



MINISTRY OF TRANSPORT

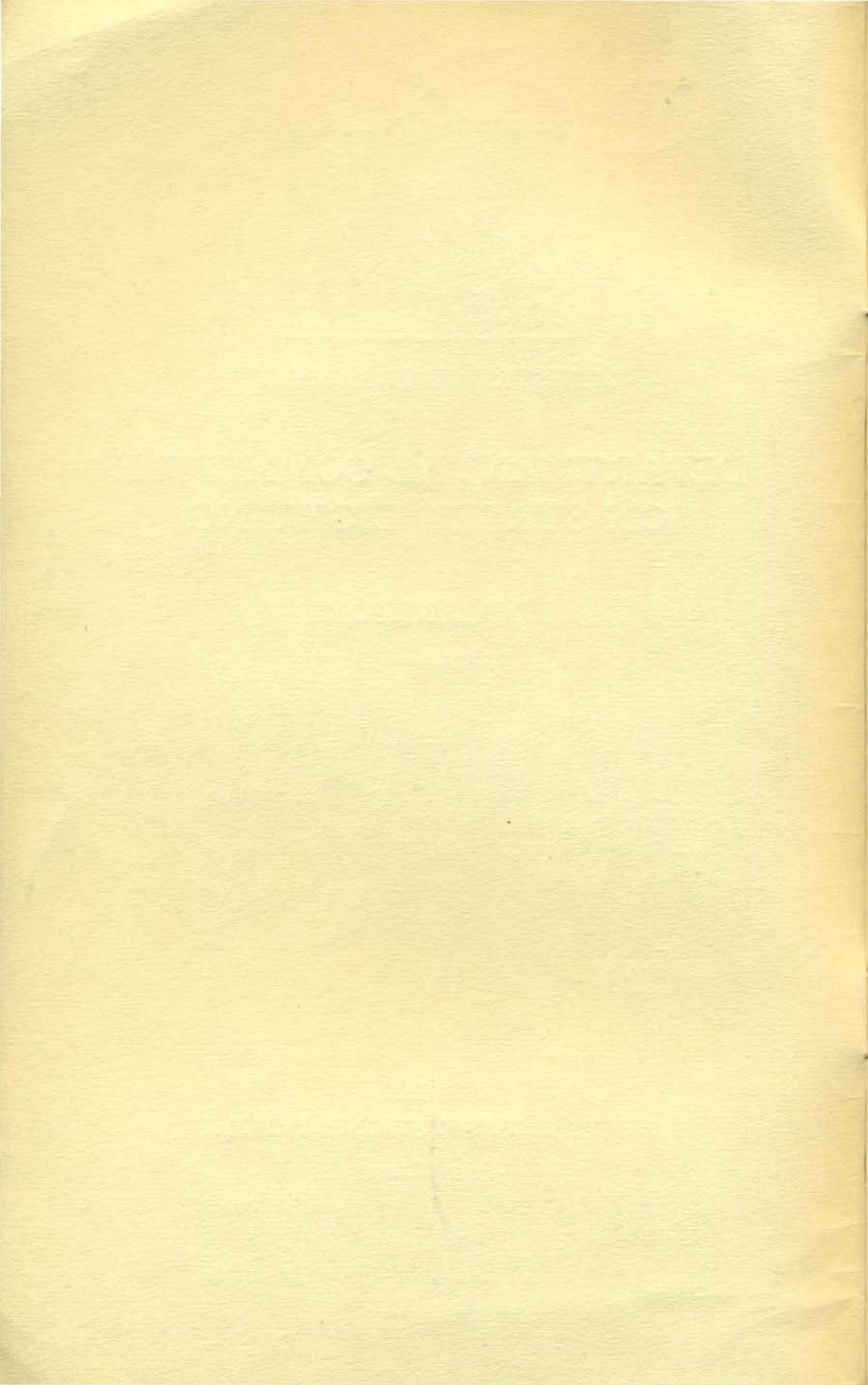
DEPARTMENTAL COMMITTEE
ON STREET LIGHTING

FINAL REPORT

August, 1937

LONDON
HIS MAJESTY'S STATIONERY OFFICE

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ON STREET LIGHTING

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Statement of Expenditure.

The estimated expenditure incurred by the Committee up to the date of the publication of this Report is £2,822 15s. od. of which £72 15s. od. represents the estimated cost of printing and publishing this Report.

MINISTRY OF TRANSPORT
DEPARTMENTAL COMMITTEE ON STREET
LIGHTING
FINAL REPORT

To the Minister of Transport.

SIR,

1. We, the undersigned, were appointed by you in June, 1934, "to examine and report what steps could be taken for securing more efficient and uniform street lighting with particular reference to the convenience and safety of traffic and with due regard to the requirements of residential and shopping areas, and to make recommendations." In September, 1935, we presented an Interim Report, with the primary intention of obviating delay on the part of local authorities in the provision or improvement of lighting installations, and we now have the honour to present our Final Report.

2. Our Interim Report was divided into two main sections dealing respectively with administration and with the technical aspects of the lighting of traffic routes, and contained also brief reference to certain other questions to which our attention had been directed. In order that the present Report may be as self-contained as possible we propose first to summarise briefly the contents of the Interim Report, together with the tentative recommendations made therein.

II.—SUMMARY OF THE INTERIM REPORT.

(I) ADMINISTRATION.

3. We stated in the Interim Report that full advantage could not be obtained from purely technical recommendations unless due regard were paid to administration and finance, and we accordingly directed attention to certain aspects of these questions in as far as they concerned the efficiency of street lighting in its technical aspects. We summarised the existing state of the law regarding the present lighting powers possessed by local authorities in England and Wales and in Scotland, drawing particular attention to the fact that, except in Scotland, there was no obligation on local authorities to provide street lighting. We also drew attention to the views expressed in evidence by several witnesses to the effect that the responsibility for street lighting should be imposed by statute upon local authorities and that the power to light roads should be confined to larger

administrative units than was at present the case. We quoted various examples illustrating the disadvantages of the present conditions and the benefit to be gained by the transfer of lighting powers to larger administrative units. We referred also to the suggestion made by several representative bodies that the cost of street lighting should be met in some degree from national funds and to the corollary that if this view were adopted the Government Department concerned would have to be empowered to specify an appropriate standard of lighting on roads to which grants should apply.

4. Our recommendations on these questions were as follows:—“Consideration should be given to the responsibility for the lighting of classified roads (and such other roads as may be agreed) being confined to large administrative units, with such exceptions as may be provided for, as in the case of road maintenance under Section 32 of the Local Government Act, 1929. We also feel bound to draw attention to the suggestion that grants should be provided from national funds (to an extent to be determined) towards the cost of lighting so much of the system of classified roads (as adopted by the Ministry of Transport) upon which public lighting may be regarded as necessary and such other roads as the responsible Government Department may agree to include for the purpose.”

5. “We are of opinion, however, that the cost of providing lighting in excess of an appropriate standard should be borne wholly by the local authority. Such a standard is not easy to define, but the question is dealt with later in this Report. It may be mentioned that the total annual cost of providing and maintaining such lighting is estimated at from £300 to £400 per mile . . . * On the assumption that all classified roads in County Boroughs and 20 per cent. of classified roads in Counties (which is a generous estimate) are lighted to the appropriate standard the annual cost would be approximately £3½ millions.”

6. “Pending any alteration of the present administrative system we recommend that authorities contemplating the installation of lighting on roads within their areas, or the improvement of existing installations, should consult with adjoining authorities with the object of securing agreement with regard to the amount of light and the height and placing of the light sources along roads which are of common interest.”

* It should be noted that this estimate was made in 1935 and referred to the standard of traffic route lighting recommended in our Interim Report. In view of the upward trend of costs since that time, the level of lighting which we recommend for traffic routes in the present Report should be referred to the upper rather than the lower figure.

7. As our deliberations since the presentation of the Interim Report have been almost entirely confined to the technical aspects of street lighting we have nothing further to add to the above recommendations, though we would observe that from time to time various circumstances have been brought to our notice which have confirmed the desirability of action being taken on the lines indicated.

8. We note that since the Interim Report was issued the Minister of Transport has been empowered to light certain roads. Section 6 (4) of the Trunk Roads Act, 1936, states that "The Minister may, if he considers that any trunk road should be illuminated or better illuminated, enter into and carry into effect agreements with any authority or person having power in that behalf, for the supply of gas, electricity or other means of illumination and for the provision of such lamps, lamp posts and other materials and apparatus as he thinks necessary for the purpose aforesaid."

(2) THE TECHNICAL ASPECT.

9. Under this heading we referred to the impossibility of determining with accuracy the extent to which bad lighting was the immediate cause of road accidents and to the difficulty of laying down a standard of lighting adequate for the needs of traffic. We stated that we were unable to accept the British Standard Specification for street lighting in all its details as the means of defining the special lighting requirements of traffic routes, but that in the absence of any more satisfactory criterion the large majority of witnesses had expressed the view that an effective installation was one which they associated with a generously planned Class F of the British Standard Specification; we recommended that pending further investigation the lighting units on traffic routes should be at least of the number and power of those required for this standard. We made a number of further recommendations regarding such questions as the mounting height, spacing and siting of sources on traffic routes and the utilisation of the available light, and put forward a tentative recommendation intended to afford some guidance to lighting authorities in the avoidance of undue glare from the sources.

10. We referred to the complexity of the problem of the road surface and stated that since the selection of road surfacing materials must continue to be governed primarily by considerations of economy and the production of durable non-skid surfaces, lighting authorities could expect no great help in this connection, and that the trend of design of lighting installations must have regard to these circumstances. We added, however, that in the selection of surfacing and surface dressing materials

consideration should be given as far as practicable to the question of lightness of colour as well as to that of reflection characteristics.

