Safety Regulation Group

Civil Aviation Authority

CAA PAPER 2003/06

Specification for an Offshore Helideck Status Light System

www.caa.co.uk

Safety Regulation Group

CAA PAPER 2003/06

Specification for an Offshore Helideck Status Light System

November 2004

ISBN 1 904862 05 5

Published November 2004

Enquiries regarding the content of this publication should be addressed to:
Research Management Department, Safety Regulation Group, Civil Aviation Authority, Aviation House, Gatwick Airport South, West Sussex, RH6 0YR.

The latest version of this document is available in electronic format at www.caa.co.uk, where you may also register for e-mail notification of amendments.

Printed copies and amendment services are available from: Documedia Solutions Ltd., 37 Windsor Street, Cheltenham, Glos., GL52 2DG.

List of Pages

Contents

Foreword

A specification for an offshore helideck status light system was produced and published in CAA Paper 98003. Further developments and additional knowledge subsequently acquired, however, led to the identification of a number of gaps in that specification and the consequent need to update the material. A revised specification has therefore been produced by CAA's Research Management Department with the assistance of QinetiQ Bedford, and is presented in this Paper. The specification contained in this Paper supersedes that detailed in CAA Paper 98003, and will be referenced in CAP 437 (Offshore Helicopter Landing Areas: Guidance on Standards).

Specification for an Offshore Helideck Status Light System

1 Introduction

This report provides a recommended technical specification for an offshore helideck status signalling system in support of CAA's best practice guidance material published in CAP 437 "Offshore Helicopter Landing Areas – Guidance on Standards" (Reference [1]). The operational requirement for the system is described along with the development of the technical specification. A test procedure for the measurement of the performance of flashing lights intended for use as helideck status lights is also presented.

2 Background

CAA's attention was initially drawn to the issue of helideck status signalling systems as a result of concerns within the industry over 'wrong-rig' landings and their associated safety hazards. A study of offshore platform identification signs, reported in CAA Paper 92006 (Reference [2]), established that there was little prospect of resolving the problem through improvements to the signage and recommended the specification of a new visual aid, the helideck status signalling system.

Although it was recognised that such a system could not prevent a helicopter landing on the wrong platform, it could help prevent it landing on a platform which is in an unsafe condition. A follow-up study was therefore commissioned with the objective of developing a specification for a status signalling system that was capable of indicating 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.

This study, performed by DERA Bedford in 1993 and reported in CAA Paper 93020 (Reference [3]), identified the practical difficulties of providing such a system. The solution would be complex and expensive and the study therefore 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 accepted. 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 were considered to be: the presence of a gas leak; moving machinery (e.g. a crane) in the area of the helideck; explosives in use on the platform; platform personnel working on or near the helideck.

DERA was tasked with producing the photometric specification for the light system, and validating it by implementing it using available 'off the shelf' lighting equipment and conducting dedicated flight trials. The trials undertaken in support of the project were performed over the period December 1994 to February 1997, and the final report containing the specification was published as CAA Paper 98003 (Reference [4]).

Further developments in the industry and additional knowledge subsequently acquired, however, led to the identification of a number of gaps in the original specification and the consequent need to improve the material. That update has been produced by CAA's Research Management Department with the assistance of QinetiQ Bedford, and is presented in this report. Where appropriate, material from earlier reports, including CAA Paper 98003, has been retained and is repeated in this document.

3 Operational Requirement

The overall top level operational requirement for the system is 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 900m from the installation at all azimuths in meteorological visibilities down to 1400m (day and night).

The minimum range of 900m (0.5NM) derives from the trials of helideck lighting systems performed at Norwich Airport during 2003 and 2004, where it was established as the range at which the pilot will be focussing more on the helideck than the platform as a whole, and from where an approach could safely be aborted if necessary. As the present minimum decision range for helicopter approaches to offshore platforms is 1400m, it follows that the minimum meteorological visibility is also 1400m.

It is recognised, however, that ongoing developments in the use of satellite navigation systems (e.g. Global Positioning System) for conducting offshore approaches may lead to a reduction in the minimum decision range in the future. Due to the constraints imposed by the obstacle environment, a minimum decision range of less than 900m (0.5NM) is not envisaged in the foreseeable future. The specification will therefore also address a second, future operational requirement relating to a minimum range of 900m in meteorological visibilities down to 900m.

4 Derivation of System Specification

4.1 Intensity

4.1.1 Requirement

The intensity of the system is determined by the range at which the signal needs to be seen, the prevailing meteorological visibility and the ambient lighting. With reference to Appendix A, it can readily be seen that the most demanding viewing condition is the bright day case. Although the probability of encountering the limiting meteorological visibility in such conditions is relatively low, the trials conducted during the earlier stages of this research project have demonstrated that the effectiveness of a light signalling system can be seriously impeded at night by the extraneous light existing at platforms that have a high level of cultural lighting. For a warning light to be effective at such platforms at night, it would need to be significantly brighter than the corresponding intensity required for 'typical night' viewing conditions, and probably similar to that required for bright day conditions. This implies that an intensity of 1758Cd is required to meet the stated operational requirement of a range of 900m in a meteorological visibility of 1400m (see Section 2 of Appendix A).

The overriding consideration in establishing the performance specification is the effectiveness of the system, i.e. the ease with which the pilot would be able to notice the signal. Given the meteorological visibility, the eye illumination threshold and the required viewing range, Allard's law provides the intensity of a steady light that would be 'detectable'. As detailed in Section 1 of Appendix A, these intensities should be increased by half an order (factored by 3.16) to give a figure that is considered to be 'conspicuous' (i.e. attention getting). This increases the intensity required from 1758Cd to 5555Cd.

It should also be noted that a system comprising two or more lights synchronised to flash alternately will confer greater conspicuity in a given set of viewing conditions as a result of the apparent 'movement' of the light source, and that the probability of detecting a light signal is also dependent on the viewing time.

4.1.2 Dimming

It can be seen from Appendix A that there is a large difference in intensity required for the full range of possible viewing conditions. It therefore follows that a system with sufficient intensity to meet the operational requirement in the worst-case conditions (i.e. at minimum meteorological visibility and on a bright sunny day or at night on a platform with a very high level of cultural lighting), may represent a significant source of glare in more benign viewing conditions.

This is not considered to be a significant issue while the helicopter is approaching the platform since the required pilot reaction is to abandon the approach, and performing the correct manoeuvre (climbing turn away from the platform) will result in the removal of any glare. The same is not true, however, in the event that the system is activated when the helicopter is landed on the helideck. At the very close viewing range in those circumstances the resulting glare would likely be severe and highly undesirable in such an emergency situation.

It is therefore recommended that some form of intensity control be provided. Where the system is installed on a manned platform this could take the form of a manually operated switch for the use of the Helicopter Landing Officer (HLO). The HLO would simply switch the system to dim once the helicopter had landed, and return the system to normal once the aircraft had departed. A means of automatically returning the system to normal after an appropriate time period (e.g. 30 minutes) should be provided to address the possibility that the system is inadvertently left dimmed. On NUIs, some form of automatic dimming would be required such as a proximity sensor to detect the presence of the helicopter on the deck.

From Reference [5], the intensity of any light visible to the pilot while landed on the helideck must not exceed 60Cd.

4.1.3 Measurement of Flashing Light Intensity

Another very important factor associated with intensity is the method by which it is measured. The visual range characteristics of flashing lights is related to their effective intensity and, since the effective intensity measured is sensitive to the detail of the test procedure employed, it is important to establish a standard measure both for consistency and to ensure the suitability of any particular light for the application. A standard test procedure for flashing lights intended for use as helideck status lights is given in Appendix B. The test procedure is based primarily on the Federal Aviation Administration's Advisory Circular 20-74 (FAA AC 20-74), has been circulated to the industry for comment, and has been 'road tested' by a major aviation lighting manufacturer in The Netherlands.

