REPORT OF THE WORK OF THE TECHNICAL CONFERENCE ON MARITIME SIGNALS

Paris, 1933.

A Technical Conference on Maritime Signals was held in Paris in the first week of July 1933, as agreed at the previous Conference held in London in July 1929.

At this meeting a number of Heads of Maritime Signal Services came together officially, besides persons interested from an industrial point of view. The following took part in the Conference (the list is taken from the Report in the French language) :

Australia : Lighthouse Authority.

Belgium : International Radiomaritime Committee.

China : Chinese Maritime Customs.

Denmark : Lighthouse Authority ; Ministry of Navigation

Finland :

France : Lighthouse Authority ; Hydrographic Service ; Technical Aeronautical Service ; *Ponts-et-Chaussées* of Morocco ; *Ponts-et-Chaussées* of the Colonies ; Barbier, Bénard & Turenne Co. of Paris.

Germany : Lighthouse Authority ; Osram, Telefunken and Julius Pintsch Companies of Berlin ; Atlas-Werke Company of Bremen.

Great Britain : Air Ministry ; Trinity House ; Northern Lighthouses Board ; Mersey Docks and Harbour Board ; Chance Bros. of Birmingham ; Gas Accumulator and Marconi Companies of London.

Iceland : Lighthouse Authority.

Irish Free State : Irish Lights Commissioners.

Italy : Alfonso Curci e Figli of Naples ; S.I.A.D.

Netherlands and Netherlands East Indies : Lighthouse Authority ; Department of Navigation ; Philips Company.

New Zealand :

Norway : Lighthouse Authority.

Old Ottoman Empire : Lighthouse Authority.

Sweden : Lighthouse Authority ; Aga Company.

U.S.A. : Submarine Signal Company ; Wallace and Tiernan Products (Inc.).

The following subjects were dealt with by the Conference :

(1) Sources of Light, i.e. new incandescent electric lights, the use of which is becoming general in the more important optical apparatus owing to the new forms of filament developed ; electrical arc lamps, which are tending to disappear from coast lights ; neon lamps, incidentally used for aerial landing lights ; compressed or liquified gases such as propane and butane, used instead of oil gas for buoy lighting ; and finally low-power electric lights fed from batteries, also used for flashing and buoy lights.

(2) Sighting and Range of Lights. — The Conference attempted to define the minimum of illumination necessary for sighting a light, and the Commission agreed on the figure of 0.2 microlux, i.e. 0.2 candle-power at 1 kilometre, proposed by the British authors for the illumination corresponding to the threshold of foveal vision. A knowledge of this minimum of perceptible illumination enables the range in a given region to be calculated *a priori*, assuming that the light is transmitted in accordance with a definite law, such as Allard's. The Conference then examined the formula giving the equivalence between fixed and flashing lights. The problem is as follows : At maximum range, what coefficient of reduction must be applied to the intensity of a revolving light for it

to be visible under the same conditions as a less brilliant fixed light ? The Commission proposed that a law of homographic form should be adopted for the variation of this coefficient as a function of the length of the flash. This form, which seems the simplest, has besides been discovered by the various authors. After discussion, the Conference finally adopted the following resolution :

In furtherance of the deliberations of the Conferences held in London in 1929 and in Paris in 1933, it is proposed that until further notice the following formulae should be used for calculating the effective intensity of marine lights :

(1) *Flashing Lights,* consisting of a rotating optical system illuminated by a source of light at the focus. The effective intensity of such a light is given by the formula

$$I_e = k.c.\ I_m$$

in which

I_m denotes the mean maximum intensity of the beam ;

k represents the coefficient of transmission through the whole of the lantern — it may be taken to average 0.7 ;

c is a coefficient of reduction representing the influence of the duration of the flash, and may be taken to average

$$\frac{t}{0.2 + t};$$

t here denotes the maximum duration of the flash in seconds, and can be found from the formula

$$t = 0.16 \frac{d}{f} T,$$

where

d denotes the width of the source,

f the focal distance of the optical apparatus, and

T the duration of a complete revolution of the rotating apparatus.

When the intensity I_m cannot be measured directly, the following formula can be used to determine it :

$$I_m = k'.b.S.$$

b denotes the mean brilliancy of the source ;

S is the net surface, projected on a plane perpendicular to the axis, of the face of emergence of the optical apparatus ;

k' represents the coefficient of transmission through the whole of the apparatus ; it may be taken as equal to 0.7.

(2) *All-round Lights :* consisting of a source of light at the focus of a fixed apparatus, which at any given moment shines equally over every point of the horizon.

