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A J Smith

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FOREWORD by the Safety Regulation Group, Civil Aviation Authority

The research, reported herein, was instigated and funded by the UK Civil Aviation Authority in response to concern in the Industry over the incidence of 'wrong-rig' landings. The importance of correct platform identification and, more particularly, the safety implications of unexpected helicopter arrivals are recognised and well understood by the Authority.

On the basis of the findings of the research, it is accepted that scope exists for improvement in the methods employed for the identification of off-shore platforms. Futhermore, it is evident that any scheme utilising 'passive' signs is unlikely to prove satisfactory over the full operating environment.

In determining the most appropriate action to be taken, the priority of the Authority is to minimise the exposure of the helicopter to the potential hazards of 'wrong-rig' landings. It is considered that this objective can best be achieved through the development of a platform status light signalling system. Although such a system cannot improve platform identification, it is seen as the most effective means of preventing an aircraft landing on a rig which is in an unsafe condition, thereby eliminating any associated risk. Further research aimed at the development of a suitable platform status light signalling system has therefore been programmed.

CONTENTS

1 INTRODUCTION

The locations of all off-shore energy facilities in the UK sector are identified for maritime and aviation purposes. One visual means of identification, originally designed for maritime purposes, is large sign boards on the side of the installation. The signs consist of black lettering on a yellow background – see Figs 1 and 2 for typical examples. The inscription is derived from the name of the operating company and the exploration block number. For aviation purposes the helideck is marked to define safe landing areas, obstacle free approach sectors and permissible landing mass. A company logo may also be provided. Nevertheless, for rig identification from the air, the yellow and black signs on the sides of the installation are the primary long range visual markings. Pilot reports and operational experience indicate, however, that these signs are not adequately meeting the purpose for which they are being used since, from time to time, helicopters land on the wrong deck due to mid-identification. The objectives of the study reported in this Working Paper are:

(a) To define the Operational Requirement for Rig Identification Signs.

(b) To propose a specification for the physical characteristics of a sign that will meet the Operational Requirement.

2 THE PROBLEM

This study was initiated as a response to reports of pilots making landings on the wrong helideck, particularly at night and after radar-aided approaches. Such occurrences cause concern for two reasons:

(a) **Safety**

A 'wrong-rig' landing can be hazardous because of the nature of rig operations. For example, when explosives are in use a 2 nm danger zone around the rig is declared for helicopter operations. Another hazard example is the movement of a crane jib into the helicopter touchdown and lift-off area because helicopter operations are not scheduled. Unexpected landings can also directly hazard rig personnel working on or near the deck. Furthermore, a 'wrong-rig' landing will occur without the presence of the required safety personnel.

(b) **Operational requirement**

While certain types of rig operation result in a 2 nm airspace safety ban around a rig, a key operational requirement for helicopter operations is the correct identification of the rig in good visibility conditions at ranges not less than 600 m. This is the range at which a helicopter will typically be committed to the final descent and deceleration phase by the pilot. However, the minimum decision range for many IFR approaches, being the point at which visual contact with the rig must have been established if the approach is to be continued, is currently 1250 m. Prior to 1986 this limit was 600 m, a value that could be reverted to if a more precise instrument approach system were to be adopted in the future. Consultation with the CAA Flight Operations Directorate indicated that while a 1250 m recognition range is desirable a 900 m range might be acceptable operationally.

3 OPERATIONAL REQUIREMENT

For the purposes of this study it is suggested that the Operational Requirement for Rig Identification Signs can be defined as follows:

> The Rig Identification Sign shall be usable by day and by night in all visibilities down to a meteorological visibility of 1250 m. The sign board shall be conspicuous from a range of 1250 m and legible from a range of 900 m, in the conditions specified above. The sign, or combination of signs, shall be usable over all approach directions.

4 DESIGN CONSIDERATIONS

If a sign is to meet the operational requirement it must be conspicuous and legible. Put another way, the pilot needs to find the sign board and read the inscription at long range. Conspicuity is the first requirement. In the rig environment there is a large amount of visual information with which the pilot has to contend. It is therefore important that the sign board be attention-getting. Conspicuity is dependent on the contrast between the sign and the background. Size is also an important factor. If the sign board is adequately conspicuous, then the effectiveness of the sign depends on the legibility of the inscription. This is also strongly influenced by contrast and by the size of the alphanumerics. The third component in the task is the visual performance of the pilot.

4.1 Conspicuity

Research by Jenkins and Cole (1982) for roadsigns showed that, by day, for a sign to be conspicuous against a complex visual background such as that presented by an off-shore facility, the luminance contrast needed for a signboard to be seen at a glance can be represented by the equation:

$$C_L = 0.19E + 0.35$$

where C_L = luminance contrast

E = angular offset of the sign from the pilot's point of regard.

and

$$C_L = \frac{L_T - L_B}{L_B}$$

where L_T = luminance of the sign (candela/m^2)

L_B = average luminance of the background (rig)

The relationship is shown in Fig 3. Inspection of this diagram clearly shows that the pilot's ability to find the sign is dependent on his line-of-sight when he begins his search. If it can be assumed that the pilot will see the rig before he sees the sign it can be assumed that eccentricities less than 10° can be expected at a contact range of 1250 m, implying a requirement for luminance contrasts for the sign against the background in the range 0.35–2.3. This requires the sign to reflect light or be artificially lit to a level of luminance 1.35–3.3 times the luminance of the background. This condition will often not be met, particularly at the higher values, and in circumstances where the sign is in shadow. It should also be noted that there is good evidence from other sources that any sign situated more than 10° from the pilot's line-of-sight will not be seen.