(3) OTHER QUESTIONS.

11. We expressed the view that the Committee concerned with street lighting should be advised by an engineer competent to deal with the problems which arise; that a whole-time specialist should be appointed in the case of the larger or more important areas; and that where circumstances did not warrant a whole-time appointment the situation might be met if the engineer to the authority had made a special study of street lighting or by the appointment of an officer who had specialised in street lighting practice and whose time should be allocated as far as necessary to the planning and maintenance of installations.

12. We referred also to the influence which auxiliary or extraneous lighting might have upon the efficiency of a street lighting installation and after mentioning existing powers of control exercised by lighting authorities we recommended that "definite power to control extraneous lighting, but only in so far as it may be seriously detrimental to the street lighting, should be given to lighting authorities."

13. As a consequence of reports made to the Ministry of Transport by the Railway Clearing House we made a recommendation that lighting authorities contemplating the erection of a new street lighting installation or modification or extension of an existing installation in the vicinity of a railway line, should notify the Railway Company before any work is put in hand with a view to making such adjustments (usually of a minor nature) as may be necessary in order to avoid possible interference with railway signals.

14. In concluding this summary of the Interim Report we would observe that we re-affirm the conclusions stated in that Report except in so far as they may be modified by the recommendations of the present Report.

15. In the Interim Report we gave the following list of organisations which had been good enough to submit memoranda for our consideration and in the majority of cases to send representatives to give oral evidence:—

The Illuminating Engineering Society.

The Association of Public Lighting Engineers.

The Automobile Association.

The Joint Gas Lighting Committee, representing

The Institution of Gas Engineers.

The National Gas Council of Great Britain and Ireland.

The British Commercial Gas Association.

The Society of British Gas Industries.

The British Electrical Development Association (Inc.).
 The Incorporated Association of Electric Power Companies.
 The Incorporated Municipal Electrical Association.
 The National Illumination Committee of Great Britain.
 The British Electrical and Allied Manufacturers Association.
 The Electric Lamp Manufacturers Association of Great Britain, Ltd.
 The Institution of Municipal and County Engineers.
 The Royal Automobile Club.
 The Pedestrians' Association.
 The Metropolitan Boroughs' Standing Joint Committee.
 The Chief Constables' Association.
 The National "Safety First" Association (Inc.).
 The Commercial Motor Users Association (Inc.).
 The Commissioner of Police of the Metropolis.
 The Cyclists' Touring Club.

16. Since issuing our Interim Report we have held 18 meetings and have made numerous inspections of lighting installations, whilst a Sub-Committee set up to deal with experimental work has held ten meetings. The present Report is based on our inspections, on the results of experimental work carried out under our direction, and on the supplementary information furnished by a number of the above organisations, in many cases in the form of comments on the Interim Report.

III.—CLASSIFICATION OF ROADS.

17. In our Interim Report we observed that the functions of street lighting could conveniently be discussed under four headings, viz.:—

- (a) the convenience and safety of road users;
- (b) police purposes;
- (c) the convenience of residents; and
- (d) special purposes in shopping areas and important urban centres,

and in that Report we dealt mainly with the first of these considerations as applied to traffic routes.

18. It is clear that in the majority of cases street lighting is concerned with several of these functions simultaneously. Instead, therefore, of attempting to decide upon a standard of lighting which should be associated with each of the four considerations enumerated above, it would appear more profitable to group roads and streets into a limited number of classes and to consider the degree of lighting necessary to satisfy the principal requirements of each class.

19. Many schemes for the classification of roads and streets according to their lighting requirements have been put forward, both in evidence before us and elsewhere. One organisation, for instance, has suggested six classes, ranging from important central thoroughfares to residential roads without through traffic, whilst another has proposed four groups varying from main thoroughfares in towns to footpaths which do not form part of vehicular routes. Another view is that by reason of the widely differing interpretations which can be placed upon such terms as "main traffic route," "residential road," and so forth, any classification which depends upon expressions of this kind is of little practical value. Whilst we recognise the force of this contention we are of opinion that any classification of roads based, for example, upon such definite considerations as the maximum or average traffic, might be even more misleading in that it would not necessarily take account of local conditions.

20. In endeavouring to classify roads and streets in a manner suitable for the purposes of this Report we have been faced with the question of deciding upon the primary purpose of street lighting in roads falling within the different groups. Whilst it is clear that in the case of a heavily trafficked main road the lighting must be designed primarily to meet the traffic conditions imposed by mechanically-propelled vehicles and that in quiet residential roads the convenience of residents and the requirements of the police are the major issues, we have to recognise that there is a considerable mileage of roads of an intermediate character of which many are of growing traffic importance. Whatever classification we adopt, it is clear that determination of the group in which any particular road should be placed must be made by the lighting authority concerned with due regard to all relevant conditions, and should not be governed primarily by the title of the group which may appear appropriate to the purpose in view.

21. The simplest classification which could be devised is into two groups, in the first of which would be placed all such roads as we define later as traffic routes, and in the second all other roads. The lighting on roads in the first group would be such as would render the use of headlights unnecessary in all circumstances, with the possible exception of fog. On roads within the second group the level would be materially lower than that on traffic routes, and it might be assumed that headlights would therefore be in general use, although by reason of the small volume and/or low speed of traffic, many drivers, especially those familiar with the road conditions, would deem their use unnecessary. Nevertheless, as the lighting could not be relied upon as entirely adequate under all conditions, drivers would have to recognise that the onus was on them to use their headlights as and when circumstances required.

22. If a classification of this kind were adopted it would be desirable to provide for two ranges of lighting, with such a definite gap between them that drivers in streets within the higher category would be in no doubt as to the use of headlights being unnecessary. The provision of a continuous range from the highest to the lowest, with no clear division at any point, would result in certain roads being lighted in such a manner that drivers might be misled as to the adequacy of the lighting, and there would therefore be no uniformity of practice in dispensing with the use of headlights on traffic routes. It may be urged that lighting levels between the upper and lower ranges would, generally speaking, be adopted for roads of minor traffic importance, on which the density of traffic would be such that the lighting might be adequate, although it would be quite unsatisfactory for more important roads; nevertheless we regard it as a matter of the first importance that drivers should be free from uncertainty as to whether or not the street lighting is intended to be entirely adequate for their needs, and we are of opinion that this object can best be attained by the classification of roads into two broad groups, with a definite gap between the level of lighting in each.

23. There is some conflict of opinion on other grounds arising from a simple classification into two groups. It has been urged upon us that the use of headlights in built-up areas is undesirable in any circumstances—a view with which we have much sympathy—and that on all roads requiring street lighting the standard should be entirely adequate for the needs of all classes of traffic. At the present time, economic considerations clearly render the general adoption of such a standard unattainable. However, since the level of lighting sufficient to meet the requirements of a minor road carrying but little traffic is very much lower than that which is necessary on an important thoroughfare, we are satisfied that a good residential road type of lighting, of somewhat higher level than has been customary in the past, would render the use of headlights unnecessary on a large number of roads within the second group, especially by those drivers familiar with the local conditions.

24. We accordingly conclude that the most practicable classification of roads with regard to their lighting requirements is into two groups with a distinct and easily recognisable difference between the levels of lighting adopted for each. This leads us to the following broad classification:—

Group A.—Traffic Routes.

Roads on which the standard of lighting should provide an ample margin of safety for all road users, without the use of headlights by motor vehicles.

Group B.—Other Roads.

All other roads which the responsible authority considers should be lighted.

25. Each of these groups comprises roads of widely different characteristics and it is clear that no one standard of lighting would be entirely satisfactory for all the roads within one group. Group B includes by far the greater mileage of roads requiring street lighting, and whilst many of them are unlikely to become of importance as thoroughfares for vehicular traffic there are others which at present have merely local value but which may later develop into traffic routes.

26. In our Interim Report we defined " traffic route " as including all those roads which form the main approaches to or traverse important centres of population, or pass through detached built-up areas, and on which there is appreciable pedestrian traffic. It has been represented to us, in particular by a number of the organisations mentioned in Paragraph 15 who have been good enough to furnish us with their observations on the Interim Report, that a more precise definition is desirable in that it would facilitate the classification of roads by lighting authorities into traffic routes and non-traffic routes. For the reason we have mentioned previously, namely the weight to be attached to local conditions, a precise definition in terms of volume of traffic might prove embarrassing rather than helpful. Generally speaking all those roads in built-up areas which are included in the Ministry of Transport's system of classification may eventually have to be regarded as traffic routes from the lighting point of view, together with such other roads as may be considered by the responsible authority to form principal arteries of the local highway system. The extent to which roads outside built-up areas should be lighted in accordance with our recommendations for traffic routes should be determined with regard to local conditions of traffic, pedestrian and otherwise. We should perhaps mention that we use the expression " built-up area " in this Report in a general sense and not necessarily in accordance with any legal or statutory definition.

27. It will be noted that the above definition does not refer specifically to specially distinctive thoroughfares in large cities or elsewhere in which very high standards of lighting are properly demanded. We are of opinion that this type of lighting, being concerned largely with factors other than those of convenience and safety, does not come within the scope of our terms of reference, and we do not propose to deal with it in this Report beyond remarking that our recommendations would usually be more than satisfied by well-designed installations of the type in question. The requirements of shopping areas on traffic routes, of which specific mention is made in our terms of

reference, would so far as traffic is concerned be met by installations designed in accordance with our recommendations for the lighting of such routes.

28. In the following sections we deal with the lighting of each of the groups of roads which we have adopted, but we would observe at the outset that in applying the views expressed in this Report to any particular road its character and probable development must be taken into consideration.

IV.—THE LIGHTING OF TRAFFIC ROUTES (GROUP A).

