HOSPITAL ENGINEERING

September 1977

International Federation Issue

The Journal of the Institute of Hospital Engineering

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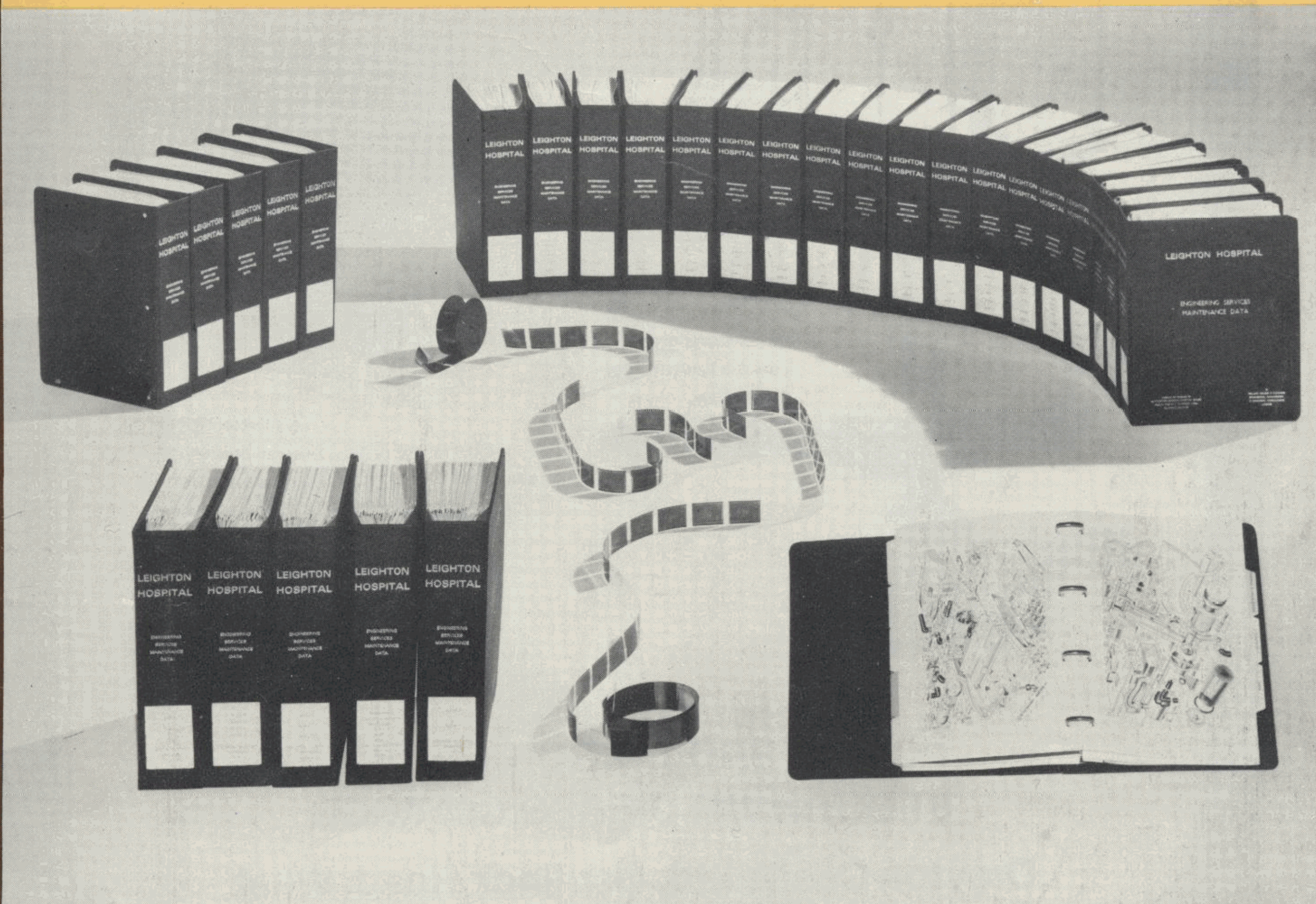

Commissioning Today

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HOSPITAL ENGINEERING

September 1977 **Vol. 31 No. 7**

The Journal of the Institute of Hospital Engineering

International Federation Issue No. 23

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Institute News

Southern Branch Programme

Date	Topic	Venue
Saturday, September 10, 1977	Visit to HMS Alliance and Submarine Museum	HMS Dolphin — Gosport War Memorial Hospital
Saturday, November 12, 1977	Work of the Commonwealth Secretariat in the Development in Engineering in Health Depts. of Emerging African Nations Speaker: Dr. Clifford Riley	St. Richard's Hospital, Chichester
Saturday, January 14, 1978	Flooring Types and Preparation Speaker: Mr. Beer	Dorset County Hospital, Dorchester
Saturday, March 11, 1978	Brain Scanner Speakers: Dr. E. H. Burrows, Miss P. Kimber	Southampton General Hospital

South Western Branch Programme

Date	Topic
Tuesday, October 4, 1977	Talk on Heat Pumps. Joint meeting with CIBS and IPlantE
Wednesday, October 12, 1977	Visit to St. Mary Radcliffe Church, Bristol
Thursday, November 24, 1977	Visit to Spirax-Sarco Limited, factory at Cheltenham. Joint visit with CIBS and IPlantE
Thursday December 8, 1977	Talk on Health and Safety — Electricity.

The Members of the South Western Branch Committee for this session are:

Chairman	S. R. Jacobs
Vice-Chairman	C. E. Watkins
Treasurer	H. R. Stiddard
Committee	K. J. Lucas
	J. W. Barnes
	B. R. Eddolls
	D. J. Shoebridge
	R. F. Field
Hon. Secretary	A. J. Graver

East Anglian Branch

On Wednesday, July 6, 1977, the branch meeting took the form of a visit to the new Postal Sorting Office, Great Yarmouth, where members were given an interesting insight into the operation of the Postal system.

The operational procedures were explained in depth from the collection, sorting and despatch of outgoing mail to the distribution of incoming mail. The office handles up to 70,000 letters per day during the summer months and 29,000 during the winter.

A lively discussion took place involving such matters as postal codes, first/second class services and the public relations problems of the Post Office.

The visit was followed by a meeting of the Branch Committee.

Symposium on the transport of hazardous materials

A major symposium has been arranged by the Council of Engineering Institutions (CEI) and the Council of Science and Technology Institutes (CSTI) through their Joint Affairs Committee. It will be held on Thursday, December 15, 1977, at the Institution of Civil Engineers under the general title of 'Transport of Hazardous Materials'. It will be devoted primarily to carriage by road and all members of the CEI and CSTI are invited to support it.

There has been a large increase in the volume of road traffic in recent years with a corresponding increase in the technical and social problems which the carriage of certain substances can present, and many of these problems will respond to an interdisciplinary approach. It is a principal aim of the symposium to encourage the investigation of such problems.

The Watt Committee on Energy

The first Report of the Watt Committee on Energy has now been published. The Report is priced at £5 but it is offered at a reduced price of £2.50 to members of learned societies who are members of the Watt Committee (as is The Institute of Hospital Engineering).

It is hoped to publish the second Report in September — Deployment of National Resources in respect of Energy R and D in the UK.

Change of address

The Hospitals and Charities Commission, Melbourne, Australia

The Commission is now located at 555 Collins Street, Melbourne, telephone: 616777. All correspondence should be addressed to. P.O. Box 4013, Melbourne 3001.

Paul Garrett

We very much regret to record the death of Paul J. Garrett, member of the Institute.

Paul Garrett died at the tragically early age of 25, in the Nottingham General Hospital on July 27.

Correction

We regret that an unfortunate error crept into the letter from Mr. P. H. Everall and Mr. C. A. Morris from the Public Health Laboratory at Shrewsbury about the testing of low-temperature steam / formaldehyde sterilisers with Bacillus stearothermophilus spores, published on page 3 of the August issue. Some 14 words (underlined) were omitted from their second paragraph, which should read:

These discrepancies could be accounted for by quantitative differences in the two preparations. (If so, this would explain the failure to demonstrate differences of the same extreme degree between the authors' own spore preparations).

Mr. King is a Principal Assistant Engineer with the Oxford RHA. Needless to say, his views do not necessarily represent Authority or DHSS policy.

The Great Mistake?

CHARLES KING BSc(Eng) CEng MIEE FIHospE

Charges at Falfield

Once upon a time a great national association of manufacturers in the lamp industry* offered a very wide range of instructional courses in the use of their products. The cynical among you may say that this was an entirely commercial venture aimed at increasing the volume of lamps sold, but whatever the basic thinking there is no doubt that the quality as well as the quantity of artificial lighting was affected for the better.

But these courses, and the individual advice which was on demand, were entirely free. Industrial organisations, large firms, small shopkeepers, housewives, all could have soundly-based lamp and lighting advice — FREE, and there was less respect for the advice *because* it was free. Although we say 'Don't look a gift horse in the mouth', and 'the best things in life are free', we are still suspicious of free offers. It is like the 'six numbers exclusively drawn for you' — something for nothing makes us wonder what the catch is! With this nasty suspicious mind almost a national characteristic, it was logical that when the policy for the Hospital Engineering Centre was being formulated the Ministry of Health steered well clear of the pitfall of offering courses without any fee.

The Hospital Enginering Centre has now firmly established itself in the hospital world, after demonstrating the excellence of its courses for over seven years.

It seems that the time has come for a reappraisal of DHSS policy; no one will want to see this exciting training development lose its momentum, or indeed its international prestige. But if it cannot be filled with course members it can only become a sterile monument to a great idea — and the financial stringency which affects the whole Service is making itself felt in the numbers of nominations.

When the financial belt is pulled in yet another notch, and the expenditure to be contained is still increasing, it is natural and right for economies to be sought in non-productive expenditure.

In a world where everyone other than doctor or nurse is considered an administrator and a parasite on the Service it is inevitable that the unseen and unsung works staffs come in for financial restraint — and training is right at the bottom of the priority list as being wholly non-productive. Nevertheless it has been shown without doubt that good training of works staff can bring immediate savings in the running costs of our hospitals and in the capital costs of new plant.

The cost of sending a nominee to the Hospital Engineering Centre is now, for the usual two-week course, about £200 including associated expenses; there is in addition the notional loss of, say, £100 of work from the nominee, although it may be claimed that others will work harder to cover his absence. £200 is a large figure to request from the Treasurer; even if approval for only the fee cost is sought this is still £160.

Is not the time right for the already substantial subsidy of the Hospital Engineering Centre from central funds to be increased?

Let us not err into the something-for-nothing philosophy, which would indeed be a great mistake, but equally let us ensure a full utilisation of our substantial capital investment by reducing the fees.

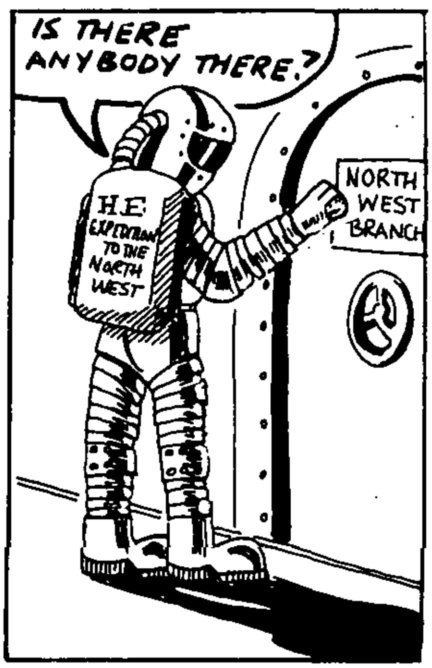
A weekly fee of £20 would not inhibit Treasurers from agreeing to requests, and would yet encourage care in selection of nominees; it would ensure that proper use as well as full use is made of our unique training establishment at Falfield.

**The Electric Lamp Manufacturers' Association and its Lighting Service Bureau.*

Letters to the Editor

Dear Sir,

Is there anybody there?



This phrase is the last line in a well-known science fiction short story. In the story the main character is an astronaut in the far future engaged in the search for intelligent life throughout the universe. He has completed years of searching without success and the final solar system has proved barren and it is his last despairing cry that ends the story.

All very interesting if like me you are a science fiction fan, but what has it got to do with Hospital Engineering?

Two months ago I wrote to the journal complaining of the lack of support and interest from members of the North West Branch. To be honest I did not expect much reaction, but I did expect the odd comment, even if it was only agreement with what I had written. However, total silence has so far been the only reaction and it leads me to believe that the branch Committee have totally misled themselves into thinking that we were producing talks and visits that had some interest to members.

So I would ask once again "is there anybody there?", give us a clue, a hint of what you want. When do you want it? And we as a Branch will try to produce a programme that gets some support.

To go back to the lonely astronaut when he despairingly asked his last question, the implied answer was NO!

But I know there is somebody there. I've even met some of you so with some little hope I will ask once again. "Is there anybody there?" I hope the answer this time will be YES!

Yours faithfully,

A. W. SCHAFFEL
8 Lathom Avenue,
Parbold, nr. Wigan, Lancs.

Dear Sir,

Training – What are our Chances and Opportunities?

I read with interest Mr. Dix's letter, *Hospital Engineering* August 1977, concerned with the training of Hospital Engineers and Assistant Hospital Engineers, as I am just about to embark on the Part II of the part-time Polytechnic BSc course.

I would agree with Mr. Dix that the social and domestic pressures are tremendous and the course is not structured for the Works Engineer, although my studies over the past year have been more relevant to my work than the HNC course. As Mr. Dix suggests, a specialist course would be the answer, but I query the merits of a correspondence course. This type of course puts extra strain on the student who has to be self-motivated and provide his own stimulus.

I have talked considerably with the course tutor about the content of the BSc courses available and it all boils down to demand. If enough people approach a college for a specialist course, i.e. Hospital Engineering to CNAA standard, there seems to be no reason why this type of course should not be run. Therefore my suggestion would be for the Regional Training Officer to collate the number of engineers in his Region who wish to attempt this further education, instead of letting them fight as individuals to get on these courses, then approach the local Polytechnic for a suitable course. Although the DHSS would lose its 200 hours per man, the drop-out rate would be less and the pass rate considerably higher than a comparable correspondence course.

