Aids to navigation at port approaches

W. R. COLBECK

Mr N. H. Hunt, Member of Council for India & Pakistan 1954-57

I congratulate Captain Colbeck on his Paper dealing with the specialized subject of navigational aids in such an interesting manner. It was a welcome addition to the Proceedings of the Institution.

96. My experience was in the zone including the Persian Gulf, India, Pakistan, Burma, Malaya and Singapore during the period 1927 to 1957 when the provision of adequate navigational aids was beginning to be made to suit international requirements especially in the smaller ports and rivers.

97. As stated in the Paper, the volume of traffic using a port has a great influence on the nature and cost of the aid which can be given, the port finance determining what may be installed to a greater extent than that for the larger lights, etc., which are nationally provided.

98. Before the period mentioned it was impossible to enter many of the ports at night. The ports which were provided with lights had apparatus the fuel of which was oil for wick burners, oil vapour and water gas for incandescent mantle burners and generated acetylene gas for open type burners, all of which at the best of times were unreliable and needed constant attention.

99. The first essential of a navigational aid is reliability which calls for continuous operation at the correct character for the period during which the light is left unattended (usually six or twelve months). With correctly filled cylinders of pure dry acetylene the Aga open type burner apparatus described by Captain Colbeck has been proved to give the required reliability. The setting up of gas-producing stations in the countries named has given an economical means of obtaining supplies of gas locally, the previous lack of which hindered the conversion of many of the older lights to the Aga system as the cost of importing the gas from Britain made the operational cost prohibitive. The question of cost meant in some cases that only two lights at the harbour entrance could be used, and in another that marking buoys were fitted with portable lights which were placed in position when a vessel of size was entering the port, and were removed after the vessel had berthed.

100. In some rivers used by country boats which are ordinarily fitted with searchlights at night, the navigation marks were simply empty kerosene tins with the sides polished and the tin suspended on a wire from a bamboo post driven into the river bed. In the breeze the tins caught the beam of light from the searchlight in the same way as the prismatic reflectors fitted to the marking buoys in the Suez Canal reflected the beam of light from ships using the canal. These instances of course, contrast with the conditions in such ports as Rangoon, Bombay, Madras and Calcutta, the latter having over a hundred navigational aids between the sea and the harbour and jetties (80 miles).

101. As the coastal trade between the ports and especially in the rivers, is carried on with country boats, the navigation of which is made without charts and depends on the acquired knowledge of the skippers the laying of lighted buoys involved the question of education of the skippers. The country craft were often allowed to drift with the tide irrespective of what was on their route, and until the importance

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of the buoys was realized, casualties due to the buoys being completely over-ridden were frequent.

102. On the question of installation of new apparatus in a modern port it would be interesting to have Captain Colbeck's views on whether a pilot is still considered necessary in view of all the aids provided, or that a pilot is essential in view of his local knowledge, both of the port and the aids installed. The Aga open type burner apparatus as before mentioned gives a concise sharp flash of constant power over its period of operation due to the accurate governing of the gas pressure and the method of supplying gas to the burner.

103. With the introduction of the electric filament lamp drawing the operating current from batteries, the life of the filament lamps is highly dependent on the applied voltage. For instance, a 10% increase in voltage will reduce the life by 70%. The light output is also very sensitive to voltage, a reduction of 10% of voltage resulting in a loss of 30% of light output. If a buoy is equipped with lead acid cells having a nominal output of 12 V, the actual voltage will vary from about 13.5 V (+12½%) at the beginning of the service period to about 11 V (-8%) at the end of the period. If primary cells are used as the power source, the variations are even greater.

104. In the equipment described in the Paper, six lamps mounted in a lamp changer are provided to cover the inevitably short life of the lamps during the early part of the service period. Even so, the intensity of the light will vary by some 70% during the service period.

105. An alternative approach to the problem is to provide voltage stabilization which can be achieved accurately and reliably by solid state devices. The output of the stabilizer can be set at about 10.3 V and this will remain constant with battery voltage variations between 18 V and 11 V, thus achieving constant light output and a predictable lamp life. Lamps are available designed for operating at 10.3 V and with a filament life of over a year on a flashing character. To guard against premature failure of a filament, a second filament is provided in the same envelope, and contactless automatic changeover can be provided in the flasher. This system eliminates the necessity for a mechanical lampchanger and also provides constant illumination throughout the service period of the buoy.