The intensity of such a light is given by the formula,

$$I = k.c.\ I_m$$

in which

k represents the coefficient of transmission through the glass of the lantern and may be taken as equal to 0.7 ;

c is a coefficient of reduction representing the influence of the duration t of apparition of the light ; it may be taken to average

$$\frac{t}{0.2 + t};$$

I_m denotes the intensity of the beam.

When the intensity of the light cannot be measured directly, it can be calculated by the formula

$$I_m = k'.b.d.H.$$

k' represents the coefficient of transmission through the whole of the apparatus, and may be taken as equal to 0.7;

b denotes the mean brilliance of the source,

d the mean diameter of the source, and

H the effective height of the apparatus.

The idea which emerges from this practical development of the law enunciated by MM. BLONDEL-REY completes and makes precise the various information of a theoretical nature concerning observations of the visibility of lights which was published in the *Hydrographic Review*, Vol. III, No. 1, November 1925, pp. 141-154. It is to be hoped that the adoption of a uniform method will enable the duration and intensity of flashes, as far as they interest the seaman, to be defined in practice and to be entered uniformly in Light Lists.

As a result of an accident which had occurred in Norway, the attention of the Conference was drawn to the influence, on the refraction of light, of condensation on the lantern. A vessel on the edge of a white sector between a red and a green sector ran aground on a reef covered by the red sector; the white sector, owing to dew on the lantern of the light, was encroaching more than 3° upon the green sector and 6° on the red.

The Commission also examined the conditions of use and of test of red and green coloured glasses, observing that it is very difficult to obtain glass with perfectly homogeneous tints. It also proceeded to collect opinions from its members on the subject of using coloured flashing lights such as red and green flashes. The Commission observed also that the use of unwatched lights was increasing owing to the technical improvements made in apparatus.

(3) SOUND SIGNALS. — The Commission took note of a certain number of brochures which had been distributed concerning the character of signals and particularly the general use of modulated sound signals with electrical vibrating membranes. The Commission discussed the use of combined signals with several sounds of different pitches, either with the exclusive use of pure sound or of sound accompanied by harmonics or beats; it concluded that on this subject it would be of great interest that experiments, analogous to those carried out by TRINITY HOUSE in 1891, should be repeated with sound signals actually used in modern practice and under varying atmospheric conditions. The German delegate gave the result of comparative experiments on the influence of the height of sound on its range, recorded by a BARCKHAUSEN sonometer; these experiments enable the practical range of projectors to be determined and to be limited to the required intensity. The use of oval-shaped horns gives very favourable results from the point of view of the concentration of sound; frequencies of 250 to 300 have given the best results from the point of view of range. For the rest, it appears that medium-pitched sounds are heard better than deep-pitched and, further, low frequencies necessitate the building of very bulky apparatus.

The Commission also examined the application of infra-red rays to marine signalling, and resolved that trials should be undertaken with a view to determining, in particular, the penetration range of invisible rays; it was suggested that in practice it would be expedient to penetrate a foggy atmosphere to a depth of one mile.

(4) RADIOBEACONS AND ALLIED SUBJECTS. — A special Commission examined all the questions concerning radiobeacons and allied subjects, besides distant control devices (telemechanical) and questions concerning radiotelephonic communication between lighthouses in the open sea and lightships and the shore.

The different questions on the agenda relating to radiobeacons proper were the following:

(i) Errors in bearing; (ii) Stabilisation of wave-lengths; (iii) Frequencies of modulation; (iv) Intensity of field necessary for taking bearings; (v) Automatic wireless direction finders; (vi) Future prospects with regard to jambing by other stations; (vii) Wireless leading lines and miscellaneous apparatus; (viii) Talking radiobeacons.

Errors in Bearings. — The Commission drew up a list of all the possible errors in such a way as to omit none of them; they may be classified in three main categories:

(*a*) Errors at short distances due to the actual shape of the field in the immediate neighbourhood of the transmitting aerial;

(*b*) Errors resulting from the actual propagation of the waves; the latter may be subdivided into (i) errors due to the trajectory of the waves being affected by the zones of separation between several different mediums (e.g. if the wave is tangent to a coast); and (ii) errors due to the fact that it is possible on board a ship to receive at the same time the direct wave and the wave passing through space which is reflected from the Heaviside layer. The latter errors assume a special importance during the night;

(*c*) Errors due to the fact that the wireless direction finder is not isolated in space but situated on board a ship, and consequently in immediate proximity to the hull, masts and stays; the latter are now the subject of examination with a view to the electrical compensation of wireless direction finders.

