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International Federation Issue

The Journal of the Institute of Hospital Engineering

I.F.H.E.

Institute Annual Conference Northumberland 1980

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Front Cover:

Alnwick Castle, Northumberland (*this, and the photograph on page 3, courtesy British Tourist Authority*)

Institute News

1980 is Hospital Energy Conservation Year

Council of the Institute has determined to take the initiative and declare 1980 to be Hospital Energy Conservation Year. It is hoped in this way to make a contribution to Energy Conservation and to encourage Energy Savings, and thus to contribute to cutting the running costs of the National Health Service.

It is intended to stage a series of four One-day Symposia throughout the year dealing with such topics as government energy strategy, ways in which 'users' may be persuaded to co-operate in saving energy and, also, systems and modifications that can be introduced by Health Authorities to reduce energy consumption.

The Institute has communicated its intention to the Department of Health and Social Security who have welcomed the initiative and offer support in the preparation of Papers and in other ways. It is hoped that a Minister may attend the first Symposium and, possibly, another Minister the last.

The Symposia will be held as shown below:

March 26 Institution of Civil Engineers
June 11 Institution of Mechanical Engineers
October 1 King's Fund Centre
December 3 King's Fund Centre.

The King Edward's Hospital Fund for London have also welcomed these proposals and will offer support as possible.

As a separate but parallel endeavour it is intended to stage a Papers Competition in the Journal throughout the year. The terms of the competition are being finalised but, of course, the intention is to publish Papers on Energy Conservation/Energy Savings schemes or innovations and it is hoped that the Minister may present a prize, given by the Institute at the final One-day Symposium.

Details of the programme for each Symposium will be publicised in the usual way and it is intended to publish the Rules of the competition in the March issue of *Hospital Engineering.*

CEI Notice to all Chartered Engineers

Notice is hereby given that the Fifteenth Annual General Meeting of The Council of Engineering Institutions will be held at The Institution of Civil Engineers 1/7 Great George Street, London SW1 on Thursday March 27, 1980 at 1430 hours. All Chartered Engineers are entitled to attend.

The business of the meeting will be the presentation and consideration of the Annual Report and Accounts for the year ended September 30, 1979, the appointment of the Auditors and the fixing of their remuneration and the announcement of the result of the ballot for the election of the elected members of the Board.

By Order of the Board
M. W. LEONARD
Secretary

Copies of the Annual Report and Accounts will be available at the meeting. Members unable to attend the AGM and who wish to receive a copy of the Report and Accounts should send an addressed envelope to The Secretary, CEI, 2 Little Smith Street, London SW1P 3DL. Summary reports including the accounts will be sent to all Chartered Engineers in due course.

1980 Annual Conference

Holiday Inn, Seaton Burn Newcastle upon Tyne May 7-9, 1980

As usual full details relating to the 1980 Annual Conference will be distributed to members in January.

Once again a Dinner Dance will be held on the middle evening, when the principle guests will include the Lord Mayor and Lady Mayoress of Newcastle-upon-Tyne, Sir George Younger Bt MP Parliamentary Under Secretary of State, and Mr George Chetwynd CBE, Chairman of the Northern Regional Health Authority.

Mr Chetwynd has also kindly agreed to open the Conference formally on the first morning.

Ladies Programme

Wednesday — May 7, 1980

9.30 am — Introductory meeting to the Ladies' programme and coffee in the Holiday Inn.
10.00 am — Coach departs for visit to Hexham — ($1\frac{1}{2}$ hours stop sightseeing).
12.30 pm — Coach departs for Wallington Hall — (Lunch and visit around Hall and Grounds).
4.00 pm — Coach departs.
4.30 pm — Arrive at Holiday Inn.

Thursday — May 8, 1980

10.00 am — Coach departs for visit to Alnwick — (Coffee and $1\frac{1}{2}$ hours stop sightseeing).
12.15 pm — Coach departs for scenic trip.
1.00 pm — Arrive at Holiday Inn for lunch.
2.00 pm — Coach departs for shopping and sightseeing in Newcastle.
4.30 pm — Coach departs for return to Holiday Inn.
5.00 pm — Arrive at Holiday Inn.

Friday — May 9, 1980

10.00 am — Coffee at Holiday Inn.
10.30 am — Talk and display on Flower Arranging (Holiday Inn).
12.15 pm — Conference Closure.

Northumberland — the historic kingdom

One of several poets who happens to be an engineer and member of the North East branch of the Institute has written a fine travalogue designed to attract the 'world weary' to the delights of Northumbria, wherein is mention of some of the places to be visited by the ladies.

It reads:

The history of Northumberland is the history of Britain. Each era, from prehistoric times to present day, has left its mark. Ancient British hill forts contrast with the lifestyle of the Romans, who occupied Northumberland for so long. Today, no frontier in the Western world is more impressive than Hadrian's Wall, built almost 2,000 years ago as the northernmost limit of the mighty Roman empire. Stand at the Wall and you can almost hear the tramp of the Fourth Cohort of Gauls which garrisoned Vindolanda when Emperor Hadrian ruled. At Vindolanda today, excavations regularly produce fresh finds, and its full-scale replica of a part of the Wall provides a mirror of the past.

Northumberland cradled the Christian faith. But then followed the fiery years when monastery and priory were the target of Viking marauders. Today, the hardware of history litters the Northumbrian landscape. Monastic ruin and humble Saxon church lie in the shadow of architectural masterpieces such as Hexham Abbey.

The history of yet another era can be found in the rich store of castles still standing sentinel, on moorland and fell, by river and sea. No region in all Britain can boast so many castles and fortified homes. Gaunt Ruins, Norham, Dunstanburgh, Warkworth and Tynemouth are far removed from the magnificence of historic store houses like Alnwick Castle, the majestic citadel of Bamburgh, the fairy tale castle of Lindisfarne. Great houses are many: Wallington, with its woods and gardens; Seaton Delaval, a Vanburgh masterpiece; and Cragside, with acre upon acre of rhododendrons and azaleas, and the first house in the world to be lit with hydro-electric power.

Northumberland provides superb walking country. The rolling moorlands and the Simonside and Cheviot hills contrast with the green tapestry of the border forests. The Northumberland National Park covers 400 square miles and contains some of the county's remotest hill country, whilst the upper reaches of river and tributary provide a wide variety of scenery to delight the visitor. You can walk all day, and see no other, over the fells where the vast skies seem to touch the purple heather. If you prefer to drive, the moorland roads will be surprisingly traffic free, and will steer you into greystone villages, unchanged for generations.

The beaches of Northumberland are excellent. At the northernmost end is Berwick upon Tweed, a town which changed hands no less than 13 times during the Border wars. Southwards, for 40 miles, the magnificent coastline is designated an 'Area of Outstanding Beauty' and is dotted with age-old fishing harbours.

Wildlife enthusiasts will find great

Hadrian's Wall, at Cuddy's Crag, looking east towards the Roman fort at Housesteads.

attractions in Northumberland. The Farne Islands are the only East coast breeding grounds for the world's rarest seal, the grey seal. They are also a major site for breeding seabirds: eider duck, puffin, kittiwake, guillemot, fulmar and tern, nesting in their hundreds. At Glanton is Britain's first bird research station, and Chillingham is the habitat of a unique herd of wild white cattle, descended from those which roamed the area in pre-historic times.

Northumberland provides for the theatre, cinema and the live arts generally, with sport aplenty. If you want the bright lights there are the pubs and clubs for which the region is famous, with restaurants to suit all tastes and pockets, and with casinos and nightclubs to follow. When you go shopping, and whether you are discussing a purchase in an antique shop in one of the small towns of the area, or wandering around Europe's largest covered shopping complex, the Eldon Centre in Newcastle, you will meet the same friendly courtesy.

This, then, is a taste of Northumberland. Whatever your choice of relaxation you will find it here, and you will be very welcome.

The Royal Commision on the NHS

It is expected that the Consultative Document will be published by mid-December and it is likely that there will be a period of three months during which comments and submissions may be offered.

In order that there may be full discussion on the possible effects of the Consultative Document on NHS Works Organisations, The Institute of Hospital Engineering will hold a special One-day Symposium on the subject. In fact an approach has been made to the Institute of Building who would like the event to be a 'joint exercise'.

The meeting will be held at The Institution of Civil Engineers, London on Thursday February 14.

Details will be distributed to members at the beginning of January.

IMechE Medical Engineering Group

The Medical Engineering Group will hold one of its regular meetings at the Institution of Mechanical Engineers on Wednesday December 19 at 5.30 pm. The Subject under discussion will be *The problems of acute medicine and surgery and the maintenance of equipment in offshore installations.*

Members of the Institute of Hospital Engineering are always welcome to attend meetings held by the Medical Engineering Group.

Personal Services

A statement from the CEI Executive Committee

For some time, the Council of Engineering Institutions has been aware of a desire among some engineers that the Council should provide a variety of personal services to individual Chartered Engineers. In late 1978, the Council engaged a consultant, Mr C. P. Morton, CEng, to establish the extent of the demand and the practicalities of meeting it.

Mr Morton has now submitted his Report which has been adopted by the Executive Committee of the CEI Board. He draws attention to the failure, for lack of support, of two bodies set up in the recent past to provide personal services to engineers. He was able to find no evidence of an increased level of support for a similar venture by CEI and concluded that the financial viability of a CEI Personal Services Unit would be seriously in doubt. The Report also examines the legal problems involved and includes a statement of Counsel's Opinion. It is clear that for CEI to sponsor a Personal Services Unit would be a breach of its Royal Charter and charitable status, and those of the member institutions, which would then become liable to corporation and other taxation which could be met only by substantial increases in membership subscriptions.

Even if it were possible to find independent sponsors and guarantors for the venture, it would not be possible to collect subscriptions through Institutions and the unit would have to be administratively independent. The difficulty and cost of setting up and running the unit would therefore be much greater than had been predicted.

The report also draws attention to the widespread confusion about the meaning of 'personal services'. A service provided by a professional body would necessarily be restricted to professional matters, and could not provide advice or legal assistance to individual members in employment matters involving disputes between employees and employers. Such matters are properly the concern of Trade Unions and the attention of members is drawn to the CEI publication 'Professional Engineers and Trade Unions' which lists the provision of personal services among the principal reasons for recommending Trade Union membership.

In view of the lack of demand and the difficulty and cost of meeting it, the Council has decided not to proceed further for the time being with the establishment of a Personal Services Unit. CEI will, however, continue its efforts to influence legislation and public attitudes affecting the working lives of engineers in the interests of the profession as a whole.

New Chartered Engineers registered through Affiliate Members

The registration of 18 new Chartered Engineers from three of the Council of Engineering Institutions' Affiliate Organisations, was announced at a meeting of the Board by Dr G. S. Hislop, CBE, Chairman of CEI.

Dr Hislop in approving and welcoming these new individual members to the CEI said, "We at the CEI are now beginning to benefit from the provisions of our new Charter which accords Chartered Engineer status to fully qualified professional engineers from our growing number of Affiliates. I see this innovation as further strengthening the standing and influence of the CEI."

The 18 new Chartered Engineers are drawn from the Institution of Agricultural Engineers, the Institution of Nuclear Engineers and the Institution of Public Health Engineers.

Hope Hospital, Salford

Work on the largest hospital building scheme in the North West — the £18.3 million first phase of Salford's huge new Hope teaching hospital — has been started.

Sidney C. Hamburger CBE MA JP, Chairman of the North Western Regional Health Authority, formally started the work by cutting the first sod — with a little help from an excavator. Also present were David H. Boot, and David H. Woolf, Chairman and Managing Director of Henry Boot Construction, the project main contractors.

This phase is the first major component of a long term project to replace the outdated Victorian hospital, and is due to be completed in late 1983.

St George's Hospital Fitting out Contract

Following successful completion of the £4½m installation of all mechanical services in phase 1 of the St George's Hospital and Medical School complex at Tooting, London SW, the London Mechanical Services division of Haden Young Limited is handling the £200,000 post-contract fitting out work.

The work includes plumbing and mechanical services installations to the hospital pharmacy and is to be completed by the end of 1979.

Haden Young, part of the Haden Carrier Group, is the largest mechanical and electrical services design and contracting organisation in the UK.

Southern Branch

January (details to be arranged). 'The Ordnance Survey'. Mr Butler, Public Relations Officer, Ordnance Survey, Southampton, at Ordnance Survey, Romsey Road, Maybush, Southampton.

Saturday March 8, at 3 pm. 'Electrical Interference in Hospitals'. Mr F. H. Baker, Principal Engineer, DHSS at St Mary's Hospital, Portsmouth.

North Western Branch

On Wednesday evening, October 24 the North Western Branch held a joint meeting with the South West Lancashire Energy Management Group. This was held at Park Hall, Charnock Richards, and was very well attended. The meeting was organised by Spirax Sarco, and besides a static display, a talk and film show was given on Correct Steam Trapping. An excellent buffet and drinks were provided, which all went to make a most enjoyable and educational evening.

North East Branch 1980 Programme

Tuesday, March 11 1980
Visit to the recently completed sections of the South Tees General Hospital followed by the Annual General Meeting.

May 7 - 9 1980
An Annual National Conference to be held at the Holiday Inn, Great North Road, Seaton Burn, Newcastle.

Environmental Effects of utilising more Coal

The Council for Environmental Science and Engineering has arranged a topical conference on 'Environmental Effects of Utilising More Coal' at the Royal Geographical Society on December 11 and 12, 1979.

Programmes and registration forms are available from the Council for Environmental Science and Engineering, Conference Office, c/o The Institute of Biology, 41 Queen's Gate, London SW7.

A New Partner

Michael J. Haynes FAI AMBIM has been made a partner in the practice of Donald Smith, Seymour and Rooley, the Consulting Engineers.

After receiving training in the administration and surveying departments of a large national multi-service contractor's office, Michael Haynes joined the Partnership of DSSR in 1963. He became an Associate in 1973.

In his capacity as Administrator to the Practice, Michael Haynes is responsible for all non-technical matters affecting the firm in this country and overseas. He is currently Chairman of 'Administrators in Architecture'.

Born in London 1941, he was educated at the Quintin School.

Obituary — F. J. Chance

It is with great regret that we have to report the death of one of our longest serving members Mr F. J. Chance, who passed away at the age of 82 on October 22, 1979.

Mr Chance worked for the Birmingham City Council as Engineer in Charge of Coleshill Hall Hospital in Warwickshire when it opened up in the early 'thirties. Later he was also responsible for Chelmsley Hospital when its use was changed from a remand home to a hospital for the mentally subnormal.

During the second world war he provided a service to Maryhill Hospital and also acted as Clerk of Works when Manston Green Hospital was under construction. After the war he again carried out Clerk of Works duties when Manston Green was converted to a maternity hospital for the Selly Oak HMC.

In 1948 he became Superintendent Engineer to Coleshill Hall HMC taking on the responsibility for Weston Hospital.

He officially retired in 1962 at the age of 65, but was persuaded to return in 1966 for a few months to supervise some installation work.

Mr Chance was a very active and loyal member of the Institute and served as a Member of Council from 1956 to 1960.

He will be remembered by his many friends and colleagues throughout the service. He leaves a widow and two married children.

Letter to the Editor

International Seminar, Falfield

Dear Sir,

The International Seminar for senior hospital engineers held in Falfield August 28–September 14, 1979 was a great success in many ways. (See page 2, *Hospital Engineering*, October 1979).

First of all we got a good view over appropriate technology, secondly it was interesting to meet people from various countries and exchange experiences, and — most important — we had a very good staff with excellent lecturers. We experienced splendid hospitality at the Hospital Engineering centre.

I think we had a great variety of papers, from briefing through the whole planning process to commissioning and evaluation. In the project work we could use and test our theoretical and practical knowledge. We also visited a few hospitals and had the opportunity to ask various persons on the hospital staff to what extent their hospital fulfilled the existing needs.

To summarise, I think we seminar members got a very good overall knowledge on the various problems of hospital planning as well as the appropriate technology for solving problems in the planning process. The seminar is going to be of great value for my future work within the Swedish Planning and Rationalization Institute of the Health Service. I thoroughly appreciate all your efforts in making the seminar such a success.

Yours sincerely,

NILS—OLOF EINARSSON

The Swedish Planning and
Rationalization Institute,
of the Health and Social Services,
Fack, S-102 50 Stockholm, Sweden.

Reflections from Oslo

21st International Hospital Congress

P. J. TANKARD *Area Works Officer, Berkshire Area Health Authority*

For the first time the International Federation of Hospital Engineering collaborated with the International Hospital Federation's 21st Hospital Congress held in Oslo June 24–29 1979.