Yours faithfully,

R. EMERSON, Assistant Engineer,
Central Birmingham Health District,
The Queen Elizabeth Medical Centre,
Edgbaston, Birmingham B15 2TH

From the Editor

Change of address

The publishers of the Journal, Earlsport Publications, will be moving offices during September. The new address will be:

Earlsport Publications,
17 St. Swithin's Lane,
London EC4.

Our present telephone number will remain in use for the time being.

* * *

News, letters, articles and papers

I would like to take this opportunity to thank all those who have contributed to the Journal. We like to feel, from the letters and comments we receive that there is now more interest in the content and that *Hospital Engineering* is being used to voice opinions and provide interesting new information to other readers.

We look forward to receiving more articles, news from the branches and your letters.

* * *

Referees

I would also like to thank the members who voluntarily referee our technical articles to ensure that their content maintains a high standard.

Notes prepared by the Consultant Architects, Messrs. Andrews Sherlock and Partners.

Background and Sequence of Work to Tender Stage

South West Thames RHA Regional Computer Centre

The Consultant Architects were approached by the Regional Architect in June 1975, and asked if they considered it feasible to design and construct a Computer Centre for the SWTRHA within the following 18 months. It was expected that the normal *Professional Service — Bill of Quantities — Tender* sequence would be employed; a 'package deal' having been considered and rejected by the SWTRHA Technical Officers. A consultant QS had already been approached and discussions with him and other Consultants confirmed that all parties were convinced that the programme could be achieved. The pre-tender work was limited to six months to allow 12 months for the construction. In order to condense the pre-tender work it was agreed that tenders would be invited on a Bill of Approximate Quantities. (Although not available at the time a new JCT Standard Form of Building Contract has since been published for this type of operation).

A sketch plan to establish a schedule of accommodation on two floors had previously been prepared. This plan was quickly analysed and amended following preliminary design work by the M & E Services Consultants, Structural Engineer, and consultations with fire officer etc. The basic planning was agreed at this stage. Production drawings were commenced and ran concurrently with the final design work. All decisions were monitored by the QS to give maximum cost control and to avoid the time-consuming exercise of 'cutting back' at tender stage. It was, of course, vital to the programme that the basic decisions concerning the structure, services and construction which were taken at this stage were not allowed to vary. Site investigations and foundation design were also determined at this stage.

General arrangement drawings from all consultants were issued along with typical details of the construction and specifications of other elements such as partitions, ceilings, floor coverings etc., during the first two months, and work on the Approximate Bill commenced. Work on the detailed design and constructional drawings continued concurrently.

Competitive tenders were invited from firms considered suitable, bearing in mind the complexity of the building and the tight programme. The lowest tender, that of Messrs. Wimpey, was accepted and work commenced in January 1976 with 54 weeks for completion.

Design considerations

The site is located in the grounds of the Psychiatric Hospital in South West London and is close to the boundary of a new residential complex for a London College. Of prime importance therefore, was the consideration of the noise emission from the plant associated with the Computer Centre. Specialist acoustic consultants were called in to advise on this aspect.

Because of the noise considerations it was decided to separate as much of the heavy plant as possible from the main building. The result is two contrasting buildings, one a single-storey brick and concrete structure housing hot water boiler plant, electrical switchroom, standby generator, transformer, motor alternator for the computer electrical supply, and oil fuel storage for the boilers and generator, and the main building which is a two-storey metal clad structure containing at ground floor level the computer suite and associated work areas for data preparation, handling and despatch, bulk paper storage, the a/c plant and telephone exchange, and at first floor the offices and staff facilities, seminar room, library and communications room, etc. Toilet accommodation is provided on both floors. It was considered important that all major work areas and offices including the computer room should be naturally lit. To achieve this at first floor level a light well, which serves as open air terrace for staff using the rest room and seminar rooms, is provided. The entire Computer Suite is air conditioned, and the component rooms, together with offices on the sun side of the first floor, are shielded from solar heat gain and glare by solar actuated external blinds.

Construction

The single-storey plant building is a conventional brick and concrete structure on strip foundations. The two-storey main building is on piled foundations with an unreinforced ground floor slab, and at roof level has light latticed steel beams, steel roof deck insulation and asphalt finish. External spandrel walls are of brick with insulated aluminium steel cladding. Windows are of horizontally sliding aluminium construction, double glazed and fixed in the air-conditioned areas. The cladding has been designed to incorporate a recessed blind box for the external sun blinds.

In the detailed design consideration was given to speed of erection, and efforts were made to segregate each of the elements of construction in order that they might be completed by the various specialist trades with a minimum of dependence on each other. Staircases were designed to be fabricated off site, and were installed early in the contract (with the temporary treads) for ease of access.

Services

The services plant, which is of a relatively complex nature, is divided into two basic elements. Firstly, central heat generating plant, and electrical supply equipment, housed in the single-storey structure. Secondly, air handling and refrigeration equipment, housed within the main building ground-floor, linear plant room with air-cooled condensers mounted on the roof, together with water storage, and localised ventilation plants serving the first floor areas.

All noisy items of plant and machinery have been sited and/or acoustically treated to contain external noise intrusion to the appropriate acceptable levels. All openings in the envelopes of the buildings where noise break-out might occur have either been provided with sound attenuators, or sealed by means of doors giving similar sound deadening qualities to the main building structure.

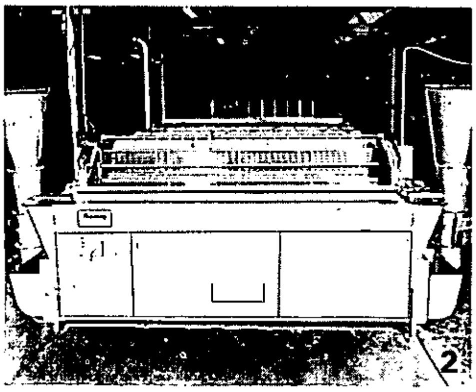
The air conditioning is split into four zones served from air handlers in the linear plant room. These zones comprise the Computer Room, the Data Preparation Area, the area containing the Ancillary Rooms and the Paper Store. Each zone has its own plant with inbuilt standby. Air is conveyed to the conditioned spaces by means of ventilated ceilings and underfloor voids, with return air grilles in the false floors.

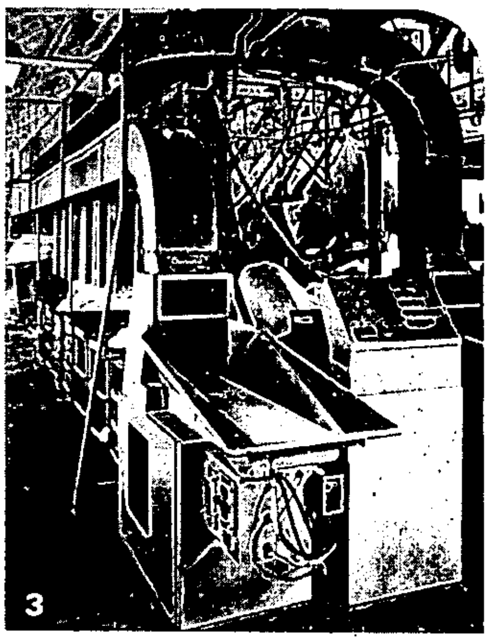
The remainder of the building is conventionally serviced with normal lighting and power, hot water radiators, and local ventilation plants for toilets, rest room, print room, and seminar room. Extensive fire and security alarm coverage is provided.

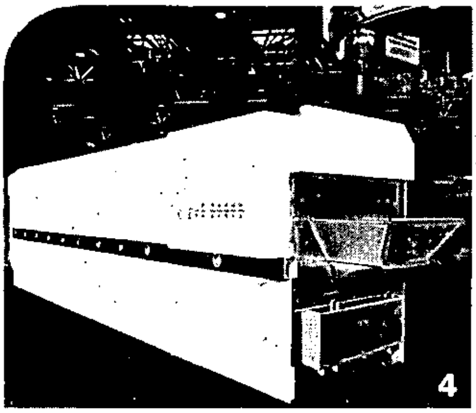
Finishes

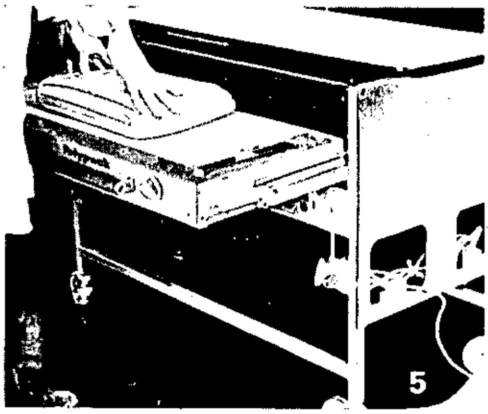
Except where necessary for fire or performance, all internal partitions are of dry construction, giving a measure of flexibility for future rearrangement if necessary. Anti-static bonded carpets are provided to all offices and computer suite areas. A heavy rubber flooring is used in the ground floor entrance hall, stairs and circulation space where a good deal of traffic is expected.

Metal pan false ceilings are used throughout the ground floor and in the rest room. The remainder of the false ceilings on first floor level are of the mineral tile type. All ceilings are fully demountable for ease of access to services.









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Commissioning Engineering Services

This is one of the papers given at the Institute's symposium held at Imperial College, London, on June 15. Two other papers were reprinted in the August 1977 issue.

Mr. Rundle is Principal Engineer, DHSS.

Commissioning Today

M Rundle BSc, BA, CEng FIMechE, MIEE, FIMarE

In 1967 the then Ministry of Health published *Hospital Technical Memorandum No. 17* dealing with the commissioning of hospital engineering installations. It had been produced by a working-party of Ministry of Health and Regional Hospital Board engineers and a representative of the Hospital Engineering Research Unit. It was felt that Hospital Authorities needed assistance in organising the commissioning of engineering installations because of reports being received of installations that were being handed over for use not properly finished off, or which were not proving satisfactory to the user in some way.

HTM 17 set out to develop a procedure which would establish that both the design work and the construction were done to the satisfaction of the user. In addition the *HTM* made the point that the commissioning process did not end when the installation was handed over for use and maintenance. The need for the engineer who would be responsible for the subsequent operation and maintenance to be shown the correct working of the installation was referred to, and the importance of record documents, users' handbooks, and maintenance instructions was also emphasised. Finally the need for adequate staff training and a follow-up procedure to provide feed-back of information of the design-in-use were noted. The way in which the aims of the *HTM* were to be met involved among other things the appointment of a Commissioning Engineer who would be responsible for commissioning the works and advising the Regional Engineer or other responsible people, that the installation had been completed satisfactorily. To assist in the proper commissioning of installations a series of supplementary manuals was issued; each manual dealt with a specific type of installation or with particular types of plants or equipment. From these manuals detailed schedules and check-lists could be prepared.

Following the publication of the document in 1967 a considerable amount of effort was devoted by Regional and other Authorities to the problem of securing installations which were ready for use at the time of handover and which were satisfactory to the user. At about this time other organisations concerned with building services, among them the IHVE, began to publish Codes dealing with the commissioning of specific types of installation and gradually a good deal of experience with the problem accumulated within the Health Service. In 1974 the DHSS established a new working group consisting of engineers representing the Department, Regional Health Authorities, Consulting Engineers, the Hospital Engineering Research Unit and Contractors to review the results of experience since the publication of the *HTM* in 1967, and the developments which had taken place associated with commissioning of engineering installations in buildings since then. A revised document has been produced in final draft form for circulation. When finally published it will supersede the earlier issue.

The purpose of this paper is to summarise the main points of the draft document and to indicate the current thinking on commissioning.

Principles and definitions

The new document is concerned to establish a framework within which those involved in carrying out the design, construction, commissioning and testing of health building engineering installations may work. The successful achievement of the project will, of course, depend upon the quality and adequacy of the designer's brief. In the latest draft of the *Technical Memorandum*, commissioning has been re-defined so as to agree more closely than formerly with the definitions used in codes of commissioning practice and other material. The new definition refers to commissioning as the process of advancing an installation from the stage of static completion to full working order to specified requirements — in other words the activation of completed installations. Other matters which were previously dealt with as part of the commissioning process are now recognised as being separate, but because of their influence on commissioning they are classed as associated activities. Clearly, these include the design and tender preparation stage, the construction stage, post-handover tests and adjustments, and the evaluation of design-in-use; all of these activities have a bearing on the final judgment as to whether the installation satisfies the user.

The members of the working group were aware that difficulties had arisen in implementing the 1967 proposal to appoint a Commissioning Engineer with duties which cut across those of the designer and the contractual obligations of the Contractor. In the revised document the duties of designers, contractors and site engineers have been more closely defined. The designation of Commissioning Engineer has been used to describe the person appointed by the Contractor to execute the commissioning process in accordance with the Contract. It has been decided to adopt the term Client's Commissioning Adviser, for the person appointed by the Client to advise whether the installation meets the specified requirements.

It is made clear that this person has only an advisory role and that he should not take away any of the responsibility of the designer during the preparation of the design and tender documentation nor of the Supervising Officer during the construction stage. The Client's Commissioning Adviser has no power under the Contract to interfere with the work of the Contractor. The new *Technical Memorandum* indicates that the Client's Commissioning Adviser may be expected to be involved during the preparation of the design, during the construction stage and throughout the commissioning and acceptance stage, as well as after installations have been handed over. Clearly a person appointed in this capacity will need to be very experienced in construction work and in commissioning installations. The important thing is that he will have the ear of the Employer — the Authority, who pays both the Designer and the Contractor — and he will exert his influence indirectly by persuasion or, if this is not effective, it will be up to the Employer to impose his views.