29. In our Interim Report we expressed the view that for traffic routes upon which sources of high luminous output were in general use the minimum standard of lighting should be that which enabled drivers to proceed with safety at 30 m.p.h. without the use of headlights, and we made a number of recommendations, of which the principal may be summarised as follows:—

- (i) Mounting Height: of the order of 25 ft.
- (ii) Spacing: generally not greater than 150 ft.
- (iii) Overhang: over the traffic lanes, i.e. about 6 ft. beyond the kerbs.
- (iv) Number and Power of Sources: those associated with a generously planned Class F installation of the British Standard Specification.
- (v) Distribution of Light: the available light should be employed to produce the maximum contrast between the brightness of the objects to be viewed and the background, provided there is no undue glare.
- (vi) Avoidance of Glare: limiting values for the magnification ratio of the fittings used were suggested tentatively.
- (vii) Siting of Posts: single-side lighting to be avoided except at bends. The arrangement of posts was left to individual preference, it being indicated that uniform spacing was not necessarily the best.

30. We deal more fully with each of these points in the ensuing paragraphs.

(I) MOUNTING HEIGHT.

31. Since the publication of our Interim Report it has been represented to us that insistence on a mounting height of 25 ft. or thereabouts is undesirable, mainly on economic grounds. We have given the matter further consideration, and having regard to the relationship of mounting height to the distribution of light

on the road surface, to glare, and to other factors, we are satisfied that we should adhere to our previous recommendation of a mounting height of the order of 25 ft. for general adoption on traffic routes. Such a mounting height has the further advantage of defining clearly those roads falling within this category.

32. An aspect of the question to which our attention has been especially directed concerns the many miles of traffic routes throughout the country which are lighted by short post installations and on which improvement of the lighting is necessary. The alternative methods of dealing with such installations are (a) to replace them entirely with new installations designed in accordance with our recommendations for the lighting of traffic routes; or (b) to improve the existing installations, at relatively low cost, by fitting to the posts extension pieces carrying lighting units of higher power and by providing additional intermediate posts. We have to bear in mind that in course of time many of these improved installations would require to be replaced on account of traffic requirements. By reason of the cost involved the attainment of the required standard might be a lengthy process, whilst adoption of the second course might result in a fairly rapid all-round improvement, though to a lower standard than we consider desirable.

33. In our view it is preferable that unsatisfactory lighting of traffic routes should be replaced by installations designed in accordance with our recommendations for traffic route lighting, even though a period of several years may have to elapse before complete conversion is possible. Nevertheless in certain cases it may be impracticable, for financial reasons, to erect an installation of the full traffic route standard, although some improvement of the lighting may be an immediate necessity. In such cases we see no objection to the temporary improvement of the lighting to the standard we describe elsewhere in this Report for roads coming within Group B, although for the reasons set out in Paragraph 22 it is undesirable that the lighting should be converted to a type intermediate between those we recommend for Groups A and B, respectively. We would add that we deprecate expenditure on the replacement of installations merely because, in respect of mounting height, they differ from our recommendations, at least until such time as replacement may become necessary on other grounds.

34. To sum up, we reaffirm our previous recommendation of a mounting height of the order of 25 ft. for general adoption for the lighting of traffic routes. We should, however, make it clear that in respect of existing installations we do not regard it as essential that the recommendation as to height should be interpreted rigidly; there may be slight differences in visibility;

and more especially in the glare which may be produced, with mounting heights ranging from, say, 22 ft. to 25 ft., but we do not regard these differences as being of such consequence as to require or justify the replacement of existing installations in which the mounting height is of the lower dimension but which in other respects are in conformity with our recommendations.

(2) SPACING.

35. Inspection of installations, more especially some of those erected since the publication of our Interim Report, has confirmed our view that an average spacing of 150 ft. should not be exceeded on straight roads. In certain circumstances, however, as for example to meet requirements of siting at junctions and intersections, it may be necessary for occasional spans to be somewhat longer, but in our opinion 180 ft. should be the maximum for any one span. Whilst it does not appear desirable that the average spacing of not more than 150 ft. should be varied on account of slight variations of the mounting height, it is nevertheless advantageous to adopt a closer spacing, e.g. 120 ft., where it is economically practicable. The reduction of spacing necessary at bends is dealt with in Paragraphs 45-47.

(3) OVERHANG.

36. It has been stated since the publication of our Interim Report that the provision of overhang may cause an undesirable reduction of visibility along the kerbs and footways, especially when the road is wet, and our inspections have confirmed that where the overhang is excessive this is in fact sometimes the case. The primary purpose of overhang is to reduce the distance between the rows of sources on either side of the road and thus prevent the centre of the carriageway from appearing unduly dark, and it is clear, therefore, that the amount of overhang provided should bear some relation to the width of the carriageway. We have observed, for example, that on roads having a carriageway more than, say, 40 ft. wide, kerb mounting tends to leave the central part of the road comparatively dark, a disadvantage which is largely overcome by overhanging the sources to a sufficient extent. We have thus to recognise that there are conflicting requirements, namely those of the kerbs and of the centre of the carriageway. Our observations have established that with the types of distribution at present in most common use and with sources of the power generally used on traffic routes, the maximum distance between the two rows of sources should not exceed about 30 ft., if a dark centre to the road is to be avoided; and that the maximum overhang which can be provided without causing the visibility at the kerbs to suffer unduly is about 6 ft.

37. With these approximate limiting distances in mind we recommend that as far as practicable the light sources should be mounted as follows:—

(a) When the carriageway is not more than 30 ft. wide the lamps should be sited vertically above the kerb. On very narrow roads there is no objection to the sources being mounted behind the kerbs provided that the distance between the two rows does not exceed 30 ft.

(b) For roads of which the carriageway is between 30 and 40 ft. in width the lamps should be overhung by an amount equal to one-half the difference between the width and 30 ft., thus maintaining the distance between the two rows of sources at 30 ft.

(c) On straight roads of which the carriageway is more than 40 ft. wide the sources should be mounted at the kerbs and additional sources should be placed centrally at intervals not exceeding 3 spans in length, in order to prevent the appearance of a dark centre to the carriageway. On bends the effect of the auxiliary central sources can often be obtained by so siting the lighting units that certain of the sources are centrally placed with respect to the adjacent straight lengths of road. There may be cases in which it is impossible to erect such centrally placed lamps (though we consider this by far the most satisfactory solution) and in such cases an overhang of 6 ft. should be provided. If the carriageway width exceeds 50 ft. we are of opinion that without central lamps in addition to the lamps at the sides of the road it is impossible to achieve satisfactory lighting with the types of distribution in most common use, and that even if considerable expense is involved arrangements should be made for their provision.

38. As we have stated above, we do not consider that in the case of straight roads an overhang of up to 6 ft. is likely to produce dangerously dark areas along the kerbs and footways, and we therefore do not regard it as necessary that existing installations in which the overhang does not exceed this limit should be modified in this respect.

(4) SITING.

39. In our Interim Report we stated that the arrangement of the lighting sources along the highway appeared to be largely a question of individual preference, but we drew attention to some of the disadvantages of central suspension and also recommended that single-side lighting should be avoided except at bends.

40. The question of central suspension is obviously bound up with the width of the road and with conditions at the sides, e.g. the presence of buildings and trees, and possibly also with the

distribution of light from the lanterns. In the case of narrow roads fronted by light-coloured buildings the central system is capable of giving good results. Further examination of the question, however, has made it clear to us that in the case of non-cut-off sources there are inherent disadvantages in the central suspension system which render it inferior to side mounting, save in the case mentioned above; these include the difficulty of ensuring adequate visibility along the kerbs and footways and of rendering junctions sufficiently conspicuous, and the formation of an unbroken area of high brightness along the middle of the carriageway which tends to invite drivers to drive near to the crown of the road without paying due consideration to conditions at the sides, e.g. to pedestrians stepping from the kerb and to traffic emerging from side streets. On bends the low kerb and footway visibility characteristic of central installations is accentuated. When the road is wet the disadvantages of the central system become even more marked, as the bright area along the crown of the road becomes still more prominent whilst the visibility at the kerbs is often dangerously inadequate. We are therefore of opinion that if non-cut-off sources are used this type of suspension should be avoided, save in special circumstances (see Paragraph 42). Our experience of installations in which the cut-off type of distribution is used has not as yet been wide enough to enable us to reach definite conclusions regarding the merits of central suspension in installations of this type. We therefore do not desire anything we say in this paragraph to prejudice the further use of the cut-off type of installation, with either central or combined central and side mounting, until such time as experience has shown whether the disadvantages we have mentioned above are important also when cut-off sources are used.

41. With regard to the alternative forms of side mounting, i.e., the opposite and staggered systems, it is clear that the former has advantages in that it involves the use of a greater number of sources, which facilitates the production of uniform brightness on the backgrounds concerned and provides improved visibility when the road is wet; this system is, however, relatively expensive, and it is only when particularly high standards of lighting are required that the additional cost, as compared with that of the staggered arrangement, is justified.

42. It therefore appears that the staggered arrangement is the most suitable for general adoption on straight roads, and we are satisfied that it is capable of giving satisfactory results, provided that the mounting height, spacing, and overhang are in accordance with the recommendations of this Report. There are nevertheless cases, such as when the road is bordered by large trees, when it is impracticable to mount the sources towards the sides of the road on account of the heavy shadows

which would be thrown on the carriageway. In such cases the adoption of central suspension may be the only solution, but if this course is adopted special attention should be given to the distribution of light from the sources with the object of reducing to some extent the unduly high brightness at the centre of the road and increasing relatively that at the sides (see also Paragraph 40).