After discussion the Commission reached the following conclusions:

Short-distance bearings being useful when a ship wishes to avail herself of radiobeacons when entering harbour, efforts will be made to eliminate the short-range errors by giving careful attention to the symmetry of the aerial of the radiobeacon and the arrangement of the various auxiliary circuits which might radiate parasitic noises.

With regard to errors due to propagation, in the neighbourhood of a coast, it seems that the error in question is the greater in proportion as the angle of approach of the waves to the coast approaches 180°. Further, the longer waves are less affected than the shorter ones and, in practice, with wave-lengths of over 2,000 metres refraction due to the proximity of the land is very small. If the coast is steep and the ground a good conductor, the errors are large; while if the ground is a bad conductor the errors are smaller. Thus in Norway, where the coast is rocky but non-conducting, errors of only 3° to 4° have been found; while in Spain, where the rocks are good conductors, larger errors have been revealed. To sum up: taking an approximately straight coast line, cut nearly at right angles by the line of bearing, there should be no error; if the angle is more acute, on the other hand, there will be a deviation, but it is hardly possible to say from what angle it will begin to make itself felt. However, this practical rule may be laid down, that it is not a good thing to take bearings which cut a coast at an angle of less than 45°.

With regard to errors due to the fact that the wireless direction finder can simultaneously receive two waves, these errors do not become apparent until at a certain distance (i.e. from the moment that the ship enters the zone where she can receive one wave reflected off the Heaviside layer), and particularly during the night.

To eliminate these errors, action may be taken either on the transmitting or the receiving station. Trials with practically the same object have been carried out to overcome fading in broadcast transmissions. The procedure employed consists in using an aerial radiating, for practical purposes, horizontally — for example a half-wave aerial. But in the case of radiobeacon waves, this procedure appears too difficult to put into effect, observing that a wave-length of 1,000 metres would necessitate an aerial of about 500 metres (1,640 ft.) in height. However, these errors are only perceptible at great distances, and they vary from one moment to another. By taking averages they can be eliminated up to a certain point. Anyhow they hardly become really noticeable under a distance of 100 miles. The error increases at sunset, and with modulated waves it may attain 3°. When bearings are taken during the hour before and the hour after sunset, it is therefore advisable to take several bearings and use the mean. Under these conditions the error is reduced to 1 ½° or 2°. Further, the navigator must not overlook the fact that at that moment he must not rely upon perfect bearings.

The Commission proceeded to examine different processes for correcting the errors of the wireless direction finder due to induced currents in the metal mass of the ship. It appears that a frequency of 300 kc. is the most suitable for these corrections. Certain interferences, due to the presence of electrical motors on board, may be corrected in the same way as is done ashore, particularly by fitting condensers to the machine in question.

The Commission then investigated *stabilizing processes* for waves emitted by the radiobeacon, and examined the different measures suggested for obtaining stability of frequency in the wave emitted by the radiobeacon, particularly the process making use of a crystal of piezo-electric quartz acting as a thermostat, or by various master oscillators used in old stations.

The Commission then examined the situation arising with regard to radiobeacons by reason of encroachments made by certain broadcasting stations into the wave band assigned to radiobeacons by the general Regulations of the various Conferences on Wireless Telegraphy. The last Lucerne Conference definitely reserved the 290-320 kc. wave band for radiobeacons.

The Commission discussed a certain number of technical questions concerning the working of radiobeacons, notably the *frequency of modulation and field intensity necessary for taking bearings.* It examined the automatic wireless direction finder submitted by the firm "Etablissements LEPAUTE" of Paris.

On the subject of *wireless leading lines* obtained by crossed frame aerials, the first experiments on which date back to 1907, the Commission proceeded to an exchange of views on the deviations of axis found with apparatus using wave lengths of the order of 1,000 metres, which deviations in some cases may attain 8° to 12° from the axis of the channel. This type of error has recently been reduced very greatly by using waves of 100 to 200 metres which enable better symmetry to be obtained on account of the smaller dimensions of the transmitting frame.

The Commission also proceeded to an exchange of information on experiments concerning the *limits of perception of infra-red rays in fog.*

The Commission discussed the conditions of use of *talking radiobeacons* and of *synchronised submarine sound signals.* The talking radiobeacon possesses the advantage that it requires no special installation. It is much used in the U.S.A.; it enables the distance to be reckoned to within one cable. But unfortunately this apparatus is not exempt from the faults of signals in the air, which are often difficult to detect owing to the existence of zones of silence; errors may also enter when a certain wind force is reached.

Submarine sound signals, though only furnishing the distance to within a mile and necessitating more expensive installations, nevertheless in certain regions have an efficiency which militates in favour of their use.