Commissioning and the associated activities

It is instructive to look at commissioning as the activity in the middle of a process which starts when the client's brief is prepared, and ends with an installation which the Client's Commissioning Adviser reports as meeting the requirements of the brief.

The designer's role is discussed in more detail in Mr. Winning's paper (pages 7-10, August 1977 issue). All that needs to be done here is to record that the draft commissioning document emphasises the need for designers to include in the contract particulars all the instructions which the contractor will need, in order to provide and set the installation to work, and where necessary, to demonstrate that it is in accordance with the contract requirements and acceptable for use. This means that the commissioning procedure needs to be selected by the designer, arrangements must be made for the operation of the installation to be explained, and details of the settings of control devices must be provided in the contract specification. The designer must decide whether items of plant need to be tested off-site, so that commissioning of installations may proceed in the knowledge that the major items of equipment will perform in accordance with the manufacturer's guarantee. He will also have to decide what tests for soundness and safety need to be carried out during the construction stage prior to commissioning, and make appropriate provision in the Contract. The intention of the *Technical Memorandum* is to make it clear that the Designer must consider how installations are to be commissioned and demonstrated, and to include adequate information and instructions in the documents to be prepared as part of the Contract.

During the construction stage the Supervising Officer, or Site Engineers under his direction, will be watching the progress of the work and inspecting it for compliance with the contractual requirements. When an installation has been put together and is complete the commissioning activity will start, and the contractor's commissioning engineer will proceed to set the installation to work, and regulate and adjust it in accordance with the designer's instructions contained in the contract specification. The new document recommends that before an installation is set to work the commissioning engineer should check it thoroughly and systematically to ensure that it is safe and in a satisfactory condition. The check should bring to notice installation deficiencies and what may appear to be design errors or omissions which have gone undetected earlier. When all is in order the installation may then be set to work, and where appropriate, regulated and adjusted as specified. The commissioning process is concluded when the installation is in full working order and acceptable for use; of course the contract may call for demonstration that it is acceptable and complies with the specified requirements.

After the installation has been handed over, measurements of performance and other tests may be required; it is suggested that these may be done under a Contract or by directly employed Hospital staff. Their purpose is to enable the performance actually achieved to be compared with that of the designer's interpretation of the client's brief. The commissioning document deals with this as a post-handover activity and refers to the problems caused by external or seasonal conditions and the effects of occupancy of the building. It is important to recognise, as the working group have done in drafting the new document, that acceptance tests and demonstrations before handover have the function of showing that the Contractor has fulfilled his obligations under the contract, ie, the designer's requirements. Proving the adequacy of the design is not the responsibility of the Contractor, although he may carry out specified performance tests and provide records of the results. If the results are judged to show that the design is not satisfactory to the Client Users the responsibility cannot be put on the Contractor unless he has carried out the design work.

The Client's Commissioning Adviser will be active at this stage of the procedure and he will be concerned to see that the user has an installation which is satisfactory, and that all the information necessary to operate and maintain it safely has been provided.

The *Technical Memorandum* also contains a reminder that the programme for the Works should include adequate time for commissioning, and that commissioning should be properly integrated into the overall programme of site work; too often slippage in the Contract programme is made up by absorbing time previously allotted to commissioning work. Finally the new document suggests that valuable information can be gained by studying the performance of completed installations during the first few months that they are in use. It recommends that records of defects, failures and user comments on unsatisfactory features be kept and reviewed regularly by the Client's Commissioning Adviser and the user.

Documentation

The new draft emphasises the need for the preparation of suitable documentation designed to assist in seeing that commissioning is properly carried out. It recommends that the Designer and Client's Commissioning Adviser discuss the form in which checks, tests and inspections carried out by the Contactor are to be recorded. Written records of measurements and details of settings which should be provided by the Contractor are matters to be specified by the Designer in the Contract specification.

The Contractor's Commissioning Engineer may expect to have from the Designer such descriptive matter as is necessary to assist in understanding the commissioning requirements and in planning his work. It is suggested that this information may include such things as flow and line diagrams and descriptions of the working installations. This information, together with Contract records and as fitted drawings, are valuable sources of information to the user's engineer when he takes up his responsibility for maintaining and operating installations.

If users are to have installations which are satisfactory to them it is essential that they should have full information on the safe operation and maintenance of the installations. It is recommended that the Health Authority's Commissioning Adviser ought to satisfy himself that arrangements have been made for the supply, under the Contract or otherwise, for the preparation of the necessary technical information.

Finally the commissioning manuals which were issued as supplements to the original *HTM* are now out of print and will be withdrawn; they will be replaced by revised and up-dated versions after discussion with Health Service colleagues.

Conclusion

The revised document has the same aim as its predecessor — to ensure the provision of installations which are satisfactory to the user and which meet the specified requirements. It differs from the earlier document by seeking to emphasise the creative role of the designer and to separate his responsibilities from those of the Contractor and site staff who are involved in translating the design into an installation in accordance with the Contract conditions. It stresses that the Client's Commissioning Adviser, although having an advisory and monitorial function, has an important part to play in achieving the desired conclusion to the project. It also tries to set commissioning in the correct position in the sequence of events, from design inception to completion of the project, and to relate this to the contract stages.

The new document does not set out in detail how the commissioning is to be done nor what specific checks and tests are to be performed. The earlier *HTM* provided much information on this, and it was taken up in the Supplementary Manuals. It is felt that today a good deal of experience has been gained throughout the building services industry of what is required to produce a satisfactory engineering installation, and procedures have been developed to assist in obtaining this. Designers, with encouragement from client authorities, are capable of drawing upon published commissioning documents and selecting appropriate details for specific projects. Contractors now frequently employ experienced commissioning agents who understand the process of commissioning and acceptance testing and have a high degree of professional competence. What the new *HTM* is seeking to do is to build upon expert knowledge and experience, and to convince client authorities that commissioning is part of the normal project procedure which when properly arranged has an important part to play in securing installations which are satisfactory in use and which can be maintained properly.

Mr. Potter is Senior Consultant to William Holder & Partners, Engineering Management & Personnel Consultants. His is the last paper given at the Institute's June 1977 Symposium on Commissioning Building Services in Hospitals.

Handover - Maintenance and Operation

DENNIS G POTTER MI NucE

Introduction

Previous speakers have concentrated on the Designer, and on the construction and commissioning of a new hospital undertaking. These ideas lead to obtaining the best possible in a construction undertaking — furthermore, they are set on ensuring that the next design generation is improved by the result of feedback. Their views, and the expressions given are important, and some points have a direct bearing on the subject of this paper.

There *is* a distinct change in considerations at the handover stage. We have to consider that the hospital is being put into immediate use to meet an ongoing medical need. The adoption of the new hospital brings responsibility for its patients, personnel employed, and custodianship of what represents a substantial capital investment.

The points I will be discussing are:

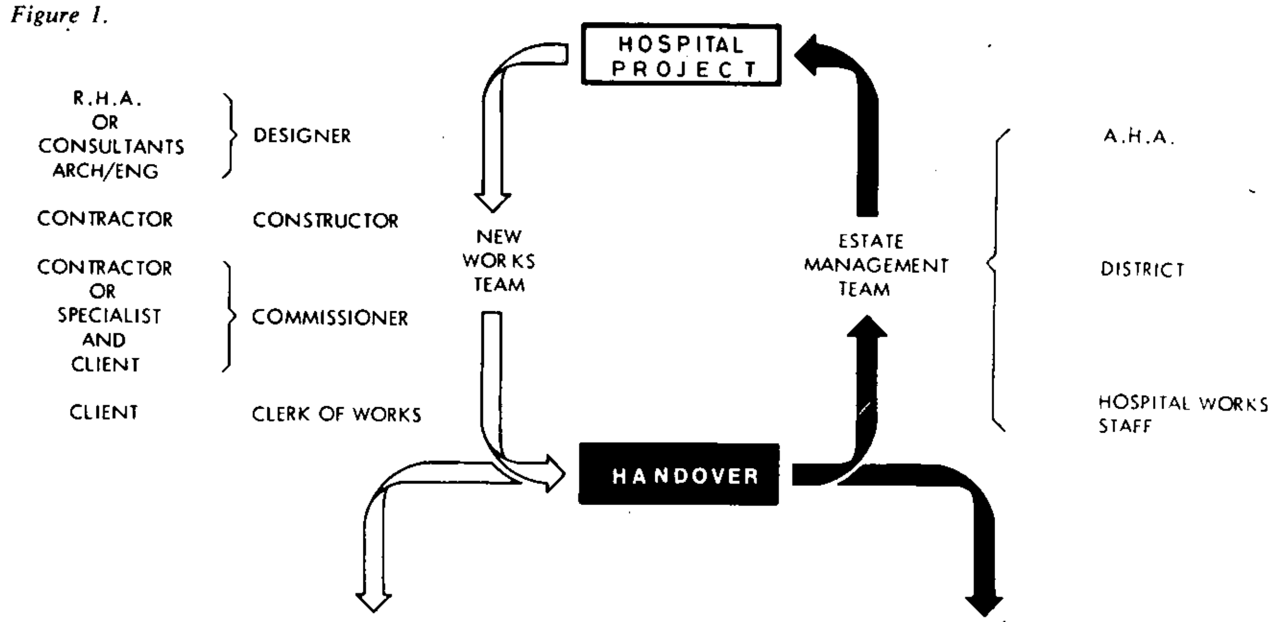
Primary function of a new hospital works department
Information required and its source
Timing of related activities
Presentation of information
Preparation by the works department for handover
Client staff (works department) training.

These points are centred on the aspect of engineering services.

Primary function of hospital works department

Figure 1 demonstrates that handover is a notable milestone in the process of providing a new hospital. The principal participants in this formal process are the Project Architect and Main Contractor. The most significant fact about the handover is that the responsibility for the building project passes from the Main Contractor to the Area and District Health Officers. From this point on, whatever happens within the hospital and the demands made on it, District and Area have a full responsibility for the outcome. You will all agree that a building does not become a hospital until it is treating patients. In the engineering sense, those most directly related to serving the patient are the hospital works staff. Hospital works staff must be of the highest quality and the ideas I am about to put forward are in no way a substitute for this. It is essential that the hospital works staff are equipped to provide this service efficiently from the time of handover. To this end every engineering organisation or authority, being representative of the various disciplines in the design,

Figure 1.



	ACTIVITY		ACTIVITY
PERIOD:	2 to 5 years.	PERIOD:	Handover through planned life of hospital.
RATE:	Gradual build-up with peak of engineering activity on approach to handover.	RATE:	Peak occurring at handover diminishing over three years to normal work load.
CONSTRAINTS:	Time to assimilate facts and conditions. No occupation or patient dependency.	CONSTRAINTS:	Time to assimilate project knowledge and provide full operational capability — zero. Occupational dependency immediate. Patient dependency imminent.

construction and commissioning of a new' hospital must be involved in seeing that this takes place. Let us consider the main works tasks in taking over and serving a new hospital.

1. Acquire knowledge of the engineering services installed
2. Derive a works operational policy in accordance with the needs of the hospital
3. Assess and obtain the staff to fulfil this policy
4. Produce job briefs and terms of reference
5. Train staff on the design, the operation and the job briefs, for the services
6. Provide plant operational policy and instruction — safety
7. Assess maintenance requirements with establishment of a planned maintenance system
8. Quantify maintenance support requirements, i.e., stores, spares, tools and equipment

The list is a simple and obvious one. It is probably incomplete but nevertheless illustrates a formidable workload, bearing in mind that from the moment of handover there is an undertaking of immediate responsibility for the operational demand and its inherent reliability and safety requirements.

If the works department were devoid of all information relating to the hospital, which, of course, it never is, it would not be impossible to reach optimum operational performance with safety, but it would take a very long time.

The problem to be resolved therefore is, WHAT and WHERE FROM information is to be provided and of course WHEN, in order that the works department can suitably prepare themselves so that the point of optimum operational performance is closest to the point of handover.

Information required and source

First let us consider the information required and its possible source: Area Health Authority and District need to know the sort of hospital being undertaken: its type and size: the medical services being provided, and in broad terms the engineering services being installed. This information is known by those involved in the project development and is essentially firm by completion of design. In my opinion this information is adequate for assessing supervisory staff requirements down to foreman level.

The works staff, and, of course, the Area and District Officers, require detailed information on the design of the services installed. The source of this information is; of course, from the designer, and is best presented in the form of a Design Concept or Design Intent document. They will also require detailed particulars of the individual plant items installed, the source of which is from the manufacturers via the contractor. I also consider it important that information obtained from construction and commissioning tests, over and above statutory tests, be provided. The source of this information would come from Clerk of Works and Commissioning Personnel. Finally, still under the heading of information requirements, there is a need for information on the operation of the plant — again its source must stem from the designer.

Although I state the source of the information, it is *not* meant to imply that the preparation and form of presentation is necessarily carried out by them. For many reasons, it may be advantageous for the information to be prepared by other specialists but I do consider that the final documents receive the seal of approval from the source of origin.

