HE Hospital Engineering

JUNE 1975

Fire Precautions Act

Institute of Hospital Engineering

'Hospital Engineering'
is published ten times a year by
Peter Peregrinus Limited,
PO Box 8, Southgate House,
Stevenage, Herts. SG1 1HQ,
England
(PPL is a member of ESIP)

Individual copies cost
£1·10 (postage paid)

The annual subscription is £10·40

Average circulation per issue
(January - December 1974):
2169 (ABC)

Editor
David Mackin, B.Sc.

Graphics Manager
M. C. Partridge

Circulation Manager
R. C. Sutton, B.A.

All correspondence relating to the Journal should be addressed to:
'Hospital Engineering',
Peter Peregrinus Limited,
PO Box 8,
Southgate House,
Stevenage, Herts. SG1 1HQ,
England
Telephone: Stevenage 3311
(s.t.d. 0438 3311)

Advertisement Manager
Barry Weitz,
Advertisement Department,
Peter Peregrinus Limited,
Station House,
Nightingale Road,
Hitchin, Herts. SG5 1RJ
Telephone: Hitchin 53331
(s.t.d. 0462 53331)

UK ISSN 0046-7960

The Institute of Hospital Engineering,
20 Landport Terrace,
Southsea, Hants. PO1 2RG,
England
Telephone: Portsmouth 23186
(s.t.d. 0705 23186)

Secretary
J. E. Furness, V.R.D.

HE

Hospital Engineering

Incorporating 'The Hospital Engineer'

Vol. 29
June 1975

The Journal of The Institute of Hospital Engineering

Contents

Special features

News features

Departments

Front cover: Photos from Clifford Partitioning Co. Ltd. (a ward at RAF Halton Hospital before its 1973 modernisation) and Telephone Rentals Ltd.

Hospital Engineering

Vol. 29
June 1975

Applications of the 1971 Fire Precautions Act to hospital building and engineering design

31st annual conference

by J. D. TWELLS

Within the near future, a designation order from the Home Office will oblige hospital authorities to comply with the 1971 Fire Precautions Act. A hospital authority cannot sit back and wait for a fire officer's report before it takes any action and neither can the subject be considered in isolation by any one group of building, engineering, administrative or medical users of the hospital. All are involved as a team and can only be effective acting as a team.

Since the application of the Fire Precautions Act is to be shared by architects and engineers, some effort has been made to try and separate the areas of professional involvement so that each can speak for his own particular zone of expertise. However, it is obvious that there is no natural division between the professions, and a more logical distinction could perhaps be made between:

(*a*) *the practical details* of the nuts, bolts and wires which (hopefully) make things work;

(*b*) *the strategic analysis* of buildings and the way they are used—seeking a safer life style for the occupants and adopting new policies affecting human activities—particularly those that may give rise to fire risk and loss of life.

Both levels of responsibility require the full involvement of both professions, and, to complicate the working arrangements slightly further, both will depend heavily on the ability to measure costs and to argue the relative degrees of safety which can be afforded by whatever sums of money that are available.

If the subject of this article is to be restricted to the application of the Fire Precautions Act then we are concerned here only with existing buildings, the Home Office and the local fire brigades; and that, as a subject on its own, is more than enough. However, new buildings, upgrading contracts etc., are shortly to become the subject of fire-safety control (both structural, and means of escape) administered by the DoE through building regulations.

The DHSS negotiates on behalf of the health service with both the Home Office and the Department of the Environment to reach agreement on how codes of guidance could best be framed to suit hospitals.

Conferences of this nature—and the training programmes that are to be set up within the NHS—are of vital importance in focusing attention on the special needs of hospitals for fire prevention.

Mr. Twells is an architect with the Department of Health & Social Security, Euston Tower, London NW1 3DN
The views represented are his own and do not necessarily represent official DHSS policy.

The subject cannot be considered in isolation by any one group of building, engineering, administrative or medical users of the hospital. All are involved, as a team, and can only be effective acting as a team.

One way to prepare for and to appreciate the technical problems is to consider the procedures required of hospital authorities under the terms of the Fire Precautions Act:

(*a*) hospitals will be 'designated' on a date yet to be agreed with the Home Office—probably this year

(*b*) the designation order will oblige the authorities to comply with the Act.
We expect to have agreed on a code of guidance before the commencement date. The order is likely to apply to all hospitals, but the DHSS with the Home Office may arrange for certain hospitals to be given priority; e.g. long-stay psychiatric etc., before new district general hospitals

(*c*) when the order is in force the owner is liable; and to discharge his responsibilities he must apply to the Home Office for a fire certificate.

With many other types of buildings, the owner can then sit back and await the report of the local fire brigade which will contain a schedule of requirements and a date by which they are to be completed to the satisfaction of the fire officer before a certificate can be issued.

For hospitals, however, it is thought, within the NHS, that this procedure will have to be modified. To start with, Crown buildings can only obtain a certificate from the Home Office Inspector and not the Fire Brigade, although local Fire Brigade Officers will inspect hospitals as agents of the Home Office Fire Inspectorate. The real point at issue is that a hospital authority cannot sit back and wait for a Fire Officer's report, which, with the very best of intentions, may cut across the key operational functions of the hospital or even the clinical needs of the patients.

Special conditions

It will be for engineers, works, professional and administrative staff, to collaborate with the local fire officer to see that his recommendations take into account the special conditions of the patients and the hospital working routines.

There will always be areas of judgment that are peculiar to local circumstances, and, so far as the NHS is concerned, problems that cannot be resolved locally will be resolved between DHSS and the Home Office and not subject to what might be a very personal opinion of one Fire Brigade chief.

There are problems on fire precautions which hospital planners try to forsee, and which they try to avoid by long-term strategic disposition of the functions and staff training etc. within the buildings. There is, of course, the problem of time lag, and there have been situations where these long-term strategies in design—with all the effects they have on patients and staff—have been carried out with great diligence only to find that, by the time they come into practice, the regulations have changed. The planning 'time lag' and the difficulty of influencing basic operational policies within hospitals make it essential that fire-prevention policies effectively concern top management on a long-term basis to avoid a heavy work load and endless expense at the detailed building/engineering end, the nuts, bolts and wires.

The primary concern of the hospital staff in time of fire is to know how to cope with the immobility of many of the patients. For this reason, the normal regulations relating to 'means of escape' have to be reconsidered. The first requirement must always be to ensure that a detection and alarm system with a swift response is available, so that the effects of smoke can be dealt with, either by the staff, automatic devices or by the fire brigade when they arrive. Time is the essence of survival. In addition, we must assume that the hospital can be appropriately compartmented to prevent the spread of smoke and fire from its source to other parts of the building. However, even with early warning and compartmentation there still remains the physical problem of actually moving bedridden patients from one set of rooms to another.

Distance travelled

It is the importance of time and method of evacuation rather than distance to be travelled that we have stressed to the Home Office. However, there is a serious problem in estimating the time it takes to move patients, and both Fire Brigades and the Home Office have suggested that, in the absence of any method of demonstrating evacuation times, the physical distance travelled to a 'protected area' or 'point of safety' must remain the controlling design criterion.

Now although this has to be accepted for the time being, the same problem presents itself in a different guise—that is, of reaching agreement on which precise distances are the right ones—and, more important, how does one define a 'protected area'. On this latter question there are two issues still to be resolved:

(*a*) Whether the traditional hospital street be made into a series of 'protected areas', so that patients can use it as their first choice of refuge from a fire in a ward. If this can be achieved, the movement is all horizontal and evacuation is feasible

(*b*) How to locate and design stairways (within protected shafts) so that they afford the best available second choice of escape. There is no doubt in the minds of some hospital staff that stairways are simply not acceptable for patient escape; the occasional practical exercises that have been tried have demonstrated far greater risks to life from falls than would have resulted from the fire itself

The only possible third choice would be the use of bed lifts; however, because of the risk of power failure during a fire, no dependence can be placed on them.

Whatever decisions are reached at Departmental level and in terms of the code of guidance (to be published by the Home Office), all of them must be acceptable to the Fire Officer and Works Officer as being achievable and enforceable.

The worst that can happen is for theoretical standards to be laid down which fail to recognise the problems of the works and professional staff in the day-to-day running of the hospital, or of the nurse or hospital porter in actually coping with patients in a smoke-logged ward.

However, the converse of this may be equally as absurd, if taken to extremes by professionals who try to protect themselves from blame. For example, situations have come to our notice where designers (architects, I have to admit) have elected on their own initiative to specify the installation of smoke and heat detectors within every room and along all corridors, and demanded that all fire doors be fitted with magnetic détentes. The cost of this investment in 'safety' has been claimed from the Treasury and probably paid, but the number of patients who could have been given medical or life-saving treatment with that money will never be known.

The fact is that wherever there is available a piece of building or engineering hardware with a demonstrable contribution to safety, the temptation is to put it in. But who is to be the arbiter of actual value for money in terms of lives saved when medical or nursing treatment is weighed against protection from fire? There is always the very real fear amongst us of the committee of inquiry into fire incidents, but there is no balancing regulation, or inquiry into the quality of health services, for which we can be called to account.

Hospital planners and designers have the task of trying to resolve these conflicting demands. They can only do so by knowing the Fire Precautions Act extremely well and also by being prepared to involve themselves with the fire brigades or Home Office in suggesting reasonable alternatives which take account of the wider interests of the hospital as a whole.

General headings

The rest of this paper will be devoted to explaining briefly what is being done within DHSS and the NHS to deal with them; they come under six general headings as follows:

(*a*) the organised management and control of NHS stock which is administered by Estmancode and deals with all aspects of estate management including compliance with the Fire Precautions Act and with building regulations

(*b*) specialised research and development into the technology of fire precautions in hospitals, which will lead us to new guidance documents for use by Regional Health Authorities

(*c*) a detailed analysis of one particular old hospital to be carried out by a working party which includes representatives of the Home Office Inspectorate and fire officers

(*d*) planning exercises in collaboration with medical, nursing and administrative representatives which will demonstrate the type of district service study required before a hospital fire precautions policy can be put into action

(*e*) the establishment of an NHS/DHSS working party on regulations which will take note of the management arrangements, staffing, qualifications, job descriptions etc. of personnel responsible for building regulations and fire precautions

(*f*) the co-ordination of fire precaution training policies for works professionals, so that the appropriate levels of expertise can be established and works staff can take on the duties allocated to them with full responsibility.

Now look at these points in a little more detail.

(*a*) *Estmancode*

There is an accumulating volume of guidance on estate management being issued by DHSS surveying division. The need is long overdue for a nationally co-ordinated system of recording the condition of building stock, and the method of setting out the programme of works required to maintain and improve it. The service that has now been set up to do this is the main line of responsibility to cope with the nuts and bolts of health buildings and also to feed back to planning, design and cost policy for both old and new health buildings.

Because of its comprehensive nature, it has been placed first in the list of activities for complying with statutory requirements, but as far as this article is concerned we merely refer those interested to the Estmancode literature already distributed to RHAs.

(*b*) *Research and development*

The regulations group within the DHSS commissioned a specialist survey of over a hundred existing hospitals to see (at least superficially) what were the implications (including an order of expenditure) of complying with Fire Precautions Act. This research is being continued to produce data on:

- cost effectiveness of investment into fire precautions
- detailed lines for discussion with the Home Office on the draft code of guidance
- the content of new guidance documents (e.g. the rewriting of Hospital Design Note 2).

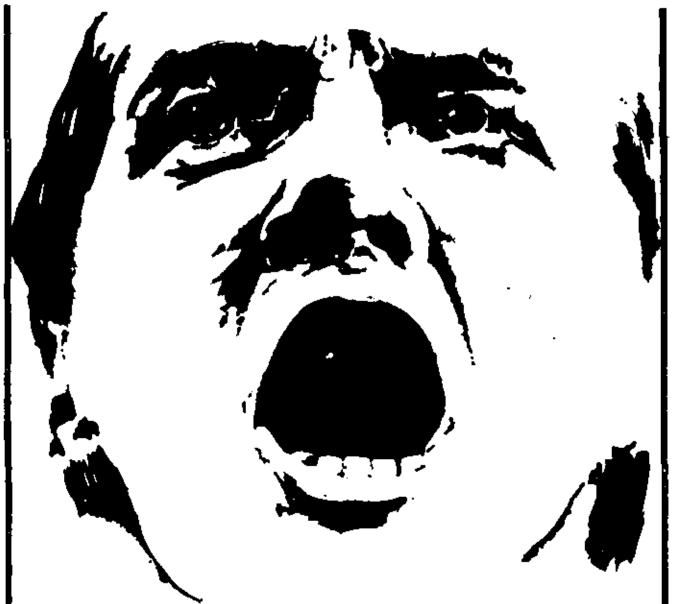
The estimate of expenditure based on a small sample of hospitals and, necessarily, not very accurate, was in the region of £80 to £100 million (at 1974 prices), and the engineers at DHSS have since suggested that another substantial sum of money will be required for associated engineering systems.

The size of this estimate alone is enough to ensure that no blind application of the Act can be entertained on *all* health buildings, *all* at once. Even if the clauses were all agreed there would have to be an agreement to apply them gradually over a period of time; and that means that some method must be devised to classify health buildings according to their degree of risk from fire, in terms of life and property.

There are already some very broad ideas which are not in dispute placing the long-stay institutions for psychiatric, physically handicapped and geriatric patients first in line for detailed study and possibly major investment. However, when the gross costs are known and the effect on nursing and administration routines are appreciated, it may become necessary to refine the classification of fire risk in new ways.

Flammability

For example, statistics show that the flammability of fabrics and furnishings account for an overwhelming percentage of fire incidents in hospitals. Or, to put it another way, if nonflammable materials could be produced (even at enormous extra cost) it might still be cheaper to use them than to make structural changes to the buildings which do not in the end reduce so effectively the fire risk to the patients.



FIRE!

If all automatic fire-detection and alarm systems are the same, why do so many choose to protect their property, businesses and future with a Sound Diffusion system? Perhaps it's because Sound Diffusion systems are backed by a history of exceptionally wide experience, proven reliability, and a caring, nationwide after-sales service. And of course, Sound Diffusion systems are available on rental terms which require no capital outlay whatsoever.

SOUND DIFFUSION LIMITED **Fire Division**, Datum Works, Davigdor Road, Hove, East Sussex BN3 1RZ. Telephone: Brighton (0273) 722891/2/3.