The Commission also examined various methods of *distant control*, particularly that which periodically resets the clocks of radiobeacons to the correct time under the impulse of the time signals from a wireless telegraphy station. The Commission also examined arrangements of distant control and verification of acetylene fog guns.

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The International Technical Conference on Maritime Signals also occupied itself, during its meeting in Paris in the month of July 1933, with a *Terminology in various languages of the characteristics of lights,* maritime lighting, and *the allocation of certain characters to determined types of signals.*

M. A. DE ROUVILLE, Director of the Lighthouse and Buoyage Service in France, had distributed to the delegates a glossary concerning the terminology employed in different languages for maritime signalling. He explained that up to the present, in France, the term *feu à éclats* (flashing light), which is thoroughly suitable for rotating lights with optical directing panels, has been used also to denote lights where the light makes brief appearances; the latter presenting, broadly speaking, the same characteristics for the navigator. This conforms with British practice, which uses the phrase "flashing light" both for true flashing lights and for lights where the light makes brief appearances. However, the French Lighthouse Service tends more and more to call these types of flashing lights, generally functioning by extinction of the source of light, by the description *feux à brèves apparitions de lumière* (lights making brief appearances) or *feux intermittents* (intermittent lights); the expression *feux à occultations* (occulting lights) is thus applicable to lights where the period of darkness is shorter than the period of light. To denote lights where the timing of the source is such that the period of light is equal to the period of darkness, the French Lighthouse Service would be inclined to use the expression *feux clignotants* (blinking lights). On the other hand, the tendency having been recognised at the Conference on Maritime Signals at Lisbon in 1930, of utilising lights with a very rapid period, the French Service would incline to call these lights *feux scintillants* (sparking lights); but it would also establish an exact definition of the limits of timing between which a light should be called "occulting", "blinking" or "sparking". It should moreover be noted that in the U.S.A. the tendency with such sparking lights is to have intervals of darkness separating trains of regular apparitions. M. DE ROUVILLE drew attention to the difficulties of terminology which may be met with in the different languages for denoting the characteristics of lights corresponding to modern improvements in marine lighting. For the rest, it seems necessary to come to an equally definite understanding on the definitions and, for example, the limits, of "sparking lights" (40 apparitions per minute as was demanded at Lisbon or 75 per minute as the Lighthouse Service of the U.S.A. proposes) and of the possibilities of producing such lights with incandescent mantles using different gases.

He concluded that it would be well to provide guidance for navigators and editors of nautical documents in clarifying this terminology of lights, by agreeing at the same time as to the various distinct characteristics to be considered and the method of denoting them. The present terms are insufficient. This should be brought to the attention of navigators, bearing in mind on the one hand the introduction of new lights and on the other the quicker rotation of flashing lights. He thought that seamen sometimes used very peculiar processes for identifying lights, such as the yellowish colour of a given light or sometimes even the direction of rotation of a flashing light.

After an exchange of views it was observed that the characteristics of lights to be shown on charts must remain very simple; that on the other hand the International Hydrographic Conferences since 1919 have agreed to define lights according to a uniform system (see *Repertory of Technical Resolutions*, Monaco, 1930, p. 33, No. 6 — "Classification of Characteristics of Lights"); that there would nevertheless be an advantage in certain cases that the navigator should be informed about the mode of production of the flashes and on how to distinguish between lights with rotating beams and lights in which a fixed source of light is periodically unmasked; that to effect this one could, for example, avoid any complication and not modify the present definitions of the lights on the charts but add, in the special books describing the lights, an index showing the method of production of the lights; and on the other hand that it would perhaps be necessary to take into account certain decisions of the International Commission for Aerial Lighting. The delegate of the Netherlands remarked that the Lighthouse Services should first of all make their terminology exact; that for the rest it is possible to conceive of two terminologies which would not contradict each other—one, for the navigator, serving as a basis for charts and the various nautical documents, and the other for the technician. Consequently the Conference appointed a special Committee to carry out a preliminary process of selection with regard to the terminology, it being understood that in each country it would be well to work in close contact with the seamen and hydrographic services.

The results of the work of the Committee will be submitted to the next technical Conference, the task of the Special Committee being to define and denote each term.

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The International Technical Conference on Maritime Signals also dealt with indications relating to the power and range of lights as given in nautical documents. On this subject it examined the note submitted by M. A. DE ROUVILLE, entitled *Réflexions sur les indications relatives aux puissances et aux portées des phares dans les documents nautiques* (Reflections on the Indications in Nautical Documents relative to the Power and Range of Lights).

In the French Light Lists, figures of intensity for the coasts of France are found, as resulting from information supplied by the Lighthouse Authorities. The range of visibility is determined experimentally and established by means of observations from lighthouse to lighthouse carried out for more than thirty years.