Figure 2. **Information Related to Works Activity**

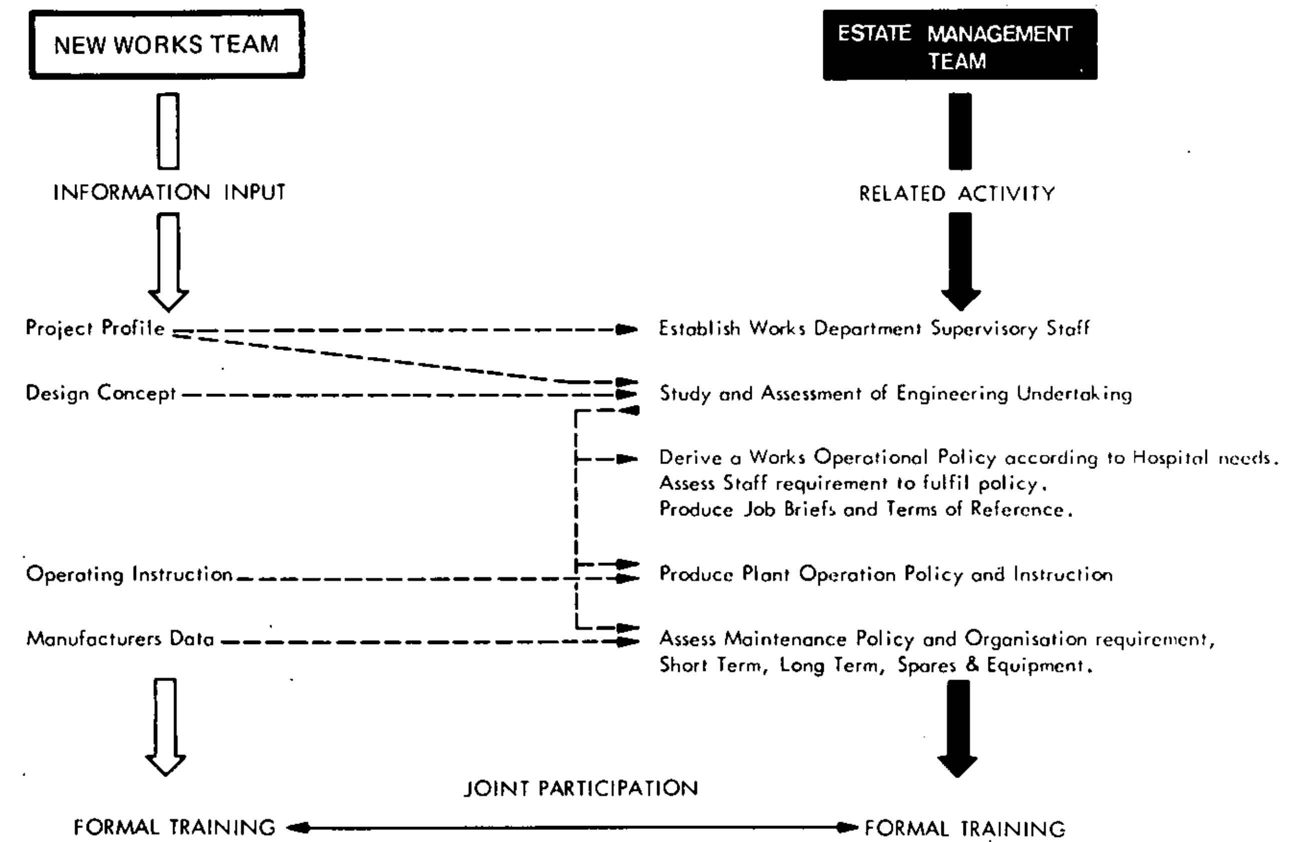
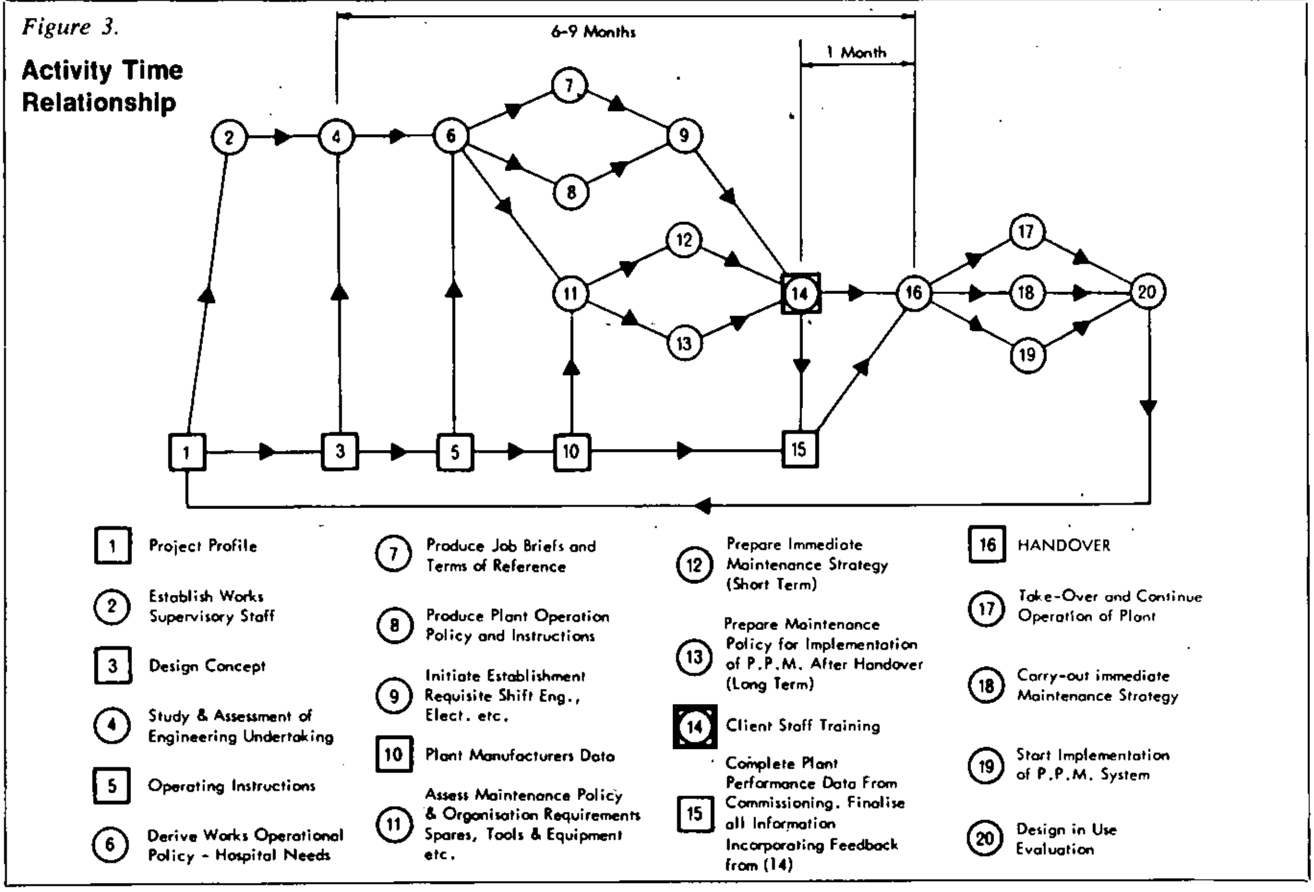


Figure 3.
Activity Time Relationship



Armed with the various types of information just mentioned, it remains to discuss the content and form of presentation to ensure that it will be of maximum benefit, which I will discuss later. It is more important at this stage of the discussion to consider the timing.

Time of related activities

In an industry of high technology, for example the power industry, you will not be surprised to learn that senior operation and maintenance staff are in post some three years before commissioning and handover. The operation and maintenance work is, of course, more complex than that met in hospitals, and during this pre-handover period they are heavily engaged in planning and preparation to meet these demands.

Hospitals are becoming very sophisticated in services design and control, but are tied to older traditions stemming from the plumbing and building trades. It therefore follows that changes should be made in the terms of contract and specification, placed on the contractor, to meet this new sophistication. In drawing some parallel with the practice of the power industry, you will see from *Figures 2* and *3* that I am suggesting that supervisory staff take up appointments approximately six to nine months before handover. For this to be a viable proposition, provision must be made to ensure that availability of the design concept document is coincident, also that it is closely followed by the issue of operating instructions and the engineering services data. To ensure this happens, stringent contract requirements must be given, possibly carrying some penalty clause.

The other time constraint I have introduced is that of client staff 'training/instruction' which is placed one month before handover. The remaining activities, i.e., 5-13 will be achieved within the intervening period, the actual time of each will be dependent upon the assessment on the work involved. The analysis depicts an ideal situation which I accept is not likely to occur in practice, delay in contract completion or availability of information, presents a different situation. However, by institution of the foregoing concept a far better start to the hospital is the prize.

Presentation of information

I would now like to talk in some detail about preparation and presentation of information.

Typical list of systems

Figure 4 shows a typical list of engineering services in a modern large hospital. Time does not permit an examination of each so we will take only one, as appropriate, to illustrate the various points. However, in practice each of these must be suitably covered in each of the documents we are considering.

Figure 4.

List of Engineering Services

1. Electrical installations
2. Alarms and controls
3. Communications
4. Lifts and hoists
5. Hot and cold rooms
6. Steam and condense
7. Heating
8. Hot and cold water services
9. Industrial gases
10. Medical gases
11. Fire service systems
12. Air conditioning and ventilation
13. Chilled water
14. Sewerage and drainage

Design concept

As previously outlined, this document is to impart to the works department information about the design and performance of the engineering services. The reading matter should be kept as short as possible but not omitting any salient points and should be given in terms acceptable to an engineer. The information should basically give:

Scope of system
Plants installed
Design features
Outputs from system
Demand loads on system
Characteristic details of plant items

It can be seen from *Figures 5* to *8* and associated text that if this detailed approach was made to each of the engineering systems installed, the hospital engineer and his staff would have a rapid appreciation of the plant they are managing. In emergency or an extraordinary situation, quick and easy reference is available, offering the best facility for sound judgement and safety.

Operating instructions

You would have gathered from what I have said earlier that I am propos-

Text continued on page 16

Figure 5.

Air Conditioning and Ventilation

Design Concept Contents

INTRODUCTION
1. SCOPE AND RATING
2. DESIGN FEATURES
3. EQUIPMENT DESCRIPTION
3.1. SUPPLY
3.1.1. Air Filtration Equipment
3.1.2. Air Motivation Equipment
3.1.3. Air Heater Batteries
3.1.4. Air Cooler Batteries
3.1.5. Air Humidifying Equipment
3.1.6. Ductwork
3.1.7. Dampers
3.1.8. Diffusers and Grilles
3.2. CHILLED WATER
3.2.1. Chiller Units
3.2.2. Ancillary Equipment
3.3. EXTRACT
3.3.1. Extract Grilles and Diffusers
3.3.2. Ductwork and Fittings
3.3.3. Extract Air Motivation Equipment
4. CONTROLS
5. PLANT SCHEMATIC DRAWING

Design internal Conditions

Figure 6.

Area served	*Plant No.*	*Location*	*Duty m³/sec*	*Design Conditions* Summer °C DB	Summer °C WB	Winter °C DB	Winter °C WB	% RH
X-Ray, Operations, Consultants' and Typing Rooms and First-floor Rooms	1	PR No. 2	3.662	23	17	21	16	54
X-Ray, Diagnostic Rooms 1-4 and Associated Areas	2	PR No. 2	1.335	21	16	21	16	54
Medical Photography and Respiratory Physiology	3	PR No. 2	2.029	23	17	21	16	54

1. SCOPE AND RATING

The design of the air conditioning and ventilation systems within the development is such as to give the environmental conditions in the areas given below when the external conditions are.

Summer	27°C DB	20°C WB
Winter	−2°C DB	−2°C WB

2. DESIGN FEATURES

Generally air conditioning and ventilation systems are of the single duct recirculation type consisting of inlet louvre, fog heater, auto-roll filter, fan, main filter (panel type), main heater, cooler battery and humidifier together with an extract fan, fresh air damper, extract air damper and recirculation damper.

Plant No. 3 is a full fresh air system due to the high heat gains of installed equipment and consists of inlet louvre, fog heater, auto-roll filter, fan, main filter (panel type), main heater battery, cooler battery and humidifier. The associated extract system is augmented by local roof extract units for use during occupation.

When the plants are operating at the design full load conditions the total energy required is given in *Figure 7* below:

3. EQUIPMENT DESCRIPTION

3.1. SUPPLY

Equipment is provided to filter, motivate, heat or cool, humidify or dehumidify air to give the environmental conditions as indicated in Section 1 above.

The conditioned air is distributed throughout the relevant areas by means of ductwork and delivered to the occupied areas by means of variable delivery supply diffusers (manually preset).

3.1.1. AIR FILTRATION EQUIPMENT

Air for ventilation is filtered in stages. Primary filtration is by automatic roll filters and secondary filtration is achieved by bag filter units.

(i) Automatic Roll Filters

Fresh air for ventilation is filtered by means of automatic roll type filters. The filter media has a clear gravometric efficiency of 93-95% when tested to BS 2831 using test dust No. 2. The average normal working air resistances with a dirty filter is 112 N/m (0.45in wg). Each filter is fitted with the following:

a. Media advance motor / gearbox assembly, controlled by a pressure differential switch set to advance the media when the pressure differential across the filter attains 125 N/m (0.5in wg) and stop the filter when the pressure falls to 100 N/m (0.4in wg).

b. End of roll alarm switch, operating a warning light on the control panel to indicate when the filter-media roll is nearing completion.

c. A manometer to give visual indication of media condition. The manometer is of the inclined type with a range of 0 to 250 N/m (0 to 1in wg) with divisions of 5 N/m (0.02in wg).

4. CONTROLS

Each plant is fitted with a control system to automatically control the operation to give the correct environmental conditions and to cater for excess heat gains by the occupied building. The control system provided for each plant is given below together with a schedule of all control devices.

Air Conditioning Plant No. 1
Start and Stop Plant

The time switch operates automatically between 9 am and 5 pm. If the start push button is operated between these hours the plant will start and run until 5 pm when it will stop automatically. If the start push button is operated between 5 pm and 9 am the plant will run for a period of up to one hour by means of an adjustable timer. The plant may be stopped at any time by means of the stop push button.