Another factor in determining the sign conspicuity is the size contrast C_S, where

$$C_S = \frac{S_T - S_B}{S_B}$$

where S_T = size of sign (m)

S_B = average size of elements (e.g. pipes/girders) that make up the background (rig).

Jenkins and Cole developed a relationship between CS and the eccentricity (E) from the point-of-regard shown in Fig 4 as follows:

$$C_S = 0.33E + 0.10$$

It is not easy to define a representative value for S_B in the case of a rig. However, since most components of the structure are of smaller size than the sign, the value of C_S is generally large. This suggests that over the range of eccentricities to be considered, the actual value of C_S will be above the minimum for detection indicated by Fig 4. Generally, therefore, the immediate sign background is such that increasing the size of the sign will not significantly enhance conspicuity, although a large signboard would beneficially allow larger alphanumerics to be displayed.

4.2 Legibility

One of the most important aspects of sign utility, assuming that the sign is sufficiently conspicuous, is the legibility of the inscription. A primary determinant is the minimum angular subtense of a legible inscription, generally assumed as being 5 min arc at the observer's eye. This leads to the formula:

$$H = 1.5D \quad (1:600)$$

where H = height of inscription (mm)

D = maximum viewing distance (m)

Applying this relationship to the ranges quoted in the Operational Requirement we get:

D(m)	H(mm)/(m)
1250	1875/1.875
900	1350/1.35

The signs currently in use have a letter height of 1.5 m, which according to the above formula implies a maximum legibility distance of 1000 m. However, the formula assumes that long viewing times are available. In the case of signs where the decision time is short and certainty of correct interpretation is required, recent trials on taxiway signs at Bedford and by the FAA suggest that practical useful ranges are much reduced on the theoretical maximum. It is not uncommon for the usable range to be as little as 50% of the value for long periods of regard when the observer is not moving. This data would suggest that the signs currently on the rigs are often only legible at ranges below 500 m, even when there is good contrast.

The legibility of a sign is also sensitive to the viewing angle. Sign design assumes normal or near-normal viewing. This geometry is not necessarily adhered to in the off-shore environment, indeed angles well in excess of 45° are not uncommon – see Fig 5. Deterioration in performance is due to reductions in contrast and legibility of the inscription.

4.3 Atmospheric Attenuation

The parameters reviewed in the preceding paragraphs assume ideal environmental conditions; no account is taken of the adverse effect of atmospheric attenuation. The meteorological range (visibility) is the distance at which the apparent brightness contrast of an object is reduced by atmospheric scattering to 2% of inherent contrast between the object and a sky background. In the context of the range of 1250 m, specified in paragraph 3, this is the distance that the rig will just become visible to a pilot. If the contrast between the sign and the background or between the sign legend and the sign board is less than 2% at the meteorological range then the sign will not be visible. This will generally be the case. The effect is to produce usable sign ranges that are considerably less than the meteorological visibility.

4.4 Other Factors

In the interests of brevity this paper does not analyse all the mechanisms that result in the rig signs being inadequate for the recognition task that has been assigned to them.

The following Table, based on the work of Caplan (1975) serves as a summary of many of the relevant factors.

Table 1 Factors affecting sign effectiveness by day

Sign Design	*Factors affecting transmission information*	*Elements influencing receipt of information*
Comprehensibility	**Environment**	**Discrimination**
o User knowledge	o Viewing distance	o Visual abilities
o Brevity	o Viewing angle	
o Accuracy	o Illumination	**Interpretation**
o Clarity	o Deterioration	o Situation knowledge
	o Competing displays	
Legibility	o Timing pressure	**Recall**
o Legend style		o Time delay
o Legend size		o Interference
o Colours		
o Borders		
o Layout		
o Abbreviations		
o Spacing		

During hours of darkness many of the same considerations still apply. However, the use of internal or external lighting of the sign can enhance both the conspicuity and legibility of the board.

5 DISCUSSION

The sign boards currently installed on rigs are not adequate for the task of providing identification information to a pilot at the necessary contact range. While the 1250 m range may seem to be large it must be recognised that the final approach deceleration must be commenced at this sort of distance since rapid decelerations are not acceptable, particularly in reduced visibility conditions. The pilot making an approach needs to acquire the identification information at a glance at the decision range. In practice this requires the sign to be visible at a range of 1250 m and readable at a range of 900 m. From a performance point of view, this requires that the sign has a contrast relative to the rig greater than the contrast between the rig and the general background. In daytime conditions these parameters are independently variable, each depending on the luminance that results from sun position and altitude. They are also dependent on the reflectances of the various surfaces involved. By day, one of the difficulties is caused by the sign board being in shadow when the rest of the rig is in sunlight, thereby changing the balance between contrast levels. An example of the way in which luminance levels can vary is given in Fig 6. This diagram shows typical data taken during contrast testing at Bedford.