43. We have referred in Paragraph 37 (c) to the need of providing additional sources along the centre of the road when the carriageway width exceeds 40 ft.

44. We reaffirm our previous recommendation that single-side mounting should be avoided, except at bends.

45. As a result of further investigation of the requirements of bends we recommend that single-side mounting should be adopted on long curves when the radius of curvature is less than about 2,000 ft. It is found in practice that long curves of even approximately constant radius are rarely encountered, and that it is impossible to state any simple rule regarding the siting at bends in terms of the radius of curvature alone.

46. Consideration of the problem shows that significant dark areas will appear on the road surface if the sources more than some 200 feet ahead of the driver appear to him to be widely separated—irrespective of their linear distance apart. For any given set of conditions, i.e., mounting height, distance, road surface, and distribution from the lanterns, the angle subtended at the observer by sources appearing to him to be adjacent should not exceed a certain value if the production of dark areas is to be avoided. It is clearly impossible to state any value for this angle which would be of general application, but on a moderately smooth surface, with fittings having the types of distribution in general use (other than those of the cut-off type) and mounted at a height of 25 feet, the angle is about $6\text{--}7^\circ$ when the nearer source is 150 ft. and the further 450 ft. from the observer, and about 5° when the sources are at distances of 200 ft. and 500 ft., respectively; when the sources considered are still further distant, i.e., 600-800 ft. from the observer, the angle falls to about 1° . On a matt surface, or if a cut-off distribution is used, the linear spacing of the sources becomes of greater relative importance, but the angle in question is reduced to about one-half the values given above.

47. The principle outlined above is applicable not merely to simple curves but to many cases in which special siting is necessary, e.g., on account of forks, staggered junctions, and abrupt changes in direction of a road. The final position of the sources is necessarily a compromise between the requirements of traffic proceeding in both directions, and it is subject also to the considerations discussed in the following paragraphs.

48. As the guiding principle in all questions of siting is that there should be a source in such a position as to produce a bright background to any object with which the driver may be concerned, it follows that in the case of an ordinary "T" junction, as where a side road enters a main road, a source should invariably be placed in the main road immediately opposite the side road in order that drivers proceeding along the latter towards the junction shall have no difficulty in detecting pedestrians crossing the mouth of the side road as well as traffic proceeding along the main road. Where two traffic routes cross at right angles there should be a source on the left-hand side of the road just beyond, but not too close to, the intersection, in order that persons or vehicles entering the crossing from one road may be clearly visible to drivers proceeding along the other; this involves the use at such cross roads of four sources, one a short distance along each road from the crossing. At roundabouts sources should be so placed that the kerbs are clearly defined to drivers entering the crossing, whilst other sources should be so arranged that persons crossing at the end of each of the entering roads will also be clearly visible.

49. It is important to ensure that sources are so sited as to indicate clearly by their position as far as possible the course of the track ahead, especially when a change of direction is involved. This is particularly important at road junctions and roundabouts, and at such places sources should be so sited that a driver approaching the junction can not only see from some distance away that he is approaching a junction but can also appreciate the routes through the junction.

50. Since circumstances vary so greatly it is not possible to state precise rules governing siting which shall be applicable in all cases. Thus the best position of the first source in a side road leaving another road at right angles can be determined only in the light of traffic conditions at the junction; the same is true with regard to the intersection of a traffic route and a road of small traffic importance. In all such cases we recommend that whilst the siting should be based on the principles enunciated and illustrated in the preceding paragraphs, the final positions of the sources should be decided only after inspection of the site by a competent lighting engineer and with due regard to local traffic conditions.

(5) POWER OF LANTERNS.

51. Since roads of widely differing characteristics are included within our definition of traffic routes, it would be wholly impracticable to recommend any one power of source which would be satisfactory for the lighting of all roads in the group, and we accordingly consider it desirable to indicate a range of outputs from which an appropriate value can be selected for the

lighting of any particular type of road. Moreover with the rapid development taking place both in the sources themselves and in the means of utilising their output we are reluctant to place close limits on the amount of light to be used by the designers of installations. Since the lamps and lanterns are usually the least expensive parts of an installation, and can be replaced without difficulty, the chief factors which must be prescribed definitely are the mounting height (25 ft.) and the average spacing (not more than 150 ft.) and we consider it desirable that our recommendations should be directed primarily to leading those responsible for the design and erection of installations to provide suitable posts in the most appropriate positions, whilst at the same time leaving a reasonably wide choice of sources.

52. For carriageway widths up to about 40 ft. we find that in practice with a mounting height of the order of 25 ft. and an average spacing of 150 ft. (diagonal arrangement), lighting of the standard we consider necessary for traffic routes is barely achieved when the sources used in the lanterns have an output of about 4,500 lumens and that the range of lighting levels commonly encountered on traffic routes involves the use of sources of which the average output during life varies between this value and about 15,000 lumens, i.e., there is a range of about 3 to 1.

53. The nomenclature ordinarily used for lighting fittings in the electrical industry is in terms of either the wattage of the lamp used in the fitting or the light output of the lamp in lumens, whilst the gas industry uses either the consumption of gas in cubic feet per hour or the lower hemispherical candle power of the lantern. In order to base our own proposals on some measure common to both we propose to speak in terms of the total light output of the lantern in lumens; but since controlled distribution of the light emitted by the lanterns is necessary in order to obtain the best results, it must not be inferred that the lantern which absorbs the least amount of light or that which has the largest total light output is necessarily the most effective.

54. We accordingly recommend that the amount of light to be provided per 100 ft. linear of road having a carriageway not more than 40 ft. in width should exceed 3,000 lumens and should lie between this value and approximately 8,000 lumens. These figures relate to the luminous output of the lantern, and refer to the average luminous output throughout the life of the source. The actual amount of light (within the limits mentioned above) to be provided in any particular case should be decided having regard to all the conditions prevailing on the road in question. The additional light required for carriageway widths exceeding 40 ft. should be provided by additional sources placed centrally, in accordance with our recommendation in Paragraph 37 (c).

(6) DISTRIBUTION.

55. We accept the view that, except in congested traffic, objects on the road at night are almost always seen in silhouette as dark objects on a bright background and that if other conditions, such as glare, remain unchanged visibility will therefore be the greater the higher the brightness of the background and the lower that of the object. Although these two factors are not the only ones involved, it follows that the distribution of light from the fittings should be designed primarily to produce as uniform and high a background brightness as possible, subject to the avoidance of undue glare, whilst at the same time maintaining as high a contrast as possible between objects and their background. The background includes not merely the carriage-way and footway surfaces, but also other surfaces such as those of buildings or fences against which objects may be seen.

56. There are, broadly speaking, two principal types of distribution in general use, both of which may be designed to comply with the recommendation in Paragraph 63 regarding glare; in one, relatively high intensities are emitted from the lantern at angles approaching the horizontal, with the object of utilising the high reflectivity characteristic of most types of road surface at large angles of incidence, whilst in the other the maximum intensities are directed at lower angles, of the order of 60° to 70° , the intensities nearer the horizontal being reduced, in some cases by the provision of a cut-off device. With the first type high road brightness is obtained but is necessarily accompanied by a certain degree of glare, whereas in the second the road brightness is lower but the glare is very much less—with a complete cut-off, indeed, glare from the sources may be almost entirely absent. It is not possible at the present time to say which is the more satisfactory type of distribution for general adoption, and it may appear as a result of further experience that there is no one type which is best in all circumstances, bearing in mind the varying conditions encountered in practice, more especially in respect of the nature of the surfaces to be lighted.

57. In Paragraph 35 we make certain recommendations regarding the spacing of the lighting units; the range given, i.e. up to 150 ft., is appropriate to any traffic route installation, irrespective of the distribution employed, but in practice it is usually found that with a cut-off or similar distribution closer spacing is required as compared with the alternative type, in order that the production of dark patches on the road may be avoided.

58. Our recommendation regarding mounting height applies equally to both types of distribution.

(7) GLARE.

59. The comments which we made on the subject of glare in our Interim Report have been confirmed by our further examination of the subject.

60. It must be recognised that glare is always present when there is, in the field of view of the observer, any object which is considerably brighter than the remainder of the field. It follows, therefore, that some degree of glare is almost unavoidable in street lighting, but such glare may vary in intensity from being almost negligible to the point at which it becomes a serious menace to the safety of road users. At one extreme the light from the lanterns, as one looks along the street, is so reduced in intensity, or the surroundings are so bright, that the street lamps in no way obtrude themselves in the field of view and certainly do nothing to distract attention or interfere noticeably with ease of vision. At the other extreme, the light from the lanterns is so intense compared with the relative darkness of the surroundings that the ability of a road user to distinguish objects easily and quickly on the road is definitely impaired. There is, of course, every intermediate stage between these two extremes, and it is important to set a limit, somewhat arbitrary as it may appear to be, to the amount of glare which may be tolerated, and to encourage any conditions which reduce it as far as practicable below this limit.

61. It has been well established that the amount of glare experienced due to a source of light in the field of view increases as (i) the intensity of the source increases, (ii) its distance from the observer decreases, (iii) it approaches closer to the direction in which the observer is looking, and (iv) the general brightness of the field of view decreases. These facts are well illustrated in the familiar case of glare from a motor-car headlight. Headlights are glaring on the road at night because (i) they are of very high intensity, (ii) they are seen at comparatively close quarters, (iii) they are close to the line of sight and (iv) they are seen against very dark surroundings (by day, the glare from a headlight is negligible).

62. In street lighting much can be done to minimise glare by careful attention to these various factors. The sources of light can be removed as far as possible from the line of sight by mounting them sufficiently high. This also deals with the second factor, because it ensures that any source which appears at all close to the line of sight will be so far off that its glaring effect is much reduced. In the case of traffic routes, Paragraph 34 makes provision for adequate mounting height. In this connection special attention should be given to the adjustment of the main beam from lamps erected at or near the crests of hills.