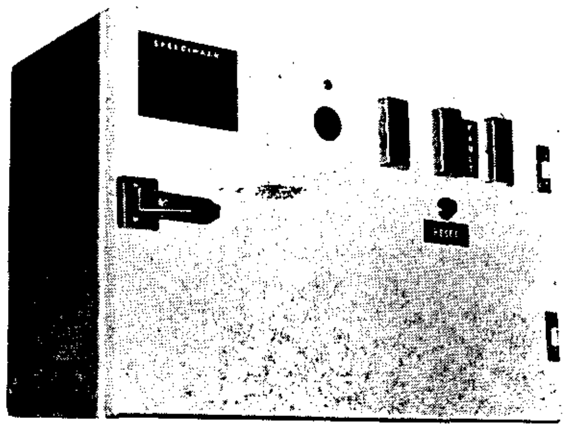
ELECTRONIC ALARMS LTD., manufacturers of Speediwarn Fire Precautions equipment, have designed a master fire alarm control unit that is considered to be unique in its field.

The **A2SD** is the only unit designed to meet BS3116, Part 4, that has all detectors, activators and sounders on the one pair of wires. Installation of this fully monitored system can be carried out in two core p.v.c. looping from smoke or heat sensors to break glass contacts and bells; a great saving over the conventional systems that require four or five core M.I.C.C.

The unit will show fault conditions, via lamp and buzzer, if any of the following occur:

(a) Line open circuit
(b) Line short circuit
(c) Removal of smoke detector
(d) Mains failure
(e) Charger failure
(f) Over charge
(g) Low charge
(h) Battery lead disconnected
(i) Fuse failure
(j) Output relay disconnected

The capacity of the **A2SD** is such that it will provide power to run 15 bells in accordance to CP1019 and BS3116, Part 4, and an unlimited number of smoke detectors, heat detectors or break glass contacts.



The company would welcome any engineers on their stand at the 'Interfire 75' exhibition to be held at Olympia on July 28th–August 1st. Tickets are available on request.

On display at 'Interfire 75' will be a multi zone unit based on the above that will include additional fault finding and testing facilities.

Many of the single zone units have been installed in hospitals throughout the country saving a great deal of time and money on otherwise expensive installations.

As well as these unique systems for which a patent has been applied for, Electronic Alarms manufacture a wide range of conventional fire alarms and emergency lighting units.

ELECTRONIC ALARMS
LIMITED
Factory No. 4, Staines Central Trading Estate, Staines, Middlesex.
Tel: Staines 56527/8/9

Alternatively it may become increasingly necessary to control more effectively smoking in wards because statistics also show that smoking is the greatest single cause of fire in hospitals. All these considerations must of course be decided by the administrative and policy divisions of the DHSS and the RHAs, but their decisions will depend on research studies and the best informed opinions available.

(*c*) *Detailed study of one old hospital*

The DHSS's works professionals, in collaboration with the regional works officer for North East Thames, and with the staff of Hackney Hospital, have agreed to study that hospital in detail. The Home Office and the local fire brigade have agreed to collaborate in an exercise to obtain a fire certificate for the hospital buildings.

Surveying buildings

The experience which can be obtained by surveying buildings in company with the Home Office inspector and the fire brigade should prove valuable to all parties. The fact that the initial consultation will take place within the working hospital will ensure that the discussions, or bargaining points, are based on real-life conditions and not abstract theories. The working parties appointed to carry out the survey and fire certificate procedures will also document their procedures, so that a final report can be drafted by the end of 1975. One vital ingredient of the analysis of Hackney Hospital will be the need to obtain the reactions of the regional planning staff and the hospital medical and nursing staff to the physical and cost consequences of compliance with the Act. Thus the sequence of work will be:

- survey the buildings
- apply the Act in the terms of works professionals, fire officers and Home Office recommendations
- analyse the cost
- compare that 'straight' investment with the production of a District Services Study, which can absorb the investment required for fire precautions within a wider strategy dealing with the way in which the hospital buildings are to be used. For example, some of the most expensive fire precautions may lead to a policy decision to change the use of or demolish an outdated building.
- apply the Act 'strategically' in accordance with district service policy.
- prepare the final schedule of works and the programme of expenditure required to obtain fire certificates for all buildings on the hospital site
- report on working party procedures for use in the production of policy and guidance documents.

(*d*) *District services study*

There is no agreed programme yet to engage in service-planning studies of hospitals and/or districts to comply with the Act, but works professionals are pressing for 'client' guidance on this subject. The analysis of Hackney Hospital will, hopefully, precipitate one such study for one particular district.

It is presumed that compliance with the Fire Precautions Act will involve Regional planners with many further studies. It will become essential for the design professionals dealing with hospitals to know how to apply their talents within the framework of a proper clients brief. The failure of the administration to brief their works professionals on matters of policy or service objectives would lead to a dangerous situation where individuals would be encouraged to exert their own professional preferences on how to comply with the Act. This, as has been mentioned before, could lead to the easy but expensive solutions, which may reduce the output of the medical and nursing services.

(*e*) *Working party on regulations*

A discussion group has been set up to consider and and advise on the works side of the management arrangements within NHS/DHSS which are necessary to comply with the Health and Safety at Works Act, the building regulations and the Fire Precautions Act.

The group includes at least one senior member of each works profession together with regional and area works officers, capital planning staff, and a nurse planner. It includes representatives from Scotland and Wales.

It is hoped that the members of the group are already well informed on the particular needs of those they work with and can advise the working party on appropriate fire precautions policies.

(*f*) *Co-ordination of fire precautions training for works professionals and for building/engineering works staff*

If responsibility is to be taken within the NHS by staff nominated to ensure that buildings conform to the statutory requirements, a fully co-ordinated training programme must be set up in relation to these responsibilities. The training policy must be structured to achieve three primary objectives from works professionals:

(*a*) the ability to advise a design team while they are producing their plans

(*b*) the ability to check through a set of design drawings and state whether they conform to the statutory requirements. A signature of approval will eventually be needed

(*c*) the ability to negotiate with the local fire brigade and Home Office Inspectorate on the terms required to receive a fire certificate for an existing building.

Current proposals

The policy has not yet had time to be put into practice, but current proposals are that expertise in compliance with regulations should be passed on to new trainees; not to large groups in classrooms, but to small groups joining the working situations of the project drawing office or in the survey or horse-trading with the fire brigade.

Each professional will need to know from their training curriculum something about the broad strategy for all participants and then, within that framework, they will train their members to be expert in their own special field.

In conclusion, the current situation is very fluid, as you will appreciate, and if the views expressed in this article seem sometimes indefinite, this merely reflects a developing situation in which we are trying to reconcile the very special needs of hospitals with legislative requirements applying to the whole building field.

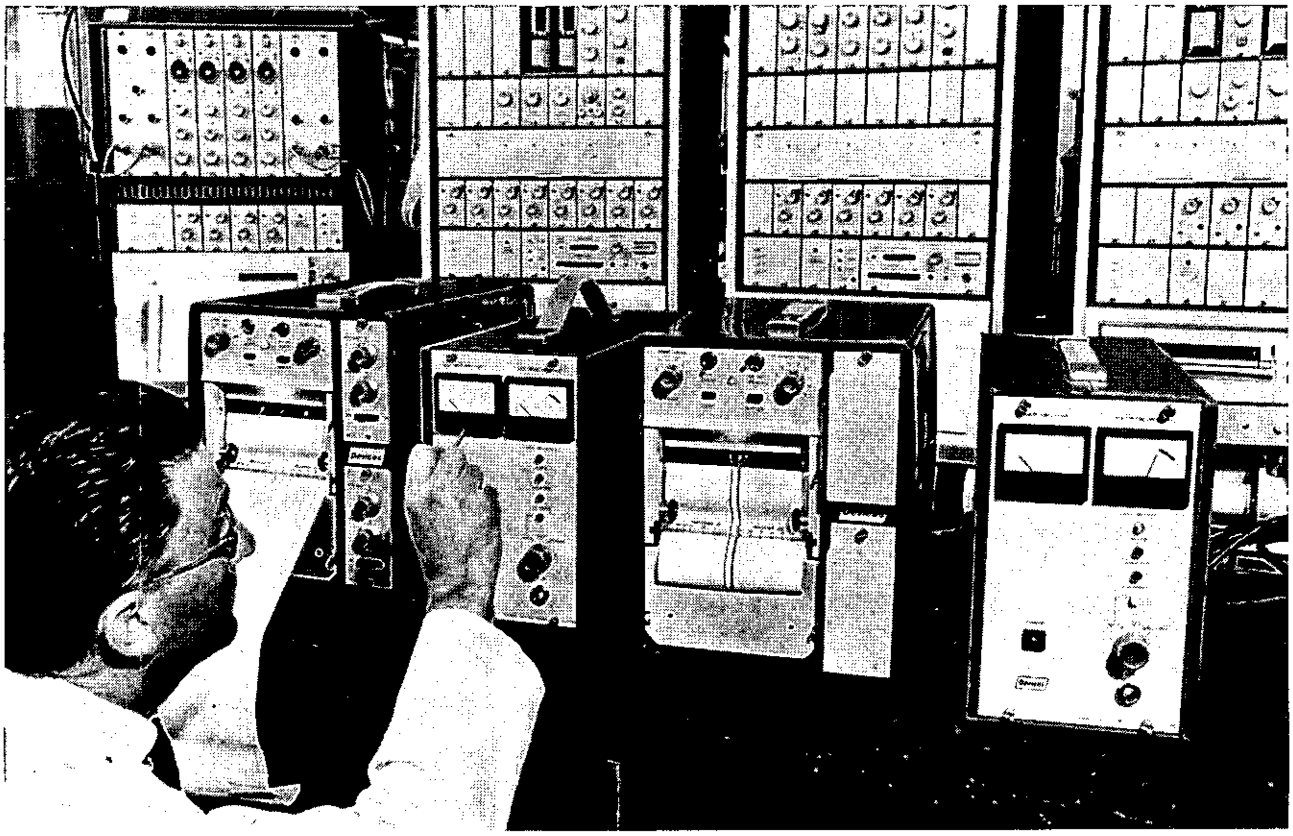


Photo: Sifam Electrical Instrument Co. Ltd.

Medical-engineering maintenance—the way ahead

31st annual conference

by G. K. ALSTON, B.Sc. (Eng.), C.Eng., F.I.E.E., F.I.Nuc.E.

The medical engineer has a real contribution to make to the National Health Service. If he cares as well for the defibrillator as he does for the boiler plant, both will function effectively. Experience shows that a great deal of medical-engineering equipment receives no regular maintenance. It is high time that adequate maintenance is given to all hospital equipment and the engineer is in the best position to provide this.

Medical-equipment maintenance

Maintenance of this equipment is necessary and has three principal objectives.

(a) the safety of the patient and the user

(b) the preservation of satisfactory standards of performance

(c) economy in the provision and use of equipment.

Capital investment on medical equipment is growing at 10–15% per annum and the annual cost of contract maintenance provided by manufacturers is often a considerable proportion of the capital cost. Several studies have reached the conclusion that a better service at less cost can usually be provided by adopting an in-house maintenance policy.

The increasing capital investment in the more complex equipment on which the Health Service now depends, makes a strong justification for a medical equipment maintenance service within the NHS.

1 Present position

Medical-engineering maintenance in the United Kingdom began to be organised about 70 years ago when the manufacturers of X ray units provided a service for the equipment they had installed in hospitals. Here was equipment totally different from anything else in medicine; to almost everyone it was a mystery and a frightening mystery, too.

Mr Alston is with the Oxford Regional Health Authority, Old Road, Headington, Oxford OX3 7LF

It would be wrong to say that X ray sets were the first medical-engineering equipment to come into use, but they certainly were the most complex of such equipment. After all, hammers and chisels have been used by surgeons for much longer. For as long as there has been medicine there has been an association of engineering with it. The Egyptians trepanned holes in living human skulls in an effort to treat migrain 3 000 years ago.

For as long as the equipment used in medicine was similar to that used in other professions, it was relatively easy to provide maintenance for it. From the early part of this century an increasing quantity of equipment used in medicine has come into service that is specialised and needs specialised maintenance.

The spectacular progress achieved in the development of electronic engineering, particularly during the last 20 years, has made it possible for a wide and complex variety of new instruments to be put into use for the advancement of medicine. The provision of such equipment is doubling every seven years. It is having a profound effect on the whole range of medical-engineering equipment which now, in total, represents about a quarter of all engineering plant and equipment in service in acute hospitals and one-tenth of all the engineering in all hospitals.

Modern hospital engineering installations make extensive use of electronics: boiler plants, communication systems, air-conditioning plants, lifts, heating installations, electricity supply systems and many more of the component parts of the hospital engineering services. To adequately maintain these installations, electronics engineers are needed. They are needed also to maintain the complex range of medical-engineering equipment in use.

Since the engineer must include on his staff those skilled in electronics, in addition to those skilled in electrical and mechanical engineering, when he is responsible for the maintenance of equipment as complex as that in a modern hospital, it is logical that his staff should be used for all the work they can effectively perform. This leads to the conclusion that they should be responsible for the maintenance of medical-engineering equipment, too.

The foregoing conclusion might be challenged by those working in other fields. Such a challenge may be countered by the argument that much medical-engineering equipment is more allied to the skills of the engineer than to those of any other profession and the engineer would seem to be the one most competent to do the work of maintenance effectively.

However much this claim may be argued, it remains that there is a vast quantity of vital equipment for which maintenance must be provided. What is far more important than who does the work is that the work is done as will be shown later in this article. It remains for engineers to prove their ability to do the work, or equally for others to prove they have an even greater ability. In the outcome it may be those with the higher qualities of leadership who are likely to provide medical-engineering maintenance.

2 The size of the task

There is a very large amount of medical-engineering equipment in service and the quantity is rapidly expanding. To better appreciate the magnitude of the task of maintaining this, some measure of the quantity and its rate of growth is necessary.

No national statistics appear to be available for the variety and quantity of medical-engineering equipment in use. In the Oxford Region the total value is about £5 million including the teaching hospitals. In the UK as a whole the corresponding figure will be of the order of £150 million, and could be nearer £200 million.