A number of solutions to the operational problem are worthy of consideration:

(a) A visual aid, such as an identification beacon, could be fitted to all rigs. The ICAO Visual Aids Panel recently reviewed the specification for such an aid. Research work is currently in hand in the UK to develop a beacon to meet this ICAO specification. The aid will emit a three letter identifier using the Morse Code. The message will be repeated at a rate of 6–8 times per minute. The light output will be 2000 cd, in green light. This will give a contact range of approximately 1200 m in 1250 m meteorological visibility. In good visibility conditions the beacon should be visible at ranges beyond 2500 m. The prototype for this beacon should be available for testing within 6 months.

(b) A new sign could be developed that has a greater contrast. The most promising technology for this is provided by fibre-optic systems. Transport Canada has been conducting tests on a taxiway sign at a number of Canadian airports. It is reported that the signs are conspicuous and legible at significantly greater ranges than those obtained with conventional signs. The trials have taken place in a variety of situations both by day and by night, including low visibilities and blizzard conditions. Very little quantitative data is available, but these tests are continuing and Transport Canada has work in hand to develop an equipment specification. In the United Kingdom there is at least one manufacturer who has the facility to make such signs. A demonstration model has been supplied to Flight Systems for test and evaluation.

(c) The present signs could be developed by adding internal illumination controlled by the ambient luminance conditions. This would enhance the conspicuity and legibility of the sign in many circumstances and should result in a more constant sign performance.

Of these three possible courses of action (a) would seem to offer a solution that is in line with general CAA policy. Each rig could be identified by a three letter code. Considering the other concepts (b) would seem to offer the greater prospect of a significant step forward in signs. If a sign is still required, a development model would need to be procured and tested. The height of the letters should be 2 m and the intensity of each fibre-optic light should be in excess of 2500 candela. An example of such a sign is shown in Fig 7 giving the general principle.

6 CONCLUSIONS

It is concluded that:

(a) The pilot needs to see the rig identification aid at a range of 1250 m, by day and by night in visibilities down to 1250 m.

(b) The visual aid must be usable from a range of at least 900 m in the conditions given in (a).

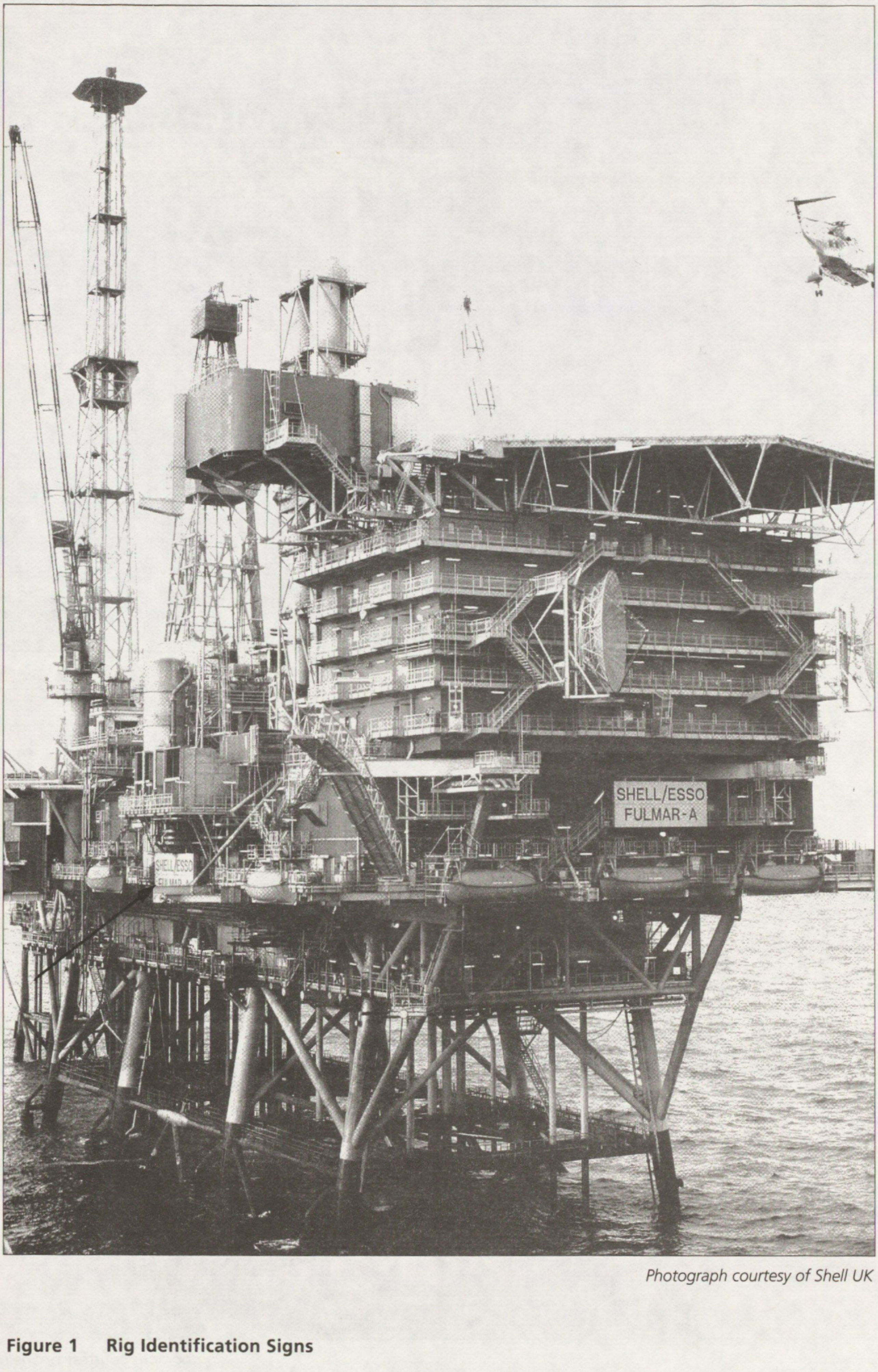
(c) The signs currently displayed on rigs do not have sufficient luminance contrast.