Factors (i) and (iv) can be dealt with by limiting the candle-power from the fittings in the direction of the observer's eye and at the same time distributing the light over the field of view in such a way as to make the surroundings (road, fences, buildings, etc.) as bright as possible. It is clear that these two factors should be dealt with in combination since they are to a certain extent mutually compensatory. A limitation of the ratio of the maximum (or peak) candle-power to the amount of light sent downward from the fitting on to the road can be used for the purpose, and in our Interim Report we recommended tentatively certain limiting values for a ratio of this kind which we defined as "the ratio of the peak candle-power to the average of the values in all directions downward from the source and lying between 30° and 45° from the vertical."

63. We have had the values of this ratio determined for a large number of representative fittings and we have examined the results in the light of our knowledge of the effects produced by the fittings under practical conditions. In consequence we recommend that for fittings mounted at a height of about 25 ft. and an average spacing not greater than 150 ft. the value of the ratio defined above should in no case exceed 6 and should preferably be not greater than 5. These values refer to fittings from which the distribution of light is non-axial. If axial distribution of the light is employed, the limit of 5 should not be exceeded.

64. Before leaving the subject of glare we feel it desirable to mention that in a street lighting installation the apparent intensity of the lighting fittings is no criterion whatever of the excellence of the system; in fact it will be apparent from what we have said above that a high intensity is a definite disadvantage unless it is accompanied by a high general brightness of the street surface and its immediate surroundings.

(8) EFFECT OF THE NATURE AND CONDITION OF THE ROAD SURFACE.

65. Practically every type of road surface in general use undergoes changes in its optical properties during life as a result of wear, and in many cases the changes are so marked that an installation designed to produce a good result on a surface which had been subjected to a few months' wear would be much less satisfactory in the case of an entirely new surface. With some materials there is considerable change in the surface during the first few months and thereafter there is but little change, whilst with others there is a gradual alteration which proceeds throughout the life of the surfacing. These changes in optical properties are greatest with the rougher types of asphalt and tar macadam and with surface dressing, and least with the smoother materials

and with stone setts; concrete subjected to much traffic sometimes becomes markedly specular in its reflection characteristics, but the degree of change naturally varies. Apart from the relatively slow changes resulting from wear, periodical abrupt changes, often very marked, may occur when the road is surface dressed and also when it is re-surfaced with either the same or a different material.

66. In view of these considerations it is clearly impracticable to make any recommendations regarding the design of a lighting installation on the basis of the nature and condition of the road surface at any particular time, or to attempt to devise recommendations regarding the most satisfactory manner of lighting various types of surface. We would observe, however, that in our view those responsible for the design of installations, and in particular of directive equipment, should be encouraged to develop types of distribution which are of the most general application, i.e., most suitable for the majority of surfaces and least affected by changes in their condition, since, although if such a type were adopted generally the best possible result would not be obtained in each and every case, a fair average standard of lighting could be maintained on the roads of the country as a whole.

67. Whilst we adhere to the views expressed in the Interim Report, viz., that the selection of road surfacing materials must continue to be governed primarily by considerations of economy and the production of durable non-skid surfaces and that tar and bituminous materials will for a considerable time to come continue to play a predominant part in road surfacing and maintenance, we would add that the road engineer can aid the lighting engineer by employing light-coloured materials for surfacing, and by avoiding as far as may be practicable the use on the one hand of materials which produce a very dark matt surface and on the other of materials giving a surface which is highly polished or which may become so under traffic.

68. It is difficult to light satisfactorily a road surface which exhibits marked variations of colour and texture, and it is therefore desirable that a surface should be provided and maintained which is as uniform as possible in these respects. The provision of light-coloured kerbs is also helpful to the lighting engineer.

(9) DUAL CARRIAGEWAYS.

69. Before discussing the lighting of dual carriageways it may be desirable to quote from the Ministry of Transport "Memorandum on the Layout and Construction of Roads" (Memorandum No. 483, Roads), in which it is stated that "The

separation of dual carriageways should be effected by a reservation of the greatest width practicable. Endeavour should be made to secure a width of 26 ft. between dual carriageways of 20 ft. and not less than 6 ft. between dual carriageways of 30 ft. in order to provide a dimension of 66 ft. between the outer kerbs”

70. There has been marked development in the provision of dual carriageways in this country and in consequence the lighting engineer has been faced with a type of problem different from those with which he has hitherto been concerned. In view of the very limited experience which has been gained in the lighting of such roads we are reluctant to make definite recommendations, and in our view there is need for considerable investigation before the most effective and economical method of dealing with the problem can be developed. In particular, it appears that by appropriate modification of the distribution in the two directions along the axis of the road it should be possible to achieve satisfactory visibility for uni-directional traffic on each carriageway and at the same time to reduce glare and distraction from the sources. Investigation on these lines is in our view to be encouraged, though care is necessary since adequate visibility is required not only in the direction in which traffic is moving but also in the opposite direction, more especially by vehicles emerging from side roads and by pedestrians.

71. Pending further investigation of the subject, we put forward the following tentative recommendations regarding the lighting of dual carriageways. With the types of lighting unit at present in general use it appears that satisfactory results can be obtained if each carriageway is lighted independently as a separate traffic route, i.e., if the installation on each carriageway conforms with our recommendations for traffic route lighting. This provides in effect for lighting units mounted over the kerbs on either side of each carriageway at a height of about 25 ft. and at an average spacing not exceeding 150 ft., and providing 3000-8000 lumens per 100 ft. linear from the lanterns. In some cases it will be practicable, unless the central reservation is of exceptional width, for the lighting units over the kerbs of the reservation to be mounted on brackets attached to common central posts. If the central reservation is narrow it may be desirable to employ a single row of units mounted centrally along the reservation, forming in conjunction with the sources along the outer kerbs a staggered arrangement on each carriageway. This practice should be adopted when the width of the reservation is not more than about 6 ft. and the carriageway width is not more than about 30 ft., as it has the advantage of reducing the number of sources in the driver's field of view and hence the amount of glare and distraction to which he is subjected.

72. We are unable to make specific recommendations regarding the lighting requirements of cycle tracks and footpaths associated with dual carriageways, as the layout may vary considerably from one road to another. In the great majority of cases, however, the type of lighting to which we have referred above will amply satisfy these requirements. If any additional lighting is required, e.g., for service roads, it should be of the type we describe elsewhere in this Report for roads other than traffic routes.

73. The sources visible to the driver on a dual carriageway lighted in accordance with the foregoing suggestions are obviously more numerous than in the case of a single carriageway. It is important therefore that in designing the lighting of such roads special care should be taken to avoid confusion on the part of drivers regarding their position in relation to the kerbs, and the general direction of the carriageway upon which they are travelling. (See also Paragraph 49.)

V.—THE LIGHTING OF OTHER ROADS (GROUP B).

(I) GENERAL.

74. In Paragraph 24 we defined this group as including all roads requiring street lighting but not falling within the category of traffic routes, and emphasised that the type of lighting should be clearly differentiated from that adopted for traffic routes.

75. Recognising that such roads constitute by far the greater mileage to be dealt with we have given consideration to the desirability of classifying them in a number of separate categories, but in view of the almost imperceptible differences by which one category merges into another, and of the difficulty of formulating adequate definitions, we have thought it desirable to deal with the group as a whole. It should be noted that although the greater proportion of the roads in this group are of the residential type in the ordinary sense of the word, some may be of only a semi-residential nature and others may be entirely industrial, or perhaps not fronted by buildings at all.

76. Before considering in detail the lighting of the roads in this group we would observe that it has been brought to our notice that in certain areas the policy has been adopted of expending a large proportion of the available funds on the lighting of the more important streets and traffic routes to the detriment of that in the less important roads. Whilst we have to recognise that financial considerations may often render it impossible to provide entirely satisfactory lighting throughout the usually considerable aggregate length of such roads and that in the interests of safety the adequate lighting of the traffic routes is of primary importance, we are of opinion that expenditure on what may be

termed spectacular lighting, or on raising the standard of lighting which is already adequate for the needs of traffic, should not be incurred until reasonably satisfactory lighting has been provided in roads within Group B.

(2) LIGHTING REQUIREMENTS OF GROUP B ROADS.

77. In our view the following are the essential requirements—not necessarily in order of importance, which may vary from one road to another—which should be fulfilled by the lighting of roads in this group:—

(a) The footway should be adequately lighted and, in particular, the kerbs should be clearly defined to pedestrians and motorists.

(b) Glare from the lighting units should not be such as to interfere unduly with the vision of the drivers of motor vehicles or of pedestrians.

(c) Where the casting of heavy shadows, e.g. by trees, is unavoidable, care should be taken that they do not fall along the kerbs or across the carriageway.

(d) The lighting should be satisfactory from the police point of view, and consideration should therefore be given to the illumination of forecourts and the lower parts of the fronts of buildings.

(e) Special attention should be given to the lighting of road junctions and intersections.

(f) The lighting and lighting equipment should be designed with due regard to the amenities of the district.

(3) GENERAL GUIDANCE FOR THE LIGHTING OF GROUP B ROADS.

78. In view of the wide variations in the characteristics of the roads within this group, e.g. in the type of buildings, nature and volume of traffic, and so on, it is not possible to prescribe within close limits a form of lighting which would be the most effective for all cases. The recommendations which follow are intended to serve as a general guide, of which the details may require to be varied according to circumstances. In order, however, to ensure clear differentiation between the lighting of this group and of traffic routes the maximum height and the maximum lantern output recommended should not be exceeded. If a road is thought to require a higher standard of lighting than may be achieved within the limits given, the installation should be designed in accordance with our recommendations for traffic route lighting.