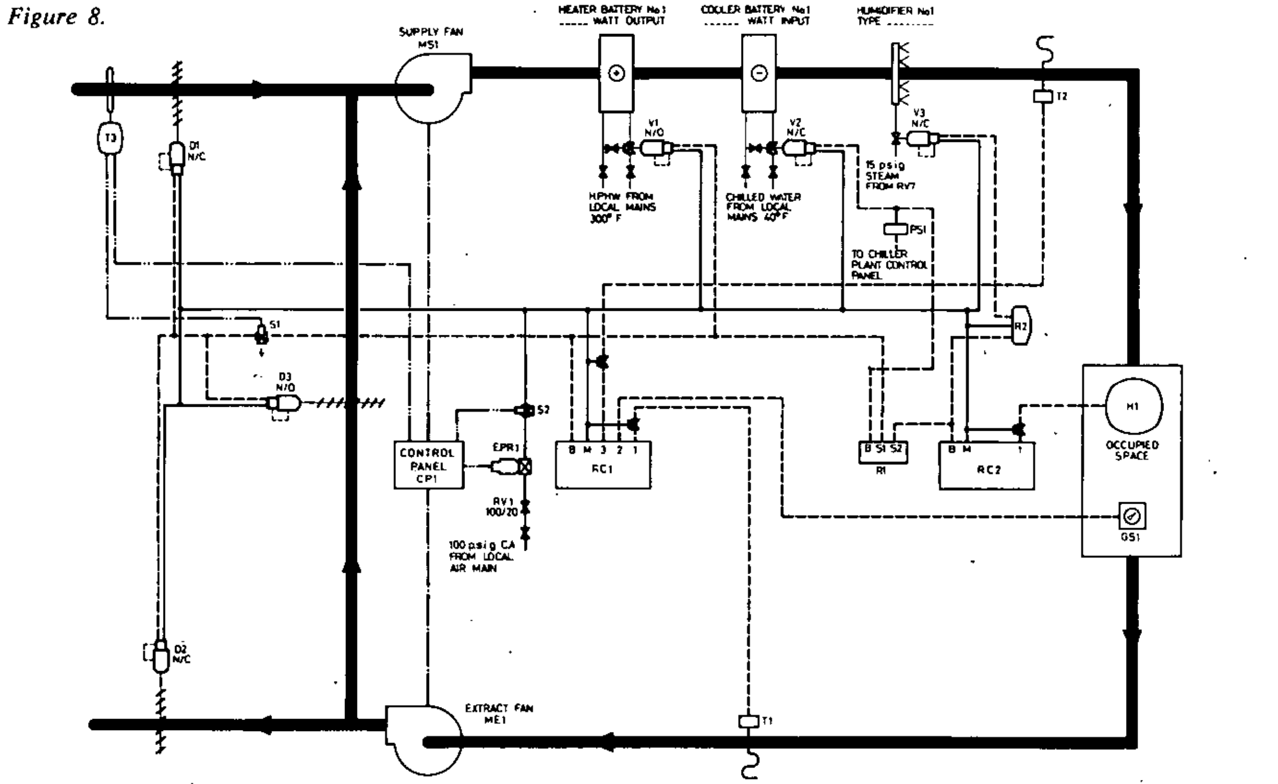
The stop and start push buttons are in the Control Unit in the X-Ray Superintendent's Office and the time switch and timer are in the Control Panel supplied by the Control Panel manufacturer.

Figure 7.

Plant No.	*Electrical Load*	*Heating Load*	*Cooling Load*	*Steam Humidifier*
1	5.5 kw	176 kw	43 kw	.025 kg/sec
2	2.5 kw	64 kw	12 kw	.007 kg/sec
3	3.7 kw	97 kw	15 kw	.009 kg/sec

Schematic Diagram of Single Duct Air Conditioning System with Recirculation AC Plant I

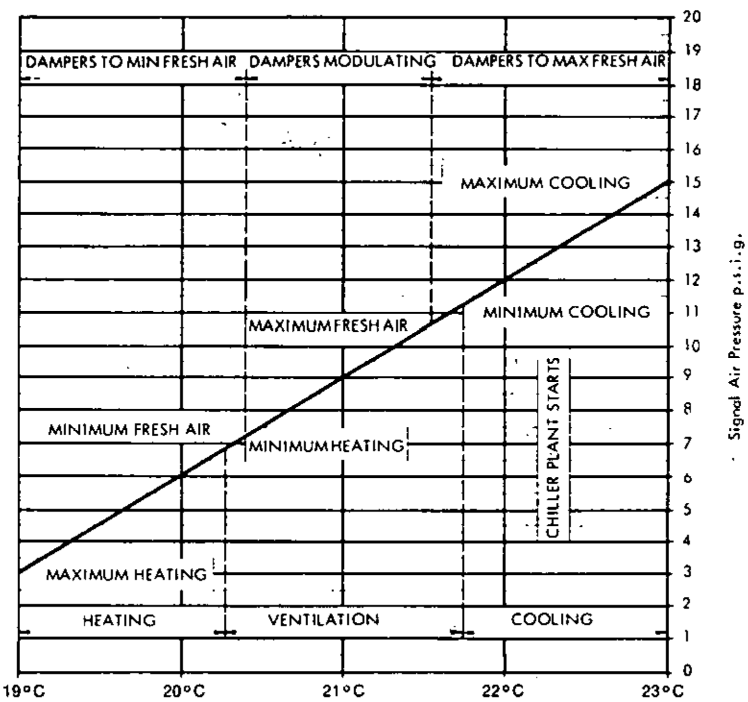
Figure 8.



D1, D2	NORMALLY OPEN PNEUMATIC DAMPERS WITH POSITIONERS
D3 3	NORMALLY CLOSED PNEUMATIC DAMPERS WITH POSITIONER
V1	NORMALLY OPEN PNEUMATIC VALVE WITH POSITIONER
V2, V3	NORMALLY CLOSED PNEUMATIC VALVE WITH POSITIONER
RC1, RC2	PNEUMATIC RECEIVER CONTROLLERS
R1	PNEUMATIC REVERSING RELAY
R2	MAXIMUM PRESSURE SELECTING RELAY
T1, T2	PNEUMATIC TEMPERATURE TRANSMITTER
T3	ELECTRIC THERMOSTAT (DUCT MOUNTING)
H1	ROOM HUMIDITY TRANSMITTER
GS1	REMOTE GRADUAL SWITCH
S1, S2	VENTING SOLENOID VALVE
EPR1	ELECTRO PNEUMATIC RELAY
PS1	PRESSURE SWITCH
RV1	PNEUMATIC PRESSURE REDUCING VALVE

Control Diagram

GRAPH OF CONTROLLER SIGNAL AIR PRESSURE PLOTTED AGAINST EXTRACT DUCT AIR TEMPERATURE WITH REMOTE GRADUAL SWITCH SET AT CENTRE POSITION & LOW LIMIT SET TO LOWEST WITH POSITION OF ACTUATORS AND PLANT CONDITIONS SHOWN



ing that operating instructions emanate from the designer. In the knowledge of the Health and Safety at Works etc. Act, somebody, I anticipate, is probably questioning this point. An Area Health Officer once suggested to me that it should be the Contractor who produced these instructions. On the other hand, the District and Hospital Engineer have the first responsibility for operational safety and maybe they only should produce these instructions? Time, however, is not on the side of the Hospital Engineer, therefore any assistance given would enhance safety. The Designer holds all the facts on his design and intended mode of operation, so I argue from a practical standpoint, that the instructions should be produced under his seal of approval. There are limitations on the Designer in this task and that is the possible permutation of prevailing operating conditions that could arise, due, for example, to partial shut down, or extension of services. It follows that there must be some standpoint from which the instructions are based — this I suggest is a normal sequential start-up and shut-down procedure of any system. This should be written without any preferential mode or procedure of the Hospital Engineer. In itself it is a good starting point for the Hospital Engineer, which has not been common past practice. The Hospital Engineer must now take these instructions in a responsible manner and satisfy himself that they comply with safety requirements. He can then, as he thinks fit, modify to suit his operational requirements.

Engineering services data library

The data library is essentially a collation of all the various individual items of information supplied by the manufacturers and suppliers. The works department is very dependent on this information for maintenance purposes, and to this end parts lists are essential. It is also important that the information is bound and indexed, to ensure that, in the first instance, no information is missing or is lost when being transferred to the works department, and secondly, to give due importance to the information it contains.

I have found in the past that Contractors treat the importance of the supply of this information lightly. They will, I fear, supply as little as possible, and at its best it is often inadequate. A big step in improving this situation is firstly in the writing of the specification and secondly, in the close monitoring of its supply. Specifications often simply call for operating and maintenance instructions. This is inadequate, and I would suggest the following is a minimum requirement, written into a specification, for all items purchased:

1. Description of items supplied with performance details and model number
2. Operating instructions for packaged units
3. Operating conditions and constraints for non-packaged units
4. Maintenance recommendations
5. Type test/performance curves (where specific test curves have not been requested)
6. Parts lists and recommended spares (where parts are replaceable)
7. Drawings or other suitable pictorial illustrations

The above to be supplied as appropriate for all machines and operational components to the satisfaction of the Engineer. It must be made available for approval nine months before the planned handover.

Data library

The photograph on the front cover of this issue shows a typical data library. The contents should be compiled to some logical pattern, and I have found system basis to be the most practical. The library can also house a copy of the design concept and operating instructions. It should most certainly contain copies of statutory test certificates and test data from the commissioning work.

Preparation by the works department

It is totally impractical to assume that a Hospital Works Department can receive at handover, a sizeable hospital engineering services network, and be able to function instantly in the most competent manner, *without* the main work force being fully acquainted with its design and operation. Their prime function is to operate and maintain these services. Before they can fulfil this function they must go through a process of familiarisation and preparation, which, depending on the size and complexity of the installation, I have suggested requires a period of six to nine months. During the first five months of this period, under the direction of the Hospital Engineer, they study the Design Concept, Operating Instructions and Services Data Library. They must be given access to the site in order to relate this information to the actual installation. Armed with the knowledge they have acquired they can:

1. Draw up a list of matters requiring clarification to be raised at the client staff training session
2. Develop their organisation structure and staff requirements
3. Produce job briefs
4. Draw up plant operating instructions, permit to work system and any other aspects regarding safe reliable operation
5. Produce spares lists and initial order requirements. Also tools and equipment that can be foreseen as being a requirement
6. Develop an immediate maintenance strategy, to be implemented on handover
7. Outline their planned preventive maintenance system requirements and policy in preparation for its development and installation after handover.

Some authorities, I have found, often propose seconding a few works staff to the construction and commissioning teams to enable them to become acquainted with the plant. Although this offers certain benefits it is limiting in comparison with the degree of preparation I am proposing.

It is essential to appreciate that those engaged in the foregoing preparation exercise must be detached from any other existing hospital activity. It must also be conducted with good management control with clearly defined objectives.

The first five points require no further explanation, the outcome being strictly a matter of local management policy, in terms of the project in hand.

Immediate maintenance strategy

It will be some time after handover that a full planned preventive maintenance system can be functioning. Also there are two facts not to be overlooked:

1. The plant has more than likely been operating for some time prior to handover. The hospital has no guarantee or evidence to the contrary that the contractor has adequately maintained during this period
2. A successful claim under the 'defects liability' clause is dependent on the hospital effectively maintaining the plant.

It would therefore be prudent to draw up a maintenance check list to an intensive programme in order to ensure that:

a. all machinery is lubricated;
b. filters, strainers and other such media are satisfactory;
c. where possible principal electrical terminations are secure to reduce risk of fire;
d. there are regular frequent visual inspections noting functional defects;
e. defects found are evaluated as to whether they are a result of a defective item supplied, of faulty adjustment or of poor maintenance. Depending on the outcome the appropriate action should be taken.

Planned preventive maintenance

The establishment of an effective Planned Preventive Maintenance system is the only way whereby it is possible to ensure reliability of the engineering services, to provide adequate protection offering optimum life of the capital investment, and to have a reasonable measure of control on maintenance demands. The accepted definition of Planned Preventive Maintenance is 'Maintenance work carried out with forethought, records and control', but if it were also considered as a means of communicating to the work force the Engineer's requirements, then I think many PPM systems would become more effective.

Used as a means of communication, the foremost function of the system should be to instruct the tradesmen, in definitive terms, of the maintenance tasks that must be carried out on each item of plant installed. Each instruction must reflect the Engineer's judgement, for which he would have considered the degree of dependency, working conditions, cost of replacement, manufacturers' recommendations, safety of personnel and statutory requirements given in various Acts of Parliament.

It therefore follows that instructions issued must be considered and tailored to a particular item of plant. The issuing of generalised instructions, whereby the tradesman has to judge for himself the requirement of a particular task, is not good practice. The reason is simple — it is because he (the tradesman) does not have all the relevant facts to make this judgement.

Defining the tasks to be carried out in the form of an instruction should not impinge on the expected skills of a craftsman within his trade.

Having defined the job tasks, the remaining activities in establishing a PPM system, *although requiring skill and experience*, are a straightforward process. Having surveyed the installation on a unit basis, times can be allocated for the tasks defined. With the plant, task and time defined, it then follows that the whole can be planned on an annual and multi-year basis.

PPM systems must be kept as simple and effective as the need demands. There is a danger of creating unnecessary paper, which is not only costly to produce, but alienates the work force and destroys the will to meet the main objective. Data feedback to management is necessary to a degree, but should be a secondary function of PPM. It is obviously of greater importance that effort should be given to ensuring that the requisite maintenance work is *properly directed* rather than concentrating on feedback systems.

Similarly, mechanical sorting devices and computers can be an aide in management but should not be allowed to deflect from the objective.

With the available skills to hand it is possible to install a PPM system, meeting the aforementioned requirements, into a hospital within six months.

Client staff (works department) training

It is an obvious requirement that, with all the preparation that has taken place both by the new works team in the supply of information, and by the Estate Management in its assimilation and other activities, the two should come together for the purpose of consolidating this knowledge.

Therefore I propose that one month before handover a formal training programme is established. These train-sessions will enable the two groups to clarify various technical ambiguities which would have come to light during the earlier preparation stages.

Training programme

Figure 9 shows how a training programme could be arranged and issued in advance in order that personnel attending are prepared to obtain maximum benefit.

Once a formal training session is established it is surprising how many people outside the works department want to join in. Too broad an interest will defeat the principal objectives, therefore attendance should be limited to works department only.