Figures are thus obtained, reasonably well checked, of the ranges attained or exceeded during 50 % of the year (average weather) and during 90 % of the year (foggy weather). Further M. DE ROUVILLE shows that observations on the frequency of visibility furnished by the International Hydrographic Bureau enable one to obtain satisfactory concordance between certain French lighthouses and a few English lighthouses situated in similar conditions. With the Spanish lights, on the contrary, one finds a systematic difference in the estimation of the ranges.

It is of more benefit to indicate the luminous range resulting from the intensity of the light, on Light Lists, than the geographical range; the latter constitutes a redundant element, since it can very easily be calculated from the height of the light above the horizon, which is given in the same documents. This is why M. DE ROUVILLE thinks it would be valuable for the Light Lists, at least in the case of a certain number of large establishments, to give both the luminous power of the light and its mean luminous range, determined experimentally when possible ; indication of the frequency of visibility of a light at the limit of its geographical range, which might also be considered, would perhaps be less simple for the seaman.

Whatever the nature of the information given, it would be useful to come to an agreement in principle on the advantage of furnishing this information in one form or another, so as to avoid divergence in the measure of efficiency of a light according to the country to which it belonged.

It would therefore be necessary to seek in Committee the best indication which the technical organisations should furnish to their services for nautical publications, with a view to having elements inserted, by degrees, giving the maximum of service to navigators without encumbering these documents.

The results of this Committee's work might well be brought to the notice of a future International Hydrographic Conference. Accurate details could thus be made available for the Resolution adopted by the International Hydrographic Conference at Monaco in 1932 (*Report of Proceedings*, p. 416 : Lists of Lights, No. 3 — "Tabular Method of Compilation"), with regard to the range in nautical miles as well as the power and eventually the type of the illuminating apparatus ; it is essential to lay down exactly the nature of the information to be inserted and to know what is meant by "range". (On this subject delegates at the Technical Conference stated the practical differences in the methods of their countries).

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After an exchange of views on the subject of the most useful information to be inserted in the Light Lists, whether by the technical services or by the authorities responsible for similar publications for the benefit of users, the International Technical Conference on Maritime Signals adopted the following resolutions with particular regard to *indicating the respective importance of the various lights :*

(1) That in these various documents the manner in which the range of lights is generally given (geographical range, luminous range, probability of visibility at the limit of geographical range, etc.) should be clearly defined, either in the preliminary notices or against such lights as are exceptions to the general rule.

(2) That in accordance with a decision of the Third International Hydrographic Conference of 1932 (Lists of Lights, No. 3) users of these documents should be given the means of knowing the real importance of a light, independently of the limitation to its use which may result from its height above sea level, or from the height of eye, or from the usual condition of the atmosphere in the district.

(3) That these two requirements should be brought to the knowledge of the various Hydrographic Services through the medium of the participants of corresponding nationality in the Paris Conference, as well as to the knowledge of the International Hydrographic Bureau of Monaco, to which the present Report of Proceedings should be addressed.

(4) That in translations or reproductions of foreign Light Lists made in certain countries, an indication of the relative importance of a light, for example its luminous power, should always be reproduced as being one of the interesting items of information to be brought to the knowledge of the readers of these translations or reproductions.

The Conference also recognised that, having regard to the widely different conditions of lighting in different countries, from the point of view of the height of lights above sea level, the greater or lesser transparency of the atmosphere, etc., it could only trust that the various national services would take the necessary steps to furnish the information on the importance of lights recommended in paragraph (2) above, in whatever form might appear the most practical to them, provided that this information should never be lacking and that its form should be clearly defined.

NOTE. — On the subject of the requirements expressed above by the International Conference on Maritime Signals, it should be noted that the different Lists of Lights published by the Hydrographic Services for the use of seamen usually show the ranges of lights as supplied by the lighthouse technicians, and that it would in fact be very desirable to come to an agreement that they should be expressed according to a uniform rule, well defined and adapted to the progress made in modern optical signals.

(1) The usual expressions such as :

Visible in clear weather as seen from a height of 15 feet above the sea (mean high water springs) ;
Greatest distance at which actually seen in clear weather ;
Portée lumineuse par temps moyen (50 chances de visibilité sur 100) ;
Sichtwerte bei Klarem Wetter ;
etc...

which are found at present in the notices of Light Lists, deserve to be better defined, clarified and unified.

(2) The indication of the *power* of the illuminating apparatus proposed in the Resolution "Lists of Lights Nos. 3 and 4" of the International Hydrographic Conference of 1932 seems to answer sufficiently to the second requirement.