First report : the acute general hospital / Departmental Committee on the Cost of Hospitals and Other Public Buildings.

MINISTRY OF HEALTH

Departmental Committee on the COST OF HOSPITALS and other Public Buildings

FIRST REPORT

The Acute General Hospital

LONDON
HIS MAJESTY'S STATIONERY OFFICE
Price 1*s*. 3*d*. net

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DEPARTMENTAL COMMITTEE ON THE COST OF HOSPITALS AND OTHER PUBLIC BUILDINGS

(Appointed by the Minister of Health by Minute dated the 5th July, 1933).

TERMS OF REFERENCE.

To consider and report on the questions of the capital cost of construction and the annual cost of maintenance of the following classes of public buildings provided by Local Authorities, viz., hospitals (including mental hospitals), public assistance institutions, mental deficiency institutions, maternity homes (including maternity departments newly constructed or added to hospitals), and baths and wash-houses, special regard being paid to (*a*) the establishment and periodic revision of standards; (*b*) modern methods of construction; and (*c*) the possibility of securing a reduction in present costs without impairing the efficiency of the buildings for the purposes for which they are designed.

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Dr. W. Rees Thomas, M.D., F.R.C.P., D.P.M.
**Mr. J. A. Lawther, M.B.E. (Secretary).

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* Appointed by Minute dated the 25th May, 1936, in place of Sir L. Amherst Selby Bigge, Bart., K.C.B.

† Appointed by Minute dated the 8th September, 1933.

‡ Appointed by Minute dated the 13th July, 1933.

§ Appointed by Minute dated the 13th June, 1934, in place of Mr. N. B. Batterbury.

** Appointed by Minute dated the 29th March, 1934, in place of Mr. J. Topping.

Note.—The estimated cost of the preparation of this Report (including the expenses of the Committee) is £445 10s. 6d., of which £63 10s. 6d. represents the estimated cost of the printing and publishing of this Report.

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DEPARTMENTAL COMMITTEE ON THE COST OF HOSPITALS AND OTHER PUBLIC BUILDINGS

FIRST REPORT.

To the Right Hon. Sir H. KINGSLEY WOOD, M.P.,
Minister of Health.

SIR,

1. We have the honour to submit the following First Report in discharge of the commission entrusted to us by your predecessor in office by his Minute of the 5th July, 1933. We were appointed "to consider and report on the questions of the capital cost of construction and the annual cost of maintenance of the following classes of public buildings provided by Local Authorities, viz., hospitals (including mental hospitals), public assistance institutions, mental deficiency institutions, maternity homes (including maternity departments newly constructed or added to hospitals), and baths and wash-houses, special regard being paid to (*a*) the establishment and periodic revision of standards; (*b*) modern methods of construction; and (*c*) the possibility of securing a reduction in present costs without impairing the efficiency of the buildings for the purposes for which they are designed".

Introductory.

2. At a Meeting of the Committee on the 29th April, 1936, Sir Amherst Selby Bigge, who was then our Chairman, informed us that he found himself unable to continue his work on the Committee and that he had submitted his resignation to you. It was with great regret that we received this announcement, and we desire to record our appreciation of his high qualities, of his keen interest in all the many aspects of the subject of our study, and of the indefatigable energy which he displayed in conducting and furthering the work of the Committee.

By your Minute of the 25th May, 1936, Mr. Adam Maitland, M.P., was appointed Chairman of the Committee.

PROCEDURE, AND SCOPE OF INQUIRY.

3. At the beginning of our inquiry we appointed a number of Sub-Committees to investigate particular subjects coming within our terms of reference. These Sub-Committees have held a total of 94 meetings, and up to the date of this Report we have sat as a full Committee on 38 occasions.

4. Several of our members have visited hospitals and other institutions in different parts of England and Wales, and we are indebted to the authorities of numerous hospitals—both

municipal* and voluntary—for the assistance they have given us in furnishing much useful information.

5. Our former Chairman, Sir Amherst Selby Bigge, and three of our Members, Dr. Bruce, Dr. McIntosh and Mr. Scott, visited hospitals in France, Italy, Switzerland, Austria, Germany and Belgium. We desire to place on record our gratitude to the hospital authorities of those countries for the cordiality with which our representatives were received and for the facilities and assistance placed at their disposal, and to the Health Organisation of the League of Nations for their co-operation in arranging the tour and for supplying information relating to many Continental hospitals.

6. We have heard evidence from witnesses on behalf of Government Departments and numerous representative bodies interested in the provision or management of different types of hospitals and other institutions. We have also had the advantage of discussions with a number of consulting engineers and other individuals concerned with some of the problems covered by our terms of reference. A list of the witnesses who have appeared before us is given in Appendix I to this Report. Other bodies and individuals have submitted memoranda which were not the subject of oral evidence, or have furnished information at our request. We desire to express our deep appreciation of the services rendered by all who have assisted us in these ways.

7. The list of public buildings enumerated in our terms of reference shows the wide field that we have been asked to cover. The collection of information and opinions, the discussion of conflicting or divergent views, and efforts to reach unanimous conclusions and to reconcile the claims of efficiency and economy have necessarily occupied much time. Progress has therefore been slow, and we have thought it advisable to issue this Report dealing with The Acute General Hospital† without waiting for the completion of our task. It was our intention to include in this Report observations on certain classes of specialised accommodation, such as maternity and children's wards, which may advantageously form departments of general hospitals, but it was found more convenient to leave these to be discussed in a later Report.

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* For want of a single adjective to cover all kinds of Local Authorities, we have used the word " municipal " in that sense.

† The expression " acute general hospital " is doubtless open to criticism, but we have used it deliberately as a convenient though rather colloquial term which is in general use. An expression which might seem to be more correct, such as " hospital for patients who are acutely ill " or " who are suffering from acute disease " would, in fact, be less accurate. By " acute general hospital " is meant a hospital designed and equipped for first class medical and surgical work, and intended for patients whose condition, whether it be acute or chronic, calls for active medical or surgical treatment.

8. Much of the ground that has been covered in the examination of this first part of our subject is common to other parts. For instance, similar questions relating to materials of construction and finishing, to engineering and administrative services and to residential accommodation for staff arise in the consideration of different types of institution. Having dealt fully with these in our present Report on general hospitals we may find that, in our subsequent recommendations relating to other institutions, a statement of appropriate variations and modifications will suffice.

9. By our terms of reference we are directed " to consider and report on the questions of the capital cost of construction and the annual cost of maintenance " of certain classes of public buildings " provided by Local Authorities ". Thus, though our Report may possibly be of interest to voluntary organisations, it specifically relates to hospitals provided by Local Authorities, and its contents are not necessarily applicable to voluntary hospitals.

10. The protection of hospitals against air raids is outside our terms of reference. We understand that this question is the subject of a separate investigation and that advice on this special aspect of the problem, which may have some bearing on our recommendations, will be available in the near future.

Matters for Special Consideration.

(a) *The Establishment of Standards.*

11. In the treatment of our subject special regard was to be paid to certain matters, of which the first was " the establishment and periodic revision of standards." It was necessary, therefore, to consider, firstly, what standards could be established, and secondly, what standards, if any, should be established.

12. On the first point, we came to the conclusion that it was not practicable to express our standards in terms of cost. In addition to the obvious difficulty that building costs vary according to time and place, there were other obstacles which it is unnecessary to particularise. The cost of an institution must depend on the amount and nature of the accommodation provided, and it seemed to us that the intention of this part of our terms of reference could best be fulfilled by advising as to what should be regarded as reasonable requirements.

13. In discussing standards with witnesses we encountered a definite feeling of apprehension as to possible effects of standardisation. It was represented to us that the establishment of standards involved a danger of obstructing experiment

and progress, an opinion which has considerable force, particularly at a time like the present, when hospital design appears to be in a transition stage, and those concerned with the construction and work of hospitals are searching for new ideas which may profoundly influence the future of hospital planning. We have attempted so to frame our conclusions that they will not tend to stereotype design or to impede progress. For this reason we have refrained from publishing standard or model plans: the few plans that have been included in our Report are in the nature of illustrative diagrams. Generally, we have felt that it was not our function to say precisely how hospitals should be planned, but to provide the data that architects require to enable them to design buildings suited to particular cases.

14. In some instances we have adopted definite standards, and these would, in our opinion, be generally accepted as consistent with good practice, though they have been framed with due regard to economy. In certain other instances standards have been frankly stated to be inapplicable; while in others the relative advantages and disadvantages of alternatives have been presented without a definite declaration in favour of one or other, a decision being left to be based (as it often should be based) on local or particular circumstances.

(b) *Modern Methods of Construction.*

15. The second matter to which our attention was specially directed was " modern methods of construction ". This is a matter which has been under consideration by a number of Committees in recent years. We have made a further examination of the subject, and our conclusions on methods and materials of construction will be found in Section X of this Report.

(c) *The Possibility of Securing a Reduction in Present Costs without Impairing Efficiency.*

16. The third matter calling for special consideration was " the possibility of securing a reduction in present costs without impairing the efficiency of the buildings for the purposes for which they are designed ". In our approach to this matter it would have been of assistance if we could have established a reliable basis for comparing the costs of different hospitals. This, for a variety of reasons, was found to be impracticable. The number of general hospitals erected under post-war conditions is not great, and building costs have varied widely during the post-war period, but these were by no means the only difficulties.

17. In order to obtain a basis of comparison, a common practice is to divide the total cost of a hospital by the number of patient beds, and call the resulting figure " the cost per bed ".

There are, however, many fallacies associated with comparisons on this basis. In the first place, the cost even of similar hospitals does not vary directly with the number of beds, since the size and cost of certain sections of the hospital do not rise and fall in proportion to this number. Secondly, the requirements of different hospitals vary considerably: one requires a large Out-Patient Department, another does not; the class and type of work done varies in different hospitals, and this is reflected in the numbers of staff required; one hospital may be staffed to a greater extent than another by non-resident personnel, and so forth. Thirdly, one hospital may have been built as a completed institution while another has been planned with a view to early extension, and administrative accommodation provided on a scale suitable to many more than the initial number of patient beds. These examples are not exhaustive, but they illustrate the difficulty of establishing any figure that could be regarded as normal " present cost ".*

18. Nevertheless, we hope that something substantial has been done to discharge our commission with regard to this part of our terms of reference. We believe that if our recommendations are adopted they will have the effect of bringing about a reasonable degree of uniformity of cost at an economical level.

19. Our aim has been to advise on a scale consistent with true economy, and to make recommendations based on good quality without extravagance. The words " without impairing the efficiency of the buildings for the purposes for which they are designed " in our terms of reference are obviously significant, and give us a clear direction. It should be remembered that annual costs of maintenance and operation are of even more importance, economically, than first cost. A hospital, once built, lasts for very many years. Interest on capital and sinking fund charges form only a comparatively small proportion of the total annual expenditure. This is no excuse for extravagance in construction, but is mentioned as a reminder that reductions in first cost may be the reverse of economy if they tend to increase costs of operation or maintenance or to impair efficiency.

20. In the all-important matter of the in-patient accommodation, therefore, our standards and conclusions represent something better than the irreducible minimum, and in the case of such vital parts of the hospital as operating theatres we have felt it right to be fairly liberal. As regards the staff quarters our recommendations are framed with the object of securing a substantial degree of comfort, though without needless expenditure. This we believe to be fully justified on the ground that

* The figures relating to cost per bed appearing in this Report refer to patient accommodation only, and are therefore free from the fallacies mentioned in this paragraph.

the success of a hospital depends, in great measure, on the possession of a healthy and contented staff. Generally, while good quality has been our objective, the purpose for which the Committee was appointed has been constantly before us, and our effort, throughout, has been to obtain the desired quality by economical means.

I.—Formulation of Building Scheme.

21. Our Report is directed to a specific purpose and is not intended to be a treatise on hospital planning and construction, but it gives some indication of the complexity of the subject and of the number and variety of considerations that enter into the preparation of a building scheme for a particular hospital. If satisfactory results are to be obtained without unnecessary expenditure, it is essential that the whole project should receive full and careful preliminary study. The particular requirements of each section must first be carefully formulated. These are the data that must be supplied to the architect and the engineer before they can begin their work of planning.

For the production of a well-conceived scheme the closest collaboration of medical, nursing, administrative, architectural and engineering advisers will be necessary, and, if possible, their combined advice should be obtained even before the site is selected. This collaboration should continue throughout all the subsequent stages.

II.—Site and General Lay-Out.

Site.

22. We are not required to enter into a discussion of all the qualities of an ideal site, but are concerned with the site only in so far as it affects building costs. The choice of a site is often limited, and it may happen that none of those available presents all the desired qualities. The aim should be to select one which, while possessing the features desirable on general grounds (quietness, accessibility, suitable altitude, favourable aspect, etc.), lends itself, by its shape, contours and the nature of its sub-soil, to economical building. Whenever possible, a site should be chosen where all the public services (water supply, sewerage, electricity and gas) are available, and in comparing the costs of alternative sites the additional expenditure involved by the absence of any of these services should be taken into account. If access to a public sewer cannot be obtained the need for sufficient land for sewage disposal should be borne in mind.

23. The site should always be large enough to permit of future extensions. This may have an important bearing on economy when extensions are required. When a hospital is established it is not easy to forecast its future development, and hospital authorities often find themselves in serious difficulties

owing to insufficiency of space on the site for necessary expansion, while adjoining land is either unobtainable or obtainable only at a high cost. Not only may an increase in the accommodation for patients and staff be required, but, owing to the progress of medical science, a need for new departments may arise which was not, and perhaps could not have been, foreseen at the time when the hospital was built. It is, therefore, sound economy to provide more space than is necessary to meet the needs that can be clearly foreseen.

General Lay-Out.

24. We are of opinion that it would be a mistake to attempt to recommend a standard lay-out. The general plan of a hospital must depend to so great an extent on the size, shape and character of the site, as well as on many other variable factors, that it must be left to be determined by the circumstances of each individual case. There are, of course, certain well-known principles which should be borne in mind. The first consideration should be to choose the most favourable position for the wards, having regard both to aspect and external noises. The lines of internal communication should be carefully studied, and the positions of inter-related parts should be such as to avoid undue distances between them. For example, communication between the operating theatre and the surgical wards should be short and easy, and the buildings which house the central services should be conveniently situated in relation to the wards and departments which they serve. It is unnecessary for us to deal exhaustively with such well-recognised principles.

High versus Low Buildings.

25. The most important question that we have had to consider from our special standpoint of economy in construction is whether it is more economical to adopt a wide-spread plan of low buildings or more concentration and higher buildings.

26. When this question is examined it is found to be so complex that a conclusive answer cannot be given to it. It would be a simple matter to compare the cost of constructing ward units in blocks of two, three, four, six or eight storeys, but such a comparison would be misleading because not only the ward blocks but the connecting corridors, staircases and lifts must be taken into account. When an attempt is made to take account of these, the problem becomes very complicated because the general plan of a hospital built in two storeys would almost certainly differ from that of a hospital composed of higher buildings. Therefore, to get a reliable comparison, it would be necessary to prepare fully detailed plans of complete hospitals of different heights, each appropriately designed for its particular height. Even then, the comparison would be open to

the objection that the designs were arbitrarily chosen, and that different plans would probably have given different results.

27. Although, for the above reasons, we are unable to give a decisive answer to the question, we have tried to give some illustrative information on the subject. For this purpose a plan, which might be regarded as a normal two storey plan of ward accommodation in 30-bed units (with one ward of 18 beds, two wards of four beds, and four single-bed wards), has been taken for comparison with other plans of ward units similarly divided, and designed for three, four, six and eight storey buildings. With the assistance of the Quantity Surveyors Committee of the Chartered Surveyors Institution we have studied the effect on cost of building in different numbers of storeys, taking these plans as a basis, and have found that:—

(*a*) Up to six storeys for a given amount of accommodation the quantity of building (cube) including the necessary connecting corridors and staircases becomes less as the number of storeys is increased;

(*b*) The cost of a given quantity of building increases slightly as the height (number of storeys) is increased; and

(*c*) The cost of engineering services, such as heating and sanitary installations, decreases slightly when the accommodation is arranged vertically.

28. The extent to which these factors neutralise one another will depend to some extent on the type of plan adopted, which again must depend partly on the size of the hospital. The following table gives the relative costs of ward accommodation in two to eight storey blocks, taking into account connecting corridors, staircases and lifts.

Number of Storeys.	*Relative Cost.* (Index figure = 100.)
Two storeys	107
Three storeys	103
Four storeys	100
Six storeys	102
Eight storeys...	107

29. For the reasons given in paragraph 26, it would be unsound to base an opinion on these figures alone, but so far as they go they indicate that the effect on cost of varying the number of storeys is small in relation to the total cost of the hospital. Our general conclusion is that the cost of construction is not affected by the number of storeys sufficiently to make it a determining factor in a decision as to the height of building to be adopted, and that this decision should rest on other considerations, such as size and cost of site available and the convenience of service obtained by concentration.

Possible Future Developments.

30. Before leaving the subject of lay-out, we would again draw attention to the necessity of having regard to possible future developments. Additional wards may be required, and the lay-out should be such that they can be suitably fitted into the general scheme. Further, it must not be forgotten that new wards will occasion the appointment of additional staff and the extension of staff accommodation and will increase the demand on the central services, thus perhaps necessitating an expansion of the buildings which house these services.

Connecting Corridors, Staircases and Lifts.

31. The extent of main corridor and the number and disposition of staircases and lifts will depend on the general plan adopted. For reasons of economy it is desirable to restrict the amount of building devoted to corridors as much as the plan will allow, and the question of communication by corridors, staircases and lifts must be considered as a whole. A further point to be kept in mind is that the chief centres of internal noises are the lift-wells, staircases and main corridors. So far as possible, therefore, these should be disposed with a view to the minimum disturbance of patients.

32. Every ward unit above the ground floor should have access to two staircases capable of taking stretchers, and in all but small hospitals should have access to two lifts.

Main corridors should be eight feet wide. A staircase which may have to be used for stretchers should have a width of 4 feet 6 inches, with half-landings six feet in depth.

33. With regard to lifts, the total number will depend on (*a*) the number of storeys, (*b*) the number of beds above the ground floor, and (*c*) the type of plan. Adequate service can be given with the minimum number of lifts if there is main corridor communication on every floor, but the cost of providing corridors on every floor may be greater than that of increasing the number of lifts.

Means of Escape in Case of Fire.

34. The provision of means of escape in case of fire is of the first importance. In planning it should be borne in mind that for sick people a horizontal means of escape is safer and more convenient than a staircase.

