time

There is also a requirement that the switch-on time for the light unit(s) when activated should be effectively instantaneous. This is to ensure that there is no delay in indicating to the pilot that the helideck is in an unsafe condition, which is particularly important in the event of a warning being triggered when the helicopter is on the final stages of its approach to the platform.

4.4 Size of unit

The light units used should be as small as possible and must comply with the height limitations (less than 25cm) of objects on the helideck. Although the high intensity strobe light used in the trials was approximately 65cm high, the lamp and lens height was only 17cm high; the rest of the unit comprised an enclosure for the transformer and electronics. For a production unit it should be feasible to install the transformer under the surface of the helideck or locate it away from the critical height area of the helideck.

4.5 'Helideck Safe' light

During the course of this work programme a number of offshore platform operators and pilots have indicated a desire for a light system that can positively identify the destination helideck. A single green helideck safe light, switched on by the HLO just before the helicopter commences its approach, could be used to fulfil this requirement. The specification of the high intensity strobe that was used on the NAM K14 trials could be adapted and used for this function. A single light unit placed on the perimeter of the helideck fitted with a green filter in place of the red filter and configured for a flash rate of 40 flashes per minute is recommended.

If a 'helideck safe' light was to be installed on a platform as well as the helideck status light system, the platform wiring design should ensure the two signals could not be activated simultaneously.

5 CONCLUSIONS

1. A specification for an offshore helideck status light system has been developed and validated through a series of flight trials and laboratory tests.

2. For daytime operations the required intensity of the system is determined by the range at which the signal needs to be seen, the prevailing visibility, the presence of bright sunlight and cloud cover. The approach or overflight path of the helicopter, together with the need for the light to be conspicuous to the pilot when on the deck but not looking directly at the light, determines the beamspread requirements.

3 For night operations, the level of cultural lighting on and around the platform largely determines the intensity requirement of the system. There are some platforms which have a very high level of cultural lighting. These require a warning light system of intensity similar to that required by day in bright sunlight to ensure that the signal is conspicuous.

4 The specification should take into consideration that the lights are required to be conspicuous on a bright, sunny day and on a 'worse case' platform with very high cultural lighting at night. If the lighting system is suitable for these extreme conditions, then on dull days or on platforms with lower cultural lighting levels the specification should still be appropriate, although some form of intensity control may be desirable.

5 The initial operational requirement of acquiring the signal at a range of 600m in 600m visibility has to be reduced to a range of 400m in 600m visibility in order to allow a red status lighting system to be specified.

6 The requirement can be met with existing technology by using three high intensity strobe lights located around the perimeter of the helideck. In some instances variation in siting arrangements may be necessary due to the characteristics of the platform or operational considerations.

7 Although not a part of the work reported in this paper, a brief study has shown that a specification for a flashing green 'helideck safe' light could be developed.

8 The development of the status light specification has been significantly affected by the high levels of light 'pollution' present on many platforms. Reduction of these levels is possible and would significantly improve the visual cueing environment at night.

6 RECOMMENDATIONS

It is recommended that the following specification, developed through this programme of work, should be adopted. It is also suggested that for each platform an aeronautical study be conducted before the lighting system is installed to ensure the system will meet the operational requirement.

6.1 Specification for an offshore helideck status light system

6.1.1 *Application*

A Helideck Status Light System shall be provided at all offshore helidecks to indicate when the helideck is unsafe for helicopter operations.

6.1.2 *Location*

A Helideck Status Light System shall be installed on all offshore facilities that contain a helideck such that the pilot of a helicopter approaching and landing on the helideck can clearly see the activated signal whilst on the deck, and from a range of at least 400m at all azimuths in visibilities of 600m (day/night).

6.1.3 *Characteristics*

- The colour of the status light(s) shall be red.
- The signal shall be visible at all azimuth angles with a vertical beam spread as shown in Figure 2. The effective intensity shall be at least 3250Cd between 5 and 10° above the horizontal and 1000Cd up to 90° above the horizontal.
- The light system shall flash at a frequency of 2Hz.
- The light system shall have a response time to full intensity not exceeding 3 seconds at all times.
- The light units shall comply with all relevant safety regulations for the installation.
- Where required, the light units shall have a brightness control facility that can easily be accessed by the Helicopter Landing Officer (HLO).
- The lighting system shall be integrated with platform safety systems such that under unsafe conditions, such as a gas cloud or moving machinery in the vicinity of the helideck, the system is activated automatically.
- A switch shall be made available to the HLO on the helideck to manually switch on the system if required.
- A facility shall be provided to allow the HLO to override automatic activation of the system.

NOTE: As indicated in Section 4.2 this specification can be met by the use of a number of lights suitably sited and sequenced.

6.2 Further recommendations

It is further recommended that the provision of a 'helideck safe' light and the issue of light 'pollution' be addressed. It is also recommended that consideration be given to the development of a light unit that could produce over 20,000 Cd red intensity with the required beamspread characteristics.

7 REFERENCES

1) CAA Paper 93020 – Helideck Status Lights, A J Smith, April 1993

8 LIST OF ABBREVIATIONS

ASL	Above Sea Level
Cd	Candela
CAA	Civil Aviation Authority
cm	Centimeter

DERA	Defence Evaluation and Research Agency
HLO	Helicopter Landing Officer
HSE	Health and Safety Executive
Hz	Hertz
m	meter
NAM	Nederlandse Aardolie Maatschappij B.V
SRG	Safety Regulation Group
UKOOA	United Kingdom Offshore Operators Association

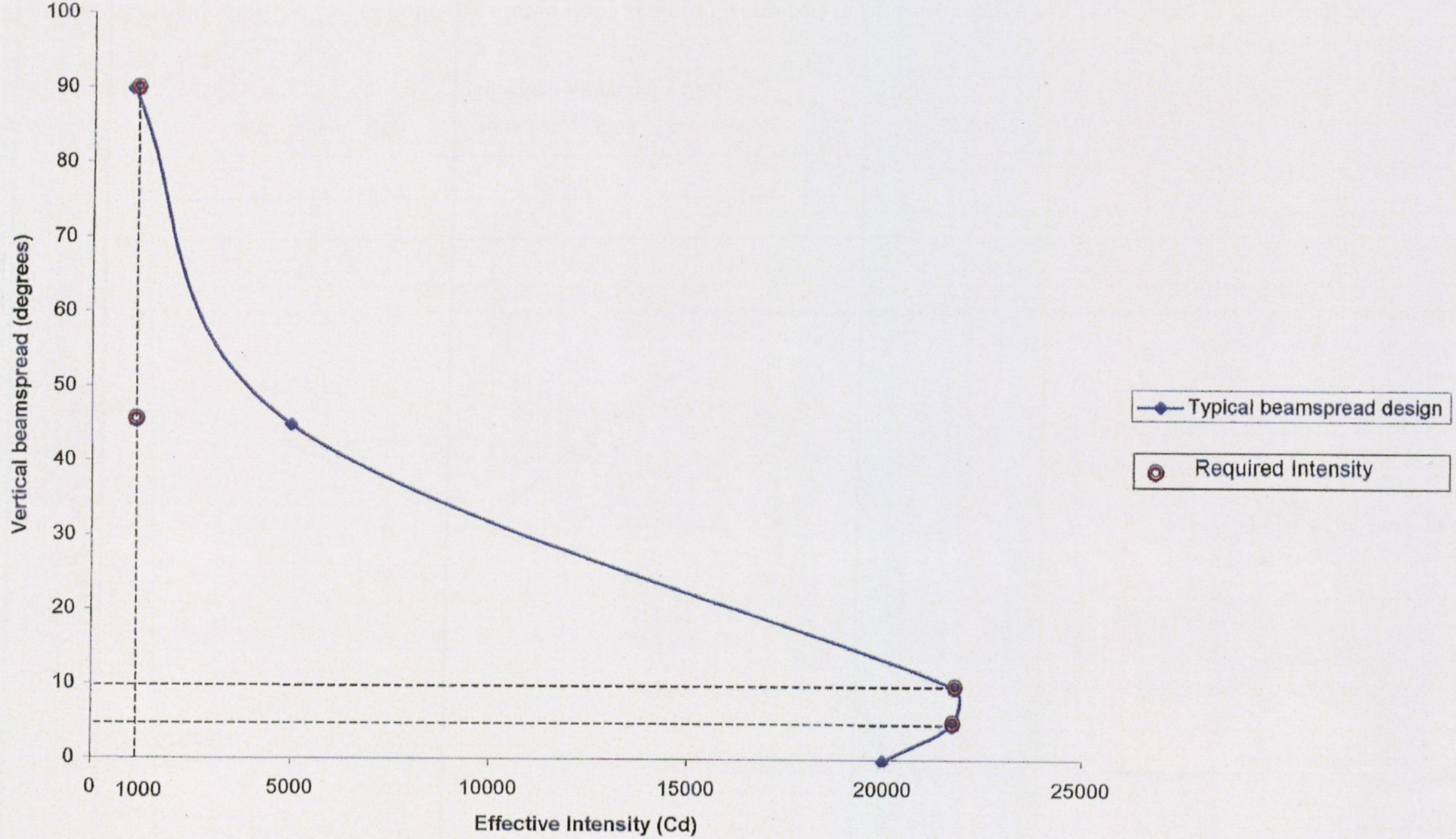


Figure 1 Intensity distribution of helideck status light system if required to be seen from a range of 600m in 600m met vis