Figure 10 shows the principle lines of training and communication which I feel should be followed, and would more than likely satisfy the Health and Safety at Work etc. Acts.

Summary

To meet the fundamental purpose of serving the patient in a new hospital, I have suggested that attention be focused on setting up the new works department's establishment to meet the engineering needs of the hospital. Senior members of the department should be in post and located on the site, at some sensible period before handover — their function to prepare themselves by working to a precise list of objectives leading to self-sufficiency by the time handover occurs. Their success is dependent upon the documentation associated with the project being released through the contract in advance of handover. The information should be well prepared, bearing in mind the short time available for its assessment. Finally, the whole pre-handover preparation exercise should culminate with a formal training session at which the participants are the principals of the new works team and the hospital works department.

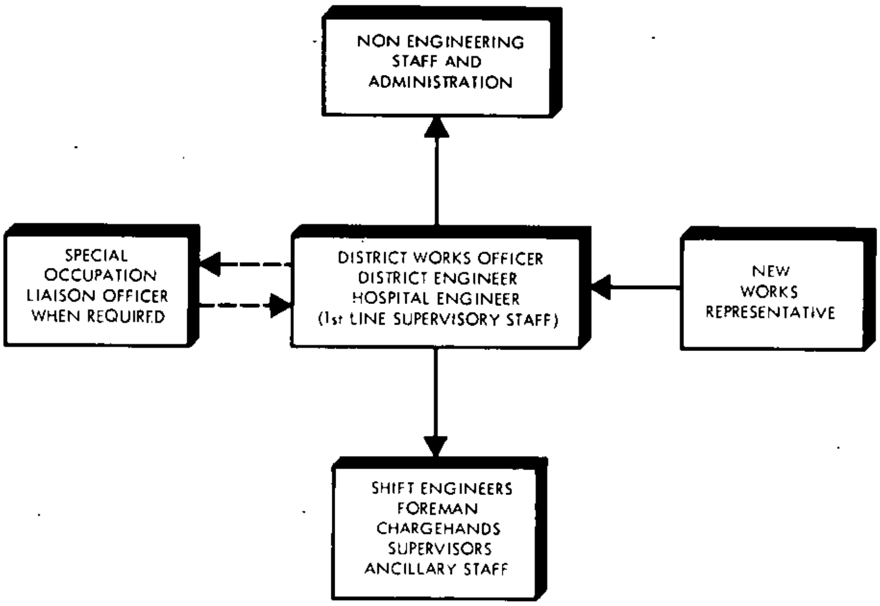
Figure 9.

Training Programme

	DAY 1 MONDAY	DAY 2 TUESDAY	DAY 3 THURSDAY	DAY 4 FRIDAY	DAY 5 WEDNESDAY
MORNING	(1) General Introduction Site Layout Primary Services a. Power b. Water c. Gas d. Sewage	(3) Electrical Services a. High Voltage b. Medium Voltage c. Final Distribution	(8) Piped Services a. Steam b. Heating c. Hot and Cold Water	(9) Air Conditioning (10) Fume Cupboards	(12) Sewage and Drainage
AFTERNOON	(2) Design Concepts a. Electrical b. Piped Services c. Sewage and Drainage d. Air Conditioning	(4) Alarms and Controls (5) Communications (6) Lifts (7) Hot and Cold Rooms	d. Industrial Gases e. Medical Gases f. Fire Services	(11) Chilled Water	(13) Summary and Completion

Figure 10.

Training Responsibility



Electronic Equipment for Health Services

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Jan Thorp has particularly taken active part in safety measures and international standardisation of hospital equipment. His paper was read at the 20th International Hospital Congress in Tokyo in May 1977.

Economic Considerations in Choosing Electronic Equipment

JAN THORP, IFHE Council member for Sweden

An explosive expansion

There is probably no branch of industry that has had such an explosive expansion as electronics. Industrial countries commit immense sums of money to research and development and this, among other things, will exert a tremendous selling pressure on consumers.

Caution – rapid development gives economic problems

It is evident that rapid changes occur where electronics are involved — an electronic device can be impossible to make one year, trivial next year and dead the following year. This makes it necessary for the consumer to be cautious with his buying decisions and to look out for rapid changes in technological development.

End result – the benefit for the patient

A basis for economic considerations in health care is the assessment of the functioning of the product but also the end result when using the product. This end result is first of all the benefit for the patient. From this point of view considerations on electronic equipment cannot be handled differently to considerations on other technologies such as fluidics, hydraulics, pneumatics, etc.

Electronic equipment in hospitals

Electronic equipment for health services can be divided into:

equipment for general technical use;
equipment interacting with the patient.

The first category does not differ very much from the conditions within industry. The economic considerations in this case can be dealt with rather easily. But industrial economics are not sufficient when the patient — the consumer — is a part of the production process itself.

Industrial influence

Health care is strongly influenced by the rest of society. This is true also when it comes to the application of electronic equipment. In a society where electronics are widely used in industry, households, military defence, etc., it is natural that electronics are widely used also in, for instance, hospitals. One common denominator in this case is electronic equipment as a rationalisation tool. And I would like to stress that point a bit further, for rationalisation has a great deal to do with economics.

Electronic equipment in industry has made it possible to automate the working processes to such an extent that we are speaking of a second industrial revolution — the first being the start of the mechanical era.

The corner stones of automation are control techniques and measuring techniques. Both of these techniques are widely used also in health services everywhere.

The industrialisation of production has had an immense impact on human working conditions. One implication has been the separation of the intellectual parts of the work from the manual, reducing the worker to a sort of physiological machine. At present, however, there is a tendency in industry seriously to question the principles of traditional production organisation. Efforts are made to create new forms of work organisation in highly automated factories. The principal aim is to involve the workers in the creative parts of the work and to give them more independence and responsibility. A radical approach is to state the desirable social effects, as well as the technical and economic requirements, and then to develop the technology and its application to meet also the demands from the social system.

From what is now said it is evident that if we in health services consider making use of sophisticated electronic equipment on a large scale we have much to learn from industry regarding technology and application methods. A step in this direction is mirrored in the definition of the aim of rationalisation work in Swedish health care which, according to an agreement between employers and employees, is not only increased efficiency, the most common definition, but also work satisfaction, good working environment and employment security.

> Rationalisation — increased efficiency — work satisfaction — good working environment — employment security

Health Services should certainly try to make use of all these new ideas for the patient's benefit and to relieve the staff from heavy, risky and dirty work, and also to make the work meaningful and stimulating.

The meaning of efficiency and productivity in health care is not easy to define, especially if you want to express it in economic terms that are generally acceptable. A simple definition is hard to achieve and a complicated one difficult to use.

Economics

High productivity does not always lead to increased efficiency. An automatic chemical analyser can produce a lot of analyses at a low cost. But its usefulness may be small compared to the cost if only a few of the results are used in a meaningful diagnostic or therapeutic way. Thus the efficiency is low in spite of high productivity.

The two main causes of economic problems are the following: First we have **limited resources** and secondly there **is always alternative use of resources.** There will always be questions of priority with such questions as: Which group of diseases should be dealt with in the first place? Safer monitoring equipment in the intensive care wards or wheelchairs for the aged patients? How much equipment do you really need for your clinic — and which parts of your request can you do without?

When a manufacturer considers buying a new machine he makes investment calculations based on well known theories and on practice. He evaluates expected productivity, and costs such as purchase price, depreciation, interest, personnel salaries, installation costs as well as costs of operation, maintenance and of spare parts.

When buying hospital equipment, investment decisions, in addition to what is said about the manufacturer's considerations, are also social and political. It is here that a social cost benefit analysis can be relevant.

The aim of this analysis is to find out whether society as a whole gains greater welfare from a particular choice rather than by abstaining from it or from performing just this action rather than some other action. Cost benefit analysis thus considers all socially relevant outcomes and transforms them into monetary terms. The big problem is the calculation of the social benefits. For the time being there seems to be no solution to this calculation problem. Instead **cost-effectiveness** analyses are recommended which do not require that benefits are expressed in monetary terms.

The reason for this recommendation is that when the patient enters the picture, intangible benefits must be considered and these are important in health care — very often most important. This includes for example comfort, kindness, convenience, enjoyment, etc. and also means relief from anxiety, depression, disablement and discomfort, just to mention a few. These intangibles have certain bearings not only on the patient and the staff but also on relatives and friends of the patient.

As practical examples it could be mentioned that we at Spri have taken a look at the new computerised axial tomographs — the head scanner and the total body scanner.

Let us leave the theories and take a few practical examples:

Example 1 – head scanner

We start with the head scanner — the computerised tomograph.

The practical and clinical experiences of the head scanner are well documented and the method is thought to result in direct economic savings. At Spri we have carried out a cost effectiveness study by comparing computerised tomography with the existing techniques of pneumo-encephalography and cerebral angiography for different numbers of examinations. We think it might not be unrealistic to believe that computerised tomography can substitute for about 70% and 50% respectively of the other two methods mentioned. Typical for the head scanner is that the investment costs are rather high while staff costs are very low compared with other methods. Thus the savings that can be made largely depend on the number of examinations. I would like to stress that the savings we have calculated for Sweden are dependent on a co-ordination of the resources for computerised tomography within and between different medical areas.

The figures shown are applicable to most of the relatively big Swedish hospitals. The upper line shows savings of 50,000 Kroner (£1 Sterling = 8.5 Sw Kr) when substituting for example 200 cerebral angiographies and 40 pneumoencephalographies. On both the positive side (savings) and the negative side (costs) you have to add the intangible benefits.

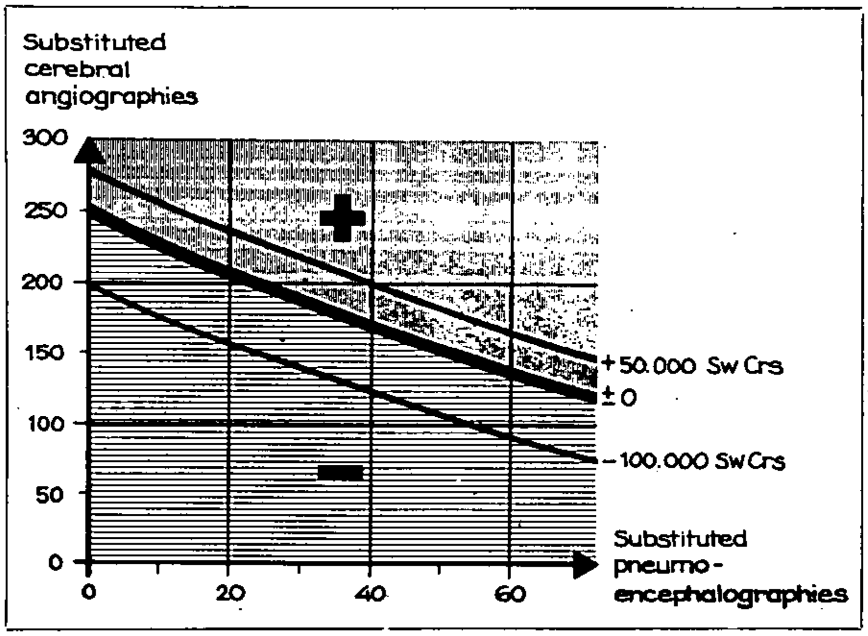
Our report on this study also considers some very important qualitative aspects, which I mentioned before, such as:

- the value of relief from pain, anxiety and fear;
- the value of reduced risks;
- the value of rapid information (for doctors' decisions, and for patients and relatives).

Example 2 – total body scanner

The second example chosen is the total body scanner which emerged a few years ago and has since then been developed very rapidly. The clinical

Figure 1. Savings/costs per year by introducing head scanners.



efficiency of this new technique is still to be proven. The study of such a new device will, of course, imply uncertainties in the clinical and technical application that make precise cost estimates very difficult. The acquisition cost must be spread over the years that the equipment is expected to be in use. The life of such costly new equipment is of special interest.

For the time being we do not know very much either of the economical or of the technical life length of tomography scanners. But we can assume alternative depreciation times.

If we assume 2,500 examinations per year (and eight hours' working day) for a total body scanner installation, the mean cost of an examination will be about 900 Kr at a depreciation time of three years, 700 Kr over five years and 550 over ten years. If we increase the working time per day, the mean cost per examination will, of course, decrease further.

We are dealing here with new medical procedures which require the use of particularly scarce and expensive resources. Assessment of such diagnostic procedures should be done not only in terms of benefits and risks but also from cost effectiveness point of view, including how to allocate the resources, with questions such as "For which examinations should the whole body scanner be used? In which hospitals?"

Example 3 – computer ECG evaluation

The third example is computer ECG evaluation. Economic considerations on the application of computer ECG evaluation show that it is essential to get a picture of the total costs. The ECG reading affects only a fraction of the whole process of the ECG examination. The cost saving by the computer, mainly by reducing the doctor's evaluation time, is about 10% of the total cost and is roughly balanced by the increased equipment cost. The end result for the patient is unchanged. The doctor's working situation is somewhat better. The introduction of alphanumeric displays may imply stress factors if the staff has to work with the monitor continuously for a long period of time. Looking at the whole ECG examination process raised costs for patient electrodes, for instance, can be of a higher order than the gains of the computer evaluation.

Example 4 – cardiac pacemakers

There are many medical electronic devices that perform well-defined tasks. In this case the market generally offers several alternatives. One example of this is the cardiac pacemaker. It is considered to fulfill a well defined function and to offer better and cheaper alternatives than medication and continuous control visits to the hospital.

The price of the pacemaker varies a lot and can be as much as — or even more than — the cost of implantation of the pacemaker including the postoperative care.

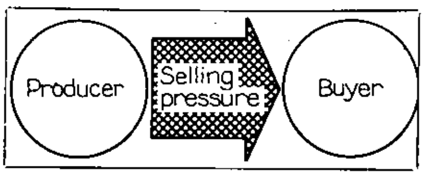
One of the most important requirements of pacemakers is reliability, including guarantees for a given life length of the batteries. A high price for a cardiac pacemaker can be justified because of high testing costs for obtaining this reliability. There is, however, a problem in predicting life length for new products such as pacemakers and batteries — good test methods for accelerated aging are lacking. Thus, accurate and complete test results exist only for old, or even obsolete, types of equipment.