A fire-escape staircase should, however, be provided at or near the end of every projecting wing over 60 feet in length which contains patient accommodation above the ground floor. The open staircase in light steel or reinforced concrete which is often adopted is unsightly, and has the disadvantage of being dangerous in frosty weather. Enclosed fire-escape

staircases are, therefore, to be preferred. If designed as an integral part of the building, as they should be, they are unlikely to cost more than open staircases, while the maintenance costs will be less.

Access to the fire-escape staircase should be from a verandah or balcony where this can conveniently be arranged. Where the staircase is entered direct from the interior of the building there should be self-closing doors to prevent the entry of smoke.

III.—The In-Patient Accommodation.

Definition and Composition of a Ward Unit.

35. The in-patient accommodation of a hospital is most conveniently considered as consisting of a series of ward units. We have used the term "ward unit" to mean a self-contained nursing unit under the charge of one sister, and comprising a group of patient beds in one or more wards together with their associated ancillary rooms. For reasons of economy the ward unit should contain the maximum number of beds that a sister can supervise, while maintaining the personal knowledge of and interest in each patient which are essential for the success of her work. This leads to economy both in staffing and in the provision of ancillary rooms and equipment. The appropriate number of beds may vary with the type of patient; but we have found general agreement that, so far as the acute medical and surgical wards in a municipal general hospital are concerned, a ward sister ought to be able adequately to supervise a unit of 30 beds, but that it is not desirable to go above this figure. We have therefore adopted a ward unit containing 30 beds as our standard.

Subdivision of Unit into Wards.

36. The cost of constructing ward units and the blocks containing them is affected by their plan, and the first question to be considered is whether, in planning a ward unit, a system of large or small wards should be adopted. This has indeed for some time been one of the most prominent subjects of discussion in the field of hospital planning and organisation. On the Continent and in the United States there is a very general tendency to distribute the beds among a number of relatively small wards, and Continental writers generally regard the large ward as discredited. In England there is now a strong body of opinion to the effect that no ward should contain more than 16 beds, while on the Continent the maximum number of beds is placed much lower, at 10, eight or even six beds.

37. Extreme examples of the large and small ward systems would be, in the one direction, a single ward containing 30 beds (which would doubtless be the cheapest); in the other, 30

rooms each containing one bed (which would, by some, be regarded as the ideal). The latter must, we feel, be ruled out on the ground of cost, both of construction and staffing, whatever opinion may be held about it in other respects. We have no hesitation in rejecting, also, the other extreme of a single ward of 30 beds, since we consider it essential that each unit should contain a certain number of single-bed rooms. These are necessary for the purpose of separation, for example of noisy or otherwise disturbing patients, of those suspected of being infectious, of those who are in particular need of quiet, and of certain patients who are seriously ill or have recently undergone operations. For this purpose we consider that a unit of 30 beds should include at least four one-bed rooms.

38. We have had more difficulty in coming to a conclusion whether the remaining 26 beds should be in one large ward or in two or more smaller wards. The chief advantages of smaller wards over a single large ward are as follows:—

(*a*) They provide greater quiet and privacy for the patients.

(*b*) They afford opportunity for classification of patients.

(*c*) They allow of elasticity by enabling certain wards to be used for children or adults, for medical or surgical cases, etc., according to the fluctuations in demand. It may also be possible to arrange that some wards can be used for either sex. This elasticity is an advantage of considerable importance and may conduce to a high percentage of occupation and a saving of beds.

(*d*) They limit the spread of infection, since, if a case of infectious disease occurs in a small ward, a lesser number of patients is exposed to the infection. Further, closure of a small ward on account of infection puts fewer beds out of action.

(*e*) They facilitate the periodical cleaning and redecoration of wards, because, on occasions when wards have to be closed for these purposes, only a small number of beds need be out of commission at one time.

39. On the other hand, large wards have important advantages.

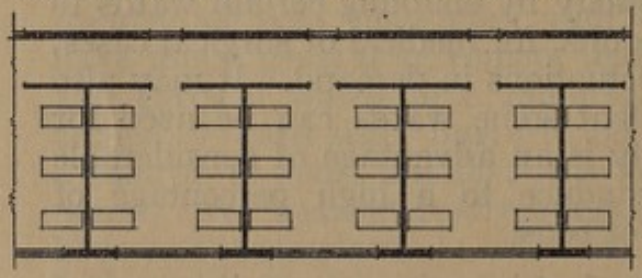
(*a*) They permit of a very simple and economical form of planning.

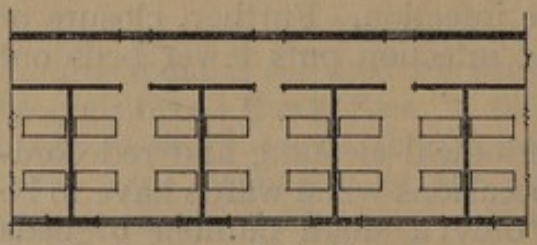
(*b*) They facilitate effective supervision of the patients by the nursing staff and thus tend to economy in staffing.

(*c*) Long rectangular wards lend themselves readily to the provision of windows on opposite sides. This ensures good lighting of all parts, and not only permits of cross ventilation and thorough flushing of the ward with air, but also enables windows on the sheltered side to be kept open even in boisterous weather. Thus, the adoption of large wards conduces to a high standard of lighting and ventilation, which in England is regarded as of the greatest importance from the hygienic and therapeutic point of view.

40. The movement towards small wards has led to the free adoption on the Continent of what is known as the " corridor system ", namely, a system of small wards ranged along one side of a corridor with ancillary rooms on the other side. This form of planning gives the advantages of small wards, but has the disadvantage that supervision is not so good as in a large ward, and that the wards are lighted and ventilated from one side only. A certain amount of cross-ventilation can, however, be obtained if fanlights, made to open, are provided in the wall separating the ward from the corridor; and, for the sake of both ventilation and lighting, the other side of the corridor should be kept free of rooms for a part of its length.

ILLUSTRATIONS OF CORRIDOR PLANNING.





41. We do not favour the 6-bed wards, 3 beds deep, so common in Germany, as the deeper the ward the less efficient are the lighting and ventilation. If the corridor system is adopted we consider that the wards should not be more than 2 beds deep (see illustrative diagrams).

The practice of ranging wards along both sides of a central corridor is seriously prejudicial to lighting and ventilation, and is therefore not recommended, though it may be justified in very special circumstances.

42. Corridor planning has both advantages and disadvantages, and we do not consider it necessary or desirable to attempt to pronounce on which side the balance lies. Indeed, the balance may be in its favour in one set of circumstances and against it in another. We consider, however, that the advantages of cross-ventilation should not be lightly abandoned. Replacing the single large ward by a series of smaller wards

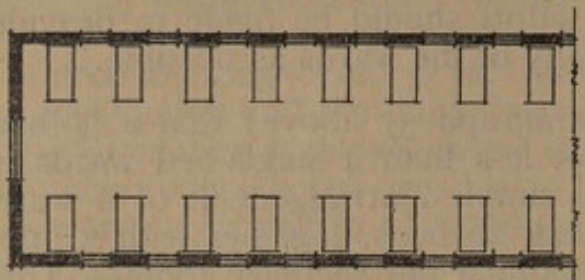
does not necessarily involve a frank acceptance of the corridor system, and in planning an effort should be made to provide full cross ventilation to as many of the wards as possible.

43. If the opinion (see paragraph 37 above) that a 30-bed ward unit should contain not less than 4 single-bed wards is accepted, it follows that the simplest arrangement of a ward unit is a main ward containing 26 beds, together with 4 one-bed rooms in the section containing the ancillary rooms. This arrangement has certain merits which have been mentioned, but we are impressed by the advantages of smaller wards and by the marked tendency to depart from large wards which has become evident in recent years. The replacement of the main ward by two or more smaller wards, by means of a different layout of the ward block, appears to us well worthy of consideration.

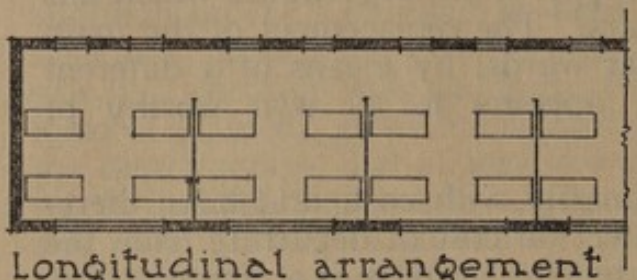
44. We are concerned primarily with cost, and have therefore tried to work out the effect on cost of departure from the large ward type of planning, but the problem is a complex one, presenting much the same kind of difficulty as in the case of high and low buildings. In the first place, the range of possible variations is considerable, and comparisons must therefore be based on plans arbitrarily selected. Secondly, comparison of the cost of differently planned ward blocks is by no means easy. Departure from the simple traditional plan tends to increase the area (in varying degree according to the plan adopted), but the height must also be taken into account since reduction of the main ward to 16 beds or less enables a reduction to be made in the height of each storey (see paragraph 64 below). Thirdly, the problem cannot be solved by examination of the cost of ward blocks alone. Varying the shape of the ward block will probably lead to variations in the general plan, with consequential effect on such items as corridors, staircases and lifts. Thus, a particular layout of the ward unit may increase the cost of ward blocks, but enable savings to be made in other respects, and these savings may wholly or partially compensate for the higher cost of the ward blocks.

45. We have considered estimates based on different plans, and have come to the conclusion that replacing the large main ward by smaller wards is likely to cause some increase in the total cost of the hospital. The increase, however, need not be great, probably of the order of £4 to £9 per bed, for a moderate degree of subdivision, such as the substitution for the 26 bed ward of one ward of 18 and two of 4 beds, or of one ward of 14 and three of 4 beds. Indeed, if the subdivision goes no further than to replace the large main ward by two smaller wards, a plan might be devised which would involve no extra cost.

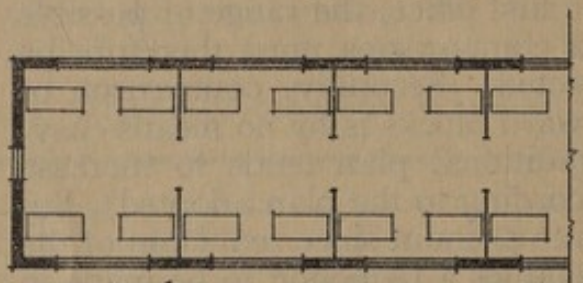
Arrangement of Beds in Wards.



Transverse arrangement of beds



Longitudinal arrangement with lateral gangway.



Longitudinal arrangement with central gangway.

46. The usual arrangement of beds in large wards consists of two rows of beds with the heads against opposite walls, each bed-head occupying the space between two windows. In recent years, however, a different arrangement has been gaining favour whereby the beds are placed parallel to the long axis of the ward, and a number of advantages have been claimed for this variation.

(*a*) It is said to provide pleasanter and more comfortable conditions for the patients than the transverse position; they can look out of the window more easily and do not lie directly facing the light. It is particularly suited to wards with an East-West axis in which, with the transverse arrangement of beds, half the patients face North.

(*b*) It lends itself to the division of wards, by screens, into groups of two beds on each side of a central gangway, or of four beds on one side of a lateral gangway, thus affording, in a large ward, some of the agreeable features of a series of small wards. The accompanying diagrams illustrate these arrangements. The screens do not very materially reduce disturbance by noise, but they do give a certain degree of privacy to each group of patients.

(*c*) The longitudinal arrangement of the beds permits of nearly the whole of one or both sides of the ward being composed of windows. This, together with the lesser width which is appropriate to the disposition of the beds, allows the sun to penetrate into and flood the whole ward to an extent that can never occur in the broader ward with narrower windows. Also, if the windows are made to open to their full extent, patients can be nursed under

practically open-air conditions. Doubts have been raised whether the amount of light admitted by very extensive windows may not sometimes be too great for the patients' comfort, and it is certainly necessary to provide them with efficient sun protection. The size of windows adopted is, however, a matter of choice, and it can safety be said in favour of this disposition of beds that it permits of greater freedom in window treatment than is possible with the more usual transverse arrangement.

The claims mentioned under (*a*), (*b*) and (*c*) have considerable force, but the experiment has scarcely gone far enough to justify positive statements as to the preference of patients. On this point we have received conflicting evidence which no doubt corresponds to differences in the taste of individual patients.

47. As regards the effect on cost of construction, it is claimed that the cost is somewhat reduced owing to the lesser width of the ward. To suit the longitudinal disposition of the beds the wards are longer and narrower than those with beds placed transversely. There is no substantial difference in the total area required, but it is claimed that the narrower span leads to more economical floor construction. It does not appear that there is much substance in this claim, but the narrowness and subdivision of the wards permits of a reduction in height.

48. The screens which divide the wards into bays are an additional item, the cost of which must be taken into account. For the division of a large 24 bed ward into six bays of four beds each, on one side of the ward, the cost would be about £150, at about £30 a screen, and for the formation of 12 bays of two beds each, six on each side of the ward, the cost would be about £170, at about £17 a screen. If, however, an ordinary long ward is divided into sections by transverse glazed partitions the difference in cost between the partitions in the one case and the screens in the other would not be material.

49. A saving claimed for the ward with one or both sides occupied almost entirely by windows is that, since open-air conditions can be obtained in the ward itself, verandahs or balconies are unnecessary. As the value of a verandah or balcony at the end of an ordinary ward seems to be generally accepted, this claim has some force, the cost of verandahs and balconies being considerable. It must be borne in mind, however, that an increase in window surface increases the cost of heating.

50. It has been suggested as an objection to the longitudinal arrangement of the beds that the position of the patients and the effect of the screens in obstructing a clear view of the whole of the ward make supervision by the nurses more difficult, and the opinion has been expressed to us that an additional nurse

would be required in a unit of this kind. From the point of view of economy this would be much more important than a small variation in the cost of construction, but we doubt whether, at present, the difficulty of supervision can be assessed in terms of the additional staff that it would necessitate.

51. We are of opinion that the large ward with beds disposed longitudinally should be regarded as still on its trial. We look on it as an interesting innovation which, so far as can be seen at present, does not appear likely to affect constructional costs materially, though there seems to be some reason to fear that it may involve additional expense in working.

In the case of small wards of two or four beds, it is of course no innovation to place the beds parallel to the windows, and this requires no special comment.

Ward Dimensions and Bed Space.

52. The only recent British standards available as to ward dimensions and bed space are those contained in:—

(1) The Ministry of Health's " Memorandum on the Construction of Poor Law Infirmaries ", 1924.

(2) The Voluntary Hospitals Commission's " Memorandum on the Construction of Voluntary Hospitals ", 1926.

(3) The Tenth Annual Report of the Scottish Board of Health, 1928; Chapter V—" Hospital Planning and Construction ".

(4) The Regulations for the Medical Services of the Army, 1932.

53. The following are the relevant passages from these documents:—

Ministry of Health.

" 24 feet is recommended as the best width for the main wards. In wards for acute sick the wall space per bed should be 8 feet . . . The height of large wards should not be more than 12 feet nor less than 11 feet ".

Voluntary Hospitals Commission.

" In main wards for adults, a wall space of 8 feet per bed should be allowed, a floor space of not less than 96 square feet, and a cubic space of not less than 1,056 cubic feet . . . The height of the large wards should not be more than 12 feet nor less than 11 feet, but in the smaller wards a minimum of 10 feet can be accepted ".

Scottish Board of Health.

" Wards should be 24 feet wide with a head space of 8 feet 6 inches per bed. This gives a floor area of 102 superficial feet per bed. The height of the ceiling may be 12 to 13 feet, but in small wards of one or two beds a height of 10 feet is sufficient ".

Army Regulations.

" Floor and cubic space for each bed in hospital. The following table shows the authorised superficial area and cubic space for each bed:—

Home Stations.

Height to wall plate or ceiling, 12 feet.

Floor space, 100 square feet.

Cubic space, 1,200 cubic feet."

54. It is to be understood that in adopting the following standards of ward dimensions and bed space we have had in mind the traditional arrangement of the beds in main wards in which they are placed in two rows with their heads against opposite walls. Further, we have not allowed for any variations which might be necessary in the case of a teaching hospital.

55. Discussions as to the number of cubic feet of air per hour required by patients and as to the amount of cubic space and frequency of air renewal necessary to provide this are to be found in many text-books, but we are of opinion that sufficiently exact data do not exist on which to base a confident opinion in respect of the space desirable on hygienic grounds. Moreover, there is very general agreement, in which the witnesses who gave evidence concurred, in regarding height as relatively unimportant in comparison with floor area and distance between bed centres, and we are of opinion that if adequate area per bed and, more especially, sufficient distance between adjacent beds are provided the demands of hygiene will be satisfied, leaving the height to be determined mainly by considerations of proportion and amenity. Accordingly, the standards we have adopted have been based upon the amount of space required for convenient working. In adopting this criterion, however, we believe that the resulting dimensions are adequate also from the hygienic point of view.

56. The distance between beds is regarded as of primary importance in connection with the danger of the spread of infection, but, on the one hand, while it appears that no reasonable amount of wall space would confer absolute immunity from risk, yet on the other hand the exact point at which the

risk is reduced to a negligible quantity has not yet been determined. We have, however, found general agreement that for convenience of nursing in acute medical and surgical wards a wall space of 8 feet per bed is required and that this provides as high a degree of safety from the spread of infection as can reasonably be demanded. We have, therefore, adopted 8 feet between bed centres as our standard.

57. As regards width of ward, no precise standard appears to have been laid down prior to the issue of the "Memorandum on the Construction of Poor Law Infirmaries" by the Ministry of Health in 1924. Standards of bed space were expressed in terms of superficial area and cubic space per bed, and it seems to have been generally accepted that in voluntary hospitals a *minimum* of 100 square feet and 1,200 cubic feet per bed should be allowed. With 8 feet between bed centres, the width of ward required to provide an area of 100 square feet per bed is 25 feet, but in pre-war voluntary hospitals both greater and lesser widths are not uncommon.

The standard width adopted by the Ministry of Health in 1924 was 24 feet, while a width of not less than 24 feet is implied in the standard of the Voluntary Hospitals Commission, quoted in paragraph 53. It should be remembered that the Ministry's standard width was a standard for Poor Law Infirmaries and was applied at a time when, generally speaking, these infirmaries, although providing treatment for acute medical and surgical cases, were not called upon to cope with the volume and character of work now undertaken in first-class municipal hospitals.

58. In determining the width of wards, adequacy of working space in the centre of the ward is the most important consideration. The beds on each side of the ward project about 7 feet from the walls and thus occupy about 14 feet of the ward width leaving, in a ward 24 feet wide, a central space of 10 feet between the two rows of beds. The main question to be decided is whether this is sufficient for convenient working. The central space is partly occupied by furniture and equipment, while screens surrounding beds and (in surgical wards) projecting fracture frames encroach upon it from the sides. Work in the ward is facilitated if articles which are frequently and, at times, urgently required are immediately at hand; and, accordingly, the customary practice of having a certain amount of furniture and equipment ranged along the centre of the ward is usually considered to be more convenient than providing space for it elsewhere. The ordinary traffic of the ward proceeds along the gangways between the central furniture and the beds. This traffic is very considerable; the staff pass to and fro, patients, food and the apparatus of treatment have to be conveyed along the gangways, which must therefore be wide enough to permit of the easy passage of beds and stretchers and the

manipulation of trolleys. On the other hand, it is recognised that the discontinuance of the practice of having stoves in the centre of the ward has contributed towards freeing the central gangway.