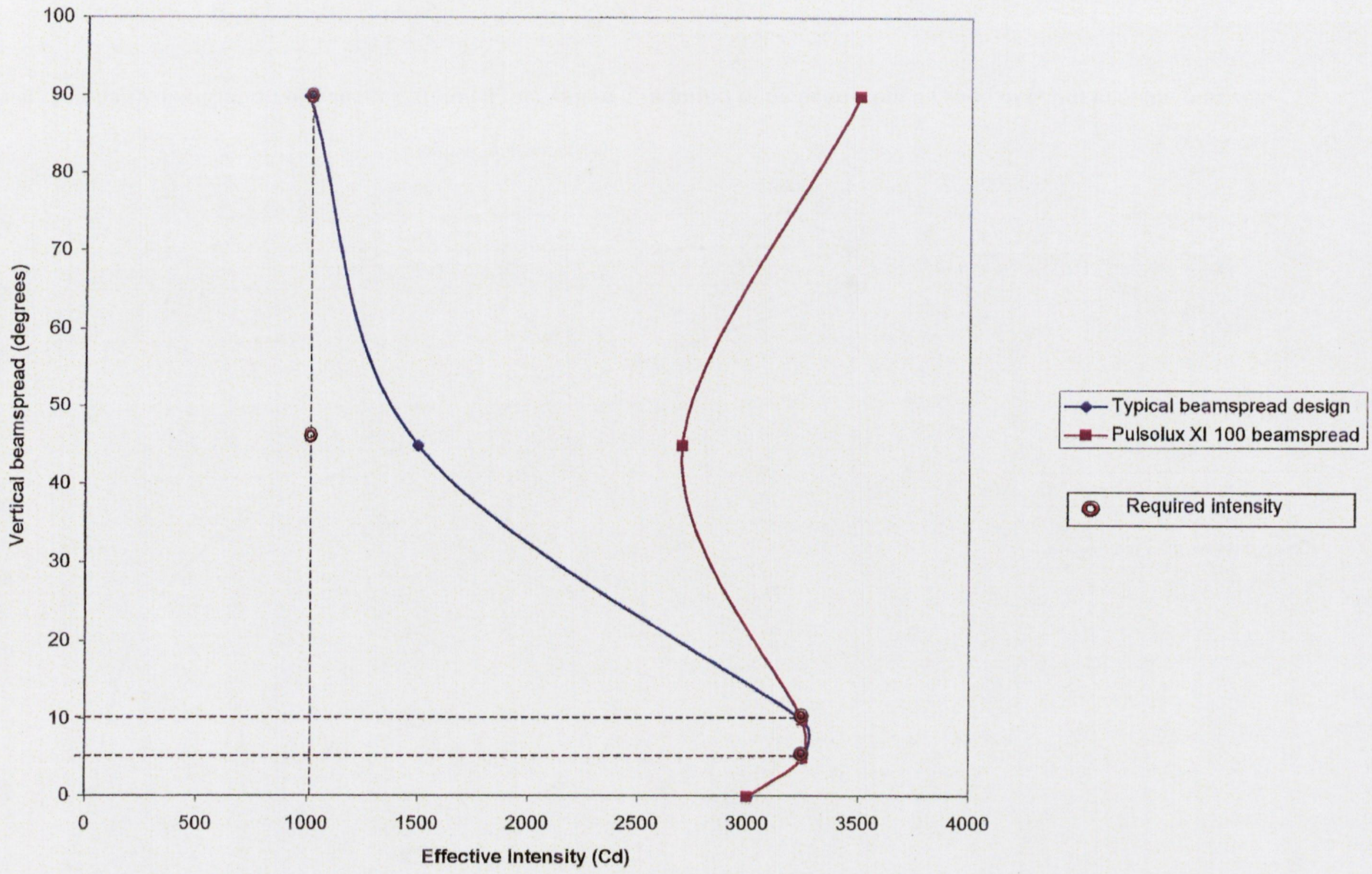


Figure 2 Intensity distribution of helideck status light system if required to be seen from a range of 400m in 600m met vis

Appendix A – Dedicated trial on safe Gothia flotel, December 1994

A.1 TRIALS INFORMATION

The objective of this trial was to evaluate the photometric specification and establish the optimum configuration of a helideck status light system.

The Safe Gothia flotel was the installation used for the trials. The flotel was moored alongside the Brent Charlie oil rig which, at the time of the trial, was not in production. The flights were conducted using a Bell 212 helicopter operated by Bristow Helicopters aircrew. A CAA pilot made a video recording from the left-hand seat. A DERA observer was seated in the back of the helicopter.

The light units evaluated in the trial were 'off-the-shelf' PRB-46 MkII revolving marine beacons (Figure A-1) purchased from AB Pharos Marine Ltd. The light unit comprised eight lenses rotating around a metal halide arc producing a flash rate of 2 Hz. Red filters had been placed in front of the lenses and the minimum effective intensity of the red light was quoted as being 11,000 Cd. The main beam was omni-directional in azimuth and 0 to 10° in elevation with the peak of the beam at 5° above the horizontal. The tops of the units were covered with black tape to prevent any stray white light escaping. The units were designed for 240V/50 Hz operation and the manufacturer confirmed that there would be no noticeable loss of performance if the Safe Gothia's 220V/40 Hz supply was used. The lights were not hazardous area certificated and the manufacturer recommended use with a portable gas detector and a hot work permit. The lights did not meet the CAA recommendations for obstacles on helidecks, standing at nearly 460mm in height above the deck. A dispensation was sought and given by the CAA for the trial to be carried out with these units on the helideck.

A.2 FLIGHT TRIALS

The flight trials were based around three configurations of the light units.

Configuration 1, shown in Figure A-2, comprised a single light unit (A) located on the bisector of the 210° obstacle free sector opposite the origin of the sector. This represented the minimum cost solution but has a divergent blind spot behind the hangar.

Configuration 2, shown in Figure A-3, comprised the two light units (B) and (C) located at the edges of the helideck on a line orthogonal to the bisector of the 210° obstacle free sector. The blind spot behind the hangar remains, but is now convergent.

Configuration 3, shown in Figure A-4, used the light unit (A) on the bisector of the 210° arc from configuration 1 with an extra light unit (D) located on the outermost edge of the platform on the extended 210° arc bisector. The addition of this light ensures full 360° coverage in azimuth.

The flight profiles comprised the following:

- A 600m orbit around the installation at about 300ft (ASL) with the status lights on.
- Two offset approaches (one left, one right) to the helideck with the status lights on.

- One approach with overshoot with the status lights turned on at short finals, at about 150m from the helideck.

Each of the above profiles was flown for each of the three configurations. All configurations were flown at night but only configuration 3 was flown during the day to demonstrate conspicuity against the high ambient light conditions.

The flying conditions for the trials were good. Reported visibility was about 20nm with periods of light precipitation during both days of the trials.

A.3 RESULTS

The conspicuity of the light unit was greatly degraded at night by the high levels of cultural lighting around the whole installation. Preliminary DERA studies had indicated that the limiting condition was most likely to be associated with initial acquisition of the signal in daylight due to the very high ambient light levels associated with a clear sunny day. The trials indicated that this was not the worst case. The lights had adequate acquisition performance during the day but were relatively poor at night. The pilot commented that at night the light unit could easily be mistaken for an aircraft anti-collision light, particularly if only one unit was visible.

Further into the approach the conspicuity and intensity of the lights seemed to reduce. This was due to the aircraft flying out of the main beam of the light. The original specification was for a main beam spread from 0° to 10° in elevation with a peak beam at 5°. Due to the operating envelope of the Bell 212, which utilises a steep approach procedure, the helicopter flew out of the main beam at about 150 to 200m from the helideck. Thus as the aircraft flew closer to the installation the pilot lost sight of the lights. This shortcoming was worse during the night flying due, mainly, to the high levels of cultural lighting which masked what was left of the beam at short ranges.

Under both day and night flying conditions, the range of adequate performance was different for each configuration. Configuration 2 was adequate from about 800m, configuration 1 was adequate from about 600m, and configuration 3 was adequate from about 1 km from the helideck. The coverage of the system varied greatly; configuration 3 had largest all round coverage with only a small area behind the Brent Charlie not covered. For some approach directions only one light was visible which could be mistaken for anti-collision lights. Configuration 2 had a larger segment behind the installation where it was not visible, and configuration 1 was only visible when the helideck was in the direct line of sight.

For the experiments where the pilot called for the units to be turned on at a range of about 150m from the installation, the time taken for the lights to power up to maximum output far exceeded the time taken to fly over the helideck. The status lights were not visible at all in this situation.

A.4 CONCLUSIONS

The conclusions of the first dedicated trial of the helideck status light system were as follows:

- None of the configurations evaluated were fully acceptable for this installation.

- The system would provide an acceptable solution for operations to installations with low levels of cultural light such as 'Not Normally Manned Installations'.

- More than one light unit is required, preferably a minimum of two on the helideck.

- Based on pilot comment, any lights on the helideck should not be outside the perimeter light boundary.

- For an installation such as the Safe Gothia, the recommended configuration for the helideck status light system would be configuration 3. This would not necessarily apply to all installations.

- The issues that needed to be addressed to make the light units suitable for in-service use were:

  (a) increasing the vertical beam spread;

  (b) removing the power up latency;

  (c) increasing the intensity;

  (d) covering the top of the unit with a red filter and

  (e) certification for use in a hazardous area.