(a) *Mounting Height.*

79. Having regard to economic considerations and to the general level of lighting required in these roads it is clearly undesirable to recommend a mounting height of the same order as

for traffic routes. Moreover, since the mounting height probably provides the most ready means of distinguishing between installations of different standards, we consider it desirable that an upper limit should be placed on the mounting height for roads in this group; a lower limit is dictated by the need of achieving satisfactory distribution and avoiding undue glare.

80. In view of these considerations we recommend a mounting height between the limits of 13 ft. and 15 ft. The upper limit is generally to be preferred to the lower in order to reduce glare and to enable the available light to be utilised most effectively. As in the case of traffic routes (see Paragraph 33) we deprecate expenditure on the replacement of installations on Group B roads merely because they differ from our recommendations in respect of mounting height.

(b) *Spacing.*

81. In many residential districts the spacing may be governed to a large extent by the requirements of siting at junctions and intersections. We recommend that the average spacing should not exceed 120 ft., with a maximum of 150 ft. for any one span (this should be necessary only in exceptional cases). Still closer spacing, e.g. 100 ft., is advantageous and should be adopted if it is economically practicable. At bends or where there are frequent intersections close spacing may be necessary. The requirements of junctions and intersections should, however, receive more attention than the mere achievement of uniform spacing.

(c) *Siting.*

82. The posts should be placed close to the kerbs but in such positions as not to interfere with traffic, pedestrian or vehicular, and should be staggered in relation to those on the opposite side of the road. Clearly no overhang is practicable in the case of lamps with the recommended mounting height.

83. The actual siting of the posts should be governed mainly by the same general rules as in the case of traffic routes, i.e. posts should normally be placed at junctions and intersections in accordance with the recommendations in Paragraphs 48-50. Due regard should be paid to police requirements in respect of entrances, etc. The positions of posts should be so selected as to reduce to a minimum the obstruction of light by trees and the casting of shadows along the kerbs and on the carriageway.

84. On bends on roads within this group it would be desirable to apply the same considerations as in the case of traffic routes (see Paragraphs 45-47), but owing to the lower mounting height, viz., 13 ft. to 15 ft., the angle subtended at the observer by the nearer sources (see Paragraph 46) would require to be not more than about 2° , which would lead in many cases to unreasonably

close spacing. We therefore recommend that the sources at bends on roads in Group B should be sited in accordance with the general principles enunciated for traffic routes, and that the angle referred to should be maintained as small as is economically practicable.

(d) *Power of Lanterns.*

85. As in the case of traffic routes we consider it desirable to recommend a reasonably wide range for the light output of the sources in order to meet the varying requirements of different roads. We recommend that the output of the lanterns, referred to the average output throughout the life of the sources, should exceed 600 lumens per 100 ft. linear and should lie between this value and approximately 2,500 lumens per 100 ft. linear. The lower limit would be suitable for roads on housing estates and other quiet residential roads carrying but little vehicular traffic, and the upper limit for those roads which, whilst not coming within the category of traffic routes, carry considerable pedestrian and local vehicular traffic. In interpreting this recommendation the observation at the end of Paragraph 53 should be borne in mind.

(e) *Distribution and Glare.*

86. The precise distribution of the light from the units used for lighting roads in Group B should be dealt with on the same principles as in the case of traffic routes, but special attention should be paid to glare, with which we deal in the ensuing paragraphs. We recommend, moreover, that care should be taken to direct part of the available flux towards the lower parts of the fronts of buildings in order to meet police requirements. (See Paragraph 77 (d).)

87. In Paragraphs 59-64 we discuss the question of glare and define a ratio which may be used to set a limit to the glare produced by street lighting fittings.

88. For non-axial fittings used for lighting Group B roads at a mounting height of between 13 ft. and 15 ft. and an average spacing not greater than 120 ft., the ratio defined in Paragraph 62 should in no case exceed 4 and should preferably not be greater than 3; if axial distribution of the light is employed the limit of 3 should not be exceeded.

VI.—MAINTENANCE.

89. In the preceding paragraphs we have described types of lighting for traffic routes and other roads in terms of the light output of the sources, mounting height, spacing, siting and so forth. Whilst these factors form a basis for the design and erection of installations, they do not in themselves lead to any

direct method of enabling the state of maintenance to be determined. In our view, satisfactory maintenance is of no less importance than correct design, and we have therefore sought a simple type of measurement which could be employed in this connection.

90. We are satisfied that illumination measurements, by virtue of their relative simplicity, provide a practicable means of assessing the state of maintenance. Since, however, installations erected according to our recommendations are not designed to any particular illumination figure on the road, it would seem necessary that the illumination at one or more convenient points should be measured when an installation is put into service and that the illumination at the corresponding points under service conditions should not be allowed to fall below a defined percentage of the initial values. The precise location of the points selected for this purpose will depend upon the type of installation, and we therefore make no recommendation on this question.

91. Illumination may conveniently be measured on a horizontal plane, in which case the illumination measured is that from several sources. As an alternative, which has the advantage of eliminating certain errors associated with the test plate, the illumination from a single source, on a test surface normal to the incident light and screened from other sources, can be measured. Since it is desirable to check not only the output of the sources and the cleanliness of the directive equipment, but also the focussing of the units, it appears desirable that measurements should be made at at least two angles, namely, one in which the intensity is not greatly influenced by slight variations of focussing, and the other in which the intensity varies markedly with small changes of focussing. The principles underlying both these methods are incorporated in the British Standard Specification for Street Lighting.

92. The precise method to be used and the conditions of the test are questions which, in our view, are best decided in the course of drafting a formal specification. We are therefore unwilling to prejudice such discussion by prescribing either method as the more desirable. We recommend, however, that effective clauses dealing with the adequate maintenance of street lighting installations should continue to form an integral part of the British Standard Specification and should be applied by those responsible for street lighting.

VII.—GRADATION.

93. In our Interim Report we recommended that there should be easy gradation from the standard of lighting adopted for traffic routes to that obtaining in side streets and at the junctions

between the lighted and unlighted portions of traffic routes. In view of the recommendation made earlier in the present Report that there should be clear differentiation between the lighting of traffic routes and Group B roads and that intermediate lighting levels should be avoided, it appears that any advantage which might be gained by grading the lighting in the manner previously suggested would be more than offset by the resulting confusion between the respective lighting levels.

94. Where, however, part of a traffic route is lighted to a very high standard as compared with the adjacent portions, as is frequently the case in shopping areas, the lighting should be graded in such a manner that drivers proceeding out of the higher lighting level are not subjected to an abrupt change in the visibility. This may be effected by appropriate variation of the power of the sources or of the spacing of the posts, according to the design of the two installations concerned.

VIII.—HOURS OF LIGHTING.

95. There is considerable variation in the lighting up and extinguishing schedules adopted by lighting authorities throughout the country, the number of hours of lighting per annum in different districts varying from less than 2000 to over 4000. The lower number is largely due to the adoption on some or all of the roads in the areas concerned of part-night lighting, i.e., of extinguishing some or all of the street lamps at say midnight or 1 a.m.

96. The consensus of opinion as expressed in evidence was that street lighting should continue throughout the hours of darkness, mainly on account of safety and police requirements, but also because of the growth of night traffic, the greater simplicity of operation and the reduction of confusion to drivers passing from one area to another. The saving which may be achieved by the adoption of part-night lighting is usually small in relation to the expenditure on street lighting throughout the area as a whole. We accept the opinion of witnesses and accordingly recommend that street lighting should be continued from dusk to dawn, i.e., for approximately 4000 hours per annum, except where financial considerations render this impracticable. We see no objection, however, to the reduction during the night of high standards of lighting in shopping and display areas to the level which we recommend for traffic routes. The best times of lighting up and extinguishing in any particular area depend to some extent on the latitude and longitude and on such circumstances as the clarity of the atmosphere and the presence or otherwise of high buildings, and must be decided in the light of these factors.

IX.—ARTIFICIAL BACKGROUNDS.

97. In our Interim Report we referred to the advantage which may often be gained by the provision of artificial light-coloured backgrounds at bends. We desire again to draw attention to the question and to recommend that consideration should be given to the provision of such backgrounds not only at bends but in other cases where the existing background is not such as enables satisfactory visibility to be produced. An example is often provided where a wide bridge, or a series of bridges, crosses the road; if the vertical walls are dark it may be difficult to provide adequate visibility, especially as the height at which the lamps may be placed is often restricted in such cases, whereas considerable improvement could be effected by rendering the walls light in colour.

X.—SIZE OF COLUMNS.

98. We have observed that the columns used for carrying street lamps are occasionally of considerably greater dimensions at the base than is necessary. Although some increase of size beyond the minimum which provides adequate strength and accommodation for essential auxiliary equipment is often justifiable for aesthetic reasons, there are objections to an unduly large base; e.g., the footway may be obstructed to an unnecessary degree and pedestrians may be forced into the carriage-way. We therefore recommend that the bases of street lighting columns should be no larger than is absolutely necessary, and that consideration should be given to so siting the columns that they cause the minimum of obstruction on the footway, without endangering passing vehicles.

XI.—THE POLICE ASPECT.

99. From the police point of view street lighting is of importance from two main aspects, namely, for the prevention of crime and for the safety and convenience of vehicular and pedestrian traffic. In this section we deal principally with the former aspect, since traffic questions are considered elsewhere.