59. We received evidence in favour of a greater width of ward than 24 feet from two witnesses which, in view of their own wide experience and that of those whom they represented (the Medical Superintendents Society and the Association of County Medical Officers of Health) deserves careful consideration. Both these witnesses stated that experience of wards 24 feet wide had shown that they were too narrow for convenient working. One of them was satisfied with 25 feet, while the other advocated 26 feet.

60. The London County Council, as a result of experience of wards of various widths, have come to the conclusion that a width of 24 feet is insufficient, and have adopted 26 feet as the standard width for all types of wards to be erected in the future at the Council's general hospitals.

61. The opinions of the medical witnesses referred to above, based as they are on practical experience of wards of varying width, must carry considerable weight, and their view is reinforced by the decision of the London County Council to adopt 26 feet as a standard width. The width of wards is of great importance in relation to convenience and rapidity of work; and, as will be seen from paragraph 66 below, the effect on cost of a variation of one or two feet in the width of a ward is comparatively small.

62. The appropriate width for main wards has been the subject of much discussion in the Committee, but we have been unable to reach complete agreement upon it. A majority of our members have come to the conclusion that the standard width should be stated as not less than 25 and not more than 26 feet. On the other hand, some of our members, having regard to the fact that wards of 24 feet have been provided in a number of hospitals in recent years, are not convinced of the need for a greater width than 24 feet.

63. Single-bed rooms require a slightly larger area than the area per bed allowed in multiple wards. A suitable size is 10 feet by 11.

64. We regard a height of 11 feet as sufficient for wards containing not more than 16 beds, but for longer wards, if not divided by transverse partitions, a height of 12 feet is desirable. The height of the small wards and ancillary rooms will usually be determined by the height of the main ward, but where this does not obtain we regard 10 feet as sufficient for small wards

up to six beds and nine feet for single-bed wards. Reference to the effect of height on cost will be found in paragraph 66 below.

65. As regards the most suitable dimensions for a large ward with the beds arranged longitudinally we do not consider ourselves to be in a position to prescribe standards. Two well-known recent examples of this type of ward* are those in the Hertford County Hospital and the Southend-on-Sea General Hospital. In the former the wards are 20 feet wide and the beds are arranged in groups of four at one side of the ward, with a lateral service gangway. The groups of four beds are separated by transverse screens extending about two-thirds of the width of the ward. The distance between screens is 20 feet. Each section of the ward therefore has an area of 400 square feet or 100 square feet per bed. At the Southend Hospital the beds are arranged along each side of the ward with a central gangway, and transverse screens on each side divide the beds into groups of two. The distance between screens is 18 feet and the width of the wards 22 feet, giving an area of 99 square feet per bed. It will thus be observed that in these two examples the floor area per bed corresponds very closely with our standards for the more usual type of ward.

66. Our inquiries have shown how slight is the amount of saving which can be effected by a small reduction in the dimensions of a main ward. The effect of varying the *length* of a 26 bed ward by one foot would be to increase or decrease the cost by 8s. to 9s. per bed, according to the number of storeys. The effect of varying the *width* of a similar ward by one foot would be about £1 2s. to £1 5s. per bed, according to the number of storeys.

In considering the effect on cost of variations in the *height* of a main ward, it is necessary to bear in mind that the height of the main ward, except in a building of only one storey, governs the height of the rest of the ward unit and (in varying degree, according to the general plan adopted) the height of main corridors, staircases and lift shafts. The effect on cost of a variation of one foot in height would be approximately £4 to £5 per bed.

Verandahs and Balconies.

67. Verandahs and balconies are very desirable accessories to wards, but are inevitably somewhat obstructive to the windows that they cover. For this reason they should be placed at the end rather than at the side of the customary long rectangular ward block. They may form an expanded end

* Diagrams illustrating this type of ward will be found in paragraph 46 above.

to the ward block but, in order to avoid obstructing the side windows, their width should not greatly exceed that of the ward. A suitable depth (from front to back) is about 14 feet.

Verandahs and balconies may be used either for temporary occupation in suitable weather, or for permanent occupation by patients undergoing open-air treatment, or both. If they are to be used for permanent occupation they should be completely enclosed (but with sliding windows giving the maximum possibility of open-air conditions) and should be provided with artificial lighting and some form of heating.

The Ancillary Rooms in a Ward Unit

68. The ancillary rooms which appear to us to be necessary in a ward unit are as follows:—

(*a*) Sluice room.
(*b*) Space for testing.
(*c*) Staff lavatory and W.C.
(*d*) Cleaners' room.
(*e*) Bathroom.
(*f*) Patients' lavatory and two W.Cs.
(*g*) Ward office.
(*h*) Ward kitchen.
(*j*) Duty room.
(*k*) Linen store.
(*l*) General store.
(*m*) Lighted recess.

69. With reference to the *sluice room,* there is obvious inconvenience in the long carrying distance for bedpans from the far end of a long ward to a sluice in the ancillary section. To meet this a second sluice room may be provided in the case of a ward of 20 beds and upwards, either at the far end of the ward or at the side, near the centre, in a projecting annexe. There are objections to the latter position when a ward has a North-South axis and the transverse arrangement of beds, and it almost necessarily involves the omission of a bed or the addition of five or six feet to the length of the ward.

A small balcony or other provision for soiled linen is useful.

70. A separate *test room* is sometimes provided, but if only such simple testing as the routine chemical analysis of urine is done within the ward unit a recess may be sufficient.

71. As regards the *ward office,* the question whether the sister in charge of the unit should have a separate room in

which to keep her papers and do her writing, etc., is one on which there is a great difference of opinion. Some of our witnesses have emphatically declared that the sister should have her writing-table in the main ward so that she can supervise the patients and the work of the ward as continuously as possible. We consider, however, that there is need for a ward office which, can be used by the sister and doctors for records, correspondence, etc., and which is also available for consultations and interviews.

72. The *ward kitchen* is intended only for the service of meals and the preparation of light meals, tea, etc.

It is therefore necessary to provide a *duty room* in which sterilisation and various other processes in connection with the medical and nursing work of the ward can be carried out.

73. In connection with the *linen store*, there is general agreement that each ward unit should have its own complete working stock of linen, for which the sister is responsible, and accordingly a linen store is necessary. Some provision for patients' clothes may be required in the ward unit, but it need not be extensive and a cupboard should suffice.

74. The *general store* is required for miscellaneous articles, some of them bulky, such as bed rests, cradles, splints, water beds, air cushions, etc. This is a very necessary provision as it is not uncommon to find hospital wards embarrassed by the lack of storage accommodation, resulting in various articles being stored in bathrooms and other unsuitable places.

75. Where ancillary and one-bed rooms are arranged along the two sides of a corridor of any considerable length, it is necessary to leave a free space, at least on one side, to allow direct access of light and air to the corridor. We think that this might take the form of a *lighted recess* which could be used as a dayroom for convalescent patients. The number of patients who are able to be up in a ward unit for acute cases is not large, though it is larger in municipal than in voluntary hospitals, because patients are commonly retained in the former till their recovery is farther advanced. We think that a fairly large recess, which could be provided with a fire, might serve as a dayroom for the few patients who would be able to make use of it and as a waiting place for visitors.

76. The ancillary rooms mentioned in paragraph 68 are those which we consider to be necessary in a municipal hospital of the first class; they might not entirely meet the needs of some hospitals and might not all be required in others, but they appear to us to constitute a good standard.

77. The dimensions of the various rooms will be to some extent affected by the exigencies of planning, but we consider the following areas as suitable:—

	Area in square feet.
Sluice room	100
Space for testing	30
Bathroom	70
Ward office	70
Ward kitchen	200
Duty room	100
Linen store	70
General store	70
Lighted recess and dayroom	100
Total	810

The branch corridor leading to the main ward should be 7 feet wide, to facilitate wheeling beds or stretchers into the side wards.

78. The area of a ward unit containing a main ward of 26 beds and four one-bed wards would be as follows:—

	Area in square feet.	
Main ward (105 ft. by 25 ft.) ...	2,625	
Four small wards (each 11 ft. by 10 ft.)	440	
		3,065
Ancillary rooms of the areas given in paragraph 77	810	
Patients' lavatory and W.C.s., staff lavatory and W.C., cleaners' room, corridor and partitions	830	
		1,640
Total area of ward unit within outer walls		4,705

It will be seen that of the total area slightly less than two-thirds is occupied by wards. In the above figures no allowance is made for staircases and lift, nor for a verandah or balcony.

IV.—The Operating Theatre Suite.

79. Operating theatres should be situated so as to be convenient of access from the wards, especially the surgical wards, and should be lighted from the north. If there is no building over the theatre suite the possibility of using roof lighting for some of the rooms facilitates planning. Where more than one theatre is required there is both convenience and economy in combining two theatres in one suite so arranged that certain ancillary rooms can be common to both.

80. We consider that the following rooms and dimensions represent a good average provision of accommodation for an operating theatre suite in a non-teaching hospital:—

	Single-Theatre Suite.	Twin-Theatre Suite.
	Dimensions or Size of Room.	Dimensions or Size of Room.
Theatre	22 ft. × 18 ft.	22 ft. × 18 ft. (Two)
Anæsthetising Room	140 sq. ft.	140 sq. ft. (Two)
Sterilizing Room and Hand Washing Facilities for Surgeons and Nurses...	230 sq. ft.	300 sq. ft.
Instrument Cleaning and Sink Room	90 sq. ft.	130 sq. ft.
Plaster Room (which might on occasion be used as a Recovery Room) ...	140 sq. ft.	140 sq. ft.
Linen and Dressings Room	—	140 sq. ft.
General Store	—	80 sq. ft.
Sister's Room	—	100 sq. ft.
Combined Linen and Dressings Room, General Store, and Sister's Room ...	170 sq. ft.	—
Nurses' Change Room and W.C. ...	120 sq. ft.	130 sq. ft.
Surgeon's Change Room, Shower and W.C.	150 sq. ft.	160 sq. ft.
Corridor	8 ft. wide	8 ft. wide
Taking advantage of roof lighting for some of the rooms, the above provision can be made within a total area inside external walls of ...	1,850 sq. ft.	2,900 sq. ft.

The height of the theatre and the sterilising room should be 12 feet, and of the other rooms 10 feet.

81. The theatre should not open directly off the main corridor but should be approached by a branch corridor 8 feet wide, which should also give access to the ancillary rooms. The anaesthetising room should be entered from the branch corridor.

It is desirable that there should be direct access from the anaesthetising room to the theatre. Exit from the theatre should not be through the anaesthetising room.

82. The size of the sterilising room is based on the assumption that the dressings steriliser, which usually supplies sterilised dressings to the wards as well as to the theatre, will not be in the theatre sterilising room. The surgeons' and nurses' hand-washing facilities should be outside the theatre, but immediately adjoining it with open communication.

83. In the case of a single-theatre suite the linen and dressings room and the general store can be combined in one room which can also serve as a sister's room. In a double-theatre suite it is preferable to separate the linen and dressings room from the general store, and to provide a sister's room in addition.

84. The instrument cleaning and sink room is intended for the washing of instruments and mackintoshes, and the disposal of surgical waste and dirty theatre linen. It should contain a slop hopper sink and an ordinary deep sink and draining board. Direct access to the outside for linen bins should be provided, and both the instrument cleaning and sink room and the sterilising room should open directly off the theatre without doors.

V.—The Reception and Out-Patient Departments.

85. The following quotation from the Annual Report for 1932 of the Chief Medical Officer of the Ministry of Health is of interest as indicating the functions of the Out-Patient Department of a Municipal Hospital:—

> "A well-organised Out-Patient Department should fulfil the following functions, namely:—
>
> (*a*) The Reception Department, where patients for admission to the hospital can be examined. The Medical Officer conducting the examination should be thoroughly conversant, not only with the resources of the particular hospital at which he works, but also with the facilities provided by the Local Authority's health services and the voluntary medical agencies in the district. This will enable him to refer to the appropriate clinic, hospital, institution, or agency, patients who either do not require hospital treatment or whose condition could be better met elsewhere.
>
> (*b*) The Casualty Department, where emergency treatment is rendered.
>
> (*c*) The centre at which continuation treatment is provided for patients who have been discharged from hospital.

(*d*) The consultative centre for specialist investigation and treatment which cannot be efficiently given in the home but does not necessitate the admission of the patient to hospital, and to which patients from the Local Authority's clinics, etc., may be referred ".

For our purposes it will be convenient to consider the Reception and Out-Patient Departments separately.

Reception Department.

86. In municipal hospitals it is usual to have a Reception Department in which patients are received and examined before being sent to the wards. The Reception Department is open at all hours of the day and night, and accident and other emergency cases brought to the hospital by police ambulance or otherwise pass through it before being sent to the wards or sent home. The Department therefore often serves as a combined Reception and Casualty Department. It should have an entrance separate from the main entrance of the Administration Block.

87. A small waiting-room and at least two examination rooms are necessary. Where the number of admissions warrants it, the examination rooms may be subdivided into cubicles. There should be sanitary provision, including at least one bathroom, space for a sink and steriliser, and a bay or recess for a wheeled stretcher. A nurses room and a room for surgical dressings and minor operations should be provided. At least one single-bed ward is desirable, and this should have a separate exit for the removal of an infectious patient. Suitable dimensions for these rooms would be:—

Waiting room	200 sq. ft.
Examination room ...	150 sq. ft. if undivided.
Examination room ...	270 sq. ft. if divided into 2 cubicles.
Examination room ...	340 sq. ft. if divided into 3 cubicles.
Nurses room	80 sq. ft.
Surgical dressings room and minor operation theatre	230 sq. ft.
Single-bedded ward ...	110 sq. ft.
Bathroom	100 sq. ft.

Out-Patient Department.

88. The Out-Patient Department is open at fixed times, mainly for consultation and for supervision and treatment of patients who have been discharged from hospital. It requires waiting, consultation and examination rooms, with the necessary sanitary provision and facilities for any forms of treatment that may be undertaken. This is a developing service in municipal

hospitals, and it does not appear that the out-patient practice of Local Authorities has yet become sufficiently standardised to enable us to suggest standards for the Department.

VI.—The Special Departments.

89. We have given consideration to the requirements of the Special Departments, some or all of which would be included in an acute general hospital.

X-Ray Department.

90. We are of opinion that the X-Ray Department is not suitable for the application of standards, as both the number and size of the rooms required vary according to the extent and nature of the work to be done, and this differs very considerably in different hospitals. We desire, however, to draw attention to the following recommendations contained in the Fourth Revised Report (June, 1934) of the British X-Ray and Radium Protection Committee:—

> "5. All rooms, including photographic dark rooms, should be provided with windows, affording good natural lighting and ready facilities for admitting sunshine and fresh air whenever possible.
>
> "6. All rooms, including photographic dark rooms, should be provided with adequate exhaust ventilation capable of renewing the air of the room not less than 10 times an hour. Low-level air inlets and high-level outlets should be arranged to afford cross-wise ventilation of the room.
>
> "7. All rooms should preferably be decorated in light colours.
>
> "8. A working temperature of about 18° to 21° C. (65° to 70°F.) is desirable in X-ray rooms.
>
> "9. X-ray rooms should be large enough to permit a convenient layout of the equipment. A minimum floor area of 250 sq. ft. (25 sq. m.) is recommended for X-ray rooms, and 100 sq. ft. (10 sq.m.) for dark rooms. Ceilings should be not less than 11 ft. (3·5 m.) high.
>
> "10. X-ray generating apparatus employing mechanical rectifiers should preferably be placed in a separate room from the X-ray tube".

Further advice on protection questions can be obtained from the National Physical Laboratory of the Department of Scientific and Industrial Research.

91. In planning an X-Ray Department, the plant should be decided upon before the building is planned, and it should be remembered that as X-ray work develops there is a tendency for more apparatus to be needed. Accordingly, it is sound policy to provide space somewhat in excess of initial requirements, and to plan in such a way as to facilitate future extension.

Department for Massage, Electrical and Light Treatment, Etc.

92. For this Department, also, it is impossible to lay down standards, in view of the progressive development of the work and consequent changes in the apparatus. Many existing hospitals are in difficulties through lack of space in this Department, and it is essential that the equipment required should be first considered and the Department planned in accordance therewith, space being allowed for possible future development.

Laboratory.

93. Every general hospital requires a laboratory, but its size and equipment will depend upon whether the hospital laboratory is to be self-sufficient or whether it is to deal only with certain classes of work while others are sent to a central laboratory working for a number of hospitals. The latter practice is followed by the London County Council and by some of the larger provincial Local Authorities. On the other hand, work for other services of the Local Authority may be done in the hospital laboratory, in which case more space may be needed than is required for the hospital work alone.

Owing to the difference in practice and the varying requirements of different hospitals we do not feel able to recommend standards for this Department.

VII.—The Administrative and Certain Other General Services

94. In this Section we deal with the requirements of a group of general services for which provision is commonly made either in a single Administration Block or in a group of contiguous and closely related buildings. Our recommendations are intended to apply to an acute general hospital of about 400 beds, and might require modification in the case of smaller or larger hospitals or to meet special circumstances.

95. Economy in planning as well as convenience and economy in administration can usually be effected by concentrating in a central Administration Block or group of buildings the following:—

(1) Committee room and offices for administrative officers and clerks.
(2) Main kitchen.
(3) Dining rooms for resident and non-resident staff of different grades.
(4) Central stores.
(5) Dispensary.
(6) Waiting accommodation for patients' friends.
(7) Cloakroom and sanitary accommodation.
(8) Quarters for the Matron and Resident Medical Officers.

Our comments on (1) to (7) are contained in the paragraphs which immediately follow, but (8) is dealt with in Section VIII: "The Residential Accommodation".

96. The entrance to the hospital grounds is commonly controlled from a porter's lodge, but economy in staff results if a separate porter's lodge can be dispensed with and the inquiry office and telephone exchange located in the Administration Block. This may not always be possible, but when it can be achieved there should be the following entrances to the Administration Block:—

(*a*) Main entrance with inquiry office combined with telephone exchange. The entrance hall should contain a telephone kiosk for staff and visitors and a post box.

(*b*) Separate goods entrance to the Stores Department.

Offices

97. The following office accommodation is required:—

(*a*) Medical Superintendent's offices.