The Congress, which was attended by 1,700 delegates and guests from 64 countries, was held at the very pleasant campus site of Oslo University. Apart from the plenary sessions on the opening and closing days of the Congress, the proceedings were organised in five discussion groups. Appropriately, in this International Year of the Child, one of the groups discussed 'Care of the Child'.

Many countries, having built expensive new hospitals, have had trouble in staffing them and many have staffing difficulties even before they can afford new buildings. A problem of universal concern to both industrialised and developing countries is the escalating cost of health care. The sessions of the discussion group on 'Cost containment and quality control' were, therefore, particularly well attended.

The themes of the other discussion groups were: Accident and Emergency Services; Cost Containment and Quality Control; Health Care Staffing in Developing Countries. The group in which the Federation of Hospital Engineering assisted in preparation was titled 'Hospital Design — Integration of Engineering Services', and was chaired by Eduardo Caetano of Portugal, the President of the International Federation of Hospital Engineering. Papers presented in this group covered the following contrasting subjects: Mutual influences of architectural design and engineering services; Design for retrofit — planning for future change; Co-ordination between architect, engineer and user, and contributions from the Director of Works Operations DHSS Mr Tom Nicholls, on 'The engineer's brief for the construction and the redevelopment of health buildings', and from Mr Howard Goodman, Director of Works Development DHSS on 'The development of interstitial floor spaces'. My own contribution was a short illustration paper on 'Access for Maintenance'.

'Interstitial Floors' — new jargon for some, provoked a very lively and controversial discussion. It would appear that a very good case can be made for a walk-in void over every floor area of acute and heavily serviced hospital departments for the installation of engineering services — the arguments in favour of this approach being: a) ease of design layout and b) ease of renewal of engineering services — or 'retrofit' — yes, 'retrofit' — more new jargon, presumably from North America!

I am not convinced by the arguments put forward for Interstitial Floor Spaces, having seen some of the maintenance problems of a six-storey maternity department with a three foot void, with the lack of manoeuvrability that this confined space gives. This criticism is countered by the suggestion that a six foot void would be the proper provision — but does not this have the effect of increasing the overall building height by some 50%? Can we afford to heat all that extra building volume? Well, the counter arguments were quick to come from the floor — it is not really heated space and some claimed that cost studies on buildings already constructed had indicated an increase in construction cost ranging only from 1% to 7%. One contributor even claimed a saving in cost due to the ease of the engineering services installation. I remain unconvinced on all three counts — maintenance, cost, and 'retrofit'. On balance (I think) the argument is in favour of a demountable ceiling tile for access as the preferred solution.

This thought was in mind when we went out to visit some of the hospitals around Oslo. Some examined a newly-built Pathology Department in the principle teaching hospital which did have a 2 m interstitial floor space. Those who saw this were very impressed with the layout of the services.

I went round some of the intensive therapy departments and research laboratories of the same teaching hospital. I was immensely impressed by the standard of the buildings, both internally and externally, considering that they were originally built at the turn of the century. Most areas had been substantially upgraded in recent years and were generally excellent examples of what can be done with basically old but sound structures.

How many countless times do we hear the maintenance engineer using unmentionable adjectives about the designer of a building, where services have been built into or otherwise hidden in the building fabric and where the operational and maintenance problems have not been taken into account in the design. This was the theme of my paper.

The Department's Hospital Technical Memorandum No. 23 is a good starting point for this subject, and lays down some good principles for designers to follow. But surely the subject needs to be part of the formalities of project planning. The clients, in the form of Doctor or Nurse, or other principal users of the project in hand, are always consulted, or should be consulted about the building layout in a functional sense. The maintenance engineer is also the client in the sense that he, or his successors. will have to maintain the building throughout its functional life at a cost far exceeding the original capital cost. Access to engineering services is a principal factor in the cost of maintenance, as indeed is the need to do a job safely. The recent 'Health and Safety at Work Act' is having an increasing impact on procedures for maintenance. It is, therefore, absolutely vital for the maintenance engineer and building officer to have a proper formal imput in the building design process.

Our stay at Oslo was not totally devoted to the fundamental professional debate, and one has a lasting impression of the open friendliness of the Norwegian people, and our free time was packed with every effort to see as much of this beautiful city as possible.

The City of Oslo held a reception in the City Hall (itself a monument to local culture and design) which started the week in elegant style. Then the Minister of health was host at a second reception in the Sonja Henie-Niels Onstad Foundation Arts Centre. The famous trolls of Norway were suspected of spiriting away the coach drivers on this particular evening, and many delegates became more familiar with this strikingly modern building on its spectacular site on the edge of Oslo Fjord than they might otherwise have planned to do.

The new Oslo Concert Hall in the

centre of town was the setting for an evening of songs, dancing and music, which featured Norwegian folk music and dancing, as well as works by the national hero, Edward Grieg. The concert opened with a recital on the splendid five-keyboard organ, which, we heard, like so much else these days, awaits computerisation! The concert hall combines attractive modern architecture with sumptuous finishes such as white marble and rich red mahogony.

Other attractions were visits to the observation tower on the hills overlooking Oslo Fjord whence it is said, on a clear day half the Kingdom can be seen, and the nearby ski-jump which is being extended in preparation for the forthcoming Winter Olympics.

I am sure that much value comes out of informal discussions at these sort of gatherings, and it is salutary to learn from these contacts that the problems which we are grappling with in the UK in terms of a flagging economy, lack of resources, long waiting lists, more rigorous fire precautions, workers' rights of consultation, the equivalent of Health and Safety at Work Acts, are common themes which were expressed by participants from other countries. Without wishing to be complacent, one had the impression that our achievements in the UK are considerable, and certainly there was an acknowledged respect of our National Health Service.

Training Biomedical Engineers and Technicians in Developing Countries

DR M. O. OLEKA

PROF HANS von der MOSEL

Department of Biomedical Engineering, College of Medicine, University of Lagos, Nigeria

Since the acknowledgement of biomedical engineering as a recognised profession 15 years ago in the USA, many universities and technical colleges in many countries around the world offer special study programmes for Biomedical Engineers (BME) and Biomedical Technicians (BMET)*. It is quite unfortunate, however, that there is very little co-ordination between these institutions in the design of these programmes, and presently there are as many different curricula in these fields as there are institutions teaching them. Also, regarding the requirements for the products of such studies there appears to be varying opinions between these institutions. These factors make it quite difficult for BME's and BMET's to find the proper professional recognition and the right employment.

In contrast to these professions in developed countries, the professional requirements for a BME or BMET in developing countries have been well identified, and from this, the development of study programmes for both is no longer difficult. We would like to give a short outline of our own analysis, the problems involved, and the curricula we have developed and quite successfully implemented.

The Problems facing BME's and BMET's in Developing Countries

Although the authors have recently published a paper dealing in great detail with these problems, we would like to give at least a short summary of these problems again as an introduction to this paper.

Basically, none of the fundamental requirements for successful applications of complex medical instrumentation systems as yet exist in developing countries. These include the stable and reliable supply of electrical energy and water, reliable communication systems, easy access to essential spare parts and tools, and well-trained and experienced technical manpower. This lack affects the maintenance and repair of such equipment as well as its proper use.

Particularly in tropical countries, such equipment is exposed to much more wear and tear due to climatic and environmental conditions. This, combined with the forementioned conditions, causes a very high rate of equipment breakdown and, consequently, an excessive work-load of maintenance and repair.

Knowledge and Skills of BME's and BMET's

From the foregoing, the requirements for the required skills and knowledge of BME's and BMET's become quite clear. They must not only have a solid knowledge of the functional theories of such equipment, but must also be well trained in *practical* repair and maintenance. They must have sufficient imagination to improvise if certain spare parts are not available. They must be capable of teaching equipment application to equipment users in clear and non-technical language. They must also be capable of doing some research in order to find solutions to the basic problems they have to face.

Any curriculum designed for such training must emphasise *practical* work, since this will be the daily 'bread and butter' of the BME and BMET in a developing country.

The Problems of Training BME's and BMET's

Again, these problems have been extensively described in the before mentioned paper, and we would like to just summarise them here again.

One of the main problems is the 'Status' of a professional. Any training

*For an example of one degree course see the November 1979 issue of *Hospital Engineering—Editor.*

which does not provide a certificate or diploma which is recognised by the respective government, and which will not result in improvement of the living conditions and career prospects of the trainee, will not bring the expected results. At the same time, being given 'status' may result in the unwillingness of the trainee actually to do the work he has been trained for, since he might become too self-important.

Further, there must be sufficient motivation for the trainee effectively to do his best to complete his training programme successfully.

Basic Requirements for BME and BMET curricula

We believe that there are some very basic requirements for any curriculum for the training of BME's and BMET's to have a chance of success. These are:

Manual skills must not be regarded as detrimental to status. On the contrary, they must be regarded as a natural extension of theoretical knowledge, and it must be stressed all the time to the student that only a combination of both theoretical knowledge and practical competence makes a true engineer. Thus, a man must be proud of his final effective accomplishment by presenting the physical product of his 'brain child' in the form of an actual machine that works and which he has built himself.

It must be stressed that the engineer will eventually be the supervisor of the technician. This is only possible if he knows and can physically do everything a technician can be expected to know and do.

One of the most important aspects in designing a career curriculum should, in our opinion, be that it does not limit the chance of the trainee to continue beyond his original goal. We have seen many students who actually wanted only to become technicians, but who eventually proved to be so interested and capable that they wanted to go on to become engineers. We have, on the other hand, seen many engineering students, who were not capable of completing the full engineering course, but also became very good and skilled technicians.

Biomedical Engineering, if seen in the right light, is a field which requires an unusually broad range of knowledge and skills. Any programme designed to produce the 'General Practitioner' type of BME or BMET must build such a broad basis first. Specialisation can only follow later. Small-spectrum specialists will be severely hampered in their later career.

Our own experiences

Based on all the above, we have designed a curriculum for BME's and BMET's, which has given us good results in the past and may be regarded as a model for others.

The basic ideas of our curriculum were as follows:

'Keep the Drop-out in mind'. This means making sure that any student may discontinue his study at any time without having wasted his time. In our programme, completion of the first year of study made the trainee capable of working as an Instrument repairman, doing limited equipment repair and maintenance under supervision, but with competence. Completion of the second year enabled him to work as a biomedical engineering technician capable of doing more sophisticated maintenance and repair work quite competently, but still under supervision. After three years of study, the trainee became a 'Certified BMET' (Biomedical Engineering Technologist), capable of practically all maintenance and repair work of even highly complex equipment systems, without supervision.

'Qualify for Supervisor'. Those who wanted to go beyond the technologist level and continue towards an engineering degree, had first to complete the above-mentioned three years, followed by one year of practical work as a Certified BMET. After this, they had one more year of study, leading to the degree of Bachelor of Biomedical Engineering. Through this design, we fulfilled the requirement already mentioned. He has, in the first three years of study and the practical year, acquired all the knowledge and skills of the technicians he will have to supervise, but has gone beyond their level.

In the course of our presentation so far, we have stressed again and again that it is extremely important to emphasise *practical* knowledge and skill. During teaching our programme, it was our goal to eliminate 'Memorisers' who could not apply their knowledge and had nothing but paper qualifications (the main handicap of all technology in developing countries). We have, therefore, made heavy use of the many commercially available Teaching Systems, such as those from Heath, Hickock, Philips etc. Our experiences with these systems were excellent, although we must admit that most of them are quite expensive. However, technical manpower is, for developing countries, of prime importance, and as far as any such country can afford such expense, it will likely be their best investment.

In subjects like electronics, mechanics, physics etc, we have obtained good results by actually eliminating conventional lectures and replacing them with, as we called them, 'Lecture-Practicals'. Such sessions consisted of two to three hours of laboratory work. The students obtained, at the beginning of each session, a short briefing of about five to ten minutes, giving them a very short explanation of the topics covered in this particular session. After this, the student had to work all by himself from a student manual and with breadboard, components and measuring equipment to solve four to eight problems described in the student manual. Thus, the student did not get 'ready-made' knowledge, but had to work out his knowledge all by himself through experimentation. Our teaching staff was available for guidance in case of difficulty, but they never provided any final answer, only got the student back on course if he should have got stuck somewhere. The results of this form of teaching were very encouraging. Theoretical knowledge and manual skill grew with each other, and the student had, in the end, a much more solid knowledge of what he had done.

We found that the Hickock System was particularly suited to our purpose, since it also provided extremely good student and teacher manuals, as well as much additional teaching material in the form of audio-visual aids such as short film strips, slides etc.

Somewhat less expensive but also very suitable are the electronics courses as offered by Heath, but they require more basic knowledge and offer only limited material.

During the first three years of study, our students constructed their own measurement equipment, such as Voltmeters, Signal Generators, Oscilloscopes etc, from Heath Kits. By doing so, they acquired substantial skills in assembly techniques, calibration, troubleshooting, maintenance and repair, and gained a deeper understanding of the function, as well as the application, of such equipment. A further motivation for special efforts in the construction of such equipment was the fact that the student was permitted to keep his equipment for himself after graduation from school.

In concluding, we would like to say that we do not insist that we have developed *the only* system of training for BME's and BMET's, but our results are very encouraging in every way, and most of our graduates are now doing their jobs better than most graduates of other schools.

Mr Soheili originally studied environmental engineering when he first became interested in hospital engineering. Previously appointed to supervise the installation of engineering services at Tehran University Medical Centres, he is now a Consultant for Hospital Engineering Systems and Equipment in governmental health organisations in Iran.

He presented this paper at the Lisbon International Congress in May/June 1978.

Low Temperature Preparation of Frozen Red Blood Cells

MASSOUD SOHEILI FIHospE

Why Frozen Blood?

General Considerations

In recent years, blood transfusion authorities have been trying to teach doctors and hospital staff developments and advances in component therapy and the intelligent use of blood components. Engineers are putting effort into improvement of techniques of freezing equipment involved in this process.

Blood component preparation involves the separation of red cells, platelets, and plasma. Fresh blood tends to degrade due to the red cell ageing, after limited storage periods at +4°C. An operating point of +4°C is the temperature of standard blood bank refrigerators. At sub-freezing temperatures, however, frozen blood can be stored for two or more years. The term 'frozen blood' is commonly given to frozen, thawed, and washed human red cells.

Frozen red cells are stored in hospitals to be used for patients with rare blood, renal dialysis patients, or for transplant candidates.

Certainly, whole blood will be used in the future, not only for the massive spontaneous bleeder, but for routine transfusion purposes in many hospitals.

Report from Iran

It is considered that a frozen blood store will be of the utmost importance in the future, in that polytransfused patients are numerous in Iran. The *Renal Dialysis and Transplantation* Committee is based upon Iranian National Blood Transfusion Service (INBTS). There are periods in the year, such as the month of Ramadan, when blood donation dwindles even though utilisation remains fixed.

Activity in the frozen blood sector has been extremely slow and limited as the years have gone by — mainly due to the unreliability of liquid nitrogen. In order to achieve self-reliance and to reduce costs, a nitrogen liquifier has been installed. At present, a store of rare blood is kept in liquid nitrogen; lymphocytes for the histocompatibility section are also allotted space. Further, in view of the interest INBTS has in population genetics, a preliminary 'archive' of sera is kept in straws under liquid nitrogen. This section will be greatly expanded.

Cryopreservation Methods

Storage Temperatures

There are two practical refrigerating techniques for preservation of human red cells, and both techniques require a cryoprotective agent. Glycerol is used as cryoprotectant, and glycerol-protected cells are stored in low-temperature and ultra-low temperature refrigerators. Of course, low temperature and ultra-low temperature are somewhat relative terms. The dividing line between low temperature and ultra-low temperature is not clear at a time when man is challenging temperature from extremely cold to absolute zero. So far there has been no international agreement among various investigators as to terms describing a definite temperature.

Glycerol Processes

The 'low glycerol' processes are referred to as storage at −150°C by liquid nitrogen refrigeration in low concentration of glycerol with fast freezing and thawing. And the 'high glycerol' processes are referred to as storage at −80°C by mechanical refrigeration in high concentration of glycerol; 40% to 50% weight by volume approximately with slow freezing and thawing. In the former processes, glycerol concentration is about 14 to 20% W/V.

In either of the two distinguished processes, the 'low glycerol' or 'high glycerol' preparations can be stored for long periods of time. All processes require the removal of glycerol prior to transfusion. An agent which would not need post-thaw washing/removing before transfusion could be an ideal cryoprotective agent. No such cryoadditive or method for the preservation of frozen blood is applicable presently.