Experience has shown that the cost of inhouse maintenance of medical-engineering equipment averages 6% per annum of the capital value of the equipment. Approximately two-thirds of the cost is for staff, from which it may be calculated that about 2 000 maintenance engineers and technicians are needed to fully maintain all the equipment in service. This represents an average of about one medical-engineering-maintenance man (or woman) per hospital, per 250 beds of all categories

It is doubtful whether there are more than 700 competent engineers and technicians working full time on medical-engineering maintenance in Britain. This includes those employed by equipment manufacturers and agents. The task of providing an adequate force is thus formidable, bearing in mind that a competent electronics engineer or technician requires several years of specialised training before being fully efficient in medical-engineering maintenance. Mechanical and electrical engineers and technicians also need similar specialised training.

To recruit and train the staff to fully maintain all the existing medical-engineering equipment in service is likely to require about ten years, during which time the equipment may well have increased to two-and-a-half times the quantity. This assumes a determined effort by all concerned to get on with the job. At the rate of progress over the last five years, the total work force will never match the expanding quantity of equipment in use.

3 The case for a maintenance service

Medical-engineering equipment is playing a more and more important part in the diagnosis and treatment of illness. It has become an essential aid to the doctor and nurse in many branches of medicine, and when equipment fails it may seriously impede treatment or even bring treatment to a halt.

In addition to providing entirely new methods of treatment, medical engineering equipment is speeding up older methods and helping to increase the throughput of patients in hospitals. It thus conserves medical and nursing manpower and contributes to cost reduction in the Health Service.

Earlier it was indicated that the total value of medical engineering equipment in Britain is of the order of £150 million. The annual cost of equipment replacements will be about £30 million and the maintenance of all the equipment will add a further £10 million. The combined cost is thus about £40 million per annum to keep all medical-engineering equipment up-to-date and in good working order.

The annual cost of doctors' and nurses' salaries in hospitals is more than £600 million or 15 times greater than the cost of providing them with the medical-engineering equipment so essential to their work. The annual maintenance cost of that equipment would be £10 million, or less than 2% of the medical salaries. Good maintenance will undoubtedly contribute more than 2% in medical cost effectiveness, in addition to ensuring the kinds of treatment and diagnosis which are impossible without that equipment.

In the parts of the country where comprehensive medical-engineering maintenance is being provided, it has been shown that only a small fraction of equipment was previously receiving regular maintenance. Some indication of the reliance placed on medical-engineering and allied equipment may be given by quoting examples:

Where autoanalysers have been installed, the number of analyses made per acute bed are roughly treble those where more tedious analysis procedures have to be used. Analyses are made available more rapidly and in greater numbers. Patient treatment is thus expedited and the length of stay in hospital is reduced.

The use of electrocardioscopes make it possible to determine the heart condition of patients, to detect improvement or deterioration in response to treatment and to know when more drastic treatment is necessary. Defibrillators have provided clinical staff with a far better tool for reviving hearts than anything previously available. The quantity of such equipment has more than doubled in the last five years and many more lives have been saved.

Radio pocket paging receivers have made it possible for key staff in hospitals to be contacted without delay. Cardiac-arrest teams can proceed with normal duties, each one in a different part of the hospital, and yet be summoned to an emergency almost instantly.

Diagnostic X ray enables many symptoms to be explored before treatment begins, enabling the surgeon or others to adopt the best course of action. Unnecessary surgery is avoided and the patient's stay in hospital minimised.

In 1001 ways medical engineering is making it possible, not only to save lives and heal patients, but to do it at a lower cost in capital and in revenue: a given staff and a given number of beds are enabled to handle more patients.

If all the hospitals in the country were equal to the best, the number of acute beds could be reduced by 20%. This represents a capital saving of £400 million and a revenue saving of £100 million per annum. Alternatively, all waiting for acute beds could cease.

It must be admitted that many factors have a bearing on bed throughput, but the availability of adequate medical-engineering facilities, in good working order, is certainly one of the more important factors. Adequate maintenance to keep this equipment in good order need cost no more than £10 million per annum for the whole country. This is a small premium to pay for life and better health, and the cost advantages quoted above.

The capital cost of providing fully equipped medical engineering maintenance workshops for the whole country would be under £20 million, or only a small fraction of the £400 million quoted above.

Little has been said about safety, but this is the most important reason of all for providing medical-engineering maintenance. It safeguards patients and staff against electric shock and other risks, and it helps to ensure correct diagnosis and treatment by accurate calibration and performance of equipment. When safety can be purchased at no extra cost, there is every reason for providing it.

The various aspects of safety warrant several articles, but to illustrate these by considering just two pieces of equipment may be helpful. There are in service in Britain roughly 5000 electrocardioscopes and 2000 defibrillators, often used in conjunction. An electrocardioscope picks up a heart potential from the surface of the skin of the order of 1 mV and amplifies it to display the heart rhythm on a cathode-ray tube. From the display, the cardiologist can assess the performance of a heart, take remedial action if need be, and then measure the improvement (if any) on the oscilloscope. To display its information the oscilloscope needs to be sensitive to power signals of a microwatt—perhaps the power of a fly's wing!

The cardiologist (or anaesthetist, physician or nurse) may find the heart signal to be nil or that the heart is in fibrillation (trembling) and no longer pumping blood. To revive the heart and restore it to a healthy rhythm, they apply the defribillator, sending through the patient's chest up to 400 J in 3 ms—a power of 133 kW or the power output of a double-decker bus. The two instruments have to be calibrated to handle the power of a fly's wing in one case and a power 100 000 000 000 times greater in the other case, with one human being's life in between. Electrocardioscopes and defibrillators represent between 2% and 3% of the value of the medical engineering equipment in service. The total quantity of the two is worth about £4 million.

4 The case for inhouse maintenance

Inhouse maintenance is justified when it can be shown that, by its adoption, the cost of maintenance is reduced and/or its quality improved. The quantity and variety of equipment to be maintained are important, since on these depend the practicability of fully employing the staff to be recruited and their capability to cope with the problems involved. There may be cases where highly specialised equipments are in limited use and where inhouse maintenance is impracticable and/or uneconomical. These need not necessarily affect the overall case for the maintenance of the balance of the equipment, which in value and quantity is likely to be many times greater than the specialised equipment.

The works officer is perfectly clear on his responsibility for providing sufficient staff to maintain the whole of the hospital fabric together with its engineering equipment, both fixed and loose. Though he may have certain plant, such as multilift installations, under contract maintenance with manufacturers, he has no doubt about the need to ensure adequate maintenance for the balance of plant by employing all the staff he needs. The increasing volume of medical-engineering equipment in the hospital as yet seems to have found no-one to take an interest in its maintenance, even though the skills of the staff needed have an application to engineering equipment in general. Three factors that play an important part in justifying inhouse maintenance are:

Contract maintenance staff spend about one-third of their time travelling. The cost of this unproductive time and the cost of transport together are the main reasons why contract maintenance is more expensive than inhouse maintenance: 10% as compared with 6% per annum of the capital value of the equipment maintained.

It is well known that equipment under contract maintenance frequently fails immediately after servicing or performs less satisfactorily. The inhouse technician is on the spot to make second or even third trimming adjustments after a major servicing. He also becomes more fully acquainted with the idiosyncracies of the equipment under his care, than is possible for the man from outside.

It is not uncommon for a period of 24 h to elapse before an outside contractor can repair a piece of faulty equipment. Often equipment has to be sent back to the maker and may be away for weeks or months. This leads to wastage of time on the part of clinical staff or to the purchase of extra spare equipment to meet the situation. Either way, extra cost is involved, and patient treatment may be impaired.

A great deal of medical equipment now in service receives no regular maintenance. This is often because contract maintenance is too expensive and, with stringency on expenditure, the maintenance of equipment suffers. An inhouse service provides maintenance at lower cost and, once it is established, it is unlikely to be axed when money is short.

For whatever reasons regular maintenance may not be available for medical-engineering equipment, the safety and well-being of the patient should overrule these considerations. The inhouse service should be there to meet the need effectively at minimum cost.

5 The case for an engineering-based service

In some parts of the UK physicists are providing excellent medical-engineering maintenance services over a varying range of equipment. By having established such services, they have also established the right to operate them. In such cases, it remains for engineers to give them full support and to decide how best to cover the maintenance of electronic and kindred equipment forming part of the services for which engineers have been traditionally responsible: telecommunication systems, boiler and air-conditioning controls, etc.

By training and experience, engineers should be better acquainted with the maintenance of plant and equipment than all other professions. If they are effectively discharging their responsibilities for maintaining traditional engineering plant and equipment in hospitals, they are well placed to extend their capabilities to include medical-engineering equipment.

50 years ago electricians were as rare as electronics technicians are today. Engineers must learn to accept the need for electronics (and other) technicians in the same way that they have accepted electricians.* In the last 50 years the use of electricity has increased 40 fold. In a much shorter time the growth in the use of electronic equipment will be equally spectacular and engineers must be ready to meet the challenge that this presents. They need to do this to cope with their own work: they should be prepared to cope with medical-engineering equipment at the same time.

When the same staff have responsibility for both research and maintenance, the latter tends to be neglected for the former, because research is the more glamorous. By training and experience the engineer is versed in performing essential work however unglamorous it is.

It is natural and sensible for clinical staff to be responsible for the use of medical engineering equipment, including research, and for the engineer to be responsible for its maintenance. This corresponds closely to the flight crews being responsible for taking an aircraft across the Atlantic and for the ground staff being responsible for its maintenance.

The specialist staff and personnel (electronics, instrument mechanics etc.) who will need to be appointed and trained to perform medical-engineering maintenance will find a wider application for their skills when employed under the aegis of engineers than any other profession. The Institutions of Mechanical, Electrical and Electronic & Radio Engineers already cater for the professional and technical standards of proficiency required of engineering in medicine.

6 Organisation of the service

There is a division of opinion on whether medical-engineering maintenance services should be organised by region area. This is natural, particularly in the light of recent reorganisation when area works officers need to establish themselves and their staff for the future. Important factors which should be taken into account in deciding how best to organise medical engineering maintenance would appear to be:

(*a*) overall economy in cost
(*b*) overall economy in the use of scarce resources
(*c*) the achievement of high standards of maintenance, ensuring safety and reliability
(*d*) the provision of adequate cover to cope with emergencies, which may arise from a number of causes such as shortage of staff or catastrophic failure of equipment
(*e*) the ready interchange of information between equipment manufacturers, the professional institutions, the DHSS, regions, areas and districts
(*f*) the establishment of standards in equipment manufacture, use and maintenance.

When a balanced view is taken of the foregoing factors, organisation on a regional basis would appear to provide the best overall arrangement for the following reasons.

One of the greatest economies to be made is in standardisation of equipment (when 'best buys' have been established). This leads to a reduction in the number of spares to be carried and shared regionally, longer equipment life, reduced maintenance cost and greater ease of use by clinical staff. The main economy is in capital expenditure on equipment, which is likely to be of the order of 20% or £6 million per annum

* The rate in growth of the number of electricians is currently three times greater than that for other trades in hospital maintenance

nationally. This goes more than half way to meeting the cost of the service.

The scarcest resource is that of manpower of the quality, calibre and experience necessary for the provision of a good medical-engineering-maintenance service. It will certainly be easier to find one or two men of this standard for each region than one for each area. By having high qualities of leadership, the quality of the service below the leaders will in the long run be of higher standard. This is crucial to the achievement of the standards of safety and reliability necessary to the service. Some specialised and expensive testing instruments are necessary, together with the expertise to use them. The overall cost is less if these are shared by all the areas of a region (or subregion).

Good maintenance begins with the selection of equipment. This means that no new equipment is purchased before it has been evaluated. Such evaluation (with full clinical co-operation) may lead to the choice of a 'best buy' which falls short in some aspects of design or construction. By good liaison with the manufacturer, improvements will be made to remedy the shortcomings. 'Good design' includes reliability with ease of maintenance, and absolute safety.

Equipment assessment is best undertaken by regional medical-engineering-maintenance staff, because of their wider knowledge of regional requirements and existing equipment in service. It also enables time to be devoted to assessment without interfering with routine maintenance.

As new equipment is increasingly subjected to the foregoing selective purchasing, it becomes easier to achieve high standards of maintenance by:

(*a*) obtaining from the manufacturer full technical information for drawing up routines for testing, maintenance and calibration

(*b*) training all staff who will use or maintain the new equipment throughout the region, on the procedures to be adopted, ensuring that they understand the new equipment adequately.

(*c*) providing test rigs for equipment where these will improve and speed up maintenance. Such rigs would be designed and built in regional workshops.

A regionally organised maintenance service would carry at regional level spare equipment and more experienced staff able to fulfil the provisions given earlier. This staff would be familiar with equipment in the areas and be able to:

(*a*) provide a standby service to areas short-staffed due to sickness or annual leave

(*b*) investigate problems beyond the capability of area staff

(*c*) cope with the servicing of highly specialised equipment in limited use (colour video equipment for instance)

(*d*) make available spares urgently needed.

Some 16 to 20 regional and/or subregional medical engineering maintenance organisations in Britain would link the 113 areas with manufacturers, the professional institutions and the DHSS, facilitating the following:

(*a*) the transmission of hazard information and remedies for hazards

(*b*) the sharing of equipment evaluation

(*c*) the drafting of standard specifications and the dissemination of these

(*d*) the standardisation of equipment

(*e*) the standardisation of maintenance and test procedures

(*f*) the provision of members for study groups, working parties and international liaison through the DHSS and the professional institutions, including the training of staff from overseas.

It will be helpful in further considering the organisation of inhouse medical engineering maintenance, to take an average region of seven areas and fifteen districts. Such a region is one seventeenth part of Britain (one fourteenth part of England) and has about 30 000 beds, 370 000 inpatients per annum and a population of 3 200 000 (Appendix 1).

It is estimated that the total value of medical-engineering equipment in the average region will be about £9 million, or one-seventeenth of the national total of £150 million. For such a quantity of equipment, experience indicates that the inhouse maintenance cost of labour would be 4% or £360 000 per annum, equivalent to a staff of about 120, when maintenance is regionally organised.