(i) Private office.

(ii) Clerks' office for two clerks.

(iii) Record room, including provision for old case-papers.

(*b*) A room for visiting medical staff.

(*c*) Matron's offices:—

(i) Private office.

(ii) Office for Assistant Matron or clerk. This room can also be used as a Night Superintendent's office.

(*d*) General waiting room. This will serve for candidates for appointment to the staff, persons waiting to see the Medical Superintendent or the Matron, etc.

(*e*) Committee room.

(*f*) Steward's offices.

(i) Private office.

(ii) General office.

(*g*) Almoner's Department. The appointment of Almoners in municipal hospitals is a comparatively recent innovation, but is now regarded as essential. In addition to the Almoner's room, a clerical office and a waiting room may be required. The work is likely to increase, particularly in connection with the Out-Patient Department, and adequate provision should therefore be made for its development.

(*h*) Patients library, which may be used as a social workers' room. This room, which may with advantage be near the Almoner's Department, is mainly for the use

of voluntary workers who visit the hospital to provide recreative, educational and occupational facilities for the patients.

(*j*) A Chaplain's room unless there is a chapel in which case the Chaplain's room would probably be associated with it.

Main Kitchen

98. The main kitchen supplies the patients' meals, and usually the staff meals, though in some hospitals there is a separate staff kitchen. We are of opinion that the provision of one kitchen to serve both patients and staff, whether the staff are housed in the Administration Block or elsewhere, is undoubtedly the most economical arrangement both in initial cost of construction and also in the subsequent cost of operation, since it leads to a saving of staff and enables the whole organisation to be placed under one skilled supervisor. Special consideration should be given to staff meals, but we do not think that they need lose in attractiveness through being cooked in the main kitchen, if suitable administrative measures, such as the appointment of an assistant cook for the staff, are taken.

99. The kitchen is usually placed on the ground floor. Objection is sometimes taken to this position as likely to give rise to the penetration of the smell of cooking to other parts of the hospital, but we consider that this objection can be met by suitable planning. Elevation of the kitchen to an upper floor complicates the transportation of supplies from the stores and of food to the wards and staff dining rooms.

100. The kitchen section is one which does not readily lend itself to the establishment of standards. We have collected information bearing on the size of the kitchen, but do not feel able in this Report to advise as to an area which would be generally suitable. A kitchen that is too large is likely to be as inconvenient as one that is too small, and before the kitchen is planned the equipment which is to be installed should be determined.

101. Owing to its central situation the kitchen section is often not capable of easy extension, and in the past when hospitals have been extended by the erection of additional ward blocks difficulties have sometimes arisen in providing for the necessary enlargement of the kitchen accommodation. The possibility of such an extension should therefore be borne in mind when the hospital is originally planned, and the kitchen section so designed as to be readily capable of expansion. If the ultimate requirements can be foreseen the best plan will often be to build the kitchen at the outset to the ultimate size,

and devote part of the space to stores until the whole accommodation is required for the kitchen. The building of additional stores is likely to be an easier matter than extending the kitchen.

Staff Dining Rooms

102. Staff dining rooms should be in proximity to the main kitchen in order to diminish transportation of food and ensure freshness of service. The opinion has been expressed that a periodic escape from the hospital atmosphere should be provided by serving the meals of the nursing staff in the Nurses' Home. Against this must be placed the inconvenience of travelling a distance, frequently in the open, for each meal, and this objection is particularly marked in the case of such meals as mid-morning tea, afternoon tea and, above all, the night nurse's meal. In some hospitals the night nurse's meal is cooked and eaten in the ward kitchens, but this practice has grave disadvantages, and in progressive hospitals a properly cooked meal is provided in the dining room. Further, if the dining rooms are in the Nurses' Home food must be transported to them from a distance, unless a separate Home kitchen is provided. In some instances, e.g., in a very large hospital, it may be justifiable to provide dining rooms and a separate kitchen in the Nurses' Home, but we are satisfied that as a general rule the provision of one central kitchen with all staff dining rooms in its immediate proximity is an economy.

103. Separate dining rooms should be provided for (*a*) sisters, (*b*) staff nurses and probationers, and (*c*) female domestic staff, and it may be useful to have folding doors between the sisters' and the nurses' dining rooms so that the two can be thrown into one for entertainment purposes. The size of the dining rooms should be based on an allowance of 12 square feet per person on the maximum number expected to be present at any meal. Small tables for four to six persons should be regarded as the standard provision. Although they involve a slightly larger space per person, small tables are more sociable than long tables, and they facilitate the clearing of the dining rooms for cleaning or for entertainments.

104. In some cases, dining room accommodation may also be necessary for officers who are normally non-resident such as clerical staff, male nursing staff or attendants and male domestic staff. The number of separate dining rooms for non-resident staff should, however, be kept as low as possible.

Central Stores.

105. A central position for the main stores is essential for convenience in issuing to the wards and to the various Departments. These stores are chiefly under the control of the Steward,

although Matron's stores are usually also required. The Steward's stores should provide accommodation for the following, but a separate room may not be required for each section:—

(*a*) Engineer's stores, so far as they are not under the control of the Engineer.

(*b*) Crockery of all kinds.

(*c*) Domestic appliances and cleaning materials.

(*d*) Hardware.

(*e*) Textiles, clothing and bedding.

(*f*) Dry food, such as tea, sugar, cereals, flour, etc.

(*g*) Milk store and distribution room, with provision for washing and sterilising milk pails.

(*h*) Butcher's shop and meat and fish store.

(*j*) Vegetable store.

The provision for food should be atmospherically separated from that for other articles, and should include cold storage accommodation. A small office for a store-keeper may be required. If there is a basement it can be used for many of the above purposes.

An isolated store must be provided for paraffin, colza oil, methylated spirit, ether, floor cleaning materials, etc.

Dispensary.

106. The dispensary should be so situated as to be convenient for distribution both to the wards and to the Out-Patient Department. There should also be a dispensary store of about 300 square feet, with convenient access for the delivery of goods.

Waiting Accommodation for Patients' Friends.

107. Some waiting room accommodation must be provided for the relatives or friends of patients who are dangerously ill or who are undergoing an operation. The minimum requirement is a comfortable warmed room, but it is sometimes considered necessary to provide couches and a canteen for people who have to wait for a long time.

108. Covered waiting accommodation for patients' visitors assembling on ordinary visiting days is also required, but as a rule this would not be in the Administration Block. It should be near the main entrance and should be so situated to give ready access to the wards. In some hospitals use is made of the Out-Patient Department for this purpose on Sundays and

other days when it is not open for treatment. In recent years there has been a great increase in the numbers of patients' visitors, and the problem which their accommodation presents is difficult to solve. While we recognise that on visiting days the stream of visitors is considerable and that some waiting accommodation is required for them, we consider that in the interests of the patients themselves as well as in the interests of general convenience and economy in planning the number of visitors per patient should be strictly limited and that suitable administrative measures should be taken to enforce this rule. If this were done there should be no occasion for large numbers of visitors to wait in or at the entrance to the hospital for long periods.

Staff Cloakroom and Sanitary Accommodation.

109. Cloakroom and sanitary accommodation is required in connection with the offices specified in paragraph 97. In the past, separate sanitary provision has sometimes been made for each of the principal officers. This is unnecessary, and with careful planning the requirements of the Committee, the Medical Superintendent, the visiting medical staff, the Matron, the Steward and the Chaplain can in most cases be met by two cloakrooms, one for each sex.

110. Further sanitary accommodation is necessary as follows:—

(i) Nursing staff; in connection with the dining rooms. This will also serve the needs of female clerks and assistants in the laboratory, dispensary, etc.

(ii) Male clerical staff.

(iii) Porters and male domestic staff.

(iv) Female domestic staff.

111. Cloakrooms, fitted with long lockers, should be provided for such of the following grades of non-resident staff as may be employed at the particular hospital:—

(i) Non-resident nursing staff, female.

(ii) Non-resident nursing staff, male.

(iii) Non-resident domestic staff, female.

(iv) Non-resident domestic staff, male.

This need is often not adequately met, but accommodation can be quite satisfactorily provided in basement premises, thus saving valuable space on the ground floor.

Separate sanitary accommodation for non-resident staff is not generally necessary, as it should be possible for them to share the accommodation provided for the appropriate resident grades.

Patients' Clothing Store.

112. Provision should be made for storing patients' clothing either in or near the Administration Block. This should be on the basis of about 25 per cent. of the number of patient beds, and an area of about 130 sq. ft. should be sufficient. It should be in addition to the small accommodation made for the same purpose in the ward blocks.

General Planning Considerations.

113. In planning the Administration Block, it will be useful to bear in mind the following general principles governing the relative positions of certain departments:—

(1) The offices of the Medical Superintendent, the Matron, and the Steward should be near the main entrance.

(2) The stores on the one hand, and the dining rooms on the other, should be situated in convenient relation to the main kitchen.

(3) The dispensary should, if possible, be placed so as to be conveniently accessible from the main corridor for service to the wards, and from the Out-Patient Department.

Laundry.

114. The laundry is referred to in this Section as one of the general services, although it does not usually form part of the Administration Block.

A laundry is not an essential part of a hospital. It is not unusual for the washing for a hospital to be done at the laundry attached to another hospital or institution, and some Local Authorities have established independent central laundries to undertake the laundry work for a number of institutions.

115. If a laundry is provided it should be situated in convenient relation to the central boiler house. The size and planning of the laundry will depend on the number of articles to be washed and the equipment necessary for this purpose. We were desirous of giving information as to the appropriate floor area required for the laundry, and have made enquiries with this object, but areas of existing hospital laundries and statements furnished by manufacturers of laundry equipment show such wide variation that at this stage we are not able to recommend a standard.

VIII.—The Residential Accommodation.

Extent of Accommodation Required.

116. The question of staff accommodation is linked up with the Administration Block, in so far as accommodation is usually provided in that block for at least some of the staff.

The requirements must necessarily vary in different hospitals according to their situation and other circumstances. For example, both the nurses' working hours and the class of work done in the hospital have a bearing on the number of nurses required. Again, although there must be some resident domestic staff, it is usual for some to be non-resident, the proportion varying considerably. Male attendants, engineers, porters, gardeners, etc., are commonly non-resident, and we have not thought it necessary to discuss the provision of quarters for them.

117. In arriving at the following recommendations we have assumed that in an acute general hospital of about 400 beds the staff for whom *residential* accommodation must be provided would approximate to the following:—

Medical Superintendent	1
Deputy Medical Superintendent	1
Other Medical Officers	5
Matron	1
Assistant Matron	1
Home Sister and Sister Tutor	2
Ward and other Sisters	18
Staff Nurses	16
Probationers	95
Maids, kitchen and personal	24

It is not the function of this Committee to specify the numbers of staff that should be provided, and indeed, as already indicated, this must vary according to circumstances. The numbers mentioned in this paragraph are intended only as a rough guide. In Appendices II and III will be found statements showing the nursing staff employed in a number of London County Council and provincial municipal hospitals.

The Medical Staff.

118. A separate house should be provided for the Medical Superintendent, and small houses or self-contained flats for one or more married Medical Officers. We desire to emphasise the importance of this, as without the provision of such separate accommodation outside the Administration Block it is difficult to retain the right type of man in the hospital medical service.

We suggest the following accommodation as being suitable for these purposes, the total areas given being those within external walls:—

Medical Superintendent of a large hospital.	3 living rooms. 5 or 6 bedrooms. 2 bathrooms and cloakroom. Large kitchen, or small kitchen and maids' sitting-room. Total—3,000 sq. ft.
Medical Superintendent of a medium sized hospital—say 400 beds.	Slightly smaller than above, but 5 bedrooms. Total—2,750 sq. ft.
Deputy Medical Superintendent of a large hospital.	3 living rooms. 4 bedrooms. Bathroom. Kitchen. Total—2,250 sq. ft.
Married Medical Officers. Small house or self-contained flat.	2 living rooms. 3 bedrooms. Bathroom. Kitchenette. Total (if a house)—1,650 sq. ft.

119. Other resident medical officers may be housed in the Administration Block. This has the advantage that their quarters are at the administrative centre of the hospital, in convenient relation to the wards, and also near the main kitchen, so facilitating the service of their meals. Each medical officer should have a sitting room and a bedroom, with a total superficial area of about 240 sq. ft., and there should be a common dining room with a serving pantry. In determining the size of the dining room the needs of the visiting medical staff should be taken into account. Fixed lavatory basins should be provided in the bedrooms, and baths should be in the proportion of one to three medical officers. An extra bedroom which would be available for a locum tenens taking the place of a sick medical officer is desirable.

The Matron.

120. Accommodation for the Matron may be provided either in the Administration Block or in a separate section of the Nurses' Home. The former is usually preferable, but in either case her quarters should be self-contained, and should comprise rooms of the following areas: sitting room, 150 sq. ft.; dining room, 150 sq. ft.; two bedrooms, 150 and 120 sq. ft.; kitchenette, 100 sq. ft.; together with bathroom, W.C., and storage accommodation.

The Nurses' Home and Training School.

121. The residential accommodation for nurses is sometimes provided in the Administration Block and sometimes in a separate Nurses' Home. In the course of our inquiry we have found a consensus of opinion against housing the nursing staff in the Administration Block, as it is considered that the nurses when off duty should be at some disance from the wards and out of the hospital atmosphere. This may not always be possible in the case of a very small hospital, but in the case of an acute general hospital for about 400 beds we are of opinion that there should be a separate Nurses' Home.

122. We have already stated our conclusion that the dining rooms for the various nursing grades should be situated in the Administration Block and served by the main kitchen, and that the quarters for the Matron may be either in the Administration Block or the Nurses' Home. This leaves to be provided in the Nurses' Home the training school and common rooms, together with bedrooms for the nursing and domestic staff, unless the latter are accommodated in the Administration Block or in a separate Maids' Home.

123. A question of some difficulty is the extent to which use should be made of the ground floor of the Nurses' Home for sleeping purposes. It is known that there are objections to this on the part of some nurses, but we are of opinion that it will not usually be found possible to plan a Home economically without making some use of the ground floor for sleeping purposes, an arrangement which is not uncommon. In the case of ground floor bedrooms some special provision should be made for security at night.

124. We do not consider a sick bay in the Nurses' Home as a normal requirement, as it is much more convenient to treat sick nurses in the ward units. This is a suitable arrangement if there is a sufficiency of small wards.

Private Rooms.

125. The Assistant Matron may be accommodated either in the Administration Block or in the Home. She should have a bedroom and a sitting-room. If she is in the Home she might share a bathroom and W.C. with one or two of the senior administrative staff. The Home Sister should live in the Home and, like the other administrative sisters, should have a bedroom and a sitting-room; the ward sisters should have bed sitting-rooms. The sisters' rooms should be grouped together, so that they may share bathroom and W.C. accommodation and be somewhat apart from the probationer staff. Each staff nurse and probationer should have a separate bedroom. A quiet situation should be selected for the rooms of the night staff.

126. The total superficial area required for an administrative sister's bedroom and sitting-room is about 240 square feet. For sisters' bed-sitting-rooms a floor space of about 140 square feet should be allowed, and about 100 square feet for bedrooms for all below the grade of sister. These areas include the space occupied by built-in furniture. The height of private sitting rooms, bed-sitting-rooms and bedrooms should be 8 feet, except where determined by the height of other rooms on the same floor.

Washing and Sanitary Accommodation.

127. We consider it desirable that a fixed basin should be provided in each bedroom. The alternative is a row of ablution cubicles in the sanitary section, but these are much less convenient and take up a considerable amount of extra space, and no appreciable saving of cost is likely to be effected if the cubicles are sufficient in number (say one to four nurses), are divided by partitions and curtains, and are of sufficient size.

128. Other washing and sanitary accommodation should be provided as follows:—

Bathrooms (which need not be provided with lavatory basins)—one to six or eight bedrooms.

W.Cs.—one to six or eight bedrooms, in addition to any sanitary accommodation not on a bedroom floor.

Facilities for shampooing—in the proportion of one fitting to about 50 nurses.

Personal laundry, drying and ironing—one room.

Housemaid's room, with slop hopper sink and provision for refuse pails—at least one on each floor.

Facilities for incineration.

Common Rooms.

129. Separate sitting-rooms should be provided for the sisters, the staff nurses, and the probationers. At least 20 square feet per head should be allowed in the sisters' room, estimated on the total number of staff of that grade. Twenty square feet should be allowed for each staff nurse and 12 square feet for each probationer, the number of occupants being reckoned as two-thirds of the total staff of each of these grades. Where the number of nurses in any grade is very small, some increase in the amount per head of sitting-room accommodation will be necessary. The rooms should have fireplaces as well as radiators.

Folding partitions may be useful between the staff nurses and probationers' sitting-rooms so as to make it possible to throw two rooms into one for dances, etc. This renders the provision of a separate recreation room unnecessary.

A small silence room for writing or study should be provided, and this may also serve as a library.

Miscellaneous Provision.

130. There should be a small service kitchen for keeping food warm, storing milk, butter, etc., and for preparing tea or simple meals. Tea-making facilities should be provided on each floor. There should also be a visitors' room in which nurses can receive friends, and this should have a W.C. and cloak-room accessible for male visitors. The hall should be large enough to serve as a waiting room for callers.

131. Storage rooms for linen and boxes are necessary. The shelves in the linen room should be 18 inches apart, 22 inches in depth, and give an allowance per resident of 15 inches of shelving. In the box room sufficient racks should be provided to take a small trunk for each occupant.

132. The Home Sister should have an office about 100 square feet in area, equipped with a medicine cupboard and facilities for minor dressings, etc., so that it may serve as a surgery.

133. A bicycle shed will be needed in many cases. The provision of tennis courts is desirable.

134. The provision of covered ways between the Nurses' Home and the main building must depend on the distance, layout, etc. They are convenient, but not essential.

Training School.

135. The training school should include a lecture room (with 12 square feet for each member of the class, assuming an attendance of one-third of the number of probationers) and a demonstration class room with a cookery section and equipment for instruction in practical nursing. The equipment* of the demonstration room occupies a considerable amount of space, and 700 square feet is the minimum size for practical convenience. The demonstration room may conveniently be arranged to open off the lecture room, divided from it by a folding partition.

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* The following is a list of customary articles of equipment in a demonstration room :—

Skeleton.
Bones.
Models—trunk, eye, ear, head, heart.
Charts—anatomy, physiology, hygiene.
Hygiene models.
Model patients—adult and child.
Bandaging models.
Bed.
Cot.
Supply of linen, mackintoshes, etc.
Air rings, pillows, etc.
Ward utensils.
Urine testing apparatus.
Instruments.
Splints.
Bandages.
Samples of stock medicines, lotions, etc.
Lantern and supply of slides.