100. In a memorandum which the Chief Constables' Association forwarded for our consideration, it is stated with regard to the deterrent effect on crime which efficient street lighting affords that—

“ in deciding the sites for lamps attention should be paid to ensure illumination of public passages and similar public places, which when left unlighted are used for the purposes

of prostitution and other vagrant offences. Adequate lighting should also be provided in the vicinity of the entrances and exits of all places of public resort, and their approaches. This observation applies with special emphasis to important public buildings of historic and utilitarian value, such as art galleries, museums, post offices, banks and other premises where considerable sums of money or valuable records are stored, without personal supervision, at night. Effective exterior lighting in this way acts as a deterrent to criminals who specialise in 'breaking' offences."

101. With regard to traffic routes, we are of opinion that lighting of the type we have recommended as adequate for the needs of vehicular traffic will in general be found satisfactory from the police point of view. Moreover, lighting in accordance with the recommendations in Section V of the Report will satisfy police requirements in residential roads, provided that attention is given to the siting of the posts to ensure that as far as possible entrances to buildings and so forth are well lighted. In both types of road, however, there may occur points which should be lighted with the object of preventing crime but which cannot be served adequately by an installation designed in accordance with our recommendations for the class of road in question. At such points it is preferable that additional lamps should be provided rather than that the efficiency of the street lighting installation itself should be impaired.

102. The lighting of public passages and similar places scarcely falls within our terms of reference, but since the question has been raised by the Chief Constables' Association and by witnesses we would draw attention to the need for the adequate lighting of such places and observe that it may in general be effected better by a relatively large number of low power units on short posts (i.e., 13 ft. to 15 ft.) than by occasional high power units mounted at a greater height. The same observation applies to passages and courts of a semi-private nature, which, although of importance to the police, do not fall within the scope of our investigations. In all such cases the principal object should be the avoidance of heavy shadows and unlighted corners.

103. Our attention has been drawn to one aspect of traffic route lighting which is of particular importance to the police, namely, means of rendering police officers conspicuous when on point duty at road junctions. In most cases the normal lighting will render the constable conspicuous as a dark figure on a bright background, but where constables on point duty are normally clad in light-coloured clothing consideration should be given to rendering them visible by means of a powerful beam of light provided by an overhead unit. No general guidance can be

given on the question, as each case requires individual examination, and we therefore recommend that before any special lighting is provided the site should be inspected and if possible a trial made to ascertain which method actually provides the best visibility. Attention should also be given to the desirability of providing artificial light-coloured backgrounds in appropriate cases.

XII.—GUARD POSTS ON REFUGES.

104. The question of the illumination of guard posts on refuges had been under consideration by the London and Home Counties Traffic Advisory Committee for some time before our appointment, and in 1933 the Departmental Committee on Traffic Signs endorsed certain recommendations which the former Committee had drawn up regarding the dimensions of such posts and the manner in which they should be lighted. It is, however, apparent that regard must be paid to the close relation between this question and that of street lighting, and moreover that the matter needs to be considered with regard to conditions throughout the country and not merely in the Metropolitan Area. We have therefore been asked to include it within our purview.

105. It may be convenient if we quote the recommendations referred to above. They are as follows:—

(i) the colour of the post should be white outlined with black, and during the hours of darkness the posts should be illuminated by white flood-lighting;

(ii) the horizontal angle of illumination of the post should be at least 120° and the projected width (i.e., the width as seen by a person directly facing the post) of the illuminated surface of the guard post facing approaching traffic should be not less than 5 inches;

(iii) the post should be illuminated for a vertical distance of not less than 2 feet and the upper edge of the illuminated portion should be not less than 3 feet and the lower edge not more than 18 inches above the road level;

(iv) the height of the post should be a minimum of 4 feet above the road level, but the height at which the light should be placed is immaterial so long as the requirements in (iii) above are observed;

(v) it is not essential that the head of the post should be illuminated, but if a light is provided it should be white and should be diffused by suitable glass.

106. We endorse these recommendations, except that (i) should be interpreted to include internally illuminated panels as well as white reflecting surfaces, but consider that they should be supplemented as follows:—

(a) Guard posts should be so designed and illuminated that they are readily identified as such and are clearly visible to motorists and other road users; care should be taken to ensure that pedestrians making use of the refuge are not obscured by the guard posts.

(b) Self-luminous posts are in general to be preferred to those which depend for their visibility on extraneous lighting.

(c) The posts should be rendered luminous by concealed sources placed (preferably) at the top. The luminous portion should extend to as near the bottom of the post as possible, and the brightness should not fall away appreciably towards the bottom. The posts should be luminous on all sides except those facing towards the middle of the island.

(d) The average brightness of the luminous portions should be about 8 equivalent foot-candles, with a variation over the whole surface of not more than 4 to 1. Our investigations have shown that a brightness of this order is adequate for roads lighted to either the Group A or Group B level, and at the same time is not so high as to produce undue glare.

(e) The kerb of the refuge should be of a material which is naturally light in colour or should be painted white periodically, whilst the light from the posts should illuminate the kerb and preferably throw the vertical sides into sharp relief.

(f) One self-luminous post should be placed at each end of the refuge and there should be a central post fitted with a light source surrounded by a diffusing globe at a height of about 16 ft. This source is intended to serve as an indication of the presence of the refuge to drivers whose view of the guard posts may be obstructed by other vehicles; it is not intended to enhance materially the visibility of, e.g., pedestrians on the refuge, which is a matter for the street lighting installation.

XIII.—STREET NAME PLATES.

107. Our attention was directed by the Commissioner of Police of the Metropolis to the difficulty frequently experienced by drivers at night in seeing and reading street name plates and to the danger of accidents arising from drivers making a

sudden turn into a side street because they were unable to see the name in time; a further point mentioned was the inconvenience caused to police officers by repeated enquiries arising from the same cause. We recommend that care should be taken in so siting name plates in relation to the street lamps that the former may be read without difficulty by drivers at night, and that consideration should be given to the need of re-siting name plates when alterations are made to the street lighting installation.

XIV.—USE OF STREET LAMPS AS WARNING DEVICES.

108. It has been brought to our notice that lighting authorities have occasionally installed, or contemplated installing, street lamps of a distinctive colour to indicate the presence of road junctions and intersections and other points requiring special care on the part of drivers. In our view this practice is open to objection for the following reasons:—

(a) In urban areas lights of various colours are often of such frequent occurrence that the significance of street lamps intended to serve as signals or warning signs is likely to be overlooked.

(b) The introduction of lamps of which the colour and perhaps also the distribution are different from those of the remainder of the installation might tend to confuse rather than aid the motorist and to reduce the uniformity of the visibility.

(c) Street lighting is intended to fulfil certain definite functions, and it appears undesirable in principle that the lamps should be used for other purposes, to the possible detriment of their main function.

(d) A warning system of this type is of little value unless it is adopted generally and the significance of the warning lamps recognised by all drivers; otherwise the utility of the warning lights would be confined to local residents, in whose interests the provision of such warnings should be unnecessary.

(e) The correct treatment of intersections, junctions and similar points in urban areas involves ensuring that the street lighting is in itself adequate and, in particular, that the lamps are properly sited, together with the use where necessary of traffic signals or other appropriate warning devices.

109. In view of the foregoing considerations we deprecate attempts to use street lamps as signalling or warning devices, whether by the use of distinctive colours or otherwise.

XV.—EXPERIMENTAL WORK.

110. Our investigation has involved considerable experimental work necessitating much detailed measurement and observation. Practically the whole of this work has been undertaken by a small Technical Panel consisting of:—

Mr. A. E. N. Taylor, B.Sc., A.M.Inst.C.E. (*Chairman*)
(Ministry of Transport),

Mr. C. Dunbar, M.Sc. (National Physical Laboratory),

Mr. F. C. Smith, F.C.S., A.M.Inst.Gas E. (Watson House
Research Laboratories, Gas Light and Coke Company),

Mr. J. M. Waldram, B.Sc., F.Inst.P. (Research Labora-
tories, General Electric Company, Ltd.).

111. The technical reports furnished to us by the Panel have proved of the greatest value to us in framing certain of our conclusions and recommendations. We desire to place on record our warm appreciation of the Panel's work, which on account of traffic conditions had almost always to be carried out between midnight and dawn, and frequently under the most adverse weather conditions.

XVI.—QUESTIONNAIRE.

112. In order to obtain information on many aspects of existing street lighting practice we found it necessary to enlist the active help of lighting authorities throughout the country, and we accordingly issued to them a questionnaire dealing with such matters as mileages of road lighted, standards of lighting adopted, costs, hours of lighting, and technical control.

113. We desire to express our appreciation of the readiness with which lighting authorities responded to our request for information on these and related questions.

XVII.—SUGGESTIONS SUBMITTED TO US FOR IMPROVED METHODS OF STREET LIGHTING.

114. We have examined many suggestions which have been brought to our notice for improvements in street lighting, ranging from slight modifications of existing practice through various less orthodox methods to schemes which are demonstrably absurd.

115. We are satisfied that none of these suggestions presents sufficient advantage over the types of lighting with which we have dealt in this Report—bearing in mind the associated disadvantages in each case—to justify any general or special recommendations designed to promote their further development. Whilst it is desirable that efforts to effect improvements

in street lighting practice should be encouraged by all means, in our view progress is most likely to result for a considerable time to come if such efforts are concentrated upon the development of existing methods.

XVIII.—FOG CONDITIONS.

116. Conditions during fog are so diverse and so different from normal conditions that in our opinion they cannot be regarded as a main factor in the design of normal street lighting installations. Special study appears to be required of measures necessary for the guidance of traffic during fog, and we do not consider it desirable that the design of installations should be prejudiced by special adaptation for fog conditions.

XIX.—BRITISH STANDARD SPECIFICATION.

117. The recommendations which we have made in this Report are not intended to serve as a specification, and in our view they should be implemented, with the minimum of delay, by the issue of a formal specification by the British Standards Institution.