(d) The contrast of the signs is very variable and dependent on environmental factors. As a result the useful range of the signs is also very variable and is often insufficient.

(e) A sign board of the type currently in use will generally have a range less than the meteorological visibility, whereas a lit sign or beacon can have ranges in excess of the meteorological visibility.

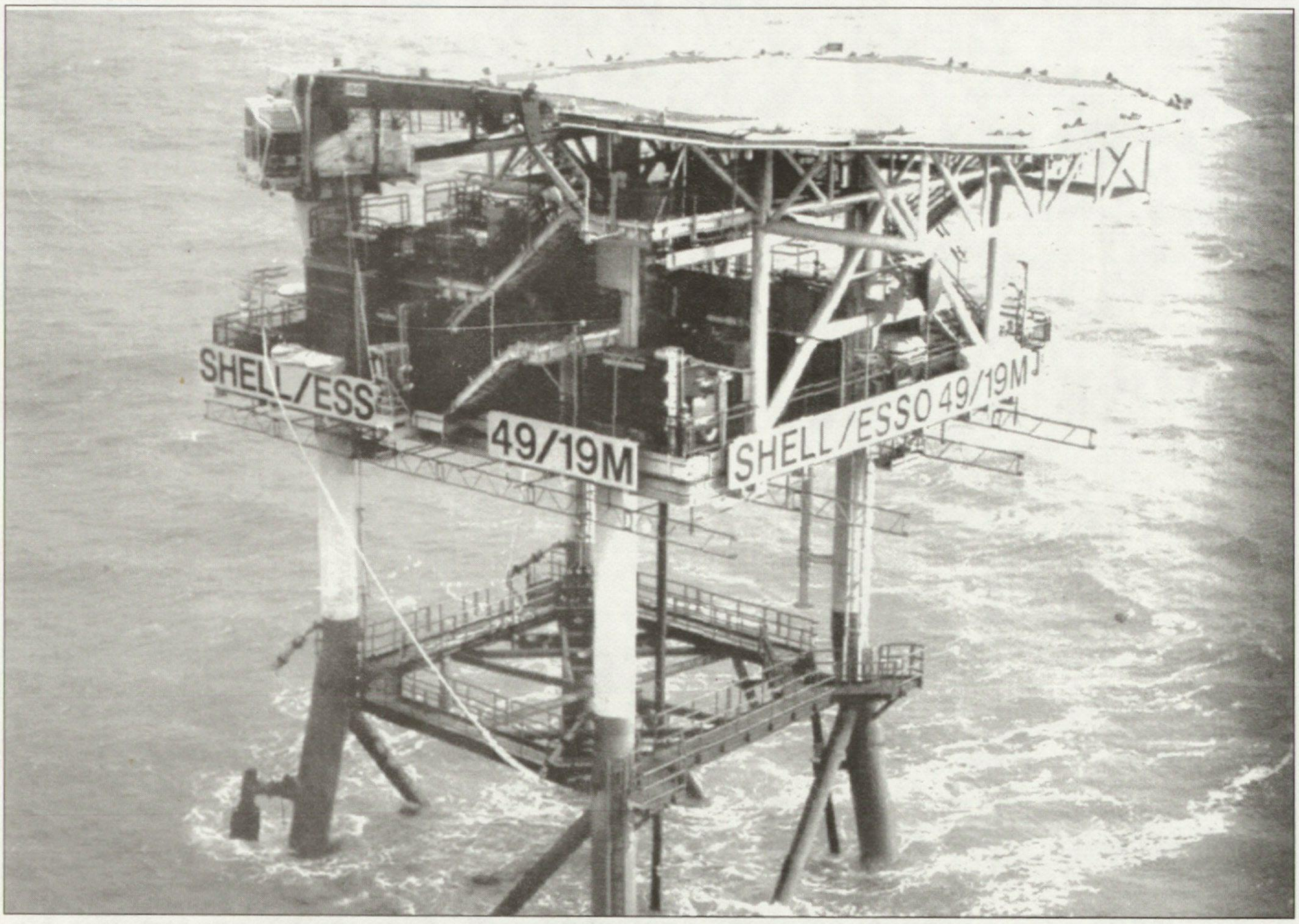
7 RECOMMENDATIONS

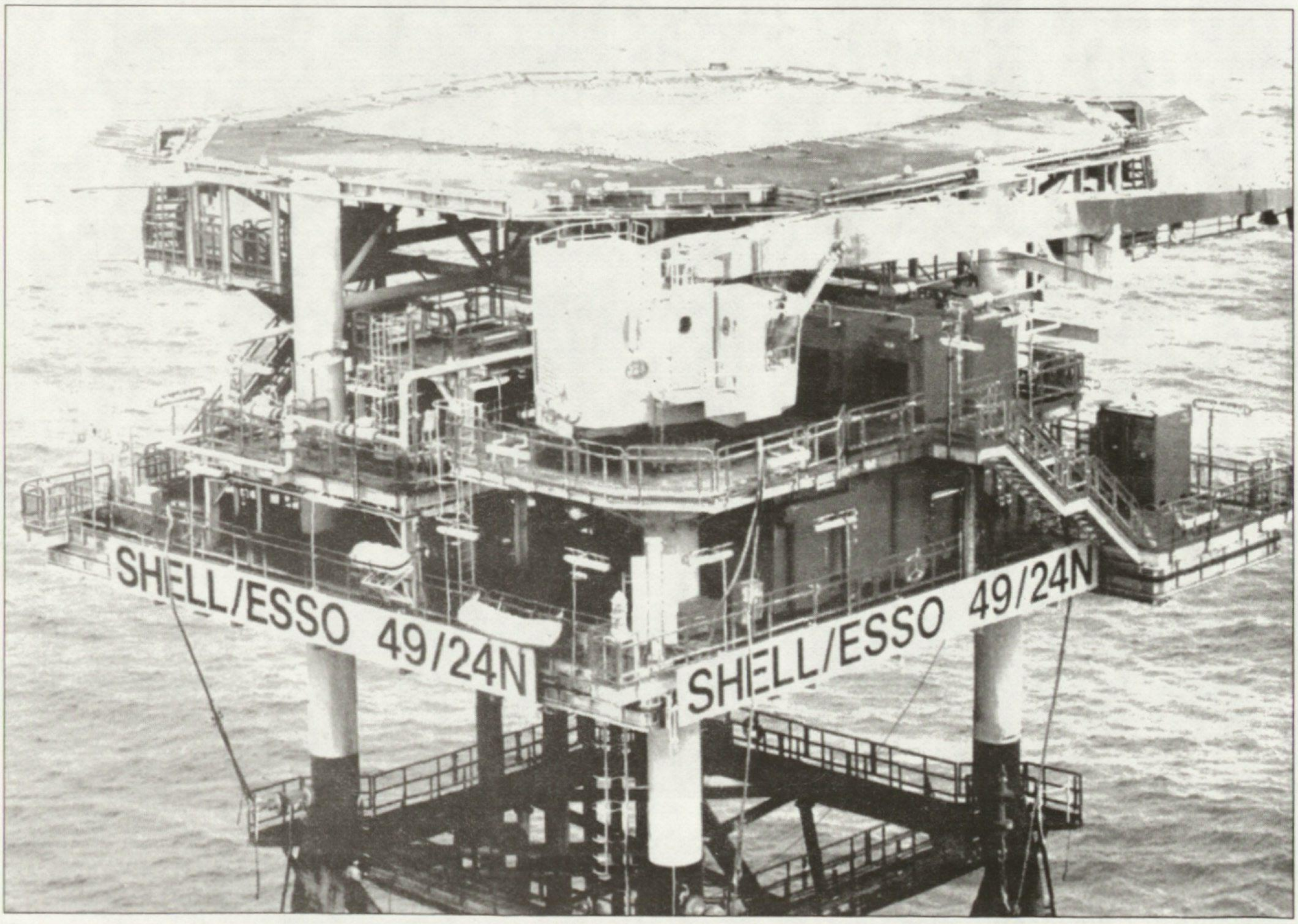
It is recommended that a new visual aid be specified. There are two options: either provide an identification beacon or develop a sign that has high contrast levels and adequate intensity to be legible at ranges in excess of 1000 m. Both options are technically feasible with current technology. The choice of option will primarily be a flight operations decision. In either case a prototype unit could be made available for trials during the first half of 1992.