There should be a reference library and an office for the Sister Tutor. The silence room mentioned in paragraph 129 should be in the training school if the school is part of the Nurses' Home.

It may sometimes be convenient to arrange a separate entrance to the training school with a small cloakroom for nurses visiting for classes or examinations.

The Domestic Staff.

136. In a hospital for about 400 beds the resident domestic staff may be small in numbers. We have assumed that about 24 of them will live in, and accommodation for them may be made either in the Administration Block or in a section of the Nurses' Home. In a very large hospital, it would probably be found more convenient to house the domestic staff in a separate Maids' Home.

137. Senior members of the domestic staff (e.g., cook, laundry supervisor, and needlewoman) should have bed-sitting-rooms, or bedrooms and sitting-rooms. There should be a common sitting-room for the rest of the domestic staff. Bathroom and sanitary accommodation should be provided on the same scale as that for the nursing staff.

IX.—The Mortuary Block.

138. The mortuary block should be placed in an inconspicuous position, and so situated that the removal of the dead may be effected as unobtrusively as possible. In addition to the room for the bodies, there should be a post-mortem room and a viewing room. The latter should be fitted for devotional purposes, and should be entered from a waiting lobby.

139. The extent of mortuary accommodation required varies according to the prevailing types of case admitted to the hospital, and no definite standard can be laid down, but a useful working rule is that an average acute general hospital requires mortuary places in the proportion of 3 to 4 per cent. of the number of patient beds.

140. A convenient arrangement for a mortuary is a rectangular room with a series of compartments in 2 or 3 tiers ranged along the back wall. The depth of the room from front to back should be not less than 17 feet, to allow of easy manipulation of trolleys. The other dimension will be determined by the number of places required. A width of three feet should be allowed for each place if refrigeration is installed. This is now a usual provision, and it should be installed in such a way that it can be applied to separate sections.

141. The essentials of a Mortuary and Post-mortem Department are as follows:—

Mortuary (for 12 bodies in 2 tiers).	300 sq. ft.
Viewing room	180 sq. ft.
Waiting room, giving access to the viewing room only.	60 sq. ft.
Post-mortem room	300 sq. ft. for one table.
or	400 sq. ft. for two tables.

W.C. accommodation for visitors and staff should be included if not conveniently available elsewhere.

142. The possibility of increased mortuary accommodation being needed at some future date should be borne in mind, and for this reason it may be useful to provide compartments in two tiers in the first instance, so that a 50 per cent. increase of accommodation can be obtained without further building, by adding a third tier of compartments. The plan should be so drawn as to allow for extension.

X.—Methods of Construction, Materials and Finishings Generally.

Modern Methods of Construction.

143. One of the matters to which we were directed to have special regard was " modern methods of construction ", and in examining possible means of securing a reduction in cost it was therefore necessary to consider whether sufficient use is being made of modern methods in the construction of hospitals.

144. We have examined the question at some length, and, if by " modern method " is to be understood any form of construction that has come into use within a generation, this would include reinforced concrete in its various forms, frame and panel construction—the frame being either of steel or reinforced concrete—and a number of new insulating materials and materials for finishing walls and floors, all of which are well known to the practising architect. Not unnaturally architects are disinclined to risk their clients' money and their own reputation by departing from well-established methods of building in favour of a new alternative before the latter has been proved to be less expensive and not less satisfactory. The experience of the years immediately following the War, when, owing to the scarcity of traditional materials, alternative materials had to be used before they were fully tested, shows the wisdom of a cautious attitude and the need for careful scrutiny of the claims of inventors and others interested in the use of new materials.

145. From the evidence submitted to us we have come to the conclusion that, while there are some useful alternatives to traditional methods, there is no new material or method of general application that is likely to lead to a substantial saving in cost, having regard to the cost of maintenance as well as initial capital cost, and we are satisfied that careful designing with due regard to economy in material and avoidance of elaborate architectural detail offers the best means of reducing cost.

Methods and Materials.

External Walls.

146. For external walls of buildings of one storey some form of pier and light panel construction would be appropriate and economical. From two to at least four storeys it will be found in most districts that normal brick construction is the most economical, while beyond six storeys the advantage in regard to cost is with frame and panel construction. In deciding on the type of external walls to be adopted the space required for concealed vertical heating pipes, water pipes and, possibly, waste pipes must be borne in mind, especially in frame construction.

Internal Walls.

147. In view of the possibility of a rearrangement of the accommodation in a hospital being required at some future date, internal walls, except those surrounding staircases and lift shafts, should be built as partitions rather than as structural or weight-carrying walls.

The internal stanchions supporting the floor beams may be of either reinforced concrete or steel. For partitions, steel and glass, hollow burnt clay blocks or light-weight concrete may be used, but solid brick or some form of double partition insulated at the edges is required where the avoidance of the passage of sound from one room to another is important.

Roofs.

148. It is frequently claimed that economy would result from the adoption of a flat roof instead of a pitched roof. In some circumstances greater freedom in planning may be conferred by release from the restrictions imposed on the shape of a building by a pitched roof. This might enable the required accommodation to be given in less space, or to be more conveniently arranged, and so lead to economy in building or in working cost. Each case should therefore be considered on its merits. But, in regard to the cost of the roof itself, given equal efficiency in weather protection, insulation and permanence, we understand that no saving is likely to result from the adoption of a

flat roof rather than a pitched roof. Moreover, the pitched roof has the advantage over the flat roof that it provides convenient space for tanks, water pipes, electric conduits, etc.

149. A flat roof suitable for the use of patients, if constructed in such a way as to avoid heavy maintenance charges, would, we are informed, cost more than a pitched roof, and the additional expense should be incurred only when there is a reasonable prospect of full use being made of the roof.

150. It is claimed that the flat roof simplifies the subsequent addition of another storey to the building, but it must be remembered that any vertical extension has the inconvenience that it necessitates the temporary vacation of the storey below.

Floors.

151. The ordinary wood-joisted floor on sleeper walls is satisfactory for ground floors of wards and many other parts of a hospital. It is economical and provides convenient space for the running of pipes, cables, etc.

Where a ground floor of concrete is to be covered with linoleum or other similar material it should be constructed as a suspended floor.

152. Upper floors should be of fire-resisting construction. In the selection of one of the many types of fire-resisting floor available, economy must be considered. The degree of fire resistance required will depend on the number of storeys, but until the investigation which we understand is being carried out by the Building Research Station of the Department of Scientific and Industrial Research is completed we hesitate to make definite recommendations as to the particular grade or grades (British Standard Definitions) which ought to be accepted as standard.

153. It should be borne in mind that the use of a thick floor will affect the height of the building and the consequent cost, and while a thick floor may have the advantage of lessening the transmission of sound, which is an important consideration, there is no real disadvantage in the structural beams projecting below the surface of the ceiling.

Ceilings.

154. A smooth ceiling finish is usual, but in suitable positions economy can be effected by the acceptance of an uneven surface, such as would be obtained by applying paint direct to the tile soffit of a fire-resisting floor.

Windows.

155. In considering the type of window to be adopted for wards, regard should be had to the following:—

(1) Provision should be made for ventilation without draughts, and for as wide a variation in the ventilation as possible.

(2) The window should be easy to clean from the *inside*, and should have the minimum number of bars and angles in which dirt can collect.

(3) The window should extend to within about six inches of the ceiling.

(4) The window sill should be 30 ins. from the floor level, but this distance may have to be increased on upper floors in order to lessen the risk of accidents.

(5) If French windows are provided on ground floors or balconies they should be not less than 3 ft. 6 ins. in width and should open outwards.

156. For many years the usual arrangement of windows in hospital wards has been a window to each bed, the window being about 3 ft. 6 ins. wide, leaving a pier about 4 ft. 6 ins. wide against which is placed the head of the bed.

157. A Report of the Royal Institute of British Architects on the Orientation of Buildings, published in 1933, suggests very wide window openings and very small piers. These are applicable only to wards with beds arranged longitudinally. This arrangement of beds is discussed in paragraphs 46 to 51 above.

158. For windows of the high narrow type, the sliding sash with a deep bottom rail, and with or without hoppers at the bottom and the top, has been largely used in the past. This, if arranged for cleaning from the inside, is satisfactory.

159. The casement window has the advantage over the sliding sash that the whole window space is available for ventilation, and a useful type is one in which there are hoppers at the top and the bottom.

160. A type of window, in which the whole window is a series of hoppers, has been frequently used in hospitals, and from a ventilation point of view appears to be satisfactory.

Doors.

161. Doors of a type which do not entail excessive noise in use should be selected. A small but often overlooked point, especially in regard to cupboard doors, is the avoidance of noisy door-catches.

162. We have considered the comparative costs of metal and timber door frames. The cost of metal door frames, taking into account the cost of erection, compares favourably with that of soft wood door frames, and is about one-third of the cost of hardwood frames. Architraves may be dispensed with; and, owing to non-shrinkage of the material, a good joint can be made with plastering or other wall finishing.

Wall and Floor Finishings.

163. We have considered the finishings which should be applied to the walls and floors of the several parts of a general hospital, but before setting out our recommendations in detail it is desirable to refer to certain general considerations.

164. Owing to its relatively high cost, the use of terrazzo—which otherwise is a most suitable material—should be restricted as far as possible to the walls and floors of specific rooms such as operating theatres.

165. Other floors requiring frequent washing should, with a view to economy, be paved with granolithic, which can be coloured successfully if the natural colour is considered objectionable. In cases where the use of a less absorbent and jointless material is desired, asphalt is available, but the cost of this is about twice as much as that of granolithic. Patches of discolouration and chemical disintegration resulting from frequent washing are believed to be largely due to bad laying, and granolithic should, therefore, always be laid by experts.

Some additional cost for first grade quarry tiles is justified for the floors of kitchens, sculleries, sluice rooms, duty rooms, and W.Cs.

166. The best finish for the floors of wards is hardwood, but a satisfactory substitute, at about half the cost of hardwood, is thick linoleum (which should have a life of about 20 years) or other similar covering, laid direct on cement screeding.

167. Rubber is a relatively expensive form of floor covering, and this has limited its use in hospitals. Thin rubber has not proved satisfactory, but when used of sufficient thickness, say of not less than five-sixteenths of an inch, rubber provides a quiet and suitable floor covering for corridors and special departments.

168. For certain parts of a hospital glazed tiles are a particularly good form of wall finishing. Their adoption or rejection depends mainly on cost. The initial cost of wall tiling is about four times as much as that of hard plaster with three coats of paint, but the maintenance cost of a tiled wall is negligible.

169. With a view to lessening noise in wards and corridors we have recommended ordinary plaster rather than hard plaster, except where the latter is required on account of liability to damage. Various sound absorbing materials are available. These are expensive, but their use may be justified in special cases.

170. At junctions of walls and floors finished in terrazzo, coved angles of the same material should be provided; but, in the case of wood floors, coved angles in wood work are costly, and a triangular hardwood fillet or a low skirting may be used. We are not convinced that rounded internal angles at vertical wall junctions are necessary.

171. Our detailed recommendations as regards wall and floor finishings are as follows:—

	Wall Finishings.	Floor Finishings.
Ward Units.		
Generally	To be smooth and capable of being easily cleaned.	
Wards	Plaster, painted, the lower 4ft. 6 inches to be hard plaster.	Hardwood *or* Thick linoleum or similar covering laid direct on cement screeding.
Ward office	ditto.	ditto.
Ward kitchen	Tiles or glazed bricks up to a height of 4 ft. 6 inches, the upper part to be of painted plaster or to have a smooth brick and paint finish.	First grade quarry tiles.
All sanitary units, including sluice rooms, duty rooms, bathrooms, WCs. and lavatories.	ditto.	Sluice rooms, duty rooms, and W.C's—first grade quarry tiles. Other floors requiring frequent washing—granolithic or asphalt.
Ward corridors.	Plaster, painted, the lower 4 ft. 6 inches to be hard plaster.	Thick linoleum or similar covering laid direct on cement screeding, with terrazzo or asphalt margins.
Main Hospital Corridors and Staircases.	Plaster, painted, the lower 4 ft. 6 inches to be hard plaster and to have external corners protected with metal or hardwood. *or* Smooth brick and paint finish.	Corridors—granolithic, or asphalt. Staircases—granolithic, or concrete with linoleum treads and metal nosings; possibly terrazzo for a main staircase.
Operating Theatre Suite.		
Theatre	Tiles or terrazzo.	Terrazzo, laid in squares.
Sterilising and sink rooms	ditto.	ditto.
Other rooms	Plaster, painted, the lower 4 ft. 6 inches to be hard plaster.	Hardwood, or terrazzo laid in squares.

	Wall Finishings.	Floor Finishings.
Reception and Out-Patient Departments and Special Treatment Rooms.		
Minor operating rooms ...	Tiles or terrazzo.	Terrazzo, laid in squares.
Waiting rooms, changing cubicles, examination rooms, clinical rooms, etc.	Plaster, painted, the lower 4 ft. 6 inches to be of hard plaster.	Waiting rooms—first grade quarry tiles. Treatment rooms–terrazzo laid in squares. Other rooms—hardwood.
Administration Block.		
Main kitchen	Tiles or glazed bricks up to a height of 6 ft., the upper part to be of painted plaster or to have a smooth brick and paint finish.	First grade quarry tiles.
Scullery	ditto.	ditto.
Staff dining rooms ...	Ordinary plaster, painted or distempered, with a hard plaster dado.	Hardwood *or* Linoleum laid direct on cement screeding.
Central stores :—		
Butcher's shop and meat and fish store, and milk store.	Tiles or glazed bricks.	First grade quarry tiles.
Other stores	Distempered brick work.	Granolithic.
Residential Accommodation.		
Private sittingrooms and common rooms.	Ordinary plaster, painted or distempered.	Hardwood *or* Linoleum laid direct on cement screeding.
Nurses Home—Training School.	ditto.	ditto.
Bed-sitting rooms, and bedrooms.	ditto.	Linoleum laid direct on cement screeding.
Corridors	ditto.	ditto.
Mortuary Block.		
Mortuary	Glazed tiles.	Granolithic.
Post-mortem room ...	ditto.	Terrazzo laid in squares.
Viewing room	Painted plaster.	Hardwood.
Remainder	ditto.	Granolithic.
Laundry.		
Wash-houses	Salt glazed bricks or engineering bricks up to a height of 4 ft. 6 inches, with ordinary brick above.	Granolithic.
Drying rooms	ditto.	ditto.
Ironing rooms	ditto.	ditto.
Sorting rooms	ditto.	ditto.

XI.—Engineering Services.

172. In this Section of our Report we have not restricted ourselves entirely to the needs of an acute general hospital, and many of our conclusions and recommendations are applicable to hospitals and institutions generally.

The engineering services of a hospital comprise water supply, drainage and sewage disposal, heating and lighting, the provision of hot water and gas, the installation of kitchen, laundry and other equipment, and possibly the generation of electric power.

173. We consider it important that not only should expert advice on the design and lay-out be obtained, but that the expert should be appointed at an early stage in the preliminary work so as to collaborate closely with the architect. The consulting engineer should be responsible for the general design and lay-out of the various engineering services and should furnish a specification which will permit of the widest range of competition among contractors.

Drainage and Sewage Disposal.

174. The foul and surface water drainage of a hospital should, wherever possible, be connected to public sewers. If none are available sufficient land should be purchased to enable the foul drainage to be dealt with on the site, and as far from the buildings as may be necessary to avoid nuisance. In such a case the drainage should be on the separate system, and surface water should not be discharged into the foul sewers. The treatment of the foul drainage should conform with the usual standards required by the Ministry of Health, and where sufficient land of a suitable nature is available broad irrigation should be adopted.

Water Supply.

175. Wherever possible, water should be obtained from a public supply. If no public supply is available, a well or bore holes will be required of sufficient size to enable duplicate pumping plant to be installed.

The quantity of water required is usually estimated at 40 to 50 gallons per head (patients and staff) per day, and in the case of a general hospital this amount should not be exceeded.

As the bulk of the water will reach the foul sewer, it is desirable that its volume should be kept as low as possible, especially if the sewage is treated at disposal works at the hospital.

We recommend the inclusion of meters to measure the water used in each of the different blocks with a view to tracing excessive use or wastage.

176. Whether the water is obtained on the site or from the public mains, it is usually delivered to a storage tank situated at such a level as to command the whole of the building site and give adequate pressure to all points of draw-off. The capacity of the storage tank should not normally exceed two days' demand, and might be considerably less if the supply is derived from a trunk main in the road, in which case a long period of interruption is unlikely.

177. When the water contains more than 10° hardness, that required for use in the laundry and for domestic hot water should be softened.

Fire Protection.

178. A separate fire main need not be provided unless considered essential by the local Fire Brigade Authority, but fire extinctors and adequate fire-fighting apparatus should be readily available to enable the staff to deal with any outbreak of fire pending the arrival of the local fire brigade.

Forms of Heating.

179. A hospital may be heated by means of (*a*) open fires or stoves, (*b*) gas or electric fires, (*c*) hot air, or (*d*) steam or hot water.

Open Fires or Stoves.

180. The provision of this form of heating is now generally limited to certain day rooms and staff rooms. Open fires or stoves are inefficient, cause considerable dust and dirt, involve labour, and are undesirable as a general heating medium in large buildings; but open fires are sometimes installed in large wards on account of their cheerful appearance and the additional comfort they afford. When they are provided in a ward or other large room which is heated by a central heating system, no allowance for the heating effect of the fire or stove is usually made when designing the system.

Gas or Electric Fires.

181. These are not usual forms of heating in hospitals, except in staff rooms and certain isolated buildings in intermittent use. They are sometimes provided in a ward to add to its cheerful appearance and to give added warmth to convalescent patients who are sitting up.

Where either gas or electricity is used the cost of operation usually compares unfavourably with that of a central heating system, and in the case of gas a flue should be provided.

Hot Air.

182. Hot air is a heating medium which is adopted in cinemas, theatres, public halls and business premises, and combines heat-

ing with ventilation, but in connection with hospitals it is now seldom adopted except for operating theatres, where the removal of ether fumes without loss of temperature constitutes the principal reason for its installation

This system is somewhat expensive to install and maintain, and the difficulty of keeping the air ducts regularly cleansed renders its use undesirable in a hospital, except in an operating theatre where the ducts can be made short and accessible.

Steam or Hot Water.

183. Steam as a medium of heating has been adopted in hospitals, but hot water is now generally preferred. The steam is passed through the system by a fall in pressure caused either by condensation in pipes or radiators or by condensation assisted by vapour pumps. In either case the surface temperature of the radiator is rather high (212° to 180° F.),* and renders a guard desirable to prevent burns.

184. The advantages of steam as a medium of heating as compared with hot water are briefly:—

(1) It enables a room to be more quickly heated.

(2) It does less damage in the event of leaks.