XX.—ACKNOWLEDGMENTS.

118. Much of the experimental work undertaken on our behalf by the Technical Panel referred to in Section XV was carried out with the aid of a special installation erected in Lonsdale Road, Barnes (to which we referred in our Interim Report), and our thanks are due to the Barnes Borough Council, to the Borough Engineer (Major F. P. Kindell, D.S.O., M.C., A.M.Inst.C.E.), the Borough Electrical Engineer (Mr. C. S. Davidson, M.I.E.E., M.I.Mech.E.), and the members of their staffs, for the facilities afforded to us in this connection.

119. We desire also to express our thanks to the organisations mentioned in Paragraph 15 and to their representatives for furnishing us with their observations on many aspects of the problems with which we were dealing.

120. Finally we desire to record our high appreciation of the services of our Secretary. Dr. Gillbe has performed the secretarial duties with unfailing correctness, tact and courtesy and brought to them a scientific knowledge which has been definitely helpful. He also acted as Secretary to the Technical Panel (to whose work we have already paid tribute) and took an active part in all the investigations with which they were concerned.

XXI.—SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS.

The following statement of our recommendations is intended to direct attention to the more important questions with which we have dealt and must not be regarded as complete in itself; the paragraphs which follow may be entirely misleading if not read in conjunction with the relevant paragraphs in the body of the Report.

1. We re-affirm the following conclusions and recommendations which were set out at length in our Interim Report.

(a) There should be reasonable uniformity in the lighting of portions of traffic routes presenting similar characteristics, but minor variations are not necessarily disadvantageous.

(b) The present system of administration is not conducive to the achievement of uniform and effective lighting on traffic routes.

(c) Consideration should be given to the responsibility for the lighting of traffic routes being confined to large administrative units, and to the suggestion that the cost of lighting roads should be aided by grants from national funds administered by the responsible Government Department.

(d) Adjoining authorities should confer together with the object of securing uniformity of lighting on routes of common interest.

(e) Lighting authorities should be advised by an engineer competent to deal with street lighting.

(f) Power to control extraneous lighting should be given to lighting authorities, but only in so far as it may be seriously detrimental to the street lighting.

(g) Street lighting installations should be complete in themselves, and no reliance should be placed on extraneous lighting.

(h) Authorities contemplating the erection or modification of a street lighting installation in the vicinity of a railway line should notify the railway company beforehand with a view to avoiding possible interference with railway signals.

2. Two ranges of lighting should be adopted, for traffic routes (Group A) and other roads (Group B), respectively, as defined in Paragraph 24, with a definite gap between them. (Paragraphs 17-26, 78.)

3. The following recommendations are made for general adoption on traffic routes:—

(a) The mounting height should be of the order of 25 ft. (Paragraphs 31-34, 58.)

(b) The average spacing should not exceed 150 ft., or where economically practicable, 120 ft.; the maximum spacing in any one span should be 180 ft. (Paragraphs 35, 57.)

(c) The overhang of the lanterns should vary according to the width of the carriageway. (Paragraphs 36-38.)

(d) On straight sections of road sources should be placed on both sides of the road in staggered formation; additional central sources should be placed in every third span when the carriageway width exceeds 40 ft. (Paragraphs 39-44.)

(e) On bends the sources should be placed on the outside of the curve. Particular attention should be given to siting at bends, junctions and intersections. (Paragraphs 45-50.)

(f) Central suspension should in general be avoided, except as noted in Paragraph 40. (Paragraphs 40, 42.)

(g) The lantern output per 100 ft. linear should be between 3,000 and 8,000 lumens, according to the conditions prevailing on the highway and the type of installation. (Paragraphs 51-54.)

(h) Excessive glare may be largely avoided if the ratio used to express the concentration of the light (see Paragraph 62) does not exceed six, or preferably five. (Paragraphs 59-64.)

(i) Pending the results of further experience, dual carriageways should be lighted as though each carriageway were an independent traffic route; additional lighting required, e.g., for service roads, should be of the type we recommend for Group B roads. (Paragraphs 69-73.)

4. For roads other than traffic routes we make the following recommendations for general guidance:—

(a) The mounting height should be between 13 ft. and 15 ft. (Paragraphs 79-80.)

(b) The average spacing should not exceed 120 ft., with a maximum of 150 ft. for any one span. (Paragraph 81.)

(c) Attention should be given to siting on the same principles as are recommended for traffic routes, especially at bends, junctions and intersections. (Paragraphs 82-84.)

(d) The lantern output should provide between 600 and approximately 2,500 lumens per 100 ft. linear, according to the conditions prevailing on the road and the type of installation. (Paragraph 85.)

(e) Part of the available light should be directed towards the lower parts of the fronts of buildings. (Paragraph 86.)

(f) The ratio used to express the concentration of the light (see Paragraph 62) should not exceed 4, or preferably 3. (Paragraphs 87-88.)

5. Our recommendations should be implemented by the issue with the minimum of delay of a formal specification. (Paragraph 117.)

6. Effective clauses dealing with adequate maintenance should form an integral part of the British Standard Specification, and should be applied by those responsible for street lighting. (Paragraphs 89-92.)

7. Gradation is necessary only where there is considerable variation in the lighting level along a traffic route. (Paragraphs 93-94.)

8. Street lighting should be continued from dusk until dawn, i.e., for approximately 4,000 hours per annum, unless financial considerations render this impracticable. (Paragraphs 95-96.)

9. Attention should be given to the provision of artificial light-coloured backgrounds in appropriate cases. (Paragraph 97.)

10. Due regard should be paid to police requirements in respect of the lighting of entrances, etc., and special lamps, additional to the installation proper, should be provided where necessary. (Paragraphs 99-103.)

11. Illuminated guard posts on refuges should be lighted in accordance with the detailed recommendations given. (Paragraphs 104-106.)

12. Street name plates should be so sited in relation to street lamps that they may be read without difficulty by drivers at night. (Paragraph 107.)

13. No attempt should be made to use street lamps of distinctive colour as warning signs. (Paragraphs 108-9.)

14. Inadequate lighting of traffic routes should be raised to the level recommended as financial conditions permit, and not to a level intermediate between those recommended for Groups A and B. (Paragraph 33.)

15. The trend of design of lighting installations must have regard to the nature of the materials available for road surfacing and surface dressing, but the provision and maintenance of surfaces which are light in colour and as uniform as possible in respect of colour and texture are definitely advantageous. (Paragraphs 65-68.)

F. C. COOK (*Chairman*).

J. F. COLQUHOUN.

C. A. MASTERMAN.

W. H. MORGAN.

C. C. PATERSON.

E. S. PERRIN.

L. ROSEVEARE.

J. R. TAYLOR.

J. W. T. WALSH.

H. F. GILLBE (*Secretary*).

OFFICIAL PUBLICATIONS ON MOTORING SUBJECTS

H.M. Stationery Office has placed on sale a number of official publications dealing with various aspects of road traffic matters. Recent reports include the following:—

THE USE OF COLOURED LIGHT FOR MOTOR CAR HEADLIGHTS

Many motorists use headlights giving coloured light, because they believe that coloured light is better than white light of the same power for driving at night or in fog. Are they right? An authoritative statement has long been needed, and Technical Paper No. 20 of the Illumination Research Committee supplies, in a simple manner, the answer which science gives to the question. Its substance has been taken from the results of experiments made by the chief scientific investigators into the subject, and is a summary of the most reliable information known at the present time. Price 9d. Post free 10d.

REGULATIONS ON CONSTRUCTION AND DESIGN, ETC.

Statutory Rule and Order No. 229 of 1927 contains requirements for the construction, weight, equipment and use of vehicles in general. Price 8d. Post free 9d.

Memorandum on the Lighting of Road Vehicles.

Price 1d. Post free 1½d.

NOISE

A Departmental Committee of the Ministry of Transport has been considering the question of noise in mechanically propelled vehicles of all kinds. Three Interim Reports have already appeared and the Committee's final report is now ready. The Interim Reports contain a scientific survey of the general problem of vehicle noise, with recommendations to deal with it, and the Final Report deals similarly with the problem of annoyance which may be caused by unnecessarily strident warning instruments. Price of the Final Report 1s. 3d. Post free 1s. 4d.

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or through any bookseller

OFFICIAL PUBLICATIONS ON MOTORING SUBJECTS

Continued from page three of cover.

ROAD SURFACES

The Road Research Board of the Department of Scientific and Industrial Research has in preparation a series of technical papers and bulletins. The following have already appeared:—

Studies in Road Friction. Road Surfaces to Skidding.
T.P.1. Price 1s. 6d. Post free 1s. 8d.

The Measurement of the non-skid Properties of Road Surfaces. B.1. Price 9d. Post free 10d.

The shape of Road Aggregate and its Measurements.
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The Control of Moisture Content of Aggregates for Concrete, introducing a new Vibration Method. T.P.4.
Price 9d. Post free 10d.

The Annual Report of the Road Research Board for the Year ended March 31, 1936. Surveys the present position and summarises progress already made in improving road construction. Price 2s. 6d. Post free 2s. 9d.

Standing orders for these publications may be sent to any of the Sale Offices whose addresses appear below.

EXPERIMENTAL WORK ON ROADS

The Report of the Roads Department of the Ministry of Transport for the year 1935-36 gives details of the work of the Technical Committee for experimental work on highways.

Report for 1936-37 in the Press. Price 1s. Post free 1s. 2d.

ROAD SAFETY AMONG SCHOOL CHILDREN

As a part of the measures to decrease the number of accidents on the roads, two inter-departmental committees appointed by the Minister of Transport, the President of the Board of Education, and the Secretary of State for Scotland, have studied the question of road safety among school children.

Report for England and Wales. Price 6d. Post free 8d.

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