Photograph courtesy of Shell UK

Figure 1 Rig Identification Signs





Photographs courtesy of Shell UK

Figure 2 Rig Identification Signs

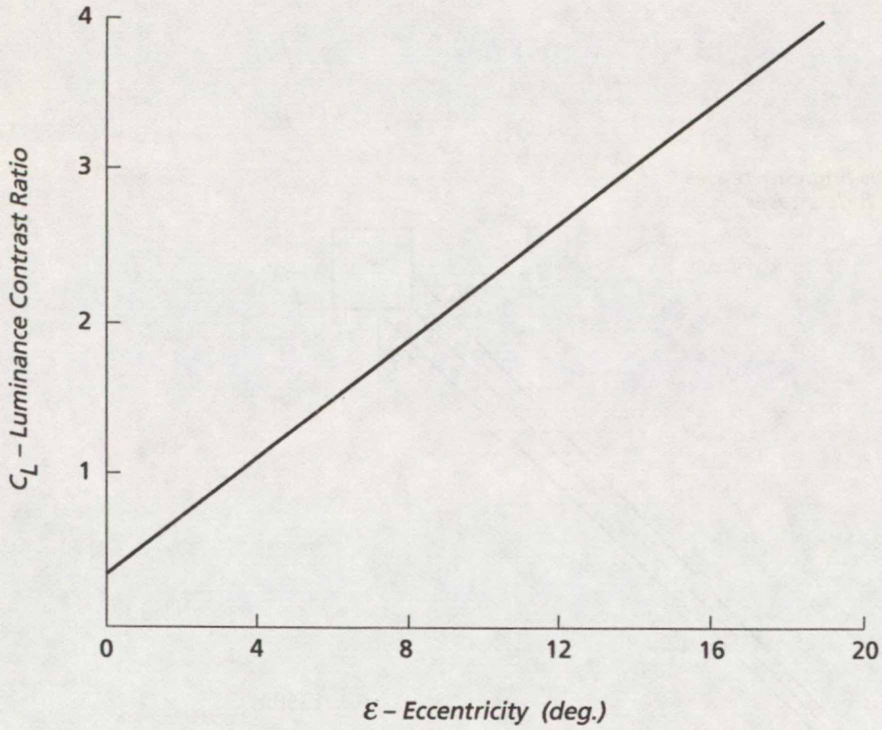