Mechanical Refrigeration

Refrigeration System

Generally speaking, production of very low temperatures by mechanical refrigeration is rather difficult. The lowest temperature that may be produced by vapour compression/cascade arrangement is about −150°C. Nevertheless, the practical limit of the small mechanical refrigerator is approximately −110°C. Multistage compression is adopted in low temperature, self-contained freezers. However, cascade arrangements exhibit a more desirable performance.

Three general vapour compression systems can refrigerate to low temperatures. When the operating temperatures are in the neighbourhood of −50°C the refrigeration system features single state, constant-run. For evaporating temperatures below −50°C either two or three-stage cascade systems are used. Three stages are recommended for red cell freezers with operating temperatures below −70°C.

In the two-stage cascade system the evaporator of the first system is used to cool the condenser of the second system to prevent extremely high condensing pressure (*see Figure 1*). The main thermodynamic disadvantage of a cascade system is the temperature overlap in the cascade condenser. It should be noted that cascade systems could be operated more satisfactorily when a good combination of refrigerants with progressively lower boiling point is used. This allows more supercooling tonnage per horsepower, such as three compressors hermetically sealed cascade systems using R13, R170 and R1150 as shown in *Figure 2*.

The refrigerating system for all the red cell freezers are hermetic. Space required for hermetically sealed cascade systems is about the same as the storage volume of low temperature cabinets.

Types of Freezers

A freezer with a −85°C pull-down temperature, and with an average capacity of 500 litres is generally thought of as a correct unit for storage of frozen red cells mixed in a high concentration of glycerol in a blood transfusion service. These freezers are more or less standardised and mass produced. However, pull-down temperature of −100°C at +21°C ambient temperature could be manufactured to a special order. In fact, the size and temperature available now can cover a wide range with standard and non-standard units. There are two cabinet models of freezers at −85°C operating temperature, in +25°C ambient:

— Chest freezer
— Upright freezer

Chest freezers are used when storage temperature constancy is one of the targets. In chest freezers with 127 mm urethane foam as the main insulant, transmission loss is limited. Also, air loss is reduced in a horizontal storage compartment. The accessibility and inventory control of frozen blood is easier in the upright models, but chest types appear to be the most widely used form of freezers.

Temperature constancy of mechanical refrigerators is ±1° at −85°C, and a drum of liquid nitrogen is normally connected to a freezer with a withdrawal tube for:

— Fast freezing
— Safeguard against mechanical failure

So if ever a refrigerating machine fails, freezing temperature can be maintained for several days.

Packing employed in these refrigerators consists of:

— Plastic bags inside cardboard boxes or inside aluminium canisters.
— Baskets on rails or basket on rack.

Performance

The performance of a mechanical refrigerator is critically dependent on room thermal environmental conditions and voltage stability of electrical supply. To minimise many ill-effects which may damage the stored product, room temperature must be controlled within the specified degree range. To ensure correct storage temperature and long refrigerator life, it is advisable to keep the ambient temperature low by air conditioning.

In most power supplies there is a harmful voltage fluctuation; which can be as much as ±10%. As this fluctuation may cause damage or actual loss of sensitive equipment, it is customary to correct this fluctuation by using line voltage regulators. Very often, if several pieces of equipment are being supplied from the voltage regulator, momentary dips or rises in the electrical distribution system may be harmful and result in under-voltage condition which would ultimately burn-out the windings of compressors. In such cases, a secondary stabilisation system is necessary, which can be achieved by installation of voltage safeguards for individual red cell freezers.

The term 'hermetic' applies to 'compressor' and 'motor' assemblies fully sealed within a welded steel housing. Hermetic units are used in blood bank refrigerators and freezers. The problem of many failures, particularly motor burn-outs of hermetic units has been magnified; whereas motor burn-outs are substantially caused by mis-application, ill treating, and neglecting the operational instructions. This was experienced by the writer who examined hermetic units returned to a factory from different countries when he practised as a test engineer in a British firm.

In a modern freezer. reliability of the 'compressors' has reached a high standard. Over-heating of the windings at various operating conditions is critical, even in a small size, fractional horsepower unit. And yet a range of environmental cold-test cabinets, beyond 5 HP rating, became available to replace open type machines. Experience so far indicates that, in most cases, 'motor burn-out' has been the cause of mechanical breakdown. In the event of mechanical failure, motor compressor replacement in the field is by no means convenient.

It is unlikely that the design of compressors needs to be changed for the time being, while it does seem necessary and there is more likelihood of improving the construction of motors.

With regard to the present situation, hermetic units available for red cell freezers should operate for approximately 10 years at 4,000 to 6,000 hours

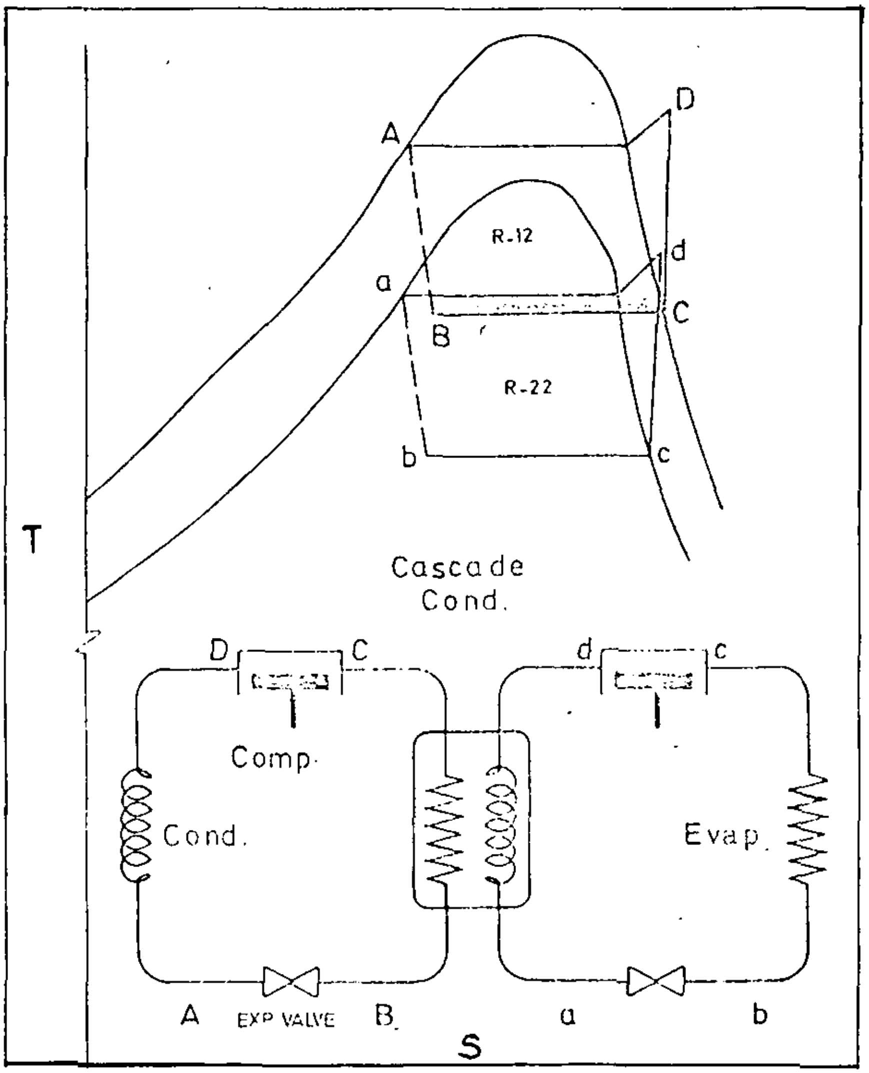
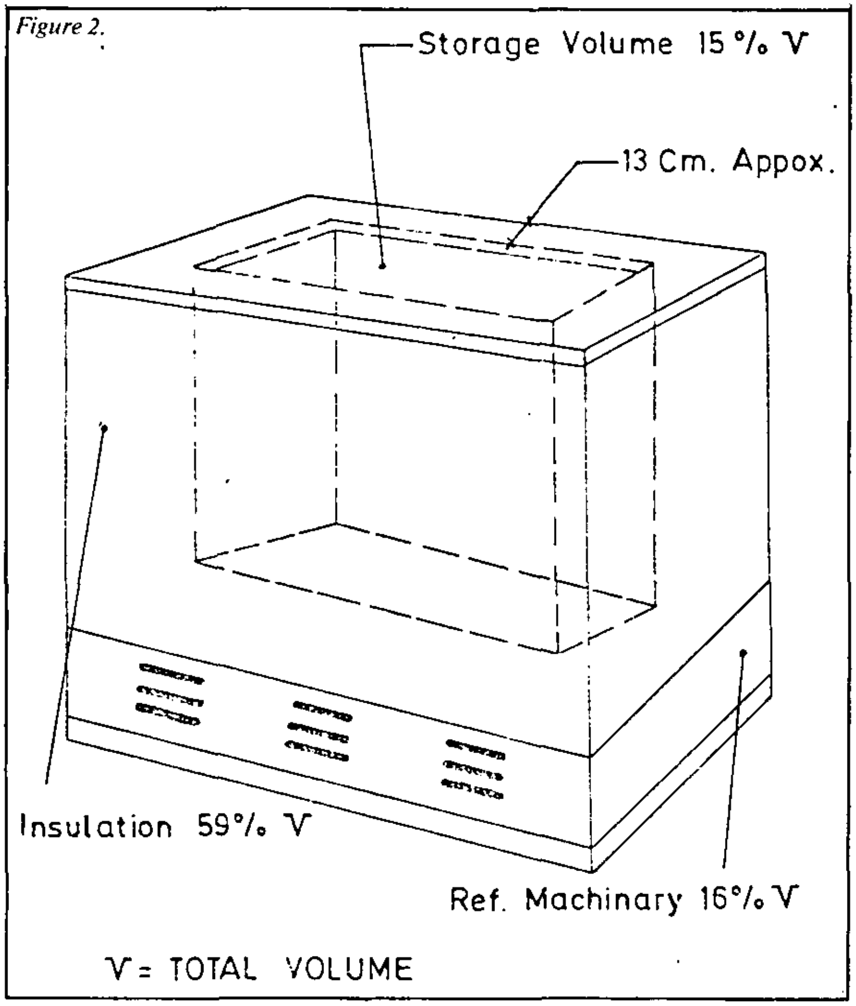


Figure 1. Two stage cascade system.

Figure 2.



a year, providing operational recommendations are followed carefully.

Liquid Nitrogen Refrigerators

LN_2 as a Refrigerant

Liquid nitrogen is an expendable refrigerant in the field of refrigeration of perishable foods, as well as in cryobiological products. The field of cryogenics involves temperatures below −150°C. When cold nitrogen gas is injected into an insulated container it produces 'cold'; and when liquid nitrogen is poured into an insulated chamber it produces 'very cold'. (Cryogenic: Kryos-Genes (Greek)). Liquid nitrogen boils at −195.8°C in a refrigerator at the tray level. Inside pressure diffuses vapour into the outside air through the gap around the lid and the neck. Temperature of the evolving vapour at the upper sections is maintained at −150°C, which is 'vapour phase storage temperature' for frozen blood. As long as liquid is present in the refrigerator, interior temperature can be controlled to any cryogenic degree above −196°C.

LN_2 Production

The liquification of air in the production of oxygen is essentially the ideal way of obtaining liquid nitrogen in industry. Various rare gases such as helium, xenon, krypton, and nitrogen are called 'cryogenic fluids'. The most important cryogenic fluid for cryopreservation is known to be LN_2. The term 'cryogenic' in blood transfusion service is normally related to temperatures below −150°C which is considered the 'warm' limit for LN_2 refrigerators. Liquid nitrogen is an expensive fluid, but the cost depends on several factors. In an industrial city LN_2 may be purchased at the lowest cost as a by-product. In another locality, to obtain LN_2 may be very inconvenient and unreliable. In the latter circumstance, the installation of a liquid nitrogen plant is advisable, bearing in mind that LN_2 produces favourable characteristics to meet increasing demands in health centres.

Though there are more efficient systems for air liquification and separation for producing large quantities of cryofluids, the Phillips plant is used principally for smaller installations.

The most popular liquid nitrogen producing plant operates on the Stirling cycle; (Robert Stirling — Scottish Minister, 1916) which was developed to be used in a hot-air engine and a refrigerator made out of the same engine within a short period afterwards.

Phillips systems are commonly used for the liquification of required nitrogen in the field of cryogenics and in producing ultra-low temperatures in blood banking. The performance of Phillips cryogenerators associated with the Stirling machine depends on the effectiveness of the regenerator to a considerable extent, which could be defined as a key to its successfulness.

Phillips liquid nitrogen plant consists of two major parts: 'cryogenerator' and 'nitrogen column', which are linked-up by the condenser flexible connection tube. As ambient air is sucked into the column, oxygen is exhausted and impurities are stored during the operation. The cryogenerator delivers LN_2 at a mean pressure of 24 Atm, and the pressurisation is accomplished by an electrometer driving pistons. On the upper part of the cryogenerator, the condenser changes the state of nitrogen from vapour to liquid. Production of LN_2 depends on working pressure, wet-bulb temperature of in-take air, altitude, cooling water temperature, and quantity.

LN_2 Storage

The most significant experiments in the history of events in the line of storage and handling of liquified gases were conducted by Sir James Dewar in 1892 when he made vacuum-jacketed glass vessels, and Linde Company developed the same principle to create super insulation. Dewar flasks are light-weighted aluminium containers used for manual pouring and storing of liquid nitrogen. The capacities of portable containers are in the range of 2 to 50 litres.

Cylinders are designed for long-term operations. Liquid cylinders have a larger storage volume and more flexibility in the distribution of liquid nitrogen. Normal evaporation pressurises the cylinder for a longer operating cycle.

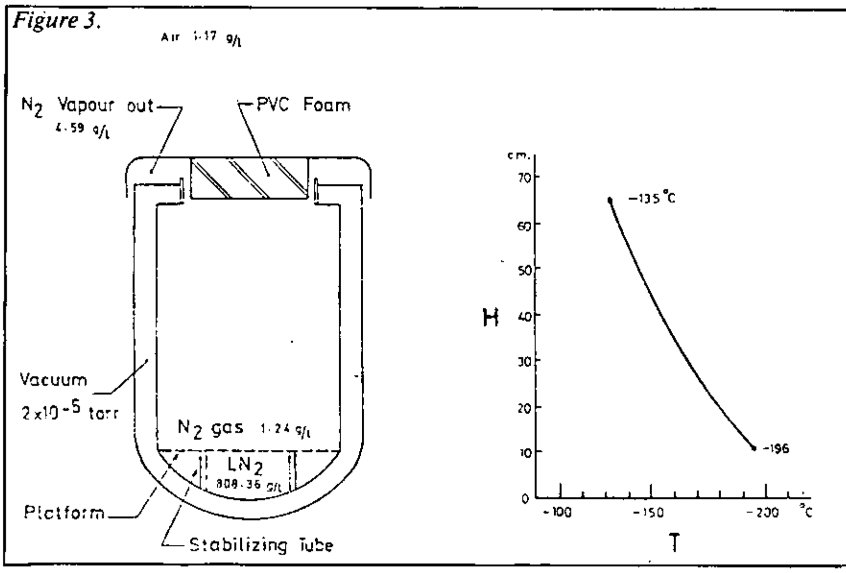
Horizontal vessels are used for storage and transport of liquid nitrogen. A vessel can be used as a collection reservoir (liquid receiver) while a liquifier feeds into an opening, and at the same time can transfer liquid as a (storage tank) with a centrifugal pump. The vessels are suitable for gravity filling from top neck and pressure dispensing by means of a pressure raising coil.

With a liquid nitrogen refrigerator, a continuous supply of refrigerant is required. For constant operation of refrigerator, liquid cylinders, horizontal vessels, etc, are made available. Automatic controls such as solenoid valves are simple controls mounted for large LN_2 refrigerators.

LN_2 Refrigerators

There are horizontal and cylindrical types of liquid nitrogen refrigerators with bulk storage capacities of approximately 50 to 800 litres. 'Refrigerator' may be defined as an apparatus for cooling and freezing. However, LN_2 refrigerators which service blood banks are used for freezing, and storage of frozen blood at cryogenic temperatures only.

Figure 3.