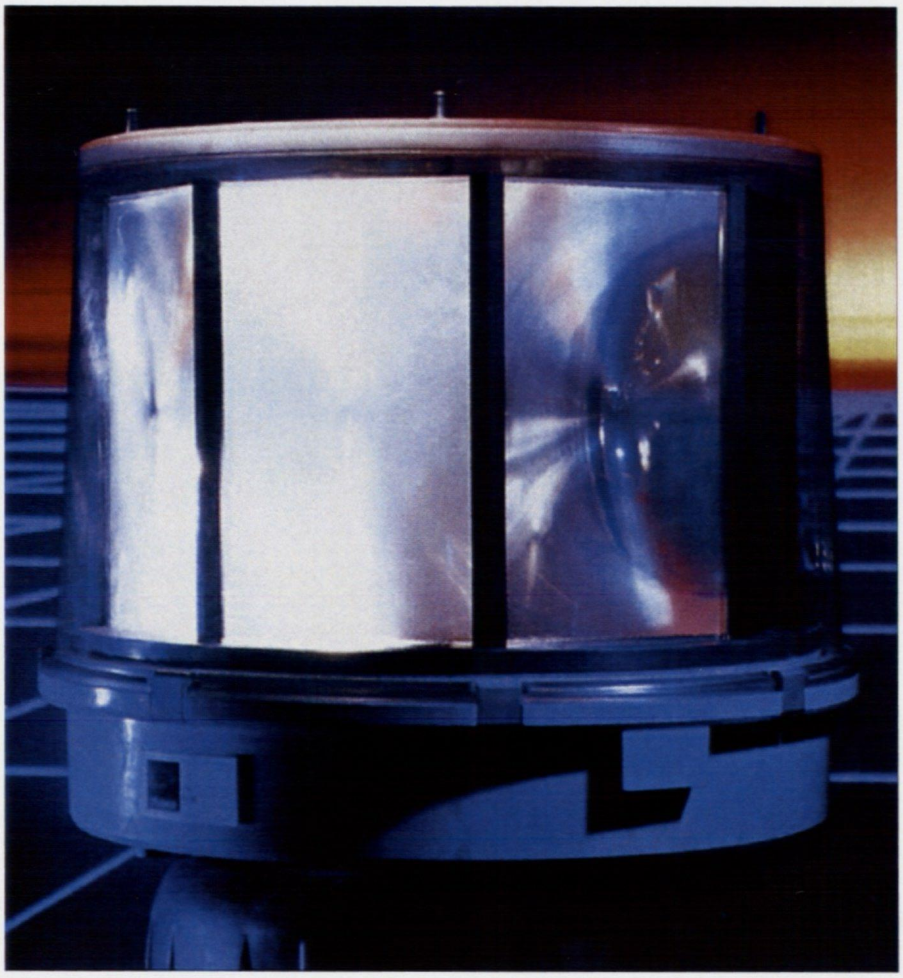


Figure A-1 PRB-46 MKII rotating marine beacon

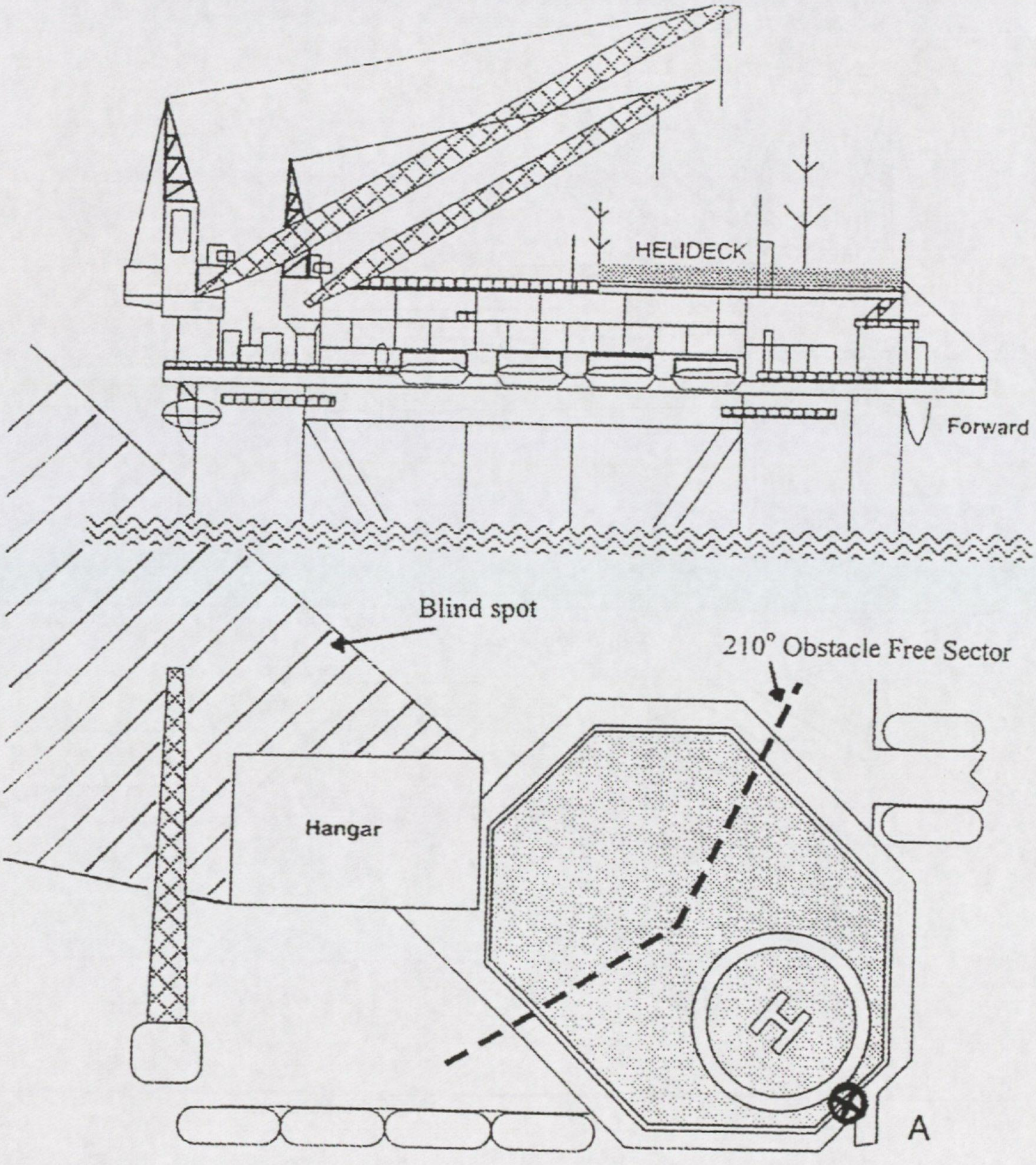


Figure A-2 Configuration 1

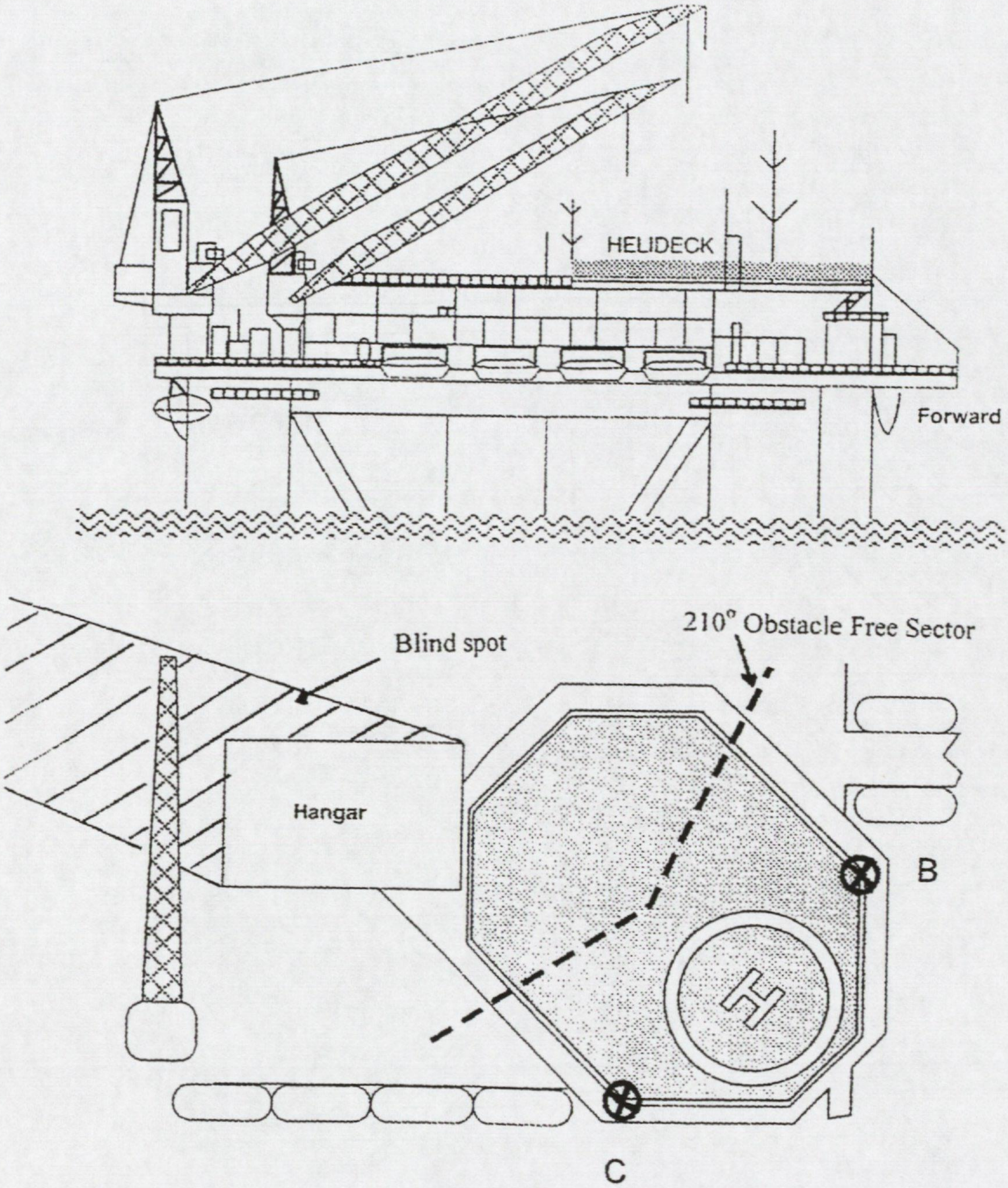


Figure A-3 Configuration 2

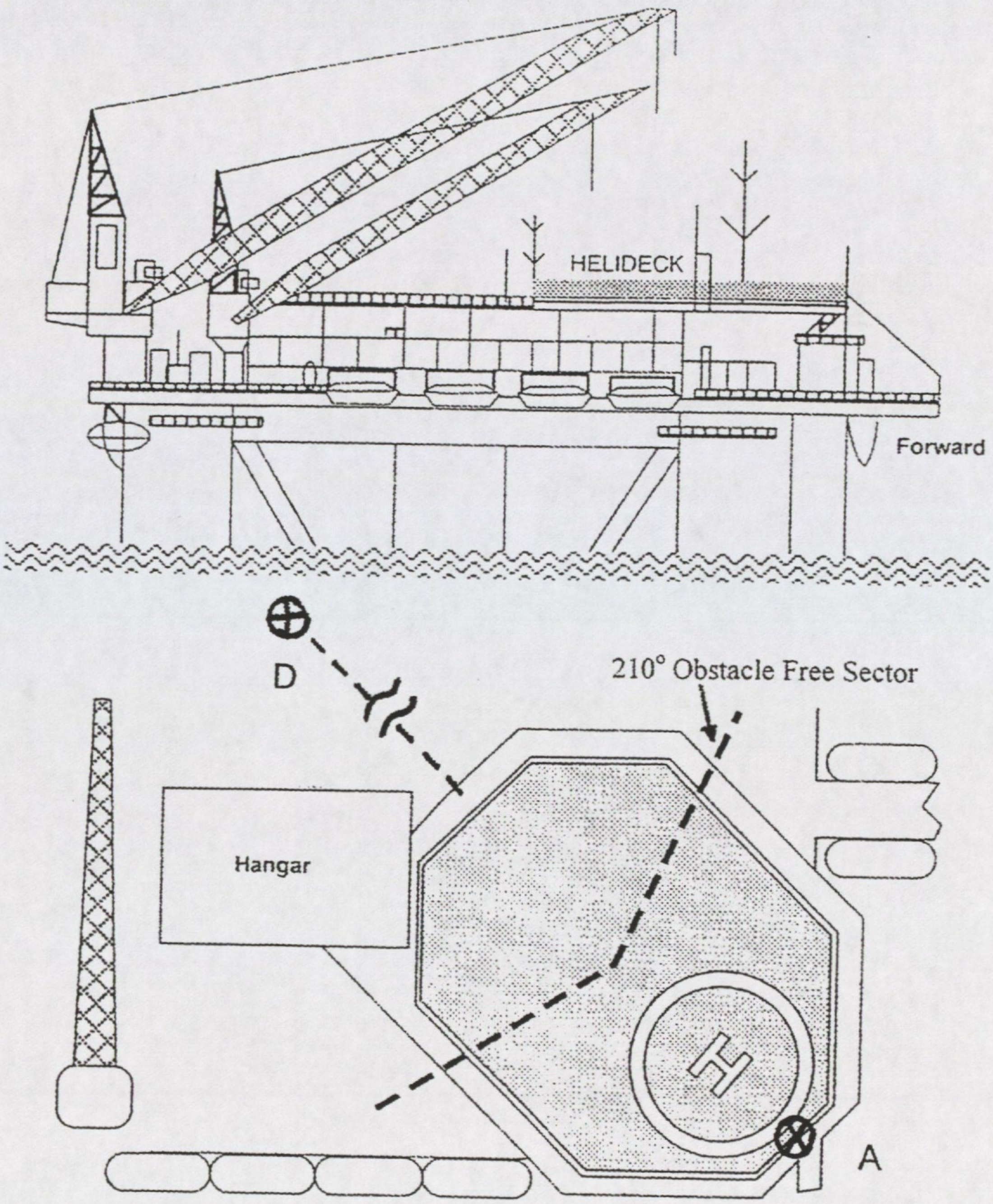


Figure A-4 Configuration 3

Appendix B – Dedicated trial on Safe Gothia flotel, May 1995

B.1 TRIALS INFORMATION

The manufacturer of the lights was approached after the first dedicated trial to see what modifications, if any, could be made to the beamspread of the light units and the power up time. Unfortunately, due to timescales and budgetary constraints, the only modification that was made was the addition of a red circular filter that could be fitted to the top of the units.

The objectives of the second dedicated trial were, firstly, to assess the flashing red light system, (complete with a red filter covering the tops of the units) set up in configuration 3 for both day and night flying conditions and, secondly, the red filters were to be removed to produce a white light system with a resultant threefold increase in intensity to 30,000Cd. This white light system was again to be assessed in configuration 3 during day and night conditions. The third objective was to assess the effectiveness of flashing the helideck perimeter lights as a method of addressing the problem of not seeing the status lights in the final stages of the approach.

The Safe Gothia flotel was again the installation used for the trials. A Bell 212 helicopter operated by Bristow crew was used for consistency and DERA and CAA observers were present as for the December 1994 trial.

B.2 FLIGHT TRIALS

Due to difficulties encountered in removing the cover from the light units, it was not possible to fit the red filters and so the units were assessed as white lights only.

Three sorties were flown, two in daylight and one at night. The first flight took place in clear, daylight conditions with the visibility around 15-20km. The second flight was around midnight, there was still no cloud cover and the visibility was over 20 km. The night flight took place just after the end of twilight and there was a lot of cultural light around the installation. The third and final flight took place the next morning in bright sunlight and with no cloud cover, these being the worst-case daylight conditions for noticing the status lights.

The trials consisted of the following:

- 600m orbits around the installation at about 300ft (ASL) with the status lights on.
- Offset approaches (left and right) to the helideck with the lights on.
- An approach with overshoot with the status lights turned on when the helicopter was at about 150m from the helideck.
- Flashing the perimeter lights on the helideck at frequencies of 0.25Hz and 1Hz when the helicopter was in the short finals stage of the approach.

B.3 RESULTS

It was immediately apparent that the white light signal was a big improvement on the red light system in both conspicuity and intensity. At night the lights were easily identifiable from a range of 2 nm and in daylight the flashing white signal was clearly visible from ranges of 600m.

The problem of the helicopter flying out of the main beam during the short finals still existed. Removing the black tape from the cover of the unit allowed a steady white beam to be seen from above, but this was not sufficiently intense to be a clear warning signal. The response time for the status lights reaching full intensity when they were powered up was far too long. Flashing the helideck perimeter lights did not prove to be an effective 'attention getter' in the short finals stage of an approach. It was also noticeable that the off-deck light was not as conspicuous as the unit on the deck. This may have been due to obscurance caused by diving equipment on the cargo-loading bay.