4.2 Beam Spread

4.2.1 Vertical Beam Spread

The vertical beam spread requirements for the status signalling system are determined by the vertical approach path of the helicopter, which has been established from data collected during normal in-service operations using the Helicopter Operations Monitoring Programme (HOMP). Vertical approach path data for 271 night approaches to 50 different offshore platforms was collected in connection with the production of a photometric specification for helideck perimeter lights, and is presented in Figure 1. The approach path data is converted to the corresponding angle of elevation from the helideck (and hence any light mounted on the helideck) as a function of range in Figure 2. As can be seen, the upper and lower limits of the vertical beam spread increase as the range from the helideck reduces. At a range of 900m the upper limit is 8.7° and the lower limit is 1.4°, and at 700m the upper limit is 9.6° and the lower limit is 2°.

A rational operational requirement associated with angles of elevation above the upper limit shown, is that the signal be available to the pilot as the helicopter flies overhead the platform during the downwind leg of the standard low visibility airborne radar approach procedure. A reasonable reference point is considered to be a position immediately above the platform where the angle of elevation is 90°, and the range is the procedural height above the sea of 1500ft (ignoring the height of the helideck which may be anything between 50ft and in excess of 200ft). As can be seen from Section 3 of Appendix A, this requirement leads to an associated intensity of 176Cd if the light is to be 'detectable', and 556Cd if the light is to be 'conspicuous'.

4.2.2 Horizontal Beam Spread

Since a helicopter may, in principal, approach an offshore platform from any direction, the horizontal beam spread requirement for the status signalling system is 360°. Since the heading of a helicopter landed on a helideck is normally unrestricted, a sufficient number of light units must be provided to ensure that the pilot can see at least one light while on the helideck.

4.3 Colour

A key factor in the recognition of a signal as a warning signal is the use of the colour red. This is encompassed in Table A in Section 2 of the UK Air Navigation Order where the interpretation of a red flashing light for aircraft in flight is defined as "do not land; aerodrome not available for landing", and "move clear of landing area" for an aircraft on the aerodrome. Red also has the benefit of being easily detected in the offshore environment due to the colour contrast it provides against the sea, sky or platform superstructure background. It is therefore very desirable to implement a practicable helideck status light system in red.

NOTE: In the event of the status light system activating while the helicopter is on the helideck, the action to be taken by the pilot will depend on instructions received from the HLO/radio operator on the platform. This will not necessarily result in the helicopter vacating the landing area.

The colour coordinates of the light should comply with the international standards for aeronautical ground lights, i.e. ICAO Annex 14 Volume 1 Appendix 1 Section 2.1.1 a). This defines the following CIE equations:

Purple boundary $y = 0.980 - x$

Yellow boundary $y = 0.335$

Although it is understood that other platform warning systems also utilise red flashing lights (e.g. sulphur dioxide release), they are located away from the helideck and comprise relatively low intensity lights. It is considered unlikely that they would be mistaken for helideck status lights, and such an eventuality would result in the helicopter aborting its approach, i.e. a safe situation. Conversely, due to their size and location, it is considered unlikely that the helideck status lights will be mistaken for any other platform warning systems.

4.4 Flash Rate and Flash Sequencing of Light Units

The recommended flash rate of the status light system is 120 flashes per minute ±10%. This was the flash rate of the high intensity rotating beacon which was deemed appropriate by a number of pilots during the earlier in-service and dedicated flight trials reported in Reference [4]. In the event that all other system performance requirements cannot be achieved at this flash rate using a single light unit, a system can be formed using two or more lights each flashing at a slower rate. In this eventuality, the flashes from each of the light units should be synchronised to ensure that there is an equal time gap between each flash produced by the system as a whole.

A lower flash frequency of not less than 60 flashes per minute is considered acceptable for the purposes of designing the system to continue to function following any single system failure. It is stressed that this concession is to be applied on a temporary basis only, and it is expected that rectification to restore the full flash rate capability be carried out at the earliest possible opportunity. The lower flash rate of 60 flashes per minute is considered adequate while the helicopter is landed on the helideck, i.e. in the event that there are landing headings for which only one light is visible to the pilot.

4.5 Activation

4.5.1 Triggering

Where practical and appropriate, the helideck status signalling system should be integrated with platform safety systems such that in the event of a process upset, e.g. a gas leak, the system is activated automatically. In addition, where installed on manned platforms, facilities must be provided for the HLO to manually switch the system on and to override the automatic activation of the system.

4.5.2 Start Up Time

It is also a requirement that the start up time for the light unit(s) when activated 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. At a typical approach speed of 70kt, a helicopter will travel approximately 100m in 3 seconds. A maximum start up time of 3 seconds is recommended.

4.5.3 Resetting

Consideration must be given as to how the system is to be reset once activated. On manned platforms, this might best be accomplished through the provision of a manual reset switch for use by the HLO. On normally unattended installations (NUIs), remote operation of any manual reset function would be necessary. Where this is not possible, then a practical solution might be for the system to be designed to automatically reset itself after an appropriate period of time (e.g. 30 minutes), provided that the system would re-activate if the hazardous condition still existed after reset. It is not considered acceptable to require a helicopter pilot to ignore the indication of a hazard and land in order for a manual reset to be performed.

4.6 Size of Unit

The light units used should be as small as possible in order to maximise the choice of location, and must comply with the height limitation (less than 25cm) of objects on the helideck. Where the light unit(s) used exceed this limitation, consideration might be given to repackaging the unit to separate the lamp from the electronics unit, mounting the latter away from the critical height area of the helideck. Otherwise, it may be possible to position unit(s) on access/monitor platform(s) within the 210° obstacle free sector (OFS) (providing that units do not exceed the height restriction for the OFS and are visible from all directions of approach) or to mount the light unit(s) within the 150° limited obstacle sector (LOS).

4.7 Integrity

As a safety system, it is important that the helideck status signalling system operate when required to do so. This means that due account must be taken of the reliability of the individual components that make up the system and the system as a whole (including the electrical power supply), and that appropriate levels of redundancy are built into the system.

An alternative to redundancy would be monitoring which, necessarily, would have to be automatic in the case of systems installed on NUIs, but on manned platforms might be achieved through regular testing and inspection.

In addition, the system and its constituent components must meet all safety regulations relevant to the intended installation, e.g. explosion proofing (by a notified body in accordance with the ATEX directive).

4.8 Number and Location of Light Units

4.8.1 Number of Light Units

The requirement that at least one light be visible to the pilot when the helicopter is on the helideck, regardless of its orientation relative to the deck, effectively dictates that more than one light is required. However, given the very short range associated with this requirement, it could likely be met using supplementary 'repeater' lights of significantly lower intensity (a minimum intensity of 16Cd is recommended for lights deployed for this purpose) in addition to the 'main' signalling light(s).

In addition the topsides layout of the platform, specifically the presence of superstructure above the level of the helideck which can obscure the pilots' view of lights located on the helideck, and the requirement that the signal be visible from any approach direction may dictate the provision of more than one 'main' signalling light.

It is also a requirement that a single system failure should not render the whole system inoperative without warning. This implies a minimum of two 'main' signalling lights meeting the full photometric specification (except for flash rate if more than one unit is employed in order to meet the minimum flash rate requirement), unless a single light is equipped with a monitoring system capable of alerting platform personnel in the event of a failure (see Section 4.7).

Finally, the ability of a single unit of the type of light to be used to meet the photometric specification in the required colour and at the required flash rate may also dictate the use of more than one 'main' signalling light (see Section 4.4).