LN_2 refrigerators in a wide variety of storage capacities can control storage temperatures from −196° to −100°C in vapour-phase. Consumption rate, or in other words, the loss rate of nitrogen vapour, is normally more than that specified in the manufacturers' catalogues. Vacuum deterioration, incidence of lid openings, and the loss in the supply lines are the governing factors for consumption rate. In fact, the static evaporation rate (normal evaporation when the lid is closed) begins to increase the moment a refrigerator is ready to be shipped from the factory due to vacuum deterioration. Containers such as polyvinyl chloride or other cryogenic blood bags in aluminium blood bottles and boxes are used as frozen blood storage systems. Freezing of blood bags is completed at a rate of approximately 65°C per minute. Rapid cool-down of red cells does not change the temperature of the freezing compartment. There is a temperature gradient between the tray level and foam-insulated cover, as shown in *Figure 3*. The platform can be adjusted to higher or lower levels which alters the gradient. LN_2 refrigerators are reliable, simple, non-mechanical equipment. Failures are due to accidental hitting and careless vacuum breaking in most cases. Physical damage to the insulation and vacuum space cannot be repaired in the field. Quite often replacement is cheaper than repairing when a unit is returned to factory for repair. Studies of heat transfer, especially by thermal conduction in the nature of diffused heat flow from ambient temperature to super-cold side, are being carried out and advances in insulation techniques are expected.

Table of Relative Natures and Characteristics of Two Types

Classification of Principles	Mechanical Refrigerator	Liquid Nitrogen Refrigerator
1. Initial cost	Less expensive	More expensive
2. Operating cost	Lower	Higher
3. Servicing cost	More	Less
4. Maintenance cost	Higher	Lower
5. Installation	Easier	Easy
6. Trouble shooting	Difficult	Easy
7. Operator's technical standard	General mechanical technical	Senior technician
8. Experience of maintenance engineer	Must be trained & needs no special training	Must be trained
9. Floor space requirement	More	Less
10. Change of operating position and location	Very easy	Very difficult (could be impossible)
11. Heat emission to the room	Considerable	None
12. Refrigerants	Toxic	Safe
13. Noise pollution	Noisy	Quiet
14. Uniformity of temperature	More uniform	Less uniform
15. Reliability	Lower	Higher

Precaution

Cryogenic fluids at low temperatures can produce 'burn', but the effect and injury is unlike the 'hot burn' by high temperature thermal fluids. 'Cold liquid burn' blisters the skin, tears the flesh, and damages sensitive tissues, such as those of the eyes. Liquid nitrogen refrigerators and storage tanks must be installed in well-ventilated areas. As nitrogen gas is just slightly denser than air, it remains in the room air at the working level. Excessive concentration of nitrogen may present a life hazard due to low oxygen content in the air. When a room has to be closed, ventilated air should provide sufficient air changes per hour. Creating negative air pressure by low sidewall registers is recommended. Nitrogen is a relatively safe refrigerant providing one is thoroughly experienced in cryofluid handling.

Conclusion

Rapid development of blood transfusion services requires trained technicians and engineers as well as the cryobiologists. Manpower insufficiencies in the field of low temperature and cryogenics have stimulated the writer to pinpoint the technical fundamentals concerning refrigerators. Comparative evaluation of the refrigeration equipment should be of prime interest to Hospital Engineers. Frozen red cells are prepared in some general hospitals for clinical use in emergencies, intensive haemorrhaging, and in massive blood volume replacement during vascular surgery.

Many doctors believe that more hospitals will be freezing blood in the future and hospital engineers should be able to assist refrigeration technicians and to provide practical guidance to medical specialists regarding the question: "How do we produce 'very cold'?"

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This paper was presented to the 5th International Congress of Hospital Engineering in Lisbon, Portugal, in May, 1978.

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Management of Hospital Maintenance and Operations Services

J. KNIPE CEng MIMechE MInstF

Introduction

The National Health Service in England which controls most of the 2,000 hospitals in the country, came into operation in 1948. In general, these hospitals were old and under maintained at that time and it was not until the early 1960s that sufficient money became available to support hospital rebuilding and finance maintenance services adequately. Since then a programme of new and improved maintenance and operations management systems has been implemented, with the following objectives:

to improve the standard of service;
to optimise the life of the physical assets;
to ensure compliance with statutory and other regulations;
to extend the range of monitoring information;
to provide data for the purpose of improving cost effectiveness.

This programme continues and some of the systems and techniques which have been or are being brought into use are described in this paper.

The Estate

English hospitals range in size from small rural buildings to large urban teaching hospitals and the age span of these properties, illustrated in *Figure 1* which demonstrates the magnitude of the maintenance and operations task.

Period	% of Total Hospital Floor Area
Not known	7
Pre 1850	7
1851-1899	27
1900-1918	15
1919-1947	22
1948-1977	22

Figure 1.

The size of the enterprise is indicated by the following statistics:

Building and engineering maintenance costs — £140,000,000 per annum;
Operational services cost (including fuel) — £120,000,000 per annum;
Maintenance and operations work force — 23,565;
Percentage of work force employed on:
Engineering maintenance — 50%
Operational services — 10%
Building works and maintenance — 40%

The Structure

The National Health Service is directed by the Department of Health and managed through a hierarchy of Regional, Area and District administrations. The District is the smallest geographical division and may have as few as one or two hospitals. However, within most Districts there is a variety of health clinics, ambulance stations and other small buildings which also require maintenance and operations services. (*See Figure 2*).

The maintenance and operations functions are managed by Works Officers at Region, Area and District. Each tier in the hierarchy is divided into building and engineering sections and has a line management structure for each discipline. The national total of management staff and skilled, semi-skilled and operational grades employed at Area and District level is shown in *Figure 3* with the figures for each grade expressed as a percentage of the total personnel employed.

The assets of the National Health Service range from large complex hospitals to small health buildings, residential units and garages; from very old buildings to modern air-conditioned hospitals; from outdated and obsolescent engineering installations to the most modern electronic and medical engineering equipment. All have to be maintained and operated in accordance with the objectives of the National Health Service plan, in compliance with statutory requirements for buildings and plant and legislation for the health and safety of staff. To meet these requirements in a cost effective manner and to come to terms with the problems of organisation in an enterprise of such magnitude has necessitated the introduction of many new systems of control and management.

Works Department Staffing

Nearly all the directly employed labour (a significant portion of specialised maintenance work is undertaken by private contractors) required for maintenance and operations in the Health Service is employed by the Area Authorities. The national staffing and structure for Areas set out in *Figure 4* shows the various grades and numbers either in post or projected.

Manpower Allocations

The duties and, in some cases, the complements of managerial staff from Area Works Officer down to Assistant Engineer/Building Supervisor level are governed by national agreements negotiated centrally between the employers and organisations representing staff interests. These agreements include formal job specifications for all these grades, outlining their duties, responsibilities, relationships and the academic qualifications necessary. They may regulate the number of posts that can be filled. For example, one, and only one, Area Works Officer, Area Engineer and Area Building Officer may be appointed in an Area and there are also conditions which affect the complements of other grades in the structure.

At maintenance craftsman level, the amount of maintenance work is the determining factor and a system which equates work load to building volume, weighted according to the complexity and intensity of the engineering services within a building, has been adopted by the writer. This system divides health buildings into three categories according to the service they provide and the range and intensity of plant and equipment installed to meet the requirements of that service. *Figure 5* illustrates the type of health buildings found in the categories and lists typical items of plant which are installed in them.

Organisational efficiency is dependent upon a number of factors but improvements may be achieved by Managers:

Developing management systems such as those described later in this report;
Encouraging self-analysis and job appraisal;
Undergoing further training.
and subordinate personnel:
Having delegated responsibility for planning and controlling work;

Figure 2. **NHS Management Structure.**

Name	*Number of*	*Functions*
Department of Health and Social Security	1	Allocates finance and provides policy guidance on maintenance and operations. Monitors performance. Gives professional and technical leadership.
Regional Health Authorities	14	Co-ordinate Area plans into Regional plans for maintenance and operations. Give professional and technical leadership. Give advice and guidance to Areas and monitor performance. Distribute funds. (Some Regions provide staff and workshops for specialist maintenance services.)
Area Health Authorities	90	Exercise responsibility for the maintenance and operations of engineering, buildings & grounds. Prepare Area maintenance programmes in accordance with Department of Health guidelines and the Regional plan. (The Area authority is the maintenance management organisation responsible for all assets within the Area.)
District Management Teams	171	Prepare District programmes in accordance with Area plans. Maintain buildings, plant and equipment, and ensure satisfactory operation of services.

Figure 3. Staff at Area and District — National Total.

	Engineering		*Building*	
	Number of Staff	*Percentage of Total Staff*	*Number of Staff*	*Percentage of Total Staff*
Management	2,025	14.5	740	7.7
Craftsmen/Techs	7,700	55.3	7,500	77.8
Semi-skilled	2,200	15.8	1,400	14.5
Operations	2,000	14.4	—	—
Total Numbers	13,925	100%	9,640	100%

Figure 4. **National Staffing Structures for Areas.**

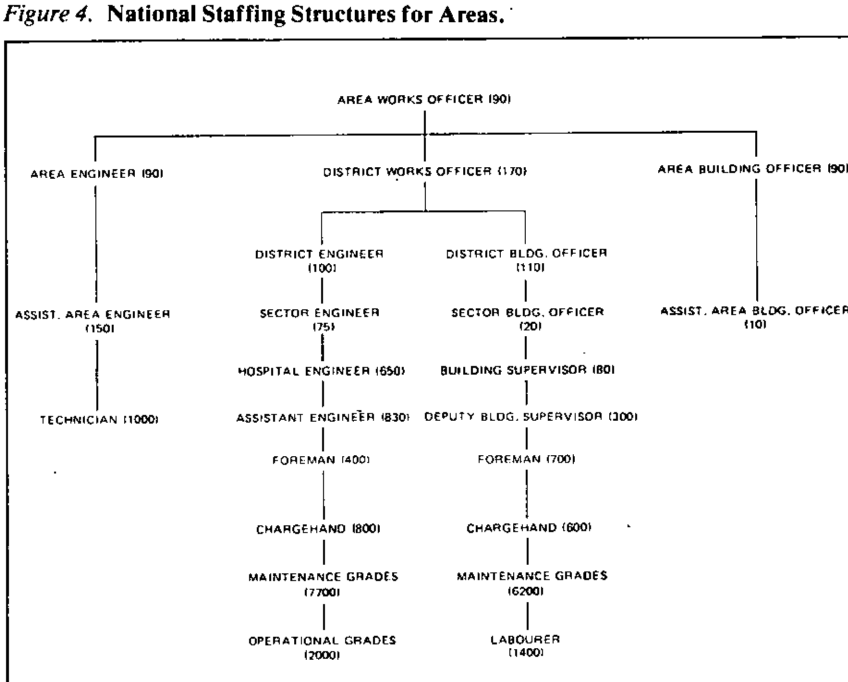

Figure 5.

Health Building Categories and Typical Plant Lists

Category A	*Typical Plant List*
Hospitals for psychiatric, chronic sick and geriatric patients, Health Centres staff accommodation, training schools. (Main objective is welfare and comfort of patients — not specialised surgery.)	Boilers, Heating Services. Water Supplies. Gas Services. Lighting and Power. Catering. Alarm Systems. Fire Fighting. Telephones. Minor Therapy Equipment. Clinical Equipment. Domestic Cleaning and Laundry Equipment. Refrigeration Plant.
Category B Acute, children's and maternity hospitals giving specialist medical and surgical treatment and having clinics laboratories, laundries, etc.	Some air-conditioning plant. Minor lift installations. Operating theatres. Piped Medical Gases. Sterilizing Equipment. X-ray equipment (diagnostic). Laboratory Equipment. Compressed Air and Vacuum Equipment. Patient call and communication systems. Some medical engineering equipment. Plus the equipment in category A buildings.
Category C Teaching and new district general hospitals having considerable and complex plant. Large, upgraded general hospitals with teaching and research facilities plus specialist installations to support medical and surgical treatment.	Air-conditioning plant (extensive). Major lifts. Central Compressed Air and Vacuum Systems. Medical Research Facilities. Dental Equipment. Pharmacy and Laboratory Equipment. Extensive sterilizing and medical engineering. X-ray equipment (Therapeutic and Diagnostic). Extensive Operaing Theatres. Piped Medical Gases (Bulk Storage) plus the equipment in Category A buildings.

Taking an active role in logistic support services;
Undergoing further education and training.

Job Appraisal

Self-analysis, job appraisal and the better utilisation of management time are among subjects included in the national advanced training courses for Works Department Managers. They are encouraged to obtain the benefits which arise from self-analysis and an objective job appraisal and it is suggested that they ask themselves and answer the following questions:

What is my role?
How well do I perform it?
Can I improve my performance?
Am I making best use of guidance and procedures?
How is my time utilised?

Estate Management (Building, Engineering and Grounds) Practices Code (Estmancode)

Estmancode is an estate management practices code for the National Health Service, providing policy and technical guidance for Works Department managers engaged in maintenance and operations of NHS assets. Some sections of the code are complete and others are still being prepared or updated but the contents list includes:

Planning and Controlling Maintenance Expenditure;
Executing Maintenance Work;
The Design/Maintenance Relationship;
Property Management;
Estate Legislation;
Maintenance Policy, Standards and Efficiency;
Works Department Organisation;
Maintenance Management Information;
Property Transactions;
Directory of Estate Management Information.

In Estmancode maintenance work is divided into four basic classifications:

(a) Periodical maintenance work;
(b) Irregular maintenance;
(c) Day-to-day requisition maintenance;
(d) Extension, improvement and adaptation of existing assets.

These classifications apply to both building and engineering assets.

All expenditure in classifications a, b and c and projects costing under £10,000 (excluding land costs) in classification d is charged to the estates Revenue budget. Projects in classification d costing over £10,000 (excluding land costs) are charged to the Capital Works budget.

Planned Preventive Maintenance

The Department of Health system of planned preventive engineering maintenance is now applied extensively to engineering plant and services in the UK and has attracted considerable interest in other countries. The system is described in detail in Estmancode.

The DHSS preventive maintenance system is comprehensive, adaptable, easily introduced and simple to use. The benefits of the system are:

A comprehensive inventory of assets is prepared which provides information to assist management decisions;
Assets are maintained and preserved in a safe and efficient condition;
The incidence of breakdowns and emergency situations is minimised;
Maintenance manpower resources are deployed on a planned basis, reducing unproductive time;
Major repair occurrences are lessened and the economic life of assets is extended.

The work of introducing the system is in five parts:

Dividing the hospital into a number of integral units to facilitate the survey and assist maintenance control. Examples of typical units are:
Boiler House;
Wards;
Residential Accommodation; etc.
Surveying the hospital, unit by unit, to establish the inventory.
Compiling the inventory from the survey.
Estimating the time taken to undertake the preventive maintenance tasks in each unit.
Calculating the manpower resources required and preparing a plan to spread the workload over the year.
Note: The preventive maintenance tasks are specified in standard manuals which are revised at intervals in response to feedback information from the field.

The system is operated according to a calendar programme by which work dockets are issued on a weekly basis to the maintenance craftsmen. These work dockets direct the craftsmen to the units where maintenance functions are due and specify the tasks required there. Progress is recorded on a chart which shows the maintenance function for each unit of the hospital for every week of the year. A similar system is used for organising building preventive maintenance.

The development of preventive maintenance techniques for engineering services has reduced the incidence of unforeseen breakdowns and the need for corrective maintenance (adjustment, repair and overhaul). Corrective maintenance is costly since it does not lend itself to close planning, and it may produce excessive periods of 'out of service' time in vital plant and equipment and thus disrupt essential services.

Preventive maintenance systems must, however, be closely monitored if they are to be operated efficiently. In many cases, the frequencies at which maintenance tasks are performed are decided at the inception of the scheme and are never reviewed to ensure that they are set at the correct intervals. It is also necessary to check from time to time that the craftsman has, in fact, carried out the maintenance function in accordance with specification and that his reports on the condition of plant and equipment are completed accurately.

Another factor which must be taken into consideration is the need to re-examine the work specifications after a period of use to ascertain that the maintenance requirement of the plant, equipment and installations is being satisfied.

Reviews of preventive maintenance programmes can produce substantial savings in labour costs and may improve the overall efficiency of plant and equipment. Feedback reports should be examined carefully and, where appropriate, the frequency of maintenance visits and the job specifications adjusted. The objective should be to ensure that the services are neither undermaintained and hence develop malfunctions between service visits, nor unnecessarily dismantled or overmaintained which may induce faults in otherwise sound plant and equipment.

Medical Engineering Maintenance

This expanding activity of the National Health Service merits special mention because of the innovative technology employed and the increasing maintenance requirements of this range of equipment in modern hospitals. Over the years, the cost of engineering installations, plant and equipment in general has mounted steadily and it is certain that medical engineering equipment costs have increased at a higher rate, particularly in category B and C hospitals.