The only way to deal with this problem is to give the buyer the opportunity to estimate the statistical or theoretical data from the manufacturer. He must also be able to evaluate the results of in vitro tests and clinical trials to evaluate the standard of manufacturing. One way to make this possible, and also to get lower prices through bulk ordering, is to buy through a centralised system with expert medical and technical knowledge at disposal.

Further staff costs

All experience shows that if we want to introduce sophisticated technical devices in our hospitals we must pay also for new staff members to ensure that the new devices are properly used and maintained. Furthermore, we must pay for basic technical education, continuous training of and information to the staff regarding the handling and the risks involved in the new methods.

Figure 2. Selling pressure.



The marketing cost of a product is often one of the biggest parts of its price. Of course marketing implies valuable information for the consumer which will increase his chances of making good decisions. In the end the consumer also has to pay for this information. It is big sums of money which we are dealing with here and it would be to the market's advantage if the health services were prepared to take the costs of being competent buyers. A general recommendation in this connection is to avoid special systems and solutions and instead to stick to installations, systems and components conforming to international standard mainly given by IEC (International Electrotechnical Commission) and ISO (International Organisation for Standardisation).

We often find different opinions among our experts when asking for advice in evaluating costly equipment. One reason is that they have different sources of information. Another is that they are sometimes deeply involved in a special system. We must live with these difficulties, and try to separate opinions based on good information from opinions based on different loyalties and personal situations.

Priorities must be set

Electronic equipment gives us very detailed information. But a full understanding of the patient is in danger when technology is placed to the fore. Thus there are physicians who feel that modern equipment places obstacles to communication between them, the patient and the staff. But it is also common that doctors claim that all new technology should be acquired for the benefit of their own particular patients. This is surely understandable and it is hard to argue against them by pointing out that the equipment is costly and might benefit only a very small percentage of all the patients. But priorities must be set and the doctors — together with other users, engineers, economists, etc. — must try to obtain the best and most effective use of the available resources.

I will close by stressing the following points:

The possibilities of
- ☐ electronic equipment
- ☐ cost analyses

The importance of
- ☐ setting priorities
- ☐ education and training
- ☐ maintenance.

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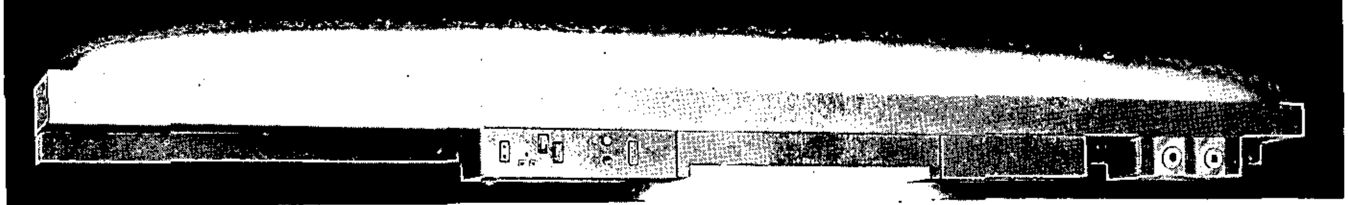

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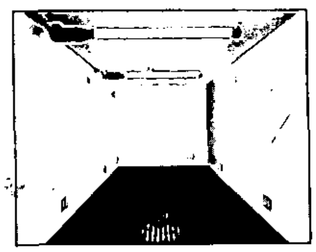

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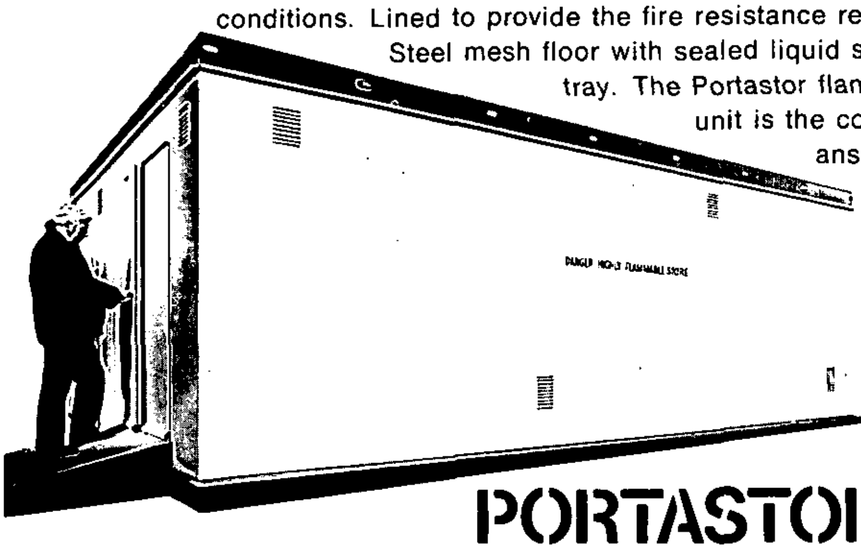

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Medical Hazards of Static Electricity

Dr M O OLEKA, Department of Biomedical Engineering, College of Medicine of the University of Lagos, Surulere, Lagos, Nigeria

Introduction

Sometimes it is necessary to have doubts as to whether the death of a patient is purely as a result of the complaints or causes which brought him to a hospital, or due to other reasons. It is rather unfortunate and equally distressing to realise that certain factors that have contributed immensely in saving lives for us pose at the same time a threat to life. With particular reference to the medical field, where the use of electricity and electronic devices has assumed a noticeable role in certain curative procedures, this good friend of ours, electricity, could become an enemy if not handled and watched with care.

This paper discusses static electricity briefly, and covers some of its peculiar medical hazards. Some suggested precautionary measures are given.

Creation of static electricity

Static electricity is the result of mutual transfer of static charges between two materials, originally in contact, when both are separated. Due to the inbalance of interatomic forces across the interface of the objects in contact, electrons tend to wander from substances of higher to lower dielectric constant through the several contacting points situated between the two objects in contact.

In a case where the objects are insulators, and electrons have migrated to one of them, it acquires a negative electrification during any process of separating, since the wandering electrons are firmly entrapped on the surface, while the surface of the other object acquires a positive electrification. The speed with which these surfaces are separated account for how many electrons are entrapped and, of course, in turn for the degree of electrification, since the electrification of substances is increased by rapid separation.

Static charges can also accumulate on other conductive objects or even persons, where such objects or persons approach an already electrostatically charged body. Two electrified surfaces in contact then act like a capacitor, the voltage between them increasing with distance of separation. Differences in potential of magnitudes as high as a hundred thousand volts between the separating surfaces can develop as a result but fail, however, to assume infinite proportions because of charge conduction leakage and ionisation loss of charge. If one such electrified surface comes close enough to a grounded conductor it is possible for an electrostatic spark to occur through induction.

Dangers of static accumulation

With particular attention to the hospital, the chief problem of static accumulation of electricity is the hazard of fire and explosion. A spot within the hospital where this kind of danger is most likely is in the operating theatre because of the highly inflammable anæsthetics normally in use.

The danger here is so emphasised because electrostatic sparks resulting from electricity discharged from one object to another through the atmosphere can ignite the vapours of inflammable anæsthetics, pure oxygen mixtures and other gases. Moreover, the ease with which electrostatic discharge in general or electrostatic sparks of ignition intensity can be created, say in an operating theatre, gives cause for alarm.[1]

The following ways are possible:

1. by simply walking across a carpet on a dry day;
2. by rapidly removing a sheet from an operating table;
3. by handling a rubber tube or rebreathing bag; or
4. by an unintentional rubbing contact of the nurse's/doctor's overall of silk or other synthetic material on any conducting surface.

In a case where a spark is created, depending on its intensity, an explosion which can lead to a disastrous conflagration can be the sad result — worst of all if in an operation room, where a patient under the influence of anæsthetics cannot get up to flee to safety. Moreover, the lives of doctors and other para-medical staff in the room or elsewhere could also be in danger, since the fire can spread to other sections of the hospital premises.

Where, for example and unfortunately, the conducting object which comes in contact with a doctor's electrostatically charged overall is a cardiac catheter, the entire electrostatic discharge could flow through the patient's heart with hazardous resulting effects.

Considering the factors which determine human response to electrical shock, which include the duration of exposure and path of current through the body, so many things may happen. Respiration may temporarily be paralysed although the heart beat may continue until the oxygen in the blood runs out. Ventricular fibrillation may follow later and the person concerned continues to gasp for breath for about one minute, suffering irreversible brain damage, only to die three minutes later.[2, 3] It is also possible that a shock results in a simultaneous and abrupt stop of both respiration and blood circulation.

Moreover, these non-therapeutic electrostatic discharges flowing through a cardiac-pacemaker — an instrument used to sustain heart functions in a severely ill patient, whose heart cannot function by itself or only partially so — can cause erratic functions of such a pacemaker or even block the circuit of a demand pacemaker, so that it fails to turn on when the need arises. This is certainly not a situation to which a patient should be subjected.

Quite apart from the hazards mentioned already, our attention is now focused on another hazard of electrostatic charges especially in intensive care units of a hospital — which is the problem of artefacts in ECG monitoring, although the possibility of obtaining acceptable monitoring nowadays has been greatly improved upon. Normally, in order to obtain a clean ECG recording, the patient is expected to be still, and movements in the room are not permitted.

The situation is, however, different in practice, since movement is not easy to control under emergency conditions. This causes electrode resistance changes due to alterations in contact pressure, skin potential changes and variations in skin resistance.[4, 5, 6] Such movements give rise to a high degree of artefacts for which the resulting electrostatic charges count among other major interferences like electromagnetic and muscle interferences.[7, 8, 9]

Such interferences in monitoring equipments, like the ECG, are capable of obscuring results to such a degree that true diagnosis is impossible. For example, there could be a baseline shift in an ECG due to a movement, even to an extent that the shift exceeds the amplitude of the R-wave.[8] The resultant false diagnosis could be fatal either by not recognising a serious malfunction of the heart, or by wrong therapy. Obviously, for a patient in an intensive care unit and in a life threatening condition, any error in attention, no matter the source, could be catastrophic.

Some precautionary measures to prevent electrostatic hazards

If the floor of a ward room with ECG monitoring systems is not earthed and the patient is also completely isolated from ground (i.e. ungrounded), artefacts attributable to electrostatic charges resulting from movements in the room occur (*Figure 1*). Under arid conditions such charges can be of the order of kilovolts. These electrostatic charging tendencies could be reduced by any procedure which makes the room more humid. Also, removing wax by washing with soap and water waxed linoleum on the floor, or spraying a carpeted floor with anti-electrostatic spray, could help.

If the hospital has a proper earthing system, grounding the patient through a common lead of the ECG amplifier would be a good solution to get rid of artefacts. But where there is no reliable system, this procedure must be avoided for fear of other likely electrical hazards. Instead, it would be advisable to make use of a shock eliminator. This device effectively earths the patient to the electrostatic voltages and protects him at the same time from electrical shock hazard. While it also limits the current from patient to ground, it simultaneously prevents voltage build-up on the patient from electrostatic charges.[7] This recommendation (*Figure 2*), however, presupposes that the ECG amplifier being used has a safety transformer isolation from power line having no fault whatsoever in the system. This is very important because a transformer-isolated electrical supply system can be hazardous even when only one fault occurs in the system as in *Figure 3*.[10]

Because of their susceptibility to easy electrostatic charging, the wearing of materials like silk, nylon and other synthetics as overalls or uniforms in operating theatres should be discouraged, at the least for fear of spark, explosion and fire. It is also advisable that cylinders of explosive and inflammable gases often required during operations should be placed quite remote from the operating table. And for easy and fast evacuation of an operating room in case of a panic resulting from one reason or the other,

Figure 1. Floor and patient NOT grounded.