B.4 CONCLUSIONS

The conclusions of the second dedicated trial of the helideck status lighting system were as follows:

- The flashing white light system tested was satisfactory as a medium to long range warning signal (i.e. from 200m out to at least 600m).
- For short ranges (i.e. when the helicopter is on the deck or within 200m range), some other supplementary visual warning signal is required.
- Flashing the helideck perimeter lights proved ineffective as a short range warning signal.
- For an installation such as the Safe Gothia where there is a hangar adjacent to the helideck, a two light system is recommended to ensure there are no blind spots where the warning signal cannot be seen.
- A one light system should be sufficient for smaller/ unmanned installations.
- The high level of cultural lighting on installations like the Safe Gothia needs to be reviewed and reduced as far as possible.

Appendix C – Dedicated trial on Safe Gothia flotel, January 1996

C.1 TRIALS INFORMATION

The objective of the trial was to evaluate a set of two lower intensity supplementary flashing red lights alongside the larger high intensity units already trailed. The four lights were deployed on the Safe Gothia as shown in Figure C-1. The supplementary lights were chosen to fulfil two requirements that the high intensity units could not meet; a) provide a clear warning at short ranges (i.e. when the helicopter is on the deck or within 200m range), and b) provide a near-instantaneous time to reach full intensity when powered-up.

The Safe Gothia flotel was again the installation used for the trials. The flotel was moored alongside the Brent Delta oil rig (on the previous two trials it was adjacent the Brent Charlie). The flights took place in a Bell 212 helicopter operated by Bristow Helicopters crew; DERA and CAA observers were present as on the previous two trials.

The high intensity units were PRB46 MkII beacons as evaluated in the first and second dedicated trials. No changes had been made to the units since the second dedicated flight trial. The supplementary lights were type ZA773 units provided by Cegelec Projects. They were fitted with a 200 Watt J1/72 lamp. Figure C-2 shows the beam pattern for the unit in elevation. In azimuth the signal was omni-directional. The units were designed for 240V/50Hz operation, although the Safe Gothia's 220/40Hz supply was used. A flasher unit was connected to the lights to provide a signal that would flash at approximately 1Hz. The effective intensity of the flashing signal was estimated to be 60Cd. The ZA773 units are hazardous area certificated, unlike the PRB46 MkII units.

C.2 FLIGHT TRIALS

Before the flying commenced it was found that the glass refractor in one of the ZA773 units had been broken, rendering it unusable. The configuration of the remaining three status lights was as shown in Figure C-3.

The light units were powered up and checked for correct operation prior to the flight tests.

Two sorties were flown, one night flight and one in daylight. The first flight took place between 2200hrs and 2300hrs on a dark night with high cloud cover. The visibility was greater than 10km, there was no precipitation and the wind was light and variable in direction. The daylight flight took place between 1100hrs and 1145hrs on a clear day with high cloud cover. The visibility was again over 10km and there was little wind and no precipitation.

The flight profiles consisted of the following:

- A 600m orbit around the installation at approximately 300ft (ASL) with all the lights switched on.

- An approach and overshoot starting at a range of approximately 5km, with all the lights on.