Figure 3 **Effect of Contrast on Sign Conspicuity. (luminance)**

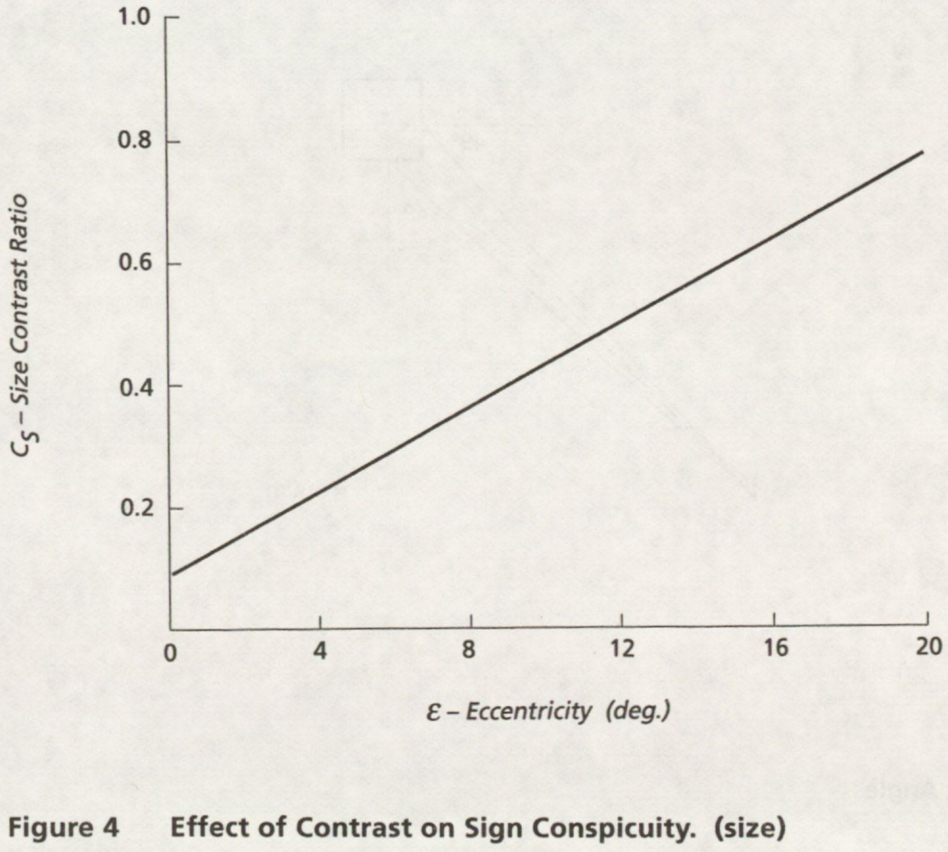


Figure 4 **Effect of Contrast on Sign Conspicuity. (size)**

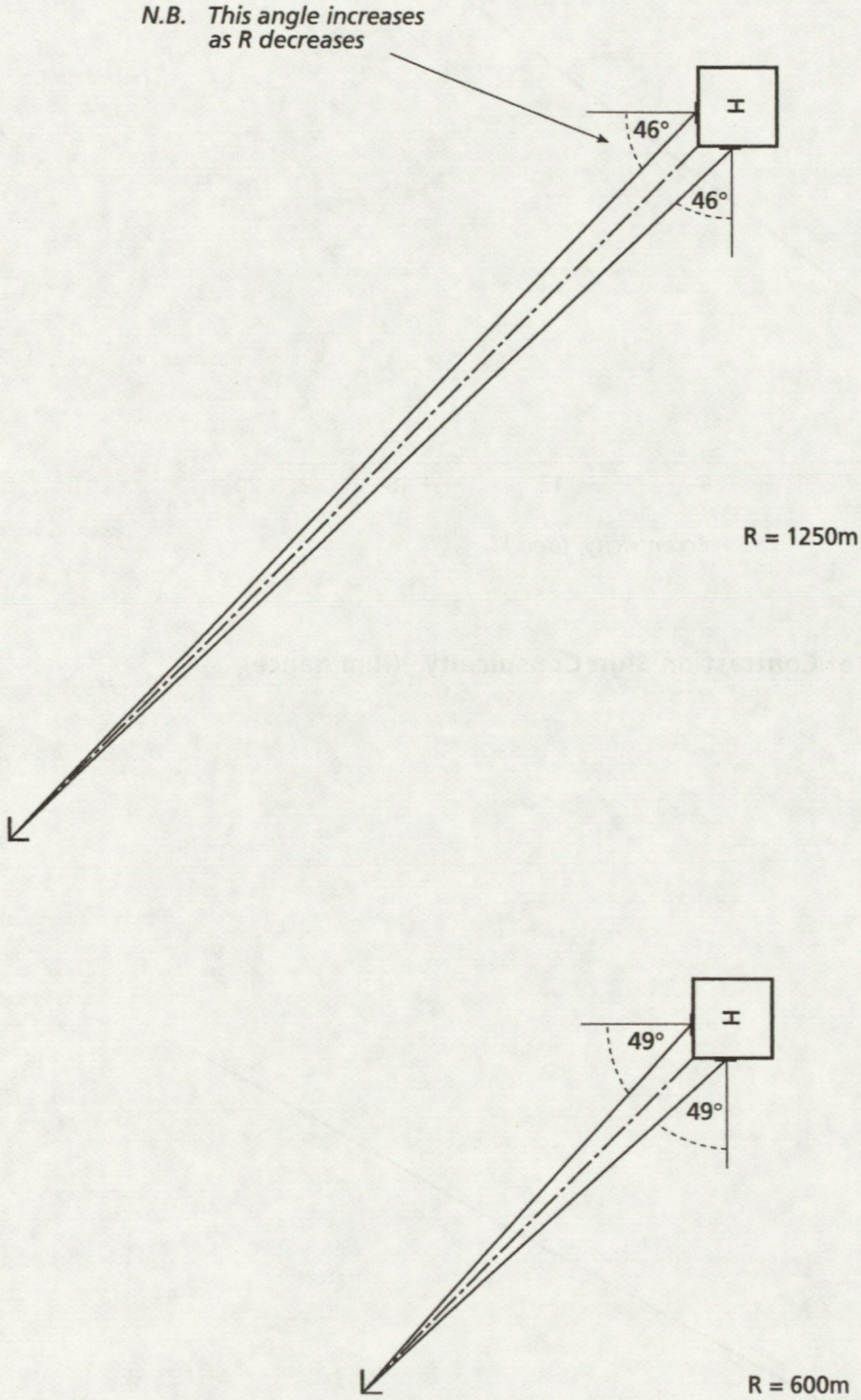