4.8.2 Location of Light Units

For maximum effectiveness and in order to avoid any potential confusion with other platform systems, it is recommended that the light units forming the helideck status signalling system be mounted on, or as near as possible to the helideck. Typically, maximum coverage in aziumuth will be obtained by mounting the 'main' signalling light(s) on the outboard edge of the helideck, opposite the origin of the 210° obstacle free sector (OFS). In the event that the size (essentially height) of the unit rules this location out, then a position within the LOS or down into an access/monitor platform within the OFS may be considered.

With some platform topsides it may not be possible to obtain 360° coverage in azimuth with light units mounted on the helideck and off-deck locations, possibly some distance from the helideck, may need to be considered. In this eventuality, careful consideration will need to be given to the effect of single system failures on overall system performance since light units mounted off-deck will likely not qualify as back-up for on-deck lights and vice versa; a single system failure must not lead to a significant loss of coverage in azimuth.

4.9 **Practical Considerations**

In arriving at a status signalling system specification,a number of factors other than the technical issues also need to be taken into consideration. In particular:

- the majority of offshore operations take place in typical day viewing conditions. Night operations normally only take place during the winter months (October through March) and represent a relatively small proportion of the overall total. Incidences of poor visibility during either night operations or in bright day conditions are therefore considered to be rare;
- the viewing conditions at offshore platforms at night will vary widely depending on the amount and intensity of the cultural lighting present and, at NUIs where the need for the status signalling system is arguably greatest, the cultural lighting environment is comparatively benign;
- a number of platforms have installed status signalling systems compliant with the earlier specification contained in CAA Paper 98003 (Reference [4]) and the 4th Edition of CAP 437 (Reference [1]). Changes from this specification have therefore only been made where considered significant.

  NOTE: Operators of platforms that are already equipped with a system complying with the technical specification contained in Section 6 of CAA Paper 98003 should discuss the requirement to modify their systems with their lighting manufacturer and the helicopter operator (see procedure for replacement or refurbishment of existing systems in letter contained in Appendix C).

- due account has been taken of the performance of available lighting products that are suitable for this application.

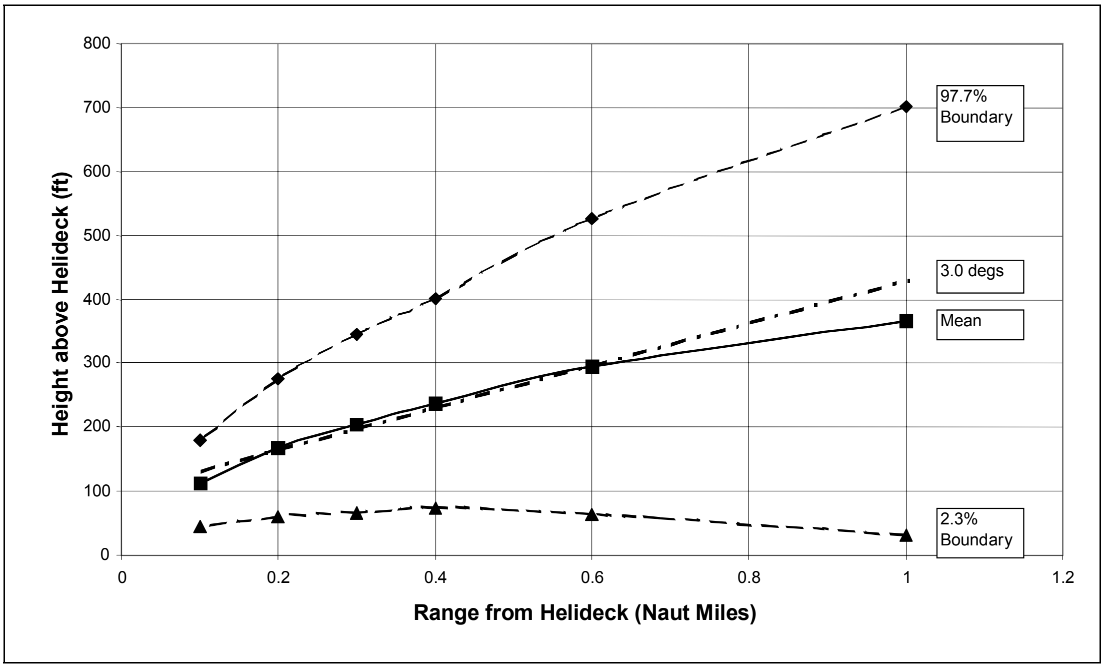

Figure 1 In-Service Data on Vertical Approach Profiles

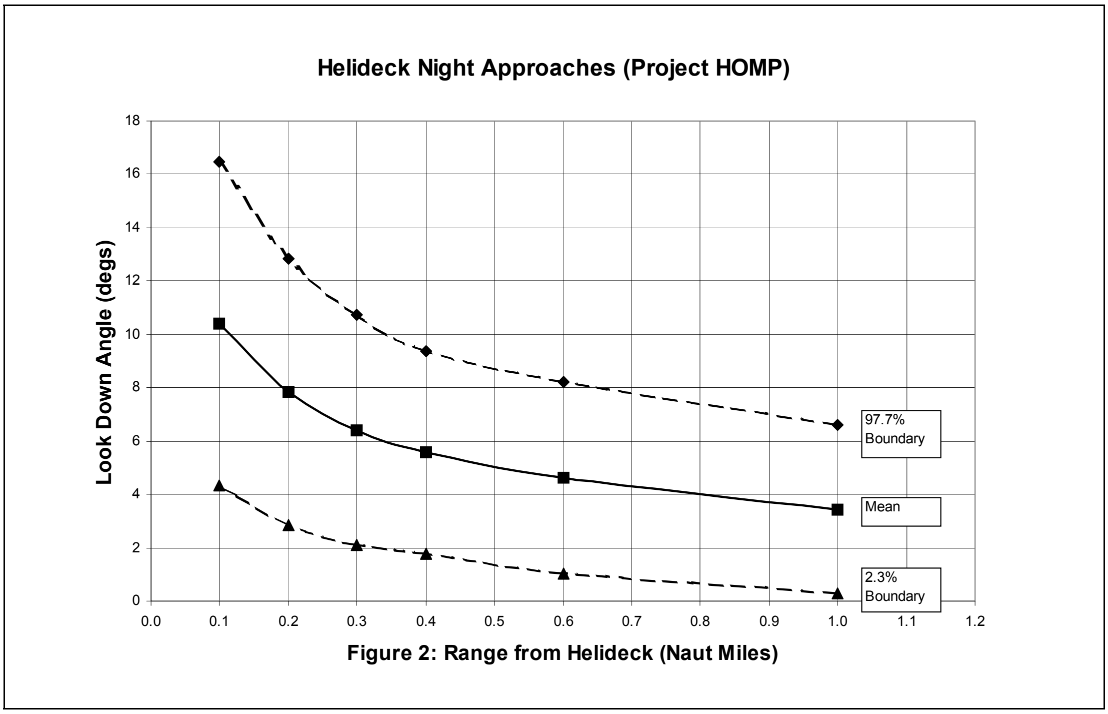

Figure 2 In-Service Data on Angle of Elevation of the Helicopter from the Helideck on Approach

5 Discussion

5.1 Current Operational Requirement and System Specification

The original specification (see Section 4.3.6 of Reference [1]) required a main beam intensity of 700Cd for use in meteorological visibilities down to 1400m. With reference to Appendix A (see Section 4), such a light would be **detectable** at 953m in typical day viewing conditions, i.e. in excess of the stated operational requirement of 900m. In the same viewing conditions, a 700Cd light would not be **conspicuous** beyond 700m. In bright day viewing conditions a 700Cd light would be **detectable** at 700m and **conspicuous** at approximately 500m. Taking account of the practical considerations detailed in Section 4.9, the fact that most practical systems will exhibit greater conspicuity than that predicted using Allard's law (see Section 4.1), and the relatively modest impact on range performance in the worst case viewing conditions, the existing main beam intensity requirement of 700Cd is to be retained.