The deployment of 120 medical-engineering maintenance staff would depend on the type of hospitals in each district, but the average would be:

15 districts each with an average of four technicians	60
Seven areas each with an average of six engineer/technicians	42
Regional staff or engineers and technicians	18
Total	120

Translated to national scale, the foregoing maintenance-staff requirements become:

14 regions in England × 120	1680
Two equivalent regions in Scotland × 120	240
Wales	120
Total	2040

The staff requirements for medical-engineering maintenance present the major problem in organising a service, whether it be inhouse or provided by manufacturers of equipment. There are probably no more than 700 staff presently employed on this work, leaving at least 1300 to be recruited and trained to meet present requirements and probably about double this number over the next 10 years to meet the expanding quantity coming into use. To provide an adequate medical-engineering maintenance service for the future, it is essential that the organisation be such as to meet the training needs. For this reason alone, organisation on a regional basis is essential so that, in each region, the service may develop as follows:

(*a*) Recruit a nucleus regional staff of the best candidates available to lead the new service, including at least one of ARE potential. If it should be possible to include an engineer fully experienced in medical-engineering maintenance, he should be appointed ARE immediately and head the service.

(*b*) Build a regional medical-engineering-maintenance workshop equipped for electronics work and capable of extension to meet later phases of development: mechanical, X ray etc.

(*c*) Tackle one district of one area of the region, preparing schedules of equipment, becoming acquainted with all relevant hospital staff, embracing any existing staff with medical-engineering-maintenance experience and undertaking repair work as capability to do so is acquired.

(*d*) Liaise with equipment manufacturers and all others who can provide help (DHSS and other regions with experience). Receive training from all possible reliable sources.

(*e*) When ready, recruit new staff to work in the area/district and begin to take equipment under maintenance. Such maintenance would probably start with safety checks and be extended to cover planned preventive maintenance and calibration progressively. The equipment taken into maintenance first should be that for which no maintenance contracts existed. Work being done under contract should be monitored.

(*f*) With the accumulating practical experience being acquired, appoint further area/district staff and promote the more capable existing area/district staff, until it became possible for the regional staff to withdraw from the district.

(*g*) Build and equip area and district workshops patterned on experience gained from the regional workshops and other regions.

(*h*) The regional staff would assist in the formation of an area staff, to take over the work of the area, extending district by district, after the fashion of the pioneering work done in the first district. The newly formed area staff would be administered by the area, with delegation to district as for other engineering work.

(*i*) The regional staff to withdraw from the area, but to continue to provide technical guidance and supervision as necessary.

(*j*) Over the development (*c*) to (*i*), some part of the regional staff would have remained at region to provide an advice and repairs service to other parts of the region. This staff would interchange with that seconded to area/district for the sharing and broadening of experience.

(*k*) Tackle a second area/district in the region and repeat the pattern of (*c*) to (*j*).

(*l*) When an electronics medical-engineering-maintenance service was substantially developed throughout the region, recruit additional regional staff, as necessary, to introduce a second phase of medical-engineering maintenance, mechanical for instance, and repeat the procedure followed for the electronics service, succeeded in due course by a final phase, including X ray.

(*m*) As the organisation grew, staff trained to undertake specialist work would be deployed at the appropriate levels to make maximum use of their experience and technical knowledge: basic categories of work would be done by district staff, more highly developed work by area staff and the most highly developed work by regional staff.

Development of a medical-engineering maintenance service on the foregoing lines to cover fully all equipment would probably take ten years to complete in a 7-area region. In larger regions there will be a case for dividing the region into two and proceeding with both halves simultaneously.

In the interests of the medical-engineering maintenance work which is already being done, it is important that poaching of existing staff on a large scale should be avoided, otherwise the overall benefit to the nation could be negative. Every effort should be made to expand the staff by training and, as maintenance services reached sufficient maturity, they could recruit trainees from schools, colleges and universities.

There is probably a doubling of medical-engineering equipment about every seven years. This means that ten years from now, a maintenance force of over 5000 may be needed. Thus, in addition to training about 1300 to bring the possible present force from 700 to 2000, a further 3000 may need to be trained in the same ten years.

It is of paramount importance that the service 'sells itself' to other hospital staff: it must not be imposed. Practical experience shows that the help of medical-engineering maintenance staff is eagerly sought as soon as others realise that they can repair equipment and solve problems. By developing the service first of all in those departments who offer a welcome, a good reputation will be built up which leads other departments to follow. Quite soon the demand exceeds the supply. The whole quality of the service, and the rate of progress in development, will depend on the choice of the right kind of people to form the regional staff. It is equally important that this staff should have every opportunity to acquire the knowledge and experience they will need to have, before they begin to teach others. If all these precautions are taken, the regional staff will inspire confidence as they proceed and in due course area staff will inspire the same confidence by following similar precautions.

The help of Regions where a medical-engineering maintenance service has already been developed effectively should be sought to the fullest extent.

The whole of the foregoing organisation will be fashioned in full consultation with the regional scientist, in the best interests of the patient, consistent with overall economy.

DHSS Study Report EY 1.0, 'Electronic and biomedical engineering maintenance', will be of considerable help to all responsible for introducing new medical-engineering maintenance services.

7 Recruitment, training and development

It is clear that recruitment, training and development are of the utmost importance in the introduction of medical-engineering maintenance on a wide scale. Recruitment and training are obvious necessities and in themselves they represent a major development. But improvement and innovation must be built into the recruitment and training if a truly worthwhile service is to be established with career prospects to attract staff of the right calibre. The whole exercise should, therefore, be conceived as John Reith conceived the BBC, having the inherent quality and vigour to grow spontaneously.

As suggested in the last section, the first step is to appoint a nucleus regional staff. Some existing member of staff will presumably take responsibility for the introduction of the new service and he should become as fully acquainted as possible with the running of similar services elsewhere in the country. He is then in a position, with the help of experienced assessors, to make the first appointments. The success of these will naturally depend on the candidates who come forward and repeated readvertising may be necessary. From a short list, or short lists, candidates should be interviewed with the intention of appointing the following in sequence:

(*a*) a chartered electronics engineer to head the service, with 1st-class qualifications and experience, high qualities of leadership and the ability to work well with others
(*b*) two chartered (or graduate) electronic engineers to assist (*a*) and with similar qualities
(*c*) two electronics technicians, experienced in trouble-shooting and building test rigs
(*d*) a technical clerk-storekeeper.

It is assumed that the engineer appointed under (*a*) will have had no previous medical-engineering experience, but if he should be so experienced some part of the following programme may be omitted. He should be seconded to a region where a medical-engineering maintenance service is well under way and where he may acquire the information and experience necessary for introducing the service into his own region. At his discretion he might be joined by members of his staff if and when they are appointed. After an initial visit of adequate length, repeat visits will be advisable.

The regional workshop should now provide accommodation for the regional staff who would select (with area I approval) a district general hospital as near as possible to the workshop and with a wide range of medical-engineering equipment. The regional team would draw up schedules of equipment in the hospital, get to know the staff and generally prepare to introduce equipment maintenance in the light of the experience gained in the region to which they had been seconded. Repeat visits to this region would be taking place. Over a period of at least six months the regional team would be performing more and more useful work in Hospital I, part of which would be straightforward for well qualified electronics engineers and technicians, particularly in the light of their training under secondment to the other regions. The balance of the work would present problems of varying degree which, with the help of manufacturers and others, they would solve. By now they should be ready to begin the introduction of a maintenance service in hospital 1 for which new staff, forming the nucleus for area I, would be required.

The aim should be to achieve an adequate standard of technical qualification in all the early recruits to the service. They should have specialised in electronics and possess one or other of the following qualifications, or be progressing well with studies leading to these qualifications:

(*a*) *City & Guilds Full Technological Certificate*
(*b*) Higher National Certificate or Diploma
(*c*) Technical Education Council Higher Certificate or Diploma.

Early recruits must also have at least seven years of relevant practical experience so that they have a thorough grasp of electronic-engineering principles and practice. Telecommunications, instrument design, manufacture and servicing, and radio and television can provide practical experience. Infrequently will candidates for posts have medical-equipment experience.

The initial staff for area I will probably number four or five, of whom at least two should be appointed ahead of the rest to join the regional team in hospital I. These should share the work being done by the regional team and help to complete the plans for the introduction of the maintenance service in hospital I.

As soon as some maintenance is under way, the balance of the initial area I staff should be recruited, bringing the team up to five as follows:

(*a*) One senior technician (already appointed) with good experience in supervision and meeting the above requirements, but with a minimum of 13 years relevant practical experience
(*b*) three technicians (one already appointed), all meeting the above requirements
(*c*) one technical clerk.

Roughly nine months will now have elapsed since the regional staff were appointed. They will have acquired good experience, maintenance procedures and test rigs will have been drawn up for the introduction of maintenance in hospital 1 and the area 1 team will have begun to do practical maintenance. After a further three months the regional team should withdraw from hospital I, but be on call as necessary to support the senior technician and his area team.

During the above progress the engineer heading the regional service will have had contacts with other areas in the region, with other members of his team, collecting information, meeting staff and preparing to move into area II for the extension of the service. Liaison will have been built up with DHSS and other regions, particularly the region where training was given.

The regional-workshop test instruments and equipment will have been built up in the light of experience and the workshop will be increasing its capability to build test rigs and cope with special problems. The proximity of the regional workshop to hospital I will have combined to provide a good training ground for both regional and area I staff. With the agreement of hospital I and area I, this facility could be of wide regional use in training staff for extending the service.

As the area I nucleus staff progresses with the introduction of the service to hospital I, it should be increased by adding staff which will be resident in that hospital, to release the area I nucleus staff to move on to other hospitals in that district to complete the introduction of the service. By repeating such recruitment in these further hospitals, the area I team will be free to move on to other districts in area I.

Coincident with this the regional team will assist area I in the provision of an area workshop and sub-workshops in each of the districts of area I. The area workshop will then become the base for the area I team. The regional team will also have been assisting area II in the provision of an area workshop and a subworkshop in the district of area II where the introduction of the maintenance service will commence. The pattern of development used in area I will be applied to area II, the regional team providing the necessary staff to train the area II team when it is appointed.

In one year the regional service will have become well established and area I service will be under way. Early in the second year area II service will have been launched and other areas will follow at about 6-monthly intervals.

In about four years from the inception of the regional service, all areas will be fully covered with electronics maintenance and should be ready for the introduction of the next phase of development.

Subsequent phases of development, mechanical (phase II) and X ray etc. (phase III), should follow about four and seven years, respectively, behind phase I, in which case all three phases should be fully operational, covering all equipment in a period of ten to 11 years in a 7-area region. In larger regions, if they were subdivided into two, the overall time would range from about six years for eight area regions to about eleven years for Scotland which has fifteen areas or health boards. The foregoing rate of development is illustrated in Appendix 2, with indications of the number of staff involved.

Over a period, which for practical purposes can be taken as ten years, a medical-engineering maintenance service covering all the hospitals of Britain could be fully implemented, using traditional 'apprentice' methods of training. For the present (1975) volume of equipment, the total estimated maintenance staff requirement would be 2040, but in ten years the quantity of equipment is likely to have increased to two-and-a-half times, requiring a work force of over 5000. The recruitment and training programme thus involves providing 500 candidates a year, with zero wastage, or 600 a year, allowing a realistic 20% wastage.

Because of the heavy reliance of the health service on medical-engineering equipment, and the present lack of adequate maintenance facilities for the equipment, there is urgent need to press forward with the development of a maintenance service. The number of staff to be recruited and trained for the service, however, makes the task formidable. In such circumstances quality is in danger of suffering, but the efficacy of the service depends on a high standard of staff performance, hence the need to build the service on the firm foundations of quality.

The recruitment, training and development outline given in this Section of the paper could not hope to deal other than in 'broad-brush' terms. Nevertheless it is hoped that it will help those concerned to appreciate the size of the task and encourage them to devote to it the attention it deserves.

An organisation chart for the fully developed regional medical engineering service is given in Appendix 3.

8 The way ahead

Medical-engineering maintenance is urgently needed for the £150 million worth of equipment in service in British hospitals in 1975. The need will be immeasurably more urgent in 1985, when the equipment will be worth about £400 million, if effective steps have not been taken to provide a good maintenance service.

In the next ten years new types of medical equipment will have come into use, extending the boon to health that medicine and engineering are providing by their continued fruitful co-operation. This may add another £100 million worth of equipment to the health service. Electroanaesthesia, the acceleration of tissue healing by the application of electrical potentials to the tissue and to the air we breathe, and the control of infection by similar means, are promising areas where relatively little work has yet been done. Other new equipment is already becoming established, but as yet has not come into extensive use: thermography for instance.

Domiciliary medicine has not been taken into account in assessing the quantity of medical equipment in use. The practice of treating the patient, so far as possible, out of hospital is likely to extend, particularly as the availability of medical-engineering equipment makes it less expensive, as in the cases of renal dialysis, possum and the family practitioner having his own e.c.g. This represents a vast area for the increased use of equipment which may add a further £100 million to the value of the quantity in use over the next ten years.

All this use of equipment represents a kind of automation: it is a means to lowering costs of production. It does not need to be an ogre, however, because the practice of medicine essentially depends on human contact. If the use of equipment gives doctors, therapists and nurses—and here electronic communication systems have a major part to play—more time with the patient, treatment will be enhanced.

A lowering of other costs provides money for extra doctors and nurses. In the UK we are in danger of not being able to make full use of equipment available, because insufficient care has been given to providing staff adequately skilled in its maintenance. Motor manufacturers have so organised trained mechanics, working in local garages, that motorists who use their services hardly ever are stranded on the road. Can those in the health service manage their affairs equally effectively?

When an airliner sets out to cross the Atlantic, it is almost certain to reach the other side safely: the captain can rely on the work of the maintenance groundstaff. Can the doctors in our hospitals place equal reliance on the equipment they use?

In the introduction to this paper, reference was made to a letter from the Chief Engineer, DHSS, urging the provision of inhouse maintenance services for medical equipment. It is now 18 months since the letter was written. What have we done about it; what are we going to do about it? The combined use of electro-cardioscopes and defibrillators was described earlier. The small input signal of the one was contrasted to the large output power of the other, 100 000 000 000 times greater. A new generation of monitors is available which also display brain impulses, these being 100 times smaller than heart impulses. This feature is provided because it is now generally accepted that it is brain activity, rather than heart activity, that indicates life or death. The medical team thus knows more clearly whether to attempt resuscitation or quickly to remove organs destined to bring life and health to other patients. Will such equipment always work reliably, or might it fail for lack of maintenance?