A typical inventory of medical engineering equipment for a District Health Authority is shown in *Figure 6.* This Authority comprises:

Two acute hospitals (575 and 203 beds);
One geriatric hospital (132 beds);
One maternity hospital (72 beds);
One mental illness hospital (1,492 beds);
One partly acute hospital (101 beds);
One mental handicap hospital (480 beds).

The table illustrated shows that 1,267 medical engineering items were in use and maintenance expenditure in 1977 was £104,112. At an estimated capital value of about £1,000,000, maintenance costs are 10% per annum which is considered reasonable for this type of equipment. It will also be noted that the labour resources required for maintenance amount to 11,135 man hours per annum.

Figure 6 **Approximate Annual Maintenance Cost of Medical Engineering Equipment in a Health District**

Equipment Types	*No. of*	*Total Hours Per Annum*	*Labour Cost**	*Spares Costs at 10% Labour*	*Total Costs £*
Electrocardiogram Monitor	39	195	1,657.5	165.75	1,823.25
Electrocardiogram Monitor with Defibrillator	18	288	2,448.0	244.8	2,692.8
Defibrillator	14	224	1,904.0	190.4	2,094.4
Chart Recorder	15	75	637.5	63.75	701.25
Fibre Optics, Cryogens, etc	17	85	722.5	72.25	794.75
Pacemaker	4	64	544.0	54.4	598.4
Multi Channel Recorders	13	65	552.5	55.25	607.75
Short Wave Diathermy	13	65	552.5	55.25	607.75
Pulse Generator	9	45	382.5	38.25	420.75
Ultrasonic Generator	6	30	255	25.5	280.5
Electrocardiograph Machine	14	70	595	59.5	654.5
Pill Counter	4	20	170	17.0	187.0
Pulse Monitor	4	20	170	17.0	187.0
Other Monitors	20	100	850	85.0	935.0
Surgical Diathermy	15	75	637.5	63.75	701.25
Blood Warmers	9	45	382.5	38.25	420.75
Telecommunications	283	1,455	12,367.5	1,236.75	13,604.25
Controls	133	1,165	9,902.5	990.25	10,892.75
Weighing Machine	1	5	42.5	4.25	46.75
Miscellaneous Measuring Instruments	93	465	3,952.5	395.25	4,347.75
Dialysis Machine	1	5	42.5	4.25	46.75
Foetal Heart and Apnoea Monitor	12	60	510.0	51.0	561.0
Electro-myograph machine	8	40	340.0	34.0	374.0
Path Lab Instruments	89	440	3,740.0	374.0	4,114.0
Pulmonary Function Instruments	12	60	510.0	51.0	561.0
Incubators	14	70	595.0	59.5	654.5
Computerised Patient Monitoring System Terminals	32	160	1,360.0	136.0	1,496.0
Teaching Aids	32	160	1,360.0	136.0	1,496.0
Anaesthetic Instruments	3	15	127.5	12.75	140.25
Electro-encephalograph Machine	14	70	595.0	59.5	654.5
Dental Equipment	9	45	382.5	38.25	420.75
Electro Convulsive Therapy Unit	6	30	255.0	25.50	280.75
Ventilators	33	1,254	10,659.0	1,065.9	11,724.50
Suction Units	278	4,170	35,445.0	3,544.5	38,989.50
Totals	1,267	11.135	94,647.5	9,464.75	104,112.25

* Labour cost at £8.50 per hour including overheads.

If, for the purposes of this paper, these figures are taken as representative for Health Districts in England, it is likely that the capital value of the medical engineering equipment throughout the country's hospitals is of the order of £180,000,000, with an annual maintenance cost of some £18,000,000. These figures do not include:

X-ray or high energy radiation equipment.
Electronic control gear as in lifts, etc.
Mobile telecommunication equipment.
Advanced electronic systems now being introduced.

The maintenance and repair of medical engineering equipment is undertaken by Area-based technicians, physicists, manufacturers' service engineers, or hospital-based technicians. In general, the use of hospital-based technicians is preferred and the employment of such personnel is easier to justify now that the medical engineering content of hospitals is increasing. It is the general practice for physicists to concentrate mainly on medical engineering development and assist with maintenance only when this is necessary. The high costs of travel and the loss of resources during travelling militate against the use of mobile personnel in most situations.

With this increasing medical engineering work load in mind, the Department of Health has paid particular attention to the requirements of technicians in the National Health Service Works Departments. Specific developments include:

Design of facilities for workshops.
Specification of test equipment.
Preparation of technical manuals.
Development of planned maintenance schedules.
General training courses on electronic subjects.
Specific training for specialised equipment.

Policy guidance and technical assistance on medical engineering matters to Regions, Areas and Districts in the National Health Service, is provided by the Department of Health and is often sought by health service engineers from other countries who are faced with a similar influx of high technology equipment.

Measurement of Performance

It is common practice to operate cost controls and monitor budget variances to measure the performance of Works Departments but it is difficult to relate expenditure to the standard of maintenance which ought to be achieved if allocations were utilised efficiently.

In the National Health Service, Works Department budgets and expenditure are monitored by the use of a cost coding system. This may be supplemented by inspecting the engineering installations and assessing the standard of maintenance so that performance may be reviewed against expenditure levels.

Cost Codes

The cost code system provides cost data under a number of headings which produce total costs for:

Basic Maintenance of Engineering Services;
Planned Maintenance (Engineering);
Minor Capital Work (Engineering);
Capital Works (Engineering);
Basic Maintenance of Buildings;
Planned Maintenance (Buildings);
Minor Capital Work (Buildings);
Capital Works (Buildings);
Maintenance of Grounds.

A two digit primary code number is used to cost major elements of maintenance expenditure. For example:

08 — Maintenance of mechanical services.
09 — Maintenance of electrical services.

A system of secondary coding breaks these main elements into sub divisions and thus refines costing information. For example:

091 — Maintenance of electrical services (power);
092 — Maintenance of electrical services (lighting);
095 — Maintenance of electrical services (Communications).

Maintenance Standards

The basis adopted for assessing maintenance standards is defined as "Those standards which represent the condition of the asset, seen to exist at the time of an inspection, when related to the condition when installed as new." The standards are determined by an inspector, working to specific guidelines and examining five facets of asset condition. These are:

Wear/corrosion;
Leakage/service loss;
Safety;
Operation;
Miscellaneous.

The record sheets and other forms required for the exercise are supplied by the Department of Health which also provides guidance for the inspectors who carry out the examination.

Many conditions can be determined visually but some are assessed by measurements of performance. Reference is also made to log books, preventive maintenance documentation and other records and, where regular inspections and tests are required by statute, certificates and registers are examined.

Records are marked taking 100 as a datum representing the 'as new' condition of the asset and making deductions for deficiencies in each of the five facets of condition as applicable. A representative sample of the assets must be inspected and for engineering this should not be less than 70% of the total installation. Typical examples of features which lose marks are given in *Figure 7.*

Figure 7.

Maintenance Facet	*Examples of lost marks*
Wear/Corrosion	Noisy bearings, chains or gears. Visual indications on ropes, chains or wheels. Rust or loss of protective coatings.
Leakage or Service Loss	Leaks from seals, glands, tanks, ducts. Loss of condensates. Leaks causing poor combustion. Unsatisfactory thermal insulation. Dirty or scaled heat transfer surfaces.

This system of measurement has proved of value in indicating maintenance requirements and in providing information for assessing priorities when allocating funds. The standards of acceptance for a particular asset will vary according to the type of hospital being inspected and according to the use to which the asset is put. Clearly the services to the operating theatre warrant a higher standard than those to residential blocks. However, all assets have to be maintained at a level which prevents waste (for example, conservation of energy) and which satisfies the Health & Safety at Work Act 1974 and other statutory obligations. A standard of 80% should be achieved when a preventive maintenance system is in operation.

Safety Audits

In addition to the above inspections, a safety audit procedure has been developed for NHS engineering installations. The audit is intended to ensure that Government legislation and Health Service regulations relating to health and safety at work are being observed and to draw attention to any hazard likely to endanger or impair the health of personnel. The audit is particularly concerned with:

Compliance with statutory regulations eg:

- fencing and guarding machinery;
- abrasive wheel procedures;
- examination and testing of pressure vessels, lifts etc;
- fire precautions;
- high voltage electricity regulations.

Display and communication of safety information.
Safety of piped medical gas, air and vacuum services.
The effectiveness of planned maintenance systems (essential for ensuring safe and efficient plant).
Availability of safety equipment and the effectiveness of safety procedures for personnel.

In the event of an unsatisfactory report on any aspect of health and safety, the responsible officer is informed and the appropriate action initiated.

Defect and Failure Reports

Defect and failure reports provide information of faults, hazards or undue wear on specific assets and lead to investigation and subsequent action upon the subject of the report. They also contribute to data banks of information about equipment, materials and manufacturers. Reports are designed to indicate:

The precise item being reported.
The nature of the defect or failure.
If any disruption of services was caused.
The extent of remedial work and its cost.

Three orders of priority exist:

HAZARD — danger to life or property — action required within two weeks.
URGENT — urgent action needed to

restore plant or service — action required within four weeks.
NORMAL — action required within three months.

Time limits for response to reports are imposed on the investigators and the originators are kept informed of progress on matters reported by them.

Commissioning

The pattern of use for an asset, the life cycle costs, and its effective life span are greatly influenced by the commissioning procedures. Commissioning is not just a 'starting' routine, but is an integrated programme which ensures the supply and installation of an asset in accordance with design and specification and the requirements of the user in a cost effective manner. Commissioning is concerned with satisfying the design intent and begins when the complete requirements of the user are prepared and specified to the designers/suppliers.

It is desirable that the commissioning engineer understands the principles of:

Asset management.
Terotechnology.
Condition monitoring.
Design-out-maintenance.
Maintainability and reliability.
Logistics support (training, information and spares.)
Ergonomics of maintenance and operations.
Inspection, testing and certification.
Maintenance planning and organisation.
Health, Safety and Fire regulations.

The commissioning process must ensure that:

The design intent as specified is met.
Installation is correct and to specification.
Delays at or after start-up are minimised.
User personnel are trained and informed.
Records are kept for comparison with later tests.
Where specified the economic life cycle costs are likely to be achieved.

The commissioning routines must record that:

Facilities for testing are in accordance with specification.
Pre-commissioning of materials and products at manufacturer's premises is provided for as specified.
Materials and spares are approved upon receipt, whether for immediate or future use.
All items are inspected after installation for good condition, workmanship and compliance with specification.
Initial run-up and test gives good results.
Full specified design intent is achieved on running.
The logistics support package as specified is satisfactory, for example:

training for operators and maintenance personnel has been arranged.
spares lists and procedures for ordering have been obtained;
planned maintenance and lubrication routines are available.
test certificates and guarantees have been provided;
drawings and wiring diagrams are correct;
operating, maintenance and spares manuals have been provided;
fault diagnosis and repair procedures are in order;
commissioning check lists and records have been prepared.

Defects are recorded and appropriate action taken.
Technical support contracts are negotiated (if necessary).

The cost of thorough commissioning can be substantial but there is an attractive trade-off in the reduction of costs from:

Possible delays in completion and handover.
Possible delays in reaching specified outputs.
Maintenance and operations in the life cycle.
Availability and reliability problems in the life cycle.
Repairs, refurbishing and eventual renewal of the asset.

The correct use of commissioning procedures and their combination with preventive maintenance records and feedback data can influence plant design, asset selection and maintenance and operations techniques as illustrated by the following examples:

Tribology studies have in some cases removed the requirement to lubricate machinery.
Changes in construction materials have reduced maintenance costs to provide a good 'trade-off' against increased initial costs.
Ergonomic studies have improved the use of assets and reduced mis-use.
Better access for maintenance purposes has reduced plant maintenance costs.

Cost benefits are already apparent in the short-term but for the next generation of assets, the savings will be considerable.

The Computer in the Works Department

The computer can process and store information which can facilitate a number of Works Department management functions including:

Inventory recording and updating.
Optimisation of maintenance plans.
Allocation of manpower resources.
Implementation of the maintenance plan.
Classification and recording of feedback.
Preparation of cost, performance and technical data.

The use of manual methods for many of these tasks is slow and costly, particularly for recording feedback and for preparation of management information. The National Health Service computer system is designed to operate within the framework of Estmancode and the Department of Health planned preventive maintenance system.

Planned preventive maintenance is generally introduced by the official Department of Health system and operated manually until proved. To transfer the system to the computer requires an appropriate computer programme and input documents by which the required data is transferred to the computer file. Each maintenance task has its individual computer input card which contains:

Physical references for the asset.
Cost code references.
Inventory code.
Estmancode maintenance classification.
Maintenance manual reference.
Description of work.
Frequency of service.
Estimated work time.

When this information is in the computer memory, a work docket will be produced in each period when a maintenance task is due. The craftsman will complete the task and enter information on the docket which will provide the computer with feedback on which costs and other statistics are based.

The computer is unrivalled as a source of statistical management information, provided that the input is disciplined to ensure accuracy and relevancy. A vast quantity of data can be 'scanned' in a very short time to produce a variety of cost, resource control and technical statistics. Additional input documents are available so that materials costs and allocations, works requisitions, capital project information and contractors costs can be included.

Management information outputs include:

Capital and revenue expenditure.
Maintenance control and planning error reports.
Summary of craftsmen's time records.
Cost statement summary per project.
Analysis of preventive maintenance effectiveness.
Comparisons of actual work times with

estimates.
Maintenance costs in each of the Estmancode classifications.
Cost coding figures.
Costs per building or other elements as required.

Other management and control applications include:

Interface with the stock control system.
Fuel, light and power analysis.
Budget comparisons.
Asset renewal calculations.
Cost ratios (such as maintenance costs to capital value).
Maintainability, reliability, availability indices.
Maintenance standards.

In the longer term the computer is the ideal tool with which to manage a data base of information concerning asset selection and operation. As an example maintainability, reliability and availability indices can be linked with the cost elements of a life-cycle analysis to guide management in the choice of assets, the selection of suppliers and contractors, and in providing feedback to design and commissioning teams so that increased attention (based on facts) is given to maintenance and operations requirements.

As an indication of the time taken by punch card operators, employed by a health authority, to produce input data for 500 Works Department personnel, 14 hours per week are required for processing time sheets (4,900 records) and 24 hours per week are required for processing work order cards/work requisitions etc (5,000 records).

Processing the work cards and requisitions is the slower operation mainly because the input documents are prepared by non technical staff and because there is a mixture of alphabetical and numerical data. However, the savings in clerical time are considerable, errors are minimised and information is quickly available for management purposes.

Condition Monitoring

In condition-based maintenance an attempt is made to base repair and overhaul activities upon a knowledge of the condition of the asset, the knowledge being gained from monitoring techniques and without the need for dismantling. This does not suggest that preventive maintenance should be discontinued: merely that it should be integrated with a condition monitoring programme. In fact, preventive maintenance routines can be involved at every level of condition monitoring.

There are four levels of condition monitoring activity:

Visual and other sensory examinations by personnel during preventive maintenance inspections.
Tests on the health of the asset using portable equipment (such as vibration testers).
Sampling and testing of lubricants.
Fixed monitoring and alarm systems.

Techniques used at the various levels include:

Level 1 — Human senses assisted by viewing devices and fixed indicators.
Level 2 — Vibration analysers, test instruments, tachometers, frequency analysers, ultrasonic devices.
Level 3 — Spectrometric analysis of lubricants, analysis of particles and debris.
Level 4 — Transducers, accelerometers and other sensors connected to instrument panels and alarms by individual wires or time division multiplex systems.

It is important when selecting monitoring equipment that:

The cost can be justified.
The monitor is more reliable than the plant and equipment that it monitors.
The equipment fails to safe.
The equipment does not attract heavy maintenance and technical support costs.
The equipment is supported by:
- training for operatives;
- training for engineers;
- information (manuals and drawings);
- spare-parts and spare modules availability.

Reliability and maintainability, with cost effectiveness in operation, are as important for the test equipment as for the assets themselves to ensure that the advantages of monitoring are not cancelled by monitoring costs.

Feedback

The feedback of costing information, performance ratings and technical data is vital for improving management of Works Departments in the National Health Service. Costing figures and their relationship to maintenance standards are important as a means of monitoring performance against targets but technical information is also required to improve design and assist in reaching planning, manning and asset procurement decisions. Elimination of health and safety hazards is also highly dependent on feedback from National Health Service Works Department managers.

The information received by the Department of Health includes:

Cost coding returns.
Defect and failure reports.
Preventive maintenance progress reports.
Maintenance standards reports.
Energy audit reports.

All the information received by the Department of Health is processed centrally, and when appropriate, eg when a hazard condition in plant or equipment has been reported, the National Health Service is advised so that remedial action may be taken.