The vertical beamwidth requirement varies with viewing range. Both the mean angle of elevation (middle curve in Figure 2) and the width of the beam (vertical distance between lower and upper curves in Figure 2) increase as the viewing range reduces. The shortest key viewing range requirement (above) is 500m, at which range the main beam intensity would need to be maintained from 2° to 11° in elevation to cover 95% of the approaches for which in-service data was obtained. This corresponds to the mean angle of elevation ±3 standard deviations if the data follows a normal distribution. At the longest key viewing range of 900m, the corresponding beamwidth extends from 1.4° to 8.7°. The ideal vertical beamwidth specification is therefore 1.4° to 11°. Taking account of the fact that the intensity of any practical light is unlikely to vary significantly at angles less that 1° from the main beam, the existing upper limit of 10° (see Section 4.3.6 of Reference [1]) is to be retained, and a new lower limit of 2° is to be introduced. While less than the original 5° lower limit, the new figure of 2° is unchanged from the interim guidance issued to industry in December 2003 (see Appendix C).

Outside of the main beam, the overflight (90° elevation) case is taken to represent a rational operational requirement for the purposes of system specification. Taking account of the practical considerations detailed in Section 4.9, and that this particular requirement is not considered critical as the pilot will have a second opportunity to detect the signal when approaching the platform, a requirement that the signal be **detectable** at 1500ft in meteorological visibilities down to 1400m in bright day viewing conditions, and **conspicuous** at the same range and meteorological visibility in typical day viewing conditions is to be adopted. This leads to a minimum off-beam intensity of 176Cd, which is less onerous than the existing figure of 215Cd.

The above requirements are summarised in Figure 3. The transition from the main beam intensity to the off-beam intensity has been designed to encompass the upper limit of the helideck elevation data in Figure 2.

The coverage of the system in azimuth must be 360° while the helicopter is either approaching or located on the helideck.

5.2 **Future Operational Requirement and System Specification**

As stated in Section 3, a reduction in minimum meteorological visibility from 1400m to 900m is envisaged as being a possibility in the foreseeable future. The only impact of this change in operational requirement is in respect of the intensity of the main signalling lights forming the system. With reference to Appendix A, applying the same arguments as for the present day operating limits yields a minimum main beam intensity of 1600Cd (see Appendix A Section 5) and a minimum off-beam intensity of 300Cd (see Appendix A Section 6). These requirements are summarised in Figure 4.

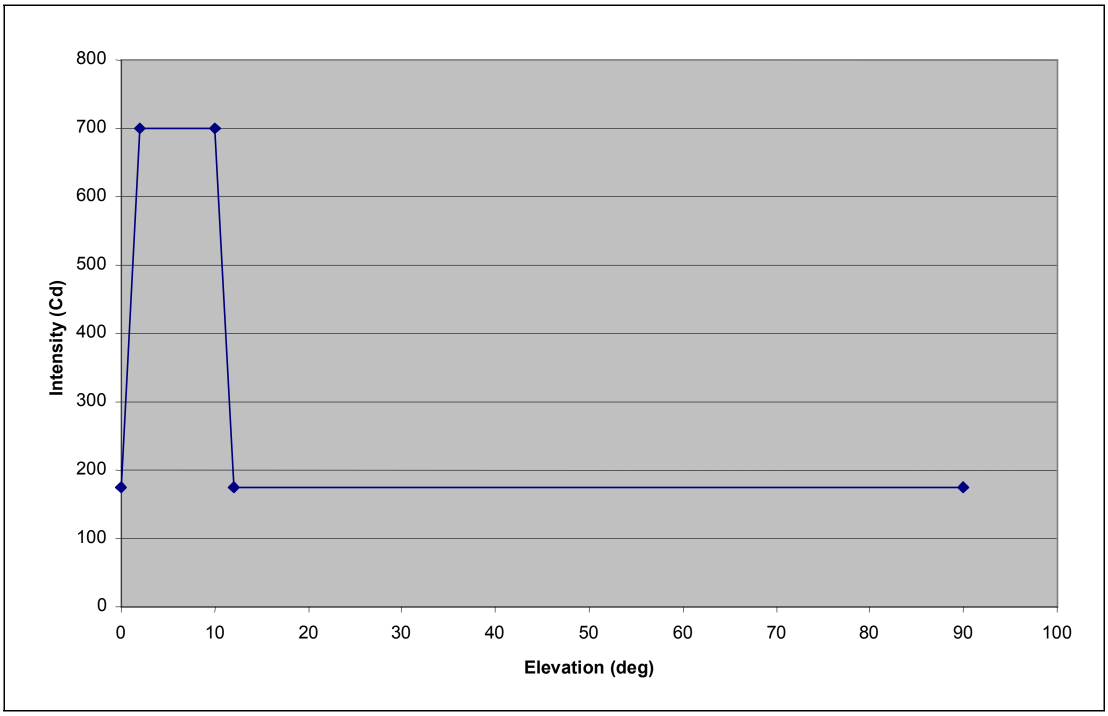

Figure 3 Vertical Beam Characteristics for Current Operating Minima (1400m minimum meteorological visibility)

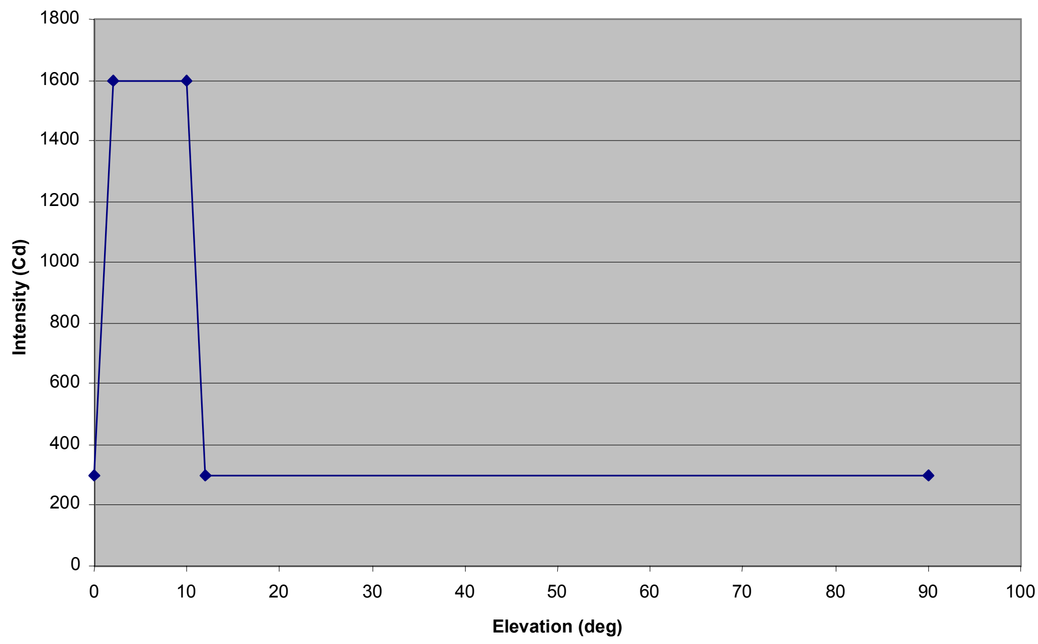

Figure 4 Vertical Beam Characteristics for Future Operating Minima (900m minimum meteorological visibility)

6 Specification

The recommended specification for the helideck status signalling system is summarised as follows:

6.1 Application

A helideck status signalling system shall be provided at all offshore helidecks where a condition can exist which may be hazardous for the helicopter or its occupants, unless alternative arrangements are accepted by the CAA.

6.2 Location

Where required, the helideck status signalling system shall be installed either on or adjacent to the helideck. Additional lights may be installed in other locations on the platform where this is necessary to meet the requirement that the signal be visible from all approach directions, i.e. 360° in azimuth (see Section 4.8.2).