- Several different approaches and overshoots from 600m range with all lights on.
- An approach and overshoot from 600m range with the high intensity light on the deck switched off.
- An approach with overshoot with the low intensity light switched on during short finals, about 150m range to the helideck.
- An approach, hover and landing with all the lights on (including changing orientation of the aircraft once on the deck).

C.3 RESULTS

The high intensity lights produced an effective medium to long range warning signal (i.e. from 150m out to 5km). The problem of the helicopter flying out of the main beam on short finals still existed. Thus, as the aircraft flew within 150m range of the lights, the signal was very weak. Once the aircraft descended in the hover above the deck the signal from the high intensity light became more apparent again. With the aircraft on the deck itself, the signal was noticeable at night if the aircraft was facing it. There was some reflection off the front of the hangar which could be seen if the aircraft was facing away from the light. During the day the effectiveness of the signal on the deck degraded. Increasing the lateral spacing between the pilot in the aircraft and the light on the deck generally brought the eye level of the pilot into the main beam of the light.

The high intensity light unit that was placed in the cargo bay (see Figure C-3) to provide all round coverage was difficult to see at some stages in the orbits. This was due to obscurance mainly by the Brent Delta platform and also by an adjacent crane and cargo. When the signal was seen from a distance it was clear and conspicuous and favourably enhanced by reflections off surrounding vertical surfaces.

The supplementary lower intensity light did not provide a clear warning signal at short ranges (i.e. when the helicopter was on the deck or within 200m range). During the 600m range orbits, the pilot commented on the light looking like a yellow helideck perimeter light. The intensity and the flash rate of the light were deemed to be too low both on short finals and when the helicopter was on the deck. The supplementary light did have a near -instantaneous response time to reach full intensity when powered-up.

C.4 DISCUSSION

The results of the trial were disappointing in that the supplementary lights did not provide an adequate signal to warn pilots close to or on the helideck. The reason for this result was that the intensity of the light projected towards the pilot was insufficient for the task.

During the planning of the trial the choice of light was determined by a number of parameters. The required vertical beam was analysed to be an effective intensity of at least 300 candela over an angle of 3 to 15 degrees with 50 candela at angles up to 45 degrees. Another requirement was that the switch-on time for the unit when activated should be almost instantaneous. Furthermore, the unit should be as small as practicable. The unit tested should also preferably be hazardous area certificated or be capable of certification.

A comprehensive review of commercially available light units showed that there was no unit available that met all the parameters. The choice was therefore between using a light that had some of the desired characteristics or delaying the trial until a built-for-purpose light could be made available. Cost and time constraints precluded the second option. However, it should be noted that whatever system is finally chosen for inclusion in the regulations, it will almost certainly require certification activity and is likely to require a complete design and development programme. The light unit used in the trials had the photometric performance shown in Figure C-2. Flashing the light at 1 Hz to produce the required signal resulted in an effective intensity of 60 Cd at low elevations, reducing to 10 Cd above 30 degrees.

Reference to the results of the two earlier trials shows that, in the polluted light environment of off-shore helidecks, any light signal must be much more intense than would be the case for normal environments. It is a very demanding requirement to make a small light unit that has a large vertical beam spread and a 360 degree coverage in azimuth due the levels of light flux that must be generated. The problem is compounded by the requirement for instantly available light since it is the low starting discharge light sources that have the high intensity outputs that are necessary to meet the requirement.

On the basis of pilot comment it is necessary for the short range status light to be not only visible but also conspicuous. There is therefore good reason to look for a solution that has an effective intensity of at least 3.5 times the threshold intensity of 300Cd, and a flash rate of 2 flashes per second. Such a light will require very careful beam design or intensity control to avoid disabling glare when the helicopter is on or over the helideck.

Light location also needs to be reviewed. Since the signal from the secondary light is to be seen at ranges of less than 600m, it can be assumed that the helicopter will be flying within the 210° sector specified as being free of obstacles. This implies that the helideck and the immediate surroundings would be in sight and the attention of the pilot centred on the helideck area. For the trial the test light was located on the deck edge. This is a practical solution but there is support for the concept of a light mounted in the aiming circle on the deck. Such a light unit does not exist. It may be feasible to develop a semi-flush unit with a diameter of 450-600mm and a height projection of 30mm but the cost and time scales for the development of such a light should not be underestimated. A light at the deck edge currently represents the most practicable solution.

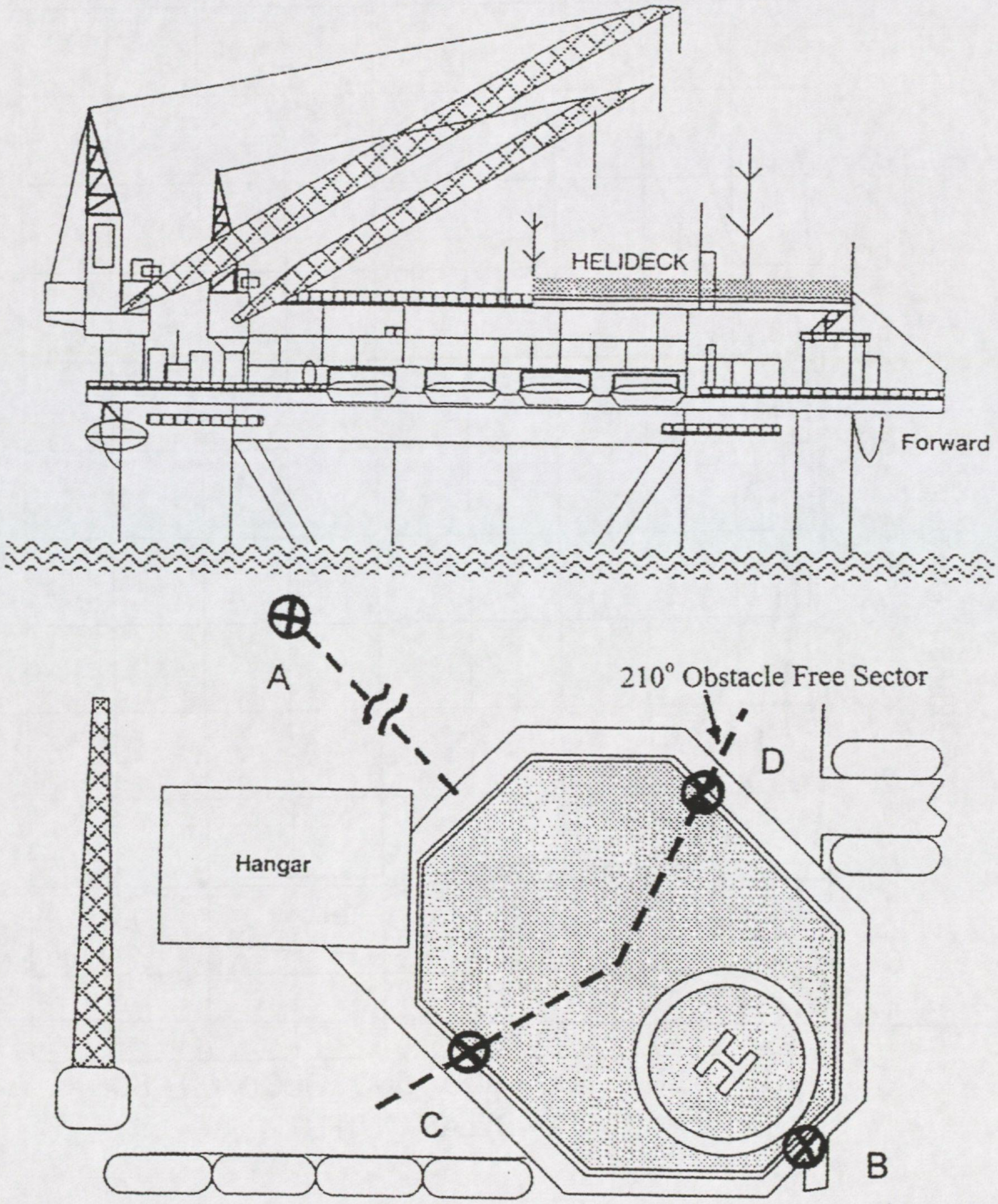
C.5 CONCLUSIONS AND RECOMMENDATIONS FROM THIS TRIAL

The third dedicated trial of the status light system clarified the situation regarding the short range requirement. A light unit having an effective intensity of around 1000Cd and a flash rate of 2 flashes per second needs to be identified and tested for an in-service trial.

The issue of the development of units to fulfil this requirement that are suitable for deployment at offshore helidecks needs to be addressed immediately due to the long timescales that are likely to be involved.