(3) The system is not subject to damage by frost when the building is disused for a long period, as in the case of Infectious Diseases Hospitals or isolation wards.

(4) The capital cost is reduced.

185. Disadvantages in the use of steam are:—

(1) The temperature cannot be so easily adapted to variations of climatic conditions, and this would have an important bearing on the quantity of coal consumed.

(2) The high working temperature tends to make air conditions less comfortable.

(3) The provision of guards makes it more difficult to keep the radiators clean.

(4) The steam traps are often noisy and are liable to get out of order, with a consequent loss of steam or increase of maintenance charges.

186. Hot water is now the most generally adopted medium of heating in hospitals, the hot water being circulated either by gravity or (usually) by pumping. A hot water system is more flexible than a steam system because the temperature of the water (usually not more than 160° F.) can easily be regulated to suit outside weather conditions, and the inside temperature kept at any desired level for a given standard of ventilation.

* It is claimed that by the use of certain patent controls the temperature can be lowered to 160°F.

It is simple in operation and can easily be extended. Its higher capital cost over that of a steam installation may be more than counterbalanced by the saving in the cost of operation.

187. The evidence of our witnesses was to the effect that, generally, low pressure hot water was the best medium to adopt, but that such a system could not be recommended for universal application, and the decision as to which form of heating should be installed could only be arrived at after consideration of all the circumstances.

Heat Emission.

Pipes.

188. The cheapest form of apparatus for distributing heat is a pipe or coil of pipes, the surface of which acts as a radiator. We were informed that in a large 24 bed ward the cost of installation would be about £100, whereas the cost of radiators would be £140. The pipes are generally placed on or near the floor, but are sometimes placed on the walls just below the ceiling. While they have the advantage of affording an even distribution of heat in the room, disadvantages raised against them are that they are unsightly, collect dust, take up floor space and obstruct entrances. They also cause discolouration to walls and, if placed above the windows, to ceilings.

Radiators.

189. Radiators are usually adopted for emitting the heat required in hospital wards. They should be of the ordinary hospital type and painted, as we were informed that if bronzed or plated they are less efficient. They should be supported on brackets fixed in the wall so as to offer no obstruction to the cleaning of the floor below them, and should not be hinged but should be far enough from the wall to give easy access for cleaning.

Objections sometimes raised to the use of radiators are that they take up floor space and are difficult to clean.

Panels.

190. Panels are of two kinds, embedded and applied.

(*a*) *Embedded panels* are constructed in the form of a coil of piping built into the inner surface of walls or ceilings during the construction of the building. Such coils warm the fabric of the building, and the temperature of the panel has therefore to be kept comparatively low, not more than about 120°F., in order to prevent cracking of the plaster. Objections to the use of embedded panels are:

(1) the liability to cracking of the plaster,

(2) the difficulty of locating and repairing leaks if they occur,

(3) the damage caused by such leaks, and

(4) the sluggishness of their operation.

(*b*) *Applied panels* are more or less a compromise between the embedded panel and the radiator, and consist essentially of a flat plate with passages for water on the reverse side. This plate is fixed to the wall or ceiling after construction and is backed with a non-conducting layer so that the fabric of the building is not heated directly. This type of panel can therefore be worked at a somewhat higher temperature than the embedded panel, but this higher temperature may cause discomfort to patients exposed to its direct radiation. Applied panels do not appear to be open to the objections mentioned above in regard to the embedded panel.

191. Both types of panel depend chiefly on direct radiation for their heating effect (the applied to a less extent than the embedded), and they should therefore be placed where they can be most effective, and should be unobstructed by furniture or fittings. The surfaces of the panels are larger than those of radiators, but have the advantage of being smooth. Panels are more or less invisible, require no special cleaning, and take up no floor space.

Radiators versus Panels.

192. The question as to which type of apparatus should be installed is one to which we have given considerable attention.

193. As regards ease of control, it is admitted that the embedded panel has a long time lag, i.e., the temperature cannot be raised or lowered quickly to conform with sudden variations in climatic conditions. In this respect, therefore, the embedded panel is inferior to both the applied panel and the radiator; but it has the advantage of being worked at a lower temperature, and in that respect is to be preferred on physiological grounds.

194. The estimated cost of installation is a material factor in determining the choice between radiators and panels, and we have therefore endeavoured to obtain reliable comparative estimates from a number of consulting engineers and contractors. For this purpose a plan was supplied with a brief statement as to the Committee's requirements. While the estimates furnished showed considerable variation, they were sufficient to enable us to form the conclusion that the installation cost of a system of embedded or applied panels was at least 33⅓ per cent. above that of radiators.

195. On the question of operating costs we have been able to obtain little evidence bearing on the quantity of fuel consumed in heating a ward block by panels and by radiators respectively. The necessary records do not appear to have been kept by hospital authorities, and the only test of which we had any particulars was one undertaken to compare the

cost of radiator and embedded panel systems installed in two office buildings of similar construction and use. The result of this test showed that the steam consumed in maintaining a rise of temperature of 30°F. in a building of 100,000 cubic feet of space was 170 lbs. per hour in the case of radiators, and 88 lbs. per hour in the case of embedded panels. The buildings were not hospitals, and it must therefore, not be assumed that the above figures would be applicable in the case of a hospital ward where a high degree of ventilation is required.

196. We have given full consideration to the relative claims of radiators and panels, and we recognise that the latter, whether embedded or applied, have certain advantages. The use of panels is, however, a comparatively recent development in heating practice, and there is insufficient evidence as to the cost of their operation and maintenance. We are, therefore, of opinion that radiators should be regarded as the standard practice until definite evidence is available as to the relative fuel consumption involved by the radiator system and the several types of the panel system. We hope that further steps may be undertaken in this direction by some competent authority.

Temperature and Air Change.

197. In the design of any system of heating the engineer has to provide heat for raising and maintaining the temperature of the air inside the building above that of the air outside, and must allow for loss of heat by ventilation and by transmission through walls, windows, floors and roofs.

There is considerable diversity of practice as to the temperatures which are specified as necessary to give the desired conditions of comfort in the various sections of the building and as to the allowance to be made for loss of heat by ventilation, which is dependent upon the number of air changes per hour.

198. The following table illustrates the difference of opinion among consulting engineers and Medical Superintendents as to the temperatures at which the various rooms should be maintained in institutions generally:—

Wards	from 60° to 65° F.
Dormitories	from 45° to 65° F.
Corridors	from 50° to 60° F.
Dayrooms and dining rooms...	from 60° to 65° F.
Nurses' bedrooms	from 50° to 60° F.
Operating theatres	from 65° to 80° F.

No doubt some of these variations are due to the different types of institution. For instance, a higher temperature would be required in buildings occupied by sick persons than in those occupied by physically healthy mental patients.

199. Not only is there lack of agreement as to the desirable atmospheric environment for different states of health and sickness, but the difficulty of representing by means of an air temperature all the factors involved in maintaining suitable conditions has not yet been overcome, and for the present we can do no more than suggest that the engineer should design his equipment to cope with a difference between the inside and outside temperature of 30° F. in wards, dormitories, dayrooms and dining rooms, 25° F. in corridors and nurses' bedrooms, and about 50° F. in operating theatres. These appear to be the figures generally in use, and they should, except in special cases, provide an adequate margin of heating power.

200. With regard to air changes, the difference of opinion is shown by the following table:—

Wards	$1\frac{1}{2}$ to 5 changes per hour.
Dormitories	
Corridors	
Dayrooms and dining rooms...	2 to 5 changes per hour.
Nurses' bedrooms	1 to 3 changes per hour.
Operating theatres	4 to 20 changes per hour.

The rate of air change cannot readily be tested, and the adoption of a particular rate does not appear to rest on any reliable experimental data. The figure assumed for the rate of air change is, however, an important factor in the calculation of heat loss.

201. Where ordinary convection apparatus (pipes and radiators) is the heating medium, we suggest the adoption of the following air change factors*:—

Wards	3 changes per hour.
Dormitories	
Dayrooms and dining rooms ...	
Corridors	2 changes per hour.
Nurses' bedrooms	
Operating theatres	10 changes per hour.

Where heat is emitted by radiation through ceiling or wall panels it is claimed that the above figures can be reduced, as with such a system a much smaller amount of air circulation is sufficient to maintain conditions of comfort and avoid any feeling of stuffiness. While such a reduction might be made in the case of dayrooms, dining rooms, corridors and nurses' bedrooms, we are not able to recommend that in the wards of a hospital or in operating theatres any reduction should be made in the air change factor to be used in the calculation of heating power.

202. With regard to means of ventilation we were informed that natural ventilation by means of windows, etc., is normally

* It should be understood that these factors are merely a basis for engineering calculations and do not represent actual air changes recommended.

sufficient for a hospital, with the exception of the operating theatre suite, X-Ray Department, kitchen and laundry. In these rooms natural ventilation should be supplemented by electric exhaust fans, but where the operating theatre is in frequent use a small air-conditioning plant should be installed.

Heat Generation.

203. The steam or hot water required for heating a building can be generated either in the building itself or at a central boiler house, and can be circulated either by pumping or by gravity. If steam is generated and the rooms are heated by hot water, the steam can be passed through calorifiers placed at the central boiler house or in the individual blocks.

The particular arrangement to be installed in any hospital must depend largely on the local conditions, and is a matter for close and careful consideration by the engineer.

In the following paragraphs the advantages and disadvantages of the alternative arrangements are broadly indicated.

Centralisation versus Independent Boilers.

204. The majority of hospitals to-day have some form of centralised boiler plant for the heating and hot water services. Where the hospital consists of a group of buildings situated close together the advantages of centralising the boiler plant are obvious; but where, as in the case of Isolation Hospitals, it comprises a number of scattered buildings, some of which may perhaps be only in intermittent occupation, the question whether each block should be independently heated requires careful consideration.

205. Generally, a central boiler house, though entailing greater capital cost, would have the following advantages:—

(1) The type of boiler plant to be installed would be more economical in operation and in fuel consumption, and a cheaper class of fuel could be used.

(2) Labour costs would probably be lower (unless suitable inmate labour were available) as there would be no cartage of coal or ashes to or from the different blocks. (One of our witnesses estimated that in a hospital for 600 beds the extra labour and fuel costs resulting from a system of independent boiler houses might amount to £1,000 per annum).

(3) The noise and dust created and the wear and tear of roads and vehicles involved by such cartage would be avoided.

(4) Basements and flues in each block would be unnecessary.

(5) There would be better regulation of the temperature in both heating and hot water services and better supervision of the labour staff.

(6) Interruption in the supply due to a breakdown of any one unit would be avoided, as duplication could be provided at a reasonable cost, whereas in the case of local generation of heat duplication by stand-by boilers in each block would be extravagant.

206. There may be special circumstances which make the centralisation of the heating and hot water services either excessively costly or impracticable. In estimating the cost of the two alternative systems it is necessary to include the cost of the ducts in which the pipes from the central boiler house would be laid (see paragraphs 226 to 230 below). Where these would traverse ground unsuitable owing to levels or to the presence of running sand or water, heavy expense in construction would be involved, and this might be a deciding factor in favour of installing independent units in each block.

207. The expert witnesses whom we have examined on this question were generally agreed that, although the first cost of centralisation is definitely higher, the economy in operating is so marked that, having regard to both capital charges and operating expenses, it will almost invariably be found more economical to provide a central boiler house, at any rate in the case of a general hospital.

Central Boiler House.

208. Where all the heat required for heating and hot water services is generated at a central boiler house, the siting of this building is important. Owing to the noise and dust caused in handling fuel and ashes, it should not be too close to ward blocks, but should be as centrally situated as possible and in convenient relation to the laundry and kitchen so as to avoid long runs of steam mains. The level contours of the site will also have to be borne in mind, particularly if steam is to be passed to the different blocks and its condensate returned to the boilers.

The buildings should be designed not only to accommodate the plant required to meet the present needs of the hospital, but so as to be capable of easy extension to meet the needs of any future enlargement of the hospital.

209. The type and number of boilers to be installed will depend on various factors, e.g.:—

(1) The type of heating system to be provided.

(2) Whether steam is required for laundry, kitchen, and sterilising.

(3) Whether the steam required for such purposes is to be separately generated, and the heat required for heating and hot water services generated in a hot water boiler.

(4) Whether electricity is to be generated on the site. (see paragraphs 241 to 245 below).

210. In small installations it may be found to be more economical to provide hot water boilers for heating and hot water and a steam boiler for the laundry, kitchen, and other purposes. The boilers for heating and hot water might be interchangeable with a single stand-by for the two services.

211. Where steam is generated for *all* services, and where hot water radiators are installed, the steam required for heating and hot water is passed through calorifiers, which may be situated either at the central boiler house or in the separate buildings or blocks. The concentration of the calorifiers at the central boiler house reduces their number and consequently their cost, but it has the disadvantage of involving the use of the larger pipes that are necessary when water is distributed than those that are required where only steam is distributed. Where steam is passed from the central boiler house to local calorifiers the only pipes required are the steam flow pipe and a smaller pipe for the condense, but where the calorifiers are situated in the central boiler house, six pipes (some of them of large diameter) are usually necessary, viz., the flow and return for heating, the flow and return for hot water supply, and possibly a small steam flow pipe and condense.

212. One of the objections to the distribution of steam over long distances is the difficulty of maintaining the joints and the traps for the condense water. A consideration affecting the decision whether local or central calorifiers are to be installed is the calculated loss of heat that may take place in the duct between the central boiler house and the building to be heated. Although steam pipes are of smaller diameter than hot water pipes they are worked at a much higher temperature, and, therefore, the loss of heat per unit of surface is greater.

213. The general opinion of our witnesses was that the most economical and efficient arrangement was to place the calorifiers at the central boiler house; this provides better control and regulation of the temperature, permits a closer supervision of labour with consequently lower maintenance costs, and produces a better all-round efficiency. Both systems are in use; and here again special circumstances may influence the choice between them.

Independent Boiler House or Chamber.

214. Where independent boilers are to be installed in each block, or group of blocks, there should be separate boilers for heating and for hot water (see paragraph 232 below), and possibly a third boiler to act as a stand-by to either of the other two boilers. Each boiler chamber should therefore be large enough to accommodate three boilers.

If in these independent schemes the boilers are placed in a chamber below the level of the ground floor of the building it will often be possible to operate the system by gravity. By this means the installation of pumps will be avoided, but larger pipes will be required.

215. Where levels allow, two or more adjacent blocks may be served from one such chamber. This is particularly desirable in the case of a first instalment of a large hospital layout where it is intended eventually to supersede these separate boilers and to connect each block to a system of underground ducts and obtain heat from a central boiler house. In such a case it is desirable so to lay out the runs of mains that they can still be used in the event of conversion to a centralised scheme. As this conversion involves the abandonment of the separate boiler chambers and their entire equipment (though the chambers might be used to accommodate calorifiers if heat is distributed to individual blocks by steam), the number of separate boiler chambers should be as low as possible. To this end the buildings of the first instalment should be in close proximity to one another and complete centralisation should take place as soon as development has sufficiently progressed.

216. If steam is required for sterilising in any blocks which are independently heated this should be supplied from a steam boiler at the laundry, if available, or otherwise by means of gas or electricity.

Types of Boilers.

217. The type of boiler to be used will depend on the nature of the duty required from it, and also on its location and the load to be carried. Boilers may be either steam raising or direct hot water heaters.

218. Hot water boilers of the size required for hospitals may have efficiencies as high as much larger steam raising units, and, being of lighter construction, are therefore considerably cheaper in first cost, and require less skilled attention. They are, however, not manufactured in a size suitable for a large central boiler house, and are usually installed only in independent blocks.

219. Steam boilers are of several types, but our witnesses were of the opinion that the fire tube boiler was generally the most suitable for hospital and institutional work.

The water tube boiler has the advantage of quick steam raising and can quickly respond to variations in load, but, having little water capacity and therefore little reserve of heat, requires more expert handling and more frequent repairs than the fire tube boiler.

Most fire tube boilers, on the other hand, have a comparatively large water capacity and are more easily manipulated than the water tube boiler.

220. The boiler generally preferred by our witnesses was the "Lancashire", owing to its reliability and low maintenance costs. Although relatively less efficient and more costly than other boilers of the same class, it has a long life and is easy to manage, and its efficiency can be improved by the provision of an economiser and mechanical stoker where the amount of steam raised justifies such a course (see paragraphs 222 and 223 below).

221. When independent boilers are to be installed in each block or in a group of blocks the boilers can be cast iron sectional hot water (not steam) boilers, and should normally be hand fired with solid fuel. Modern developments in the design of mechanical stokers have produced a plant which would be suitable in connection with small boiler units, but any proposal to instal such stokers should be adopted only if it can be justified on grounds of economy and efficiency.

Other Boiler House Equipment.

222. It was put to us that where at least two large Lancashire boilers were installed it was worth while to provide an economiser. While the cost of this apparatus for a hospital of 500 to 700 beds might amount to about £700 or £800, it was stated that its adoption would probably reduce the amount of fuel consumed by about 10 per cent. Unless the saving so effected is at least equivalent to the loan charges, an economiser should not be installed.

223. In the case of a large installation mechanical stokers may be justified on the grounds of reduced labour costs and the saving to be effected by the use of lower grade coals. We were informed that the adoption of mechanical stokers in one large institution had resulted in a saving of £500 in 15 months.

224. In addition to mechanical stokers and economisers, a large boiler house installation will include certain other equipment such as pumps, motors, and instruments of various kinds. The whole system should be designed on the simplest possible lines, each unit being selected as the best suited for the duty it has to perform.

225. We were informed that instruments such as meters, thermometers and those for the measurement of carbon dioxide were most valuable and amply repaid their cost in the hands of an intelligent man in charge. The full benefit of these instruments would not, however, be obtained unless sufficiently skilled labour is employed.

Subways and Trenches.

226. In any centralised heating scheme it is necessary to convey steam or hot water from the central boiler house to the separate blocks. The pipes are laid in ducts which may be built of brick or concrete and should be so constructed as to prevent the access of water which, if accumulated in the ducts, might destroy the heat insulation of the pipes. These ducts may be in the form of " trenches " which are of shallow depth and provided with removable covers for easy access, or in the form of " subways " which are large enough to enable a man to walk upright, and have a fixed roof with manholes at intervals. Intermediate between these two forms are " creepways " just large enough to allow a man to crawl through them.

227. The cost of providing these ducts is a material factor in the cost of the heating service and should be taken into consideration when the system of heating is being decided upon. For instance, we were informed that a watertight reinforced concrete trench 4 ft. by $3\frac{1}{2}$ ft. internal measurements would cost about £1 10s. 0d. per lineal foot, whereas a subway 6 ft. by 7 ft., built either of brick or reinforced concrete walls with a concrete roof and floor, would cost about £5 per foot.