Processing feedback data on a national scale is time consuming and costly but it is hoped that by extending the use of computers it will be possible to process more information quickly and accurately and thus improve Works Department efficiency.

Training

The trained manager can make his organisation cost effective and at the same time deploy his human and material resources to best effect in order to ensure a high standard of service to medical staff and patients, and maximum protection of the buildings and other assets. In the National Health Service it is difficult to provide profit and loss statistics in monetary terms, as is normal in industry, but, secondary to the all-important task of maintaining standards of patient care, the objectives are comparable in terms of utilisation factors and asset protection. This latter point is becoming increasingly important in an inflationary period, when renewal costs for buildings, plant and equipment are escalating.

In this context the education and training of management and other personnel represents a very good investment. Not only does it encourage best performance of duties but it enables managers and others to look for improvements and developments. Training is essential when new management systems, such as described in this report, are introduced. As an example, large numbers of personnel are trained in the application of the National Health Service system for preventive maintenance. Considerable benefit can be obtained from management training in maintenance planning, in resource allocation, and in the techniques for adjusting plans in response to feedback data.

Training programmes also exist for works personnel who have to become familiar with new types of equipment or more complex installations. These programmes are useful for personnel entering the health service from other fields of work and also for personnel being transferred from Category A type hospitals to those in Categories B or C.

Subjects covered include:

Automatic controls.
Refrigeration.
Sterilization.
Ventilation and air-conditioning.
Electronics.
Electrical engineering for mechanical engineers.
Steam conservation and utilisation.
Communication and alarm systems.

Terotechnology

In recent years a number of systems and codes of practice have been introduced into National Health Service Works Departments to develop efficient management of hospital engineering. In parallel with these developments, investigations by a Government Ministry, the Department of Trade and Industry, produced the concept of Terotechnology which is defined as:

"A combination of management, financial, engineering and other practices applied to physical assets in the pursuit of economic life-cycle costs."

Its practice is concerned with the specification and design for reliability and maintainability of plant, machinery, equipment, buildings and structures, with their installation, commissioning, maintenance, modification and replacement, and with feedback of information on design, performance and costs.

The concept of terotechnology introduces a comprehensive approach to the maintenance and operations of assets, relating not only to management systems but extending back to design, commissioning, procurement, and capital works planning. Within the National Health Service many of the new systems and codes of practice have helped to ensure that assets are provided, maintained and operated in a cost effective way. Considered together these systems and practices represent applied terotechnology as defined above and, if implemented conscientiously, will ensure the provision of safe, reliable, cost effective engineering installations, plant and equipment and effective use of the human and material resources available to Works Department managers.

Conclusion

This paper describes a number of ways in which those engaged in Works Department activities can effectively contribute to the efficient management of maintenance and operations services for buildings, plant and equipment in the National Health Service. There are immediate benefits from adopting these techniques and, in the long term, the feedback to designers and procurement officers responsible for the provision of new assets will further improve the efficiency of Works Departments and optimise life-cycle costs.

National Health Service procedures, consultancy arrangements and training programmes have been introduced by an increasing number of hospital authorities in other countries. In England experience has been acquired over a considerable time span but it is desirable, in World Health terms, to reduce the learning period wherever hospital and health facilities are being provided or extended. In particular, investors of the future can be expected to benefit substantially from the mass of feedback information now being generated, especially when technical data and cost information is computer processed and easily retrievable.

The success or otherwise of hospital maintenance and operations services ultimately depends on the quality of managers, technicians and craftsmen rather than on procedures or systems. They need however, the co-operation of the medical, administrative, financial and other hospital professions if they are to play their full part in the rewarding task of providing vital services and amenities for hospital patients.

Hospital Fire Precautions: Towards Cost Effective Design

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This paper was also given at the Lisbon Congress in May 1978.

Introduction

In recent years a combination of factors has led to a growth of safety legislation in the UK, not least in the field of fire precautions. This has been partly due to technological changes, such as the greater use of plastic materials, which have increased the risks, and partly also as a result of growing affluence. The recent economic downturn has posed the problem of reconciling increased demands for more safety with less money. It is therefore essential that resources devoted to safety are used to maximum effectiveness. Nowhere is this need greater than in the Health Service, where increased building costs due to fire precautions would result in fewer new health facilities. In most cases these facilities might be expected to have a far greater life-saving potential than conventional fire precautions.

In recent years there has been a growth of interest in probabilistic systems-based approaches to hazard analysis. The drive has come primarily from the Nuclear and Chemical Industries, both of which present potentially catastrophic hazards. More recent attempts, however, have been made in the USA by the NBS and the NFPA to apply these methods to the general fire problem. This offers the possibility of optimising expenditure on fire precautions on the basis of recorded fire statistics.

The need to maximise cost effectiveness has also led the drive to develop cheaper fire protection hardware.

UK Hospital Fire Statistics

In the UK there are about 2,000 hospital fires reported to the fire brigade each year. The true figure is certainly higher but those fires not reported are all very small. Seventy per cent of reported fires are put out before the fire brigade arrives by using no more than a first aid hose reel. The proportion of fires involving injury or fatality is very small.

Over an eight-year period between 1968 and 1975 there were 99 fatalities in hospital fires in England and Wales reported to the Department of Health and Social Security. All except one were in mental illness, mental handicap, geriatric or similar long stay wards. Two thirds of these fatalities occurred in six multiple-fatality fires. In order to put these figures into perspective we must consider the total population at risk and the length of time they are at risk. We can then calculate a statistic known as the fatal accident fatality rate (FAFR) which is defined as the number of fatalities per 10^8 exposed hours. Thus:

$$\text{FAFR} = \frac{\text{No. of fatalities per annum}}{\text{No. of hours per annum}} \times 10^8$$

In *Table 1*, below, fatal accident fatality rates are shown for a variety of risks.

Table 1. Risk of death per 10^8 exposed hours

1. In fire at home	0.2
2. In fire in *long stay hospital ward*	0.7
3. In fire acute ward	.003*
4. At home by accident	3.0
5. In hotel by fire	1.0
6. Motor car	57.0

(*Based on 1 fatality).

Clearly the fire fatality risk in acute wards is negligible. In long stay wards the fire fatality risk is relatively small in comparison with other general risks, but it is significant in comparison with other fire risks. As already mentioned, two thirds of the casualties have been due to multiple fatality fires. Thus we can identify the hospital fire problem in the UK as primarily the problem of the multiple fatality fire in the long stay ward. It is worth pointing out that this may not necessarily be true internationally. Fire fatality rates differ widely: eg 5.7 per 100,000 inhabitants in the USA compared with 0.2 in Switzerland. International comparisons of hospital fires might offer useful guidelines for fire precaution policy.

Another aspect to the complexity of the phenomenon of fire is that it is necessary to regard it as a stochastic or probabilistic process. The complexity leads to uncertainty. It will never be possible to determine an optimum fire precaution policy on the basis of a few simple rules. If the determination of such policy is not to degenerate into a meaningless charade of opinion and counter opinion then it must have a quantifiable objective. Safety is only definable in terms of a probability, or as the complement of a hazard rate. The systems approach and particularly the decision or fault tree approach to hazard analysis has been developed in some depth by the Nuclear and Chemical industries. Its application to general fire problems is being developed in the USA by the National Bureau of Standards and the National Fire Protection Association. In the UK the Department of Health and Social Security, in collaboration with the Department of Fire Safety Engineering at the University of Edinburgh, have been developing a similar approach.

A simplified version of a decision tree applied to a hospital ward multiple fatality fire is shown below.

The essence of the method is the construction of a model of the chain of events or failures which lead to the final outcome. Stages or events are linked by AND gates or OR gates. Each event has a probability of occurrence which can in many cases be derived from actual fire statistics. For 'Failure' logic, and where probabilities are small and random, we add probabilities in the OR gate and multiply them in the AND gate. In the USA they use 'success' logic and the above rules are reversed.

The Decision or Fault Tree approach is not the only possible systems approach to fire hazard analysis. If one were not able to identify one major outcome then it would be necessary to consider many outcomes. This could be done by applying matrix methods. The technique of the decision table (BERENBLUT) is applicable to the situation where it is not possible to draw up a model and where every possible combination of events needs to be considered.

Further consideration of the tree approach enables one to predict the effect of particular fire precautions on the final outcome. As an example it has been suggested elsewhere[2] that in hospitals a strategy based on early warning and extinction by first aid means might have an 80% success rate (0.2 probability of failure) (see *Figure 1*).

In general the effect of extra fire precautions will be to reduce the probability of a multiple fatality fire from P1 to P2 per annum. Let us call this reduction Δp. Let the average number of lives lost in a multiple fatality fire be N, plant or building life of fire precautions Y years, J_T is the interest time (or present worth or DCF factor) ΔC is the extra cost for a reduction of probability Δp, V is the medical opportunity cost of saving life by fire precautions versus the cost of saving life by medical means. D is the disaster premium referred to earlier. Then for cost effectiveness:

$$\Delta C < \Delta p . D . N . J_T . Y . V$$

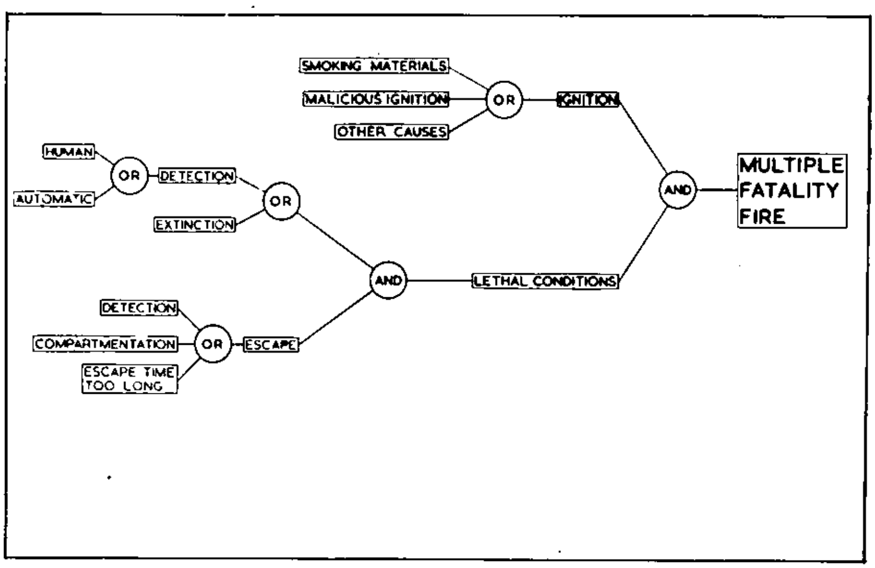


Figure 1. The Decision or Fault Tree (applied to a fire in a hospital ward).

Cost-Effective Fire Precautions and Equipment

The systems approach to fire precautions leads directly to the concept of trade-offs between different types of fire precautions aimed at maximising cost effectiveness. It has been suggested elsewhere[2] that active fire precautions, eg detectors etc, may be more cost effective in existing hospitals in the UK than extensive structural alteration.

Beyond optimising the application of existing technology there is still a need to develop cheaper and more cost effective methods. There are still financial restraints on the use of automatic detectors. There is also a need for higher reliability. The National Health Service and the DHSS have been in the forefront of encouraging the application and development of new and more cost effective fire detection and other fire protection systems. To give a few examples: the application of time division multiplexing to fire alarm systems; the STAMP smoke sampling system based on the UK Fire Research Station separated chamber ionisation detector; the Dorgard pneumatic door detente; the Harwell smoke detector tester.

Time Division Multiplexing Fire Alarm System

In a large fire alarm installation, particularly on a scattered site like a 19th Century British mental hospital, a major part of the total cost is in the wiring. Thus a system which substantially reduces the total wiring can substantially reduce total cost. Time division multiplexing[3] has been used widely in telemetry systems in chemical and similar plants. The basis of a time division multiplexing system is that instead of each fire alarm zone being connected back to the main control panel by two or more wires — as in a conventional system — a single two core cable is run around the site in a ring from zone to zone. The main control panel then puts on to the cable a series of pulses. Each zone is allotted a different time interval in which to 'reply' to the main control panel. A signal back to the main control panel is made by the zone unit modifying the pulse sent out by the main control unit. *See Figure 2.*

As can be seen from the diagram above the time occupied by each zone is very small and the whole system is scanned many times per second.

TDM and similar systems have been operating successfully in several British hospitals for some years.

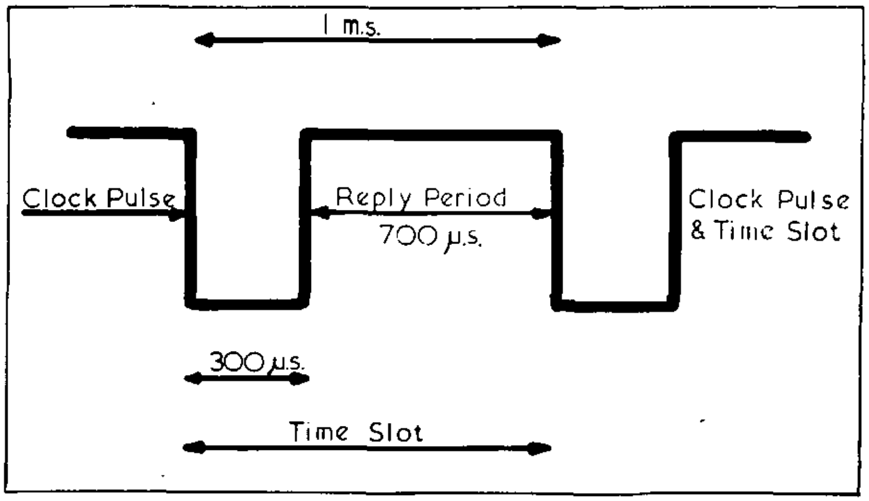


Figure 2. Time slot diagram.

STAMP Smoke Sampling System

The application of the STAMP smoke sampling system to the field of hospitals and residential homes is, in a way, the reverse of the TDM situation. The situation in residential homes and hostels is generally of a building with a large number of separate rooms. There is increasing evidence that delay in detection of fire by smoke detectors in an adjoining corridor may be unacceptably long. The fire may have developed to a dangerous state before it is detected. Unfortunately the cost of providing detectors in every room is unacceptably high. The cost of providing for every bedroom alone in a fifty-place home would be nearly £5,000.

A smoke sampling system, comprising both a central detector and a pump drawing smoke from the spaces to be protected, offers a potentially cheaper solution: once the central detector and control equipment have been purchased the marginal cost of extra rooms becomes merely the cost of extra tubing to connect to the central unit. There is nothing new about smoke sampling systems. They have been used on ships for many years. The problem in the past has been the dilution resulting from drawing smoke from a number of points and the lack of a sensitive smoke detector which can accept this dilution. This was overcome with the development of the separated chamber ionisation detector,[4] which was originally developed by the UK Fire Research Station as a standard instrument. It differs from the conventional ionisation smoke detector in having the ionisation source and the collector separated at opposite ends of, originally, a tube and now a spiral. The recombination zone is the length of the tube or spiral. This induces a time delay which produces, in principle, a sensitivity infinitely variable. The separated chamber ionisation detector is illustrated in *Figure 3.*

The STAMP system as at present developed will take up to 48 points. Blocks of four points are connected into each of 12 main tubes. These connect back to a 12-point sequencing unit which *samples each of the main tubes in turn.* The air (or smoke) then passes to the detector and then to the pump and exhaust. The system is shown in *Figure 4.*

The cost of the central control unit including sequencing unit is around £2,000. In comparison with a conventional detector system break even point is about twenty points. Beyond this the STAMP system rapidly becomes cheaper.

The Dorgard Pneumatic Door Detente System

A survey by Ramachandran and Langdon Thomas in 1965 showed that 45% of fire doors in institutional buildings

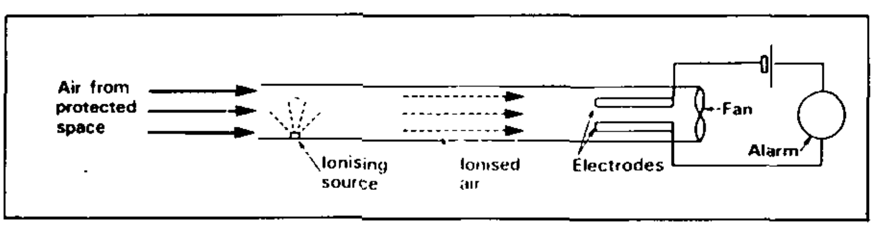


Figure 3. The separated chamber ionisation detector.