6.3 Characteristics

- The effective intensity shall be a minimum of 700Cd between 2° and 10° above the horizontal and at least 176Cd at all other angles of elevation (see Section 4.1.1).
- The system shall be provided with a facility to enable the output of the lights (if and when activated) to be dimmed to an intensity not exceeding 60Cd while the helicopter is landed on the helideck (see Section 4.1.2).
- The signal shall be visible from all possible approach directions and while the helicopter is landed on the helideck, regardless of heading, with a vertical beam spread as shown in Figure 3 (see Sections 4.2 and 4.8).
- The colour of the status light(s) shall be red as defined in ICAO Annex 14 Vol.1 Appendix 1, colours for aeronautical ground lights (see Section 4.3).

- The light system as seen by the pilot at any point during the approach shall flash at a rate of 120 flashes per minute. Where two or more lights are needed to meet this requirement, they shall be synchronised to ensure an equal time gap (to within 10%) between flashes. While landed on the helideck, a flash rate of 60 flashes per minute is acceptable (see Sections 4.4 and 4.8).
- The light system shall be integrated with platform safety systems such that it is activated automatically in the event of a process upset (see Section 4.5.1).
- Facilities shall be provided for the HLO to manually switch on the system and/or override automatic activation of the system (see Section 4.5.1).
- The light system shall have a response time to full intensity not exceeding 3 seconds at all times (see Section 4.5.2).
- Facilities shall be provided for resetting the system which, in the case of NUIs, do not require a helicopter to land on the helideck (see Section 4.5.3).
- The system shall be designed so that no single failure will prevent the system operating effectively. In the event that more than one light unit is used to meet the flash rate requirement, a reduced flash frequency of at least 60 flashes per minute is considered acceptable in the failed condition for a limited period (see Sections 4.7 and 4.8).
- The system and its constituent components light shall comply with all regulations relevant to the installation (see Sections 4.6 and 4.7).
- Where supplementary 'repeater' lights are employed for the purposes of achieving the 'on deck' 360° coverage in azimuth, these should have a minimum intensity of 16Cd and a maximum intensity of 60Cd (see Section 4.8.1).

6.4 Operational Procedures

The procedures to be followed by the helicopter pilot in the event of the status light system being activated either during the approach, or while the helicopter is landed on the helideck, shall be common for all platforms. At the time of writing, suitable procedures have been established and are contained in Reference [6].

7 References

[1] CAP 437 - Offshore Helicopter Landing Areas – Guidance on Standards - 4th Edition, September 2002.

[2] CAA Paper 92006 - Offshore Platform Identification Signs - April 1992.

[3] CAA Paper 93020 - Helideck Status Signalling System - September 1993.

[4] CAA Paper 98003 - Specification for an Offshore Helideck Status Signalling System - December 1998.

[5] TNO Human Factors report ref. TM-02-C003.

[6] "British Helicopter Advisory Board Status Light Protocol", Addendum 16 of "UKOOA Guidelines for the Management of Offshore Helideck Operations", Issue 4, February 2003.

8 List of Abbreviations

ATEX	Atmosphere Explosiv (EU Directive)
Cd	Candela
CAA	Civil Aviation Authority
CIE	Commission Internationale de L'Eclairage (International Commission on Illumination)
cm	Centimeter
DERA	Defence Evaluation and Research Agency
HLO	Helicopter Landing Officer
HSE	Health and Safety Executive
Hz	Hertz
ICAO	International Civil Aviation Organisation
kt	knots
LOS	limited obstacle sector
m	meter
NM	nautical mile
NUI	normally unattended installation
OFS	obstacle free sector
SRG	Safety Regulation Group (of the UK CAA)
UKOOA	United Kingdom Offshore Operators Association

Appendix A Calculations of Required Intensity for a Warning Light System

1 Introduction

Allard's law will be used to estimate the intensity required for seeing a light.

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 Et depends on the background brightness and the probability of detection. For a bright day Et = 10-3.5, for a typical day Et = 10-4.0 and for a typical night Et = 10-6.0. These values have been associated with operations to Precision Approach runways (see Attachment D to ICAO Annex 3) and are used in the absence of data relevant to offshore platforms.

I = Intensity of the light unit (Candelas).

σ = Extinction coefficient (m^{-1}). This represents the atmospheric attenuation.

R = Visual range of a light in the specified conditions of E_t and σ.

Meteorological Visibility or Met Vis (M)

As defined in Attachment D to ICAO Annex 3 this relates to a dynamic viewing situation such as when a pilot is approaching a runway in mist, or fog and specifies a contrast threshold of 5%. This gives rise to a relationship to extinction coefficient of:

$$\sigma = 2.996/M$$

The intensity value that will be obtained from the above is that required for the light to be just visible. A warning light needs to stand out from the background rather than be just detectable. A practical way to improve conspicuity, at the detection range, is to increase the threshold intensity by half an order (i.e. 3.16).

NOTE: The intensities generated by Allard's Law are independent of the colour of the light. No allowance for the response of the human eye to light of different wave lengths is required in the intensities quoted as this is normally accounted for in the characteristics of the photometer used to measure the light under test.

2 Intensities for Required Visual Ranges in a Meteorological Visibility of 1400m

Given a value of M = 1400 then $\sigma = 2.996/1400\ m^{-1}$. Table 1 summarises the required effective (flash) intensity for a warning light under different viewing conditions.

Table 1

Conditions for viewing lighting	E_t (lux)	Required intensity (cd) for a detectable light at 900m	Required Intensity (cd) for a conspicuous light at 700m
Bright day	$10^{-3.5}$	1758	2192
Typical day	$10^{-4.0}$	556	693
Typical night	$10^{-6.0}$	~6	~7

3 Intensities for a Required Visual Range of 1500ft (457m) in a Meteorological Visibility of 1400m

Given a value of M = 1400 then $\sigma = 2.996/1400\ m^{-1}$. Table 2 summarises the required effective (flash) intensity for a warning light under different viewing conditions.

Table 2

Conditions for viewing lighting	E_t (lux)	Required intensity (cd) for a detectable light at 457m	Required Intensity (cd) for a conspicuous light at 457m
Bright day	$10^{-3.5}$	176	~556
Typical day	$10^{-4.0}$	56	176
Typical night	$10^{-6.0}$	~1	~2

4 Visual range of Light of 700cd in a Meteorological Visibility of 1400m

Given values of I = 700 and $\sigma = 2.996/1400\ m^{-1}$, Table 3 summarises the achieved visual range for a warning light under different viewing conditions.

Table 3

Conditions for viewing lighting	E_t (lux)	Detectable range (m) for a light of 700cd	Conspicuous range (m) for a light of 700cd
Bright day	$10^{-3.5}$	701	494
Typical day	$10^{-4.0}$	953	701
Typical night	$10^{-6.0}$	2288	1916

It is noted that the term Meteorological Visibility (M), is meaningless at night and it is assumed that the equivalent daylight value is that implied.

5 Intensities for Required Visual Ranges in a Meteorological Visibility of 900m

Given a value of M = 900m then $\sigma = 2.996/900\ m^{-1}$. Table 4 summarises the required effective (flash) intensity for a warning light under different viewing conditions.

Table 4

Conditions for viewing lighting	E_t (lux)	Required intensity (cd) for a detectable light at 900m	Required intensity (cd) for a conspicuous light at 700m
Bright day	$10^{-3.5}$	5118	5034
Typical day	$10^{-4.0}$	1618	1592
Typical night	$10^{-6.0}$	16	16

It is noted that the term Meteorological Visibility (M), is meaningless at night and it is assumed that the equivalent daylight value is that implied.

6 Intensities for a Required Visual Range of 1500ft (457m) in a Meteorological Visibility of 900m

Given a value of M = 900 then $\sigma = 2.996/900\ m^{-1}$. Table A-5 summarises the required effective (flash) intensity for a warning light under different viewing conditions.