106. Captain Colbeck refers to Xenon discharge tubes as an alternative to filament lamps for use on buoys. It is appreciated that Xenon lamps are inherently more efficient than filament lamps. However, there are certain points on which information would be appreciated.

- (a) When the lamps are derated so as to give a year's service life, is the efficiency still higher than that of filament lamps, and if so, by what factor?
- (b) What are the limitations on flasher length with these tubes?
- (c) What is the effective intensity of the rapid flashing system described, in which the flash lengths are extremely short?
- (d) Is the rapid flashing character as suitable from the mariner's point of view as the single flash of longer duration which is obtainable with filament sources?
- (e) Is the colour of a Xenon tube satisfactory in sea conditions?
- (f) What reduction factor is appropriate when red or green colour filters are used with a Xenon?
- (g) Have any problems arisen in service due to the relatively high voltages necessary for Xenon lamps?

107. In the concluding paragraphs of his Paper Captain Colbeck mentions developments and future requirements so it is of interest to note that since the Paper was written a paragraph has appeared in the press describing Britain's first atom-powered lighthouse which is being installed at Dungeness, and which has a battery calculated to last for five years.

Dr E. Laverick, Elliott-Automation Radar Systems Limited

With regard to the radar-aided navigation of channels (§ 15) it is worth noting that radars are becoming available with automatic plotting facilities, and that, as in the airborne case, it is relatively easy to arrange for the radar map to be superimposed on a map of the channel in question, with the ship's heading suitably indicated (i.e., a moving map display).

109. Another possible improvement could be achieved by fitting buoys, etc., with radar reflectors which are coded so that the reflected signal from the buoys is easily distinguishable from the other reflecting objects such as small boats. If required, different buoys could be coded differently thereby giving identity to specific buoys. This form of coded reflector, although battery operated, is passive in that it does not contain a transmitter as does the racon. It might well prove a simpler and cheaper solution than using transistorized racons as suggested by the Author.

Captain R. G. Swallow, Chamber of Shipping of the United Kingdom

I have a few minor comments on this most interesting and valuable Paper.

111. I suggest that §§ 15 and 16 when taken together tend to give a misleading impression; § 15 describes the limitations of shipborne radar and although perhaps it slightly exaggerates the chances of confusion between the echo of a small ship and a buoy at any rate to a skilled observer, is otherwise considered fair.

112. Paragraph 16 points out the advantages of a port operations service in which the value of shore based radar information passed by VHF radio to a ship navigating in a narrow channel in low visibility is correctly stressed. It does, however, imply that this is an alternative method to the use of shipborne radar rather than a complementary one. In such circumstances it is considered that the use of shipborne radar to decide, for example, the precise instant for 'wheel over' when altering course on approaching a bend or when shaping up for the berth will always be necessary.

113. With regard to § 85 it should perhaps be added that while transistorized racons for use with buoys will almost certainly be available within the next few years it is not so today.

Mr K. H. Brittain (AM)

As with the lights referred to in § 30, the distance at which a buoy can be seen is a function of height of buoy and height of eye. For those making landfalls or approaching harbours in small craft, the height of eye may be such that the horizon is less than four miles distant. Daymarkers need to be of substantial area and height if they are going to be seen.

115. The basic colours in which buoys are painted, black, red and green, are not necessarily the best colours for visual detection—in airfields yellows and oranges have been proved effective. Systematic research to establish the optimum colours for buoys should be undertaken.

Dr G. Wiedemann, Ministry of Transport, Federal Republic of Germany

Captain Colbeck's description of the basic elements and techniques in port approach marking is very comprehensive. The marking methods surveyed are, I think, in fairly general use today. National differences are often historically explained. I fully agree also with the evaluation of the specific elements used in port approach marking.

117. In Germany, where port approaches on the rivers Elbe, Weser, Jade and Ems are comparatively long, the marking of approaches is not a port but federal government responsibility under the latter's general responsibility for maritime signals.