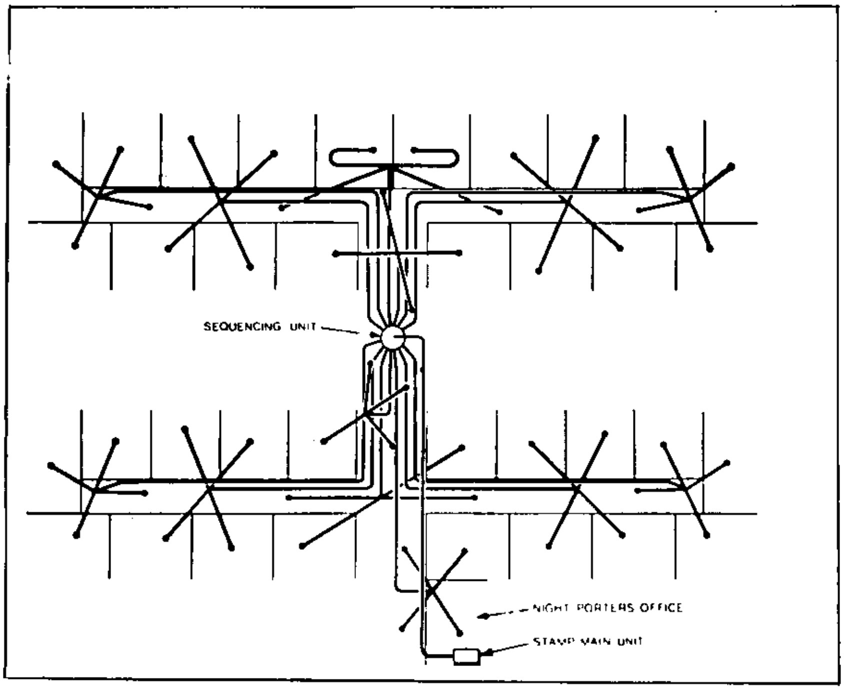


Figure 4. STAMP smoke sampling system. Smoke detection in an old people's home is achieved very simply with a STAMP system. The system can be fitted quickly and economically, with very little disruption to the smooth running of the home, providing greater safety for the occupants and staff.

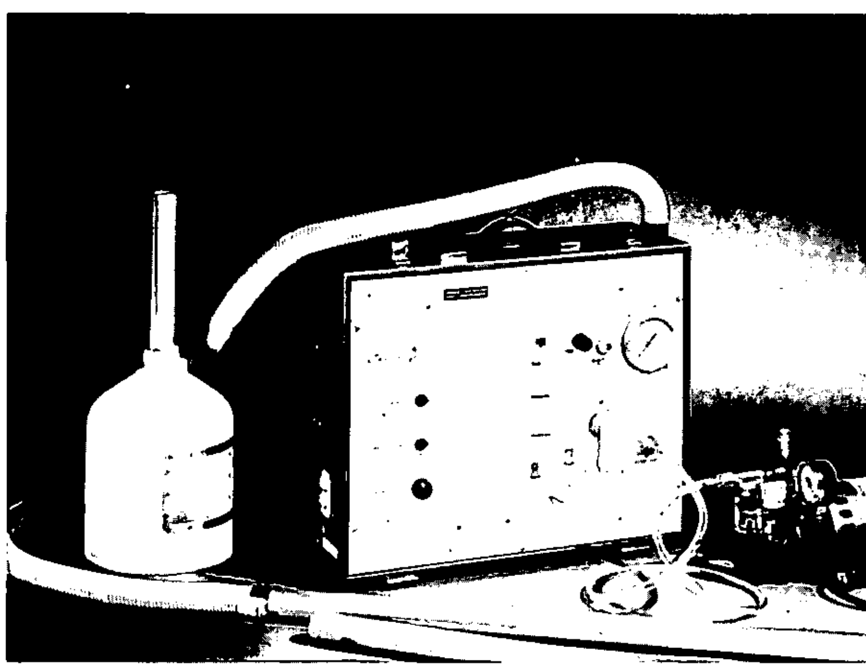
were left open. The problem was highlighted again in 1975 by the report of the committee of inquiry into the fire at Fairfield Home for the elderly at Edwalton, Nottinghamshire, England.

Door detentes of course overcome this problem by holding fire doors open and releasing them only in the event of fire. Conventionally these devices are electromagnetic with an electromagnet on the wall. They are expensive, however. A pair installed currently costs around £100, the main part of the cost being in the installation.

A pneumatic door detente comprising a ball fitted to the door and a pneumatically operated socket on the wall has been developed, which seems likely to offer a cheaper solution. The socket is held on by means of the pneumatic supply and in the event of a fire the pressure is released releasing the ball from the socket and hence allowing the door to close under the action of its closer. The pneumatic system has lower installation costs. Lower grade labour can be used to fit the nylon tubing used for the pneumatic system. In any case the installation is simpler. Furthermore, whereas the electromagnetic system consumes power continuously, once the pneumatic system is up to pressure the compressor operates only a couple of times per hour to maintain pressure. The system has been installed at a home for the elderly in Swindon but of course it has a much wider application, potentially, than only in residential homes.

The Harwell Smoke Detector Tester

The testing of smoke detectors, whilst not aimed directly at cutting the cost of fire precautions, is an integral part of a systems approach to fire precautions, as outlined earlier. In order to determine the optimum strategy we must know the reliability of detection systems. The probability of a detection system failure depends fundamentally on two factors: the inherent fault rate; and the test frequency. In the case of smoke detectors available tests have involved producing a smoke or smoke-like aerosol of unknown properties and blowing it at the detector. The UKAEA at Harwell, in association with the engineering division of DHSS and the UK Fire Research Station, has developed a smoke detector tester which produces an aerosol of known mass concentration and size distribution which can be related to smoke density. The mass concentration is also capable of being varied; and hence a range of simulated smoke densities can be produced. The essential component of the device is the nebuliser which, as its name implies, produces a nebula of droplets. This is driven from a compressor and draws up aerosol liquid, dioctyl phthalate (DOP) (a harmless substance used in filter testing), and blasts it against a ball which breaks it up into small droplets. There is a secondary air supply to give the right concentration; a filter to remove the large particles; and a bleed off system to facilitate variation in mass concentration. The device is shown in *Figure 5*.



Conclusion

An attempt has been made to describe an approach to fire precautions in health buildings which takes account of the wider context of the health service, but to show that accepting these restraints is not a negative approach. It used to be said in Britain that an engineer was someone who could do for five-and-a-half-pence what any fool could do for six-pence.

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[2]Woolliscroft, M. Detectors v Compartmentation Hospitals and Residential Homes. *Fire Surveyor 6 4 August 1977.*

[3]Wooton, R. Time Division Multiplexing for Fire Alarms. *Electrical Review 13 December 1974.*

[4]Kennedy, R. The Separated Ionisation Chamber Smoke Detector. Department of Environment Fire Research Station. *Fire Research Note.*

[5]Ramachandran, G. and Langdon Thomas, G. J. *The Fire Check door Building 1968* 2.141.(6512), pp 141, 2, 4.

Product News

Minicomputer-Based Pathology System

The pathology departments of six Australian hospitals are developing a reporting and patient identification system believed to be the first minicomputer-based system of its kind in the world.

The system is based on a Data General NOVA minicomputer and a computer programme written by Hospitals Computer Service at Monash University.

It processes the results of tests and prints cumulative reports on each patient.

Patients' records are stored in the computer and updated by the entering of data through visual display terminals in the laboratory and patient reception areas.

Dandenong and District Hospital, one of the latest hospitals to install the system, reports major increases in efficiency after only about two months of operation.

The cumulative reports produced at this hospital so far provide a biochemical and haematological history of its patients.

Eventually, with the development of a total laboratory system, microbiological and histopathological data will be included.

The system is designed entirely for patient care and is used for both inpatients and out-patients. In addition to cumulative patient reports, it also produces ward reports which provide the latest test results for patients in each ward at any time of the day or night. It also has facilities for direct result reading from many instruments into the processor via paper tape.

Hospital officials say the system has greatly reduced clerical work and the volume of paper records and made quality control easier. It has allowed laboratory staff to concentrate on tests instead of manually transcribing figures.

The officials say the staff are getting back to the job they were trained for — working at the laboratory bench on technology, including the proper evaluation of quality control before results are processed.

"The system has enabled us to cope with a workload during an expansion period and this would not have been possible using the old manual system," one official said.

The hospital's bed capacity was increased this year, with the opening of a new block, from 205 to 340. A recent survey showed the hospital is providing services to 203,000 people in five municipalities in the south-eastern suburbs of Melbourne and this is expected to rise to 300,000 by 1982.

The pathology department is at present using six visual display units and is planning to install two more in 18 months' time — one in medical records and one in the intensive care ward.

The configuration is a Data General NOVA 3/10 processor, 64K memory, two megabyte disc drives, six visual display units, one magnetic tape and one paper tape reader.

The programme has been modified for the various laboratories to accept minor changes in test code files.

Data General Corporation is one of the world's leading manufacturers of computers and peripherals including minicomputers, microcomputers and magnetic storage devices. The company's microNOVA, NOVA and ECLIPSE computer families are sold worldwide. Data General has manufacturing facilities in Southboro, Mass; Westbrook, Maine; Portsmouth, New Hampshire and Sunnyvale, California and assembly operations in the Far East.

For further information contact: Andrew Mackay, Hill and Knowlton (UK) Ltd, Swiss Centre, 10 Wardour Street, London W1V 3HG. Tel: 01-734 7617.

Theatres for Middle East

While the NHS is economising, Middle East countries are investing substantially in ultra-modern British operating theatre suites. This fact was revealed this week by Mr Simon Lovegrove, export sales manager of Medical Installations Co Ltd, recently returned from a two-week sales mission to Abu Dhabi, Kuwait and Egypt.

"At present we have contracts totalling more than £1 million from Middle East countries for the design and installation of our Medic operating theatre suites," he says. "They range from operating theatres for military hospitals through to a private hospital in Tunis".

The Medic operating theatre system itself, it is claimed, provides the ideal environment for the surgeon and theatre staff to work to optimum efficiency.

The help for this export success was provided by DHSS staffs advising Middle East medical authorities.

"There are many very competent DHSS staff, eg, regional health engineers, acting as advisors to Arab governments, and they are most helpful to UK companies like ourselves who have contracts out there".

However the key issue is undoubtedly the Medic system which centres on an octagonal igloo-shaped theatre that has all essential service units built-in to the wall panels, and ensures first-class air conditioning.

Besides the actual theatre, the Medic system encompasses all the ancilliary sterile, preparation, recovery rooms, etc, to comprise the whole operating suite. Moreover the system may be readily designed to replace old operating suites, or be added on to an existing hospital building to update the vital surgical facility.

"Replacing or adding new operating theatre suites in this way is obviously cost-saving," says Mr Lovegrove, "and this issue of costs is just as relevant in some countries in the Middle East as it is in the UK. I believe there is further potential for our exports to the Arab nations, as well as providing total operating departments in new hospitals".

Further details from: Medical Installations Co Ltd, West Street, Erith, Kent DA8 1AA.

Service Laboratory aids Asbestos Measurement

Both industrial and government employers are well aware of the health hazards created through the use of asbestos and asbestos-containing materials. These hazards have led to the development of sensitive sampling and analysis techniques to ensure that employees are not subjected to levels of airborne asbestos exceeding the adopter Threshold Limit Values.

Monitoring of working atmospheres and analysis of the collected materials can impose burdens on small organisations who have neither the equipment nor the qualified staff necessary to assess quickly and precisely the total employee exposure level. Where large numbers of samples require processing, the time-consuming and tedious job of repetitive microscopic analysis also creates high work loads, even in large industrial concerns.

To overcome the problems outlined above ASCA (Air Samples Count Analysis) of Staines, Middlesex, have set up a service laboratory equipped with an automatic image analyser fitted with a light pen facility for asbestos fibre counts of high magnification phase contrast microscopy, allowing samples to be analysed rapidly and accurately (ie, 24-hour service if required).

Fibres are selected on the basis of aspect ratio and size, stored in a peripheral minicomputer and automatically classified. As the last fibre is measured, results are formulated providing both statistical analysis and size distribution.

To complete the services offered, ASCA will undertake complete surveys including bulk and airborne sampling, slide preparation counting and analysis.

For further information contact: ASCA Ltd, 7a London Road, Staines, Middlesex.

The Mark IV King's Fund Bed

Nesbit Evans have introduced their new Mark IV King's Fund Bed, which replaces their highly successful Mark III, reputedly Britain's best selling King's Fund Bed.

The Mark IV is notably lighter in weight, and therefore more manoeuvrable. The weight-saving has been achieved largely by re-designing the undercarriage.

The manufacturers say that the new bed is easier to clean, and the surfaces are more accessible. All the mechanical parts are enclosed in a neat module slung underneath the undercarriage.

The bed continues to use an improved version of the foot-operated mechanical system developed and patented by the Nesbit Evans design team in the early '70s. It will be the only King's Fund Bed available that does not use a hydraulic pump.

It can be stored on its side to save space, if required, which cannot safely be done with a hydraulically operated bed.

No maintenance is required — only routine cleaning. The lifting mechanism is guaranteed for ten years, and samples have been tested to simulate 25 years' hospital use.

The bed can be raised and lowered more easily than either the previous scissor type bed, or any hydraulically operated bed, there is less bed-weight to raise, and the movement is smooth and circular. A charged damper, with a positive gas pressure, gives the nurse some power assistance in raising the bed.

On depressing the down pedal, the bed lowers itself slowly and safely.

In an orthopaedic situation, with foot up tilt, the Mark IV gives four-point mattress support, because of two tilt rods. All other King's Fund Beds have only one-point support at the foot end which can cause instability.

The bed is virtually silent in operation which can be important, particularly in geriatric wards and at night. A further help to simple, silent raising and lowering of the bed, even in pitch darkness, is provided by the luminous labels on the two independent 'up' and 'down' pedals.

There is a full range of accessories available for use with the Mark IV Bed, with improvements in the design and attachment of certain accessories.

This new Nesbit Evans Mark IV Kings' Fund Bed has been approved for the Health Service and is available on DHSS contract.

For further information, please contact: P. Beresford or D. Hughes. Tel: 021-556 1511/0119.

Line Marking

A cost-saving British invention for line marking, recently featured on BBC-tv's 'Tomorrow's World' programme is quickly replacing traditional and expensive methods of painting white or yellow lines in and around Britain's factories, warehouses and other premises, claim the manufacturers, Rocol Ltd.

Called 'Easyline', the new system costing less than £50 is already proving attractive in hospitals. Staff and emergency admission parking areas can be clearly identified, and confusion with visit parking areas avoided.

Where outpatients or visitors are required to walk from one building to another, routes can be marked on hard surface paths and repainted in very little time in heavy traffic areas.

Further information is available from Easyline Division, Rocol Ltd, Rocol House, Swillington, Leeds LS26 8BS. Tel: (0532) 866511.

Boiler Cleaning

Economix is a non-toxic free flowing powder formulated specially to loosen stubborn deposits from boiler plant heat transfer surfaces, and to minimise the sooty, corrosive formations throughout the system which reduce heat transfer efficiency.

It is stated to be able to clean boilers while they are actually operating, removing the need for shutdown of plant to remove the combustion deposits which occur when solid or liquid fuels are burned. Such deposits act as insulants on the heat transfer surfaces: the hot combustion gases become less turbulent and lose some of their ability to give up heat with consequent fuel wastage.

Economix helps to remove these deposits, giving increased fuel efficiency and thus a saving on fuel costs.

Further details of the surveys are avail- Chalbar Ltd, Efficiency Products, 247/249 Watling Street, Radlett, Herts WD7 7AL.

Energy Saving Technology

Colt International have three strategies for energy saving technology.

1. In Scheme Design — Software — Leaflet No 13 (burning cheque). The Wastemaster Energy Survey and Technology. Colt's Area Manager will carry out a detailed examination of buildings and processes with specific objective to reduce winter heating requirements to a minimum.

2. In Heating Hardware — Instant Changeover Dual Fuel Heater — Leaflet No 111. A versatile range of warm air heaters which give instant choice and reduced consumption of the cheapest fuel available with changeover between oil and gas firing at the flick of a switch.

Wastemaster Recirculation Units — By recirculating warm air to working level and reducing temperature gradients a Colt Wastemaster System saves valuable heat otherwise lost through the roof, whilst maintaining comfortable and productive working conditions.

Optimiser — Leaflet No 112 — Cuts waste by starting the pre-work warm-up period at just the right time to ensure optimum comfort conditions when work starts — but not before. So heat is not wasted on an empty building.