Appendix 1

Statistics

Hospital data (1971)

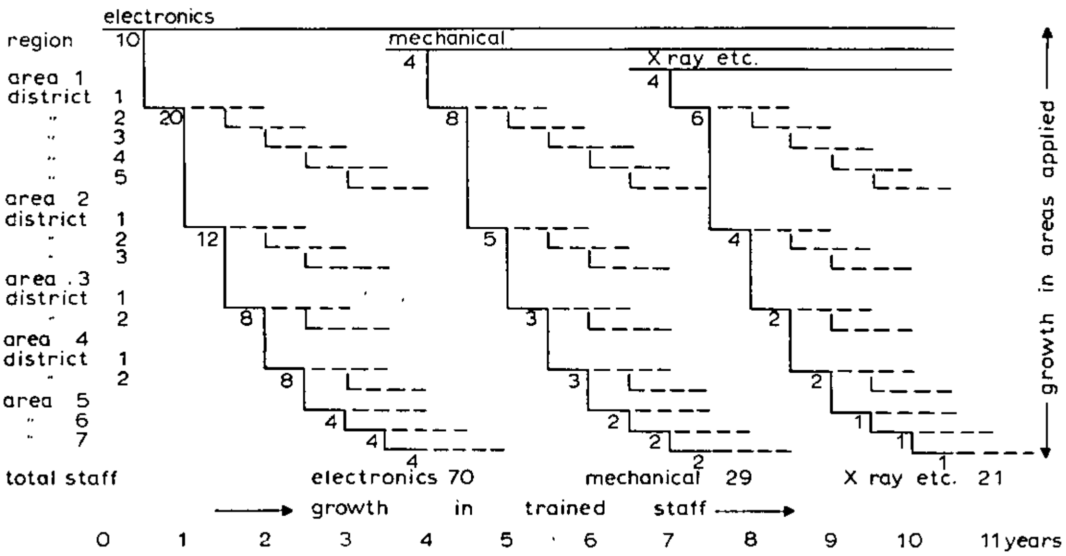
	Regions* or equivalent	Population		Allocated beds		In-patients	
		Total	Average per region*	Total	Average per region*	Total	Average per region*
		$\times 10^3$	$\times 10^3$	$\times 10^3$	$\times 10^3$	$\times 10^3$	$\times 10^3$
England	14	46,100	3,300	424	30	5,223	373
Scotland	2	5,200	2,600	66	33	657	329
Wales	1	2,700	2,700	26	26	327	327
Britain	17	54,000	3,200	516	30	6,207	365

*as now reorganised

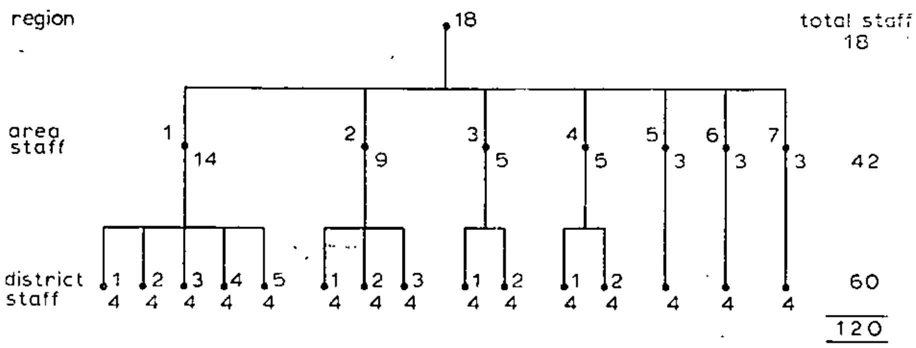
Reorganised regional data

	Regions or Equivalent	Areas or Health boards	Districts	Average Areas per region	Average Districts per region	Average Districts per area
England	14	90	204	6.4	14.6	2.27
Scotland	2	15	34	7.5	17.0	2.26
Wales	1	8	17	8.0	17.0	2.13
Britain	17	113	255	6.7	15.0	2.26

Appendix 2



Appendix 3



Fire-prevention courses

The British Fire Services Association will be holding its National Training Week this year at Pontin's Holiday Village, Prestatyn, from the 27th September to 4th October 1975.

The Association believes that for the forseeable future industry and the Health Service will have to look after much of its own fire protection, as the public fire service is still shaking-down after local government reorganisation and, at the same time, bearing an ever greater legislative responsibility. To enable its members to meet the demands likely to fall upon them the BFSA is running two fire-prevention courses at the national training week, in addition to competitive field and indoor events. There will be a basic fire-prevention course, with optional examination, for junior ranks and a nonexaminable advanced course for officers of station-officer rank (including fire prevention officers) and above.

There will also be a qualifying course in first aid for all ranks. Course fees for the advanced course will be £20 per student, and for the basic and first-aid courses £5 per student, in each case exclusive of the cost of accommodation.

Details and application forms are available from: The General Secretary, British Fire Services Association, 86 London Road, Leicester LE2 0QR.

IFSSEC at Olympia

The International Fire, Security & Safety Exhibition and Conference (IFSSEC) will be held at Olympia, London, from the 26th–30th April 1976, and thereafter will be staged annually.

The plans for IFSSEC '76 are well under way. 14 months before the event, more than 120 companies had already booked space in the exhibition.

Conferences

Three separate conference programmes will run concurrently throughout IFSSEC week. The 'Fire protection conference' the 'Security and crime prevention conference' and the 'Industrial safety and occupational health conference' each comprise seven half-day seminars covering the identification of risk and the specification and implementation of preventive techniques. Speakers are being invited from all parts of the world to present papers on vital and topical issues in all 21 conference sessions.

Pertinent subjects

The organisers have worked with police, fire and industrial-safety authorities; with national and international research bodies; government departments; standards and equipment approval bodies; trade associations; institutions and insurance interests to select the most pertinent subjects for inclusion in the conference programmes and to ensure comprehensive coverage of the subject matter. To cater for overseas delegates, simultaneous translation into French, German, Spanish and English will be provided to all conference sessions. All three conferences and the exhibition will be staged at Olympia. This will be made possible by the construction of a specially designed conference complex, including seminar rooms and dining facilities, adjacent to the main exhibition hall.

Further information is available from Victor Green Publications Ltd., 44 Bedford Row, London WC1R 4LL.

Technical news

MAINTENANCE-ENGINEERING CONFERENCE

The 7th National Maintenance Engineering Conference will be held at the Royal Lancaster Hotel, London WC2, from the 24th–26th February 1976.

Workshops

Sponsored by the Department of Industry, the British Council of Maintenance Associations, and the journal *Maintenance Engineering*, the conference will cover the maintenance contribution to manufacturing managememt; manufacturing demands on maintenance technology—and on terotechnology; and a 'how we did it' day, when three concurrent workshop groups comprising presentations and discussions will meet to explore in depth the main themes introduced during the two previous days.

Further information is available from Conference Communication, Hollytree House, 1 Gorse Lane, Wrecclesham, Farnham, Surrey GU10 4SD.

November conference on energy conservation

A joint conference on Energy Conservation and Energy Management in Buildings is being arranged by the Institution of Heating & Ventilating Engineers, the Illuminating Engineering Society, the Institute of Fuel and the Department of Energy, at the Westminster Theatre, London SW1 on the 13th and 14th November 1975.

Sessions

The programme will include sessions on: energy problems and policies; saving energy now; economics of energy management; and building design and energy conservation—the future. Papers will be presented by leading specialists on subjects such as: energy policy and buildings; legislation and energy conservation; spending money to save energy; energy economy in government buildings; economic aspects of energy conservation; policies for lighting provision; insulation of housing stock—a national problem; energy saving in industrial buildings built form and energy needs; building services—an energy demand review; energy in buildings—future possibilities and prospects; and several case studies.

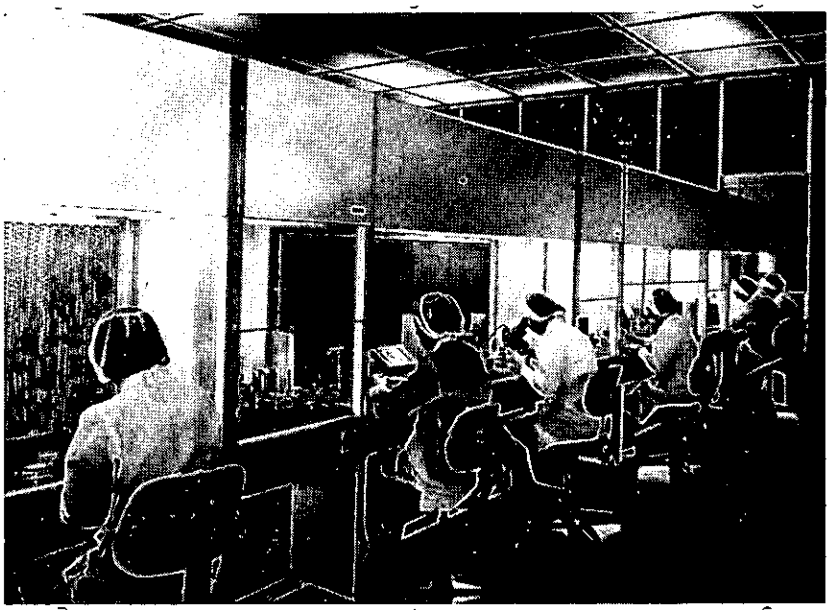
It is hoped to arrange a manufacturers exhibition as part of the conference.

The registration fee for the conference is £45. Further information from the Conference Secretary, Construction Industry Conference Centre Ltd., PO Box 31, Welwyn, Herts. AL6 0XA. The registration fee includes preprints of papers, morning coffee, lunch and tea during the conference.

Clean air for bacteria

Clean-air and contamination-control techniques are now becoming part of more operating-theatre ventilation systems, and many hospital-laboratory and pharmacy processes are carried out in clean-room conditions. However, there are also processes in hospital-laboratory work where only small batches of drugs, organisms or materials need to be handled. In these cases localised control of particles and bacteria, with operator access from outside the work area, is the requirement.

With Pathfinder (Environmental) 1974 Ltd.'s Laminar Flow Cabinets uni-directional clean filtered air flows either vertically or horizontally around the items or material being processed. The cabinets permit work to be performed in a locally-controlled contamination-free atmosphere. By using high-efficiency-particulate-absolute filters with a 99·997% efficiency conforming to BS 3928, these laminar-flow clean-air cabinets meet the class 100 requirements of the internationally recognised US Federal Standard 209B.



Conservation in Cardiff

A 2-day conference on energy conservation in industry and commerce is being organised by the Departments of Industry and Energy in conjunction with University College, Cardiff. The conference will take place on the 10th and 11th July 1975 at the Sherman Theatre, Cardiff.

The purpose of the conference is to illustrate to industry, commerce and local government that significant savings can be achieved in current energy usage. Energy resources and designs for energy conservation will also be discussed. The savings in present uses will be illustrated by case studies which will concentrate on schemes involving the minimum of capital expenditure and which can be readily implemented.

Further details can be obtained from The Manager, Cardiff University Industry Centre, University College, PO Box 78, Cardiff, Wales.

Factory extension

To meet the demand for the company's 'European' and 'Windsor' ranges of Shell Boilers, both at home and overseas, B. & E. Boilers Ltd. has recently extended its manufacturing facilities at its Bracknell factory.

This addition to the facilities has enabled the company to reduce its boiler prices by up to $8\frac{1}{2}\%$ and reduce its delivery times by up to six weeks.

Central laundries aid spread of infestations

The reorganisation of the hospital service has led to pests becoming a more serious problem than ever, according to Miss Susan Beatson, Senior Scientific Officer of the Ministry of Agriculture, Fisheries & Food. Speaking at the Fourth British Pest Control Conference in Jersey on the 23rd April, Miss Beatson said that central laundries, stores and CSSD packing units supply wide areas, and infestations can be spread with them throughout hospital groups if speedy efficient action is not taken.

Modern hospital construction helps the unseen proliferation of pests by providing large ceiling cavities, boxed in pipe runs and service ducts from basement to roof with branches to all floors, along which ants, cockroaches, mice and even fleas can move freely and undetected.

Miss Beatson pointed out that it is now twenty years since infestation-control staff demonstrated that the disease-carrying Pharaoh's ant could be eradicated comparatively easily by thorough and complete treatment, yet this insect is still a serious threat posing a risk of crossinfection in many hospitals. These ants cause massive wastage by contaminating food and sterile equipment and cause serious distress to patients.

Unhygienic conditions

Cockroaches, said Miss Beatson, have always found attractive living quarters in hospitals, emerging at night from floor and wall cavities, heating ducts and other equipment.

Feral pigeons and cats are a problem in many hospitals, largely because of the parasites they carry and the unhygienic conditions they produce.

Miss Beatson quoted a case where a maternity unit was closed because of cat fleas emerging through the floor boards and 150 cats were removed from the area under the floor.

Cross infestation may be lessened, she said, if one pest-control company covers all the hospitals in an area. In the past the amount of money made available for pest control by hospital authorities has been pitifully small. That pest control cannot be obtained on the cheap is a point continually stressed by the Ministry.