228. In view of this large difference in cost, we have endeavoured to ascertain to what extent subways were necessary. The main object of the ducts is to enable the hot water and steam pipes to be inspected and kept in repair, and all our witnesses were agreed that creepways were unsatisfactory for this purpose, as considerable damage might be done to the lagging of the pipes by the workmen. Most of our witnesses expressed the view that where main steam pipes were to be laid the duct should be of such a size as to enable a man to obtain ready access to the pipes to do ordinary repairs and maintenance work, but we have not been able to obtain any definite evidence as to the frequency with which subways are in fact used in hospitals where they exist. We have come to the conclusion that subways should be provided only where steam mains have to be carried, and that where steam pipes have not to be carried trenches should usually be sufficient.

229. In a general hospital where the various blocks are connected on the ground floor by a main corridor it is usual to carry the foundation walls deep enough to form a subway under that corridor of sufficient size to contain all the cables and pipes, and a subway so constructed is often made large enough to be used in addition as a service subway for other purposes. Where subways are provided otherwise than under a main corridor we would emphasise the desirability of restricting their width to the essential requirements.

230. Where pipes have to be carried under suspended ground floors, they can be laid under those floors without requiring the provision of ducts, if access is available.

Domestic Hot Water.

231. The methods of production and distribution of domestic hot water are similar to those employed in the case of the heating service, i.e., the heat can be generated at local independent hot water boilers, or at a central boiler house and the hot water circulated by gravity or pumping according to circumstances, or steam can be generated at the central boiler house and passed through calorifiers either at the boiler house or in the blocks to be supplied.

232. There should be two completely separate systems of pipework for hot water supply and for central heating. Combined systems have been installed with a considerable saving in capital cost, but have proved to be unsatisfactory and uneconomical in operation. The domestic hot water must be kept at a fairly constant temperature of 130° F. to 140° F. while, if proper economy is to be observed, the temperature of the water in the heating system should be raised or lowered to meet weather changes. These two requirements cannot be met in a combined system except by the provision and use of a complicated arrangement of hand-controlled mixing valves. Moreover, a heavy draught on the hot water may lower the temperature in the radiators below that required for heating purposes. Further, in the case of most waters, mineral salts are deposited in the pipes and radiators, and this deposit, which tends to reduce efficiency, is greatly increased in amount if a combined system is adopted, owing to the change of water which occurs whenever hot water is drawn off.

233. In the absence of adequate reliable information as to the quantity of hot water required in different types of hospitals, there is a conflict of opinion among engineers and others as to the basis on which schemes should be designed, and it follows that engineers are apt to design their schemes with a wide margin of safety. This necessarily leads to uneconomical design, but in the circumstances, we are unable to make any specific recommendation.

234. Figures have been submitted to us indicating that the consumption of hot water varies very considerably in different hospitals of similar class. All our witnesses were agreed that in many cases the quantity of hot water consumed in a hospital, particularly in the Nurses' Home, was unnecessarily high. This leads to waste of fuel in providing the heat required, and we are of opinion that economy in capital and operating costs in this service can be secured by the exercise of proper control

and supervision in the use of hot water. We suggest that provision should be made in the layout to enable the consumption of hot water in each individual block to be recorded. If the meters are regularly inspected and administrative action taken wherever the consumption recorded is excessive, the cost of the meters will be more than repaid.

235. There is no recognised rule for calculating the amount of hot water storage to be provided. Much will depend on the maximum rate of demand, and the general opinion of our witnesses was that five gallons storage per head (patients and staff) was sufficient.

236. Light gauge copper piping is often used for this service, and with the prices ruling to-day, and taking into consideration the simplicity of jointing light copper tubes, there is not a great difference between the cost of copper and that of galvanised iron pipe work. This does not apply to pipes of over two inch diameter, which in copper would require to be of medium or heavy gauge. Copper piping is desirable where the water to be heated is soft, but there appears to be a tendency to instal copper piping even where the quality of the water does not call for it, and with any material change in the relative prices of materials, this might result in unnecessary expenditure.

Fuel.

237. The following types of fuel may be used in hospital boiler houses.

(*a*) *Coal.*—Coal is the fuel generally used for hospital purposes. The class of coal and its price will, of course, vary with the locality and the circumstances of the case.

(*b*) *Coke.*—It was represented to us that advantages of using coke instead of coal were that the price of coke remained practically stable without seasonal or other variation; that its quality was uniform; and that it was a smokeless fuel, clean to handle and producing little or no ash.

A disadvantage of the use of coke is its greater bulk which involves larger storage space, but it is claimed that regular deliveries under all circumstances can be assured, thus reducing the amount of storage space necessary.

(*c*) *Gas.*—Gas has the advantage over solid fuel of cleanliness, convenience and saving in labour. It is also a useful form of power where there is lack of space for storing solid fuel. The witnesses for the gas industry did not suggest that gas could be considered as an economical form of power at the central boiler house of a large hospital, and we know of no instance where it is so used. It might, however, be suitable in special circumstances, for example, where the price of gas is exceptionally low and there are several widely scattered blocks.

(*d*) *Oil.*—The advantages claimed for gas, viz., cleanliness, convenience and saving in labour, would apply also to oil, but to a less extent. We understand, however, that at the prices at present prevailing the inclusive costs of operation of an oil-fired plant are greatly in excess of those for coal-fired plants of similar size.

We were informed that at one large hospital where oil had been used owing to the difficulty of obtaining suitable coal deliveries it had been found very costly, and a reversion to solid fuel had taken place.

(*e*) *Electricity.*—Electricity has the advantage that its use causes no nuisance from noise, smoke, dust or dirt at the hospital. It is also flexible, easy to regulate and control, and economical in labour. The use of electricity as the general means of heating a hospital would under normal conditions at present be ruled out on the ground of expense in operation. Where it is proposed to use electric power to generate heat it is usual to instal electrode boilers or immersion heaters, combined with sufficient storage to enable the consumer to obtain power during "off peak" hours at a considerably reduced charge per unit. We understand that unless the charge for electricity under these conditions is exceedingly low, it would be uneconomical to adopt this form of power. In addition to being expensive to run, these storage plants require considerable floor area and are expensive in capital cost.

238. Local conditions and prices will vary, so that it would not be wise to rule out all but solid fuel. We have, however, assumed that coal or coke will normally be used in hospital boiler houses, and we consider that another source of power should not be adopted unless it can be shown by a comparison of estimates of the annual cost (including labour and capital charges) that it would be more economical.

Coal Storage.

239. The opinions of our witnesses as to the amount of coal storage that should be provided varied from one week's to two months' supply. Where paid labour is utilised in the handling of coal, and where annual contracts for the supply and delivery of the coal are in force, it is uneconomical to provide large storage space, and experience has shown that three weeks of the winter demand should be ample in normal circumstances. To meet any unusual emergency, such as a threatened coal strike, it would suffice if temporary arrangements were made for storing additional coal.

240. It was represented to us that steam coal stored in the open air lost about 10 per cent. of its thermal value in a period of one year. For this reason it was suggested that the store

should be covered, and that this had the added advantage of controlling the dust raised in the process of handling. In view of the small amount of time that elapses between delivery and use of the coal, we are of opinion that the amount of deterioration that takes place in the open is not sufficient to call for the provision of a covered store as a measure of economy, but where coal has to be stored near the wards it should be covered.

Generation of Electricity.

241. One of the major problems confronting an engineer when designing the engineering services for a hospital is whether he is to provide for generation of electricity in the central boiler house.

242. It has been suggested to us that electricity can be generated at a hospital at a lower cost than that at which it can be purchased from an electricity supply authority, owing to the fact that the exhaust steam at the hospital power station can be used in the heating and hot water supply services, the electric power being largely a mere by-product of the process.

243. This assumes that there is a perfect balance between the demand for electricity and that for heating and hot water, so that all the steam exhausted from the electric generators may be utilised. To ascertain whether and to what extent this would take place requires detailed investigation of load curves for the particular case concerned, and if it is found that a large proportion of exhaust steam from the generating plant at times of electrical peak load could not be used for heating or hot water supply, the efficiency of generation on the site would accordingly be adversely affected. In such circumstances, it is often possible, largely if not wholly, to overcome the difficulty either by providing sufficient storage of hot water for domestic supplies to absorb the temporary excess of exhaust steam or by generating part of the electricity at peak periods of the day by means of an oil engine.

244. Certain of our witnesses were of the opinion that if electricity were to be generated at a hospital the labour employed in the boiler house would be considerably increased above that required where the current was obtained from an outside source. This opinion assumes that the generating plant is large enough to require separate engine room attendants, whereas experience indicates that in most hospitals where electricity is generated on the site this is not the case and there is no appreciable difference in labour costs.

245. The problem is a complicated one, and is not capable of a single solution to meet all cases. There are other factors than a mere comparison of the cost per unit from the two

alternative sources which have to be taken into consideration. For instance, it is desirable that hospital engineering plant should be as simple to handle as possible. On the other hand, the liability to interruption of a public supply owing to breakdown must not be ignored. Each proposal for local generation should therefore be supported by a carefully reasoned estimate comparing its cost with that of a public supply, and this estimate should be prepared by an independent engineer experienced in that branch of engineering, while due weight should also be given to the other factors indicated above. Even if it can be shown that local generation would be cheaper, we recommend that where there is no great difference in cost, a public supply should be taken, especially in view of the general tendency towards reduction in charges for public supplies.

Lighting.

246. It is assumed that a general hospital will always be lighted by electricity, owing to its convenience, ease of control, and cleanliness. The wiring should be laid out in conformity with the rules of the Institution of Electrical Engineers, and should generally be wiring in screwed conduits, the tubes and fittings being electrically and mechanically continuous and carefully earthed.

Direct lighting by exposed bulbs consumes the least current, and should wherever suitable be adopted, but in the wards a restful rather than a brilliant result should be aimed at and glare should be avoided.

A saving in capital costs can be effected by a careful scrutiny of the number and position of the points to be installed, and economy in running costs can be secured by reducing to a minimum the number of high wattage lamps and by the installation of meters in each block.

247. The arrangement of the lighting points is a matter largely for individual opinion, but there was a general consensus of opinion among our witnesses to the effect that in addition to centre ceiling lights in the wards, there should be a bracket light over each bed and also a point for a hand lamp for every two beds. An obscured night light reflecting on to the ceiling should also be provided. Dull-coloured walls and dark bed covers will materially reduce the intensity of illumination, and light colours are therefore preferable.

In the case of the operating theatre suite special equipment is required, which should be installed only under expert advice.

248. Emergency lighting should be by gas or by electricity from a storage battery. The number of points served by such plant should be reduced to a minimum, but should enable the operating theatre to have its full load.

XII.—Summary of Conclusions and Recommendations.

249. We append a summary of the principal conclusions and recommendations contained in this Report:—

General Conclusions.

(1) It is not practicable to express our standards in terms of cost, and we therefore advise as to what should be regarded as reasonable requirements. We refer to possible dangers of standardisation, which we have endeavoured to avoid. In some instances, we have adopted definite standards; in others, standards have been frankly stated to be inapplicable; while in others, the relative advantages and disadvantages of alternatives have been presented without a definite declaration in favour of one or other (paragraphs 11 to 14).

(2) We refer to the difficulty of establishing any figure that could be regarded as representing normal "present cost" and to the fallacy of comparison on a "cost per bed" basis. This has been an obstacle in complying with that part of our terms of reference which relates to "the possibility of securing a reduction in present costs without impairing the efficiency of the buildings for the purposes for which they are designed", but we believe that our recommendations would have the effect of fulfilling the intentions underlying this part of our terms of reference (paragraphs 16 to 20).

I.—Formulation of Building Scheme.

(3) In the formulation of a scheme the earliest collaboration between advisers is essential (paragraph 21).

II.—Site and General Lay-Out.

(4) A site should be selected which, while possessing the features desirable on general grounds, lends itself to economical building (paragraph 22).

(5) Recommendation of a general lay-out is not considered desirable, but certain principles of general planning are touched upon. A conclusive answer to the important question whether a widespread plan of low buildings or more concentration and higher buildings should be adopted cannot be based on cost of construction, and a decision should rest upon other considerations (paragraphs 24 to 29).

(6) We lay stress on the importance, in the choice of site and lay-out plan, of having regard to possible need for future extensions (paragraphs 23 and 30).

(7) The problem of internal communication by corridors, staircases and lifts should be considered as a whole, and care should be taken to avoid devoting an undue amount

of building to corridors or needlessly multiplying lifts and staircases. Main corridors should be 8 feet wide. Staircases which may have to be used for stretchers should be 4 feet 6 inches wide, with half-landings 6 feet deep (paragraphs 31 to 33).

III.—The In-Patient Accommodation.

(8) The standard ward unit should contain 30 beds, of which four should be in one-bed rooms (paragraphs 35 and 37).

(9) We are impressed by the marked tendency to depart from large wards which has become evident in recent years, and the replacement of the main ward by two or more smaller wards is well worthy of consideration (paragraphs 43 to 45).

(10) The longitudinal arrangement of beds in a large ward should be regarded as still on its trial. We look on it as an interesting innovation which, so far as can be be seen at present, does not appear likely to affect constructional costs materially (paragraph 51).

(11) We have adopted the following standards for wards with the traditional arrangement of beds:—

Space between bed centres	8 ft.
Width of main wards	Not less than 25 and not more than 26 ft.*
Height of main wards containing not more than 16 beds ...	11 ft.
Height of undivided longer wards ...	12 ft.
Height of small wards, where not determined by the height of the main ward ...	9 or 10 ft.
Size of single-bed rooms	10 ft. by 11 ft. (paragraphs 56, and 62 to 64).

(12) We do not consider ourselves to be in a position to prescribe standard dimensions for a large ward with the beds arranged longitudinally, but examples of such wards which we quote show floor areas per bed corresponding very closely with our standards for the more usual type of ward (paragraph 65).

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* This was not a unanimous decision. Some members were not convinced of the need for a greater width than 24 feet (*see* paragraph 62).

(13) The ancillary rooms necessary in a ward unit (with suitable areas) are as follows:—

	Sq. ft.
Sluice room	100
Space for testing	30
Bathroom	70
Ward office	70
Ward kitchen	200
Duty room	100
Linen store	70
General store	70

together with patients' lavatory and W.Cs., staff lavatory and W.C., and cleaners room. The branch corridor leading to the main ward should be 7 ft. wide (paragraphs 76 to 78).

IV.—The Operating Theatre Suite.

(14) An operating theatre should be 22 ft. long, 18 ft. wide and 12 ft. high. We give the rooms and dimensions which we consider will represent a good average provision of accommodation for single-theatre and twin-theatre suites in a non-teaching hospital (paragraph 80).

V.—The Reception and Out-Patient Departments.

(15) We give particulars of the minimum accommodation necessary for the Reception Department (paragraph 87), but we are of opinion that the out-patient practice of Local Authorities has not yet become sufficiently standardised for us to suggest standards for the Out-Patient Department (paragraph 88).

VI.—The Special Departments.

(16) The X-Ray Department is not suitable for the application of standards. The plant should be decided upon before the building is planned, and it is sound policy to provide space somewhat in excess of initial requirements and to plan in such a way as to facilitate future extension (paragraphs 90 and 91).

(17) For the Department for Massage, Electrical and Light Treatment, etc., also, it is impossible to lay down standards. The equipment required should be first considered and the Department planned in accordance therewith, space being allowed for possible future development (paragraph 92).

VII.—The Administrative and Certain Other General Services.

(18) We give particulars of the office accommodation required (paragraph 97).

(19) The provision of one kitchen to serve both patients and staff is recommended. The kitchen section is one which does not lend itself to the establishment of standards, but it should be planned around the equipment which it is to contain (paragraphs 98 to 101).

(20) Staff dining rooms should be in proximity to the main kitchen. In nurses' dining rooms sufficient space should be provided to permit the use of small tables, i.e., 12 sq. ft. per head calculated on the maximum number expected to be present at any meal (paragraphs 102 to 104).

(21) We state the main purposes for which central storage accommodation is necessary (paragraph 105).

VIII.—The Residential Accommodation.

(22) A separate house should be provided for the Medical Superintendent, and small houses or self-contained flats for one or more married Medical Officers (paragraph 118).

(23) As a general rule, the nursing staff should not be accommodated in the Administration Block, but in a separate Nurses' Home (paragraph 121).

(24) We make the following recommendations with regard to the accommodation to be provided in a Nurses' Home:—

(*a*) Administrative sisters should each have a bed-room and sitting room with a total superficial area of about 240 sq. feet. Ward sisters should have bed-sitting rooms of an area of about 140 sq. ft. Nurses' bedrooms should be about 100 sq. ft. The height of these rooms should be 8 ft., where not determined by the height of other rooms on the same floor (paragraphs 125 and 126).

(*b*) Bedrooms should be fitted with fixed basins. Bathrooms and W.Cs. should be provided on a scale of one of each to six or eight bedrooms (paragraphs 127 and 128).

(*c*) The sisters' common room should be on the basis of at least 20 sq. ft. per head, calculated on the total number of sisters. Common rooms for staff nurses should be on the basis of 20 sq ft. per head, and for probationers 12 sq. ft. per head, the number of occupants being reckoned as two-thirds of the total staff of each grade (paragraph 129).

(*d*) The training school should include a lecture room (with 12 sq. ft. for each member of the class, assuming an attendance of one-third of the number of probationers) and a demonstration room of not less than 700 sq. ft. (paragraph 135).

IX—The Mortuary Block.

(25) We give particulars of the essential accommodation of a Mortuary and Post-mortem Department (paragraph 141).

X—Methods of Construction, Materials and Finishings Generally.

(26) While there are some useful alternatives to traditional methods of construction, there is no new material or method of general application that is likely to lead to a substantial saving in cost, and careful designing with due regard to economy in material and avoidance of elaborate architectural detail offers the best means of reducing cost (paragraph 145).

(27) We make recommendations as to the form of construction of internal and external walls (paragraphs 146 and 147).

(28) If the costs of flat and pitched roofs of equal efficiency in weather protection, insulation and permanence are compared, it will be found that no saving is likely to result from the adoption of a flat roof (paragraph 148).

(29) We make recommendations with regard to the construction of floors and ceilings (paragraphs 151 to 154), the type of window to be adopted for wards (paragraphs 155 to 160), and the type of doors and door frames to be used (paragraphs 161 and 162).

(30) We refer to certain general considerations governing the finishings which should be applied to the walls and floors of the several parts of a hospital (paragraphs 163 to 170), and set out our detailed recommendations as regards wall and floor finishings (paragraph 171).

XI—Engineering Services.

(31) Wherever possible water should be obtained from a public supply, and foul and surface water drainage should be connected to public sewers (paragraphs 174 and 175).