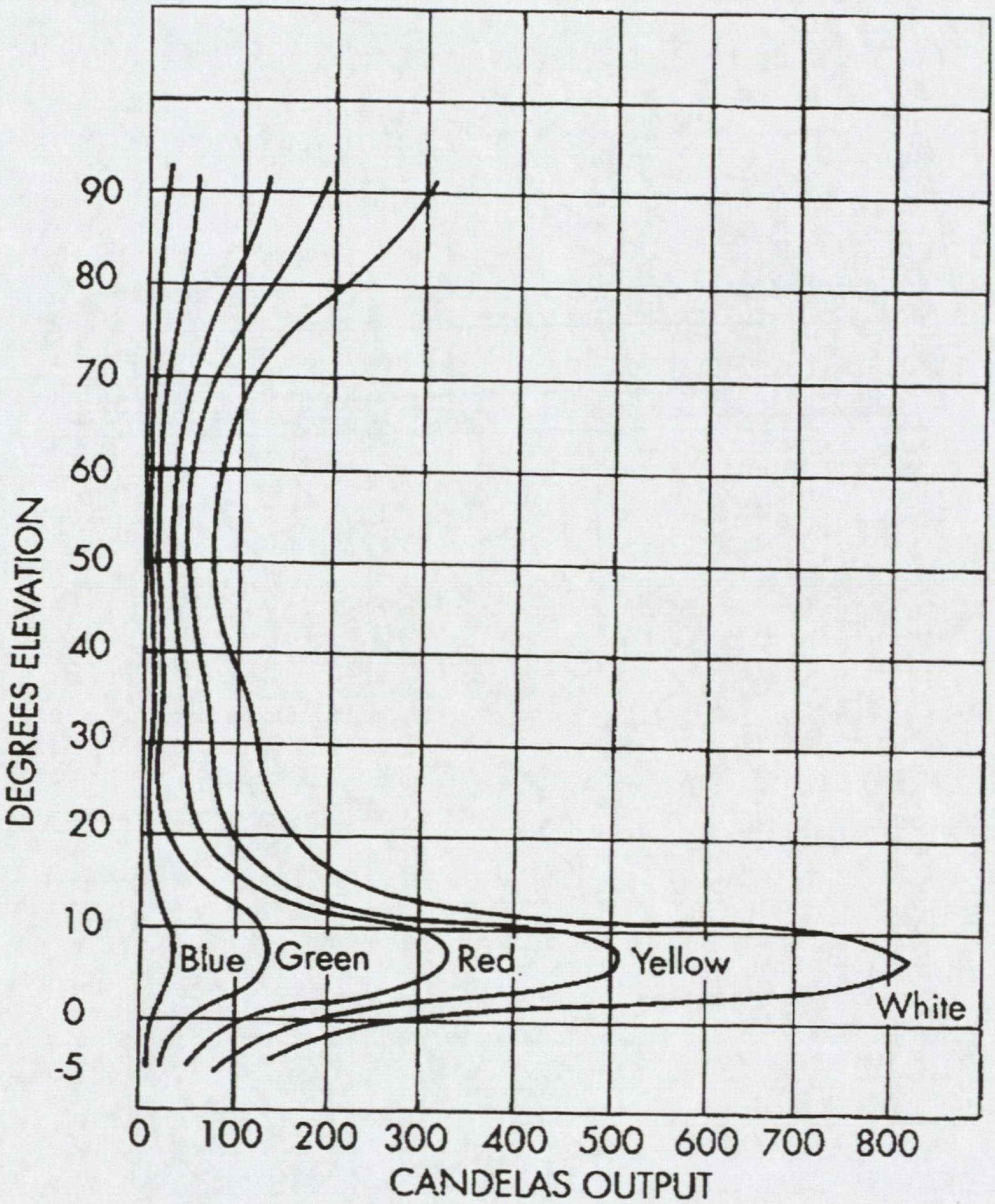
As has been stated in other reports, the problems of providing good visual signalling at off-shore facilities are significantly increased by the high levels of light pollution produced by inappropriate floodlighting units that are badly sited and inadequately maintained. Until this problem is addressed the task of providing good visual cueing for aviation purposes will always be very difficult.

It is therefore recommended that an in-service trial be conducted once a short-range light unit that meets the criterion stated in this report is available. It is also recommended that, irrespective of the outcome of the trials with the short range light, an in-service trial be held of the high intensity long range light units since these will provide a fully usable signal for the majority of emergency situations.



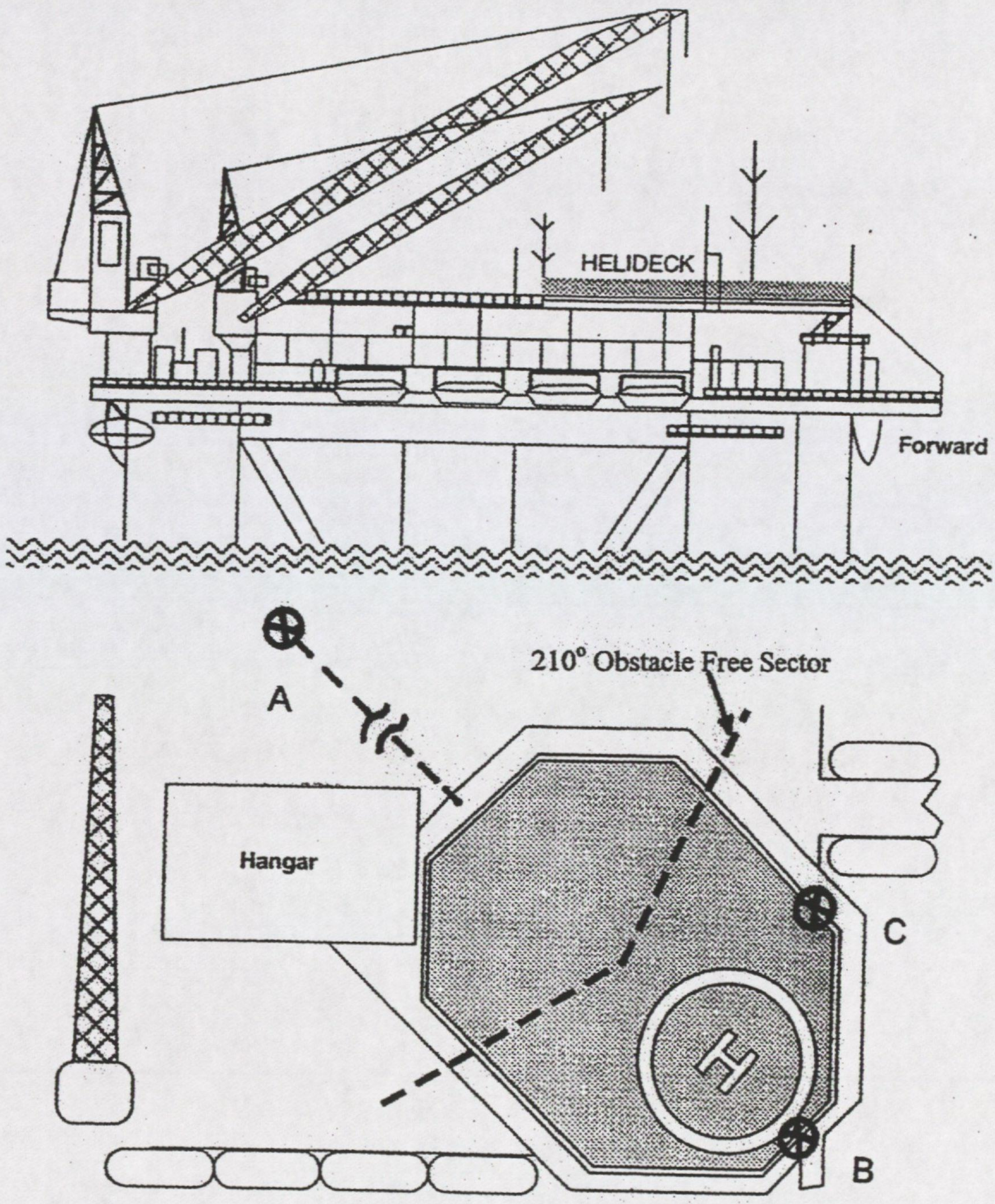
A & B are high intensity long range flashing white lights
C & D are low intensity short range flashing white lights

Figure C-1 Proposed status light configuration for third off-shore trial



200 Watt J1/72 Light Curve

Figure C-2 Beam pattern for ZA773 unit



A & B are high intensity long range flashing white lights
C is a low intensity short range flashing white light

Figure C-3 Actual configuration for status lights in third offshore trial

Appendix D – In-service flight trial on Safe Gothia, March-July 1996

D.1 TRIALS INFORMATION

The objective of the trial was to evaluate the operational effectiveness of PRB46 MkII high intensity rotating beacons as warning lights in an in-service environment. These white lights, having a flash rate of 2Hz and an effective intensity of 30,000Cd, had been identified in previous dedicated trials as being capable of meeting the requirements. The Safe Gothia flotel was the installation used for the trials. The flotel was moored alongside the Brent Delta oil platform in the North Sea. Two light units were installed on the Safe Gothia as shown in Figure D-1. These prototype units were not hazardous area certificated. The CAA provided an amended approval to operate the deck for the duration of the trial.

Pilots operating to and from the chosen installation were requested to carry out the evaluation and report their comments by completing a questionnaire (Figure D-2). The pilot was requested to evaluate the overall operational effectiveness of the visual signal produced by the flashing warning lights during normal operations to/from the helideck. Particular attention was given to determining if the lighting system provided a clear warning signal at all times when the helicopter was within a range of 600m from the installation. In addition, the pilot was asked to assess the signal provided by the lights in terms of conspicuity and 'attention getting' properties in the event of the status light being activated while the helicopter was on the deck. The pilot was also asked to confirm that the signal would not produce a disabling glare, which could effect the performance of the aircrew.

D.2 RESULTS

Bristow Helicopters and British International Helicopters were the two companies that were operating to the Safe Gothia at the time of the trials. A total of thirty questionnaires were completed and returned to DERA. The majority of flights took place during daytime but some took place in twilight and night conditions. Table D-1 summarises the results and pilot comments.

The results generally indicated that:

- the visual acquisition range of the lights was greater than 3km in good visibility;
- the lighting system was conspicuous and 'attention getting' at a range of 600m;
- within a range of 400m and when the helicopter is on the deck itself, the warning signal was not very apparent.

D.3 CONCLUSIONS

The results of the in-service trial were as expected, similar to those obtained in previous dedicated trials. The high intensity rotating beacon provided a long to medium range solution for the warning light system. A red light system would be the preferred colour associated with warnings, but only white light produced adequate intensity levels to meet the range and conspicuity requirements. For an offshore platform that does not have the same light pollution problems as the Brent Delta (and Safe Gothia), a red light system may be acceptable at night, but by day the achievable intensity would not provide a conspicuous signal in bright daylight conditions.