118. Captain Colbeck was right in describing the situation of these approaches separately as there is a substantial difference between the conditions of navigation

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there and in coastal waters or on the high seas. This presumably will also be the area where new problems would first arise, with evident repercussions on the conventional marking system.

119. These are due to the following developments:

- (a) the increasing density of traffic and size of ships making it impossible for some ships to pass or overtake in narrow channels;
- (b) the trend towards automation in ships, i.e. mechanized navigation.

120. In case (a) the authority responsible for safety of approach will be faced with the necessity of providing a warning service or some system of traffic control. In the initial stage such a warning service might be organized mutually between ships, without aid of a shore station, e.g. by VHF radio communication from ship to ship. In my opinion, intervention of a shore station should be considered as a last resort only. This does not mean, however, that a mutual ship service can be organized without the assistance of the authorities or their equipment.

121. As regards (b) we still find ourselves at the development stage. The precedent in this case is the aeroplane with automatic steering directed by radio beacons. The extent to which this would be possible on waterways is as yet an open question, although similar radio locating procedures would certainly be a necessary prerequisite. I think that the future development of radio beacons should also be viewed from this aspect. Yet, whatever the eventual development might be, conventional signals, lights, beacons and buoys, will in any case continue to be used as safe and necessary aids and will retain their value.

122. In both cases care must be taken to ensure proper co-ordination of traditional aids with the development of new ones. This would best be done by having a single organization to develop and operate them as it would offer maximum guarantee that information for the mariner were transmitted in a suitable and adequate form. As the same aid (VHF radio or radar) often has to be used for both purposes, separate solutions would result in a double burden for the mariner or would even adversely affect both tasks.

123. In earlier years it was possible to perform the variety of tasks involved in ensuring a waterway's navigational safety independently of each other. The unification which technological progress offers raises difficulties of organization, and discussion may be useful in overcoming these.

Captain W. R. Colbeck

In reply to Mr Hunt I would say that among ports which experience tidal conditions, a pilot is still considered necessary in view of his detailed local knowledge.

125. A system of navigational aids should be self-explanatory to the experienced mariner but a detailed knowledge of currents or tidal streams is essential for the safety of large vessels when berthing at a jetty or entering a dock. Although descriptions of these conditions are published in the Admiralty Pilot Volumes and certain data shown on charts, this information can only be in very general terms and local knowledge is essential.

126. With regard to Mr Hunt's remarks on variations of voltage, the 70% factor referred to is quite reasonable for filament light sources and the variations with voltage are as follows:

<i>Voltage</i>	<i>Intensity</i>	<i>Life</i>
+12½%	150%	25% of nominal
-8%	75%	310% of nominal

As performances are quoted at nominal voltage, the variations met in service are +50% and -25% for intensity and +210% and -75% for lamp life.

127. Mr Hunt asks if when Xenon lamps are derated so as to give a year's service life, the efficiency is still higher than that of filament lamps, and if so, by what factor

(§ 106(a)). No one answer can be given as, due to source size and optical system, the criterion of lumens per watt is not the only one. In a practical equipment conversion losses also confuse the issue; however, in the same lens, using the same character (but scintillating) and judged subjectively (with the aid of a neutral filter) to be the same intensity at threshold, the input power to the equipment is approximately 20% less in the case of the scintillating Xenon installation.

128. There are no limitations on flasher length with these tubes (§ 106(b)) within mean power input maximum of 10 watts. The question of the effective intensity of the rapid flashing system described, in which the flash lengths are extremely short (§ 106(c)) is under detailed examination so as to arrive at an acceptable law. For maximum range my remarks in § 126 above apply but a scintillating Xenon source of the same maximum range as a filament seems brighter than the same filament when within maximum range, i.e. with the lights well above threshold.

129. In reply to § 106(d) the duration of the effective character of a Xenon lamp in normal use, is the same as for a filament lamp, for instance, 0.5 s light, 4.5 s dark, but during the light period of the Xenon lamp there may have been actually seven or eight flashes. Tests have been carried out by various authorities, including Trinity House and the US Coastguard, and, although at short ranges a certain fluttering of the light is discernible, at long ranges, i.e., up to two miles, a Xenon light appears as a steady flash, but at close and medium ranges, it is easier to pick up against background lighting than the light from a filament lamp.