Continuous automatic garment washer

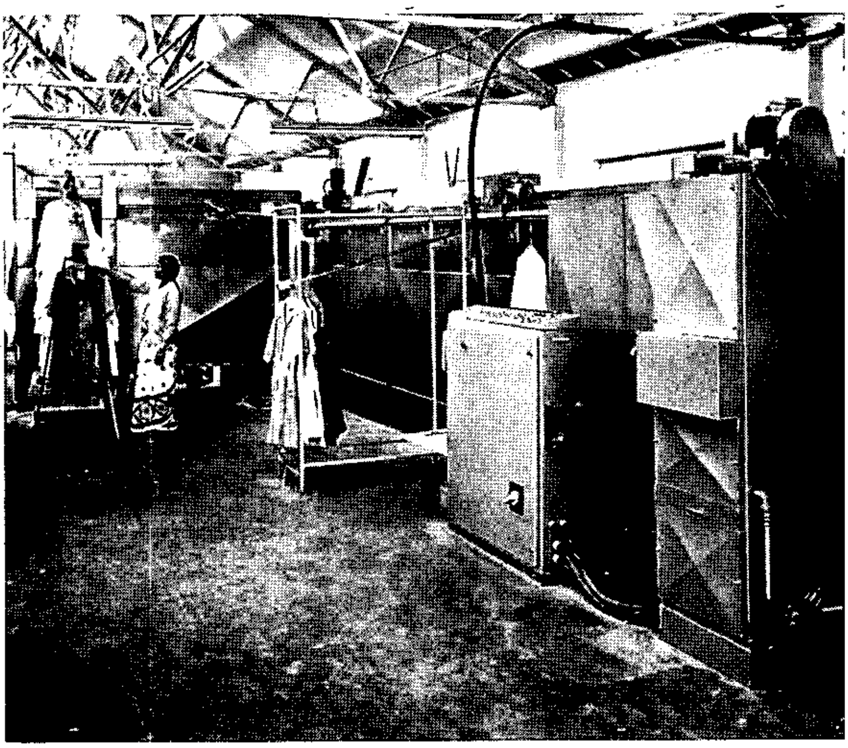
A continuous production automatic machine that combines soaking, washing and drying of polyester and cottons in conditions that suit the particular fabric, called the Stream-line garment washer, is being marketed by Baker Perkins Ltd. Outputs range from 30 to 400 garments/h, and only one operator is required. As the process time is predetermined, the machine can be left unattended for periods. The only manual operations are loading and taking off at the delivery end.

Four operations

The entire program is controlled by one timer, which progresses the laundry through each of four operations —prewash and drip, two washes and drying. At the end of the loading conveyor, the garments turn through 90° prior to entering the prewash and drip, and are automatically located on a saw-tooth conveyor where they are sprayed with a concentration of fresh detergent. Recirculated detergent completes the soaking, and, after all the surplus has drained off, the garments move on for their initial wash. Here they are sprayed with alkali-laden water at temperatures varying from 30 to 70°C that is applied by high-velocity revolving jets, which will expel fluff or other similar substances. In the second wash, fresh water is applied. In both wash sections, squeeze rollers greatly reduce the moisture, empty pockets and other cavities before the garments enter the drier. Garments are dried by turbulence which shakes out creases.

There are individual controls for all phases including thermostat control for drying temperature, automatic count of garments and visual observation at each section. The unit is completely self-contained, does not need any foundation work and all supply tanks are an internal part of the system.

A Stream-line batch washer has also been developed recently by the company. Laundry is fed in from either overhead, or flat-bed conveyors in weighed batches, and progresses through the machine by means of an oscillating semispiral construction. This oscillates for a given period and completes a full revolution to pass the batch on to the next process station. There is complete control of the liquor level and chemical concentration without using any rotating glands. All supplies are injected from external shells on this machine which, besides being easier to manufacture, is also easier to install.



RECLAMATION OF REFUSE FOR REUSE

A new prototype plant designed to process domestic refuse for reclamation of reusable materials, recovery of energy and materials from a wide range of scrap and waste, and offensive odour research will be featured on four open days which the Department of Industry's Warren Spring Laboratory, Stevenage, is holding from the 17th–20th June, when the laboratory will be open from 10.00 a.m. to 4.30 p.m.

Programme

One purpose of these open days is to give industry, research associations and local authorities an opportunity to see the laboratory, which has a programme covering both industrial and environmental technology.

Other examples of the laboratory's current programme of work on display will include many aspects of reclamation and recycling; bulk materials handling; mineral processing; metals extraction; systems development; control engineering; online analysis; catalysis; marine and air pollution. The expertise of WSL staff and facilities of the laboratory are available on a prepayment basis for contract research.

For further information contact The Director, Warren Spring Laboratory, Department of Industry, PO Box 20, Gunnels Wood Road, Stevenage, Hertfordshire SG1 2BX.

Electrical contract

A £150 000 contract for the complete electrical installation in the 6-storey diagnostic block at Whittington Hospital, Highgate, London has been awarded to Duncan Watson Ltd by the North West Metropolitan Regional Hospital Board.

Services

The contract includes heating, lighting, power, switchgear, fire alarms, nurse call and services to heating and ventilating equipment, and represents phase one of the complete rebuilding of the hospital.

The main contractor is McLaughlin & Harvey Ltd.

Fire precautions —the next step

by ANTHONY BONE

So far the effect of the 1971 Fire Precautions Act has been concentrated on public residential accommodation. To the materials supplier the act brought an unprecedented demand for noncombustible boards to meet the increased need for wall linings, ceilings and fire-resistant doors. Later this year it is expected that a designatory order will focus on hospitals and similar institutions. Here, the effect of the act is discussed from the standpoint of a supplier.

The act concerns the safe escape of people from burning buildings and it is well to highlight the essential difference between the act and building regulations. These latter apply to buildings not yet erected and buildings to be altered; the new act applies to existing buildings.

Under the existing order, there are perhaps 100 000 premises out of a total of 450 000 which will be affected when all the building uses which may be covered by the act are enforced. The figures illustrate the major task presented to both the materials producer and the building industry. They are the people who are directly involved in providing material and labour to carry out any necessary new and conversion work. It might take ten years before all the buildings of this type can be considered safe within the meaning of the act.

As more designatory orders are made (it is anticipated that the next order will be made later this year and will apply to about 17 000 institutions, such as hospitals) more demands for the supply of fire-resistant boards will be placed on the manufacturers.

Types of material

Asbestos-cement building materials, in particular flat boards, can be broadly divided into two groups in accordance with their density. Examples of high-density products are corrugated sheets and fully compressed flat sheets, while a typical low-density product is asbestos insulation board. It is very important to understand that asbestos-cement sheets which are normally used for the outside surface of buildings such as the high- and medium-density boards are not suitable for use as fire-resistant barriers. Only those of low density, which are typified by the asbestos insulation boards manufactured to BS 3536, should be used for providing resistance to the passage of fire.

The unique character of building boards made from asbestos-cement is the inability of the product to burn and support flames. At sustained high temperatures it will chemically change and gradually degenerate without emitting smoke and toxic fumes. Being classified as noncombustible and unable to spread and support flame, asbestos insulation board and wallboard such as asbestos wood are defined in the best category results when they are fire tested in accordance with BS 476, Parts 4 to 7 inclusive.

These tests are performed on materials, whereas BS 476, Part 8 defines the test methods for the fire resistance of parts of buildings usually expressed as a period of time during which the building component is capable of satisfying criteria as to the stability, integrity and insulation.

A building-board material that is classified as noncombustible and does not give off smoke or toxic gases during conditions of fire, is considered by most authorities to be a very suitable specification for enabling buildings to comply with legislation for fire situations. Asbestos insulation board is a fire-resistant board and is manufactured in accordance with BS 3536, 'Asbestos insulating board and wallboards'. Wallboard is noncombustible and is capable of retaining its integrity for a long time during conditions of fire where hotels, boarding houses and other buildings are required to have resistance to fire increased. Wall and ceiling linings, partitions, linings to staircase enclosures, and improvements to the fire resistance of existing timber doors are only a few of the applications for which both materials are being increasingly specified. An existing timber panelled door that is not less than 45 mm thick can have its fire resistance improved to the satisfaction of most fire authorities by fixing asbestos insulation board to the timber panels on the fire-risk side only. The thickness of the board required will depend on the thickness of the timber panel, as most fire authorities will require the fire-protective panel to be made flush with the stiles and rails of the door.

Wallboard and, in particular, asbestos insulation board can be easily worked with normal hand tools and can be fixed with either screws or nails. The material is sufficiently dense for nail heads to be punched below the surface and filled with proprietary fillers. Surface decoration can be by either paint or wallpaper, and there is at least one company specialising in applying a nylon flock coating to asbestos insulation board to make a most attractive lining board in a choice of colours for use in prestige areas where a class 'O' surface is required.

In places where damage is likely to be a problem such as kitchen doors or corridors in which wheeled trolleys are used, an excellent material to use is wallboard. This is equally suitable for fire protection and made to the same British Standard as asbestos insulation board. It is a noncombustible board and eminently suitable for specifying where a more robust material is required.

Another board material suitable for lining walls and corridors is partition board which has a similar density to asbestos wood. Being less expensive than either asbestos insulation board or wallboard it has a surface which complies with the requirements for Class 'O' as defined in the Building Regulations 1972 and the Building Standards for Scotland and is suitable for lining fire escape routes. The standard required for hospitals will hardly be of a lower standard. For periods of fire resistance of short duration partition board has been successfully tested at the Fire Research Station and a 6 mm board is capable of providing a period of fire resistance of half an hour to timber floors.

Mr. Bone is with the Fire Protection Advisory Service, TAC Construction Materials Ltd., PO Box 22, Trafford Park, Manchester M17 1RU

Appointments

Wessex Region

The following have been appointed district works officers in the Wessex Region:

	District	Previous Post
R. J. Francis	Portsmouth & SE Hants	Group Engineer
W. A. J. Whiffin	Southampton & SW Hants	Group Engineer
Clegg	Central Hampshire	Architect Wessex RHA
Davies	North Hampshire	Architect Wessex RHA
K. Heskett	East Dorset	Engineer Wessex RHA
L. House	West Dorset	Group Engineer
Clarke	Bath	Engineer South West RHA
D. R. Wilson	Salisbury	Group Engineer

West Midlands RHA

The following have been successful in the initial competition for area engineers, building officers and district works officers:

AHA	*Area Engineer*	*Previous post*
Coventry	R. Heyworth	PAE West Midlands RHA
Dudley	T. A. Workman	Assistant Group Engineer, Solihull AHA
Hereford/Worcester	M. J. Kirby	
Salop	R. Edwards	
Sandwell	J. T. Lakin	Group Engineer, Sandwell AHA
Solihull	J. Smillie	Deputy Group Engineer Solihull AHA
Staffordshire	C. Lamb	PAE West Midlands AHA
Walsall	P. Scott	Group Engineer, Walsall AHA
Wolverhampton	J. A. Simpson	Group Engineer, Wolverhampton AHA

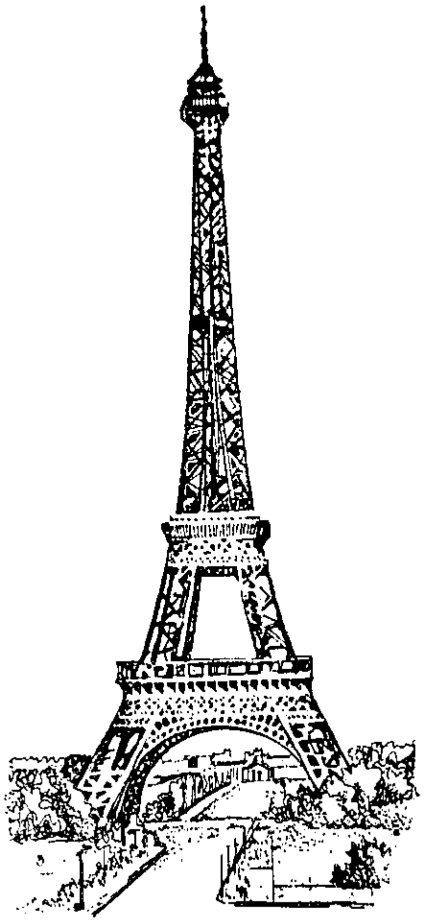
AHA	*District Works Officer*	*Previous post*
Birmingham Central	G. E. Minshaw	Assistant Regional Engineer, West Midlands RHA
Birmingham North	J. T. Yeomans	Acting Group Engineer, Staffs AHA
Birmingham South	W. Paton	Deputy Group Engineer, Birmingham AHA
Bromsgrove/Redditch	J. R. Reese	Deputy Group Engineer, Hereford District
Hereford	C. W. Sheldrake	Group Engineer, Worcester and Hereford AHA
Kidderminster	R. J. Sear	Acting Deputy Group Engineer, Kidderminster District
Worcester	J. P. Addison	Deputy Group Engineer, Wolverhampton AHA
Staffordshire North	G. D. Pagon	Deputy Group Engineer, Staffordshire AHA
Staffordshire Mid	C. B. Denne	Acting Group Engineer, Mid Staffs AHA
Staffordshire South-East	A. W. Craine	Group Engineer, Staffordshire AHA
Warwickshire North	E. Carder	Deputy Group Engineer, Coventry AHA
Warwickshire South	A. S. Dixon	Deputy Group Engineer, Warwickshire AHA

AHA	*Area Building Officer*	*Previous post*
Birmingham	E. Edwards	Architect, RHA
Coventry	C. Rogers	Building Supervisor, Coventry AHA
Dudley	C. R. Williams	Principal Assistant Quantity Surveyor, RHA
Salop	T. D. Lee	Building Supervisor, Warwickshire AHA
Solihull	G. Richards	Building Supervisor, Solihull AHA
Staffordshire	E. Hawkins	PAA, West Midlands RHA
Walsall	G. H. R. Grimwood	Building Surveyor, West Midlands RHA
Warwickshire	D. A. Brant	Building Surveyor, West Midlands RHA
Wolverhampton	C. F. Rea	Building Supervisor, Birmingham AHA

Institute news

Paris in the wintertime?

Sponsorship of two young members to attend Paris Congress



The King Edward's Hospital Fund for London is to make available to the Institute a grant to assist in meeting the travelling and hotel expenses and conference fees of two young members of the Institute selected to attend the 4th International Congress of Hospital Engineering to be held in Paris in January 1976.

Selection, in the first instance, will be by way of a written competition. Candidates, who should be under 30 on the 1st June 1975, should write an article of not more than 2000 words, on one of the following subjects:

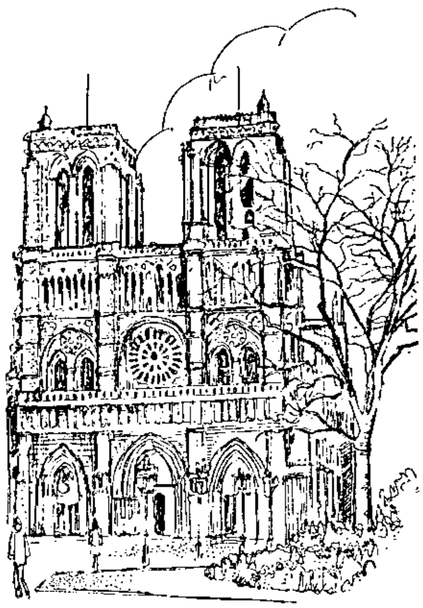
(*a*) Describe the benefits you would expect to receive from the experience of attending an international congress of hospital engineering and how this might affect your career development.