Figure 5 Viewing Angles

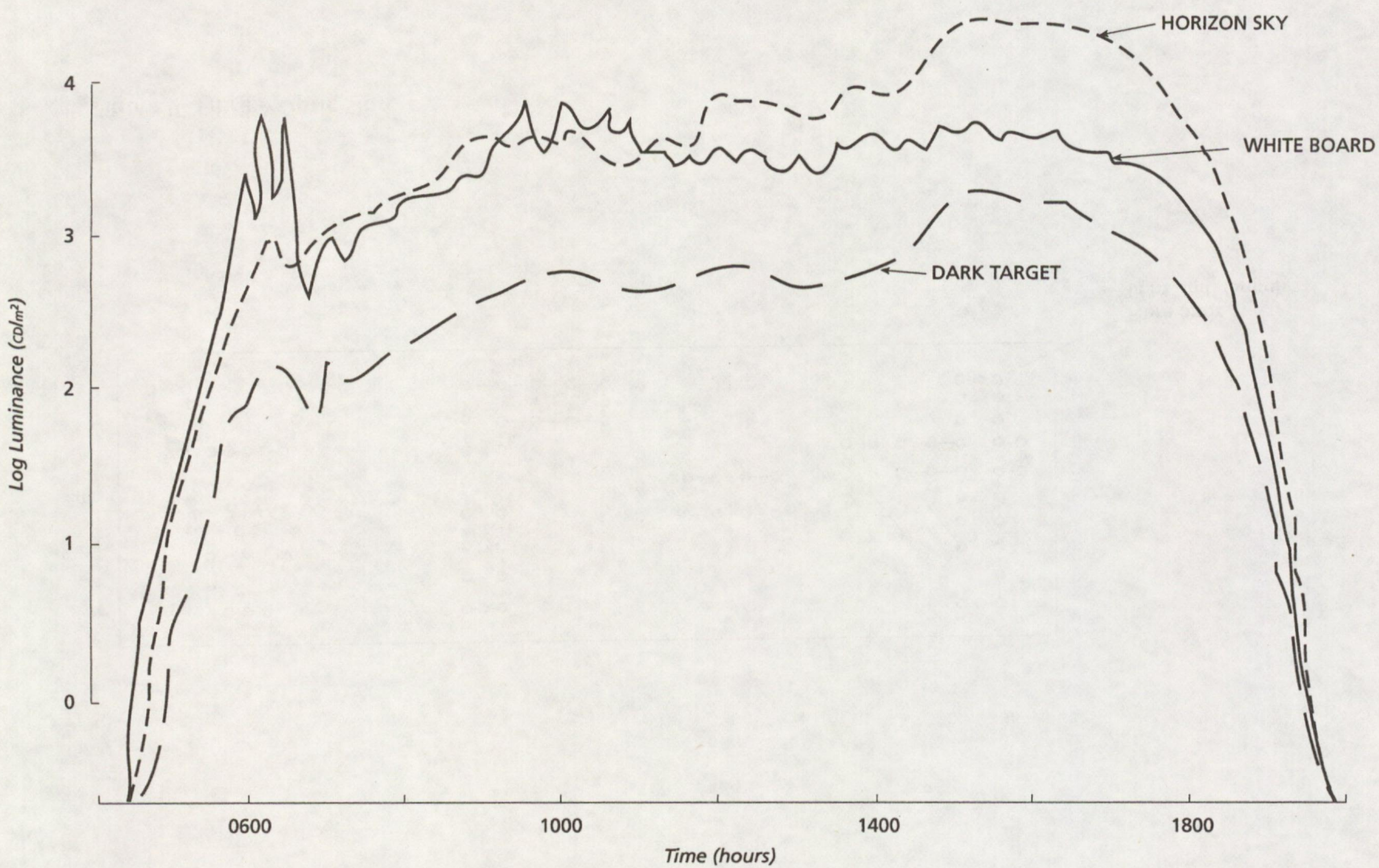


Figure 6 Variation of Luminance

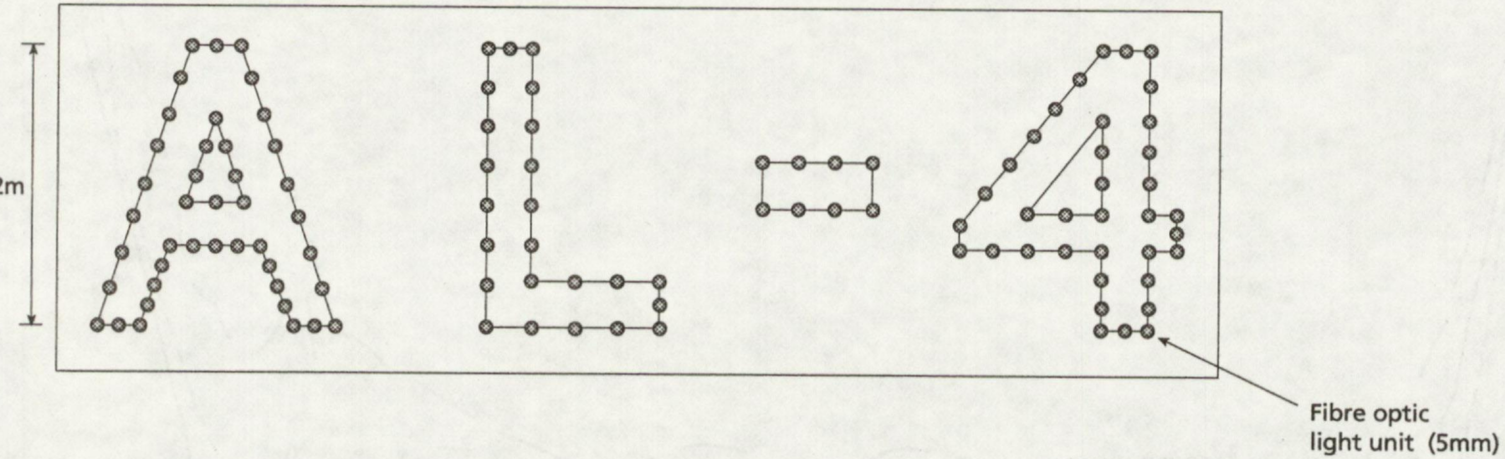


Figure 7 Fibre – Optic Sign