130. Regarding colour (§ 106(e)) the blue-white colour of the Xenon may be the subjective impression of a true white light, when the reference white is a yellow filament. In any case, the blue content is quickly absorbed by atmospheric losses. In my own view, the Xenon white light is no more blue than the filament white light is yellow and this is a matter of what one gets used to.

131. When red or green colour filters are used with a Xenon (§ 106(f)) the transmission is about 20% when using a red filter and about 23% when using a green filter.

132. No problems have arisen due to the relatively high voltages necessary for Xenon lamps (§ 106(g)) but all high voltage parts are very effectively sealed by the use of silicone rubber castings.

133. Dr Laverick's suggestion of a superimposed radar map would require more sophisticated and expensive equipment than is normally fitted and would produce serious problems in ensuring the supply of up to date radar maps, particularly for vessels on long voyages and visiting a large number of ports. A dangerous situation might be introduced if out of date maps were used since, unlike an airfield and its approaches, approach channels in many areas can alter their alignment quite considerably in short periods of time and the buoys and markings may be moved to cover these alterations.

134. I have not had personal experience with the coded reflectors he suggests but, as stated in § 85 of the Paper, any device which produces additional echoes on the display has to be used with caution as these additional echoes may obscure other targets. This would be a particular requirement in narrow channels where the vessel has to pass close to the buoys where, in the case of a racon and without the use of a differentiator, the transmission may virtually blank out the whole area of the display.

135. I did not intend to imply that the use of shore based radar was an alternative to the use of ship-borne radar and agree with Captain Swallow that the two should be complementary. At Liverpool, where some 8000 vessels have been successfully assisted in navigating the sea channels since the station was opened, the normal procedure is as Captain Swallow describes, the ship's radar being put on to a large scale, say one mile and used for the immediate conning, the information from the port operations station providing advice of other vessels navigating in the area and confirmation of the vessel's position in the channel.

136. There have, however, been at least three occasions when the vessel's own radar has failed during the passage of the channel which has been successfully

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completed on the shore information. There have also been a considerable number of successful transits, particularly in the earlier days, of vessels which were not radar fitted.

137. With regard to Captain Swallow's third point, I am not aware of any transitorized racons actually fitted on buoys but at least one manufacturer has produced a prototype which appears promising.

138. In reply to Mr Brittain, considerable research has been carried out over many years with a view to improvements in daymarks and their colours, as well as into lighting, and this is continuing. Navigational buoys in the adopted system are required to indicate information by their colour as well as their shape.

139. Yellow or orange is ideal for good contrast against the sea in sunny weather if the angle of observation is fairly high and for this reason ships' lifeboats are usually fitted with orange sails to facilitate their observation from the air but yellows do not have sufficient contrast with the horizon when the weather is cloudy. In the vicinity of the horizon the sea and the sky are of almost identical colour in cloudy weather and take a darker colour only to a limited extent in sunshine. For this reason black is very suitable for recognition at long range; due to its fairly low luminosity factors red may be confused with black. This disadvantage disappears as the range shortens.

140. Green is only used in the uniform system of buoyage for wreck marking and, normally, would not be required to be recognized at long range.

141. The visibility of a red painted mark can be improved by approximately $\frac{3}{4}$ by the use of a daylight fluorescent paint. Unfortunately the fluorescent paints produced to date require an undercoat, two finishing coats and a coat of varnish and even then, on experiments so far carried out, will not satisfactorily last for twelve months. Panels consisting of a film mounted on aluminium or plywood have a much longer life but are much more expensive than conventional paint and in most circumstances the extra cost is not economically justified.

142. Dr Wiedemann refers to the problems that will arise in future developments. There is no doubt, as has been publicly discussed following the loss of the *Torrey Canyon*, that in the future a form of traffic control will have to be extended much further into the open sea and information and navigational aids on a scale approaching those required in the port approaches will have to be provided.

143. International discussions on open sea routing have been going on for some years and charts have been produced for the English Channel area showing the internationally agreed traffic routing which has been initiated in an attempt to reduce the risk of collision in this area. As Dr Wiedemann states, the aids to such routing will no doubt be based on various electronic systems, but visual maritime signals will still continue to be used as necessary aids to the safe transit of shipping.