(*b*) Describe what you know about health services in other countries.

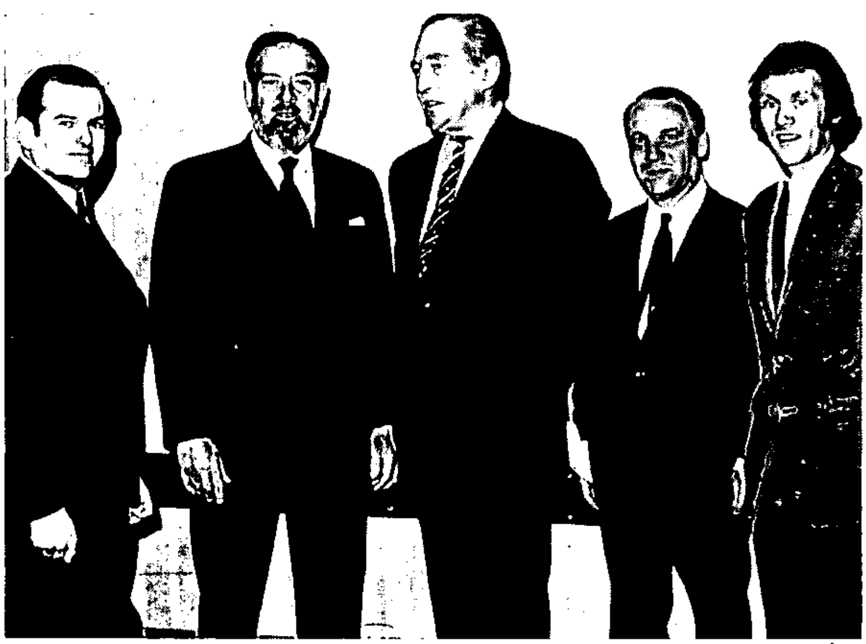
Entries should reach this office not later than the 3rd September, 1975.

The Articles will be judged by a Council Committee and a short list of candidates will be compiled. The short-listed members will be interviewed by a panel of adjudicators, who will select the two successful candidates.

Any enquiries for additional information should be addressed to: The Secretary, The Institute of Hospital Engineering, 20, Landport Terrace, Southsea, Hants. PO1 2RG.



Bournemouth beginnings



Officers of the Institute at the official opening of the Institute Conference at Bournemouth in May. (left to right)

D. J. Wicks (Chairman, Southern Branch)

Dr. B. G. B. Lucas (then President of the Institute)

Col. Sir Joseph Weld (Chairman, Wessex RHA)

J. E. Furness (Institute Secretary)

D. R. Wilson (Honorary Secretary, Southern Branch)

A report on the conference will appear in the July issue of *Hospital Engineering*.

Product news

FUME CUPBOARD

The Safebench is an effective low-cost fume-cupboard-type work station that can be used to protect laboratory technicians while they are manipulating pathogenic organisms. Exhaust air passes first through a coarse filter, which removes gross contamination of not less than 95% of particles of 5 μm or larger in size, and then through a filter before it is discharged into the open air. The connecting ducting between a Safebench and its exhaust fan can be formed by standard plastics soil pipe and rubber-sealing-ring kits are supplied.

Pathfinder (Environmental) 1974 Ltd., Solent Road, Havant, Hants. PO9 1JF.

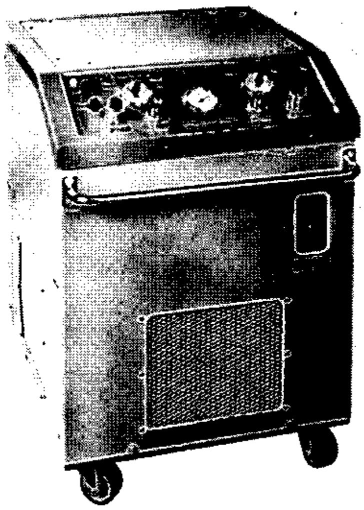
AIRSPRING

The Airspring acts as a flexible air reservoir which absorbs pressure variations to prevent 'water hammer'. The unit can be fitted at any appropriate point in the plumbing system and it is made of reinforced neoprene rubber. It will expand and contract under pressure without leakage to 14 kgf/cm^2. However, it cannot operate at temperatures above 120°C.

Olin Energy Systems Ltd., North Hylton Road, Sunderland SR5 3JD.

BLANKET CONTROLLER

The mark III temperature controlled water unit circulates water at a temperature in the range 4–40 deg C to a cellular triflow construction blanket that allows a continuous flow of water at the controlled temperature to be applied to a patient's body. The main components for the storage and temperature control of the water are housed in a corrosion resistant cabinet mounted on castors. The machine top is strengthened to take additional hospital operating theatre equipment. Hot and cold water is available from the machine. In the refrigerated tank providing the cold water, a reserve of cooling power is built up in the form of an ice bank. The machine is designed for operation from a standard 240 V supply.



Each unit contains a voltage-operated earth-leakage trip switch that will trip on a fault current of 35 mA or less to isolate the machine from the mains supply and positively earth the main frame.

East of Oxford, Sandy Lane West, Littlemore, Oxford OX4 5JT.

WATER COOLER

The Coolspray mark I is a closed-circuit water cooler intended for external roof-mounting and the water, which circulates in a closed loop, is cooled on the air-blast principle. When the temperature of the water rises above a pre-determined level, a thermostatically controlled pump operates a water spray. Because the spray assistance improves the performance of the unit, the size of the fan can be kept to a minimum and so the noise level is kept very low. The Coolspray is available in four sizes ranging from 25 to 100 kW. Prices are from £450.

F & R Cooling Ltd., Wellington, Som.

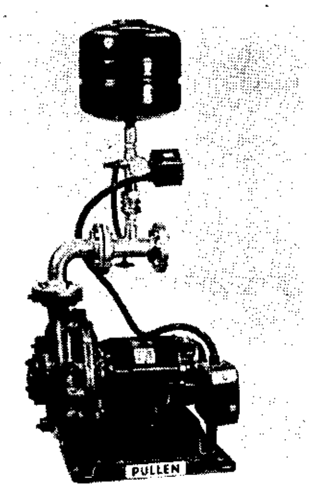
ENERGY SAVER

The Cal-Econ thermal economiser recycles heat that normally rises into the roof space of a building. It is thermostatically controlled, and can be set so that a centrifugal fan comes into operation when the temperature of the air surrounding the unit has risen to an adjustable point between 27°C and 49°C. When heat rises into a building's roof space and reaches a temperature of say 30°C, the Cal-Econ will start automatically collecting this heated air and redelivering it to floor level, and it will continue to operate until all the useful heat in the roof has been recirculated. A thermostat in the unit prevents it from pulling cold air down. The mark 2 range of Cal-Econ units comprises the CE-1800, CE-2400 and CE-4000, and their outputs are 64 000, 85 000 and 140 000 cm^3/min, respectively.

Powrmatic Ltd., Winterhay Lane, Ilminster, Som.

PRESSURE CONTROL UNIT

The Prescon pressure control unit is designed so that a small diaphragm tank, mounted above the pump discharge, and charged with air to 0·14 kgf/cm^2 below the pressure cut-in, provides the initial source of energy. The pump is controlled by a differential pressure switch. Thus, in a system which is at rest or pressurised, the operation of a tap or fitting will cause the water, energised by the air in the expansion tank, to drain down the vessel thus lowering the pressure. When the pump 'cut-in'



pressure is reached, the pump will start and supply the water to the services. As 'draw-off' ceases, the pump will gradually pressurise the water in the tank until 'cut-in' pressure is reached. The vessel is refilled by water travelling via a lag valve which controls the time cycle of the pump and thus prevents hunting.

Pullen Pumps Ltd., 58 Beddington Lane, Croydon, Surrey CR9 4PT.

Institute news

EAST ANGLIAN BRANCH

The Annual General Meeting of the Branch was held at St. Andrew's Hospital, Thorpe, Norwich, on the 22nd March 1975.

The Chairman Mr. Holtz reported a further increase in membership, which now stands at 48 members, a considerable improvement since the days when the Branch first received full Branch status after breaking away from the London Branch. The year was successful in the attendances and the interest shown at the Branch meetings.

Mr. Holtz went on to thank the Secretary for his services during the year, wished the future Chairman good luck in his post and formally handed over the Chair to Mr. Parker at the conclusion of his report.

Mr. Parker thanked Mr. Holtz for his services to the Branch and was pleased to have the honour of taking the Chair he had so ably filled. He introduced the guest he had brought to the meeting, Mr. Jones, the Regional Training Officer for Liverpool region.

Annual Conference, Norwich, 1976

The Chairman enquired of the Secretary how Council had reacted to the tentative proposals for holding the 1976 Conference in the Hotel Norwich. The Secretary stated that Council would prefer Cambridge as a venue and had asked that enquiries be made at both centres to compare the facilities. Unfortunately, the Garden House Hotel is not large enough and the Secretary had not had time to approach the University Arms Hotel in Cambridge for their terms prior to the meeting. Mr. Holtz then proposed that the Conference be held in Norwich. This was seconded by Mr. R. G. Kidsley and carried by the meeting.

Advantages

The advantages of holding the Conference in Norwich were discussed and it would appear that Mrs. Morgan, who is a member of the Area Health Authority, will be Mayor of Norwich for the year 1976 and would be a very appropriate guest of honour. The ladies' programme was discussed and an interesting programme could easily be provided for them, as it was understood that Sandringham would be open to the public next year and there could be outings on the Broads and to Anglia House, the headquarters of Anglia Television.

Mr. Parker agreed to call a special meeting of the Conference Committee as soon as he had spoken to Mr. Furness about the above details. The date was assumed to be the 21st–23rd April, 1976, but this would need to be confirmed.

The Secretary raised the problem of suitable subject matter for the meetings. He suggested that occasional debates be held on a subject of members' choice. This was generally agreed.

Mr. Tarlton asked what the Institute's main interest in the educational field would be when they lose the Keele courses. The Secretary replied to say that it is intended to increase the number of seminars with the Institution of Mechanical Engineers, which have proved so successful in the last year or two.

WELSH BRANCH

J. Allen, Sales Manager, Haigh Hygiene Ltd., attended the February meeting of the Branch to present a paper on 'Waste disposal by maceration'. In view of the small number attending Mr. Allen thought it better to devote the time to discussing problems associated with the installation and maintenance of hospital macerator systems. The following is a summary of the recommendations for troublefree systems.

'A macerator only preconditions waste for disposal into a drainage system. The waste must be rendered water borne, requiring approximately 30 litres of water per kilogramme of waste. Cold water is essential since hot water emulsifies fats.'

Loading macerators

Care should be exercised in loading macerators, since the inclusion of unsuitable articles is the major cause of breakdown. Proper training of nursing staff in correct use is very important.

Bends should be 'slow'. It is better to use two 135° bends than one square bend.

When wastes become blocked the papier mâché tends to harden. Rodding facilities are therefore very important and blockages are best jetted away upstream.

During a short questions and answers period that followed Mr. Allen was asked if there might be a better material than papier mâché for disposable bed pans. He explained that they are manufactured from old newsprint and the material was probably the best available today. Further discussion took place on the high consumption of water in disposal machines, an important feature in these times of conservation and high costs.

At the conclusion Mr. Allen was warmly thanked by the Chairman for his talk which had dealt with problems every hospital engineer experienced at some time.

In view of the high cost of travelling and poor attendances, members' views were sought on the future of meetings generally held once yearly at hospitals some distance from Cardiff.

Lengthy discussion took place and it was felt that members in Wales generally should have the opportunity to attend meetings. It was thought that Aberystwyth did afford an opportunity for members not usually able to travel to some of the more usual venues.

SOUTHERN BRANCH

At a meeting of the Southern Branch at Queen Alexandra Hopital, Portsmouth a talk was given on patient monitoring by P. Silbey, a Senior Medical Sales Engineer with Hewlett Packard Ltd.

Mr. Sibley opened his talk by describing the four main parameters required to be continually monitored, i.e. e.c.g., blood pressure, respiration, and temperature, and how instruments for measuring these have developed over the last fifty years. With the aid of slides Mr. Sibley went on to describe how the e.c.g. waveform is developed by the electrical impulses spreading through the heart muscles. He mentioned the large quantity of blood required to be pumped, being in the region of 8100 litres per day and over a normal life span some 118 million litres.

Catheter

Mr. Sibley also described how the high arterial pressure and the low veinous

Institute news

blood pressure can be measured in the heart with the aid of a saline-filled thinwalled catheter. The pressure signal is transmitted by hydraulic action of the saline fluid in contact with a diaphragm which causes a small change in current through a transducer according to the variations in blood pressure. The current is then amplified and displayed as necessary. Systolic and diastolic pressure can also be displayed in the same manner, determined by the site of the catheter.

The importance of accurate temperature measurements was also explained and how this may be obtained by insertion of a small temperature-sensitive resistive probe into the oesophagus or rectum. This type of temperature monitoring is particularly useful in neonatal medicine where an infant's body temperature can change rapidly.

Mr. Sibley went on to explain how respiration can be measured via e.c.g. electrodes on the patient's chest, and how the electrical resistance across the chest varies with breathing. This small change in resistance is detected by the respiration amplifier, and displayed on a digital readout.

Mr. Sibley concluded with a demonstration of various e.c.g., temperature respiration and telemetry instructions together with slides showing various applications and functions.

SOUTHERN BRANCH

At a recent meeting, members of the Southern Branch were addressed by Mr. Barrett of ICI, who gave a paper on cavity-foam insulation.

Mr. Barrett mentioned the usual forms of insulation i.e. of roof and windows and the maximum insulation that they can give. He then gave a brief history of the development of the cavity wall following the solid-wall construction and then the progression of insulating the cavity.

Mr. Barrett completed his talk by detailing the design and contracting sections of his company and emphasising that when 'foaming' new buildings it was most important for his company to be aware of certain structural details in order to be sure that the correct application could be made. Throughout the talk two films were shown which demonstrated the application of cavity foaming and high-lighted many of the advantages.

Mr. Wicks thanked Mr. Barrett for his most interesting and topical talk which had been enjoyed by all members present.