3. In Ventilation Hardware — Lowloss Seefire — A highly efficient louvred natural ventilator of advanced design, which enables summer comfort and productivity and incorporates special high efficiency seals to reduce winter heat loss by 75%. Also available: a kit to modify existing Seefire installations to reduce ventilation losses during the winter.

The Colt Conditionair — Improves the overall environment and protects people at work by effectively capturing dust and fume at source, then recirculating clean filtered air to the workplace. This saves heat otherwise lost in winter by wasteful air extraction.

Further details of all these products are available from Colt International Ltd, Havant, Hampshire PO9 2LY. Tel: 0705-451111.

COLT International

CI/SfB 1976 (56/57) (H6)
SIC XI

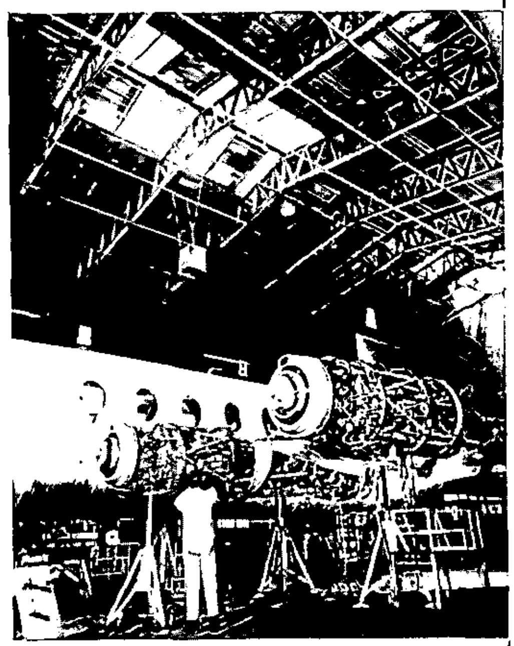
Leaflet No. CH/C/1

January 1978

Heating and Wastemaster Case History

Aviation Traders (Engineering) Ltd.

No. 1 Hangar, Stansted Airport, Essex.



Date	March 1976.
Customer's business	Maintenance and overhaul of aircraft and components. Independent company started 25 years ago, now subsidiary of Aer Lingus.
Building details	An aircraft hangar 97.5m x 37.18m. Roof height 8.83m to eaves, 11.73m to ridge. The roof is steel-trussed with unlined corrugated iron sheeting; glazed sections are arranged at intervals along the ridge.
Activity in building	Aircraft maintenance at one end, mezzanine floor workshops, stores and offices at other end. Areas divided by heavy plastic curtain.

Lexan Sheet

Trafford Area Health Authority have selected Lexan Polycarbonate Sheet for glazing the second and third floor levels of the Bridgewater Hospital at Eccles near Manchester.

These levels contain a psychiatric ward and the need arose to provide a high level of security without distressing the patients. Lexan sheet offers an extremely tough yet clear glazing material Which met these performance requirements and blended in well with the traditional glass at ground floor level.

Further details about Lexan Sheet are available from General Electric Engineering Polymers Ltd, Birchwood Park, Risley, Warrington, Cheshire WA3 6OA. Tel: 0925 811522.

Proplene Pipe

For applications throughout industry, and particularly for chemical, industrial, building, laboratory and hospital usage, Chemical Pipe & Vessel Co Ltd, have introduced metric pipe 250 mm and 280 mm (outside diameter) in heat-stabilised Propelene copolymer polypropylene.

There are two gauges, normal and heavy. The former is for drainage and light duty applications and the latter for up to 4 bar pressure pipe installations. Pipe is continuously extruded and is available in six metre lengths or special lengths to order. A matching range of fabricated fittings for pipework installations is available from CPV.

Because Proplene is highly corrosion-resistant, combining strength with lightness in weight, it can be used in most industries, being particularly suitable for chemical drainage and laboratories. It will maintain its strength up to 100°C, enabling it to convey such things as hot slurry and hot corrosive fluids etc. Its smooth bore assists flow and reduces the possibility of scale build-up.

Further details are available from: Chemical Pipe & Vessel Co Ltd, Frimley Road, Camberley, Surrey GU15 2QG. Tel: Camberley 64414.

Bedside Call Unit

Bedside nurse call and radio hand units probably suffer more breakages than most items of hospital equipment. To help reduce this problem, Cass Electronics are making swivel arms units available to all hospitals as a separate item of equipment.

The units are supplied with all the Cass hospital communication systems and have proved to be both reliable in performance and virtually unbreakable. Depending on whether or not the hospital has a speech programme in its communication systems, the swivel arm unit consists of on/off and programme selection buttons for the radio, a nurse call button, an earphone socket, a 'dim' light that enables the controls to be located easily in the dark, and a microphone loudspeaker. All cables are encased in the tubular arm; this swivels out of the way if doctors or nurses need access to the patient so nothing can suffer breakage or damage.

Another advantage of swivel arms over bed-head units is the ease with which they can be adjusted to the correct height for the patient.

Full information from Cass Electronics Limited, Crabtree Road, Thorpe, Surrey. Tel: Egham 6266.

Classified Advertisements

APPOINTMENTS AND SITUATIONS VACANT

MEDWAY

HEALTH DISTRICT

Medway District General Hospital, Gillingham, Kent

SENIOR ENGINEER

Candidates must possess the necessary qualifications as stated in the Whitley Council PTB conditions. The hospital also contains an ALAC area CSSD Laundry Accident Emergency Centre.

This post requires to be filled by a fully competent and experienced engineer and offers wide experience to the successful applicant.

A bonus scheme is currently being introduced in which the senior engineer will be required to participate.

Pay and conditions of service as per the PTB handbook. Open to male and female candidates.

Application forms and job description can be obtained from the District Works Officer, Medway Health District, Keycol Hospital, near Sittingbourne, Kent. Tel: Newington 842222. Closing date January 7, 1980.

DORSET AREA HEALTH AUTHORITY
EAST DORSET HEALTH CARE DISTRICT

ENGINEER

Required to assist the senior engineer in the organisation and maintenance of all engineering services at Christchurch Hospital and other associated units. Applicants should have completed an apprenticeship in Mechanical or Electrical Engineering or have otherwise acquired a thorough practical training and possess a minimum qualification of ONC in engineering or equivalent. A management qualification is also desirable together with a knowledge of planned preventive maintenance systems and their operation.

Salary scale £5,178-£5,784 with further enhancement pending.

In addition, an allowance (currently 15%), is payable for the satisfactory management of the tradesmens' incentive bonus scheme.

The successful candidate will be required to participate in an "on-call" rota.

Application forms and job description available from District Employment Officer, OMT Offices, Royal Victoria Hospital, Shelley Road, Boscombe, Bournemouth.

Closing date for receipt of completed applications December 21, 1979.

WAKEFIELD Area Health Authority — Eastern District (Pontefract) — Pontefract General Infirmary. ENGINEER. Salary scale £4,497 to £5,073 (under review). The holder is required to assist the Senior Engineer with engineering maintenance, operation programme and small capital works. Applicants must hold the Ordinary National Certificate in engineering or alternative acceptable qualification and have served an approved apprenticeship. Job description and application form to be returned by December 31, 1979 from District Administrator Churchill House, 29 Mill Hill, Pontefract WF8 4LD.

Central Public Health Laboratory

Senior Engineer

Senior Engineer required for the operation and maintenance of the engineering services and related building maintenance. Applicants must be experienced Maintenance Engineers and have a practical knowledge of boilers, mechanical and associated electrical equipment, with a knowledge of plumbing installations an advantage. HNC or City & Guilds in Engineering or equivalent qualifications. Whitley Council salary scale for Senior Hospital Engineers at present £5,336 rising by five annual increments to £6,116 inclusive of London Weighting.

For application form together with a more detailed job description please apply to Personnel Officer, Central Public Health Laboratory, Colindale Avenue, Colindale, London NW9 5HT. Telephone No. 01-205 7041.

LEWISHAM HEALTH DISTRICT

ENGINEERS

(2 posts)

(Male/female) required for this busy Health District. Although each post will either be based at the District Office or one of the hospitals, our Engineers are moved around the district to enable them to gain further experience. Possession of ONC Mechanical or Electrical or equivalent is required.

Salary: £5,532–£6,138 pa inclusive. A bonus scheme is pending.

Further details from the District Personnel Department, Lewisham Hospital, High Street, SE13 6LH. Telephone 01-690 4311, extension 344.

Closing date: December 21, 1979.

PROFESSIONAL Engineers' Services. Send for YOUR Trade Buying and Credit Reference Card today. Details from PES, Eden House, Maidstone, Kent ME14 1XL.

District Works Department

Two Engineering Officer Posts

To assist the Senior Engineer in each of two hospital sectors over the whole range of their duties.

(a) **Blackburn Royal Infirmary Sector** which is mainly a modern acute hospital with additional properties within its geographical location. The post offers a full range of engineering experience and training to the engineer who seeks a career grade structure opportunity in Hospital Engineering.

(b) **Brockhall Hospital Sector** formerly of single group status is mainly a large subnormal hospital set in approximately 200 acres of the Ribble Valley just off the A59 and 15 minutes from the M6. It contains extensive services, a large modern laundry, maintains all the District transport and has a large central boiler house and steam operated engine room. The boiler house is to be replaced commencing 1980 with a modern solid fuel fired installation. The successful applicant shall be offered a tenancy of a centrally heated estate dwelling.

Salary scale: £5,178–£5,784 plus 15% bonus allowance, on call payment and overtime as appropriate.

Applicants may apply for either or both positions but must possess either ONC/OND or equivalent Mechanical or Electrical certificates and have served an engineering apprenticeship.

Provision for day release to attain higher qualifications may be afforded suitable successful applicants.

Application forms and job description available from the District Personnel Office, District Offices, Queen's Park Hospital, Blackburn, Lancs. Tel: Blackburn 661311 Ext. 223/281.

Closing date: December 28, 1979.

BLACKBURN HEALTH DISTRICT

Lancashire Area Health Authority

SOUTHERN DISTRICT of the HIGHLAND HEALTH BOARD

SENIOR ENGINEER

Inverness

The Senior Engineer will be assisted by an Engineer and will be responsible to the District Engineering Officer for the engineering maintenance of Hilton and Culduthel Hospitals and a number of other properties in Inverness plus other small hospitals and/or other properties in East Ross-shire, Nairn, Strathspey and Badenoch.

The successful candidate will also be responsible for the Planner/Manager function in respect of the engineering planner/estimators involved in an incentive bonus scheme and for certain responsibilities in relation to the development of a District planned preventive maintenance scheme.

Salary — £5,628 per annum rising by five increments to £6,519. An incentive bonus scheme is currently being introduced and participating PTB staff are receiving a 10% allowance. The salary scale is currently under review.

Applicants must possess an HNC in Mechanical Engineering, Electrical or Electrical and Electronic Engineering or Engineering or City and Guilds Certificate No 293, 225, 57 or 281. Applicants may be required to hold other specified certificates.

For application form, job description, full list of properties and qualifications required, please write to or telephone The District Personnel Officer, Southern District — Highland Health Board, 14 Ardross Street, Inverness IV3 5NT. Tel No Inverness (0463) 32401 ext 44. Closing date for receipt of completed application forms is January 6, 1980.

Further information can be obtained from the District Engineering Officer, 28 Queensgate, Inverness. Tel No Inverness (0463) 221771.

WEST BIRMINGHAM HEALTH DISTRICT

Engineering Officer

(Contracts)

£4,497 to £5,073

(increase imminent)

Two experienced and suitably qualified Engineering Officers are required to assist the Senior Engineer (Contracts) in the provision of Engineering design/drawing for both electrical and mechanical works being undertaken by private contractors.

They will also be required to assist in the supervision of the works as they progress.

Applicants male or female, to this new post should ideally have the minimum qualification of ONC or other qualification approved by the DHSS.

Engineering Officer

(operational)

£4,497 to £5,073

(increase imminent)

Three experienced and suitably qualified Engineering Officers are required to assist the Senior Engineers who are responsible for the operation and Maintenance of Engineering plant and services, (mechanical and electrical), in this large District General Hospital carrying 1,357 beds.

Applicants, male or female, to these posts should have completed an apprenticeship and possess a minimum of ONC or other qualification approved by the DHSS.

Application forms and job description available from District Works Officer, Dudley Road Hospital, Birmingham B18 7OH. Telephone: 021 554 3801 ext. 4838.

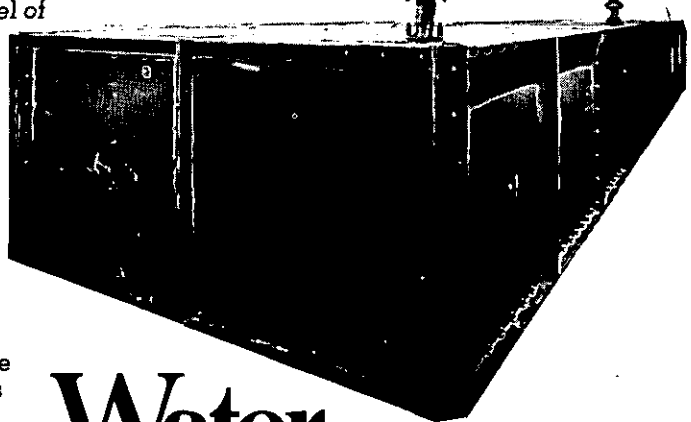
Please quote Ref: 206/HE.

Water...

No one would deny that Brinton's of Kidderminster is one of the UK's leading carpet manufacturers. They keep their high quality reputation by attention to detail—and one of those details is sophisticated and critical air *conditioning, necessary to maintain a proper level of* humidity, without which yarns would knot and tangle under the influence of static.

The space so humidified is 1181 x 656 feet (360 x 200m). Which means that a tank containing 20,000 gallons of demineralised water is necessary. And it so happens that access to the tank is extremely limited.

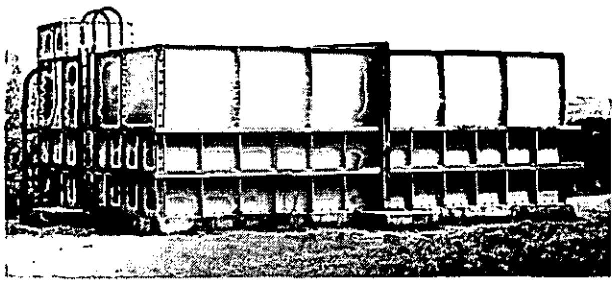
Brinton's installed a Hydroglas Sectional Water Tank for the purpose. Unique modular construction system and lightweight GRP panels meant that the tank could be constructed in situ. GRP also meant that, in spite of the humid atmosphere, the tank has remained corrosion-free with scarcely any maintenance in the seven years since installation.

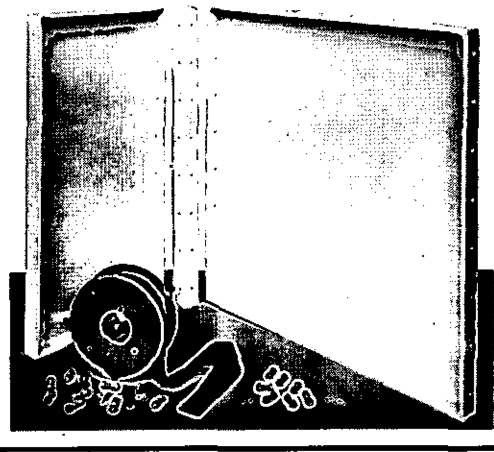


Water...

The Hydroglas tank at the popular Pontins Holiday Camp at Breen Sands presents a different story. Here we have an honest-to-goodness drinking water storage facility, which is vital to the efficient operation of the bustling camp. There just isn't time in the holiday season to plan a maintenance programme, and one thing the camp just can't afford is any question about the water supply.

The 19,000 gallon tank is exposed to all winds and weathers all the year round. But that's no problem to Hydroglas.





Anywhere

Brinton's and Pontins are by no means the most extre problems which Hydrogas Water Tanks by BTR Permali ha solve. They are in successful use from burning Middle Easi deserts to wind and rain-swept Lundy Island. Some are on mountain tops, some are buried underground.

So anywhere you need a tank which exhibits strength, durability, and ease of construction, Hydroglas is your best answer. Get in touch and find out more.

HYDROGLAS
WATER STORAGE TANKS

Full information, please, on immensely strong, lightweight Hydroglas Sectional Water Tanks.

Name ____________________

Position ____________________

Organisation ____________________

Address ____________________

____

BTR-Permali R P Ltd
Hydroglas Works
Bristol Road
Gloucester GL1 5TT
England

Telephone 0452 28671
Telex 43546