Table 5

Conditions for viewing lighting	E_t (lux)	Required intensity (cd) for a detectable light at 457m	Required intensity (cd) for a conspicuous light at 457m
Bright day	$10^{-3.5}$	302	956
Typical day	$10^{-4.0}$	96	302
Typical night	$10^{-6.0}$	1	3

Appendix B Flashing Light Test Procedure

1 Introduction

The purpose of this appendix is to specify a procedure for testing flashing lights to be used as a standard by manufacturers and test houses to ensure compliance with the helideck status light photometric specification. The procedure has been produced by collating requirements from existing advisory material and known standards into one document, and is based on the flashing light test procedure contained in Reference [1].

The performance of a light is specified by the intensity distribution. To show compliance with any particular specification, it is necessary to make measurements of intensity at different angles of azimuth and elevation. The techniques for conducting measurements on steady burning lights are well established and for flashing lights many of the same considerations apply. However, the flash characteristic requires some modifications to the test procedures that are employed.

Flashing lights, in the context of this appendix, are those lights where the light signal is discontinuous. This may be achieved through the electrical switching of the source (e.g. tungsten filament), or by the mechanical occulting of a steady burning light. The latter method generally produce flashes that are significantly longer than those achieved with discharge lights, which can produce flashes of very short duration (e.g. 1 to 10 milliseconds).

Note, however, that the test procedure contained in this appendix is not valid for multiple pulse flashing lights, i.e. for flashing lights where individual flashes comprise a series or group of flashes with a repetition rate that is sufficiently high for the whole group to be seen as one flash.

2 Objective

The objective of the test shall be to measure the effective intensity of the light over the range of operationally required angles in both elevation and azimuth with an overall accuracy of better than 10%.

3 Requirements

The following constitute the requirements in respect of the various aspects of testing.

3.1 Dark Room Requirement

Measurements should be made in a dark room environment. The construction of the dark room should be such that the influence of multiple reflections on the measurement values obtained is kept to an absolute minimum. Evidence of the level of spurious light present shall be supplied to the competent authority.

3.2 Equipment Operating Requirement

The test light should be installed and operated in compliance with the normal installation guidelines for that equipment. An electrical supply providing the specified voltage, or current, and frequency should be used. Where appropriate, cables should replicate the capacities and lengths to be used in service. The latter is particularly important where a light unit and the associated control gear are not co-located. The characteristics of the electrical supply at the unit shall be provided to the competent authority.

3.3 Inverse Square Law Requirement

Since measurements of illuminance are to be made, the distance between the photometer and the light under test should be such that the inverse square law, relating intensity to illumination, is obeyed. That is to say the distance between the light under test and the photometer must be such that the intensity calculated from illuminance is unaffected by a change in distance. Evidence of conformity to the inverse square law shall be supplied to the competent authority.

Information

In these circumstances, the illuminance at the photometer is solely proportional to the intensity and the constant of proportionality is equal to the inverse of the square of the distance between the light and the photometer.

$$E = \frac{I}{R^2}$$

Where: E is the illuminance at the photometer (lux)

I is the intensity of the light (candela)

R is the distance between the light and the photometer (metres)

Compliance with this requirement can be demonstrated by making measurements at a number of distances, and demonstrating that the distance to be used for the verification testing is equal to, or greater than, the distance at which the computed intensity becomes independent of the distance used. The light and photometer may be mounted on some form of track or rail to facilitate this.

The distance at which compliance is achieved is a function of both the aperture and beam spread of the light under test. The greater the aperture and the smaller the beamspread, the greater will be the distance required. For the majority of aviation ground lighting equipments this distance will need to be approximately 20-30 metres. An alternative means of estimating an acceptable measurement distance assumes the minimum range to be 100 times the aperture of the light under test. Further information can be found at Reference [3].

3.4 Angular Sampling Requirement

The light output shall be sampled over an orthogonal grid in elevation and azimuth. The sample interval in elevation shall be no less than 5% of the beam width (in elevation), or at a 1° interval, which ever is the lesser. If the former, then the azimuth axis is to be sampled at 5% of the beam width in azimuth; if the latter then at 10° intervals over the range of elevation angles which are operationally significant. The data shall be supplied to the competent authority.

For the present purpose, the beam width in each axis, is defined as the angle containing the peak of intensity, subtended by the points either side of the peak where the intensity falls to 3% of the value at the peak.

Information

It is recommended that the light under test be installed on a Goniometer so that its angular position in relation to the photometer can be readily and repeatedly adjusted.

Where a beam has dimensions of approximately ± 10°, in azimuth and elevation, the intensity measurements would be made using the grid pattern shown in Figure 1. This figure can also be found in Reference [4].

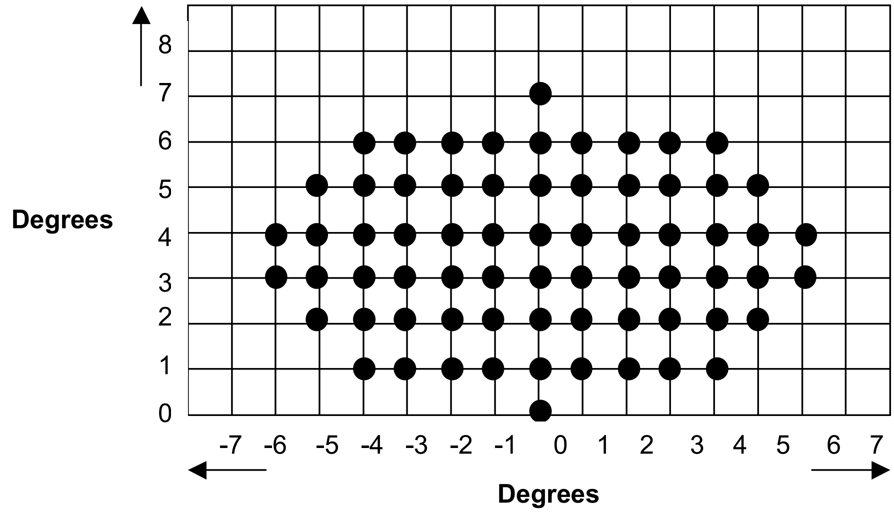

Figure 1 Typical Intensity Distribution Measurement Diagram

3.5 **Photometer Aperture Requirement**

The measured intensity angular distribution of the light shall not be affected by the angle subtended by the aperture of the photometer at the light. The aperture of the photometer shall be such that it subtends an angle at the light no greater than half of the angular sampling interval employed in Section 3.4.

3.6 **Angular Positioning Requirement**

The angular position of the light under test with respect to its datum axes shall be known to within an angle no greater than half of the angular sampling interval employed in Section 3.4.

3.7 **Photometer Spectral Response Requirement**

The output from the unit under test shall be measured using a photometer having a spectral response conforming to the 1931 CIE Standard Observer curve for photopic vision (Reference [5]). Evidence of conformity shall be supplied to the competent authority.

3.8 **Photometer Temporal Response Requirement**

The temporal response of the photometer should not introduce an error of more than 5% in the measurement of the effective intensity of the flash. Evidence of the accuracy achieved shall be supplied to the competent authority.

3.9 **Flash Repeatability Requirement**

The intensity at each point on the grid should be the average of at least 5 flashes. The typical flash to flash dispersion in intensity shall be recorded and supplied to the competent authority.

4 Calculation of Effective Intensity

The effective intensity of a flashing light for any flash having a duration of less than 0.15 seconds, will be defined using the Blondel-Rey relationship (References [2], [6] and [7]). The method of calculation is illustrated below in equation form and graphically in Figures 2 and 3. The methods for applying the equation are outlined in Section 5.

$$I_e = \left[\frac{\int_{t_1}^{t_2} I d_t}{a + (t_2 - t_1)}\right]_{max}$$

Where: Ie is the effective intensity in candelas

I is the instantaneous intensity in candelas

a is a constant (equal to 0.2 seconds (Reference [2]))

and t_1 and t_2 are the limits of integration.