As a result of the in-service trial it was concluded that the issue of providing a supplementary short range system that can be powered up instantaneously still needed to be addressed for the reasons identified in the dedicated trial of January 1996.

Light unit location also needed further review. Several pilots noted that a single light on the edge of the helideck would not be seen if the helicopter had landed facing away from it. Spacing three lights around the edge of the deck would overcome this problem.

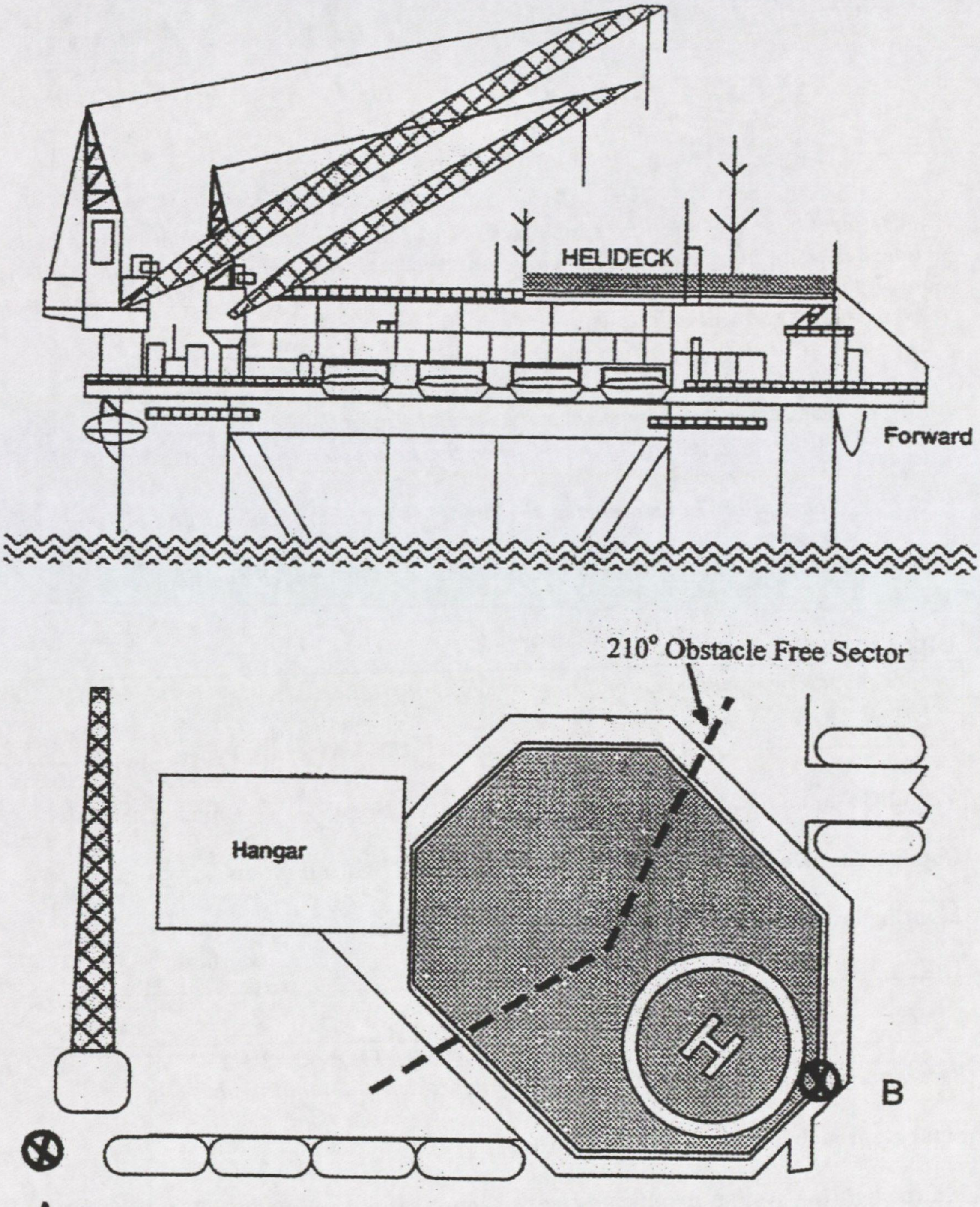


Figure D-1 Configuration of lights on Safe Gothia

Safe Gothia Helideck Status Signalling System Trial – Revised Questionnaire

The Helideck Status Signalling system is used to tell the pilot of an approaching helicopter that the helideck is in an unsafe condition. There are two high intensity flashing white lights located on the Safe Gothia- one on the deck itself and the other in the cargo bay. So far, the results of previous assessment has shown the following:

- *a. The visual acquisition range of the rig is generally greater than 5km*
- *b. The visual acquisition range of the lights is generally greater than 3km*
- *c. The lighting system is conspicuous and 'attention getting' at a range of 600m*
- *d. Within a range of 400m and when the helicopter is on the deck itself , the warning signal is not so apparent*
- *e. Some pilots have assessed the lights as an approach/ landing aid and not as a warning system.*

Bearing these observations in mind, please complete this revised questionnaire.

OPERATIONAL DATA

Record the following information prior to the flight trial.

Date: .... Time: .... GMT Aircraft Type: ....

Visibility: .... (km) Precipitation: None Rain Snow

Conditions: Day Twilight Night/moon Night/no moon

Lighting levels on installation: 1 (low) 2 3 4 5 (high)

VISUAL ACQUISITION DATA

Record the following information during the approach and landing phase.

Final Approach Track: ....(deg)

Did the lighting system produce a clear, strong warning signal at all stages of the approach and landing? (particularly within 600m range of the deck?) YES / NO

Did the lighting system produce a clear, strong warning signal at all times when the helicopter was on the deck? YES / NO

Comments:

Figure D-2 Safe Gothia helideck status signalling system trial – revised questionnaire

Table D-1 Summary of pilot comments

T= day/ twilight						R= Acquisition range of lights (km)
V=visibility (km)						L= range from the deck lights were 'lost' (m) during short finals
A=Approach track (deg)						F= acceptability of flash rate used in trial (2Hz)
T	V	A	R	L	F	Comments
day	50+	40	5+	?	fast	_
day	10	240	5+		good	*Saw light going down wind but not into wind*
day	8	360	5+	500	good	*Need green/ red light for landing clearance/ no clearance*
day	10	330	3-5	?	good	*Light quite bright on the deck*
day	?	?	?	?	?	*Light not switched on - takes a few minutes to warm up.*
day	10+	60	3-5	?	good	_
day	50	35	5+	200	good	*System works fine.*
day	10+	20	5+	450	good	_
day	?	40	5+	600	good	_
day	10+	250	5+	?	?	*On this track deck is not visible until 300m. Don't recall seeing lights*
day	10+	55	5+	?	good	*Did not notice in short finals as I was landing on Brent Delta*
day	15	300	3-5	?	good	_
day	25	310	5+	200	good	_
day	8	300	5+	?	fast	*Superfluous.*
day	40	350	3-5	0	good	_
day	10+	40	2-3	200	good	*Quite distracting in final approach. Saw at 3 miles in strong sunlight.*
day	10	300	5+	600	good	*Deck light not visible when aircraft on deck.*
twilight	10	160	3-5	500	good	*Good conspicuity. Not confused with platform lighting*
twilight	6	80	3-5	400	fast	*Less effective at ranges less than 600m*
day	1.5	150	0.5-1	300	good	*Did not notice the lights on the final stages of the approach*
all	1.4-10+	various	1-5	460	good	*Flew over 30 approaches. Light highly visible throughout except below 0.25nm.*
day	6	30	_	_	_	*Not prominent enough within 600m and on deck.*
day	10	270	_	_	_	*Not striking enough within 600m and when on deck.*
day	10+	170	_	_	_	*For final stages have 4 white strobes on each corner of the deck*
day	10+	270	_	_	_	*Not switched on!*
day	20	20	5+	?	_	*Can't see light facing North on deck*
day	10+	360	3.5+	?	_	*Prominent from 1nm to 0.5nm. After 0.5nm lose it. On deck light aft of aircraft.*
day	10+	360	3	?	_	*Good from 1.5nm, less so as get closer. On deck can't see if facing N to SE*
day	20	360	4	?	_	

Appendix E – Dedicated trial on K14A platform – February 1997

E.1 TRIALS INFORMATION

The flight trial took place on 24th February 1997 at the K14 gas platform. This platform is situated in the Dutch sector of the North Sea. The trial consisted of two daytime flights and one night flight. A total of thirty eight approaches were performed, of which six addressed the evaluation of the status light system.

The trial aircraft was an S76B helicopter owned and co-piloted by KLM (UK). CAA pilots flew the aircraft for all of the sorties. The trial participants were from the following organisations:

KLM (pilot)
CAA (pilot, test pilot and observer)
RLD (observer)
NAM (platform supervisor)
DERA (trials manager, observer and equipment installer/ operator)

There were two main objectives of the trial:

(a) To evaluate several different visual aids systems on an offshore helideck by means of a dedicated flight trial. The aids were installed on or near the helideck. The trial was to determine how successful the aids were at providing improved visual cues to helicopter pilots for locating, approaching and landing on helidecks.

(b) To evaluate the performance of a red helideck status light system, which is to warn pilots of approaching/ landed helicopters of an unsafe helideck condition (e.g. moving machinery, gas cloud).

This appendix describes the results of the helideck status light system testing.

A Pulsolux XI-100 omni-directional xenon strobe light (Figure E-1), manufactured by Smith Airfield Equipment and designed for en-route obstacle lighting applications, became available at the end of 1996. A review of the manufacturer's specification suggested the unit was worth evaluating in parallel with other flight trials planned on NAM's K14A platform. This platform did not have the same level of light pollution as the Brent Delta/Charlie. It was decided to set up the PRB-46 MKII high intensity rotating beacon on the same helideck to enable a direct comparison between the two lights. A battery operated low intensity status light (rotary beacon) was also positioned on one edge of the deck to provide a short-range solution. Filter material was used to achieve the desired red warning colour for all the units under evaluation.