(32) Low pressure hot water is the best medium of heating, but the decision whether a steam or hot water system should be installed can only be arrived at after consideration of all the circumstances (paragraph 187).

(33) Panels, whether embedded or applied, have certain advantages over radiators, but the use of panels is a comparatively recent development in heating and there is insufficient evidence as to the cost of their upkeep and maintenance. Radiators should therefore be regarded as the standard practice for the present (paragraph 196).

(34) We suggest the differences between inside and outside temperatures and also the air change factors which should be used by the engineer in the design of heating systems (paragraphs 199 and 201).

(35) The question whether steam or hot water required for heating should be generated at a central boiler house or in independent boiler chambers for individual blocks or groups of blocks is a matter which must depend largely upon local conditions. It will generally be found, however, that although the capital cost is definitely higher a central boiler house is more economical in operation and more convenient (paragraphs 203 to 207).

(36) We make recommendations as to the siting of a central boiler house and of independent boiler houses, the situation of calorifiers, and the types of boilers and other boiler house equipment required (paragraphs 208 to 225).

(37) In any centralised heating scheme the cost of providing ducts in which the pipes are laid between the central boiler house and the separate blocks is a material factor in the cost of the heating system. Subways, large enough to enable a man to walk upright, should be provided only where steam pipes have to be carried, and their width should be restricted to the essential requirements. Where steam pipes have not to be carried, trenches should usually be sufficient (paragraphs 227 to 229).

(38) There should be two completely separate systems of pipe-work for hot water supply and for central heating (paragraph 232).

(39) There is a conflict of opinion among engineers and others as to the quantity of hot water which might be considered as a reasonable provision to be made for different types of hospitals. The consumption of hot water varies very considerably in different hospitals of similar class. Economy in capital and operating costs in this service can be secured by the exercise of proper control and supervision in the use of hot water, and provision should be made in the lay-out for meters to enable the consumption of hot water in each individual block to be recorded (paragraphs 233 and 234).

(40) Coal storage for three weeks of the winter demand should be an ample provision in normal circumstances.

The amount of deterioration that takes place in the open is not sufficient to call for the provision of a covered coal store as a measure of economy, but where coal has to be stored near the wards it should be covered (paragraphs 239 and 240).

(41) The problem whether electricity should be generated in a central boiler house or obtained from a public supply is a complicated one, and is not capable of a single solution to meet all cases. Even if it can be shown that local generation would be cheaper, where there is no great difference in cost a public supply should be taken, especially in view of the general tendency towards reduction in charges for public supplies (paragraph 245).

250. In concluding our Report we desire to express our gratitude to Mr. J. A. Lawther, Secretary to the Committee, and to his predecessor, Mr. J. Topping. Mr. Topping's work, excellently performed, was mainly of a preliminary character, as he was, to our regret, called to other duties at an early stage of our Inquiry. The main burden has fallen on Mr. Lawther, whose accurate recording and intimate knowledge of all the details of our work and of the large amount of material that has passed through his hands have been invaluable throughout the proceedings of the Committee and in the preparation of this Report. The way in which he has accomplished a complicated and onerous task is highly appreciated by us all.

ADAM MAITLAND (*Chairman*).
JOHN ALLCOCK.
A. STRACHAN BENNION.
H. W. BRUCE.
JANET M. CAMPBELL.
REGINALD C. COX.
J. FERGUSON.
J. KIRKLAND.
F. BARRIE LAMBERT.
T. S. MCINTOSH.
RODEN H. P. ORDE.
L. G. PEARSON.
C. F. ROUNDELL.
A. SCOTT.
W. REES THOMAS.

J. A. LAWTHER (*Secretary*).

16th December, 1936.

APPENDICES.

APPENDIX I.

LIST OF WITNESSES.

(See paragraph 7.)

MINISTRY OF HEALTH.

Dr. (now Sir) ARTHUR S. MACNALTY, M.D., F.R.C.P., a Senior Medical Officer.
Dr. H. A. MACEWEN, O.B.E., M.B., a Senior Medical Officer.
Dr. J. R. HUTCHINSON, M.D., a Medical Officer.

BOARD OF CONTROL.

Mr. (now Sir) LAURENCE G. BROCK, C.B., Chairman of the Board.
Sir HUBERT BOND, K.B.E., D.Sc., M.D., F.R.C.P., a Member of the Board.

DEPARTMENT OF HEALTH FOR SCOTLAND.

Mr. JOHN WILSON, F.R.I.B.A., Chief Architect.

ELECTRICITY COMMISSION.

Mr. J. N. KENNEDY, O.B.E., M.Inst.C.E., M.I.E.E., an Electricity Commissioner.
Mr. T. P. WILMSHURST, M.B.E., M.Inst.C.E., M.I.E.E., an Electricity Commissioner.
Mr. A. N. EAST, M.I.E.E., an Engineering Inspector of the Electricity Commission.
Mr. S. RUDD, M.I.E.E., of the Central Electricity Board.
Mr. R. C. SYMONDSON, of the Electrical Development Association.

ASSOCIATION OF COUNTY MEDICAL OFFICERS OF HEALTH.

Dr. JOHN TATE, M.R.C.S., L.R.C.P., D.P.H., County Medical Officer of Health, Middlesex County Council.

ASSOCIATION OF MUNICIPAL CORPORATIONS.

Mr. Alderman W. L. RAYNES, Cambridge Borough Council.
Mr. (now Sir) HERBERT H. HUMPHRIES, C.B.E., M.Inst.C.E., L.R.I.B.A., City Engineer and Surveyor, Birmingham.
Dr. H. P. NEWSHOLME, M.A., M.D., B.Sc., F.R.C.P., D.P.H., Medical Officer of Health, Birmingham.

BRITISH COMMERCIAL GAS ASSOCIATION.

INSTITUTION OF GAS ENGINEERS.

NATIONAL GAS COUNCIL.

Sir FRANCIS GOODENOUGH, C.B.E.
Mr. H. H. CREASEY, Deputy Controller of Gas Sales, Gas Light and Coke Company.
Mr. W. BOON, Manager, London and Counties Coke Association.

BRITISH HOSPITALS ASSOCIATION.

Mr. S. Clayton Fryers, House Governor and Secretary, Leeds General Infirmary.
Mr. Frank G. Hazell, late General Superintendent and Secretary, Manchester Royal Infirmary.
Mr. Charles M. Power, M.C., Secretary, Westminster Hospital.

COUNTY AND COUNTY BOROUGH HOSPITAL MATRONS' ASSOCIATION.

Miss L. S. Clark.
Miss J. Inglis.

COUNTY COUNCILS ASSOCIATION.

Dr. S. Gurney-Dixon, Hampshire County Council.
Mr. M. T. Hughes, A.S.A.A., County Accountant, West Sussex County Council.
Mr. G. S. Widdows, F.R.I.B.A., County Architect, Derbyshire County Council.

INCORPORATED ASSOCIATION OF CLERKS AND STEWARDS OF MENTAL HOSPITALS.

Mr. W. J. Longden, Steward, St. Audrey's Hospital, Melton, Suffolk.
Mr. C. G. Rolliston, Steward, East Sussex Mental Hospital, Hellingly, and President of the Association.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.

Mr. F. Wilkinson, M.Inst.C.E., Borough Engineer, Willesden.

MEDICAL SUPERINTENDENTS SOCIETY.

Dr. J. B. Cook, M.D., Medical Superintendent, West Middlesex County Hospital, Isleworth.

MENTAL HOSPITALS ASSOCIATION.

Mr. Alderman W. Locke, J.P., Newcastle-upon-Tyne, Chairman of the Association.
Dr. T. C. Graves, F.R.C.S., Medical Director, Birmingham Mental Hospitals.
Mr. D. E. Turner, L.R.I.B.A., Chief Officer of Works, Birmingham Mental Hospitals.
Mr. L. T. Feldon, Secretary of the Association.

NATIONAL ASSOCIATION OF ADMINISTRATORS OF LOCAL GOVERNMENT ESTABLISHMENTS.

Mr. T. Spire Dempsey, Master, Oster House Institution, St. Albans.
Mr. W. Richards, Master, Luton Institution.
Mr. R. J. Layland, Master, Woolwich Institution.
Mr. E. H. Heeley, Master, Kettering Institution.

REINFORCED CONCRETE ASSOCIATION.

Mr. Douglas H. Green, O.B.E., B.Sc., A.C.G.I., A.M.Inst.C.E., a Member of the Council of the Association.

ROYAL INSTITUTE OF BRITISH ARCHITECTS.

Mr. C. E. Elcock, F.R.I.B.A.

ROYAL MEDICO-PSYCHOLOGICAL ASSOCIATION.

Dr. F. Douglas Turner, M.B., Medical Superintendent, Royal Eastern Counties Institution, Colchester.
Dr. J. S. I. Skottowe, M.D., D.P.M., Medical Superintendent, Cefn Coed Mental Hospital, Sketty, Swansea.
Dr. R. Worth, O.B.E., M.B., Medical Superintendent, Springfield Mental Hospital, Tooting.

SOCIETY OF MEDICAL OFFICERS OF HEALTH.

Dr. G. Lissant Cox, M.D., Chief Tuberculosis Officer, Lancashire County Council.
Dr. A. Joe, D.S.C., M.D., D.P.H., Medical Superintendent, North Western (Fever) Hospital, Hampstead.
Dr. D. A. Powell, M.D., Principal Medical Officer, Welsh National Memorial Association.
Dr. J. W. Miller, M.B., D.P.H., Medical Officer of Health, Lewisham Metropolitan Borough Council.
Dr. T. W. Naylor Barlow, O.B.E., D.P.H., late Medical Officer of Health, Wallasey County Borough Council.
Mr. Guy Elliston, M.A., Secretary of the Society.

Mr. A. H. Barker, M.Inst.C.E., A.I.E.E., M.I.Mech.E.
Mr. E. W. Butler, O.B.E., Chief Structural Engineer in the Architects Division of H.M. Office of Works.
*Dr. W. Allen Daley, M.D., B.S., B.Sc., a Principal Medical Officer of the London County Council.
Mr. E. W. Dorey, A.M.I.E.E.
Mr. Ernest Griffiths, M.I.Mech.E., and Mr. E. Edwin Griffiths, A.M.I.Mech.E.
*Mr. F. R. Hiorns, F.S.A., F.R.I.B.A., an Assistant Architect of the London County Council.
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* The assistance informally given by these officers did not constitute evidence on behalf of the London County Council and must not be regarded as in any way committing the Council.

APPENDIX II.

NURSING STAFFS IN LONDON COUNTY COUNCIL ACUTE GENERAL HOSPITALS.

(See paragraph 117.)

Note.—The working hours for nurses are 54 a week. In the case of probationers this includes two hours for lectures.

Name of Hospital.	New End.	St. Nicholas.	St. Pancras.	St. Luke's, Chelsea.	St. Peter's.	St. George-in-the-East	Hammersmith (Hospital and Institution).	Mile End.	Highgate.	St. Mary Abbots.	Fulham.	St. Leonard's.	Paddington.	St. Andrew's.
No. of patient beds	264	331	380	390	404	410	460	534	550	555	559	561	603	626
Matrons	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Assistant matrons ...	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Night superintendents ...	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Sister tutors	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Sister housekeepers ...	1	1	1	—	—	—	1	—	1	1	1	1	1	—
Home sisters	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Dieticians	—	—	—	—	—	—	1	—	—	—	—	—	—	—
Food supervisors ...	—	—	—	1	1	1	—	1	—	—	—	—	—	1
Administrative sisters ...	—	1	—	—	1	1	3	1	1	1	1	1	1	1
Departmental sisters ...	3	3	2	2	2	3	5	3	1	3	3	2	3	4
Sisters	9	11	10	13	14	13	31	19	23	24	18	20	21	20
Staff nurses	26	38	31	36	38	39	118	52	45	61	51	54	57	54
Probationer nurses ...	47	69	74	61	57	84	100	101	94	111	108	109	117	133
Assistant nurses, senior...	—	—	—	—	—	—	8	—	—	—	—	—	—	—
Assistant nurses, Class I	—	—	—	—	—	—	31	5	—	—	—	—	—	—
Nursery nurses	—	—	—	—	—	—	—	8	—	—	—	—	—	—
Head or charge nurses (male)	1	—	—	—	1	—	—	—	—	—	—	—	—	—

Staff nurses (male) ...	3	5	4	3	6	4	10	4	3	4	4	4	4	4
Probationer nurses (male)	8	—	—	—	15	—	—	—	—	—	—	—	—	—
Ward orderlies (nursing) (male) Class I ...	—	3	2	1	2	2	6	2	2	2	2	3	2	2
Service relief sisters ...	—	—	—	—	—	—	—	1	1	1	1	1	1	1
Totals	103	136	129	122	142	152	319	202	176	213	194	200	212	225

APPENDIX II—*continued—see next page.*

APPENDIX II—*continued.*

Name of Hospital.	St. Alfege's.	Bethnal Green.	Archway.	St. Olave's.	St. Stephen's.	Dulwich.	St. Charles'.	Hackney.	Lewisham.	St. Giles'.	St. Mary, Islington.	St. James'.
No. of patient beds	634	650	664	686	718	728	766	772	781	810	858	903
Matrons	1	1	1	1	1	1	1	1	1	1	1	1
Assistant matrons	1	1	1	1	1	1	1	1	1	1	1	1
Night superintendents	1	1	1	1	1	1	1	1	1	1	1	1
Sister tutors	1	1	1	1	1	1	1	1	1	1	1	1
Sister housekeepers	1	1	—	1	1	1	1	1	1	1	1	1
Home sisters	1	1	1	1	1	1	1	1	1	1	1	1
Dieticians	—	—	—	—	—	—	—	—	—	—	—	—
Food supervisors	—	—	1	—	—	—	—	—	—	—	—	—
Administrative sisters	2	1	1	1	1	1	2	2	1	1	1	1
Departmental sisters	3	3	1	3	3	3	2	3	3	4	3	3
Sisters	21	18	16	25	29	28	26	32	33	32	30	33
Staff nurses	60	59	40	55	61	60	56	65	75	75	69	70
Probationer nurses	119	135	86	140	146	131	142	125	151	158	154	203
Assistant nurses, senior	—	—	—	—	—	—	—	—	—	—	—	—
Assistant nurses, Class I	—	—	—	—	—	—	—	—	—	—	—	—
Nursery nurses	—	—	—	—	—	—	—	—	—	—	—	—
Head or charge nurses (male)	—	—	—	—	1	—	1	1	—	—	—	—
Staff nurses (male)	4	6	3	4	8	5	8	7	6	4	4	6
Probationer nurses (male)	—	—	—	—	—	—	—	14	—	—	—	—
Ward orderlies (nursing) (male) Class I	2	6	2	2	5	3	5	—	4	3	3	2
Service relief sisters	1	1	1	1	1	1	1	1	1	1	1	1
Totals	218	235	156	237	261	238	249	256	280	284	271	325

APPENDIX III.

NURSING STAFFS IN PROVINCIAL MUNICIPAL HOSPITALS.

(See paragraph 117.)

Name of Hospital.	Cardiff, Llandough.	Lancashire C.C., Davyhulme.	Liverpool, Mill Road.	West Ham, Whipps Cross.	Essex C.C., Romford, Oldchurch.	Birmingham, Dudley Road.	Middlesex C.C., North Middlesex.	Nottingham, City.	Manchester, Withington.	Leeds, St. James.	Middlesex C.C., West Middlesex.	Manchester, Crumpsall.	Liverpool, Walton.
No. of patient beds ...	345	500	762	850	860	900	950(*i*)	981	1,220	1,330	1,383(*r*)	1,543	1,852
Matron	1	1	1	1	1	1	1	1	1	1	1	1	1
Assistant matron ...	1	1	2	1	3	3	3	1	3	2	3	4	3
Home sister	1	1	1	2	2	2	3	1	3	1	4	3	2
Sister tutor	1	1	1	2	2	2	2	1	2	1	2	2	2
Ward and other sisters	17	16	23(*d*)	28	35(*f*)	46	46(*j*)	22	35	28	52	35	44(*w*)
Staff nurses	9	16	11	41	41	72	92(*k*)	12	67	29	135(*s*)	59	32
Probationers... ...	78(*a*)	94(*c*)	110	120	270	240	216(*l*)	141	161	179(*p*)	155(*t*)	156	231
Assistant nurses ...	—	2	—	—	12(*g*)	—	18	—	13	56(*q*)	118(*u*)	51	—
Male nurses	1	—	15	3	4	—	16	15	8	33	34	11	24
Totals	109(*b*)	132	164	198	370	366	397	194(*m*)	293	330	504	322	339
No. of working hours per week of nurses	56	56	56	52(*e*)	54	53(*h*)	48	58(*n*)	53(*o*)	48	48	51(*v*)	56

Notes—see next page.

APPENDIX III.—*continued.*

Notes.

Cardiff, Llandough.

(*a*) Includes 7 sub-probationers.
(*b*) A proposal is under consideration to increase the nursing staff by 25.

Lancashire County Council, Davyhulme.

(*c*) Includes 20 pupil midwives.

Liverpool, Mill Road.

(*d*) Includes 2 night superintendents.

West Ham, Whipps Cross.

(*e*) Hours of day nurses.

Essex County Council, Romford, Oldchurch.

(*f*) Includes 1 night superintendent, 3 night sisters, and also day and night theatre nurses.
(*g*) A proposal is under consideration that the 12 assistant nurses posts should be dispensed with and replaced by staff nurses.

Birmingham, Dudley Road.

(*h*) Includes 6½ hours in school.

Middlesex County Council, North Middlesex.

(*i*) Including 66 maternity cots. About 65 per cent. of the accommodation is for acute cases.
(*j*) Includes 2 sister housekeepers, 1 sister-in-charge, Maternity Department, and 1 chief night sister.
(*k*) Includes 22 staff and assistant mental nurses.
(*l*) Includes 24 staff nurse midwifery pupils, and 12 paying pupil midwives.

Nottingham, City.

(*m*) It is stated that the staff of nurses is not adequate, and will be increased when extensions to the Nurses Home are completed. Nurses are aided by a class of women known as ward orderlies.
(*n*) Hours of probationers only.

Manchester, Withington.

(*o*) Hours of probationers.

Leeds, St. James.

(*p*) Includes 4 pupil midwives.
(*q*) Includes 17 attendants in mental wards.

Middlesex County Council, West Middlesex.

(*r*) 486 acute, 603 chronic, 136 mental, 79 maternity beds, and 79 maternity cots.
(*s*) Includes 25 staff midwives.
(*t*) Includes 30 pupil midwives.
(*u*) Includes 9 mental nurses.

Manchester, Crumpsall.

(*v*) Hours of probationers.

Liverpool, Walton.

(*w*) Includes night superintendent and assistant.

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