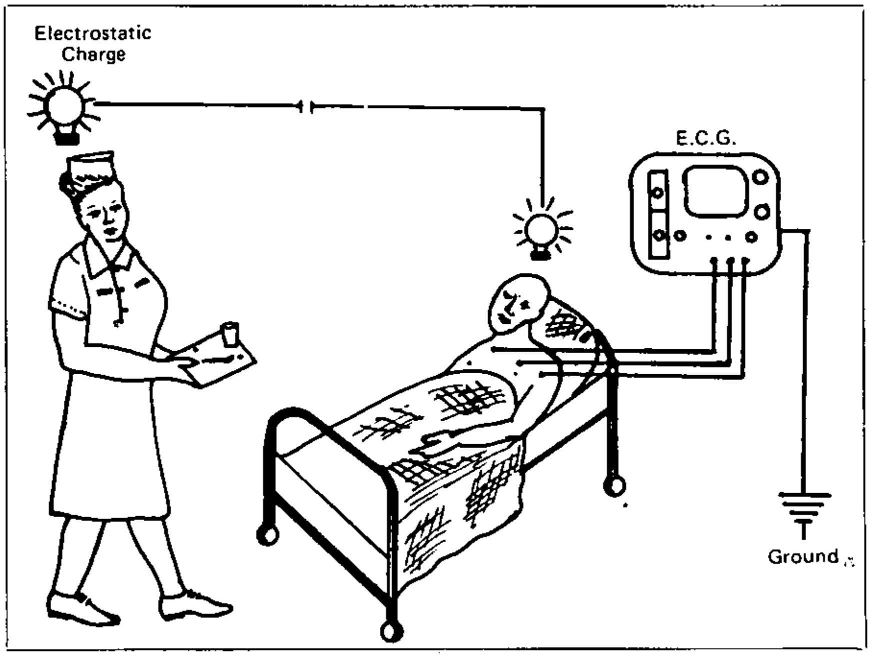
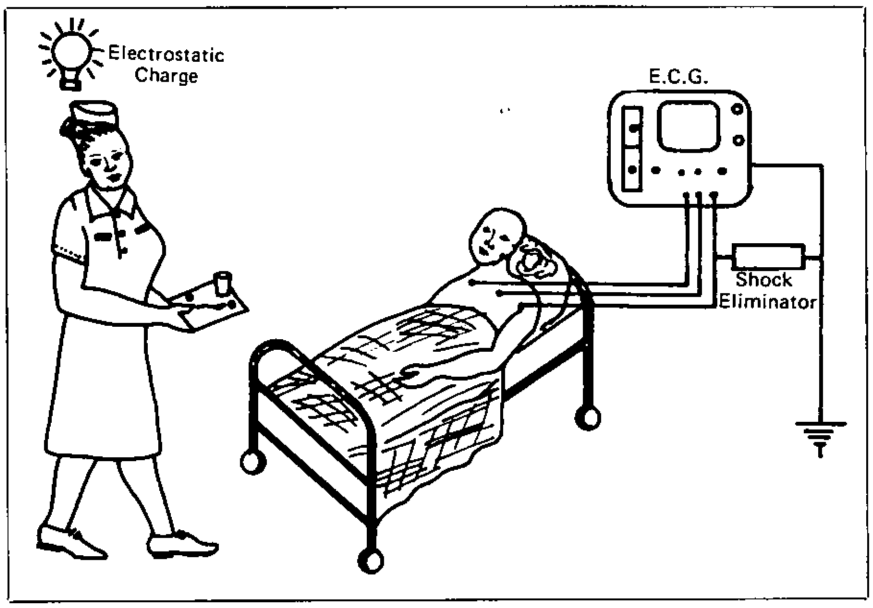


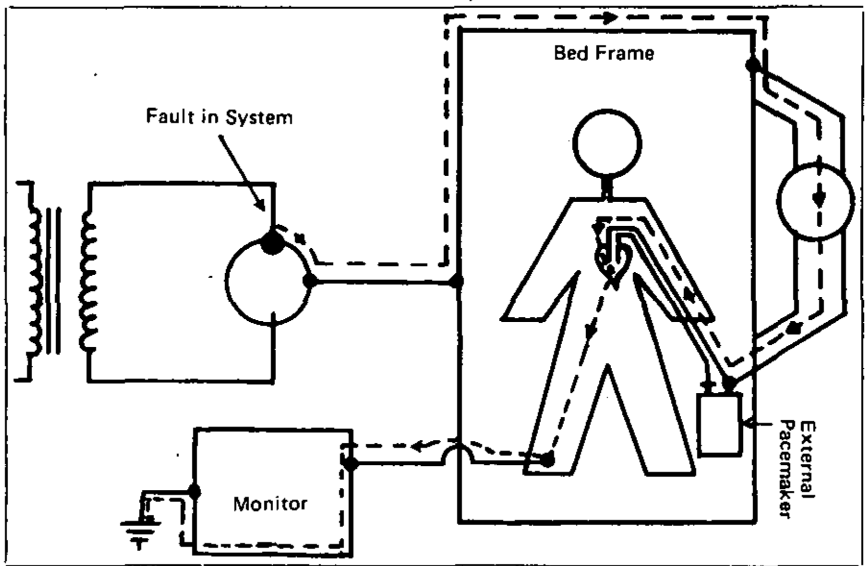
Figure 2. Shock eliminator grounds patient to electrostatic charges.



doors in operating theatres should be so constructed that they can be opened outwards and not inwards into the theatre.

Unfortunately, accidents can still occur after precautionary measures have been taken. The thought, therefore, comes to mind about a means of combating any fire outbreak. Here, the installation of portable fire extinguishers in the room recommends itself in order to control at the early stages any fire, thereby preventing it from spreading. To this effect the Class B fire extinguisher (according to the classification) adopted by National Fire Protection Association of the US would be recommended, because of its ability to exclude or limit oxygen and to interrupt the flame through a combustion inhibiting effect.[11] Water fails to extinguish fire from inflammable liquids and gases, since it can even spread the fire.

Figure 3. Inadequacy of power line isolation where a single fault occurs in the system.



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Product News

Asbestos stripping service

Recent government legislation on health and safety at work has underlined the demand for an efficient asbestos stripping service under controlled conditions. The Dismantling Division of Thos. W. Ward has been involved in the removal of asbestos lagging and insulation from power stations, gasworks, chemical plants and other industries for many years; as pioneers in the industrial field they are well equipped to deal with the complex problems of municipal and public contracts.

Factories and other industrial installations can be cleared of people while the necessary lagging or stripping is carried out. Hospitals must continue to function; or, if the problem is not localised but widespread, the job must be completed in the shortest possible time.

The number of contracts the company has undertaken since a special section to deal with asbestos stripping was formed within the Division last year is steadily increasing. Ward believe this vindicates their view that a separate section to deal with the immediate and long-term problems of working with asbestos was needed *and* the growing professional reputation they have won for themselves as a result.

The company places great emphasis on training and work safety enforcement for its employees working on asbestos contracts. The education of new employees in this field is handled through training lectures and practical demonstrations for all management supervisors, foremen and chargehands, carried out at the company's training centre at Templeborough Works, Sheffield.

Further information: *Thos. W. Ward Ltd., Albion Works, Sheffield S4 7UL. Telephone: (0742) 26311.*

Guide to Air Control

Most work operations in manufacturing or production can be classified as 'Move', 'Hold', 'Form' or 'Process' functions. To demonstrate that these are the jobs air control can do best, Schrader Pneumatics have produced a twenty-page booklet called 'Guide to Air Control'.

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'Guide to Air Control' explains some ideas that have been useful and how to select the right air controls for the required job. Using the Move, Hold, Form or Process functions as the theme, the booklet illustrates twenty air cylinder applications, giving the benefits, pneumatic equipment requirements and cost. A further 27 sketches demonstrate pneumatically controlled levers and toggles.

Copies from: *P. J. Lane, Schrader Pneumatics, Walkmill Lane, Bridgtown, Cannock, Staffs. WS11 3LR. Telephone: Cannock 2644.*

New ICU at East Birmingham

A sophisticated monitoring system for East Birmingham Hospital has been produced by American Optical Co. Ltd. The installation is valued at £30,000 and was specially designed to meet a specification drawn up by the hospital authorities. The ten units are directly linked to a fully automatic central console fitted with trend recording equipment and alarm systems.

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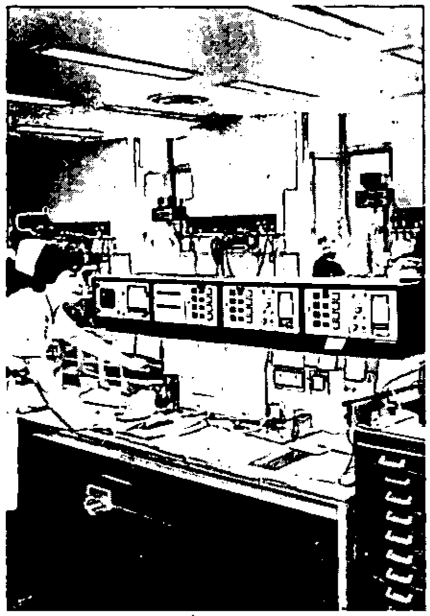

Central console of the system.

The bedside monitors are comprised of a two-channel memory display system giving 12 seconds cascaded memory for ECG or, alternatively, six seconds for ECG and six seconds for blood pressure. Also at the bedside are modular blood pressure and temperature modules. The blood pressure module measures 7½ × 3 ins and displays digitally systolic, diastolic and mean blood pressures; systolic and diastolic being either sequentially displayed or individually selected.

These units are calibrated to transducers electronically so that there is no need for lengthy recalibration procedures.

The system, one of the most sophisticated to be installed in the country includes a Lown Cardioverter in non-synchronised and also synchronised versions.

Further information from: Eddie Beakhouse, *American Optical Co. Ltd., 820 Yeovil Road, Slough, Berks. Telephone: Slough (0735) 31351.*

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Application form and job description obtainable from: Mr. A. E. Wilding, District Personnel Officer, Manchester Area Health Authority (Teaching), Withington Hospital, Nell Lane, Manchester M20 8LR.

Further information available from: Mr. R. D. Wilson, District Works Officer. Tel. 061-445 8111, Ext. 2102. Closing date: September 30, 1977.

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A broad appreciation of mechanical or electrical engineering services is required and knowledge of developments in hospital engineering services and design is desirable.
Applicants must be corporate members of the Institution of Mechanical and/or Institution of Electrical Engineers.

For an application form please telephone: 01-262 8011, Extension 261, or write to the Regional Personnel Officer, North West Thames Regional Health Authority, 40 Eastbourne Terrace, London W2 3QR, quoting reference number 178. Closing date September 20, 1977.

CLASSIFIED ADVERTISEMENTS
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APPOINTMENTS AND SITUATIONS VACANT

South West Thames Regional Health Authority

Engineering Technical Assistant I

For the Works Department of the Croydon Area Health Authority which provides engineering services to hospitals and other Health Service premises. The work will be primarily mechanical, but a knowledge of electrical services, and the ability to work, under guidance, in this field is necessary. The duties are varied and include: the production of estimates and drawings; site surveys; supervision of contractors employed to carry out minor works; assisting in the training of apprentices; and representing the Area Works Officer/Engineer at meetings within the Area Health Authority.
The person appointed will preferably be qualified to HNC level and have at least 10 years' experience in the fields mentioned.
Location — Queen's Hospital, Croydon.
TOTAL REMUNERATION — £4,594-£5,350 per annum.

Application form and job description from: Personnel Officer (S2), 40 Eastbourne Terrace, London W2 3QR. Completed applications to be returned not later than September 23.

To place an advertisement in the next issue of **HOSPITAL ENGINEERING** appearing on **OCTOBER 7, 1977,** please contact:
Sue Cartwright,
EARLSPORT PUBLICATIONS,
17 St. Swithin's Lane,
London EC4
Telephone: 01-248 0148
by **September 27** latest

Closing dates

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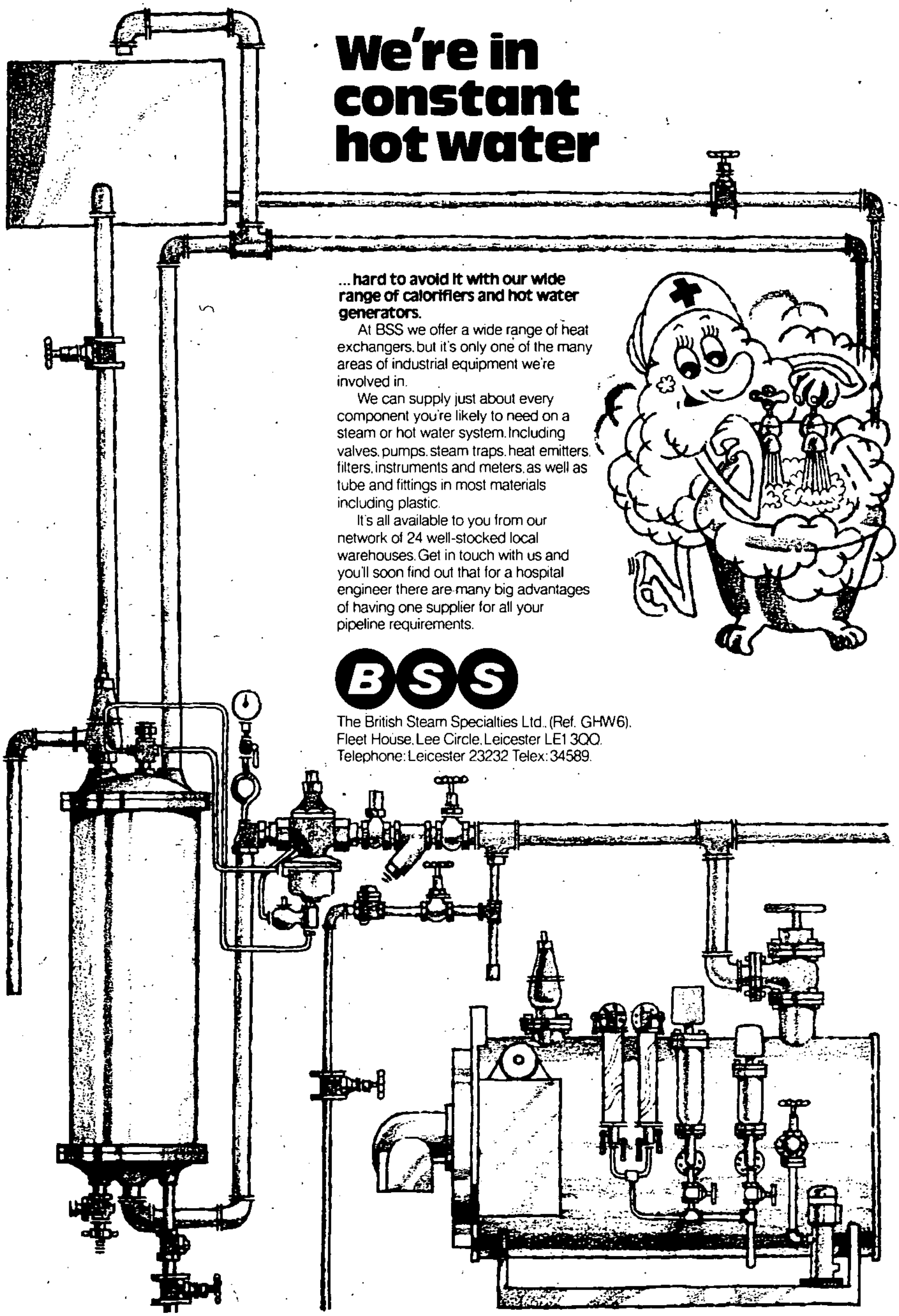
Monthly publications do not receive preferential treatment by the Post Office and circulation lists in hospitals also delay receipt of the Journal by many potential applicants.

Index to Advertisers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