I_e is obtained by maximising the value of the function (see Section 5.2).

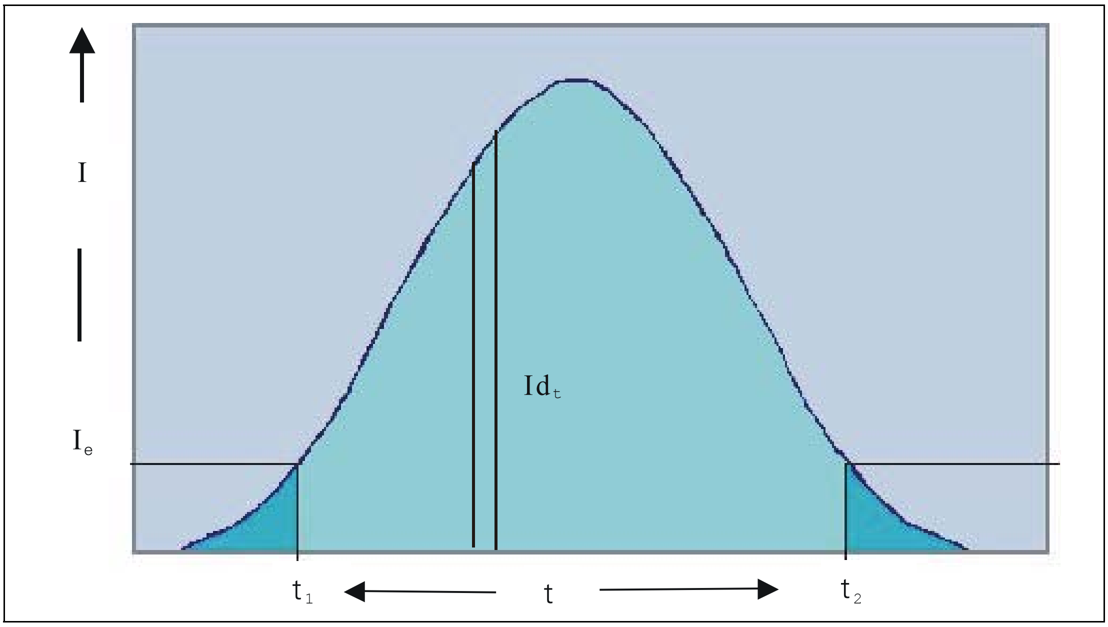

Figure 2 Effective Intensity of a Single Flash

5 Methods for Deriving Effective Intensity

The measurements made by the photometer may be used to derive the effective intensity by one of the three following methods.

5.1 Method for Automatic Flash Measurement

This may be used where the output of the photometer is processed by an integrating device calibrated in candela seconds, and where the duration of the flash (t_2-t_1) is insignificant in relation to 0.2 seconds. Under these circumstances the effective intensity will be obtained by multiplying the value in integrated candela-seconds by 5 (see equation in Section 4 above). The stated accuracy of the instrument used to obtain the effective intensity shall be provided to the competent authority.

5.2 General Method for Measurement

This method is particularly suitable where the value (t_2-t_1) is significant in relation to 0.2 seconds.

The output of the photometer is recorded against a timebase (e.g. high-speed data logger or storage oscilloscope). These data form the basis of the iterative process, described in the Information Section below, by which the value of the effective intensity is calculated. The accuracy achieved, or evidence thereof, shall be supplied to the competent authority.

The error induced by the interval and algorithm used for the integration process shall be no greater than 2% of the integral. Evidence of this shall be supplied to the competent authority.

Where a single flash has multiple peaks, the maximum in the intensity function shall reflect the overall envelope of the flash. Evidence of this, where applicable, shall be supplied to the competent authority.

Evidence of convergence in the iteration process and that the step to step change in intensity at the solution is no more than 1% shall be supplied to the competent authority.

Information

A value of time (t_1) near to the start of the flash is chosen and an instantaneous intensity is read from the curve. Using this intensity a second value of time (t_2) near to the end of the flash is read from the curve as shown in Figure 2. The numerical integral between t_1 and t_2 is then obtained from the curve and applied together with t_1 and t_2 to the equation given in Section 4. The value of t_1, and hence those of t_2 and the integral are varied until a maximum value for the equation is obtained. This maximum value is the effective intensity (I_e).

The interval for sampling the instantaneous intensity, whether graphical, or numerical must be sufficiently small to avoid error. It is recommended that the effect on the intensity integral of halving the interval be tested.

To minimise the effort required to conduct the iteration process, an initial value for t_1 relating to an instantaneous intensity of approximately 20% of the maximum may be used.

5.3 Method for Rotating Beacon Measurements

This method can be used for the flash measurement of a rotating beacon and avoids the need to make rapid response intensity measurements against time.

If the rotation mechanism can be disabled, then the beam flash characteristics can be determined from the azimuth intensity characteristics by plotting instantaneous intensity against angle in degrees using the resolution specified in Section 3. The values for the times t_1 and t_2 may then be calculated using the normal speed of rotation of the light and the same procedure followed as for Section 5.2.

6 References

[1] Puffett, A., A Generic Test Procedure for the Measurement of Flashing Lights, QinetiQ Report Ref. QINETIQ/FST/CSS/CR011654, Issue M dated 07 May 2002.

[2] International Civil Aviation Organisation Visual Aids Panel Working Paper, VAP/ 13 – WP/ 33, 1997, Measurement of Intensity for Steady Burning and Flashing Lights

[3] Moerman, J. J. B. & Holmes, J. G., The Choice of Test Distance to Control Errors in the Photometry of Round Projectors Focused at a Long Distance, Lightning Research and Technology, Volume 13, No 2, 1981

[4] International Civil Aviation Organisation International Standards and Recommended Practices, Annex 14 Volume 1, Aerodrome Design and Operations, Second Edition, 1995

[5] International Commission on Illumination (CIE), Standard Observer & Co-ordinate System, Eighth Session, (1931), Publication No 15, Colorimetry, 1971

[6] Douglas, C. A., Computation of the Effective Intensity of Flashing Lights, Illuminating Engineering Society, Volume 53, p600, November. 1958

[7] Illuminating Engineering Society Guide for Calculating the Effective Intensity of Flashing Signal Lights, Volume 59, p747, November 1964

7 Bibliography

1 Federal Aviation Administration, Advisory Circular 20-74, Aircraft Position and Anti-Collision Light Measurements

2 International Commission on Illumination (CIE), Draft Technical Report on the Effective Intensity of Flashing Lights

Appendix C Interim Guidance Issued by CAA in December 2003

Safety Regulation Group
Flight Ops Inspectorate (Helicopters)

31st December 2003
Ref 10A/253/16/2B

Dear

HELIDECK STATUS LIGHTS ON OFFSHORE INSTALLATIONS AND VESSELS

Further to my letter dated 24 September 2002, we have now completed further work with the assistance of our contractor QinetiQ, to refine the status light specification contained in CAP 437. This will lead to the publication of a new CAA Paper (no. 2003/06) in due course which will supersede CAA Paper 98003. By way of advanced information, this letter sets out the main changes to the status light specification and provides additional guidance on the following issues:

- Further guidance on who needs to fit helideck status lights.
- Procedure to mitigate for wrong rig landings on 'unsafe' helidecks at night.
- Procedure for replacement/ refurbishment of existing 'non compliant' systems.
- Revised specification to be published in CAA Paper 2003/06 and CAP 437.