E.2 CONDITIONS UNDER WHICH THE TRIAL TOOK PLACE

For the first daytime flight the visibility was around 10km and there was no precipitation. The helicopter took off around 1600hrs and landed at 1700hrs (GMT). The cloud cover was 6/8 with the sun shining briefly during the early runs. The only platform lights that were switched on were the helideck perimeter and flood-lights and the equipment under test. The wind speed was in the region of 30kts.

The second daytime flight took place as dusk was approaching (1700hrs-1715hrs).

The night flight began around 1830hrs (GMT) in drizzle. The visibility was again around 10km. A refuelling took place around 2015hrs by which time it was raining. High wind speeds of around 30kts were still present.

E.3 RUN DETAILS

A briefing session took place before the trial began. All trial participants including the Helicopter Landing Officer were briefed on their roles and responsibilities during the trial, the objectives of the whole exercise and the order of approaches.

A total of 6 approaches were carried out to evaluate all the helideck status lights (day and night). The approaches were started between 3.5nm and 2.5nm from the platform and the evaluation included the helicopter hovering over the deck.

E.4 RESULTS

The results of the trial indicated that the all three red lighting units provided conspicuous signals that could clearly be interpreted as warnings for the conditions at the time of the trials (10km visibility, 6/8 cloud cover and drizzle). The high intensity rotating beacon emitting red light had a good flash rate (2 per second) and could generally be seen from a range of 3km. The problem of flying out of the main beam on short finals was still apparent. The short-range battery operated light worked well and could be seen when the aircraft was over the deck and within a range of 200m.

The red high intensity strobe light unit was the preferred solution for the warning system application under these visibility conditions. It had a very good beamspread that allowed it to be clearly seen from a range of 3.5km to when the helicopter was on the deck. There were only two aspects of this light that the pilots and observers would have liked to improve. Firstly, the flash rate of 20 flashes per minute was deemed to be too slow, an increase to 120 flashes per minute is necessary to make the signal 'attention getting'. Secondly, with only one of these units on the deck, there is a possibility that the aircrew will not see the signal if the aircraft is facing away from it. Therefore, two or three units should be spaced around the helideck perimeter.

A debriefing session took place when the helicopter returned to the KLM base in Norwich. A list of comments and observations made is shown in Table E-1.

Table E-1

Unit under test	*Comments*
High intensity rotating beacon status light	• This worked well at longer ranges, but the problem of flying out of the main beam on short finals was still apparent. • One CAA pilot suggested using this light for locating the deck.
High intensity strobe status light	• This light was suitable for the status light application. • The flash rate should be increased to around 120 flashes per minute.
Battery operated low intensity status light (rotating beacon)	• The beam spread, intensity and flash rate of this light was suitable for close range/ on deck warning signals. (i.e. within 200m)

Figure E-1   X1-100 high intensity strobe light

Appendix F – Laboratory tests of high intensity strobe light, July 1997

F.1 TRIALS INFORMATION

The strobe light unit used for the K14 flight trials contains a discharge lamp. The design of the unit allowed the flash rate to be varied between 8 and 90 flashes per minute by adjusting a potentiometer. However, it was anticipated that if the flash rate was increased, the intensity of the light could drop significantly. The manufacturer's red lens was obtained to establish whether the DERA measurements agreed with data they had previously provided with the equipment.

The testing of the strobe light was conducted in July 1997 at DERA Farnborough. The objectives of the testing were as follows:

- Confirm by measurement that the manufacturer's data on intensity at 40 flashes per minute was correct
- Measure/calculate the intensity of the unit at 20 flashes per minute
- Measure/calculate the intensity of the unit at 90 flashes per minute.
- Measure/calculate the intensity of the unit at 60 flashes per minute.
- Confirm that the effective intensity of the light fitted with the red lens is around 15 per cent of the effective intensity of the light fitted with a clear lens.

F.2 RESULTS

It was not possible to obtain accurate measurements for absolute luminous intensity and so relative measurements were made. The graph shown in Figure F-1 plots the relative peak intensity (referenced to that at 8 flashes per minute) and relative effective intensity against the period between the flashes (seconds). I_{max} gives an indication of the peak intensity of the light pulse, while I_{eff} takes into account a slight broadening of the pulse at lower intensities. As can be seen, the intensity of the flash falls as the repetition rate is increased, particularly at flash rates greater than 35 per minute. This is mainly because at higher flash rates the capacitor within the unit has insufficient time to recover the full charge. If the chosen flash rate is increased from 20 per minute to 35 flashes per minute, the effective intensity is reduced by 5-10 per cent. However, if the flash rate is increased from 20 to 60 per minute, the effective intensity of the light will be reduced by 50 per cent and if the flash rate is increased to 90 per minute the effective intensity of the light will be reduced by 60 per cent.

The photopic intensity of the flash with the red filter was found to be 15 per cent of the brightness of the flash when fitted with a clear filter. This result corresponded to the data provided by the manufacturer.

It should be noted that at 40 flashes per minute I_{max} = 2,300,000Cd and I_{eff} = 21,900Cd (quoted from manufacturer's data).

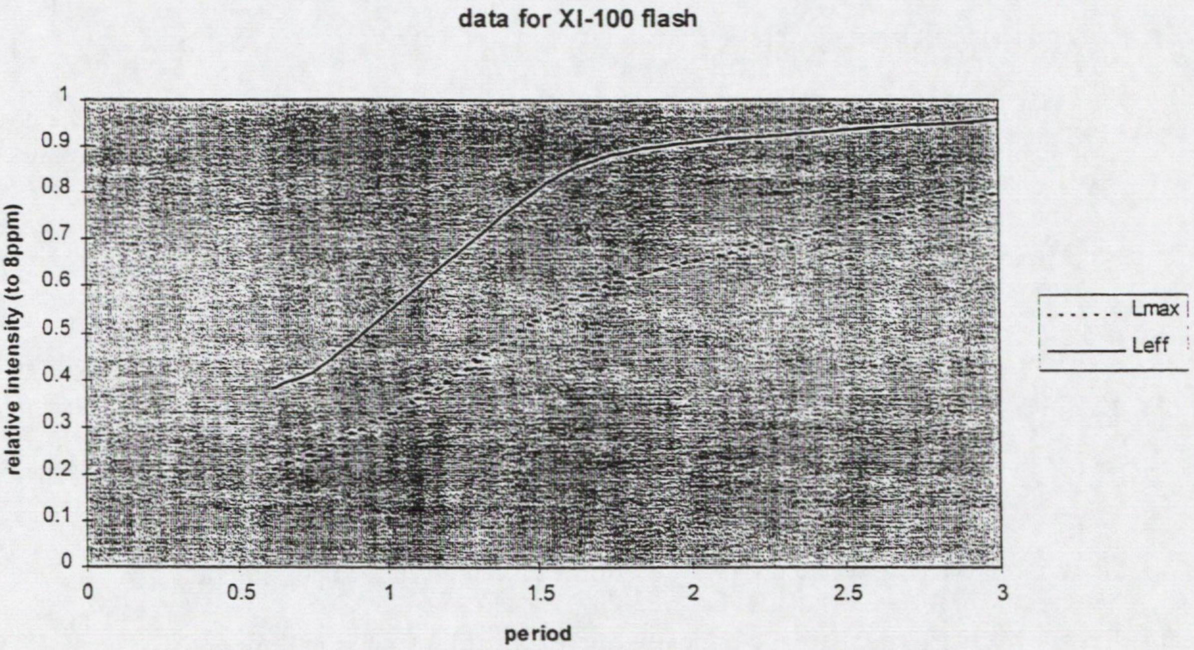


Figure F-1 Intensity vs flash rate characteristics for Pulsolux XI-100 unit (white light)

Appendix G – Calculations of required effective intensity of warning light system

G.1 To estimate the intensity required for seeing a light Allard's law is used.

The equation used to define Allard's Law is:

$E_t = I/R^2 \cdot e^{-\sigma R}$

Where

E_t = Eye Illumination threshold (lux). The value of E_t depends on the background brightness. For a bright day $E_t = 10^{-3.5}$, for a typical day $E_t = 10^{-4.0}$ and for a typical night $E_t = 10^{-6.0}$.

I = Intensity of the light unit (Candelas)

R= Visual range of a light in the specified conditions of E_t and meteorological visibility (m).

σ = Extinction coefficient. This represents the attenuation of the light by fog or mist. It is calculated by the formula:

Meteorological visibility (met vis) = $4 / \sigma$ (m)

The intensity value obtained from this equation is the intensity required for the light to be just visible. A warning light needs to stand out rather than be just detectable. The practical way to improve conspicuity is to multiply the threshold intensity by a factor of 3.5.

G.2 VISUAL RANGE OF LIGHT = 600M AND VISIBILITY = 600M

From this it can be assumed that R = 600 and $4 / \sigma = 600$. Table G1 summarises the required intensity of the lighting system under different viewing conditions.

Table G-1

Conditions for viewing lighting	*E_t (lux)*	*Threshold Intensity (Cd)*	*Required intensity of warning light (Cd)*
Bright day	$10^{-3.5}$	6215	~21,750
Typical day	$10^{-4.0}$	1965	~6,880
Typical night	$10^{-6.0}$	20	~70

G.3 INTENSITY OF LIGHT = 3250CD AND VISIBILITY = 600M

Table G-2

Conditions for viewing lighting	*E_t (lux)*	*Threshold Intensity (Cd)*	*Range at which light is conspicuous (m)*
Bright day	$10^{-3.5}$	920	420
Typical day	$10^{-4.0}$	920	526
Typical night	$10^{-6.0}$	920	1018