WEST OF SCOTLAND BRANCH

The annual dinner dance of the branch was held at the Macdonald Hotel, East Wood Toll, Glasgow on the 28th February 1975. 150 members, guests and partners took part, including Dr. B. G. B. Lucas and Mrs. Lucas.

Computers as a management tool for operation and maintenance engineers

by Col. A. P. SMITH, O.B.E., B.A., C.Eng., F.I.C.E., F.I.Mech.E.

Three of the biggest problem areas for the maintenance engineer are in budgeting, staffing levels and plant replacement.

Forward projections are often nothing better than guesswork.

This article describes how the engineer can use the computer to make a more scientific assessment of these factors.

Computers are machines for calculations and the processing of data which cannot be done by hand economically or in the time available. They are best suited either to complex processing of a relatively small amount of data or to relatively simple processing of a larger amount of data. All computers, from electronic calculators up to the largest mainframe computer, consist of an electronic machine which gives an output —in the form of a printout, an engineering drawing, a display on an oscilloscope or control of a machine tool —if it is fed with input information. This output will only be of value if the user asks himself 'Why do I want the information?' and 'What exactly do I want?', If he cannot arrive at sensible answers, he had better forget the matter.

Assuming that he satisfies himself on this, he must now do two things. Call in his systems analyst and programmer and sort out what information is or can be made available; how and by whom it is to be collected; how accurate it needs to be and exactly how it is to be processed. Together they must estimate the cost of collecting the information and processing it. This may show that the project is not worth undertaking or, as is not uncommon, that conventional processing can be so much improved by the use of computation forms and a calculator or desk-top computer that a programme for the mainframe machine is not the best method.

At this stage the question must be asked 'Who else wants information from this basic data?'. They must be asked if they want to join in the project. If they do, this may involve the collection of additional data and additional steps in processing which may or may not prove worthwhile. Here comes a snag. One man's meat is another man's poison, and if all users get the total output from a program, it may be so voluminous that it is useful to nobody. This is particularly the case with information collected for the sake of historic or statistical record. The program must contain filters so that each user gets only the output he needs, in the form he wants it and when he wants it.

For instance, if you are controlling expenditure against a budget, you need to know monthly how much in total you are over or under spent against what you expected, and what has caused this: so the computer must also tell you monthly what are the important over and under spendings against the budget subheads but not every minor variation. Nor do you need full details of every unit rate or production cost which you may need to know at longer intervals or to record for statistical purposes.

Think of steam costs: for day-to-day management of the boiler plant you probably don't need to know the exact current unit rate or average boiler efficiency or thermal cost of fuel or to compare steam usage against the number of beds or cubic content or number of degree days in the month: it is enough to watch the fuel bill against what you had planned. But for preparing next year's budget, for setting operational targets and, even more so, for predicting the performance and running cost of a new boiler plant in your own or another hospital, you need access to all this information. Only if the monthly and cumulative fuel bill is

Col. Smith is with the Northern Regional Health Authority, Benfield Road, Walker Gate, Newcastle upon Tyne NE6 4PY

way out will you need to ask the computer to tell you why. This may help you to discover corrective action or lead to a change in your budget plan.

To repeat myself, you must think out exactly what you want, why you want it and when you want it. If you are clear on this your programmer will help by devising forms for the collection of input data and a code by which the input must be classified so that the information can be transcribed on to paper or magnetic tape which the computer can read. He will then also write the program of instructions to the computer.

Such a computer program can undoubtedly be of assistance to an engineer responsible for the operation and maintenance of an engineering installation. Many such applications have been described in DoE conferences on maintenance from 1966 onwards. and one of the most interesting papers presented to these was from M. V. Jarman, then Chief Engineer to the Pressed Steel Company, describing his computer program to analyse the cost of maintaining his plant.

Problems

As I see it, the problem pressing most hard on any engineer responsible for the operation, serviceability, upkeep and replacement of engineering equipment, plant and installations is threefold:

(*a*) What is the cost of maintaining it? What will it be next year?

(*b*) What staff is required to maintain it, now and next year?

(*c*) When will it require replacement and how much should I include in annual budgets for doing so?

With the corollary:

How can I persuade the accountant and the board to accept my figures?

At the moment we are all guilty of the utter improvidence of buying equipment or installing plant without knowing how much money to provide to run and maintain it: what staff will be needed: when it will need replacement and what it will cost. At best we can guess.

The first essential of a computer-controlled program for controlling planned maintenance, throwing up the monthly and annual total costs and providing data for budget planning in the form of unit rates, is a coded inventory of what has to be maintained in the computer memory. To analyse the cost and produce unit rates, other information has to be given to the computer, such as the area and cube of the departments served, and the skill will be in selecting on what basis and in what detail to analyse the recorded costs.

For your own hospital the unit rates from last year will apply next year, when corrected for inflation, and if you buy or install new equipment someone else may have unit rates for maintaining it even if you have not. Add the repairs and overhauls planned for next year; deduct the cost of those you did this year which you can forget next year and there is your budget. The computer will work it out for you and be able to prove it to the treasurer and the committee. You can then apply your knowledge, skill and experience to asking yourself: 'Did I really get value for my spending on maintenance? What did I spend wastefully? What past omissions have proved false economy?' And, of course, regional unit rates will be immensely valuable in building up the maintenance budget of a new hospital from the inventories of its installations and equipment which are prepared years in advance of the hospital opening.

For prediction of maintenance staffing we already have good information on the maintenance routines for every type of equipment or installation in use in the hospital service and the annual manpower bill for its maintenance can be worked out. We do not need to wait for the maintenance program to throw this up although it can check it and if necessary provide more detail, and in due time tell us that one maker's machine costs less to maintain than his rival's. Tell the computer what you know already and it will calculate how many men you need for the planned maintenance of your inventory. Add 30 or 40% for unplanned maintenance and planned repairs and you have a first approximation to your manpower bill. This is particularly important when your inventory is growing fast as it is in electronic equipment or when you are building a new department. Our present crude norms of so many craftsmen per 100 beds aren't much help when you build an outpatient department or a dental school. But controlled data processing of the inventory will be of great value. What about the scale effect? Well, within limits, the planned maintenance of a large engine will be much the same as that of a small one until it is so big that it needs an extra man to take the cylinder head off for a top overhaul!

Plant replacement

The economic life of plant and equipment can be assessed by experience. The first cost is known: this can be updated by an annual factor for inflation and corrected in the light of more recent purchase costs. So assuming that the plant continues to be able to meet the demands upon it, you know within limits when you will have to replace it and what it will cost you. You can record the output or throughput of a plant. The rate of growth of load may give a pointer to when overload will occur. But there are two jokers: the addition of a new department and technical improvement in design which can have the effect that equipment which is still perfectly capable of meeting what was the users' need five years ago, is obsolete and useless because they have found new needs. Staff-location equipment is a good example of this trend but, on the other hand, old valve-based diathermy equipment is still in use and still found perfectly satisfactory. It could well be that data processing of the equipment inventory, intelligently applied, would give a valuable first approximation of your plant-replacement programme for the next 5 years and give you time to modify the print out in the light of your experience—or in other words give you more information to be processed by that human computer the brain—than you can collect with your own hands and those of your staff.

So in these three big problems, budgets, establishment and plant replacement, I see possibilities of the computer being of the greatest service to the operations and maintenance engineer provided that he keeps on top of it. In Newcastle there are well established pilot experiments in all of these.

Classified Advertisements

OFFICIAL APPOINTMENTS
SITUATIONS VACANT
COURSES, EQUIPMENT ETC.

To place an advertisement in this section, please write or telephone:
Classified Advertisement Department, *HOSPITAL ENGINEERING*
Peter Peregrinus Ltd.
Station House, Nightingale Road,
Hitchin, Herts. SG5 1RJ, England
Telephone: Hitchin (s.t.d. 0462) 53331, ext. 276

APPOINTMENTS AND SITUATIONS VACANT

UNIVERSITY OF GLASGOW

BUILDING SERVICES RESEARCH UNIT

BUILDING SERVICES ENGINEER

Applications are invited for the post of Building Services Engineer in the Building Research Unit. Candidates should hold a B.Sc. degree, Higher National or equivalent qualification in mechanical, electrical, or electronic engineering.

A good practical knowledge of mechanical and electrical engineering services installations, and a familiarity with their instrumentation is essential.

Experience in electronics or a practical knowledge of air conditioning plants and their associated control systems would be a definite advantage as would a knowledge of the organisation and protocol of the hospital service, and experience of responsibility for the work and discipline of a small team.

The post is supported by a grant from the Department of Health and Social Security and is tenable, in the first instance, until 31st March, 1977.

Initial salary will be within the salary scale of £2118-£3990 per annum, plus threshold allowance (£229). Appropriate Superannuation Scheme will apply.

Applications, giving relevant particulars and the names of two referees, should be sent to The Leader, Building Services Research Unit, University of Glasgow, 3 Lilybank Gardens, Glasgow, G12 8RZ.

In reply please quote Ref. No. 3670 FG.

ASSISTANT ENGINEERS

Assistant Engineers are required for managerial duties associated with the maintenance and operation of engineering services both mechanical and electrical. Duties will include the implementation of planned preventative maintenance schemes, together with the maintenance of specialised equipment.

Applicants should have served a recognised apprenticeship in mechanical or electrical engineering and have obtained O.N.C. or equivalent qualifications.

Previous management experience would be an advantage.

Basic Salary: **£2270–£2600 p.a.**

Write for job description and application form to:—

Acting District Works Officer,
Dudley Road Hospital,
Box 293, Dudley Road,
Birmingham B18 7QH.

Please quote Ref. 343/HE.

West Birmingham
Health District

BIRMINGHAM AREA HEALTH AUTHORITY (TEACHING)

SOUTH BIRMINGHAM HEALTH DISTRICT

ASSISTANT ENGINEER (ELECTRICAL)

Required to assist the District Works Officer in the District Offices. Duties will include the design of new works of an electrical nature and there will be involvement with various aspects of maintenance of engineering plant and equipment.

This position would give a young, ambitious engineer a worthwhile career in hospital engineering with the opportunity for day release for further study.

O.N.C. in Electrical Engineering required.

Salary Scale £2271-£2601 p.a. plus Threshold. Whitley Council conditions of service apply.

Job description and Application Form available from District Works Officer, South Birmingham Health District, Oak Tree Lane, Selly Oak, Birmingham B29 6JF.

Applications to be returned by the 4th July 1975

NORTH WEST THAMES REGIONAL HEALTH AUTHORITY

PRINCIPAL ASSISTANT ENGINEER, MAIN GRADE ENGINEER, and TECHNICAL ASSISTANTS Grades I, II and III required to carry out design for Mechanical and Electrical Services.

Principal Assistant Engineer
The successful candidate will lead a design team of the Regional Engineer's Department, covering the development of electrical or mechanical services for new hospitals, extensions etc. Candidates should have had experience in the design of service installations in large buildings, the control of design staff and implementation of contracts on site. Duties include the preparation of design briefs, control and advice to staff at all stages of the engineering works.
Applicants must have M.I.Mech.E. or M.I.E.E.
SALARY SCALE: £4545—£5409 per annum plus £312 per annum London Weighting plus £229 per annum Threshold Agreement payments. Ref. 925

Main Grade Engineer
Applicants for Main Grade Engineer should be M.I.E.E. or M.I.Mech.E./M.I.H.V.E., Graduates would be considered.
SALARY within the range (age 25 and over) £2574—£4671 per annum plus £312 London Weighting plus £229 per annum Threshold Agreement payments. Applicants with A.M.I.H.V.E., only (and less than 10 years' experience) do not proceed beyond £4275. Non-corporate members do not proceed beyond £3630. It is possible for both corporate and non-corporate members to enter at a salary above the minimum. Ref. No. 926

Technical Assistants
Applicants for Technical Assistant I and II should have O.N.C. or equivalent qualification plus relevant experience of ten years and seven years respectively. Applicants for Technical Assistant III should have O.N.C. plus four years' experience. Exceptionally applicants with three years relevant experience can be considered for entry to this grade.
SALARY SCALES: Plus £312 per annum London Weighting plus £229 per annum Threshold Agreement payments.

Technical Assistant Grade I	£2979—£3609	Ref. 927
Technical Assistant Grade II	£2622—£2976	Ref. 928
Technical Assistant Grade III	£1833—£2577	Ref. 929

Application forms from the Regional Personnel Officer, North West Thames Regional Health Authority, 40 Eastbourne Terrace, London W2 3QR., quoting the appropriate reference number. Closing Date 27th June.

MISCELLANEOUS

IEE medical electronics volume 2: monographs 7-12

edited by Dr. D. W. Hill and Dr. B. W. Watson

172 pp., hard covers, six papers, 230 × 150 mm, letterpress, ISBN 0 901223 51 4, published 21st January 1974, £6.50

Contents:
Microelectrodes and input amplifiers, *C. Guld.* **Fundamental properties of physiological electrodes,** *W. Greatbatch.* **Instrumentation for electroencephalography,** *C. D. Binnie.* **Cardiac pacemakers,** *J. Kenny.* **Evoked-response audiometry,** *J. R. Roberts and B. W. Watson.* **Myoelectric control,** *R. N. Scott, P. A. Parker and V. A. Dunfield*

Medical electronics continues to find an increasing acceptance in a wide variety of medical disciplines, both in the development of specific instrumentation and in clinical applications. Each year, a more detailed understanding is emerging of how electronic techniques for diagnosis, therapy and data reduction can play a significant part in both routine medical services and research.

This second volume in the IEE Medical Electronics Monographs series provides a valuable source of reference material for departments in hospitals, medical schools and pharmacological-, physiological- and psychological-research laboratories. Subjects covered range from the design of implanted cardiac pacemakers and microelectrodes, and their associated amplifiers for use in electrophysiological investigations, to techniques for use in evoked-response audiometry and the use of myoelectric control systems in aids for the handicapped. The book will be of great value to medical doctors, life scientists, engineers and physicists who wish to add to their knowledge of useful techniques.

Orders, with remittances, should be sent to:
Publication Sales Department, Peter Peregrinus Ltd., Station House, Nightingale Road, Hitchin, Herts. SG5 1RJ, England

Index to Advertisers

Please mention 'Hospital Engineering' when replying to advertisers

Printed in England by C. F. Hodgson & Son Limited, 50 Holloway Road, London N7 8JL