Who needs to fit helideck status lights

In our earlier letter it was emphasised that all installations (fixed and mobile) and vessels should consider fitting helideck status light systems if a condition could exist which may be hazardous for the helicopter or its occupants. It was stated that the sole condition/ requirement for automatic activation of a status light system should be to cover the occurrence of process upset conditions (e.g. impending gas release). CAA has agreed with HSE and UKOOA that it is reasonable for operators of manned installations and vessels to consider other 'manual' systems for alerting helicopters of helideck unsafe conditions providing it can be demonstrated that the 'alternative means of compliance' will deliver a level of safety equivalent to the status light system described in CAA Paper 2003/06. CAA has agreed with HSE and UKOOA that this is not achievable in the case of a Normally Unattended Installation (NUI) where fully compliant automatically activated status light systems will need to be installed.

Procedure to mitigate for wrong rig landings on 'unsafe' helidecks at night

Instances of wrong rig landings in the UK sector are well documented through the Mandatory Occurrence Reporting Scheme (MOR's) that record a peak level of reportable instances in the late 1990's. There has been no MOR filed for wrong rig landings since 2001. Originally part of the design objective for the status light system was to introduce a capability to alert a pilot who was unknowingly making an approach to the wrong rig that was either unprepared and/or unsafe for helicopter operations. Whilst it may be embarrassing for a pilot to land on the wrong rig, it is the view of the CAA that it is not necessarily an issue of safety unless the deck is obstructed or otherwise unfit to accept a helicopter movement (e.g. moving crane, planned or unplanned gas venting, obstructions on or over the helideck including personnel on the helideck).

For public transport operations at night, the Air Navigation Order (ANO) places a shared responsibility for safe helicopter operations between the helicopter operator, who is required to operate safely in accordance with the Rules of the Air, and the owner of an aerodrome, who is required to display appropriate aeronautical lighting to identify the landing area at night. In the past it was suggested that to mitigate for wrong rig landings on helidecks, installations and vessels, which were in an unsafe condition, should manually activate 'flashing red' helideck status lights to warn pilots to 'stay away' from the installation/ vessel. Whilst this system would achieve the desired effect, CAA is concerned that if a 'flashing red' warning was adopted as the common procedure at night, then high intensity flashing lights could present a source of distraction to a pilot particularly if operating in a multi-platform field environment. It is considered more appropriate that installations and vessels switch off their helideck lighting systems if, for any reason, the installation (vessel) or the helideck itself is in a condition which makes it unsafe for helicopter operations. In conformity with this procedure, if the perimeter lights are switched on during night time operations, a pilot may assume that in the event of an emergency or unusual situation occurring, the helideck is safe to receive a helicopter and, in these 'unusual circumstances', he may attempt an unscheduled landing on the helideck. By day it is assumed that the commander of the aircraft would take an operational decision regarding the suitability of a landing area in the event he should need to make an unscheduled 'wrong rig' landing due to 'unusual circumstances'.

Following a 'finals to the deck' call from the helicopter, the use of the HLO to confirm (or not as the case may be) that he is visual with a helicopter approaching the appropriate deck, can also be an effective means of minimising the risk of a pilot making an inadvertent landing on the wrong platform.

Procedure for replacement or refurbishment of existing non-compliant systems

Our earlier letter (ref: 10A/253/16/2B) recognises that helideck status (wave off) lights were first fitted to platforms in the North Sea around 1991. This pre dates a requirement to provide status lights against a formal specification. Indeed, it was not until the publication of the UKOOA issue no.2 guidelines for Helicopter Operations to Normally Unattended Installations in March 1997, that a formal specification was first published in guidance literature. Although the characteristics published in UKOOA issue 2 guidance were only a 'prototype' for the final specification, to be published in 2003/06, the CAA does recognise that systems conforming to the UKOOA guidance and the developed technical specification published in CAA Paper 98003, **may** be acceptable for the duration of the life of the unit(s), providing the technical specification of the unit(s) are demonstrated to be adequate and verified by the manufacturer to the satisfaction of the helicopter operator. It is understood that some existing units could be refurbished; specifically to realign the 'main beam' of the unit with the operational requirement derived using HOMP data (see later). It is recommended that duty holders contact their manufacturers to discuss these requirements. For existing status light systems in use on Normally Unattended Installations (NUI), it is essential that units are fitted with a remote reset facility (reset usually from the 'mother' platform) and desirable that 'main' lights are fitted with an HLO operated dimming switch with a means of automatically returning the system to full intensity. It is a requirement for systems without redundancy (i.e. only one main light) to develop procedures and monitor systems to ensure immediate rectification of failures.

CAA believes it is unlikely that status lights fitted prior to 1997 will be acceptable against the final specification without requiring major modification. In most cases modification will be impractical and, therefore, fully compliant replacement systems should be sought at the earliest opportunity. A programme for fitment should be agreed with the helicopter operator.

In summary, status light systems fitted during or after 1997 may be acceptable, with some manufacturer approved modification(s), whilst units fitted prior to 1997 are likely to require replacement at the earliest opportunity. Programmes for replacement or refurbishment should be agreed with the helicopter operator (or their agents). The lighting manufacturer should oversee any programme of refurbishment and should make a revised specification available to the helicopter operator and to BHAB Helidecks inspectors during routine visits.

Revised specification for publication in CAP 437 and CAA Paper 2003/06

In 1998, CAA published a specification for a status light system in CAA Paper 98003 which is referenced in CAP 437. Since then, developments have occurred necessitating the re-issue of the specification. To avoid confusion, a new CAA Paper (no.2003/06) will shortly be published which will supersede CAA Paper 98003. By way of advance information, the main changes to the status light specification will be as follows:

- All references to a green 'helideck safe' light will be removed. This scheme is not compatible with the new green perimeter lighting being introduced.
- The operational requirement will be changed to reflect the current minimum meteorological visibility of 1400m and a minimum typical day viewing range of 900m (detectable) and 700m (conspicuous), yielding a minimum intensity over the main beam of 700cd, and a minimum intensity of 215cd at other elevations. Table 4.1 will be removed from CAP 437 and information will be provided for lower operational visibilities in an appendix to CAA Paper 2003/06.
- A new appendix will be added containing a recommended flashing light test procedure. The actual value of effective intensity measured can be very sensitive to the test procedure employed. CAA's contractor (QinetiQ, Bedford) has produced a test procedure based on FAA AC 20-74 which has been subjected to Industry consultation, and has been 'road tested' by a major offshore helideck lighting manufacturer.
- The vertical beam spread requirements will be redefined with the main beam lying between 2° and 10°. This change has resulted from the availability of actual helicopter vertical approach profile data from the Helicopter Operational Monitoring Programme (HOMP). The new beam spread is based on data from 271 night approaches to approximately 50 different offshore helidecks.
- Additional guidance on intensity control will be provided. The provision of a manual, HLO-operated dimming switch will be recommended for use when the helicopter is on the helideck. A means of automatically returning the system to full intensity will also be recommended to eliminate the possibility of the system being inadvertently left dimmed.
- The need to cater for single failures will be added. This may involve adding redundancy to the system (e.g. by employing additional main lights), and/or including a monitoring system and associated procedures.
- Where redundancy is added by employing additional main lights, the benefits in conspicuity of configuring lights to flash alternately will be emphasized. The apparent 'movement' of the light that results can significantly enhance conspicuity.
- Where redundancy is added by employing additional main lights, clarification will be added confirming that the 2Hz flash rate applies to the system and not individual lights, e.g. two lights synchronized to flash alternately each flashing at 1Hz is acceptable.

- The example of moving machinery as an input for automatic activation will be removed.
- The need to provide a remote reset facility for status light systems on NUIs will be added.

It is expected that installation and vessel duty holders will comply with the requirements of this letter at the earliest convenient opportunity with an absolute cut off for compliance by 1 January 2007.

Yours sincerely

Kevin P Payne
Flight Operations Inspectorate (Helicopters)